Introduction to Artificial Intelligence
COMP 3501 / COMP 4704-4
Lecture 16: Robotics

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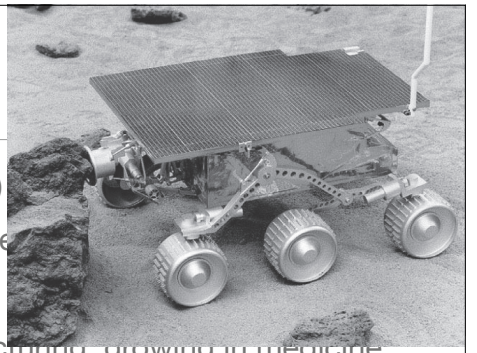
Today

- Finish up examples of RL
- Robotics
  - Most a high-level overview of concepts

Robotics (Ch 25)

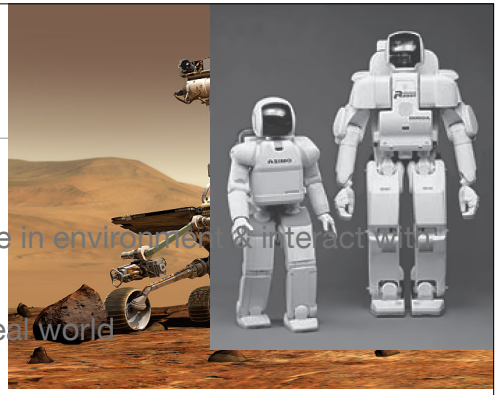
- So far we have only talked about software agents
- Robots are physical agents
  - Move and manipulate objects in the physical world
  - A variety of sensors
    - Cameras (Ch 24 - vision)
    - Laser range-finders
    - Gyroscopes, accelerometers
      - Getting much cheaper

Robot Categories



- Manipulators (robot arms)
  - Anchored to work space
  - Manipulable joints (turn
  - Widely used in manufacturing, growing in medicine
- Mobile robots
  - Used for loading docks in Australia
  - Mars exploration rovers
  - Unmanned air vehicles (UAVs)

Robot Categories



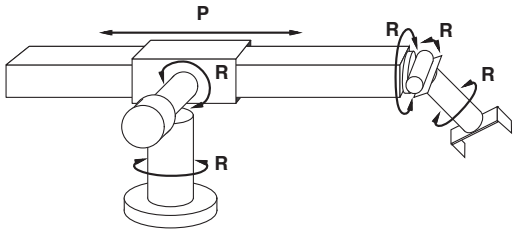
- Mobile Manipulator
  - Robots that can move in environment & interact with it
  - Must cope with the real world
    - Uncertain sensing
    - Uncertain locations
    - Uncertain actions

Robot Hardware - Sensors

- Passive
  - Cameras - capture observations
- Active
  - Sonar, laser range finders - actively probe
  - GPS

Robot Hardware - Effectors

- Means of manipulating robot & environment
- Effectors have degrees of freedom (DOF)
  - Represent location with 3-d location & 3 rotations



Robot Hardware - Effectors

- Mobile robots may be limited by hardware
  - A car has three effective degrees of freedom
    - Can only control two at once
    - Thus is nonholonomic
  - A round robot with differential drive can turn in place
    - Is it holonomic?

Robot Hardware - Effectors

- A robot is statically stable if it can remain upright when not moving
- A robot is dynamically stable if it can remain upright when moving around

Robotic Perception

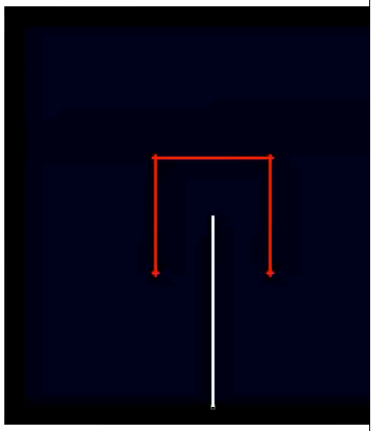
- Robotic measurements are noisy
  - Difficult to compare to “ground truth”
  - Use techniques from Ch 15
    - Kalman filters, hidden markov models
    - Estimate current location

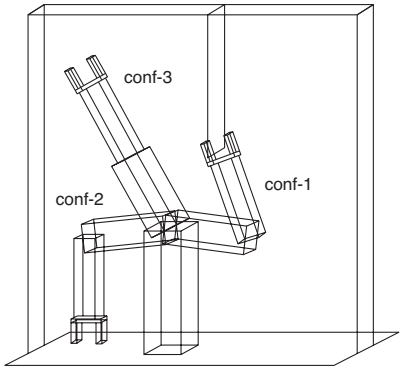
Robotic Perception

- Common tasks include
  - Localization
    - Finding obstacles and location relative to obstacles
  - Mapping
    - Building a model of the world
- Many SLAM algorithms
  - Perform both simultaneosly

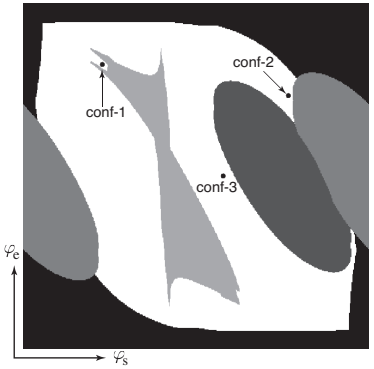
Robotic Planning

- Consider moving a robotic arm
- Workspace representation
  - x/y coordinates of arm
- Configuration representation
  - Angles of joints
- Often need to switch between representations





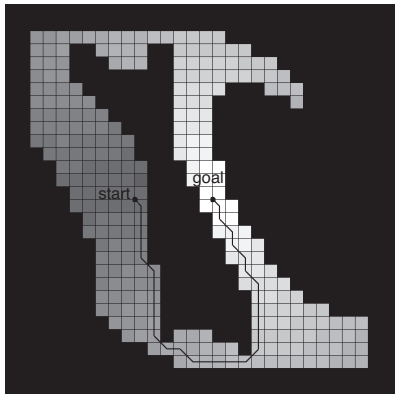
Workspace

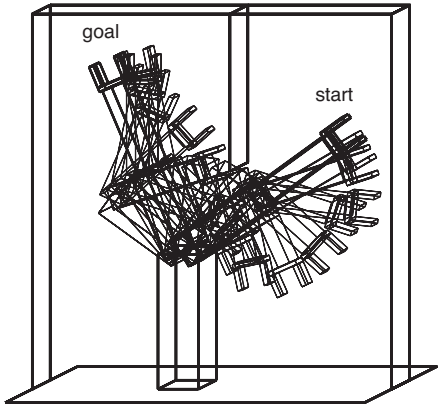


Configuration Space

Possible Representations

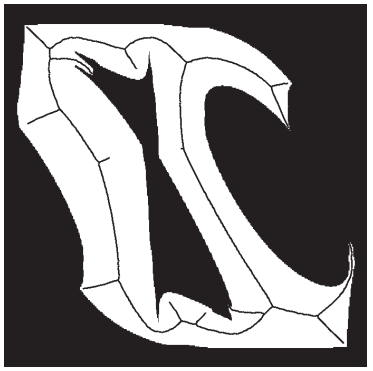
- Cell decomposition

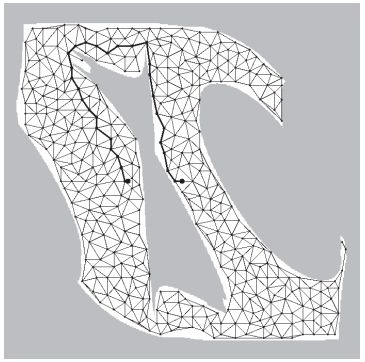




Possible Representations

- Skeletonization
  - Voronoi graphs / probabilistic roadmaps

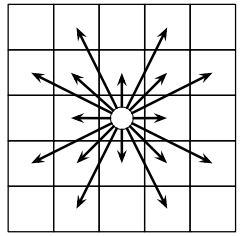




Motion Planning

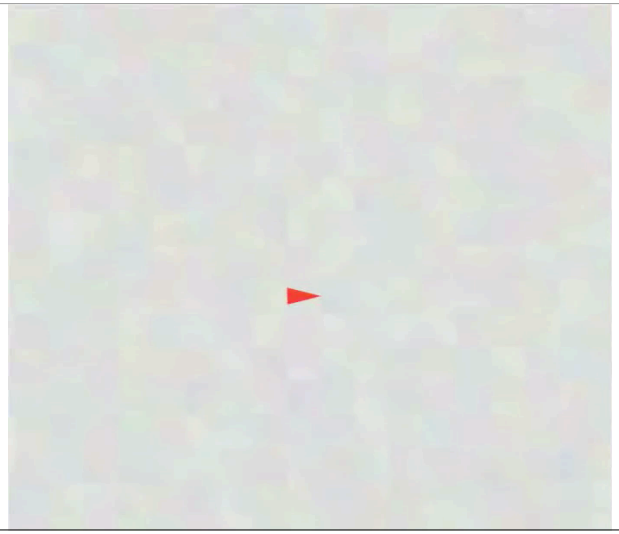
- Planning space is possibly real-valued
- Use high-level primi model possible mov
- Expensive to plan m short distances

Vehicle Model



- 16 possible headings (22.5°)
- Move forward/reverse
  - 5 possible speeds:
    - {-1, 0, 1, 2, 3}
  - Change speed by 2 per action
  - Possible turns:
    - {2, 0, 3, 1, 0}
- 80x blow-up of search space

Vehicle Model



Grand Challenges

- DARPA Challenges
  - 2004, 2005
    - Desert
  - 2007
    - Urban Challenge
- Google Car