optimising railways

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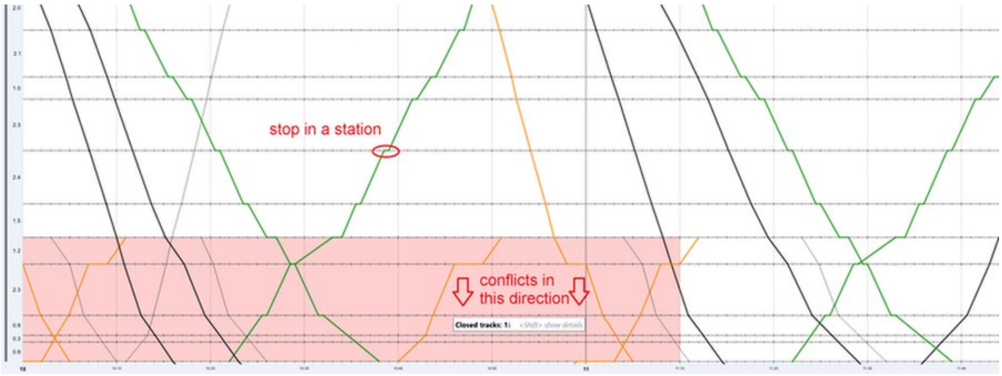
Automated Possession Planning

Using the Viriato Algorithm Platform, SMA is developing an automated function for rescheduling trains from a given timetable in the case of track possessions. This functionality has now been used productively for the first time in a consultancy project in Belgium. The following example shows an excerpt from a graphic timetable (also known as a train graph, time distance diagram or string line chart) in Viriato. In this case, the horizontal axis represents the timescale, and the vertical axis the distance with the stations and junctions along the infrastructure indicated by markers. Lines plotted on the graph represent the individual trains, with trains travelling in the forward direction over the infrastructure being plotted diagonally from top-left to bottom right, and trains travelling in the reverse direction being plotted from bottom-left to top-right. Stops can be observed on this graph where the plotted line is horizontal, i.e. for a period of time the train does not move over the infrastructure. In our example, the region with the pink background colour represents a section track closure, and the Viriato tooltip indicates that Track 1 is closed. This information is sufficient to enable an experienced train planner to identify the trains that have to be rescheduled due to the engineering works, but the algorithm detects this automatically for defining the search space.



The algorithm works as follows: After the user has entered a time window for which the algorithm should replan trains, it determines the set of trains in conflict with the track closures. In this example case, the algorithm detects the trains running from the top to the bottom of the graphic timetable. Using a simultaneous path search method based on a mixed-integer linear programming formulation of the problem (MILP), multiple instances of these trains are reinserted into the timetable by the algorithm. This algorithm allows trains in the possessed area to be retimed and to change tracks in order to resolve conflicts. Any trains that cannot be reinserted by this algorithm will be automatically cancelled. The solution is written back to Viriato and can be inspected by the user using Viriato's normal visualisation functions. In the screenshot below we can now see the solution produced by the algorithm. Dashed lines indicate that a train has been replanned to run on the other section track which is not affected by the closure. In the graphic timetable, observe on the far left of the diagram (marked as '1') a representation of the infrastructure, with two vertical lines indicating that there are two section tracks in this region. Therefore, as one of these two tracks is closed during the time window being studied, trains can only cross at nodes (see '2' for an example of two trains crossing) as the resultant infrastructure available is temporarily single track only. To allow these crossings, the algorithm may retime trains, i.e. can make them faster by reducing planned running time reserves or slower by adding additional reserve times. In the plot this is represented by altering the gradient of the lines, as this represents the speed of the train. In this example, the algorithm delayed the second black train from the left (indicated as '3'). We can also see that for the same train the algorithm has introduced a stop in at node at 10:25 (indicated as '4') to enable the crossing with the first green train. It can be seen that most of the trains represented by the thin black lines from the original set of trains are missing in the solution. As these trains have lower priority than the others – as determined by a user defined set of rules - and there is insufficient capacity on the infrastructure due to the given closure, these have been cancelled by the algorithm. For this problem instance, we can see that the combination of switching section tracks, introducing stops, delaying or accelerating trains and finally utilising the option of cancelling trains allows the algorithm to make the timetable feasible, i.e. conflict-free while maintaining a good level of service.