Supporting Information (Text S1)

Nodes having a major influence to break cooperation define a novel centrality measure: game centrality

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Summary

In this Supporting Information (Text S1) we give a detailed description of the NetworGame spatial social dilemma game simulation program package. Besides the pseudocode description of the NetworGame algorithm the Supporting Information also contains a supplementary figure, 2 supplementary tables as well as 11 references.

The computer programs of the NetworGame package with a User Guide can be downloaded from here: www.linkgroup.hu/NetworGame.php.

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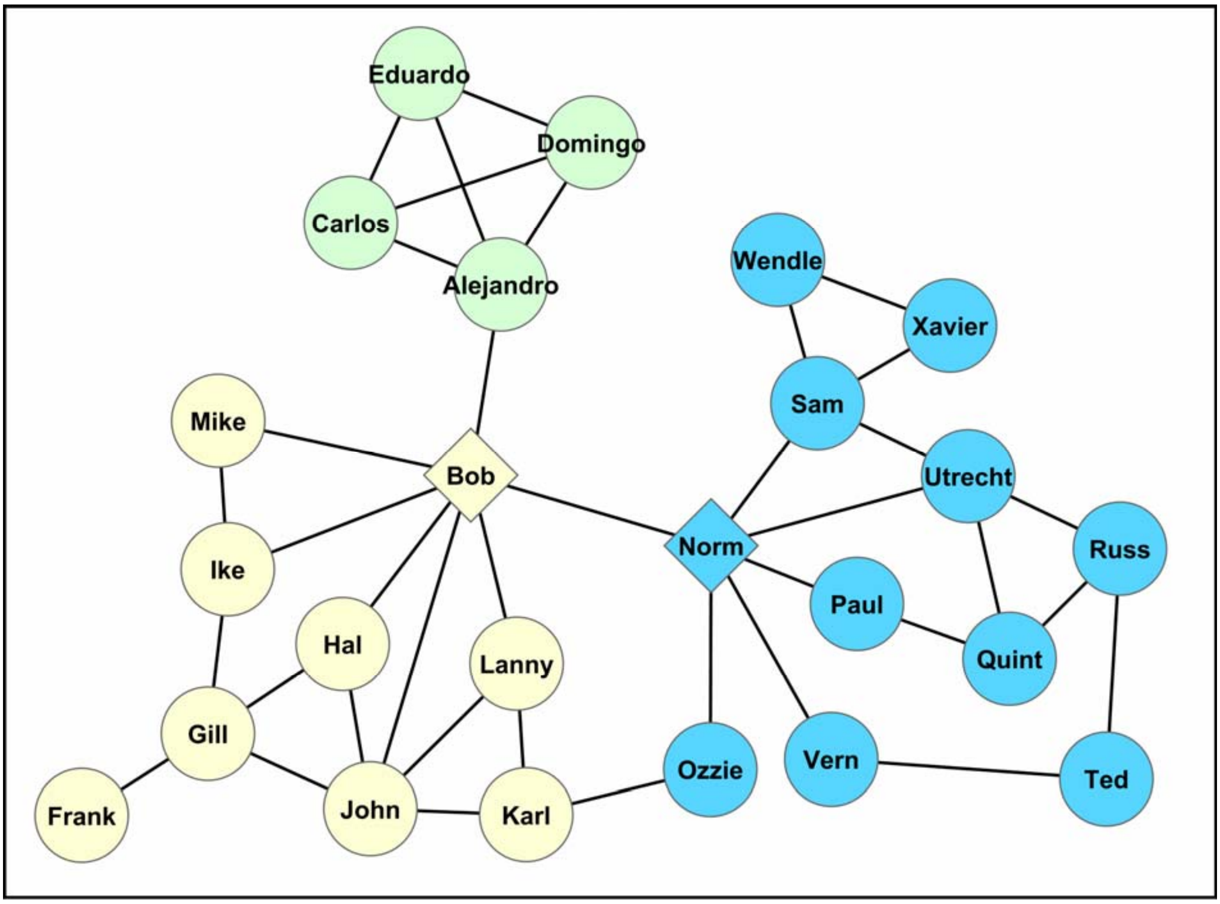

Supplementary Figure S1. Michael's strike network [1]. The three worker groups of a former forest product manufacturing factory containing younger, English-speaking (yellow); older, English-speaking (blue); or younger, Spanish-speaking workers (green) were marked. Sam and Wendle (top right) were the union leaders, who failed to break the strike, while Bob and Norm (center, marked with diamonds) were the pair of workers, who successfully broke the strike.

Supplementary Tables

Table S1. List of consensus party hubs

Consensus party hub ORFs[a]

YAR002W
YAR003W
YBL004W
YBL007C
YBL038W
YBL050W
YBL084C
YBL099W
YBR010W
YBR084W
YBR087W
YBR118W
YBR245C
YDL029W
YDL065C
YDL134C
YDL208W
YDL213C
YDR103W
YDR118W
YDR244W
YDR264C
YDR395W
YER157W
YFR002W
YFR036W
YGL004C
YGL153W
YGL200C
YHL030W
YHR016C
YHR077C
YHR089C
YHR166C
YHR200W
YIL115C
YJR045C
YJR065C
YJR068W
YJR121W
YKL018W
YKL022C
YKL068W
YKL085W
YKL129C
YLR127C
YLR212C
YMR080C
YMR109W
YMR116C
YNL016W
YNL094W
YNL102W
YNL138W
YNL172W
YNL290W
YOL094C
YOR157C
YOR249C
YOR250C
YOR270C
YPL213W
YPR088C

[a] The open reading frame names of 63 consensus yeast party hubs were determined and listed as in [2] comparing the party hubs of the high fidelity yeast protein-protein interaction network [3] with those published in other 5 publications [4-8], and listing only those as ‘consensus party hubs’, which were never classified as a date hub.

Table S2. List of consensus date hubs

Consensus date hub ORFs[a]

YAL005C
YBL016W
YBL023C
YBL093C
YBL105C
YBL106C
YBR011C
YBR089C-A
YBR114W
YBR119W
YBR126C
YBR135W
YBR160W
YBR175W
YBR254C
YBR274W
YBR279W
YCR009C
YDL047W
YDL101C
YDL126C
YDL160C
YDL188C
YDR142C
YDR155C
YDR170C
YDR172W
YDR192C
YDR216W
YDR238C
YDR240C
YDR309C
YDR473C
YDR523C
YEL009C
YER081W
YER095W
YER110C
YER148W
YER155C
YER165W
YFL017W-A
YFR021W
YFR028C
YFR034C
YGL003C
YGL092W
YGL116W
YGL198W
YGL207W
YGR009C
YGR040W
YGR086C
YGR104C
YGR134W
YGR218W
YGR274C
YHR061C
YHR099W
YHR152W
YIL038C
YIL046W
YIL094C
YJL081C
YJL095W
YJL138C
YJL141C
YJL164C
YJL187C
YJL194W
YJR066W
YJR090C
YJR091C
YKL081W
YKL095W
YKL104C
YKL166C
YKL203C
YKR001C
YKR026C
YKR068C
YLL021W
YLL026W
YLL039C
YLR044C
YLR096W
YLR180W
YLR229C
YLR310C
YLR319C
YLR337C
YLR342W
YLR423C
YLR452C
YML007W
YML010W
YML064C
YML109W
YMR001C
YMR012W
YMR043W
YMR054W
YMR125W
YMR139W
YMR199W
YMR201C
YMR213W
YMR273C
YMR304W
YNL006W
YNL093W
YNL127W
YNL135C
YNL243W
YNL263C
YNL271C
YNL298W
YOL086C
YOL090W
YOL108C
YOL123W
YOL133W
YOL135C
YOR039W
YOR089C
YOR106W
YOR212W
YOR244W
YOR304W
YOR308C
YPL004C
YPL031C
YPL082C
YPL129W
YPL153C
YPL161C
YPL181W
YPL248C
YPL256C
YPR054W
YPR072W
YPR086W
YPR107C
YPR119W
YPR182W

[a] The open reading frame names of 145 consensus yeast date hubs were determined and listed as in [2] comparing the date hubs of the high fidelity yeast protein-protein interaction network [3] with those published in other 5 publications [4-8], and listing only those as ‘consensus date hubs’, which were never classified as a party hub.

Description of the NetworGame algorithm

The 2.0 version of the NetworGame program is an updated version of the NetworGame 1.0 version published in a preliminary conference report [9]. NetworGame 2.0 is available in our web-site (www.linkgroup.hu/NetworGame.php). The 2.0 version utilizes our experiences gained with the 1.0 version. The NetworGame 2.0 program package is a cross-platform, generic tool to simulate repeated spatial games. This simulation program includes i.) options for pay-off matrices of any symmetric normal form games (with 2 strategies); ii.) several well-known, replicator-type strategy update rules, as well as the option for additional, user-defined strategy update rules in a ‘plugin’-type format; iii.) synchronous, and semi-synchronous updating [10]; iv.) and the option for the inclusion of any real world networks in a Pajek format [11].

Here we provide the pseudocode for the algorithm, which describes the flow of the program and the effects of the configuration parameters. A User Guide of version 2.0 can be downloaded from here: www.linkgroup.hu/NetworGame.php.

Configurator

- testNode and testEdge are configuration parameters
- printSteps, printStepsStdDev and printLast are configuration parameters
- Nodes and Edges represent the network, where Edges is a set of pairs (src,dst)

```
initialize payoff matrix
if (testNode specified) then
  for i in Nodes do
    initialize strategies
    Si = testNode
    run simulations
    print statistics
  end
else if (testEdge specified) then
  for (src,dst) in Edges do
    initialize strategies
    Ssrc = testEdge
    Sdst = testEdge
    run simulations
    print statistics
  end
else
  initialize strategies
  run simulations
  if (printSteps) then print step-wise average cooperation levels
  if (printStepsStdDev) then print step-wise standard deviances
  if (printLast) then print average cooperation for each node at last step
end
```

Run simulations

- M is a set of simulations
- L is number of steps
- n is the size of M
- memUsage and elapsedTime are internal variables representing the current memory usage of the system and the elapsed time since the start of the simulations
- maxError is a parameter controlling the statistical accuracy
- numberofsimulations, numberofsteps, mem and time are configuration parameters

```
if (numberofsimulations specified) then
  n = numberofsimulations, i.e. M has size of numberofsimulations
else
  n = 100, i.e. M has size of 100 initially, but it can grow
end

if (numberofsteps specified) then
  L = numberofsteps is the number of steps in each simulation
else
  L = 101 (and it can grow)
end

  - run simulations until we reach the specified resource limits, or get below the desired statistical error
while (memUsage < mem and elapsedTime < time) do
  for m in M do
    simulate m up to steps L
  end
  $A_i$ = average cooperation at step i for each m in M
  currMean = average of $A_x$, where x=L-50 to L
  prevMean = average of $A_x$, where x=L-150 to L-100
  stddev   = standard deviation of $A_x$, where x=L-50 to L
  meanerror = sqrt(stddev / n*(n-1))
  if (numberofsteps unspecified and abs(prevmean-currmean) > maxError) then
    L = L + 1
  else if (numberofsimulation unspecified and meanerror > maxError/2) then
    add a simulation to M (inherently n = n + 1)
  else
    finish simulations
  end
end
  - calculate statistics for printing
for i = 1,2...,L do
  calculate average cooperation at step i over all m in M
  calculate standard deviation at step i over all m in M
end

for n in Nodes do
  calculate average cooperation at last step for n over all m in M
end
```

Simulate m up to steps L

- S_i is the current strategy of node i
- P_i is the current payoff of node i
- useWeights, x0 and x1 are weight parameters controlling the effect of edge weights
- Neighbors(i) is the set of neighbors for node i
- Payoff[i,j] is the payoff matrix value when strategy j plays against strategy j
- payoffSchema is a configuration parameter

```
for n = 1,2,...,L do
  - simulating current round and calculating payoffs
    for i in Nodes do
      $P_i$ = 0
      counter = 0
  - the probability of a game is dependent on the weight parameters and edge weight $W_{i,j}$
      for j in Neighbors(i) do
        if (not useWeights or random(0,1) <= ($W_{i,j}$-x0)/(x1-x0)) then
          $P_i$ = $P_i$ + Payoff[$S_i$,$S_j$]
          counter = counter + 1
      end
      if (payoffSchema = degree or payoffSchema = averaging) then
        $P_i$ = $P_i$ / counter (if counter > 0)
    end
  - updating strategies (strategyUpdateRule can be implemented as a plugin, it may have memory,
    or might be one of the built-in rules: best takes over or proportional update
    for k in Nodes do
      $S_k$ = strategyUpdateRule(...)
    end
end
```

Supplementary References

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