Project Management and System Development

Activity Classification with Persistent Homology Barcodes

Intermediate Presentation 27/06/2017

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Project Reminder

Classify repetitive movements according to distance measurement between them

Topological data analysis
Insensitive to orientation changes and does not suffer from extensive augmentation needs.

First trial of persistence homology for medical application.
Project Reminder

Classify repetitive movements according to distance measurement between them

Persistence Homology

Source: [https://dsweb.siam.org/The-Magazine/Article/topological-data-analysis](https://dsweb.siam.org/The-Magazine/Article/topological-data-analysis)
Last Accessed: 26/6/17
Tasks

1- Collect the data: 3D pose series
   • Acquisition interface -> OpenIGTLink Library
   • Obtain data generated by the FRAMOS Optical Tracking System of different movements repeatedly.

2- Distance function algorithm.

3- Calculate the homology barcodes for each data window. -> Ripser Library
   Ripster library home page

4- Separate de barcodes via SVM (Support Vector Machine)

5- Evaluate de classification.
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- Finished
- In progress
- To do
Distance Function Algorithm Prototype

Output: Distance Matrix

\[
\begin{bmatrix}
0 & d_{w_1,w_2} & d_{w_1,w_j} \\
\vdots & \ddots & \vdots \\
0 & \ldots & 0 \\
\end{bmatrix}
\]

\[d(w_i, w_j) = \sum_{k=1}^{N-1} d(b_{i-k}, b_{j-k})\]

N = window size
i,j = \{1, \ldots, T\} (T: number of frames)
b = box
w = window
Distance Function Algorithm Prototype

\[
d(b_{i-k}, b_{j-k}) = d(p_{i-k}, p_{j-k}) + \lambda d(o_{i-k}, o_{j-k})
\]

\(N = \text{window size}\)

\(i,j = [1, \ldots, T] (T: \text{number of frames})\)

\(b = \text{box}\)

\(p = \text{translation}\)

\(o = \text{orientation}\)
Workflow Prototype

1. Data retrieval from Optical Tracking System

The object is lit using near IR light

Retro-reflective markers reflect back

Source: http://www.ps-tech.com/3d-technology/optical-tracking
Last accessed: 26/6/17

2. Text File with pose matrices

OpenIGTLink
Data Acquisition

Server / Tracker

Waits for client at a given host

Request for a connection with the server

Network

Connection Successful

Data Transfer

Source: inspect magazine
Last accessed: 26/6/17
Workflow Prototype

2. Text File with pose matrices

```
-1 0 0 50
0 0.142857 0.989743 0
0 0.989743 -0.142857 50
0 0 0 1
-0.9888895 0.113525 49.0033
0.9888895 0.142857 0.984799 9.93347
-0.113525 0.984799 -0.131457 49.0033
0 0 0 1
-0.954892 -0.196632 0.222525 46.0531
0.196632 0.142857 0.970014 19.4709
-0.222525 0.970014 -0.0977491 46.0531
0 0 0 1
```

3. Square Distance Matrix

```
0  d_{w_1,w_2}   d_{w_1,w_j}
:::   :::
0   ...   0
```

Distance Algorithm

4. Homology Barcodes

Ripser Library
Barcode Example (Artificial Data)

Linear Movement. Constant velocity

Circular movement. Constant angular velocity
Workflow Prototype

4. Homology Barcodes

5. Persistent Images

6. Barcode Classifier

(To implement)

SVM

For further information: https://arxiv.org/abs/1507.06217
Problems Encountered

• Build OpenIGTLink Library in C++ -> Delay in the timeline
• Integration of Ripser Library in Matlab -> File based communication.

Risks

• Lack of robustness in the final classifier
• Long computation times

Variations from initial scheme

• Persistent barcodes/images as input for classifier instead of average landscapes.
Timeline

- Jun 11: Data Acquisition
- Jun 18: Obtain movement data, Interim Presentation
- Jun 25: Generate Barcodes, Obtain Average Landscapes
- Jul 2: Test with real data
- Jul 9: Classification
- Jul 16: Test Results
- Jul 23: Final Presentation
Questions?
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