Immune scores for ER+ breast cancer

Heindl et al.
1. Abundance score ITLR, ATLR and DTLR

Lymphocytes were classified into three categories: ITLs, ATLs and DTLs based on their spatial proximity to cancer cells. Spatial proximity to cancer was quantified using kernel density of cancer.
Unsupervised clustering

Figure 2. A representative example illustrating the three lymphocyte classes in cancer density map of a tumor. (a) Density map of cancer and the spatial distribution of three classes of lymphocytes (spatial points colored according to the classes). Black contour lines denote cut-off thresholds for the three classes of lymphocytes according to cancer density. (b) Histogram showing the three types of lymphocytes in this sample. (c) A higher-resolution image of a region in this sample; color codes follow (a).
Green areas show where the cancer cells are; black, darkblue and lightblue dots show where the ITLs, ATLs and DTLs are.
Getis-Ord hotspot analysis can be used to identify tumor regions with higher cell density than expected considering the overall mean of cell density in the tumor.

Hotspot analysis
Spatial statistics for identifying cell hotspots

Hotspots: Spatial regions with higher number of events than expected by chance

Getis-Ord hotspot analysis
It is a method used widely in ecology and criminology. For example, to identify crime hotspots in cities.

The advantage for this method over simple density-based method is that it considers the distribution of other cells as well. For example, when there are more populations, it is likely that there will be more crime. But we can only consider a place to be a “crime hotspot”, if there is more crime than you expect, given the amount of population there.

Similarly, we can only consider a tumor region to be an “immune hotspot”, if there are more immune cells than you expect, given the number of cells there.
Hotspots high example 1

1 immune-cancer hotspot

2 immune hotspot

3 immune hotspot
Hotspots low example 1
Hotspots low example 2

1 Immune-cancer hotspot

2 Immune-cancer hotspot

3 Immune-cancer hotspot