A Multi-Agent Approach to Simulate Autonomous Traffic with Games: How to Transform GTA-SA/SA-MP in Your Simulation Platform

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Introduction

- Urban mobility is among the greatest problems of society, it costs:
  - Lives
  - Money
  - Air purity
- Autonomous vehicles are a promising proposal to deal with these challenges
- Simulation is key to building effective and safe self-driving cars
- There are many simulation tools in the academic world

Introduction

- Most of the simulations found in the literature are 2D, like the Texas

  University's AIM project

- 2D is good for testing algorithms in a surface level

- Realistic 3D environments can evaluate safety and effectiveness from many

  other perspectives

  - How to deal with relief dynamics

  - How the consumption cost is affected by the relief

  - How to deal with climate changes

  - How distinct kinds of vehicles influence the simulation

Grand Theft Auto: San Andreas (GTA-SA)

- 3D sandbox game

- Developed by Rockstar North in 2004

- Around 385 kilometers of roads and streets (239.2 miles)

- 155 different models of terrestrial vehicles

- Can simulate big vehicle networks in 3D spaces

San Andreas Multiplayer (SA-MP)

- Modification of GTA-SA that allows multiplayer

- Allows customly scripted servers

- Allows loading C++ modules

Creating a graph

- Graph representing every street and road

- Nodes information in game files

  - Path nodes: determines the path of the street

  - Navi nodes: complements information of path nodes like amount of lanes and level of traffic.

- Vehicles calculate minimal path based on the graph

Nodes in game

Finding Minimal Path

```
 1: for all u ∈ V(G) do
 2:     d(u) ← ∞ {Initial distance is unknown}
 3:     p(u) ← ∅ {Identify which vertex is incident over u in
           the minimal path}
 4: end for
 5: d(s) ← 0
 6: INSERT_HEAP(A, s) {Creates a priority queue A based
       on the distance to s}
 7: while |A| ≥ 1 do
 8:     u ← REMOVE_HEAP(A) {Removes the vertex with
           minimal distance from A}
 9:     for all uv ∈ E(G), v ∈ V(G) do
10:         if d(v) > d(u)+ CALCULATE_COST(uv) then
11:             d(v) ← d(u)+ CALCULATE_COST(uv)
12:             p(v) ← {u}
13:             INSERT_HEAP(A, v)
14:         end if
15:     end for
16: end while
17: return  (p, d) {Returns a pair with the minimal distances
       d to all vertexes and a set p that identifies incidences}
```

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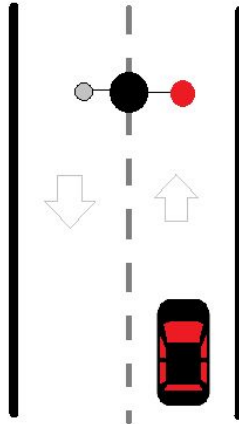# Finding Minimal Path: Dijkstra vs A*
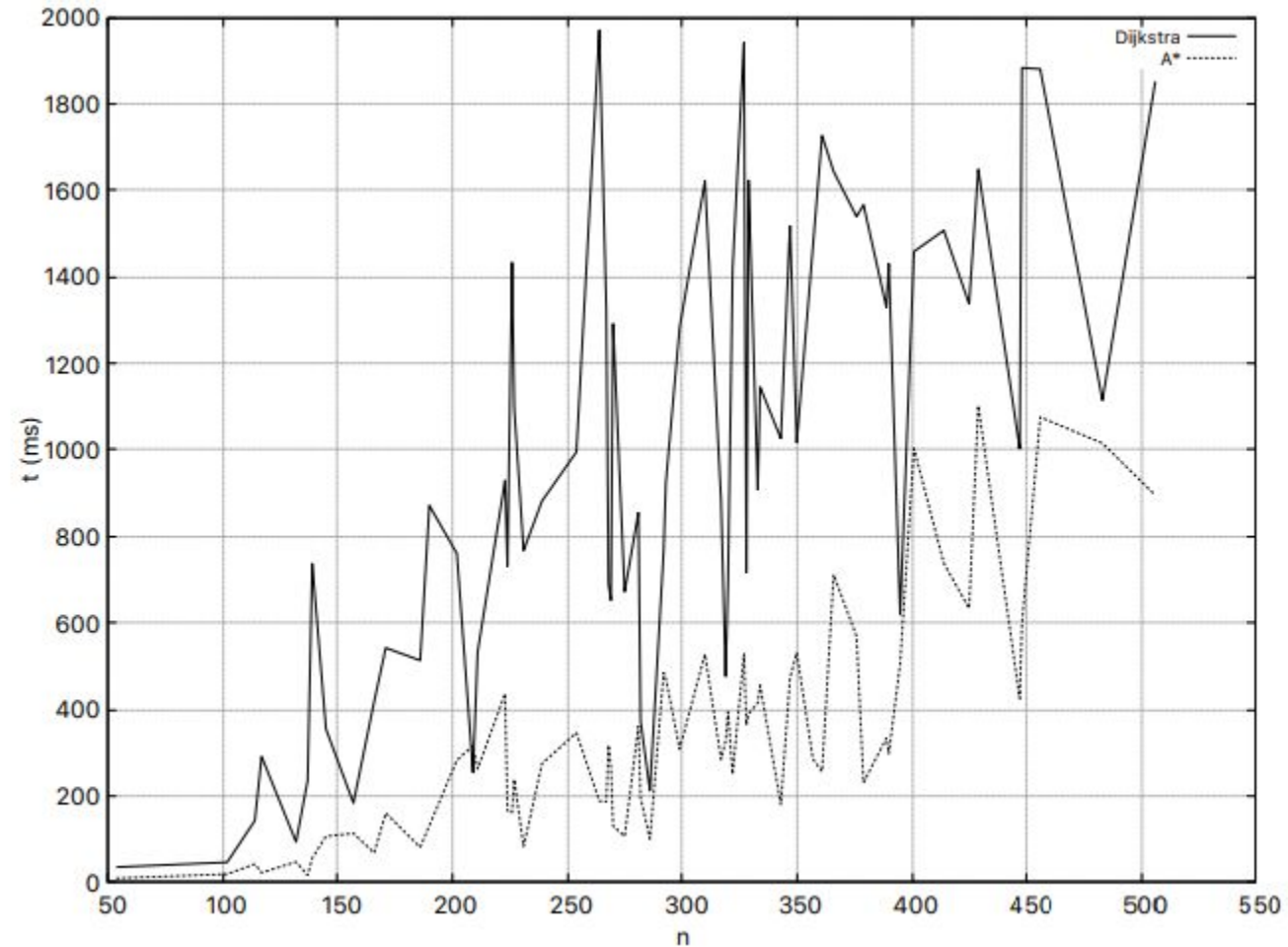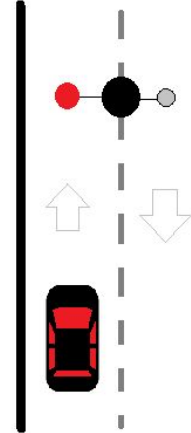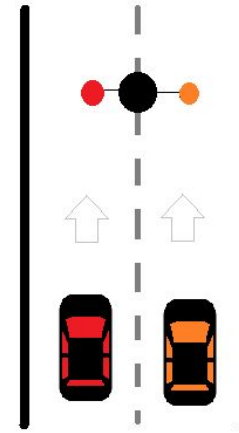
Calculate position on the street

Future Work

- The structure built enables many kinds of simulations to test different algorithms:

  - Autonomous Intersections Management algorithms

  - Driverless cars behaviours when emergency vehicles are nearby (e. g. ambulance, fireman, police)

  - Hybrid environments: it's a multiplayer game, thus, real people can test the simulation along with autonomous vehicles

Thanks

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