CPSC 290 Project Proposal
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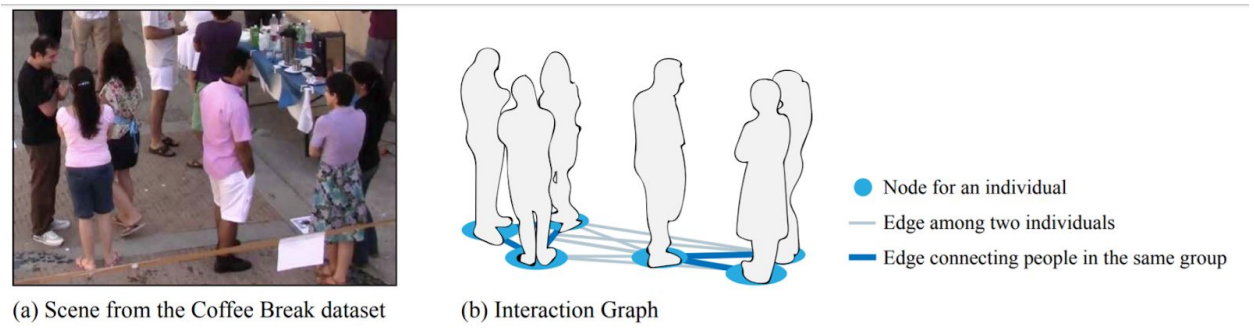
Improving Social Awareness and Group Detection through Deep Learning

Background:

Automatic group detection using computer vision is critical to surveillance systems, socially-aware mobile systems, interactive displays, and more. In the field of human-robot interaction, group detection is necessary for optimal verbal and non-verbal behavior [1]. Group conversation can be visually recognized by analyzing the location and orientation of all individuals. In this model, each individual is a node on a graph, with edges connecting people in the same group [2]. Figure 1 below gives an example input and output of this process.



(a) Scene from the Coffee Break dataset (b) Interaction Graph

Figure 1: Sample Input and Output [2]

Currently, explicitly modeled heuristics are used to group people by spatial arrangement, but these methods do not generalize well to more complex scenarios [3]. With increasingly available high-quality data inputs, powerful deep learning methods can improve the detection of conversational groups in comparison to prior approaches. The current state-of-the-art technique uses a Deep Affinity Network (DANTE) and Dominant Set (DS) clustering algorithm to create group clustering predictions [2]. The data analysis pipeline is shown in Figure 2 below.

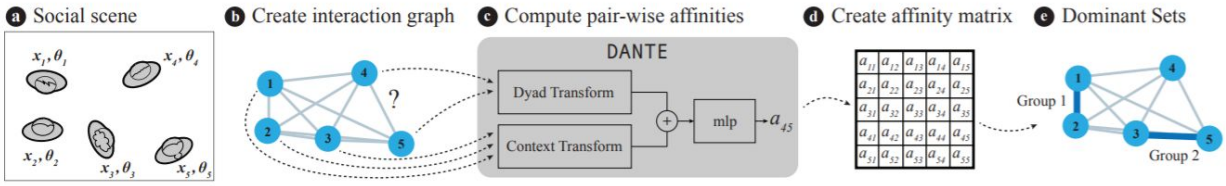


Figure 2: DANTE Pipeline [2]

In (a) the scene is captured and feature vectors for each individual are extracted. An interaction graph is created in (b) and DANTE uses both Dyad and Context Transforms with several multilayer perceptrons (c) to create an affinity matrix, showin in (d). Finally, Dominant Sets (e) is applied to determine the predicted group structure. The DANTE algorithm is preferred for its deep learning components and ability to contextualize both individual interactions and the overall social scene. Compared to previous benchmarks tested on publicly available datasets, DANTE reaches greater precision and recall with statistical significance [2]. However, this method also has some flaws and room for growth.

Proposed Project:

In this project, I would collaborate with Dr. Vazquez and the Interactive Machines Group to further refine the DANTE algorithm. Currently, the program is only able to handle six people simultaneously, reducing its effectiveness in crowded locations. Using Max Pooling, the overall number of individuals does not impact the feature input for the Context multilayer perceptron, so this should be a feasible goal.

We also are looking into upgrading the camera with depth perception to expand the feature space, and collecting additional data to further train the model. I will also be updating the publicly-shared ROS nodes that allow for real-time usage of this application with the interactive Shutter tabletop robot. This semester, I hope to pursue all these avenues to improve the speed, accuracy, and robustness of the model.

Timeline:

Over the 12 week course, I intend to make steady progress towards the final goal of an improved group clustering implementation. A tentative timeline is shown below.

1. January 15 - 22: Create Project Proposal and get course approved.
2. January 23 - 26: Familiarize myself with the codebase and understand current progress
3. January 27 - February 9: Update DANTE to handle larger graphs using Max Pooling
4. February 10 - March 6: Upgrade Shutter with depth perception and expand feature space
5. March 23 - April 12: Collect improved dataset and train DANTE model on new inputs
6. April 13 - April 24: Package into ROS node and create documentation

Although I do not expect to adhere strictly to the timeline due to natural slowdowns and/or breakthroughs, this planning will help ensure that I stay on track throughout the semester.

Deliverables:

My deliverables for this project will be the improvements to the DANTE project in scalability and accuracy. Particularly, I will expand the program to handle more than six individuals, improve the feature space, and assist in collecting an improved dataset for training.

References:

[1] Marynel Vázquez, Elizabeth J Carter, Braden McDorman, Jodi Forlizzi, Aaron Steinfeld, and Scott E Hudson. 2017. Towards robot autonomy in group conversations: Understanding the effects of body orientation and gaze. In Proceedings of the 2017 ACM/IEEE International Conference on Human-Robot Interaction. ACM, 42–52

[2] Mason Swofford, John Peruzzi, Nathan Tsoi, Sydney Thompson, Roberto Martin-martin, Silvio Savarese, and Marynel Vázquez. 2018. Improving Social Awareness Through DANTE: A Deep Affinity Network for Clustering Conversational Interactants. J. ACM 37, 4, Article 111 (August 2018), 22 pages. https://doi.org/10. 1145/1122445.1122456

[3] Francesco Setti, Chris Russell, Chiara Bassetti, and Marco Cristani. 2015. F-formation detection: Individuating freestanding conversational groups in images. PloS one 10, 5 (2015), e0123783