Apprenticeship Learning for Motion Planning with Application to Parking Lot Navigation

Presented by: Paul Savickas

Outline

- Motivation
- Background
- The Problem
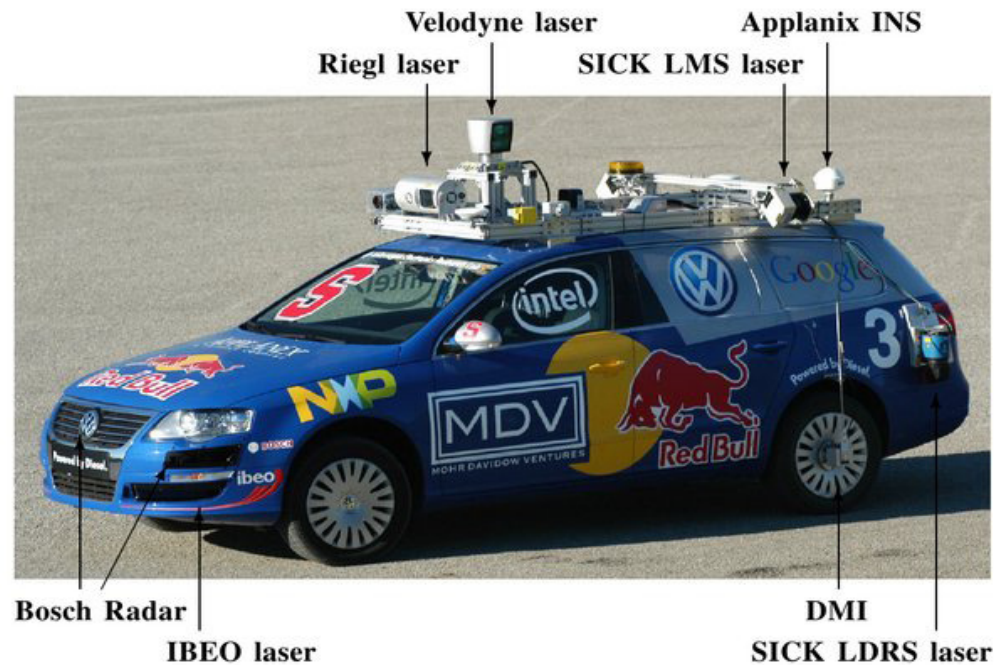- Methods and Model
- Results
- Discussion

Motivation

- In 2005:
- ~6,420,000 Auto Accidents in the US
- Total financial cost >$230 Billion
- Injuries ~2.9 Million
- 42,636 Deaths
  - 115 per day
  - 1 every 13 minutes

- Source: http://www.car-accidents.com/pages/stats.html

Background

- DARPA Urban Challenge
- Stanford Racing Team
- Junior

Stanford's "Junior"

- http://www.youtube.com/watch?v=BSS0MZvoltw&NR=1

The Problem

- Motion/Path planning algorithms are complex
  - Many parameters
  - Hand tuning required

How can we simplify this process?

Methods

- Path-Planning and Optimization
  - Sequence of states
  - Potential-field terms
  - Weights

$$\Phi(s) = \sum_{k=1}^{p} w_k \phi_k(\mathbf{s}).$$

$$\min_{\mathbf{s} \in \mathbf{S}} \Phi(\mathbf{s}).$$

Apprenticeship Learning

- Learn parameters from expert demonstration
- Useful when no reward function available

- Example: Teaching a person to drive

Model

- Parameters
  - Length
  - Length (Reverse)
  - Direction Changes
  - Proximity to Obstacles
  - Smoothness
  - Parking Lot Conventions
  - Lane Conventions

Parameter Tuning

Switching Directions
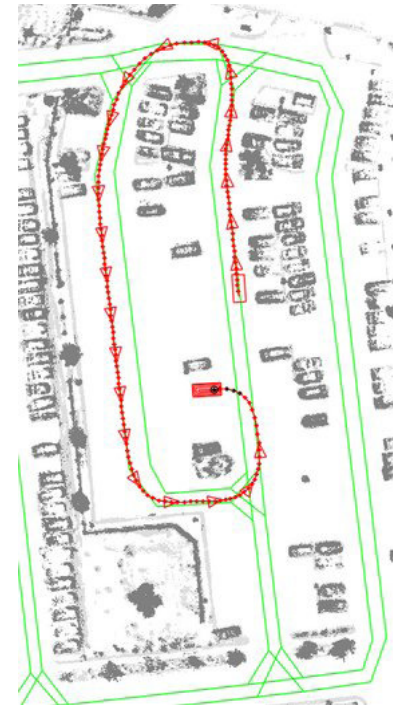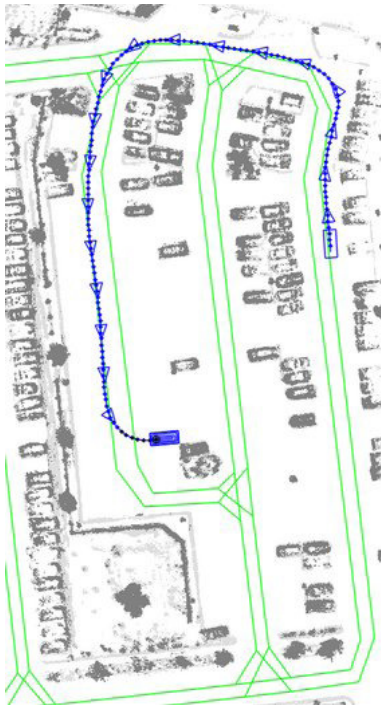
Penalize Switching

Follow Directions
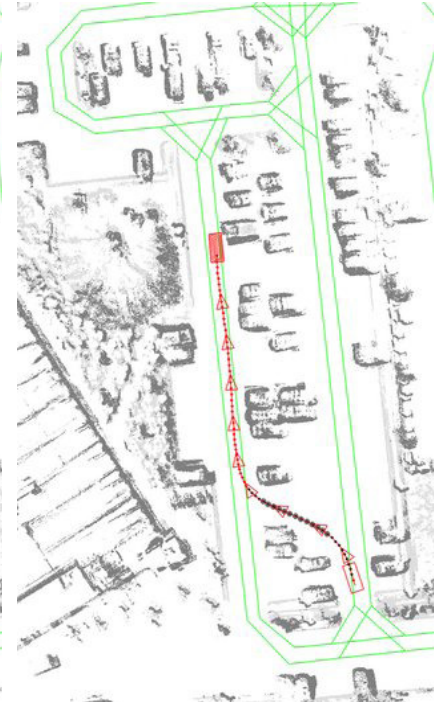
Penalize offroad

Distance from lane

Experiment

- Human Driver demonstration
  - "Nice"
  - "Sloppy"
  - "Reverse-allowed"

- Autonomous Navigation using learned parameters
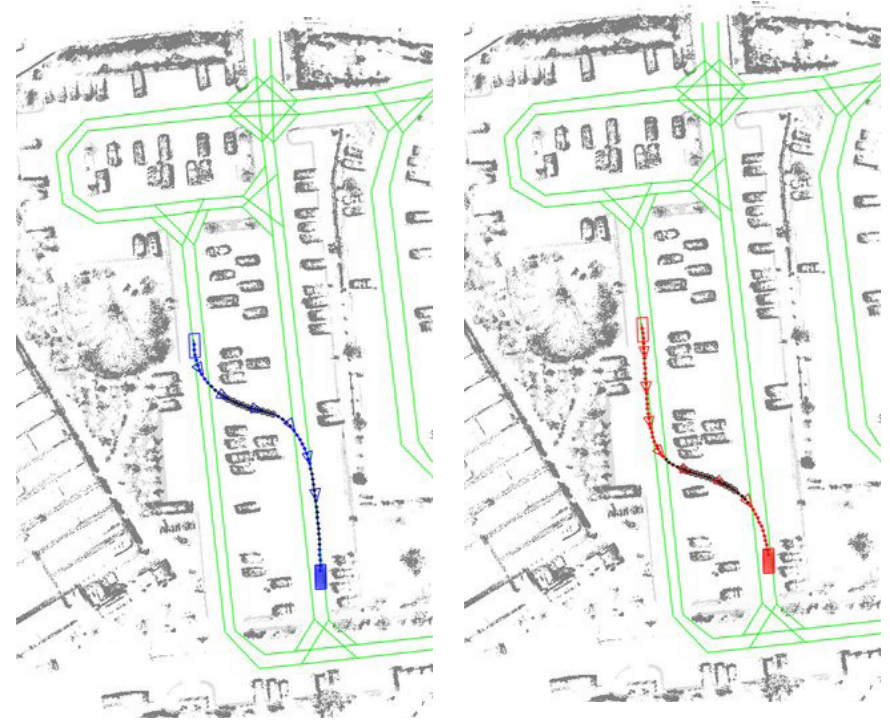
Results – "Nice"

Results – "Sloppy"

Results – "Reverse-allowed"

Results – Interesting Anomalies

Discussion

- How do these results apply to other problems?

- Determination of parameters is still an issue.

- Why would we want to drive "sloppy"?..

- Where do we go from here?

Video

- DARPA Urban Challenge
- [http://www.youtube.com/watch?v=P0NTV2m bJhA&feature=related](http://www.youtube.com/watch?v=P0NTV2mbJhA&feature=related)

- Junior's Results
- [http://www.youtube.com/watch?v=xcNFUi06f h8](http://www.youtube.com/watch?v=xcNFUi06fh8)