CAREER: Generalized Image Understanding with Probabilistic Ontologies and Dynamic Adaptive Graph Hierarchies

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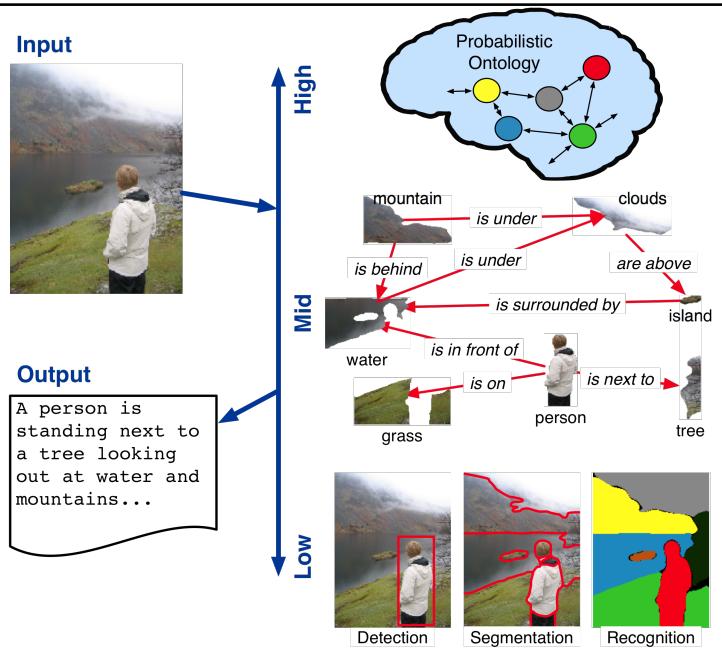

Motivation:

- Relates to Robust Intelligence because we attempt to understand and make complex inferences from natural images.
- Research is motivated by the need for a better understanding between low-, mid-, and high-level computer vision.
- Critical gap to be addressed is the signal-symbol gap.
- Vertically advances the field by defining a unified mathematical machinery—adaptive graph hierarchies—to help bridge said gap.
- Transformative because it directly incorporates probabilistic ontologies in a principled manner during visual inference.

Objective:

To advance the understanding of the relationship between low-level pixels and features, mid-level latent structure, and high-level semantic models (probabilistic ontologies) to automatically infer a comprehensive yet parsimonious description of an image.

Technical Approach:

We propose a unified methodology that incorporates low-, mid-, and high-level information into a coherent probabilistic model coupled with an algorithm that dynamically manipulates the hierarchy during inference. Our research builds upon our past contributions in adaptive graph hierarchies, probabilistic models on hierarchies, and dynamic graph-shifts inference.

Outreach and Broader Impacts Plan:

- Undergraduates will play a primary role in building a new benchmark dataset for image understanding.
- Ontologies of the visual world are of broad interdisciplinary interest for general visual perception.
- Research and Education are integrated in both curriculum development and a web-forum for the problem.

Prior Results, Deliverables:

- Result: Our graph-shifts algorithm performs energy minimization by dynamically manipulating the image graph hierarchy.
- Deliverable: Ontology of the visual world.
- Deliverable: Benchmark dataset with textual description of images.
- Deliverable: Software for inference in graph-hierarchies.

Schedule:

We expect advances in adaptive graph hierarchy methods in the 1st year, the dataset to be available in the 2nd year, advances for incorporating high-level semantic models / ontologies into statistical modeling and inference in the 3rd and 4th years, and the full inference engine on a sub-class of natural images in the 5th year.

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