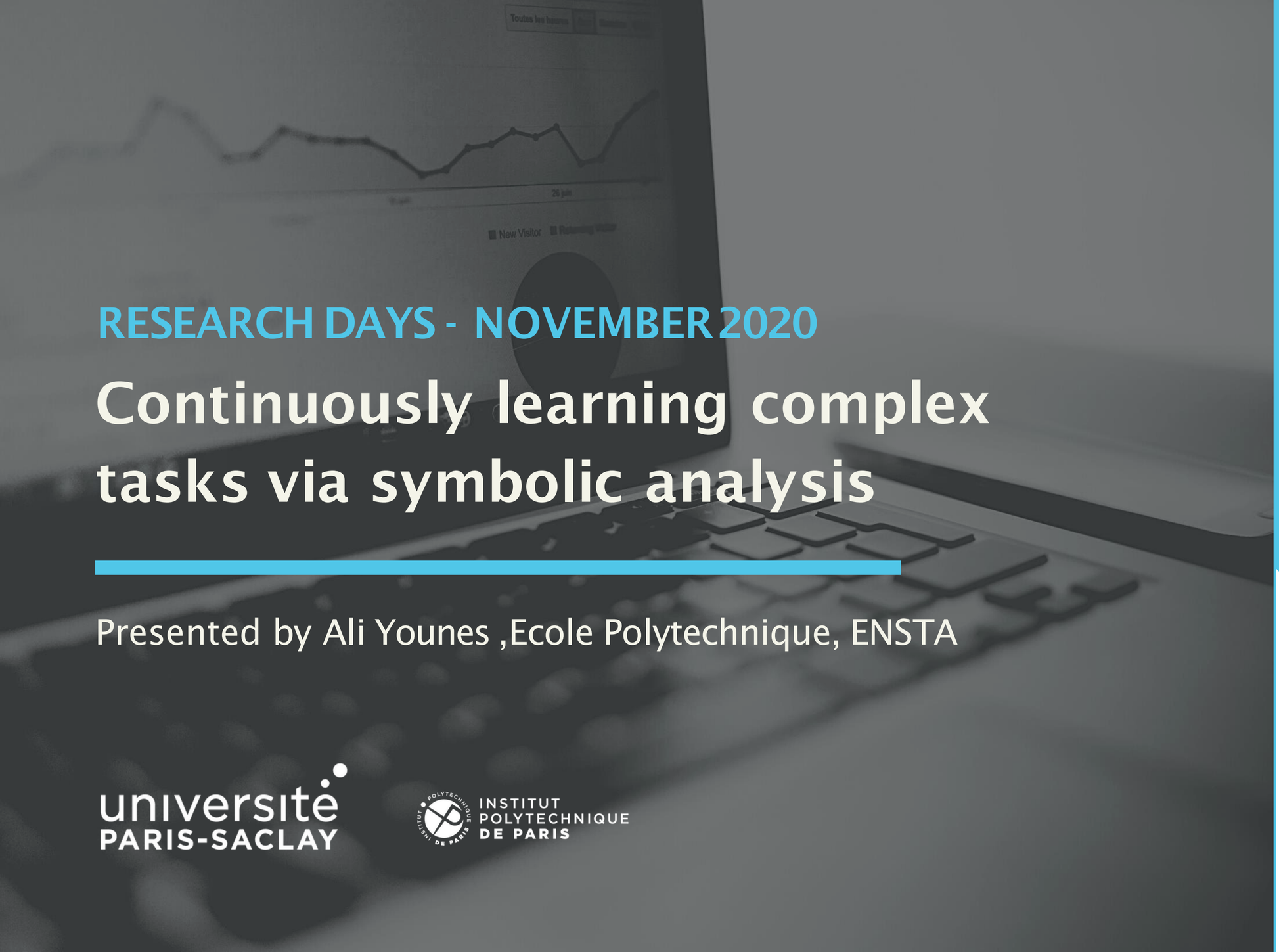

RESEARCH DAYS - NOVEMBER 2020

Continuously learning complex tasks via symbolic analysis

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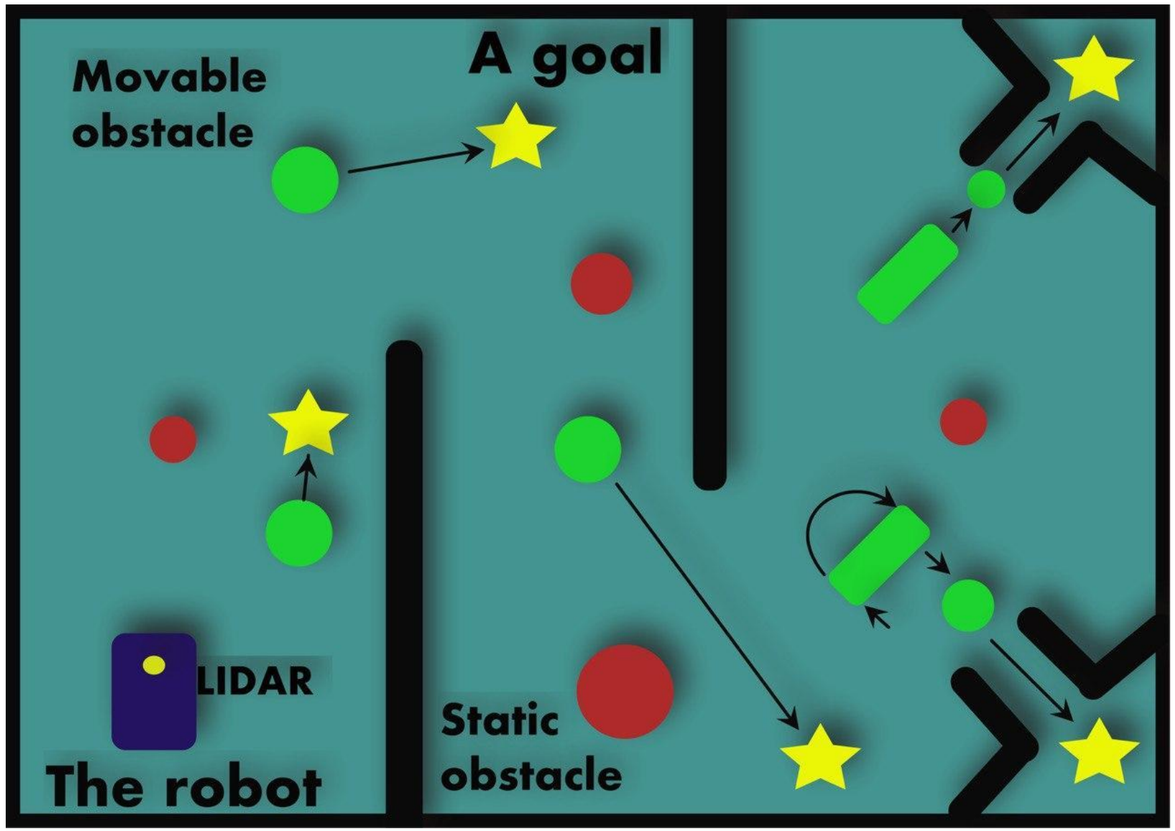
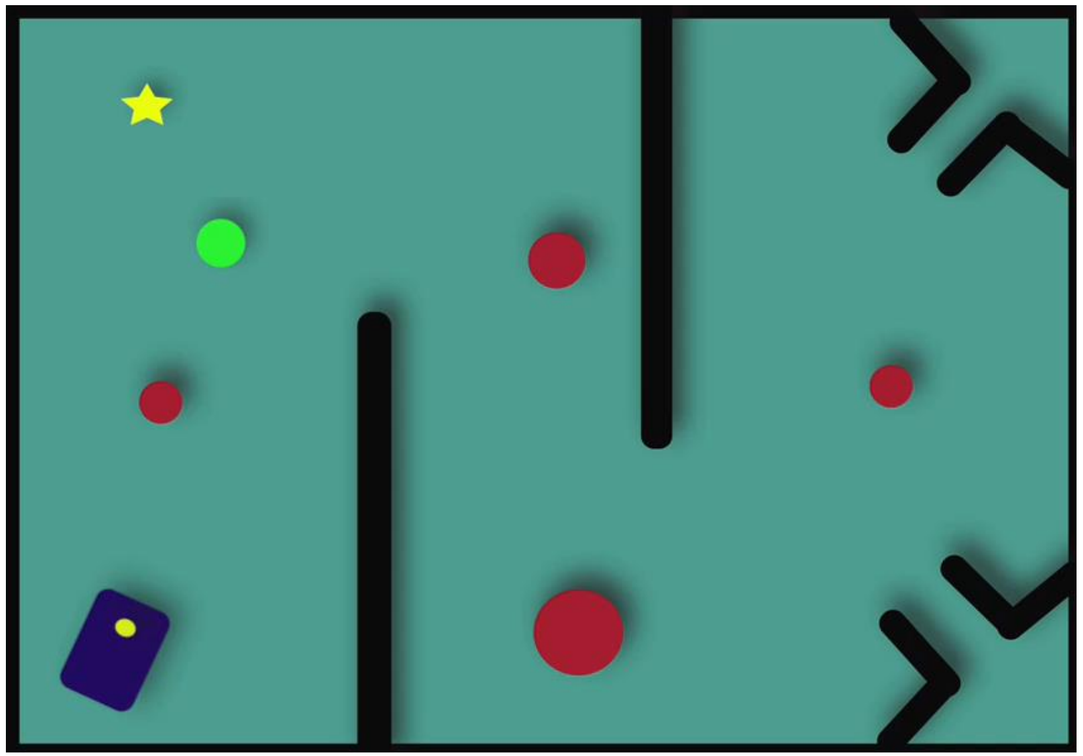
Continual Learning

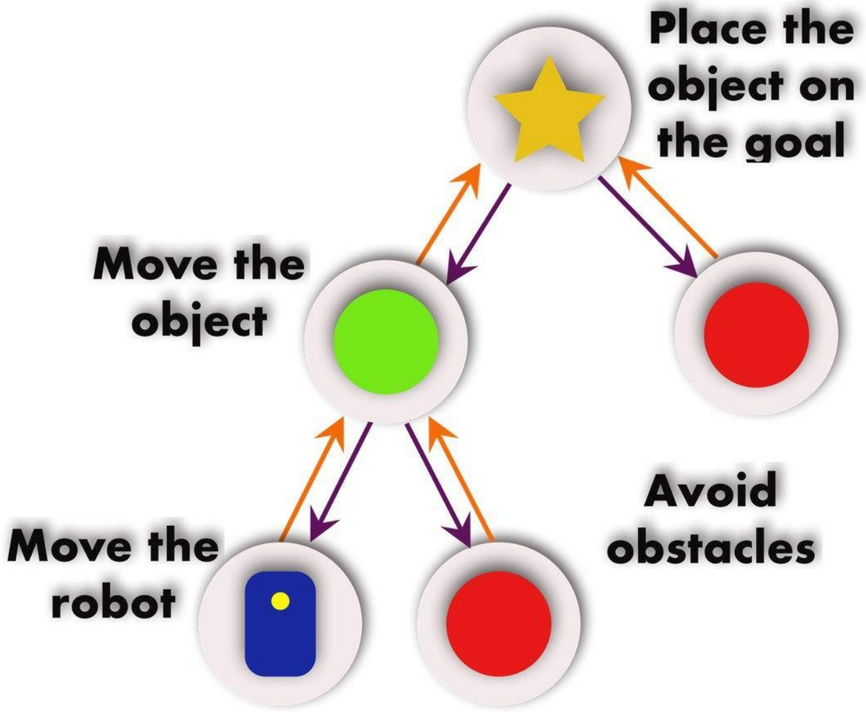
- The Continual learning problem is defined as the ability to incrementally learn and expand the knowledge by gaining new skills and expertise.
- A system of a mobile robot pushing object to goals could represent a continual learning problem.



Hierarchical continual Learning

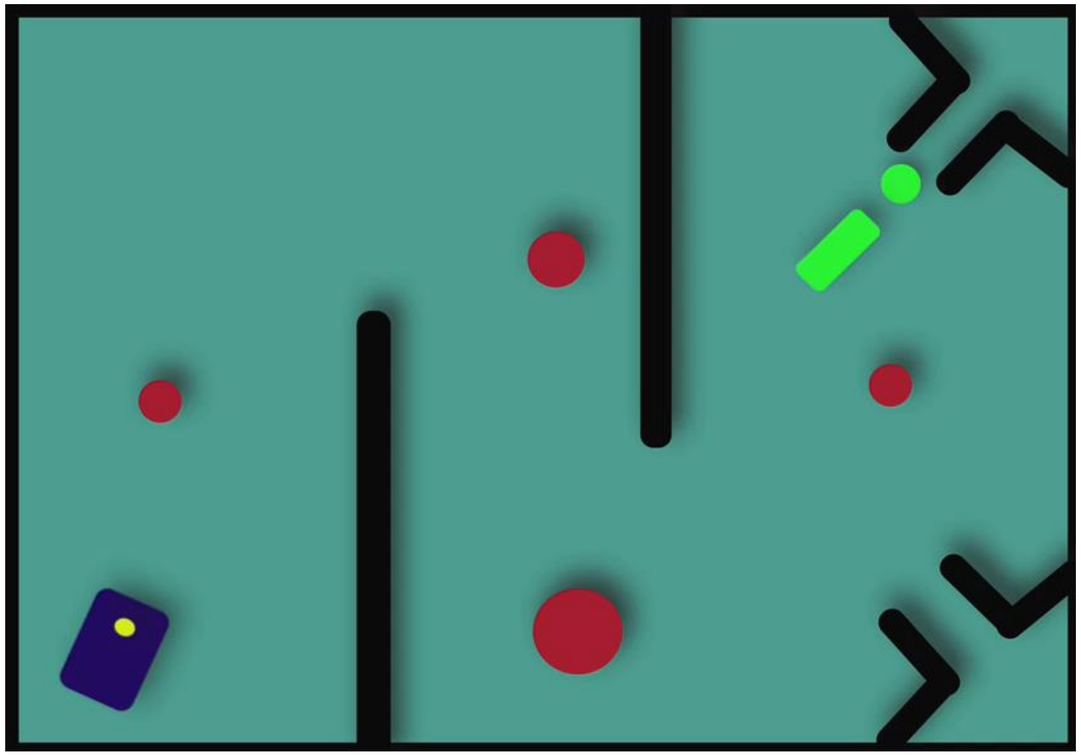
- The robot dissect the task into simpler tasks, and build a hierarchy of skills to solve the task.
- In the first part of the task, the robot use the hierarchy:

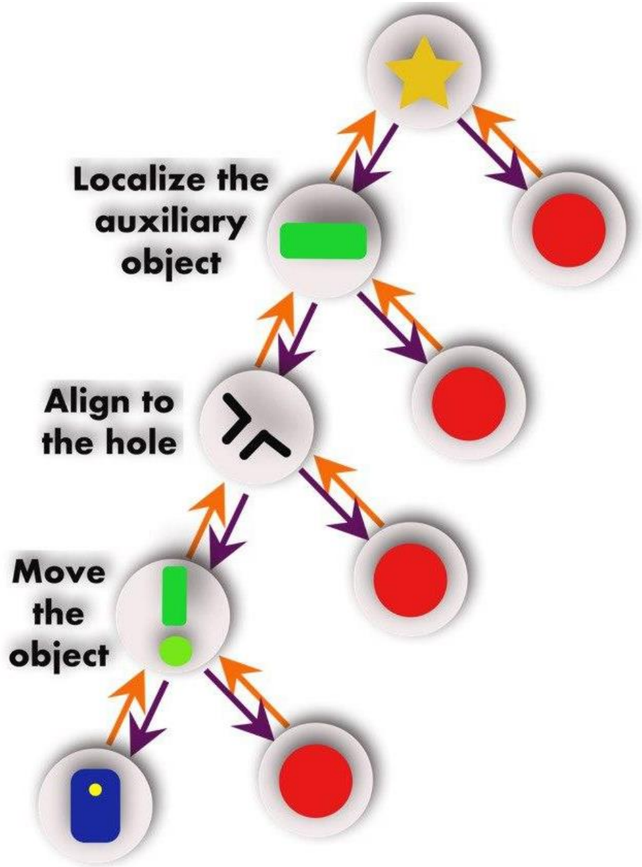




Hierarchical continual Learning

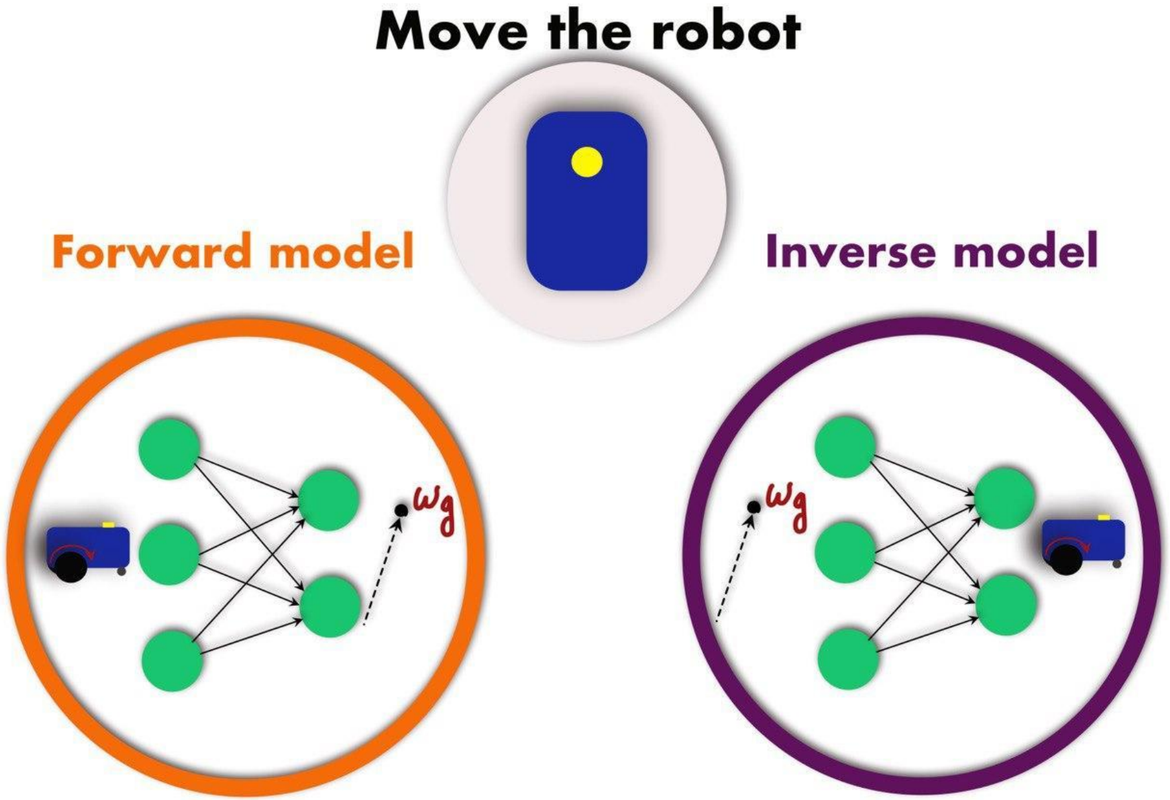
- The robot dissect the task into simpler tasks, and build a hierarchy of skills to solve the task.
- In the second part of the task, the robot has to extend the hierarchy:





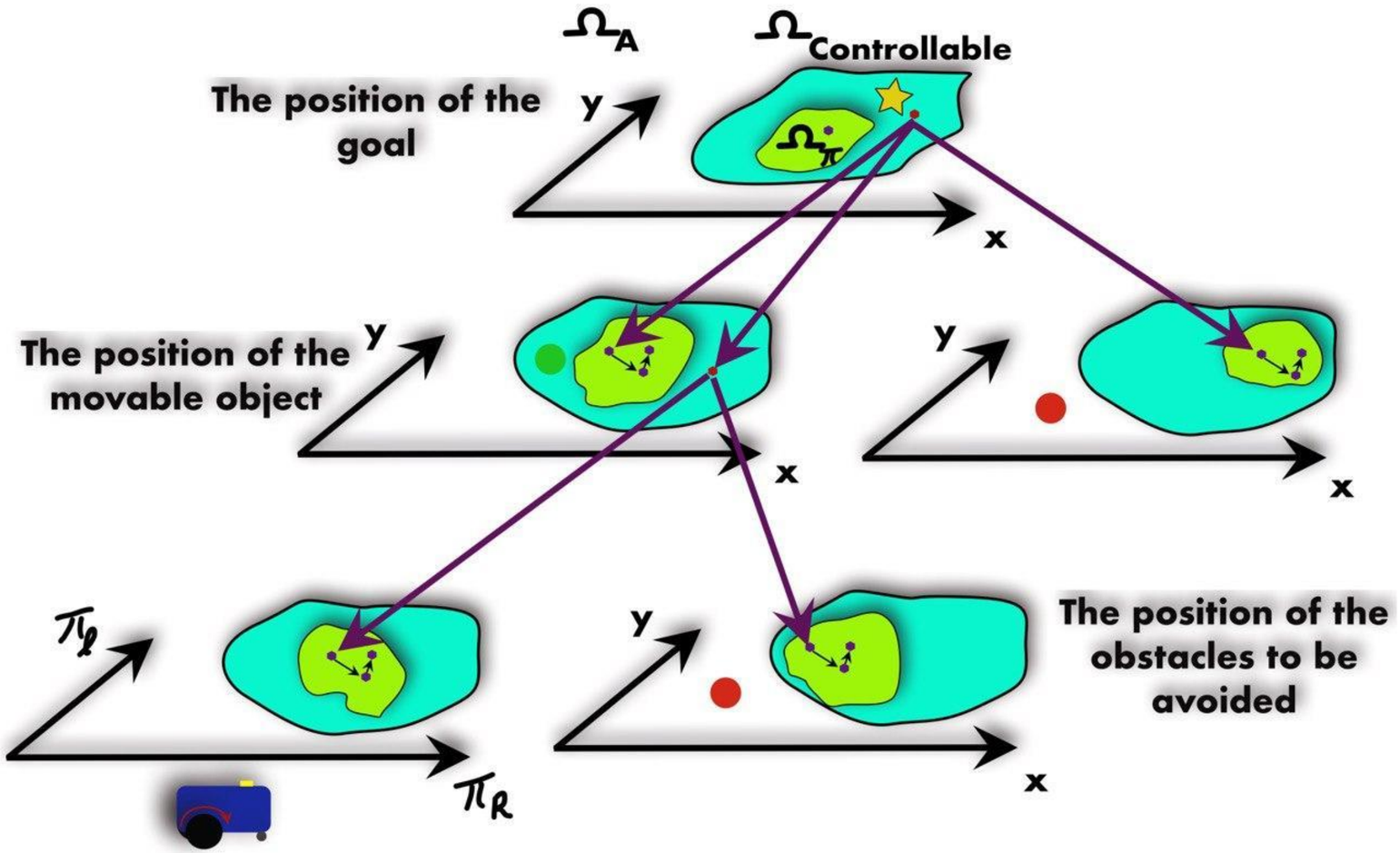
Planning in hierarchical learning

- Each skill has a forward and an inverse model.



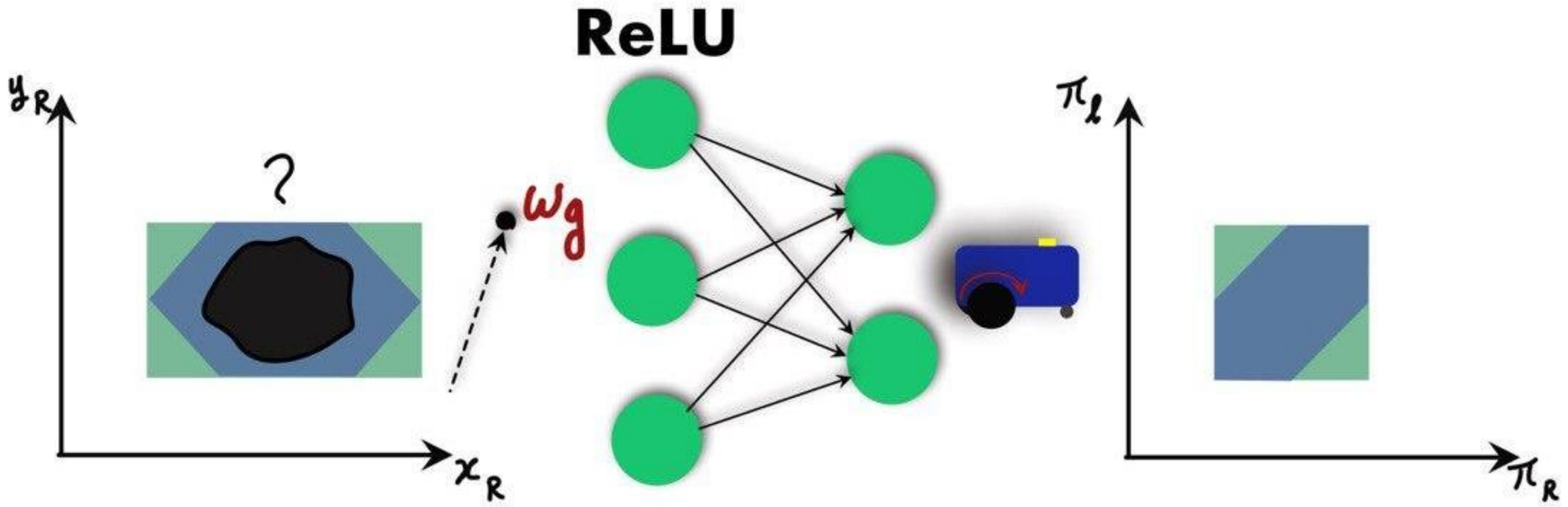
Planning in hierarchical learning

- Inverse models from various skills are used for planning over the hierarchy.



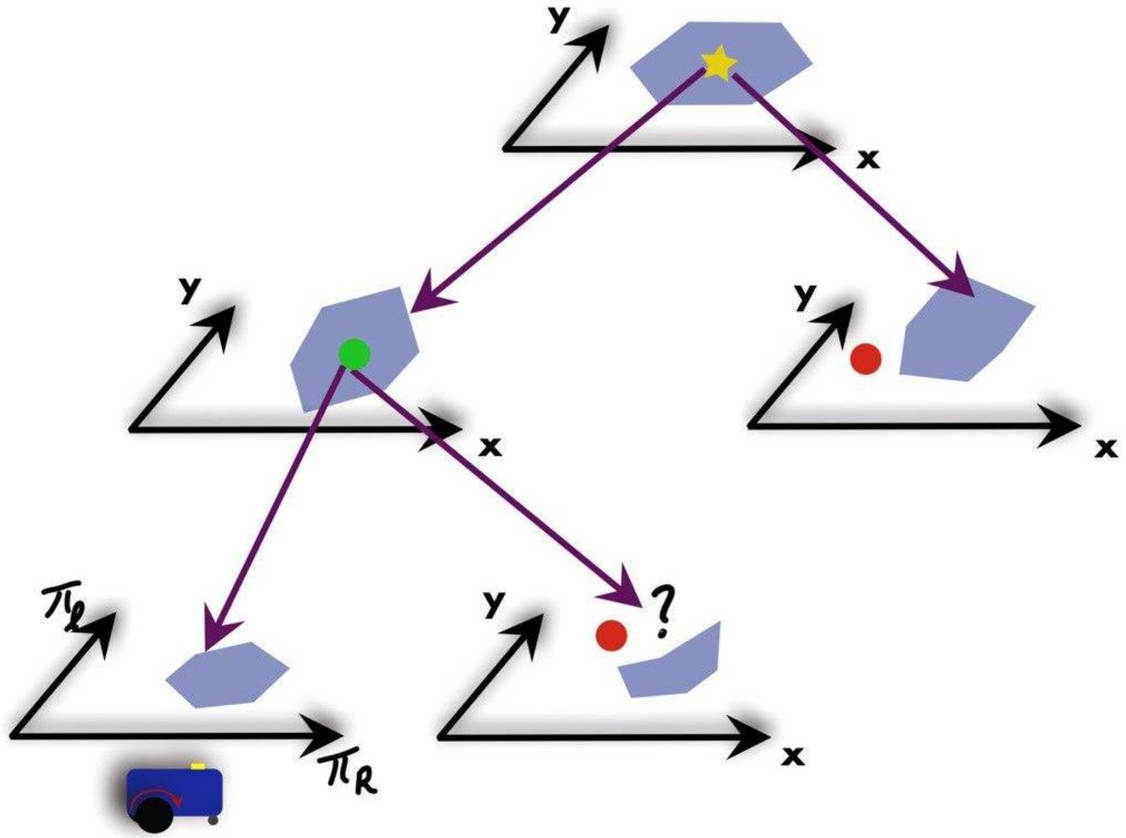
Using symbolic analysis

- Current hierarchical learning approaches struggles with data-efficiency as the hierarchy grows (for complex tasks).
- We propose using set-based methods (e.g. abstract interpretation) as a way to reduce the number of training samples.
- Inferring over sets is more efficient than inferring over points in the common sense, but we may need special abstract domains for NN with ReLU activation functions.



Using symbolic analysis

- New planning is needed for set-based methods as well, in which controllable regions would be the output of the inverse model. This leads to an improved planning over the conventional method.



Objectives and Challenges

- A life-long learning algorithm, uses symbolic analysis for efficient hierarchical learning.
- Novel abstract domains (for abstract interpretation); exploring the trade-offs between precision and computational cost.
- Novel algorithms for efficient planning in goal oriented hierarchical structures.
- Experiments in simulation, and with real-world robots (mobile robots, manipulators), gradually increasing the complexity of the environment.