| | **Patch Classification Measures** |
|---|---|
| 1 | patch volume |
| 2 | patch surface area |
| 3 | patch perimeter |
| 4 | patch radius |
| 5 | patch closure surface area |
| 6 | patch volume / (patch closure surface area)$^{3/2}$ |
| 7 | patch surface area / patch closure surface area |
| 8 | patch radius / (patch surface area)$^{1/2}$ |
| 9 | patch surface area / (patch perimeter)$^{2}$ |
| 10 | patch variation from a sphere |
| 11 | patch shape diameter function |
| 12 | maximum mean curvature on patch |
| 13 | average of mean curvature on patch |
| 14 | standard deviation of mean curvature on patch |
| 15 | average Gaussian curvature on patch |
| 16 | average of mean curvature on patch edge |
| 17 | $\lvert$patch closure center − average patch position$\rvert$ |
| 18 | $\lvert$weighted average patch position − average patch position$\rvert$ / patch radius |
| 19 | $\lvert$patch closure center − average patch position$\rvert$ / patch radius |
| 20 | $\lvert$patch closure center − weighted average patch position$\rvert$ / patch radius |
| 21 | cell volume |
| 22 | cell surface area |
| 23 | patch count |

**Supplementary Table 1**

Geometric patch features used for SVM-based patch classification.

**Patch Merging Measures**

1 average of the mean curvature at the interface between the two patches
2 average of the Gaussian curvature at the interface
3 average of the mean curvature at the interface − the average curvature of the two patches
4 maximum of the mean curvature at the interface
5 maximum of the mean curvature at the interface − the maximum curvature of the two patches
6 standard deviation of the mean curvature at the interface
7 standard deviation of the Gaussian curvature at the interface
8 fraction of mean curvature at the interface that is above 80th percentile for the cell
9 fraction of mean curvature at the interface that is below 20th percentile for the cell
10 fraction of mean curvature at the interface that is above 80th percentile for the two patches
11 fraction of mean curvature at the interface that is below 20th percentile for the two patches
12 fraction of Gaussian curvature at the interface that is above 80th percentile for the cell
13 fraction of Gaussian curvature at the interface that is below 20th percentile for the cell
14 fraction of Gaussian curvature at the interface that is above 80th percentile for the two patches
15 fraction of Gaussian curvature at the interface that is below 20th percentile for the two patches
16 fraction of mean curvature at the interface that is above 90th percentile for the cell
17 fraction of mean curvature at the interface that is below 10th percentile for the cell
18 twice interface length / (perimeter patch 1 + perimeter patch 2)
19 difference in the averages of the mean curvature for the two patches
20 difference in the maxima of the mean curvature for the two patches
21 difference in the (patch closure surface area) / (patch perimeter)$^2$ for the two patches
22 difference in the (patch volume) / (patch surface area)$^{1.5}$ for the two patches
23 difference in the (patch volume) / (patch closure surface area)$^{1.5}$ for the two patches
24 average of the averages of the mean curvature for the two patches
25 average of the maxima of the mean curvature for the two patches
26 average of the (patch closure surface area) / (patch perimeter)$^2$ for the two patches
27 average of the (patch volume) / (patch surface area)$^{1.5}$ for the two patches
28 average of the (patch volume) / (patch closure surface area)$^{1.5}$ for the two patches
29 fraction of the interface that is ridged
30 fraction of the interface that is very ridged
31 fraction of the interface that is valley-like
32 fraction of the interface that is very valley-like
33 fraction of the interface that is domed
34 fraction of the interface that is cratered
35 fraction of the interface that is flat
36 fraction of the interface that is saddle-like

**Supplementary Table 2**

Geometric features of adjacent patch pairs used for SVM-based patch merging.

## Distinguishing Features

### Blebs vs. Non-Blebs

1. patch volume / (patch closure surface area)$^{3/2}$
2. average of mean curvature on patch edge

### Filopodia vs. Non-Filopodia

1. |patch closure center − average patch position|
2. patch surface area
3. |weighted average patch position − average patch position| / patch radius
4. patch surface area / patch closure surface area
5. cell volume
6. average of mean curvature on patch edge
7. patch perimeter

### Lamellipodia vs. Non-Lamellipodia

1. |patch closure center − average patch position|
2. patch volume
3. |weighted average patch position − average patch position| / patch radius
4. patch radius / (patch surface area)$^{1/2}$

**Supplementary Table 3**

Geometric patch features that best distinguish morphological motifs from non-motifs.

|  | Feature Selection Iterations | Precision | Recall | $F_1$ |
|---|---|---|---|---|
| Linear SVM | 0 | 0.904 | 0.965 | 0.934 |
| Linear SVM | 1 | 0.917 | 0.955 | 0.936 |
| Linear SVM | 10 | 0.913 | 0.960 | 0.936 |
| Radial SVM | 1 | 0.924 | 0.874 | 0.898 |
| Radial SVM | 10 | 0.926 | 0.949 | 0.937 |
| Random forest, 30 trees | 0 | 0.950 | 0.938 | 0.944 |
| Random forest, 300 trees | 0 | 0.949 | 0.939 | 0.944 |
| Random forest, 30 trees | 1 | 0.950 | 0.938 | 0.944 |
| Random forest, 30 trees | 10 | 0.954 | 0.925 | 0.939 |

**Supplementary Table 4**

The precision, recall, and $F_1$ score of various machine-learning models used for filopodia detection on 13 HBEC cells.

| Dataset | | | | Deconvolution parameters | | | Surface extraction parameters | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | mode *one* parameters | | | mode *two* parameters | | |
| **cell** | **label** | **scope** | **motif** | **mode** | **param.** | **apo. height** | **mode** | **image smooth** | **image gamma** | **mesh smooth** | **inside gamma** | **dilate radius** | **erode radius** |
| dendritic | Lifeact | meSPIM | lamellipodia | Wiener | 0.018 | 0.06 | three | 0 | 1 | 6 | 0.6 | 5 | 6.5 |
| melanoma | tractin | meSPIM | blebs | Wiener | 0.018 | 0.04 | one | 0 | 1 | 0 | | | |
| HBEC | tractin | meSPIM | filopodia | Wiener | 0.015 | 0 | one | 0.6 | 1 | 0 | | | |
| melanoma | Kras | meSPIM | blebs | Wiener | 0.018 | 0.06 | one | 0 | 0.7 | 0 | | | |
| melanoma | $PIP_2$ | meSPIM | blebs | Wiener | 0.018 | 0.06 | two | 0 | 0.7 | 0 | 0.6 | 4 | 6 |
| melanoma | tractin | meSPIM | blebs & filopodia | Wiener | 0.015 | 0 | one | 0.6 | 1 | 2 | | | |
| melanoma | tractin | meSPIM | filopodia | Wiener | 0.015 | 0 | one | 0.6 | 1 | 2 | | | |
| U2OS | tractin | meSPIM | blebs | RL | 8 | 0.08 | two | 0 | 0.5 | 0 | 0.6 | 5 | 6 |
| melanoma | PI3K | ASLM | blebs | RL | 7 | 0.06 | two | 0 | 0.7 | 0 | 0.6 | 4 | 6 |
| melanoma | tractin | confocal | blebs | RL | 10 | 0 | two | 1 | 0.6 | 6 | 0.6 | 5 | 6 |
| microglia | P2Y12 | light sheet | extensions | RL | 10 | 0.06 | three | 0 | 1 | 6 | 0.5 | 5 | 6.5 |
| melanoma | cytosol | ASLM | blebs | RL | 10 | 0.04 | one | 0 | 1 | 6 | | | |
| T cell | Lifeact | lattice | lamellipodia | RL | 10 | 0.06 | three | 0 | 0.8 | 6 | 0.3 | 5 | 6 |
| breast cancer | CAAX | AO lattice | extensions | none | | | one | 0.8 | 0.45 | 30 | | | |
| melanoma | cytosol & tractin | meSPIM | blebs | Wiener | auto | 0.055 | one | 0 | 1 | 0 | | | |
| melanoma | cytosol | meSPIM | blebs | Wiener | auto | 0.04 | one | 0 | 1 | 0 | | | |

**Supplementary Table 5**

**Deconvolution and surface extraction parameters for all described datasets.**

In the deconvolution parameters section, RL refers to Richardson-Lucy deconvolution. For Wiener deconvolution, the *param* column shows the Wiener parameter, whereas for Richardson-Lucy deconvolution it shows the number of iterations. In the surface extraction parameters section, in mode *one* an isosurface is created directly from the Otsu-normalized deconvolved image, in mode *two*, it is created from the combination of the Otsu-normalized image and an “inside” image, and in mode *three*, it is created from the combination of the Otsu-normalized image, an “inside” image, and a surface filtered image.

### Features Selected

**User 1**

patch radius / (patch surface area)$^{1/2}$
average of mean curvature on patch edge
patch shape diameter function
|patch closure center – average patch position|
|weighted average patch position – average patch position| / patch radius
|patch closure center – average patch position| / patch radius
|patch closure center – weighted average patch positionl / patch radius
cell volume
cell surface area

**User 2**

patch closure surface area
patch volume / (patch closure surface area)$^{3/2}$
patch surface area / (patch perimeter)$^{2}$
patch shape diameter function
average of mean curvature on patch
average of mean curvature on patch edge

**User 3**

patch closure surface area
patch radius / (patch surface area)$^{1/2}$
maximum mean curvature on patch
|patch closure center – average patch position|

**Supplementary Table 6**

Automatically selected features for bleb detection models generated from three different users training on the same four cells.