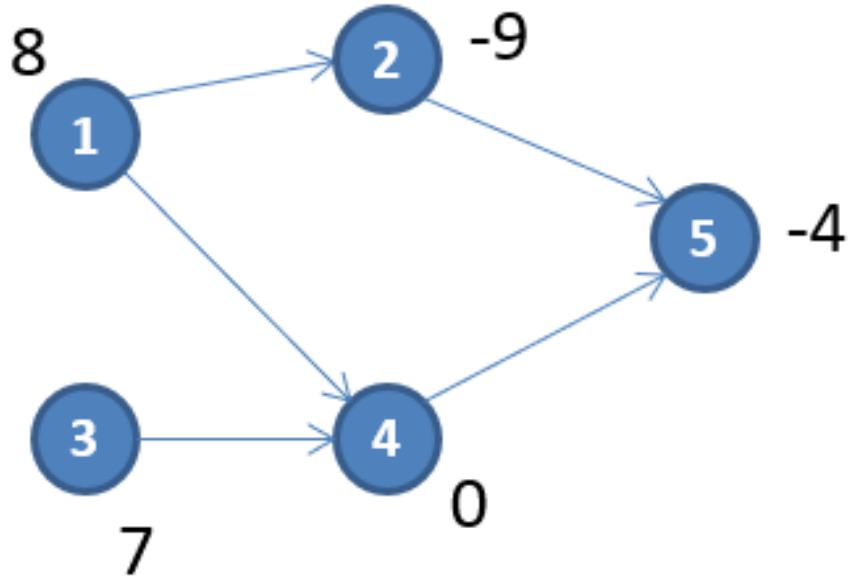
Optimum Closure

#EX9: basic example

1) Understand the MCF model formulation.
2) Try to translate the math to the python code:
    1) Numpy library for matrix operations
    2) Scipy library for LP optimization
3) Use scipy.linprog to get the maximum flow
4) Understand the outputs
5) What´s the minimum cut and what does it means for the optimum closure problem?
6) What could happen if node 5 changes its weight from -4 to -10?



Optimum Closure

#EX10: selecting between a group of facilities

A company wants to offer new routes to attract customers. The objective is to maximize the profit obtained considering that it has to decide which terminals should invest in:

Terminal	Cost
1	200
2	200
3	100
4	50
5	50

Route	Terminal A	Terminal B	Profit
1	1	2	50
2	2	3	200
3	3	4	50
4	1	4	100
5	4	5	150

Shortest path with time constraints

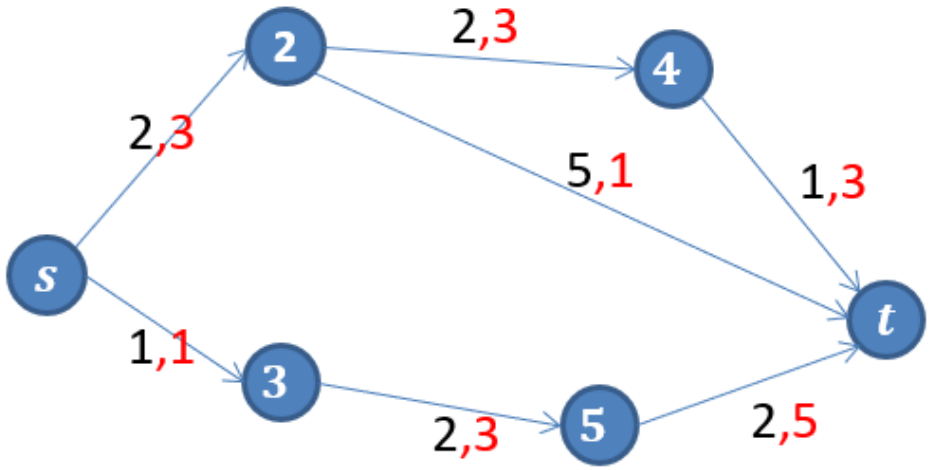
#EX11: direct LP approach

The shortest path between node s and t has to be found. Each arc has a distance but also the time that it takes to travel between its corresponding vertices.

1) If a person had to travel between s and t in less than 9 hours (T). What's the shortest path? Try to solve the problem with a simple LP model.

2) What if the maximum available time that this person has drops to 8 hours? What's the new shortest path? Understand the LP model outputs.

3) What's the first solution that comes to your mind in order to solve point 2 issues? Is it feasible in reality?

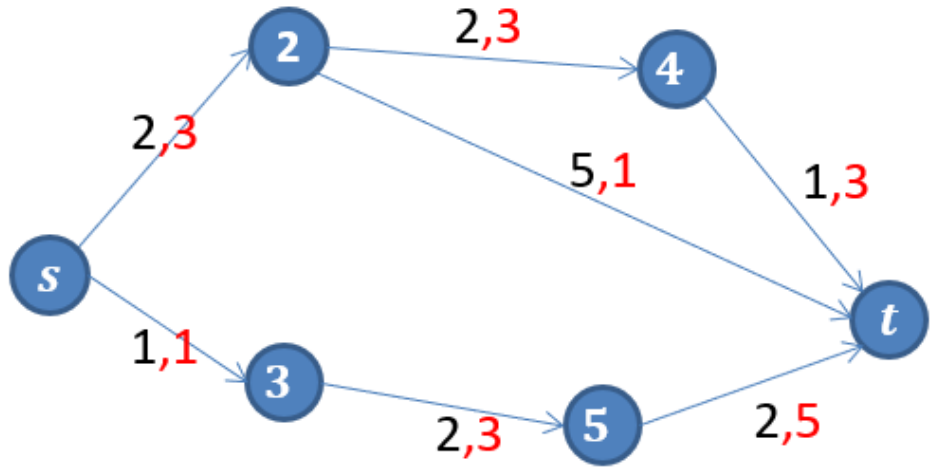


References: **Distance,** **Time (hours)**

Shortest path with time constraints

#EX12: Lagrangian Relaxation

1) For #EX11 and $\mathrm{T} \leq 8\, hs$. apply the Lagrangian Relaxation method and find a solution iterating for different values of lagrangian multipliers (λ) between 0 and 1.
2) Plot all the objective function primal solutions for the set of lagrangian multipliers used in 1).
3) What should be the optimum λ related to the shortest path solution?

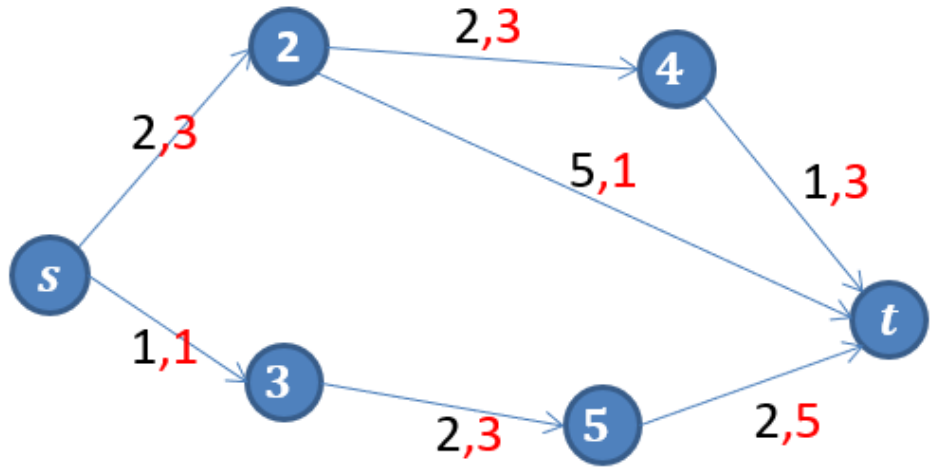


References: **Distance,** **Time (hours)**

Shortest path with time constraints

#EX13: Lagrangian Relaxation with Subgradient Method

1) For #EX11 and $\mathrm{T} \leq 8\, hs$. apply the Lagrangian Relaxation method and find the shortest path iterating between several values of lagrangian multipliers using the subgradient method.



References: **Distance,** **Time (hours)**