Problem Set 7

due: June 11, 2018

Exercise 1   8 points

Consider the subway network of Vienna, Austria. The data is available in GTFS format on the course website (`wien.zip`).

- There are 5 subway lines.

- Every line is served every 5 minutes by two periodic trips, i.e., one trip per direction.

- The data in `stop_times.txt` can be interpreted as a periodic timetable, repeating every 5 minutes.

- The minimum turnaround time at the endpoints is 0 minutes, all other transfers are supposed to take at least 2 or 3 minutes (see `transfers.txt`).

(a) If the line network is supposed to be undirected, how many vertices (i.e., stops) and edges does it have?

(b) Count the driving, waiting and transfer activities in the periodic expansion for the period time $T = 5$ minutes. Transfer activities include transfers to the other direction of the same line, and hence in particular turnarounds at endpoints.

(c) Compute the weighted periodic tension of the given periodic timetable, where each activity has weight 1. Do not forget to take the minimum transfer times into account.
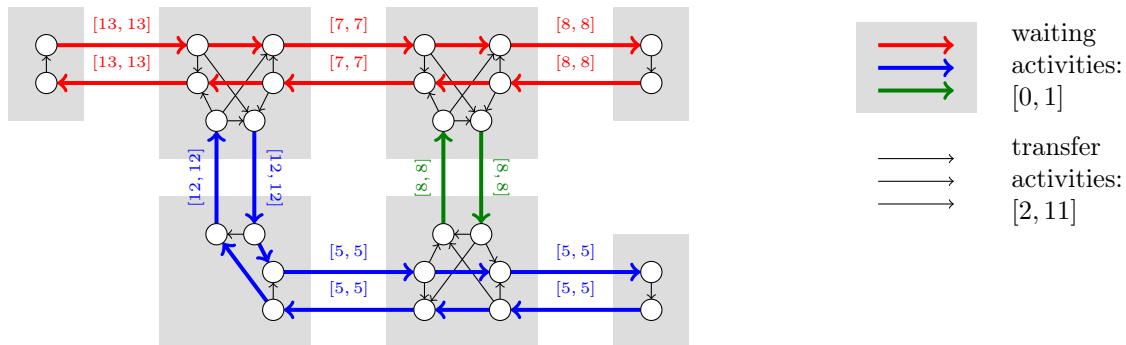
GTFS reference: `developers.google.com/transit/gtfs/reference`

Please turn over!

Exercise 2   12 points

Consider the following PESP instance with 28 events, 14 driving activities, 6 waiting activities, and 26 transfer activities:

The period time is $T = 10$, the weight of each activity is 1.

(a) Compute an integral cycle basis.

(b) Write a file in *LP format* containing the cycle-and-slack MIP formulation of this PESP instance.

(c) Solve the PESP instance using a MIP solver. What is the optimal timetable? What is the minimal weighted periodic slack?

Resources:

- LP format: lpsolve.sourceforge.net/5.0/CPLEX-format.htm

- SCIP: scip.zib.de
  Binaries for Linux, MacOS, Windows are available for download. In the interactive mode, use the commands read filename.lp, optimize and write solution filename.sol.

- Gurobi on NEOS: neos-server.org/neos/solvers/milp:Gurobi/LP.html
  Check the box *Return .sol file*.

If you use programming, then send your code. Do not forget to write down the results. Please submit also the LP file and the solution file.