

Robotics

July 26, 2005

CS 486/686

University of Waterloo

Outline

- Robotics
 - Perception
 - Planning
- Reading: R&N Sect. 25.1-25.4

Robots

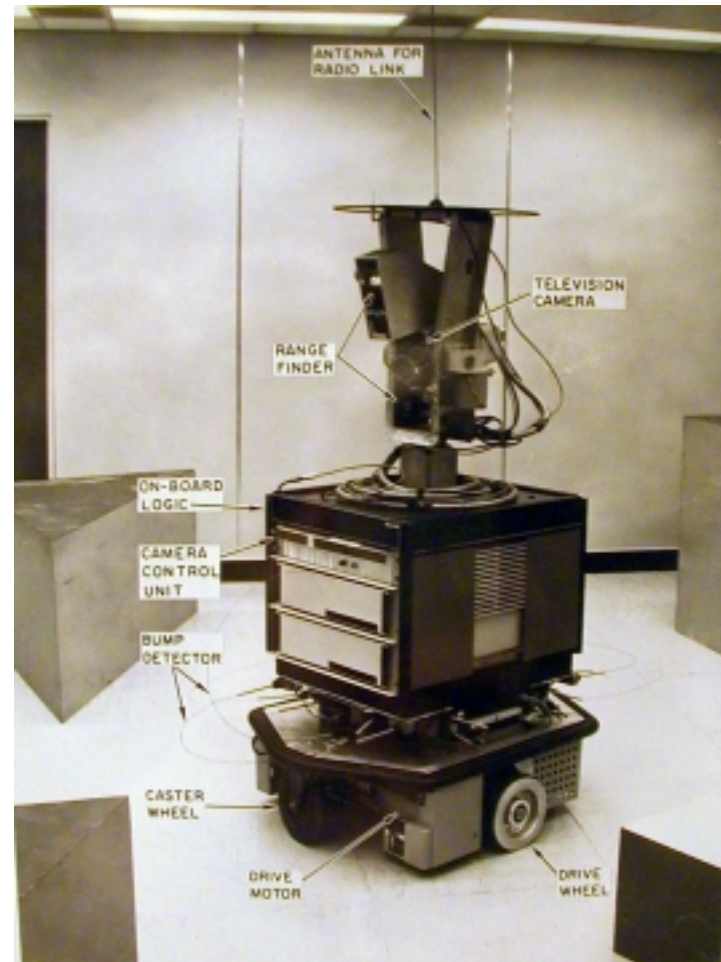
- Manipulators
 - Physically anchored
 - Most industrial robots
 - Assembly lines

Robots

- Mobile robots
 - Shakey the robot (SRI 1968)
 - First mobile robot
 - Service robots (CMU's Minerva)
 - Museum tour guide robot
 - Unmanned land vehicle (NavLab)
 - Autonomous highway driving
 - Unmanned air vehicles
 - Surveillance, crop-spraying, military operations
 - Autonomous underwater vehicles
 - Deep see exploration
 - Planetary rovers (Nasa's Sojourner)

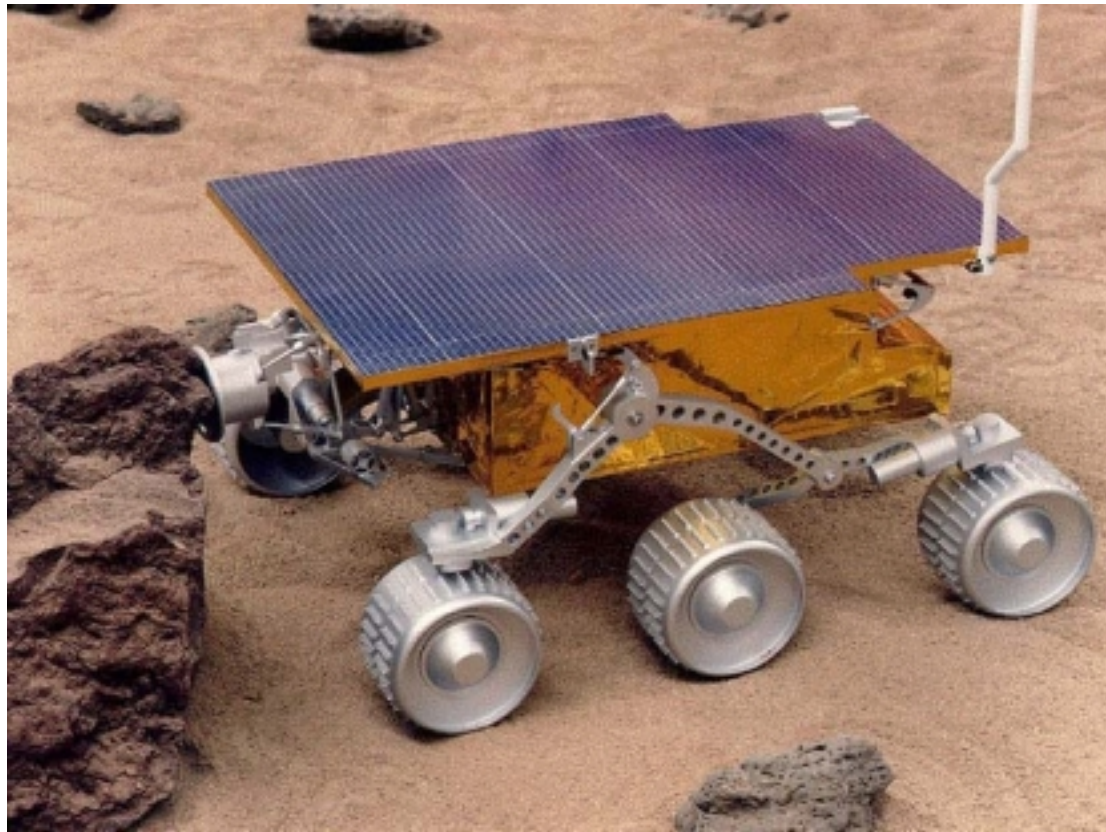
Shakey the robot

- First mobile robot (SRI 1968)



Nasa's Sojourner

- Planetary rover



Honda's P3 and Asimo

- Humanoid robots



Robot Hardware

- Sensors

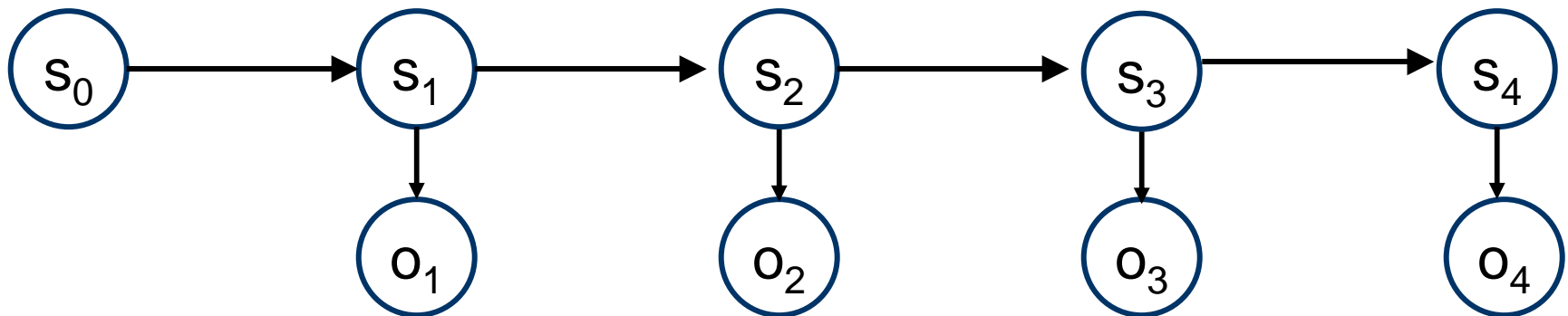
- Range finders (sonars, lasers)
- Tactile sensors
- GPS
- Imaging (video cameras)
- Proprioceptive sensors (odometry)
- Microphones

Range scan example



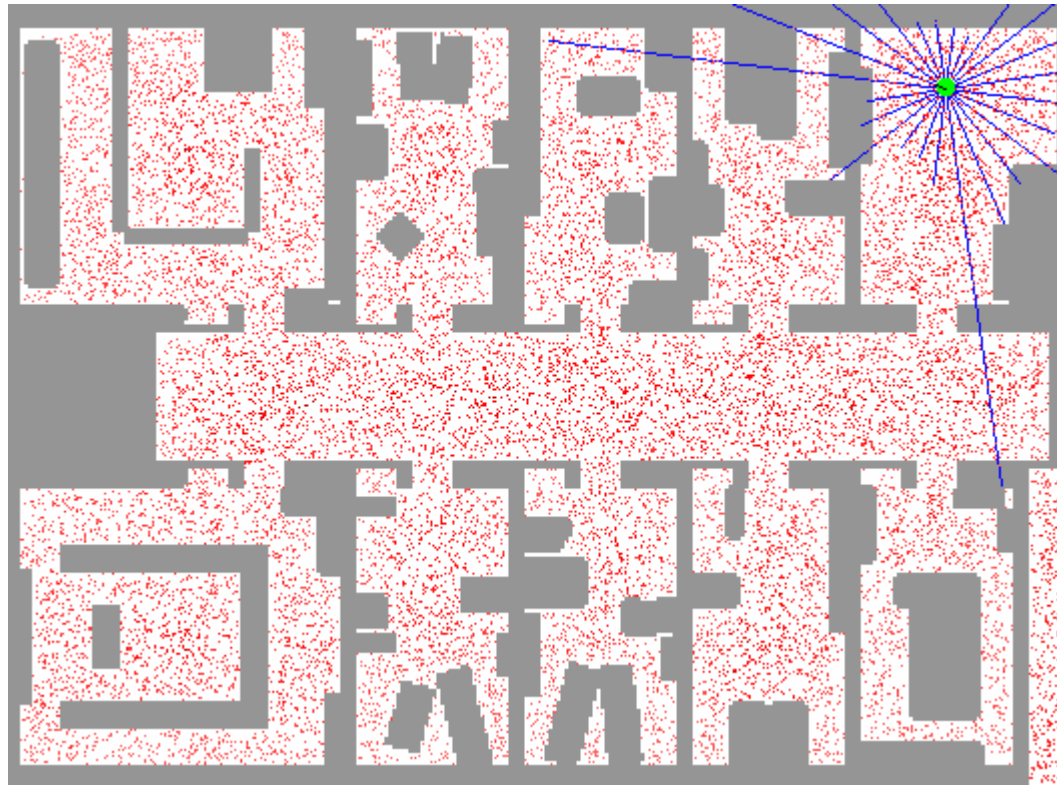
Robotic Perception

- Challenge: noisy sensors
- What statistical model should we use to infer the state of the world?
- HMMs (or DBNs)



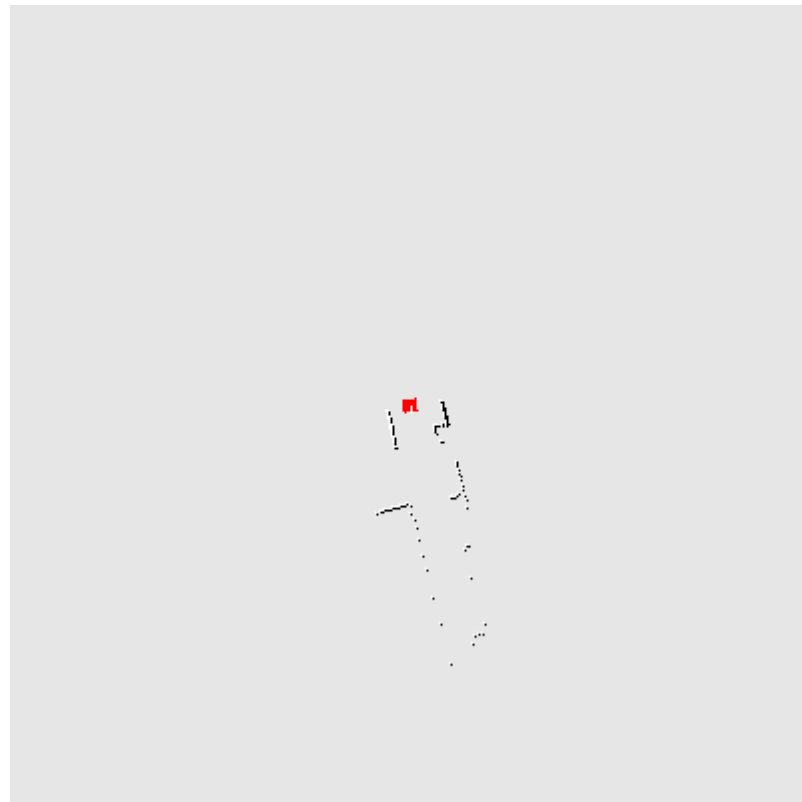
Robot Localisation

- Sebastian Thrun
- <http://robots.stanford.edu/movies/sca80a0.avi>



Simultaneous mapping and localisation

- <http://robots.stanford.edu/movies/mapping1-new.avi>
- Sebastian Thrun

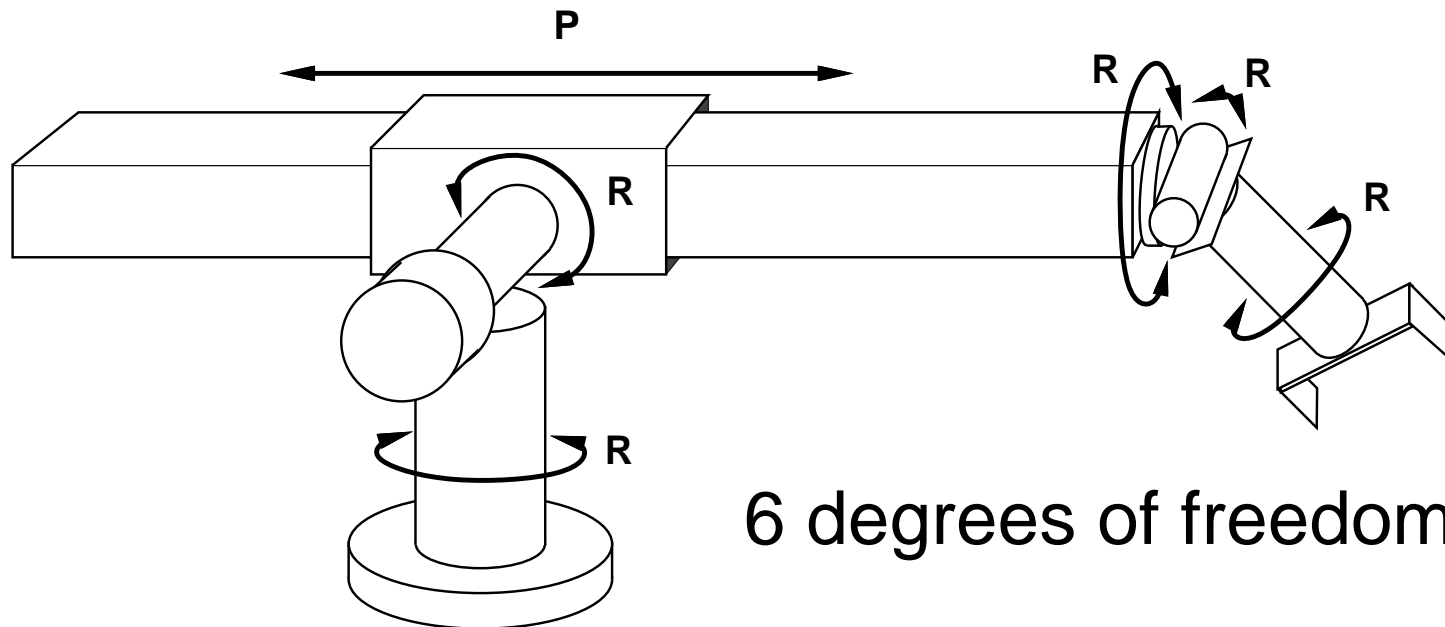


Robot Hardware

- Effectors
 - Revolute joints and prismatic joints
 - Grippers
 - Wheels
 - Legs
 - Speakers

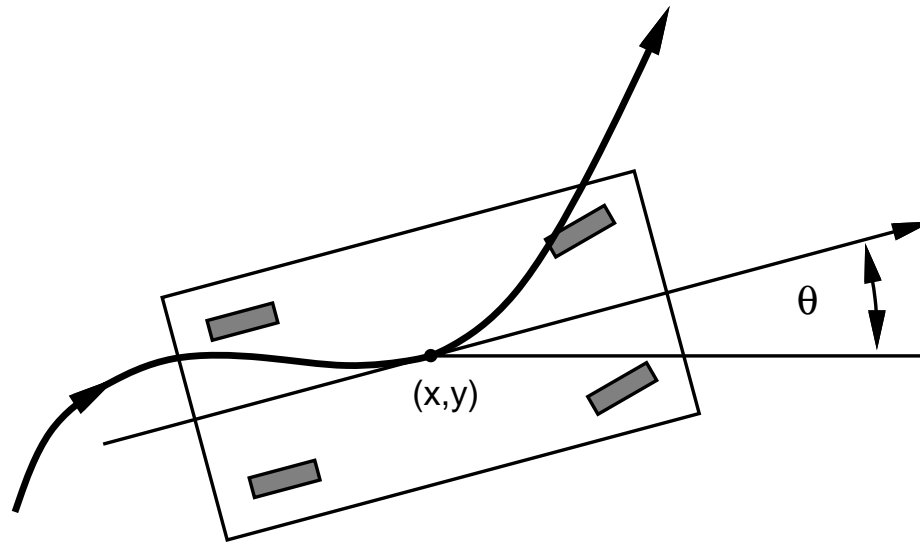
Degrees of Freedom

- A robot has one degree of freedom for each independent direction of movement



Degrees of Freedom

- How many degrees of freedom (DOF) does a car have?
 - 3 **effective DOF**: x , y , orientation
 - 2 **controllable DOF**



Degrees of Freedom

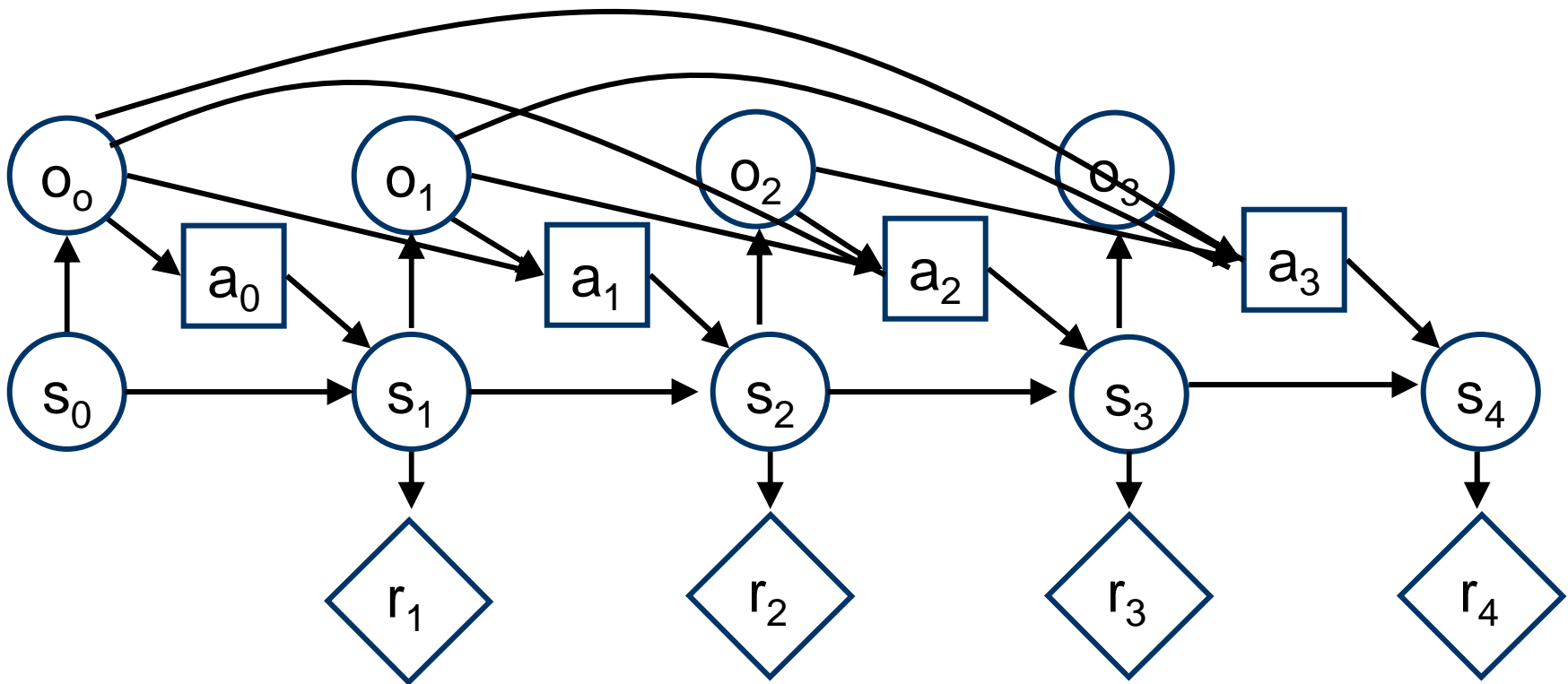
- **Holonomic robots:**
 - # effective DOF = # controllable DOF
 - Most robot arms
 - Easy to control
 - Complex mechanics
- **Non-holonomic robots**
 - # effective DOF > # controllable DOF
 - Most mobile robots
 - Harder to control
 - Simple mechanics

Planning

- Challenge:
 - Noisy sensors
 - Uncertain action effects
- What statistical model can we use?
 - Partially observable Markov decision process (POMDP)
 - Dynamic decision network (DDN)

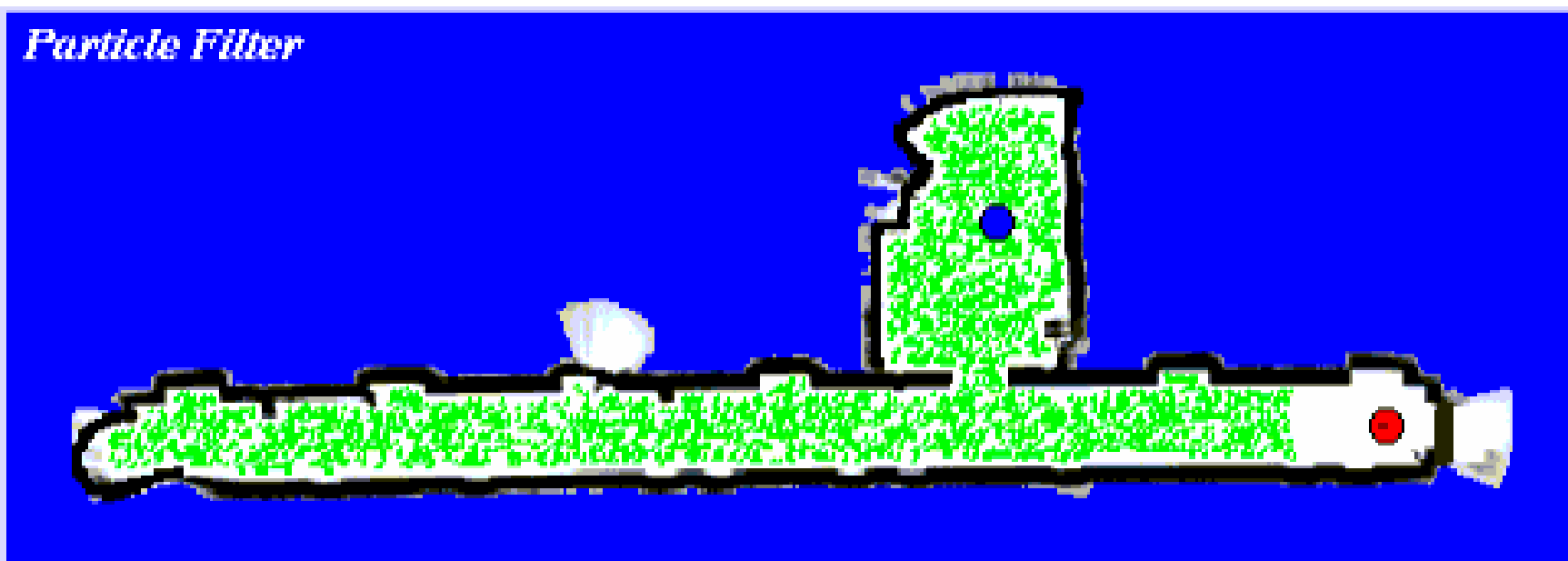
POMDP (or DDN)

- Graphical Representation



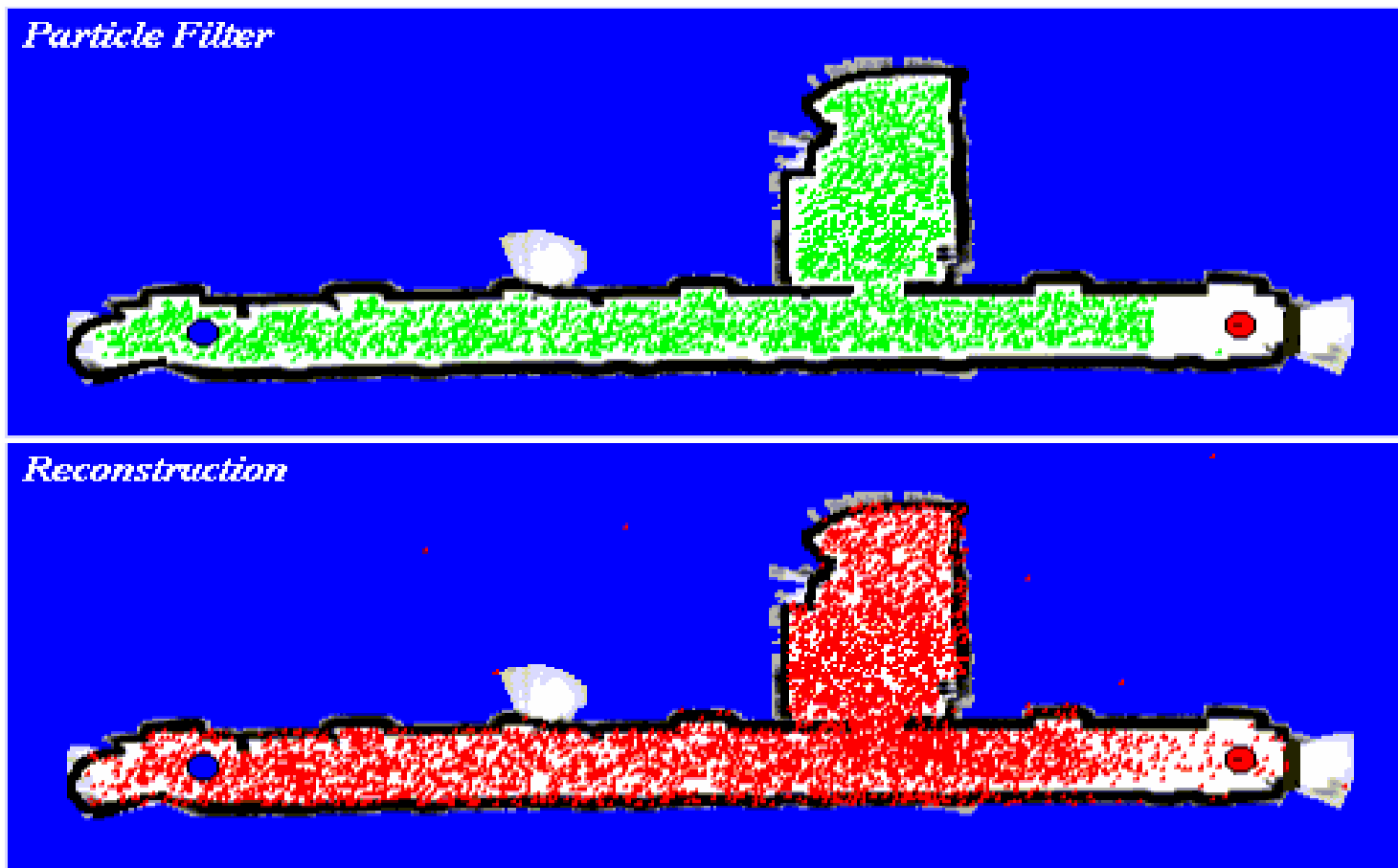
Greedy Patient Finding

- Sebastian Thrun
- <http://robots.stanford.edu/movies/bad.people.avi>



POMDP Patient Finding

- Sebastian Thrun
- <http://robots.stanford.edu/movies/good.people.avi>



Other subfields of Robotics

- Mechanics
 - Hardware engineering
- Control
 - Form of planning
 - Mainly concerned with “stability”

Next Class

- Next Class:
 - Course wrap up
 - Final exam info
 - Other AI courses