

Using math to speed up school buses

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Credit: Carmine Savarese

(PhysOrg.com) -- Optimizing school bus routes is a lot more complicated than one might think. The International School of Geneva handed their problem over to a group of EPFL mathematicians.

“Our student population is increasing rapidly,” observes Michel Chinal, Director General of the International School of Geneva. And the rising number of parents picking up and dropping off their children is creating traffic problems in the village of Founex, just outside Geneva. The bus service offered by the school is too slow. “Parents often say that they would like to sign their children up, but the bus ride is too long.” The buses pick up students in an area bounded by Morges, Geneva and neighboring France. So how can they improve the routes of 11 different buses carrying a total of 283 students to and from school? That’s the problem that was given to the [mathematicians](#) in EPFL’s Discrete Optimization Group.

EPFL chemist Rainer Beck, whose child attends the school, offered to optimize the service during a meeting of the parent's association. He asked his mathematical colleague Friedrich Eisenbrand to tackle the problem. "Coming up with a simple arithmetic algorithm is not difficult. But that's not an efficient approach -- due to the enormous number of possible itineraries, the calculations are painfully slow. We needed to develop an algorithm that quickly rejected most routes, so that the computation could be completed before the end of the Universe," explains Eisenbrand. With the assistance of his PhD student Adrian Bock, the mathematician came up with a solution for this complex problem. Using a few clever techniques, the calculations only take half a day to complete.

The researchers modeled student and parent satisfaction using specific parameters, such as "regret" (also called "opportunity loss"), a term used in decision theory. For this case, the regret was the difference between the ideal direct route – in a car – and the route taken by the bus. This parameter enabled the mathematicians to determine the threshold that would convince more students to take the bus. Once the calculations were finished, the gain was impressive: the largest discrepancies between the bus and car routes were cut by 25%.

Optimization is a technique that can be taken well beyond the problem of ferrying kids back and forth from school. The mathematicians are collaborating not only with world leaders in the telecommunications and airline industries to improve communications devices, but also with insurance companies to streamline their lengthy computations. Thus, in everyday life, as soon as we tap into a network, such as the Internet, we are benefiting from all the optimization work that is hidden behind it.

In addition to its evident economic advantages, this research can also help meet objectives for reducing environmental impact. "Our school is seriously concerned with pollution, and we are trying to find responsible

solutions,” adds Chinal.

More information: Decision theory: en.wikipedia.org/wiki/Regret_theory

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