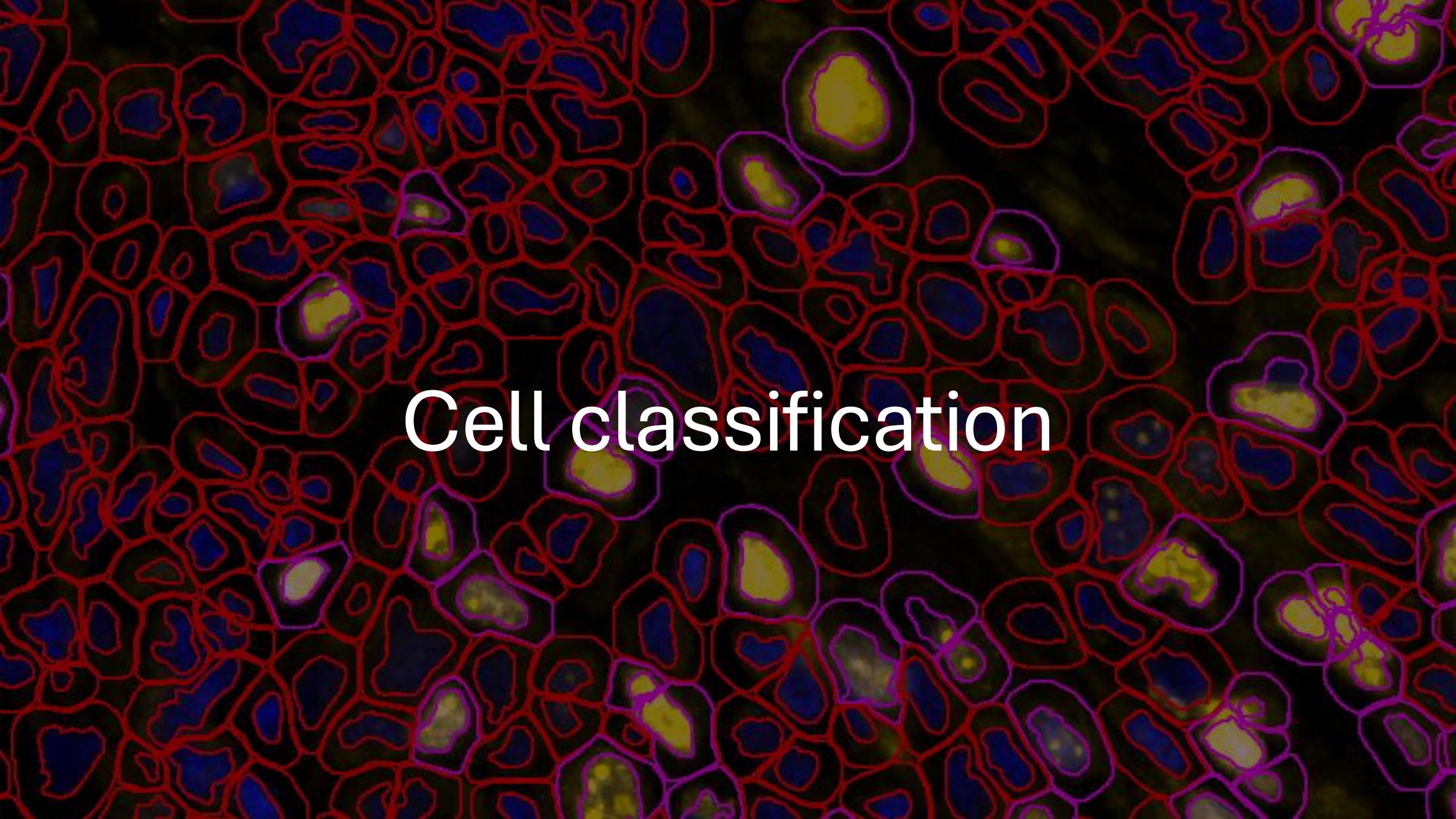

Cell classification

What is cell classification?

explain in one sentence to a toddler what is cell classification in the context of image analysis

5/5

Cell classification is like sorting different kinds of toys into separate boxes based on how they look.

Thank you, I'm sure students will love being compared to toddlers

3/3

It's all about finding the right analogy for understanding! If it helps simplify a complex concept, then it's worth it.

What is cell classification?

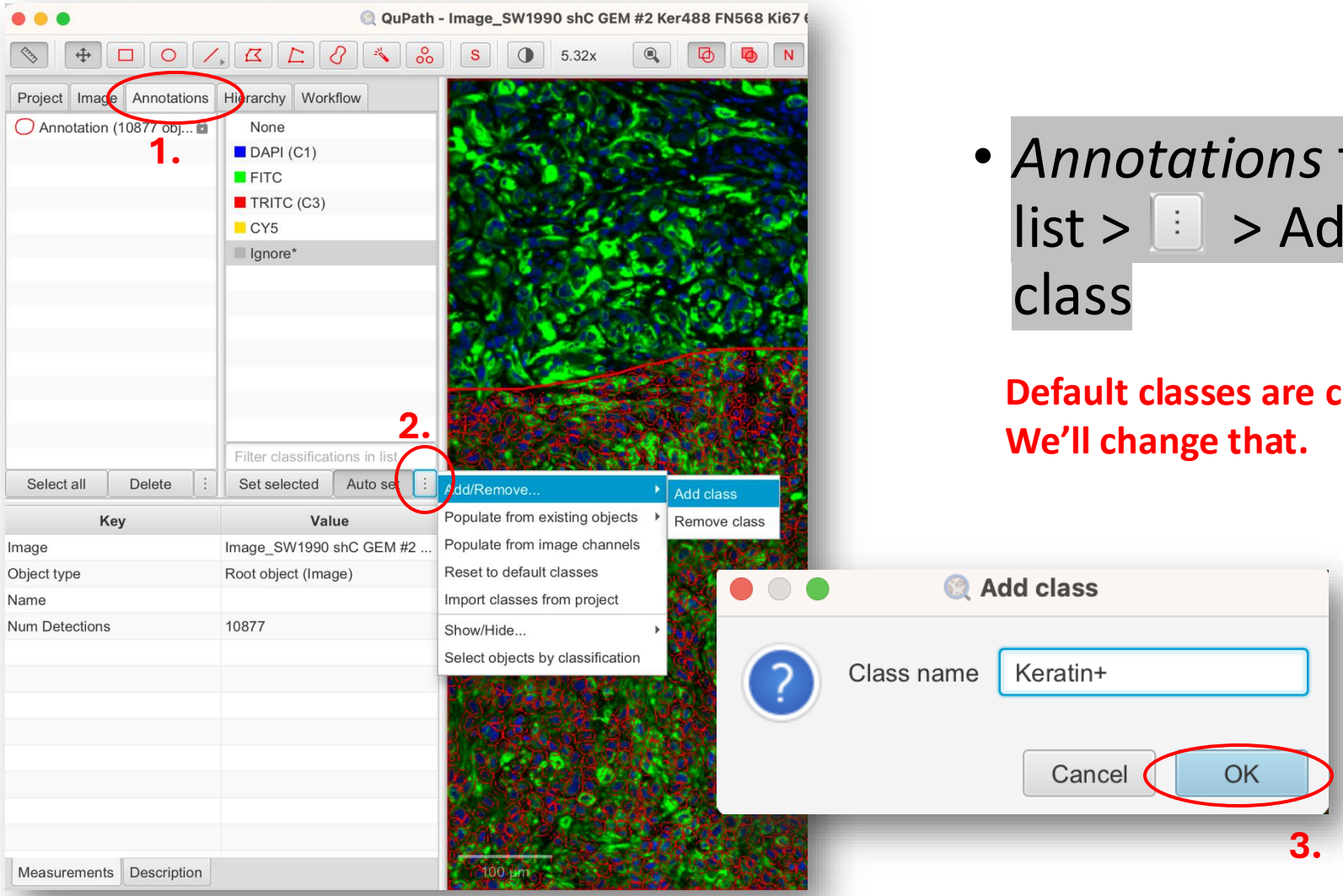
- Cell classification in image analysis is sorting different types of cells into groups based on their features or characteristics, such as shape, color, position, neighbors, etc.

- If visually you can’t discriminate cells in your images, then your algorithm might be separating cell on very fine differences (careful of *overfitting*)

Cell classification in QuPath

- Single measurement classifier (Keratin positive vs negative)
- Composite classifier: combine single measurement thresholders together (Keratin positive vs negative; Ki67 positive vs negative)
- Train a machine learning classifier

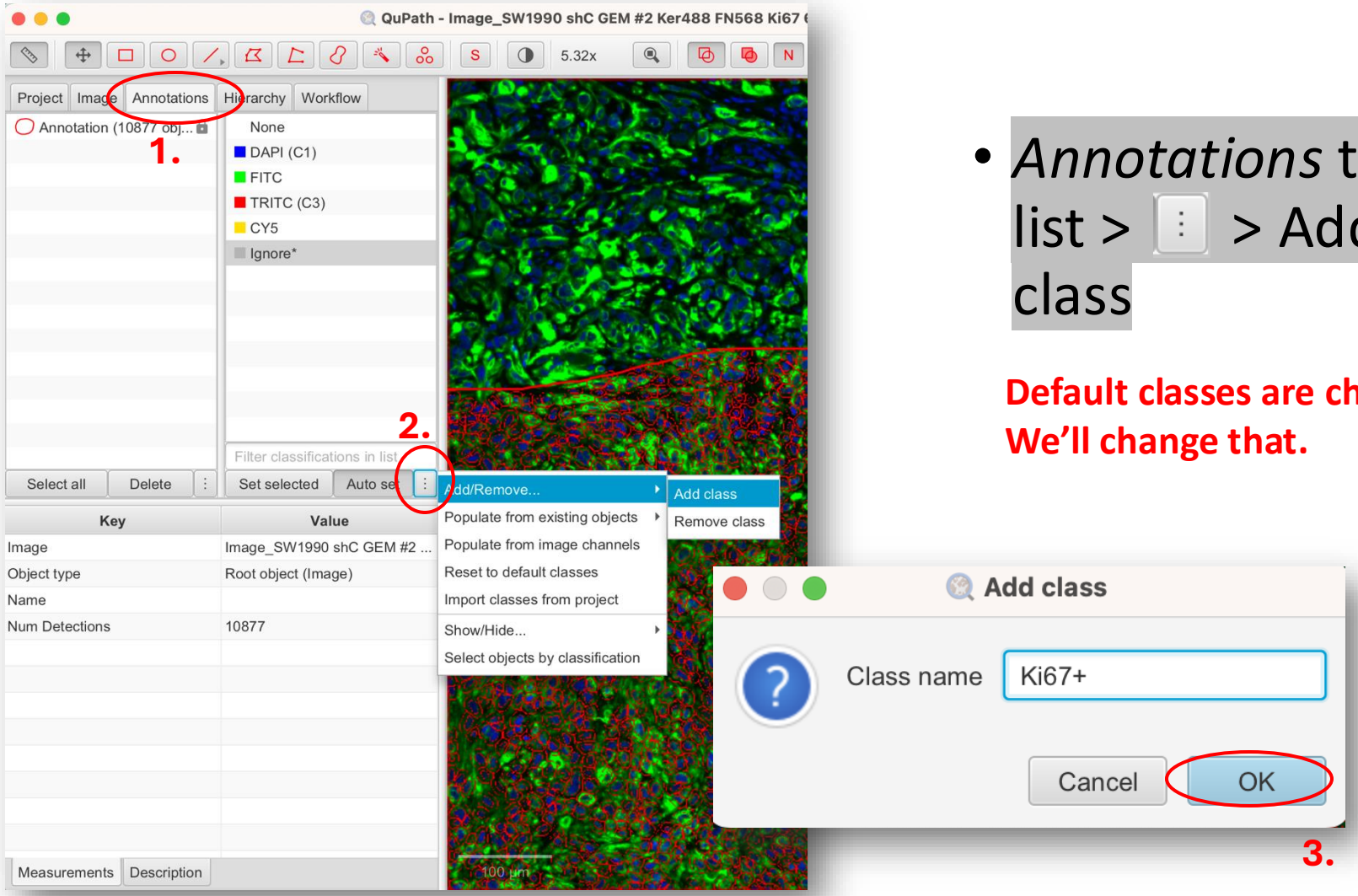
Create a class named ‘Keratin+’



- *Annotations* tab > Classification list > ⋮ > Add/Remove… > Add class

Default classes are channel names.
We’ll change that.

Create a second class named ‘Ki67+’

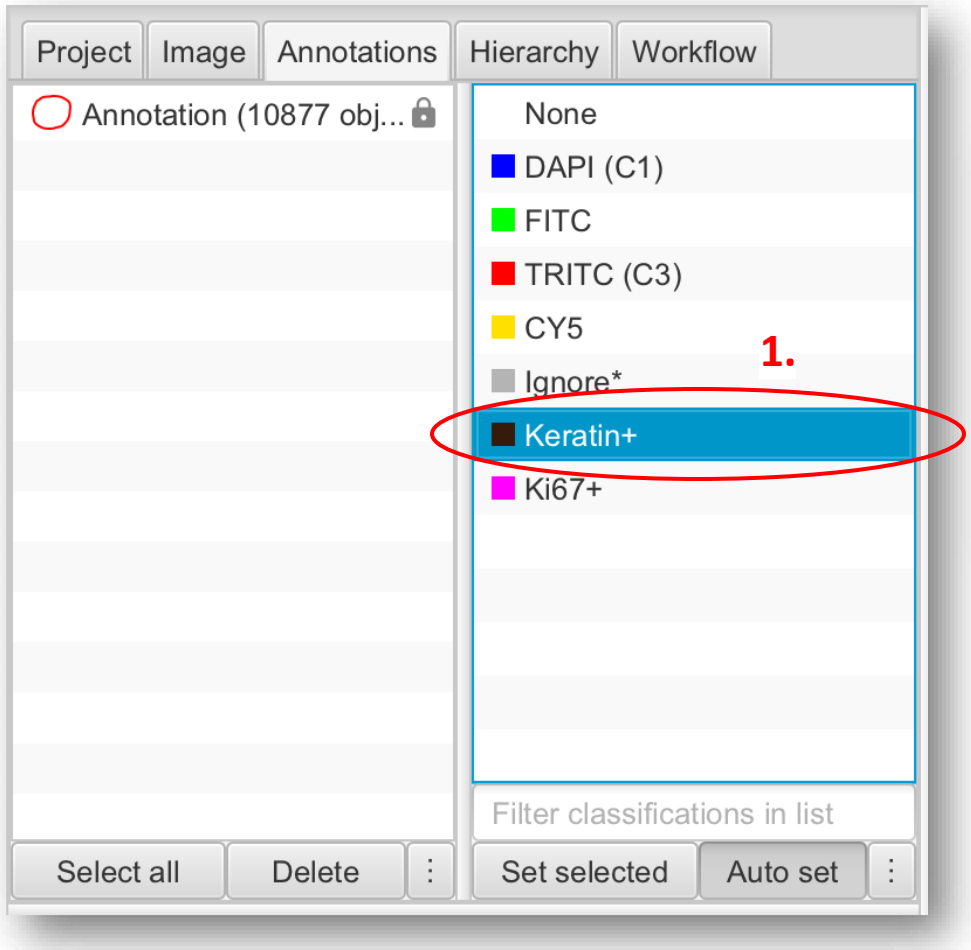


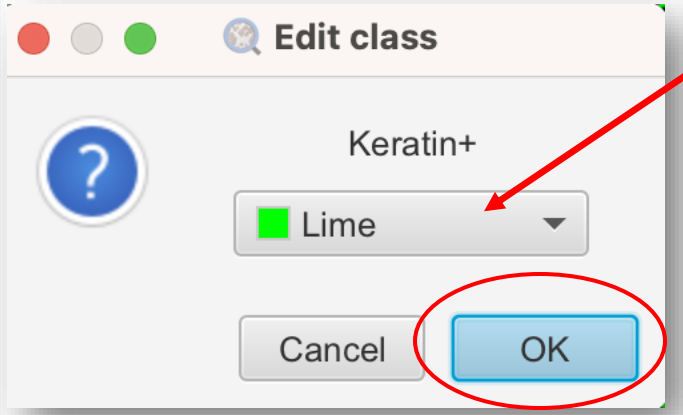
- *Annotations* tab > Classification list > ⋮ > Add/Remove… > Add class

Default classes are channel names.
We’ll change that.

Change the color of a class

- Double click on the class > Edit class > Choose a new color > *OK*



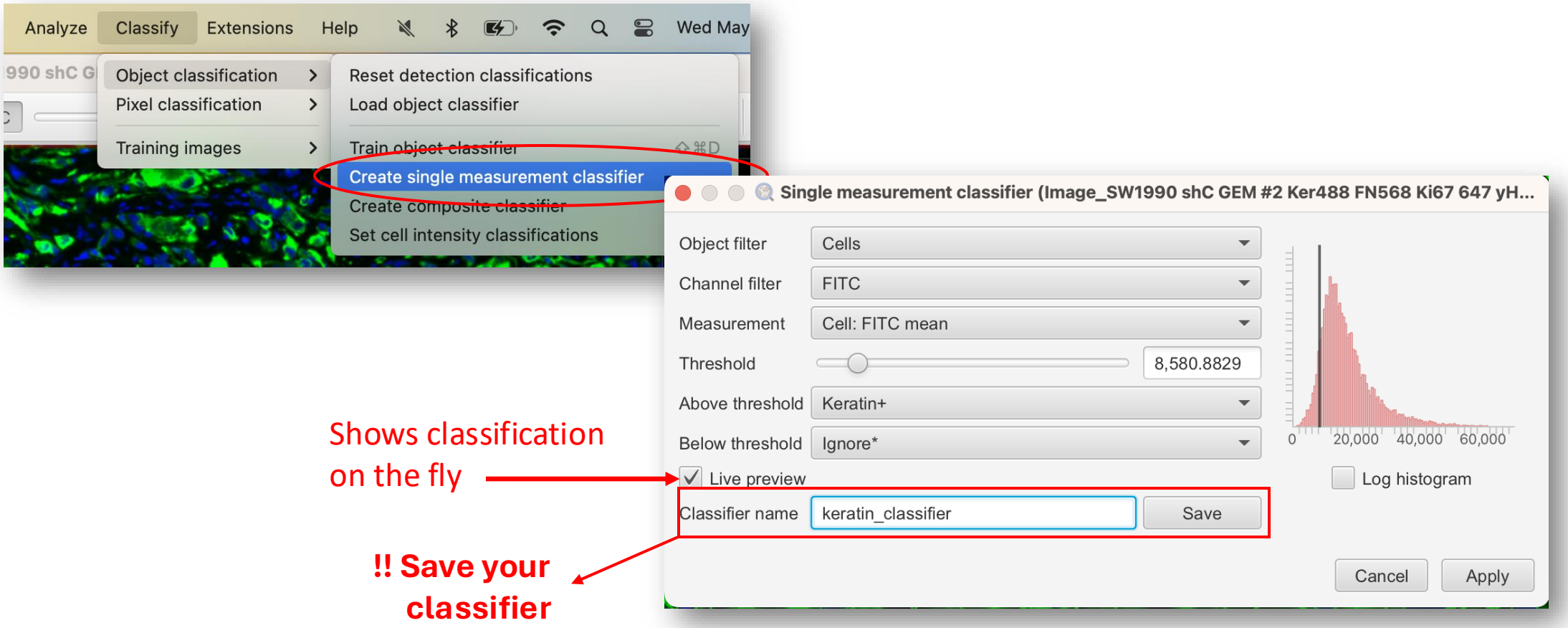


Your favorite color.

By default, classes are populated by image channels.

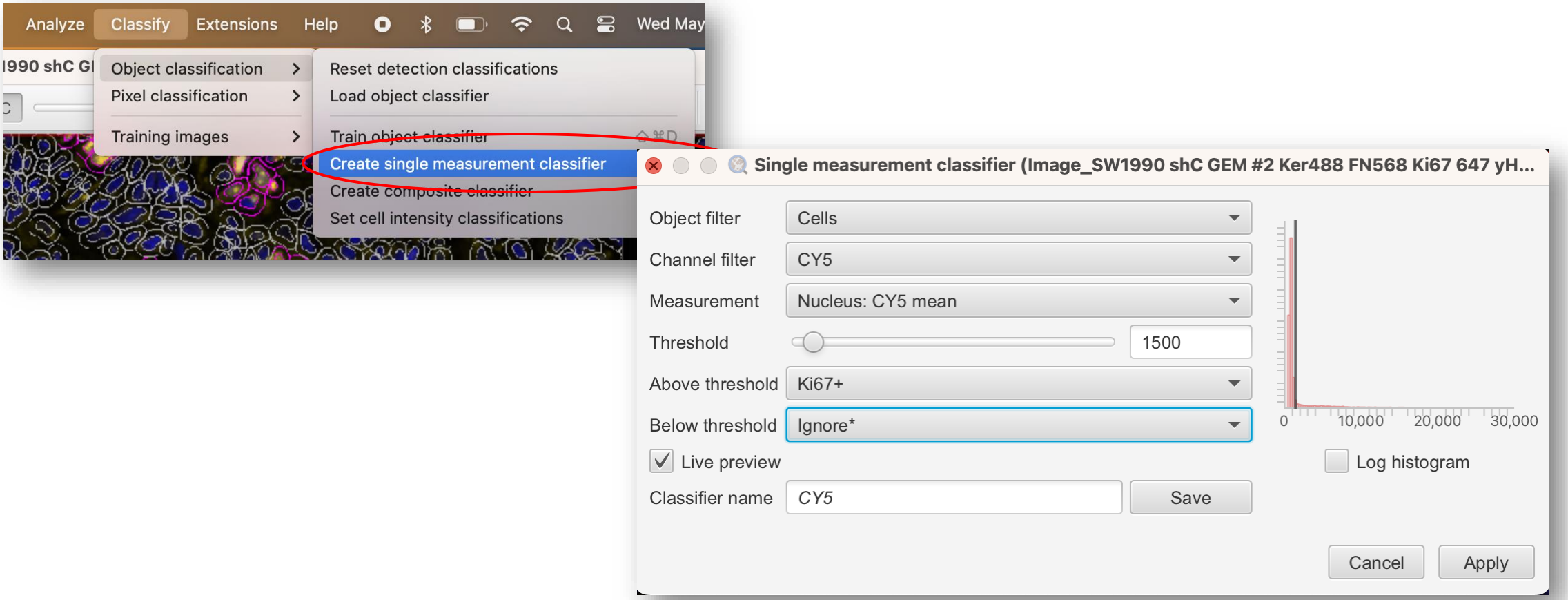
Simple measurement classifier on Keratin signal intensity (FITC channel)

- *Classify > Object classification > Create single measurement classifier*



Simple measurement classifier on Ki67 signal intensity (CY5 channel)

- *Classify > Object classification > Create single measurement classifier*

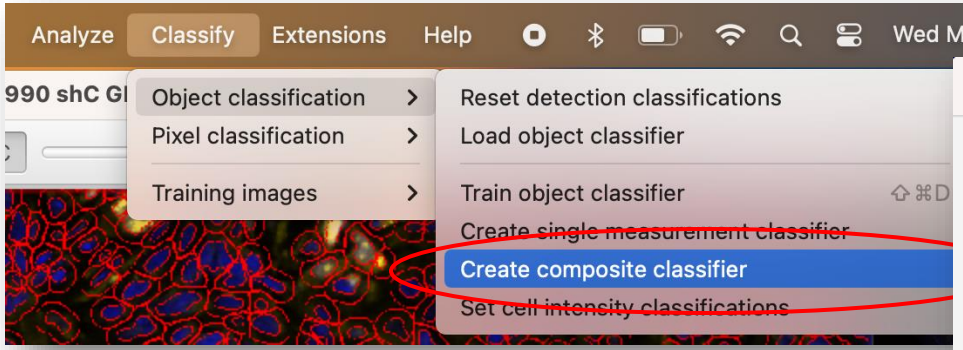


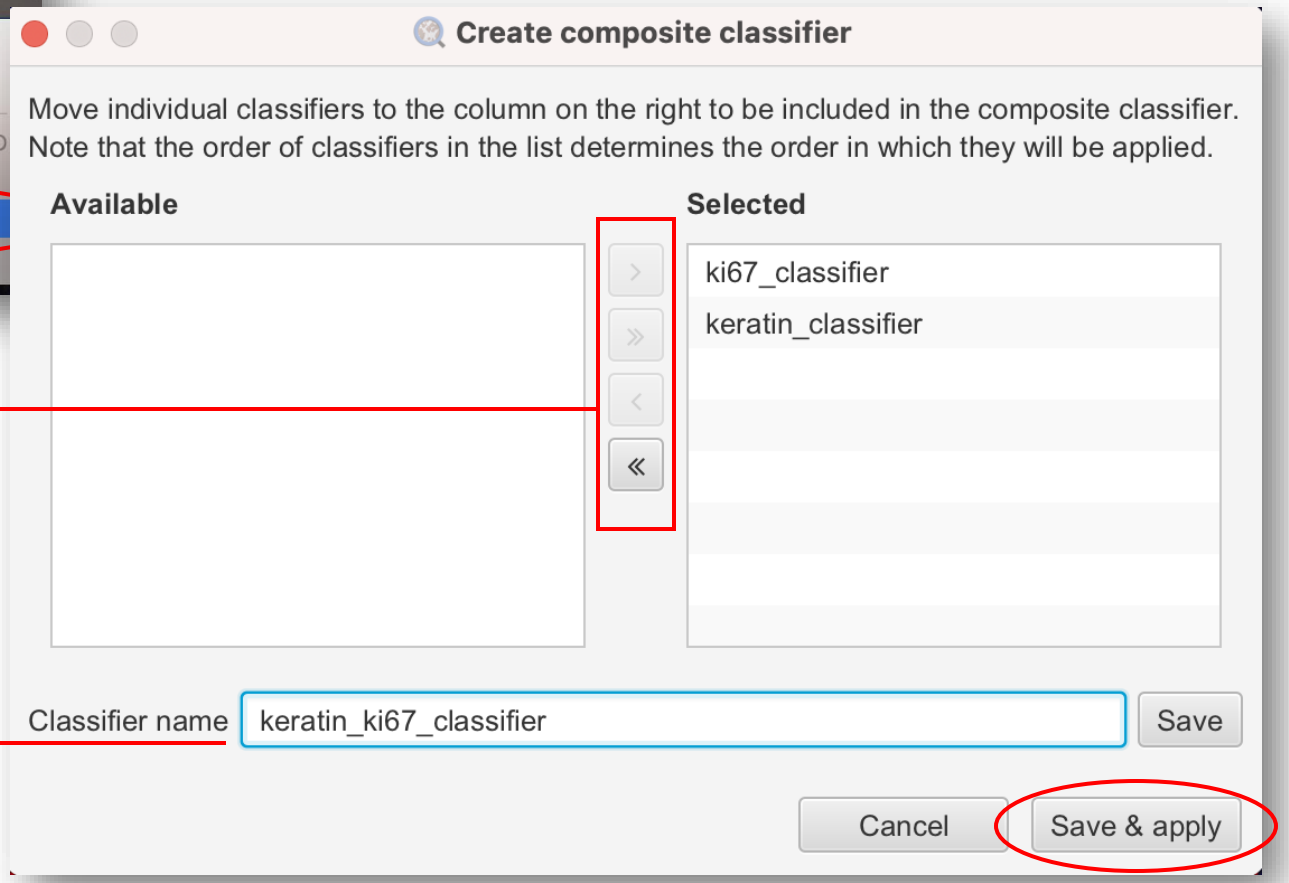
Practice time

Exercise 4.a: single-measurement classifier

Combine single measurement classifiers into a composite classifier

- *Classify > Object classification > Create composite classifier*





Select a classifier by moving it onto the 'Selected' list.

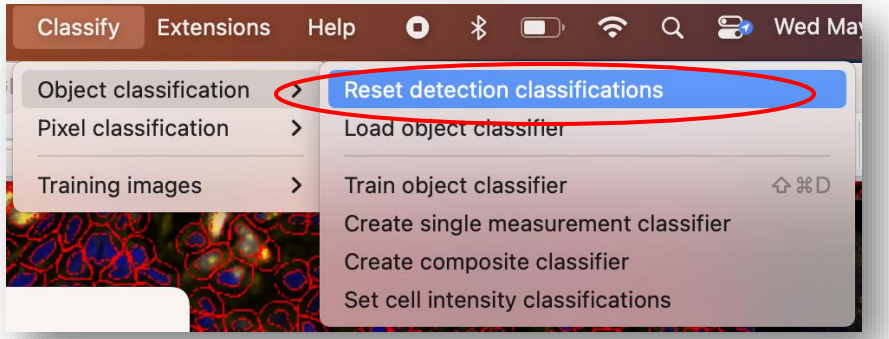
A name is required to 'Save & apply'

Practice time

Exercise 4.b: composite classifier

Reset detection classes

- *Classify > Object classification > Reset detection classifications*



Populate classes in the classification panel

- *Annotations* tab > Classification list > ⋮ > *Populate from existing objects > All classes (including sub-classes)*

Object classification using machine learning

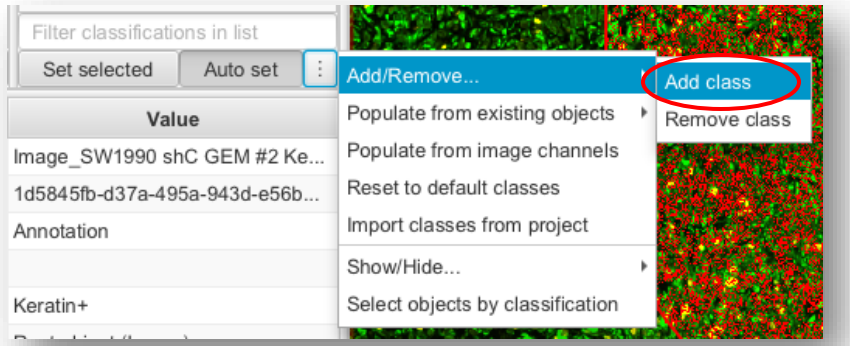
- Detections (and annotations) can be classified into classes using a ML classifier
- Classification requires measurements!
- Object classifiers are trained using manual annotations of 2 or more classes
  - Need to create some training data points

- **Live demo of object classification using ML**

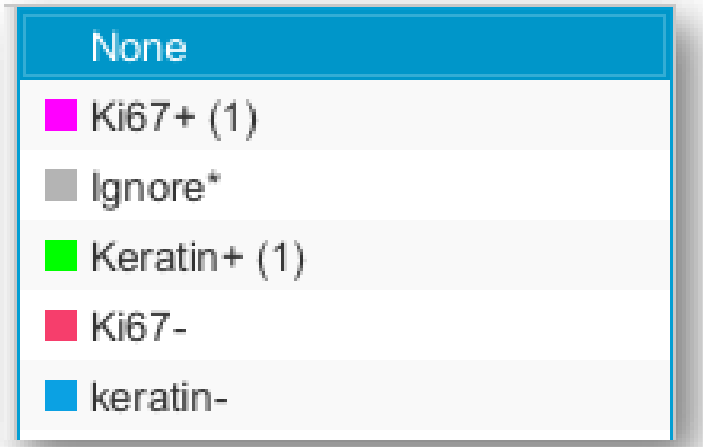
Reset your detection classes!

Train an object classifier: create classes

- *Annotations* tab > Classification list > ⋮ > Add/Remove... > Add class



- Create 4 classes:
  - Keratin+
  - Keratin-
  - Ki67+
  - Ki67-

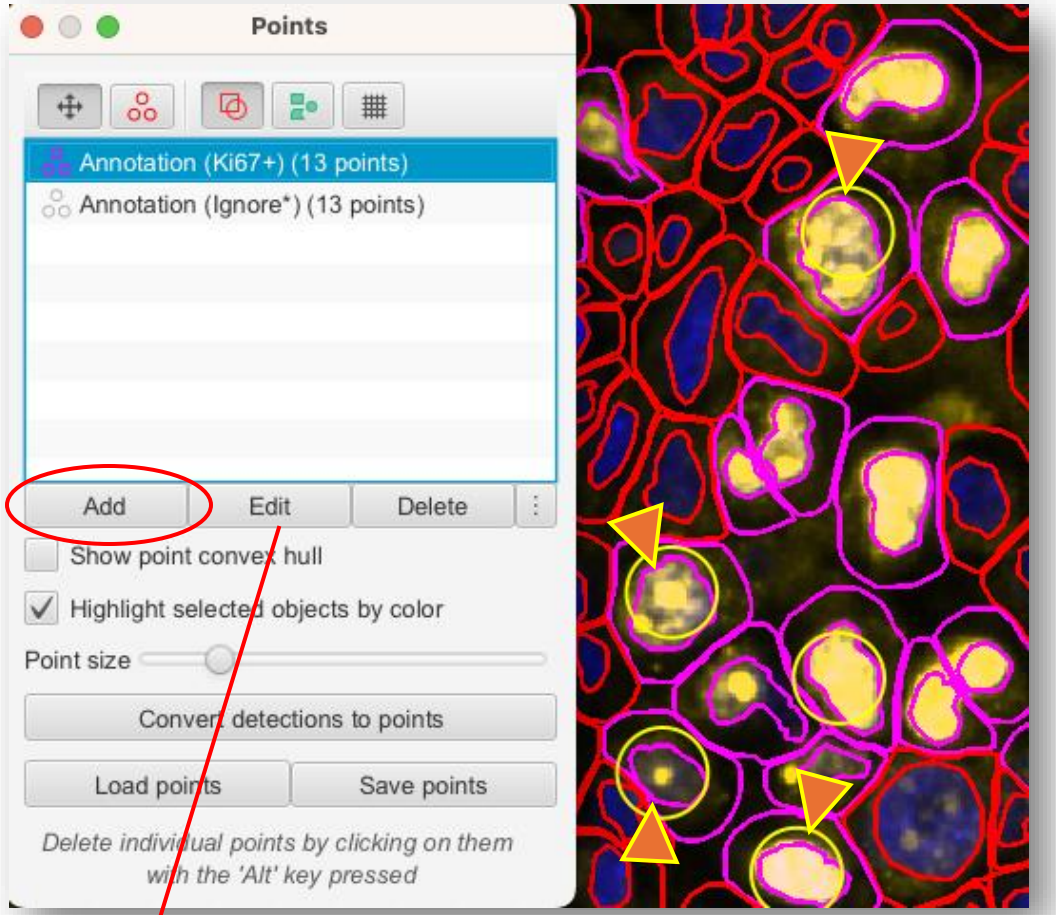


Train an object classifier: training data points

-  > *Add* > Label ~10 for each class

To remove a single point:
Option + click (Mac) or left-click

- Assign each training data set a class:
  - Select the annotation set
  - Select the class

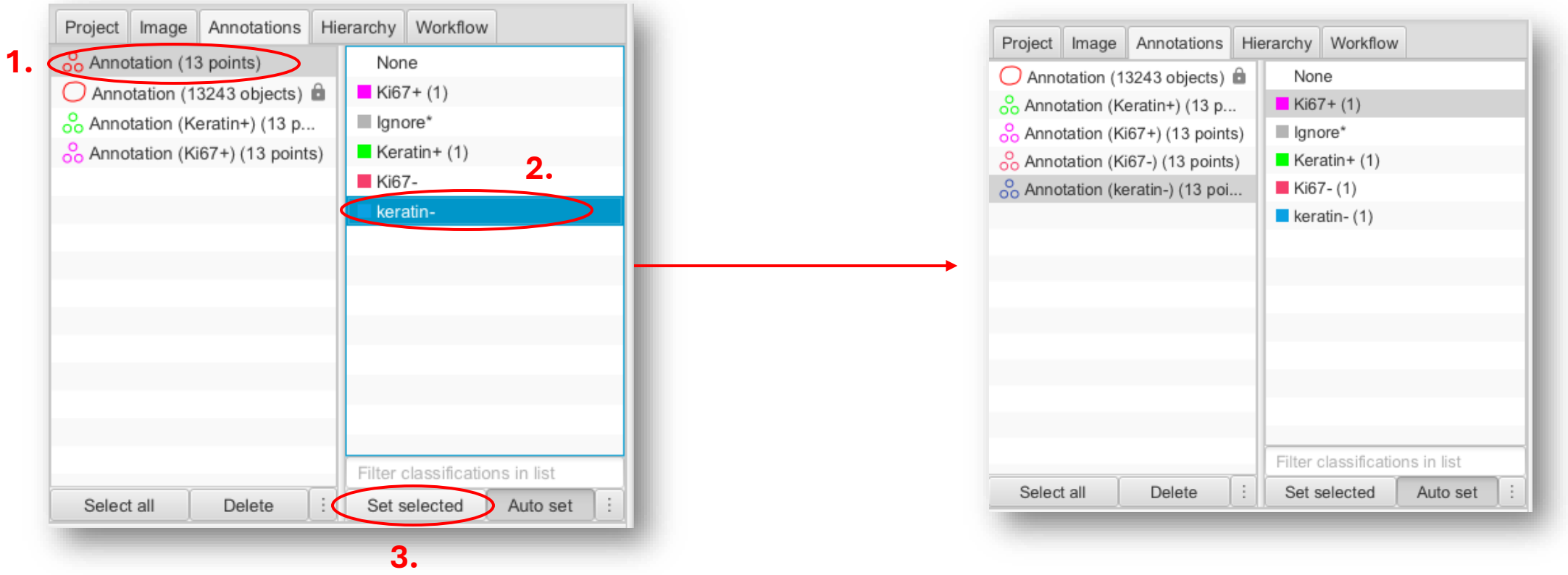


Click edit to change color

Training data

Train an object classifier: training data points

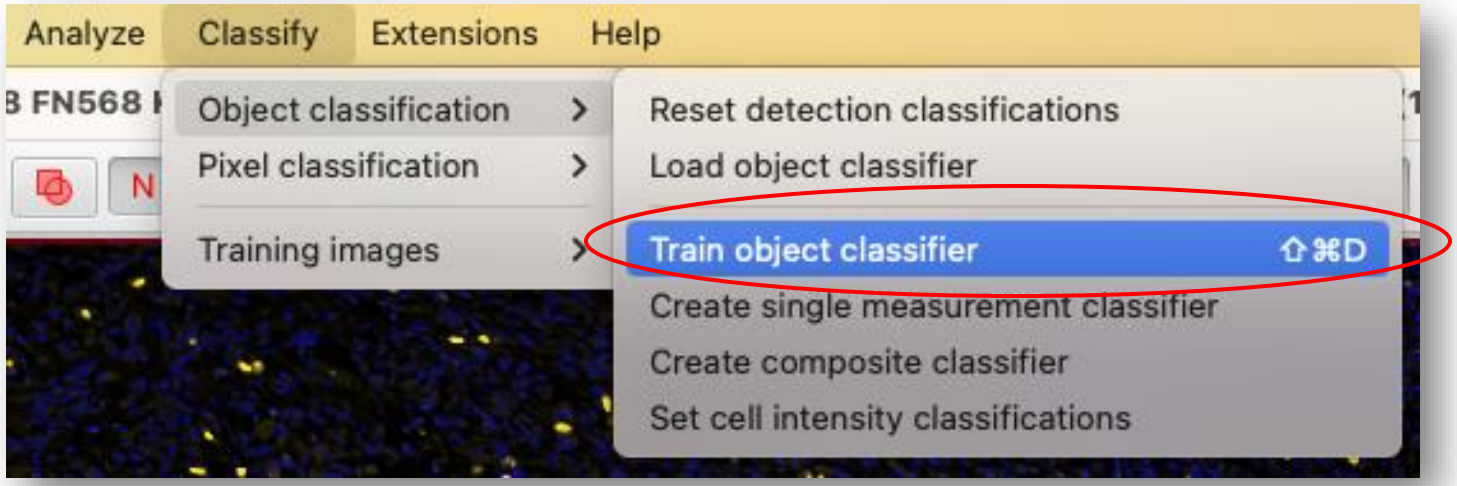
- Assign each training data set a class in the *Annotations* tab



Make sure to lock your annotation: Ctrl+click > Lock

Train an object classifier

- *Classify > Object classification > Train object classifier*

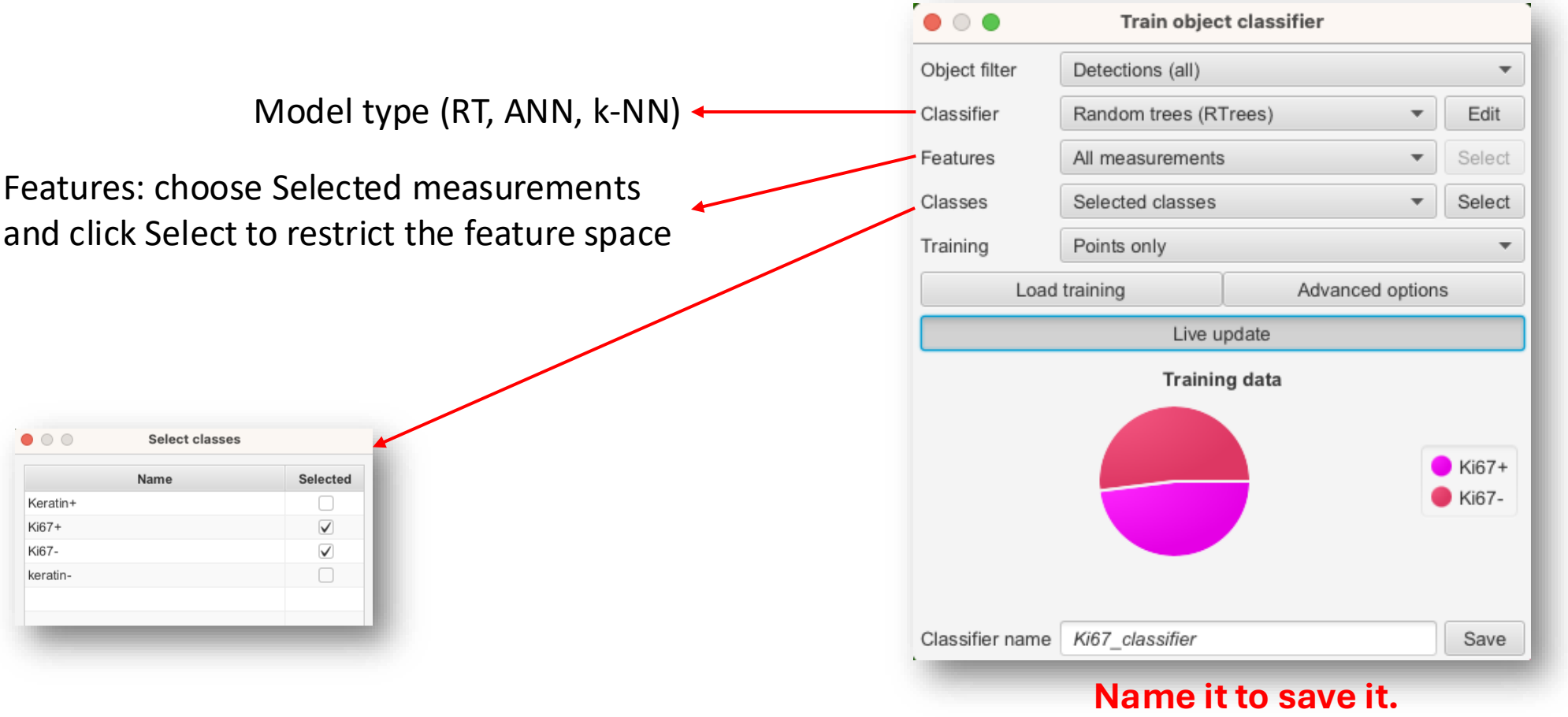


Train an object classifier

- *Classify > Object classification > Train object classifier*

Model type (RT, ANN, k-NN)

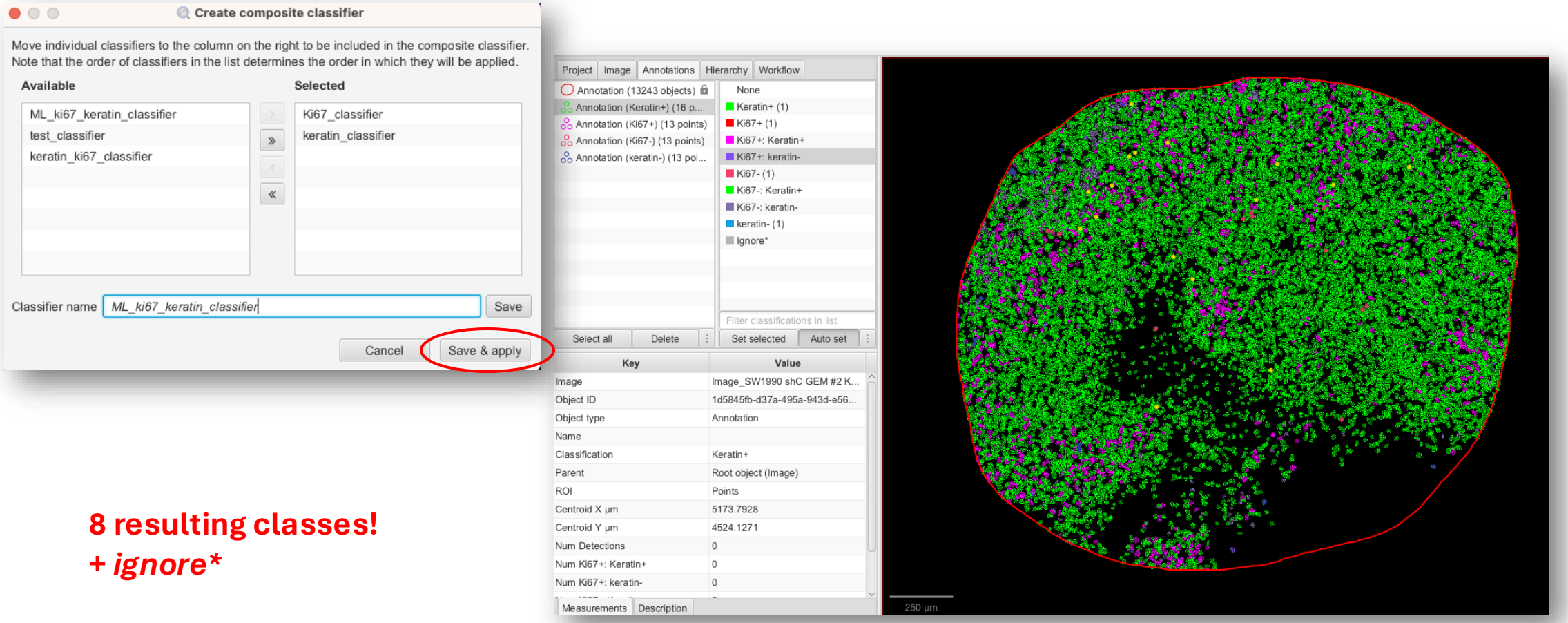
Features: choose Selected measurements and click Select to restrict the feature space



Name it to save it.

Combine multiple ML classifiers together

- *Classify > Object classification > Create composite classifier*



8 resulting classes!
+ ignore*

Refine your classifier

- Add more training data points
  - Classification results will change in real time if ‘Live update’ option is enabled

- Typically, *fewer*, but *well-chosen* features provides more robust results

Visualizing results using density maps

- Analyze > Density maps > Create density maps