Complementary Corrective Demonstration for Task Refinement

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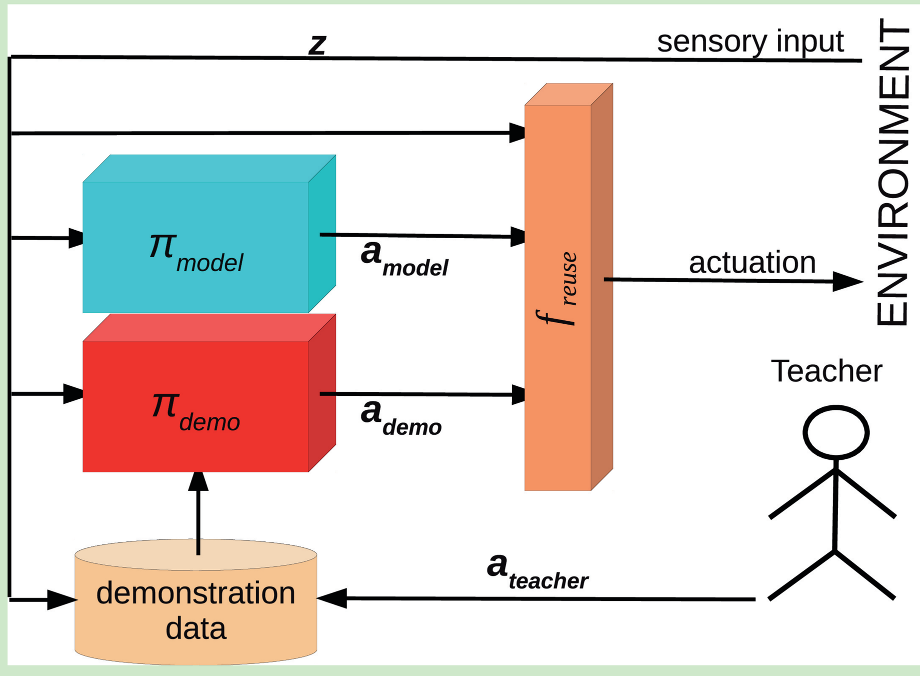
Introduction

- We introduce the notion of **Complementary Corrective Demonstration**.
- Human feedback is used to provide corrections to an algorithm for a given state.
- We also introduce the notion of **Multi-Resolution Task Execution** for reducing the computational cost of task execution.
- We present formal models and experimental evaluation results for the proposed approaches.

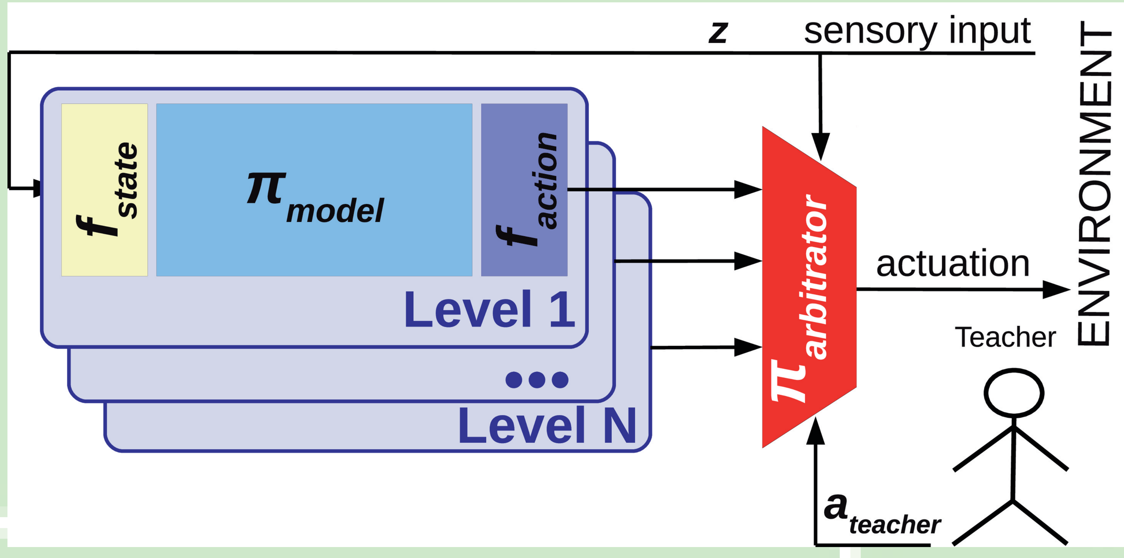
Model Plus Correction (M+C)

- M+C is an approach for complementing an algorithm with corrective human feedback.
- A set of corrections to the algorithm are learned from demonstration.
- The policy reuse function computes a final action to be executed.



Multi-Resolution Task Execution (MRTE)

- Consists of different algorithms running at various detail resolutions.
- The **arbitrator policy** is learned from human demonstration.
- MRTE learns when to use which detail resolution.

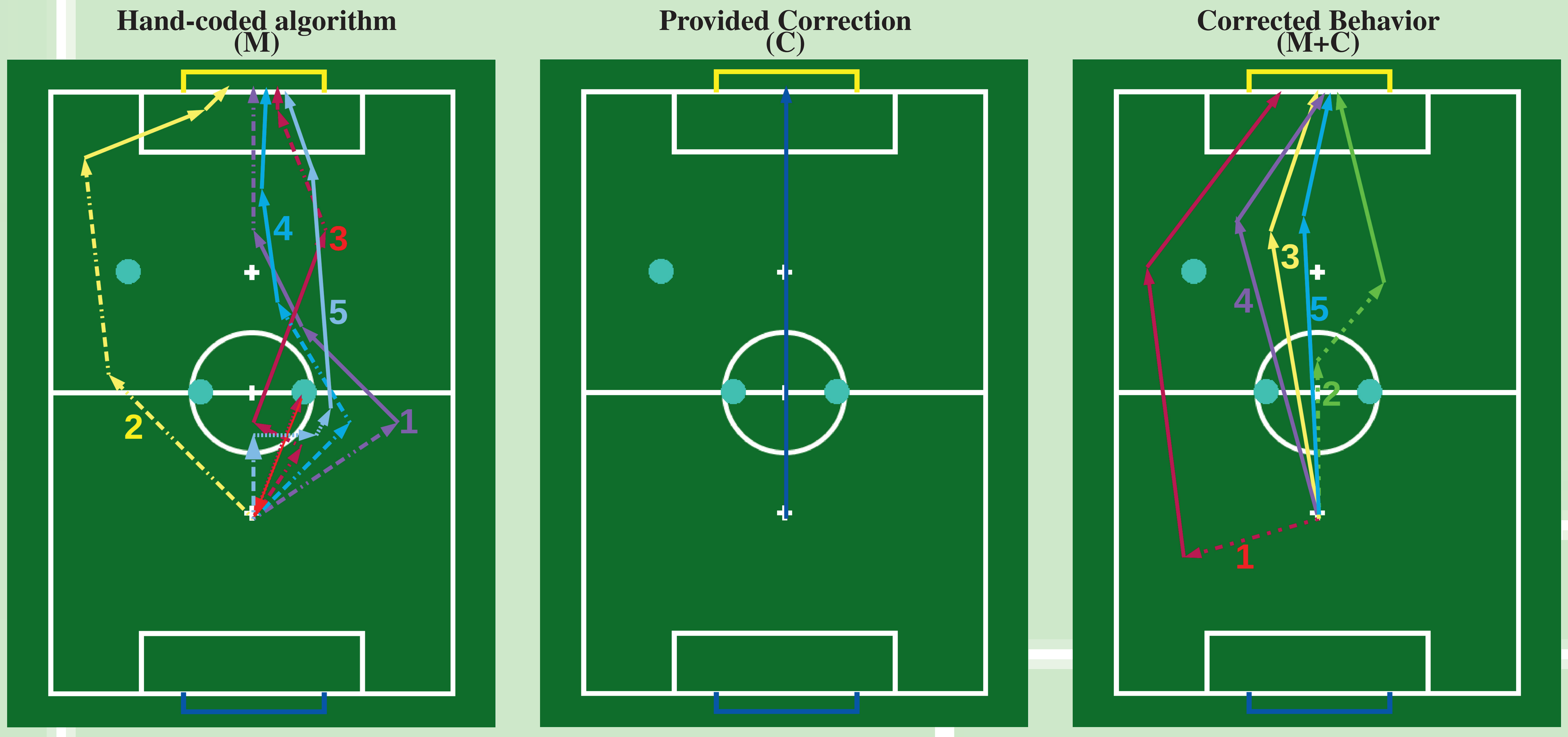


Single Resolution Task Refinement: Ball Dribbling Task

- The aim is to score a goal without the robot or the ball touching the stationary robots placed on the field.
- Two actions:
  - **shoot** to kick the ball towards the opponent goal
  - **dribble** to roll the ball in a more controlled manner
- We used a regular RoboCup Standard Platform League field, and Aldebaran Nao humanoid robots in our experiments.
- We evaluated the proposed approach using 3 different obstacle configurations and we performed 5 trials per configuration.

An example obstacle configuration used in the experiments

Hand-coded algorithm (M) | Provided Correction (C) | Corrected Behavior (M+C)



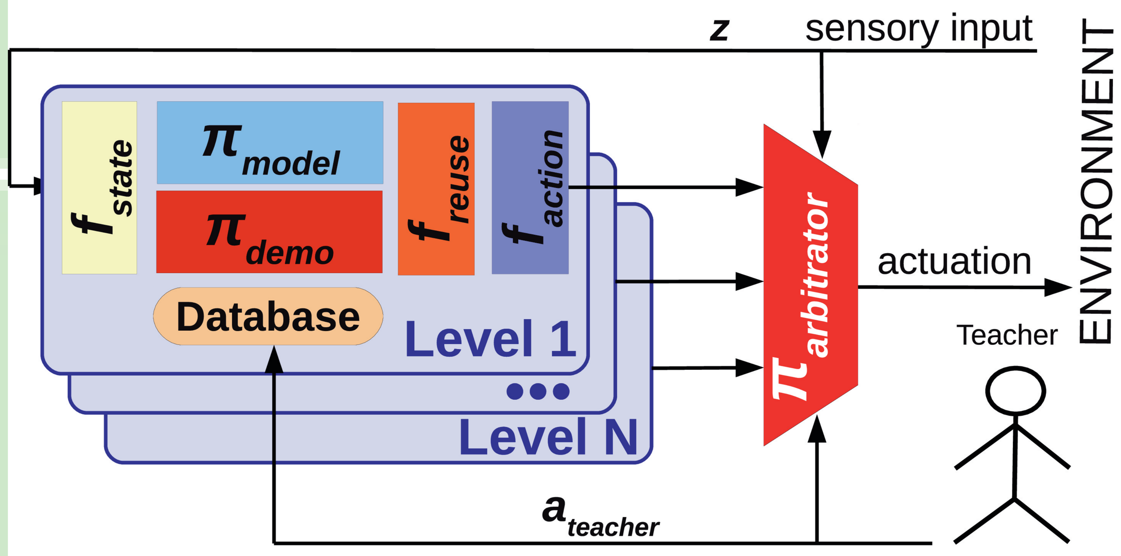
The illustration of the performance evaluation run for the example configuration shown above. Different colors denote different runs. The dashed lines represent dribbles, and the solid lines represent shoots.

	Configuration #1		Configuration #2		Configuration #3	
	M	M+C	M	M+C	M	M+C
Mean Completion Time (sec)	161	94	185	112	134	116

Average task completion times per algorithm and obstacle configuration

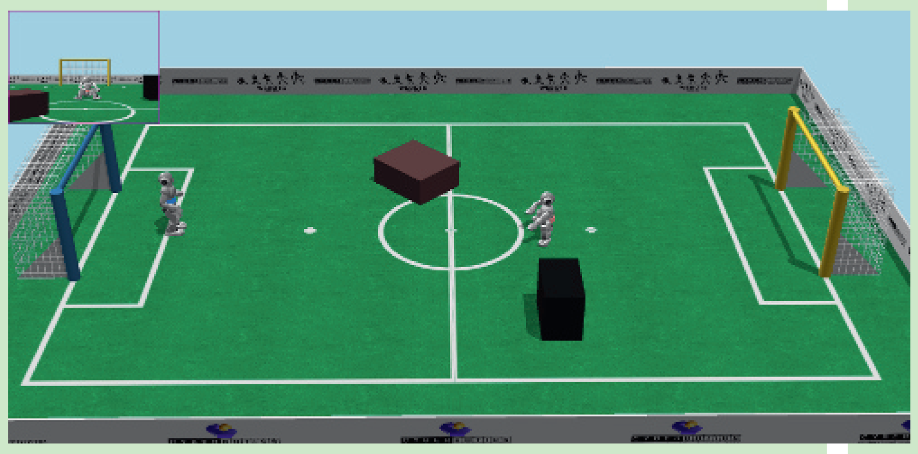
Multi-Resolution Model Plus Correction (MRM+C)

- MRM+C combines M+C and MRTE.
- Each detail resolution is an M+C instance.
- The arbitrator policy and corrections to the individual algorithms are learned from demonstration.

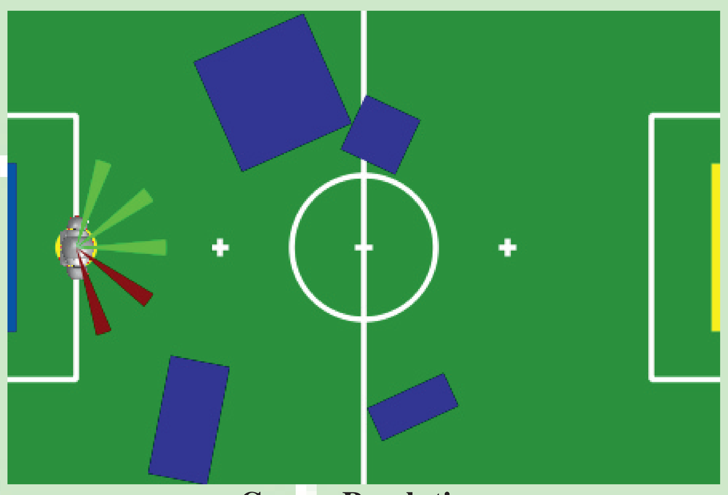


Multi-Resolution Task Refinement: Obstacle Avoidance Task

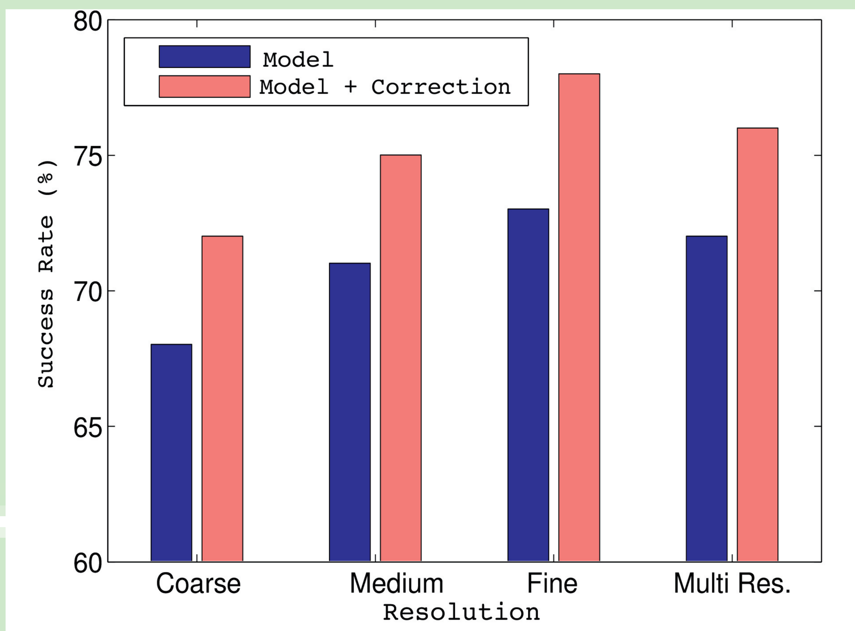
- The aim is to reach the opponent goal without bumping into the obstacles placed on the field.
- We defined 3 detail resolutions with different algorithms and state-action representations.
- We evaluated the individual algorithms (M), M+C instances, MRTE, and MRM+C.
- We ran 100 trials per method using randomly changed obstacle configurations.
- We used the task completion rate as the success metric.



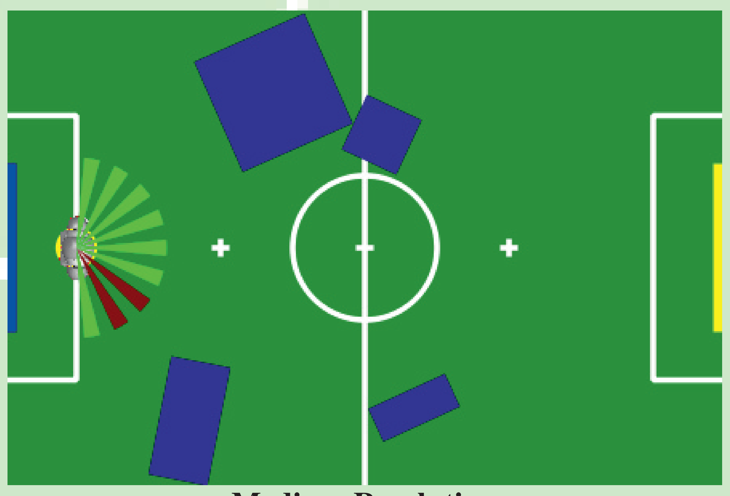
An example obstacle configuration for the obstacle avoidance task



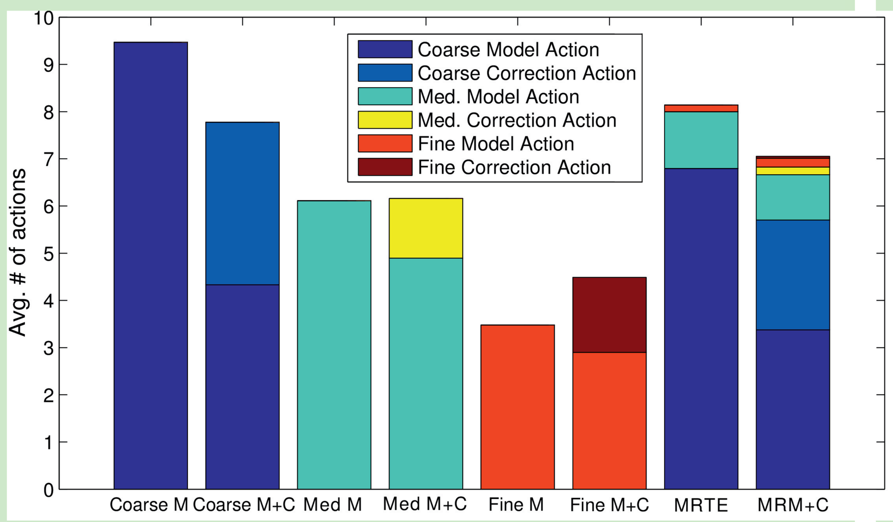
Coarse Resolution



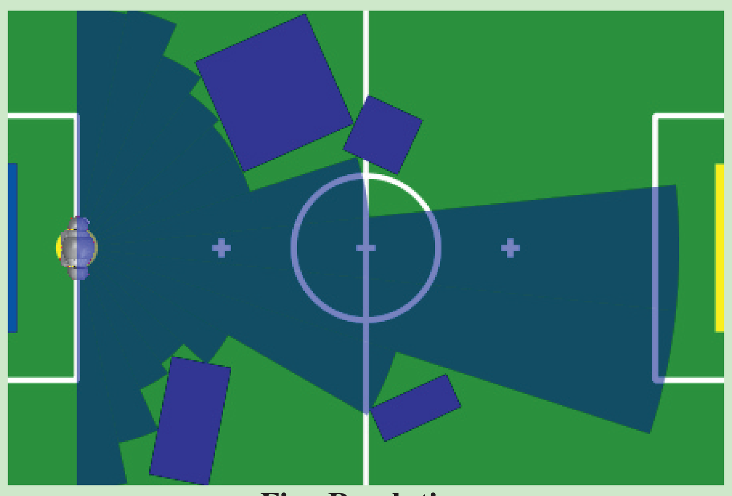
Average success rate per method



Medium Resolution

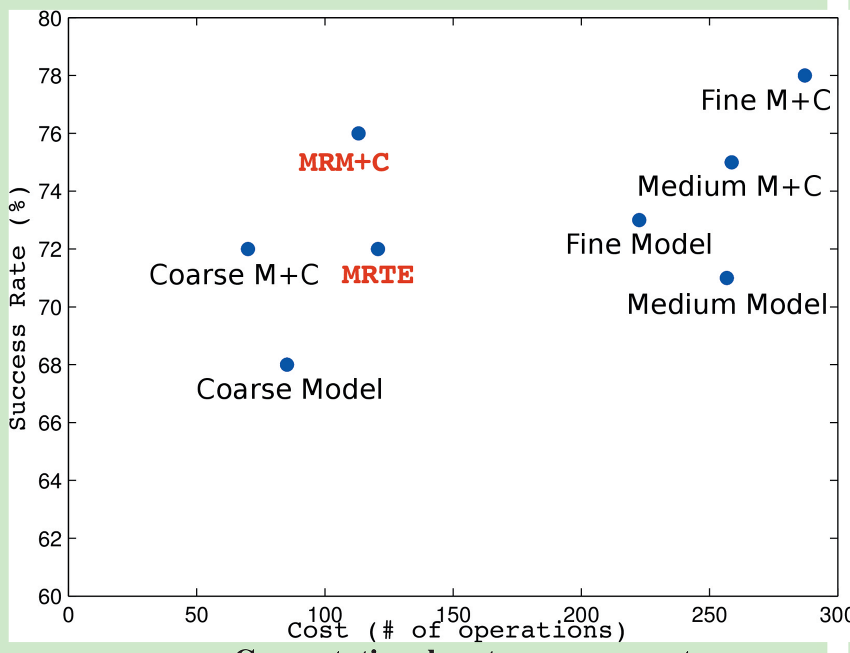


Average number of actions per method



Fine Resolution

State representation for the same situation in different detail resolutions



Computational cost vs. success rate

Summary

- We introduced the **Complementary Corrective Demonstration** concept to correct and modify a robot controller without modifying the underlying algorithm.
- It is particularly suitable for mass deployment and lifelong learning scenarios as it allows the robots to be deployed with a default set of skills, and enables the users to modify and correct the robot behaviors as needed.
- We also presented a multi-resolution approach for running different algorithms with different complexities depending on the difficulty of a given situation.
- This approach reduces the computational footprint of a robot controller without drastically suffering from performance degradation.

References

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- Çetin Meriçli, Manuela Veloso, and H. Levent Akın. Multi-Resolution Corrective Demonstration for Efficient Task Execution and Refinement. International Journal of Social Robotics (to appear), 2012.