Integrated pollster and vehicle routing

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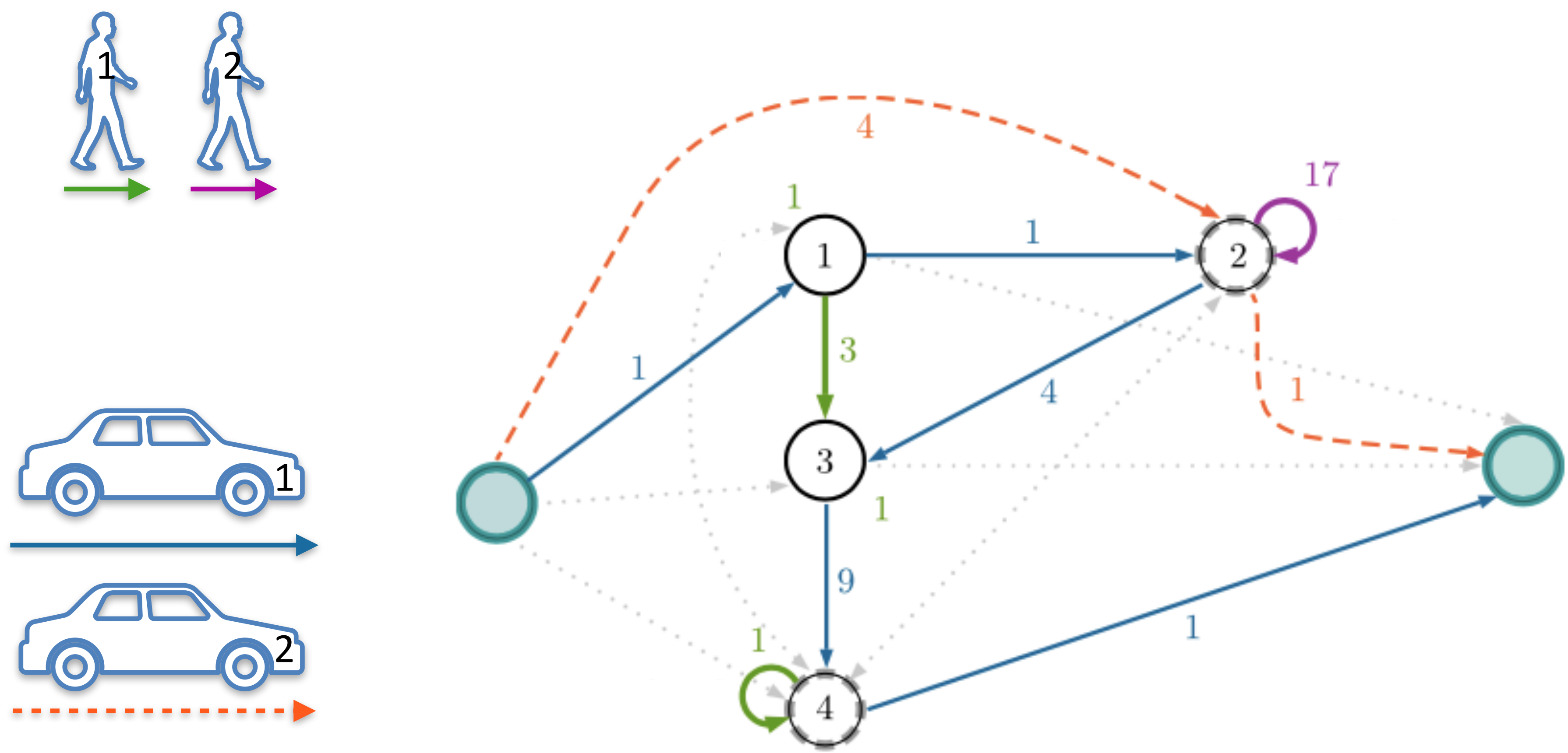
Outline

- Motivation and problem definition
- Modeling via mixed integer programming
- Computational results
- Conclusions

The problem

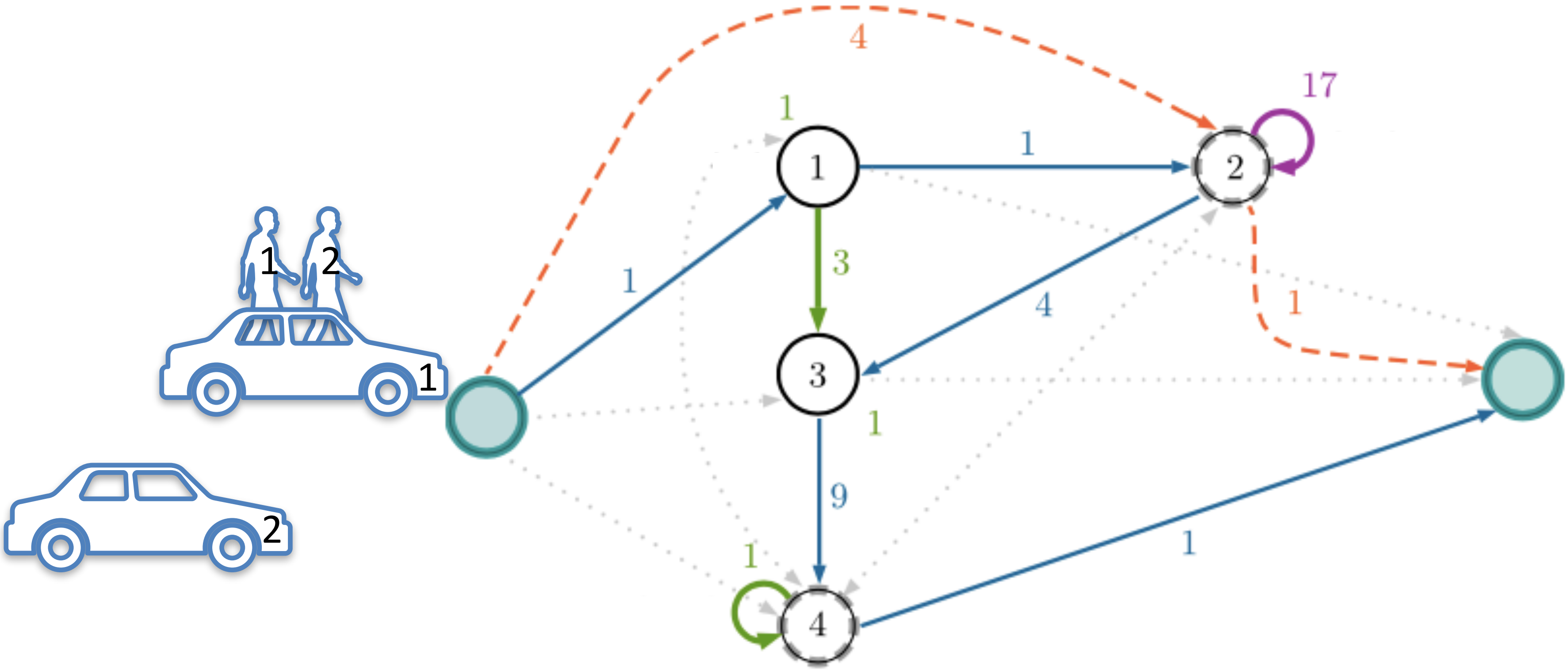
- The National Statistics Bureau of Ecuador (INEC) is responsible for constructing the Consumer Price Index.
- To collect information a sample set of stores must be visited monthly.
- Stores are visited by a set of pollsters, transported by a fleet of hired vehicles. Pollsters also walk between stores.
- Tasks:
  - schedule visits to stores within time horizon
  - schedule daily service duties for pollsters
  - define daily routes for vehicles

A Mixed Linear and Integer Programming Problem



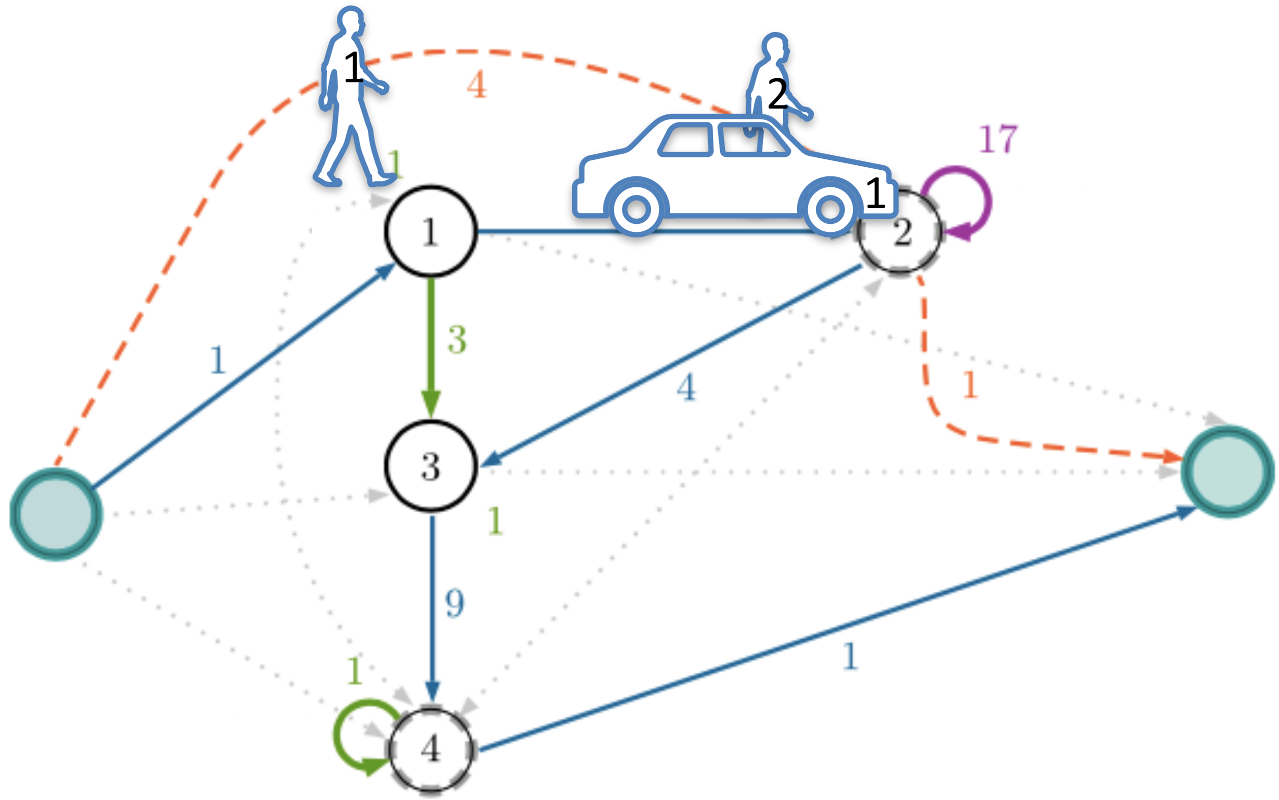
A Mixed Linear and Integer Programming Problem

$t = 0$



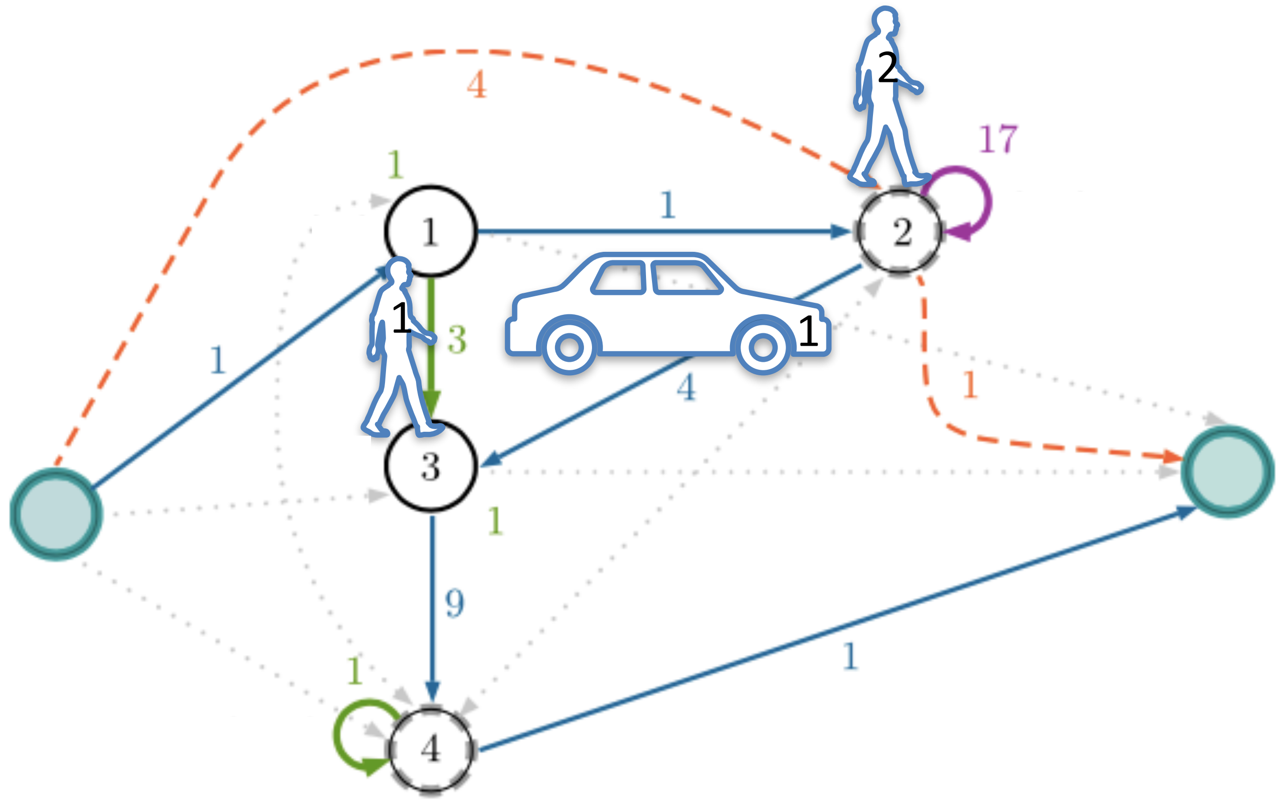
A Mixed Linear and Integer Programming Problem

$t = 2$



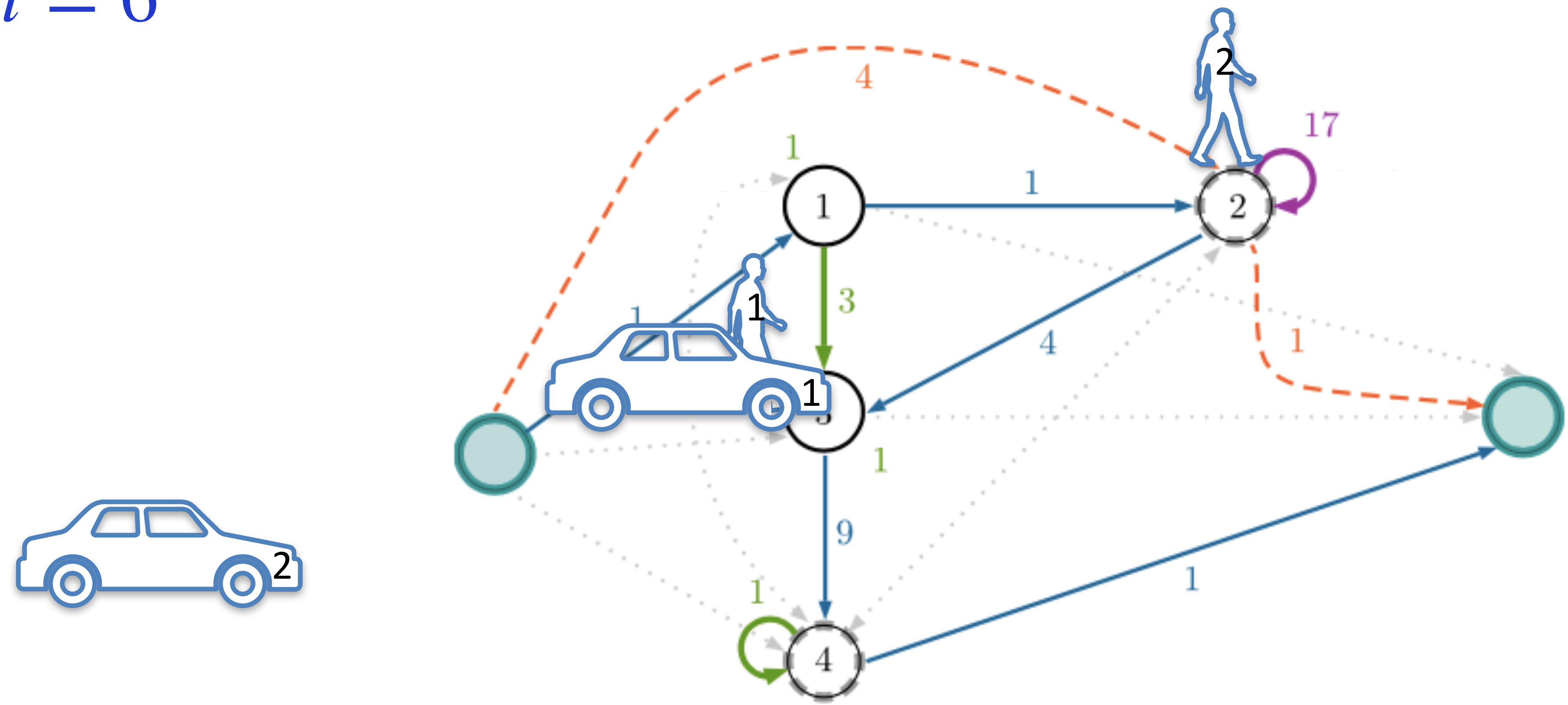
A Mixed Linear and Integer Programming Problem

$t = 5$



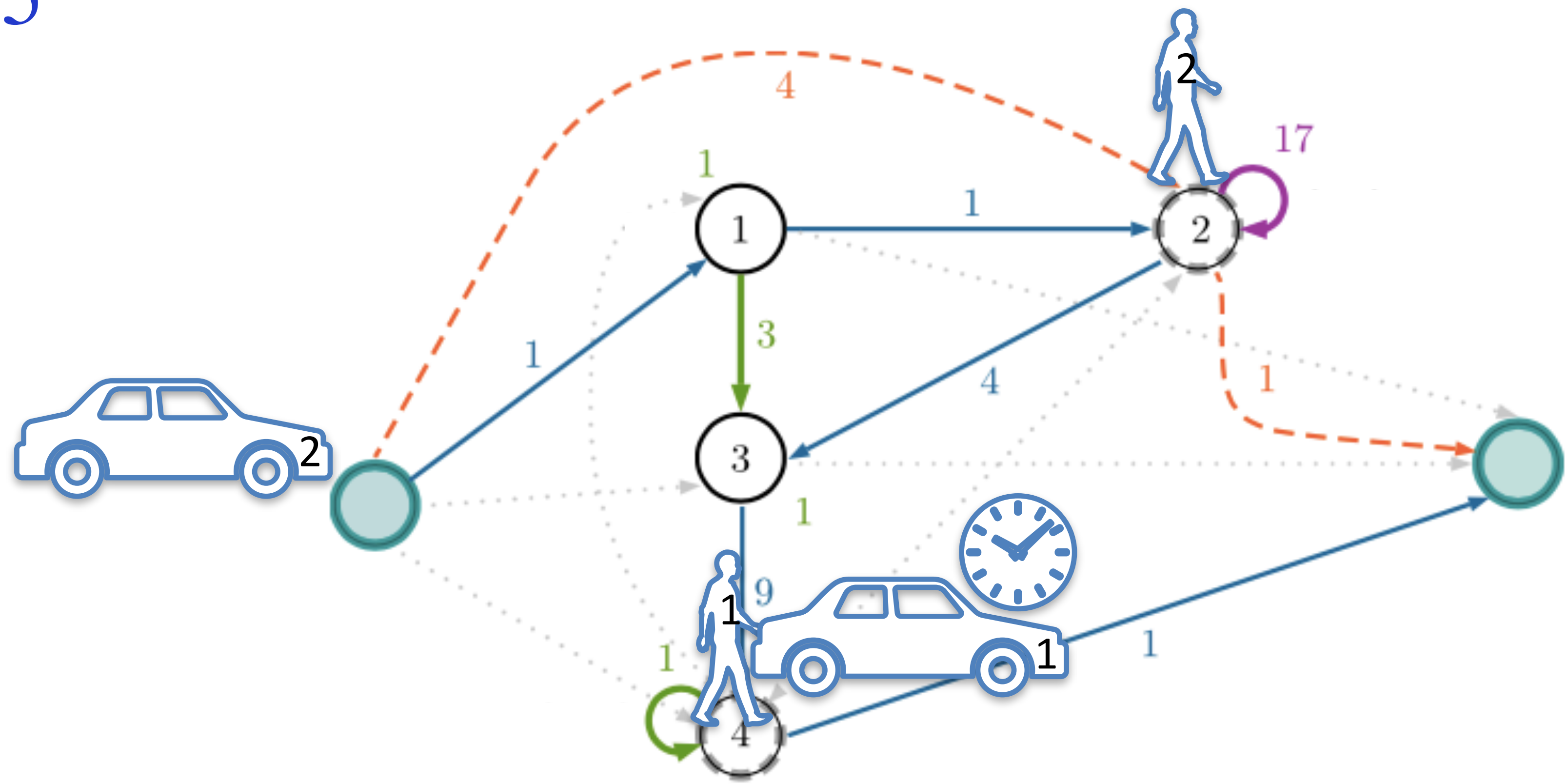
A Mixed Linear and Integer Programming Problem

$t = 6$



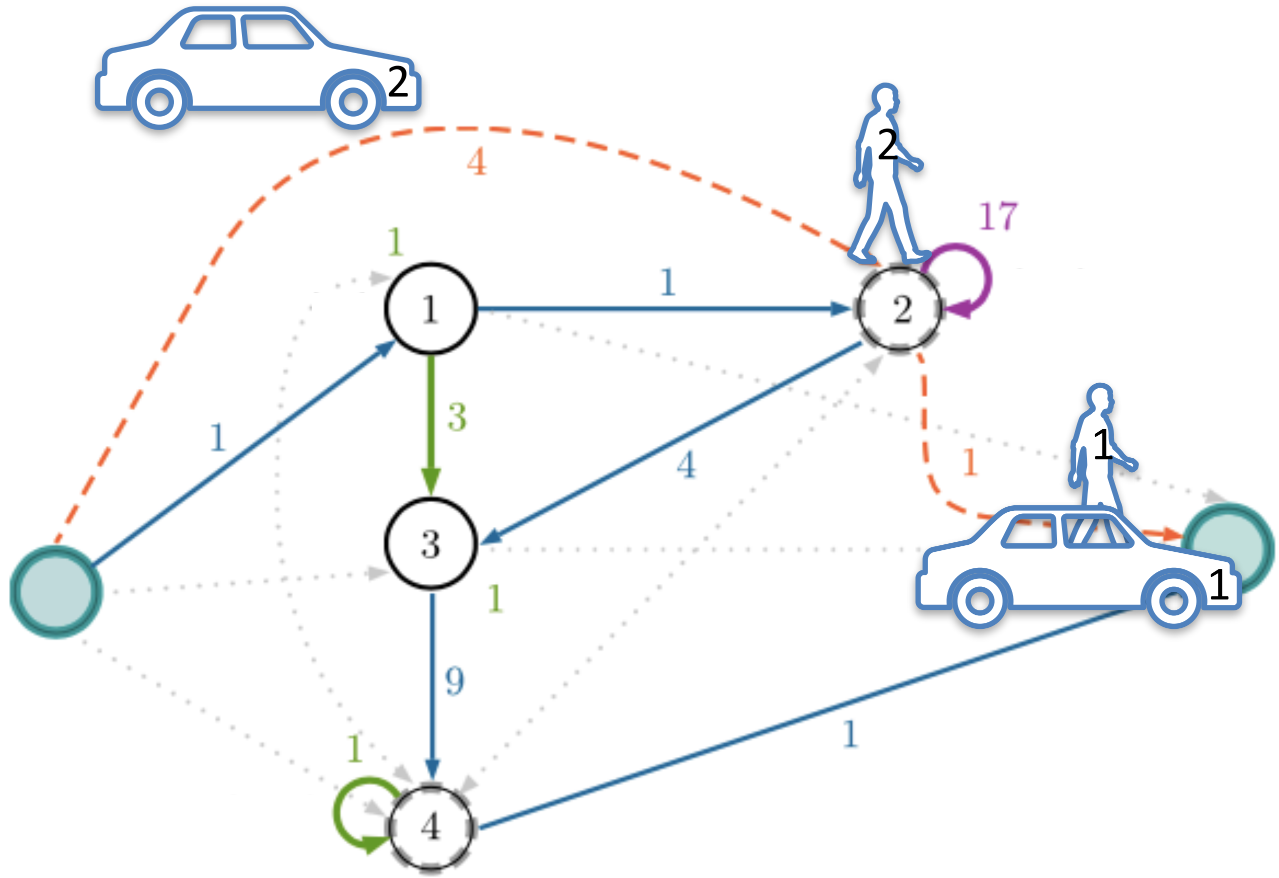
A Mixed Linear and Integer Programming Problem

$t = 15$



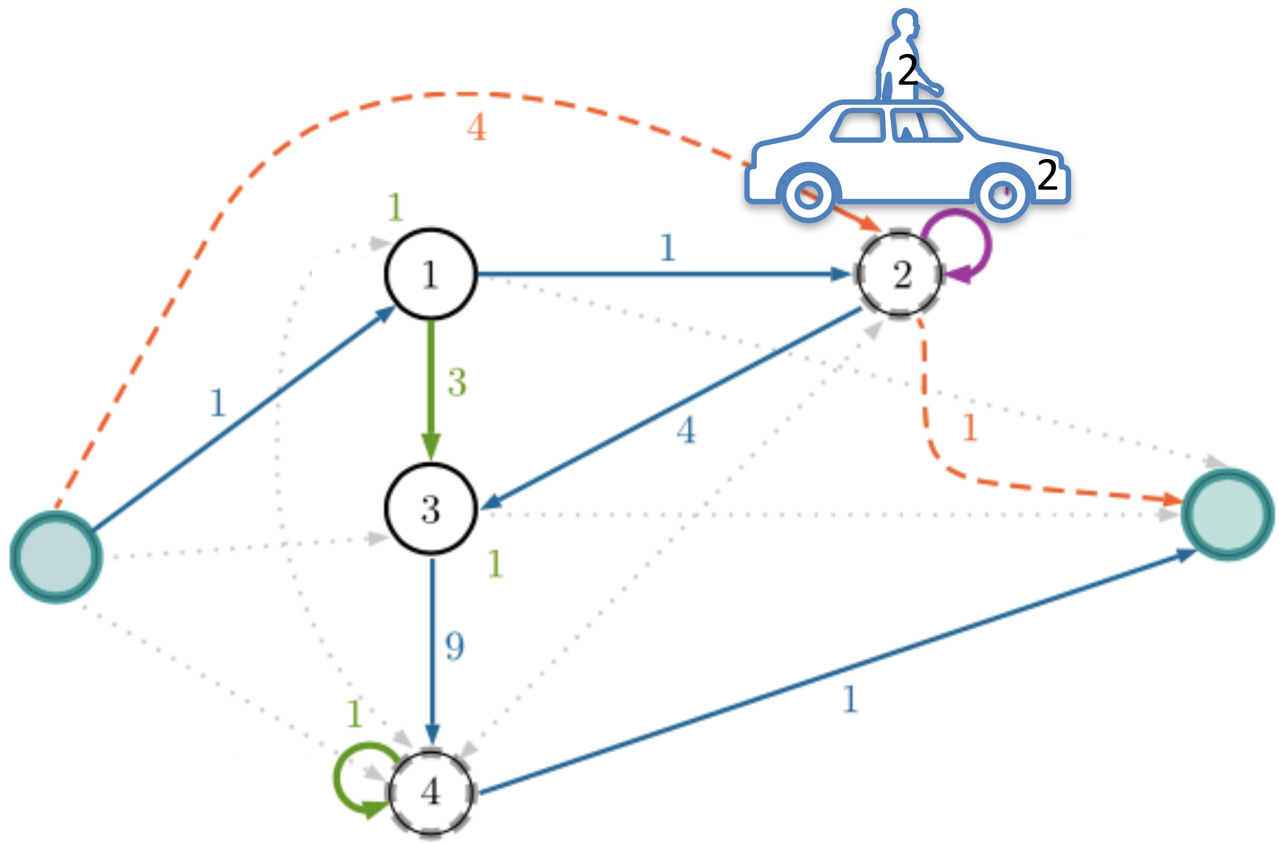
A Mixed Linear and Integer Programming Problem

$t = 17$



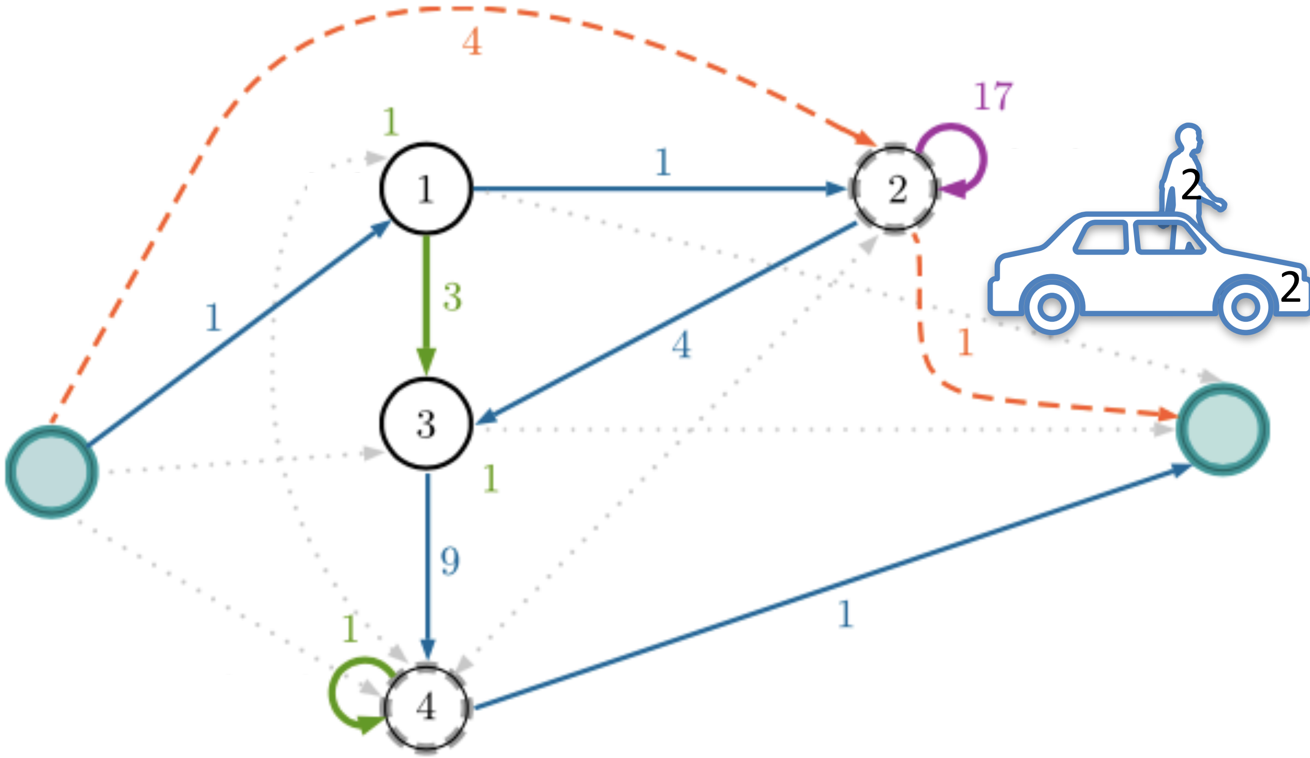
A Mixed Linear and Integer Programming Problem

$t = 19$



A Mixed Linear and Integer Programming Problem

$$t = 20$$



Definitions: sets

- E: pollsters
- K: vehicles
- set of n stores
- S: days within time horizon for planning

Definitions: network

- two nodes for each store (customer)

  $C_- := \{1, \ldots, n\}$ (arrival at store)

  $C_+ := \{n+1, \ldots, 2n\}$ (departure from store)

- two nodes $0, 2n+1$ for depot

- $C := C_- \cup C_+, \quad V := C \cup \{0, 2n+1\}$

- three sets of weighted arcs

  $A_S := \{(i, i+n) \ : \ i \in C_-\}$

  service arcs; service times $t_{i,i+n}$

  $A_W := \{(i,j) \ : \ i \in C_+, j \in C_-, j \neq i+n\}$

  walking arcs; walk times $t_{i,j}$

  $A_V := \{(i,j) \ : \ i, j \in C\} \cup \{(0,$ … $\in C\}$

  vehicle transportation arcs; travel times $\tau_{i,j}$

Definitions: paths and routes

- A walking path for a pollster is a simple path from $i \in C_-$ to $j \in C_+$ with alternating arcs from the sets A_S and A_W.
- A vehicle path is a directed path between two nodes in V using only arcs from A_V.
- A service route for a pollster is a dipath from 0 to $2n+1$ consisting of an alternating sequence of vehicle and walking subpaths.
- A vehicle route is a vehicle path from 0 to $2n+1$.
- The duration of a route is the sum of its arc weights.
- A service route is feasible if it does not exceed a maximum allowed duration, including time for a lunch break.

Definitions: schedules

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- Vehicles pick-up and deliver pollsters to certain stores; pollsters can share vehicles.
- Vehicle fleet is homogeneous, with vehicle capacity Q.
- Pollster "fleet" is homogeneous: any pollster can visit any store.
- A daily schedule consists of a set of feasible pollster routes and "compatible" vehicle routes, i.e., for any $(i,j) \in A_V$:
  - if (i,j) is contained in some service route, then it is contained in a vehicle route
  - (i,j) is not contained in more than Q service routes

The IPVRP

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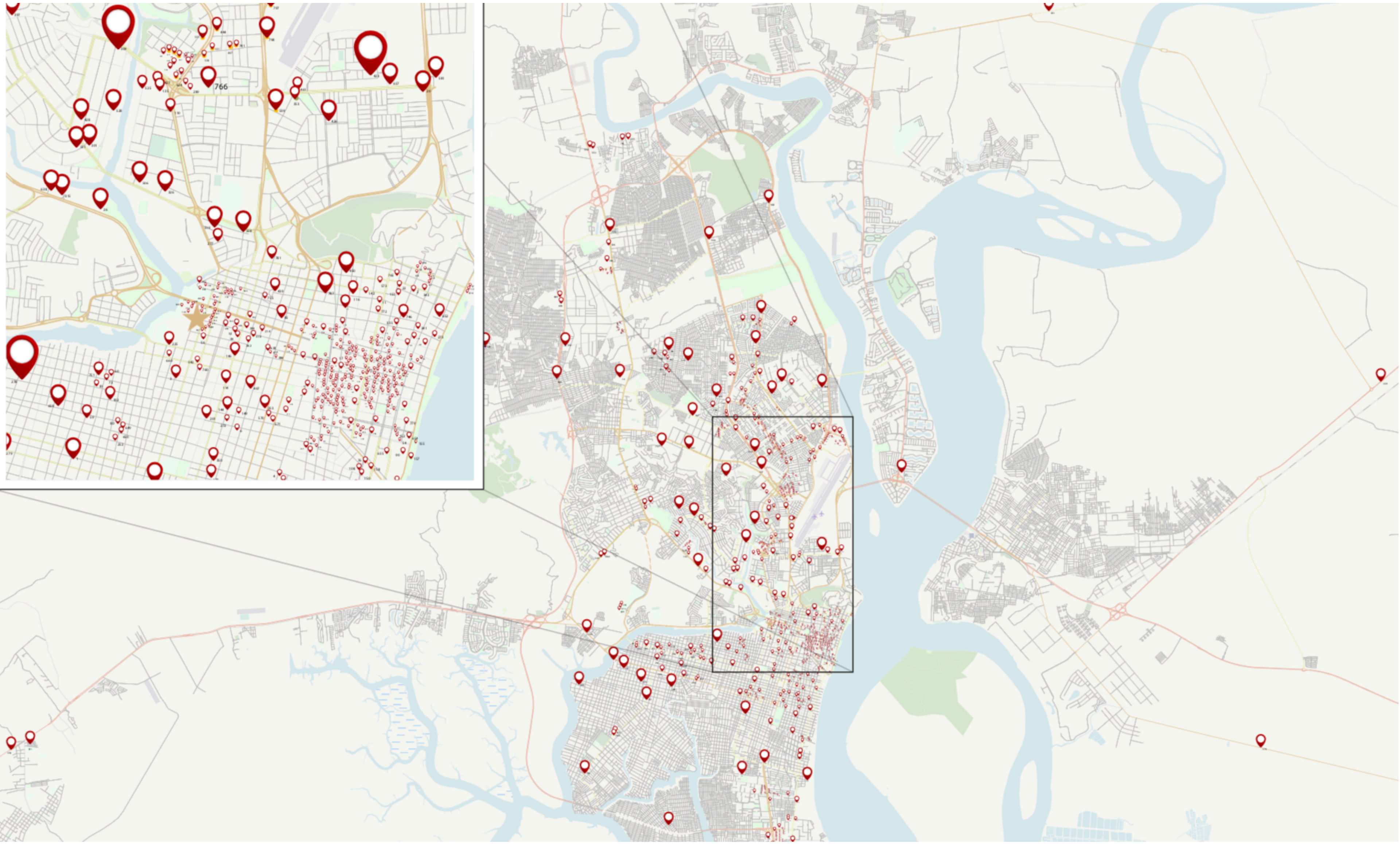
Task:

Find a set of daily schedules, at most one for each day in a given time horizon, such that:

* Each store is visited once.
* Number of working days is minimized.
* Number of service routes is minimized.
* Number of vehicle routes is minimized.

The INEC instance



Outline

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- Conclusions

Pollster routing: variables

Binary variables:

$x^{e,s}_{i,i+n}$, $\forall (i, i+n) \in A_S, e \in E, s \in S$: $x^{e,s}_{i,i+n} = 1 \Leftrightarrow e$ visits store i on day s

$x^{e,s}_{i,j}$, $\forall (i, j) \in A_W, e \in E, s \in S$: $x^{e,s}_{i,j} = 1 \Leftrightarrow e$ walks from i to j on day s

$z^{e,s}_{i,j}$, $\forall (i, j) \in A_V, e \in E, s \in S$: $z^{e,s}_{i,j} = 1 \Leftrightarrow e$ is transported from i to j on day s

$b^{e,s}_{i}$, $\forall i \in C\_, e \in E, s \in S$: $b^{e,s}_{i} = 1 \Leftrightarrow i$ is start of a walking path for e on day s

$f^{e,s}_{i}$, $\forall i \in C_+, e \in E, s \in S$: $f^{e,s}_{i} = 1 \Leftrightarrow i$ is end of a walking path of e on day s

u_s, $s \in S$: $u_s = 1 \Leftrightarrow s$ has a daily schedule assigned to it

Pollster routing: constraints

$$\sum_{s\in S}\sum_{e\in E} x^{e,s}_{i,i+n} = 1, \qquad \forall i \in C_-,$$

$$\sum_{(j,i)\in A_W} x^{e,s}_{j,i} - x^{e,s}_{i,i+n} = -b^{e,s}_i, \qquad \forall i \in C_-, e \in E, s \in S,$$

$$x^{e,s}_{i-n,i} - \sum_{(i,j)\in A_W} x^{e,s}_{i,j} = f^{e,s}_i, \qquad \forall i \in C_+, e \in E, s \in S,$$

$$\sum_{(j,i)\in A_V} z^{e,s}_{j,i} \le 1 - x^{e,s}_{i,i+n} + b^{e,s}_i, \qquad \forall i \in C_-, e \in E, s \in S,$$

$$\sum z^{e,s}_{i,j} \le 1 - x^{e,s}_{i-n,i} + f^{e,s}_i, \qquad \forall i \in C_+, e \in E, s \in S,$$

each store is visited by one pollster on one day

$$\sum_{(j,i)\in A_V} z^{e,s}_{j,i} - \sum_{(i,j)\in A_V} z^{e,s}_{i,j} = -f^{e,s}_i, \qquad \forall i \in C_+, e \in E, s \in S,$$

$$\sum_{i\in C} z^{e,s}_{0,i} \le u_s, \qquad \forall e \in E, s \in S\,.$$

Pollster routing: constraints

$$\sum_{s\in S}\sum_{e\in E} x_{i,i+n}^{e,s} = 1, \qquad \forall i \in C_-,$$

$$\sum_{(j,i)\in A_W} x_{j,i}^{e,s} - x_{i,i+n}^{e,s} = -b_i^{e,s}, \qquad \forall i \in C_-, e \in E, s \in S,$$

$$x_{i-n,i}^{e,s} - \sum_{(i,j)\in A_W} x_{i,j}^{e,s} = f_i^{e,s}, \qquad \forall i \in C_+, e \in E, s \in S,$$

$$\sum_{(j,i)\in A_V} z_{j,i}^{e,s} \leq 1 - x_{i,i+n}^{e,s} + b_i^{e,s}, \qquad \forall i \in C_-, e \in E, s \in S,$$

$$\sum_{(i,j)\in A_V} z_{i,j}^{e,s} \leq 1 - x_{i-n,i}^{e,s} + f_i^{e,s}, \qquad \forall i \in C_+, e \in E, s \in S,$$

“multicommodity flow demand” constraints for walking paths: sync x variables with b and f variables

$$\sum_{(j,i)\in A_V} z_{j,i}^{e,s} - \sum_{(i,j)\in A_V} z_{i,j}^{e,s} = b_i^{e,s}, \qquad \forall i \in C_-, e \in E, s \in S,$$

$$\sum_{(j,i)\in A_V} z_{j,i}^{e,s} - \sum_{(i,j)\in A_V} z_{i,j}^{e,s} = -f_i^{e,s}, \qquad \forall i \in C_+, e \in E, s \in S,$$

$$\sum_{i\in C} z_{0,i}^{e,s} \leq u_s, \qquad \forall e \in E, s \in S.$$

Pollster routing: constraints

$$\sum_{s\in S}\sum_{e\in E} x_{i,i+n}^{e,s} = 1, \qquad \forall i \in C_-,$$

$$\sum_{(j,i)\in A_W} x_{j,i}^{e,s} - x_{i,i+n}^{e,s} = -b_i^{e,s}, \qquad \forall i \in C_-, e \in E, s \in S,$$

$$x_{i-n,i}^{e,s} - \sum_{(i,j)\in A_W} x_{i,j}^{e,s} = f_i^{e,s}, \qquad \forall i \in C_+, e \in E, s \in S,$$

$$\sum_{(j,i)\in A_V} z_{j,i}^{e,s} \le 1 - x_{i,i+n}^{e,s} + b_i^{e,s}, \qquad \forall i \in C_-, e \in E, s \in S,$$

$$\sum z_{i,j}^{e,s} \le 1 - x_{i-n,i}^{e,s} + f_i^{e,s}, \qquad \forall i \in C_+, e \in E, s \in S,$$

degree constraints for vehicle transportation:
forbid arcs that cannot connect properly to walking paths

$$\sum_{(j,i)\in A_V} z_{j,i}^{e,s} - \sum_{(i,j)\in A_V} z_{i,j}^{e,s} = -f_i^{e,s}, \qquad \forall i \in C_+, e \in E, s \in S,$$

$$\sum_{i\in C} z_{0,i}^{e,s} \le u_s, \qquad \forall e \in E, s \in S.$$

Pollster routing: constraints

$$\sum_{s\in S}\sum_{e\in E} x_{i,i+n}^{e,s} = 1, \qquad \forall i \in C_-,$$

$$\sum_{(j,i)\in A_W} x_{j,i}^{e,s} - x_{i,i+n}^{e,s} = -\,b_i^{e,s}, \qquad \forall i \in C_-, e \in E, s \in S,$$

$$x_{i-n,i}^{e,s} - \sum_{(i,j)\in A_W} x_{i,j}^{e,s} = f_i^{e,s}, \qquad \forall i \in C_+, e \in E, s \in S,$$

$$\sum_{(j,i)\in A_V} z_{j,i}^{e,s} \le 1 - x_{i,i+n}^{e,s} + b_i^{e,s}, \qquad \forall i \in C_-, e \in E, s \in S,$$

“multicommodity flow demand” constraints for vehicle transportation (pickup and delivery of pollsters):
sync z variables with b and f variables

$$\sum_{(j,i)\in A_V} z_{j,i}^{e,s} - \sum_{(i,j)\in A_V} z_{i,j}^{e,s} = -\,f_i^{e,s}, \qquad \forall i \in C_+, e \in E, s \in S,$$

$$\sum_{i\in C} z_{0,i}^{e,s} \le u_s, \qquad \forall e \in E, s \in S\,.$$

Pollster routing: constraints

$$\sum_{s\in S}\sum_{e\in E} x^{e,s}_{i,i+n} = 1, \qquad \forall i \in C_-,$$

$$\sum_{(j,i)\in A_W} x^{e,s}_{j,i} - x^{e,s}_{i,i+n} = -b^{e,s}_i, \qquad \forall i \in C_-, e \in E, s \in S,$$

$$x^{e,s}_{i-n,i} - \sum_{(i,j)\in A_W} x^{e,s}_{i,j} = f^{e,s}_i, \qquad \forall i \in C_+, e \in E, s \in S,$$

$$\sum_{(j,i)\in A_V} z^{e,s}_{j,i} \le 1 - x^{e,s}_{i,i+n} + b^{e,s}_i, \qquad \forall i \in C_-, e \in E, s \in S,$$

$$\sum z^{e,s}_{i,j} \le 1 - x^{e,s}_{i-n,i} + f^{e,s}_i, \qquad \forall i \in C_+, e \in E, s \in S,$$

degree constraint at depot (at most one route per pollster and day)

$(j,i)\in A_V \qquad (i,j)\in A_V$

$$\sum_{(j,i)\in A_V} z^{e,s}_{j,i} - \sum_{(i,j)\in A_V} z^{e,s}_{i,j} = -f^{e,s}_i, \qquad \forall i \in C_+, e \in E, s \in S,$$

$$\sum_{i\in C} z^{e,s}_{0,i} \le u_s, \qquad \forall e \in E, s \in S\,.$$

Vehicle routing: variables

Binary variables:

$y_{i,j}^{k,s}, \forall (i,j) \in A_V, k \in K, s \in S:$ $y_{i,j}^{k,s} = 1 \Leftrightarrow k$ travels through (i,j) on day s

Remind that...

$z_{i,j}^{e,s}, \forall (i,j) \in A_V, e \in E, s \in S:$ $z_{i,j}^{e,s} = 1 \Leftrightarrow e$ is transported from i to j on day s

$b_i^{e,s}, \forall i \in C_-, e \in E, s \in S:$ $b_i^{e,s} = 1 \Leftrightarrow i$ is start of a walking path for e on day s

$f_i^{e,s}, \forall i \in C_+, e \in E, s \in S:$ $f_i^{e,s} = 1 \Leftrightarrow i$ is end of a walking path of e on day s

$u_s, \ s \in S:$ $u_s = 1 \Leftrightarrow i$ if day s has a daily schedule assigned to it

Vehicle routing: constraints

$$\sum_{k\in K}\sum_{(i,j)\in A_V} y_{i,j}^{k,s} = \sum_{e\in E} b_i^{e,s}, \qquad \forall i \in C_-, \forall s \in S,$$

$$\sum_{k\in K}\sum_{(i,j)\in A_V} y_{i,j}^{k,s} = \sum_{e\in E} f_i^{e,s}, \qquad \forall i \in C_+, \forall s \in S,$$

$$\sum_{(j,i)\in A_V} y_{j,i}^{k,s} - \sum_{(i,j)\in A_V} y_{i,j}^{k,s} = 0, \qquad \forall i \in C, k \in K, s \in S,$$

degree constraints for vehicle routes:
out-degree is required to be 1 if node is starting or ending node of some walking path, 0 otherwise

Vehicle routing: constraints

$$\sum_{k\in K}\sum_{(i,j)\in A_V} y_{i,j}^{k,s} = \sum_{e\in E} b_i^{e,s}, \qquad \forall i \in C_-, \forall s \in S,$$

$$\sum_{k\in K}\sum_{(i,j)\in A_V} y_{i,j}^{k,s} = \sum_{e\in E} f_i^{e,s}, \qquad \forall i \in C_+, \forall s \in S,$$

$$\sum_{(j,i)\in A_V} y_{j,i}^{k,s} - \sum_{(i,j)\in A_V} y_{i,j}^{k,s} = 0, \qquad \forall i \in C, k \in K, s \in S,$$

multicommodity flow conservation constraints at stores

$$\sum_{e\in E} z_{i,j}^{e,s} \le Q \sum_{k\in K} y_{i,j}^{k,s}, \qquad \forall (i,j) \in A_V, s \in S,$$

Vehicle routing: constraints

$$\sum_{k\in K}\sum_{(i,j)\in A_V} y_{i,j}^{k,s} = \sum_{e\in E} b_i^{e,s}, \qquad \forall i \in C_-, \forall s \in S,$$

$$\sum_{k\in K}\sum_{(i,j)\in A_V} y_{i,j}^{k,s} = \sum_{e\in E} f_i^{e,s}, \qquad \forall i \in C_+, \forall s \in S,$$

$$\sum_{(j,i)\in A_V} y_{j,i}^{k,s} - \sum_{(i,j)\in A_V} y_{i,j}^{k,s} = 0, \qquad \forall i \in C, k \in K, s \in S,$$

degree constraint at depot:
at most one route allowed per vehicle, and only on days used in the schedule

$$\sum_{e\in E} z_{i,j}^{e,s} \leq Q \sum_{k\in K} y_{i,j}^{k,s}, \qquad \forall (i,j) \in A_V, s \in S,$$

Vehicle routing: constraints

$$\sum_{k \in K} \sum_{(i,j) \in A_V} y_{i,j}^{k,s} = \sum_{e \in E} b_i^{e,s}, \qquad \forall i \in C_-, \forall s \in S,$$

$$\sum_{k \in K} \sum_{(i,j) \in A_V} y_{i,j}^{k,s} = \sum_{e \in E} f_i^{e,s}, \qquad \forall i \in C_+, \forall s \in S,$$

$$\sum_{(j,i) \in A_V} y_{j,i}^{k,s} - \sum_{(i,j) \in A_V} y_{i,j}^{k,s} = 0, \qquad \forall i \in C, k \in K, s \in S,$$

each arc of the vehicle network with positive transportation demand must be covered by a vehicle route;

account for vehicle capacity Q

$$\sum_{e \in E} z_{i,j}^{e,s} \leq Q \sum_{k \in K} y_{i,j}^{k,s}, \qquad \forall (i,j) \in A_V, s \in S,$$

Shift-length: Variables

Variables

$B_i, \forall i \in V :$ arrival time at store i, if $i \in C_-$

departure time from store $i - n$, if $i \in C_+$

duration of longest service route, if $i = 2n + 1$

equals to 0 for consistency, if $i = 0$

$w_i^{e,s}, \forall i \in C_-, e \in E, s \in S :$ $w_i^{e,s} = 1 \Leftrightarrow e$ takes break after visiting i on day s

(in this case, B_{i+n} is departure time after break)

Remind that...

$x_{i,j}^{e,s}, \forall (i,j) \in A_W, e \in E, s \in S :$ $x_{i,j}^{e,s} = 1 \Leftrightarrow e$ walks from i to j on day s

$y_{i,j}^{k,s}, \forall (i,j) \in A_V, k \in K, s \in S :$ $y_{i,j}^{k,s} = 1 \Leftrightarrow k$ travels through (i,j) on day s

Shift-length: constraints

$$B_{i+n} \geq B_i + t_{i,i+n} + P \sum_{e \in E} \sum_{s \in S} w_i^{e,s}, \qquad \forall (i, i+n) \in A_S,$$

$$B_j \geq B_i + t_{i,j} - M\left(1 - \sum_{e \in E} \sum_{s \in S} x_{i,j}^{e,s}\right), \qquad \forall (i,j) \in A_W,$$

$$B_j \geq B_i + \tau_{i,j} - M\left(1 - \sum_{k \in K} \sum_{s \in S} y_{i,j}^{k,s}\right), \qquad \forall (i,j) \in A_V,$$

account for service times and duration of lunch breaks (when present)

Parameters:

$t_{i,i+n}$: service time at store i

P : duration of lunch break

Shift-length: constraints

$$B_{i+n} \geq B_i + t_{i,i+n} + P \sum_{e \in E} \sum_{s \in S} w_i^{e,s}, \qquad \forall (i, i+n) \in A_S,$$

$$B_j \geq B_i + t_{i,j} - M\left(1 - \sum_{e \in E} \sum_{s \in S} x_{i,j}^{e,s}\right), \qquad \forall (i,j) \in A_W,$$

$$B_j \geq B_i + \tau_{i,j} - M\left(1 - \sum_{k \in K} \sum_{s \in S} y_{i,j}^{k,s}\right), \qquad \forall (i,j) \in A_V,$$

account for walking times between consecutive stores

Parameters:

$$B_{2n+1} \leq B_{\max},$$

$t_{i,j}$: walking time from store i to store j

M : sufficiently large constant

$$B_0 = 0,$$

Shift-length: constraints

$$B_{i+n} \geq B_i + t_{i,i+n} + P \sum_{e \in E} \sum_{s \in S} w_i^{e,s}, \qquad \forall (i, i+n) \in A_S,$$

$$B_j \geq B_i + t_{i,j} - M\left(1 - \sum_{e \in E} \sum_{s \in S} x_{i,j}^{e,s}\right), \qquad \forall (i,j) \in A_W,$$

$$B_j \geq B_i + \tau_{i,j} - M\left(1 - \sum \sum y_{i,j}^{k,s}\right), \qquad \forall (i,j) \in A_V,$$

account for vehicle transportation times

when $j=2n+1$, maximum duration of a service route is computed

Parameters:

- $\tau_{i,j}$: driving time from node i to node j
- M : sufficiently large constant

$$B_0 = 0,$$

Shift-length: constraints

$$B_{i+n} \geq B_i + t_{i,i+n} + P \sum_{e \in E} \sum_{s \in S} w_i^{e,s}, \qquad \forall (i, i+n) \in A_S,$$

$$B_j \geq B_i + t_{i,j} - M\left(1 - \sum_{e \in E} \sum_{s \in S} x_{i,j}^{e,s}\right), \qquad \forall (i,j) \in A_W,$$

$$B_j \geq B_i + \tau_{i,j} - M\left(1 - \sum_{k \in K} \sum_{s \in S} y_{i,j}^{k,s}\right), \qquad \forall (i,j) \in A_V,$$

specify upper bound for route length

Parameters:

$B_{\max}$: maximum allowed duration for a route

$$B_0 = 0,$$

Pollster breaks

$$T_0 \sum_{e\in E}\sum_{s\in S} w_i^{e,s} \le B_i + t_{i,i+n} \le T_1 + M\left(1 - \sum_{e\in E}\sum_{s\in S} w_i^{e,s}\right), \qquad \forall i \in C_-,$$

$$w_i^{e,s} \le x_{i,i+n}^{e,s}, \qquad \forall i \in C_-, e \in E, s \in S,$$

each break must start within the prescribed time window

Parameters:

$$\sum_{i\in C_-} w_i^{e,s} = \sum_{j\in C} z_{0,j}^{e,s}, \qquad \forall e \in E, s \in S.$$

- $[T_0, T_1]$: time window for starting of break
- $t_{i,i+n}$: service time at store i
- M : sufficiently large constant

Pollster breaks

$$T_0 \sum_{e \in E} \sum_{s \in S} w_i^{e,s} \leq B_i + t_{i,i+n} \leq T_1 + M\left(1 - \sum_{e \in E} \sum_{s \in S} w_i^{e,s}\right), \qquad \forall i \in C_-,$$

$$w_i^{e,s} \leq x_{i,i+n}^{e,s}, \qquad \forall i \in C_-, e \in E, s \in S,$$

sync variables $w_i^{e,s}$ and $x_{i,i+n}^{e,s}$:
pollster e can have a break after visiting store i on day s only if e serves i on that day

Pollster breaks

$$T_0 \sum_{e\in E} \sum_{s\in S} w_i^{e,s} \le B_i + t_{i,i+n} \le T_1 + M\left(1 - \sum_{e\in E} \sum_{s\in S} w_i^{e,s}\right), \qquad \forall i \in C_-,$$

$$w_i^{e,s} \le x_{i,i+n}^{e,s}, \qquad \forall i \in C_-, e \in E, s \in S,$$

each pollster must have exactly one break on each service route

Objective function

$$\min \kappa_0 \sum_{s \in S} u_s + \kappa_1 \sum_{s \in S} \sum_{k \in K} \sum_{i \in C} y_{0,i}^{k,s} + \kappa_2 \sum_{s \in S} \sum_{k \in K} \sum_{i \in C} z_{0,i}^{e,s}$$

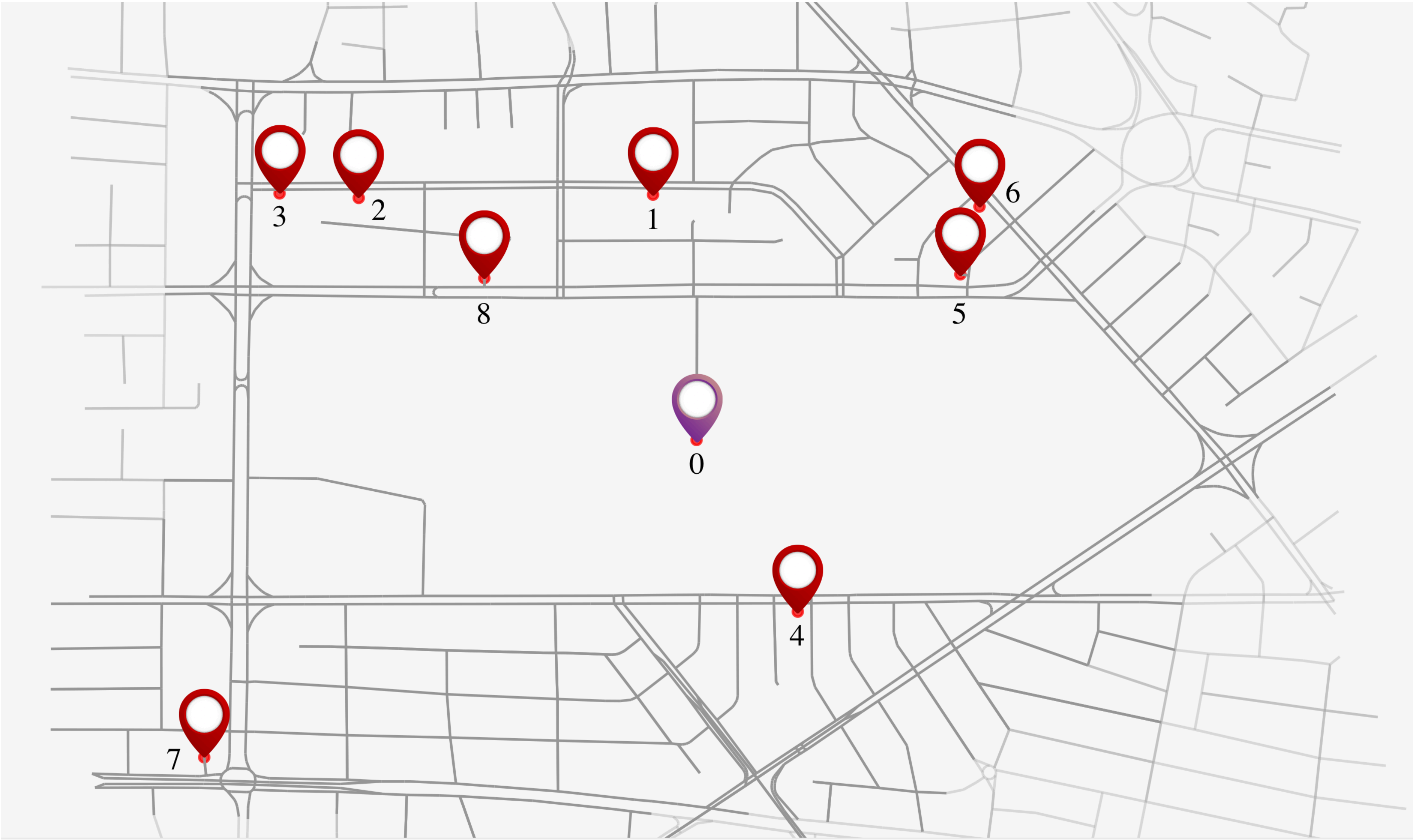
Weighted sum of three components:

- number of working days
- total number of required vehicle routes
- total number of required service routes

Outline

- Motivation and problem definition
- Modeling via mixed integer programming
- Computational results
- Conclusions

A “toy” example

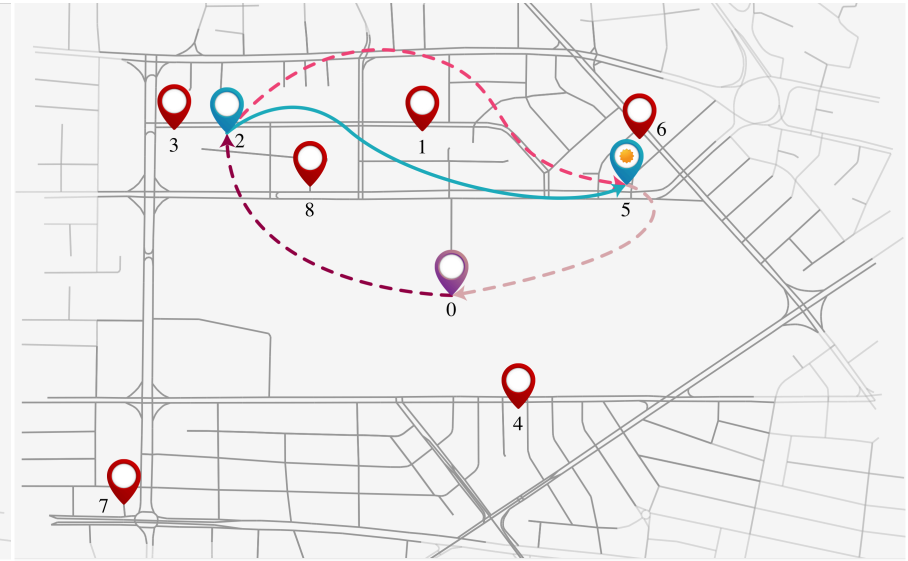


A “toy” example

- 8 stores, 2 pollsters, 2 vehicles, 3 days in time horizon
- Service times in [2; 34]
- Walking times in [2; 28]
- Vehicle transportation times in [0.5; 7]
- Shift-duration $B_{\max} = 120.$
- Pollster break duration $P = 20$, and must be taken in time window [50; 90]
- Objective coefficients: $\kappa_0 = 200,\ \kappa_1 = 100,\ \kappa_2 = 40.$

A "toy" example

Day 1



Day 2

- MIP model with 2923 variables and 1683 rows
- Solved on a MacBook Pro i7 2.6GHz with 16 GB RAM, OSX Catalina, using Gurobi 9.0.2. as MIP solver, TimeLimit= 3600 (best solution and LB found within 2 minutes)
- Feasible solution with Gap= 52.8%, uses 1 vehicle, 2 pollsters, 2 days.

The INEC complete instance

$|C| = 820$

$|S| = 17$

$|E| = 5$

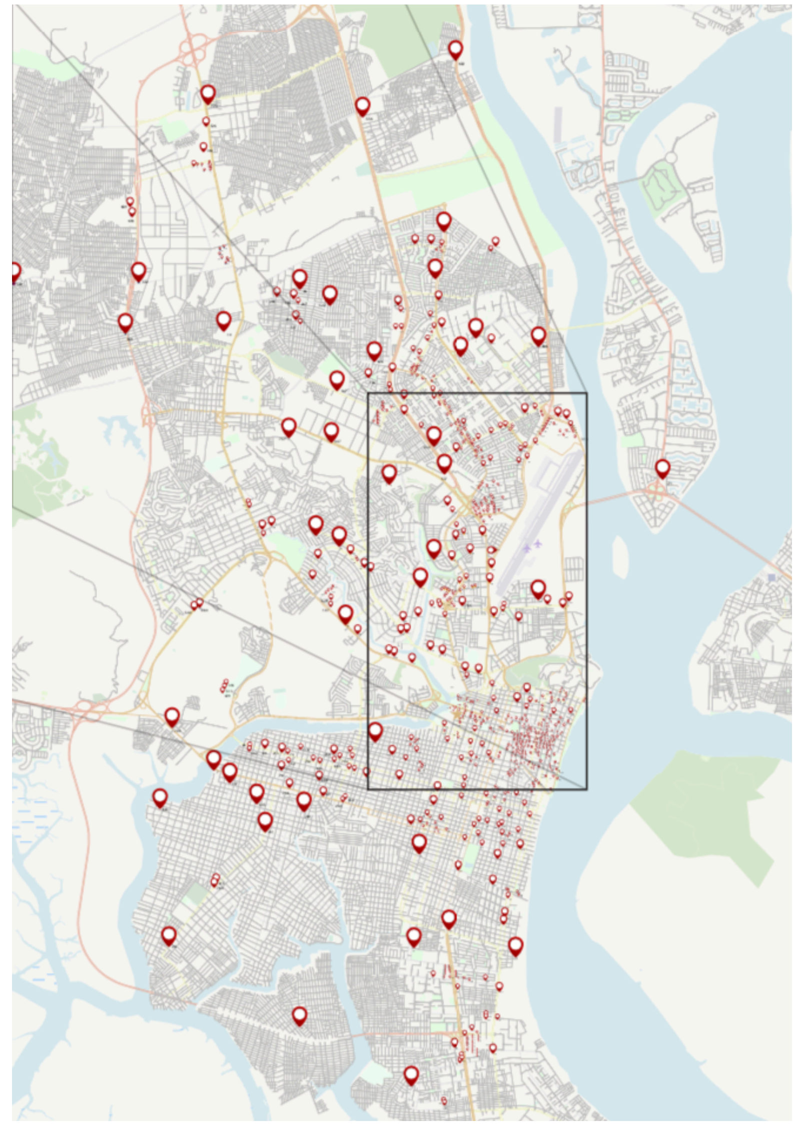
$|K| = 3$

$Q = 3$

$|A| \approx 3.4$ mio.

$P = 8$

$B_{\max} = 84$

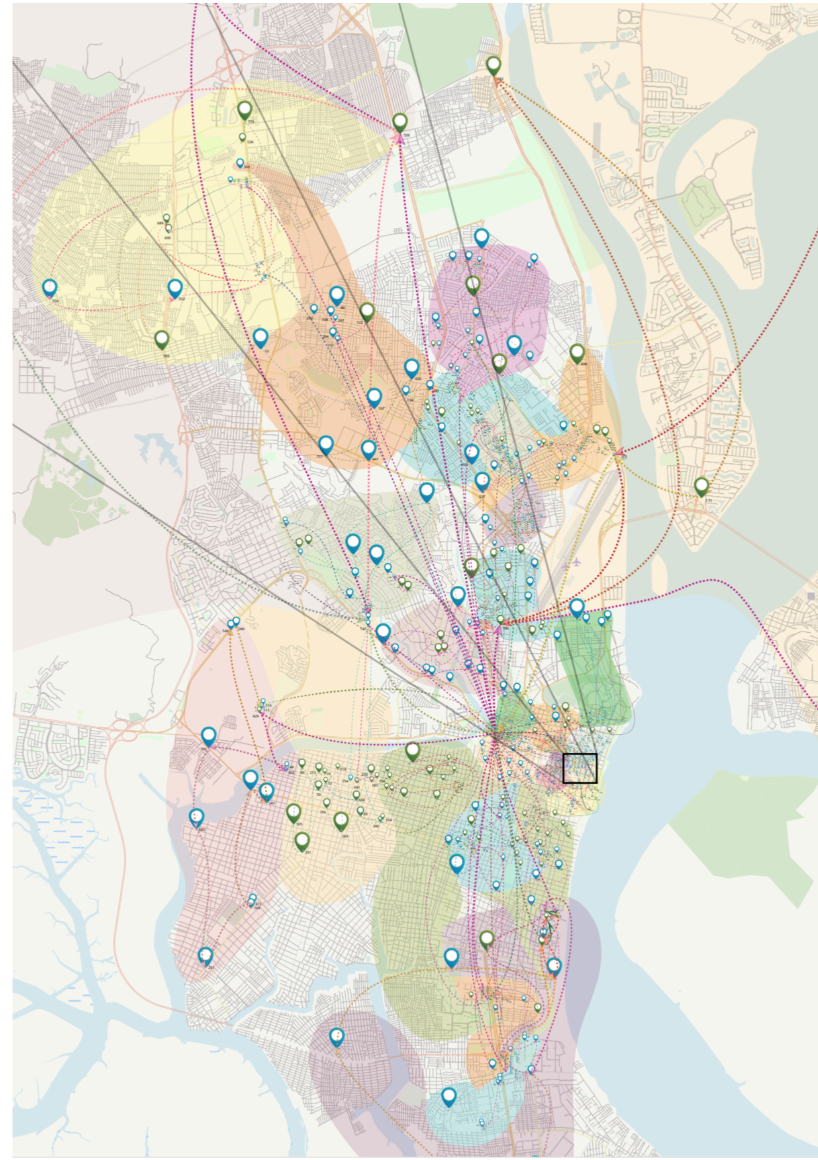


> 420 mio. binary variables!!!

> 49 mio. constraints!!!

Solution approach

1. Partition of the instance into “half-daily snapshots” (Graph partitioning techniques balancing total node load).
2. Route pollsters and vehicles in each partition without considering lunch break.
3. Link partial solutions into a complete schedule (matching problem).



Results

- 30 partitions were constructed, with aggregated service times varying in [90; 210]
- Each partition could be solved using 2 pollsters and 1 vehicle.
- Global schedule with 15 days, 2 pollsters, 1 vehicle (previous: 17d, 5p, 3v)

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Conclusions & Outlook

- Presented a mixed integer programming model for scheduling the visits of stores and for the integrated routing of pollsters and vehicles.
- Model is hard to solve even for small “toy” instances.
- Three-phase solution approach: partitioning of stores into half-day instances, partial (vehicle + pollster) routing, matching of routes into daily schedules.

Future work

- Tighten linear relaxation (cutting-planes)
- Alternative formulations? Column generation?

Thank you for your attention!!!

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