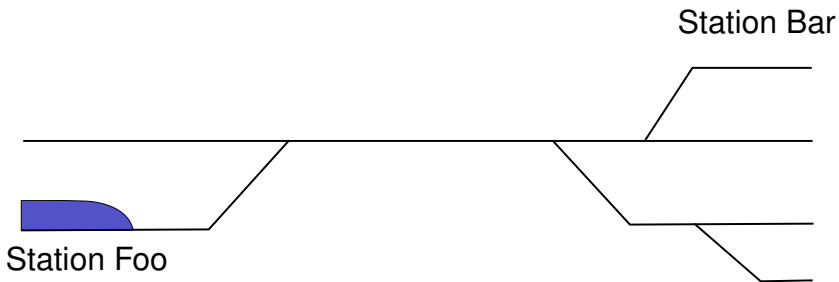


Automated short-term train planning in OSRD

Eloi Charpentier - SNCF Réseau

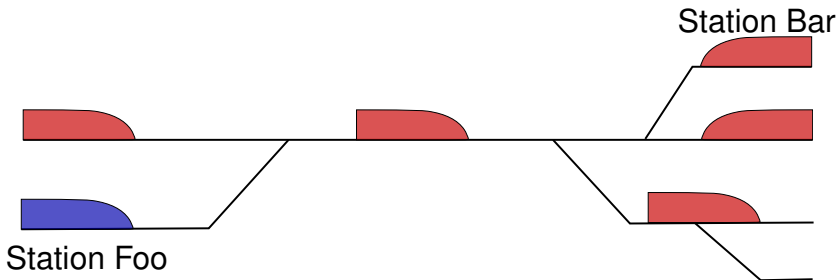
Problem presentation

A train wants to go from Station Foo to Station Bar.

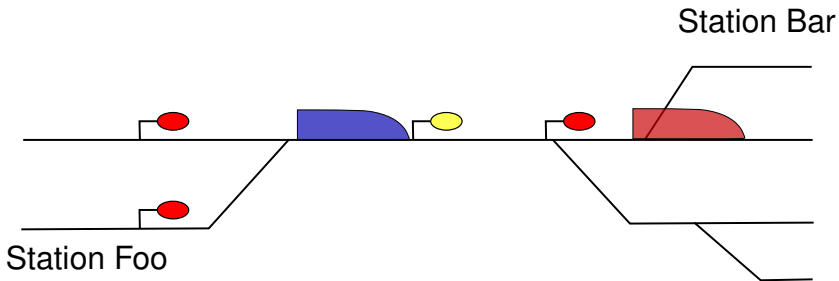


Problem presentation

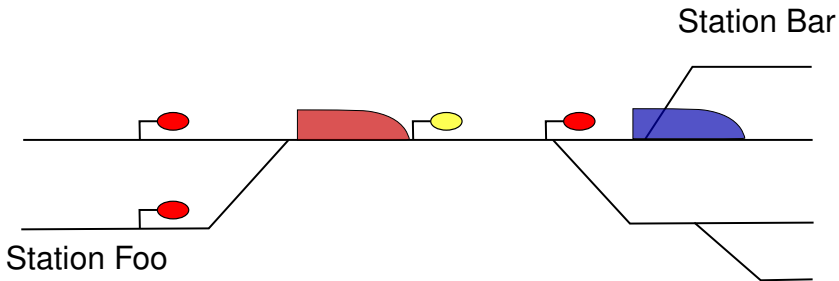
But many trains have already been scheduled, finding some room won't be easy.



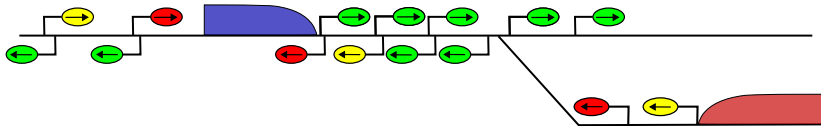
A new train can't be delayed by other trains.



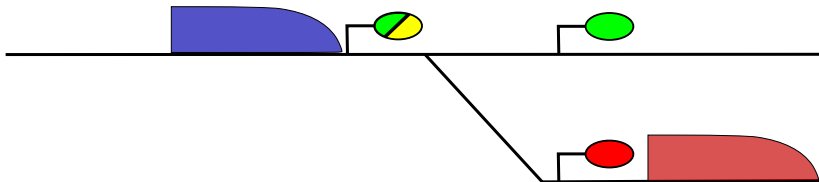
A new train can't delay other trains.



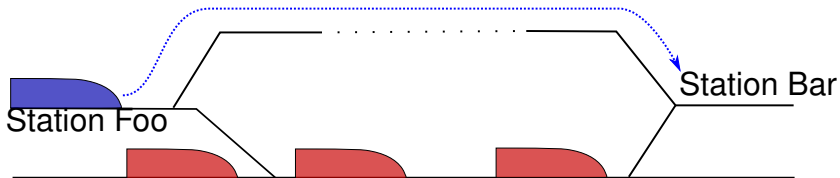
All the intricacies of signaling systems need to be handled.



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.

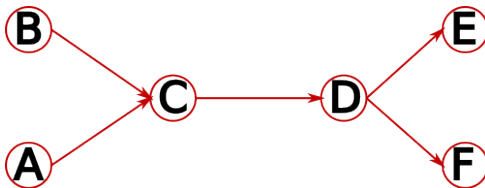


Defining the problem as a graph search

- 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.

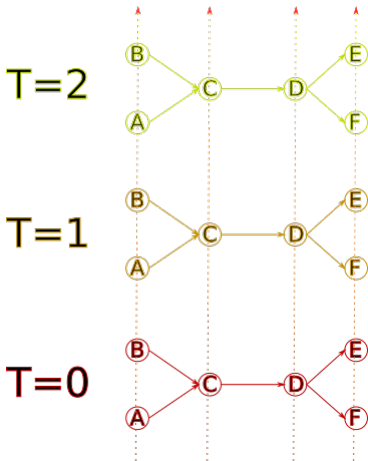
Graphical representation (1/3)

Given a simple graph (track sections):



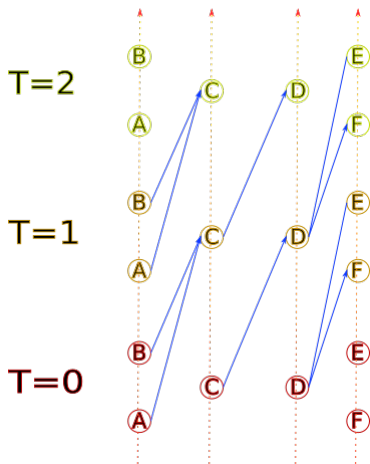
Graphical representation (2/3)

Several nodes are created for each space location, at different times.



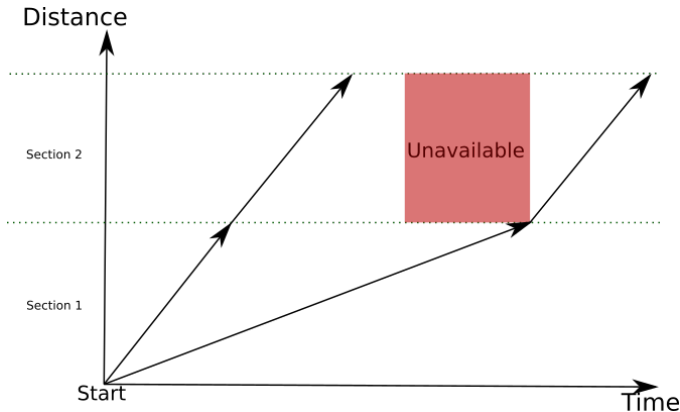
Graphical representation (3/3)

They are linked in a way that reflects travel time: the train move forward in both space and time.



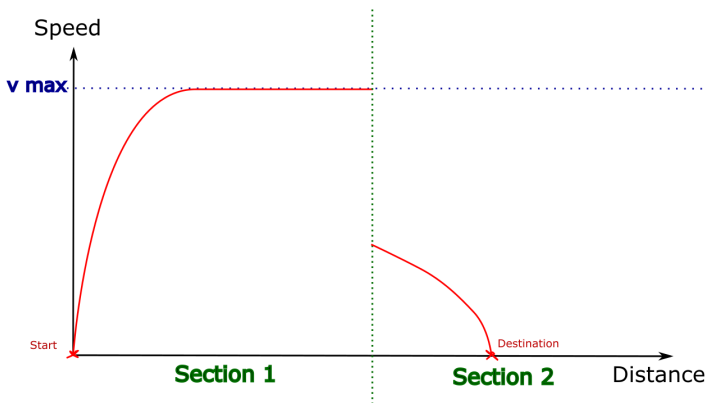
- The graph is constructed as we explore it.
- It is **discretized** in time when evaluating visited locations.
- A path is found by running an A^* on the resulting graph.
 - cost function: run time
 - optimization heuristic: based on geographic coordinates

- By default, the maximum possible speed is used.
- When the path can go before or after a scheduled train: several edges are created.



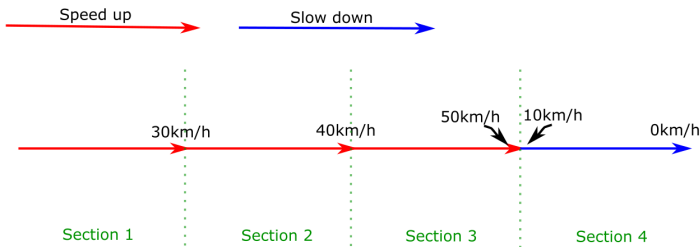
First problem: speed discontinuities

- 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.



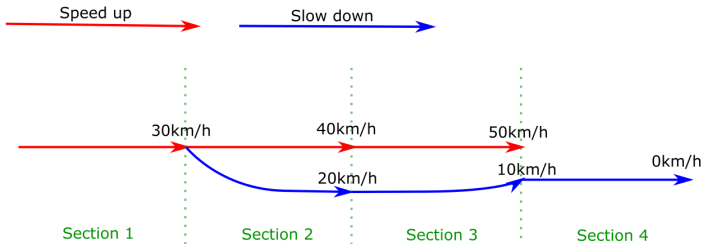
First problem: speed discontinuities

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



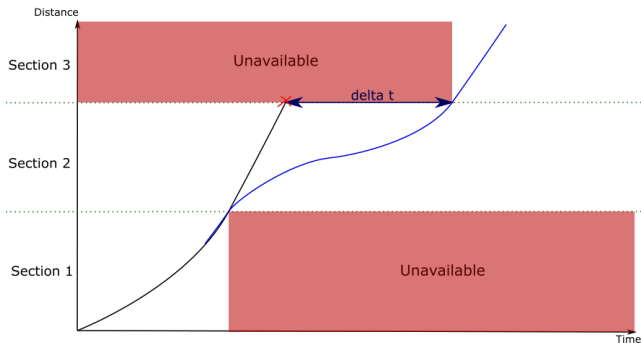
Solution: backtracking

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



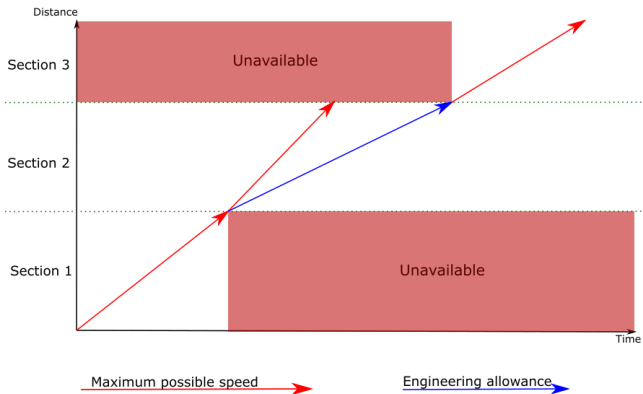
Second problem: adding delay

- 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`

Chat with us: `https://web.libera.chat/#osrd`

Email: `contact@osrd.fr`