

Robust and Efficient Physics-based Learning and Reasoning in Degraded Environments

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We propose to develop and integrate model learning, simulation, and planning algorithms to enable the deployment of robots to unstructured and cluttered environments that occur around disaster sites.



RoboMantis



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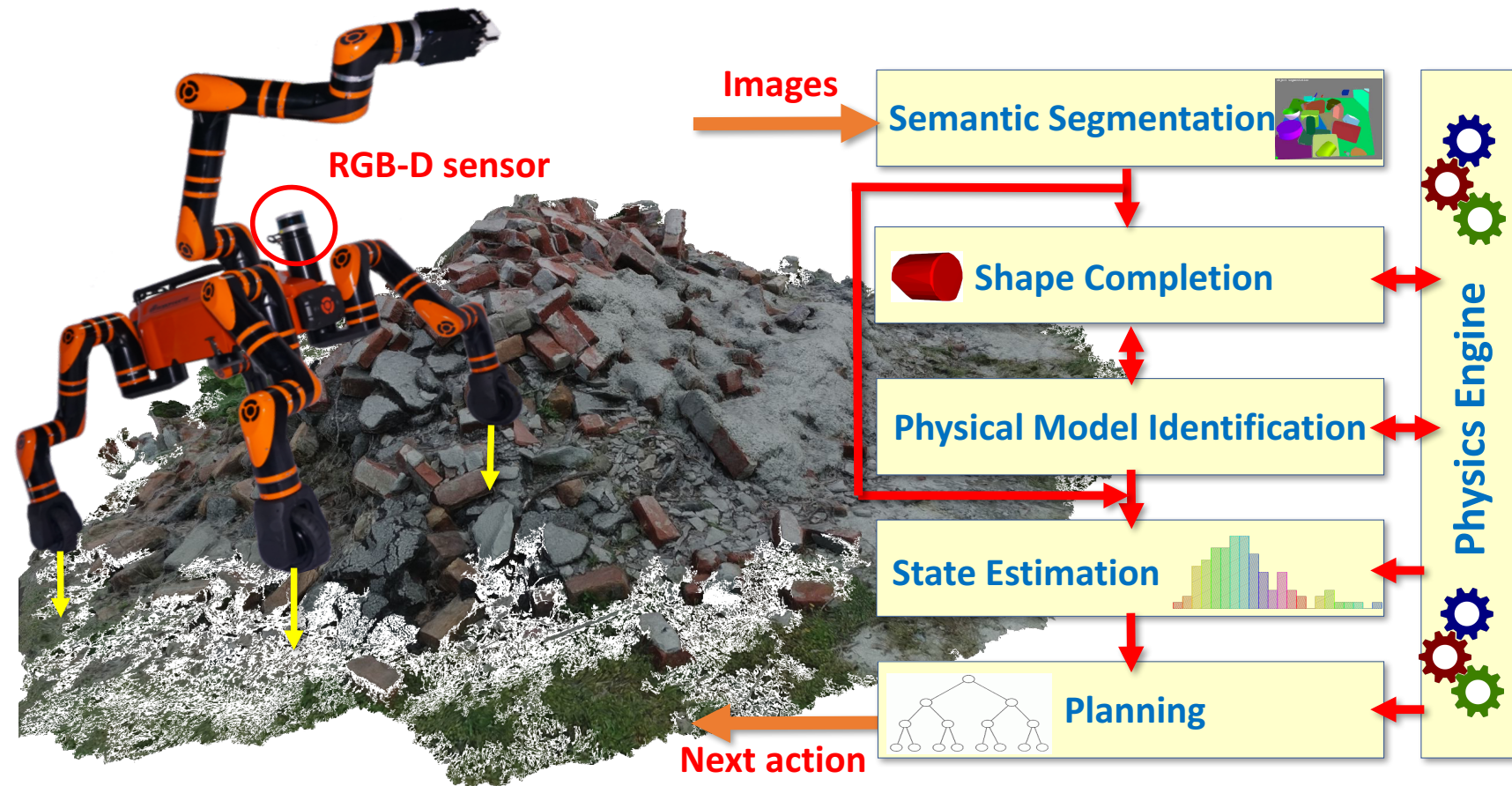
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We propose novel algorithms that can learn models of objects on the fly, quickly simulate the reactions of objects to robotic actions, and plan safe decluttering and navigation strategies accordingly, while accounting for partial knowledge and uncertainty.



Overview of the integrated system with the four-legged *RoboMantis*.



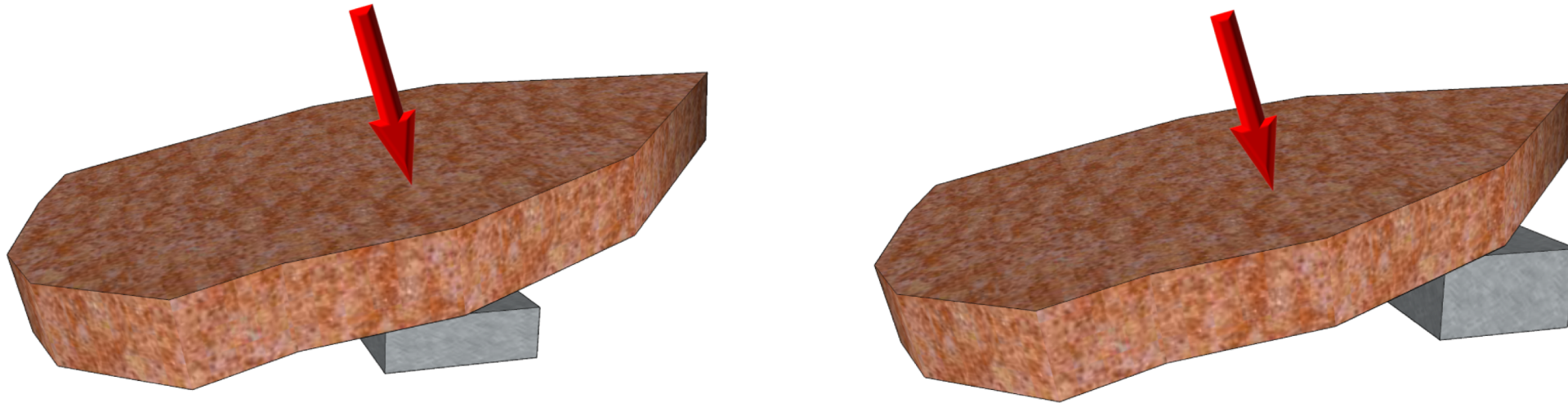
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Poking two surfaces with same apparent look at the same spot may reveal that one surface (left) provides poor support.

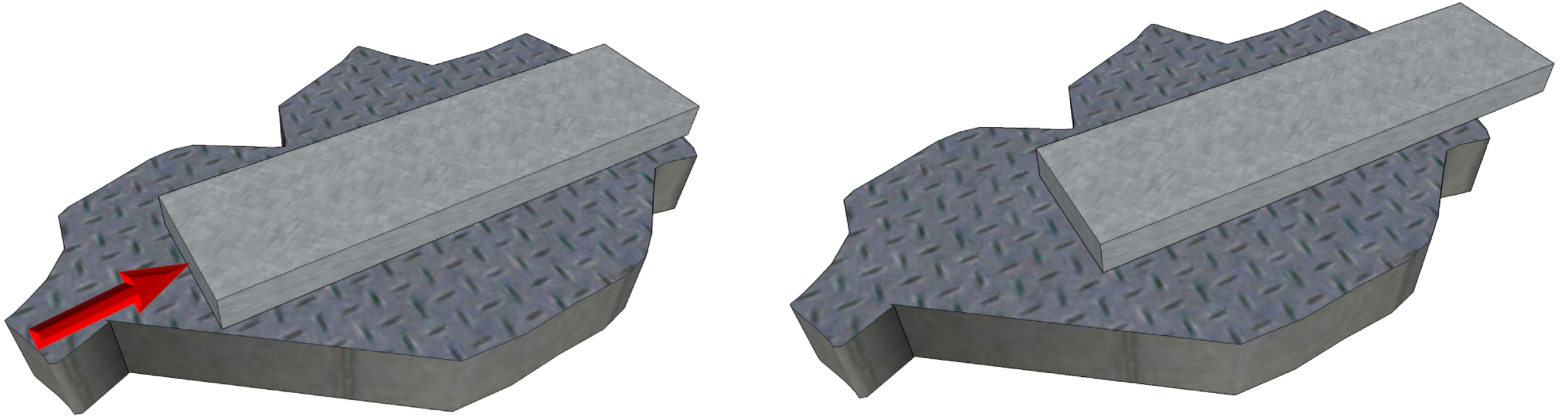
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Pushing an object (left) can bring it into a pose (right) conducive to grasping.

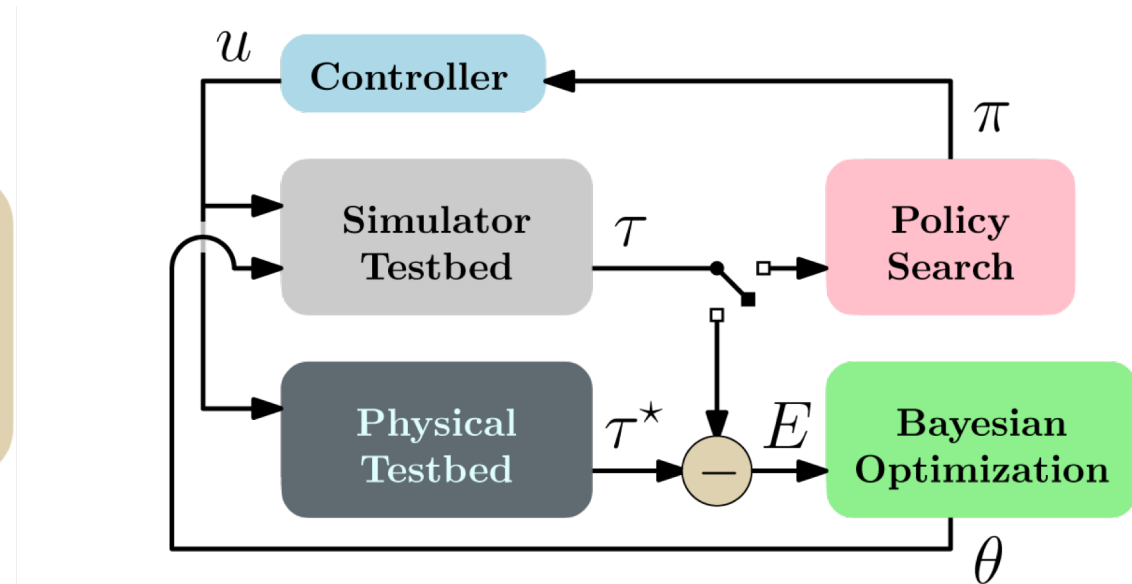
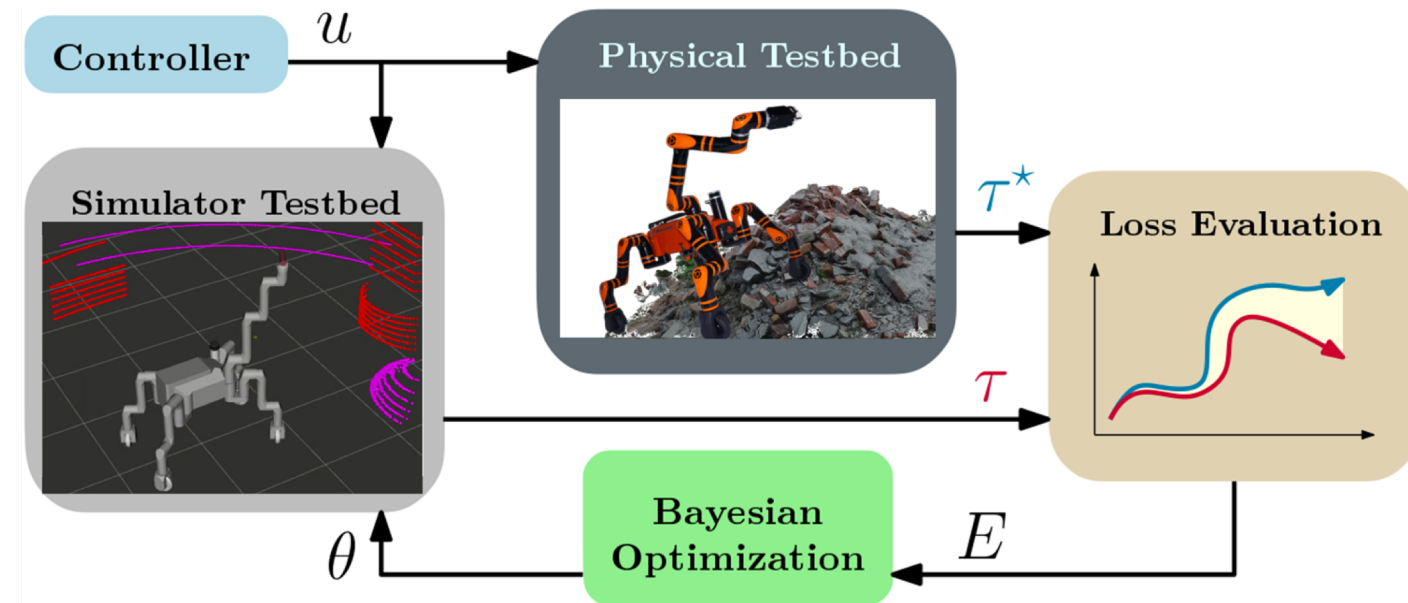
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Model identification with Bayesian Optimization.

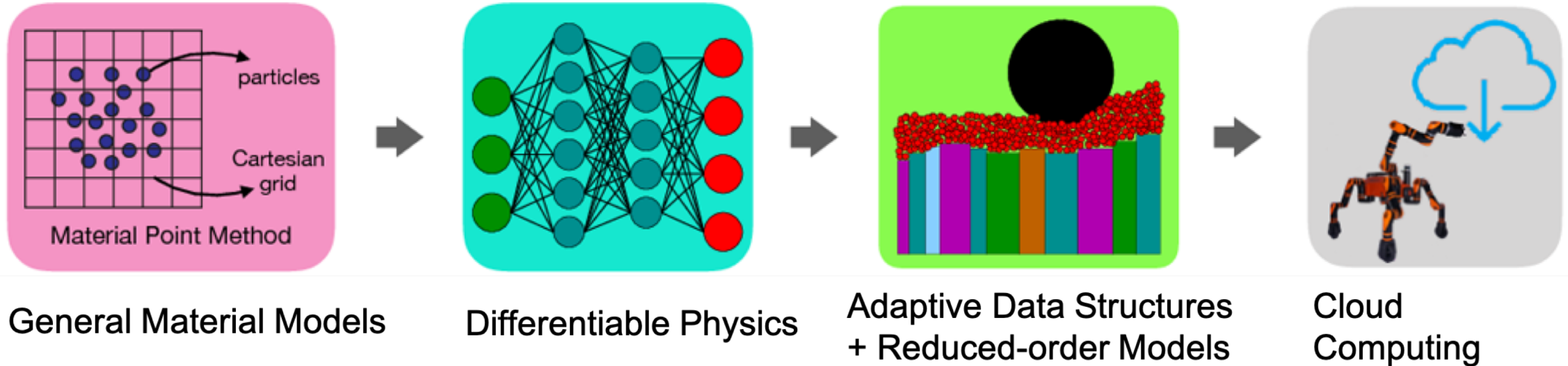
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The material point method (MPM) is used for simulating the rubble, which can accommodate general material models and avoids costly remeshing operations with topology changes.

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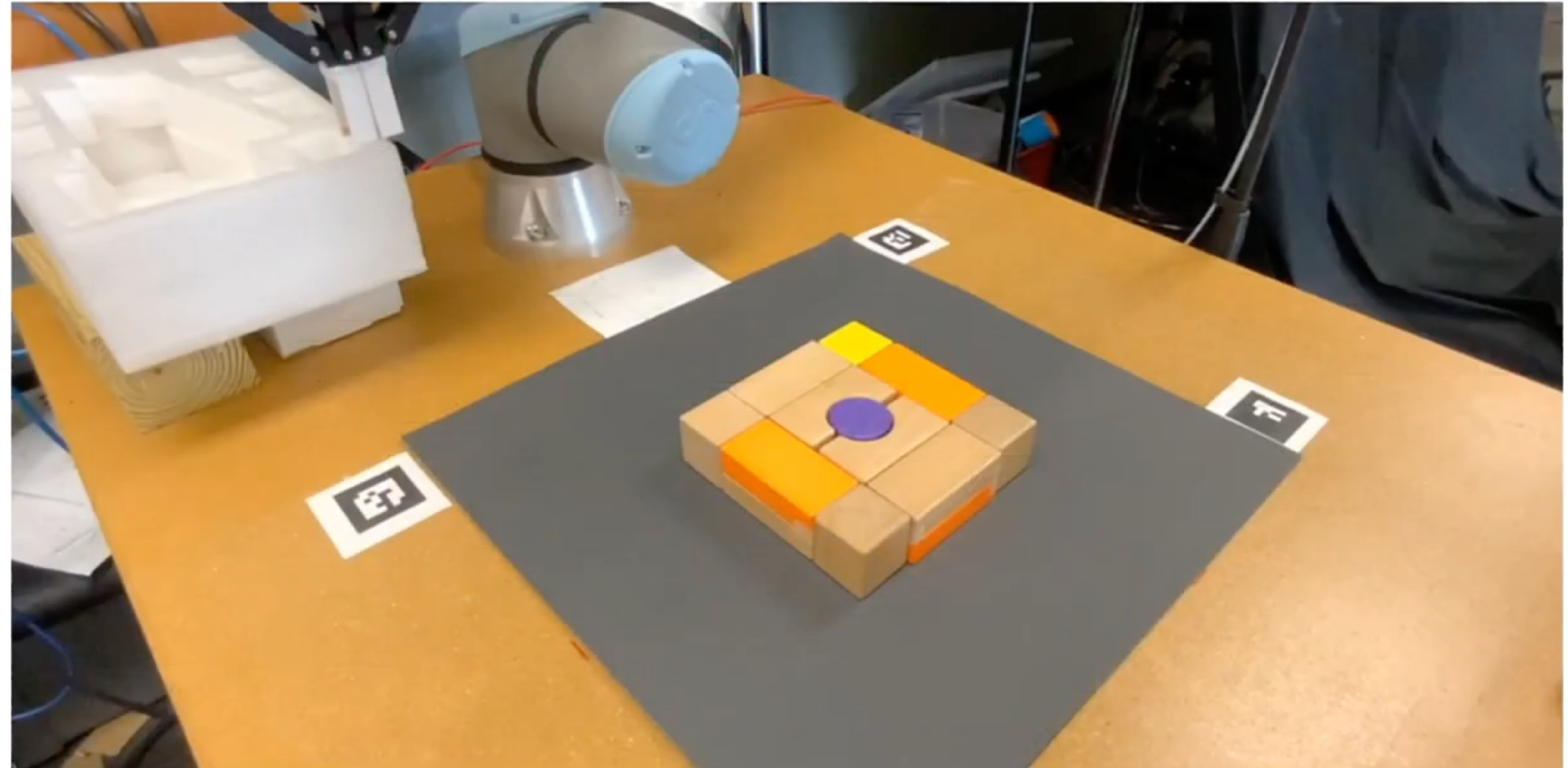
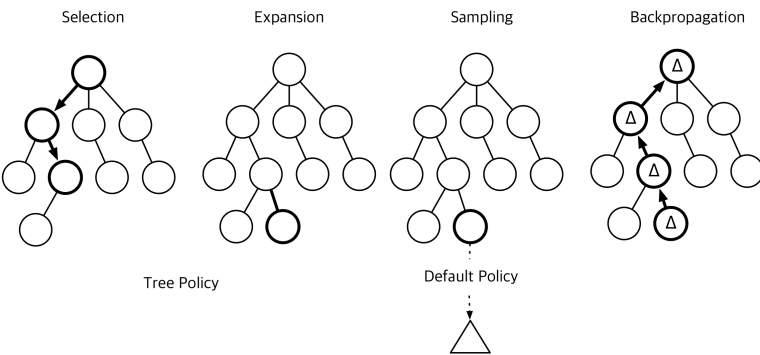
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Monte Carlo Tree Search with Learned Models



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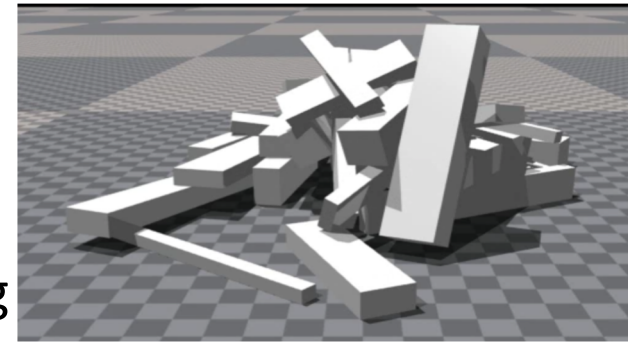
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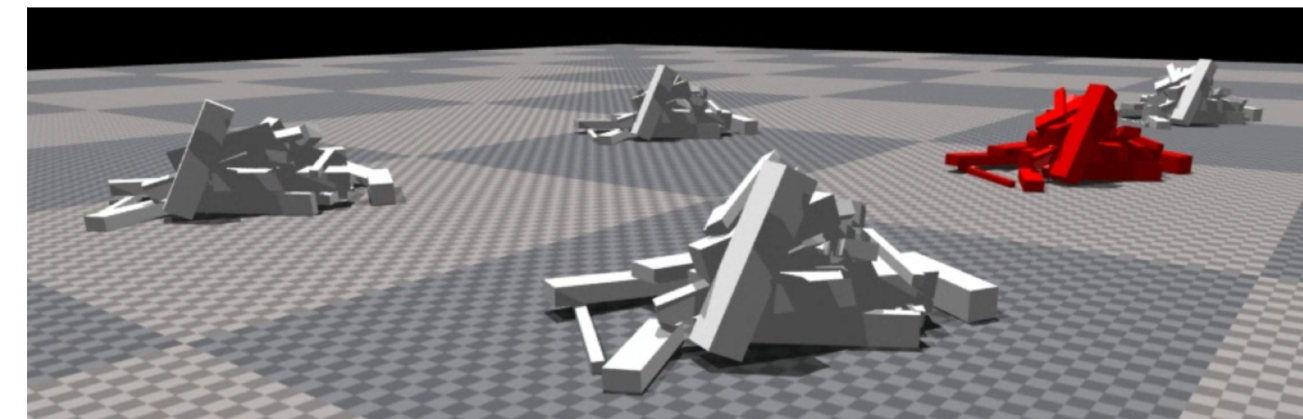
Safe Pile Deconstruction for Search-and-Rescue

Objective: fully deconstruct a pile of 3D objects while respecting a safety constraint appropriate for a search-and-rescue context.

A data-driven approach is used to learn how manipulating the pile compromises the safety of the scene.



An RGB-D point cloud of a pile's hull is used as problem input.



Multiple GPU-accelerated simulations are run in parallel to improve training time.