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If NYC subways obeyed quantum maths trains wouldn't be delayed

Mind the gap
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By **Mark Kim**

WITH its antiquated trains, rusty rails and straphangers who keep the doors from closing, the New York City subway system could hardly be described as efficient. And yet, some trains arrive with a reliable regularity, following a neat statistical model similar to that seen in quantum systems.

Aukosh Jagannath at the University of Toronto, Canada, and Tom Trogdon at the University of California, Irvine, used the subway system's real-time data feeds to analyse gaps between arrival times on two lines.

They found that the southbound 1 line that runs down the west side of Manhattan shows what are called random matrix patterns, which are "a sign of greater efficiency", says Jagannath, who is now at Harvard University. These trains run at more regular intervals (*Physical Review E*, doi.org/cczj).

In contrast, the 6 line that runs up the east side of Manhattan is inefficient. Its trains follow the Poisson distribution, a statistical model describing particles that arrive more or less randomly.

"If you were waiting at a stop for 5 minutes, waiting for the next 5 minutes does you no good," says Trogdon. In a more functional transit system, you'd expect that after waiting for a while, the probability of a train arriving soon would be quite high. The Poisson distribution does not guarantee this.

"I think the data is confirming people's intuition about the two lines," says Trogdon. The 1 line is one of the three local subway lines serving the west side of Manhattan, so it's far less crowded than the 6, which at the time of the study was the only local line on the east side.

"The southbound 1 train on the west side of Manhattan follows more efficient random matrix patterns"

The efficiency analysis was inspired by a landmark 1990 study in Cuernavaca, Mexico. At that time, buses in Cuernavaca operated with no central controlling agency, and each bus belonged to the driver. To maximise the number of passengers they could transport – and therefore profit – the drivers set up a series of checkpoints to avoid clustering.

Upon arriving at a checkpoint, the driver would learn when the previous bus had stopped, and would slow down or speed up to optimise gaps between vehicles. Analysing the records of when buses came and went, researchers found that the buses in Cuernavaca obeyed random matrix patterns.

The parallel isn't exact for the New York City subway system, however. The random matrix patterns break down at the last 10 stations of the southbound 1 line. What's more, the northbound 1 line does not follow those patterns.

"The analysis of the New York system is less clear [than for Cuernavaca]," says Ariel Amir at Harvard University. Still, he says this kind of analysis is the first step towards optimising the subway system. For the commuters who take more than 1.7 billion rides on New York's subterranean rails a year, that's always going to be a plus.

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