Master’s project I: Trajectory Prediction (Pedestrian/Human, Cyclist, Car)

Task Description:

Trajectory prediction of different road users in mixed-traffic scenarios is attracting huge interest due to its importance in different artificial intelligence powered fields like autonomous vehicles and service/co-working robots. The challenge lies within predicting accurate yet realistic trajectories (e.g., interactions, avoiding conflict/near-conflict situations).

Within this project, we will go through this process of predicting/forecasting trajectories with one road user as our prediction focus.

N.B: By trajectory, we mean x and y coordinate positions of a certain road user at a certain time step. From now on we will use “pedestrian” as an example of a “road user”.

Choose a dataset that provides the most important information (i.e., obstacle positions, destination points, group information).

Sample data source: https://github.com/crowdbotp/OpenTraj

Tasks:

1. Prepare a small report/presentation about the dataset (with visualizations). **(19/05)**
2. Extract the required features: **(02/06)**
    a. pedestrians’ speed (Newtonian) at each time-steps (if not given)
    b. euclidean distance (and/or direction vector) from the destination points (if not given, think about how to extract it)
    c. euclidean distance from the nearest obstacle point (if obstacle positions are given)
    d. euclidean distance from the nearest pedestrian (neighbor). Here, a neighbor pedestrian can be defined as a pedestrian who’s present in the scene at the same time-step.
    e. euclidean distance from group members (if group info is given)
    f. And so on. N.B. **It is not mandatory to extract all the features mentioned above (except a, b, and d).**
3. Design a trajectory prediction model that can: for each certain pedestrian predict the next 4.8 seconds of trajectory (12 time-steps at 25 fps) with a maximum of 3.2 seconds (8 time-steps at 25 fps) of previous trajectory data (motion history) and other extracted features as input. **(23/06)**
4. Use at least two different algorithms (Machine learning) to design the prediction model. i.e., two different versions of the prediction model with two different algorithms. Compare the performance of each of the models. **(23/06)**
5. Use the following metrics to evaluate the model performance: **(07/07)**
    a. **Average displacement error (ADE):** ADE is the mean of all euclidean distance values between the real and predicted values at each time-steps. Lower is better.
    b. **Final displacement error (FDE):** FDE is the distance between the last predicted coordinate (x, y) and the last real coordinate (x, y) of the primary pedestrian. Lower is better.

    c. **percentage of near-collisions:** Calculate the percentage of near-collisions in the model predicted trajectories of the pedestrians. A near-collision takes place when the Euclidean distance between the pedestrians is below 0.1 meters.

6. Take a sample scenario (with at least four pedestrians) from the dataset and visualize (simple) the predicted and real trajectories to qualitatively compare model performance. **(07/07)**

Master project II: Group detection/ Clustering

Task Description:

In crowded areas, road users tend to move in groups (i.e., couples, friends, family, etc.) and exhibit different motion patterns compared to individuals. Again, a group interacts with other road users differently and as a group. Automatic detection of groups in large-scale datasets is an important task for designing accurate motion models, and trajectory prediction models for aiding emerging technologies like autonomous vehicles and service/co-working robots. However, automatic group detection is a non-trivial task, due to the dynamic environment, dynamic group sizes, and mixed interactions. Again, a group can lose or gain members at a certain time step due to interactions with other road users.

In this project, we will go through the process of identifying groups in a certain large-scale dataset.

N.B: typically, co-existence time and maintained distance (among two or more road users) are used to find or determine group members. Please go through [1] for further interesting ideas.

Choose a dataset that provides the most important information (i.e., obstacle positions, destination points, group information).

Sample data source: https://github.com/crowdbotp/OpenTraj

Tasks:

1. Choose a dataset that already provides ground truth values of groups (group members)
2. Prepare a small report/presentation about the dataset (with visualizations). **(19/05)**
3. Extract required features (e.g., co-existence time, Euclidean distance among pedestrians, etc.) **(02/06)**
4. At each time step for each pedestrian detect/cluster its group members (if any). **(23/06)**
5. Evaluate the group detection model using appropriate metrics. **(07/07)**
    - **Interaction over Union (IoU):** IoU is the intersection divided by union, which is commonly used for evaluating object detection in computer vision. In terms of pedestrian groups, the intersection consists of the correctly predicted members for a group. The union is the combination of all the members either in the predicted or in the true group [1].

Master project III: Trajectory Data representation

Task description:

Trajectory data consists of different types of parameters, i.e., temporal parameters (e.g., position coordinates), and spatial parameters (e.g., obstacle positions, destination). It is important to represent these different types of parameters efficiently to use them effectively for tasks like motion modeling and behavioral prediction. Again, there are different forms of relationships (neighbors, group members) and interactions between different road users in crowded zones. These factors also need to be properly represented.

In this project, we will go through the process of representing data in a certain large-scale dataset.

N.B: **choose a dataset that provides the most important information** (i.e., obstacle positions, destination points, group information).

Sample data source: https://github.com/crowdbotp/OpenTraj

Tasks:

1. Prepare a small report/presentation about the dataset (with visualizations). **(19/05)**
2. Identify and extract (if needed) important features (at least four features) for representing a road user's motion (and/or state) including interaction with other road users. i.e., features that can be useful to best describe a certain road user's motion and state. [take ideas from previous project's description]. **(02/06)**
3. Choose an appropriate approach to represent and visualize the data (i.e., graph theory [**recommended**], probability density diagram, etc.). **(23/06)**
4. Design a conceptual model of the data representation. **(23/06)**
5. Store the data as represented in step 4. in an appropriate manner. i.e., in a Graph database if graph theory is used. **(07/07)**

N.B.: Please investigate [2] for ideas.

References:

[1] Cheng, H., Li, Y., & Sester, M. (2019, June). Pedestrian group detection in shared space. In 2019 IEEE Intelligent Vehicles Symposium (IV) (pp. 1707-1714). IEEE

[2] Hossain, S., T. Johora, F., P. Müller, J., & Hartmann, S. (2020, September). A Conceptual Model of Conflicts in Shared Spaces. In *2020 The 6th International Conference on Industrial and Business Engineering* (pp. 228-235).