Rapid Physical Predictions from Convolutional Neural Networks

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Introduction

- Physical prediction can be explained by probabilistic simulation using an “intuitive physics engine” [1]
- Simulations are general-purpose yet computationally costly, so quick decisions may be based on heuristics
- Can we capture heuristics for physics prediction with CNNs?
- If so, what heuristics are learned and when do people use them?

Models

![Models to compare](image)

2. Modified GoogLeNet [3] predicts red/green probability from 2 input frames (based on ~1M training examples)

Task

- Continuous prediction of goal the ball will reach first
- Responses aggregated: what proportion of participants predicted red vs. green every 100ms?

Results

Partial correlations (excl. other model) at each trial step

Correlation between CNN/Physics and Humans

<table>
<thead>
<tr>
<th>Heuristic</th>
<th>CNN Correct Goal</th>
<th>CNN Other Goal</th>
<th>Physics Correct Goal</th>
<th>Physics Other Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance to Goal</td>
<td>-0.650</td>
<td>0.503</td>
<td>-0.323</td>
<td>0.110</td>
</tr>
<tr>
<td>Wall Between</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heading Offset</td>
<td>0.001</td>
<td>-0.042</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goal Area</td>
<td>0.109</td>
<td>0.079</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discussion

- CNN explains human some predictions, but not as well as noisy physical simulation
- Predictive power of CNN is strongest in initial seconds – suggests it may capture quick impressions over simulation
- CNN predictions best described using heuristics and statistical regularities
- Human physical prediction may initially rely on quick heuristics, then later on rich physical simulation

High and low confidence trial samples

![High and low confidence trial samples](image)

References