Automated short-term train planning in OSRD

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A train wants to go from Station Foo to Station Bar.
But many trains have already been scheduled, finding some room won’t be easy.
A new train can’t be delayed by other trains.
A new train can’t delay other trains.
All the intricacies of signaling systems need to be handled.
It can be necessary to know where the train will go next.
A new train can take detours and not always go at maximum speed.
OSRD (Open-Source Railway Designer)

- In **OSRD**, we are currently working on a solution to this problem.
- OSRD is an open-source project that can be used to edit railway infrastructures and run simulations.
- We’ve come a long way, but this feature is still a work in progress.
Defining the problem as a graph search

- The solution space has several dimensions:
  - position
  - time
  - speed

- We represent search space as a graph that consider these dimensions.

- A node has a position, a time, and a speed. Most are implicit.

- We run train simulations to get speeds and positions as functions of time.
Graphical representation (1/3)

Given a simple graph (track sections):
Several nodes are created for each space location, at different times.
They are linked in a way that reflects travel time: the train move forward in both space and time.
The graph is constructed as we explore it.

- It is **discretized** in time when evaluating visited locations.

A path is found by running an A* on the resulting graph.

- Cost function: run time
- Optimization heuristic: based on geographic coordinates
- By default, the maximum possible speed is used.
- When the path can go before or after a scheduled train: several edges are created.
First problem: speed discontinuities

- The train behavior is simulated **one edge at a time**, without knowing what comes after.
- The distance between the start of the edge and the destination can be too short to brake.
First problem: speed discontinuities

With a train that can accelerate/decelerate by 10km/h per section:
Solution: backtracking

- Solution: new edges are created on previous sections, with braking.
- New and old edges coexist in the graph, they can lead to different solutions.
Second problem: adding delay

- When possible, the delay is added by shifting the departure time.
- It is not always possible, like in this case:
solution: creating new edges with an allowance

- Same kind of solution as fixing the discontinuities.
- New edges are created with the right amount of delay.
In short: what we can do

- We can find a path that avoids any unexpected delay on any train.
- The train can take detours and slow down in parts of the path.
- The user can input allowances parameters.
- Performances: requests take up to 5s => not a problem for now.
What’s left

There are some features that are not there yet:

- We only support the simplest signaling systems, with some simplifications.
- We can only specify the departure time window and leave the arrival time unspecified, the opposite should be possible.
- We can’t set intermediate stops.
Questions

Any question?

For more information: osrd.fr
Github link: github.com/DGEXSolutions/osrd
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