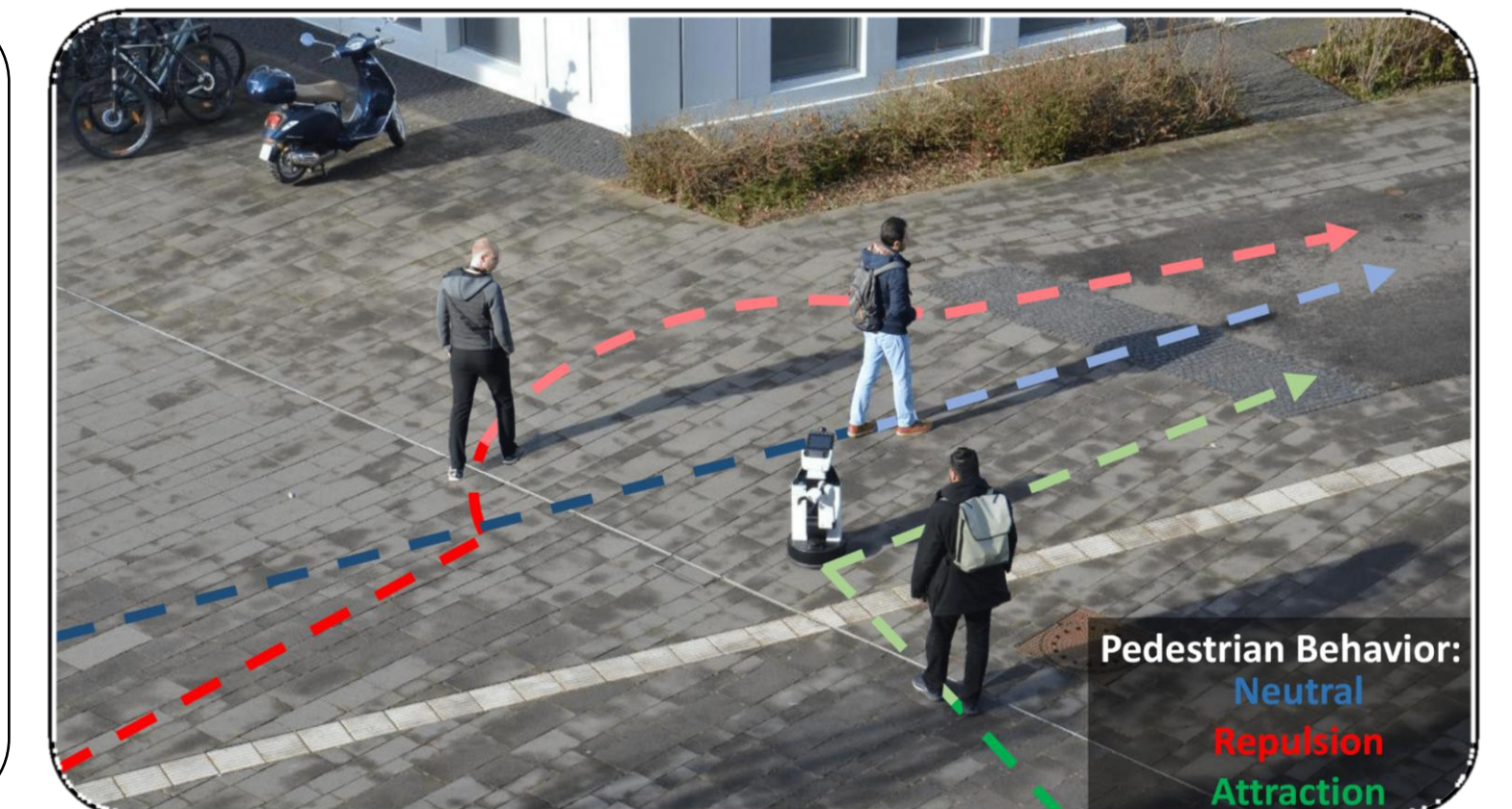
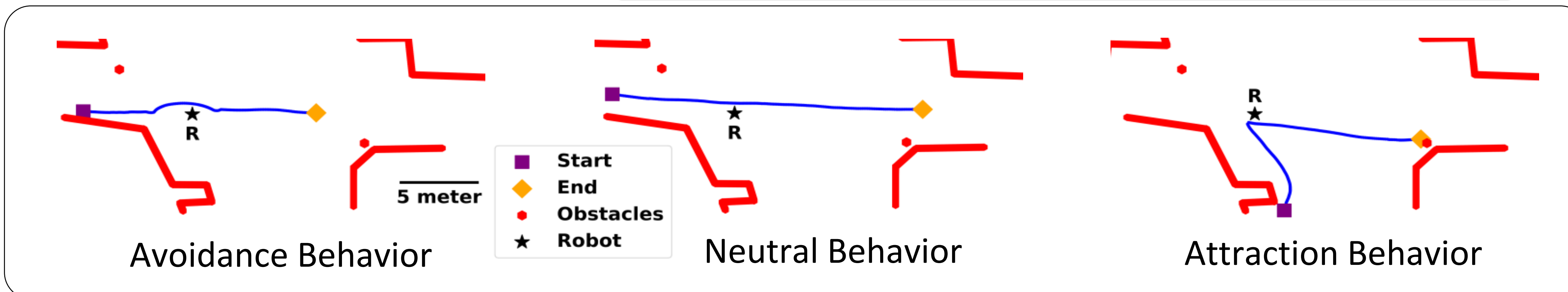


PeRoI: A Pedestrian-Robot Interaction Dataset for Learning Avoidance, Neutrality, and Attraction Behaviors in Social Navigation

Subham Agrawal, Nico Ostermann-Myrau, Nils Dengler, and Maren Bennewitz
Humanoid Robots Lab, University of Bonn, Germany



Overview



Motivation:

- Pedestrians do **not always avoid** robots during navigation but also show **neutrality** towards the robot and even **attraction behavior**
- **Existing datasets** do not that clearly capture or annotate these various reactions of pedestrians to robots
- Need to learn these pedestrian behaviors to enable robots to reason about them

Our Approach:

- Collection of the **Pedestrian Robot Influence (PeRoI)** dataset that captures pedestrian reactions to robots (avoidance, neutrality, and attraction) under various situations
- Novel **Neural Robot Social Force Model (NeuRoSFM)** model that enhances the traditional social force model for improved pedestrian trajectory prediction
- Pedestrian simulation system for learning and benchmarking robot navigation policies based on the NeuRoSFM

Dataset



- Data collected from 2 outdoor environments
- **Yolov11** model for tracking pedestrians while following **anonymization** protocol
- **18,699 trajectories** recorded in over two weeks
- 3 scenarios with 3 robot types:
 - **Pedestrians only (PD)**
 - **Pedestrians with Stationary Robot (PD-SR)**
 - **Pedestrians with a Moving Robot (PD-MR)**

Results

- Breakdown of pedestrian behavior in our dataset

Robot Type	Attraction (%)	Avoidance (%)	Avg. Distance (m)
HSR (Stationary)	4.39	27.17	3.05
MPO700 (Stationary)	1.6	33.95	3.26
Go1 (Stationary)	7.82	26.39	3.24
Go1 (Moving)	7.96	26.1	3.41

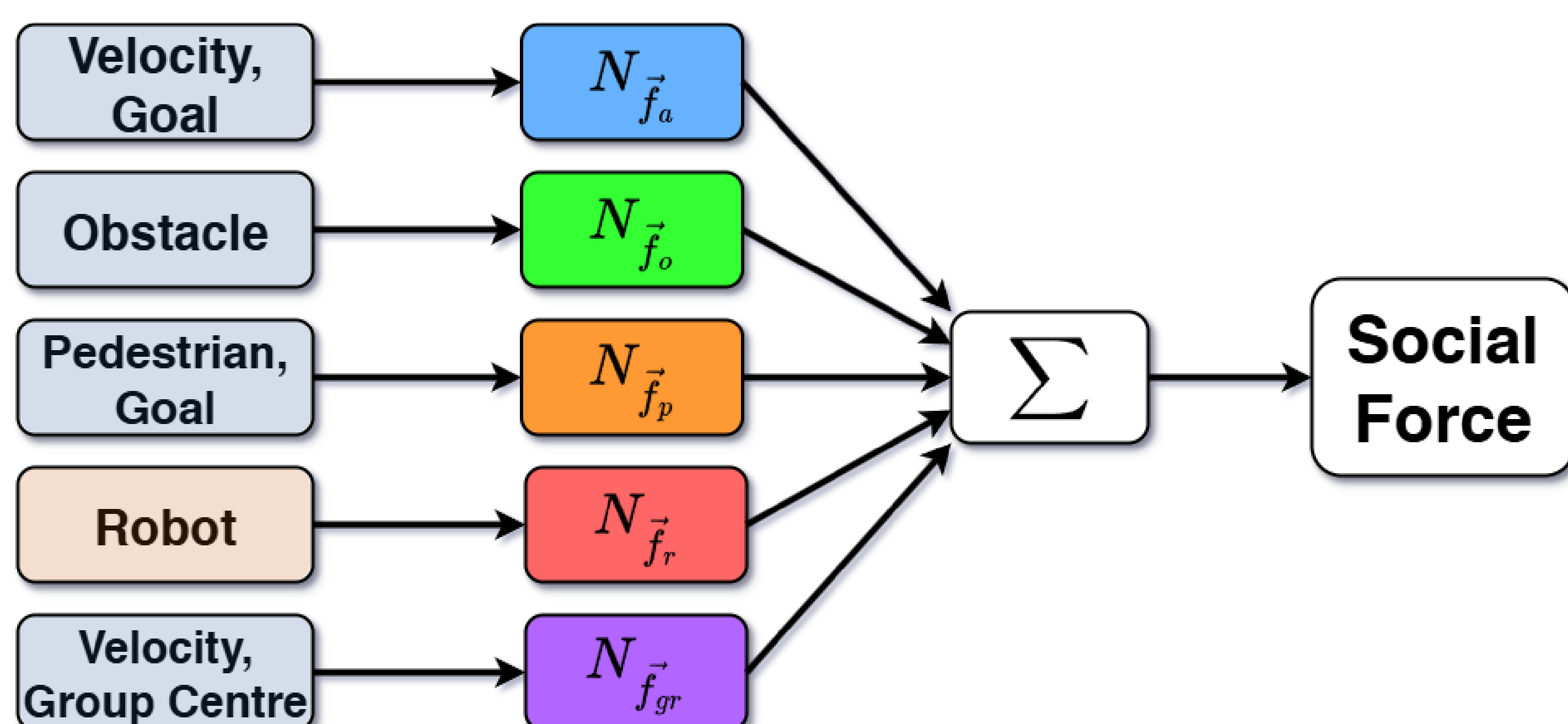
- Comparison of our dataset using average displacement error (ADE)/final displacement error(FDE) of learned policy

Method \ Sets	ETH(ADE/FDE) ↓	Hotel(ADE/FDE) ↓	Average(5 sets) ↓
DDL (train w/o PeRoI)	0.26/0.50	0.15/0.35	0.20/0.39
DDL (train w/ PeRoI)	0.23/0.44	0.10/0.21	0.17/0.34

- Comparison of our NeuRoSFM model against ablations

Model	ADE ↓		
	ETH	JRDB	PeRoI (Ours)
NeuRoSFM (ours)	0.474	0.217	0.744
SRFM	0.616	0.336	1.117
SFM	0.616	0.412	1.118

NeuRoSFM

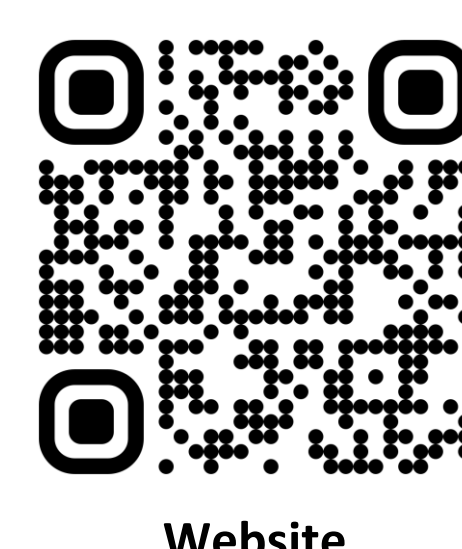


- Five separate neural networks take robot and pedestrian information as input, and compute the individual force factors of the NeuRoSFM
- Output of all the models is summed to compute the final pedestrian force and subsequent velocity

Summary

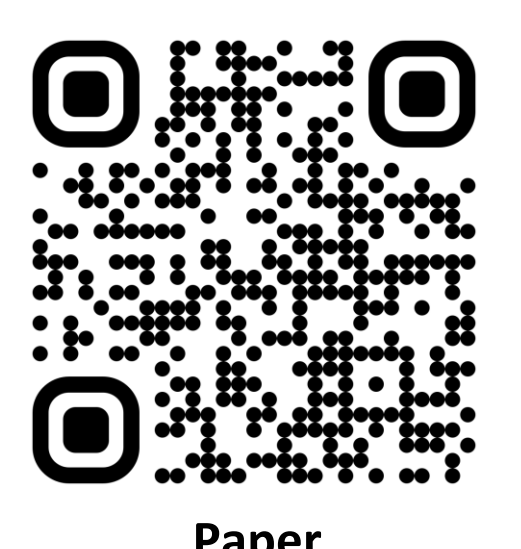
- **Large dataset** collected with 3 stationary and moving robots – **Toyota HSR, Neobotix MPO700, and Unitree Go1**
- **Significantly more trajectories and human interactions** in the introduced dataset compared to **ETH** and **JRDB** datasets
- SFM-based NeuRoSFM architecture enables an **interpretable, modular** policy that can be scaled when needed
- **NeuRoSFM** demonstrates **lower ADE** compared to **SFM** and **SRFM** baselines on all the datasets, demonstrating success in learning pedestrian behavior towards robots

Contact



Website

Subham Agrawal
sagrawal@cs.uni-bonn.de
Humanoid Robots Lab
University of Bonn
Germany



Paper