

CAREER: Enhancing the Robustness of Human-Robot Interactions via Automatic Scenario Generation

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Motivation

- Robots deployed in the real world encounter a wide variety of scenarios, many of which can be missed by a manual tester.
- Testing on a diverse set of environments is crucial in ensuring robustness and identifying failures before their deployment in the real world.
- Hence, we require an automatic method of generating scenarios that can elicit diverse agent behavior and effectively identify the strengths and weaknesses of the agent being tested.

Key insight

- Quality Diversity (QD) algorithms can generate diverse environments but require expensive system evaluations.
- Deep neural networks can make rapid predictions but need diverse data to be accurate.
- We replace system evaluation with surrogate model predictions and train a surrogate model online with system evaluations.

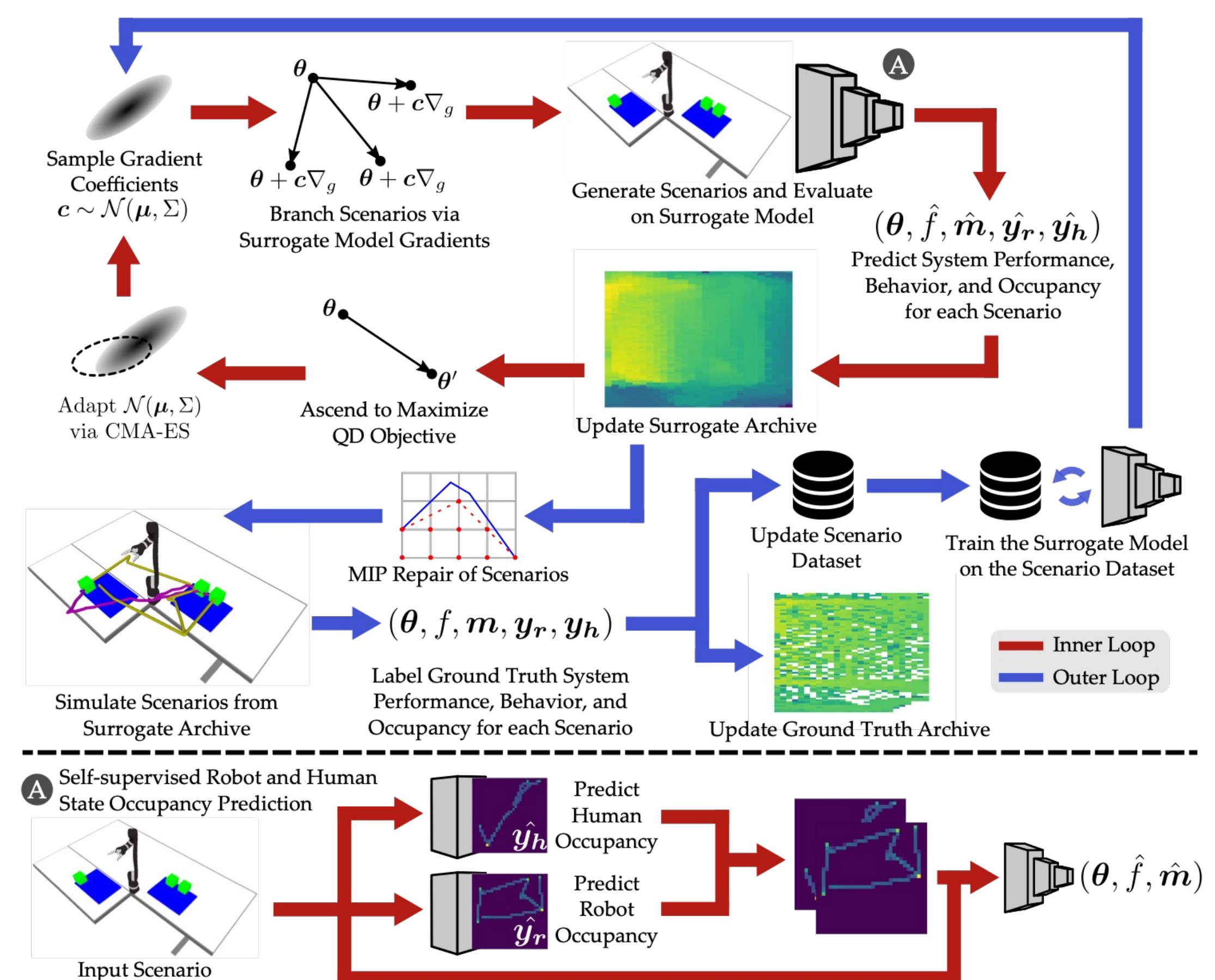
Method

Maintain a surrogate model of agent behavior:

- Given an environment and human agent parameters as inputs, e.g. in the form of an image of its layout, the model outputs the predicted human-robot interaction outcomes.
- We can additionally perform self-supervised prediction of the agent trajectory to improve prediction accuracy.

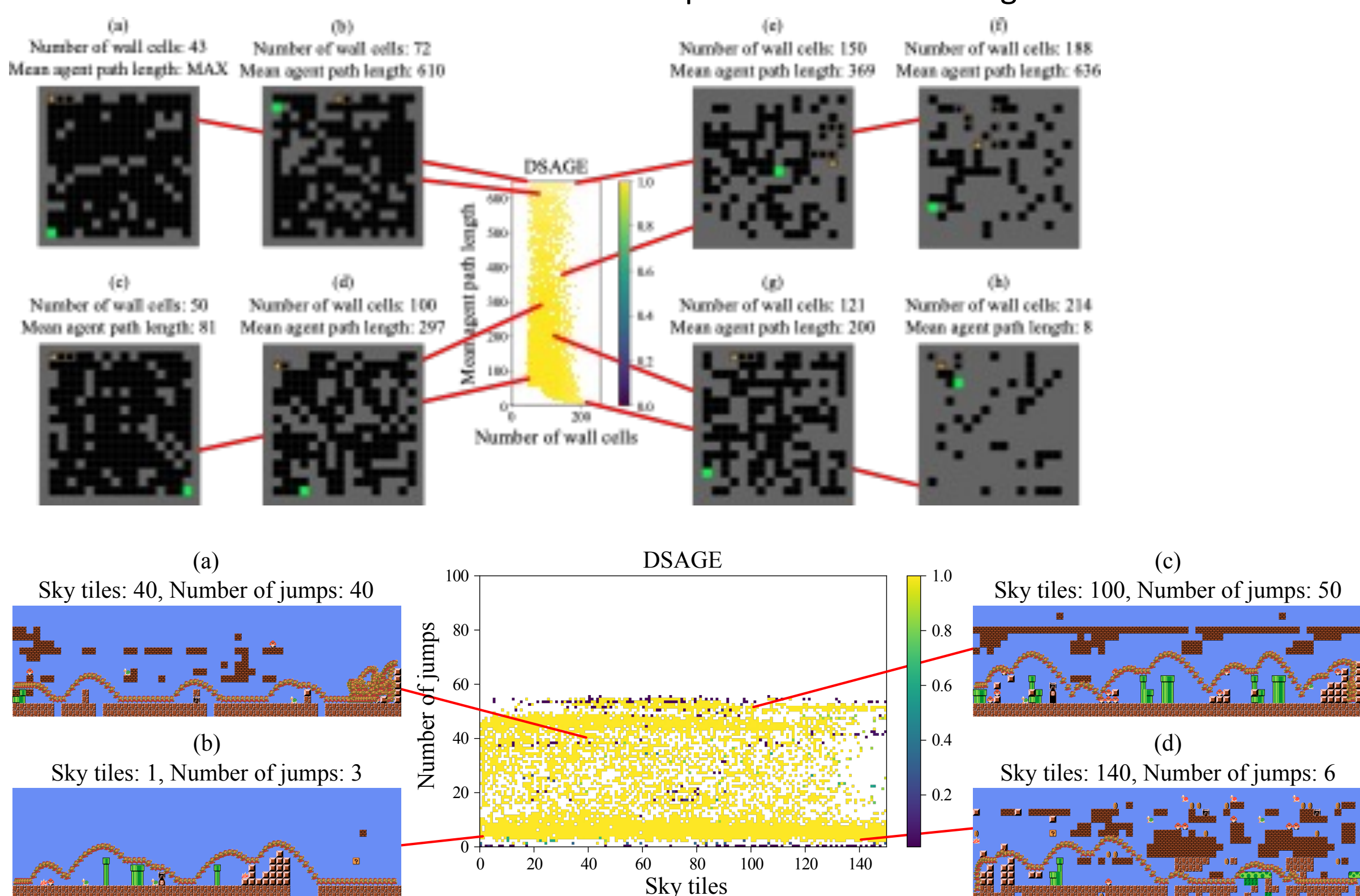
Generate scenarios in two phases:

- Inner Loop:** Generate a set of environments and human models rapidly with a QD (or a differentiable QD) optimization algorithm exploiting the surrogate model predictions.
- Outer Loop:** Select a subset of generated scenarios, evaluate them to create ground-truth data, and train the surrogate model on the updated dataset.



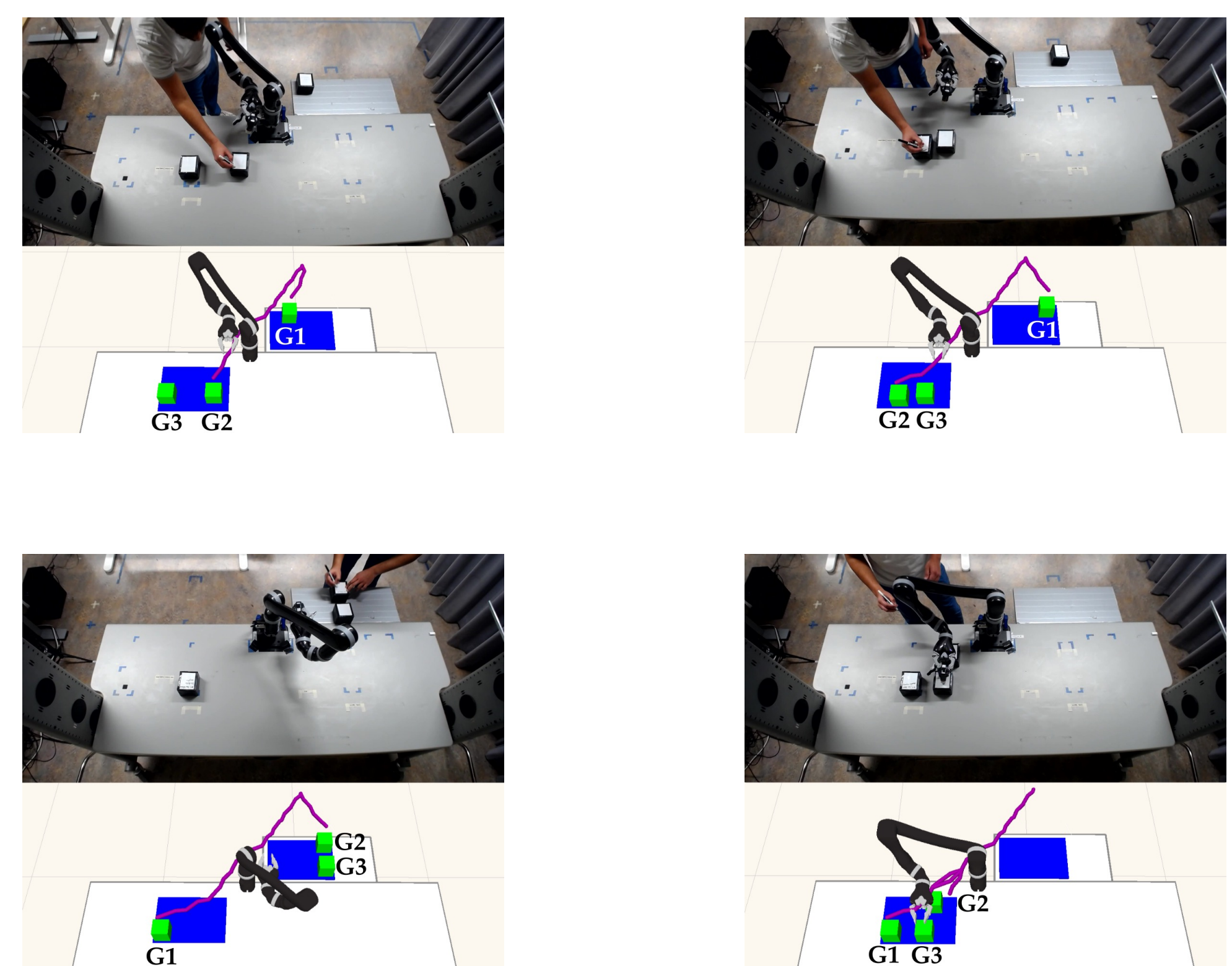
Results: Video Game Domains

Generates mazes and Mario levels that elicit specified behavior in agents.



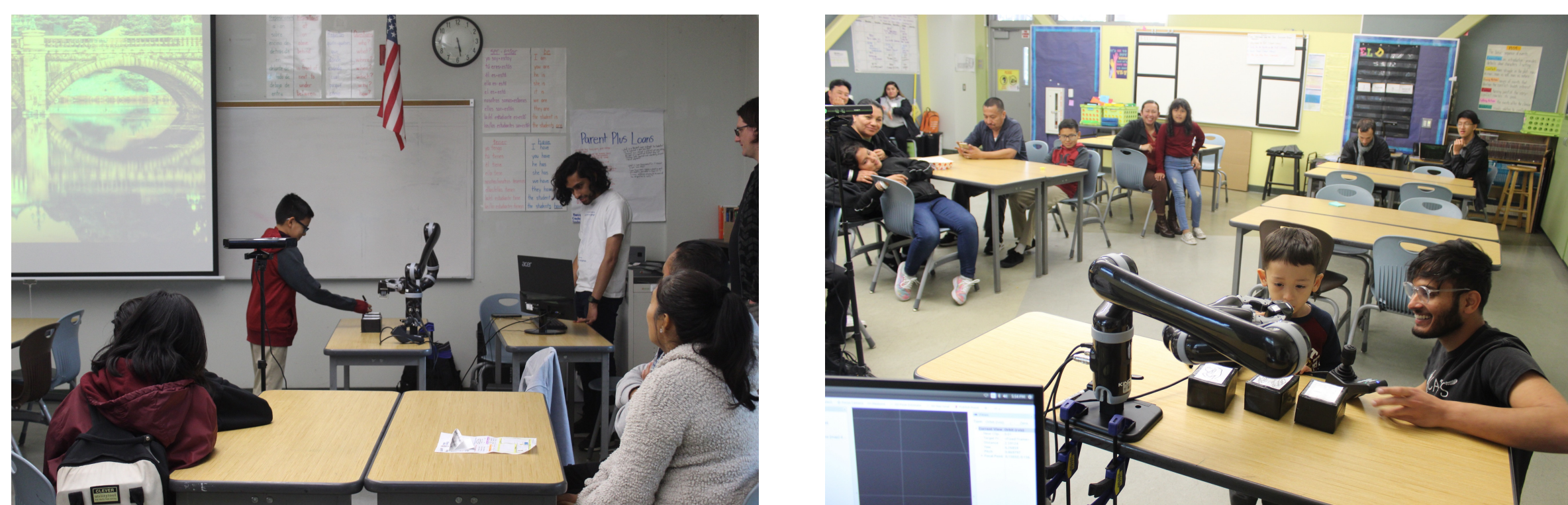
Results: HRI Domains

Generates human-robot interaction scenarios that lead to different types of failures in a human-robot collaboration task.



Broader Impacts

Introduced a robotics curriculum for high-school students in South LA.



Open-sourced **pyribs**, a Python library for QD optimization. The library includes multiple tutorials that enable users to quickly learn about QD optimization and experiment with problems from the QD literature.

