Introduction to Transportation Planning

Route-choice, fixed point, assignment

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Fixed-point problem in transportation

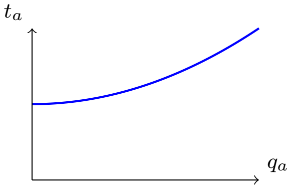
Limited-capacity

Travel time is variable and changes with the demand.

Waiting time

How long will I travel across the Aleje?

$$t_a = f(q_a)$$



Travel time **non-linearly** grows with number of cars at Aleje.

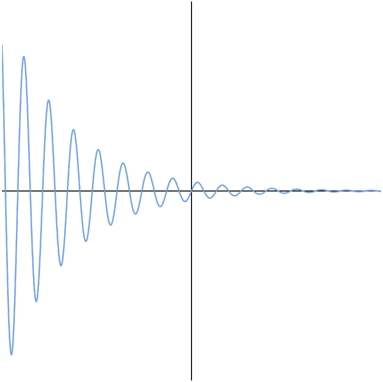
Fixed-point problem in transportation

$$q_z^n = f(q_z^{n-1})$$

1. how many drivers will select Aleje today (day n)?
2. it depends on how satisfied they were from their decision yesterday (day $n-1$).
3. if number of drivers who selected Aleje today equals the number of drivers who selected Aleje yesterday - we are in the fixed-point - the system **stabilized/equilibrated**.
4. it also means that travel time at Aleje is exaclty, like it was yesterday, and exactly like it was expected by the drivers who selected Aleje.

Fixed-point problem in transportation
Convergence

$$q_z^n = f(q_z^{n-1})$$



$$q_z^n = f(q_z^{n-1})$$

Days (iterations):

- 1st users on shortest paths - congested shortest paths
- 2-∞ users try to avoid congestion and find better path, which are however not as good as expected
- ∞ User Equilibrium

User Equilibrium

1. The journey times on all the routes actually used are equal and less than those which would be experienced by a single vehicle on any unused routes
2. user-optimized equilibrium is reached when no user may lower his transportation cost through unilateral action.

Path choice

Road network path choice

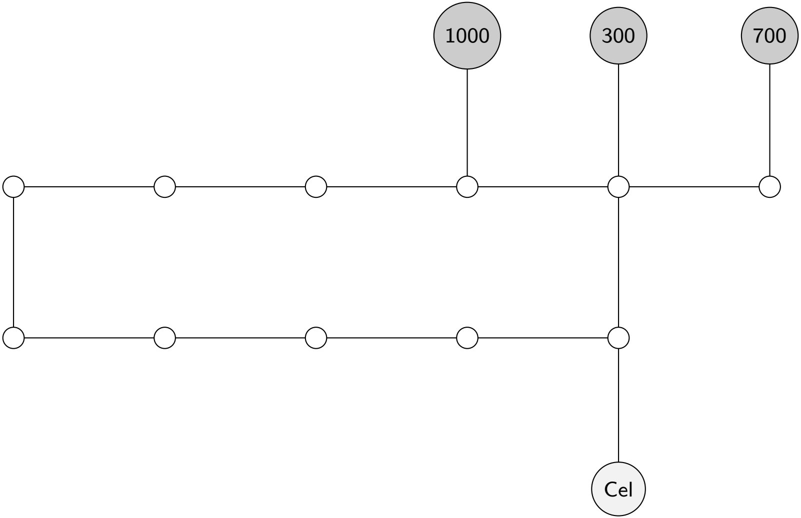
For the transport network illustrated below let's determine the traffic flows on the bridge (dashed) and resulting travel time (t_a) Numbers in zones show demand, i.e. number of cars willing to travel from the zone to the destination (factory) at the bottom.
Let's assume all links are of equal length and their free flow travel time is 1min. Let's further assum

1. unlimited capacity of all arcs
2. bridge capacity (Q_a) is 500 vehicles/hour, other links have unkimited capacity. TO estimate travel time use this BPR formula: $t_a = t_a^0 \cdot (1 + (q_a/Q_a)^2)$. Give approximated value close to Wardop conditions.

Road network path choice

numerical example

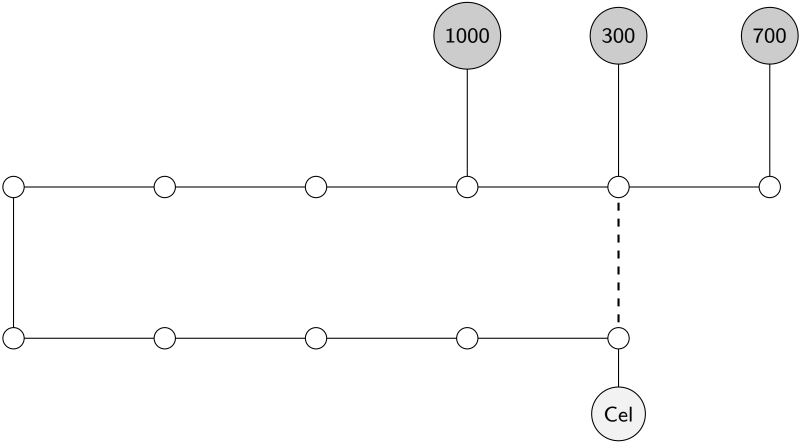
A: inifnite capacity on all roads



Road network path choice

numerical example

B: bridge capacity (Q_a) is 500 vehicles/hour, other links have unkimited capacity. TO estimate travel time use this BPR formula: $t_a = t_a^0 \cdot (1 + (q_a/Q_a)^2)$. Give approximated value close to Wardop conditions.



Path choices

Path/route choice

Rationale

I want (demand) to travel from origin o to destination d on a directed network graph $G(N, A)$ where both arcs $a \in A$ and nodes $n \in N$ have some associated travel costs c_a, c_n.

Cost is:

- user-perceived (subjective)
- typically related with time $c_a \propto t_a$ or hugely driven by time
- may include other variables, like: length, comfort, toll (price), user-bias
- are often demand related $c_a = f(q_a)$ which constitutes a fixed point.

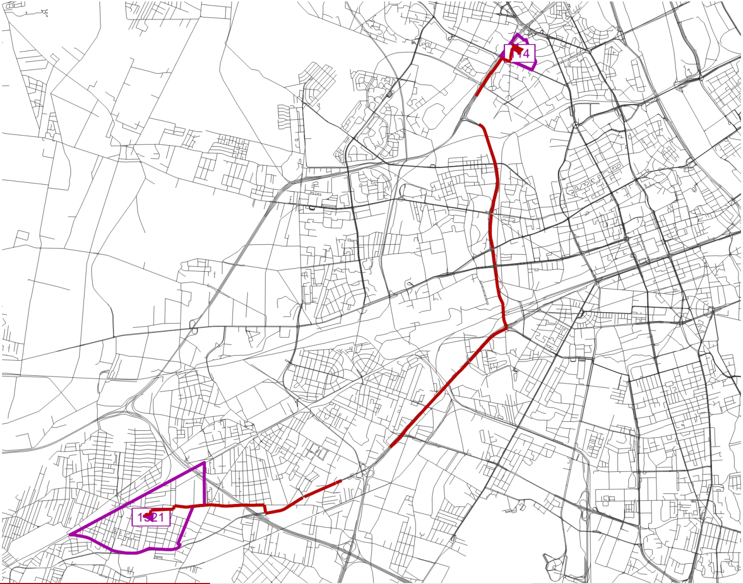
Path/route choice

Route choice problem

- Identify feasible paths K_{od} from o to d. Compuationally hard, number of alternatives explode.
- Define probabilities of selecting a path based on given criteria.
- Select the most probable path (deterministic, all-or-nothing)
- or determine path probabilities (probablistic, stochastic, multi-path).

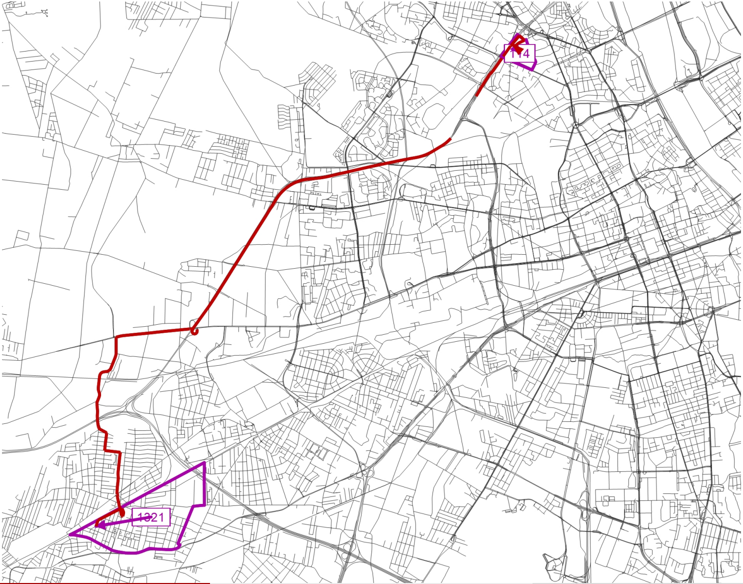
Shortest paths

distance



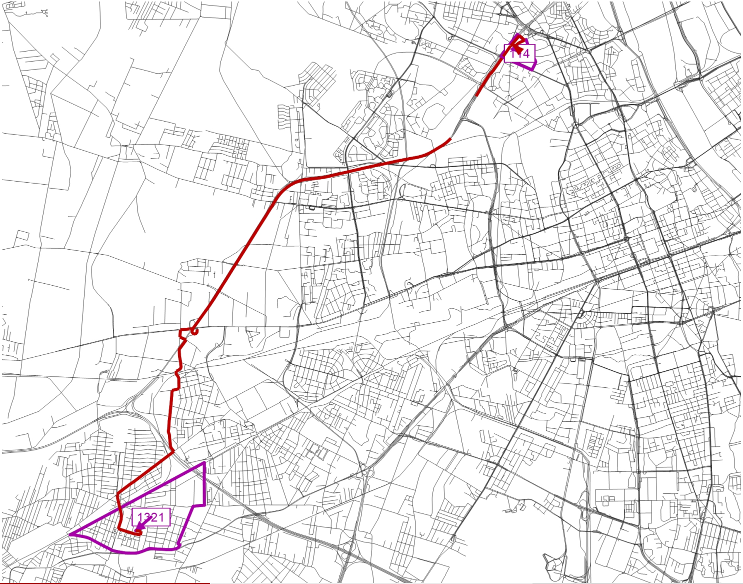
Shortest paths

time



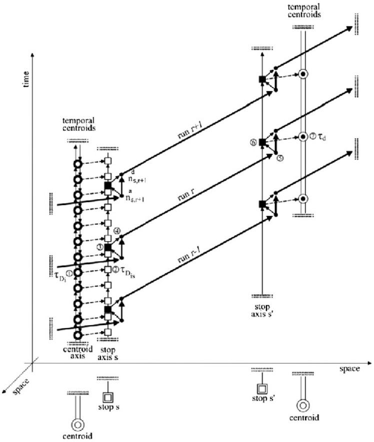
Shortest paths

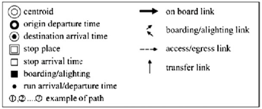
Congested time



Shortest paths

Transit path choice





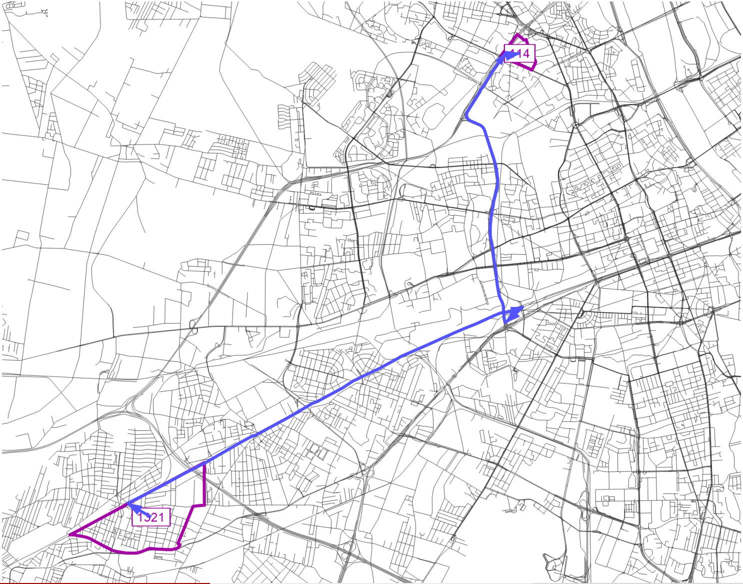
Transit path choice

Criteria

- access walk time (to stop)
- wait time (at stop)
- ride time (or times)
- ride/wait/walk comfort
- transfer walk time (or times)
- transfer wait time (or times)
- egress walk time

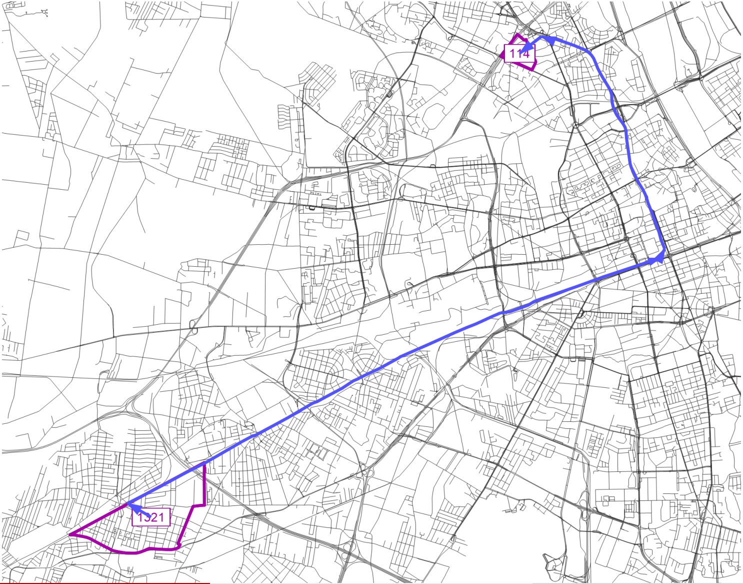
Shortest paths

Transit AM peak



Shortest paths

Transit late evening



Shortest paths

Heterogeneity

For the same od pair and the same costs c_a each individual (belongi ng to a given group) may have various choices:

- *comforters* - low number of transfers, long ride and wait time acceptable
- *in rush from place* - any trip with earliest arrival time.
- *in rush to place* - any trip with latest departure time.
- *walkers* - may walk to save time.

Summary

Thanks for attention

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