ECMM427
Group Development Project

CA4 Demonstration

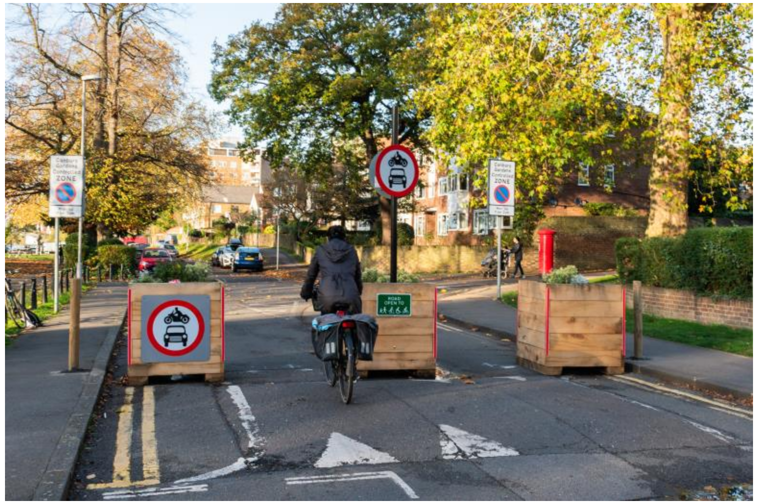
LTN Project

The Team

- Oscar
- Zdenek
- Tomas
- Ahmad
- Scott
- Ted

Introduction

- Low traffic neighbourhoods (LTNs) use traffic calming measures to limit/prevent traffic flowing through certain neighbourhoods
  - These systems use barriers, humps, etc. to regulate/limit traffic
  - Purpose of LTN is to encourage alternative transport
- LTNs are being trialled in Heavitree
  - Has faced pushback/dissatisfaction from local residents
  - Protests and poor press reception in local news



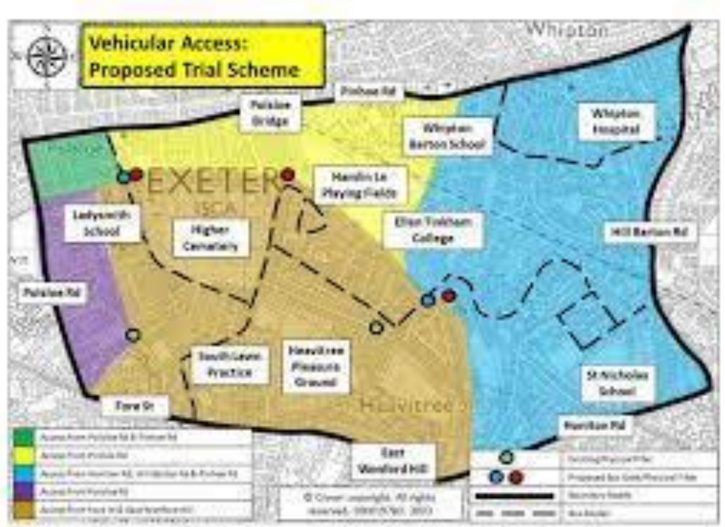


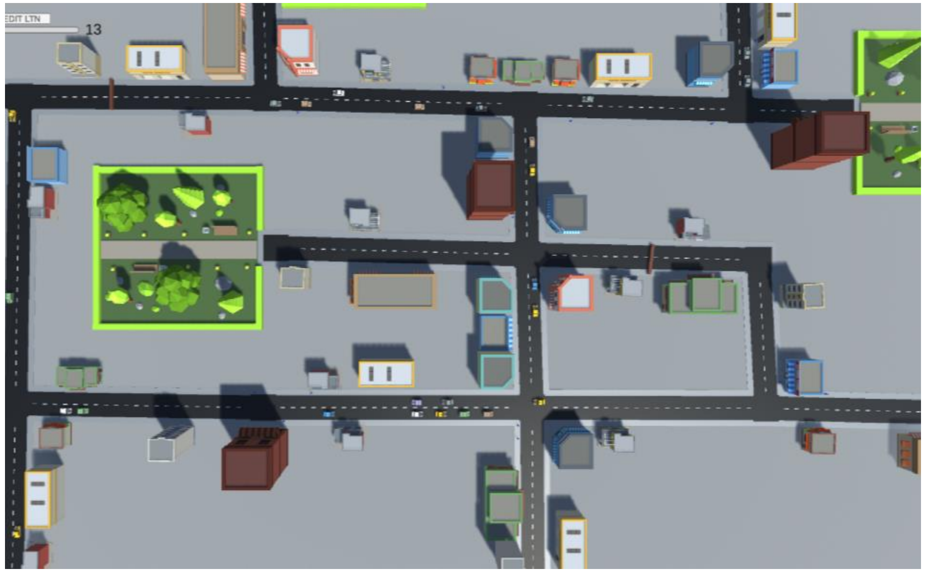
Figure 4: Overview of vehicular access under proposed trial scheme.

Introduction

- Aim is to understand impact of LTNs *without* impacting residents
  - Create an accurate/realistic simulation to understand impact on traffic
- Our stakeholders/clients include:
  - The RAMM
  - The local council
  - Residents of Heavitree

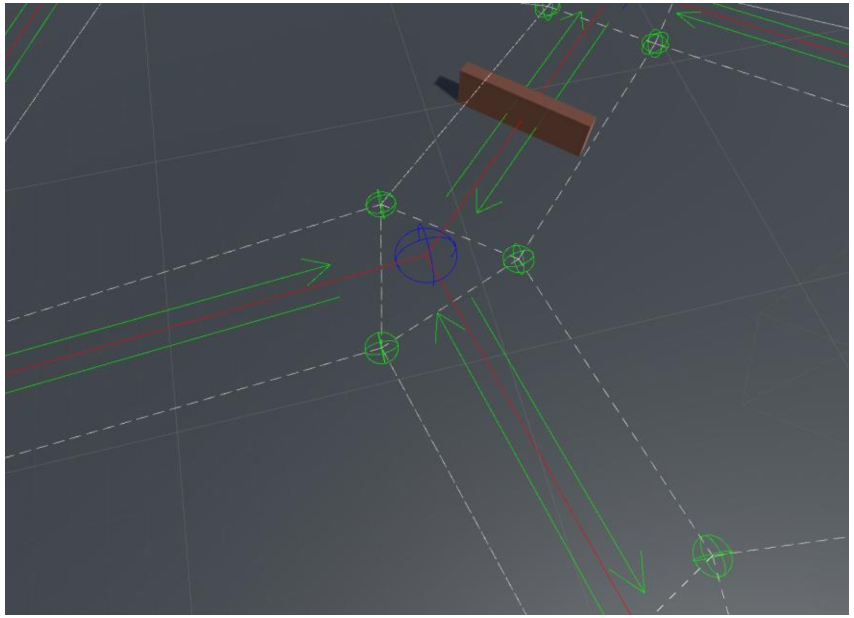
Current Feature Set of the Program

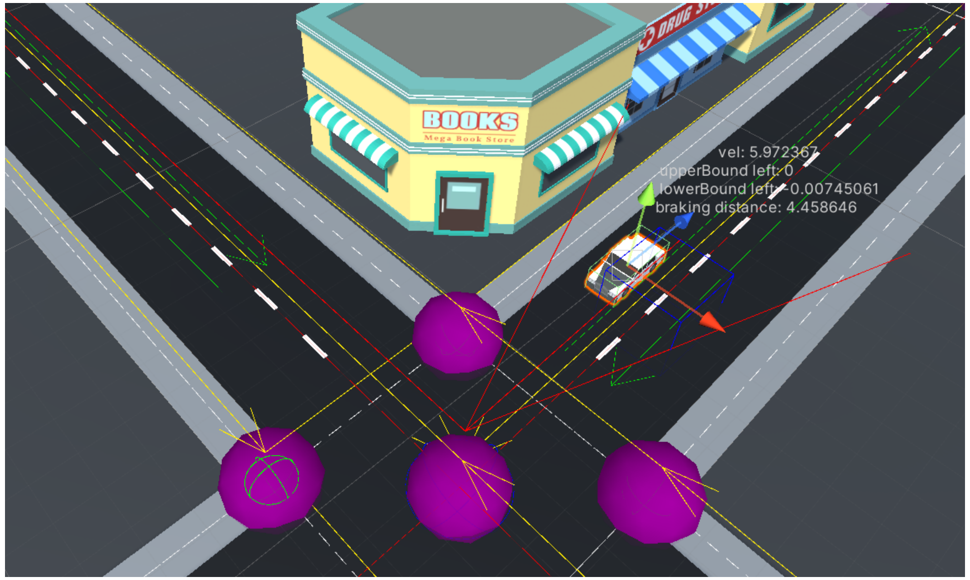
1. Traffic Simulation
2. Visual Representation of the ongoing simulation
3. Measuring key variables of the simulation
4. Presentation of Statistics



Traffic Simulation

1. Graph based map
    - Dynamic pavement generation
    - Barriers
2. Agents
    - Dynamic agent velocity
    - Agent collision
    - Braking distance-based separation
3. Agent Manager
    - Stochastic Spawning of Agents
    - Stochastic Destination determination
4. Agent Pathfinding

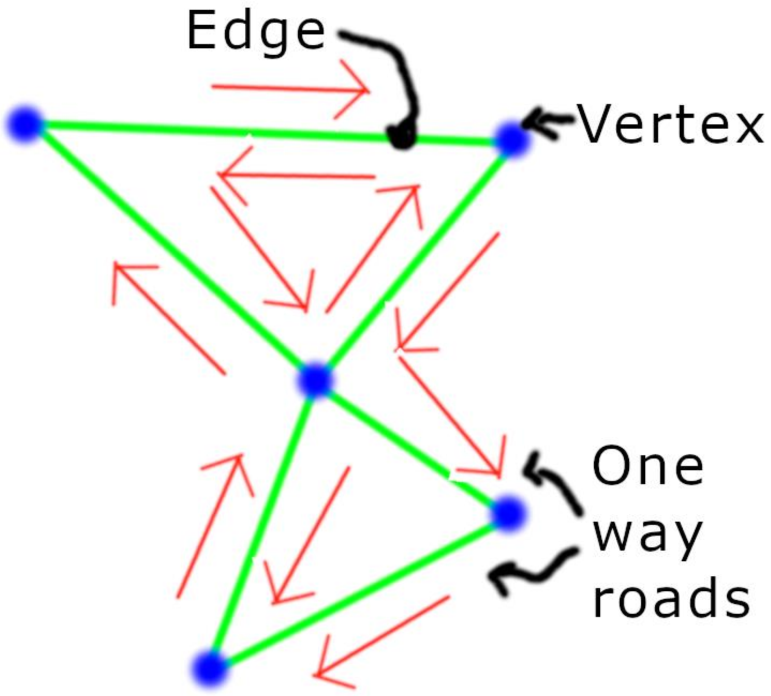




```
vel: 5.972367
upperBound left: 0
lowerBound left: -0.00745061
braking distance: 4.458646
```

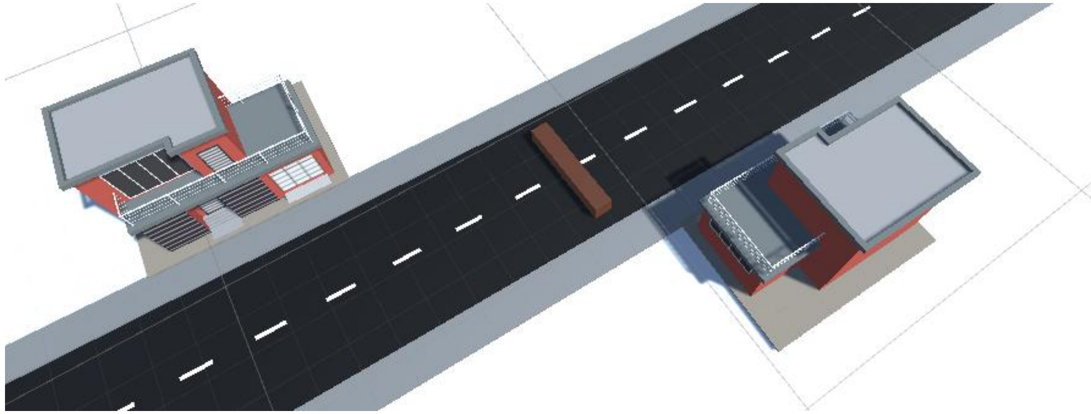
Graph Based Map

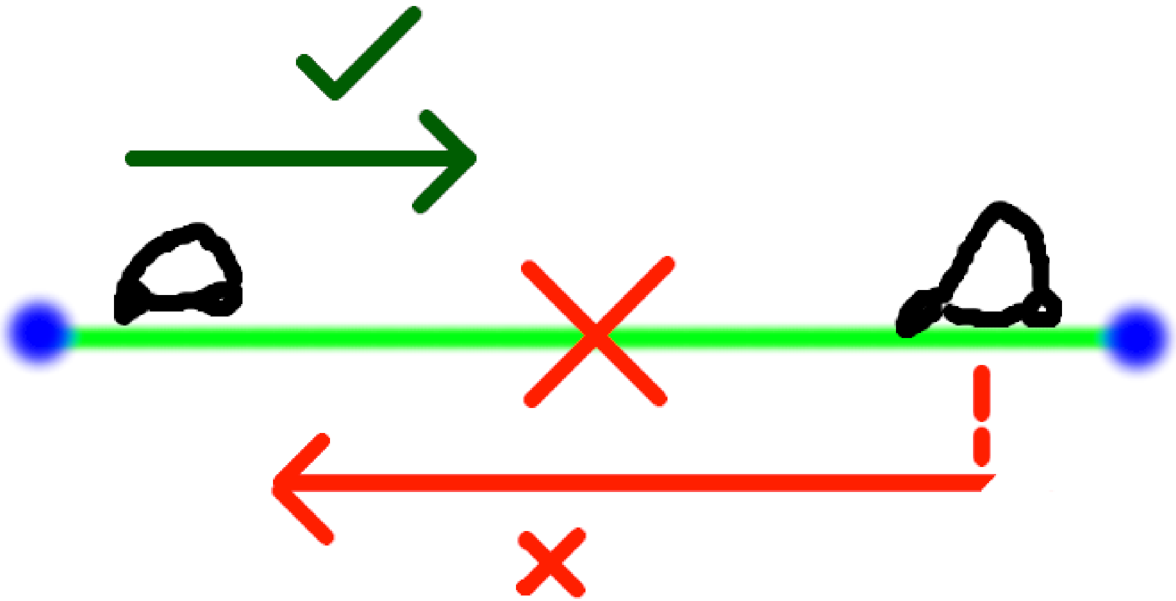
- Map consists of Waypoints (representing junctions) and directed Edges (representing roads)
- Movement along edge is only possible along the direction of the edge
- Nodes are placed at a location of natural junctions and/or dead ends.



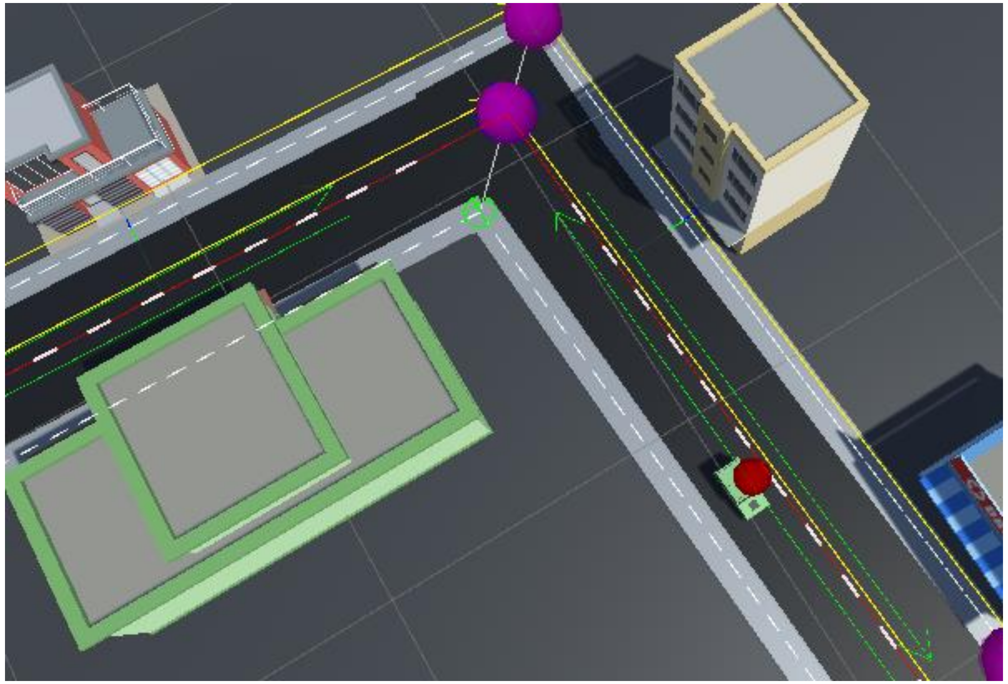
Barriers

- Edges may be inaccessible to specific forms of traveler.
- Barriers may be placed on edges to prevent travellers from passing through.





Agent Pathfinding Implementation



- Agents use Djikstras Algorithm to decide path to take
  - Path internally represented as a list of waypoints to traverse

During development, we discovered and corrected several edge cases:

- If a barrier is placed on the edge of a road, agents will "take the long way around" to find a destination
- Pedestrians do not consider barriers when deciding path

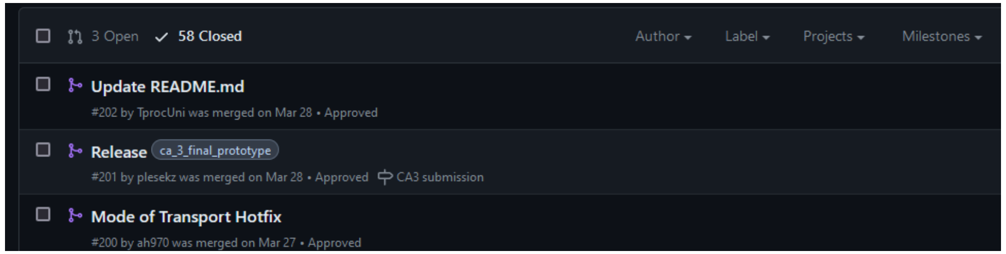
Development - Tooling

- Unity 3D engine to run simulation
  - Provides runtime and 3D game engine, graphics library, etc.
- VS Code, Git and GitHub used for development
  - Used for asynchronous development of simulation

MADE WITH Unity®

Development - Methodology

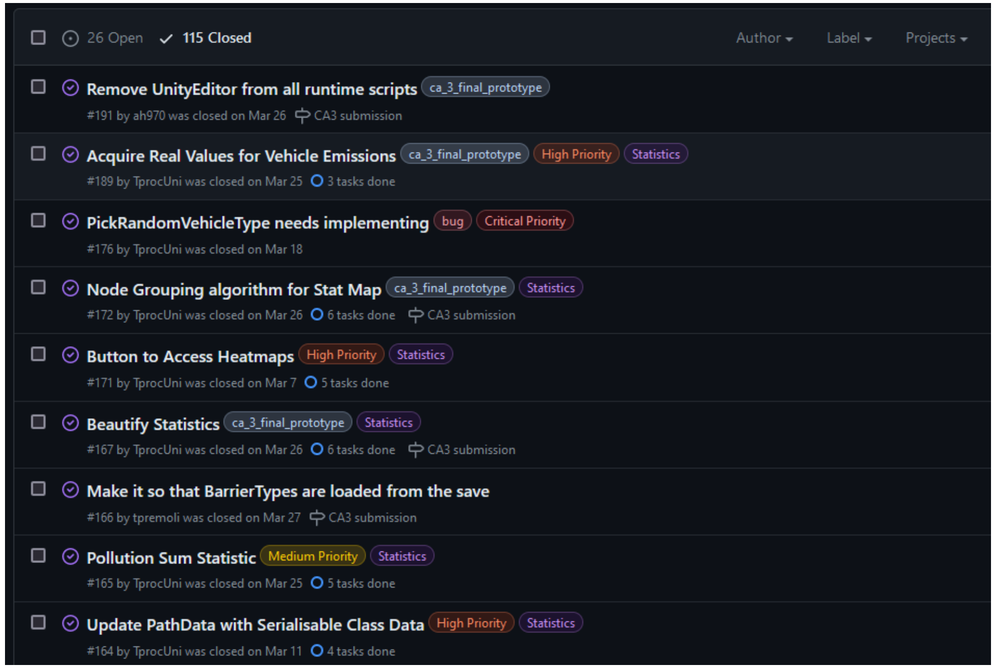
- Agile methodology used to specify, design, implement and test simulation
- Available under MIT licence



□ **Update README.md**
#202 by TprocUni was merged on Mar 28 • Approved

□ **Release** ca_3_final_prototype
#201 by plesekz was merged on Mar 28 • Approved CA3 submission

□ **Mode of Transport Hotfix**
#200 by ah970 was merged on Mar 27 • Approved



□ **Remove UnityEditor from all runtime scripts** ca_3_final_prototype
#191 by ah970 was closed on Mar 26 CA3 submission

□ **Acquire Real Values for Vehicle Emissions** ca_3_final_prototype High Priority Statistics
#189 by TprocUni was closed on Mar 25 3 tasks done

□ **PickRandomVehicleType needs implementing** bug Critical Priority
#176 by TprocUni was closed on Mar 18

□ **Node Grouping algorithm for Stat Map** ca_3_final_prototype Statistics
#172 by TprocUni was closed on Mar 26 6 tasks done CA3 submission

□ **Button to Access Heatmaps** High Priority Statistics
#171 by TprocUni was closed on Mar 7 5 tasks done

□ **Beautify Statistics** ca_3_final_prototype Statistics
#167 by TprocUni was closed on Mar 26 6 tasks done CA3 submission

□ **Make it so that BarrierTypes are loaded from the save**
#166 by tpremoli was closed on Mar 27 CA3 submission

□ **Pollution Sum Statistic** Medium Priority Statistics
#165 by TprocUni was closed on Mar 25 5 tasks done

□ **Update PathData with Serialisable Class Data** High Priority Statistics
#164 by TprocUni was closed on Mar 11 4 tasks done

Operation

- Binaries available from GitHub releases: https://github.com/2023-24-UoE-ECMM427/ltn-demonstrator/releases
- Thorough documentation covering maintenance and usage guides available: https://github.com/2023-24-UoE-ECMM427/ltn-demonstrator/tree/main/docs

Challenges Overcome – Waypoint Mover

- Represents many vehicles
    - different modes of transportation (e.g., pedestrian, car, bicycle) and assigns vehicle types.
- Deals with various constraints
    - Velocity and Movement Constraints
- Manages collisions with other travellers to prevent overlapping and unrealistic entity behaviour
    - Including initial coroutine that waits until there is no immediate collision threat at the traveller's initial position to spawn

Challenges Overcome – Path Finding

- Dynamic Pathfinding
  - Paths adapt to changes in complexity
    - New edges are added to the graph
    - Blockades added to the graph
- Multi-Component Interaction
  - Manages complex interactions with other movers
  - "Traffic Jams" occur within crowded roads
  - Collision avoidance

- Supports various transport modes (pedestrian, car, bicycle)
  - adjusted movement parameters for realistic behaviour.
- Precise movement along paths
  - considering physical dimensions and movement constraints.
- Path tracing aiding in development and optimization.

Challenges Overcome – Procedural Graph

- Build using separate materials for roads, dashes, and curbs.
- Utilizes graph data to create roads between waypoints
- Generates intersections at multi-waypoint junctures
- Curbs added to sides and intersections
- Menu options
- Easy loading/clearing of road objects
    - Snap/Rotate Buildings onto the road
    - Integrates unity editor

Challenges Overcome – Unity3D

- Unity Editor for road building (procedural graph)
- UI Building
- Learning C#
- Interaction between code and runtime testing