NRI-FND: Human-robot Collaboration and Planning in Uncertain Environments
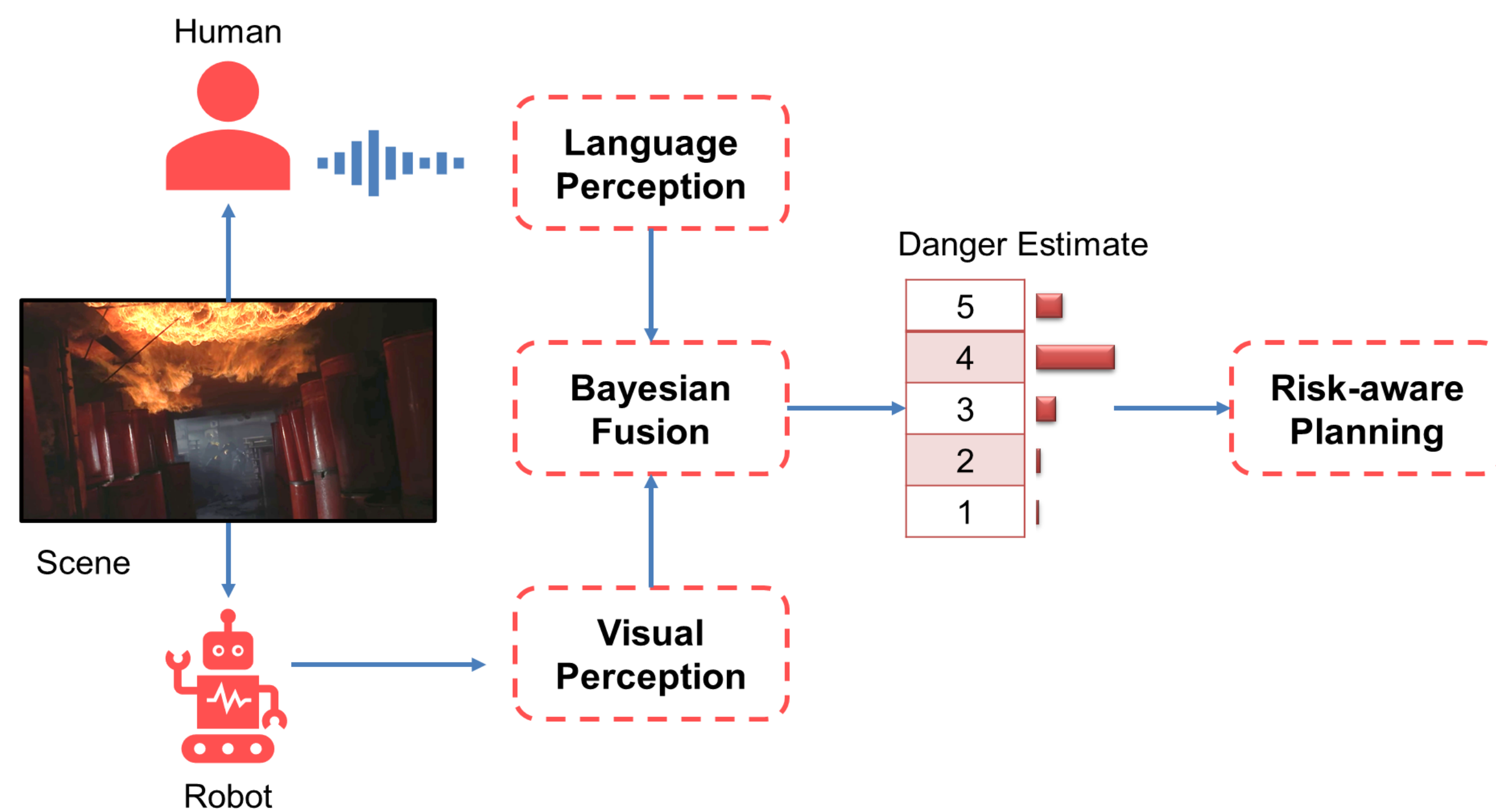
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Cornell University

Project goal: develop foundational theory and validated algorithms for fostering collaboration between human and robot during missions in complex environments that *evolve over space and time*

Key problems: human-robot information exchange, human-aware multiagent planning, and reasoning about uncertainty

Unified Scene Perception: Collaborate with human to assess scene danger and plan a risk-aware path to an exit.

- Fusion pipeline to combine image and NL-based scene danger estimate
- 20% improvement in success rate compared to shortest path planner

Uncertainty driven Planning: Reason about path hypotheses while accounting for uncertainty in occupancy grid maps

- Tested on Jackal robot with stereo camera
- Proposed method helps in avoiding dead-ends

1) Hypotheses and NBV Generation

2) Navigation to NBV and commitment to single hypothesis

3) Hypothesis following and replanning

The project is focused on search and rescue, but the proposed methodology will be more broadly applicable to various real-world environments.

The project currently funds two PhD students that are involved in education and outreach activities:
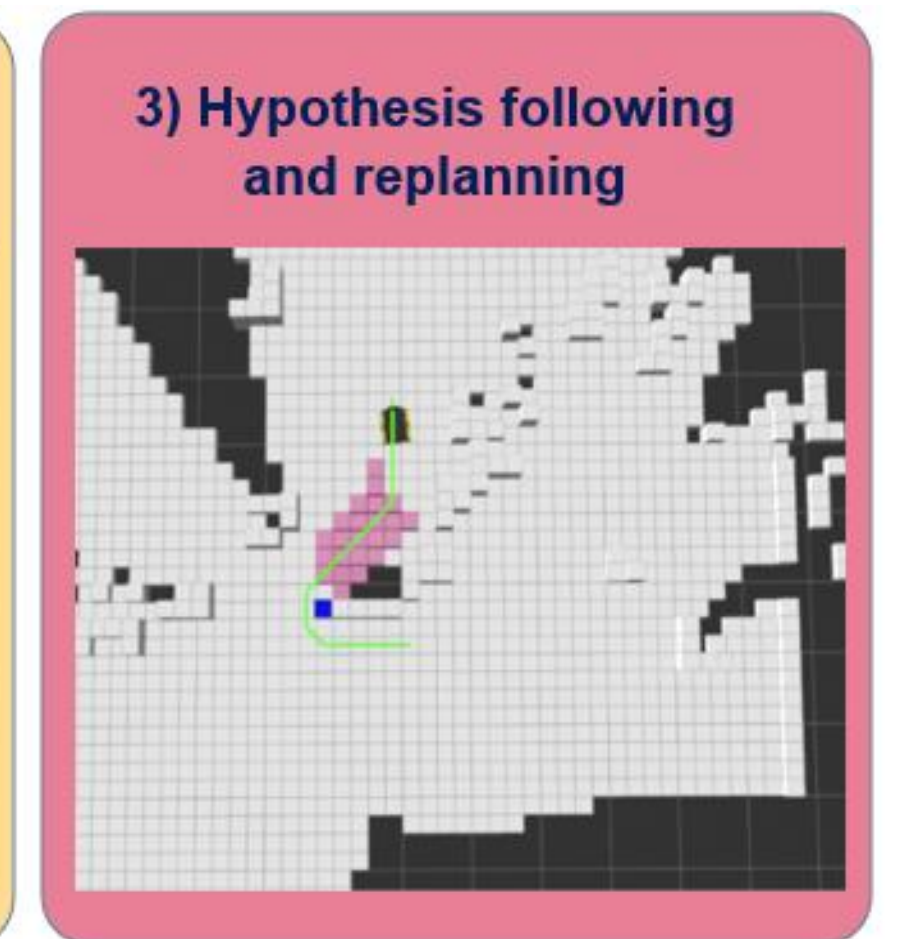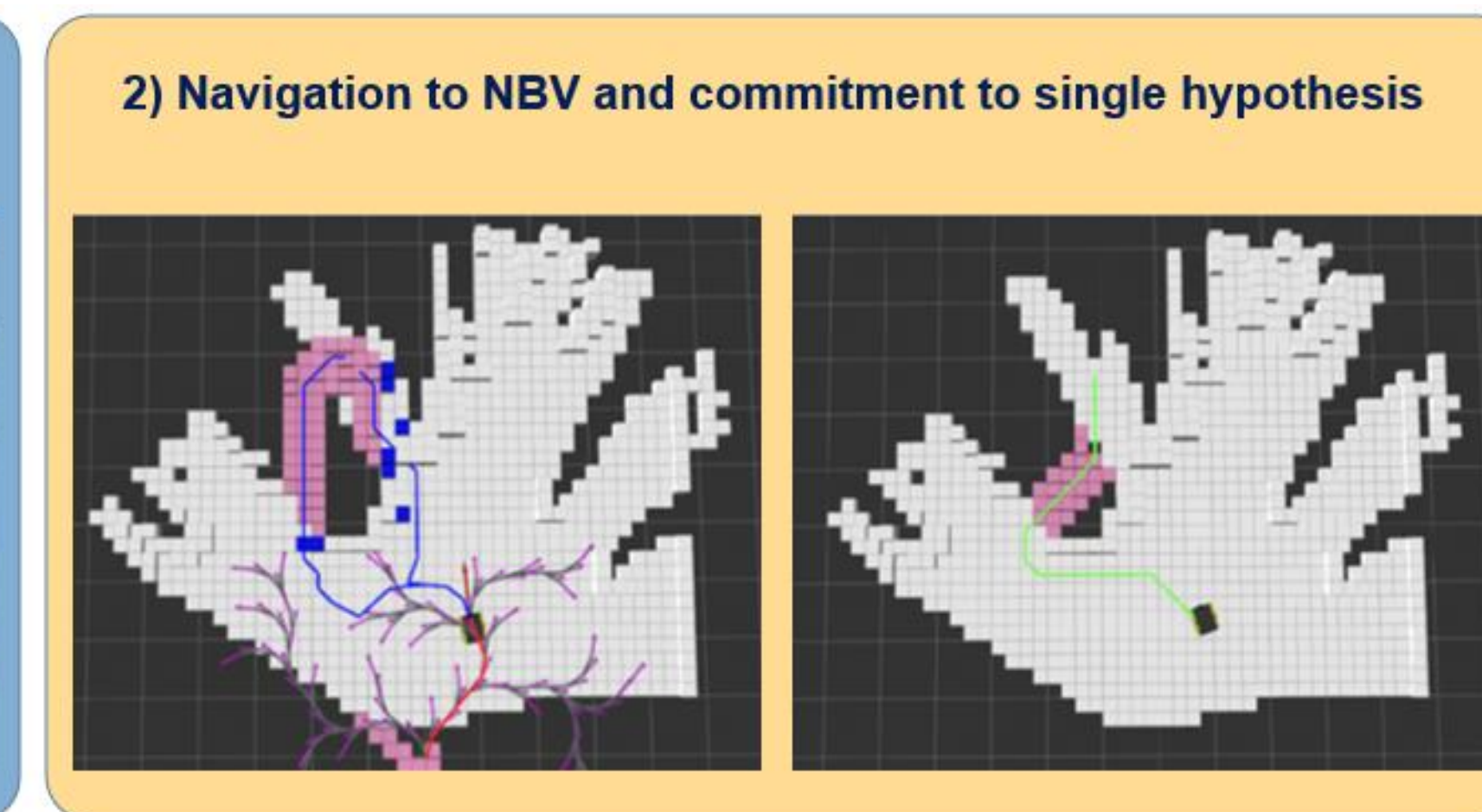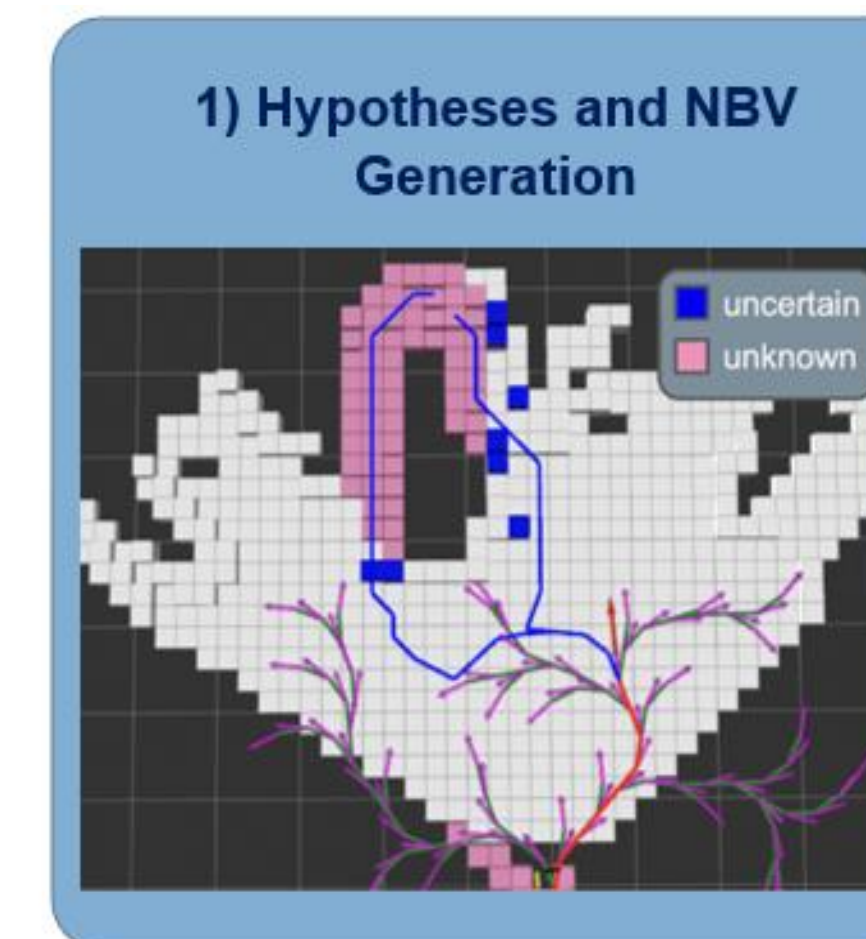

Duckietown project
www.duckietown.org

NYS 4-H Career Explorations Program

Publications:

- J Banfi*, L Woo*, and M Campbell. "Is It Worth to Reason about Uncertainty in Occupancy Grid Maps during Path Planning?", in **ICRA 2022**.
- V Shree, S Allen, BA Asfora, J Banfi, and M Campbell. "Multi-modal Perception for Cooperative Escape Planning in Hazardous Environments", under review in I**ROS 2022**.
- V Shree*, BA Asfora*, R Zheng, S Hong, J Banfi and M Campbell. "Exploiting Natural Language for Efficient Risk-Aware Multi-robot SaR Planning", **RA-L 2021**
- V Shree, WL Chao and M Campbell. "Interactive Natural Language-based Person Search," in **RA-L 2020**
- BA Asfora, J Banfi, and M Campbell, 2020. "Mixed-Integer Linear Programming Models for Multi-Robot Non-Adversarial Search", **RA-L 2020**