WORKSHOP ON TEST METHODS AND METRICS FOR EFFECTIVE HRI IN REAL WORLD HUMAN-ROBOT TEAMS (HRI'20)

BENCHMARKING HUMAN MOTION PREDICTION METHODS

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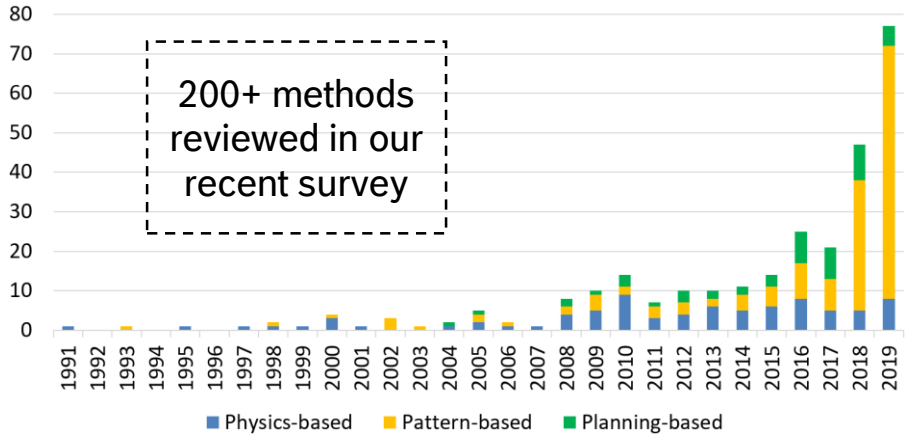
Motivation
Human motion in HRI

- Motion is a key element of human robot interaction
  - Gestures, full body poses, head orientations, facial expressions…
- In particular, taking into account – *predicting* – trajectories of people in important whenever a robot navigates in social spaces
  - With the goal of safety, efficiency and legibility of the robot motion planning during HRI

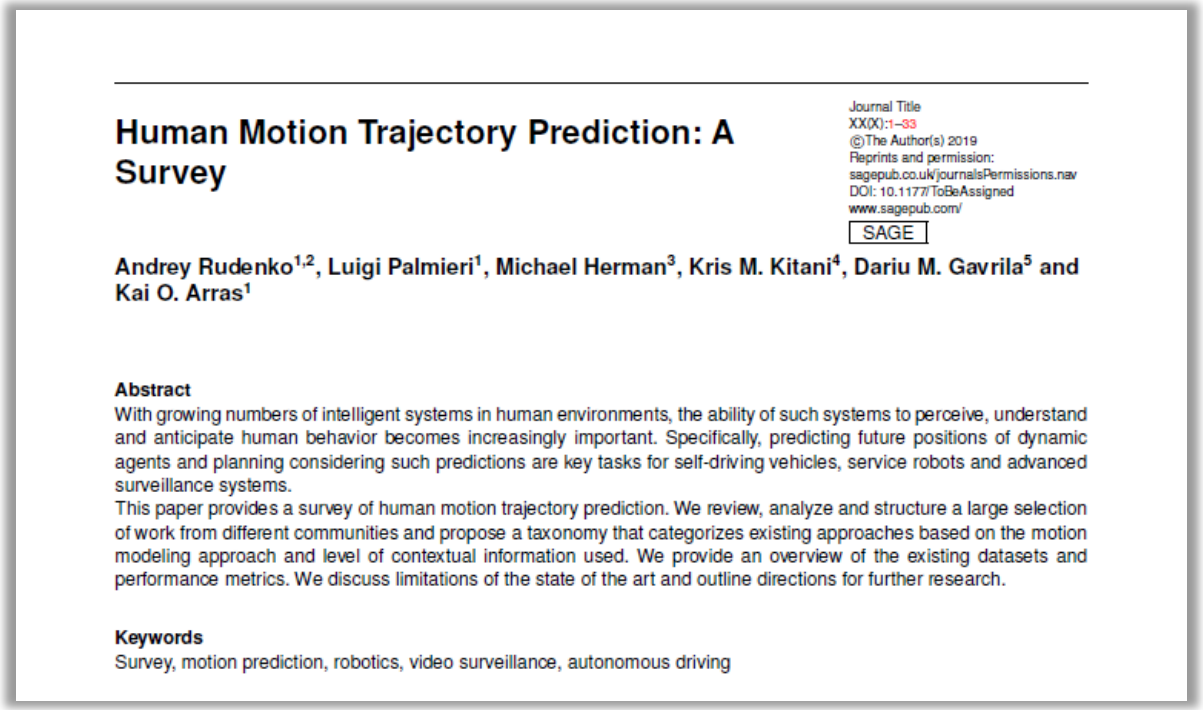
Motivation
Social navigation

Motivation
Human motion prediction

- To this end exists a vast amount of algorithms for human motion prediction



- Motion data is often used for learning and validation



Human Motion Trajectory Prediction: A Survey

Journal Title
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Andrey Rudenko[1,2], Luigi Palmieri[1], Michael Herman[3], Kris M. Kitani[4], Dariu M. Gavrila[5] and Kai O. Arras[1]

Abstract
With growing numbers of intelligent systems in human environments, the ability of such systems to perceive, understand and anticipate human behavior becomes increasingly important. Specifically, predicting future positions of dynamic agents and planning considering such predictions are key tasks for self-driving vehicles, service robots and advanced surveillance systems.
This paper provides a survey of human motion trajectory prediction. We review, analyze and structure a large selection of work from different communities and propose a taxonomy that categorizes existing approaches based on the motion modeling approach and level of contextual information used. We provide an overview of the existing datasets and performance metrics. We discuss limitations of the state of the art and outline directions for further research.

Keywords
Survey, motion prediction, robotics, video surveillance, autonomous driving

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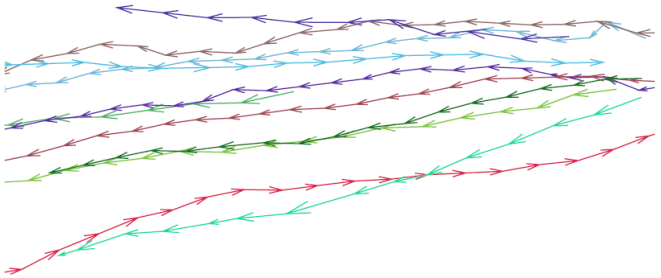
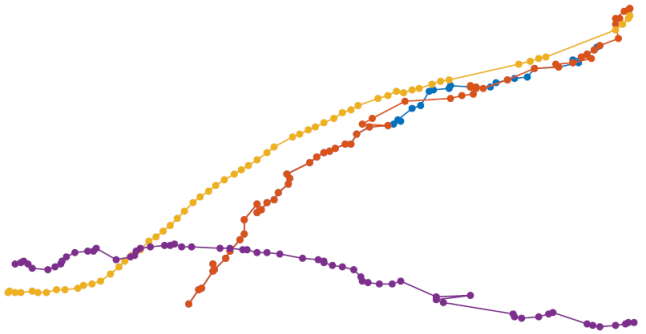
Motivation
Prior art motion datasets

- The data quality, however, is lagging behind
  - Often very noisy, inaccurate trajectories in very simple environments are available



ETH dataset

Uniform motion in straight lines



Edinburgh dataset

Inaccurate ground truth

Low annotation quality

Stanford Drone dataset

Motivation
Prior art motion datasets

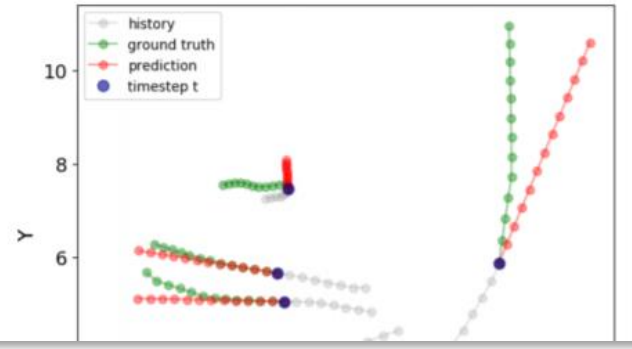
- No wonder that state-of-the-art methods can‘t learn anything meaningful from it!

“A simple Constant Velocity Model can outperform even state-of-the-art neural models”

What the Constant Velocity Model Can Teach Us About Pedestrian Motion Prediction

Christoph Schöller[1,2], Vincent Aravantinos[1], Florian Lay[1,2] and Alois Knoll[2]

***Abstract*—Pedestrian motion prediction is a fundamental task for autonomous robots and vehicles to operate safely. In recent years many complex approaches based on neural networks have been proposed to address this problem. In this work we show that – surprisingly – a simple Constant Velocity Model can outperform even state-of-the-art neural models. This indicates that either neural networks are not able to make use of the additional information they are provided with, or that this information is not as relevant as commonly believed. Therefore, we analyze how neural networks process their input and how it impacts their predictions. Our analysis reveals pitfalls in training neural networks for pedestrian motion prediction and clarifies**



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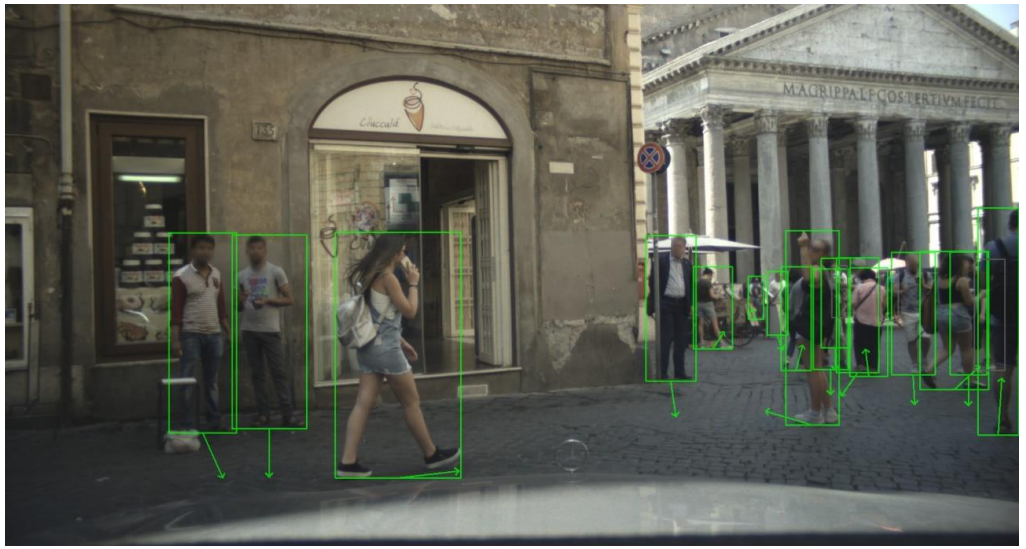
Motivation
Automated driving

- Compare this to the state-of-the-art automated driving datasets:

Cityscapes dataset



Eurocity dataset

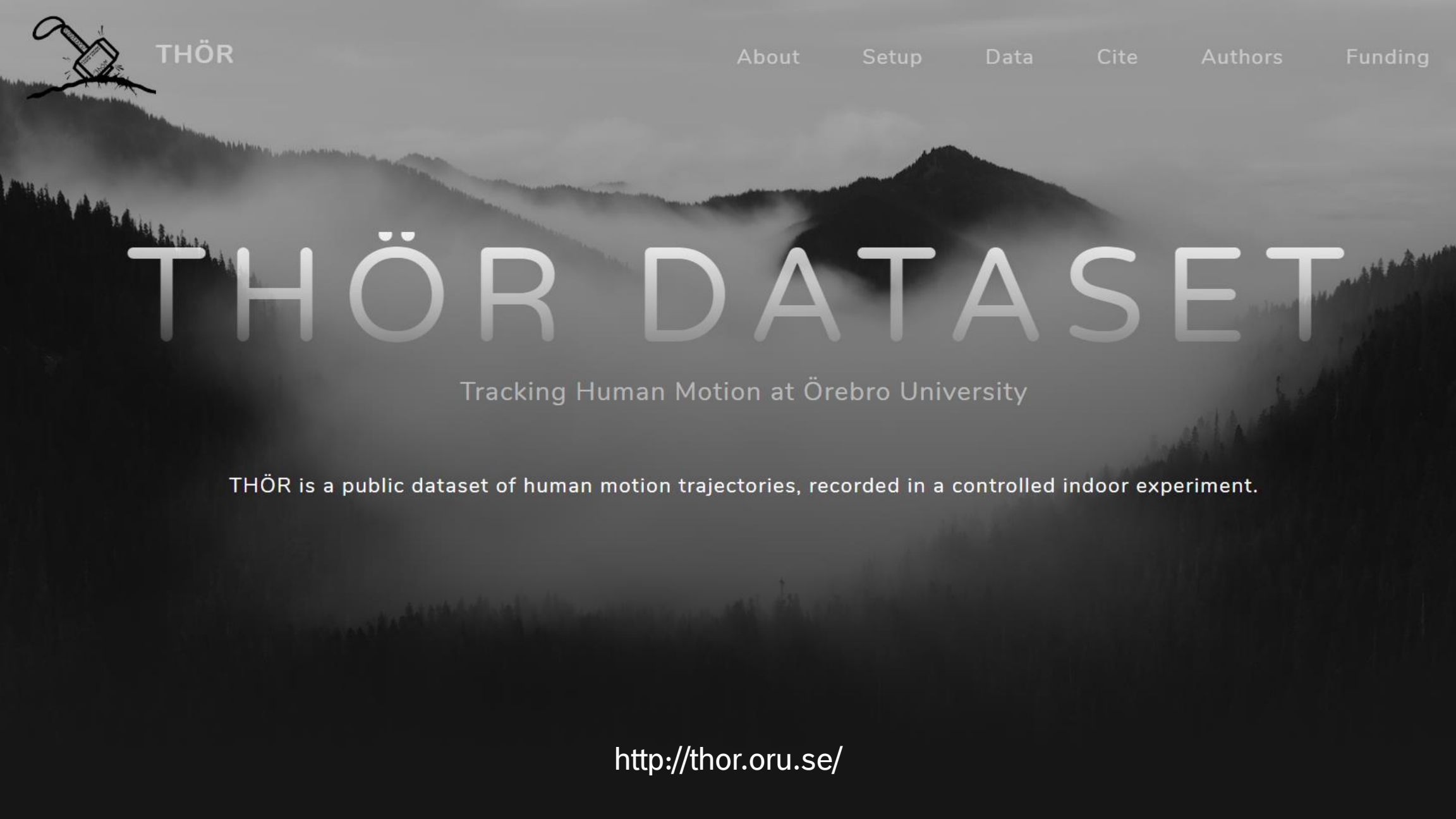
- We aim to bring human motion data and benchmarking for social robots to the same advanced level

THÖR dataset
Towards an advanced benchmark

- **Main goal:**
  - Record accurate motion data
  - Create a challenging dataset which cannot be solved by today's state-of-the-art
  - Record a wide variety of motion cues which can potentially be useful for advanced human motion assessment
- What are we missing for a better benchmarking:
  - Various obstacle layouts
  - Different types of obstacles
  - Different robots
  - Different robot motion policies

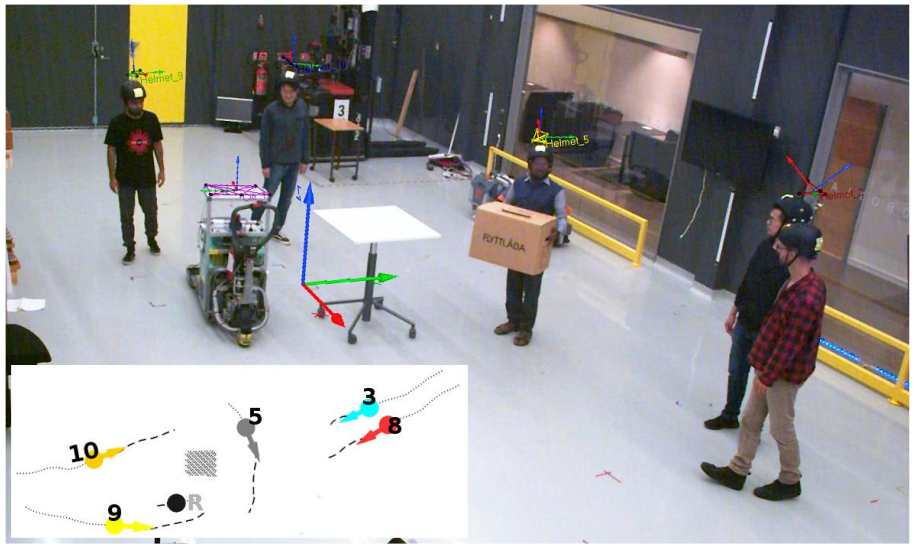
    (i) Unaware, (ii) slowing down and wanting, (iii) avoiding collisions…
  - Metrics
  - Different challenges

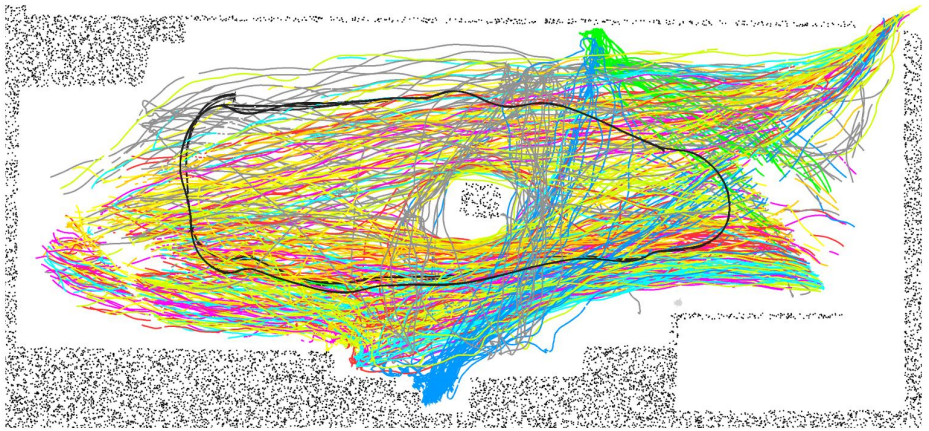
    (i) Crowded environment, (ii) cluttered environment…


THÖR
About
Setup
Data
Cite
Authors
Funding
THÖR DATASET
Tracking Human Motion at Örebro University
THÖR is a public dataset of human motion trajectories, recorded in a controlled indoor experiment.
http://thor.oru.se/

THÖR dataset
Data collection procedure

- Elaborate weakly-scripted motion generation scenario
  - Participants execure simple navigation-related tasks
  - Several social roles
  - Dynamically allocated groups of people
  - Active interaction between participants
- Robot continuously navigating in the room
- Varying obstacle layout
- Recorded scenarios include:
  - Fast and slow motion
  - Navigation in more and less crowded spaces
  - Cyclical event patterns in the environment
  - Idle wandering and purposeful goal-oriented motion





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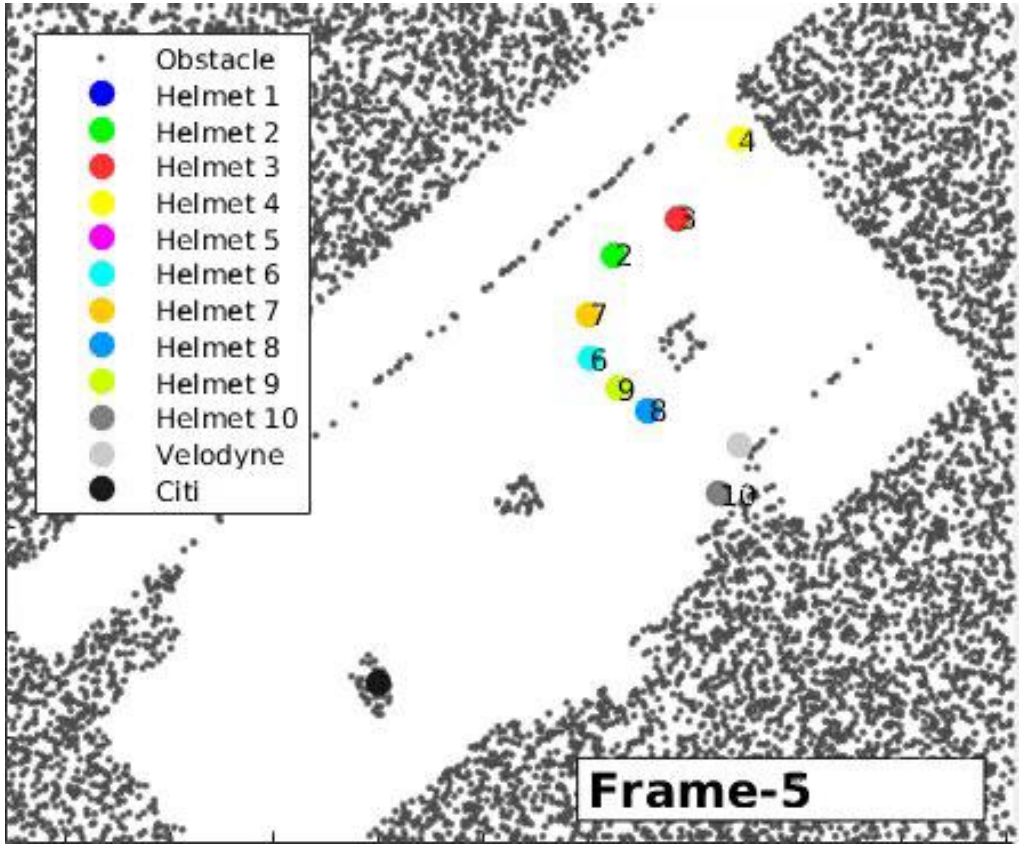
THÖR dataset
Features

- 60 minutes of motion, over 600 individual and group trajectories
- Positions and head orientations for all participants
- Very accurate data: motion capture system (100 Hz, 4mm error)
- 3D LiDAR scans
- Video recording from a static camera
- Gaze directions for one person
- Groups, goals, maps of obstacles



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THÖR dataset
Summary

- **Main goal:**
  - Accurate motion data 
  - Challenging dataset which cannot be solved by today's state-of-the-art 
  - Wide variety of motion cues which can potentially be useful for advanced human motion assessment 
- Towards an advanced benchmarking:
  - Various obstacle layouts 
  - Different types of obstacles 
  - Different robots
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Thank you! Questions?

http://thor.oru.se/

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