Aggregating Crowdsourced Image Segmentations

Doris Jung-Lin Lee[1], Akash Das Sarma[2], Aditya Parameswaran[1]
[1] University of Illinois, [2] Facebook Inc.

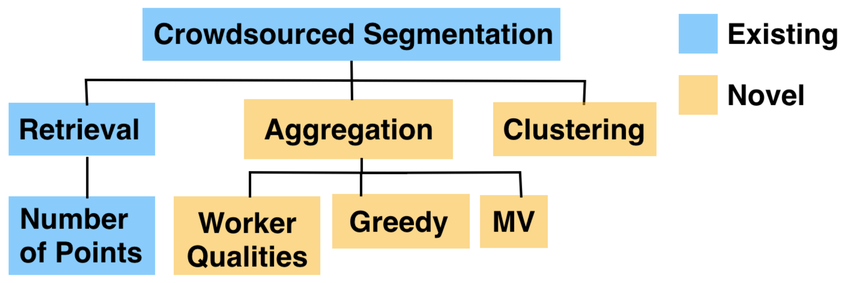
Research Overview

- Characterization of common worker errors in crowdsourced segmentation
- Clustering preprocessing algorithm for capturing workers with different semantic perspectives, result in performance improvement
- Develop novel class of aggregation-based algorithms which attain higher accuracies than existing retrieval-based approaches, while scaling better with increasing numbers of worker segmentations.

Problem Description

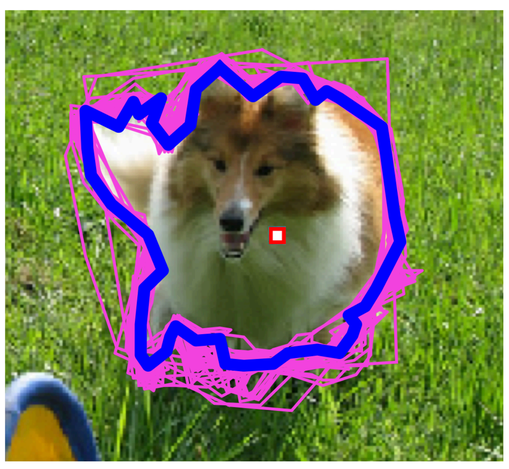
- Precise segmentations around a semantic object
- Applications: robotics, image organization, biology
- Worker responses often noisy → quality evaluation
- Retrieval-based: pick "best" based on heuristics
- Aggregation-based: combine multiple segmentations

Taxonomy of quality evaluation algorithms

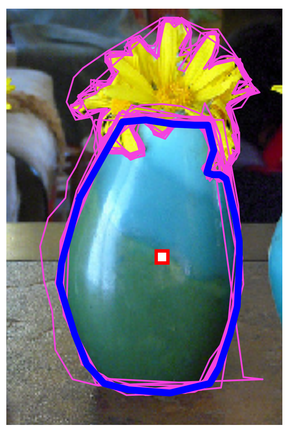


Dataset Description & Error Analysis

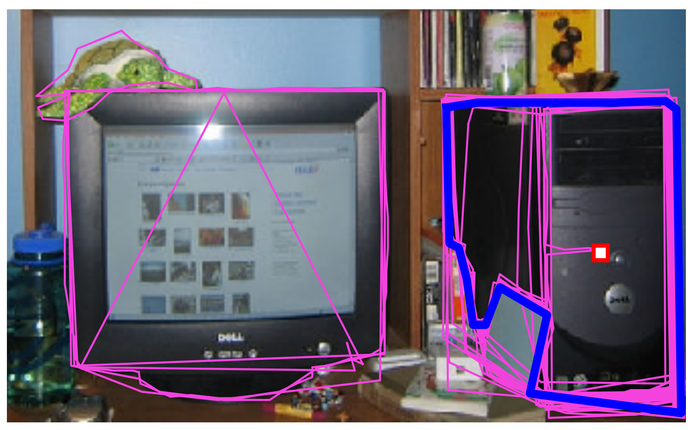
Boundary Imprecision [dog]



Semantic Ambiguity [vase]



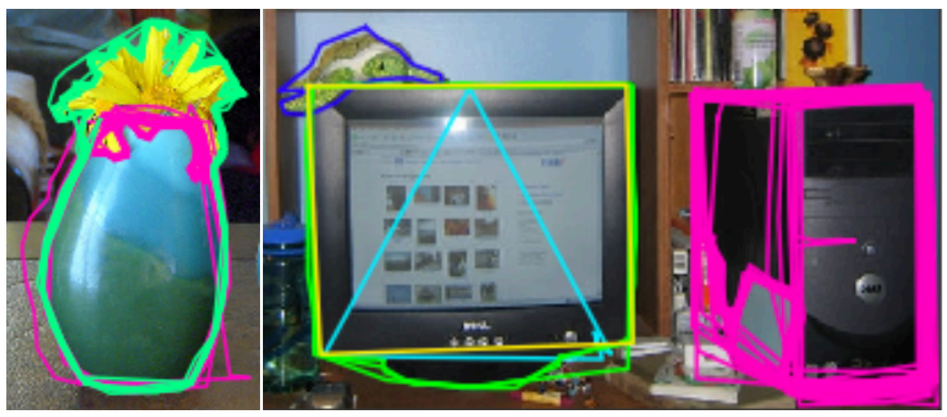
Semantic Error [computer]



- 46 objects in 9 images from the MSCOCO, total 1840 segmentations
- Semantic ambiguity and errors: wrong subject or portions of objects segmented
- Prior work on quality evaluation focusses on addressing bounding imprecision.

Perspective Resolution

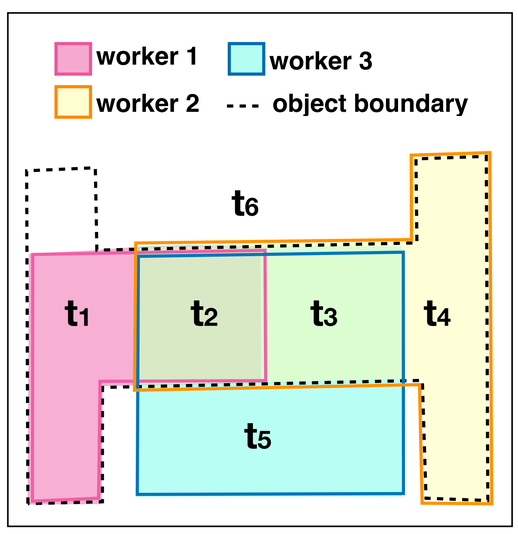
- Resolving differing semantic perspectives
- Spectral clustering on pairwise Jaccard matrix
- Preprocess by retaining largest cluster
- Improves Jaccard score of algorithms up to 5.92%

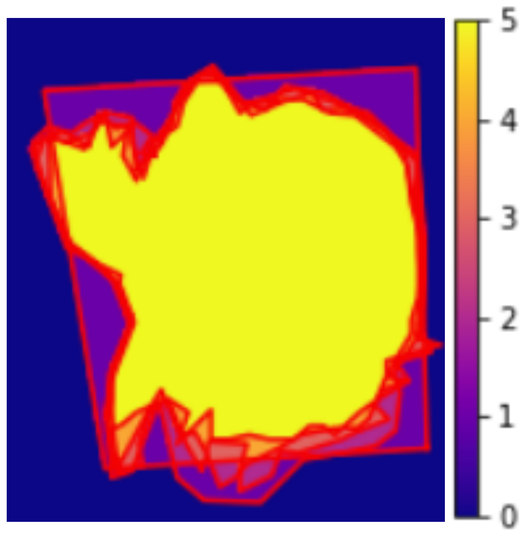


Fixing Boundary Imperfections

Tile Data Representation

- Tiles: non-overlapping unit of worker segmentations overlaid on each other
- Inference on tiles → aggregation across multiple worker segmentations
- Worker segmentation → "boolean votes" on tiles





Algorithms

- **Majority vote:** include tile if picked by > 50% workers
- **Expectation Maximization:** infer likelihood that a tile is part of the ground truth segmentation, while simultaneously estimating hidden worker qualities
- **Greedy Tile Picking:** pick tiles in descending order of tiles' estimated ratios of overlap area with the ground truth

Experimental Results

- Number of control points as retrieval baseline
- Variants that makes use of ground truth information estimates the upper bound achievable by each algorithm
- Aggregation-based algorithms guarantees performance scaling as as number of workers in sample increases.

Conclusion & Future Work

Contribution:
Semantic perspective resolution through clustering and novel tile-based aggregation algorithms

Future Work:

- Worker qualities good indicators of actual segmentation accuracy, future work on improving inference algorithms
- Incorporating vision signals in tile-based inference