



Séminaire du CIRRELT Seminar

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A MULTI-LAYER NETWORK DESIGN MODEL FOR PLANNING BICYCLE INFRASTRUCTURE

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Abstract: We address the problem of designing a set of bicycle lanes over a given street network to fulfill a given origin-destination demand. Different infrastructure technologies are available to be deployed over each street section, in such a way that if we build a more expensive technology in terms of construction cost, the user travel cost gets improved.

Given an available total construction budget, we find a feasible allocation of technologies to each street section, so as to minimize the total user travel cost. We assume bicycle users travel from origin to destination following the least costly path, including sections of different infrastructure technologies, even those where no infrastructure is built. Moreover, we penalize the cost of the path, whenever there is a switch to a worse technology along it ("discontinuity"). We cast this problem into a fixed-charge multi-commodity network design model, formulated over a multi-layer network representing different available technologies.

The proposed methodology is tested with data from Montevideo, the main city of Uruguay. We consider an abstraction of the street network, derived from a zonal division of the city. Origin-destination data is inferred from detailed records of public transportation usage. The first set of computational experiments studies the sensitivity of results to variations in both available budget and discontinuity penalization. Results are analyzed in terms of (i) distribution of budget, length, and user flow among different technologies, and (ii) total network length, user cost, distance traveled, and discontinuities experienced. In the second set of experiments, we analyze particular solutions of the optimization model for the test case, in terms of the distribution of the demand experiencing different degrees of deviation from the ideal solution (the one where all the demand travels over the best technology) and different numbers of discontinuities. Moreover, we provide graphical output of the solutions, showing the technology built and the user flow over each street section. Finally, we provide managerial insights regarding the allocation of budget, according to different values of discontinuity penalization and its impact over the user travel cost, distance traveled, and discontinuities experienced.

Note: This presentation will be based on the one given at the recent IFORS 2023 Conference, Santiago, Chile (The 23rd Conference of the International Federation of Operational Research Societies).

JEUDI / THURSDAY

21 septembre 2023, 10h00
September 21, 2023, 10:00

Pavillon André-Aisenstadt
Salle / Room 5441

Ouvert à tous / Open to all

Responsable / Organizer
Michel Gendreau