Introduction:
Machine learning on microscopy images

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The structure of a protein can be specified by listing the spatial coordinates of each atom.
- The atoms move relative to one another, but by a limited amount.

In a cell, many of the molecules can move from one side of the cell to another.
- We could specify the position of every molecule, but that will vary substantially from one point in time to another (for a given cell) or between genetically and functionally identical cells.

Instead, we want a statistical description.

“Machine learning” = statistics.
Morphological profiling

• Goal: recognize whether or not (or how much) a cell has been perturbed in a certain way
  – For example, distinguish between cells that have been treated by a particular drug and those that have not
  – Or distinguish between diseased and healthy cells
• Traditionally, this is done using certain hand-picked features (e.g., micronucleus count)
• One of Thursday’s paper instead does it with convolutional neural networks
  – Without even segmenting out the cells
  – Using pre-training based on “natural” photographs
Repurposing image assays

- High-throughput screening (HTS) is a standard method to find initial hits in drug discovery.
- In each discovery campaign, one generally develops a new assay (measurement).
  - Often these assays involve imaging and then extracting a certain measurement from each image.
- One of Thursday’s papers shows that one can take existing HTS imaging data and use it to replace a screen for an entirely different property.
  - To do this, learn how image features relate to the property of interest.
Tracking cells over time

- The third paper presents a method to track cells in videos
- The problem is complicated by the facts that:
  - They want to track cell lineages, meaning they have to keep track of which cells divide into which other cells
  - The density of cells in the images can be very high
- They use machine learning (classifiers) in a couple different ways
  - Classifying background objects
  - Predicting cell types
Background

• Fluorescence microscopy