Robotics

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Manipulator robots

MOBILE ROBOTS

Legged robots

Snake robots

ASSEMBLY ROBOTS

PAINTING ROBOTS

MINIMALLY-INVASIVE ROBOTIC SURGERY

Mars exploration

$\mathcal{S}$pace $\mathfrak{R}$obots

SERVICE ROBOTS

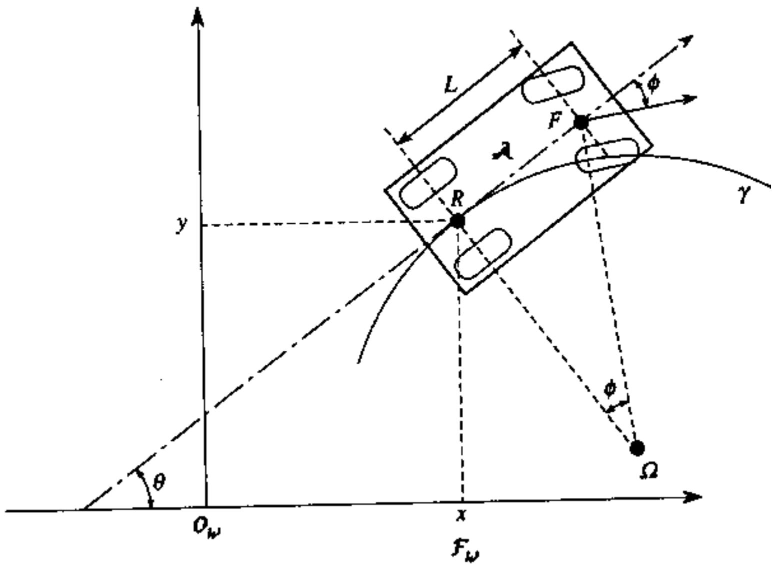
Androids

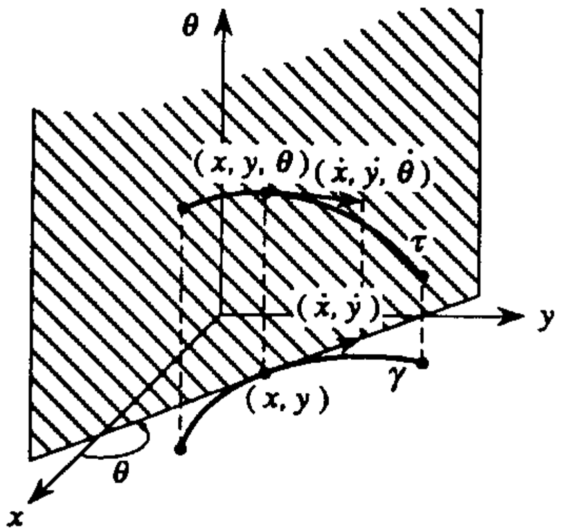
A robot is a programmable machine that achieves tasks by physically interacting with an environment, e.g., by exerting forces.

Action	Controllability Achievability
Sensing	Observability Recognizability
Reasoning	Complexity

The Controllability Issue: Car-Like Robots

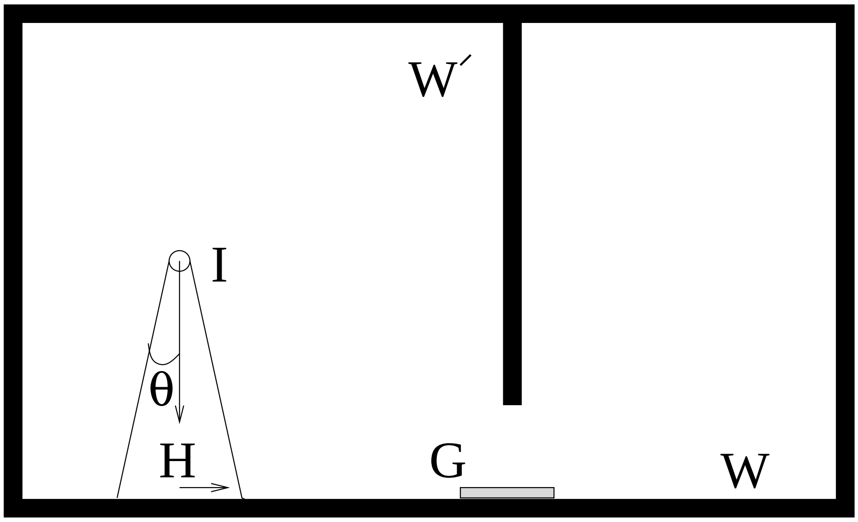
A robot (a system) is **controllable** if from any conguration q, the robot can achieve any configuration in a neighborhood $\mathcal{U}$ of q without leaving $\mathcal{U}$.

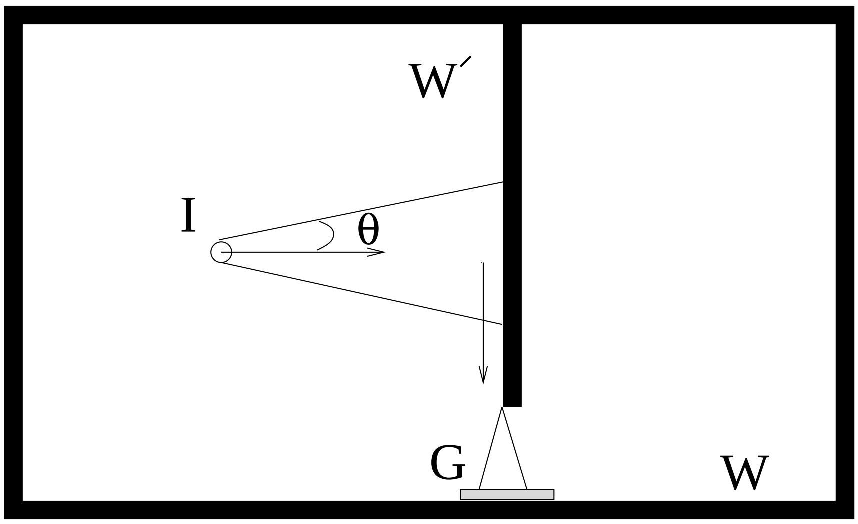




The Rewcognizability Issue: Mobile Robot Navigation

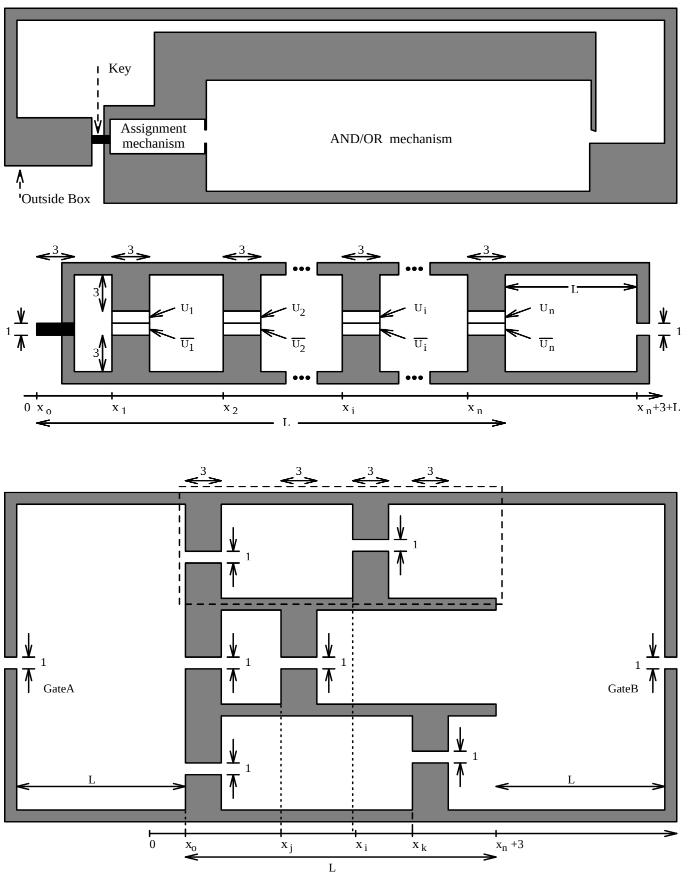
Robot sensing and motion control are imperfect. How to recognize states?



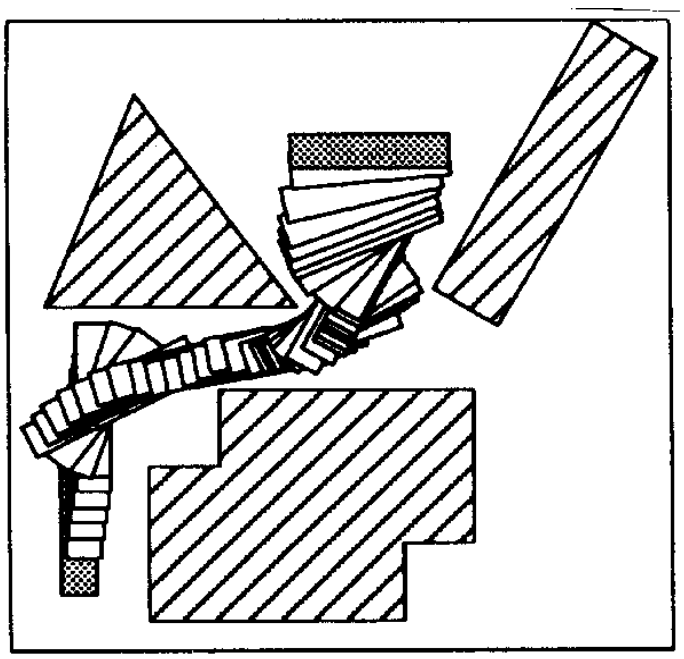


The Complexity Issue: Partitioning an Assembly is NP-Hard

Environments can be set up such that achieving a task is at least as hard as solving a computationally hard problem (e.g., 3-SAT).



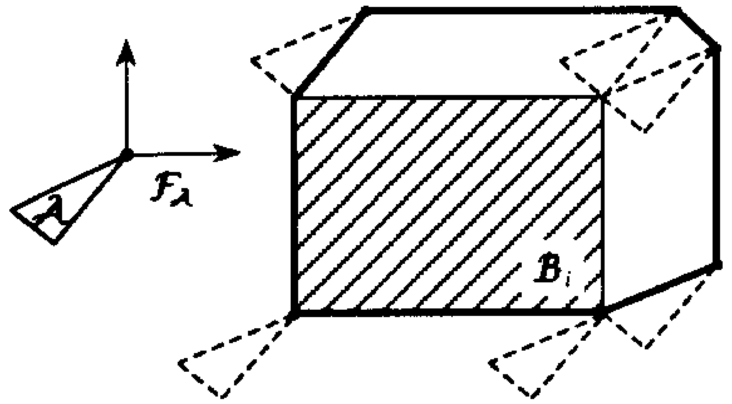
Motion Planning

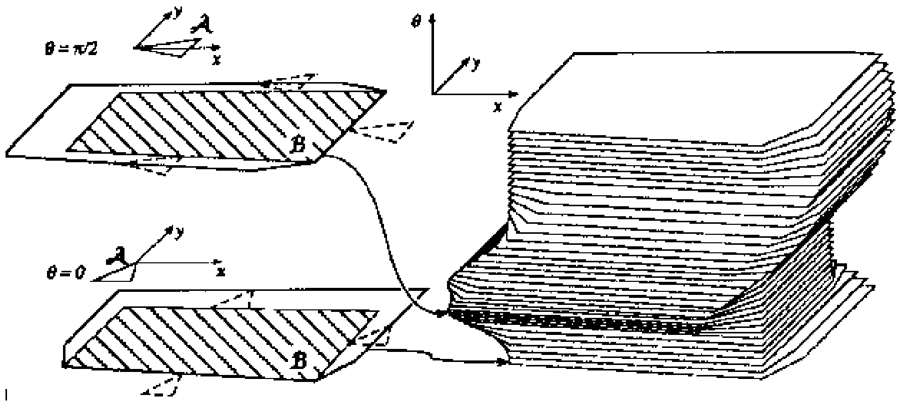


Some variants:

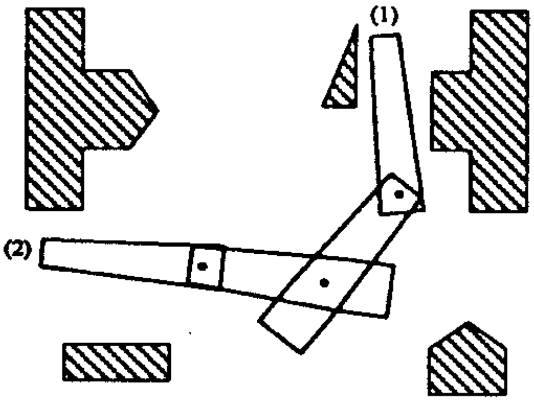
- Motion planning with moving obstacles
- Motion planning in unknown environment
- Motion planning with uncertainty in control and sensing
- Assembly planning
- Motion planning with visibility constraints

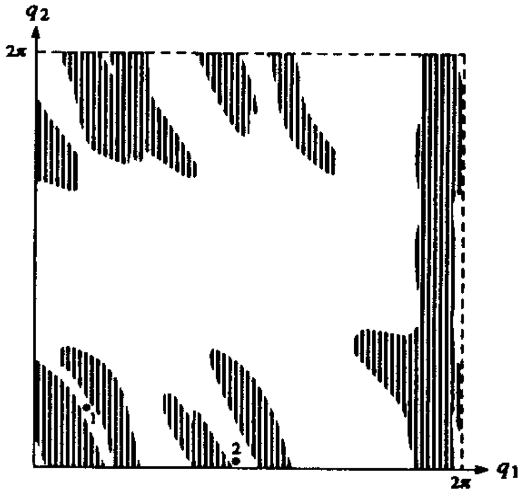
Configuration Space
(Rigid Object)



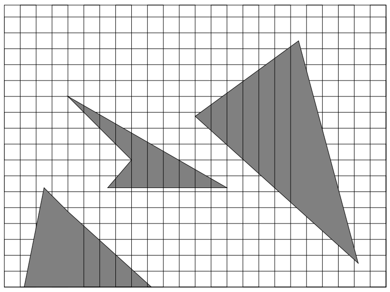


Configuration Space
(Articulated Object)

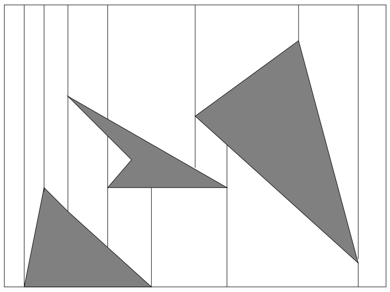




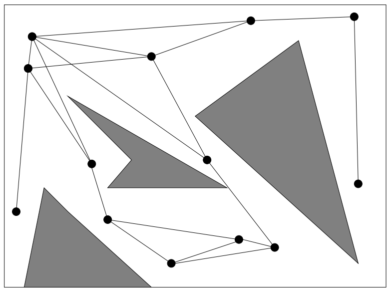
Planning Paradigms



Grid techniques + Potential Fields



Exact Cell Decomposition

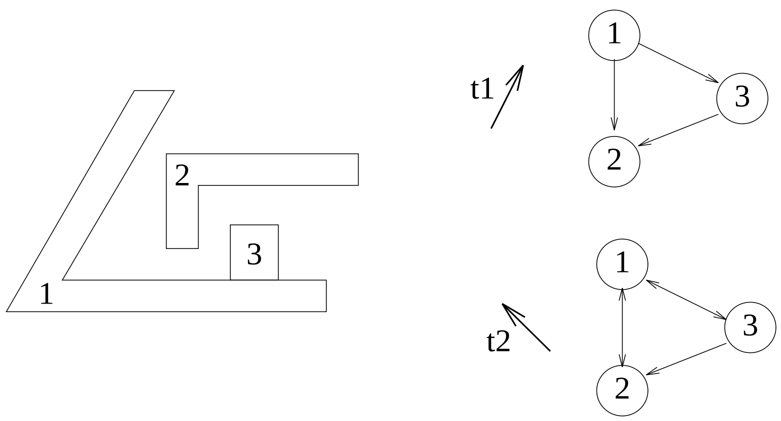


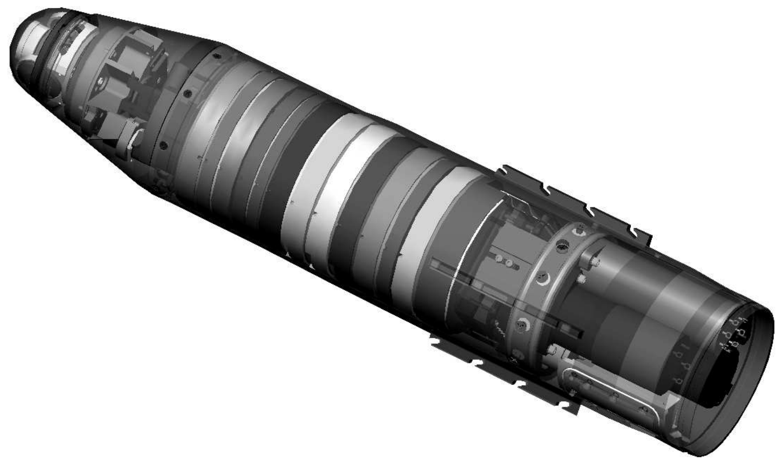
Probabilistic Roadmaps

Projects

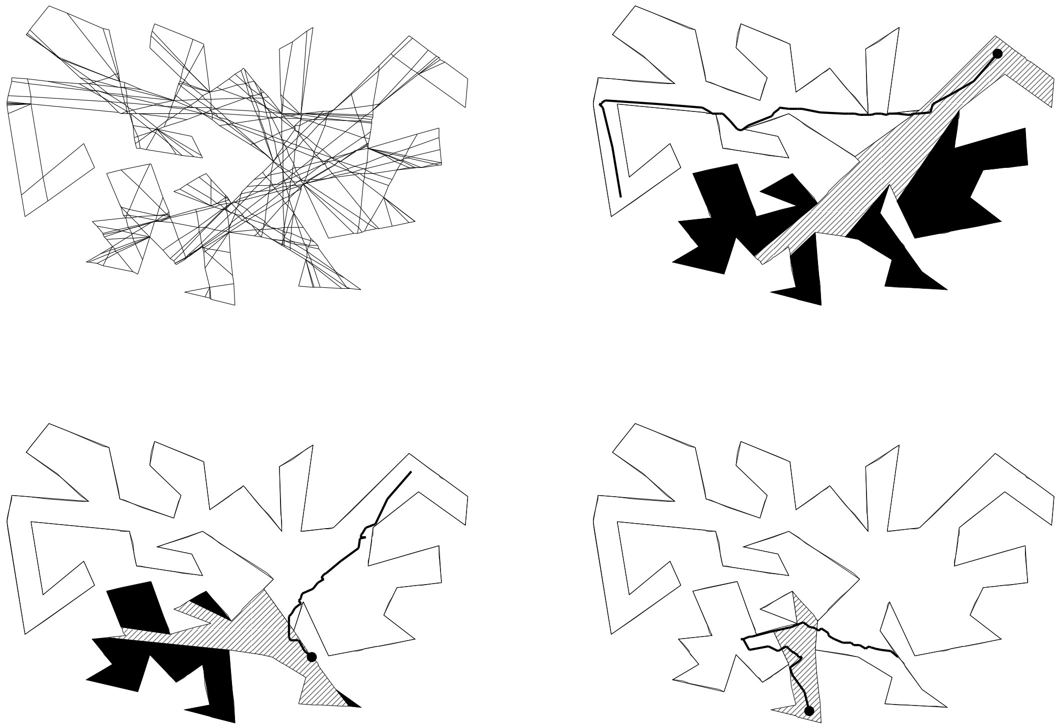
- Probabilistic roadmaps
- Assembly planning
- Autonomous observer
- Digital actors
- Robotic surgery
- Drug design

Assembly Planning

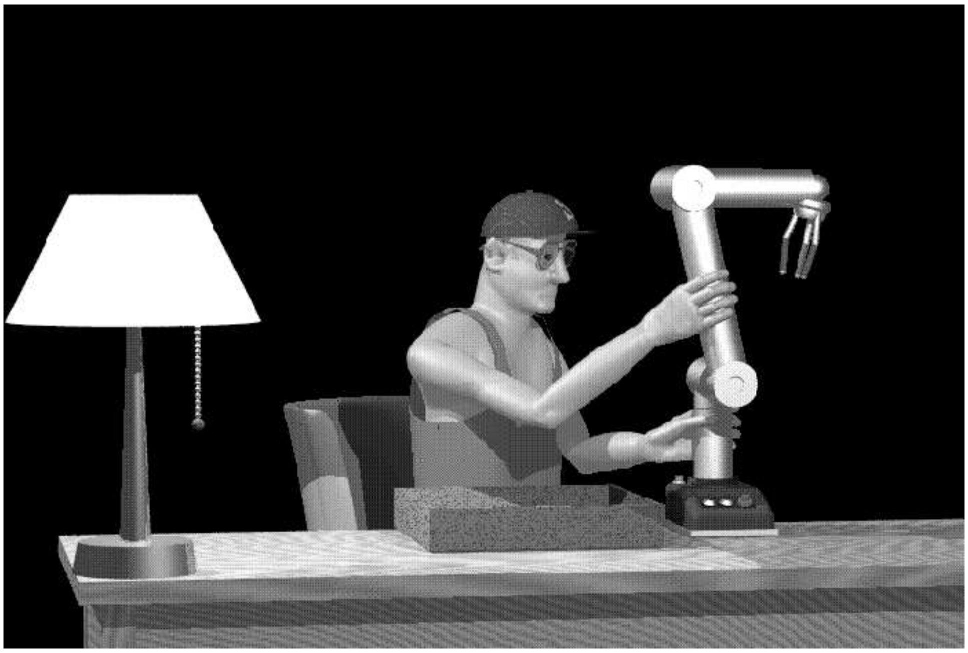




Autonomous Observer: Target Tracking



Digital Actors



Stereotactic Radiosurgery of the Brain