Simulation of group behaviour during a protest

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The purpose of our project is to study the behavior of a crowd during a protest. In order to so, we will first create a unified modular development environment that implements the basic flocking model. Then we will add obstacle avoidance and place the model in a topological map of Ljubljana. Furthermore, we will divide agents into different groups (e.g. leader, regular protest member and bystander) and create different behavioural patterns for each group based on human psychology. Finally, we will add agents for crowd control (e.g. police) and examine the effect they have on the behaviour of the crowd. Optional: we will attempt to optimize police behaviour with methods such as genetic algorithms (the purpose being crowd dispersal or redirection).

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Protests are a widespread phenomenon involving typically large groups of people, oftentimes with different, or even conflicting goals between their respective subgroups. As such they are a fascinating subject for studies in various fields, from human psychology to group behaviour simulations, which will be our primary focus during the course of this project.

The central idea for the project was inspired specifically by the 2020 protests in Ljubljana, that had a distinguishing feature of having an individual leader, but we will try to make our model applicable more generally (for instance, with minor parameter adjustments, we should be able to easily model sports riots or other similar events with various subgroups).

Related work

There are many existing attempts to model protest behaviour, but our project will primarily build on concepts proposed in [1]. The basic idea is to split the agents into subgroups depending on their level of involvement with the protest. The proposed subgroups are:

- active protesters (which are further divided by their level of "passion" or "interest" in the protest),
- bystanders (which may or may not at one point be persuaded to become active protesters, based on parameters discussed in [2]),
- media (which we will likely ignore, as it will not be relevant to our observations): agents attracted to moving in the direction (in their field of view) where the most significant "action" is taking place,
- police/crowd control agents (described in more detail in [3]): their primary goal is dispersing a crowd or redirecting it in a specific direction.

Note: if we are intending to model specifically the 2020 Ljubljana protests, we need to additionally implement the concept of a leader, who is to a large extent controlling the movement of all active protesters within a given range and as such also becomes a more significant target for crowd control agents.

We will attempt to model behaviour of each of the aforementioned subgroups by assigning them a parameter vector based on human psychology. These parameters are intended to cover a wide range of human emotion, such as willingness to participate in a protest (to determine how likely it is that a bystander will join a protest if the majority of agents in their vicinity are active protesters), inclination towards violence, etc. In [2] these parameters are referred to as levels of recruitment and defection (willingness) and "mild unrest", "moderate unrest" and "severe unrest" (levels of violence).

For crowd control agents, we will primarily be using ideas presented in [3]. The goal is to experiment with different formations of these agents to achieve maximum success rate in terms of crowd dispersal. The effectiveness of these agents should also

By conducting simulations of protests using various models for different subgroups of people, we hope to gain some insight into group behaviour during such events, that might make them logistically easier to organize/control in the future.

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vary depending on parameters attributed to an individual protester agent. Effectively this means there should be different levels of cooperation with the police depending on which subgroup a protester belongs to. Depending on the level of detail we are aiming for, we might also differentiate between different subgroups of police agents (e.g. more intimidating/less intimidating).

Methods

Implementation of the model will be done in Unity, in a 2-dimensional space observed from bird's-eye view. First step will be the creation of a topological map of Ljubljana, or rather a portion of it (for instance a square and several adjacent streets - enough to allow us to observe a crowd of several hundred agents). To ensure the correct scale and proportions, we will be using Google Maps for this step, as well as taking into account the estimated maximum numbers of people that can fit into spaces of particular dimensions. In other words, we will try to create an environment that's as realistic as possible, so that the obtained results will potentially be useful in various practical applications.

Depending on the size of the map, we will then populate the space with 100-500 agents that will represent protesters and bystanders. Afterwards we will add a considerably smaller number of police agents (up to 50) with the goal of dispersing the crowd. One of the experiments will be to determine the smallest police to protester ratio for which the crowd control is still effective.

Finally, we will attempt to optimize police behaviour (i.e. find different formations) using approaches such as genetic algorithms to observe if we can further decrease the number of necessary crowd control agents, while maintaining the same effectiveness in terms of crowd dispersal.

Results

At this stage in the development of our project, we haven't obtained any meaningful results yet (other than the basic visualization shown in 1), however, we do have certain hypotheses/expected outcomes:

- we expect outcomes of simulations to differ considerably, depending only on group size, even if other parameters within each subgroup remain the same
- we expect the behaviour of the agents (from all subgroups) to vary depending also on the shape of the surrounding environment (e.g. a wide square, versus a narrow street)
- we expect that by introducing the concept of a leader, the crowd will become more cohesive and thus more difficult to control, but at the same time, this might lead to a situation with a single point of failure (i.e. the leader becomes an obvious target for the police)
- it should be possible to optimize the efficiency of crowd control agents using genetic algorithms or similar approaches, instead of using pre-defined formations based on expert knowledge.

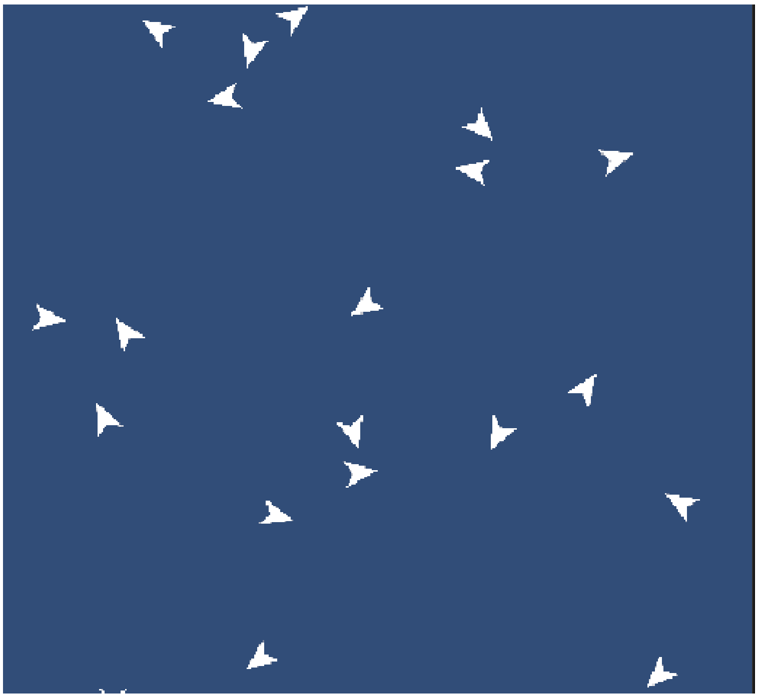

Figure 1. Example of a visualization of static, randomly positioned agents in Unity

Discussion

The project is currently progressing according to plan, except for the creation of a topological map of a whole city, which might have been an overly ambitious goal. Instead, we will likely limit ourselves to a smaller portion of a city (though still large enough to fit several hundred agents, as quantity will be of significant importance, particularly when observing crowd dispersal or redirection).

CONTRIBUTIONS. NČ is going to implement the baseline model, PNM is going to optimize parameters, PM is going to create the topological map, LB wrote the first report and is going to be working on crowd control.

Bibliography

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