Experts, non-experts and automatic methods in crowdsourcing for wildlife image annotation

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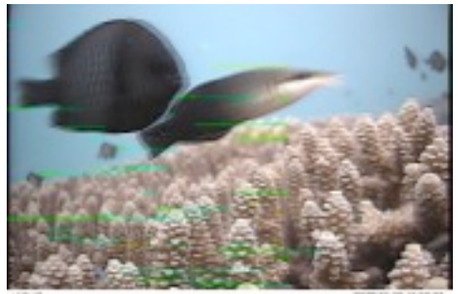
soHuman 2012

The big picture

The Fish4Knowledge Project



Videos

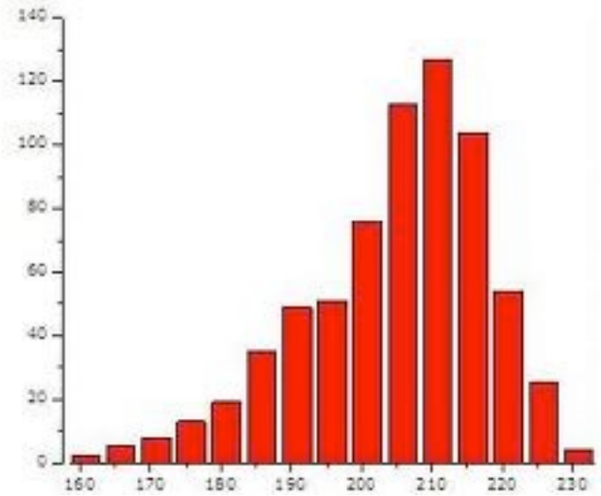
Underwater cameras

Computer vision systems

Detection

Tracking

Recognition



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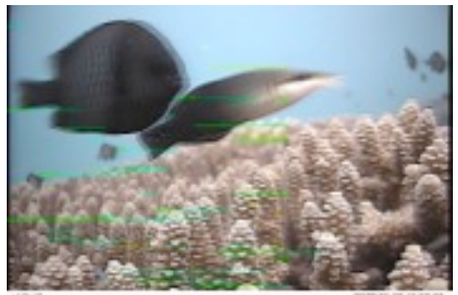
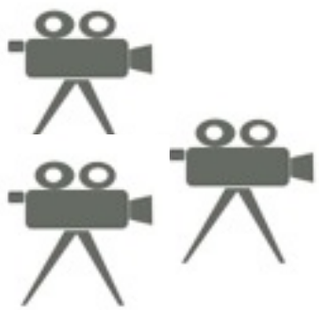
The big picture

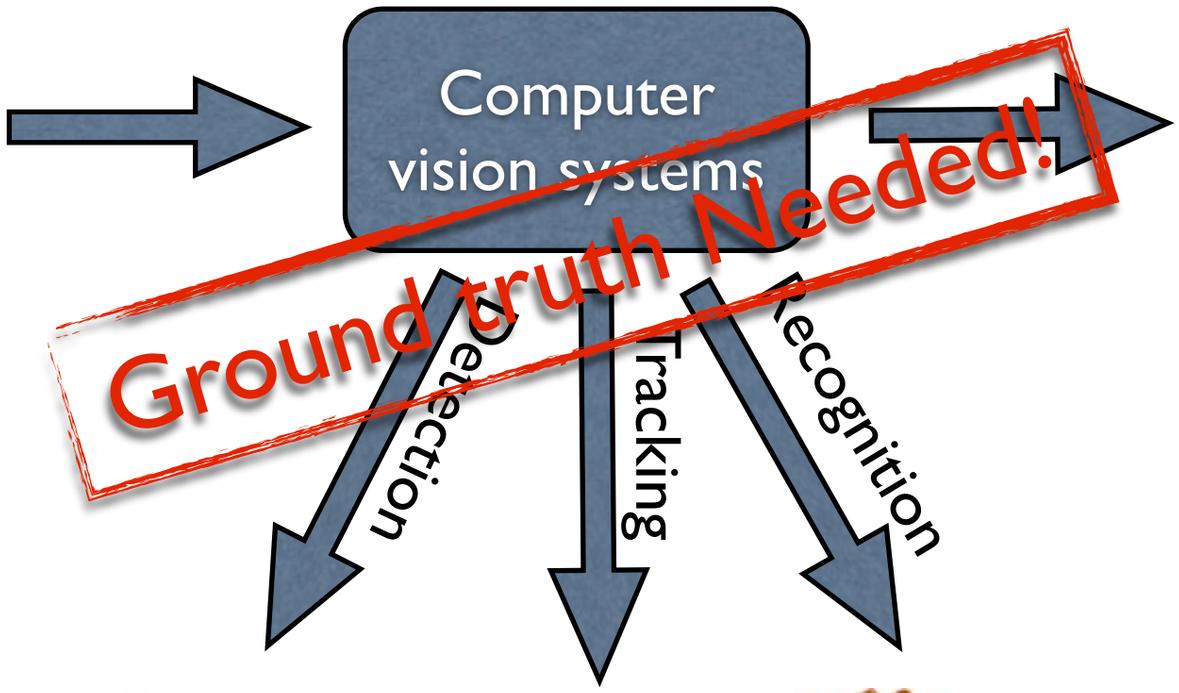
The Fish4Knowledge Project

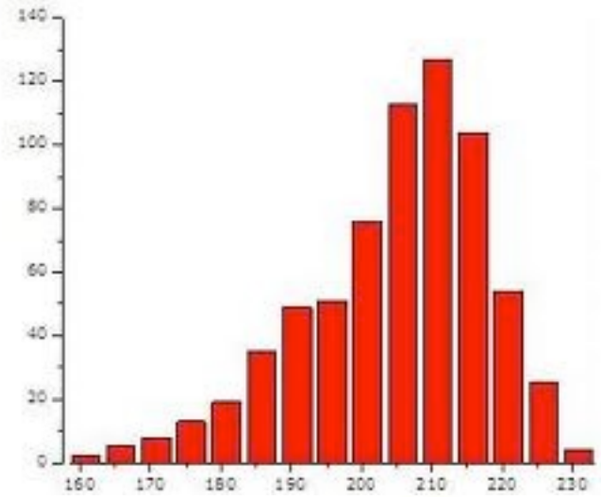


Videos



Underwater cameras





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Fish recognition: a difficult problem

- Goal: given an image containing a fish, assign the species name of the fish to the image
- Large amount of images
- Expert knowledge needed
  - Non-experts often lack the knowledge needed to recognize a fish
  - Non-experts may not be able to map the common name of a fish to its scientific name
  - Even experts can have their expertise in different types of fish or fish in different areas
- Experts are expensive, rare resources

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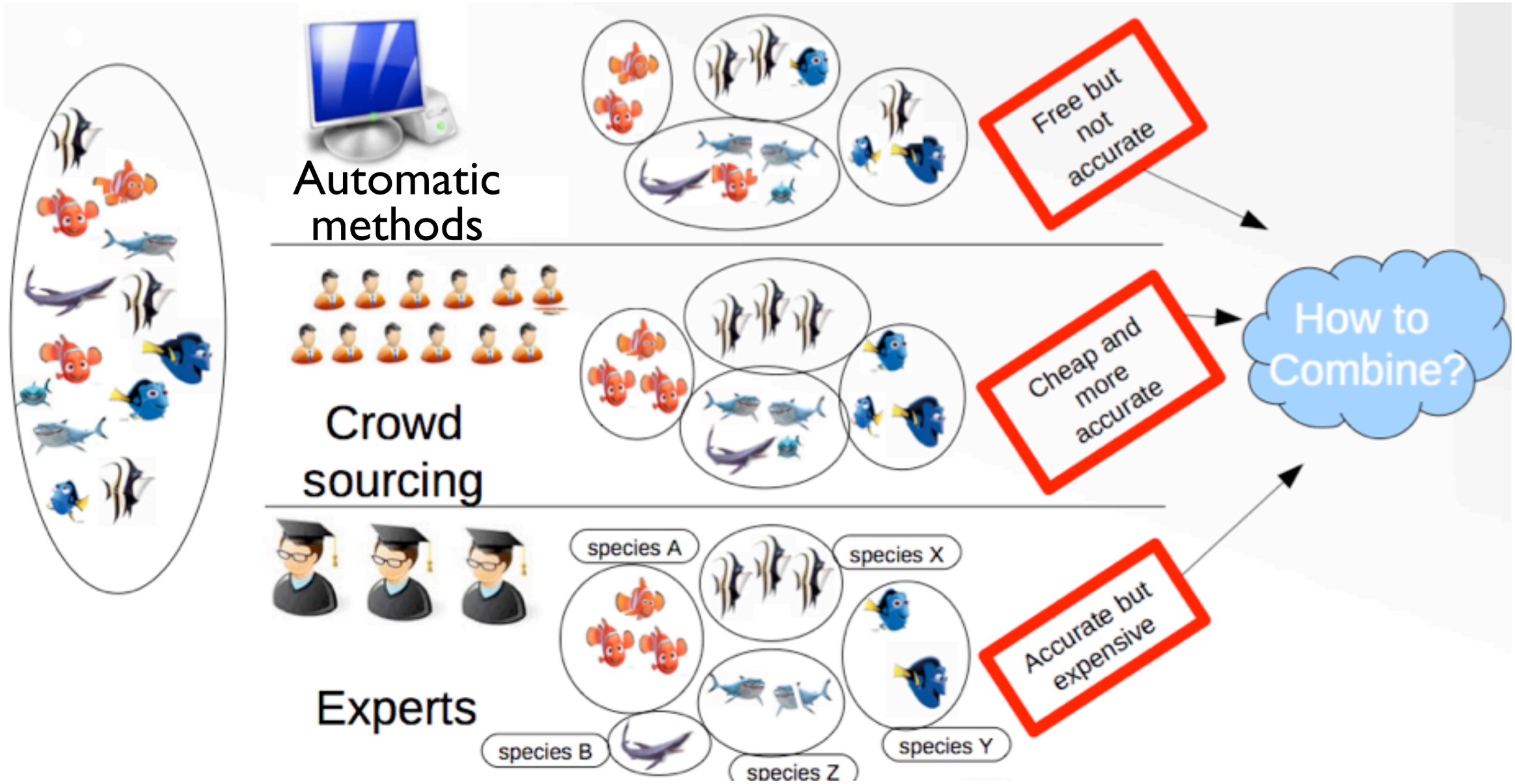
What can non-experts (not) do?

- Assumptions
  - Non-experts are not able to name fish species
  - But may be able to tell if two fish are visually similar
- Possible tasks
  - Manual clustering
  - Classification with textbook images as category labels

Automatic methods, crowds, and experts



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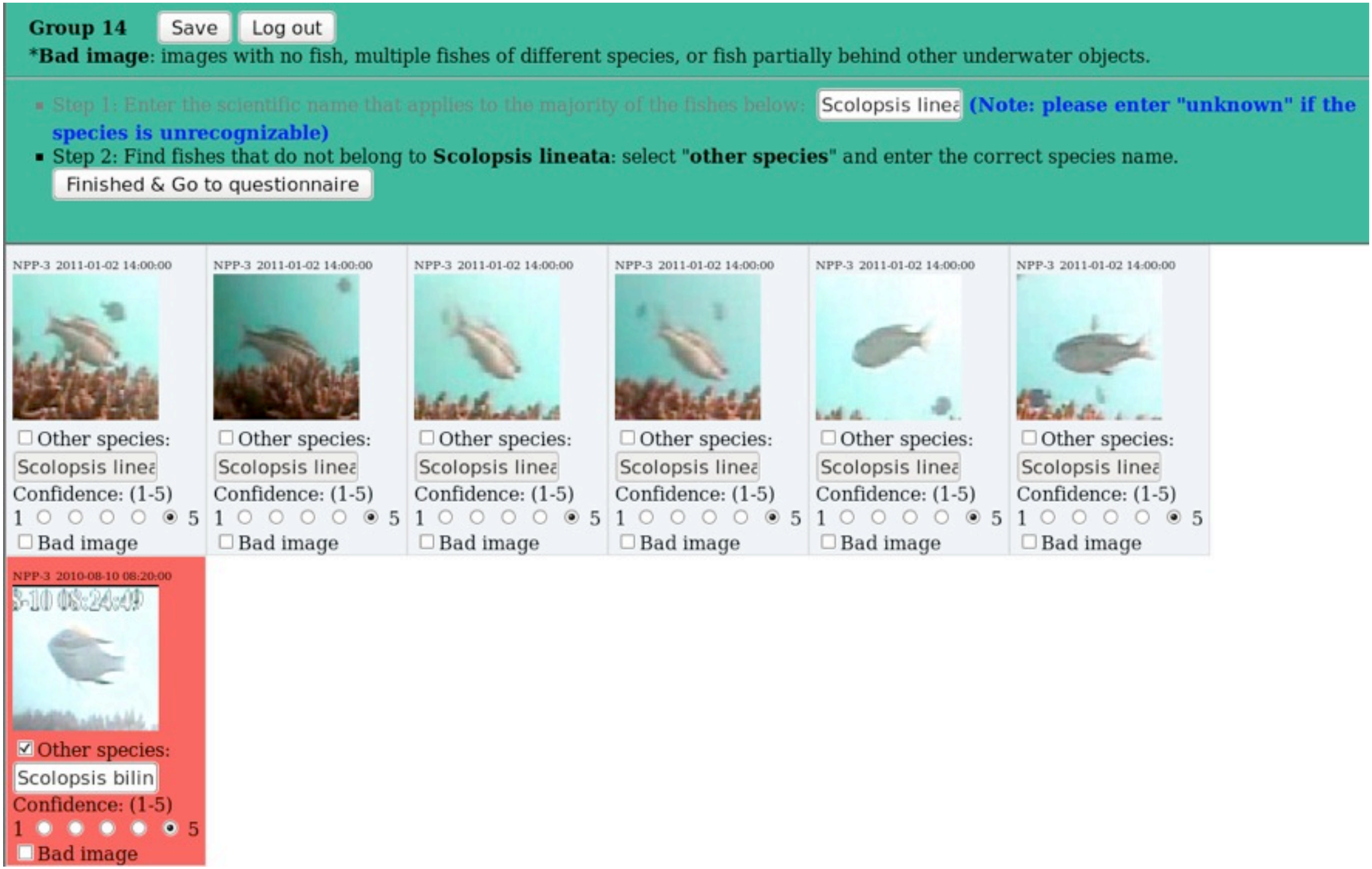
Using non-experts' effort to support expert annotation

- Cluster-based labeling
  - clusters constructed by non-experts
  - instead of labeling every image, experts label the clusters
  - correct the labels of individual images that are wrongly placed in a cluster
  - worst case: labeling every image

Interface (1)


Group 14
Save
Log out
*Bad image: images with no fish, multiple fishes of different species, or fish partially behind other underwater objects.
Step 1: Enter the scientific name that applies to the majority of the fishes below: Scolopsis linea (Note: please enter "unknown" if the species is unrecognizable)
Step 2: Find fishes that do not belong to Scolopsis lineata: select "other species" and enter the correct species name.
Finished & Go to questionnaire
NPP-3 2011-01-02 14:00:00
Other species:
Scolopsis linea
Confidence: (1-5)
1 5
Bad image
NPP-3 2010-08-10 08:20:00
Other species:
Scolopsis bilin
Confidence: (1-5)
1 5
Bad image

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Interface (2)

- A questionnaire after labeling each cluster
  - How difficult was it to recognize the fish (1-5 scale)
  - What makes the recognition difficult?
  - What helps recognition?
  - Are the “other species” related to the main species in the taxonomy tree?
  - What are the most discriminative features of the main species in the cluster?

Expert annotated data

- 3 marine biologists with over 10-25 years' research experience in Taiwan sea area.
- 27 manually constructed clusters
  - For each cluster, at most 30 images are randomly sampled to be shown to the biologists

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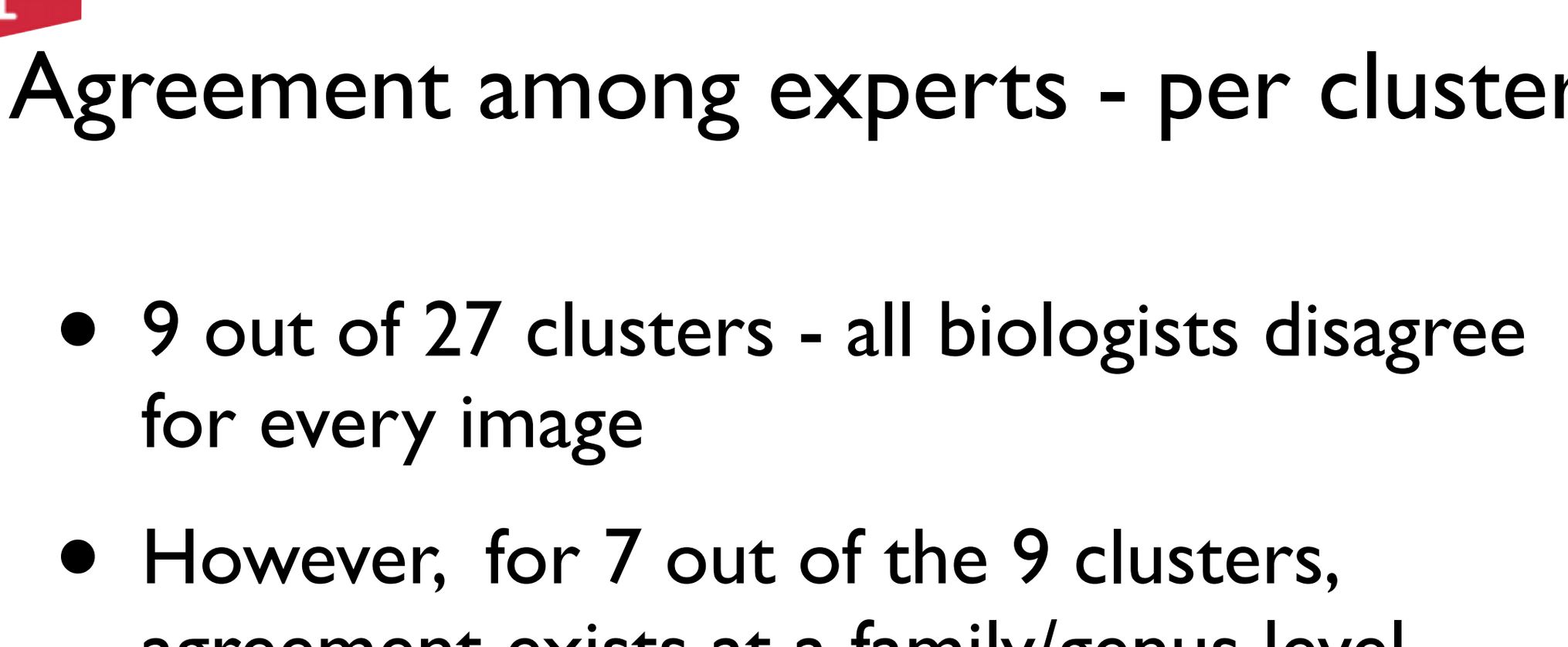
Agreement among experts - image level

- 82.6% images - at least 2 biologists agree on a name
- 56.3% images - 3 biologists agree on a name
- Note: sizes of clusters are not evenly distributed

Agreement among experts - per cluster

- 9 out of 27 clusters - all biologists disagree for every image
- However, for 7 out of the 9 clusters, agreement exists at a family/genus level



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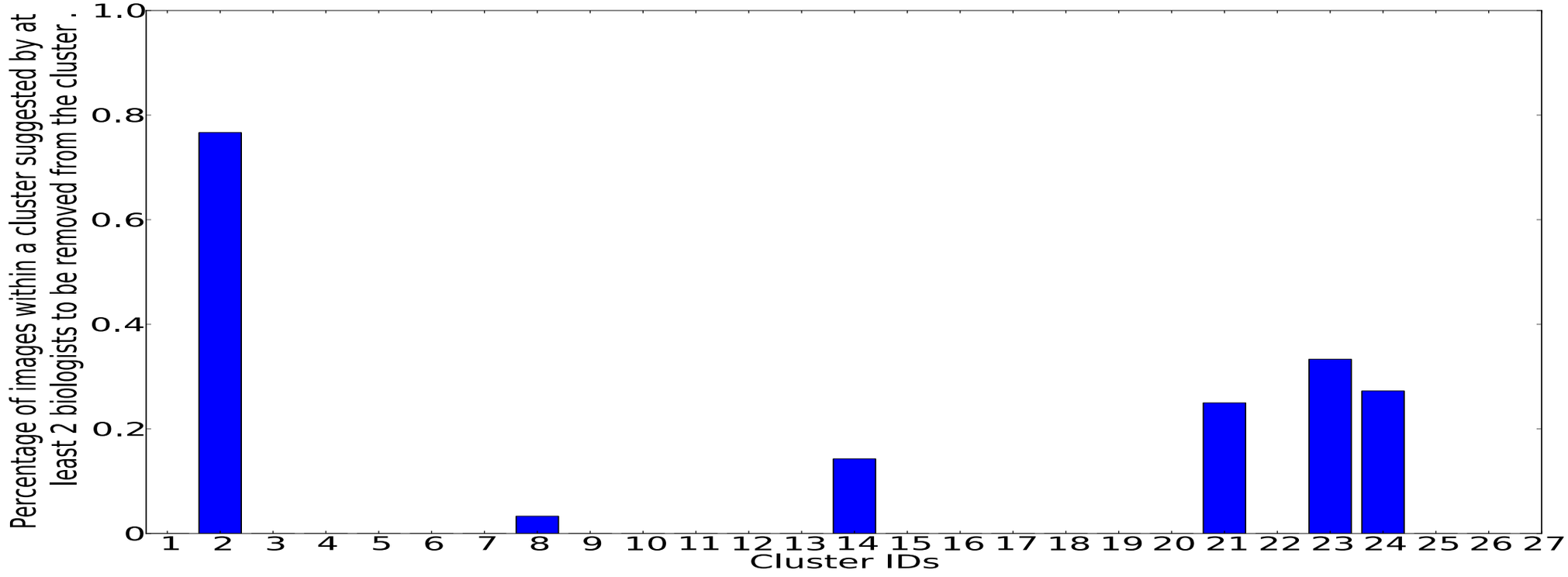
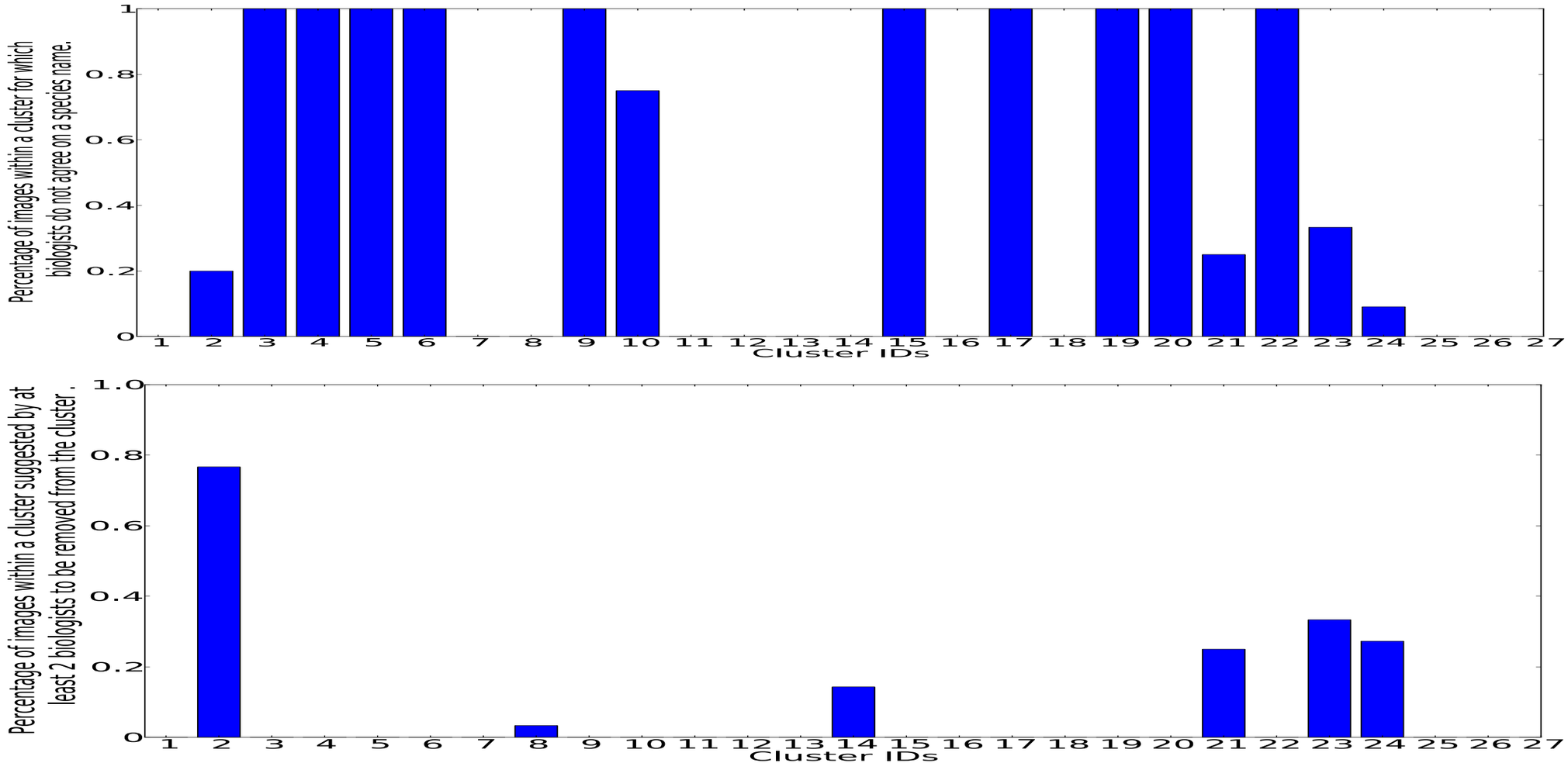
Performance of non-expert manual clustering

- 6 out of 27 clusters contain "other species"



Experts vs. non-experts

- Difficult for experts ! = difficult for non-expert
- Clustering != Recognition



Questionnaire

- What makes recognition difficult?
  - 21/27 cases: low resolution
  - 17/27 cases: there exist very similar species

- What helps recognition?
  - 24/27 cases: features of the fish
  - 17/27 cases: experience
  - 5/27 cases: location
  - 3/27 cases: better resolution

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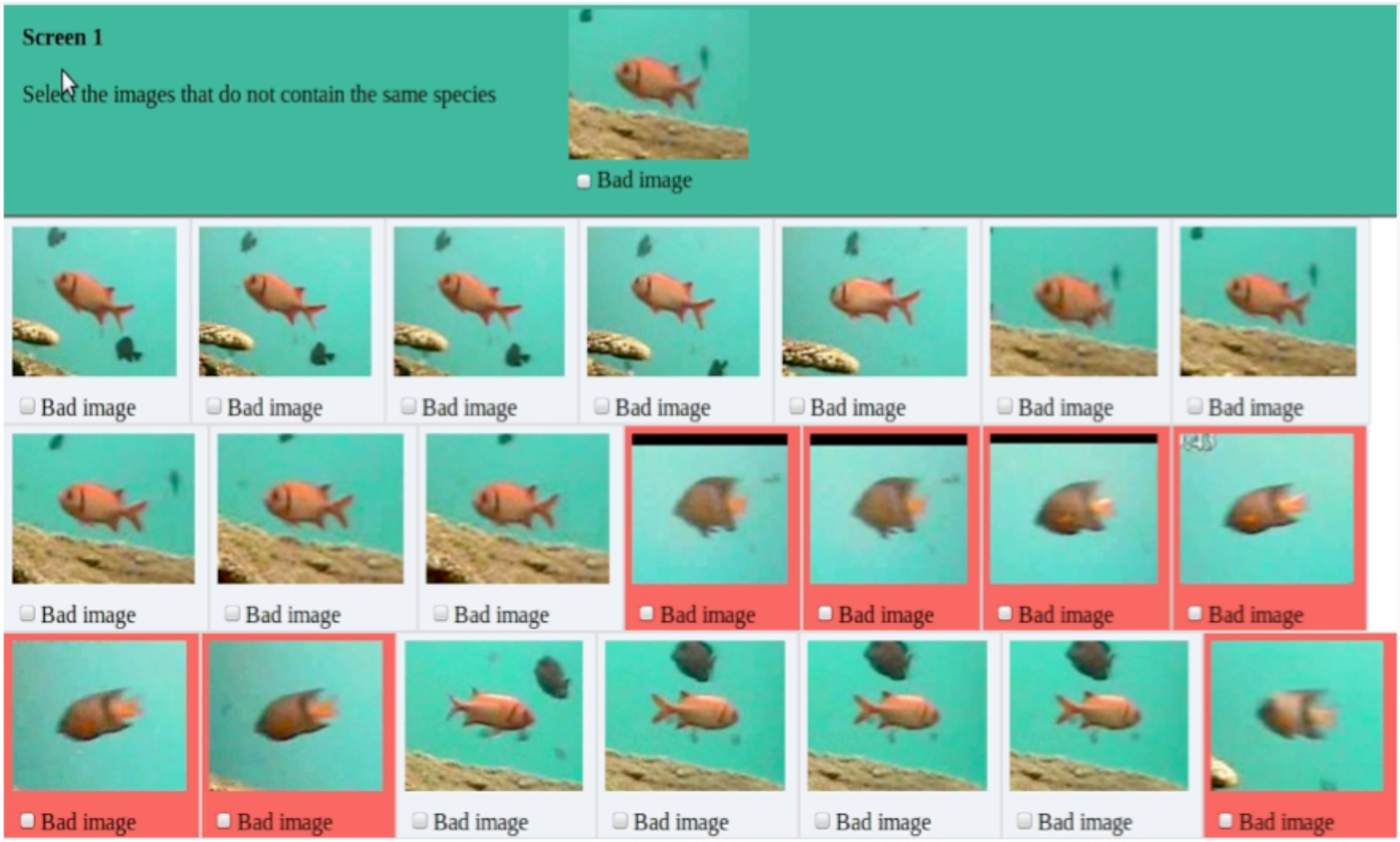
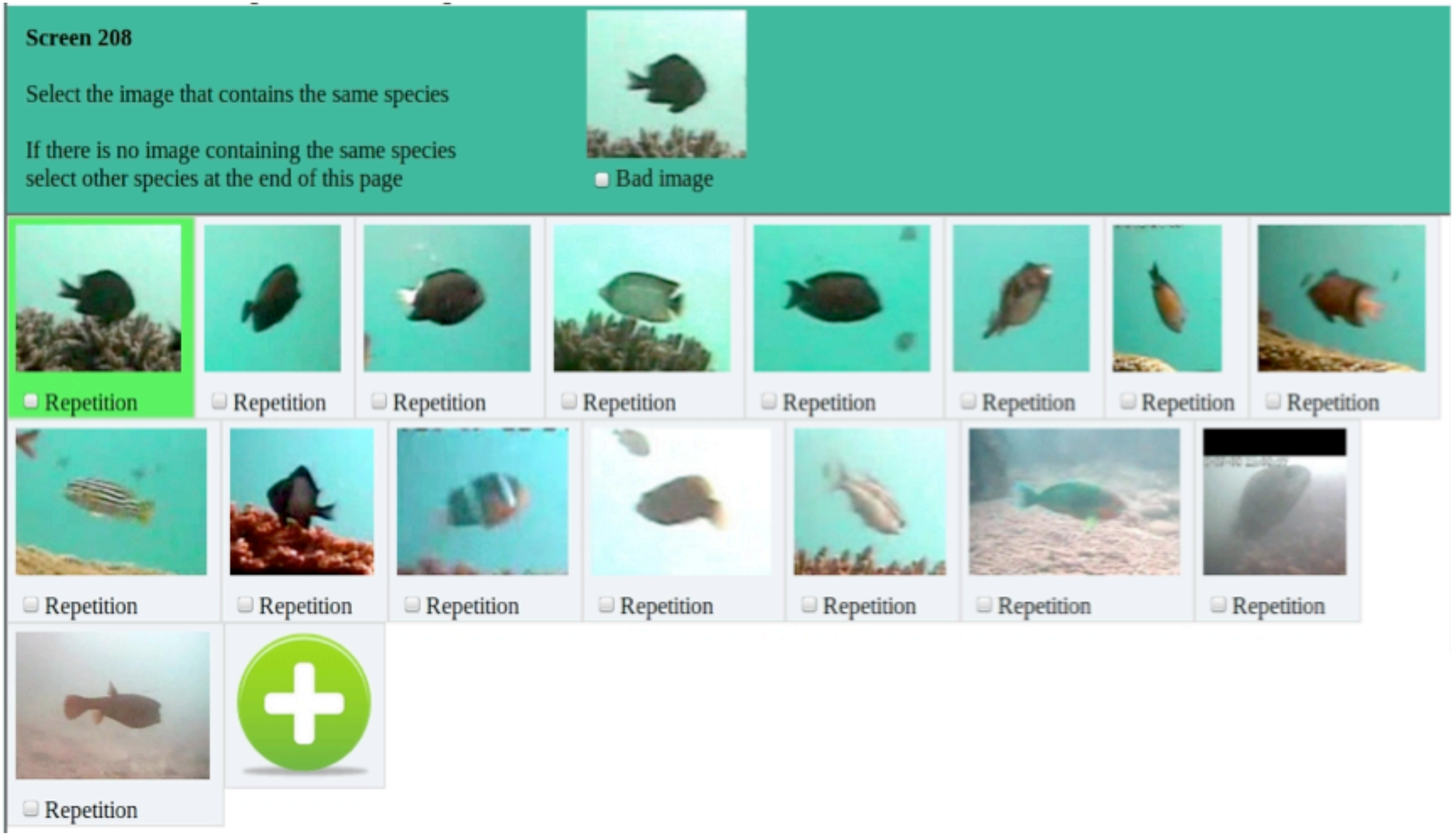
Lessons learnt

- Cluster-based labeling approach enables experts to label a relatively large amount of images with a limited amount of effort
- Non-experts are able to measure the visual similarity between fish images, thus clustering or classification with visual labels are possible
- Gap exists between clustering and recognition - nontrivial even for experts

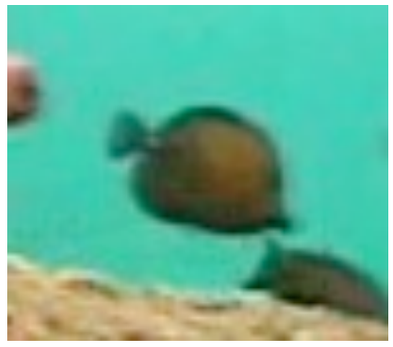
Using automatic method to support non-expert annotation: cluster-validation (1)

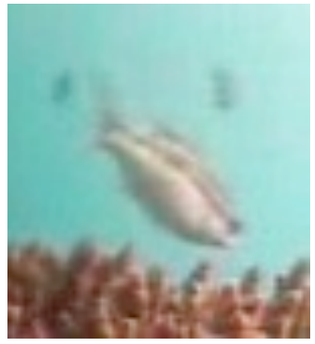


Using automatic method to support non-expert annotation: cluster-validation (2)



How many different species are there?





How many different species are there?

Dascyllus reticulatus

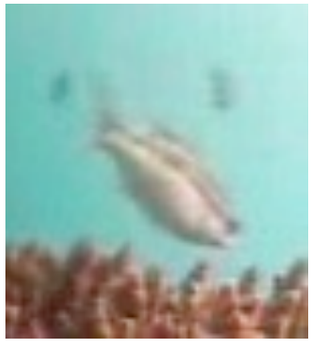
Acanthurus sp.

Zebrasoma scopas

Acanthurus sp.

Scolopsis bilineata

Scolopsis lineata



Scolopsis lineata

Further steps

- Bridging gap between clustering and recognition
  - Linking clusters to species names
    - Using crowd votes to refine the annotations of images that are visually similar
- Online learning to combine the effort of automatic methods, crowd and experts