Introduction to Robot Perception and Learning

Nived Chebrolu

Slides adapted from Cyrill Stachniss at University of Bonn.

Autonomous Mobile Systems

Two Fundamental Questions in Robotics

- What is the state of the world?

State Estimation

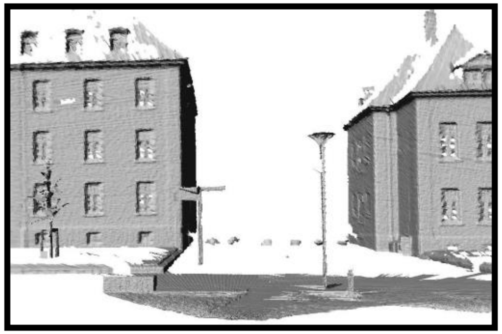
- Which action to execute?

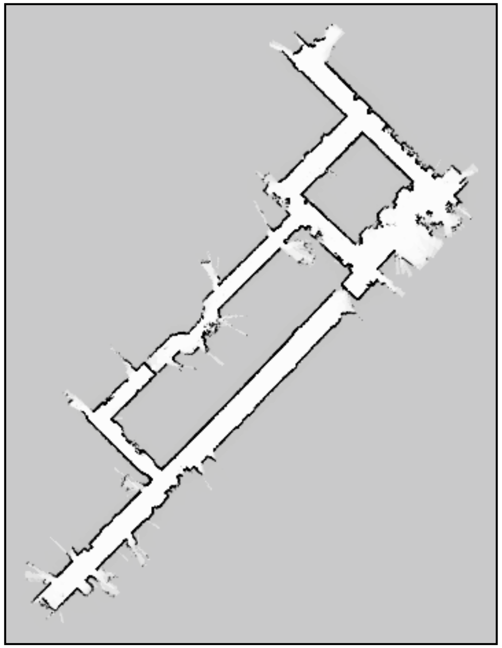
Action Selection

Robot Perception: Sensors

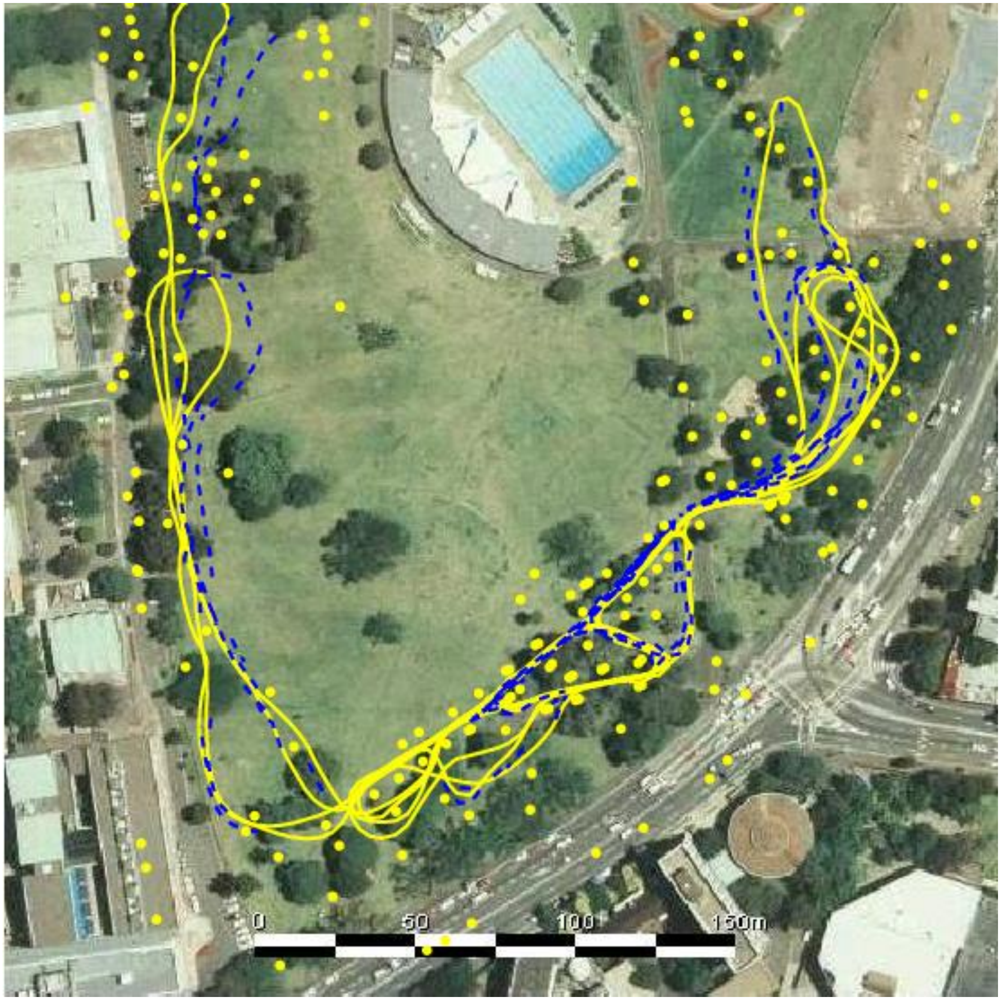
Courtesy: Matrix Vision, FLIR, Microsoft, Hokuyo, Velodyne

Robot Perception : Maps that capture Geometry



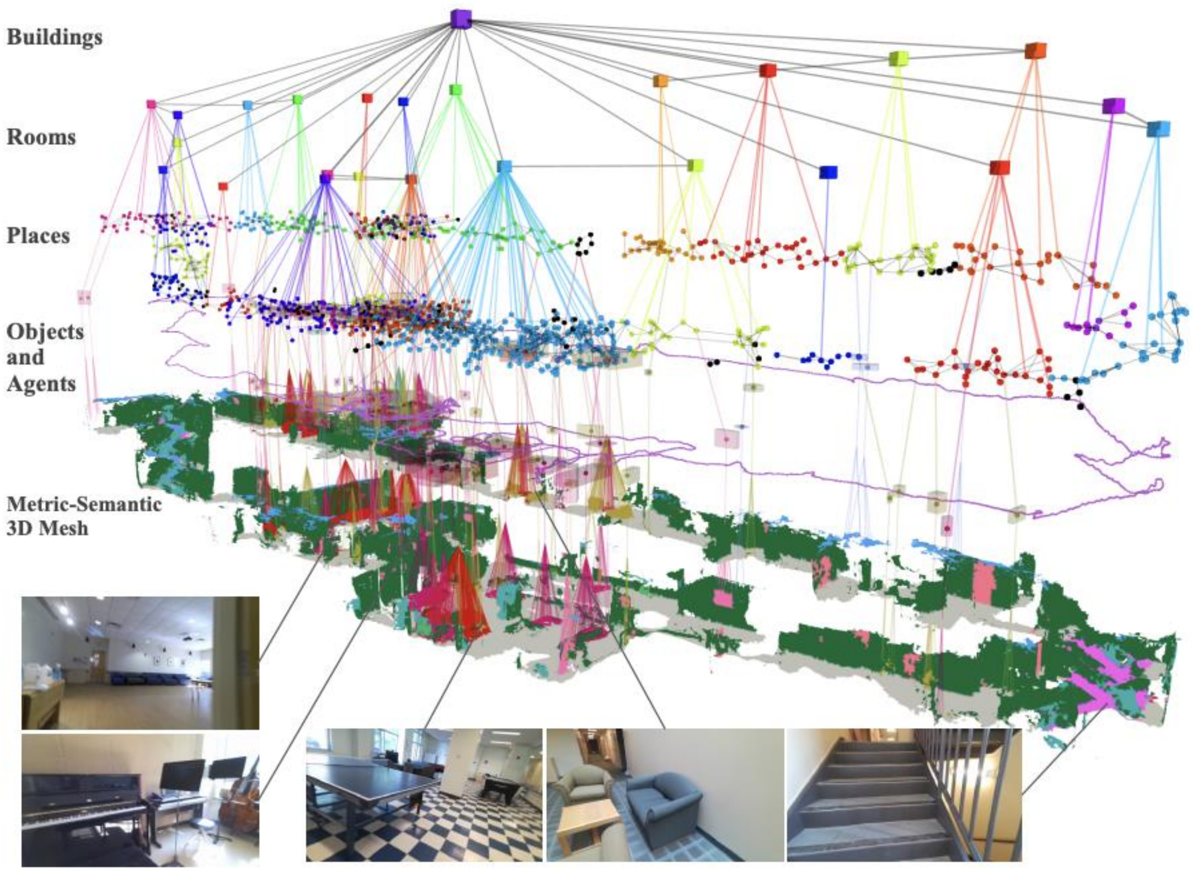


Courtesy: D. Hähnel



Courtesy: E. Nebot

Robot Perception: Maps that capture Semantics



Courtesy: N Hughes et al

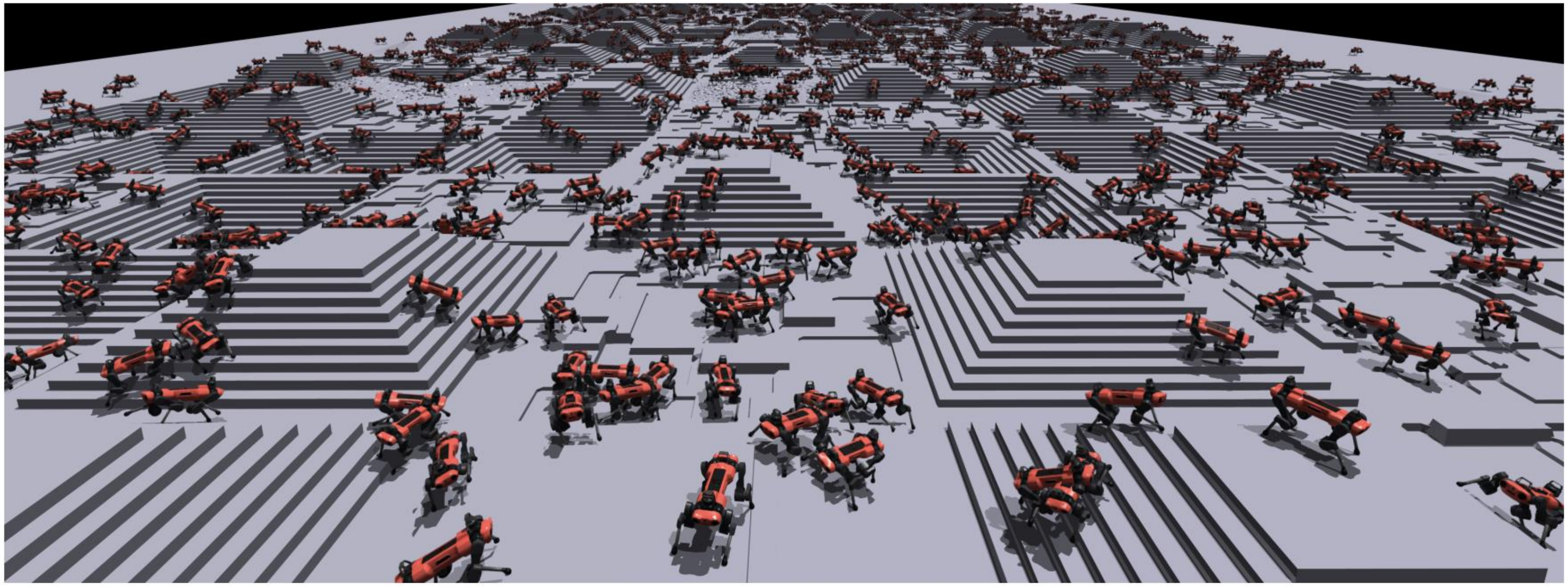
Robot Learning

- Learning Perception

Courtesy: Cityscapes dataset

Robot Learning

- Learning dynamics and controls



Courtesy: N. Rudin

Robot Learning

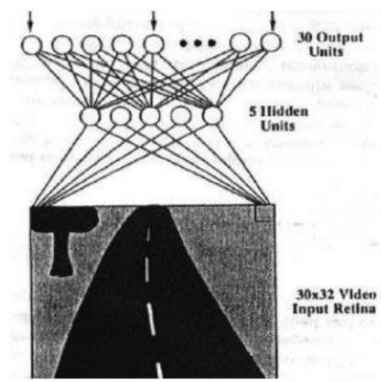
- Learning from demonstrations

Deep Imitation Learning in 1989

- A CMU paper!
  - CMU has incubated many self-driving companies

ALVINN:
AN AUTONOMOUS LAND VEHICLE IN A NEURAL NETWORK

Dean A. Pomerleau
Computer Science Department
Carnegie Mellon University
Pittsburgh, PA 15213



Topics of This Course

- Probabilistic Robotics
  - Recursive state estimation
  - Locomotion
  - Motion and observation models
  - Extended Kalman filter & EKF localization
  - Particle filter & Monte Carlo localization

- Mapping and SLAM
  - Occupancy grid mapping
  - EKF SLAM
  - Graph SLAM
  - Map representations
  - SLAM frontends

Topics of This Course

- Planning and Decision Making
  - Motion Planning
  - Planning under uncertainty
  - Exploration
  - Informative path planning

- Robot Learning
  - Learning perception capabilities
  - Learning from demonstrations
  - Reinforcement learning
  - Sequence models, visual-language-action models

Formal Aspects

Course Evaluation

- Mid-semester Exam: 15%
- End-semester Exam: 15%
- Assignments (4): 40%
- Labs (4): 20%
- Attendance/Quizzes: 10%
- Minimum attendance of 80%
- Note: Exams will be a combination of coding and theory problems

Assignments

- Deadline given on the assignments
- All assignments must be done **individually**
- Assignments are a mix of **coding** and **analysis**
- **Viva** for each assignment in the lab session
- Assignment/submission via Moodle
- See policy for using external resources and AI tools on the course website

Labs

- Labs will be done in groups of **two**
- **Demonstrate** the algorithms developed in the assignments on robot hardware
- **Evaluation** will happen during lab sessions
- **Tue/Fri** for half of the groups
- **Mon** sessions are open to all, TA and Instructor hours

Coding

- Building intelligent systems requires programming
- Python – the new de-facto standard for scientific programming and prototyping
- Python will be used for the exercises in this course

Announcements

- First lab session will be **next Monday**, **Aug 3rd** at **8:15 AM** at **SL3**, **CC Bldg.**
- **Next Monday** session is **mandatory**
- Jaison will be leading a ROS tutorial in this session
- **In the next Wednesday and Friday** sessions, you will be assembling the robots. Also **mandatory.**

Enjoy the Course