Real-time Collision Prediction

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Project Overview

**Question:** Given a driving sequence of 5 seconds, can we predict whether a driver will crash in 5 to 10 seconds?

- How much streaming data do we need to store?
- How far ahead in time can we predict risky behavior?

**Applications:** Insurance companies, triggering in-car warnings, etc.
Collision Segmentation

Collisions are ubiquitous

- We segment drives into collision and non-collision sequences
- 9 drivers produce 179 collision segments over course
  - ~20 collisions per driver in < 1 hour: clearly unrealistic
  - Drives are difficult, risk profile is reduced in a simulation
Mining Tiny Data Sets

- 9 users’ driving simulations, each < 1 hr
- Segment into collision and no-collision sequences
  - Largest sequence size: 2613
  - Smallest sequence size: 657
- Dimensionality of a single sensor reading: 76
- ..so we stick to simple models
Data Exploration

- We see driving factors and environmental factors at play
Methodology

- Baselines: Logistic Regression, RFs
- Deep learning architectures
  - LSTM: 60 dim hidden state
  - 1D-CNN: 2 x (conv → relu → max-pool) → FC
    - Conv layers use 80 & 40 kernels, filter size of 3
    - Max-pool with kernel size = 2
  - Cross-Entropy Loss, ADAM Optimizer
  - Loss weights to address imbalanced classes
- We see noisy loss due to loss weights, overfitting (~1500 total data points)
- Run random search on hyperparameters
  - CNN performs slightly better across the board
Methodology

- 9 “settings”
  - 3 sequences lengths: 3, 5, 10 seconds
  - 3 window sizes: (1, 6), (5, 10), (15, 20) seconds from present
Results (F1 scores)

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<thead>
<tr>
<th>Sequence Length</th>
<th>Window Size</th>
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<tbody>
<tr>
<td></td>
<td>(1, 6)</td>
<td>(5, 10)</td>
<td>(15, 20)</td>
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<tr>
<td>3</td>
<td>0.17</td>
<td>0.29</td>
<td>0.39</td>
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<td>5</td>
<td>0.24</td>
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<td>10</td>
<td>0.40</td>
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Challenges/Future Work

● Simulation with little/no risk -- how applicable are these results?
  ○ Assessing our model's accuracy is difficult in this context
● We experimented with training in one scenario and testing in another, however results not meaningful given dataset size
  ○ Proof of concept: analyze whether a model can predict collisions in one driving scenario giving training data in another
● We'd like to further study how different sequence/window lengths affect predictions in different environments
  ○ Hypothesis: shorter sequences more predictive in urban environments than rural environments and vice versa
Thank you!