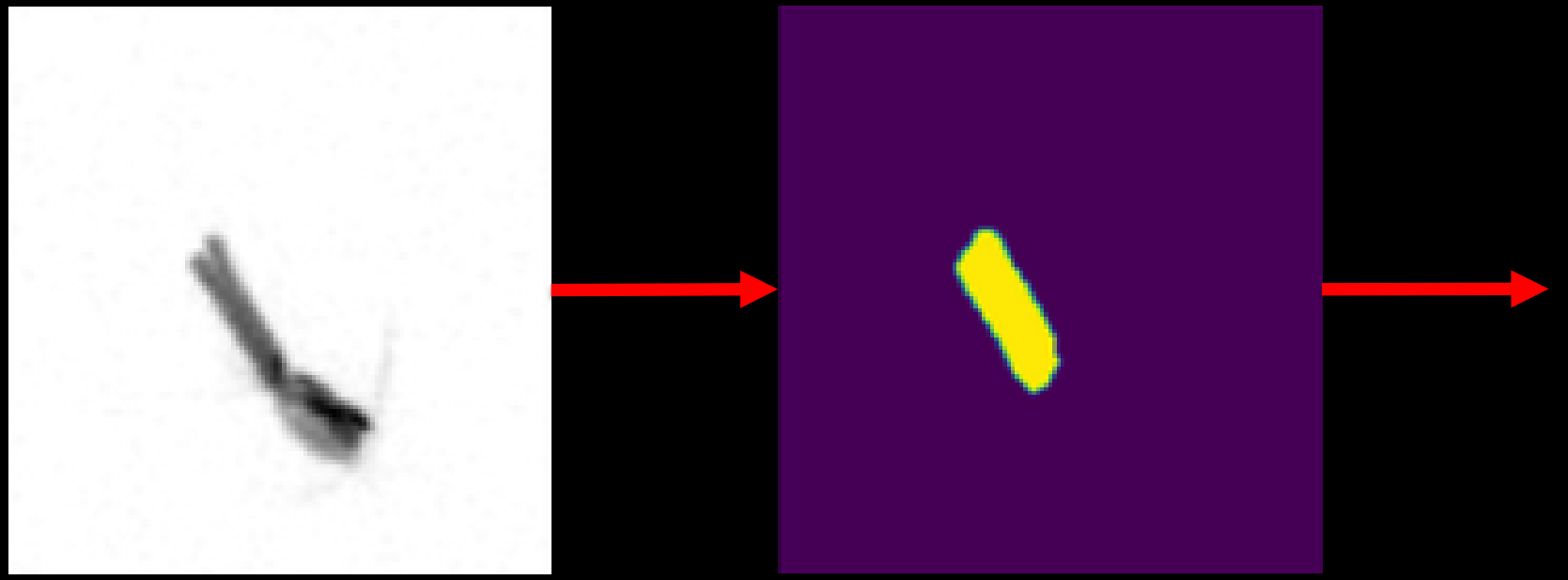
Designing new tools for functional trait extraction from in situ plankton images



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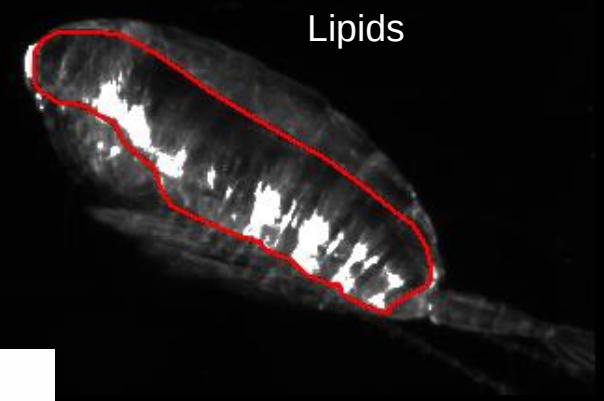
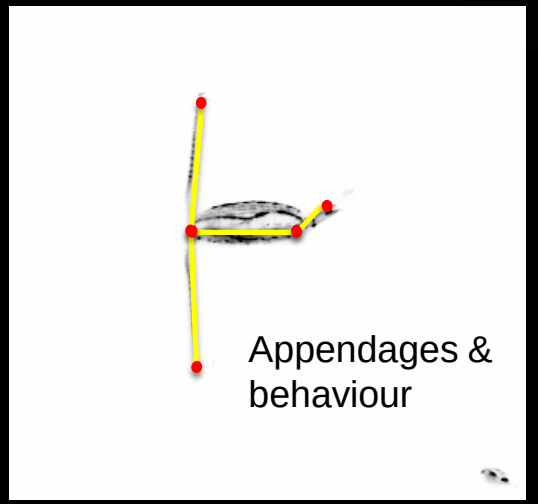
Functional traits

- Characteristics of individual organism that impacts fitness
- Ecosystems can be described as structured by such traits
- Many traits are directly measurable from image data





A crucial trait: egg production

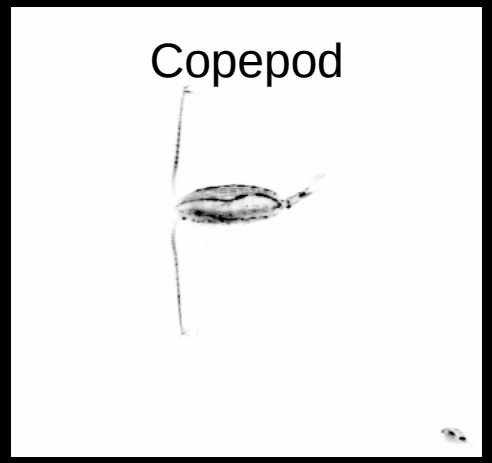
- Question: What is the timing and intensity of copepod reproduction in different populations?
- Objective: Detect reproduction as indicated from egg bearing images.

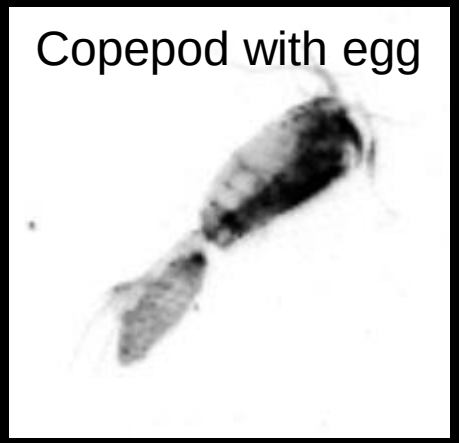
A crucial trait: egg production

- Data
  - Underwater Visual Profiler images
  - Globally distributed
  - Hand segmented all egg pixels from each ROI
  - Copepods: ~160k
  - With eggs: 1909

Experiments

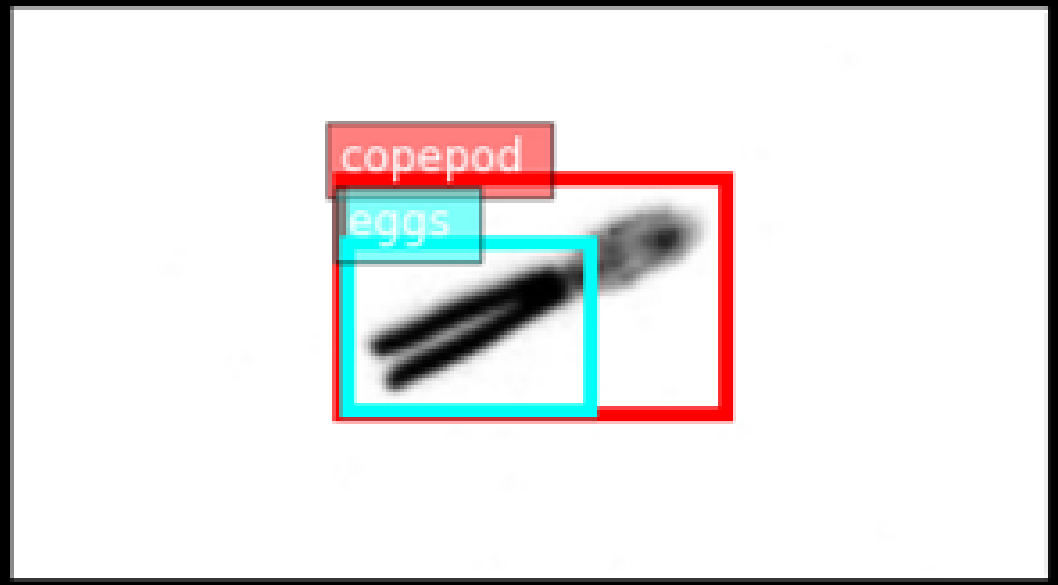
- Goal: estimate eggs in a given image
- Approaches:
  - Semantic classification





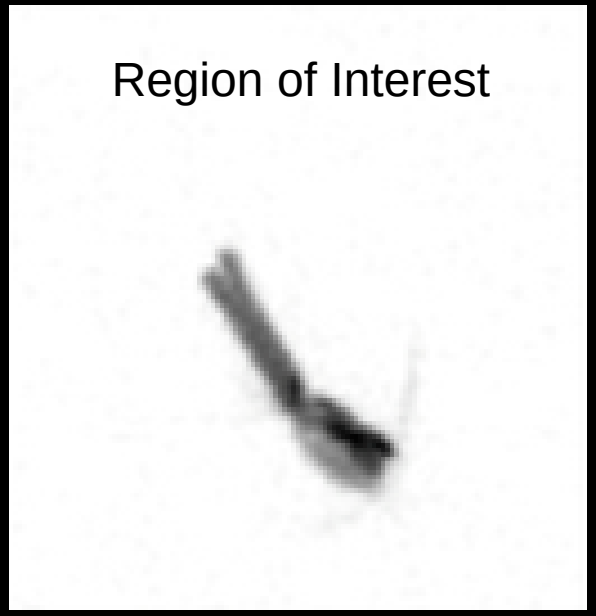
Experiments

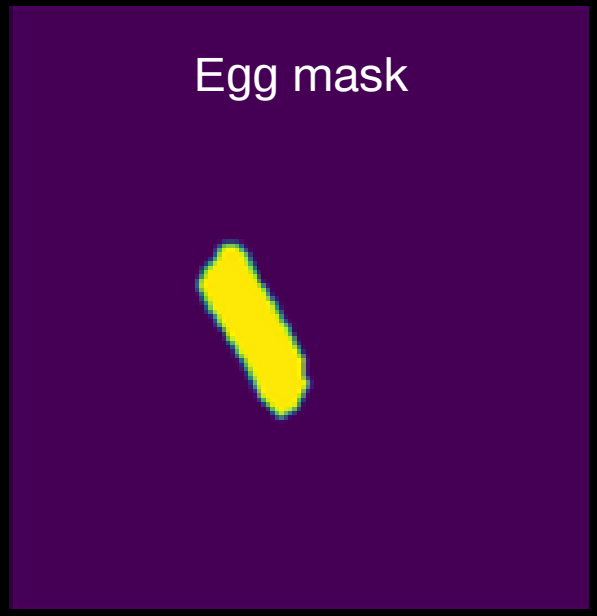
- Goal: estimate eggs in a given image
- Approaches:
  - Semantic classification
  - Object detection



Experiments

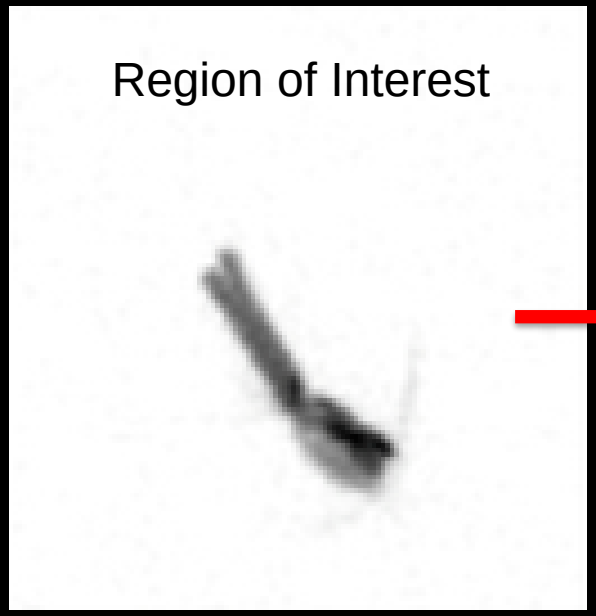
- Goal: estimate eggs in a given image
- Approaches:
  - Semantic classification
  - Object detection
  - Semantic segmentation





Experiments

- Goal: estimate eggs in a given image
- Approaches:
  - Semantic classification
  - Object detection
  - Semantic segmentation
  - Deep regression

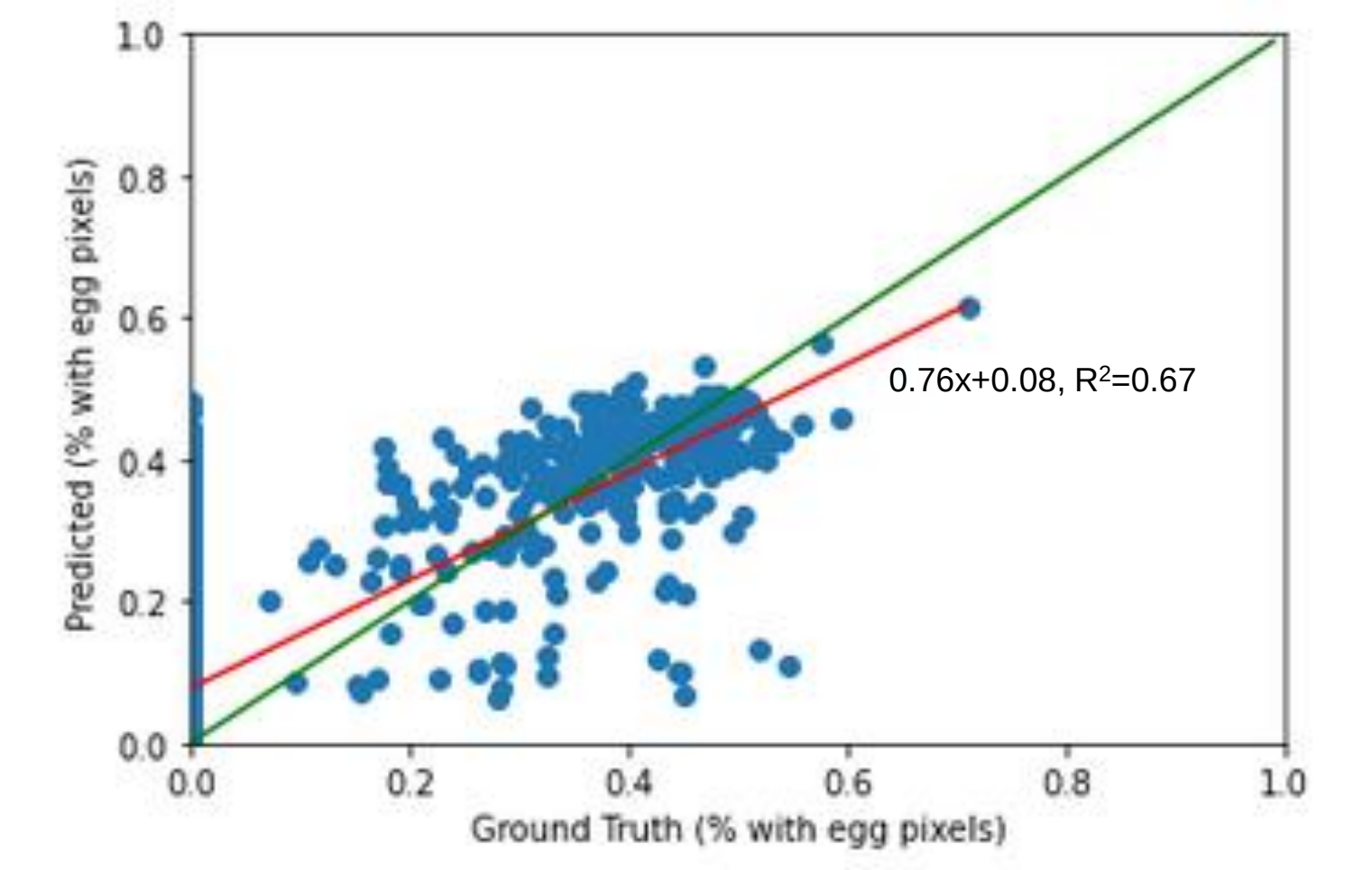


65% egg pixels

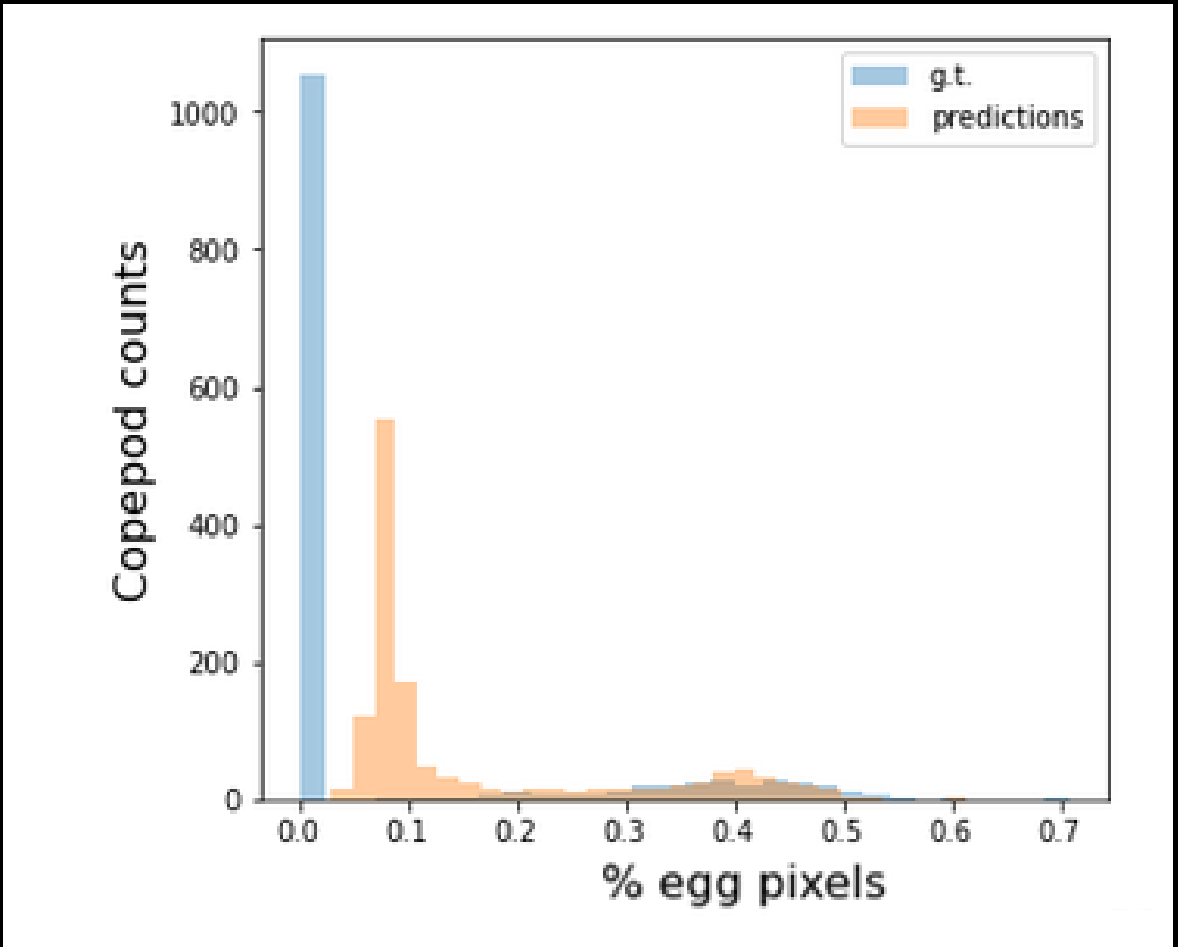
Deep regression

- Two training stages:
  1. Semantic classifier to select egg-bearing copepods
  2. Deep regression model to estimate % egg pixels
- Final evaluation is done passing data not seen in either training through both stages
- Evaluation is done comparing the true egg mass distribution to the estimated one from the regression

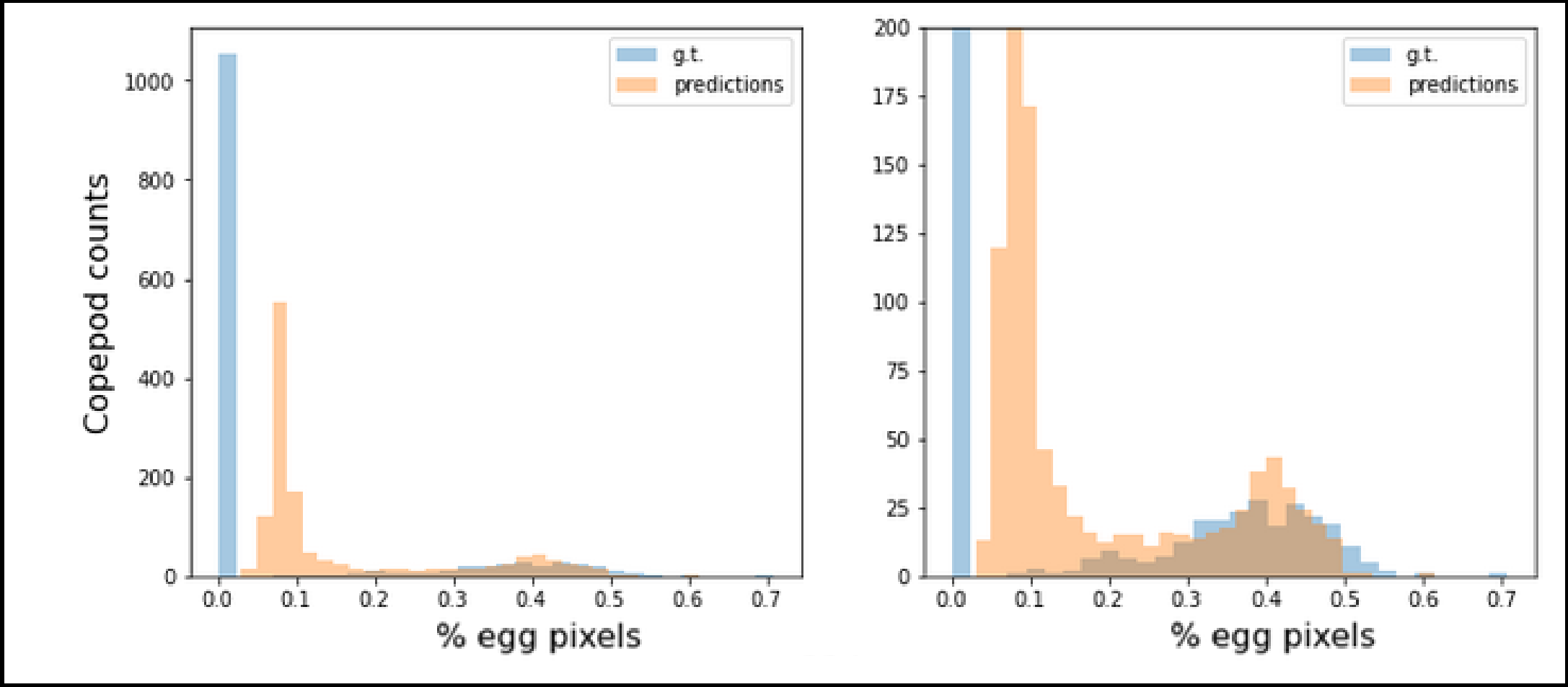
Deep regression



Deep regression



Deep regression



Things to do/think about

- How to deal with data imbalance due to:
  - many more non-egg bearing copepod images?
  - natural distribution per region/profile?
  - appearance of eggs different species?
- Empirical threshold for minimum egg-mass?
- How to expand these techniques to other functional traits?
- How to leverage output to ease annotation burden?

Take home

- Computer vision approaches to automate functional trait extraction are viable and potentially valuable.
- Using them can help us create new, large datasets of functional traits at the individual and population level

Thank you!