DEVS Assignment

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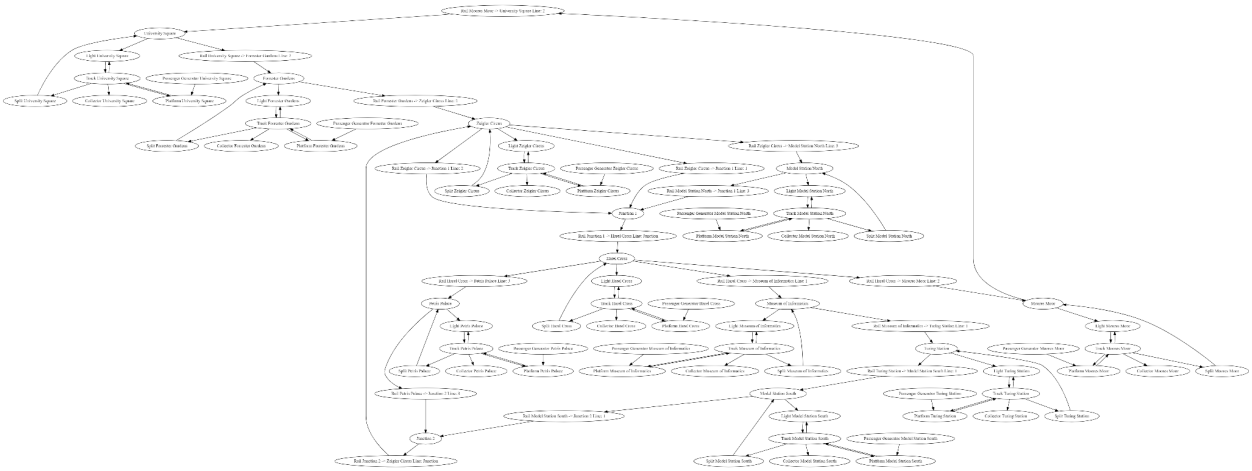
Implementation Overview

Our implementation can be found in the ‘ptr_system’ directory. These are the files it consists of:

- config.py: You can set all the configuration variables and the rail network layout here
- config_objects.py: Only contains StationConfig, which is an object used to describe the configuration for a station
- experiment_2.py: Contains the code to run the simulation and show statistics
- dot.py: Contains the “DotBuilder”, which is a class used to generate dot variables. Running this python file also generates a dot file for the prt_model (called “output.dot”) that contains the layout of the system.
- prt_model.py: CoupledDEVS, loads the code from the config file to build the network
- collector.py: Collects data from the passengers that have been unboarded in a station
- Generator.py: Generates passengers at a specified normal distribution and outputs them to the platform (the Station class does the linking)
- helper.py: Contains code for a Passenger, a Trolley, a Queue, a Logger and some helper functions
- junction.py: Code for the junctions
- light.py: Code for the lights
- rail.py: Code for a rail between two stations (or a junction)
- split.py: Code for a split at the end of a station
- Station.py: CoupledDEVS, links all components of a station together as described in the assignment
- track.py: Code for the track in a station
- Trolley_generator.py: Similar to a passenger generator, but then for trollies. This was our initial solution to get trollies on the track, but isn’t used anymore, since we added extra functionality to add a trolley immediately to the track of a station when setting up the model.
- ptr_platform.py: Code for the platform

GraphViz

You can see the GraphViz output of our model in the picture below. This is generated using the dot.py file.



Normal statistics

Note that there are some stations without any passengers. This is because at the time of writing, there are still some bugs being fixed in the code.

Those where the requested statistics (for a 24 hour simulation):

1. Average travel time of a passenger.
2. For each trolley, a summarized overview of trolley capacity over time.
3. For each trolley, the time-average trolley capacity.
4. For each station, the amount of people that have exited at that station.
5. For each station, the amount of people that have exited at their desired destination.
6. For each station, the average travel time of people that have exited at that station.
7. Total amount of people that have traveled over the PRT.
8. Number of people that have succesfully arrived at their desired destination.
9. Number of people still commuting when the experiment terminates.
10. Number of people with a destination that equals their origin station.

Output velocity 50

Seed 0

7. Total number of people arrived at a destination: 2133
1. Avg. travel time: 512.9824660103143s
2. (see generated output graphs)
3. time-average trolley capacity:
 Trolley(line=1, v=50, n=0): 0

Trolley(line=2, v=50, n=0): 0
Trolley(line=1, v=50, n=0): 0
Trolley(line=2, v=50, n=0): 0
Trolley(line=1, v=50, n=0): 0
Trolley(line=3, v=50, n=0): 0
Trolley(line=2, v=50, n=0): 0
Trolley(line=3, v=50, n=0): 0
4+5+6. University Square: 146 exited, of which 36 at the wrong destination, with avg time of 352.55616438356157s
4+5+6. Forrester Gardens: 155 exited, of which 58 at the wrong destination, with avg time of 553.1122580645157s
4+5+6. Zeigler Circus: 554 exited, of which 152 at the wrong destination, with avg time of 512.6281588447664s
4+5+6. Model Station North: 118 exited, of which 24 at the wrong destination, with avg time of 456.5966101694913s
4+5+6. Harel Cross: 491 exited, of which 96 at the wrong destination, with avg time of 568.8024439918538s
4+5+6. Petris Palace: 116 exited, of which 16 at the wrong destination, with avg time of 515.8586206896555s
4+5+6. Moores Moor: 114 exited, of which 15 at the wrong destination, with avg time of 593.4982456140348s
4+5+6. Museum of Informatics: 91 exited, of which 8 at the wrong destination, with avg time of 669.9076923076924s
4+5+6. Turing Station: 178 exited, of which 54 at the wrong destination, with avg time of 452.9056179775282s
4+5+6. Model Station South: 170 exited, of which 57 at the wrong destination, with avg time of 416.190588235294s
8. Total successful arrivals: 1617
9. TODO
10. Number of people with a destination that equals their origin station: 0

Seed 1

7. Total number of people arrived at a destination: 2146
1. Avg. travel time: 513.8190121155645s
2. (see generated output graphs)
3. time-average trolley capacity:
Trolley(line=2, v=50, n=0): 0
Trolley(line=1, v=50, n=0): 0
Trolley(line=1, v=50, n=0): 0
Trolley(line=2, v=50, n=0): 0
Trolley(line=1, v=50, n=0): 0
Trolley(line=3, v=50, n=0): 0
Trolley(line=2, v=50, n=0): 0

Trolley(line=3, v=50, n=0): 0
4+5+6. University Square: 157 exited, of which 49 at the wrong destination, with avg time of 356.12738853503197s
4+5+6. Forrester Gardens: 156 exited, of which 49 at the wrong destination, with avg time of 539.9307692307692s
4+5+6. Zeigler Circus: 575 exited, of which 167 at the wrong destination, with avg time of 522.0055652173918s
4+5+6. Model Station North: 108 exited, of which 22 at the wrong destination, with avg time of 451.7185185185192s
4+5+6. Harel Cross: 469 exited, of which 89 at the wrong destination, with avg time of 554.70618336887s
4+5+6. Petris Palace: 118 exited, of which 10 at the wrong destination, with avg time of 520.7491525423733s
4+5+6. Moores Moor: 112 exited, of which 24 at the wrong destination, with avg time of 540.0964285714283s
4+5+6. Museum of Informatics: 134 exited, of which 34 at the wrong destination, with avg time of 635.038805970149s
4+5+6. Turing Station: 151 exited, of which 41 at the wrong destination, with avg time of 498.8768211920532s
4+5+6. Model Station South: 166 exited, of which 44 at the wrong destination, with avg time of 428.033734939759s
8. Total successful arrivals: 1617
9. TODO
10. Number of people with a destination that equals their origin station: 0

Discussion

Since we have quite a long simulation time, most variable average are heading towards the same variables. The number of passengers with seed 1 is slightly higher, but the number of successful arrivals is still the same. There is still a problem with our trollies. Since our initial reference from a trolley disappears, we can't access the logged variables in a trolley. This is why some statistics related to this are giving a wrong output.

Output half velocity 25, half 50

Seed 0

7. Total number of people arrived at a destination: 2215
1. Avg. travel time: 576.8124604966154s
2. (see generated output graphs)
3. time-average trolley capacity:
Trolley(line=2, v=25, n=0): 0

Trolley(line=2, v=50, n=0): 0
Trolley(line=3, v=50, n=0): 0
Trolley(line=1, v=50, n=0): 0
Trolley(line=2, v=25, n=0): 0
Trolley(line=3, v=25, n=0): 0
Trolley(line=1, v=25, n=0): 0
Trolley(line=1, v=50, n=0): 0
4+5+6. University Square: 145 exited, of which 51 at the wrong destination, with avg time of 479.6358620689654s
4+5+6. Forrester Gardens: 183 exited, of which 62 at the wrong destination, with avg time of 413.19562841530046s
4+5+6. Zeigler Circus: 632 exited, of which 171 at the wrong destination, with avg time of 576.5310126582284s
4+5+6. Model Station North: 115 exited, of which 19 at the wrong destination, with avg time of 516.7269565217381s
4+5+6. Harel Cross: 495 exited, of which 106 at the wrong destination, with avg time of 699.567676767677s
4+5+6. Petris Palace: 97 exited, of which 14 at the wrong destination, with avg time of 646.317525773196s
4+5+6. Moores Moor: 106 exited, of which 22 at the wrong destination, with avg time of 657.7735849056606s
4+5+6. Museum of Informatics: 112 exited, of which 27 at the wrong destination, with avg time of 707.1964285714287s
4+5+6. Turing Station: 148 exited, of which 40 at the wrong destination, with avg time of 488.5405405405412s
4+5+6. Model Station South: 182 exited, of which 49 at the wrong destination, with avg time of 431.1736263736264s
8. Total successful arrivals: 1654
9. TODO
10. Number of people with a destination that equals their origin station: 0

Seed 1

7. Total number of people arrived at a destination: 2176
1. Avg. travel time: 561.5402573529431s
2. (see generated output graphs)
3. time-average trolley capacity:
Trolley(line=2, v=25, n=0): 0
Trolley(line=2, v=50, n=0): 0
Trolley(line=3, v=50, n=0): 0
Trolley(line=1, v=50, n=0): 0
Trolley(line=2, v=25, n=0): 0
Trolley(line=3, v=25, n=0): 0
Trolley(line=1, v=50, n=0): 0

Trolley(line=1, v=25, n=0): 0
4+5+6. University Square: 143 exited, of which 43 at the wrong destination, with avg time of 430.3972027972026s
4+5+6. Forrester Gardens: 161 exited, of which 42 at the wrong destination, with avg time of 448.8372670807453s
4+5+6. Zeigler Circus: 577 exited, of which 154 at the wrong destination, with avg time of 561.3899480069334s
4+5+6. Model Station North: 121 exited, of which 17 at the wrong destination, with avg time of 520.4859504132233s
4+5+6. Harel Cross: 512 exited, of which 108 at the wrong destination, with avg time of 667.4742187500001s
4+5+6. Petris Palace: 112 exited, of which 25 at the wrong destination, with avg time of 614.2071428571427s
4+5+6. Moores Moor: 106 exited, of which 14 at the wrong destination, with avg time of 683.8226415094343s
4+5+6. Museum of Informatics: 109 exited, of which 21 at the wrong destination, with avg time of 654.6568807339447s
4+5+6. Turing Station: 154 exited, of which 40 at the wrong destination, with avg time of 493.93506493506476s
4+5+6. Model Station South: 181 exited, of which 67 at the wrong destination, with avg time of 390.9082872928176s
8. Total successful arrivals: 1645
9. TODO
10. Number of people with a destination that equals their origin station: 0

Discussion

It's strange that the number of people passing now is in both cases higher than with all trollies at a higher speed.

Destination rules

Our initial implementation already allowed passengers only to take a destination on the same line that is reachable and not the same as the original station. We can still compare the results with a reduced exiting chance.

20% Chance (same results as Seed 0 Above)

7. Total number of people arrived at a destination: 2215
1. Avg. travel time: 576.8124604966154s
2. (see generated output graphs)
3. time-average trolley capacity:
Trolley(line=2, v=25, n=0): 0

Trolley(line=2, v=50, n=0): 0
Trolley(line=3, v=50, n=0): 0
Trolley(line=1, v=50, n=0): 0
Trolley(line=2, v=25, n=0): 0
Trolley(line=3, v=25, n=0): 0
Trolley(line=1, v=25, n=0): 0
Trolley(line=1, v=50, n=0): 0
4+5+6. University Square: 145 exited, of which 51 at the wrong destination, with avg time of 479.6358620689654s
4+5+6. Forrester Gardens: 183 exited, of which 62 at the wrong destination, with avg time of 413.19562841530046s
4+5+6. Zeigler Circus: 632 exited, of which 171 at the wrong destination, with avg time of 576.5310126582284s
4+5+6. Model Station North: 115 exited, of which 19 at the wrong destination, with avg time of 516.7269565217381s
4+5+6. Harel Cross: 495 exited, of which 106 at the wrong destination, with avg time of 699.567676767677s
4+5+6. Petris Palace: 97 exited, of which 14 at the wrong destination, with avg time of 646.317525773196s
4+5+6. Moores Moor: 106 exited, of which 22 at the wrong destination, with avg time of 657.7735849056606s
4+5+6. Museum of Informatics: 112 exited, of which 27 at the wrong destination, with avg time of 707.1964285714287s
4+5+6. Turing Station: 148 exited, of which 40 at the wrong destination, with avg time of 488.5405405405412s
4+5+6. Model Station South: 182 exited, of which 49 at the wrong destination, with avg time of 431.1736263736264s
8. Total successful arrivals: 1654
9. TODO
10. Number of people with a destination that equals their origin station: 0

3% Chance (also with Seed 0)

7. Total number of people arrived at a destination: 2228
1. Avg. travel time: 732.9220825852797s
2. (see generated output graphs)
3. time-average trolley capacity:
Trolley(line=3, v=50, n=0): 0
Trolley(line=1, v=50, n=0): 0
Trolley(line=2, v=25, n=0): 0
Trolley(line=3, v=25, n=0): 0
Trolley(line=2, v=50, n=0): 0
Trolley(line=1, v=25, n=0): 0
Trolley(line=1, v=50, n=0): 0

Trolley(line=2, v=25, n=0): 0
4+5+6. University Square: 147 exited, of which 6 at the wrong destination, with avg time of 617.703401360544s
4+5+6. Forrester Gardens: 166 exited, of which 9 at the wrong destination, with avg time of 463.08915662650594s
4+5+6. Zeigler Circus: 542 exited, of which 19 at the wrong destination, with avg time of 723.2597785977866s
4+5+6. Model Station North: 150 exited, of which 5 at the wrong destination, with avg time of 627.5439999999996s
4+5+6. Harel Cross: 522 exited, of which 16 at the wrong destination, with avg time of 883.3831417624518s
4+5+6. Petris Palace: 132 exited, of which 0 at the wrong destination, with avg time of 694.6242424242427s
4+5+6. Moores Moor: 133 exited, of which 4 at the wrong destination, with avg time of 856.5443609022561s
4+5+6. Museum of Informatics: 161 exited, of which 5 at the wrong destination, with avg time of 935.7714285714283s
4+5+6. Turing Station: 137 exited, of which 7 at the wrong destination, with avg time of 671.778102189781s
4+5+6. Model Station South: 138 exited, of which 9 at the wrong destination, with avg time of 505.1246376811594s
8. Total successful arrivals: 2148
9. TODO
10. Number of people with a destination that equals their origin station: 0

Discuss

As expected, we get a lot more successful arrivals.

Altering constants

Lowering parameters like the boarding time or the chance a passenger hops off at the wrong station of course resulted in a better performing system

New parameters

TROLLEY_DEFAULT_VELOCITY = 500
TROLLEY_MAX_CAPACITY = 100

GENERATOR_AVG_MINUTES = 5
GENERATOR_DEVIATION_MINUTES = 1

```
TRACK_WAITING_TIME_SECONDS = 30
BOARDING_TIME_SECONDS = 5

MIN_LOG_LEVEL = 5

MIN_RAIL_TROLLEY_WAIT_SECONDS = 5
TROLLEY_JUNCTION_WAIT_TIME = 40


WRONG_STATION_UNBOARD_CHANCE = 0.00

# Linenumber, StationConfig list
STATIONS = [StationConfig("University Square", lines=[2], generate_trollies=True),
        StationConfig("Forrester Gardens", lines=[2], generate_trollies=True),
        StationConfig("Zeigler Circus", lines=[1, 2, 3]),
        StationConfig("Model Station North", lines=[3], generate_trollies=True),
        StationConfig("Harel Cross", lines=[1, 2, 3]),
        StationConfig("Petris Palace", lines=[3], generate_trollies=True),
        StationConfig("Moores Moor", lines=[2], generate_trollies=True),
        StationConfig("Museum of Informatics", lines=[1], generate_trollies=True),
        StationConfig("Turing Station", lines=[1], generate_trollies=True),
        StationConfig("Model Station South", lines=[1], generate_trollies=True)]
```

Output

```
7. Total number of people arrived at a destination: 2205
1. Avg. travel time: 255.50619501133778s
2. (see generated output graphs)
3. time-average trolley capacity:
 Trolley(line=3, v=500, n=0): 0
 Trolley(line=1, v=500, n=0): 0
 Trolley(line=2, v=500, n=0): 0
 Trolley(line=3, v=500, n=0): 0
 Trolley(line=2, v=500, n=0): 0
 Trolley(line=1, v=500, n=0): 0
 Trolley(line=1, v=500, n=0): 0
 Trolley(line=2, v=500, n=0): 0
4+5+6. University Square: 146 exited, of which 0 at the wrong destination, with avg time of
175.95397260273998s
4+5+6. Forrester Gardens: 147 exited, of which 0 at the wrong destination, with avg time of
123.67102040816299s
4+5+6. Zeigler Circus: 503 exited, of which 0 at the wrong destination, with avg time of
446.9268389662044s
```

4+5+6. Model Station North: 137 exited, of which 0 at the wrong destination, with avg time of 153.32875912408196s
4+5+6. Harel Cross: 536 exited, of which 0 at the wrong destination, with avg time of 253.31611940298498s
4+5+6. Petris Palace: 114 exited, of which 0 at the wrong destination, with avg time of 183.32701754386312s
4+5+6. Moores Moor: 143 exited, of which 0 at the wrong destination, with avg time of 226.5362237762234s
4+5+6. Museum of Informatics: 153 exited, of which 0 at the wrong destination, with avg time of 239.8768627450956s
4+5+6. Turing Station: 183 exited, of which 0 at the wrong destination, with avg time of 167.159125683057s
4+5+6. Model Station South: 143 exited, of which 0 at the wrong destination, with avg time of 121.3239160839229s
8. Total successful arrivals: 2205
9. TODO
10. Number of people with a destination that equals their origin station: 0

Discuss

Weirdly, even though it would make sense for the statistics to improve with given parameters, there isn't an improvement visible. We have no declaration for this (only that we didn't have enough time to test different variables)

Deterministic model

No time to prove this.