Fall School 2023 - Day 1

Robot Control with PyCRAM

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Demonstration





- 1. Abstract Machine
- 2. CRAM Plan Executive Primitives Parameters Designators
- 3. Tutorials



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Motivation



One plan to accomplish all variations of fetch and place:

different objects, environments, robot platforms, applications.



Abstract Machines in Computer Science

Adapted from Pedro Domingos: "What's Missing in AI: the Interface Layer"

Field	Interface Layer	Below the Layer	Above the Layer
Operating Systems	virtual machines	hardware	software
Programming	high-level	compilers,	programming
systems	languages	optimizers,	
Databases	relational model	query optimization, db	enterprise
		design,	applications
		transaction mgmt	



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Personal robotics	CRAM	grounding in robot, AI	robot application pro-
		tools, the nuts and bolts	gramming
		of intelligent robotics,	

Raise the conceptual level at which service and personal robot applications are programmed!



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CRAM General Overview



The CRAM 2.0 system.

CRAM Plan Executive



Challenges Tackled by the Plan Executive

- 1. Define which actions to execute to achieve the goal.
- 2. Infer which parameters to use for each action.
- 3. Monitor task execution and react to failures.



Primitives: Motions and Percepts

Primitives of Mobile Pick and Place for PR2-like Robots

Primitive	Description	
moving-base	Move the base to the target pose.	
moving-arm	Move the joints of the arm / arms to the target configuration in	
	joint, cartesian or constraint space.	
moving-finger	Move the joint of the hand $/$ hands to the target joint position.	
gripping	Close the hand $/$ hands to grasp an object.	
moving-torso	Move the torso joint to the target joint position.	
moving-neck	Move the neck to the target configuration or to direct the camera	
	gaze to a target pose.	
detecting	Detect the described object in the environment and update the	
	internal world state with the acquired information.	
monitoring-joint-states	Monitor if the joint positions of robot body parts exceed the given	
	threshold.	



Parameters of Motion and Perception Primitives

Primitive	Parameters
moving-base	goal_pose,, speed,
moving-arm	goal_pose_for_hand, goal_positions, collisions,
moving-finger	goal_position
gripping	hand, grasping_force, object_properties,
moving-torso	goal_position,
moving-neck	goal_positions, goal_coordinate_to_look_at,
detecting	object_description,
monitoring-joints	joint_name, joint_value, monitoring_function,

Calculating parameter values that maximize success probability: heuristics, learning from experience, imitation learning, ask a human



Choice of Parameter Values is Crucial For Success



 Often very many possible values to choose from

Example: from which side and with which hand to grasp?

- Effects can be:
 - immediate
 - short-term
 - long-term

CRAM Plan Executive

Tutorials



Location Designators



Finding the right location.



Action Designators: Searching



Combining primitives into high-level actions

CRAM Plan Executive



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Monday: Robot Control with PyCRAM

http://cram-system.org/tutorials/



