MATRiX | Multi-Agent Trajectory Representation in Extended Reality

A New Way to Collect Data

Motivation

The development of safe autonomous vehicles requires intelligent systems to predict the movements of groups of pedestrians. However, the availability of pedestrian movement datasets is limited. There is also a limit on the utility of each set as there is only so much information a model can get from one dataset. This presents an obstacle to the development of new models and the improvement of existing ones, as well as a risk of non-generalizable results due to limited environments.

Background

Recent research has demonstrated that data gathered in virtual environments can be used for training, offering a promising solution to these concerns[1]. This research, however, involved pedestrians acting alone, while many recent models focus on how pedestrians influence each other in groups[2,3]. A human participant interacting with virtual pedestrians could theoretically create valid training data, but this requires virtual pedestrians that behave realistically and react to the movements of the human subject.

Methodology

Step 1:	Choose Machine Learning Model	
Step 2:	Group 1	Group 2
	Train Chosen Model (SCAN)	Build Unity Environment
Step 3:	Develop Interface Between SCAN and Unity	
Step 4:	Translate SCAN Predictions to Agent Behavior	

Research Question

Can machine learning prediction models be integrated into a virtual environment to define the trajectories of virtual agents?

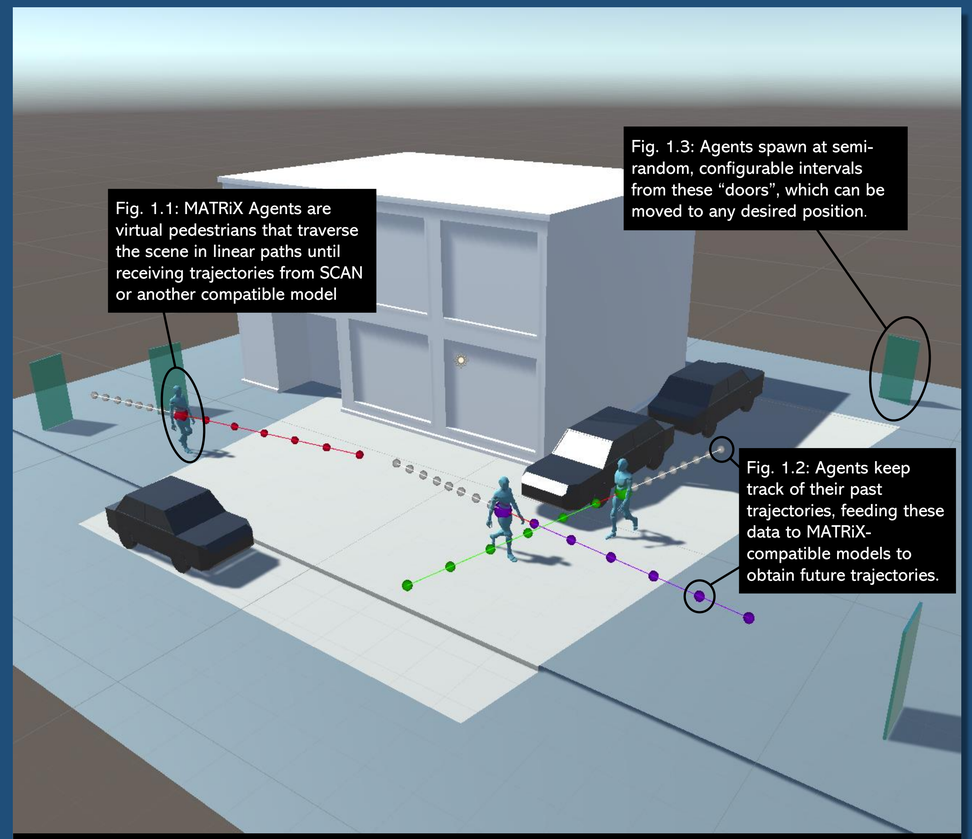

Figure 1: The MATRiX environment. For demonstration purposes, Agents' past and predicted trajectories are depicted on-screen (Fig. 1.2).

References

[1] Kalatian, A., & Farooq, B. (2022). A context-aware pedestrian trajectory prediction framework for automated vehicles. *Transportation Research Part C: Emerging Technologies*, *134*, 103453. https://doi.org/10.1016/j.trc.2021.103453

[2] Sekhon, J., & Fleming, C. (2021). *SCAN: A Spatial Context Attentive Network for Joint Multi-Agent Intent Prediction*. arXiv. http://arxiv.org/abs/2102.00109

[3] Alahi, A., Goel, K., Ramanathan, V., Robicquet, A., Fei-Fei, L., & Savarese, S. (2016). Social LSTM: Human Trajectory Prediction in Crowded Spaces. 2016 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 961–971. https://doi.org/10.1109/CVPR.2016.110

Progress

Currently, MATRiX is a virtual environment containing a replica of the site of the Zara video dataset.

Figure 3: Image predictions from the Zara dataset.

Figure 4: Virtual Zara environment.

By default, agents follow linear trajectories from their spawn point. MATRiX communicates with models through a TCP server. We were unable to configure SCAN to accept raw input, but we adjusted MATRiX to output data as a text file read by SCAN. At our current stage, however, SCAN does not perform as expected, and predictions do not map correctly onto the environment.

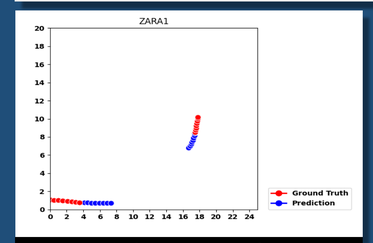

Figure 5: Graph of SCAN predictions from MATRiX data.

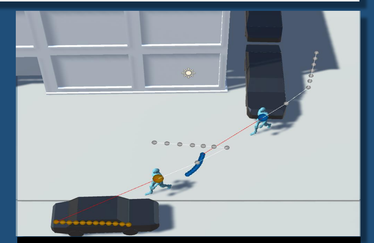

Figure 6: Unexpected mapping of SCAN predictions onto the scene.

What's Next?

Future Work

- Outline guidelines for MATRiX compatibility
- Develop a custom MATRiX model
- Replicate more datasets
- Human-subject testing and UX streamlining
- User Interface for configuring MATRiX outside of Unity

Applications

- Data collection in fully custom environments and scenarios
- Expansion of existing datasets
- Model evaluation
- Interdisciplinary potential:
  - Psychological research
  - Agoraphobia therapy
  - Game development

Presenters: Charles Brailovsky, Alli Brophy, Meriem Hcini
Mentors: Cody Fleming, Ph.D.

Iowa State University
Virtual Reality Applications Center

Funded By NSF Grant #1757900