Expectancy-Based Robot Localization through Context Evaluation

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overview

- background
- data
- methods
- experiments
- conclusions
**background**

sensory input from a real environment  

Robust identification: selecting the best signal-driven hypothesis by evaluating what is expected given the context.

Dynamic network model: combines sensory input and contextual knowledge
background

- robot in a real environment: self localization and mapping (SLAM)
- visual observations to build topological map

Robust identification: selecting the best landmark hypothesis by evaluating what is expected given the location on the map.
data: topological map

- wall
- driving path
- places
method: learn contextual knowledge

eexample state sequence:

1 1 1 1 2 2 1 2 2 3 3 4 4 1 4

matrix with transition probabilities:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.50</td>
<td>0.33</td>
<td>0</td>
<td>0.17</td>
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<tr>
<td>2</td>
<td>0.25</td>
<td>0.50</td>
<td>0.25</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0.50</td>
<td>0.50</td>
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<tr>
<td>4</td>
<td>0.33</td>
<td>0</td>
<td>0</td>
<td>0.67</td>
</tr>
</tbody>
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method: learn contextual knowledge

- \( w_{o,l} \): inverse to distance between observation and landmark
- \( w_{l,r} \): specificity of landmark for place
method: dynamic network model

observation 1
method: dynamic network model
method: dynamic network model

landmark 1

observation 1
method: dynamic network model

landmark 1

observation 1

landmark 2
method: dynamic network model
method: dynamic network model
method: dynamic network model
method: dynamic network model
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method: dynamic network model
experiments: simulated data

Noise: randomize test data compared to training data

Prediction results

- EB top-1
- DD top-1
- EB top-2
- EB top-3
- correct (%)
- amount of noise (%)

Graph showing prediction results for different types of noise.
experiment: real data

- 225 unique landmarks in training data
- 24% of landmarks in training data are ambiguous
- 107 landmarks from training data are re-observed in the test phase
- 114 new landmarks in the test phase
experiment: real data

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<th></th>
<th>Top-1</th>
<th>Top-2</th>
<th>Top-3</th>
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<tbody>
<tr>
<td>Data-driven</td>
<td>56%</td>
<td>69%</td>
<td>76%</td>
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<tr>
<td>Expectancy-based</td>
<td>63%</td>
<td>81%</td>
<td>88%</td>
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conclusions

Context evaluation improves results for real and simulated data

- expectancy enhances the stability of the model

Future work includes

- incremental learning
- improve expectancy (e.g. odometry)
- more complex environments
- multiple modalities in dynamic network model
Questions?

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