Large-Scale Allocation of Personalized Incentives

Partner Institution

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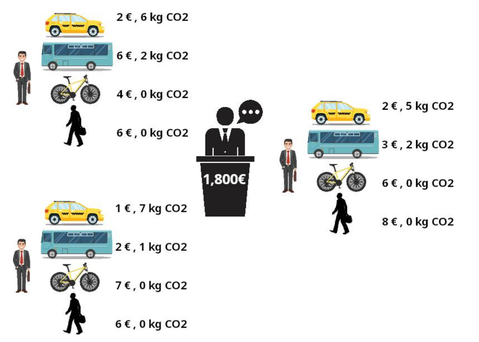
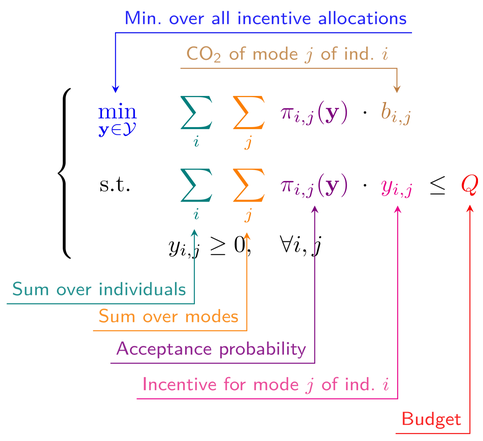
Conference paper

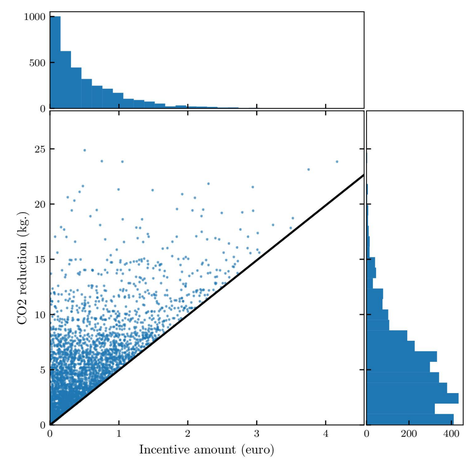
Javaudin, Lucas, et al. "Large-scale allocation of personalized incentives." *2022 IEEE International Intelligent Transportation Systems Conference (ITSC)*. IEEE, 2022.



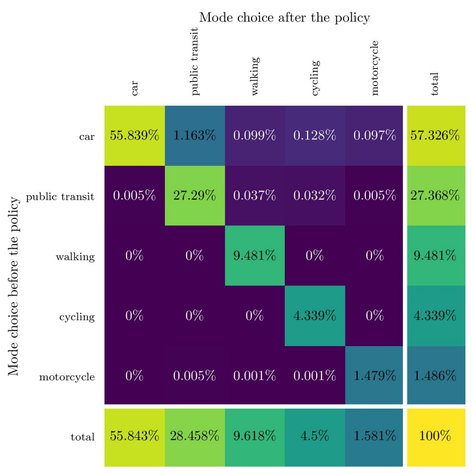
Simplified representation of the framework



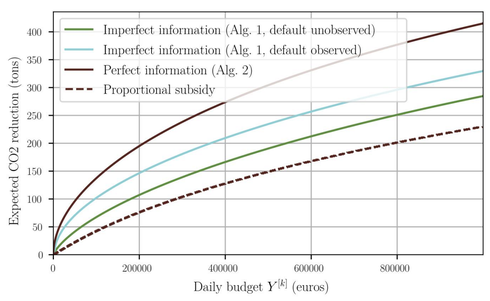
Optimization problem of the regulator



Distribution of incentive amount and CO_2 reduction (Scenario 3)



Evolution of modes shares before and after the policy (Scenario 3)



Expected CO_2 emissions reduction in the 4 scenarios

Definitions and Framework

Personalized-Incentive Policy

- **Topic: Mode choice** for the commute to work of many individuals
- Each mode of transportation is characterized by an **individual value** (or *utility*) and a level of **CO_2 emissions**
- A **regulator proposes incentives** to induce individual to switch to another transportation mode
- **Goal of the regulator: Minimize CO_2 emissions**, subject to the **budget constraint**
- **Assumptions:** Fixed congestion; independent CO_2 emissions

Solution under Perfect Information

Multiple-Choice Knapsack Problem and Greedy Algorithm

- **Perfect information:** The regulator knows exactly the individual values for each mode of each commuter
- The regulator optimization problem reduces to a **multiple-choice knapsack problem**
- A near-optimal incentive allocation can be found in polynomial time, using a **greedy algorithm** from Kellerer et al. (2004)
- **Properties:** Anytime algorithm, diminishing returns on budget spent

Solution under Imperfect Information

Choice Probabilities and a Novel Algorithm

- **Imperfect information:** The regulator knows the distribution of the individual values
- A **novel polynomial-time algorithm** can be used to find a near-optimal incentive allocation
- The algorithm uses **acceptance probabilities** (probability that the individual accepts the incentive)

Large-Scale Application

Mode Choice in Lyon Metropolitan Area

- Over **200 thousands individuals** and over **1 million alternatives**
- **5 modes of transportation:** car, public transit, walking, cycling and motorcycle
- **Four scenarios:**
  1. imperfect information with default unobserved,
  2. imperfect information with default observed,
  3. perfect information,
  4. proportional subsidy
- With a **daily budget of 25k euros**, CO_2 emissions can be reduced by **25 tons** (scenario 1), **50 tons** (scenario 2), **67 tons** (scenario 3) or **15 tons** (scenario 4)
- The **average incentive amount** is 3.99 euros in scenario 1, 1.56 euros in scenario 2 and 1.92 euros in scenario 3
- The **mode share of car** decreases from 57.3 % to 57.1 % (scenario 1), 52.6 % (scenario 2) or 51.8 % (scenario 3)

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