

# **CS 287: Advanced Robotics**

## **Fall 2013**

Lecture 1: Introduction

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WWW

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- <http://www.cs.berkeley.edu/~pabbeel/cs287-fa13>
- [Step through webpage]

# Remainder of Lecture Outline

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- Questions?
- A few robotic success stories ...  
and connections with materials covered in the course

# Driverless Cars

- Darpa Grand Challenge: First long-distance driverless car competition
  - 2004: CMU vehicle drove 7.36 out of 150 miles
  - 2005: 5 teams finished, Stanford team won [nova-race](#)
- Darpa Urban Challenge (2007)
  - Urban environment: other vehicles present
  - 6 teams finished (CMU won) [urban challenge](#)
- Google Autonomous Cars
  - 2010: Mountain View -> Santa Monica; >140,000 miles; Lombard, Golden Gate, Tahoe, Pacific Coast Highway
  - 2012: 300K miles completed autonomously without accident
- Ernst Dickmanns / Mercedes Benz: autonomous car on European highways
  - Paris highway and 1758km trip Munich -> Odense, lane changes at up to 140km/h; longest autonomous stretch: 158km (1995)
- Maneuvers: [parking](#)

Kalman filtering, LQR, mapping, terrain & object recognition

# Autonomous Helicopter Flight

[Coates, Abbeel & Ng]



Kalman filtering, model-predictive control, LQR, system ID, trajectory learning

# Four-legged locomotion

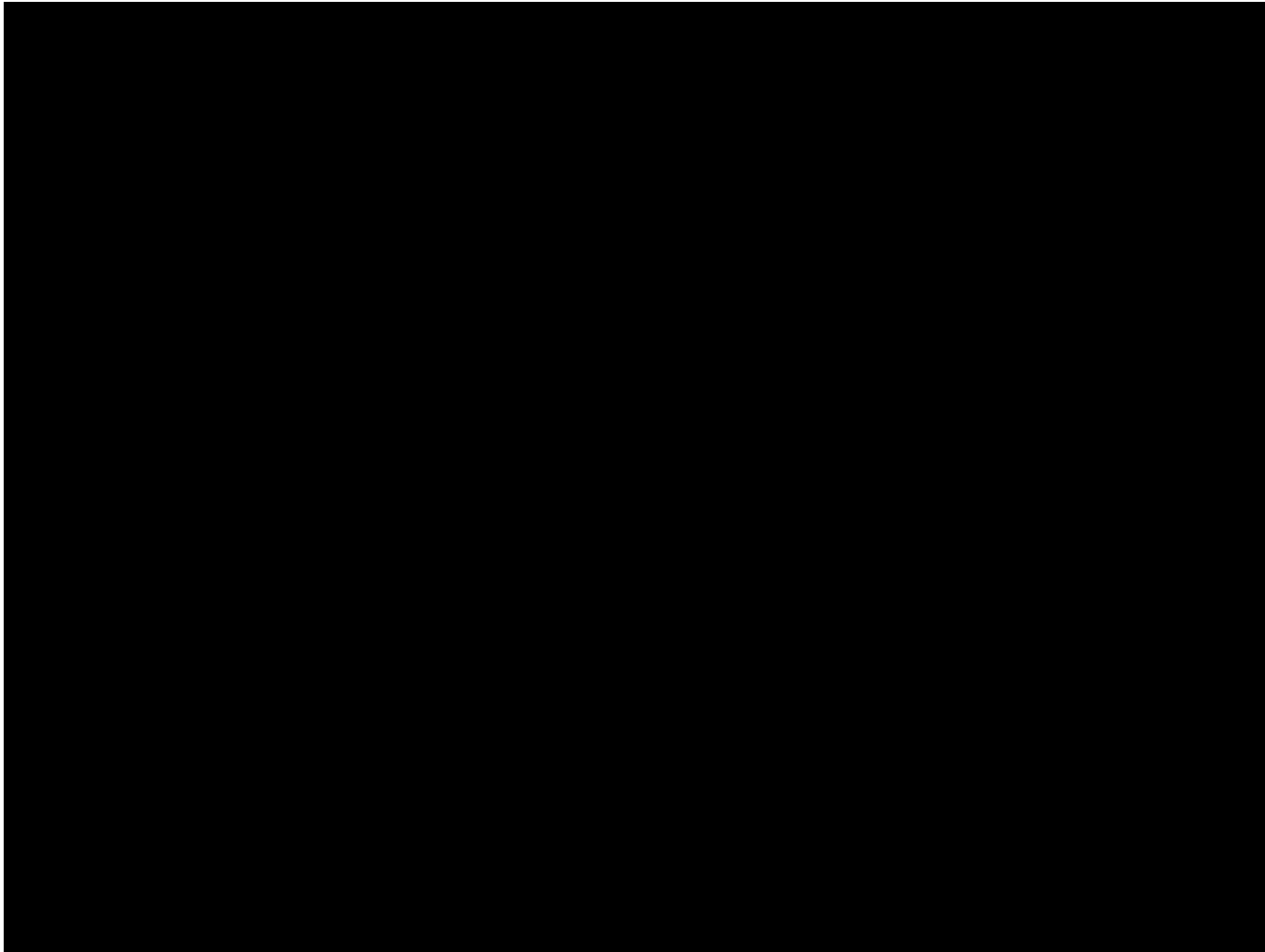
[Kolter, Abbeel & Ng]



value iteration, receding horizon control, motion planning, inverse reinforcement learning, nolearning, learned

# Two-legged locomotion

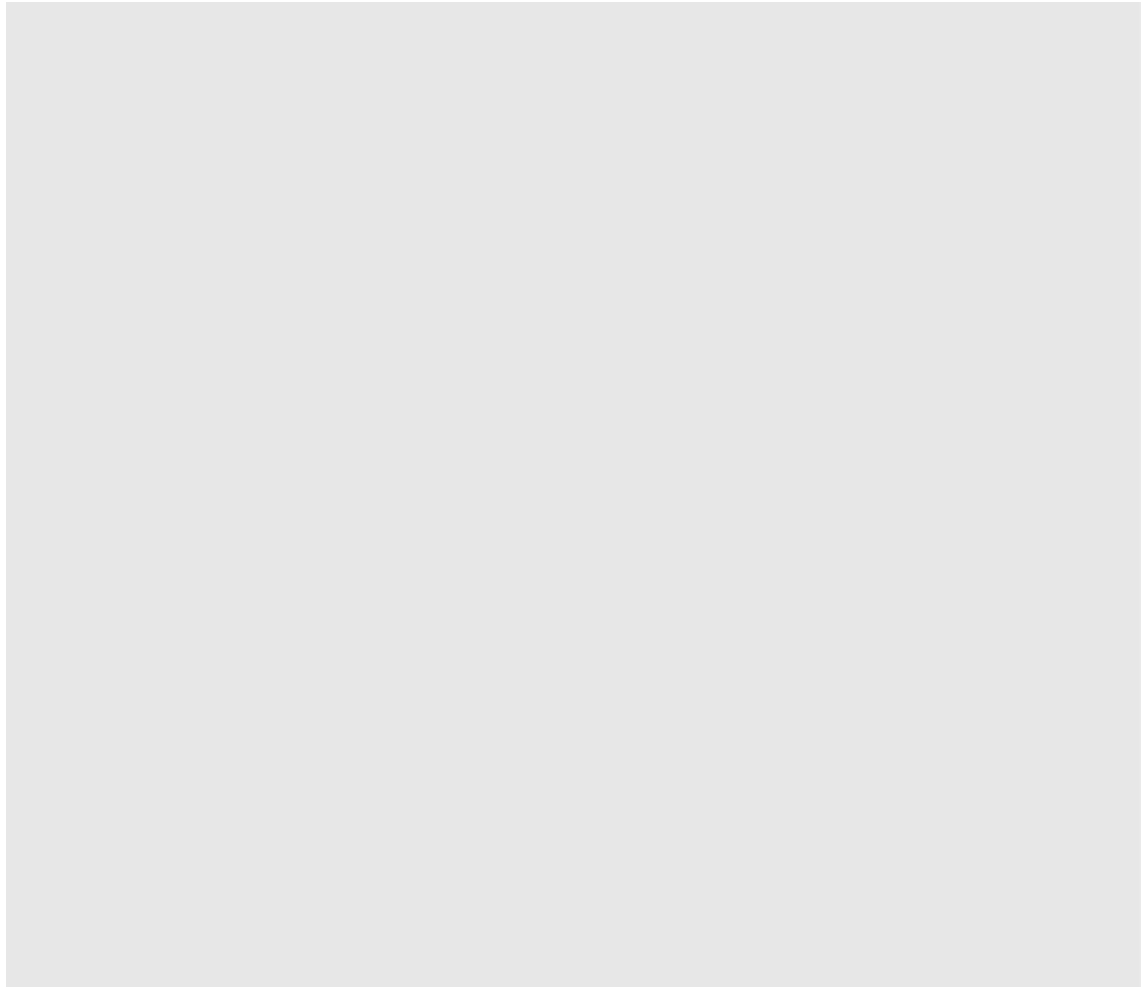
[Tedrake +al.]



Policy gradient

# Mapping

[Video from W. Burgard and D. Haehnel]

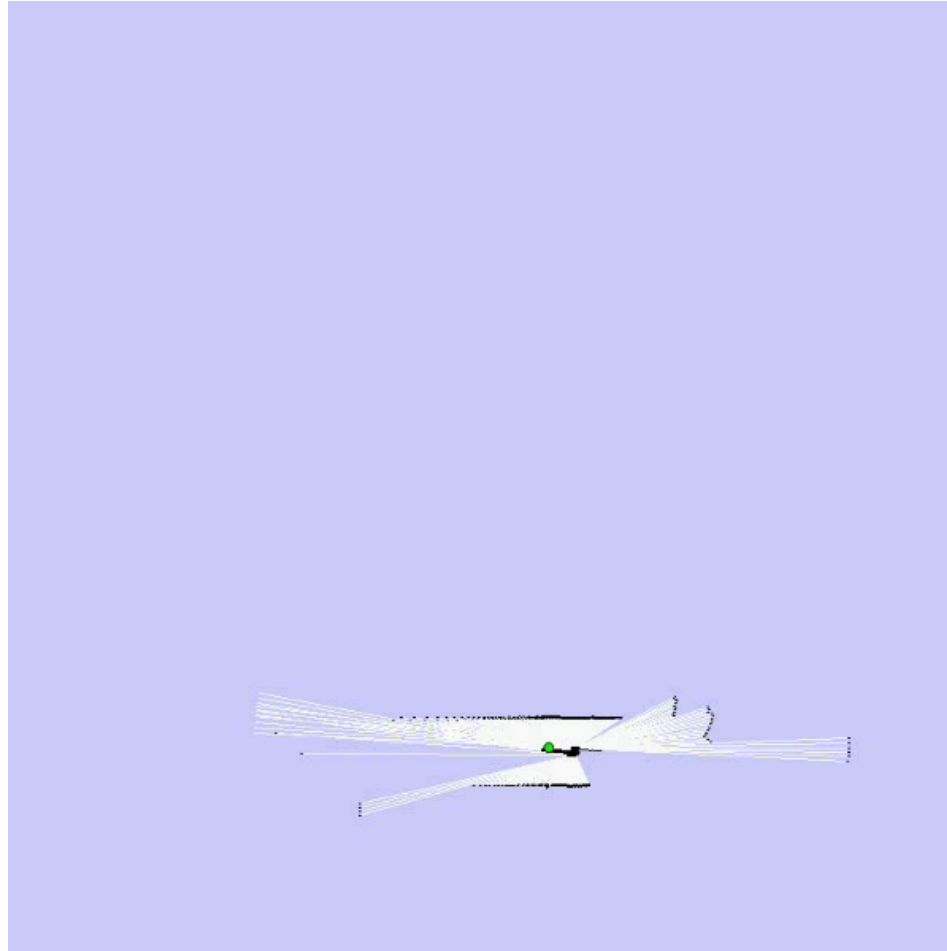


“baseline” : Raw odometry data + laser range finder scans



# Mapping

[Video from W. Burgard and D. Haehnel]



FastSLAM: particle filter + occupancy grid mapping

# Mobile Manipulation

[Quigley, Gould, Saxena, Ng + al.]



SLAM, localization, motion planning for navigation and grasping, grasp point selection, visual category recognition (speech recognition and synthesis)

# Mobile Manipulation

[Maitin-Shepard, Cusumano-Towner, Lei, Abbeel, 2010]



localization, motion planning for navigation and grasping, grasp point selection, visual recognition

# Why a Great Time to Study CS287 Advanced Robotics?

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- Robotic hardware is getting in great shape, expertise in algorithms+math+programming are limiting factors
- So many different robotic systems, yet a few core techniques are (near-)sufficient to rule them all
  - Probabilistic Reasoning
  - Optimization
- Applicability of these techniques extends well beyond robotics

# That's it for today

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- Starting optimal control on Tuesday
- Check out the webpage!
- Sign up on piazza!
  
- Come talk to me now about any lingering questions you might have