Introduction To Cognitive Robots

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Rm 33-418

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Outline

- Examples of Robots as Explorers
- Course Objectives
- Student Introductions and Goals
- Introduction to Model-based Programming

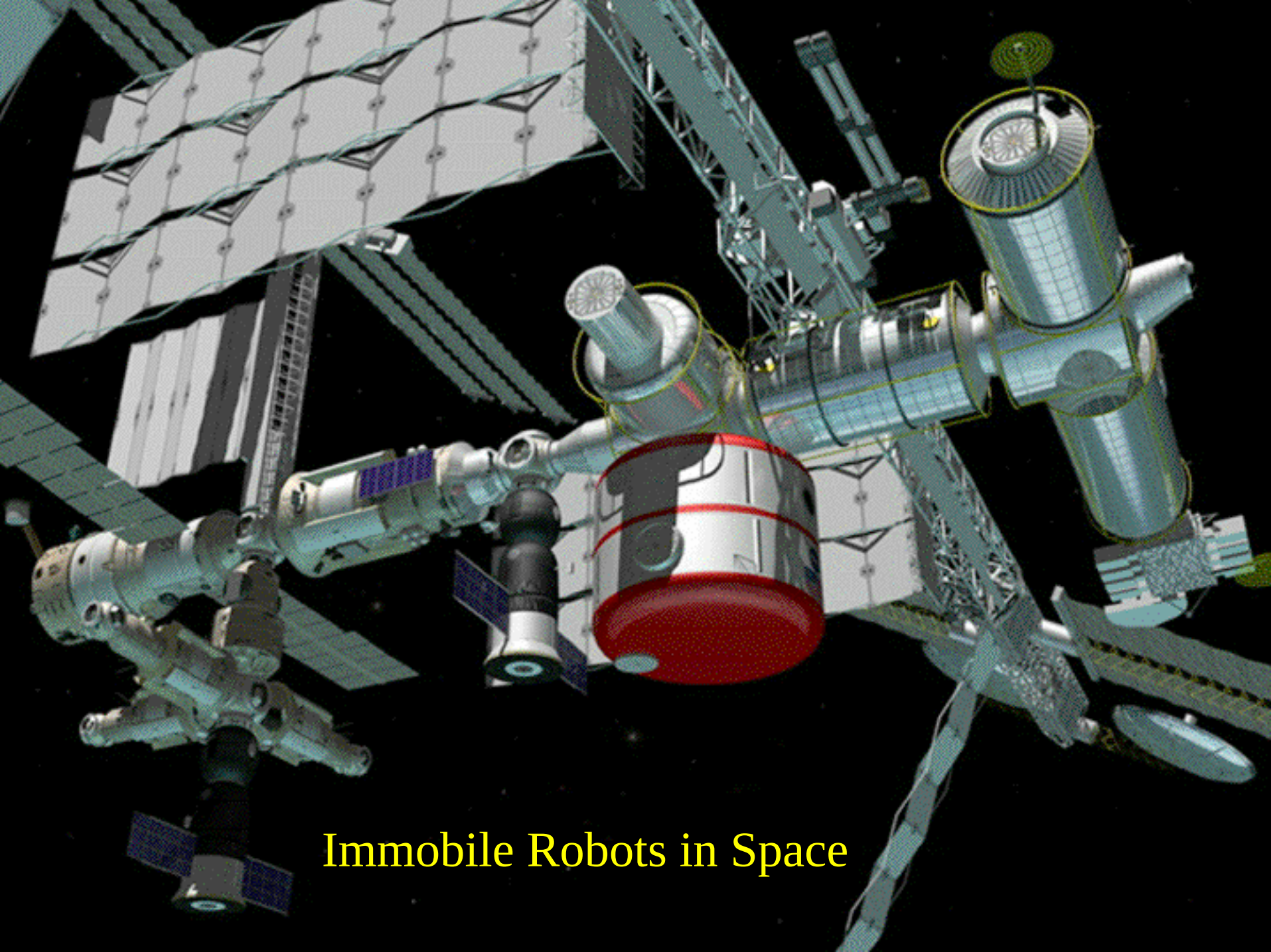
Course Objective 1

To understand the main types of cognitive robots and their driving requirements:

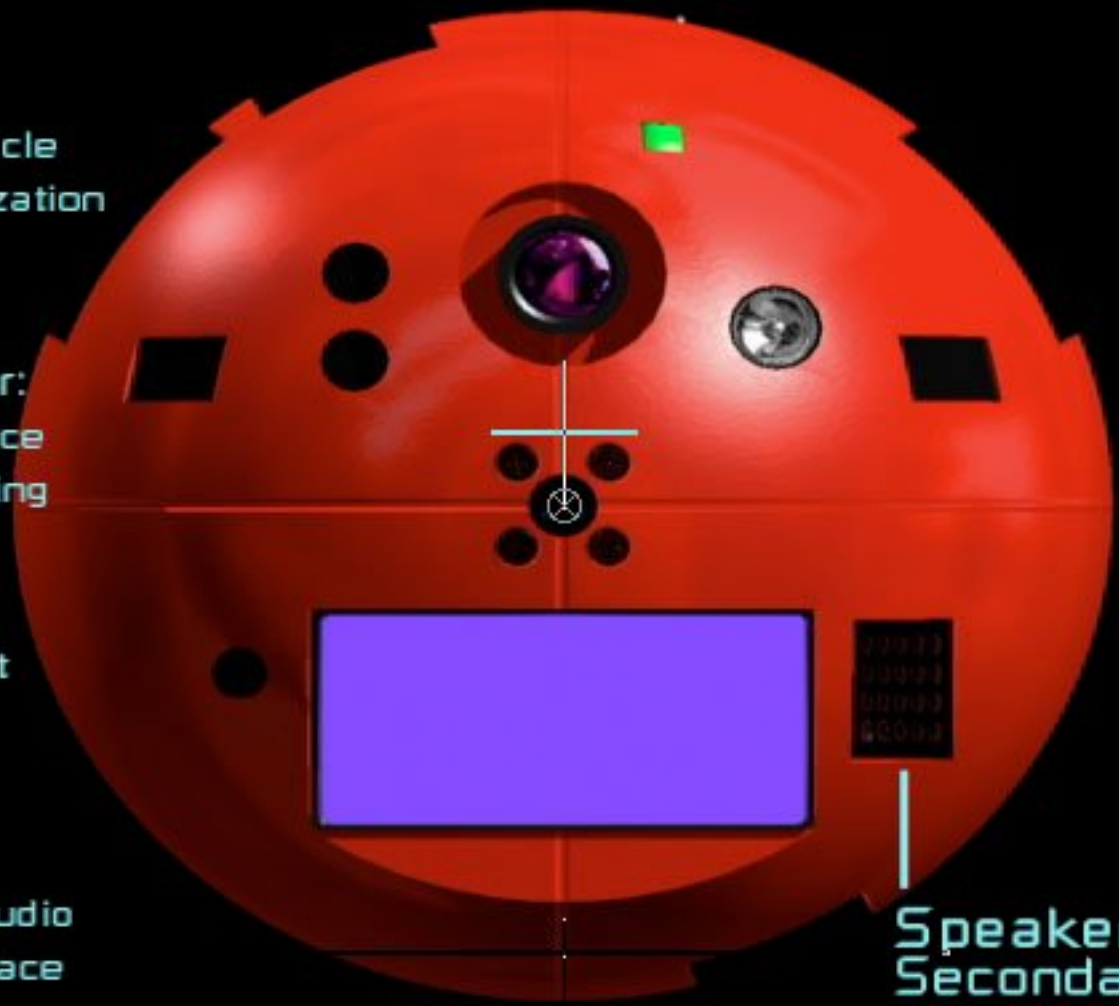
- "Immobile" Robots and Engineering Operations
  - Robust space probes, ubiquitous computing
- Robots That Navigate
  - Hallway robots, Field robots, Underwater explorers, stunt air vehicles
- Cooperating Robots
  - Cooperative Space/Air/Land/Underwater vehicles, distributed traffic networks, smart dust.

Accomplished by:

➢ Case studies, invited lectures & final projects.


Immobile Robots in Space

Portable Satellite Assistant



Range Finder :
Navigation, obstacle avoidance, localization support

Motion Detector:
Obstacle avoidance and remote sensing

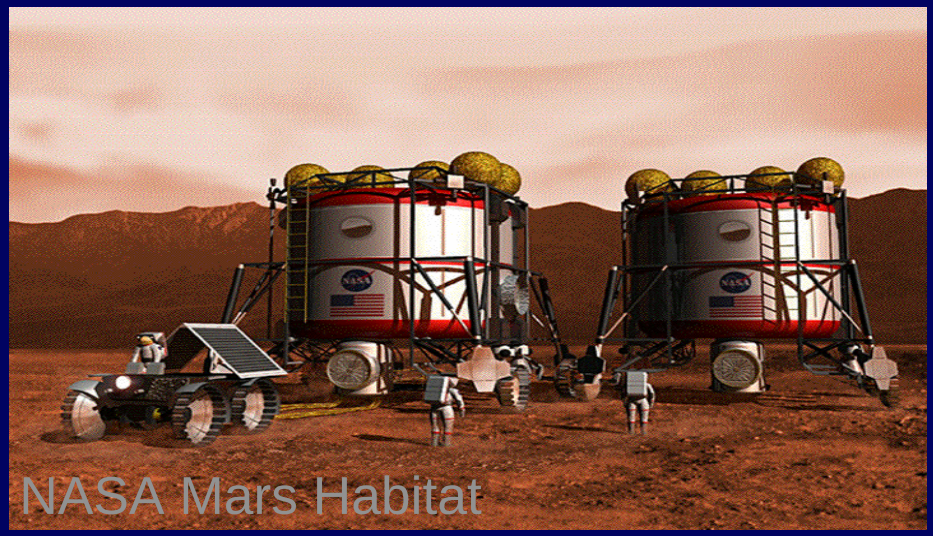
Thrust Port:
Microthrust duct fan locomotion

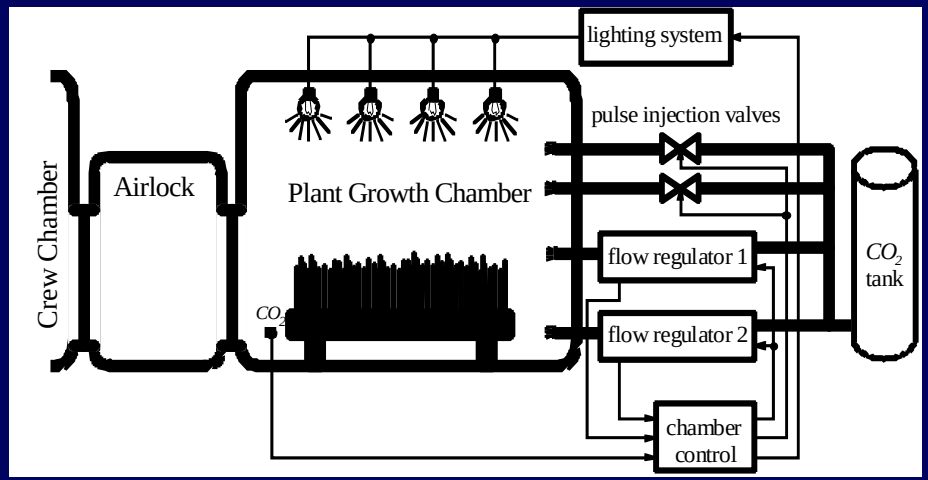
Microphone:
Primary Crew audio command interface

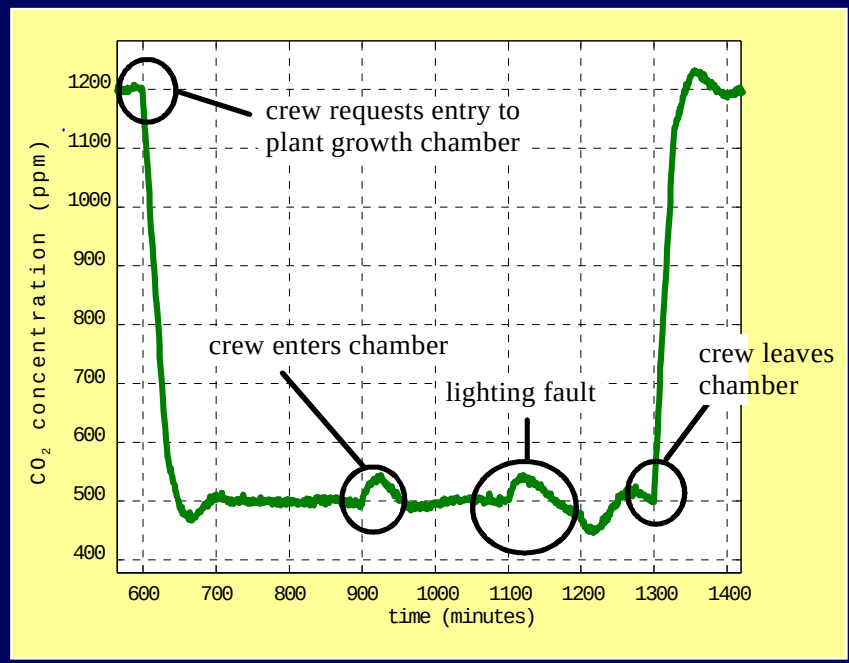
Speaker:
Secondary Crew output audio interface

courtesy NASA Ames

Autonomous Systems use Models to Anticipate or Detect Subtle Failures

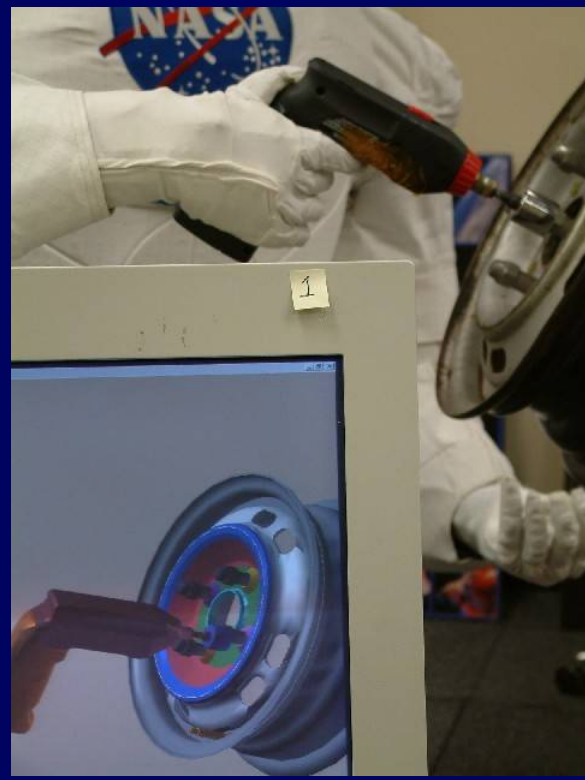






The Role of Robots in Human Exploration

Robonaut: Robotic Assistance For Orbital Assembly and Repair



Exploration by Quadrapeds and Bi-Peds
Marc Raibert, MIT Leg Lab & Boston Dynamics

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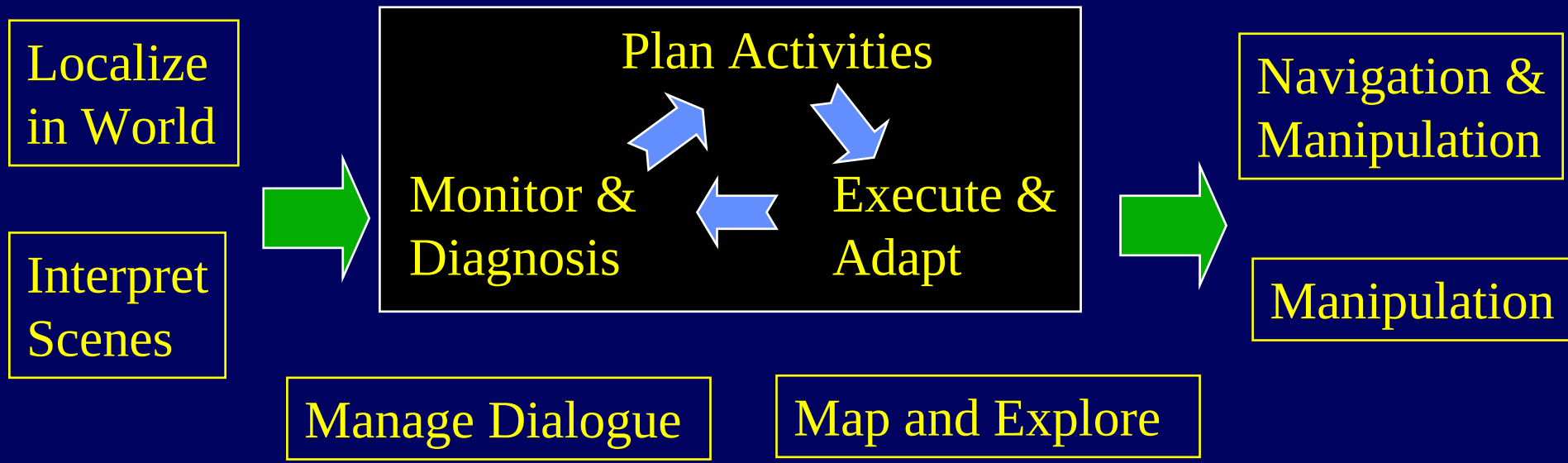
Course Objective 2

- To understand advanced methods for creating highly capable cognitive robots.



Accomplished by:

- Lectures on advanced core methods
- ~ Implement & empirically compare two core methods.

Lectures: Planning and Acting Robustly

Monitoring, and Diagnosis

- Diagnosing Multiple Faults
- Constraint-based Monitoring
- Hybrid Monitoring and Estimation

Planning Missions

- Planning using Informed Search
- Planning with Time and Resources
- Robust Plan Execution Through Dynamic Scheduling
- Reactive Planning and Execution

Lectures: Interacting With The World

Simultaneous Localization and Mapping

- Basic SLAM
- Vision-based SLAM

Cognitive Vision

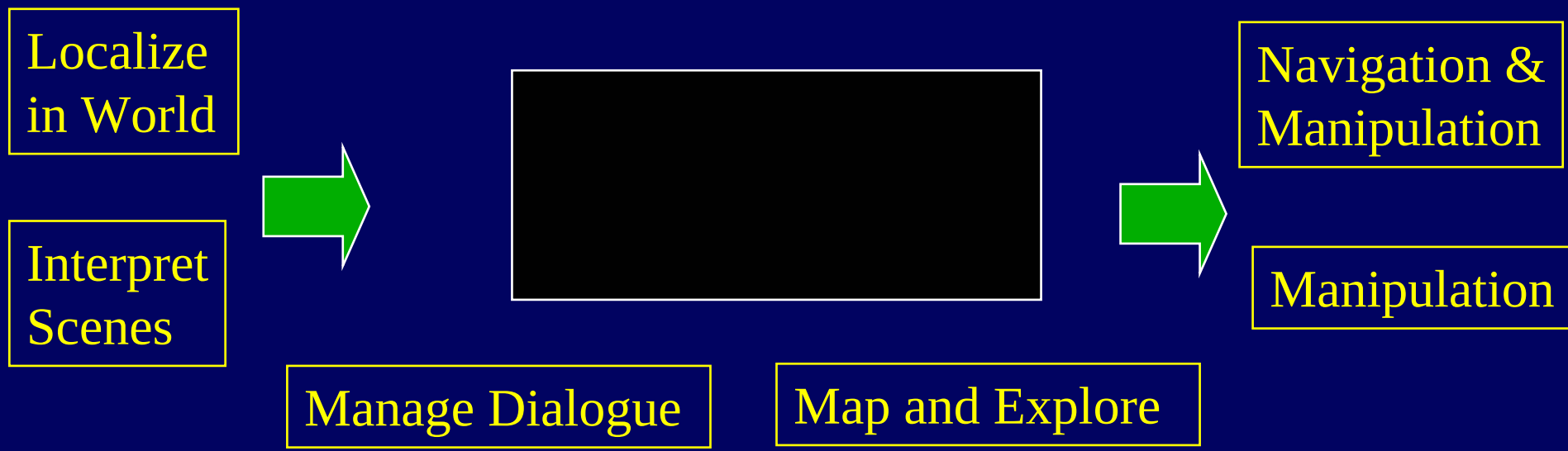
- Visual Interpretation using Probabilistic Grammars
- Context-based Vision

Navigation & Manipulation

- Probabilistic Path Planning
- Exploring Unknown Environments

Human - Robot Interaction

- Discourse Management & Nursebot
- Social Robotics



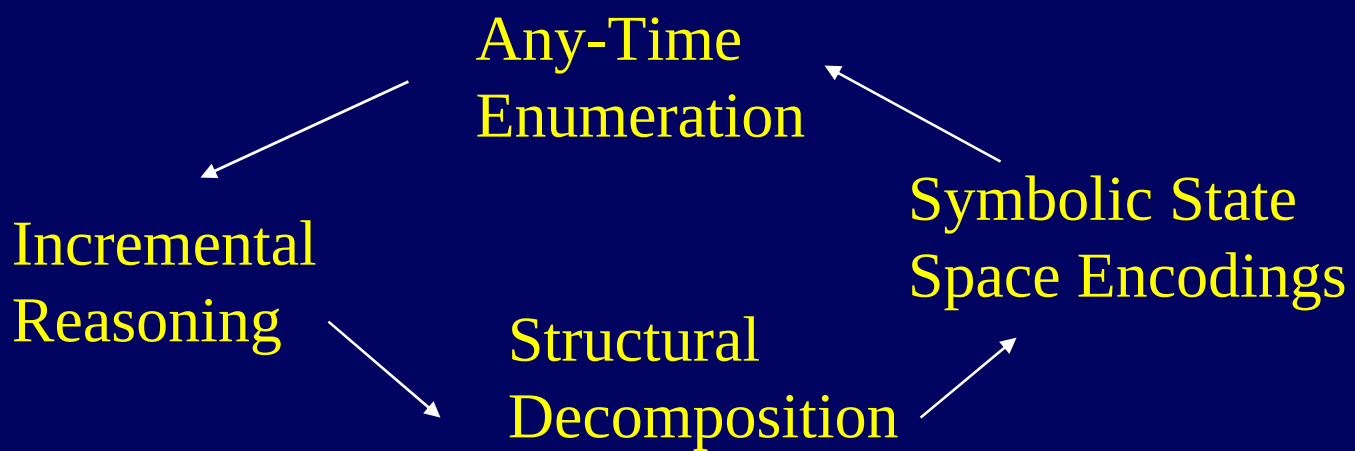
Lectures: Fast, Large-scale Reasoning

Optimality and Soft Constraints

- Optimal CSPs and Conflict-Learning
- Valued CSPs and Dynamic Programming
- Solving CSPS through Tree Decomposition

Incremental Methods

- Incremental Satisfiability
- Incremental Scheduling
- Incremental Path Planning



Topics On Cognitive Robot Capabilities

- Robots that Plan and Act in the World
  - Robots that Deftly Navigate
  - Planning and Executing Complex Missions
- Robots that Are State-Aware
  - Robots that Find Their Way In The World
  - Robots that Deduce Their Internal State
- Robots that Preplan For An Uncertain Future
  - Theoretic Planning in a Hidden World
  - State and Fault Aware Systems

Course Objective 3

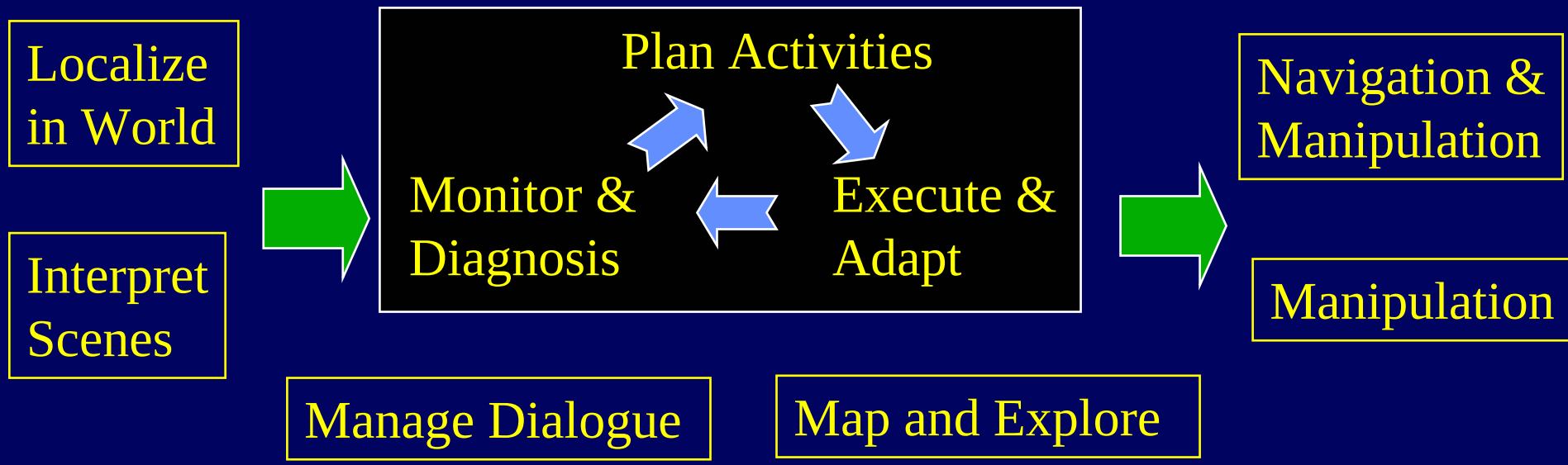
- To dive into the recent literature, and collectively synthesize, clearly explain and evaluate the state of the art in cognitive robotics.

Accomplished by:

- Group lectures on advance topic
  - One 40 minute lecture per student
  - tutorial article on ~2 methods, to support lectures.
  - Groups of size ~2.

Course Objective 4

To apply one or more core reasoning methods to create a simple agent that is driven by goals or rewards



Accomplished by: Final project during half of course

- Implement and demonstrate one or more reasoning methods in a simple cognitive robot scenario (simulated or hardware).
- Final project report.
- Short project demonstration.

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