

Grafopoli

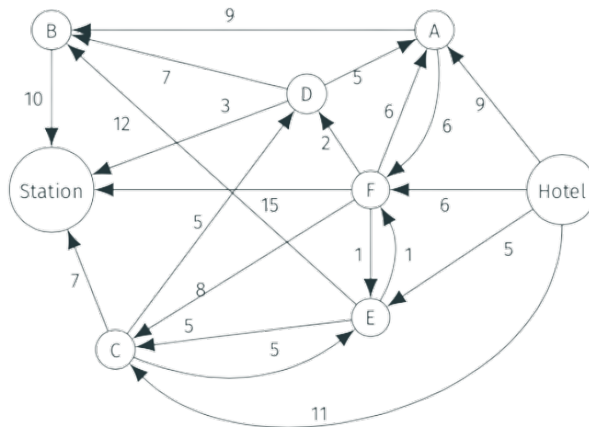
Difficulty level: intermediate

Keywords

- Graph theory
- Directed graphs
- Dijkstra's algorithm
- Heuristic algorithms
- Integer Linear Programming
- Excel Solver
- Python+PuLP

Problem description

Remo has to leave the city of Grafopoli and go back to his home. The return train will leave the Central Station at 11:03 but Remo, as always late, only manages to leave the hotel at 10:50. The graph below represents the city network, where each arc is associated with its travel time (in minutes), which is considered reliable.



Tasks

1. What is a path that would allow Remo to save the most time possible? Is there only one path or more than one? Why?
2. Would Remo have a chance to get to the station in time to catch the 11:03 train? If so, how many minutes early could he arrive? If not, how many minutes late?
3. Now suppose that Remo, discouraged by the delay, decides to spend a few more hours visiting the city of Grafopoli. In particular, each node of the graph represents a point of interest to visit (e.g., a museum, a square, a monument, etc.). The table below shows the estimated visiting times for each attraction and the closing times (if there is a “–”, it means that the attraction is always open).

	A	B	C	D	E	F
Visiting time	20	5	30	60	10	20
Closing time	12:00	–	13:00	13:30	–	–

Assuming that Remo leaves the hotel at 11:00, what path can he take to visit as many attractions as possible and not arrive at the station after 14:00?

- (a) Formulate and describe step by step (i.e., input, output, and all the steps) an algorithm that solves the proposed problem.
 - (b) Find a possible solution for the problem by applying the developed algorithm.
4. Now formulate the starting problem as an Integer Linear Programming problem, and solve it with the help of Excel Solver.
 5. Implement the mathematical model in Python and solve it by exploiting the PuLP library.