Visual Analysis of Reactionary Train Delay from an Agent Based Model

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Problem
Reactionary ("knock-on") delay is an increasing problem for UK train operators and is hard to understand. Train operators want to know the key locations and reasons, so they can design interventions.

What is reactionary delay?
Primary delays... ...can cause reactionary delays... ...which are the knock-on effects that are hard to predict.

Our approach
We build an Agent Based Model that explicitly models interactions between trains, then design interactive visualisation to help understand the problem to inform designing interventions. We can then run the model again to see if this works.

Agent Based Model
The agent-based model stochastically generates primary delays including small natural variation according to historical data, the interactions between trains and the resulting reactionary delay. The model runs 150 times (Monte-Carlo style) and it generates thousands of delays for hundreds of trains.

Interactive visualisation
Our interactive visualisation takes the model's output and (A) provides the association between primary and reactionary delay location. [B] gives the uncertainty around this result through model run agreement, and (C) explains the mechanism of the chain of delays.

[A] Association between primary and reactionary locations

The matrix shows the association between locations where primary delays occur (columns) and where the resulting reactionary delays (rows) occur.

[B] Uncertainty, through comparison of model runs

Looking at the variation between model runs indicates the certainty (or liklihood) of that outcome

[C] Explain mechanism of reactionary delay chains

Looking at the interaction between trains helps understand what kinds of interventions may be effective.

[Colour key below]

Blue shading is the number of primary delay minutes - here it is more than the resulting reactionary minutes

Red shading is the number of reactionary delay minutes - here it was caused by a smaller amount of primary delay minutes

See colour key below

Rows are locations where reactionary delays occur, ordered by total reactionary delay

Columns are locations where primary delays occur, ordered by amount of reactionary they cause

Bars are total number of primary delay minutes causing reactionary delay at each location

Each bar is a primary reactionary delay location pair

Delay types by proportion of primary delay minutes for mouseovered location ("EALINGB") - see bottom for colour key