(* GSVD Comparative Analysis of Yeast and Human Cell Cycles *)

```
<< LinearAlgebra`MatrixManipulation`;
<< NumericalMath`TrigFit`;
<< Graphics`Graphics`;
<< Graphics`Arrow`;
Off[General::"spell"]; Off[General::"spell1"];
```

```
(* Define HardDrive *)

name = "Marzipan";

(* Read Yeast Data *)

stream = StringJoin[name, ":Desktop Folder:PNAS Data:Yeast.txt"];
matrix = ReadList[stream, Word, RecordLists -> True, NullWords -> True];
{genes, arrays} = Dimensions[matrix] - {2, 6}
Clear[stream];
```

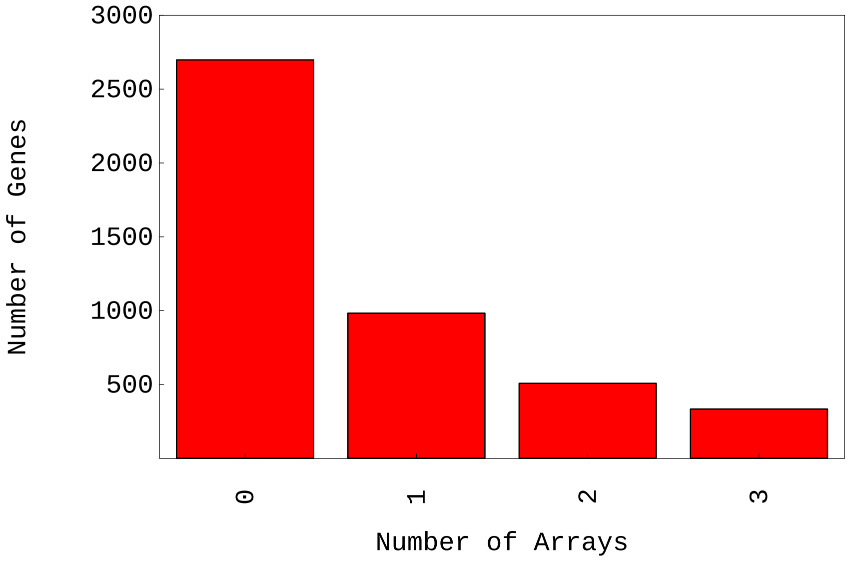
```
{4523, 18}
```

```
genenames = TakeRows[
   TakeColumns[matrix, {1, 6}],
   {3, genes + 2}];
arraynames = TakeColumns[
   TakeRows[matrix, {1, 2}],
   {7, arrays + 6}];
matrix = TakeColumns[
   TakeRows[matrix, {3, genes + 2}],
   {7, arrays + 6}];
matrix = ToExpression[matrix];

sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[arraynames[[2, a]]
      ]]],
    {a, 1, arrays}]];
size = Sort[sizes, OrderedQ[{#2, #1}] &][[1]];
Do[
  Do[arraynames[[2, a]] = StringJoin[ToString[arraynames[[2, a]]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, arrays}];
```

(* Estimate Missing Yeast Data Using SVD *)

```
(* Count Null Data *)

counter = Table[Dimensions[Position[matrix[[a]], Null]][[1]], {a, 1, genes}];
```

```
(* Locate Gene Position of Null Data *)

Clear[positions];
positions = Table[0, {a, 1, arrays + 1}];
Do[
  positions[[a]] = Flatten[
    Position[Flatten[counter], a - 1]],
  {a, 1, arrays + 1}];
numbers = Flatten[
   Table[
    Dimensions[positions[[a]]],
    {a, 1, Round[arrays * 0.2]}]];

(* Create Display Of Gene Position Of Null Data *)

framex = Table[{a, a - 1}, {a, 1, Round[arrays * 0.2]}];
framey = {500, 1000, 1500, 2000, 2500, 3000};
labelx = ColumnForm[{"Number of Arrays"}, Center];
labely = ColumnForm[{"Number of Genes"}, Center];
g = BarChart[numbers,
   Frame -> True,
   Axes -> False,
   FrameLabel -> {labelx, labely, None, None},
   FrameTicks -> {framex, framey, None, None},
   GridLines -> {None, None},
   PlotRange -> {{0.5, Round[arrays * 0.2] + 0.5}, {0, 3000}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 0.75, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., 1.}] →
    Text[labelx, {b, c - 400}, {0, 1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., 1.}] →
    Text[a, {b, c - 200}, {0, 0}, {0, 1}];

(* Display Gene Position Of Null Data *)

Show[g, PlotRange -> All];
```



```
(* Select Genes by Number of Missing Data Points *)

matrix = AppendRows[Table[{counter[[a]]}, {a, 1, genes}], genenames, matrix];
matrix = Sort[matrix, OrderedQ[{#1, #2}] &];
fullgenenames = TakeColumns[
   TakeRows[matrix, {1, numbers[[1]]}],
   {2, 7}];
fullmatrix = TakeColumns[
   TakeRows[matrix, {1, numbers[[1]]}],
   {8, arrays + 7}];
missinggenenames1 = TakeColumns[
   TakeRows[matrix, {numbers[[1]] + 1, numbers[[1]] + numbers[[2]]}],
   {2, 7}];
missingmatrix1 = TakeColumns[
   TakeRows[matrix, {numbers[[1]] + 1, numbers[[1]] + numbers[[2]]}],
   {8, arrays + 7}];
missinggenenames2 = TakeColumns[
   TakeRows[matrix,
    {numbers[[1]] + numbers[[2]] + 1,
     numbers[[1]] + numbers[[2]] + numbers[[3]]}],
   {2, 7}];
missingmatrix2 = TakeColumns[
   TakeRows[matrix,
    {numbers[[1]] + numbers[[2]] + 1,
     numbers[[1]] + numbers[[2]] + numbers[[3]]}],
   {8, arrays + 7}];
missinggenenames3 = TakeColumns[
   TakeRows[matrix,
    {numbers[[1]] + numbers[[2]] + numbers[[3]] + 1,
     numbers[[1]] + numbers[[2]] + numbers[[3]] + numbers[[4]]}],
   {2, 7}];
missingmatrix3 = TakeColumns[
   TakeRows[matrix,
    {numbers[[1]] + numbers[[2]] + numbers[[3]] + 1,
     numbers[[1]] + numbers[[2]] + numbers[[3]] + numbers[[4]]}],
   {8, arrays + 7}];

(* Locate Array Position of Null Data *)

locator1 = Table[0, {numbers[[2]]}];
Do[
  locator1[[a]] = locator1[[a]] + Flatten[Position[missingmatrix1[[a]], Null]],
  {a, 1, numbers[[2]]}];
locator2 = Table[0, {numbers[[3]]}];
Do[
  locator2[[a]] = locator2[[a]] + Flatten[Position[missingmatrix2[[a]], Null]],
  {a, 1, numbers[[3]]}];
locator3 = Table[0, {numbers[[4]]}];
Do[
  locator3[[a]] = locator3[[a]] + Flatten[Position[missingmatrix3[[a]], Null]],
  {a, 1, numbers[[4]]}];
```

```
(* Sort Raw Elutriation Data According to the Position of Missing Data Points for Each Gene *)

missingmatrix1 = AppendRows[locator1, missinggenenames1, missingmatrix1];
missingmatrix1 = Sort[missingmatrix1, OrderedQ[{#1, #2}] &];
locator1 = TakeColumns[missingmatrix1, {1, 1}];
missinggenenames1 = TakeColumns[missingmatrix1, {2, 7}];
missingmatrix1 = TakeColumns[missingmatrix1, {8, arrays + 7}];
missingmatrix2 = AppendRows[locator2, missinggenenames2, missingmatrix2];
missingmatrix2 = Sort[missingmatrix2, OrderedQ[{#1, #2}] &];
locator2 = TakeColumns[missingmatrix2, {1, 2}];
missinggenenames2 = TakeColumns[missingmatrix2, {3, 8}];
missingmatrix2 = TakeColumns[missingmatrix2, {9, arrays + 8}];
missingmatrix3 = AppendRows[locator3, missinggenenames3, missingmatrix3];
missingmatrix3 = Sort[missingmatrix3, OrderedQ[{#1, #2}] &];
locator3 = TakeColumns[missingmatrix3, {1, 3}];
missinggenenames3 = TakeColumns[missingmatrix3, {4, 9}];
missingmatrix3 = TakeColumns[missingmatrix3, {10, arrays + 9}];

(* Examine Subset of Genes with Full Data *)

(* Calculate SVD *)

{eigenarrays, eigenexpressions, eigengenes} = SingularValues[fullmatrix];
eigenarrays = Transpose[eigenarrays];
fractions = eigenexpressions^2 / Sum[eigenexpressions[[a]]^2, {a, 1, arrays}];
entropy = -N[Sum[fractions[[a]] * Log[fractions[[a]]], {a, 1, arrays}] / Log[arrays]];
entropy = N[Round[100 * entropy] / 100]

0.17

(* Create Fractions Bar Charts Displays *)

fractions[[3]]

0.00817395

limit = 0.01;

Clear[gridx, framex, framey, sizes];
gridx = Table[a, {a, 0, limit, N[limit / 5]}];
framex = gridx;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[framex[[a]]
      ]]], {a, 1, 6}]];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " "],
   {b, 1, 5 - sizes[[a]]}],
  {a, 1, 6}];
framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 6}];
gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 6}];
framey = Table[{a + 1, arrays - a - 6}, {a, 0, 12 - 3}];
table = Table[fractions[[arrays - a]], {a, 6, arrays - 3}];
```

```
g = BarChart[table,
   BarOrientation -> Horizontal,
   PlotRange -> {{0, limit * 1.0001}, {0.5, 12 - 2 + 0.5}},
   AspectRatio -> 1,
   Axes -> False,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, None, None, None},
   GridLines -> {gridx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 1.75}, {0, 0}, {0, 1}];
g1 = Show[g,
   AspectRatio -> 1.25,
   PlotRange -> All,
   DisplayFunction -> Identity];

gridx = Table[a, {a, 0, 1, 0.2}];
framex = gridx;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[framex[[a]]
      ]]], {a, 1, 6}]];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, 6}];
framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 6}];
gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 6}];
framey = Table[{a + 1, arrays - a}, {a, 0, arrays - 1}];
labelx = ColumnForm[
   {"(b) Eigenexpression Fraction", StringJoin["d′1 = ", ToString[entropy]], " "},
   Center];
g = BarChart[
   Table[fractions[[arrays - a]], {a, 0, arrays - 1}],
   BarOrientation -> Horizontal,
   PlotRange -> {{0, 1.0001}, {0.5, arrays + 0.5}},
   AspectRatio -> 1,
   Axes -> False,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, None, labelx, None},
   GridLines -> {gridx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 2.7}, {0, 0}, {0, 1}];
g2 = Show[{g,
    Graphics[{RGBColor[1, 1, 0.8], Rectangle[{0.1, 0.6}, {0.98, 16.6}]}],
    Graphics[{Rectangle[{0.1, 0.6}, {0.98, 16.6}, g1]}]},
   AspectRatio -> 1.35,
   PlotRange -> All,
   DisplayFunction -> Identity];
```

```
(* Create Eigengenes 2 D Red & Green Raster Display *)

contrast = 3.5;
displaying = Table[
   If[contrast * eigengenes[[i, j]] > 0,
    If[contrast * eigengenes[[i, j]] < 1, {contrast * eigengenes[[i, j]], 0}, {1, 0}],
    If[contrast * eigengenes[[i, j]] > -1, {0, -contrast * eigengenes[[i, j]]}, {0, 1}]],
   {i, 1, arrays}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
framey = Table[{a + 1 - 0.5, arrays - a}, {a, 0, arrays - 1}];
labely = "Eigengenes";
labelx = ColumnForm[{"(a) Arrays", " ", " "}, Center];

g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, arrays, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 3, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 2.7}, {0, 0}, {0, 1}];
g1 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction -> Identity];

(* Create Selected Eigengenes Graph Display *)

eigengenes3 = Chop[TrigFit[Drop[eigengenes[[3]], {1}], 2, {x - 1, arrays - 1}], 0.15]
eigengenes4 = Chop[TrigFit[Drop[eigengenes[[4]], {1}], 2, {x - 1, arrays - 1}], 0.15]
eigengenes5 = Chop[TrigFit[Drop[eigengenes[[5]], {1}], 2, {x - 1, arrays - 1}], 0.15]
```

$$-0.152794\,\mathrm{Cos}\left[\frac{2}{17}\pi\,(-1+x)\right]-0.154139\,\mathrm{Sin}\left[\frac{2}{17}\pi\,(-1+x)\right]-0.197288\,\mathrm{Sin}\left[\frac{4}{17}\pi\,(-1+x)\right]$$

$$-0.263474\,\mathrm{Cos}\left[\frac{4}{17}\pi\,(-1+x)\right]$$

$$0.157833\,\mathrm{Cos}\left[\frac{4}{17}\pi\,(-1+x)\right]-0.204812\,\mathrm{Sin}\left[\frac{4}{17}\pi\,(-1+x)\right]$$

```
eigengenes3 = -Sqrt[2 / 3 / 17.] * Sin[4 * Pi * (x - 1) / 17] - Sqrt[2 / 3 / 17.] * Sin[2 * Pi * (x - 1) / 17 + Pi / 4];
eigengenes4 = -Sqrt[2 / 17.] * Cos[4 * Pi * (x - 1) / 17];
eigengenes5 = Sqrt[2 / 17.] * Cos[4 * Pi * (x - 1) / 17 + Pi / 4];
```

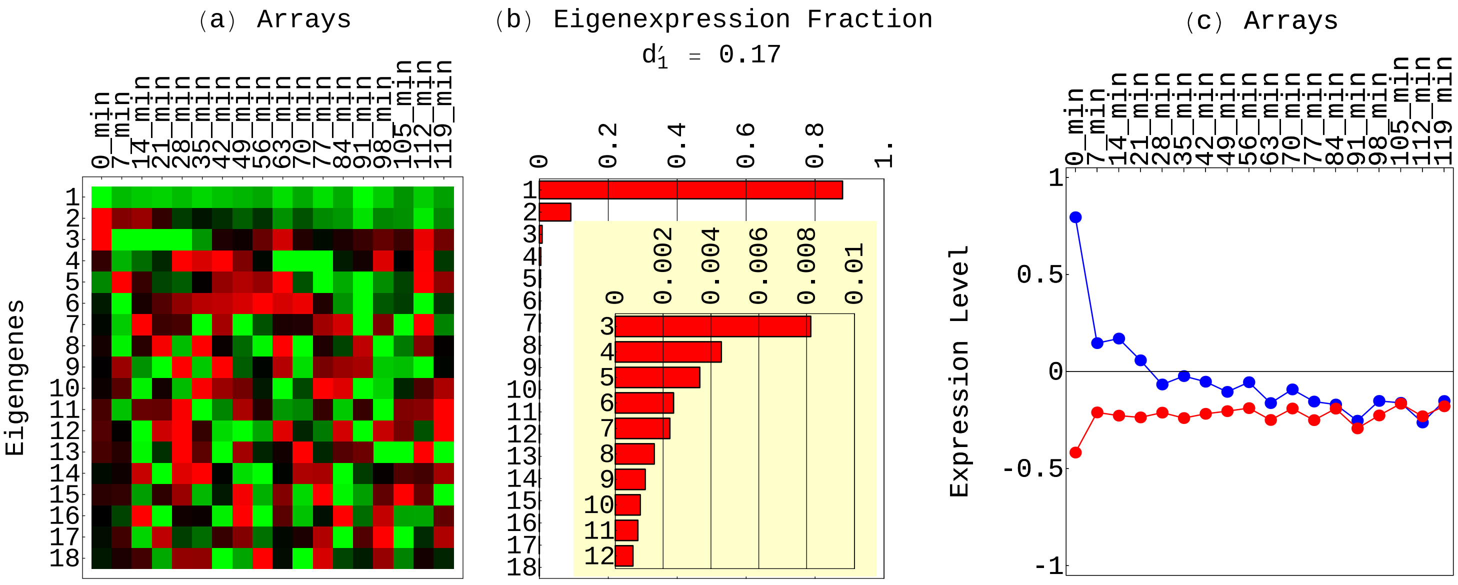
```
labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[1, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[1, 0, 0], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p1 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];

labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[2, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0, 1], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p2 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
graph = Plot[eigengenes3,
   {x, 1, arrays - 1},
   PlotStyle -> {RGBColor[1, 0, 0], Dashing[{0.03, 0.02}]},
   DisplayFunction -> Identity];
labelx = ColumnForm[{"(d) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[3, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[1, 0, 0], line}],
    graph,
    Graphics[{RGBColor[1, 0, 0], Text["-√(2/(3 T)) [sin(2 πt/T + π/4) +", {6.5, 0.75}]}],
    Graphics[{RGBColor[1, 0, 0], Text["sin(4 πt/T)] ", {13.5, 0.5}]}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p3 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity,
   DisplayFunction → Identity];
```

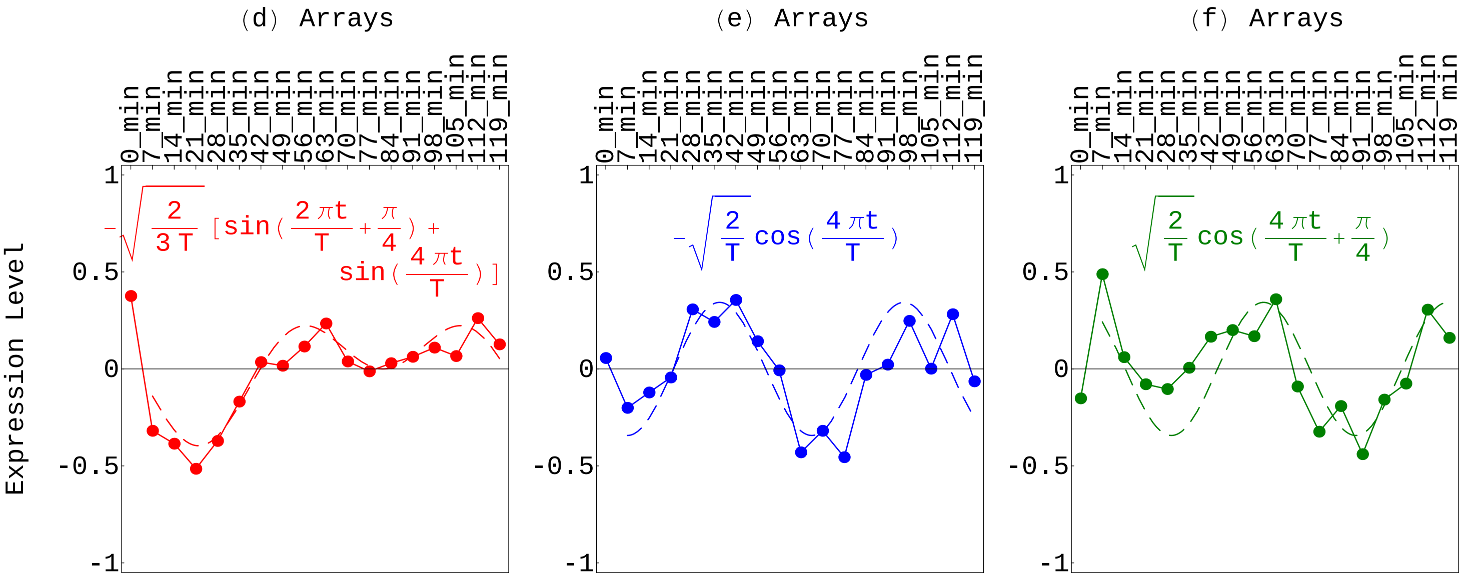
```
graph = Plot[eigengenes4,
   {x, 1, arrays - 1},
   PlotStyle -> {RGBColor[0, 0, 1], Dashing[{0.03, 0.02}]},
   DisplayFunction -> Identity];
labelx = ColumnForm[{"(e) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[4, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0, 1], line}],
    graph,
    Graphics[{RGBColor[0, 0, 1], Text["-√(2/T) cos(4 πt/T) ", {8.5, 0.7}]}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p4 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
graph = Plot[eigengenes5,
   {x, 1, arrays - 1},
   PlotStyle -> {RGBColor[0, 0.5, 0], Dashing[{0.03, 0.02}]},
   DisplayFunction -> Identity];
labelx = ColumnForm[{"(f) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[5, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0.5, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0.5, 0], line}],
    graph,
    Graphics[{RGBColor[0, 0.5, 0], Text["√(2/T) cos(4 πt/T + π/4) ", {8.5, 0.7}]}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p5 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Display Selected Eigengenes *)

g3 = Show[{p2, p1},
   DisplayFunction -> Identity];

(* Display Eigengenes, Fractions and Selected Eigengenes *)

Show[GraphicsArray[{g1, g2, g3}],
  GraphicsSpacing -> -0.15];
```



```
Show[GraphicsArray[{p3, p4, p5}],
  GraphicsSpacing -> -0.15];
```



```
(* Choose Subset of Eigengenes for Estimation *)

eigengenes = TakeRows[eigengenes, {1, 5}];

(* Estimate Missing Data *)

Do[
 missingmatrix1[[a, locator1[[a, 1]]]] =
  N[Round[Flatten[Dot[Dot[
          Transpose[Drop[
            Transpose[{missingmatrix1[[a]]}],
            {locator1[[a, 1]]}]],
          PseudoInverse[Transpose[Drop[
             Transpose[eigengenes],
             {locator1[[a, 1]]}]]]],
         eigengenes]][[locator1[[a, 1]]]] * 100] / 100],
 {a, 1, numbers[[2]]}]

Do[Do[
  missingmatrix2[[a, locator2[[a, b]]]] =
   N[Round[Flatten[Dot[Dot[
           Transpose[Drop[Drop[
              Transpose[{missingmatrix2[[a]]}],
              {locator2[[a, 2]]}], {locator2[[a, 1]]}]],
           PseudoInverse[Transpose[Drop[Drop[
               Transpose[eigengenes],
               {locator2[[a, 2]]}], {locator2[[a, 1]]}]]]],
          eigengenes]][[locator2[[a, b]]]] * 100] / 100],
  {b, 1, 2}],
 {a, 1, numbers[[3]]}]

Do[Do[
  missingmatrix3[[a, locator3[[a, b]]]] =
   N[Round[Flatten[Dot[Dot[
           Transpose[Drop[Drop[Drop[
               Transpose[{missingmatrix3[[a]]}],
               {locator3[[a, 3]]}], {locator3[[a, 2]]}], {locator3[[a, 1]]}]],
           PseudoInverse[Transpose[Drop[Drop[Drop[
                Transpose[eigengenes],
                {locator3[[a, 3]]}], {locator3[[a, 2]]}], {locator3[[a, 1]]}]]]],
          eigengenes]][[locator3[[a, b]]]] * 100] / 100],
  {b, 1, 3}],
 {a, 1, numbers[[4]]}]

genenames = AppendColumns[
   fullgenenames,
   missinggenenames1,
   missinggenenames2,
   missinggenenames3];
matrix = AppendColumns[
   fullmatrix,
   missingmatrix1,
   missingmatrix2,
   missingmatrix3];
{genes, arrays} = Dimensions[matrix];
matrix1 = matrix;
genenames1 = genenames;
arraynames1 = arraynames;
{genes1, arrays1} = Dimensions[matrix1]

{4523, 18}
```

```
(* Examine Yeast Data After Missing Data Estimation *)

(* Calculate SVD *)

{eigenarrays, eigenexpressions, eigengenes} = SingularValues[matrix];
eigengenes[[3]] = -eigengenes[[3]];
eigengenes[[4]] = -eigengenes[[4]];
eigengenes[[5]] = -eigengenes[[5]];
eigenarrays = Transpose[eigenarrays];
fractions = eigenexpressions^2 / Sum[eigenexpressions[[a]]^2, {a, 1, arrays}];
entropy = -N[Sum[fractions[[a]] * Log[fractions[[a]]], {a, 1, arrays}] / Log[arrays]];
entropy = N[Round[100 * entropy] / 100]
```

```
0.17
```

```
(* Create Fractions Bar Charts Displays *)

fractions[[3]]
```

```
0.0089566
```

```
limit = 0.01;

Clear[gridx, framex, framey, sizes];
gridx = Table[a, {a, 0, limit, N[limit / 5]}];
framex = gridx;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[framex[[a]]
      ]]], {a, 1, 6}]];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " "],
   {b, 1, 5 - sizes[[a]]}],
  {a, 1, 6}];
framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 6}];
gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 6}];
framey = Table[{a + 1, arrays - a - 6}, {a, 0, 12 - 3}];
table = Table[fractions[[arrays - a]], {a, 6, arrays - 3}];
g = BarChart[table,
   BarOrientation -> Horizontal,
   PlotRange -> {{0, limit * 1.0001}, {0.5, 12 - 2 + 0.5}},
   AspectRatio -> 1,
   Axes -> False,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, None, None, None},
   GridLines -> {gridx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 1.75}, {0, 0}, {0, 1}];
g1 = Show[g,
   AspectRatio -> 1.25,
   PlotRange -> All,
   DisplayFunction -> Identity];
```

```
gridx = Table[a, {a, 0, 1, 0.2}];
framex = gridx;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[framex[[a]]
      ]]], {a, 1, 6}]];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, 6}];
framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 6}];
gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 6}];
framey = Table[{a + 1, arrays - a}, {a, 0, arrays - 1}];
labelx = ColumnForm[
   {"(b) Eigenexpression Fraction", StringJoin["d1  = ", ToString[entropy]], " "},
   Center];
g = BarChart[
   Table[fractions[[arrays - a]], {a, 0, arrays - 1}],
   BarOrientation -> Horizontal,
   PlotRange -> {{0, 1.0001}, {0.5, arrays + 0.5}},
   AspectRatio -> 1,
   Axes -> False,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, None, labelx, None},
   GridLines -> {gridx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 2.7}, {0, 0}, {0, 1}];
g2 = Show[{g,
    Graphics[{RGBColor[1, 1, 0.8], Rectangle[{0.1, 0.6}, {0.98, 16.6}]}],
    Graphics[{Rectangle[{0.1, 0.6}, {0.98, 16.6}, g1]}]},
   AspectRatio -> 1.35,
   PlotRange -> All,
   DisplayFunction -> Identity];

(* Create Eigengenes 2 D Red & Green Raster Display *)

contrast = 3.5;
displaying = Table[
   If[contrast * eigengenes[[i, j]] > 0,
    If[contrast * eigengenes[[i, j]] < 1, {contrast * eigengenes[[i, j]], 0}, {1, 0}],
    If[contrast * eigengenes[[i, j]] > -1, {0, -contrast * eigengenes[[i, j]]}, {0, 1}]],
   {i, 1, arrays}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
framey = Table[{a + 1 - 0.5, arrays - a}, {a, 0, arrays - 1}];
labely = "Eigengenes";
labelx = ColumnForm[{"(a) Arrays", " ", " "}, Center];
```

```
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, arrays, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 3, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 2.7}, {0, 0}, {0, 1}];
g1 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction -> Identity];
```

```
(* Create Selected Eigengenes Graph Display *)
```

```
eigengenes3 = Chop[TrigFit[Drop[eigengenes[[3]], {1}], 2, {x - 1, arrays - 1}], 0.15]
eigengenes4 = Chop[TrigFit[Drop[eigengenes[[4]], {1}], 2, {x - 1, arrays - 1}], 0.15]
eigengenes5 = Chop[TrigFit[Drop[eigengenes[[5]], {1}], 2, {x - 1, arrays - 1}], 0.15]
```

$$-0.221702\,\mathrm{Sin}\left[\frac{4}{17}\,\pi\,(-1+x)\right]$$

$$-0.262143\,\mathrm{Cos}\left[\frac{4}{17}\,\pi\,(-1+x)\right]$$

$$0.158409\,\mathrm{Cos}\left[\frac{4}{17}\,\pi\,(-1+x)\right]-0.194379\,\mathrm{Sin}\left[\frac{4}{17}\,\pi\,(-1+x)\right]$$

```
eigengenes3 = -Sqrt[2 / 3 / 17.] * Sin[4 * Pi * (x - 1) / 17] - Sqrt[2 / 3 / 17.] * Sin[2 * Pi * (x - 1) / 17 + Pi / 4];
eigengenes4 = -Sqrt[2 / 17.] * Cos[4 * Pi * (x - 1) / 17];
eigengenes5 = Sqrt[2 / 17.] * Cos[4 * Pi * (x - 1) / 17 + Pi / 4];
```

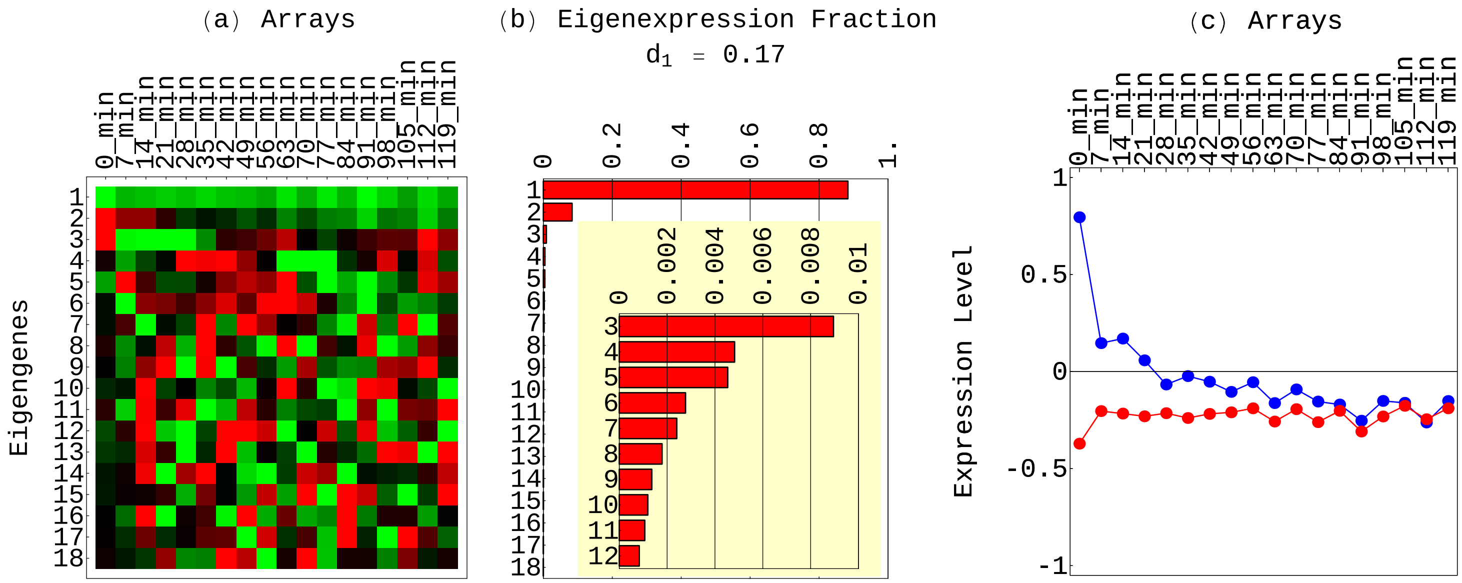
```
labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[1, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[1, 0, 0], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p1 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];

labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[2, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0, 1], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {{{17.5, RGBColor[0, 0, 0]}, {19.5, RGBColor[0, 0, 0]}}, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p2 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
graph = Plot[eigengenes3,
   {x, 1, arrays - 1},
   PlotStyle -> {RGBColor[1, 0, 0], Dashing[{0.03, 0.02}]},
   DisplayFunction -> Identity];
labelx = ColumnForm[{"(d) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[3, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[1, 0, 0], line}],
    graph,
    Graphics[{RGBColor[1, 0, 0], Text["-√(2/(3 T)) [sin(2 πt/T + π/4) +", {6.5, 0.75}]}],
    Graphics[{RGBColor[1, 0, 0], Text["sin(4 πt/T)] ", {13.5, 0.5}]}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p3 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity,
   DisplayFunction → Identity];
```

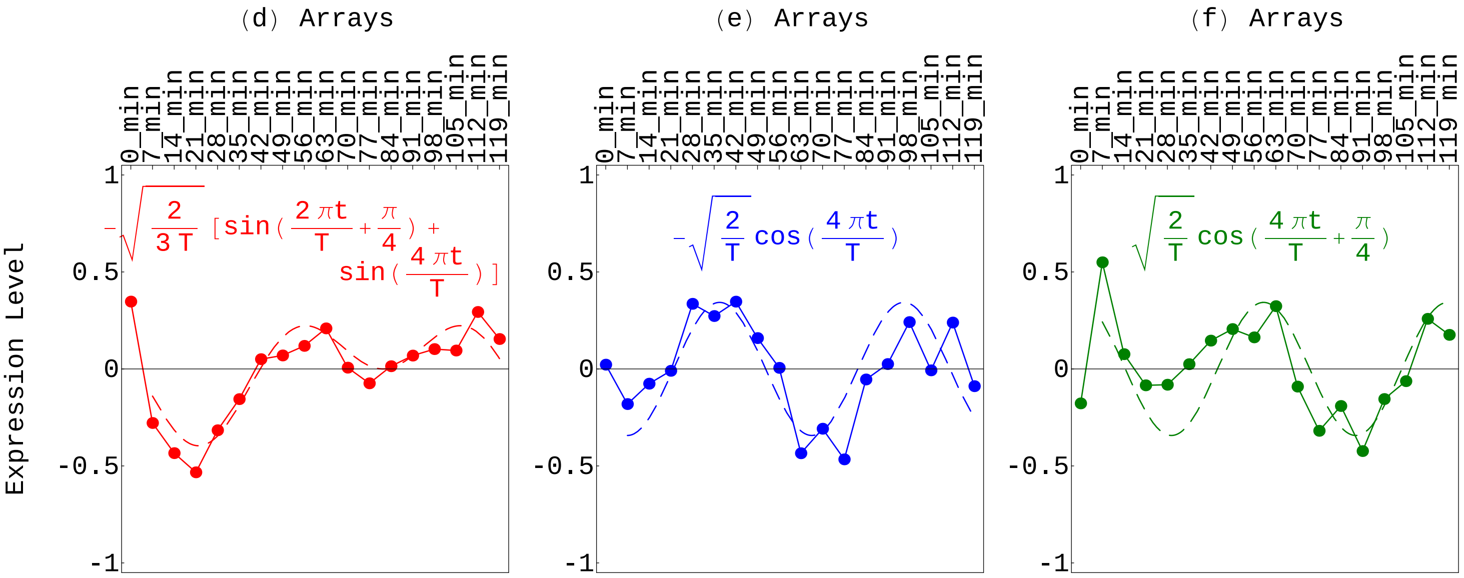
```
graph = Plot[eigengenes4,
   {x, 1, arrays - 1},
   PlotStyle -> {RGBColor[0, 0, 1], Dashing[{0.03, 0.02}]},
   DisplayFunction -> Identity];
labelx = ColumnForm[{"(e) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[4, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0, 1], line}],
    graph,
    Graphics[{RGBColor[0, 0, 1], Text["-√(2/T) cos(4πt/T)", {8.5, 0.7}]}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p4 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
graph = Plot[eigengenes5,
   {x, 1, arrays - 1},
   PlotStyle -> {RGBColor[0, 0.5, 0], Dashing[{0.03, 0.02}]},
   DisplayFunction -> Identity];
labelx = ColumnForm[{"(f) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[5, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0.5, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0.5, 0], line}],
    graph,
    Graphics[{RGBColor[0, 0.5, 0], Text["√(2/T) cos(4πt/T + π/4) ", {8.5, 0.7}]}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p5 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Display Selected Eigengenes *)

g3 = Show[{p2, p1},
   DisplayFunction -> Identity];

(* Display Eigengenes, Fractions and Selected Eigengenes *)

Show[GraphicsArray[{g1, g2, g3}],
  GraphicsSpacing -> -0.15];
```



```
Show[GraphicsArray[{p3, p4, p5}],
  GraphicsSpacing -> -0.15];
```



```
(* Read Human Data *)

stream = StringJoin[name, ":Desktop Folder:PNAS Data:Human.txt"];
matrix = ReadList[stream, Word, RecordLists -> True, NullWords -> True];
{genes, arrays} = Dimensions[matrix] - {2, 5}
Clear[stream];
```

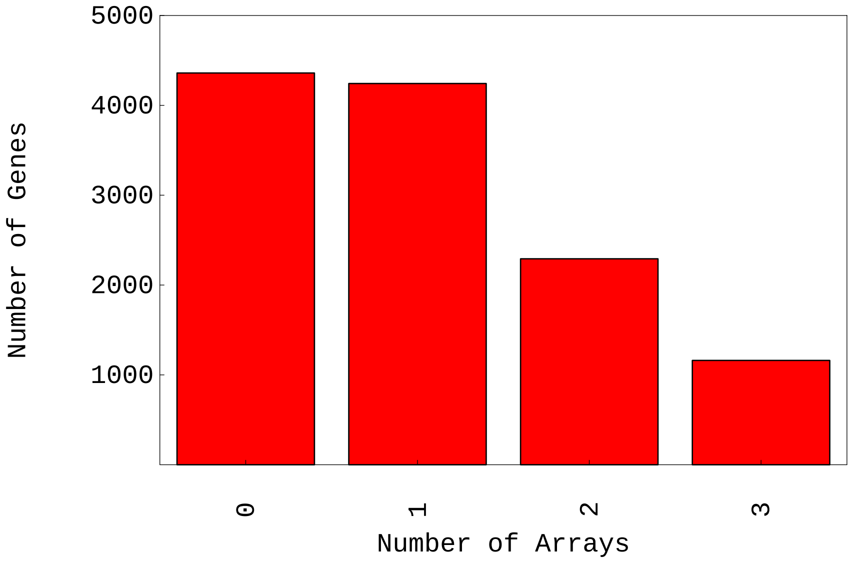
```
{12056, 18}
```

```
genenames = TakeRows[
   TakeColumns[matrix, {1, 5}],
   {3, genes + 2}];
arraynames = TakeColumns[
   TakeRows[matrix, {1, 2}],
   {6, arrays + 5}];
matrix = TakeColumns[
   TakeRows[matrix, {3, genes + 2}],
   {6, arrays + 5}];
matrix = ToExpression[matrix];

sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[arraynames[[2, a]]
      ]]], {a, 1, arrays}]];
size = Sort[sizes, OrderedQ[{#2, #1}] &][[1]];
Do[
  Do[arraynames[[2, a]] = StringJoin[ToString[arraynames[[2, a]]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, arrays}];
```

```
(* Estimate Missing Human Data Using SVD *)
```

```
(* Count Null Data *)

counter = Table[Dimensions[Position[matrix[[a]], Null]][[1]], {a, 1, genes}];

(* Locate Gene Position of Null Data *)

Clear[positions];
positions = Table[0, {a, 1, arrays + 1}];
Do[
  positions[[a]] = Flatten[
    Position[Flatten[counter], a - 1]],
  {a, 1, arrays + 1}];
numbers = Flatten[
   Table[
    Dimensions[positions[[a]]],
    {a, 1, Round[arrays * 0.2]}]];
```

```
(* Create Display Of Gene Position Of Null Data *)

framex = Table[{a, a - 1}, {a, 1, Round[arrays * 0.2]}];
framey = {1000, 2000, 3000, 4000, 5000};
labelx = ColumnForm[{"Number of Arrays"}, Center];
labely = ColumnForm[{"Number of Genes"}, Center];
g = BarChart[numbers,
    Frame -> True,
    Axes -> False,
    FrameLabel -> {labelx, labely, None, None},
    FrameTicks -> {framex, framey, None, None},
    GridLines -> {None, None},
    PlotRange -> {{0.5, Round[arrays * 0.2] + 0.5}, {0, 5000}},
    DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
        Text[labely, {b_, c_}, {1., 0.}] ->
            Text[labely, {b - 0.75, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
        Text[labelx, {b_, c_}, {0., 1.}] ->
            Text[labelx, {b, c - 600}, {0, 1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
        Text[a_, {b_, c_}, {0., 1.}] ->
            Text[a, {b, c - 400}, {0, 0}, {0, 1}];

(* Display Gene Position Of Null Data *)

Show[g, PlotRange -> All];
```



```
(* Select Genes by Number of Missing Data Points *)

matrix = AppendRows[Table[{counter[[a]]}, {a, 1, genes}], genenames, matrix];
matrix = Sort[matrix, OrderedQ[{#1, #2}] &];
fullgenenames = TakeColumns[
   TakeRows[matrix, {1, numbers[[1]]}],
   {2, 6}];
fullmatrix = TakeColumns[
   TakeRows[matrix, {1, numbers[[1]]}],
   {7, arrays + 6}];
missinggenenames1 = TakeColumns[
   TakeRows[matrix, {numbers[[1]] + 1, numbers[[1]] + numbers[[2]]}],
   {2, 6}];
missingmatrix1 = TakeColumns[
   TakeRows[matrix, {numbers[[1]] + 1, numbers[[1]] + numbers[[2]]}],
   {7, arrays + 6}];
missinggenenames2 = TakeColumns[
   TakeRows[matrix,
    {numbers[[1]] + numbers[[2]] + 1,
     numbers[[1]] + numbers[[2]] + numbers[[3]]}],
   {2, 6}];
missingmatrix2 = TakeColumns[
   TakeRows[matrix,
    {numbers[[1]] + numbers[[2]] + 1,
     numbers[[1]] + numbers[[2]] + numbers[[3]]}],
   {7, arrays + 6}];
missinggenenames3 = TakeColumns[
   TakeRows[matrix,
    {numbers[[1]] + numbers[[2]] + numbers[[3]] + 1,
     numbers[[1]] + numbers[[2]] + numbers[[3]] + numbers[[4]]}],
   {2, 6}];
missingmatrix3 = TakeColumns[
   TakeRows[matrix,
    {numbers[[1]] + numbers[[2]] + numbers[[3]] + 1,
     numbers[[1]] + numbers[[2]] + numbers[[3]] + numbers[[4]]}],
   {7, arrays + 6}];

(* Locate Array Position of Null Data *)

locator1 = Table[0, {numbers[[2]]}];
Do[
  locator1[[a]] = locator1[[a]] + Flatten[Position[missingmatrix1[[a]], Null]],
  {a, 1, numbers[[2]]}];
locator2 = Table[0, {numbers[[3]]}];
Do[
  locator2[[a]] = locator2[[a]] + Flatten[Position[missingmatrix2[[a]], Null]],
  {a, 1, numbers[[3]]}];
locator3 = Table[0, {numbers[[4]]}];
Do[
  locator3[[a]] = locator3[[a]] + Flatten[Position[missingmatrix3[[a]], Null]],
  {a, 1, numbers[[4]]}];
```

```
(* Sort Raw Elutriation Data According to the Position of Missing Data Points for Each Gene *)

missingmatrix1 = AppendRows[locator1, missinggenenames1, missingmatrix1];
missingmatrix1 = Sort[missingmatrix1, OrderedQ[{#1, #2}] &];
locator1 = TakeColumns[missingmatrix1, {1, 1}];
missinggenenames1 = TakeColumns[missingmatrix1, {2, 6}];
missingmatrix1 = TakeColumns[missingmatrix1, {7, arrays + 6}];
missingmatrix2 = AppendRows[locator2, missinggenenames2, missingmatrix2];
missingmatrix2 = Sort[missingmatrix2, OrderedQ[{#1, #2}] &];
locator2 = TakeColumns[missingmatrix2, {1, 2}];
missinggenenames2 = TakeColumns[missingmatrix2, {3, 7}];
missingmatrix2 = TakeColumns[missingmatrix2, {8, arrays + 7}];
missingmatrix3 = AppendRows[locator3, missinggenenames3, missingmatrix3];
missingmatrix3 = Sort[missingmatrix3, OrderedQ[{#1, #2}] &];
locator3 = TakeColumns[missingmatrix3, {1, 3}];
missinggenenames3 = TakeColumns[missingmatrix3, {4, 8}];
missingmatrix3 = TakeColumns[missingmatrix3, {9, arrays + 8}];

(* Examine Subset of Genes with Full Data *)

(* Calculate SVD *)

{eigenarrays, eigenexpressions, eigengenes} = SingularValues[fullmatrix];
eigenarrays = Transpose[eigenarrays];
fractions = eigenexpressions^2 / Sum[eigenexpressions[[a]]^2, {a, 1, arrays}];
entropy = -N[Sum[fractions[[a]] * Log[fractions[[a]]], {a, 1, arrays}] / Log[arrays]];
entropy = N[Round[100 * entropy] / 100]

0.04

(* Create Fractions Bar Charts Displays *)

fractions[[2]]

0.00573569

limit = 0.008;

Clear[gridx, framex, framey, sizes];
gridx = Table[a, {a, 0, limit, N[limit / 4]}];
framex = gridx;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[framex[[a]]
      ]]], {a, 1, 5}]];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " "],
   {b, 1, 5 - sizes[[a]]}],
  {a, 1, 5}];
framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 5}];
gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 5}];
framey = Table[{a + 1, arrays - a - 8}, {a, 0, 10 - 2}];
table = Table[fractions[[arrays - a]], {a, 8, arrays - 2}];
```

```
g = BarChart[table,
   BarOrientation -> Horizontal,
   PlotRange -> {{0, limit * 1.0001}, {0.5, 10 - 1 + 0.5}},
   AspectRatio -> 1,
   Axes -> False,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, None, None, None},
   GridLines -> {gridx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 1.75}, {0, 0}, {0, 1}];
g1 = Show[g,
   AspectRatio -> 1.25,
   PlotRange -> All,
   DisplayFunction -> Identity];

gridx = Table[a, {a, 0, 1, 0.2}];
framex = gridx;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[framex[[a]]
      ]]], {a, 1, 6}]];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, 6}];
framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 6}];
gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 6}];
framey = Table[{a + 1, arrays - a}, {a, 0, arrays - 1}];
labelx = ColumnForm[
   {"(b) Eigenexpression Fraction", StringJoin["d′2 = ", ToString[entropy]], " "},
   Center];
g = BarChart[
   Table[fractions[[arrays - a]], {a, 0, arrays - 1}],
   BarOrientation -> Horizontal,
   PlotRange -> {{0, 1.0001}, {0.5, arrays + 0.5}},
   AspectRatio -> 1,
   Axes -> False,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, None, labelx, None},
   GridLines -> {gridx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 2.7}, {0, 0}, {0, 1}];
g2 = Show[{g,
    Graphics[{RGBColor[1, 1, 0.8], Rectangle[{0.1, 0.6}, {0.98, 16.6}]}],
    Graphics[{Rectangle[{0.1, 0.6}, {0.98, 16.6}, g1]}]},
   AspectRatio -> 1.35,
   PlotRange -> All,
   DisplayFunction -> Identity];
```

```
(* Create Eigengenes 2 D Red & Green Raster Display *)

contrast = 3.5;
displaying = Table[
   If[contrast * eigengenes[[i, j]] > 0,
    If[contrast * eigengenes[[i, j]] < 1, {contrast * eigengenes[[i, j]], 0}, {1, 0}],
    If[contrast * eigengenes[[i, j]] > -1, {0, -contrast * eigengenes[[i, j]]}, {0, 1}]],
   {i, 1, arrays}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
framey = Table[{a + 1 - 0.5, arrays - a}, {a, 0, arrays - 1}];
labely = "Eigengenes";
labelx = ColumnForm[{"(a) Arrays", " ", " "}, Center];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, arrays, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 3, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 2.7}, {0, 0}, {0, 1}];
g1 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction -> Identity];

(* Create Selected Eigengenes Graph Display *)

eigengenes4 = Chop[TrigFit[eigengenes[[4]], 2, {5 / 4 * (x - 1), arrays - 1}], 0.1]
eigengenes5 = Chop[TrigFit[eigengenes[[5]], 2, {5 / 4 * (x - 1), arrays - 1}], 0.175]
```

$$0.146569\,\mathrm{Sin}\left[\frac{5}{17}\,\pi\,(-1+x)\right]$$

$$-0.228962\,\mathrm{Cos}\left[\frac{5}{17}\,\pi\,(-1+x)\right]$$

```
eigengenes4 = Sqrt[2 / 17.] * Sin[5 * Pi * (x - 1) / 17];
eigengenes5 = -Sqrt[2 / 17.] * Cos[5 * Pi * (x - 1) / 17];
```

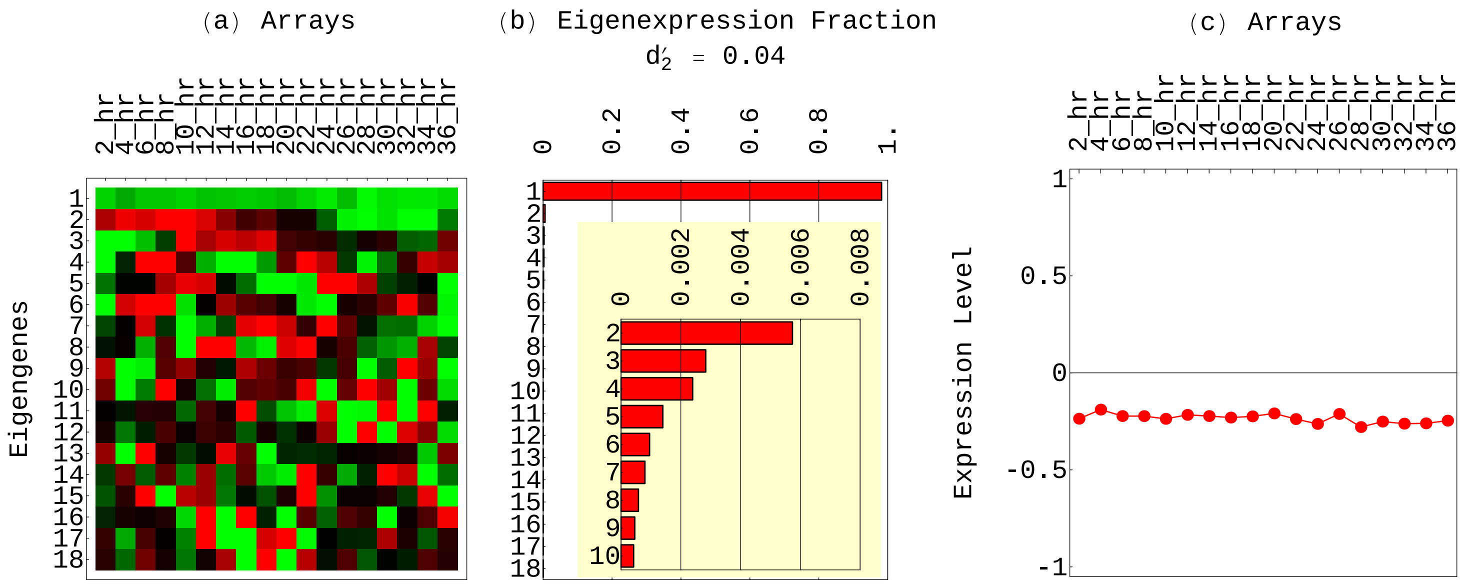
```
labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[1, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[1, 0, 0], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p1 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];

labelx = ColumnForm[{"(d) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[2, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[1, 0, 0], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p2 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = ColumnForm[{"(d) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[3, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0, 1], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p3 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

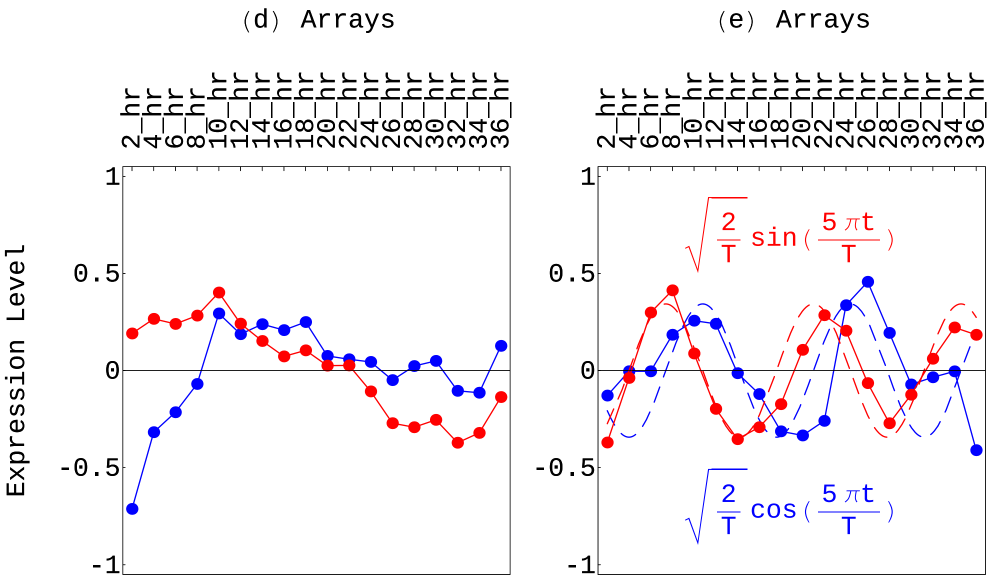
```
graph = Plot[eigengenes4,
   {x, 0, arrays - 1},
   PlotStyle -> {RGBColor[1, 0, 0], Dashing[{0.03, 0.02}]},
   DisplayFunction -> Identity];
labelx = ColumnForm[{"(e) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[4, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[1, 0, 0], line}],
    graph,
    Graphics[{RGBColor[1, 0, 0], Text["√(2/T) sin(5πt/T)", {8.5, 0.7}]}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p4 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
graph = Plot[eigengenes5,
   {x, 0, arrays - 1},
   PlotStyle -> {RGBColor[0, 0, 1], Dashing[{0.03, 0.02}]},
   DisplayFunction -> Identity];
labelx = ColumnForm[{"(e) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[5, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0, 1], line}],
    graph,
    Graphics[{RGBColor[0, 0, 1], Text["√(2/T) cos(5 πt/T)", {8.5, -0.7}]}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p5 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Display Selected Eigengenes *)

g3 = Show[{p3, p2},
   DisplayFunction -> Identity];
g4 = Show[{p5, p4},
   DisplayFunction -> Identity];

(* Display Eigengenes, Fractions and Selected Eigengenes *)

Show[GraphicsArray[{g1, g2, p1}],
  GraphicsSpacing -> -0.15];
```



```
Show[GraphicsArray[{g3, g4}],
  GraphicsSpacing -> -0.15];
```



```
(* Choose Subset of Eigengenes for Estimation *)

eigengenes = TakeRows[eigengenes, {1, 5}];

(* Estimate Missing Data *)

Do[
 missingmatrix1[[a, locator1[[a, 1]]]] =
  N[Round[Flatten[Dot[Dot[
          Transpose[Drop[
            Transpose[{missingmatrix1[[a]]}],
            {locator1[[a, 1]]}]],
          PseudoInverse[Transpose[Drop[
             Transpose[eigengenes],
             {locator1[[a, 1]]}]]]],
         eigengenes]][[locator1[[a, 1]]]] * 100] / 100],
 {a, 1, numbers[[2]]}]

Do[Do[
  missingmatrix2[[a, locator2[[a, b]]]] =
   N[Round[Flatten[Dot[Dot[
           Transpose[Drop[Drop[
              Transpose[{missingmatrix2[[a]]}],
              {locator2[[a, 2]]}], {locator2[[a, 1]]}]],
           PseudoInverse[Transpose[Drop[Drop[
               Transpose[eigengenes],
               {locator2[[a, 2]]}], {locator2[[a, 1]]}]]]],
          eigengenes]][[locator2[[a, b]]]] * 100] / 100],
  {b, 1, 2}],
 {a, 1, numbers[[3]]}]

Do[Do[
  missingmatrix3[[a, locator3[[a, b]]]] =
   N[Round[Flatten[Dot[Dot[
           Transpose[Drop[Drop[Drop[
               Transpose[{missingmatrix3[[a]]}],
               {locator3[[a, 3]]}], {locator3[[a, 2]]}], {locator3[[a, 1]]}]],
           PseudoInverse[Transpose[Drop[Drop[Drop[
                Transpose[eigengenes],
                {locator3[[a, 3]]}], {locator3[[a, 2]]}], {locator3[[a, 1]]}]]]],
          eigengenes]][[locator3[[a, b]]]] * 100] / 100],
  {b, 1, 3}],
 {a, 1, numbers[[4]]}]

genenames = AppendColumns[
   fullgenenames,
   missinggenenames1,
   missinggenenames2,
   missinggenenames3];
matrix = AppendColumns[
   fullmatrix,
   missingmatrix1,
   missingmatrix2,
   missingmatrix3];
{genes, arrays} = Dimensions[matrix];
matrix2 = matrix;
genenames2 = genenames;
arraynames2 = arraynames;
{genes2, arrays2} = Dimensions[matrix2]
```

```
{12056, 18}
```

```
(* Examine Human Data After Missing Data Estimation *)

(* Calculate SVD *)

{eigenarrays, eigenexpressions, eigengenes} = SingularValues[matrix];
eigenarrays = Transpose[eigenarrays];
fractions = eigenexpressions^2 / Sum[eigenexpressions[[a]]^2, {a, 1, arrays}];
entropy = -N[Sum[fractions[[a]] * Log[fractions[[a]]], {a, 1, arrays}] / Log[arrays]];
entropy = N[Round[100 * entropy] / 100]
```

```
0.04
```

```
(* Create Fractions Bar Charts Displays *)

fractions[[2]]
```

```
0.00536708
```

```
limit = 0.008;

Clear[gridx, framex, framey, sizes];
gridx = Table[a, {a, 0, limit, N[limit / 4]}];
framex = gridx;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[framex[[a]]
      ]]], {a, 1, 5}]];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " "],
   {b, 1, 5 - sizes[[a]]}],
  {a, 1, 5}];
framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 5}];
gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 5}];
framey = Table[{a + 1, arrays - a - 8}, {a, 0, 10 - 2}];
table = Table[fractions[[arrays - a]], {a, 8, arrays - 2}];
g = BarChart[table,
   BarOrientation -> Horizontal,
   PlotRange -> {{0, limit * 1.0001}, {0.5, 10 - 1 + 0.5}},
   AspectRatio -> 1,
   Axes -> False,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, None, None, None},
   GridLines -> {gridx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 1.75}, {0, 0}, {0, 1}];
g1 = Show[g,
   AspectRatio -> 1.25,
   PlotRange -> All,
   DisplayFunction -> Identity];
```

```
gridx = Table[a, {a, 0, 1, 0.2}];
framex = gridx;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[framex[[a]]
      ]]], {a, 1, 6}]];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, 6}];
framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 6}];
gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 6}];
framey = Table[{a + 1, arrays - a}, {a, 0, arrays - 1}];
labelx = ColumnForm[
   {"(b) Eigenexpression Fraction", StringJoin["d2 = ", ToString[entropy]], " "},
   Center];
g = BarChart[
   Table[fractions[[arrays - a]], {a, 0, arrays - 1}],
   BarOrientation -> Horizontal,
   PlotRange -> {{0, 1.0001}, {0.5, arrays + 0.5}},
   AspectRatio -> 1,
   Axes -> False,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, None, labelx, None},
   GridLines -> {gridx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 2.7}, {0, 0}, {0, 1}];
g2 = Show[{g,
    Graphics[{RGBColor[1, 1, 0.8], Rectangle[{0.1, 0.6}, {0.98, 16.6}]}],
    Graphics[{Rectangle[{0.1, 0.6}, {0.98, 16.6}, g1]}]},
   AspectRatio -> 1.35,
   PlotRange -> All,
   DisplayFunction -> Identity];
```

```
(* Create Eigengenes 2 D Red & Green Raster Display *)

contrast = 3.5;
displaying = Table[
   If[contrast * eigengenes[[i, j]] > 0,
    If[contrast * eigengenes[[i, j]] < 1, {contrast * eigengenes[[i, j]], 0}, {1, 0}],
    If[contrast * eigengenes[[i, j]] > -1, {0, -contrast * eigengenes[[i, j]]}, {0, 1}]],
   {i, 1, arrays}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
framey = Table[{a + 1 - 0.5, arrays - a}, {a, 0, arrays - 1}];
labely = "Eigengenes";
labelx = ColumnForm[{"(a) Arrays", " ", " "}, Center];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, arrays, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 3, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 2.7}, {0, 0}, {0, 1}];
g1 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction -> Identity];

(* Create Selected Eigengenes Graph Display *)

eigengenes4 = Chop[TrigFit[eigengenes[[4]], 2, {5 / 4 * (x - 1), arrays - 1}], 0.1]
eigengenes5 = Chop[TrigFit[eigengenes[[5]], 2, {5 / 4 * (x - 1), arrays - 1}], 0.175]
```

$$0.182993\,\mathrm{Sin}\left[\frac{5}{17}\pi\,(-1+x)\right]$$

$$-0.224054\,\mathrm{Cos}\left[\frac{5}{17}\pi\,(-1+x)\right]$$

```
eigengenes4 = Sqrt[2 / 17.] * Sin[5 * Pi * (x - 1) / 17];
eigengenes5 = -Sqrt[2 / 17.] * Cos[5 * Pi * (x - 1) / 17];
```

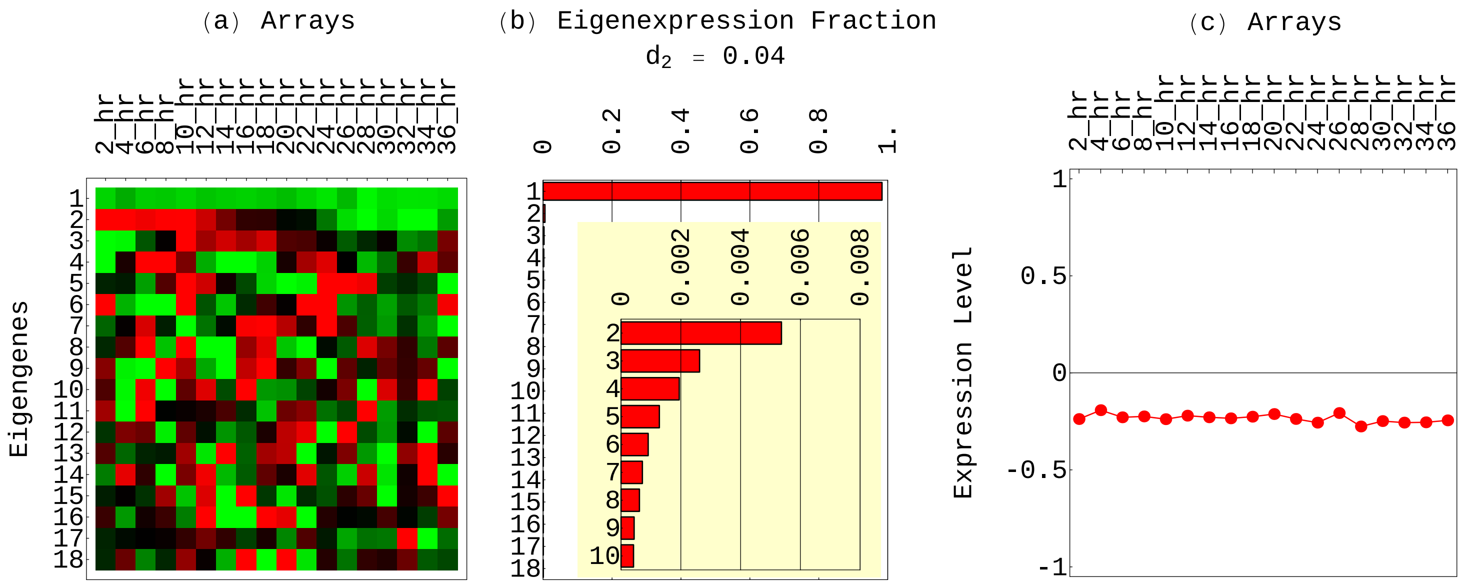
```
labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[1, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[1, 0, 0], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p1 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];

labelx = ColumnForm[{"(d) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[2, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[1, 0, 0], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p2 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = ColumnForm[{"(d) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[3, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0, 1], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p3 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

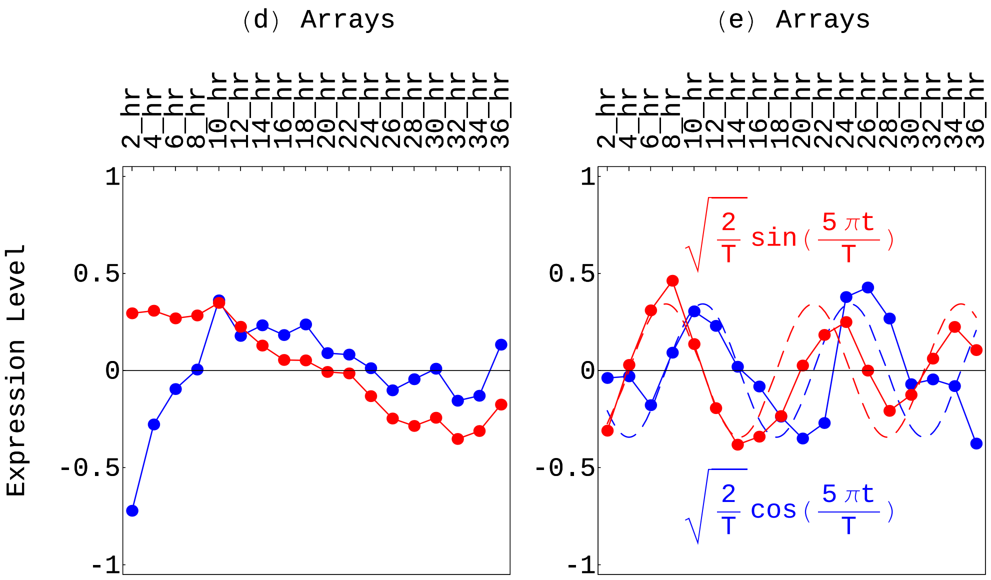
```
graph = Plot[eigengenes4,
   {x, 0, arrays - 1},
   PlotStyle -> {RGBColor[1, 0, 0], Dashing[{0.03, 0.02}]},
   DisplayFunction -> Identity];
labelx = ColumnForm[{"(e) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[4, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[1, 0, 0], line}],
    graph,
    Graphics[{RGBColor[1, 0, 0], Text["√(2/T) sin(5 πt/T)", {8.5, 0.7}]}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p4 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
graph = Plot[eigengenes5,
   {x, 0, arrays - 1},
   PlotStyle -> {RGBColor[0, 0, 1], Dashing[{0.03, 0.02}]},
   DisplayFunction -> Identity];
labelx = ColumnForm[{"(e) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[5, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0, 1], line}],
    graph,
    Graphics[{RGBColor[0, 0, 1], Text["√(2/T) cos(5 πt/T)", {8.5, -0.7}]}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p5 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Display Selected Eigengenes *)

g3 = Show[{p3, p2},
    DisplayFunction -> Identity];
g4 = Show[{p5, p4},
    DisplayFunction -> Identity];

(* Display Eigengenes, Fractions and Selected Eigengenes *)

Show[GraphicsArray[{g1, g2, p1}],
  GraphicsSpacing -> -0.15];
```



```
Show[GraphicsArray[{g3, g4}],
  GraphicsSpacing -> -0.15];
```



```
(* Calculate GSVD of Yeast and Human Data *)
```

```
matrix = AppendColumns[matrix1, matrix2];
{q, r} = QRDecomposition[matrix];
q = Conjugate[Transpose[q]];
q1 = TakeRows[q, {1, genes1}];
{u1, w1, v1} = SingularValues[q1];
genelets = Dot[v1, r];
Do[genelets[[a]] = genelets[[a]] / Sqrt[Dot[genelets[[a]], genelets[[a]]]],
 {a, 1, arrays}]

genelets[[3]] = -genelets[[3]];
genelets[[4]] = -genelets[[4]];
genelets[[5]] = -genelets[[5]];
genelets[[6]] = -genelets[[6]];
genelets[[15]] = -genelets[[15]];
genelets[[18]] = -genelets[[18]];

arraylets1 = Dot[matrix1, Inverse[genelets]];
arraylets2 = Dot[matrix2, Inverse[genelets]];
arraylets1 = Transpose[arraylets1];
Do[arraylets1[[a]] = arraylets1[[a]] / Sqrt[Dot[arraylets1[[a]], arraylets1[[a]]]], {a, 1, arrays}];
arraylets1 = Transpose[arraylets1];
arraylets2 = Transpose[arraylets2];
Do[arraylets2[[a]] = arraylets2[[a]] / Sqrt[Dot[arraylets2[[a]], arraylets2[[a]]]], {a, 1, arrays}];
arraylets2 = Transpose[arraylets2];
d1 = Chop[Dot[PseudoInverse[arraylets1], matrix1, Inverse[genelets]]];
d2 = Chop[Dot[PseudoInverse[arraylets2], matrix2, Inverse[genelets]]];

(* Create Angular Distances Bar Charts Displays *)

arraynames = Transpose[Table[{a, a}, {a, 1, arrays}]];
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[arraynames[[2, a]]
      ]]], {a, 1, arrays}]];
size = 5;
Do[
  Do[arraynames[[2, a]] = StringJoin[ToString[arraynames[[2, a]]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, arrays}];
distances =
  Table[N[ArcTan[d1[[a, a]] / d2[[a, a]]] / Pi], {a, 1, arrays}] -
   Table[0.25, {a, 1, arrays}];

Clear[gridx, framex, framey, sizes];
gridx = {-0.25, -0.125, 0, 0.125, 0.25};
framex = {"-π/4", "-π/8", "0    ", "π/8 ", "π/4 "};
framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 5}];
gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 5}];
framey = Table[{a + 1, arrays - a}, {a, 0, arrays - 1}];
labelx = ColumnForm[{"(b) Angular Distance", " ", " "}, Center];
```

```
g = BarChart[
   Table[distances[[arrays - a]], {a, 0, arrays - 1}],
   BarOrientation -> Horizontal,
   BarStyle → RGBColor[1, 0, 0],
   PlotRange -> {{-0.25 * 1.0001, 0.25 * 1.0001}, {0.5, arrays + 0.5}},
   AspectRatio -> 1,
   Axes -> False,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, None, labelx, None},
   GridLines -> {gridx, None},
   DisplayFunction → Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1.6}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 2}, {0, 0}, {0, 1}];
g2 = Show[g,
   AspectRatio -> 1.35,
   PlotRange -> All,
   DisplayFunction → Identity];

(* Create Genelets 2 D Red & Green Raster Display *)

average = Table[1, {a, 1, arrays}];
average = N[average / Sqrt[Dot[average, average]]];
centergenelets = genelets - N[Outer[Times, Dot[genelets, average], average]];

contrast = 4;
displaying = Table[
   If[contrast * centergenelets[[i, j]] > 0,
    If[contrast * centergenelets[[i, j]] < 1, {contrast * centergenelets[[i, j]], 0}, {1, 0}],
    If[contrast * centergenelets[[i, j]] > -1, {0, -contrast * centergenelets[[i, j]]}, {0, 1}]],
   {i, 1, arrays}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
framey = Table[{a + 1 - 0.5, arrays - a}, {a, 0, arrays - 1}];
labely = "Genelets";
labelx = ColumnForm[{"(a) Arrays", " ", " "}, Center];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, arrays, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 3, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1.6}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 2}, {0, 0}, {0, 1}];
g1 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Create Selected Genelets Graph Display *)

labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, genelets[[1, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[1, 0, 0], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.22}, {0, 0}, {0, 1}];
p1 = Show[g,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];

labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, genelets[[2, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0, 1], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.22}, {0, 0}, {0, 1}];
p2 = Show[g,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
genelets3 = Sqrt[2 / 3 / 17.] - Sqrt[2 / 3 / 17.] * Cos[4 * Pi * x / 17. + Pi / 3];
graph = Plot[genelets3,
   {x, 0, arrays - 1},
   PlotStyle -> {RGBColor[1, 0, 0], Dashing[{0.03, 0.02}]},
   DisplayFunction -> Identity];
labelx = ColumnForm[{"(a) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, genelets[[3, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[1, 0, 0], line}],
    graph,
    Graphics[{RGBColor[1, 0, 0], Text["√(2/(3 T)) [1 - cos(4 πt/T + π/3)]", {9, 1}]}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-0.85, 1.25},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.22}, {0, 0}, {0, 1}];
p3 = Show[g,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
genelets4 = -Sqrt[2 / 3 / 17.] + Sqrt[2 / 3 / 17.] * Cos[4 * Pi * x / 17.];
graph = Plot[genelets4,
   {x, 0, arrays - 1},
   PlotStyle -> {RGBColor[0, 0, 1], Dashing[{0.03, 0.02}]},
   DisplayFunction -> Identity];
labelx = ColumnForm[{"(a) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, genelets[[4, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0, 1], line}],
    graph,
    Graphics[{RGBColor[0, 0, 1], Text["-√(2/(3 T)) [1 - cos(4 πt/T)]", {9, 0.65}]}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-0.85, 1.25},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.22}, {0, 0}, {0, 1}];
p4 = Show[g,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
genelets5 = Sqrt[2 / 17.] * Cos[4 * Pi * x / 17. - Pi / 3];
graph = Plot[genelets5,
   {x, 0, arrays - 1},
   PlotStyle -> {RGBColor[0, 0.5, 0], Dashing[{0.03, 0.02}]},
   DisplayFunction -> Identity];
labelx = ColumnForm[{"(a) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, genelets[[5, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0.5, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0.5, 0], line}],
    graph,
    Graphics[{RGBColor[0, 0.5, 0], Text["√(2/T) cos(4πt/T - π/3) ", {11.5, -0.65}]}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-0.85, 1.25},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.22}, {0, 0}, {0, 1}];
p5 = Show[g,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, genelets[[6, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0.75, 0, 1], PointSize[0.022], points}],
    Graphics[{RGBColor[0.75, 0, 1], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.22}, {0, 0}, {0, 1}];
p6 = Show[g,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

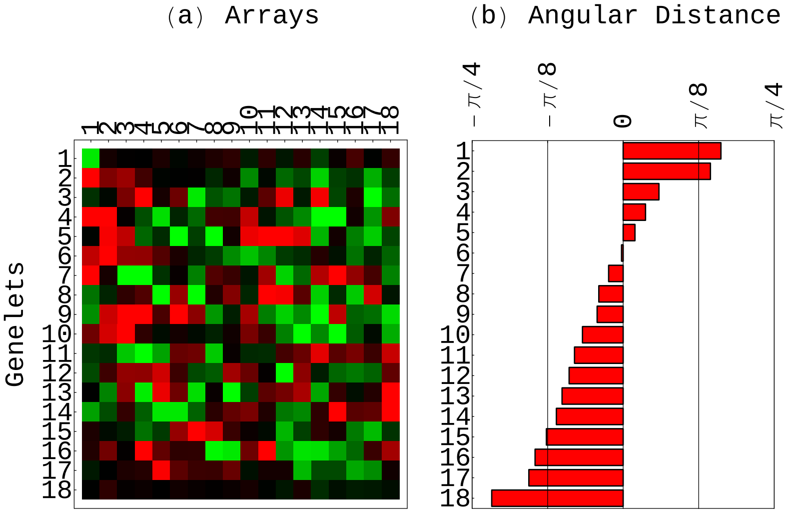
```
genelets14 = -Sqrt[2 / 3 / 17.] + Sqrt[2 / 3 / 17.] * Cos[5 * Pi * x / 17. - Pi / 3];
graph = Plot[genelets14,
   {x, 0, arrays - 1},
   PlotStyle -> {RGBColor[1, 0, 0], Dashing[{0.03, 0.02}]},
   DisplayFunction -> Identity];
labelx = ColumnForm[{"(b) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, genelets[[14, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[1, 0, 0], line}],
    graph,
    Graphics[{RGBColor[1, 0, 0], Text["-√(2/(3 T)) [1 - cos(5 πt/T - π/3)]", {9, 1}]}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-0.85, 1.25},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.22}, {0, 0}, {0, 1}];
p14 = Show[g,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
geneletsl5 = Sqrt[2 / 3 / 17.] + Sqrt[2 / 3 / 17.] * Cos[5 * Pi * x / 17. + Pi / 3];
graph = Plot[geneletsl5,
   {x, 0, arrays - 1},
   PlotStyle -> {RGBColor[0, 0, 1], Dashing[{0.03, 0.02}]},
   DisplayFunction -> Identity];
labelx = ColumnForm[{"(b) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, genelets[[15, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0, 1], line}],
    graph,
    Graphics[{RGBColor[0, 0, 1], Text[" √(2/(3 T)) [1 + cos(5 πt/T + π/3)]", {9, 0.65}]}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-0.85, 1.25},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.22}, {0, 0}, {0, 1}];
p15 = Show[g,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

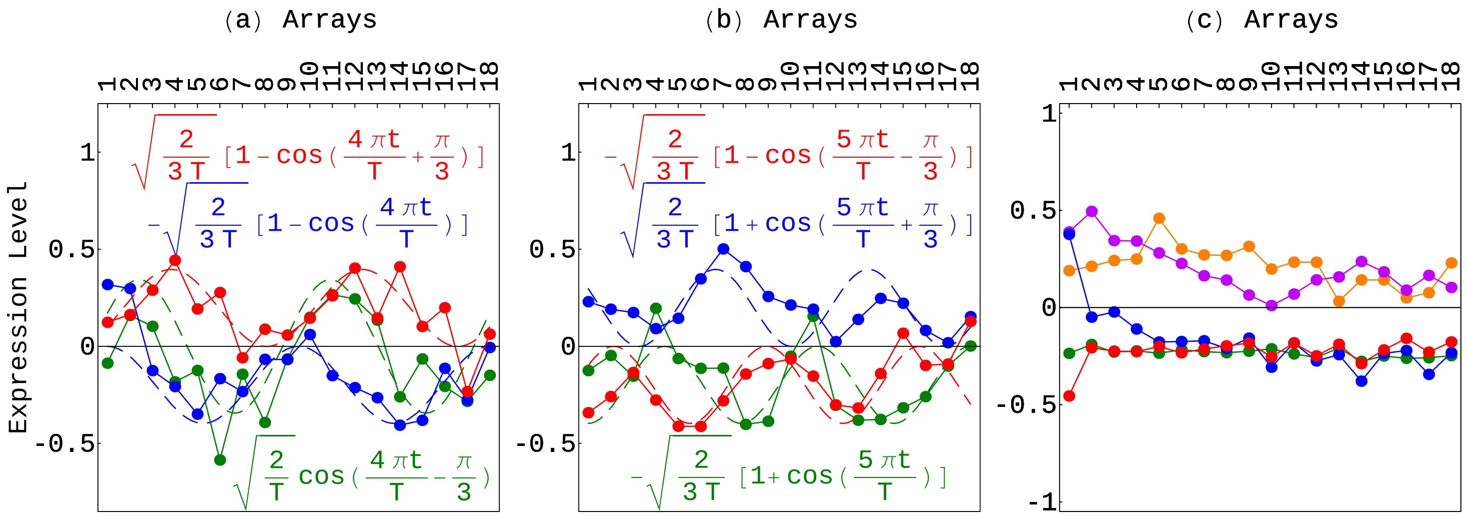
```
genelets16 = -Sqrt[2 / 3 / 17.] - Sqrt[2 / 3 / 17.] * Cos[5 * Pi * x / 17.];
graph = Plot[genelets16,
   {x, 0, arrays - 1},
   PlotStyle -> {RGBColor[0, 0.5, 0], Dashing[{0.03, 0.02}]},
   DisplayFunction -> Identity];
labelx = ColumnForm[{"(b) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, genelets[[16, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0.5, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0.5, 0], line}],
    graph,
    Graphics[{RGBColor[0, 0.5, 0], Text["-√(2/(3 T)) [1+cos(5 πt/T)]", {9, -0.65}]}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-0.85, 1.25},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.22}, {0, 0}, {0, 1}];
p16 = Show[g,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, genelets[[17, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0.5, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[1, 0.5, 0], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.22}, {0, 0}, {0, 1}];
p17 = Show[g,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];

labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, genelets[[18, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0.5, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0.5, 0], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.22}, {0, 0}, {0, 1}];
p18 = Show[g,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Display Selected Genelets *)

g3 = Show[{p18, p17, p6, p2, p1},
   DisplayFunction -> Identity];
g4 = Show[{p5, p4, p3},
   DisplayFunction -> Identity];
g5 = Show[{p16, p15, p14},
   DisplayFunction -> Identity];

(* Display Genelets, Angular Distances and Selected Genelets *)

Show[GraphicsArray[{g1, g2}],
    GraphicsSpacing -> -0.18];
```



```
Show[GraphicsArray[{g4, g5, g3}],
    GraphicsSpacing -> -0.12];
```



```
(* Create Yeast Generalized Fractions Bar Chart Display *)

d = Table[d1[[a, a]], {a, 1, arrays}];
fractions = d^2 / Sum[d[[a]]^2, {a, 1, arrays}];
coordinates = Sort[Table[{fractions[[a]], a}, {a, 1, arrays}], OrderedQ[{{#2}, {#1}}] &];
fractions = Flatten[TakeColumns[coordinates, {1, 1}]];
entropy = -N[Sum[fractions[[a]] * Log[fractions[[a]]], {a, 1, arrays}] / Log[arrays]];
entropy = N[Round[100 * entropy] / 100]
```

```
0.36
```

```
fractions[[3]]
```

```
0.0516352
```

```
limit = 0.052;

Clear[gridx, framex, framey, sizes];
gridx = Table[a, {a, 0, limit, N[limit / 4]}];
framex = gridx;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[framex[[a]]
      ]]], {a, 1, 5}]];
size = Sort[sizes, OrderedQ[{#2, #1}] &][[1]];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " "],
   {b, 1, 7 - sizes[[a]]}],
  {a, 1, 5}];
framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 5}];
gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 5}];
framey = Flatten[TakeColumns[coordinates, {2, 2}]];
framey = Table[{arrays - a, framey[[a + 1]]}, {a, 2, arrays - 1}];
table = Table[fractions[[arrays - a]], {a, 0, arrays - 3}];
g = BarChart[table,
   BarOrientation -> Horizontal,
   PlotRange -> {{0, limit * 1.0001}, {0.5, arrays - 2 + 0.5}},
   AspectRatio -> 1,
   Axes -> False,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, None, None, None},
   GridLines -> {gridx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 3}, {0, 0}, {0, 1}];
g1 = Show[g,
   AspectRatio -> 1.25,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
fractions[[1]]
```

```
0.738543
```

```
limit = 0.8;
```

```
Clear[gridx, framex, framey, sizes];
gridx = Table[a, {a, 0, limit, N[limit / 5]}];
framex = gridx;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[framex[[a]]
      ]]], {a, 1, 6}]];
size = Sort[sizes, OrderedQ[{#2, #1}] &][[1]] + 1;
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, 6}];
framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 6}];
framey = Flatten[TakeColumns[coordinates, {2, 2}]];
framey = Table[{arrays - a, framey[[a + 1]]}, {a, 0, arrays - 1}];
labely = "Genelets";
labelx = ColumnForm[
   {"(a) Generalized Fraction", "   of Eigenexpression", StringJoin["D₁ = ", ToString[entropy]], " "},
   Center];
g = BarChart[
   Table[fractions[[arrays - a]], {a, 0, arrays - 1}],
   BarOrientation -> Horizontal,
   PlotRange -> {{0, limit * 1.0001}, {0.5, arrays + 0.5}},
   AspectRatio -> 1,
   Axes -> False,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {gridx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 0.16, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 2}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 1.75}, {0, 0}, {0, 1}];
g5 = Show[{g,
    Graphics[{RGBColor[1, 1, 0.8], Rectangle[{0.1, 0.6}, {0.78, 16.5}]}],
    Graphics[{Rectangle[{0.1, 0.6}, {0.78, 17}, g1]}]},
   AspectRatio → 1.15,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Create Human Generalized Fractions Bar Chart Display *)

d = Table[d2[[a, a]], {a, 1, arrays}];
fractions = d^2 / Sum[d[[a]]^2, {a, 1, arrays}];
coordinates = Sort[Table[{fractions[[a]], a}, {a, 1, arrays}], OrderedQ[{{#2}, {#1}}] &];
fractions = Flatten[TakeColumns[coordinates, {1, 1}]];
entropy = -N[Sum[fractions[[a]] * Log[fractions[[a]]], {a, 1, arrays}] / Log[arrays]];
entropy = N[Round[100 * entropy] / 100]
```

```
0.12
```

```
fractions[[2]]
```

```
0.0148912
```

```
limit = 0.016;

Clear[gridx, framex, framey, sizes];
gridx = Table[a, {a, 0, limit, N[limit / 4]}];
framex = gridx;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[framex[[a]]
      ]]], {a, 1, 5}]];
size = Sort[sizes, OrderedQ[{#2, #1}] &][[1]];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " "],
   {b, 1, 7 - sizes[[a]]}],
  {a, 1, 5}];
framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 5}];
gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 5}];
framey = Flatten[TakeColumns[coordinates, {2, 2}]];
framey = Table[{arrays - a, framey[[a + 1]]}, {a, 1, arrays - 1}];
table = Table[fractions[[arrays - a]], {a, 0, arrays - 2}];
g = BarChart[table,
   BarOrientation -> Horizontal,
   PlotRange -> {{0, limit * 1.0001}, {0.5, arrays - 1 + 0.5}},
   AspectRatio -> 1,
   Axes -> False,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, None, None, None},
   GridLines -> {gridx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 3}, {0, 0}, {0, 1}];
g1 = Show[g,
   AspectRatio -> 1.25,
   PlotRange -> All,
   DisplayFunction → Identity];
```

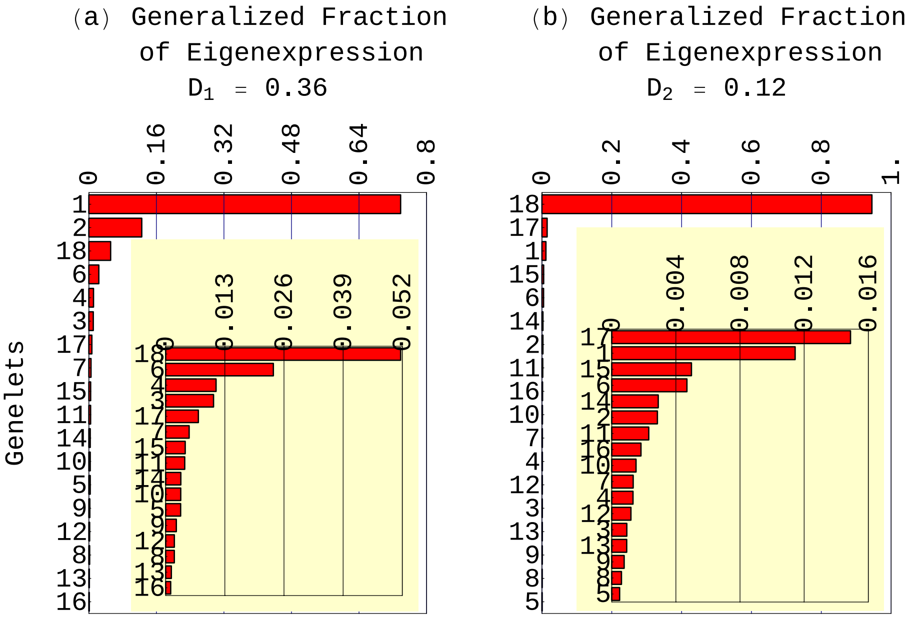
```
fractions[[1]]
```

```
0.945012
```

```
limit = 1;
```

```
Clear[gridx, framex, framey, sizes];
gridx = Table[a, {a, 0, limit, N[limit / 5]}];
framex = gridx;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[framex[[a]]
      ]]], {a, 1, 6}]];
size = Sort[sizes, OrderedQ[{#2, #1}] &][[1]] + 2;
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, 6}];
framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 6}];
framey = Flatten[TakeColumns[coordinates, {2, 2}]];
framey = Table[{arrays - a, framey[[a + 1]]}, {a, 0, arrays - 1}];
labely = " ";
labelx = ColumnForm[
   {"(b) Generalized Fraction", "   of Eigenexpression", StringJoin["D₂ = ", ToString[entropy]], " "},
   Center];
g = BarChart[
   Table[fractions[[arrays - a]], {a, 0, arrays - 1}],
   BarOrientation -> Horizontal,
   PlotRange -> {{0, limit * 1.0001}, {0.5, arrays + 0.5}},
   AspectRatio -> 1,
   Axes -> False,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {gridx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 0.16, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 2}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 1.75}, {0, 0}, {0, 1}];
g6 = Show[{g,
    Graphics[{RGBColor[1, 1, 0.8], Rectangle[{0.1, 0.6}, {0.98, 17}]}],
    Graphics[{Rectangle[{0.1, 0.6}, {0.98, 17.5}, g1]}]},
   AspectRatio → 1.15,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Display Yeast and Human Generalized Fractions *)

Show[GraphicsArray[{g5, g6}],
  GraphicsSpacing → -0.15];
```



```
(* Save Arraylets Data in Arraylets.txt *)

(* Save Yeast Arraylets *)

{genes, arrays} = Dimensions[arraylets1];
savematrix = AppendRows[genenames1, N[Round[arraylets1 * 100000] / 100000]];
savematrix = AppendColumns[
   AppendRows[
    {{"YORF", "NAME", "PROCESS", "FUNCTION",
      "MICROARRAY_CLASSIFICATION", "TRADITIONAL_CLASSIFICATION"}},
    {Table[a, {a, 1, arrays}]}],
   savematrix];
stream = OpenWrite[
   StringJoin[name, ":Desktop Folder:PNAS Data:Yeast_Arraylets.txt"],
   PageWidth -> Infinity];
Write[stream, OutputForm[
   TableForm[savematrix, TableSpacing -> {0, 1}]]];
Close[stream];

(* Save Human Arraylets *)

{genes, arrays} = Dimensions[arraylets2];
savematrix = AppendRows[genenames2, N[Round[arraylets2 * 100000] / 100000]];
savematrix = AppendColumns[
   AppendRows[
    {{"CLID", "SYMBOL", "NAME",
      "MICROARRAY_CLASSIFICATION", "TRADITIONAL_CLASSIFICATION"}},
    {Table[a, {a, 1, arrays}]}],
   savematrix];
stream = OpenWrite[
   StringJoin[name, ":Desktop Folder:PNAS Data:Human_Arraylets.txt"],
   PageWidth -> Infinity];
Write[stream, OutputForm[
   TableForm[savematrix, TableSpacing -> {0, 1}]]];
Close[stream];
```

```
(* Estimate Significance of Association of Genelets and Arraylets with the Cell Cycle *)
```

```
(* Display Sorted Yeast Arraylets *)

genes = genes1;
genenames = genenames1;
arraynames = arraynames1;
arraylets = Transpose[arraylets1];

(* Sort Selected Yeast Arraylets *)

arraylets[[3]] = Sort[arraylets[[3]], OrderedQ[{{#2}, {#1}}] &];
arraylets[[4]] = Sort[arraylets[[4]], OrderedQ[{{#2}, {#1}}] &];
arraylets[[5]] = Sort[arraylets[[5]], OrderedQ[{{#2}, {#1}}] &];
arraylets[[14]] = Sort[arraylets[[14]], OrderedQ[{{#2}, {#1}}] &];
arraylets[[15]] = Sort[arraylets[[15]], OrderedQ[{{#2}, {#1}}] &];
arraylets[[16]] = Sort[arraylets[[16]], OrderedQ[{{#2}, {#1}}] &];

(* Create Selected Sorted Yeast Arraylets Graph Display *)

labelx = "Expression Level";
labely = ColumnForm[
   {" ", "(a) Number of Genes", " ", " ", " ", " ", " ", " ", " ", " "},
   Center];
framex = {{-0.05, "-0.05  "}, {0, "0      "}, {0.05, "0.05   "}, {0.1, "0.1    "},
   {0.15, "0.15   "}, {0.2, "0.2    "}, {0.25, "0.25   "}, {0.3, "0.3    "},
   {0.35, "0.35   "}, {0.4, "0.4    "}, {0.45, "0.45   "}};
framey = {{-100, "100"}, {-2250, "2250"}, {-genes + 100, "4423"}};
coordinates = Table[
   If[arraylets[[3, a]] < -0.05, -0.05,
    If[arraylets[[3, a]] > 0.3, 0.3, arraylets[[3, a]]]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[1, 0, 0], line}],
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, framey, framex, None},
   GridLines -> {{{0, RGBColor[0, 0, 0]}}, {{-100, RGBColor[0, 0, 0]},
      {-2250, RGBColor[0, 0, 0]}, {-genes + 100, RGBColor[0, 0, 0]}}},
   PlotRange -> {{-0.05, 0.3001}, {135, -genes + 1 - 135}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1300}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 800}, {0, 0}, {0, 1}];
p3 = Show[g,
   AspectRatio → 1 / 1.6 / GoldenRatio,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = "Expression Level";
labely = ColumnForm[
   {" ", "(a) Number of Genes", " ", " ", " ", " ", " ", " ", " ", " "},
   Center];
framex = {{-0.05, "-0.05  "}, {0, "0      "}, {0.05, "0.05   "}, {0.1, "0.1    "},
   {0.15, "0.15   "}, {0.2, "0.2    "}, {0.25, "0.25   "}, {0.3, "0.3    "},
   {0.35, "0.35   "}, {0.4, "0.4    "}, {0.45, "0.45   "}};
framey = {{-100, "100"}, {-2250, "2250"}, {-genes + 100, "4423"}};
coordinates = Table[
   If[arraylets[[4, a]] + 0.05 < -0.05, -0.05,
    If[arraylets[[4, a]] + 0.05 > 0.3, 0.3, arraylets[[4, a]] + 0.05]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[1, 0.5, 0], line}],
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, framey, framex, None},
   GridLines -> {{{0.05, RGBColor[0, 0, 0]}}, {{-100, RGBColor[0, 0, 0]},
      {-2250, RGBColor[0, 0, 0]}, {-genes + 100, RGBColor[0, 0, 0]}}},
   PlotRange -> {{-0.05, 0.3001}, {135, -genes + 1 - 135}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1300}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 800}, {0, 0}, {0, 1}];
p4 = Show[g,
   AspectRatio → 1 / 1.6 / GoldenRatio,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = "Expression Level";
labely = ColumnForm[
   {" ", "(a) Number of Genes", " ", " ", " ", " ", " ", " ", " ", " "},
   Center];
framex = {{-0.05, "-0.05  "}, {0, "0      "}, {0.05, "0.05   "}, {0.1, "0.1    "},
   {0.15, "0.15   "}, {0.2, "0.2    "}, {0.25, "0.25   "}, {0.3, "0.3    "},
   {0.35, "0.35   "}, {0.4, "0.4    "}, {0.45, "0.45   "}};
framey = {{-100, "100"}, {-2250, "2250"}, {-genes + 100, "4423"}};
coordinates = Table[
   If[arraylets[[5, a]] + 0.1 < -0.05, -0.05,
    If[arraylets[[5, a]] + 0.1 > 0.3, 0.3, arraylets[[5, a]] + 0.1]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[0, 0.5, 0], line}],
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, framey, framex, None},
   GridLines -> {{{0.1, RGBColor[0, 0, 0]}}, {{-100, RGBColor[0, 0, 0]},
      {-2250, RGBColor[0, 0, 0]}, {-genes + 100, RGBColor[0, 0, 0]}}},
   PlotRange -> {{-0.05, 0.3001}, {135, -genes + 1 - 135}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1300}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 800}, {0, 0}, {0, 1}];
p5 = Show[g,
   AspectRatio → 1 / 1.6 / GoldenRatio,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = "Expression Level";
labely = ColumnForm[
   {" ", "(a) Number of Genes", " ", " ", " ", " ", " ", " ", " ", " "},
   Center];
framex = {{-0.05, "-0.05  "}, {0, "0      "}, {0.05, "0.05   "}, {0.1, "0.1    "},
   {0.15, "0.15   "}, {0.2, "0.2    "}, {0.25, "0.25   "}, {0.3, "0.3    "},
   {0.35, "0.35   "}, {0.4, "0.4    "}, {0.45, "0.45   "}};
framey = {{-100, "100"}, {-2250, "2250"}, {-genes + 100, "4423"}};
coordinates = Table[
   If[arraylets[[14, a]] + 0.15 < -0.05, -0.05,
    If[arraylets[[14, a]] + 0.15 > 0.3, 0.3, arraylets[[14, a]] + 0.15]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[0, 0, 1], line}],
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, framey, framex, None},
   GridLines -> {{{0.15, RGBColor[0, 0, 0]}}, {{-100, RGBColor[0, 0, 0]},
      {-2250, RGBColor[0, 0, 0]}, {-genes + 100, RGBColor[0, 0, 0]}}},
   PlotRange -> {{-0.05, 0.3001}, {135, -genes + 1 - 135}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1300}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 800}, {0, 0}, {0, 1}];
p14 = Show[g,
   AspectRatio → 1 / 1.6 / GoldenRatio,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = "Expression Level";
labely = ColumnForm[
   {" ", "(a) Number of Genes", " ", " ", " ", " ", " ", " ", " ", " "},
   Center];
framex = {{-0.05, "-0.05  "}, {0, "0      "}, {0.05, "0.05   "}, {0.1, "0.1    "},
   {0.15, "0.15   "}, {0.2, "0.2    "}, {0.25, "0.25   "}, {0.3, "0.3    "},
   {0.35, "0.35   "}, {0.4, "0.4    "}, {0.45, "0.45   "}};
framey = {{-100, "100"}, {-2250, "2250"}, {-genes + 100, "4423"}};
coordinates = Table[
   If[arraylets[[15, a]] + 0.2 < -0.05, -0.05,
    If[arraylets[[15, a]] + 0.2 > 0.3, 0.3, arraylets[[15, a]] + 0.2]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[0.75, 0, 1], line}],
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, framey, framex, None},
   GridLines -> {{{0.2, RGBColor[0, 0, 0]}}, {{-100, RGBColor[0, 0, 0]},
      {-2250, RGBColor[0, 0, 0]}, {-genes + 100, RGBColor[0, 0, 0]}}},
   PlotRange -> {{-0.05, 0.3001}, {135, -genes + 1 - 135}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1300}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 800}, {0, 0}, {0, 1}];
p15 = Show[g,
   AspectRatio → 1 / 1.6 / GoldenRatio,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = "Expression Level";
labely = ColumnForm[
   {" ", "(a) Number of Genes", " ", " ", " ", " ", " ", " ", " ", " "},
   Center];
framex = {{-0.05, "-0.05  "}, {0, "0      "}, {0.05, "0.05   "}, {0.1, "0.1    "},
   {0.15, "0.15   "}, {0.2, "0.2    "}, {0.25, "0.25   "}, {0.3, "0.3    "},
   {0.35, "0.35   "}, {0.4, "0.4    "}, {0.45, "0.45   "}};
framey = {{-100, "100"}, {-2250, "2250"}, {-genes + 100, "4423"}};
coordinates = Table[
   If[arraylets[[16, a]] + 0.25 < -0.05, -0.05,
    If[arraylets[[16, a]] + 0.25 > 0.3, 0.3, arraylets[[16, a]] + 0.25]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[1, 0, 0], line}],
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, framey, framex, None},
   GridLines -> {{{0.25, RGBColor[0, 0, 0]}}, {{-100, RGBColor[0, 0, 0]},
      {-2250, RGBColor[0, 0, 0]}, {-genes + 100, RGBColor[0, 0, 0]}}},
   PlotRange -> {{-0.05, 0.3001}, {135, -genes + 1 - 135}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1300}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 800}, {0, 0}, {0, 1}];
p16 = Show[g,
   AspectRatio → 1 / 1.6 / GoldenRatio,
   PlotRange -> All,
   DisplayFunction → Identity];

(* Display Selected Sorted Yeast Arraylets *)

g1 = Show[{p3, p4, p5, p14, p15, p16}];
```

```
(* Display Sorted Human Arraylets *)

genes = genes2;
genenames = genenames2;
arraynames = arraynames2;
arraylets = Transpose[arraylets2];

(* Sort Selected Human Arraylets *)

arraylets[[3]] = Sort[arraylets[[3]], OrderedQ[{{#2}, {#1}}] &];
arraylets[[4]] = Sort[arraylets[[4]], OrderedQ[{{#2}, {#1}}] &];
arraylets[[5]] = Sort[arraylets[[5]], OrderedQ[{{#2}, {#1}}] &];
arraylets[[14]] = Sort[arraylets[[14]], OrderedQ[{{#2}, {#1}}] &];
arraylets[[15]] = Sort[arraylets[[15]], OrderedQ[{{#2}, {#1}}] &];
arraylets[[16]] = Sort[arraylets[[16]], OrderedQ[{{#2}, {#1}}] &];

(* Create Selected Sorted Human Arraylets Graph Display *)

labelx = "Expression Level";
labely = ColumnForm[
   {" ", "(b) Number of Genes", " ", " ", " ", " ", " ", " ", " ", " "},
   Center];
framex = {{-0.05, "-0.05  "}, {0, "0      "}, {0.05, "0.05   "}, {0.1, "0.1    "},
   {0.15, "0.15   "}, {0.2, "0.2    "}, {0.25, "0.25   "}, {0.3, "0.3    "},
   {0.35, "0.35   "}, {0.4, "0.4    "}, {0.45, "0.45   "}};
framey = {{-100, "100"}, {-6000, "6000"}, {-genes + 100, "11956"}};
coordinates = Table[
   If[arraylets[[3, a]] < -0.05, -0.05,
    If[arraylets[[3, a]] > 0.3, 0.3, arraylets[[3, a]]]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[1, 0, 0], line}],
   Frame -> True,
   FrameLabel -> {None, labely, None, None},
   FrameTicks -> {None, framey, None, None},
   GridLines -> {{{0, RGBColor[0, 0, 0]}}, {{-100, RGBColor[0, 0, 0]},
      {-6000, RGBColor[0, 0, 0]}, {-genes + 100, RGBColor[0, 0, 0]}}},
   PlotRange -> {{-0.05, 0.3001}, {360, -genes + 1 - 360}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1400}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 800}, {0, 0}, {0, 1}];
p3 = Show[g,
   AspectRatio → 1 / GoldenRatio,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = "Expression Level";
labely = ColumnForm[
   {" ", "(b) Number of Genes", " ", " ", " ", " ", " ", " ", " ", " "},
   Center];
framex = {{-0.05, "-0.05  "}, {0, "0      "}, {0.05, "0.05   "}, {0.1, "0.1    "},
   {0.15, "0.15   "}, {0.2, "0.2    "}, {0.25, "0.25   "}, {0.3, "0.3    "},
   {0.35, "0.35   "}, {0.4, "0.4    "}, {0.45, "0.45   "}};
framey = {{-100, "100"}, {-6000, "6000"}, {-genes + 100, "11956"}};
coordinates = Table[
   If[arraylets[[4, a]] + 0.05 < -0.05, -0.05,
    If[arraylets[[4, a]] + 0.05 > 0.3, 0.3, arraylets[[4, a]] + 0.05]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[1, 0.5, 0], line}],
   Frame -> True,
   FrameLabel -> {None, labely, None, None},
   FrameTicks -> {None, framey, None, None},
   GridLines -> {{{0.05, RGBColor[0, 0, 0]}}, {{-100, RGBColor[0, 0, 0]},
      {-6000, RGBColor[0, 0, 0]}, {-genes + 100, RGBColor[0, 0, 0]}}},
   PlotRange -> {{-0.05, 0.3001}, {360, -genes + 1 - 360}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1400}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 800}, {0, 0}, {0, 1}];
p4 = Show[g,
   AspectRatio → 1 / GoldenRatio,
   PlotRange -> All,
   DisplayFunction → Identity];
```

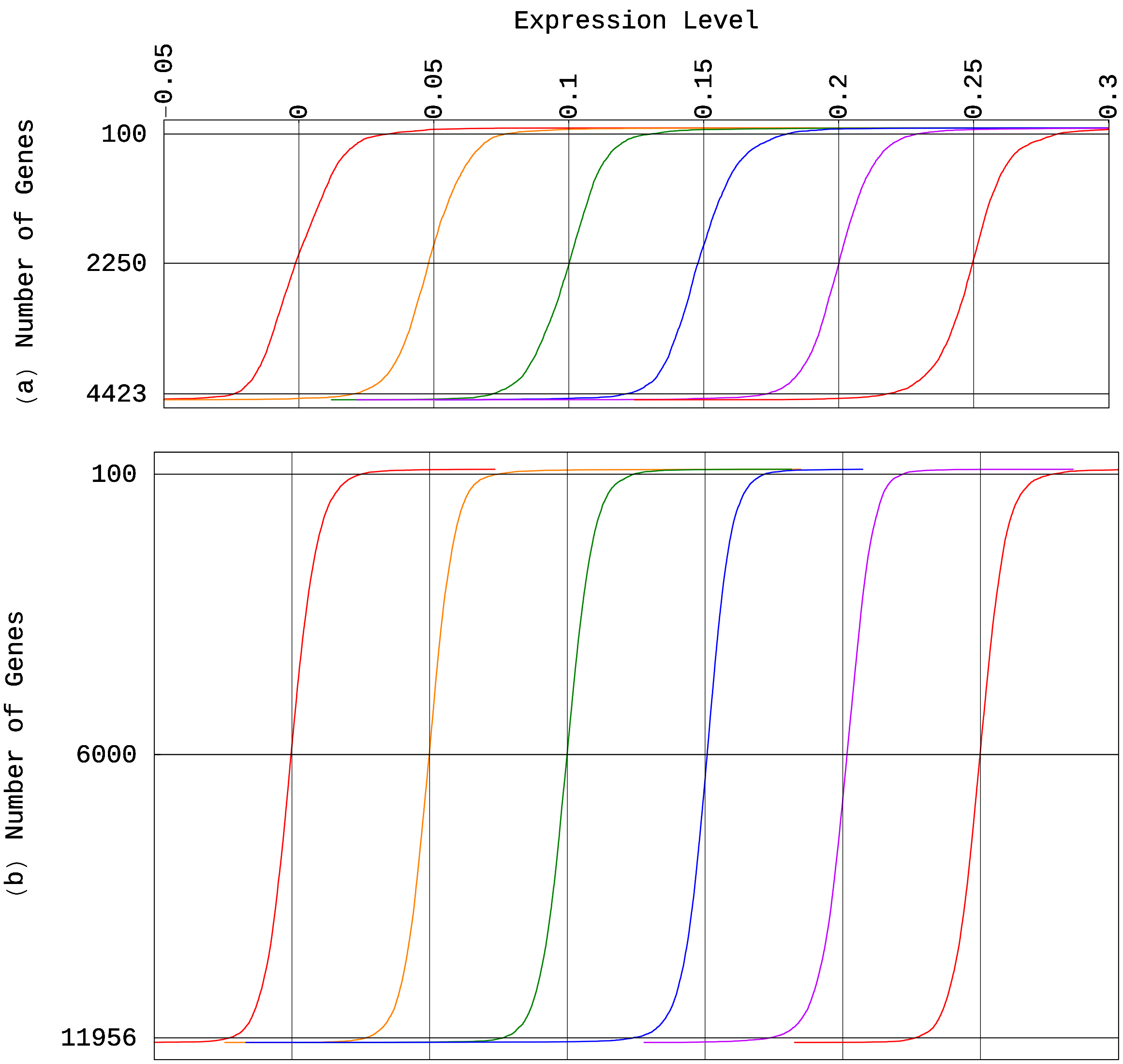
```
labelx = "Expression Level";
labely = ColumnForm[
   {" ", "(b) Number of Genes", " ", " ", " ", " ", " ", " ", " ", " "},
   Center];
framex = {{-0.05, "-0.05  "}, {0, "0      "}, {0.05, "0.05   "}, {0.1, "0.1    "},
   {0.15, "0.15   "}, {0.2, "0.2    "}, {0.25, "0.25   "}, {0.3, "0.3    "},
   {0.35, "0.35   "}, {0.4, "0.4    "}, {0.45, "0.45   "}};
framey = {{-100, "100"}, {-6000, "6000"}, {-genes + 100, "11956"}};
coordinates = Table[
   If[arraylets[[5, a]] + 0.1 < -0.05, -0.05,
    If[arraylets[[5, a]] + 0.1 > 0.3, 0.3, arraylets[[5, a]] + 0.1]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[0, 0.5, 0], line}],
   Frame -> True,
   FrameLabel -> {None, labely, None, None},
   FrameTicks -> {None, framey, None, None},
   GridLines -> {{{0.1, RGBColor[0, 0, 0]}}, {{-100, RGBColor[0, 0, 0]},
      {-6000, RGBColor[0, 0, 0]}, {-genes + 100, RGBColor[0, 0, 0]}}},
   PlotRange -> {{-0.05, 0.3001}, {360, -genes + 1 - 360}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1400}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 800}, {0, 0}, {0, 1}];
p5 = Show[g,
   AspectRatio → 1 / GoldenRatio,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = "Expression Level";
labely = ColumnForm[
   {" ", "(b) Number of Genes", " ", " ", " ", " ", " ", " ", " ", " "},
   Center];
framex = {{-0.05, "-0.05  "}, {0, "0      "}, {0.05, "0.05   "}, {0.1, "0.1    "},
   {0.15, "0.15   "}, {0.2, "0.2    "}, {0.25, "0.25   "}, {0.3, "0.3    "},
   {0.35, "0.35   "}, {0.4, "0.4    "}, {0.45, "0.45   "}};
framey = {{-100, "100"}, {-6000, "6000"}, {-genes + 100, "11956"}};
coordinates = Table[
   If[arraylets[[14, a]] + 0.15 < -0.05, -0.05,
    If[arraylets[[14, a]] + 0.15 > 0.3, 0.3, arraylets[[14, a]] + 0.15]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[0, 0, 1], line}],
   Frame -> True,
   FrameLabel -> {None, labely, None, None},
   FrameTicks -> {None, framey, None, None},
   GridLines -> {{{0.15, RGBColor[0, 0, 0]}}, {{-100, RGBColor[0, 0, 0]},
      {-6000, RGBColor[0, 0, 0]}, {-genes + 100, RGBColor[0, 0, 0]}}},
   PlotRange -> {{-0.05, 0.3001}, {360, -genes + 1 - 360}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1400}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 800}, {0, 0}, {0, 1}];
p14 = Show[g,
   AspectRatio → 1 / GoldenRatio,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = "Expression Level";
labely = ColumnForm[
   {" ", "(b) Number of Genes", " ", " ", " ", " ", " ", " ", " ", " "},
   Center];
framex = {{-0.05, "-0.05  "}, {0, "0      "}, {0.05, "0.05   "}, {0.1, "0.1    "},
   {0.15, "0.15   "}, {0.2, "0.2    "}, {0.25, "0.25   "}, {0.3, "0.3    "},
   {0.35, "0.35   "}, {0.4, "0.4    "}, {0.45, "0.45   "}};
framey = {{-100, "100"}, {-6000, "6000"}, {-genes + 100, "11956"}};
coordinates = Table[
   If[arraylets[[15, a]] + 0.2 < -0.05, -0.05,
    If[arraylets[[15, a]] + 0.2 > 0.3, 0.3, arraylets[[15, a]] + 0.2]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[0.75, 0, 1], line}],
   Frame -> True,
   FrameLabel -> {None, labely, None, None},
   FrameTicks -> {None, framey, None, None},
   GridLines -> {{{0.2, RGBColor[0, 0, 0]}}, {{-100, RGBColor[0, 0, 0]},
      {-6000, RGBColor[0, 0, 0]}, {-genes + 100, RGBColor[0, 0, 0]}}},
   PlotRange -> {{-0.05, 0.3001}, {360, -genes + 1 - 360}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1400}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 800}, {0, 0}, {0, 1}];
p15 = Show[g,
   AspectRatio → 1 / GoldenRatio,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = "Expression Level";
labely = ColumnForm[
   {" ", "(b) Number of Genes", " ", " ", " ", " ", " ", " ", " ", " "},
   Center];
framex = {{-0.05, "-0.05  "}, {0, "0      "}, {0.05, "0.05   "}, {0.1, "0.1    "},
   {0.15, "0.15   "}, {0.2, "0.2    "}, {0.25, "0.25   "}, {0.3, "0.3    "},
   {0.35, "0.35   "}, {0.4, "0.4    "}, {0.45, "0.45   "}};
framey = {{-100, "100"}, {-6000, "6000"}, {-genes + 100, "11956"}};
coordinates = Table[
   If[arraylets[[16, a]] + 0.25 < -0.05, -0.05,
    If[arraylets[[16, a]] + 0.25 > 0.3, 0.3, arraylets[[16, a]] + 0.25]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[1, 0, 0], line}],
   Frame -> True,
   FrameLabel -> {None, labely, None, None},
   FrameTicks -> {None, framey, None, None},
   GridLines -> {{{0.25, RGBColor[0, 0, 0]}}, {{-100, RGBColor[0, 0, 0]},
      {-6000, RGBColor[0, 0, 0]}, {-genes + 100, RGBColor[0, 0, 0]}}},
   PlotRange -> {{-0.05, 0.3001}, {360, -genes + 1 - 360}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1400}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 800}, {0, 0}, {0, 1}];
p16 = Show[g,
   AspectRatio → 1 / GoldenRatio,
   PlotRange -> All,
   DisplayFunction → Identity];

(* Display Selected Sorted Human Arraylets *)

g2 = Show[{p3, p4, p5, p14, p15, p16}];
```

```
(* Display Sorted Yeast and Human Selected Arraylets *)

Show[{
   Graphics[{Rectangle[{0, 0}, {5, 161}, g2]}],
   Graphics[{Rectangle[{0, 166}, {5, 270}, g1]}]},
  PlotRange -> All];
```



```
(* Calculate Significance of Cell Cycle Associations in Yeast *)

genes = genes1;
arraynames = arraynames1;
arraylets = arraylets1;

(* Use Microarray Classification of Yeast Genes *)

genenames = TakeColumns[genenames1, {5}];
stages = {"M/G1", "G1", "S", "S/G2", "G2/M", "None"};
numbers = Flatten[Table[{Count[Flatten[genenames], stages[[a]]]}, {a, 1, 6}]];
genelet = {{3}, {4}, {5}, {14}, {15}, {16}};
probability = Table[{0}, {a, 1, 6}];
parallelannotation = Table[{0}, {a, 1, 6}];
parallelprobability = Table[{0}, {a, 1, 6}];
antiannotation = Table[{0}, {a, 1, 6}];
antiprobability = Table[{0}, {a, 1, 6}];

Do[{
  arraylet = TakeColumns[Sort[
     AppendRows[TakeColumns[arraylets, genelet[[c]]], genenames],
     OrderedQ[{{#2}, {#1}}] &], {2}],
  table = Table[{
     stages[[a]],
     numbers[[a]],
     Count[Flatten[TakeRows[arraylet, {1, 100}]], stages[[a]]]},
    {a, 1, 6}],
  probability = Table[{
     Sum[N[Binomial[table[[a, 2]], b] * Binomial[genes - table[[a, 2]], 100 - b] /
         Binomial[genes, 100]], {b, table[[a, 3]], 100}],
     stages[[a]]},
    {a, 1, 6}],
  parallelannotation[[c]] = {Sort[probability, OrderedQ[{{#1}, {#2}}] &][[1, 2]]},
  parallelprobability[[c]] = {ScientificForm[Sort[probability, OrderedQ[{{#1}, {#2}}] &][[1, 1]], 2]},
  table = Table[{
     stages[[a]],
     numbers[[a]],
     Count[Flatten[TakeRows[arraylet, {genes - 99, genes}]], stages[[a]]]},
    {a, 1, 6}],
  probability = Table[{
     Sum[N[Binomial[table[[a, 2]], b] * Binomial[genes - table[[a, 2]], 100 - b] /
         Binomial[genes, 100]], {b, table[[a, 3]], 100}],
     stages[[a]]},
    {a, 1, 6}],
  antiannotation[[c]] = {Sort[probability, OrderedQ[{{#1}, {#2}}] &][[1, 2]]},
  antiprobability[[c]] = {ScientificForm[Sort[probability, OrderedQ[{{#1}, {#2}}] &][[1, 1]], 2]}},
 {c, 1, Dimensions[genelet][[1]]}]

table1 = AppendRows[
   genelet,
   parallelannotation,
   parallelprobability,
   antiannotation,
   antiprobability];
```

```
(* Use Traditional Classification of Yeast Genes *)

genenames = TakeColumns[genenames1, {6}];
stages = {"M/G1", "G1", "S", "S/G2", "G2/M", "None"};
numbers = Flatten[Table[{Count[Flatten[genenames], stages[[a]]]}, {a, 1, 6}]];
genelet = {{3}, {4}, {5}, {14}, {15}, {16}};
probability = Table[{0}, {a, 1, 6}];
parallelannotation = Table[{0}, {a, 1, 6}];
parallelprobability = Table[{0}, {a, 1, 6}];
antiannotation = Table[{0}, {a, 1, 6}];
antiprobability = Table[{0}, {a, 1, 6}];

Do[{
  arraylet = TakeColumns[Sort[
     AppendRows[TakeColumns[arraylets, genelet[[c]]], genenames],
     OrderedQ[{{#2}, {#1}}] &], {2}],
  table = Table[{
     stages[[a]],
     numbers[[a]],
     Count[Flatten[TakeRows[arraylet, {1, 100}]], stages[[a]]]},
    {a, 1, 6}],
  probability = Table[{
     Sum[N[Binomial[table[[a, 2]], b] * Binomial[genes - table[[a, 2]], 100 - b] /
         Binomial[genes, 100]], {b, table[[a, 3]], 100}],
     stages[[a]]},
    {a, 1, 6}],
  parallelannotation[[c]] = {Sort[probability, OrderedQ[{{#1}, {#2}}] &][[1, 2]]},
  parallelprobability[[c]] = {ScientificForm[Sort[probability, OrderedQ[{{#1}, {#2}}] &][[1, 1]], 2]},
  table = Table[{
     stages[[a]],
     numbers[[a]],
     Count[Flatten[TakeRows[arraylet, {genes - 99, genes}]], stages[[a]]]},
    {a, 1, 6}],
  probability = Table[{
     Sum[N[Binomial[table[[a, 2]], b] * Binomial[genes - table[[a, 2]], 100 - b] /
         Binomial[genes, 100]], {b, table[[a, 3]], 100}],
     stages[[a]]},
    {a, 1, 6}],
  antiannotation[[c]] = {Sort[probability, OrderedQ[{{#1}, {#2}}] &][[1, 2]]},
  antiprobability[[c]] = {ScientificForm[Sort[probability, OrderedQ[{{#1}, {#2}}] &][[1, 1]], 2]}},
 {c, 1, Dimensions[genelet][[1]]}]

table2 = AppendRows[
   genelet,
   parallelannotation,
   parallelprobability,
   antiannotation,
   antiprobability];
```

```
(* Calculate Significance of Cell Cycle Associations in Human *)

genes = genes2;
arraynames = arraynames2;
arraylets = arraylets2;

(* Use Microarray Classification of Human Genes *)

genenames = TakeColumns[genenames2, {4}];
stages = {"M/G1", "G1/S", "S", "G2", "G2/M", "None"};
numbers = Flatten[Table[{Count[Flatten[genenames], stages[[a]]]}, {a, 1, 6}]];
genelet = {{3}, {4}, {5}, {14}, {15}, {16}};
probability = Table[{0}, {a, 1, 6}];
parallelannotation = Table[{0}, {a, 1, 6}];
parallelprobability = Table[{0}, {a, 1, 6}];
antiannotation = Table[{0}, {a, 1, 6}];
antiprobability = Table[{0}, {a, 1, 6}];

Do[{
  arraylet = TakeColumns[Sort[
     AppendRows[TakeColumns[arraylets, genelet[[c]]], genenames],
     OrderedQ[{{#2}, {#1}}] &], {2}],
  table = Table[{
     stages[[a]],
     numbers[[a]],
     Count[Flatten[TakeRows[arraylet, {1, 100}]], stages[[a]]]},
    {a, 1, 6}],
  probability = Table[{
     Sum[N[Binomial[table[[a, 2]], b] * Binomial[genes - table[[a, 2]], 100 - b] /
         Binomial[genes, 100]], {b, table[[a, 3]], 100}],
     stages[[a]]},
    {a, 1, 6}],
  parallelannotation[[c]] = {Sort[probability, OrderedQ[{{#1}, {#2}}] &][[1, 2]]},
  parallelprobability[[c]] = {ScientificForm[Sort[probability, OrderedQ[{{#1}, {#2}}] &][[1, 1]], 2]},
  table = Table[{
     stages[[a]],
     numbers[[a]],
     Count[Flatten[TakeRows[arraylet, {genes - 99, genes}]], stages[[a]]]},
    {a, 1, 6}],
  probability = Table[{
     Sum[N[Binomial[table[[a, 2]], b] * Binomial[genes - table[[a, 2]], 100 - b] /
         Binomial[genes, 100]], {b, table[[a, 3]], 100}],
     stages[[a]]},
    {a, 1, 6}],
  antiannotation[[c]] = {Sort[probability, OrderedQ[{{#1}, {#2}}] &][[1, 2]]},
  antiprobability[[c]] = {ScientificForm[Sort[probability, OrderedQ[{{#1}, {#2}}] &][[1, 1]], 2]}},
 {c, 1, Dimensions[genelet][[1]]}]

table3 = AppendRows[
   genelet,
   parallelannotation,
   parallelprobability,
   antiannotation,
   antiprobability];
```

```
(* Use Traditional Classification of Human Genes *)

genenames = TakeColumns[genenames2, {5}];
stages = {"M/G1", "G1/S", "S", "G2", "G2/M", "None"};
numbers = Flatten[Table[{Count[Flatten[genenames], stages[[a]]]}, {a, 1, 6}]];
genelet = {{3}, {4}, {5}, {14}, {15}, {16}};
probability = Table[{0}, {a, 1, 6}];
parallelannotation = Table[{0}, {a, 1, 6}];
parallelprobability = Table[{0}, {a, 1, 6}];
antiannotation = Table[{0}, {a, 1, 6}];
antiprobability = Table[{0}, {a, 1, 6}];

Do[{
  arraylet = TakeColumns[Sort[
     AppendRows[TakeColumns[arraylets, genelet[[c]]], genenames],
     OrderedQ[{{#2}, {#1}}] &], {2}],
  table = Table[{
     stages[[a]],
     numbers[[a]],
     Count[Flatten[TakeRows[arraylet, {1, 100}]], stages[[a]]]},
    {a, 1, 6}],
  probability = Table[{
     Sum[N[Binomial[table[[a, 2]], b] * Binomial[genes - table[[a, 2]], 100 - b] /
         Binomial[genes, 100]], {b, table[[a, 3]], 100}],
     stages[[a]]},
    {a, 1, 6}],
  parallelannotation[[c]] = {Sort[probability, OrderedQ[{{#1}, {#2}}] &][[1, 2]]},
  parallelprobability[[c]] = {ScientificForm[Sort[probability, OrderedQ[{{#1}, {#2}}] &][[1, 1]], 2]},
  table = Table[{
     stages[[a]],
     numbers[[a]],
     Count[Flatten[TakeRows[arraylet, {genes - 99, genes}]], stages[[a]]]},
    {a, 1, 6}],
  probability = Table[{
     Sum[N[Binomial[table[[a, 2]], b] * Binomial[genes - table[[a, 2]], 100 - b] /
         Binomial[genes, 100]], {b, table[[a, 3]], 100}],
     stages[[a]]},
    {a, 1, 6}],
  antiannotation[[c]] = {Sort[probability, OrderedQ[{{#1}, {#2}}] &][[1, 2]]},
  antiprobability[[c]] = {ScientificForm[Sort[probability, OrderedQ[{{#1}, {#2}}] &][[1, 1]], 2]}},
 {c, 1, Dimensions[genelet][[1]]}]

table4 = AppendRows[
   genelet,
   parallelannotation,
   parallelprobability,
   antiannotation,
   antiprobability];
```

```
(* Display Significance of Association of Genelets and Arraylets with the Cell Cycle *)

headerx = {{
    ColumnForm[{" ", " ", " "}, Left],
    ColumnForm[{" ", " ", "Dataset"}, Left],
    ColumnForm[{" ", " ", "Classification"}, Left],
    ColumnForm[{"Genelet", "and", "Arraylet"}, Left],
    ColumnForm[{"Most Likely", "Parallel", "Association"}, Left],
    ColumnForm[{"P-Value of", "Parallel", "Association"}, Left],
    ColumnForm[{"Most Likely", "Antiparallel", "Association"}, Left],
    ColumnForm[{"P-Value of", "Antiparallel", "Association"}, Left]},
   {" ", " ", " ", " ", " ", " ", " ", " "}};
spacerx = {{" ", " ", " ", " ", " "}};
headery = Table[" ", {a, 1, 27}, {b, 1, 3}];
headery[[1]] = {"(a)", "Yeast", "Microarray"};
headery[[8]] = {"(b)", " ", "Traditional"};
headery[[15]] = {"(c)", "Human", "Microarray"};
headery[[22]] = {"(d)", " ", "Traditional"};
association =
  AppendColumns[headerx,
   AppendRows[headery,
    AppendColumns[table1, spacerx, table2, spacerx, table3, spacerx, table4]]];
TableForm[association, TableSpacing → {1, 1}]
```

```
                              Genelet   Most Likely  P-Value of   Most Likely   P-Value of
                              and       Parallel     Parallel     Antiparallel  Antiparallel
     Dataset  Classification  Arraylet  Association  Association  Association   Association

(a)  Yeast    Microarray      3         G1           2.1×10^-49   G2/M          1.6×10^-18
                              4         G2/M         2.9×10^-15   G1            1.1×10^-36
                              5         M/G1         1.3×10^-36   S/G2          7.2×10^-8
                              14        G2/M         8.8×10^-8    G1            2.6×10^-13
                              15        S/G2         5.9×10^-7    G1            3.3×10^-14
                              16        M/G1         6.6×10^-9    S             7.5×10^-3

(b)           Traditional     3         G1           1.7×10^-12   G2/M          1.9×10^-4
                              4         M/G1         8.2×10^-6    G1            2.6×10^-22
                              5         M/G1         1.2×10^-10   S             5.4×10^-4
                              14        G2/M         1.9×10^-4    G1            2.2×10^-8
                              15        G2/M         3.2×10^-3    G1            5.4×10^-14
                              16        M/G1         2.6×10^-7    S             1.5×10^-5

(c)  Human    Microarray      3         G2/M         5.6×10^-3    G1/S          7.9×10^-2
                              4         S            8.2×10^-21   M/G1          1.3×10^-3
                              5         G2/M         6.9×10^-8    G1/S          6.4×10^-5
                              14        G2           3.3×10^-34   M/G1          1.3×10^-3
                              15        G1/S         4.×10^-37    G2            1.9×10^-37
                              16        G2/M         2.×10^-33    G1/S          3.×10^-10

(d)           Traditional     3         G2/M         1.×10^-1     S             3.2×10^-3
                              4         S            1.5×10^-8    G1/S          7.6×10^-3
                              5         G2           4.9×10^-2    G1/S          1.2×10^-1
                              14        G2           6.6×10^-8    None          5.4×10^-1
                              15        G1/S         2.1×10^-13   G2/M          2.1×10^-14
                              16        G2/M         9.×10^-17    S             1.1×10^-5
```

```
(* Sort Yeast and Human Data in Common Cell Cycle Subspace *)
```

```
(* Approximate 6 D Subspace of Genelets with 2 D Subspace *)

(* Assume 4 πt/T ~ 5 πt/T → z *)

genelets3 = Sqrt[2 / 3 / 17] - Sqrt[2 / 3 / 17] * Cos[z + Pi / 3];
genelets4 = -Sqrt[2 / 3 / 17] + Sqrt[2 / 3 / 17] * Cos[z];
genelets5 = Sqrt[2 / 17] * Cos[z - Pi / 3];
genelets14 = -Sqrt[2 / 3 / 17] + Sqrt[2 / 3 / 17] * Cos[z - Pi / 3];
genelets15 = Sqrt[2 / 3 / 17] + Sqrt[2 / 3 / 17] * Cos[z + Pi / 3];
genelets16 = -Sqrt[2 / 3 / 17] - Sqrt[2 / 3 / 17] * Cos[z];
```

$$\text{(* Define 2 D Subspace } \{x,y\} \equiv \left\{\sqrt{2/T}\cos(z), \sqrt{2/T}\sin(z)\right\} \text{ *)}$$

```
(* Project 6 D Subspace of Genelets Onto 2 D Subspace *)

Clear[a1, a2, b1, b2, c1, c2];
Chop[
 Simplify[
  TrigExpand[
   (a1 * genelets3 + b1 * genelets4 + c1 * genelets5 +
      a2 * genelets15 + b2 * genelets16 + c2 * genelets14) /
    Sqrt[2 / 17]]]]
```

$$\frac{1}{6}\left(2\sqrt{3}\,(a1 + a2 - b1 - b2 - c2) + \left(-\sqrt{3}\,a1 + \sqrt{3}\,a2 + 2\sqrt{3}\,b1 - 2\sqrt{3}\,b2 + 3\,c1 + \sqrt{3}\,c2\right)\mathrm{Cos}[z] + 3\,\left(a1 - a2 + \sqrt{3}\,c1 + c2\right)\mathrm{Sin}[z]\right)$$

```
(* Sort Yeast Data *)

genes = genes1;
arraynames = arraynames1;
genenames = TakeColumns[genenames1, 1];

(* Sort Yeast Arrays *)

(* Center Genelets and Calculate Contributions of Arraylets to Arrays *)

arraycontributions3 = (genelets[[3]] - Sqrt[2 / 3 / 17.]) * d1[[3, 3]];
arraycontributions4 = (genelets[[4]] + Sqrt[2 / 3 / 17.]) * d1[[4, 4]];
arraycontributions5 = genelets[[5]] * d1[[5, 5]];
arraycontributions14 = (genelets[[14]] + Sqrt[2 / 3 / 17.]) * d1[[14, 14]];
arraycontributions15 = (genelets[[15]] - Sqrt[2 / 3 / 17.]) * d1[[15, 15]];
arraycontributions16 = (genelets[[16]] + Sqrt[2 / 3 / 17.]) * d1[[16, 16]];
```

```
(* Project Arrays from 6 D Arraylets Subspace Onto 2 D Subspace  *)

coordinates = Table[{
    (-Sqrt[3] * (arraycontributions3[[a]] - arraycontributions15[[a]]) +
        2 * Sqrt[3] * (arraycontributions4[[a]] - arraycontributions16[[a]]) +
        (3 * arraycontributions5[[a]] + Sqrt[3] * arraycontributions14[[a]])) / 6 /
     Sqrt[(arraycontributions3[[a]] - arraycontributions15[[a]]) ^ 2 / 3 +
       (arraycontributions4[[a]] - arraycontributions16[[a]]) ^ 2 / 3 +
       (arraycontributions5[[a]] + arraycontributions14[[a]] / Sqrt[3]) ^ 2 +
       Abs[(arraycontributions3[[a]] - arraycontributions15[[a]]) / Sqrt[3] *
          (arraycontributions4[[a]] - arraycontributions16[[a]])] / Sqrt[3] +
       Abs[(arraycontributions3[[a]] - arraycontributions15[[a]]) / Sqrt[3] *
         (arraycontributions5[[a]] + arraycontributions14[[a]] / Sqrt[3])] +
       Abs[(arraycontributions4[[a]] - arraycontributions16[[a]]) / Sqrt[3] *
         (arraycontributions5[[a]] + arraycontributions14[[a]] / Sqrt[3])]],
    (3 * (arraycontributions3[[a]] - arraycontributions15[[a]]) +
        Sqrt[3] * (3 * arraycontributions5[[a]] + Sqrt[3] * arraycontributions14[[a]])) / 6 /
     Sqrt[(arraycontributions3[[a]] - arraycontributions15[[a]]) ^ 2 / 3 +
       (arraycontributions4[[a]] - arraycontributions16[[a]]) ^ 2 / 3 +
       (arraycontributions5[[a]] + arraycontributions14[[a]] / Sqrt[3]) ^ 2 +
       Abs[(arraycontributions3[[a]] - arraycontributions15[[a]]) / Sqrt[3] *
          (arraycontributions4[[a]] - arraycontributions16[[a]])] / Sqrt[3] +
       Abs[(arraycontributions3[[a]] - arraycontributions15[[a]]) / Sqrt[3] *
         (arraycontributions5[[a]] + arraycontributions14[[a]] / Sqrt[3])] +
       Abs[(arraycontributions4[[a]] - arraycontributions16[[a]]) / Sqrt[3] *
         (arraycontributions5[[a]] + arraycontributions14[[a]] / Sqrt[3])]]},
   {a, 1, arrays}];

(* Create Parameter Graph of Yeast Arrays Projected Onto 2 D Subspace *)

points1 = {Point[coordinates[[1]]], Point[coordinates[[2]]],
   Point[coordinates[[10]]], Point[coordinates[[11]]]};
points2 = {Point[coordinates[[3]]], Point[coordinates[[4]]],
   Point[coordinates[[12]]], Point[coordinates[[13]]]};
points3 = {Point[coordinates[[5]]], Point[coordinates[[6]]],
   Point[coordinates[[14]]], Point[coordinates[[15]]]};
points4 = {Point[coordinates[[7]]], Point[coordinates[[16]]]};
points5 = {Point[coordinates[[8]]], Point[coordinates[[9]]],
   Point[coordinates[[17]]], Point[coordinates[[18]]]};
textcoordinates = coordinates;
Do[
  textcoordinates[[a, 1]] = If[
    textcoordinates[[a, 1]] > 0,
    textcoordinates[[a, 1]] - 0.085,
    textcoordinates[[a, 1]] + 0.095],
  {a, 1, 9}];
Do[
  textcoordinates[[a, 1]] =
   If[textcoordinates[[a, 1]] > 0,
    textcoordinates[[a, 1]] - 0.11,
    textcoordinates[[a, 1]] + 0.12],
  {a, 10, arrays}];
textcoordinates[[1]] = textcoordinates[[1]] + {0.04, -0.095};
textcoordinates[[3]] = textcoordinates[[3]] + {0.18, 0};
textcoordinates[[7]] = textcoordinates[[7]] + {0.18, 0};
textcoordinates[[8]] = textcoordinates[[8]] + {0.18, 0};
textcoordinates[[11]] = textcoordinates[[11]] + {0.12, -0.11};
textcoordinates[[12]] = textcoordinates[[12]] - {0.23, 0.06};
textcoordinates[[13]] = textcoordinates[[13]] + {0.23, 0};
textcoordinates[[15]] = textcoordinates[[15]] - {0.23, 0};
textcoordinates[[16]] = textcoordinates[[16]] - {0.02, 0.095};
textcoordinates[[17]] = textcoordinates[[17]] - {0.23, 0};
textcoordinates[[18]] = textcoordinates[[18]] + {0.11, 0.11};
```

```
texts = Table[Text[a, textcoordinates[[a]]], {a, 1, arrays}];
radius = Sqrt[coordinates[[2, 1]]^2 + coordinates[[2, 2]]^2];
p = Show[
   {Graphics[{RGBColor[1, 1, 0], PointSize[0.035], points1}],
    Graphics[{RGBColor[0, 0.5, 0], PointSize[0.035], points2}],
    Graphics[{RGBColor[0, 0, 1], PointSize[0.035], points3}],
    Graphics[{RGBColor[1, 0, 0], PointSize[0.035], points4}],
    Graphics[{RGBColor[1, 0.5, 0], PointSize[0.035], points5}],
    Graphics[{RGBColor[1, 0.5, 0], Text["G2/M", {1.075, -0.52}]}],
    Graphics[{RGBColor[0, 0, 0], Text["M/G1", {0.9, 0.75}]}],
    Graphics[{RGBColor[1, 0, 0], Text["S/G2", {0.775, -0.85}]}],
    Graphics[{RGBColor[0, 0, 1], Text["S", {-0.95, -0.6}]}],
    Graphics[{RGBColor[0, 0.5, 0], Text["G1", {-0.8, 0.8}]}],
    Graphics[{RGBColor[0, 0, 0], Text["(a)", {-0.9, 0.95}]}],
    Graphics[{RGBColor[0, 0, 0], Text["ϕ=π/3 ", {0.825, 0.95}]}],
    Graphics[{RGBColor[0, 0, 0], Text["ϕ=0", {1.12, -0.12}]}],
    Graphics[{RGBColor[0, 0, 0], Text[" |x〉", {1.12, 0.12}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|y〉", {-0.12, textcoordinates[[11, 2]]}]}],
    Graphics[{RGBColor[0, 0, 0], Text["ϕ=-π/3", {0.825, -0.975}]}],
    Graphics[texts],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 0.5]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 1]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Line[{{0, 1.05}, {0, -1.05}}]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05 / Tan[Pi / 3.], 1.05}, {1.05 / Tan[Pi / 3.], -1.05},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05, 0}, {1.25, 0},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05 / Tan[Pi / 3.], -1.05}, {1.05 / Tan[Pi / 3.], 1.05},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Circle[{0, 0}, 0.6,
       {ArcTan[coordinates[[1, 2]] / coordinates[[1, 1]]], 0}]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{0.6 * Cos[-0.05], 0.6 * Sin[-0.05]}, {0.6 * Cos[0], 0.6 * Sin[0]},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{0, 0}, coordinates[[1]],
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Text["r", {0.5, -0.35}]}],
    Graphics[{RGBColor[0, 0, 0], Text["ϕ", {0.65, -0.15}]}]},
   AspectRatio -> 1,
   PlotRange -> {{-1.05, 1.25}, {-1.05, 1.05}},
   Frame -> True,
   FrameTicks -> False,
   FrameLabel -> {None, None, None, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   DisplayFunction -> Identity];
p = FullGraphics[p];
p[[1, 2]] = p[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {-1.18, 0}, {0, 0}, {0, 1}];
p1 = Show[p,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Sort Yeast Genes *)

(* Center Arraylets and Calculate Contributions of Genelets to Genes *)

centerarraylets = Transpose[arraylets1];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
centerarraylets = centerarraylets - N[Outer[Times, Dot[centerarraylets, average], average]];
centerarraylets = Transpose[centerarraylets];
genecontributions = Transpose[Dot[centerarraylets, d1]];

(* Project Genes from 6 D Genelets Subspace Onto 2 D Subspace  *)

coordinates = Table[{
    (-Sqrt[3] * (genecontributions[[3, a]] - genecontributions[[15, a]]) +
        2 * Sqrt[3] * (genecontributions[[4, a]] - genecontributions[[16, a]]) +
        (3 * genecontributions[[5, a]] + Sqrt[3] * genecontributions[[14, a]])) / 6 /
     Sqrt[(genecontributions[[3, a]] - genecontributions[[15, a]]) ^2 / 3 +
       (genecontributions[[4, a]] - genecontributions[[16, a]]) ^2 / 3 +
       (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3]) ^2 +
       Abs[(genecontributions[[3, a]] - genecontributions[[15, a]]) / Sqrt[3] *
          (genecontributions[[4, a]] - genecontributions[[16, a]])] / Sqrt[3] +
       Abs[(genecontributions[[3, a]] - genecontributions[[15, a]]) / Sqrt[3] *
         (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])] +
       Abs[(genecontributions[[4, a]] - genecontributions[[16, a]]) / Sqrt[3] *
         (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])]],
    (3 * (genecontributions[[3, a]] - genecontributions[[15, a]]) +
        Sqrt[3] * (3 * genecontributions[[5, a]] + Sqrt[3] * genecontributions[[14, a]])) / 6 /
     Sqrt[(genecontributions[[3, a]] - genecontributions[[15, a]]) ^2 / 3 +
       (genecontributions[[4, a]] - genecontributions[[16, a]]) ^2 / 3 +
       (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3]) ^2 +
       Abs[(genecontributions[[3, a]] - genecontributions[[15, a]]) / Sqrt[3] *
          (genecontributions[[4, a]] - genecontributions[[16, a]])] / Sqrt[3] +
       Abs[(genecontributions[[3, a]] - genecontributions[[15, a]]) / Sqrt[3] *
         (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])] +
       Abs[(genecontributions[[4, a]] - genecontributions[[16, a]]) / Sqrt[3] *
         (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])]]},
   {a, 1, genes}];

(* Create Parameter Graph of 603 Cell Cycle Genes Projected Onto in 2 D Subspace *)

stream = StringJoin[name, ":Desktop Folder:PNAS Data:Spellman_Yeast_Classify.txt"];
list = ReadList[stream, Word, RecordLists -> True, NullWords -> True];
list = Drop[list, 1];
stages = {"M/G1", "G1", "S", "S/G2", "G2/M"};
points = {points1, points2, points3, points4, points5};
radii = {radii1, radii2, radii3, radii4, radii5};
Do[{
  position = Position[list, stages[[b]]],
  table = Table[list[[position[[a, 1]], 1]], {a, 1, Dimensions[position][[1]]}],
  position = Table[Position[genenames, table[[a]]], {a, 1, Dimensions[table][[1]]}],
  table = Flatten[Position[position, {}]],
  Do[
   position = Drop[position, {table[[a]], table[[a]]}],
   {a, Dimensions[table][[1]], 1, -1}],
  points[[b]] = Table[Point[coordinates[[position[[a, 1, 1]]]]], {a, 1, Dimensions[position][[1]]}],
  radii[[b]] = Table[
    Sqrt[coordinates[[position[[a, 1, 1]], 1]]^2 + coordinates[[position[[a, 1, 1]], 2]]^2],
    {a, 1, Dimensions[position][[1]]}]},
 {b, 1, Dimensions[stages][[1]]}]
```

```
Dimensions[points[[1]]][[1]]
Dimensions[points[[2]]][[1]]
Dimensions[points[[3]]][[1]]
Dimensions[points[[4]]][[1]]
Dimensions[points[[5]]][[1]]
```

```
76

233

56

92

147
```

```
radii = Sort[Flatten[radii], OrderedQ[{{#1}, {#2}}] &];
N[Round[radii[[57]] * 100] / 100]
N[Round[radii[[58]] * 100] / 100]
```

```
0.49

0.5
```

```
(* 604 cell cycle genes, 76 in M/G1, 233 in G1, 56 in S, 92 in S/G2, 147 in G2/M. *)

(* For 547 genes, 50 % or more of the contributions of the 6 genelets add up. *)
```

```
kar4 = coordinates[[Position[genenames, "YCL055W"][[1, 1]]]];
cik1 = coordinates[[Position[genenames, "YMR198W"][[1, 1]]]];
p = Show[
   {Graphics[{RGBColor[0, 0, 0], Text["φ=π/3 ", {0.825, 0.95}]}],
    Graphics[{RGBColor[0, 0, 0], Text["φ=0", {1.12, -0.12}]}],
    Graphics[{RGBColor[0, 0, 0], Text[" |x⟩", {1.12, 0.12}]}],
    Graphics[{RGBColor[0, 0, 0], Text["φ=-π/3", {0.825, -0.975}]}],
    Graphics[{RGBColor[1, 1, 0], PointSize[0.02], Point[kar4]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-0.9, 0.65}, kar4,
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Text["KAR4", {-0.9, 0.7}]}],
    Graphics[{RGBColor[1, 0, 0], PointSize[0.02], Point[cik1]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-0.72, -0.93}, cik1,
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Text["CIK1", {-0.85, -0.93}]}],
    Graphics[{RGBColor[1, 0.5, 0], PointSize[0.02], points[[5]]}],
    Graphics[{RGBColor[1, 1, 0], PointSize[0.02], points[[1]]}],
    Graphics[{RGBColor[1, 0, 0], PointSize[0.02], points[[4]]}],
    Graphics[{RGBColor[0, 0.5, 0], PointSize[0.02], points[[2]]}],
    Graphics[{RGBColor[0, 0, 1], PointSize[0.02], points[[3]]}],
    Graphics[{RGBColor[1, 0.5, 0], Text["G2/M", {1.075, -0.52}]}],
    Graphics[{RGBColor[0, 0, 0], Text["M/G1", {0.9, 0.75}]}],
    Graphics[{RGBColor[1, 0, 0], Text["S/G2", {0.775, -0.85}]}],
    Graphics[{RGBColor[0, 0, 1], Text["S", {-0.95, -0.6}]}],
    Graphics[{RGBColor[0, 0.5, 0], Text["G1", {-0.8, 0.8}]}],
    Graphics[{RGBColor[0, 0, 0], Text["(b)", {-0.9, 0.95}]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 0.5]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 1]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Line[{{0, 1.05}, {0, -1.05}}]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05 / Tan[Pi / 3.], 1.05}, {1.05 / Tan[Pi / 3.], -1.05},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05, 0}, {1.25, 0},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05 / Tan[Pi / 3.], -1.05}, {1.05 / Tan[Pi / 3.], 1.05},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}]},
   AspectRatio -> 1,
   PlotRange -> {{-1.05, 1.25}, {-1.05, 1.05}},
   Frame -> True,
   FrameTicks -> False,
   FrameLabel -> {None, None, None, None},
   GridLines -> {None, None},
   DisplayFunction -> Identity];
p = FullGraphics[p];
p[[1, 2]] = p[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {-1.18, 0}, {0, 0}, {0, 1}];
p2 = Show[p,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Create Parameter Graph of 77 Cell Cycle Genes Projected Onto 2 D Subspace *)

stream = StringJoin[name, ":Desktop Folder:PNAS Data:Traditional_Yeast_Classify.txt"];
list = ReadList[stream, Word, RecordLists -> True, NullWords -> True];
list = Drop[list, 1];
stages = {"M/G1", "G1", "S", "S/G2", "G2/M"};
points = {points1, points2, points3, points4, points5};
radii = {radii1, radii2, radii3, radii4, radii5};
Do[{
  position = Position[list, stages[[b]]],
  table = Table[list[[position[[a, 1]], 1]], {a, 1, Dimensions[position][[1]]}],
  position = Table[Position[genenames, table[[a]]], {a, 1, Dimensions[table][[1]]}],
  table = Flatten[Position[position, {}]],
  Do[
   position = Drop[position, {table[[a]], table[[a]]}],
   {a, Dimensions[table][[1]], 1, -1}],
  points[[b]] = Table[Point[coordinates[[position[[a, 1, 1]]]]], {a, 1, Dimensions[position][[1]]}],
  radii[[b]] = Table[
    Sqrt[coordinates[[position[[a, 1, 1]], 1]]^2 + coordinates[[position[[a, 1, 1]], 2]]^2],
    {a, 1, Dimensions[position][[1]]}]},
 {b, 1, Dimensions[stages][[1]]}]

Dimensions[points[[1]]][[1]]
Dimensions[points[[2]]][[1]]
Dimensions[points[[3]]][[1]]
Dimensions[points[[4]]][[1]]
Dimensions[points[[5]]][[1]]

14

33

8

8

14

radii = Sort[Flatten[radii], OrderedQ[{{#1}, {#2}}] &];
N[Round[radii[[6]] * 100] / 100]
N[Round[radii[[7]] * 100] / 100]

0.32

0.54

(* 77 cell cycle genes, 14 in M/G1, 33 in G1, 8 in S, 8 in S/G2, 14 in G2/M. *)

(* For 71 genes, 50 % or more of the contributions of the 6 genelets add up. *)
```

```
kar4 = coordinates[[Position[genenames, "YCL055W"][[1, 1]]]];
cik1 = coordinates[[Position[genenames, "YMR198W"][[1, 1]]]];
p = Show[
   {Graphics[{RGBColor[0, 0, 0], Text["ϕ=π/3 ", {0.825, 0.95}]}],
    Graphics[{RGBColor[0, 0, 0], Text["ϕ=0", {1.12, -0.12}]}],
    Graphics[{RGBColor[0, 0, 0], Text[" |x⟩", {1.12, 0.12}]}],
    Graphics[{RGBColor[0, 0, 0], Text["ϕ=-π/3", {0.825, -0.975}]}],
    Graphics[{RGBColor[0, 0.5, 0], PointSize[0.02], Point[kar4]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-0.9, 0.65}, kar4,
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Text["KAR4", {-0.9, 0.7}]}],
    Graphics[{RGBColor[1, 0, 0], PointSize[0.02], Point[cik1]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-0.72, -0.93}, cik1,
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Text["CIK1", {-0.85, -0.93}]}],
    Graphics[{RGBColor[1, 0.5, 0], PointSize[0.02], points[[5]]}],
    Graphics[{RGBColor[1, 1, 0], PointSize[0.02], points[[1]]}],
    Graphics[{RGBColor[1, 0, 0], PointSize[0.02], points[[4]]}],
    Graphics[{RGBColor[0, 0.5, 0], PointSize[0.02], points[[2]]}],
    Graphics[{RGBColor[0, 0, 1], PointSize[0.02], points[[3]]}],
    Graphics[{RGBColor[1, 0.5, 0], Text["G2/M", {1.075, -0.52}]}],
    Graphics[{RGBColor[0, 0, 0], Text["M/G1", {0.9, 0.75}]}],
    Graphics[{RGBColor[1, 0, 0], Text["S/G2", {0.775, -0.85}]}],
    Graphics[{RGBColor[0, 0, 1], Text["S", {-0.95, -0.6}]}],
    Graphics[{RGBColor[0, 0.5, 0], Text["G1", {-0.8, 0.8}]}],
    Graphics[{RGBColor[0, 0, 0], Text["(c)", {-0.9, 0.95}]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 0.5]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 1]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Line[{{0, 1.05}, {0, -1.05}}]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05 / Tan[Pi / 3.], 1.05}, {1.05 / Tan[Pi / 3.], -1.05},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05, 0}, {1.25, 0},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05 / Tan[Pi / 3.], -1.05}, {1.05 / Tan[Pi / 3.], 1.05},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}]},
   AspectRatio -> 1,
   PlotRange -> {{-1.05, 1.25}, {-1.05, 1.05}},
   Frame -> True,
   FrameTicks -> False,
   FrameLabel -> {None, None, None, None},
   GridLines -> {None, None},
   DisplayFunction -> Identity];
p = FullGraphics[p];
p[[1, 2]] = p[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {-1.18, 0}, {0, 0}, {0, 1}];
p3 = Show[p,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Sort Human Data *)

genes = genes2;
arraynames = arraynames2;
genenames = TakeColumns[genenames2, 1];

(* Sort Human Arrays *)

(* Center Genelets and Calculate Contributions of Arraylets to Arrays *)

arraycontributions3 = (genelets[[3]] - Sqrt[2 / 3 / 17.]) * d2[[3, 3]];
arraycontributions4 = (genelets[[4]] + Sqrt[2 / 3 / 17.]) * d2[[4, 4]];
arraycontributions5 = genelets[[5]] * d2[[5, 5]];
arraycontributions14 = (genelets[[14]] + Sqrt[2 / 3 / 17.]) * d2[[14, 14]];
arraycontributions15 = (genelets[[15]] - Sqrt[2 / 3 / 17.]) * d2[[15, 15]];
arraycontributions16 = (genelets[[16]] + Sqrt[2 / 3 / 17.]) * d2[[16, 16]];

(* Project Arrays from 6 D Arraylets Subspace Onto 2 D Subspace  *)

coordinates = Table[{
    (-Sqrt[3] * (arraycontributions3[[a]] - arraycontributions15[[a]]) +
       2 * Sqrt[3] * (arraycontributions4[[a]] - arraycontributions16[[a]]) +
       (3 * arraycontributions5[[a]] + Sqrt[3] * arraycontributions14[[a]])) / 6 /
     Sqrt[(arraycontributions3[[a]] - arraycontributions15[[a]])^2 / 3 +
       (arraycontributions4[[a]] - arraycontributions16[[a]])^2 / 3 +
       (arraycontributions5[[a]] + arraycontributions14[[a]] / Sqrt[3])^2 +
       Abs[(arraycontributions3[[a]] - arraycontributions15[[a]]) / Sqrt[3] *
          (arraycontributions4[[a]] - arraycontributions16[[a]])] / Sqrt[3] +
       Abs[(arraycontributions3[[a]] - arraycontributions15[[a]]) / Sqrt[3] *
         (arraycontributions5[[a]] + arraycontributions14[[a]] / Sqrt[3])] +
       Abs[(arraycontributions4[[a]] - arraycontributions16[[a]]) / Sqrt[3] *
         (arraycontributions5[[a]] + arraycontributions14[[a]] / Sqrt[3])]],
    (3 * (arraycontributions3[[a]] - arraycontributions15[[a]]) +
       Sqrt[3] * (3 * arraycontributions5[[a]] + Sqrt[3] * arraycontributions14[[a]])) / 6 /
     Sqrt[(arraycontributions3[[a]] - arraycontributions15[[a]])^2 / 3 +
       (arraycontributions4[[a]] - arraycontributions16[[a]])^2 / 3 +
       (arraycontributions5[[a]] + arraycontributions14[[a]] / Sqrt[3])^2 +
       Abs[(arraycontributions3[[a]] - arraycontributions15[[a]]) / Sqrt[3] *
          (arraycontributions4[[a]] - arraycontributions16[[a]])] / Sqrt[3] +
       Abs[(arraycontributions3[[a]] - arraycontributions15[[a]]) / Sqrt[3] *
         (arraycontributions5[[a]] + arraycontributions14[[a]] / Sqrt[3])] +
       Abs[(arraycontributions4[[a]] - arraycontributions16[[a]]) / Sqrt[3] *
         (arraycontributions5[[a]] + arraycontributions14[[a]] / Sqrt[3])]]},
   {a, 1, arrays}];
```

```
(* Create Parameter Graph of Human Arrays Projected Onto 2 D Subspace *)

points1 = {Point[coordinates[[5]]], Point[coordinates[[6]]],
   Point[coordinates[[12]]], Point[coordinates[[13]]]};
points2 = {Point[coordinates[[7]]], Point[coordinates[[14]]]};
points3 = {Point[coordinates[[1]]], Point[coordinates[[2]]], Point[coordinates[[8]]],
   Point[coordinates[[9]]], Point[coordinates[[15]]], Point[coordinates[[16]]]};
points4 = {Point[coordinates[[3]]], Point[coordinates[[10]]], Point[coordinates[[17]]]};
points5 = {Point[coordinates[[4]]], Point[coordinates[[11]]], Point[coordinates[[18]]]};
textcoordinates = coordinates;
Do[
  textcoordinates[[a, 1]] = If[
    textcoordinates[[a, 1]] > 0,
    textcoordinates[[a, 1]] - 0.085,
    textcoordinates[[a, 1]] + 0.095],
  {a, 1, 9}];
Do[textcoordinates[[a, 1]] =
   If[
    textcoordinates[[a, 1]] > 0,
    textcoordinates[[a, 1]] - 0.11,
    textcoordinates[[a, 1]] + 0.12],
  {a, 10, arrays}];
textcoordinates[[1]] = textcoordinates[[1]] + {0.18, 0};
textcoordinates[[3]] = textcoordinates[[3]] + {0.18, -0.075};
textcoordinates[[5]] = textcoordinates[[5]] + {0, 0.08};
textcoordinates[[6]] = textcoordinates[[6]] + {0, 0.08};
textcoordinates[[7]] = textcoordinates[[7]] + {0.18, 0};
textcoordinates[[8]] = textcoordinates[[8]] + {0.18, 0};
textcoordinates[[11]] = textcoordinates[[11]] - {0.23, 0};
textcoordinates[[12]] = textcoordinates[[12]] - {0.23, 0};
textcoordinates[[15]] = textcoordinates[[15]] + {0.23, 0};
textcoordinates[[17]] = textcoordinates[[17]] - {0, 0.08};
```

```
texts = Table[Text[a, textcoordinates[[a]]], {a, 1, arrays}];
zerophase = N[ArcTan[coordinates[[1, 2]] / (coordinates[[1, 1]])]];
radius = Sqrt[coordinates[[2, 1]]^2 + coordinates[[2, 2]]^2];
p = Show[
   {Graphics[{RGBColor[1, 1, 0], PointSize[0.035], points1}],
    Graphics[{RGBColor[0, 0.5, 0], PointSize[0.035], points2}],
    Graphics[{RGBColor[0, 0, 1], PointSize[0.035], points3}],
    Graphics[{RGBColor[1, 0, 0], PointSize[0.035], points4}],
    Graphics[{RGBColor[1, 0.5, 0], PointSize[0.035], points5}],
    Graphics[{RGBColor[1, 0.5, 0], Text["G2/M", {-0.875, 0.75}]}],
    Graphics[{RGBColor[0, 0, 0], Text["M/G1", {-0.875, -0.75}]}],
    Graphics[{RGBColor[1, 0, 0], Text["G2", {-0.45, 0.975}]}],
    Graphics[{RGBColor[0, 0, 1], Text["S", {0.95, 0.6}]}],
    Graphics[{RGBColor[0, 0.5, 0], Text["G1/S", {0.825, -0.8}]}],
    Graphics[{RGBColor[0, 0, 0], Text["(d)", {-0.9, 0.95}]}],
    Graphics[{RGBColor[0, 0, 0], Text["ϕ=π/3 ", {0.825, 0.95}]}],
    Graphics[{RGBColor[0, 0, 0], Text["ϕ=0", {1.12, 0.12}]}],
    Graphics[{RGBColor[0, 0, 0], Text[" |x⟩", {1.12, -0.12}]}],
    Graphics[{RGBColor[0, 0, 0], Text["ϕ=-π/3", {0.825, -0.975}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|y⟩", {-0.12, textcoordinates[[18, 2]]}]}],
    Graphics[texts],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 0.5]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 1]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Line[{{0, 1.05}, {0, -1.05}}]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05 / Tan[Pi / 3.], 1.05}, {1.05 / Tan[Pi / 3.], -1.05},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05, 0}, {1.25, 0},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05 / Tan[Pi / 3.], -1.05}, {1.05 / Tan[Pi / 3.], 1.05},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Circle[{0, 0}, 0.6,
       {ArcTan[coordinates[[1, 2]] / coordinates[[1, 1]]], 0}]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{0.6 * Cos[-0.05], 0.6 * Sin[-0.05]}, {0.6 * Cos[0], 0.6 * Sin[0]},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{0, 0}, coordinates[[1]],
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Text["ϕ", {0.63, -0.25}]}],
    Graphics[{RGBColor[0, 0, 0], Text["r", {0.275, -0.15}]}]},
   AspectRatio -> 1,
   PlotRange -> {{-1.05, 1.25}, {-1.05, 1.05}},
   Frame -> True,
   FrameTicks -> False,
   FrameLabel -> {None, None, None, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   DisplayFunction -> Identity];
p = FullGraphics[p];
p[[1, 2]] = p[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {-1.18, 0}, {0, 0}, {0, 1}];
p4 = Show[p,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Sort Human Genes *)

(* Center Arraylets and Calculate Contributions of Genelets to Genes *)

centerarraylets = Transpose[arraylets2];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
centerarraylets = centerarraylets - N[Outer[Times, Dot[centerarraylets, average], average]];
centerarraylets = Transpose[centerarraylets];
genecontributions = Transpose[Dot[centerarraylets, d2]];

(* Project Genes from 6 D Genelets Subspace Onto 2 D Subspace  *)

coordinates = Table[{
    (-Sqrt[3] * (genecontributions[[3, a]] - genecontributions[[15, a]]) +
        2 * Sqrt[3] * (genecontributions[[4, a]] - genecontributions[[16, a]]) +
        (3 * genecontributions[[5, a]] + Sqrt[3] * genecontributions[[14, a]])) / 6 /
     Sqrt[(genecontributions[[3, a]] - genecontributions[[15, a]])^2 / 3 +
       (genecontributions[[4, a]] - genecontributions[[16, a]])^2 / 3 +
       (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])^2 +
       Abs[(genecontributions[[3, a]] - genecontributions[[15, a]]) / Sqrt[3] *
          (genecontributions[[4, a]] - genecontributions[[16, a]])] / Sqrt[3] +
       Abs[(genecontributions[[3, a]] - genecontributions[[15, a]]) / Sqrt[3] *
         (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])] +
       Abs[(genecontributions[[4, a]] - genecontributions[[16, a]]) / Sqrt[3] *
         (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])]],
    (3 * (genecontributions[[3, a]] - genecontributions[[15, a]]) +
        Sqrt[3] * (3 * genecontributions[[5, a]] + Sqrt[3] * genecontributions[[14, a]])) / 6 /
     Sqrt[(genecontributions[[3, a]] - genecontributions[[15, a]])^2 / 3 +
       (genecontributions[[4, a]] - genecontributions[[16, a]])^2 / 3 +
       (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])^2 +
       Abs[(genecontributions[[3, a]] - genecontributions[[15, a]]) / Sqrt[3] *
          (genecontributions[[4, a]] - genecontributions[[16, a]])] / Sqrt[3] +
       Abs[(genecontributions[[3, a]] - genecontributions[[15, a]]) / Sqrt[3] *
         (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])] +
       Abs[(genecontributions[[4, a]] - genecontributions[[16, a]]) / Sqrt[3] *
         (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])]]},
   {a, 1, genes}];

(* Create Parameter Graph of 750 Cell Cycle Genes Projected Onto 2 D Subspace *)

stream = StringJoin[name, ":Desktop Folder:PNAS Data:Whitfield_Human_Classify.txt"];
list = ReadList[stream, Word, RecordLists -> True, NullWords -> True];
list = Drop[list, 1];
stages = {"M/G1", "G1/S", "S", "G2", "G2/M"};
points = {points1, points2, points3, points4, points5};
radii = {radii1, radii2, radii3, radii4, radii5};
Do[{
  position = Position[list, stages[[b]]],
  table = Table[list[[position[[a, 1]], 1]], {a, 1, Dimensions[position][[1]]}],
  position = Table[Position[genenames, table[[a]]], {a, 1, Dimensions[table][[1]]}],
  table = Flatten[Position[position, {}]],
  Do[
   position = Drop[position, {table[[a]], table[[a]]}],
   {a, Dimensions[table][[1]], 1, -1}],
  points[[b]] = Table[Point[coordinates[[position[[a, 1, 1]]]]], {a, 1, Dimensions[position][[1]]}],
  radii[[b]] = Table[
    Sqrt[coordinates[[position[[a, 1, 1]], 1]]^2 + coordinates[[position[[a, 1, 1]], 2]]^2],
    {a, 1, Dimensions[position][[1]]}]},
 {b, 1, Dimensions[stages][[1]]}]
```

```
Dimensions[points[[1]]][[1]]
Dimensions[points[[2]]][[1]]
Dimensions[points[[3]]][[1]]
Dimensions[points[[4]]][[1]]
Dimensions[points[[5]]][[1]]
```

```
145

121

123

166

195
```

```
radii = Sort[Flatten[radii], OrderedQ[{{#1}, {#2}}] &];
N[Round[radii[[41]] * 100] / 100]
N[Round[radii[[42]] * 100] / 100]
```

```
0.49

0.5
```

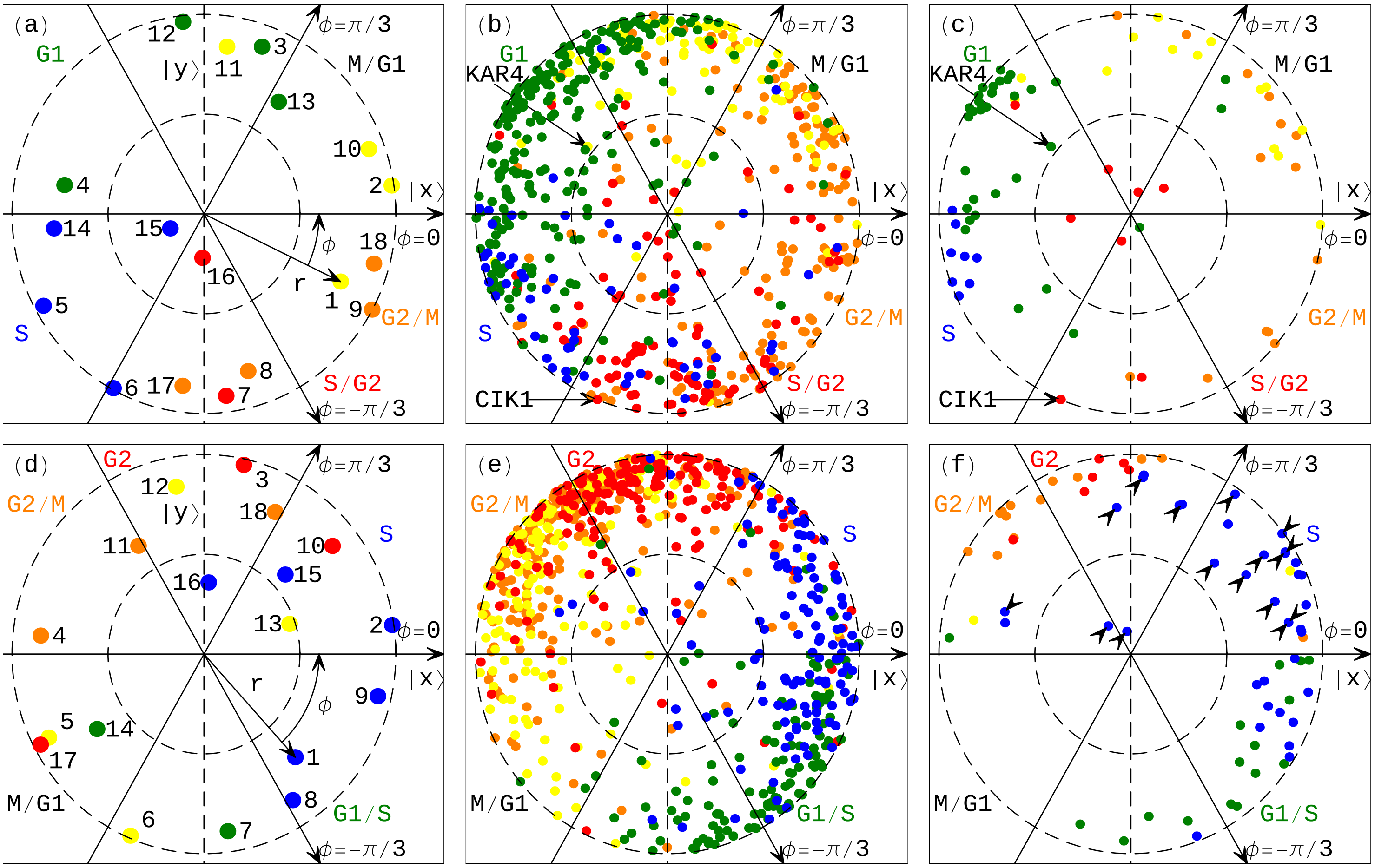
```
(* 750 cell cycle genes, 145 in M/G1, 121 in G1, 123 in S, 166 in S/G2, 195 in G2/M. *)

(* For 709 genes, 50 % or more of the contributions of the 6 genelets add up. *)
```

```
p = Show[
   {Graphics[{RGBColor[1, 0.5, 0], PointSize[0.02], points[[5]]}],
    Graphics[{RGBColor[1, 1, 0], PointSize[0.02], points[[1]]}],
    Graphics[{RGBColor[1, 0, 0], PointSize[0.02], points[[4]]}],
    Graphics[{RGBColor[0, 0.5, 0], PointSize[0.02], points[[2]]}],
    Graphics[{RGBColor[0, 0, 1], PointSize[0.02], points[[3]]}],
    Graphics[{RGBColor[1, 0.5, 0], Text["G2/M", {-0.875, 0.75}]}],
    Graphics[{RGBColor[0, 0, 0], Text["M/G1", {-0.875, -0.75}]}],
    Graphics[{RGBColor[1, 0, 0], Text["G2", {-0.45, 0.975}]}],
    Graphics[{RGBColor[0, 0, 1], Text["S", {0.95, 0.6}]}],
    Graphics[{RGBColor[0, 0.5, 0], Text["G1/S", {0.825, -0.8}]}],
    Graphics[{RGBColor[0, 0, 0], Text["(e)", {-0.9, 0.95}]}],
    Graphics[{RGBColor[0, 0, 0], Text["ϕ=π/3 ", {0.825, 0.95}]}],
    Graphics[{RGBColor[0, 0, 0], Text["ϕ=0", {1.12, 0.12}]}],
    Graphics[{RGBColor[0, 0, 0], Text[" |x⟩", {1.12, -0.12}]}],
    Graphics[{RGBColor[0, 0, 0], Text["ϕ=-π/3", {0.825, -0.975}]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 0.5]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 1]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Line[{{0, 1.05}, {0, -1.05}}]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05 / Tan[Pi / 3.], 1.05}, {1.05 / Tan[Pi / 3.], -1.05},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05, 0}, {1.25, 0},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05 / Tan[Pi / 3.], -1.05}, {1.05 / Tan[Pi / 3.], 1.05},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}]},
   AspectRatio -> 1,
   PlotRange -> {{-1.05, 1.25}, {-1.05, 1.05}},
   Frame -> True,
   FrameTicks -> False,
   FrameLabel -> {None, None, None, None},
   GridLines -> {None, None},
   DisplayFunction -> Identity];
p = FullGraphics[p];
p[[1, 2]] = p[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {-1.18, 0}, {0, 0}, {0, 1}];
p5 = Show[p,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Create Parameter Graph of 73 Cell Cycle Genes Projected Onto 2 D Subspace *)

stream = StringJoin[name, ":Desktop Folder:PNAS Data:Traditional_Human_Classify.txt"];
list = ReadList[stream, Word, RecordLists -> True, NullWords -> True];
list = Drop[list, 1];
stages = {"M/G1", "G1/S", "S", "G2", "G2/M"};
points = {points1, points2, points3, points4, points5};
radii = {radii1, radii2, radii3, radii4, radii5};
Do[{
  position = Position[list, stages[[b]]],
  table = Table[list[[position[[a, 1]], 1]], {a, 1, Dimensions[position][[1]]}],
  position = Table[Position[genenames, table[[a]]], {a, 1, Dimensions[table][[1]]}],
  table = Flatten[Position[position, {}]],
  Do[
   position = Drop[position, {table[[a]], table[[a]]}],
   {a, Dimensions[table][[1]], 1, -1}],
  points[[b]] = Table[Point[coordinates[[position[[a, 1, 1]]]]], {a, 1, Dimensions[position][[1]]}],
  radii[[b]] = Table[
    Sqrt[coordinates[[position[[a, 1, 1]], 1]]^2 + coordinates[[position[[a, 1, 1]], 2]]^2],
    {a, 1, Dimensions[position][[1]]}]},
 {b, 1, Dimensions[stages][[1]]}]
Dimensions[points[[1]]][[1]]
Dimensions[points[[2]]][[1]]
Dimensions[points[[3]]][[1]]
Dimensions[points[[4]]][[1]]
Dimensions[points[[5]]][[1]]

2

16

36

6

13

radii = Sort[Flatten[radii], OrderedQ[{{#1}, {#2}}] &];
N[Round[radii[[2]] * 100] / 100]
N[Round[radii[[3]] * 100] / 100]

0.18

0.63

(* 73 cell cycle genes, 2 in M/G1, 16 in G1, 36 in S, 6 in S/G2, 13 in G2/M. *)

(* For 71 genes, 50 % or more of the contributions of the 6 genelets add up. *)

h1f0 = coordinates[[Position[genenames, "IMAGE:343744"][[1, 1]]]];
h1f2 = coordinates[[Position[genenames, "IMAGE:66317"][[1, 1]]]];
h1fx = coordinates[[Position[genenames, "IMAGE:347560"][[1, 1]]]];
h2afo = coordinates[[Position[genenames, "IMAGE:488964"][[1, 1]]]];
h2afp = coordinates[[Position[genenames, "IMAGE:128802"][[1, 1]]]];
h2afy = coordinates[[Position[genenames, "IMAGE:2315147"][[1, 1]]]];
h2afz = coordinates[[Position[genenames, "IMAGE:2315147"][[1, 1]]]];
h2bfb = coordinates[[Position[genenames, "IMAGE:1500000"][[1, 1]]]];
h2bfb2 = coordinates[[Position[genenames, "IMAGE:243784"][[1, 1]]]];
h2bfc = coordinates[[Position[genenames, "IMAGE:2056049"][[1, 1]]]];
h2bfq = coordinates[[Position[genenames, "IMAGE:430235"][[1, 1]]]];
h2bfr = coordinates[[Position[genenames, "IMAGE:1675553"][[1, 1]]]];
h3f3a = coordinates[[Position[genenames, "IMAGE:884272"][[1, 1]]]];
h3f3a2 = coordinates[[Position[genenames, "IMAGE:1415750"][[1, 1]]]];
h3f3b = coordinates[[Position[genenames, "IMAGE:950574"][[1, 1]]]];
h3f3b2 = coordinates[[Position[genenames, "IMAGE:2114004"][[1, 1]]]];
```

```
p = Show[
   {Graphics[{RGBColor[1, 0.5, 0], PointSize[0.02], points[[5]]}],
    Graphics[{RGBColor[1, 1, 0], PointSize[0.02], points[[1]]}],
    Graphics[{RGBColor[1, 0, 0], PointSize[0.02], points[[4]]}],
    Graphics[{RGBColor[0, 0.5, 0], PointSize[0.02], points[[2]]}],
    Graphics[{RGBColor[0, 0, 1], PointSize[0.02], points[[3]]}],
    Graphics[{RGBColor[1, 0.5, 0], Text["G2/M", {-0.875, 0.75}]}],
    Graphics[{RGBColor[0, 0, 0], Text["M/G1", {-0.875, -0.75}]}],
    Graphics[{RGBColor[1, 0, 0], Text["G2", {-0.45, 0.975}]}],
    Graphics[{RGBColor[0, 0, 1], Text["S", {0.95, 0.6}]}],
    Graphics[{RGBColor[0, 0.5, 0], Text["G1/S", {0.825, -0.8}]}],
    Graphics[{RGBColor[0, 0, 0], Text["(f)", {-0.9, 0.95}]}],
    Graphics[{RGBColor[0, 0, 0], Text["φ=π/3 ", {0.825, 0.95}]}],
    Graphics[{RGBColor[0, 0, 0], Text["φ=0", {1.12, 0.12}]}],
    Graphics[{RGBColor[0, 0, 0], Text[" |x〉", {1.12, -0.12}]}],
    Graphics[{RGBColor[0, 0, 0], Text["φ=-π/3", {0.825, -0.975}]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 0.5]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 1]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Line[{{0, 1.05}, {0, -1.05}}]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h1f0 - {0.045, 0.045}, h1f0 - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h1f2 - {0.045, 0.045}, h1f2 - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h1fx - {0.045, 0.045}, h1fx - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2afo - {0.045, 0.045}, h2afo - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2afp - {0.045, 0.045}, h2afp - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2afy + {0.045, 0.045}, h2afy + {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2afz - {0.045, 0.045}, h2afz - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2bfb - {0.045, 0.045}, h2bfb - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2bfb2 - {0.045, 0.045}, h2bfb2 - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2bfc - {0.045, 0.045}, h2bfc - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2bfq + {0.045, 0.045}, h2bfq + {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2bfr + {0.045, 0.045}, h2bfr + {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h3f3a - {0.045, 0.045}, h3f3a - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h3f3a2 + {0.045, 0.045}, h3f3a2 + {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h3f3b - {0.045, 0.045}, h3f3b - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h3f3b2 - {0.045, 0.045}, h3f3b2 - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05 / Tan[Pi / 3.], 1.05}, {1.05 / Tan[Pi / 3.], -1.05},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05, 0}, {1.25, 0},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05 / Tan[Pi / 3.], -1.05}, {1.05 / Tan[Pi / 3.], 1.05},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}]},
   AspectRatio -> 1,
   PlotRange -> {{-1.05, 1.25}, {-1.05, 1.05}},
   Frame -> True,
   FrameTicks -> False,
   FrameLabel -> {None, None, None, None},
   GridLines -> {None, None},
   DisplayFunction -> Identity];
```

```
p = FullGraphics[p];
p[[1, 2]] = p[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {-1.18, 0}, {0, 0}, {0, 1}];
p6 = Show[p,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];

(* Display Both Arrays & Genes Parameter Graphs *)

Show[GraphicsArray[{{p1, p2, p3}, {p4, p5, p6}}],
    GraphicsSpacing -> 0];
```



```
(* Reconstruct Yeast and Human Data in Common Cell Cycle Subspace *)
```

```
(* Sort Yeast Genes *)

matrix = matrix1;
genes = genes1;
arraynames = arraynames1;
genenames = genenames1;

(* Center Arraylets and Calculate Contributions of Genelets to Genes *)

centerarraylets = Transpose[arraylets1];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
centerarraylets = centerarraylets - N[Outer[Times, Dot[centerarraylets, average], average]];
centerarraylets = Transpose[centerarraylets];
genecontributions = Transpose[Dot[centerarraylets, d1]];

(* Project Genes from 6 D Genelets Subspace Onto 2 D Subspace  *)

coordinates = Table[{
    (-Sqrt[3] * (genecontributions[[3, a]] - genecontributions[[15, a]]) +
        2 * Sqrt[3] * (genecontributions[[4, a]] - genecontributions[[16, a]]) +
        (3 * genecontributions[[5, a]] + Sqrt[3] * genecontributions[[14, a]])) / 6 /
     Sqrt[(genecontributions[[3, a]] - genecontributions[[15, a]]) ^ 2 / 3 +
       (genecontributions[[4, a]] - genecontributions[[16, a]]) ^ 2 / 3 +
       (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3]) ^ 2 +
       Abs[(genecontributions[[3, a]] - genecontributions[[15, a]]) / Sqrt[3] *
          (genecontributions[[4, a]] - genecontributions[[16, a]])] / Sqrt[3] +
       Abs[(genecontributions[[3, a]] - genecontributions[[15, a]]) / Sqrt[3] *
         (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])] +
       Abs[(genecontributions[[4, a]] - genecontributions[[16, a]]) / Sqrt[3] *
         (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])]],
    (3 * (genecontributions[[3, a]] - genecontributions[[15, a]]) +
        Sqrt[3] * (3 * genecontributions[[5, a]] + Sqrt[3] * genecontributions[[14, a]])) / 6 /
     Sqrt[(genecontributions[[3, a]] - genecontributions[[15, a]]) ^ 2 / 3 +
       (genecontributions[[4, a]] - genecontributions[[16, a]]) ^ 2 / 3 +
       (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3]) ^ 2 +
       Abs[(genecontributions[[3, a]] - genecontributions[[15, a]]) / Sqrt[3] *
          (genecontributions[[4, a]] - genecontributions[[16, a]])] / Sqrt[3] +
       Abs[(genecontributions[[3, a]] - genecontributions[[15, a]]) / Sqrt[3] *
         (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])] +
       Abs[(genecontributions[[4, a]] - genecontributions[[16, a]]) / Sqrt[3] *
         (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])]]},
   {a, 1, genes}];

(* Define the Initial Phase *)

zerophase = Pi / 2;
```

```
(* Sort Genes Accodring to Phases in 2 D Subspace *)

coordinates = Table[{
    coordinates[[a, 1]] / Sqrt[coordinates[[a, 1]] ^2 + coordinates[[a, 2]] ^2],
    coordinates[[a, 2]] / Sqrt[coordinates[[a, 1]] ^2 + coordinates[[a, 2]] ^2]},
   {a, 1, genes}];
coordinates = Table[{
    -coordinates[[a, 1]] * Cos[zerophase] - coordinates[[a, 2]] * Sin[zerophase],
    -coordinates[[a, 2]] * Cos[zerophase] + coordinates[[a, 1]] * Sin[zerophase]},
   {a, 1, genes}];
coordinates = Table[{
    coordinates[[a, 1]],
    coordinates[[a, 2]],
    N[ArcTan[coordinates[[a, 1]] / coordinates[[a, 2]]] / Pi]},
   {a, 1, genes}];
sortmatrix = AppendRows[coordinates, genenames, matrix];
sortmatrix = Sort[sortmatrix, OrderedQ[{{#1}, {#2}}] &];
negative1 = 2112;
positive1 = 2113;
sortmatrix[[negative1, 1]]
sortmatrix[[positive1, 1]]
```

```
-0.0007522

0.000147134
```

```
sortmatrix = Transpose[Drop[Transpose[sortmatrix], {1}]];
sortmatrix = AppendColumns[
  Sort[
   TakeRows[sortmatrix, {1, negative1}],
   OrderedQ[{{#2}, {#1}}] &],
  Sort[
   TakeRows[sortmatrix, {positive1, genes}],
   OrderedQ[{{#1}, {#2}}] &]];
phases = TakeColumns[sortmatrix, {2, 2}];
sortmatrix = Transpose[Drop[Transpose[sortmatrix], {1, 2}]];
```

```
(* Classify Gene Phases into Cell Cycle Phases *)

ph1 = 0;
ph2 = -1 / 2.;
ph3 = -1.;
ph4 = -4 / 3.;
ph5 = -5 / 3.;

endph5 = genes;
beginph1 = 1;
phases[[endph5]] - ph1
phases[[beginph1]] - ph1

{0.0000468343}

{-0.000239433}

endph1 = 1107;
beginph2 = 1108;
phases[[endph1]] - ph2
phases[[beginph2]] - ph2

{0.00152245}

{0.999794}

endph2 = 2112;
beginph3 = 2113;
phases[[endph2]] - ph3
phases[[beginph3]] - ph3

{1.0003}

{0.999906}

endph3 = 2816;
beginph4 = 2817;
phases[[endph3]] - ph4
phases[[beginph4]] - ph4

{1.0009}

{0.99987}

endph4 = 3827;
beginph5 = 3828;
phases[[endph4]] - ph5
phases[[beginph5]] - ph5

{2.00019}

{1.99935}

(* 4523 yeast genes, 1107 in M/G1, 1005 in G1, 704 in S, 1011 in S/G2, 696 in G2/M. *)

(* Reconstruct Data With Sorted Genes *)

matrix1 = TakeColumns[sortmatrix, {7, arrays + 6}];
genenames1 = TakeColumns[sortmatrix, {1, 6}];
```

```
(* Sort Human Genes *)

matrix = matrix2;
genes = genes2;
arraynames = arraynames2;
genenames = genenames2;

(* Center Arraylets and Calculate Contributions of Genelets to Genes *)

centerarraylets = Transpose[arraylets2];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
centerarraylets = centerarraylets - N[Outer[Times, Dot[centerarraylets, average], average]];
centerarraylets = Transpose[centerarraylets];
genecontributions = Transpose[Dot[centerarraylets, d2]];

(* Project Genes from 6 D Genelets Subspace Onto 2 D Subspace  *)

coordinates = Table[{
    (-Sqrt[3] * (genecontributions[[3, a]] - genecontributions[[15, a]]) +
        2 * Sqrt[3] * (genecontributions[[4, a]] - genecontributions[[16, a]]) +
        (3 * genecontributions[[5, a]] + Sqrt[3] * genecontributions[[14, a]])) / 6 /
     Sqrt[(genecontributions[[3, a]] - genecontributions[[15, a]])^2 / 3 +
       (genecontributions[[4, a]] - genecontributions[[16, a]])^2 / 3 +
       (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])^2 +
       Abs[(genecontributions[[3, a]] - genecontributions[[15, a]]) / Sqrt[3] *
          (genecontributions[[4, a]] - genecontributions[[16, a]])] / Sqrt[3] +
       Abs[(genecontributions[[3, a]] - genecontributions[[15, a]]) / Sqrt[3] *
         (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])] +
       Abs[(genecontributions[[4, a]] - genecontributions[[16, a]]) / Sqrt[3] *
         (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])]],
    (3 * (genecontributions[[3, a]] - genecontributions[[15, a]]) +
        Sqrt[3] * (3 * genecontributions[[5, a]] + Sqrt[3] * genecontributions[[14, a]])) / 6 /
     Sqrt[(genecontributions[[3, a]] - genecontributions[[15, a]])^2 / 3 +
       (genecontributions[[4, a]] - genecontributions[[16, a]])^2 / 3 +
       (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])^2 +
       Abs[(genecontributions[[3, a]] - genecontributions[[15, a]]) / Sqrt[3] *
          (genecontributions[[4, a]] - genecontributions[[16, a]])] / Sqrt[3] +
       Abs[(genecontributions[[3, a]] - genecontributions[[15, a]]) / Sqrt[3] *
         (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])] +
       Abs[(genecontributions[[4, a]] - genecontributions[[16, a]]) / Sqrt[3] *
         (genecontributions[[5, a]] + genecontributions[[14, a]] / Sqrt[3])]]},
   {a, 1, genes}];

(* Define the Initial Phase *)

zerophase = Pi / 2;
```

```
(* Sort Genes Accodring to Phases in 2 D Subspace *)

coordinates = Table[{
    coordinates[[a, 1]] / Sqrt[coordinates[[a, 1]]^2 + coordinates[[a, 2]]^2],
    coordinates[[a, 2]] / Sqrt[coordinates[[a, 1]]^2 + coordinates[[a, 2]]^2]},
   {a, 1, genes}];
coordinates = Table[{
    -coordinates[[a, 1]] * Cos[zerophase] - coordinates[[a, 2]] * Sin[zerophase],
    -coordinates[[a, 2]] * Cos[zerophase] + coordinates[[a, 1]] * Sin[zerophase]},
   {a, 1, genes}];
coordinates = Table[{
    coordinates[[a, 1]],
    coordinates[[a, 2]],
    N[ArcTan[coordinates[[a, 1]] / coordinates[[a, 2]]] / Pi]},
   {a, 1, genes}];
sortmatrix = AppendRows[coordinates, genenames, matrix];
sortmatrix = Sort[sortmatrix, OrderedQ[{{#1}, {#2}}] &];
negative1 = 5803;
positive1 = 5804;
sortmatrix[[negative1, 1]]
sortmatrix[[positive1, 1]]

-0.000356952

0.0000427899

sortmatrix = Transpose[Drop[Transpose[sortmatrix], {1}]];
sortmatrix = AppendColumns[
  Sort[
   TakeRows[sortmatrix, {1, negative1}],
   OrderedQ[{{#2}, {#1}}] &],
  Sort[
   TakeRows[sortmatrix, {positive1, genes}],
   OrderedQ[{{#1}, {#2}}] &]];
phases = TakeColumns[sortmatrix, {2, 2}];
sortmatrix = Transpose[Drop[Transpose[sortmatrix], {1, 2}]];
```

```
(* Classify Gene Phases into Cell Cycle Phases *)

ph1 = -1 / 3;
ph2 = -2 / 3.;
ph3 = -1;
ph4 = -4 / 3.;
ph5 = 1 / 3.;

endph5 = 1817;
beginph1 = 1818;
phases[[endph5]] - ph1
phases[[beginph1]] - ph1

{0.0000222109}

{-0.0000823037}

endph1 = 3941;
beginph2 = 3942;
phases[[endph1]] - ph2
phases[[beginph2]] - ph2

{1.}

{0.999534}

endph2 = 5803;
beginph3 = 5804;
phases[[endph2]] - ph3
phases[[beginph3]] - ph3

{1.00011}

{0.999986}

endph3 = 7574;
beginph4 = 7575;
phases[[endph3]] - ph4
phases[[beginph4]] - ph4

{1.}

{0.999956}

endph4 = 9827;
beginph5 = 9828;
phases[[endph4]] - ph5
phases[[beginph5]] - ph5

{0.000191402}

{-0.000147269}

(* 12056 human genes, 4046 in S, 2124 in S/G2, 1862 in G2/M, 1771 in M/G1, 2253 in G1. *)

(* Reconstruct Data With Sorted Genes *)

matrix2 = TakeColumns[sortmatrix, {6, arrays + 5}];
genenames2 = TakeColumns[sortmatrix, {1, 5}];
```

```
(* Calculate GSVD of Sorted Yeast and Human Data *)

matrix = AppendColumns[matrix1, matrix2];
{q, r} = QRDecomposition[matrix];
q = Conjugate[Transpose[q]];
q1 = TakeRows[q, {1, genes1}];
{u1, w1, v1} = SingularValues[q1];
genelets = Dot[v1, r];
Do[genelets[[a]] = genelets[[a]] / Sqrt[Dot[genelets[[a]], genelets[[a]]]],
 {a, 1, arrays}]

genelets[[2]] = -genelets[[2]];
genelets[[3]] = -genelets[[3]];
genelets[[5]] = -genelets[[5]];
genelets[[14]] = -genelets[[14]];
genelets[[16]] = -genelets[[16]];
genelets[[17]] = -genelets[[17]];

arraylets1 = Dot[matrix1, Inverse[genelets]];
arraylets2 = Dot[matrix2, Inverse[genelets]];
arraylets1 = Transpose[arraylets1];
Do[arraylets1[[a]] = arraylets1[[a]] / Sqrt[Dot[arraylets1[[a]], arraylets1[[a]]]], {a, 1, arrays}];
arraylets1 = Transpose[arraylets1];
arraylets2 = Transpose[arraylets2];
Do[arraylets2[[a]] = arraylets2[[a]] / Sqrt[Dot[arraylets2[[a]], arraylets2[[a]]]], {a, 1, arrays}];
arraylets2 = Transpose[arraylets2];
d1 = Chop[Dot[PseudoInverse[arraylets1], matrix1, Inverse[genelets]]];
d2 = Chop[Dot[PseudoInverse[arraylets2], matrix2, Inverse[genelets]]];
```

```
(* Display Sorted and Reconstructed Yeast Data *)

genes = genes1;
genenames = genenames1;
arraynames = arraynames1;
{endph1, endph2, endph3, endph4, endph5} = {1107, 2113, 2818, 3827, 4523};

(* Reconstruct Sorted Yeast Data *)

Do[d1[[a, a]] = 0, {a, 1, 2}];
Do[d1[[a, a]] = 0, {a, 6, 13}];
Do[d1[[a, a]] = 0, {a, 17, 18}];
matrix = Dot[arraylets1, d1, genelets];

(* Center Reconstructed Sorted Yeast Data *)

average = Table[1, {a, 1, arrays}];
average = N[average / Sqrt[Dot[average, average]]];
matrix = matrix - N[Outer[Times, Dot[matrix, average], average]];
matrix = Transpose[matrix];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
matrix = matrix - N[Outer[Times, Dot[matrix, average], average]];
matrix = Transpose[matrix];

(* Create Recosntructed Sorted Yeast Data 2 D Red & Green Raster Display *)

contrast = 10 * 1.5;
displaying = Table[
   If[contrast * matrix[[i, j]] > 0,
    If[contrast * matrix[[i, j]] < 1, {contrast * matrix[[i, j]], 0}, {1, 0}],
    If[contrast * matrix[[i, j]] > -1, {0, -contrast * matrix[[i, j]]}, {0, 1}]],
   {i, 1, genes}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {
   {genes - endph1 / 2, "M/G1"},
   {genes - (endph1 + endph2) / 2, "G1"},
   {genes - (endph2 + endph3) / 2, "S"},
   {genes - (endph3 + endph4) / 2, "S/G2"},
   {(genes - endph4) / 2, "G2/M"}};
gridy = {
   {genes - endph1 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph2 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph3 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph4 + 0.5, {RGBColor[0, 0, 0]}}};
labelx = "(a) Arrays";
labely = ColumnForm[{" ", "Genes", " ", " ", " ", " ", " ", " "}, Center];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, genes, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, gridy},
   DisplayFunction -> Identity];
```

```
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 1.5, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1100}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 550}, {0, 0}, {0, 1}];
g1 = Show[g,
   AspectRatio -> GoldenRatio * 1.2,
   PlotRange -> All,
   DisplayFunction → Identity];

(* Center Sorted Yeast Arraylets *)

arraylets = Transpose[arraylets1];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
arraylets = arraylets - N[Outer[Times, Dot[arraylets, average], average]];
arraylets = Transpose[arraylets];

(* Create Sorted Yeast Arraylets 2 D Red & Green Raster Display *)

contrast = 75 * 1.5;
displaying = Table[
   If[contrast * arraylets[[i, j]] > 0,
    If[contrast * arraylets[[i, j]] < 1, {contrast * arraylets[[i, j]], 0}, {1, 0}],
    If[contrast * arraylets[[i, j]] > -1, {0, -contrast * arraylets[[i, j]]}, {0, 1}]],
   {i, 1, genes}, {j, 1, arrays}];
labelx = "(b) Arraylets";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framey = {
   {genes - endph5 / 2, "    ", 0},
   {genes - (endph5 + endph1) / 2, "  ", 0},
   {genes - (endph1 + endph2) / 2, " ", 0},
   {genes - (endph2 + endph3) / 2, "    ", 0},
   {genes - (endph3 + endph4) / 2, "    ", 0},
   {(genes - endph4) / 2, "    ", 0}};
gridy = {
   {genes - endph1 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph2 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph3 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph4 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph5 + 0.5, {RGBColor[0, 0, 0]}}};
framex = Table[{a - 0.5, ToString[a]}, {a, 1, arrays}];
size = 7;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      framex[[a, 2]]
     ]], {a, 1, arrays}]];
Do[
  Do[framex[[a, 2]] = StringJoin[framex[[a, 2]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, arrays}];
```

```
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, genes, 1, -1}, {j, 1, arrays}
     ]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, gridy},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 1.5, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1100}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 550}, {0, 0}, {0, 1}];
g2 = Show[g,
   AspectRatio -> GoldenRatio * 1.2,
   PlotRange -> All,
   DisplayFunction → Identity];

(* Create Selected Sorted Yeast Arraylets Graph Display *)

arraylets = Transpose[arraylets1];

arraylets3 = Chop[TrigFit[arraylets[[3]], 1, {x, genes - 1}], 0.001]
arraylets4 = Chop[TrigFit[arraylets[[4]], 1, {x, genes - 1}], 0.001]
arraylets5 = Chop[TrigFit[arraylets[[5]], 1, {x, genes - 1}], 0.001]
arraylets14 = Chop[TrigFit[arraylets[[14]], 1, {x, genes - 1}], 0.001]
arraylets15 = Chop[TrigFit[arraylets[[15]], 1, {x, genes - 1}], 0.001]
arraylets16 = Chop[TrigFit[arraylets[[16]], 1, {x, genes - 1}], 0.001]
```

$$-0.00350482\,\mathrm{Cos}\left[\frac{\pi x}{2261}\right]+0.0105327\,\mathrm{Sin}\left[\frac{\pi x}{2261}\right]$$

$$-0.00146993+0.011125\,\mathrm{Cos}\left[\frac{\pi x}{2261}\right]$$

$$0.00621296\,\mathrm{Cos}\left[\frac{\pi x}{2261}\right]+0.00846298\,\mathrm{Sin}\left[\frac{\pi x}{2261}\right]$$

$$-0.0012217+0.00423362\,\mathrm{Cos}\left[\frac{\pi x}{2261}\right]+0.00682806\,\mathrm{Sin}\left[\frac{\pi x}{2261}\right]$$

$$0.00425716\,\mathrm{Cos}\left[\frac{\pi x}{2261}\right]-0.00622375\,\mathrm{Sin}\left[\frac{\pi x}{2261}\right]$$

$$-0.00500703\,\mathrm{Cos}\left[\frac{\pi x}{2261}\right]$$

```
graph = ParametricPlot[{arraylets3, -x},
   {x, 0, genes - 1},
   PlotStyle -> {RGBColor[0, 0, 0], Thickness[0.016]},
   DisplayFunction -> Identity];
labelx = "(c) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0       "}, {0.06, "0.06   "}, {0.12, "0.12   "}};
coordinates = Table[
   If[arraylets[[3, a]] < -0.025 * 1.2, -0.025 * 1.2,
    If[arraylets[[3, a]] > 0.125 * 1.2, 0.125 * 1.2, arraylets[[3, a]]]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], line}],
    graph},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025 * 1.2, 0.125 * 1.2}, {135, -genes + 1 - 135}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1125}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 575}, {0, 0}, {0, 1}];
p3 = Show[g,
   AspectRatio -> GoldenRatio * 1.2765,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
graph = ParametricPlot[{arraylets4 + 0.05 * 1.2, -x},
   {x, 0, genes - 1},
   PlotStyle -> {RGBColor[0, 0, 0], Thickness[0.016]},
   DisplayFunction -> Identity];
labelx = "(c) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0      "}, {0.06, "0.06   "}, {0.12, "0.12   "}};
coordinates = Table[
   If[arraylets[[4, a]] + 0.05 * 1.2 > 0.125 * 1.2, 0.125 * 1.2,
    If[arraylets[[4, a]] + 0.05 * 1.2 < -0.025 * 1.2, -0.025 * 1.2, arraylets[[4, a]] + 0.05 * 1.2]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], line}],
    graph},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0.05 * 1.2, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025 * 1.2, 0.125 * 1.2}, {135, -genes + 1 - 135}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1125}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 575}, {0, 0}, {0, 1}];
p4 = Show[g,
   AspectRatio -> GoldenRatio * 1.2765,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
graph = ParametricPlot[{arraylets5 + 0.1 * 1.2, -x},
   {x, 0, genes - 1},
   PlotStyle -> {RGBColor[0, 0, 0], Thickness[0.016]},
   DisplayFunction -> Identity];
labelx = "(c) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0      "}, {0.06, "0.06   "}, {0.12, "0.12   "}};
coordinates = Table[
   If[arraylets[[5, a]] + 0.1 * 1.2 < -0.025 * 1.2, -0.025 * 1.2,
    If[arraylets[[5, a]] + 0.1 * 1.2 > 0.125 * 1.2, 0.125 * 1.2, arraylets[[5, a]] + 0.1 * 1.2]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0.5, 0], line}],
    graph},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0.1 * 1.2, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025 * 1.2, 0.125 * 1.2}, {135, -genes + 1 - 135}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1125}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 575}, {0, 0}, {0, 1}];
p5 = Show[g,
   AspectRatio -> GoldenRatio * 1.2765,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
graph = ParametricPlot[{arraylets14, -x},
   {x, 0, genes - 1},
   PlotStyle -> {RGBColor[0, 0, 0], Thickness[0.016]},
   DisplayFunction -> Identity];
labelx = "(d) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0       "}, {0.06, "0.06   "}, {0.12, "0.12   "}};
coordinates = Table[
   If[arraylets[[14, a]] < -0.025 * 1.2, -0.025 * 1.2,
    If[arraylets[[14, a]] > 0.125 * 1.2, 0.125 * 1.2, arraylets[[14, a]]]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], line}],
    graph},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025 * 1.2, 0.125 * 1.2}, {135, -genes + 1 - 135}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1125}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 575}, {0, 0}, {0, 1}];
p14 = Show[g,
   AspectRatio -> GoldenRatio * 1.2765,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
graph = ParametricPlot[{arraylets15 + 0.05 * 1.2, -x},
   {x, 0, genes - 1},
   PlotStyle -> {RGBColor[0, 0, 0], Thickness[0.016]},
   DisplayFunction -> Identity];
labelx = "(d) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0       "}, {0.06, "0.06   "}, {0.12, "0.12   "}};
coordinates = Table[
   If[arraylets[[15, a]] + 0.05 * 1.2 > 0.125 * 1.2, 0.125 * 1.2,
    If[arraylets[[15, a]] + 0.05 * 1.2 < -0.025 * 1.2, -0.025 * 1.2, arraylets[[15, a]] + 0.05 * 1.2]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], line}],
    graph},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0.05 * 1.2, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025 * 1.2, 0.125 * 1.2}, {135, -genes + 1 - 135}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1125}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 575}, {0, 0}, {0, 1}];
p15 = Show[g,
   AspectRatio -> GoldenRatio * 1.2765,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
graph = ParametricPlot[{arraylets16 + 0.1 * 1.2, -x},
   {x, 0, genes - 1},
   PlotStyle -> {RGBColor[0, 0, 0], Thickness[0.016]},
   DisplayFunction -> Identity];
labelx = "(d) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0      "}, {0.06, "0.06   "}, {0.12, "0.12   "}};
coordinates = Table[
   If[arraylets[[16, a]] + 0.1 * 1.2 > 0.125 * 1.2, 0.125 * 1.2, arraylets[[16, a]] + 0.1 * 1.2],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0.5, 0], line}],
    graph},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0.1 * 1.2, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025 * 1.2, 0.125 * 1.2}, {135, -genes + 1 - 135}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1125}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 575}, {0, 0}, {0, 1}];
p16 = Show[g,
   AspectRatio -> GoldenRatio * 1.2765,
   PlotRange -> All,
   DisplayFunction → Identity];

(* Display Selected Sorted Yeast Arraylets *)

g3 = Show[{p3, p4, p5},
   DisplayFunction -> Identity];
g4 = Show[{p16, p14, p15},
   DisplayFunction -> Identity];
```

```
(* Display Sorted and Reconstructed Human Data *)

genes = genes2;
genenames = genenames2;
arraynames = arraynames2;
{endph1, endph2, endph3, endph4, endph5} = {3941, 5803, 7574, 9827, 1817};

(* Reconstruct Sorted Human Data *)

Do[d2[[a, a]] = 0, {a, 1, 2}];
Do[d2[[a, a]] = 0, {a, 6, 13}];
Do[d2[[a, a]] = 0, {a, 17, 18}];
matrix = Dot[arraylets2, d2, genelets];

(* Center Sorted Human Data *)

average = Table[1, {a, 1, arrays}];
average = N[average / Sqrt[Dot[average, average]]];
matrix = matrix - N[Outer[Times, Dot[matrix, average], average]];
matrix = Transpose[matrix];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
matrix = matrix - N[Outer[Times, Dot[matrix, average], average]];
matrix = Transpose[matrix];

(* Create Recosntructed Sorted Human Data 2 D Red & Green Raster Display *)

contrast = 15 * 1.5;
displaying = Table[
   If[contrast * matrix[[i, j]] > 0,
    If[contrast * matrix[[i, j]] < 1, {contrast * matrix[[i, j]], 0}, {1, 0}],
    If[contrast * matrix[[i, j]] > -1, {0, -contrast * matrix[[i, j]]}, {0, 1}]],
   {i, 1, genes}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {
   {genes - endph5 / 2, "S"},
   {genes - (endph5 + endph1) / 2, "G2"},
   {genes - (endph1 + endph2) / 2, "G2/M"},
   {genes - (endph2 + endph3) / 2, "M/G1"},
   {genes - (endph3 + endph4) / 2, "G1/S"},
   {(genes - endph4) / 2, "S"}};
gridy = {
   {genes - endph1 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph2 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph3 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph4 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph5 + 0.5, {RGBColor[0, 0, 0]}}};
labelx = "(e) Arrays";
labely = ColumnForm[{" ", "Genes", " ", " ", " ", " ", " ", " "}, Center];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, genes, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, gridy},
   DisplayFunction -> Identity];
```

```
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 1.5, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1100}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 450}, {0, 0}, {0, 1}];
g5 = Show[g,
   AspectRatio -> GoldenRatio * 2,
   PlotRange -> All,
   DisplayFunction → Identity];

(* Center Sorted Human Arraylets *)

arraylets = Transpose[arraylets2];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
arraylets = arraylets - N[Outer[Times, Dot[arraylets, average], average]];
arraylets = Transpose[arraylets];

(* Create Sorted Human Arraylets 2 D Red & Green Raster Display *)

contrast = 125 * 1.5;
displaying = Table[
   If[contrast * arraylets[[i, j]] > 0,
    If[contrast * arraylets[[i, j]] < 1, {contrast * arraylets[[i, j]], 0}, {1, 0}],
    If[contrast * arraylets[[i, j]] > -1, {0, -contrast * arraylets[[i, j]]}, {0, 1}]],
   {i, 1, genes}, {j, 1, arrays}];
labelx = "(f) Arraylets";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framey = {
   {genes - endph5 / 2, "    "},
   {genes - (endph5 + endph1) / 2, " "},
   {genes - (endph1 + endph2) / 2, "  "},
   {genes - (endph2 + endph3) / 2, "    "},
   {genes - (endph3 + endph4) / 2, "    "},
   {(genes - endph4) / 2, "    "}};
gridy = {
   {genes - endph1 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph2 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph3 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph4 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph5 + 0.5, {RGBColor[0, 0, 0]}}};
framex = Table[{a - 0.5, ToString[a]}, {a, 1, arrays}];
size = 5;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      framex[[a, 2]]
     ]], {a, 1, arrays}]];
Do[
  Do[framex[[a, 2]] = StringJoin[framex[[a, 2]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, arrays}];
```

```
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, genes, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, gridy},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 1.5, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1100}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 450}, {0, 0}, {0, 1}];
g6 = Show[g,
   AspectRatio -> GoldenRatio * 2,
   PlotRange -> All,
   DisplayFunction → Identity];

(* Create Selected Sorted Human Arraylets Graph Display *)

arraylets = Transpose[arraylets2];

arraylets3 = Chop[TrigFit[arraylets[[3]], 1, {x, genes - 1}], 0.001]
arraylets4 = Chop[TrigFit[arraylets[[4]], 1, {x, genes - 1}], 0.001]
arraylets5 = Chop[TrigFit[arraylets[[5]], 1, {x, genes - 1}], 0.001]
arraylets14 = Chop[TrigFit[arraylets[[14]], 1, {x, genes - 1}], 0.001]
arraylets15 = Chop[TrigFit[arraylets[[15]], 1, {x, genes - 1}], 0.001]
arraylets16 = Chop[TrigFit[arraylets[[16]], 1, {x, genes - 1}], 0.001]
```

$$-0.0014217\,\mathrm{Cos}\left[\frac{2\,\pi\,x}{12055}\right]+0.00391491\,\mathrm{Sin}\left[\frac{2\,\pi\,x}{12055}\right]$$

$$0.00502234\,\mathrm{Cos}\left[\frac{2\,\pi\,x}{12055}\right]$$

$$0.00315384\,\mathrm{Cos}\left[\frac{2\,\pi\,x}{12055}\right]+0.00340225\,\mathrm{Sin}\left[\frac{2\,\pi\,x}{12055}\right]$$

$$0.00459832\,\mathrm{Cos}\left[\frac{2\,\pi\,x}{12055}\right]+0.00471871\,\mathrm{Sin}\left[\frac{2\,\pi\,x}{12055}\right]$$

$$0.00100965+0.00370318\,\mathrm{Cos}\left[\frac{2\,\pi\,x}{12055}\right]-0.00745771\,\mathrm{Sin}\left[\frac{2\,\pi\,x}{12055}\right]$$

$$-0.00570353\,\mathrm{Cos}\left[\frac{2\,\pi\,x}{12055}\right]$$

```
graph = ParametricPlot[{arraylets3, -x},
   {x, 0, genes - 1},
   PlotStyle -> {RGBColor[0, 0, 0], Thickness[0.016]},
   DisplayFunction -> Identity];
labelx = "(g) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0      "}, {0.05, "0.05  "}, {0.1, "0.1   "}};
coordinates = Table[
   If[arraylets[[3, a]] < -0.025, -0.025, arraylets[[3, a]]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], line}],
    graph},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025, 0.125}, {360, -genes + 1 - 360}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1150}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 550}, {0, 0}, {0, 1}];
p3 = Show[g,
   AspectRatio -> GoldenRatio * 2.1275,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
graph = ParametricPlot[{arraylets4 + 0.05, -x},
   {x, 0, genes - 1},
   PlotStyle -> {RGBColor[0, 0, 0], Thickness[0.016]},
   DisplayFunction -> Identity];
labelx = "(g) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0     "}, {0.05, "0.05  "}, {0.1, "0.1   "}};
coordinates = Table[
   If[arraylets[[4, a]] + 0.05 > 0.125, 0.125, arraylets[[4, a]] + 0.05],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], line}],
    graph},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0.05, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025, 0.125}, {360, -genes + 1 - 360}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1150}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 550}, {0, 0}, {0, 1}];
p4 = Show[g,
   AspectRatio -> GoldenRatio * 2.1275,
   PlotRange -> All,
   DisplayFunction → Identity];
```

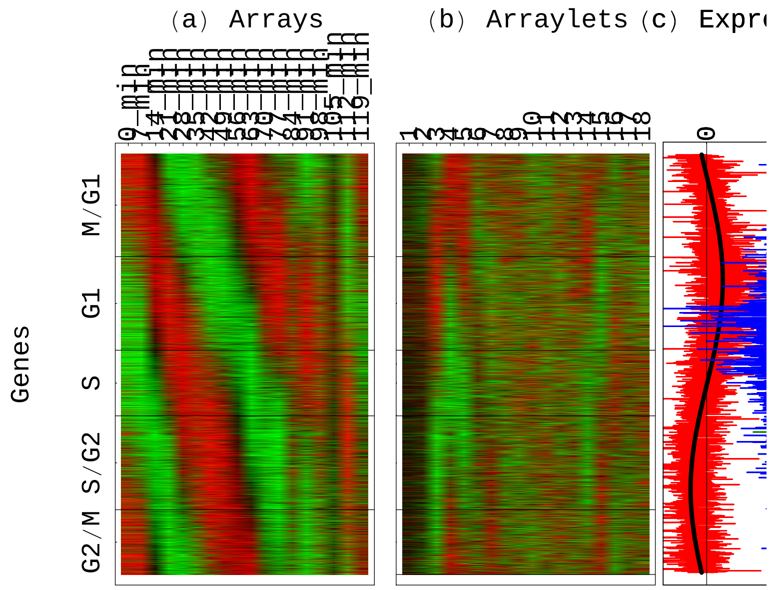
```
graph = ParametricPlot[{arraylets5 + 0.1, -x},
   {x, 0, genes - 1},
   PlotStyle -> {RGBColor[0, 0, 0], Thickness[0.016]},
   DisplayFunction -> Identity];
labelx = "(g) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0      "}, {0.05, "0.05  "}, {0.1, "0.1   "}};
coordinates = Table[
   If[arraylets[[5, a]] + 0.1 > 0.125, 0.125, arraylets[[5, a]] + 0.1],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0.5, 0], line}],
    graph},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0.1, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025, 0.125}, {360, -genes + 1 - 360}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1150}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 550}, {0, 0}, {0, 1}];
p5 = Show[g,
   AspectRatio -> GoldenRatio * 2.1275,
   PlotRange -> All,
   DisplayFunction → Identity];
```

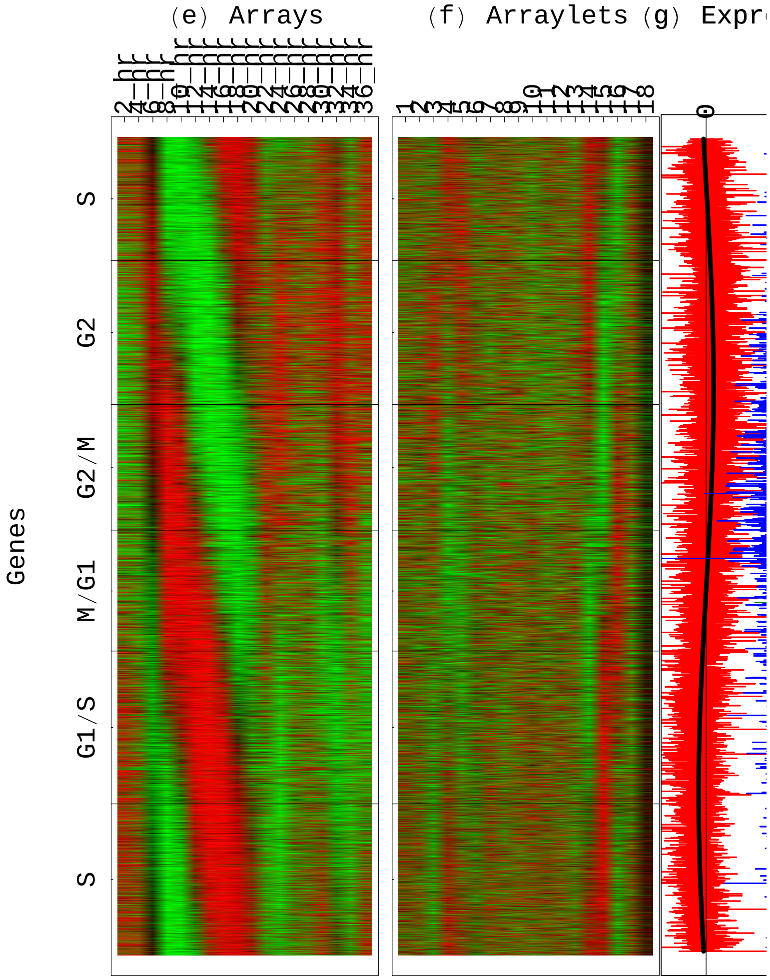
```
graph = ParametricPlot[{arraylets14, -x},
   {x, 0, genes - 1},
   PlotStyle -> {RGBColor[0, 0, 0], Thickness[0.016]},
   DisplayFunction -> Identity];
labelx = "(h) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0     "}, {0.05, "0.05  "}, {0.1, "0.1   "}};
coordinates = Table[
   If[arraylets[[14, a]] < -0.025, -0.025, arraylets[[14, a]]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], line}],
    graph},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025, 0.125}, {360, -genes + 1 - 360}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1150}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 550}, {0, 0}, {0, 1}];
p14 = Show[g,
   AspectRatio -> GoldenRatio * 2.1275,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
graph = ParametricPlot[{arraylets15 + 0.05, -x},
   {x, 0, genes - 1},
   PlotStyle -> {RGBColor[0, 0, 0], Thickness[0.016]},
   DisplayFunction -> Identity];
labelx = "(h) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0     "}, {0.05, "0.05  "}, {0.1, "0.1   "}};
coordinates = Table[If[arraylets[[15, a]] + 0.05 < -0.025, -0.025,
    If[arraylets[[15, a]] + 0.05 > 0.125, 0.125, arraylets[[15, a]] + 0.05]], {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], line}],
    graph},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0.05, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025, 0.125}, {360, -genes + 1 - 360}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1150}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 550}, {0, 0}, {0, 1}];
p15 = Show[g,
   AspectRatio -> GoldenRatio * 2.1275,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
graph = ParametricPlot[{arraylets16 + 0.1, -x},
   {x, 0, genes - 1},
   PlotStyle -> {RGBColor[0, 0, 0], Thickness[0.016]},
   DisplayFunction -> Identity];
labelx = "(h) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0      "}, {0.05, "0.05  "}, {0.1, "0.1   "}};
coordinates = Table[
   If[arraylets[[16, a]] + 0.1 > 0.125, 0.125, arraylets[[16, a]] + 0.1],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0.5, 0], line}],
    graph},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0.1, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025, 0.125}, {360, -genes + 1 - 360}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1150}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 550}, {0, 0}, {0, 1}];
p16 = Show[g,
   AspectRatio -> GoldenRatio * 2.1275,
   PlotRange -> All,
   DisplayFunction → Identity];

(* Display Selected Sorted Human Arraylets *)

g7 = Show[{p5, p3, p4},
   DisplayFunction -> Identity];
g8 = Show[{p16, p15, p14},
   DisplayFunction -> Identity];
```

```
(* Display Recosntructed Sorted Yeast and Human Data, Arraylets and Selected Arraylets *)

Show[{
   Graphics[{Rectangle[{0, 0}, {25, 84}, g5]}],
   Graphics[{Rectangle[{4, 0}, {29, 84}, g6]}],
   Graphics[{Rectangle[{8, 0}, {33, 84}, g7]}],
   Graphics[{Rectangle[{12, 0}, {37, 84}, g8]}],
   Graphics[{Rectangle[{0, 85}, {25, 135}, g1]}],
   Graphics[{Rectangle[{4, 85}, {29, 135}, g2]}],
   Graphics[{Rectangle[{8, 85}, {33, 135}, g3]}],
   Graphics[{Rectangle[{12, 85}, {37, 135}, g4]}]},
  PlotRange -> All];
```


(a) Arrays
(b) Arraylets
(c) Expr
Genes
M/G1
G1
S
S/G2
G2/M
0_min
7_min
14_min
119_min
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
0


(e) Arrays
(f) Arraylets
(g) Expr
Genes
S
G2
G2/M
M/G1
G1/S
S
2_hr
4_hr
6_hr
8_hr
10_hr
36_hr
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
0

```
(* Display GSVD of Sorted Yeast and Human Data  *)
```

```
(* Recalculate GSVD of Sorted Yeast and Human Data *)

matrix = AppendColumns[matrix1, matrix2];
{q, r} = QRDecomposition[matrix];
q = Conjugate[Transpose[q]];
q1 = TakeRows[q, {1, genes1}];
{u1, w1, v1} = SingularValues[q1];
genelets = Dot[v1, r];
Do[genelets[[a]] = genelets[[a]] / Sqrt[Dot[genelets[[a]], genelets[[a]]]],
 {a, 1, arrays}]

genelets[[2]] = -genelets[[2]];
genelets[[3]] = -genelets[[3]];
genelets[[5]] = -genelets[[5]];
genelets[[14]] = -genelets[[14]];
genelets[[16]] = -genelets[[16]];
genelets[[17]] = -genelets[[17]];

arraylets1 = Dot[matrix1, Inverse[genelets]];
arraylets2 = Dot[matrix2, Inverse[genelets]];
arraylets1 = Transpose[arraylets1];
Do[arraylets1[[a]] = arraylets1[[a]] / Sqrt[Dot[arraylets1[[a]], arraylets1[[a]]]], {a, 1, arrays}];
arraylets1 = Transpose[arraylets1];
arraylets2 = Transpose[arraylets2];
Do[arraylets2[[a]] = arraylets2[[a]] / Sqrt[Dot[arraylets2[[a]], arraylets2[[a]]]], {a, 1, arrays}];
arraylets2 = Transpose[arraylets2];
d1 = Chop[Dot[PseudoInverse[arraylets1], matrix1, Inverse[genelets]]];
d2 = Chop[Dot[PseudoInverse[arraylets2], matrix2, Inverse[genelets]]];
```

```
(* Display Sorted Yeast Data *)

genes = genes1;
genenames = genenames1;
arraynames = arraynames1;
matrix = matrix1;

(* Center Sorted Yeast Data *)

average = Table[1, {a, 1, arrays}];
average = N[average / Sqrt[Dot[average, average]]];
matrix = matrix - N[Outer[Times, Dot[matrix, average], average]];
matrix = Transpose[matrix];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
matrix = matrix - N[Outer[Times, Dot[matrix, average], average]];
matrix = Transpose[matrix];

(* Create Sorted Yeast Data 2 D Red & Green Raster Display *)

contrast = 10 * 1.5;
displaying = Table[
   If[contrast * matrix[[i, j]] > 0,
    If[contrast * matrix[[i, j]] < 1, {contrast * matrix[[i, j]], 0}, {1, 0}],
    If[contrast * matrix[[i, j]] > -1, {0, -contrast * matrix[[i, j]]}, {0, 1}]],
   {i, 1, genes}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
labelx = "Arrays";
labely = ColumnForm[{" ", "       Genes", " ", " ", " "}, Center];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, genes, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, None, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1500}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 750}, {0, 0}, {0, 1}];
g1 = Show[g,
   AspectRatio -> GoldenRatio * 1,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Center Sorted Yeast Arraylets *)

arraylets = Transpose[arraylets1];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
arraylets = arraylets - N[Outer[Times, Dot[arraylets, average], average]];
arraylets = Transpose[arraylets];

(* Create Sorted Yeast Arraylets 2 D Red & Green Raster Display *)

contrast = 75 * 1.5;
displaying = Table[
   If[contrast * arraylets[[i, j]] > 0,
    If[contrast * arraylets[[i, j]] < 1, {contrast * arraylets[[i, j]], 0}, {1, 0}],
    If[contrast * arraylets[[i, j]] > -1, {0, -contrast * arraylets[[i, j]]}, {0, 1}]],
   {i, 1, genes}, {j, 1, arrays}];
labelx = "Arraylets";
labely = ColumnForm[{" ", "       Genes", " ", " ", " "}, Center];
framex = Table[{a - 0.5, ToString[a]}, {a, 1, arrays}];
size = 7;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      framex[[a, 2]]
     ]], {a, 1, arrays}]];
Do[
  Do[framex[[a, 2]] = StringJoin[framex[[a, 2]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, arrays}];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, genes, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, None, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1500}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 750}, {0, 0}, {0, 1}];
g2 = Show[g,
   AspectRatio -> GoldenRatio * 1,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Create Yeast Expression Fractions Red & Green Raster Display *)

contrast = 0.03;
displaying = Table[
   If[contrast * d1[[i, j]] > 0,
    If[contrast * d1[[i, j]] < 1, {contrast * d1[[i, j]], 0}, {1, 0}],
    If[contrast * d1[[i, j]] > -1, {0, -contrast * d1[[i, j]]}, {0, 1}]],
   {i, 1, arrays}, {j, 1, arrays}];
framex = Table[a, {a, 1, arrays}];
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[framex[[a]]
      ]]], {a, 1, arrays}]];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, arrays}];
framex = Table[{a - 0.5, framex[[a]]}, {a, 1, arrays}];
framey = Table[{a + 1 - 0.5, arrays - a}, {a, 0, arrays - 1}];
labely = ColumnForm[{" ", "Arraylets", " "}, Center];
labelx = ColumnForm[{"Genelets", " ", " "}, Center];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, arrays, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 4.2, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 3.6}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 3.9}, {0, 0}, {0, 1}];
g3 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Center Genelets *)

average = Table[1, {a, 1, arrays}];
average = N[average / Sqrt[Dot[average, average]]];
centergenelets = genelets - N[Outer[Times, Dot[genelets, average], average]];

(* Create Genelets 2 D Red & Green Raster Display *)

contrast = 3;
displaying = Table[
   If[contrast * centergenelets[[i, j]] > 0,
    If[contrast * centergenelets[[i, j]] < 1, {contrast * centergenelets[[i, j]], 0}, {1, 0}],
    If[contrast * centergenelets[[i, j]] > -1, {0, -contrast * centergenelets[[i, j]]}, {0, 1}]],
   {i, 1, arrays}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
framey = Table[{a + 1 - 0.5, arrays - a}, {a, 0, arrays - 1}];
labely = ColumnForm[{" ", "Genelets", " "}, Center];
labelx = ColumnForm[{"Arrays", " ", " "}, Center];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, arrays, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 4.2, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 3.6}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 3.9}, {0, 0}, {0, 1}];
g4 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

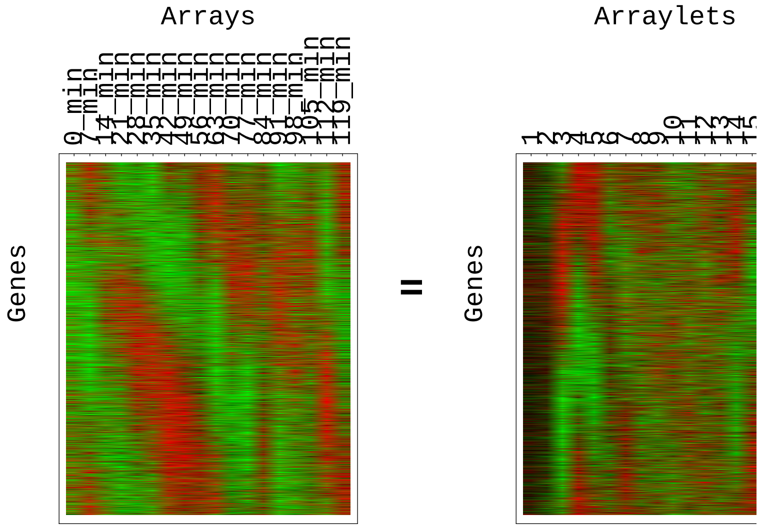
```
(* Display Sorted Human Data *)

genes = genes2;
genenames = genenames2;
arraynames = arraynames2;
matrix = matrix2;

(* Center Sorted Human Data *)

average = Table[1, {a, 1, arrays}];
average = N[average / Sqrt[Dot[average, average]]];
matrix = matrix - N[Outer[Times, Dot[matrix, average], average]];
matrix = Transpose[matrix];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
matrix = matrix - N[Outer[Times, Dot[matrix, average], average]];
matrix = Transpose[matrix];

(* Create Sorted Human Data 2 D Red & Green Raster Display *)

contrast = 15 * 1.5;
displaying = Table[
   If[contrast * matrix[[i, j]] > 0,
    If[contrast * matrix[[i, j]] < 1, {contrast * matrix[[i, j]], 0}, {1, 0}],
    If[contrast * matrix[[i, j]] > -1, {0, -contrast * matrix[[i, j]]}, {0, 1}]],
   {i, 1, genes}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
labelx = "Arrays";
labely = ColumnForm[
   {" ", "                                         Genes", " ", " ", " "},
   Center];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, genes, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, None, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1300}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 600}, {0, 0}, {0, 1}];
g5 = Show[g,
   AspectRatio -> GoldenRatio * 2,
   PlotRange -> All,
   DisplayFunction -> Identity];
```

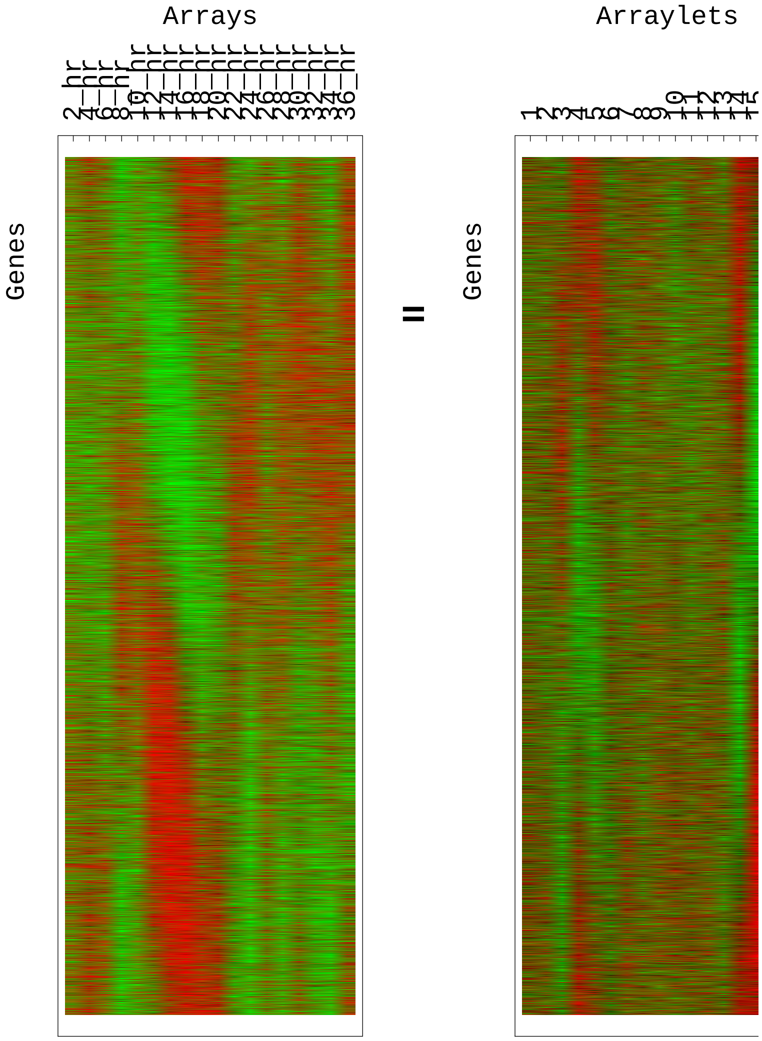
```
(* Center Sorted Human Arraylets *)

arraylets = Transpose[arraylets2];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
arraylets = arraylets - N[Outer[Times, Dot[arraylets, average], average]];
arraylets = Transpose[arraylets];

(* Create Sorted Human Arraylets 2 D Red & Green Raster Display *)

contrast = 125 * 1.5;
displaying = Table[
   If[contrast * arraylets[[i, j]] > 0,
    If[contrast * arraylets[[i, j]] < 1, {contrast * arraylets[[i, j]], 0}, {1, 0}],
    If[contrast * arraylets[[i, j]] > -1, {0, -contrast * arraylets[[i, j]]}, {0, 1}]],
   {i, 1, genes}, {j, 1, arrays}];
labelx = "Arraylets";
labely = ColumnForm[
   {" ", "                                        Genes", " ", " ", " "},
   Center];
framex = Table[{a - 0.5, ToString[a]}, {a, 1, arrays}];
size = 5;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      framex[[a, 2]]
     ]], {a, 1, arrays}]];
Do[
  Do[framex[[a, 2]] = StringJoin[framex[[a, 2]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, arrays}];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, genes, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, None, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1300}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 600}, {0, 0}, {0, 1}];
g6 = Show[g,
   AspectRatio -> GoldenRatio * 2,
   PlotRange -> All,
   DisplayFunction -> Identity];
```

```
(* Create Human Expression Fractions Red & Green Raster Display *)

contrast = 0.03;
displaying = Table[
   If[contrast * d2[[i, j]] > 0,
    If[contrast * d2[[i, j]] < 1, {contrast * d2[[i, j]], 0}, {1, 0}],
    If[contrast * d2[[i, j]] > -1, {0, -contrast * d2[[i, j]]}, {0, 1}]],
   {i, 1, arrays}, {j, 1, arrays}];
framex = Table[a, {a, 1, arrays}];
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      ToString[framex[[a]]
      ]]], {a, 1, arrays}]];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, arrays}];
framex = Table[{a - 0.5, framex[[a]]}, {a, 1, arrays}];
framey = Table[{a + 1 - 0.5, arrays - a}, {a, 0, arrays - 1}];
labely = ColumnForm[{" ", "Arraylets", " "}, Center];
labelx = ColumnForm[{"Genelets", " ", " "}, Center];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, arrays, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 2.2}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 3}, {0, 0}, {0, 1}];
g7 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction -> Identity];
```

```
(* Center Genelets *)

average = Table[1, {a, 1, arrays}];
average = N[average / Sqrt[Dot[average, average]]];
centergenelets = genelets - N[Outer[Times, Dot[genelets, average], average]];

(* Create Genelets 2 D Red & Green Raster Display *)

contrast = 3;
displaying = Table[
   If[contrast * centergenelets[[i, j]] > 0,
    If[contrast * centergenelets[[i, j]] < 1, {contrast * centergenelets[[i, j]], 0}, {1, 0}],
    If[contrast * centergenelets[[i, j]] > -1, {0, -contrast * centergenelets[[i, j]]}, {0, 1}]],
   {i, 1, arrays}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
framey = Table[{a + 1 - 0.5, arrays - a}, {a, 0, arrays - 1}];
labely = ColumnForm[{" ", "Genelets", " "}, Center];
labelx = ColumnForm[{"Arrays", " ", " "}, Center];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, arrays, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 2.2}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 3}, {0, 0}, {0, 1}];
g8 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Display GSVD of Sorted Yeast and Human Data *)

equal = Show[Graphics[
            Text[StyleForm["=", FontSize → 20, FontWeight -> Bold], {0, 0}]
        ], DisplayFunction -> Identity];
times = Show[Graphics[
            Text[StyleForm["×", FontSize -> 20, FontWeight -> Bold], {0, 0}]
        ], DisplayFunction -> Identity];
doubleverticalbar = Show[Graphics[
            Text[StyleForm["‖", FontSize → 20, FontWeight -> Bold], {0, 0}]
        ], DisplayFunction -> Identity];

Show[{
   Graphics[{Rectangle[{0, -15}, {25, 84}, g5]}],
   Graphics[{Rectangle[{7, 25}, {25, 84}, equal]}],
   Graphics[{Rectangle[{9, -15}, {29, 84}, g6]}],
   Graphics[{Rectangle[{16, 25}, {29, 84}, times]}],
   Graphics[{Rectangle[{18, 40}, {33, 84}, g7]}],
   Graphics[{Rectangle[{25, 25}, {33, 84}, times]}],
   Graphics[{Rectangle[{27, 40}, {37, 84}, g8]}],
   Graphics[{Rectangle[{0, 85}, {25, 135}, g1]}],
   Graphics[{Rectangle[{7, 81}, {25, 135}, equal]}],
   Graphics[{Rectangle[{9, 85}, {29, 135}, g2]}],
   Graphics[{Rectangle[{16, 81}, {29, 135}, times]}],
   Graphics[{Rectangle[{18, 91}, {33, 135}, g3]}],
   Graphics[{Rectangle[{25, 81}, {33, 135}, times]}],
   Graphics[{Rectangle[{27, 91}, {37, 135}, g4]}],
   Graphics[{Rectangle[{28, 40}, {37, 135}, doubleverticalbar]}]}],
  PlotRange -> All];
```


Arrays
0_min
7_min
14_min
21_min
28_min
35_min
42_min
49_min
56_min
63_min
70_min
77_min
84_min
91_min
98_min
105_min
112_min
119_min
Genes
=
Arraylets
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Genes


Arrays
2_hr
4_hr
6_hr
8_hr
10_hr
12_hr
14_hr
16_hr
18_hr
20_hr
22_hr
24_hr
26_hr
28_hr
30_hr
32_hr
34_hr
36_hr
Genes
=
Arraylets
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Genes

```
(* Sort Yeast Data in Exclusive Pheromone Response Subspace *)
```

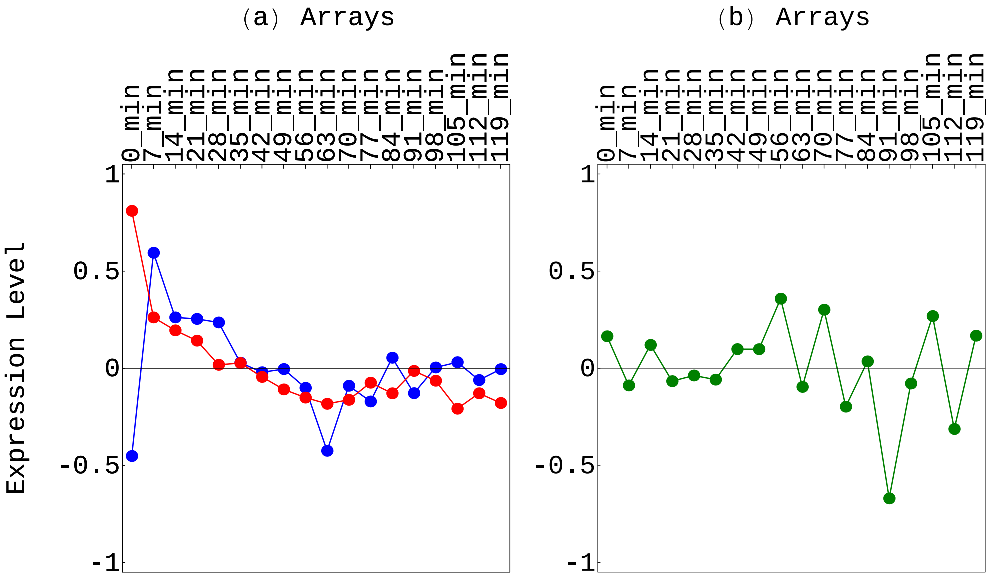
```
(* Sort Yeast Data *)

genes = genes1;
arraynames = arraynames1;
genenames = TakeColumns[genenames1, 1];

(* Least-Squares Approximate 3 D Subspace of Genelets with 2 D Subspace Using SVD *)

average = Table[1, {a, 1, arrays}];
average = N[average / Sqrt[Dot[average, average]]];
centergenelets1 = genelets[[1]] - N[Outer[Times, Dot[genelets, average], average]][[1]];
centergenelets1 = N[centergenelets1 / Sqrt[Dot[centergenelets1, centergenelets1]]];
centergenelets2 = genelets[[2]] - N[Outer[Times, Dot[genelets, average], average]][[2]];
centergenelets2 = N[centergenelets2 / Sqrt[Dot[centergenelets2, centergenelets2]]];
centergenelets6 = genelets[[6]] - N[Outer[Times, Dot[genelets, average], average]][[6]];
centergenelets6 = N[centergenelets6 / Sqrt[Dot[centergenelets6, centergenelets6]]];
{u, w, v} = SingularValues[{centergenelets1, centergenelets2, centergenelets6}];
Sum[w[[a]]^2, {a, 1, 2}] / Sum[w[[a]]^2, {a, 1, 3}]
```

```
0.89623
```

```
(* Define 2 D Subspace {x,y} ≡  {-v[[1]],v[[2]]} *)

(* Create -v[[1]], v[[2]] and v[[3]] Graph Displays *)

labelx = ColumnForm[{"(a) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, -v[[1, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[1, 0, 0], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {{{17.5, RGBColor[0, 0, 0]}, {19.5, RGBColor[0, 0, 0]}}, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p1 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = ColumnForm[{"(a) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, v[[2, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0, 1], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {{{17.5, RGBColor[0, 0, 0]}, {19.5, RGBColor[0, 0, 0]}}, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p2 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];

labelx = ColumnForm[{"(b) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, v[[3, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0.5, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0.5, 0], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {{{17.5, RGBColor[0, 0, 0]}, {19.5, RGBColor[0, 0, 0]}}, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p3 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Display -v[[1]], v[[2]] and v[[3]] *)

g = Show[{p2, p1},
   DisplayFunction -> Identity];
Show[GraphicsArray[{g, p3}],
  GraphicsSpacing -> -0.15];
```



```
(* Calculate Amplitudes of the Projections of the Genelets *)

a1 = Sqrt[Dot[genelets[[1]], v[[1]]]^2 + Dot[genelets[[1]], v[[2]]]^2];
a2 = Sqrt[Dot[genelets[[2]], v[[1]]]^2 + Dot[genelets[[2]], v[[2]]]^2];
a6 = Sqrt[Dot[genelets[[6]], v[[1]]]^2 + Dot[genelets[[6]], v[[2]]]^2];

(* Calculate Angular Directions of the Projections of Genelets *)

c1 = ArcTan[Dot[genelets[[1]], v[[2]]] / Dot[genelets[[1]], v[[1]]]];
c2 = ArcTan[Dot[genelets[[2]], v[[2]]] / Dot[genelets[[2]], v[[1]]]];
c6 = ArcTan[Dot[genelets[[6]], v[[2]]] / Dot[genelets[[6]], v[[1]]]];
c12 = 2 * Abs[Cos[c1 - c2]];
c16 = 2 * Abs[Cos[c1 - c6]];
c26 = 2 * Abs[Cos[c2 - c6]];

(* Sort Yeast Arrays *)

(* Center Genelets and Calculate Contributions of Arraylets to Arrays *)

arraycontributions1 =
  (genelets[[1]] - N[Outer[Times, Dot[genelets, average], average]][[1]]) * d1[[1, 1]];
arraycontributions2 =
  (genelets[[2]] - N[Outer[Times, Dot[genelets, average], average]][[2]]) * d1[[2, 2]];
arraycontributions6 =
  (genelets[[6]] - N[Outer[Times, Dot[genelets, average], average]][[6]]) * d1[[6, 6]];
```

```
(* Project Arrays from 3 D Arraylets Subspace Onto 2 D Subspace  *)

coordinates = Table[{
    -(Dot[genelets[[1]], v[[1]]] * arraycontributions1[[a]] +
        Dot[genelets[[2]], v[[1]]] * arraycontributions2[[a]] +
        Dot[genelets[[6]], v[[1]]] * arraycontributions6[[a]]) /
     Sqrt[(a1 * arraycontributions1[[a]])^2 + (a2 * arraycontributions2[[a]])^2 +
       (a6 * arraycontributions6[[a]])^2 +
       c12 * Abs[(a1 * arraycontributions1[[a]]) * (a2 * arraycontributions2[[a]])] +
       c16 * Abs[(a1 * arraycontributions1[[a]]) * (a6 * arraycontributions6[[a]])] +
       c26 * Abs[(a2 * arraycontributions2[[a]]) * (a6 * arraycontributions6[[a]])]],
    (Dot[genelets[[1]], v[[2]]] * arraycontributions1[[a]] +
       Dot[genelets[[2]], v[[2]]] * arraycontributions2[[a]] +
       Dot[genelets[[6]], v[[2]]] * arraycontributions6[[a]]) /
     Sqrt[(a1 * arraycontributions1[[a]])^2 + (a2 * arraycontributions2[[a]])^2 +
       (a6 * arraycontributions6[[a]])^2 +
       c12 * Abs[(a1 * arraycontributions1[[a]]) * (a2 * arraycontributions2[[a]])] +
       c16 * Abs[(a1 * arraycontributions1[[a]]) * (a6 * arraycontributions6[[a]])] +
       c26 * Abs[(a2 * arraycontributions2[[a]]) * (a6 * arraycontributions6[[a]])]]},
   {a, 1, arrays}];

(* Create Parameter Graph of Yeast Arrays Projected Onto 2 D Subspace *)

Clear[points];
points1 = Point[coordinates[[1]]];
points2 = {Point[coordinates[[2]]], Point[coordinates[[3]]], Point[coordinates[[4]]]};
points3 = {Point[coordinates[[5]]], Point[coordinates[[6]]]};
points4 = {
   Point[coordinates[[7]]], Point[coordinates[[8]]], Point[coordinates[[9]]],
   Point[coordinates[[10]]], Point[coordinates[[11]]], Point[coordinates[[12]]],
   Point[coordinates[[13]]], Point[coordinates[[14]]], Point[coordinates[[15]]],
   Point[coordinates[[16]]], Point[coordinates[[17]]], Point[coordinates[[18]]]};
textcoordinates = coordinates;
Do[
  textcoordinates[[a, 1]] = If[
    textcoordinates[[a, 1]] > 0,
    textcoordinates[[a, 1]] - 0.085,
    textcoordinates[[a, 1]] + 0.095],
  {a, 1, 9}];
Do[textcoordinates[[a, 1]] = If[
    textcoordinates[[a, 1]] > 0,
    textcoordinates[[a, 1]] - 0.11,
    textcoordinates[[a, 1]] + 0.12],
  {a, 10, arrays}];
textcoordinates[[1]] = textcoordinates[[1]] + {0.02, -0.08};
textcoordinates[[3]] = textcoordinates[[3]] + {0.18, 0.02};
textcoordinates[[4]] = textcoordinates[[4]] + {0.18, 0};
textcoordinates[[5]] = textcoordinates[[5]] - {0.18, 0};
textcoordinates[[7]] = textcoordinates[[7]] + {-0.02, 0.1};
textcoordinates[[8]] = textcoordinates[[8]] + {0, 0.03};
textcoordinates[[9]] = textcoordinates[[9]] + {-0.02, 0.12};
textcoordinates[[11]] = textcoordinates[[11]] - {0.21, 0.06};
textcoordinates[[13]] = textcoordinates[[13]] + {0, 0.06};
textcoordinates[[15]] = textcoordinates[[15]] + {-0.21, 0.02};
textcoordinates[[16]] = textcoordinates[[16]] + {-0.21, 0.12};
textcoordinates[[17]] = textcoordinates[[17]] - {0.02, 0.08};
textcoordinates[[18]] = textcoordinates[[18]] + {-0.21, 0.08};
```

```
texts = Table[Text[a, textcoordinates[[a]]], {a, 1, arrays}];
p = Show[
   {Graphics[{RGBColor[1, 0, 0], PointSize[0.035], points1}],
    Graphics[{RGBColor[1, 0.5, 0], PointSize[0.035], points2}],
    Graphics[{RGBColor[0, 0.5, 0], PointSize[0.035], points3}],
    Graphics[{RGBColor[0, 0, 1], PointSize[0.035], points4}],
    Graphics[{RGBColor[1, 0, 0], Text["E1", {1.0, -0.5}]}],
    Graphics[{RGBColor[1, 0.5, 0], Text["E2", {1.0, 0.5}]}],
    Graphics[{RGBColor[0, 0, 0], Text["M1", {0.65, 0.9}]}],
    Graphics[{RGBColor[0, 0.5, 0], Text["M2", {-0.65, 0.9}]}],
    Graphics[{RGBColor[0, 0, 1], Text["L1", {-1.0, -0.5}]}],
    Graphics[{RGBColor[0.75, 0, 1], Text["L2", {-0.65, -0.9}]}],
    Graphics[{RGBColor[0, 0, 0], Text["(a)", {-1., 0.95}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|x〉", {0.85, 0.08}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|y〉", {0.12, 0.915}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|α₁〉", {-0.92, 0.75}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|α₂〉", {-0.35, 0.08}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|α₆〉", {0.92, 0.8}]}],
    Graphics[texts],
    Graphics[{RGBColor[0, 0, 0], Circle[{0, 0}, 0.85,
       {ArcTan[coordinates[[1, 2]] / coordinates[[1, 1]]], 0}]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[
       {0.85 * Cos[-0.05], 0.85 * Sin[-0.05]}, {0.85 * Cos[0], 0.85 * Sin[0]},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{0, 0}, coordinates[[1]],
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Text["r", {0.8, -0.15}]}],
    Graphics[{RGBColor[0, 0, 0], Text["ϕ", {0.775, -0.06}]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 0.5]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 1]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Line[{{0, 1.05}, {0, -1.05}}]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Line[{{-1.15, 0}, {1.15, 0}}]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{1.15, -1.15 * Tan[c1]}, {-1.15, 1.15 * Tan[c1]},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.15, 1.15 * Tan[c2]}, {1.15, -1.15 * Tan[c2]},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.15, 1.15 * Tan[c6]}, {1.15, -1.15 * Tan[c6]},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}]},
   AspectRatio -> 1,
   PlotRange -> {{-1.15, 1.15}, {-1.05, 1.05}},
   Frame -> True,
   FrameTicks -> False,
   FrameLabel -> {None, None, None, None},
   GridLines -> {None, None},
   DisplayFunction -> Identity];
p = FullGraphics[p];
p[[1, 2]] = p[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {-1.18, 0}, {0, 0}, {0, 1}];
g1 = Show[p,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Sort Yeast Genes *)

(* Center Arraylets and Calculate Contributions of Genelets to Genes *)

centerarraylets = Transpose[arraylets1];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
centerarraylets = centerarraylets - N[Outer[Times, Dot[centerarraylets, average], average]];
centerarraylets = Transpose[centerarraylets];
genecontributions = Transpose[Dot[centerarraylets, d1]];

(* Project Genes from 3 D Genelets Subspace Onto 2 D Subspace  *)

coordinates = Table[{
    -(Dot[genelets[[1]], v[[1]]] * genecontributions[[1, a]] +
        Dot[genelets[[2]], v[[1]]] * genecontributions[[2, a]] +
        Dot[genelets[[6]], v[[1]]] * genecontributions[[6, a]]) /
     Sqrt[(a1 * genecontributions[[1, a]])^2 + (a2 * genecontributions[[2, a]])^2 +
       (a6 * genecontributions[[6, a]])^2 +
       c12 * Abs[(a1 * genecontributions[[1, a]]) * (a2 * genecontributions[[2, a]])] +
       c16 * Abs[(a1 * genecontributions[[1, a]]) * (a6 * genecontributions[[6, a]])] +
       c26 * Abs[(a2 * genecontributions[[2, a]]) * (a6 * genecontributions[[6, a]])]],
    (Dot[genelets[[1]], v[[2]]] * genecontributions[[1, a]] +
       Dot[genelets[[2]], v[[2]]] * genecontributions[[2, a]] +
       Dot[genelets[[6]], v[[2]]] * genecontributions[[6, a]]) /
     Sqrt[(a1 * genecontributions[[1, a]])^2 + (a2 * genecontributions[[2, a]])^2 +
       (a6 * genecontributions[[6, a]])^2 +
       c12 * Abs[(a1 * genecontributions[[1, a]]) * (a2 * genecontributions[[2, a]])] +
       c16 * Abs[(a1 * genecontributions[[1, a]]) * (a6 * genecontributions[[6, a]])] +
       c26 * Abs[(a2 * genecontributions[[2, a]]) * (a6 * genecontributions[[6, a]])]]},
   {a, 1, genes}];

(* Create Parameter Graph of 172 Yeast Pheromone Response Genes Projected Onto 2 D Subspace *)

Clear[points, radii];
stream = StringJoin[name, ":Desktop Folder:PNAS Data:Yeast_Pheromone_Classify.txt"];
list = ReadList[stream, Word, RecordLists -> True, NullWords -> True];
list = Drop[list, 1];
points = {points1, points2, points3, points4, points5, points6};
radii = {radii1, radii2, radii3, radii4, radii5, radii6};
stages = {"E1", "E2", "M1", "M2", "L1", "L2"};
Do[{
  position = Position[list, stages[[b]]],
  table = Table[list[[position[[a, 1]], 1]], {a, 1, Dimensions[position][[1]]}],
  position = Table[Position[genenames, table[[a]]], {a, 1, Dimensions[table][[1]]}],
  table = Flatten[Position[position, {}]],
  Do[
   position = Drop[position, {table[[a]], table[[a]]}],
   {a, Dimensions[table][[1]], 1, -1}],
  points[[b]] = Table[Point[coordinates[[position[[a, 1, 1]]]]], {a, 1, Dimensions[position][[1]]}],
  radii[[b]] = Table[
    Sqrt[coordinates[[position[[a, 1, 1]], 1]]^2 + coordinates[[position[[a, 1, 1]], 2]]^2],
    {a, 1, Dimensions[position][[1]]}]},
 {b, 1, Dimensions[stages][[1]]}]
```

```
Dimensions[points[[1]]][[1]]
Dimensions[points[[2]]][[1]]
Dimensions[points[[3]]][[1]]
Dimensions[points[[4]]][[1]]
Dimensions[points[[5]]][[1]]
Dimensions[points[[6]]][[1]]
```

```
37

15

37

23

22

38
```

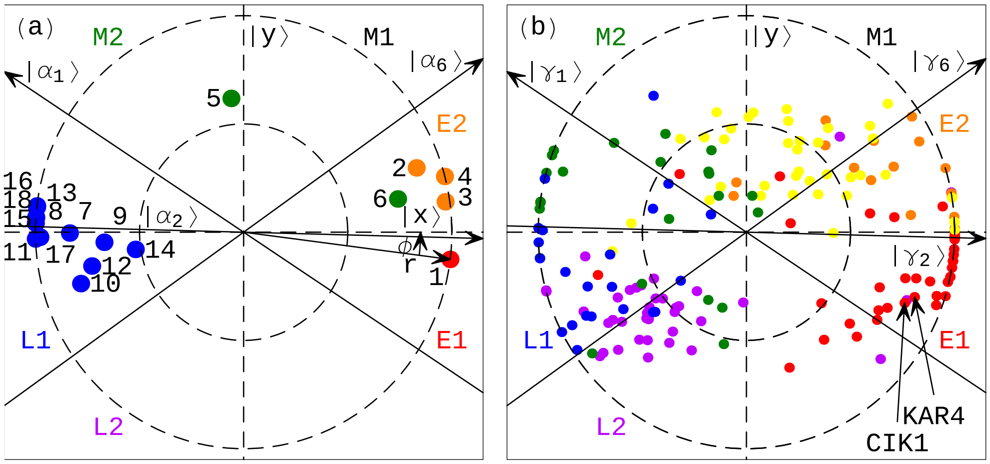
```
radii = Sort[Flatten[radii], OrderedQ[{{#1}, {#2}}] &];
N[Round[radii[[42]] * 100] / 100]
N[Round[radii[[43]] * 100] / 100]
```

```
0.49

0.51
```

```
(* 172 pheromone response genes, 37 in E1, 15 in E2, 37 in M1, 23 in M2, 22 in L1, 38 in L2. *)

(* For 130 genes, 50 % or more of the contributions of the 6 genelets add up. *)
```

```
kar4 = coordinates[[Position[genenames, "YCL055W"][[1, 1]]]];
cik1 = coordinates[[Position[genenames, "YMR198W"][[1, 1]]]];
p = Show[
   {Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 0.5]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 1]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Line[{{0, 1.05}, {0, -1.05}}]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Line[{{-1.15, 0}, {1.15, 0}}]}],
    Graphics[{RGBColor[0.75, 0, 1], PointSize[0.02], points[[6]]}],
    Graphics[{RGBColor[1, 0.5, 0], PointSize[0.02], points[[2]]}],
    Graphics[{RGBColor[1, 0, 0], PointSize[0.02], points[[1]]}],
    Graphics[{RGBColor[1, 1, 0], PointSize[0.02], points[[3]]}],
    Graphics[{RGBColor[0, 0.5, 0], PointSize[0.02], points[[4]]}],
    Graphics[{RGBColor[0, 0, 1], PointSize[0.02], points[[5]]}],
    Graphics[{RGBColor[1, 0, 0], Text["E1", {1.0, -0.5}]}],
    Graphics[{RGBColor[1, 0.5, 0], Text["E2", {1.0, 0.5}]}],
    Graphics[{RGBColor[0, 0, 0], Text["M1", {0.65, 0.9}]}],
    Graphics[{RGBColor[0, 0.5, 0], Text["M2", {-0.65, 0.9}]}],
    Graphics[{RGBColor[0, 0, 1], Text["L1", {-1.0, -0.5}]}],
    Graphics[{RGBColor[0.75, 0, 1], Text["L2", {-0.65, -0.9}]}],
    Graphics[{RGBColor[0, 0, 0], Text["(b)", {-1., 0.95}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|y〉", {0.12, 0.915}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|γ1〉", {-0.92, 0.75}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|γ2〉", {0.825, -0.1}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|γ6〉", {0.92, 0.8}]}],
    Graphics[{RGBColor[1, 0, 0], PointSize[0.02], Point[kar4]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{0.9, -0.75}, kar4,
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Text["KAR4", {0.9, -0.85}]}],
    Graphics[{RGBColor[1, 0, 0], PointSize[0.02], Point[cik1]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{0.725, -0.875}, cik1,
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Text["CIK1", {0.725, -0.975}]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 0.5]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 1]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{1.15, -1.15 * Tan[c1]}, {-1.15, 1.15 * Tan[c1]},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.15, 1.15 * Tan[c2]}, {1.15, -1.15 * Tan[c2]},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.15, 1.15 * Tan[c6]}, {1.15, -1.15 * Tan[c6]},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}]},
   AspectRatio -> 1,
   PlotRange -> {{-1.15, 1.15}, {-1.05, 1.05}},
   Frame -> True,
   FrameTicks -> False,
   FrameLabel -> {None, None, None, None},
   GridLines -> {None, None},
   DisplayFunction -> Identity];
p = FullGraphics[p];
p[[1, 2]] = p[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {-1.18, 0}, {0, 0}, {0, 1}];
g2 = Show[p,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Display Both Arrays & Genes Parameter Graphs *)

Show[GraphicsArray[{g1, g2}],
    GraphicsSpacing -> 0];
```



```
(* Reconstruct Yeast Data in Exclusive Pheromone Response Subspace *)
```

```
(* Sort Yeast Genes *)

matrix = matrix1;
genes = genes1;
arraynames = arraynames1;
genenames = genenames1;
```

```
(* Center Arraylets and Calculate Contributions of Genelets to Genes *)

centerarraylets = Transpose[arraylets1];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
centerarraylets = centerarraylets - N[Outer[Times, Dot[centerarraylets, average], average]];
centerarraylets = Transpose[centerarraylets];
genecontributions = Transpose[Dot[centerarraylets, d1]];
```

```
(* Project Genes from 3 D Genelets Subspace Onto 2 D Subspace  *)

coordinates = Table[{
    - (Dot[genelets[[1]], v[[1]]] * genecontributions[[1, a]] +
        Dot[genelets[[2]], v[[1]]] * genecontributions[[2, a]] +
        Dot[genelets[[6]], v[[1]]] * genecontributions[[6, a]]) /
     Sqrt[(a1 * genecontributions[[1, a]]) ^ 2 + (a2 * genecontributions[[2, a]]) ^ 2 +
       (a6 * genecontributions[[6, a]]) ^ 2 +
       c12 * Abs[(a1 * genecontributions[[1, a]]) * (a2 * genecontributions[[2, a]])] +
       c16 * Abs[(a1 * genecontributions[[1, a]]) * (a6 * genecontributions[[6, a]])] +
       c26 * Abs[(a2 * genecontributions[[2, a]]) * (a6 * genecontributions[[6, a]])]],
    (Dot[genelets[[1]], v[[2]]] * genecontributions[[1, a]] +
       Dot[genelets[[2]], v[[2]]] * genecontributions[[2, a]] +
       Dot[genelets[[6]], v[[2]]] * genecontributions[[6, a]]) /
     Sqrt[(a1 * genecontributions[[1, a]]) ^ 2 + (a2 * genecontributions[[2, a]]) ^ 2 +
       (a6 * genecontributions[[6, a]]) ^ 2 +
       c12 * Abs[(a1 * genecontributions[[1, a]]) * (a2 * genecontributions[[2, a]])] +
       c16 * Abs[(a1 * genecontributions[[1, a]]) * (a6 * genecontributions[[6, a]])] +
       c26 * Abs[(a2 * genecontributions[[2, a]]) * (a6 * genecontributions[[6, a]])]]},
   {a, 1, genes}];
```

```
(* Define the Initial Phase *)

zerophase = Pi / 2;
```

```
(* Sort Genes Accodring to Phases in 2 D Subspace *)

coordinates = Table[{
    coordinates[[a, 1]] / Sqrt[coordinates[[a, 1]]^2 + coordinates[[a, 2]]^2],
    coordinates[[a, 2]] / Sqrt[coordinates[[a, 1]]^2 + coordinates[[a, 2]]^2]},
   {a, 1, genes}];
coordinates = Table[{
    -coordinates[[a, 1]] * Cos[zerophase] - coordinates[[a, 2]] * Sin[zerophase],
    -coordinates[[a, 2]] * Cos[zerophase] + coordinates[[a, 1]] * Sin[zerophase]},
   {a, 1, genes}];
coordinates = Table[{
    coordinates[[a, 1]],
    coordinates[[a, 2]],
    N[ArcTan[coordinates[[a, 1]] / coordinates[[a, 2]]] / Pi]},
   {a, 1, genes}];
sortmatrix = AppendRows[coordinates, genenames, matrix];
sortmatrix = Sort[sortmatrix, OrderedQ[{{#1}, {#2}}] &];
negative1 = 2358;
positive1 = 2359;
sortmatrix[[negative1, 1]]
sortmatrix[[positive1, 1]]
```

```
-0.00066054

0.000366875
```

```
sortmatrix = Transpose[Drop[Transpose[sortmatrix], {1}]];
sortmatrix = AppendColumns[
  Sort[
   TakeRows[sortmatrix, {1, negative1}],
   OrderedQ[{{#2}, {#1}}] &],
  Sort[
   TakeRows[sortmatrix, {positive1, genes}],
   OrderedQ[{{#1}, {#2}}] &]];
phases = TakeColumns[sortmatrix, {2, 2}];
sortmatrix = Transpose[Drop[Transpose[sortmatrix], {1, 2}]];
```

```
(* Classify Gene Phases into Pheromone Response Phases *)

ph1 = c6 / Pi;
ph2 = 0.5;
ph3 = c1 / Pi;
ph4 = 1 + c6 / Pi;
ph5 = 1;
ph6 = c2 / Pi;

endph6 = 640;
beginph1 = 641;
phases[[endph6]] - ph1
phases[[beginph1]] - ph1

{0.000221009}

{-0.000301123}

endph1 = 1241;
beginph2 = 1242;
phases[[endph1]] - ph2
phases[[beginph2]] - ph2

{-0.999615}

{-0.000682573}

endph2 = 1835;
beginph3 = 1836;
phases[[endph2]] - ph3
phases[[beginph3]] - ph3

{0.000045203}

{-0.000284979}

endph3 = 3129;
beginph4 = 3130;
phases[[endph3]] - ph4
phases[[beginph4]] - ph4

{-0.999914}

{-1.00006}

endph4 = 3687;
beginph5 = 3688;
phases[[endph4]] - ph5
phases[[beginph5]] - ph5

{-1.49993}

{-0.50056}

endph5 = 4496;
beginph6 = 4497;
phases[[endph5]] - ph6
phases[[beginph6]] - ph6

{0.0000461515}

{-0.000172979}

(* 4523 yeast genes, 809 in E1, 667 in E2, 601 in M1, 594 in M2, 1294 in L1, 558 in L2. *)
```

```
(* Reconstruct Data With Sorted Genes *)

matrix1 = TakeColumns[sortmatrix, {7, arrays + 6}];
genenames1 = TakeColumns[sortmatrix, {1, 6}];

(* Calculate GSVD of Sorted Yeast and Human Data *)

matrix = AppendColumns[matrix1, matrix2];
{q, r} = QRDecomposition[matrix];
q = Conjugate[Transpose[q]];
q1 = TakeRows[q, {1, genes1}];
{u1, w1, v1} = SingularValues[q1];
genelets = Dot[v1, r];
Do[genelets[[a]] = genelets[[a]] / Sqrt[Dot[genelets[[a]], genelets[[a]]]],
 {a, 1, arrays}]

genelets[[2]] = -genelets[[2]];
genelets[[5]] = -genelets[[5]];
genelets[[14]] = -genelets[[14]];
genelets[[16]] = -genelets[[16]];
genelets[[17]] = -genelets[[17]];
genelets[[18]] = -genelets[[18]];

arraylets1 = Dot[matrix1, Inverse[genelets]];
arraylets2 = Dot[matrix2, Inverse[genelets]];
arraylets1 = Transpose[arraylets1];
Do[arraylets1[[a]] = arraylets1[[a]] / Sqrt[Dot[arraylets1[[a]], arraylets1[[a]]]], {a, 1, arrays}];
arraylets1 = Transpose[arraylets1];
arraylets2 = Transpose[arraylets2];
Do[arraylets2[[a]] = arraylets2[[a]] / Sqrt[Dot[arraylets2[[a]], arraylets2[[a]]]], {a, 1, arrays}];
arraylets2 = Transpose[arraylets2];
d1 = Chop[Dot[PseudoInverse[arraylets1], matrix1, Inverse[genelets]]];
d2 = Chop[Dot[PseudoInverse[arraylets2], matrix2, Inverse[genelets]]];

(* Display Sorted and Reconstructed Yeast Data *)

genes = genes1;
genenames = genenames1;
arraynames = arraynames1;
{endph1, endph2, endph3, endph4, endph5, endph6} = {1241, 1835, 3129, 3687, 4496, 640};

(* Reconstruct Sorted Yeast Data *)

Do[d1[[a, a]] = 0, {a, 3, 5}];
Do[d1[[a, a]] = 0, {a, 7, 18}];
matrix = Dot[arraylets1, d1, genelets];

(* Center Sorted Yeast Data *)

average = Table[1, {a, 1, arrays}];
average = N[average / Sqrt[Dot[average, average]]];
matrix = matrix - N[Outer[Times, Dot[matrix, average], average]];
matrix = Transpose[matrix];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
matrix = matrix - N[Outer[Times, Dot[matrix, average], average]];
matrix = Transpose[matrix];
```

```
(* Create Recosntructed Sorted Yeast Data 2 D Red & Green Raster Display *)

contrast = 10 * 1.5;
displaying = Table[
   If[contrast * matrix[[i, j]] > 0,
    If[contrast * matrix[[i, j]] < 1, {contrast * matrix[[i, j]], 0}, {1, 0}],
    If[contrast * matrix[[i, j]] > -1, {0, -contrast * matrix[[i, j]]}, {0, 1}]],
   {i, 1, genes}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {
   {genes - endph6 / 2, "E2"},
   {genes - (endph6 + endph1) / 2, "M1"},
   {genes - (endph1 + endph2) / 2, "M2"},
   {genes - (endph2 + endph3) / 2, "L1"},
   {genes - (endph3 + endph4) / 2, "L2"},
   {genes - (endph4 + endph5) / 2, "E1"},
   {(genes - endph5) / 2, "E2"}};
gridy = {
   {genes - endph5 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph6 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph1 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph2 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph3 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph4 + 0.5, {RGBColor[0, 0, 0]}}};
labelx = "(a)  Arrays";
labely = ColumnForm[{" ", "Genes", " ", " ", " ", " ", " ", " "}, Center];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, genes, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, gridy},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 1.5, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1100}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 550}, {0, 0}, {0, 1}];
g1 = Show[g,
   AspectRatio -> GoldenRatio * 1.2,
   PlotRange -> All,
   DisplayFunction → Identity];

(* Center Sorted Yeast Arraylets *)

arraylets = Transpose[arraylets1];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
arraylets = arraylets - N[Outer[Times, Dot[arraylets, average], average]];
arraylets = Transpose[arraylets];
```

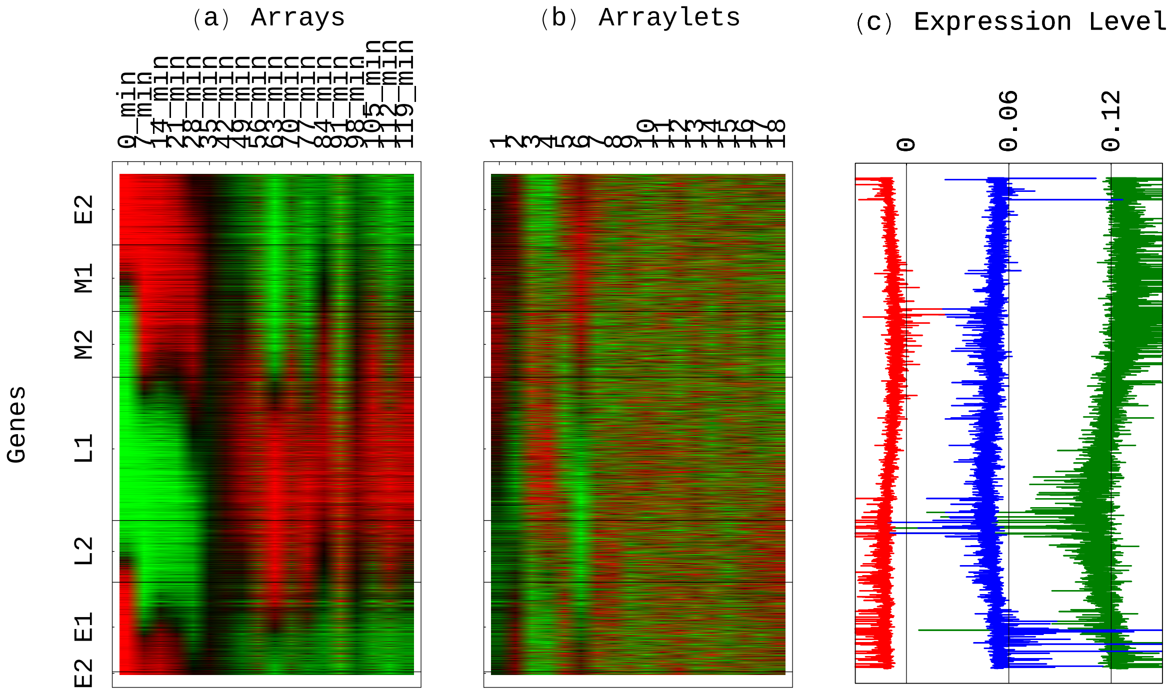
```
(* Create Sorted Yeast Arraylets 2 D Red & Green Raster Display *)

contrast = 75 * 1.5;
displaying = Table[
   If[contrast * arraylets[[i, j]] > 0,
    If[contrast * arraylets[[i, j]] < 1, {contrast * arraylets[[i, j]], 0}, {1, 0}],
    If[contrast * arraylets[[i, j]] > -1, {0, -contrast * arraylets[[i, j]]}, {0, 1}]],
   {i, 1, genes}, {j, 1, arrays}];
labelx = "(b) Arraylets";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framey = {
   {genes - endph6 / 2, "  "},
   {genes - (endph6 + endph1) / 2, "  "},
   {genes - (endph1 + endph2) / 2, "  "},
   {genes - (endph2 + endph3) / 2, "  "},
   {genes - (endph3 + endph4) / 2, "  "},
   {genes - (endph4 + endph5) / 2, "  "},
   {(genes - endph5) / 2, "  "}};
gridy = {
   {genes - endph1 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph2 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph3 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph4 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph5 + 0.5, {RGBColor[0, 0, 0]}}};
framex = Table[{a - 0.5, ToString[a]}, {a, 1, arrays}];
size = 7;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      framex[[a, 2]]
     ]], {a, 1, arrays}]];
Do[
  Do[framex[[a, 2]] = StringJoin[framex[[a, 2]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, arrays}];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, genes, 1, -1}, {j, 1, arrays}
     ]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, gridy},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 1.5, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1100}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 550}, {0, 0}, {0, 1}];
```

```
g2 = Show[g,
   AspectRatio -> GoldenRatio * 1.2,
   PlotRange -> All,
   DisplayFunction → Identity];

(* Create Selected Sorted Yeast Arraylets Graph Display *)

arraylets = Transpose[arraylets1];

labelx = "(c) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0       "}, {0.06, "0.06    "}, {0.12, "0.12    "}};
coordinates = Table[
   If[arraylets[[1, a]] < -0.025 * 1.2, -0.025 * 1.2,
    If[arraylets[[1, a]] > 0.125 * 1.2, 0.125 * 1.2, arraylets[[1, a]]]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[1, 0, 0], line}],
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025 * 1.2, 0.125 * 1.2}, {135, -genes + 1 - 135}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1125}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 575}, {0, 0}, {0, 1}];
p1 = Show[g,
   AspectRatio -> GoldenRatio * 1.2765,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = "(c) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0      "}, {0.06, "0.06   "}, {0.12, "0.12   "}};
coordinates = Table[
   If[arraylets[[2, a]] + 0.05 * 1.2 > 0.125 * 1.2, 0.125 * 1.2,
    If[arraylets[[2, a]] + 0.05 * 1.2 < -0.025 * 1.2, -0.025 * 1.2, arraylets[[2, a]] + 0.05 * 1.2]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[0, 0, 1], line}],
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0.05 * 1.2, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025 * 1.2, 0.125 * 1.2}, {135, -genes + 1 - 135}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1125}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 575}, {0, 0}, {0, 1}];
p2 = Show[g,
   AspectRatio -> GoldenRatio * 1.2765,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = "(c) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0      "}, {0.06, "0.06   "}, {0.12, "0.12   "}};
coordinates = Table[
   If[arraylets[[6, a]] + 0.1 * 1.2 < -0.025 * 1.2, -0.025 * 1.2,
    If[arraylets[[6, a]] + 0.1 * 1.2 > 0.125 * 1.2, 0.125 * 1.2, arraylets[[6, a]] + 0.1 * 1.2]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[0, 0.5, 0], line}],
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0.1 * 1.2, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025 * 1.2, 0.125 * 1.2}, {135, -genes + 1 - 135}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1125}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 575}, {0, 0}, {0, 1}];
p6 = Show[g,
   AspectRatio -> GoldenRatio * 1.2765,
   PlotRange -> All,
   DisplayFunction → Identity];

(* Display Selected Sorted Yeast Arraylets *)

g3 = Show[{p6, p2, p1},
   DisplayFunction -> Identity];
```

```
(* Display Recosntructed Sorted Yeast and Human Data, Arraylets and Selected Arraylets *)

Show[GraphicsArray[{g1, g2, g3}],
    GraphicsSpacing -> -0.2];
```



```
(* Sort Human Data in Exclusive Stress Response Subspace *)
```

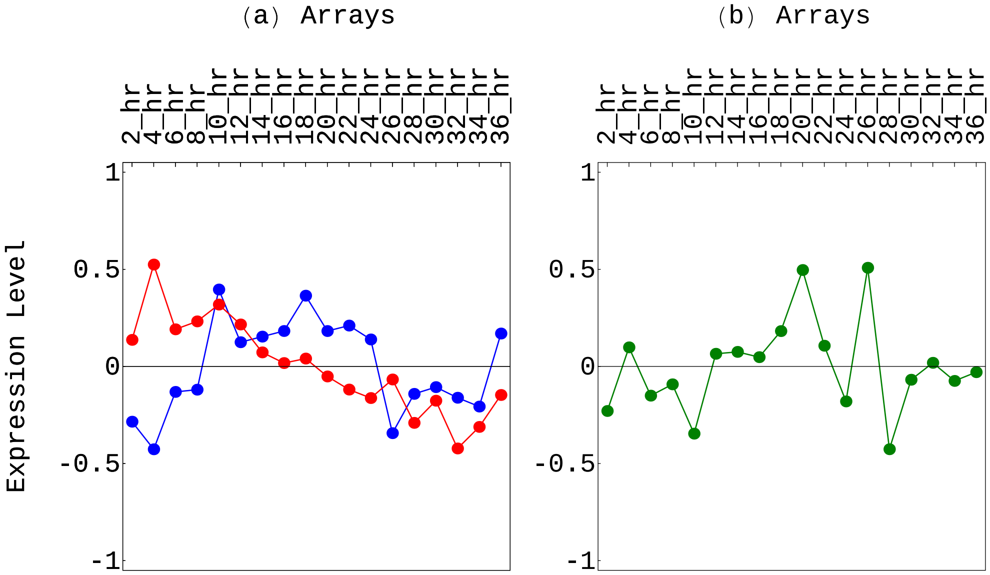
```
(* Sort Human Data *)

genes = genes2;
arraynames = arraynames2;
genenames = TakeColumns[genenames2, 1];

(* Least-Squares Approximate 3 D Subspace of Genelets with 2 D Subspace Using SVD *)

average = Table[1, {a, 1, arrays}];
average = N[average / Sqrt[Dot[average, average]]];
centergenelets6 = genelets[[6]] - N[Outer[Times, Dot[genelets, average], average]][[6]];
centergenelets6 = N[centergenelets6 / Sqrt[Dot[centergenelets6, centergenelets6]]];
centergenelets17 = genelets[[17]] - N[Outer[Times, Dot[genelets, average], average]][[17]];
centergenelets17 = N[centergenelets17 / Sqrt[Dot[centergenelets17, centergenelets17]]];
centergenelets18 = genelets[[18]] - N[Outer[Times, Dot[genelets, average], average]][[18]];
centergenelets18 = N[centergenelets18 / Sqrt[Dot[centergenelets18, centergenelets18]]];
{u, w, v} = SingularValues[{centergenelets6, centergenelets17, centergenelets18}];
Sum[w[[a]]^2, {a, 1, 2}] / Sum[w[[a]]^2, {a, 1, 3}]
```

```
0.777199
```

```
(* Define 2 D Subspace {x,y} ≡ {-v[[1]],v[[2]]} *)

(* Create -v[[1]], v[[2]] and v[[3]] Graph Displays *)

labelx = ColumnForm[{"(a) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, -v[[1, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[1, 0, 0], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p1 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = ColumnForm[{"(a) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames2[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, v[[2, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0, 1], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p2 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];

labelx = ColumnForm[{"(b) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, v[[3, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
   {Graphics[{RGBColor[0, 0.5, 0], PointSize[0.022], points}],
    Graphics[{RGBColor[0, 0.5, 0], line}]},
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
   FrameTicks -> {None, framey, framex, None},
   PlotRange -> {-1.05, 1.05},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p3 = Show[g,
   AspectRatio -> 1.05,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Display -v[[1]], v[[2]] and v[[3]] *)

g = Show[{p2, p1},
   DisplayFunction -> Identity];
Show[GraphicsArray[{g, p3}],
  GraphicsSpacing -> -0.15];
```



```
(* Calculate Amplitudes of the Projections of the Genelets *)

a6 = Sqrt[Dot[genelets[[6]], v[[1]]]^2 + Dot[genelets[[6]], v[[2]]]^2];
a17 = Sqrt[Dot[genelets[[17]], v[[1]]]^2 + Dot[genelets[[17]], v[[2]]]^2];
a18 = Sqrt[Dot[genelets[[18]], v[[1]]]^2 + Dot[genelets[[18]], v[[2]]]^2];

(* Calculate Angular Directions of the Projections of Genelets *)

c6 = ArcTan[Dot[genelets[[6]], v[[2]]] / Dot[genelets[[6]], v[[1]]]];
c17 = ArcTan[Dot[genelets[[17]], v[[2]]] / Dot[genelets[[17]], v[[1]]]];
c18 = ArcTan[Dot[genelets[[18]], v[[2]]] / Dot[genelets[[18]], v[[1]]]];
c617 = 2 * Abs[Cos[c6 - c17]];
c618 = 2 * Abs[Cos[c6 - c18]];
c1718 = 2 * Abs[Cos[c17 - c18]];

(* Sort Human Arrays *)

(* Center Genelets and Calculate Contributions of Arraylets to Arrays *)

arraycontributions6 =
  (genelets[[6]] - N[Outer[Times, Dot[genelets, average], average]][[6]]) * d2[[6, 6]];
arraycontributions17 =
  (genelets[[17]] - N[Outer[Times, Dot[genelets, average], average]][[17]]) * d2[[17, 17]];
arraycontributions18 =
  (genelets[[18]] - N[Outer[Times, Dot[genelets, average], average]][[18]]) * d2[[18, 18]];
```

```
(* Project Arrays from 3 D Arraylets Subspace Onto 2 D Subspace  *)

coordinates = Table[{
    - (Dot[genelets[[6]], v[[1]]] * arraycontributions6[[a]] +
         Dot[genelets[[17]], v[[1]]] * arraycontributions17[[a]] +
         Dot[genelets[[18]], v[[1]]] * arraycontributions18[[a]]) /
      Sqrt[(a6 * arraycontributions6[[a]])^2 +
         (a17 * arraycontributions17[[a]])^2 + (a18 * arraycontributions18[[a]])^2 +
         c617 * Abs[(a6 * arraycontributions6[[a]]) * (a17 * arraycontributions17[[a]])] +
         c618 * Abs[(a6 * arraycontributions6[[a]]) * (a18 * arraycontributions18[[a]])] +
         c1718 * Abs[(a17 * arraycontributions17[[a]]) * (a18 * arraycontributions18[[a]])]],
     (Dot[genelets[[6]], v[[2]]] * arraycontributions6[[a]] +
         Dot[genelets[[17]], v[[2]]] * arraycontributions17[[a]] +
         Dot[genelets[[18]], v[[2]]] * arraycontributions18[[a]]) /
      Sqrt[(a6 * arraycontributions6[[a]])^2 +
         (a17 * arraycontributions17[[a]])^2 + (a18 * arraycontributions18[[a]])^2 +
         c617 * Abs[(a6 * arraycontributions6[[a]]) * (a17 * arraycontributions17[[a]])] +
         c618 * Abs[(a6 * arraycontributions6[[a]]) * (a18 * arraycontributions18[[a]])] +
         c1718 * Abs[(a17 * arraycontributions17[[a]]) * (a18 * arraycontributions18[[a]])]]},
   {a, 1, arrays}];

(* Create Parameter Graph of Yeast Arrays Projected Onto 2 D Subspace *)

Clear[points];
points1 = {Point[coordinates[[1]]], Point[coordinates[[2]]],
   Point[coordinates[[3]]], Point[coordinates[[4]]]};
points2 = {Point[coordinates[[5]]], Point[coordinates[[6]]], Point[coordinates[[7]]]};
points3 = {Point[coordinates[[8]]], Point[coordinates[[9]]], Point[coordinates[[10]]]};
points4 = {Point[coordinates[[11]]], Point[coordinates[[12]]]};
points5 = {Point[coordinates[[13]]], Point[coordinates[[14]]], Point[coordinates[[15]]],
   Point[coordinates[[16]]], Point[coordinates[[17]]], Point[coordinates[[18]]]};
textcoordinates = coordinates;
Do[
  textcoordinates[[a, 1]] = If[
    textcoordinates[[a, 1]] > 0,
    textcoordinates[[a, 1]] - 0.085,
    textcoordinates[[a, 1]] + 0.095],
  {a, 1, 9}];
Do[
  textcoordinates[[a, 1]] = If[
    textcoordinates[[a, 1]] > 0,
    textcoordinates[[a, 1]] - 0.11,
    textcoordinates[[a, 1]] + 0.12],
  {a, 10, arrays}];
textcoordinates[[7]] = textcoordinates[[7]] + {0.085, -0.105};
textcoordinates[[8]] = textcoordinates[[8]] + {0.18, -0.04};
textcoordinates[[9]] = textcoordinates[[9]] + {0.085, -0.105};
textcoordinates[[11]] = textcoordinates[[11]] - {0.11, -0.105};
textcoordinates[[12]] = textcoordinates[[12]] - {0, 0.04};
textcoordinates[[15]] = textcoordinates[[15]] + {-0.02, 0.08};
textcoordinates[[16]] = textcoordinates[[16]] + {-0.02, 0.08};
textcoordinates[[17]] = textcoordinates[[17]] - {0.14, 0.11};
```

```
texts = Table[Text[a, textcoordinates[[a]]], {a, 1, arrays}];
p = Show[
   {Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 0.5]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 1]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Line[{{0, 1.05}, {0, -1.05}}]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Line[{{-1.15, 0}, {1.15, 0}}]}],
    Graphics[{RGBColor[1, 0, 0], PointSize[0.035], points1}],
    Graphics[{RGBColor[1, 0.5, 0], PointSize[0.035], points2}],
    Graphics[{RGBColor[1, 1, 0], PointSize[0.035], points3}],
    Graphics[{RGBColor[0, 0.5, 0], PointSize[0.035], points4}],
    Graphics[{RGBColor[0, 0, 1], PointSize[0.035], points5}],
    Graphics[{RGBColor[1, 0, 0], Text["E1", {1.0, -0.5}]}],
    Graphics[{RGBColor[1, 0.5, 0], Text["E2", {1.0, 0.5}]}],
    Graphics[{RGBColor[0, 0, 0], Text["M1", {0.65, 0.9}]}],
    Graphics[{RGBColor[0, 0.5, 0], Text["M2", {-1, 0.5}]}],
    Graphics[{RGBColor[0, 0, 1], Text["L1", {-1.025, -0.55}]}],
    Graphics[{RGBColor[0.75, 0, 1], Text["L2", {-0.65, -0.9}]}],
    Graphics[{RGBColor[0, 0, 0], Text["(a)", {-0.9, 0.95}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|x⟩", {0.62, 0.08}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|y⟩", {-0.12, 0.915}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|α6⟩", {-0.995, 0.65}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|α17⟩", {-0.92, -0.8}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|α18⟩", {0.65, -0.15}]}],
    Graphics[texts],
    Graphics[{RGBColor[0, 0, 0],
      Circle[{0, 0}, 0.4, {ArcTan[coordinates[[1, 2]] / coordinates[[1, 1]]], 0}]}],
    Graphics[{RGBColor[0, 0, 0],
      Arrow[{0.4 * Cos[-0.05], 0.4 * Sin[-0.05]}, {0.4 * Cos[0], 0.4 * Sin[0]},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{0, 0}, coordinates[[1]],
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Text["r", {0.3, -0.65}]}],
    Graphics[{RGBColor[0, 0, 0], Text["ϕ", {0.275, -0.125}]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.15, 1.15 * Tan[c18]}, {1.15, -1.15 * Tan[c18]},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05 / Tan[c17], 1.05}, {1.05 / Tan[c17], -1.05},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{1.15, -1.15 * Tan[c6]}, {-1.15, 1.15 * Tan[c6]},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}]},
   AspectRatio -> 1,
   PlotRange -> {{-1.15, 1.15}, {-1.05, 1.05}},
   Frame -> True,
   FrameTicks -> False,
   FrameLabel -> {None, None, None, None},
   GridLines -> {None, None},
   DisplayFunction -> Identity];
p = FullGraphics[p];
p[[1, 2]] = p[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {-1.18, 0}, {0, 0}, {0, 1}];
g1 = Show[p,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Sort Human Genes *)

(* Center Arraylets and Calculate Contributions of Genelets to Genes *)

centerarraylets = Transpose[arraylets2];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
centerarraylets = centerarraylets - N[Outer[Times, Dot[centerarraylets, average], average]];
centerarraylets = Transpose[centerarraylets];
genecontributions = Transpose[Dot[centerarraylets, d2]];

(* Project Genes from 3 D Genelets Subspace Onto 2 D Subspace  *)

coordinates = Table[{
    -(Dot[genelets[[6]], v[[1]]] * genecontributions[[6, a]] +
        Dot[genelets[[17]], v[[1]]] * genecontributions[[17, a]] +
        Dot[genelets[[18]], v[[1]]] * genecontributions[[18, a]]) /
     Sqrt[(a6 * genecontributions[[6, a]])^2 +
       (a17 * genecontributions[[17, a]])^2 + (a18 * genecontributions[[18, a]])^2 +
       c617 * Abs[(a6 * genecontributions[[6, a]]) * (a17 * genecontributions[[17, a]])] +
       c618 * Abs[(a6 * genecontributions[[6, a]]) * (a18 * genecontributions[[18, a]])] +
       c1718 * Abs[(a17 * genecontributions[[17, a]]) * (a18 * genecontributions[[18, a]])]],
    (Dot[genelets[[6]], v[[2]]] * genecontributions[[6, a]] +
       Dot[genelets[[17]], v[[2]]] * genecontributions[[17, a]] +
       Dot[genelets[[18]], v[[2]]] * genecontributions[[18, a]]) /
     Sqrt[(a6 * genecontributions[[6, a]])^2 +
       (a17 * genecontributions[[17, a]])^2 + (a18 * genecontributions[[18, a]])^2 +
       c617 * Abs[(a6 * genecontributions[[6, a]]) * (a17 * genecontributions[[17, a]])] +
       c618 * Abs[(a6 * genecontributions[[6, a]]) * (a18 * genecontributions[[18, a]])] +
       c1718 * Abs[(a17 * genecontributions[[17, a]]) * (a18 * genecontributions[[18, a]])]]},
   {a, 1, genes}];

(* Create Parameter Graph of 172 Yeast Pheromone Response Genes Projected Onto 2 D Subspace *)

Clear[points, radii];
stream = StringJoin[name, ":Desktop Folder:PNAS Data:Human_Stress_Classify.txt"];
list = ReadList[stream, Word, RecordLists -> True, NullWords -> True];
list = Drop[list, 1];
stages = {"E1", "E2", "M1", "M2", "L1", "L2"};
points = {points1, points2, points3, points4, points5, points6};
radii = {radii1, radii2, radii3, radii4, radii5, radii6};
Do[{
  position = Position[list, stages[[b]]],
  table = Table[list[[position[[a, 1]], 1]], {a, 1, Dimensions[position][[1]]}],
  position = Table[Position[genenames, table[[a]]], {a, 1, Dimensions[table][[1]]}],
  table = Flatten[Position[position, {}]],
  Do[
   position = Drop[position, {table[[a]], table[[a]]}],
   {a, Dimensions[table][[1]], 1, -1}],
  points[[b]] = Table[Point[coordinates[[position[[a, 1, 1]]]]], {a, 1, Dimensions[position][[1]]}],
  radii[[b]] = Table[
    Sqrt[coordinates[[position[[a, 1, 1]], 1]]^2 + coordinates[[position[[a, 1, 1]], 2]]^2],
    {a, 1, Dimensions[position][[1]]}]},
 {b, 1, Dimensions[stages][[1]]}]
```

```
Dimensions[points[[1]]][[1]]
Dimensions[points[[2]]][[1]]
Dimensions[points[[3]]][[1]]
Dimensions[points[[4]]][[1]]
Dimensions[points[[5]]][[1]]
Dimensions[points[[6]]][[1]]
```

```
15

24

48

36

188

37
```

```
radii = Sort[Flatten[radii], OrderedQ[{{#1}, {#2}}] &];
N[Round[radii[[11]] * 100] / 100]
N[Round[radii[[12]] * 100] / 100]
```

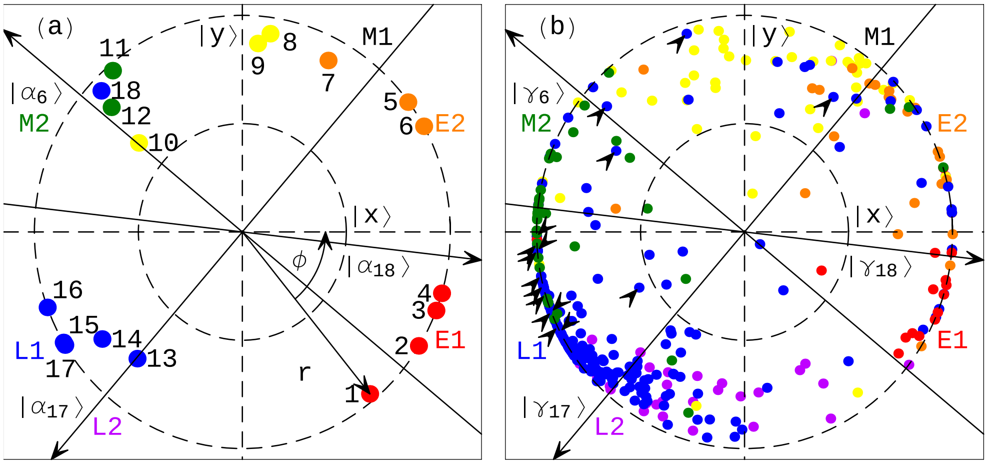
```
0.48

0.53
```

```
(* 348 stress response genes, 15 in E1, 24 in E2, 48 in M1, 36 in M2, 188 in L1, 37 in L2. *)

(* For 337 genes, 50 % or more of the contributions of the 6 genelets add up. *)
```

```
h1f0 = coordinates[[Position[genenames, "IMAGE:343744"][[1, 1]]]];
h1f2 = coordinates[[Position[genenames, "IMAGE:66317"][[1, 1]]]];
h1fx = coordinates[[Position[genenames, "IMAGE:347560"][[1, 1]]]];
h2afo = coordinates[[Position[genenames, "IMAGE:488964"][[1, 1]]]];
h2afp = coordinates[[Position[genenames, "IMAGE:128802"][[1, 1]]]];
h2afy = coordinates[[Position[genenames, "IMAGE:2315147"][[1, 1]]]];
h2afz = coordinates[[Position[genenames, "IMAGE:2315147"][[1, 1]]]];
h2bfb = coordinates[[Position[genenames, "IMAGE:1500000"][[1, 1]]]];
h2bfb2 = coordinates[[Position[genenames, "IMAGE:243784"][[1, 1]]]];
h2bfc = coordinates[[Position[genenames, "IMAGE:2056049"][[1, 1]]]];
h2bfq = coordinates[[Position[genenames, "IMAGE:430235"][[1, 1]]]];
h2bfr = coordinates[[Position[genenames, "IMAGE:1675553"][[1, 1]]]];
h3f3a = coordinates[[Position[genenames, "IMAGE:884272"][[1, 1]]]];
h3f3a2 = coordinates[[Position[genenames, "IMAGE:1415750"][[1, 1]]]];
h3f3b = coordinates[[Position[genenames, "IMAGE:950574"][[1, 1]]]];
h3f3b2 = coordinates[[Position[genenames, "IMAGE:2114004"][[1, 1]]]];
```

```
p = Show[
   {Graphics[{RGBColor[0.75, 0, 1], PointSize[0.02], points[[6]]}],
    Graphics[{RGBColor[1, 1, 0], PointSize[0.02], points[[3]]}],
    Graphics[{RGBColor[1, 0.5, 0], PointSize[0.02], points[[2]]}],
    Graphics[{RGBColor[0, 0, 1], PointSize[0.02], points[[5]]}],
    Graphics[{RGBColor[1, 0, 0], PointSize[0.02], points[[1]]}],
    Graphics[{RGBColor[0, 0.5, 0], PointSize[0.02], points[[4]]}],
    Graphics[{RGBColor[1, 0, 0], Text["E1", {1.0, -0.5}]}],
    Graphics[{RGBColor[1, 0.5, 0], Text["E2", {1.0, 0.5}]}],
    Graphics[{RGBColor[0, 0, 0], Text["M1", {0.65, 0.9}]}],
    Graphics[{RGBColor[0, 0.5, 0], Text["M2", {-1, 0.5}]}],
    Graphics[{RGBColor[0, 0, 1], Text["L1", {-1.025, -0.55}]}],
    Graphics[{RGBColor[0.75, 0, 1], Text["L2", {-0.65, -0.9}]}],
    Graphics[{RGBColor[0, 0, 0], Text["(b)", {-0.9, 0.95}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|x⟩", {0.62, 0.08}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|y⟩", {0.12, 0.915}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|γ6⟩", {-0.995, 0.65}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|γ17⟩", {-0.92, -0.8}]}],
    Graphics[{RGBColor[0, 0, 0], Text["|γ18⟩", {0.65, -0.15}]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h1f0 - {0.045, 0.045}, h1f0 - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h1f2 - {0.045, 0.045}, h1f2 - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h1fx - {0.045, 0.045}, h1fx - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2afo - {0.045, 0.045}, h2afo - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2afp - {0.045, 0.045}, h2afp - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2afy + {0.045, 0.045}, h2afy + {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2afz - {0.045, 0.045}, h2afz - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2bfb - {0.045, 0.045}, h2bfb - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2bfb2 - {0.045, 0.045}, h2bfb2 - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2bfc - {0.045, 0.045}, h2bfc - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2bfq + {0.045, 0.045}, h2bfq + {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h2bfr + {0.045, 0.045}, h2bfr + {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h3f3a - {0.045, 0.045}, h3f3a - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h3f3a2 + {0.045, 0.045}, h3f3a2 + {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h3f3b - {0.045, 0.045}, h3f3b - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[h3f3b2 - {0.045, 0.045}, h3f3b2 - {0.01, 0.01},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 0.5]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 1]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Line[{{0, 1.05}, {0, -1.05}}]}],
    Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Line[{{-1.15, 0}, {1.15, 0}}]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.15, 1.15 * Tan[c18]}, {1.15, -1.15 * Tan[c18]},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{-1.05 / Tan[c17], 1.05}, {1.05 / Tan[c17], -1.05},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}],
    Graphics[{RGBColor[0, 0, 0], Arrow[{1.15, -1.15 * Tan[c6]}, {-1.15, 1.15 * Tan[c6]},
       HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75]}]},
   AspectRatio -> 1, PlotRange -> {{-1.15, 1.15}, {-1.05, 1.05}}, Frame -> True,
   FrameTicks -> False, FrameLabel -> {None, None, None, None},
   GridLines -> {None, None},
   DisplayFunction -> Identity];
```

```
p = FullGraphics[p];
p[[1, 2]] = p[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {-1.18, 0}, {0, 0}, {0, 1}];
g2 = Show[p,
   AspectRatio → 0.95,
   PlotRange -> All,
   DisplayFunction → Identity];

(* Display Both Arrays & Genes Parameter Graphs *)

Show[GraphicsArray[{g1, g2}],
    GraphicsSpacing -> 0];
```



```
(* Reconstruct Human Data in Exclusive Stress Response Subspace *)
```

```
(* Sort Human Genes *)

matrix = matrix2;
genes = genes2;
arraynames = arraynames2;
genenames = genenames2;

(* Center Arraylets and Calculate Contributions of Genelets to Genes *)

centerarraylets = Transpose[arraylets2];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
centerarraylets = centerarraylets - N[Outer[Times, Dot[centerarraylets, average], average]];
centerarraylets = Transpose[centerarraylets];
genecontributions = Transpose[Dot[centerarraylets, d2]];

(* Project Genes from 3 D Genelets Subspace Onto 2 D Subspace  *)

coordinates = Table[{
    - (Dot[genelets[[6]], v[[1]]] * genecontributions[[6, a]] +
        Dot[genelets[[17]], v[[1]]] * genecontributions[[17, a]] +
        Dot[genelets[[18]], v[[1]]] * genecontributions[[18, a]]) /
     Sqrt[(a6 * genecontributions[[6, a]])^2 +
       (a17 * genecontributions[[17, a]])^2 + (a18 * genecontributions[[18, a]])^2 +
       c617 * Abs[(a6 * genecontributions[[6, a]]) * (a17 * genecontributions[[17, a]])] +
       c618 * Abs[(a6 * genecontributions[[6, a]]) * (a18 * genecontributions[[18, a]])] +
       c1718 * Abs[(a17 * genecontributions[[17, a]]) * (a18 * genecontributions[[18, a]])]],
    (Dot[genelets[[6]], v[[2]]] * genecontributions[[6, a]] +
       Dot[genelets[[17]], v[[2]]] * genecontributions[[17, a]] +
       Dot[genelets[[18]], v[[2]]] * genecontributions[[18, a]]) /
     Sqrt[(a6 * genecontributions[[6, a]])^2 +
       (a17 * genecontributions[[17, a]])^2 + (a18 * genecontributions[[18, a]])^2 +
       c617 * Abs[(a6 * genecontributions[[6, a]]) * (a17 * genecontributions[[17, a]])] +
       c618 * Abs[(a6 * genecontributions[[6, a]]) * (a18 * genecontributions[[18, a]])] +
       c1718 * Abs[(a17 * genecontributions[[17, a]]) * (a18 * genecontributions[[18, a]])]]},
   {a, 1, genes}];

(* Define the Initial Phase *)

zerophase = Pi / 2;
```

```
(* Sort Genes Accodring to Phases in 2 D Subspace *)

coordinates = Table[{
    coordinates[[a, 1]] / Sqrt[coordinates[[a, 1]]^2 + coordinates[[a, 2]]^2],
    coordinates[[a, 2]] / Sqrt[coordinates[[a, 1]]^2 + coordinates[[a, 2]]^2]},
   {a, 1, genes}];
coordinates = Table[{
    -coordinates[[a, 1]] * Cos[zerophase] - coordinates[[a, 2]] * Sin[zerophase],
    -coordinates[[a, 2]] * Cos[zerophase] + coordinates[[a, 1]] * Sin[zerophase]},
   {a, 1, genes}];
coordinates = Table[{
    coordinates[[a, 1]],
    coordinates[[a, 2]],
    N[ArcTan[coordinates[[a, 1]] / coordinates[[a, 2]]] / Pi]},
   {a, 1, genes}];
sortmatrix = AppendRows[coordinates, genenames, matrix];
sortmatrix = Sort[sortmatrix, OrderedQ[{{#1}, {#2}}] &];
negative1 = 6050;
positive1 = 6051;
sortmatrix[[negative1, 1]]
sortmatrix[[positive1, 1]]
```

```
-0.000203326

0.000163054
```

```
sortmatrix = Transpose[Drop[Transpose[sortmatrix], {1}]];
sortmatrix = AppendColumns[
  Sort[
   TakeRows[sortmatrix, {1, negative1}],
   OrderedQ[{{#2}, {#1}}] &],
  Sort[
   TakeRows[sortmatrix, {positive1, genes}],
   OrderedQ[{{#1}, {#2}}] &]];
phases = TakeColumns[sortmatrix, {2, 2}];
sortmatrix = Transpose[Drop[Transpose[sortmatrix], {1, 2}]];
```

```
(* Classify Gene Phases into Cell Cycle Phases *)

ph1 = c17 / Pi;
ph2 = -c6 / Pi;
ph3 = c18 / Pi;
ph4 = 1 + c17 / Pi;
ph5 = 1 - c6 / Pi;
ph6 = 1 + c18 / Pi;

endph6 = 2523;
beginph1 = 2524;
phases[[endph6]] - ph1
phases[[beginph1]] - ph1

{0.0000166825}

{-0.000104095}

endph1 = 4127;
beginph2 = 4128;
phases[[endph1]] - ph2
phases[[beginph2]] - ph2

{-0.282855}

{0.716697}

endph2 = 5850;
beginph3 = 5851;
phases[[endph2]] - ph3
phases[[beginph3]] - ph3

{0.0000244319}

{-0.000107144}

endph3 = 8600;
beginph4 = 8601;
phases[[endph3]] - ph4
phases[[beginph4]] - ph4

{-0.999973}

{-1.00008}

endph4 = 10100;
beginph5 = 10101;
phases[[endph4]] - ph5
phases[[beginph5]] - ph5


{-1.28262}

{-0.282974}

endph5 = 11839;
beginph6 = 11840;
phases[[endph5]] - ph6
phases[[beginph6]] - ph6

{-0.999879}

{-1.00005}

(* 12056 human genes, 1739 in E1, 2740 in E2, 1604 in M1, 1723 in M2, 2750 in L1, 1500 in L2. *)
```

```
(* Reconstruct Data With Sorted Genes *)

matrix2 = TakeColumns[sortmatrix, {6, arrays + 5}];
genenames2 = TakeColumns[sortmatrix, {1, 5}];

(* Calculate GSVD of Sorted Human and Yeast Data *)

matrix = AppendColumns[matrix1, matrix2];
{q, r} = QRDecomposition[matrix];
q = Conjugate[Transpose[q]];
q1 = TakeRows[q, {1, genes1}];
{u1, w1, v1} = SingularValues[q1];
genelets = Dot[v1, r];
Do[genelets[[a]] = genelets[[a]] / Sqrt[Dot[genelets[[a]], genelets[[a]]]],
 {a, 1, arrays}]

genelets[[2]] = -genelets[[2]];
genelets[[5]] = -genelets[[5]];
genelets[[14]] = -genelets[[14]];
genelets[[16]] = -genelets[[16]];
genelets[[17]] = -genelets[[17]]; genelets[[18]] = -genelets[[18]];

arraylets1 = Dot[matrix1, Inverse[genelets]];
arraylets2 = Dot[matrix2, Inverse[genelets]];
arraylets1 = Transpose[arraylets1];
Do[arraylets1[[a]] = arraylets1[[a]] / Sqrt[Dot[arraylets1[[a]], arraylets1[[a]]]], {a, 1, arrays}];
arraylets1 = Transpose[arraylets1];
arraylets2 = Transpose[arraylets2];
Do[arraylets2[[a]] = arraylets2[[a]] / Sqrt[Dot[arraylets2[[a]], arraylets2[[a]]]], {a, 1, arrays}];
arraylets2 = Transpose[arraylets2];
d1 = Chop[Dot[PseudoInverse[arraylets1], matrix1, Inverse[genelets]]];
d2 = Chop[Dot[PseudoInverse[arraylets2], matrix2, Inverse[genelets]]];

(* Display Sorted and Reconstructed Human Data *)

genes = genes2;
genenames = genenames2;
arraynames = arraynames2;
{endph1, endph2, endph3, endph4, endph5, endph6} = {4127, 5850, 8600, 10100, 11839, 2523};

(* Reconstruct Sorted Human Data *)

Do[d2[[a, a]] = 0, {a, 1, 5}];
Do[d2[[a, a]] = 0, {a, 7, 16}];
matrix = Dot[arraylets2, d2, genelets];

(* Center Sorted Human Data *)

average = Table[1, {a, 1, arrays}];
average = N[average / Sqrt[Dot[average, average]]];
matrix = matrix - N[Outer[Times, Dot[matrix, average], average]];
matrix = Transpose[matrix];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
matrix = matrix - N[Outer[Times, Dot[matrix, average], average]];
matrix = Transpose[matrix];
```

```
(* Create Recosntructed Sorted Human Data 2D Red & Green Raster Display *)

contrast = 15 * 1.5;
displaying = Table[
   If[contrast * matrix[[i, j]] > 0,
    If[contrast * matrix[[i, j]] < 1, {contrast * matrix[[i, j]], 0}, {1, 0}],
    If[contrast * matrix[[i, j]] > -1, {0, -contrast * matrix[[i, j]]}, {0, 1}]],
   {i, 1, genes}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {
   {genes - endph6 / 2, "E2"},
   {genes - (endph6 + endph1) / 2, "M1"},
   {genes - (endph1 + endph2) / 2, "M2"},
   {genes - (endph2 + endph3) / 2, "L1"},
   {genes - (endph3 + endph4) / 2, "L2"},
   {genes - (endph4 + endph5) / 2, "E1"},
   {(genes - endph5) / 2, "E2"}};
gridy = {
   {genes - endph5 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph6 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph1 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph2 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph3 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph4 + 0.5, {RGBColor[0, 0, 0]}}};
labelx = "(a) Arrays";
labely = ColumnForm[{" ", "Genes", " ", " ", " ", " ", " ", " "}, Center];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, genes, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1,
   Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, gridy},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 1.5, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1100}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 450}, {0, 0}, {0, 1}];
g1 = Show[g,
   AspectRatio -> GoldenRatio * 2,
   PlotRange -> All,
   DisplayFunction → Identity];

(* Center Sorted Human Arraylets *)

arraylets = Transpose[arraylets2];
average = Table[1, {a, 1, genes}];
average = N[average / Sqrt[Dot[average, average]]];
arraylets = arraylets - N[Outer[Times, Dot[arraylets, average], average]];
arraylets = Transpose[arraylets];
```

```
(* Create Sorted Human Arraylets 2 D Red & Green Raster Display *)

contrast = 125 * 1.5;
displaying = Table[
   If[contrast * arraylets[[i, j]] > 0,
    If[contrast * arraylets[[i, j]] < 1, {contrast * arraylets[[i, j]], 0}, {1, 0}],
    If[contrast * arraylets[[i, j]] > -1, {0, -contrast * arraylets[[i, j]]}, {0, 1}]],
   {i, 1, genes}, {j, 1, arrays}];
labelx = "(b) Arraylets";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framey = {
   {genes - endph6 / 2, "  "},
   {genes - (endph6 + endph1) / 2, "  "},
   {genes - (endph1 + endph2) / 2, "  "},
   {genes - (endph2 + endph3) / 2, "  "},
   {genes - (endph3 + endph4) / 2, "  "},
   {genes - (endph4 + endph5) / 2, "  "},
   {(genes - endph5) / 2, "  "}};
gridy = {
   {genes - endph5 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph6 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph1 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph2 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph3 + 0.5, {RGBColor[0, 0, 0]}},
   {genes - endph4 + 0.5, {RGBColor[0, 0, 0]}}};
framex = Table[{a - 0.5, ToString[a]}, {a, 1, arrays}];
size = 5;
sizes = Flatten[
   Table[
    Dimensions[
     Characters[
      framex[[a, 2]]
     ]], {a, 1, arrays}]];
Do[
  Do[framex[[a, 2]] = StringJoin[framex[[a, 2]], " "],
   {b, 1, size - sizes[[a]]}],
  {a, 1, arrays}];
g = Show[
   Graphics[
    RasterArray[
     Table[
      RGBColor[displaying[[i, j, 1]], displaying[[i, j, 2]], 0],
      {i, genes, 1, -1}, {j, 1, arrays}]]],
   AspectRatio -> 1, Frame -> True,
   FrameTicks -> {None, framey, framex, None},
   FrameLabel -> {None, labely, labelx, None},
   GridLines -> {None, gridy},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 1.5, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1100}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 450}, {0, 0}, {0, 1}];
g2 = Show[g,
   AspectRatio -> GoldenRatio * 2,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
(* Create Selected Sorted Human Arraylets Graph Display *)

arraylets = Transpose[arraylets2];

labelx = "(c) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0      "}, {0.05, "0.05  "}, {0.1, "0.1   "}};
coordinates = Table[
   If[arraylets[[6, a]] < -0.025, -0.025,
    If[arraylets[[6, a]] > 0.125, 0.125, arraylets[[6, a]]]],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[1, 0, 0], line}],
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025, 0.125}, {360, -genes + 1 - 360}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1150}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 550}, {0, 0}, {0, 1}];
p6 = Show[g,
   AspectRatio -> GoldenRatio * 2.1275,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = "(c) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0      "}, {0.05, "0.05  "}, {0.1, "0.1   "}};
coordinates = Table[
   If[arraylets[[17, a]] + 0.05 > 0.125, 0.125, arraylets[[17, a]] + 0.05],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[0, 0, 1], line}],
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0.05, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025, 0.125}, {360, -genes + 1 - 360}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1150}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 550}, {0, 0}, {0, 1}];
p17 = Show[g,
   AspectRatio -> GoldenRatio * 2.1275,
   PlotRange -> All,
   DisplayFunction → Identity];
```

```
labelx = "(c) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {{0, "0      "}, {0.05, "0.05   "}, {0.1, "0.1    "}};
coordinates = Table[
   If[arraylets[[18, a]] + 0.1 > 0.125, 0.125, arraylets[[18, a]] + 0.1],
   {a, 1, genes}];
coordinates = Table[{coordinates[[a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
   Graphics[{RGBColor[0, 0.5, 0], line}],
   Frame -> True,
   FrameLabel -> {None, labely, labelx, None},
   FrameTicks -> {None, None, framex, None},
   GridLines -> {{{0.1, RGBColor[0, 0, 0]}}, None},
   AspectRatio -> GoldenRatio * 1.15,
   PlotRange -> {{-0.025, 0.125}, {360, -genes + 1 - 360}},
   DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
   Text[labely, {b_, c_}, {1., 0.}] →
    Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {1., 0.}] →
    Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
   Text[labelx, {b_, c_}, {0., -1.}] →
    Text[labelx, {b, c + 1150}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
   Text[a_, {b_, c_}, {0., -1.}] →
    Text[a, {b, c + 550}, {0, 0}, {0, 1}];
p18 = Show[g,
   AspectRatio -> GoldenRatio * 2.1275,
   PlotRange -> All,
   DisplayFunction → Identity];

(* Display Selected Sorted Human Arraylets *)

g3 = Show[{p6, p17, p18},
   DisplayFunction → Identity];
```

```
(* Display Recosntructed Sorted Yeast and Human Data, Arraylets and Selected Arraylets *)

Show[GraphicsArray[{g1, g2, g3}],
    GraphicsSpacing -> -0.2];
```