Route optimization of garbage trucks to reduce traffic with A-Star

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GARBAGE COLLECTION

Garbage collection suffers from many flaws, creating adverse effects on the environment while wasting taxpayer money and causing disturbances

ROAD CONGESTION

Slow, large trucks make frequent stops and are impossible to safely pass, causing backups in traffic and blockages in roads

GAS CONSUMPTION

Garbage trucks get on average 3 miles per gallon of gas, making them one of the most inefficient vehicles on the road.

FRUSTRATION

Getting stuck behind a garbage trucks is one of the most frustrating experiences as a driver, as their sudden stops make it impossible to accelerate smoothly

ECONOMIC DOWNSIDES

As garbage collection is a municipal service, any inefficiencies in the process of garbage collection leads to the expense of all taxpayers in the town. This is on top of the price of collection mandated by each town

ENVIRONMENTAL IMPACT

As trucks stop along their lengthy routes, their engine guzzle gas while in idle, releasing harmful gasses into the environment

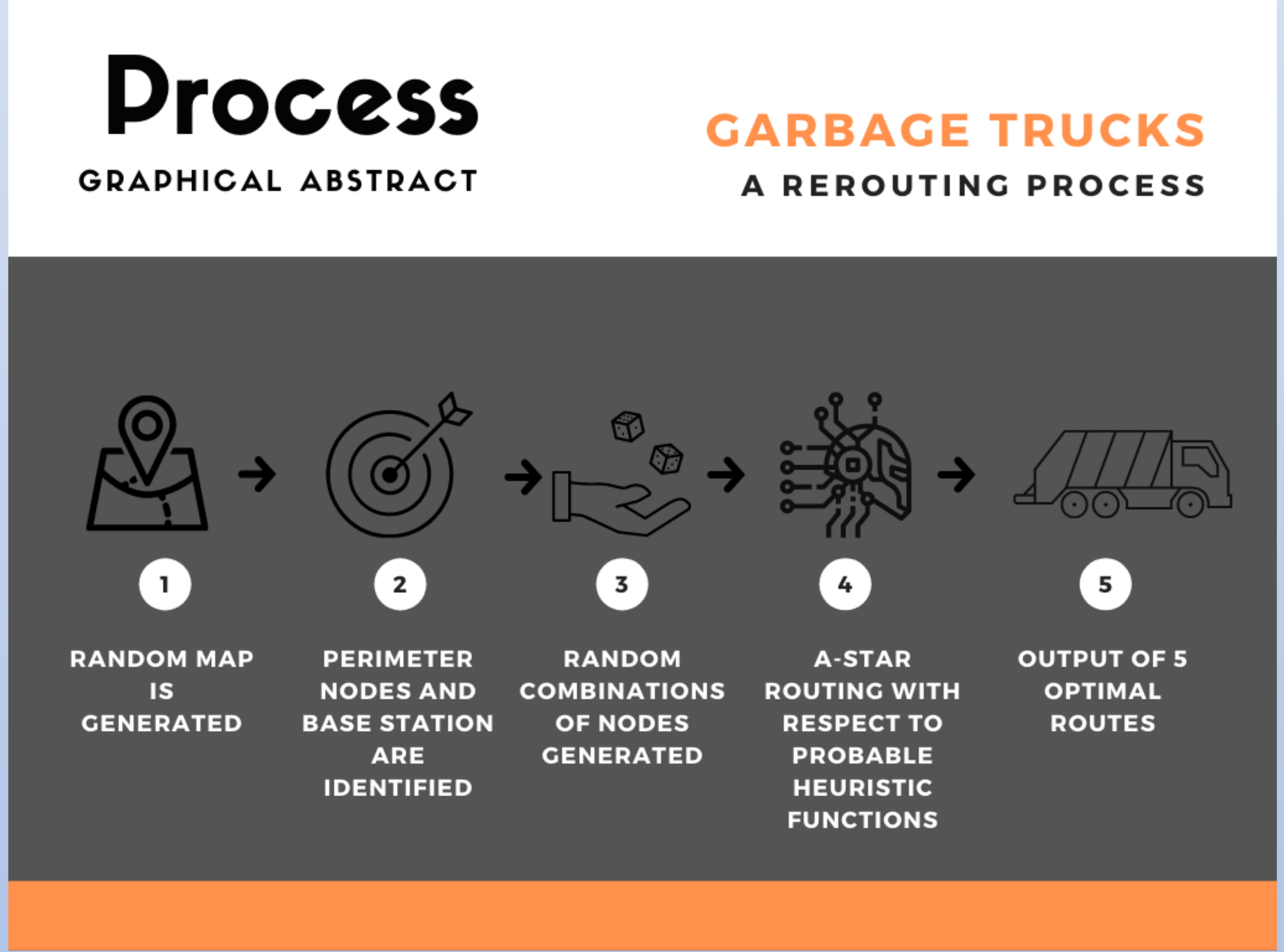
KAZ ERDOS

Problem Statement

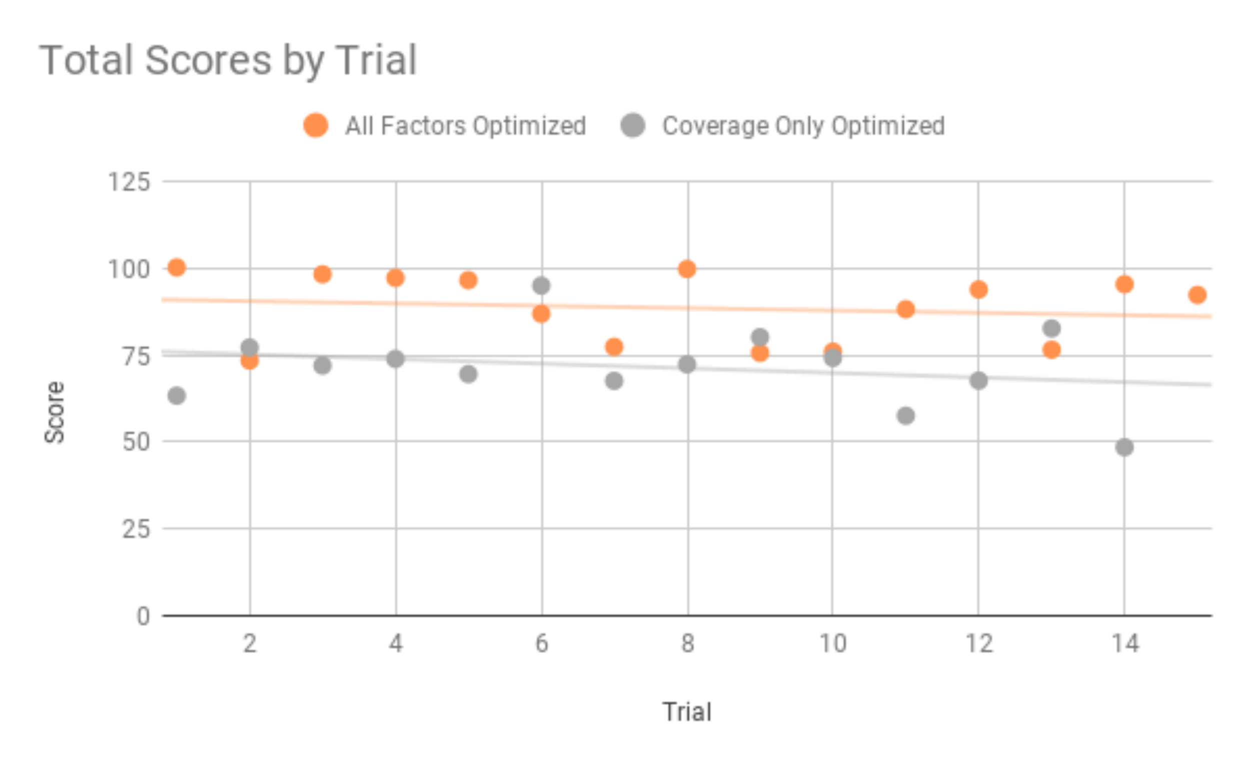
How do the routes of Garbage Trucks and their size affect traffic in the local area?

Research Objective

The goal of this project is to engineer a new system for garbage collection, which would be applied to the current routes of trucks used as well as smaller, less obtrusive vehicles.

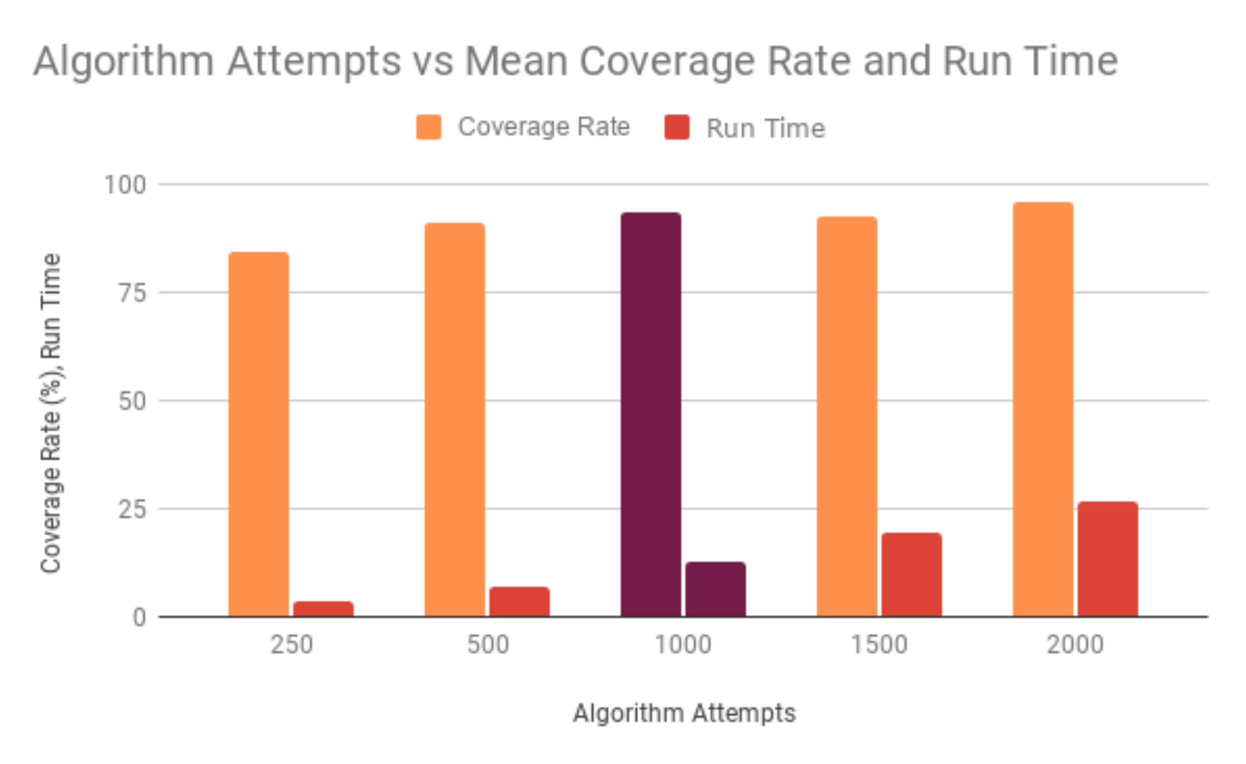


Results



The Data Shows...

When A-Star was Adapted to account for all the heuristics, the mean total scores improved over the version of the algorithm only made to optimize waste bin covered by 21.91%. ($p = 0.0001$)



of Random Attempts

By recording the mean coverage rate and timing the run time of the algorithm over a varying number of random attempts, it was found that 1000 attempts struck the balance of effectiveness and efficiency (Shown in purple).

Conclusions:

- Optimized A-Star was shown to consistently outperform base A-Star
- Base Station variation has more real-world applicability
- Runtime of the algorithm is fast, averaging around 12 seconds
- Constant Random Road Networks allowed for more objective testing (avoiding bias)

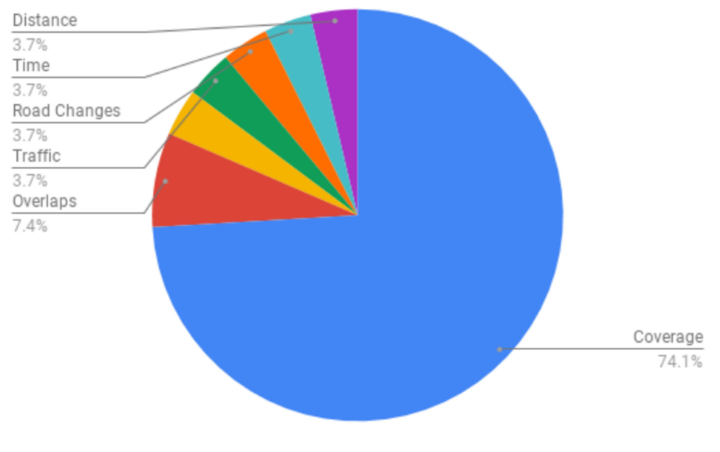
Future Work:

- Utilize Google Maps API to enable real-world testing
- Port application to mobile or a website
- Allow for custom heuristics to be added for specific use
- Update GUI with more information

VARIABLES

S_c	Coverage Score: % of Houses Covered
S_o	Overlap Score: # of Squares Overlapped
S_f	Fuel / Cost Score
S_{tr}	Traffic Score: Probable Impact
S_r	Road Score: # of Road Changes
S_t	Time Score
S_d	Distance Score

TOTAL SCORE BREAKDOWN



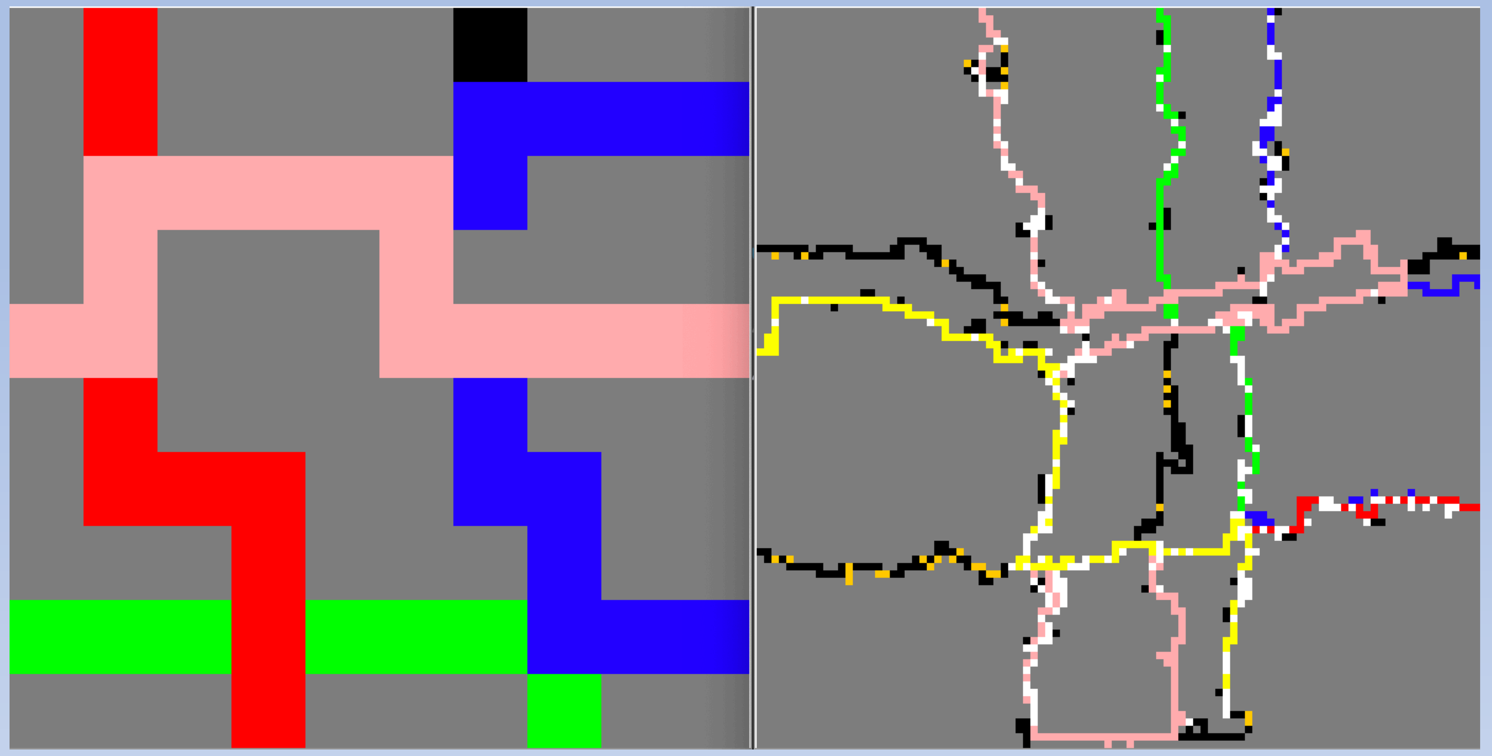
$$TotalScore = S_c - \frac{S_o}{10} - \frac{S_f}{20} + \frac{S_t}{20} - \frac{S_r}{20} - \frac{S_t}{20} - \frac{S_d}{20}$$

MATERIALS

VERSIONS

- Proof of Concept 1: A-Star Test
- Proof of Concept 2: Traffic/Random Test
- Version 1: A-Star + Random, Small Environment
- Version 2: Added Large, Random Environments
- Version 3: Added Waste Bin Tracking
- Version 4: Added Base Station Routing
- Version 5: Added Full Traffic Model
- Version 6: Added Probable Heuristics

First Versus Final Version



References:

- Edelkamp, S., Jabbar, S., & Lluch-Lafuente, A. (2005). Cost-Algebraic Heuristic Search. *Proceedings of the National Conference on Artificial Intelligence. 3.* 1362-1367.
- Ghaffari, A. (2014). An Energy Efficient Routing Protocol for Wireless Sensor Networks using A-star Algorithm. *Journal of Applied Research and Technology*, *12*(4). https://doi.org/10.1016/S1665-6423(14)70097-5
- Gunawan, D., Marzuki, I., & Candra, A. (2018). *J. Phys.: Conf. Ser.* 978 012122