Beyond Active Noun Tagging

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Problem: Active Learning for Scene Understanding Tasks





Image Entropy





Introduce new ways of collecting knowledge which go beyond labeling regions

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Linguistic Questions

> Use high confidence detections as anchors to ask questions about the unknown objects in a scene

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Introduce new ways of collecting knowledge which go beyond labeling regions

Contextual Questions

Importance of relationships



Introduce new ways of collecting knowledge which go beyond labeling regions

Contextual Questions

Importance of relationships

- Learn general contextual relationships
- directly from the annotator



Introduction

Scene Understanding

- \succ Learn O(n) appearance models
- \succ Learn $O(n^2)$ relationship models



Heavy Tailed Distribution

- The large majority of classes occur rarely
- Holds for relationships too



Randomly annotating training data is extremely inefficient

Active Learning



Active Learning



Active Learning

Binary Classification Problems

SVMs, Tong & Koller, 2001





Active Learning : Multi-Class

Binary Classification Problems → SVMs, Tong & Koller, 2001

Multi-Class Classification Problems

Jain & Kapoor, 2009

Caltech 101/256



Active Learning : Scene Understanding

Binary Classification Problems → SVMs, Tong & Koller, 2001

Multi-Class Classification Problems

Jain & Kapoor, 2009

Active Learning for Scene Understanding



Uncertainty Based Approaches



Uncertainty Based Approaches























Entropy over all possible label assignments

Second order approximation

Sum of the joint entropies of all pairs of regions



Active Learning Framework

Training Data



Active Learning Framework

Training Data



Types of Questions



Region Labeling Questions



Linguistic Questions

What is the relationship

between boat and water?

Contextual Questions

Types of Questions





Region Labeling Questions

What is the relationship between boat and water?

Appearance Model



Appearance Model









Importance of a Question



Initial Image Entropy



Final expected Image Entropy given labeling

Types of Questions





Linguistic Questions

What is the relationship between boat and water?

Appearance Model



Contextual Model



Appearance Model





Contextual Model





Appearance Model





What is above the water?





Appearance Model


Linguistic Questions

Appearance Model



Linguistic Questions



Linguistic Questions: Expected Entropy Reduction



What is **below** the **sky**?

Linguistic Questions: Expected Entropy Reduction



What is **below** the **sky**?



Linguistic Questions: Expected Entropy Reduction



What is **below** the **sky**?



Entropy Reduction

Expected Image Entropy given a weak labeling \mathcal{C}_q of the relevant regions

Types of Questions





What is the relationship between boat and water?

Contextual Questions

Contextual Questions

Appearance Model



Contextual Model



Contextual Questions

Appearance Model



Contextual Model



What is the relationship between boat and water?



Contextual Questions

Appearance Model



Appearance Model

Contextual Questions: Expected Entropy Reduction





Correct Relationship Prior

- > Constrains the image labeling problem
- Results in a large entropy reduction

Sample object pairs based on their co-occurrence

Experiments

MSRC Dataset

- > 532 images (276 training, 256 test)
- > 21 categories and multi-label images

Ground Truth Segmentations





















Region Labeling Questions

Our Approach (Image Entropy)





Region Labeling Questions



Our Approach (Image Entropy)



Region Labeling Questions



Our Approach (Image Entropy)



Region Labeling Questions

Our Approach (Image Entropy)





Linguistic Questions



What is above the ground?

What is above the grass?

What is more blue than the ground?

Contextual Questions

building-tree
cow-grass
tree-ground
sky-building
sky-tree
grass-building
sky-grass
tree-grass
boat-water

Experiments

MSRC Dataset

- 532 images (276 training, 256 test)
- 21 categories and multi-label images

Automatic Segmentations











Experiments: Stanford Dataset

Stanford Dataset

- 715 images (415 training, 300 test)
- Annotated using Amazon Mechanical Turk
- 8 categories and multi-label images



Results: Stanford Dataset



Results: Stanford Dataset



Results: Stanford Dataset



Summary

Active learning method for learning contextual object recognition models

Image Entropy

Linguistic Questions

Contextual Questions





Questions?









Please visit our poster located at B4