H4.2: Human Annotation for Natural Language Understanding

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Objective:

Enable robots to formulate rich models of space from user-provided natural language descriptions

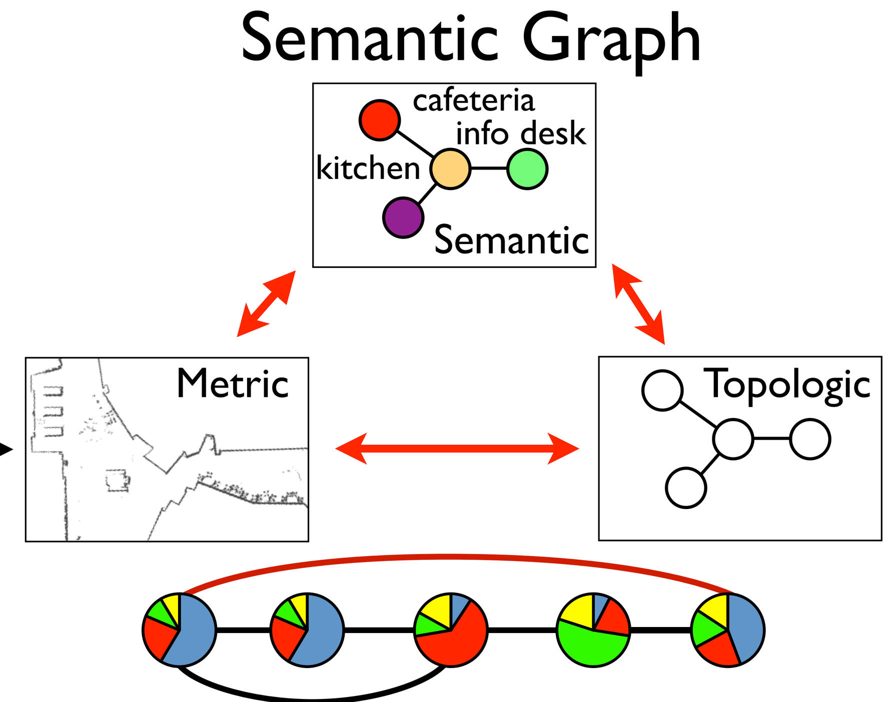
Benefit:

Efficiently learn spatial, topological, and semantic properties of the environment, without a priori knowledge or a domain expert

Impact:

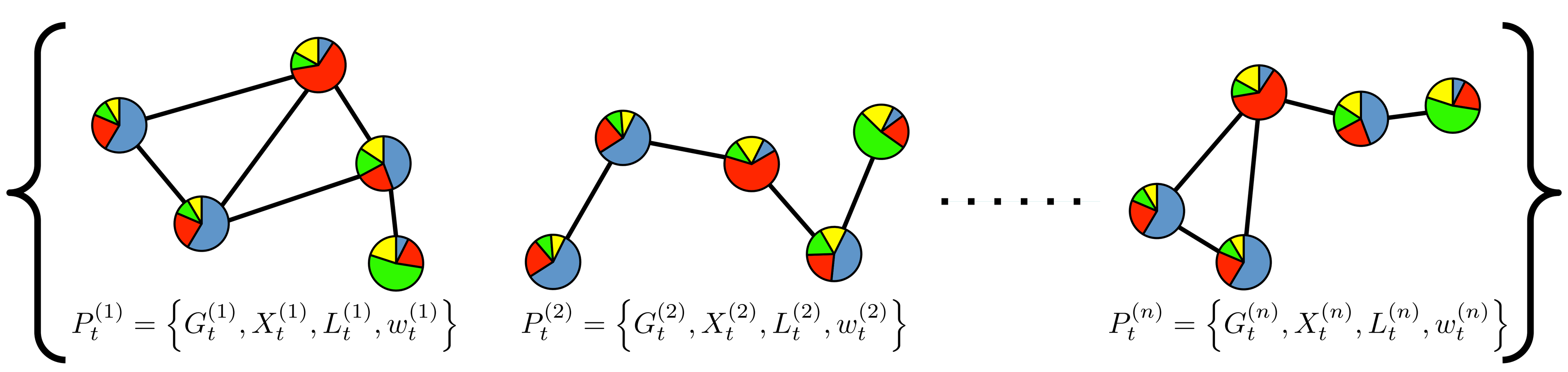
Estimate world models that are more accurate than the previous state-of-the-art by exploiting human-conveyed knowledge

Approach:



topology, sensors, language, poses, labels

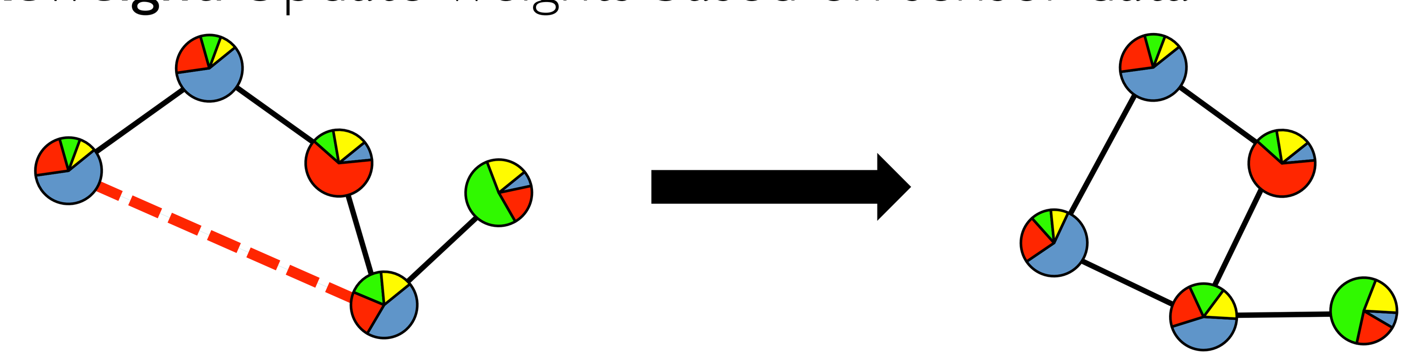
$$p(G_t, X_t, L_t | s^t, \lambda^t) = \underbrace{p(L_t | X_t, G_t, s^t, \lambda^t)}_{\text{Dirichlet}} \times \underbrace{p(X_t | G_t, s^t, \lambda^t)}_{\text{Gaussian}} \times \underbrace{p(G_t | s^t, \lambda^t)}_{\text{Particles}}$$



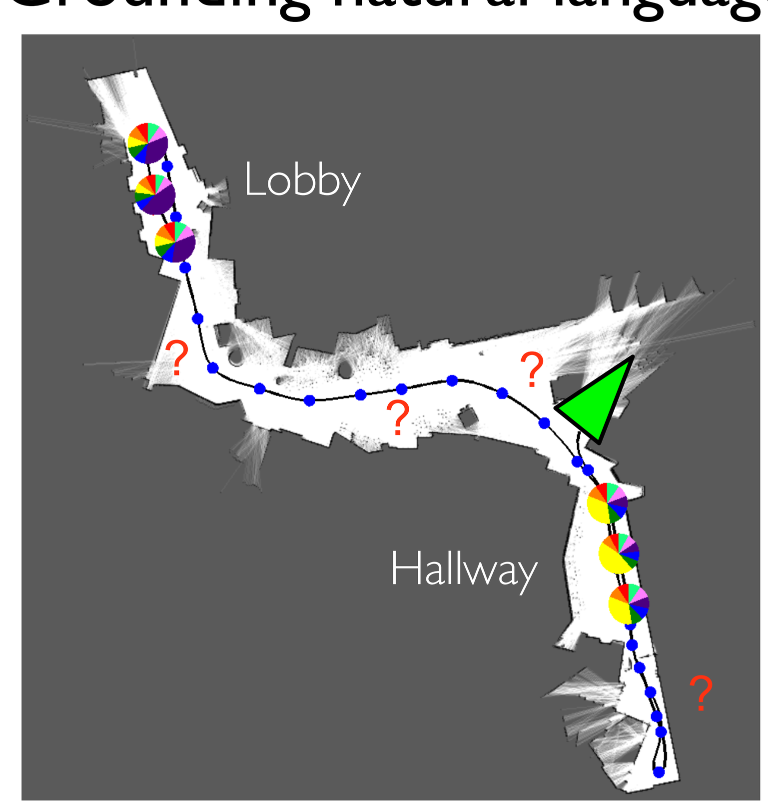
Rao-blackwellized particle filter

For each particle $P_{t-1}^{(i)}$

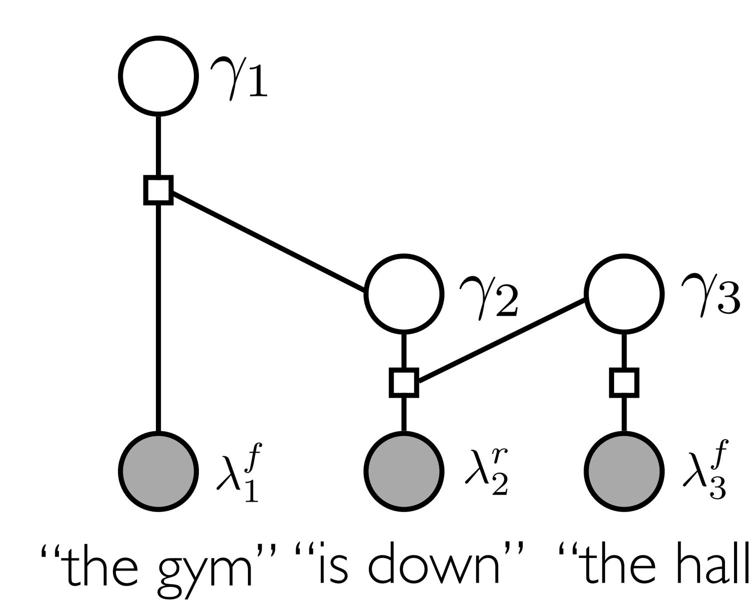
1. **Proposal**: Modify topology based on metric & semantic maps
2. **Update**: Perform Bayesian update of Gaussian
3. **Update**: Update Dirichlet over labels per language
4. **Reweight**: Update weights based on sensor data



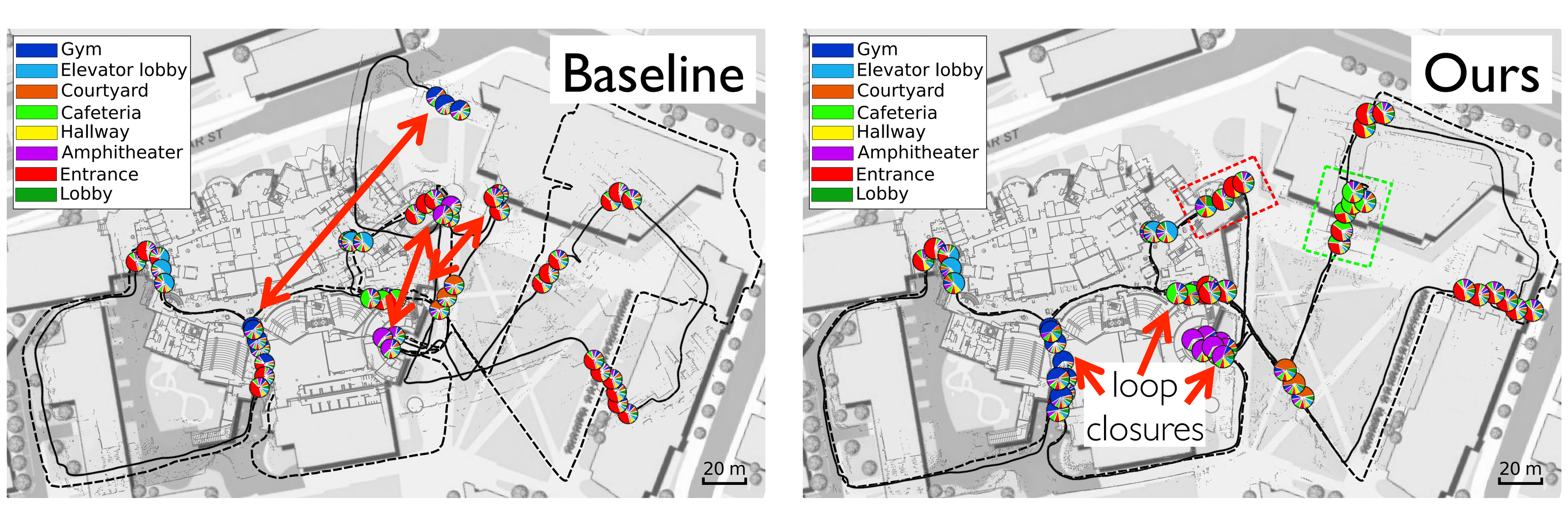
Grounding natural language descriptions

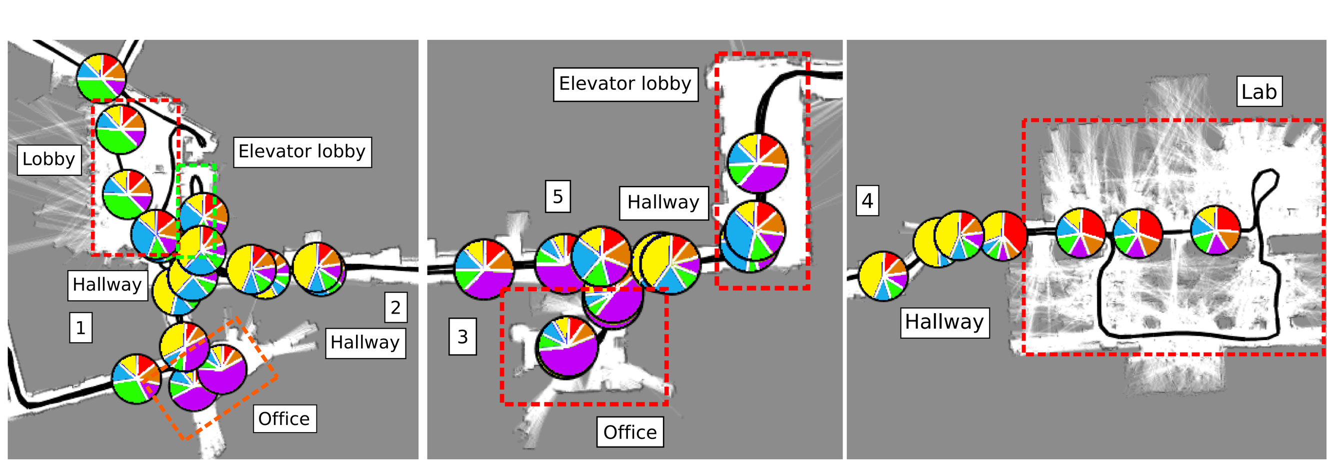


$$p(\phi_{v_i}^f = \mathtt{T}) = \sum_{v_j} p(\phi_{v_i}^f = \mathtt{T} | \phi_{v_j}^l = \mathtt{T})\, p(\phi_{v_j}^l = \mathtt{T})$$



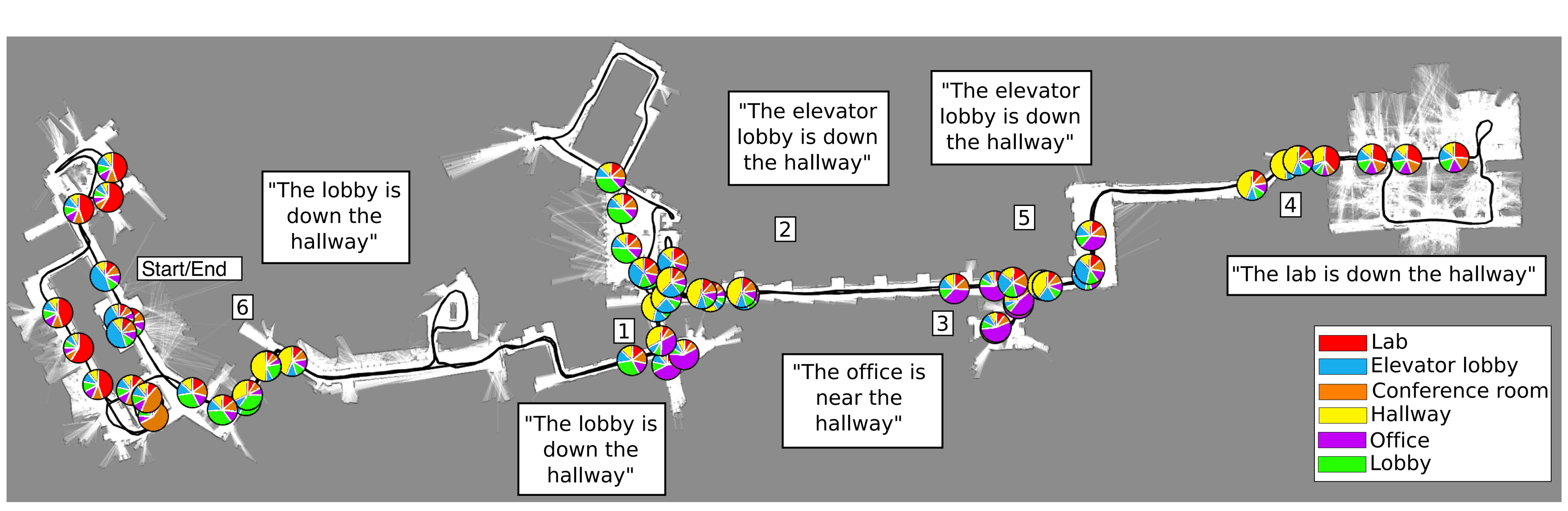
Results:



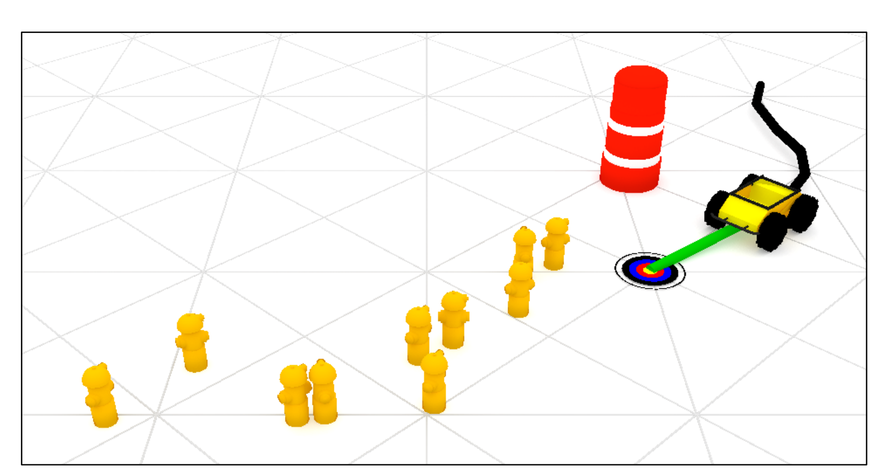


Navigation Cost

	Baseline	Ours
1	42m	24m
2	68m	36m
3	43m	26m

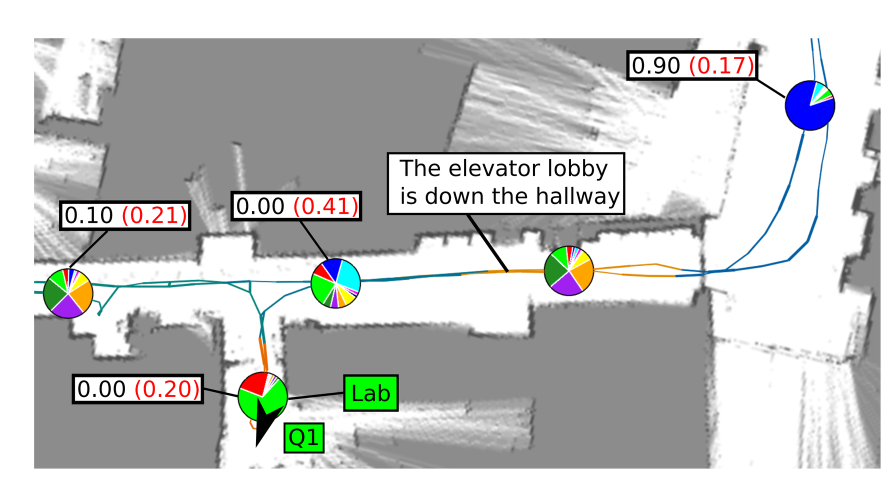


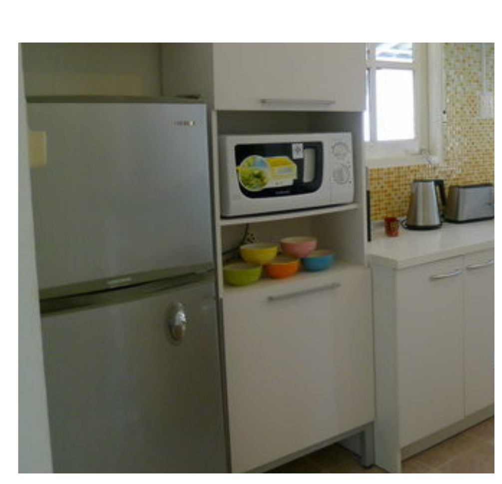
Future Work:



Natural language understanding without a world model: Joint inference over maps and behaviors

Exploratory grounding: Use dialogue with the user and exploration as information-gathering actions





Model and learn from additional semantic cues, including object co-occurrence and text

Linkages

Carnegie Melon University, University of Central Florida

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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Objective:

Benefit:

Scientific Foundation:

Impact:

Investigators:

Approach

Results

The Path Forward

Linkages: