Graph Theory in Operational Research

Application exercise 2

Water supply

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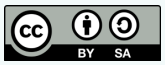

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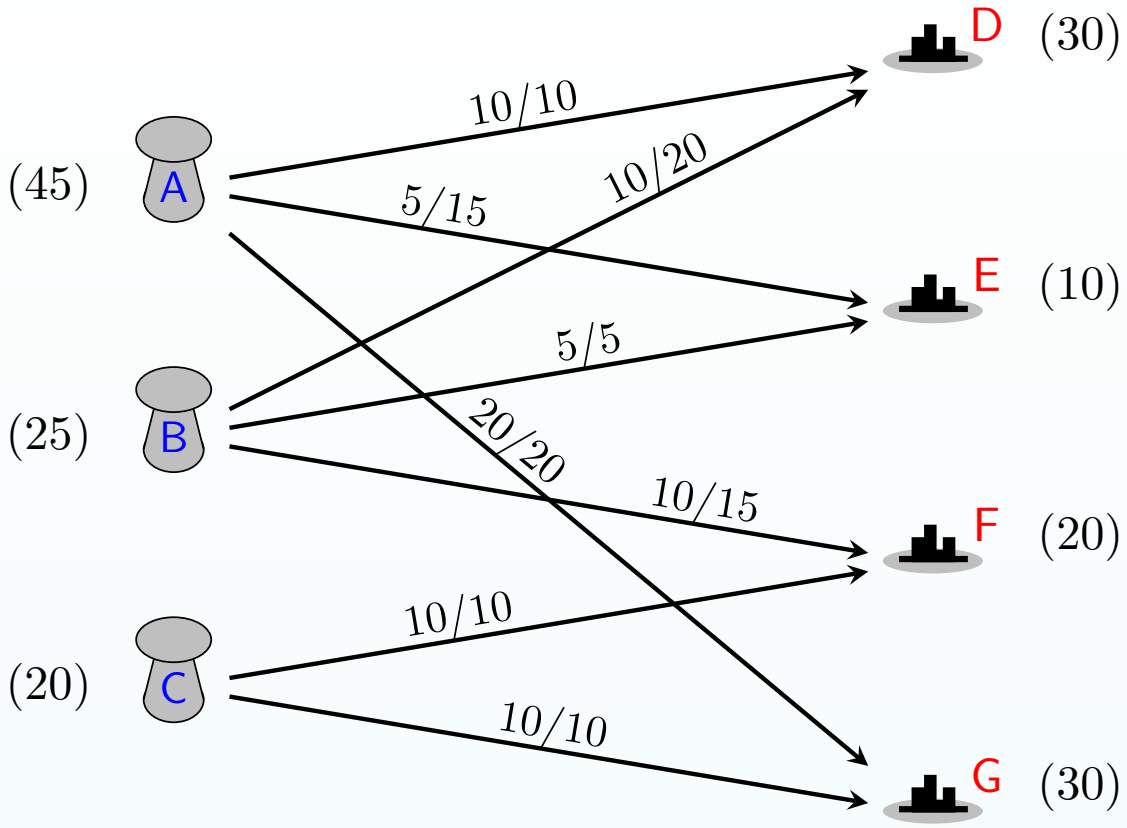
Water supply

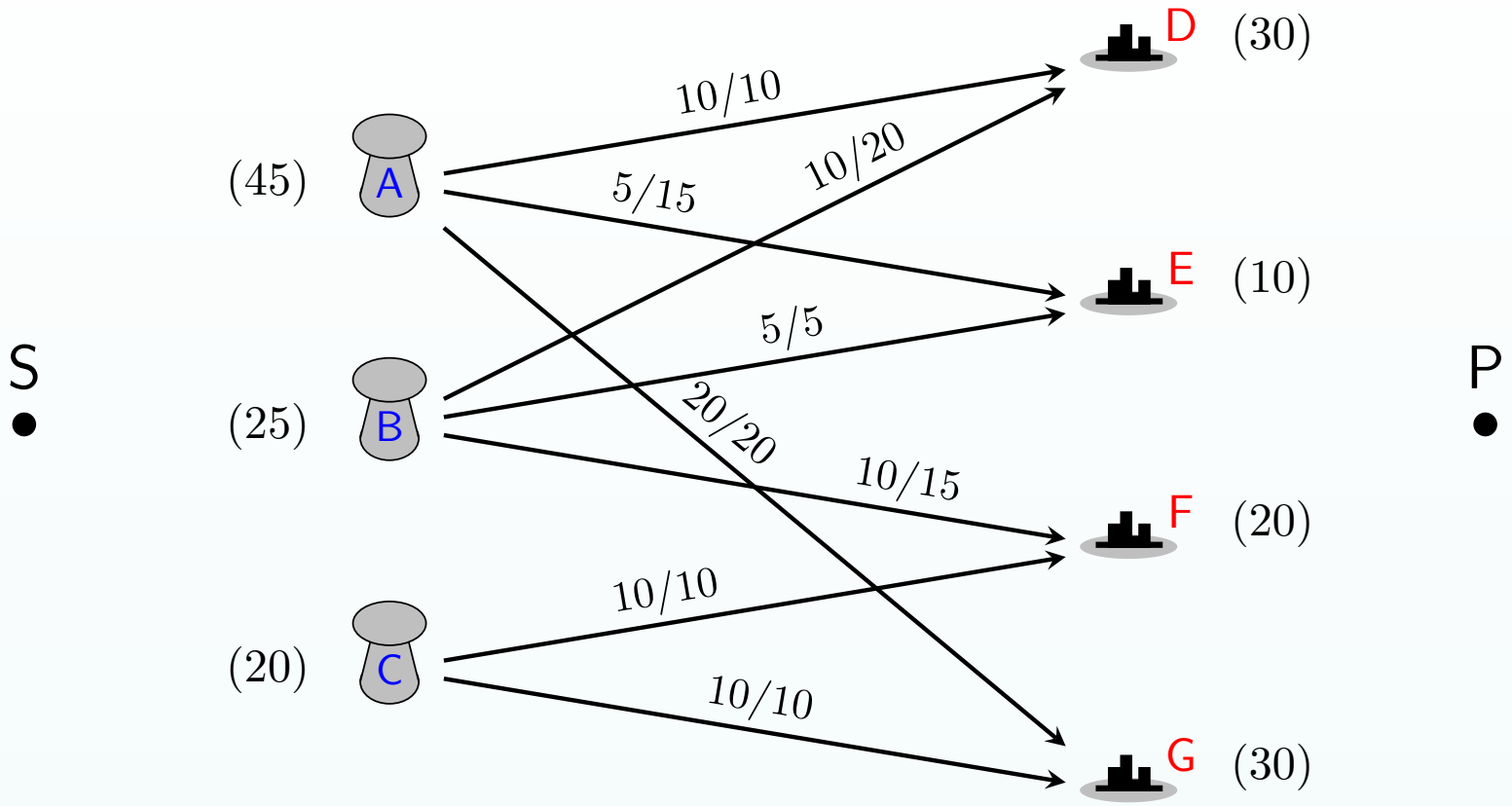
- 4 villages are supplied with water by 3 water towers
- Each water tower has a maximum rate of flow expressed in L/s
- Each village expresses preferential needs in L/s
- Various pipes exist between water towers and villages, whose current capacities and uses are known

Water supply



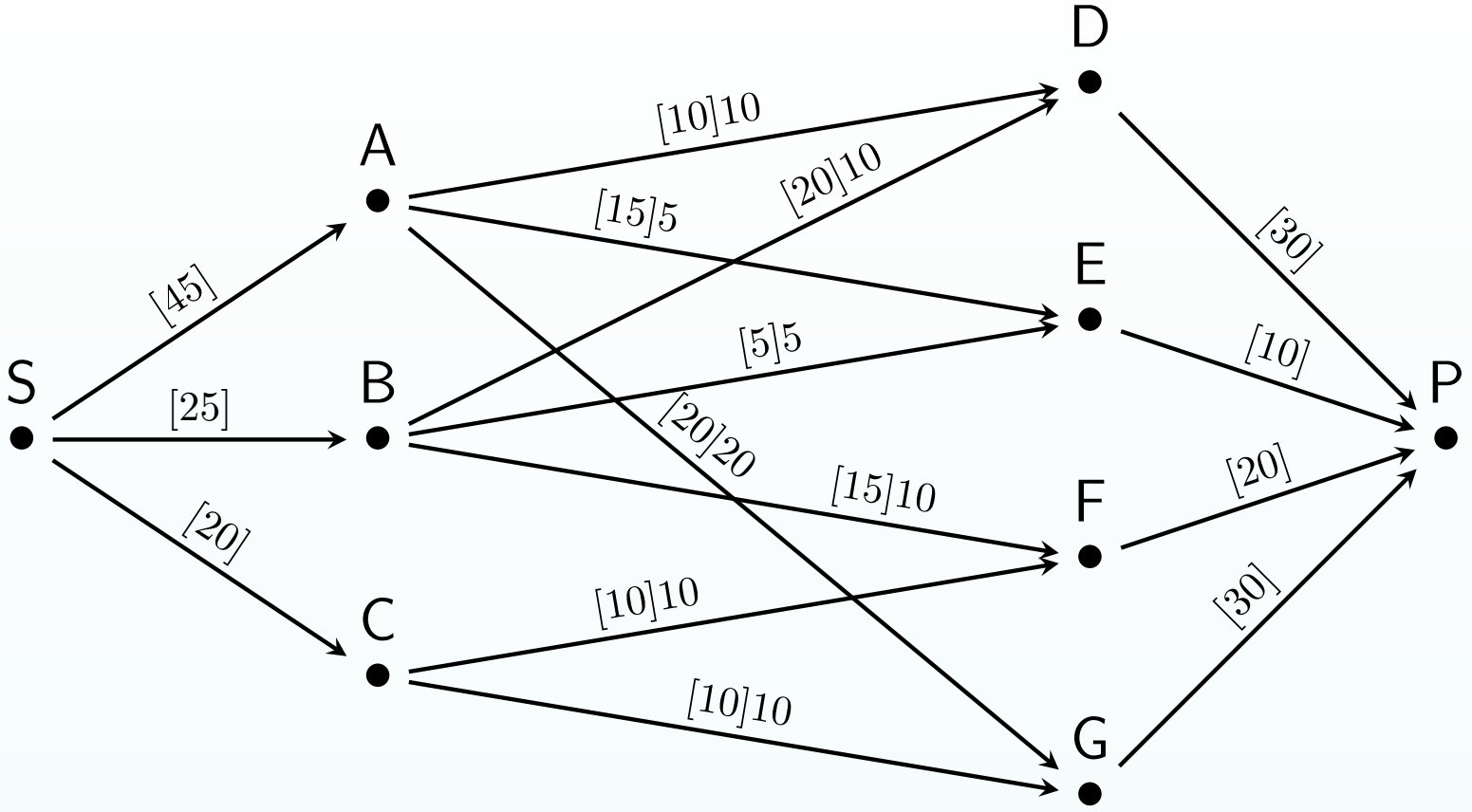
1. Modelize the transport network. What is the value of the flow?
2. Determine the maximum flow.
3. Formulate the possible additions to meet the minimum requirements.

Transport network and flow value



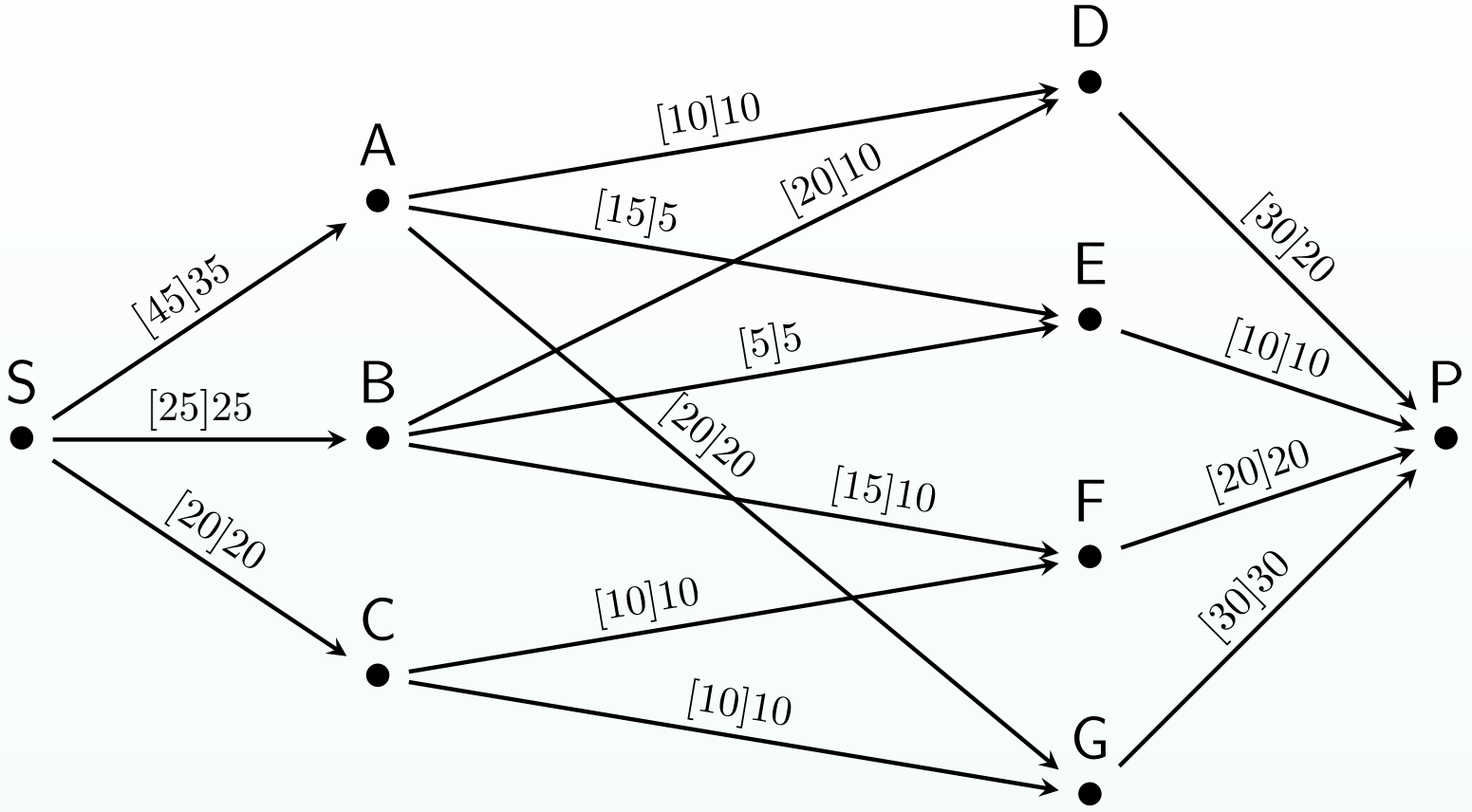
- Adding virtuals source and sink

Transport network and flow value



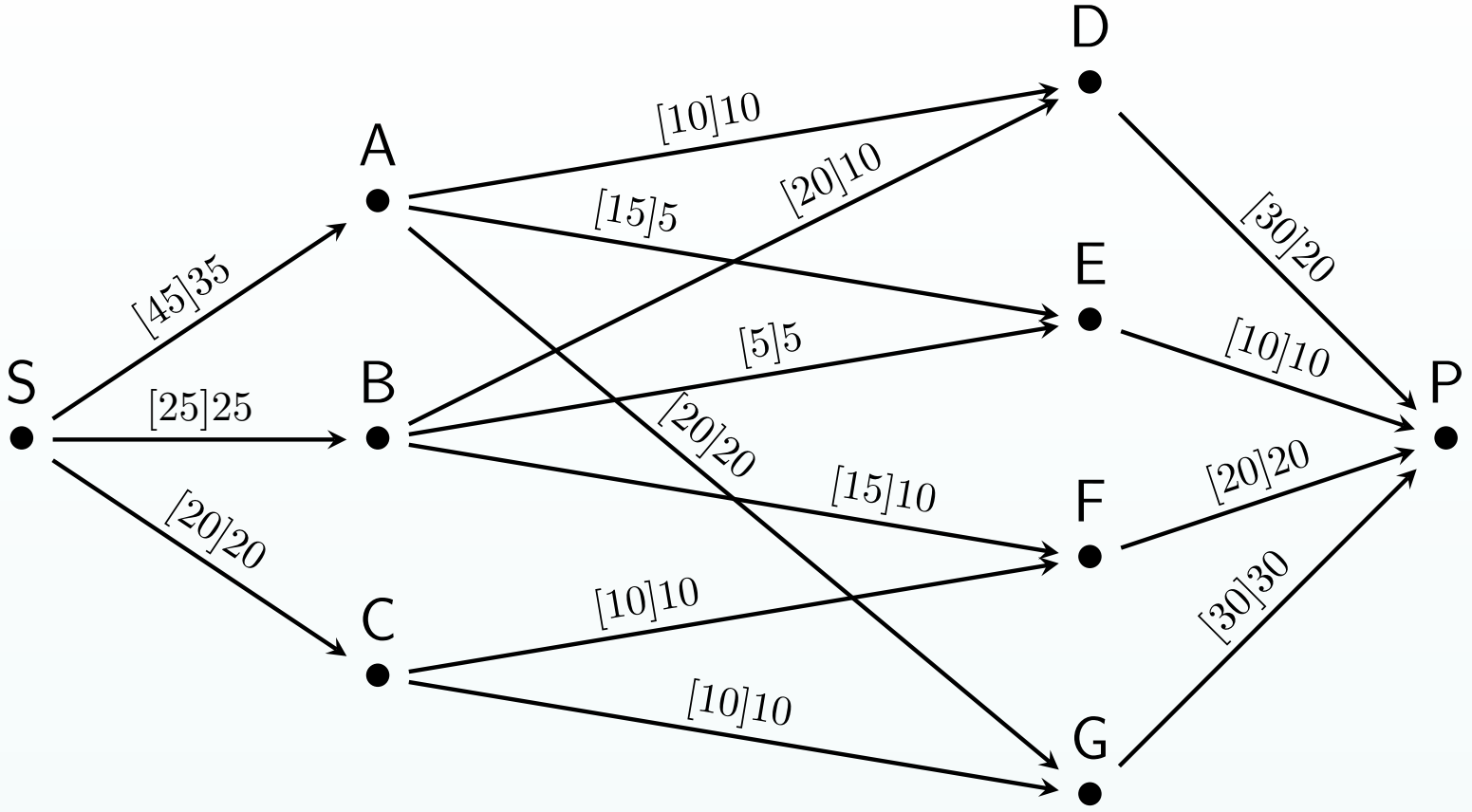
- Capacities related to the problem values

Transport network and flow value



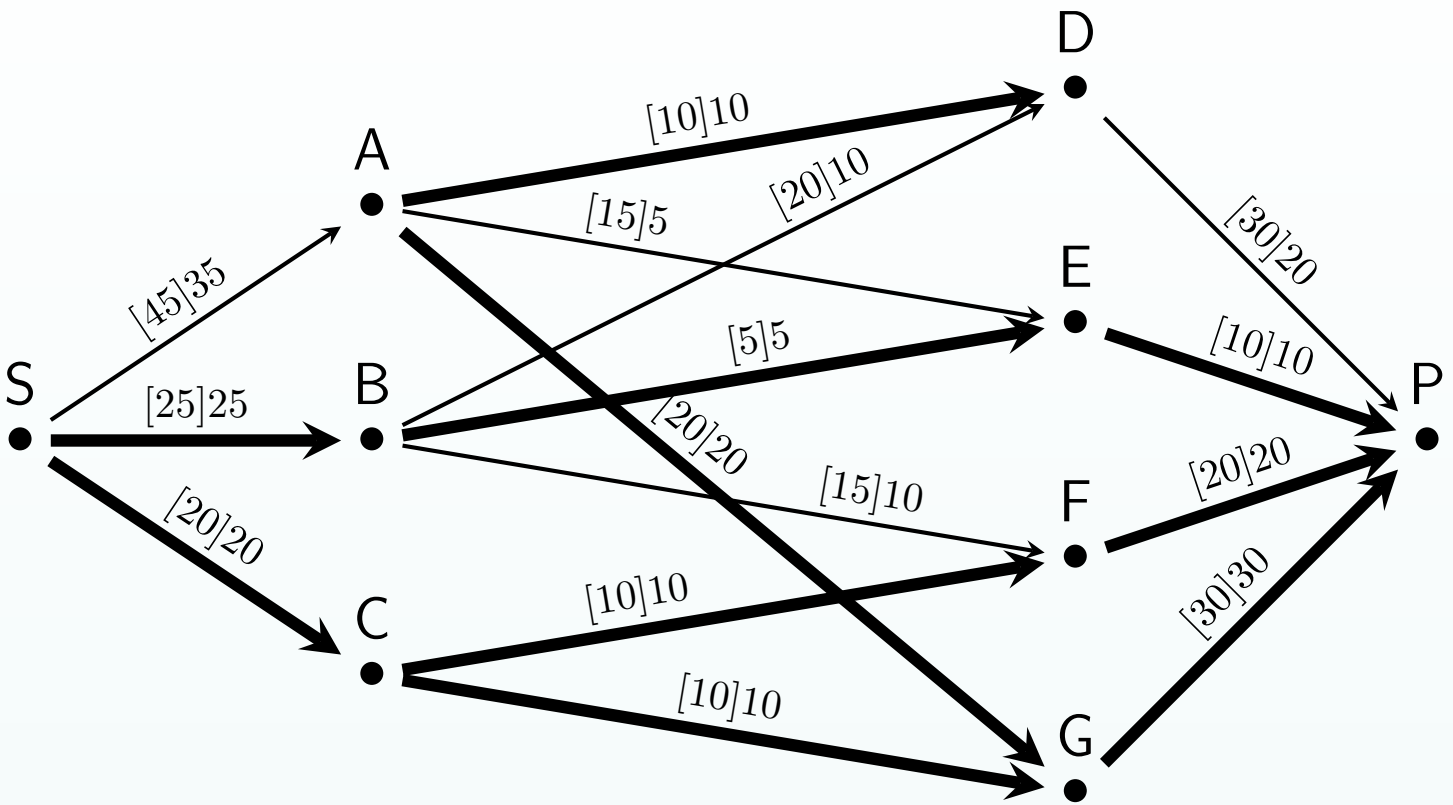
- Flow calculated by Kirchhoff's law

Transport network and flow value

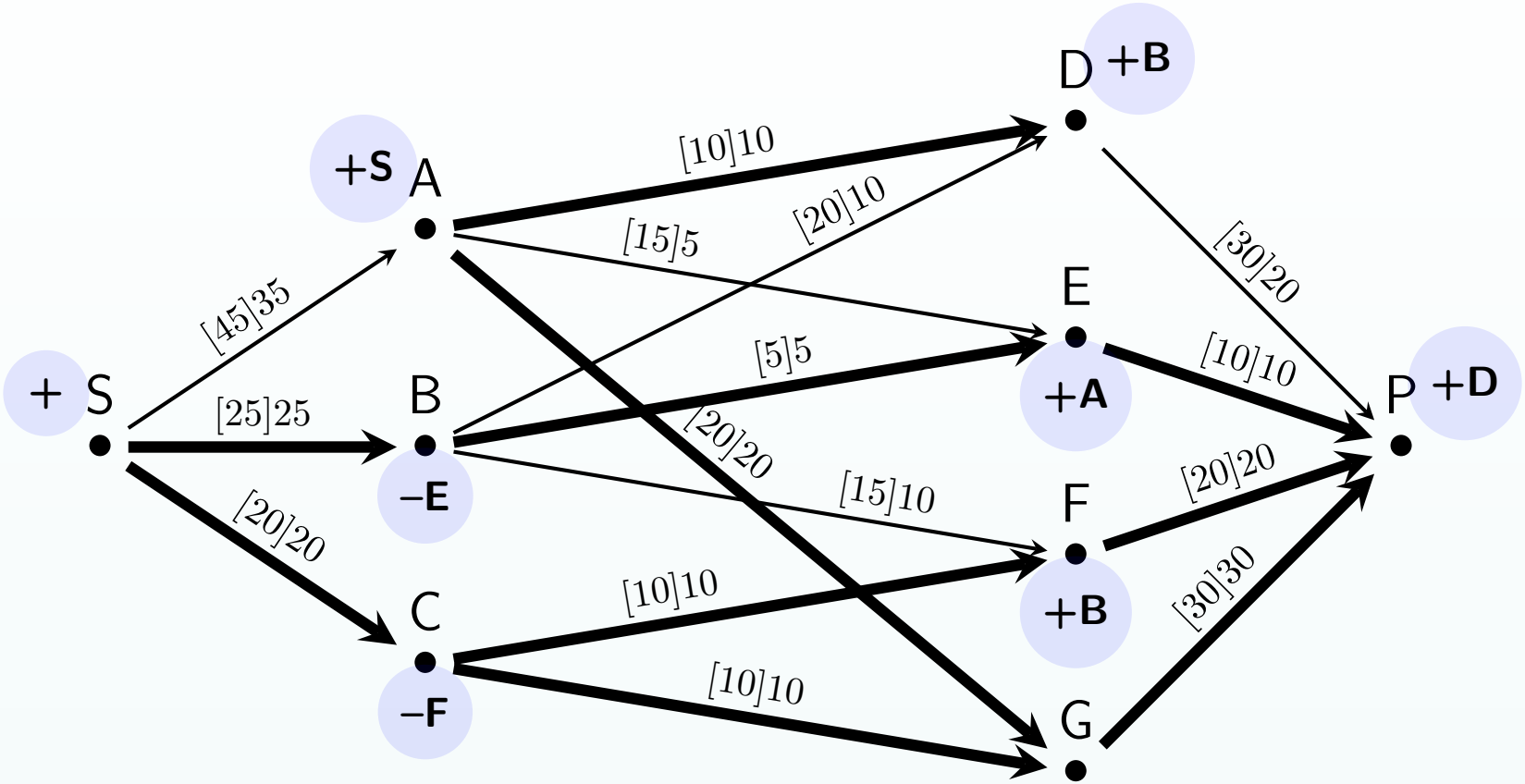


- Flow calculated by Kirchhoff's law
- $\varphi = 80$

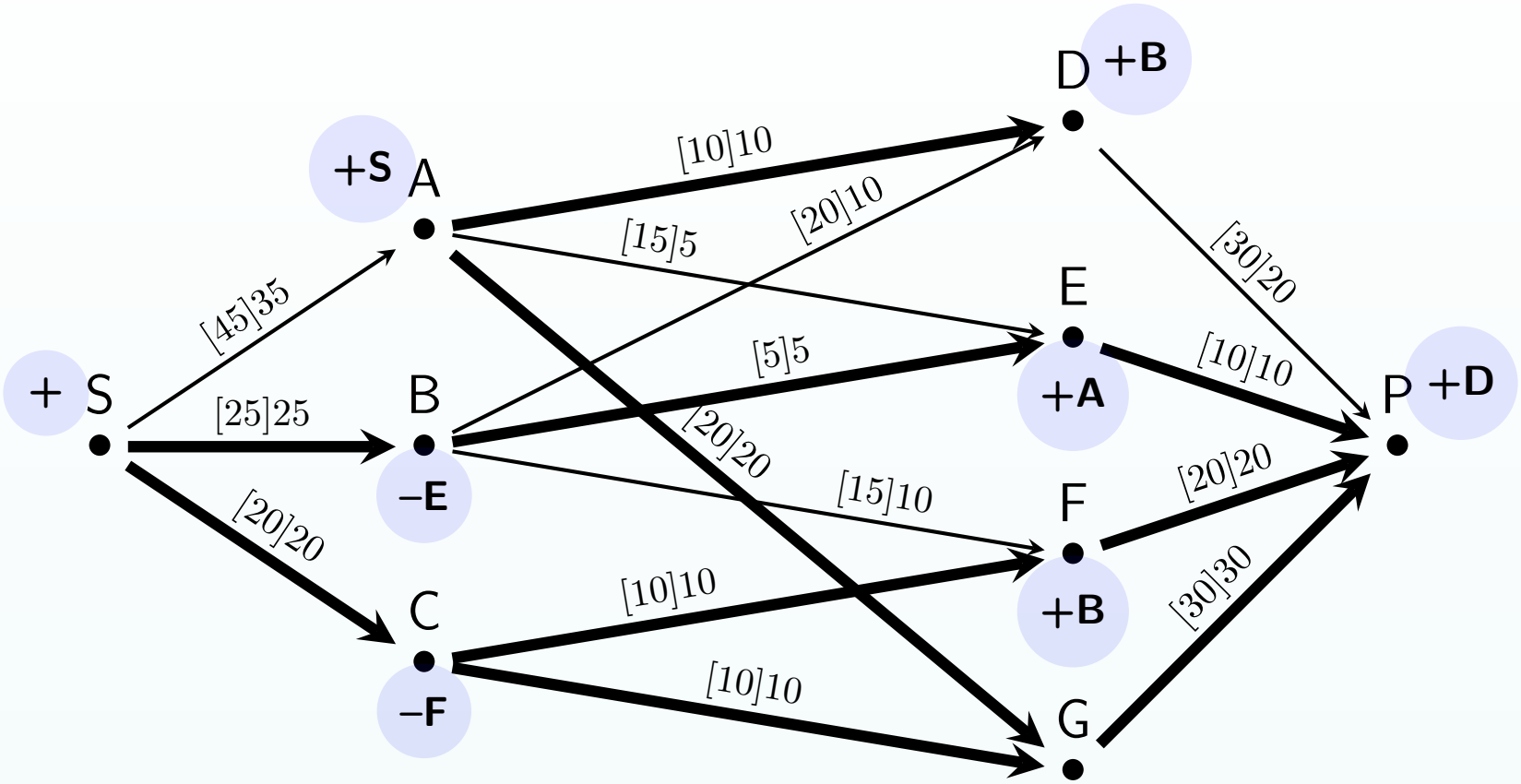
Maximum flow



Maximum flow

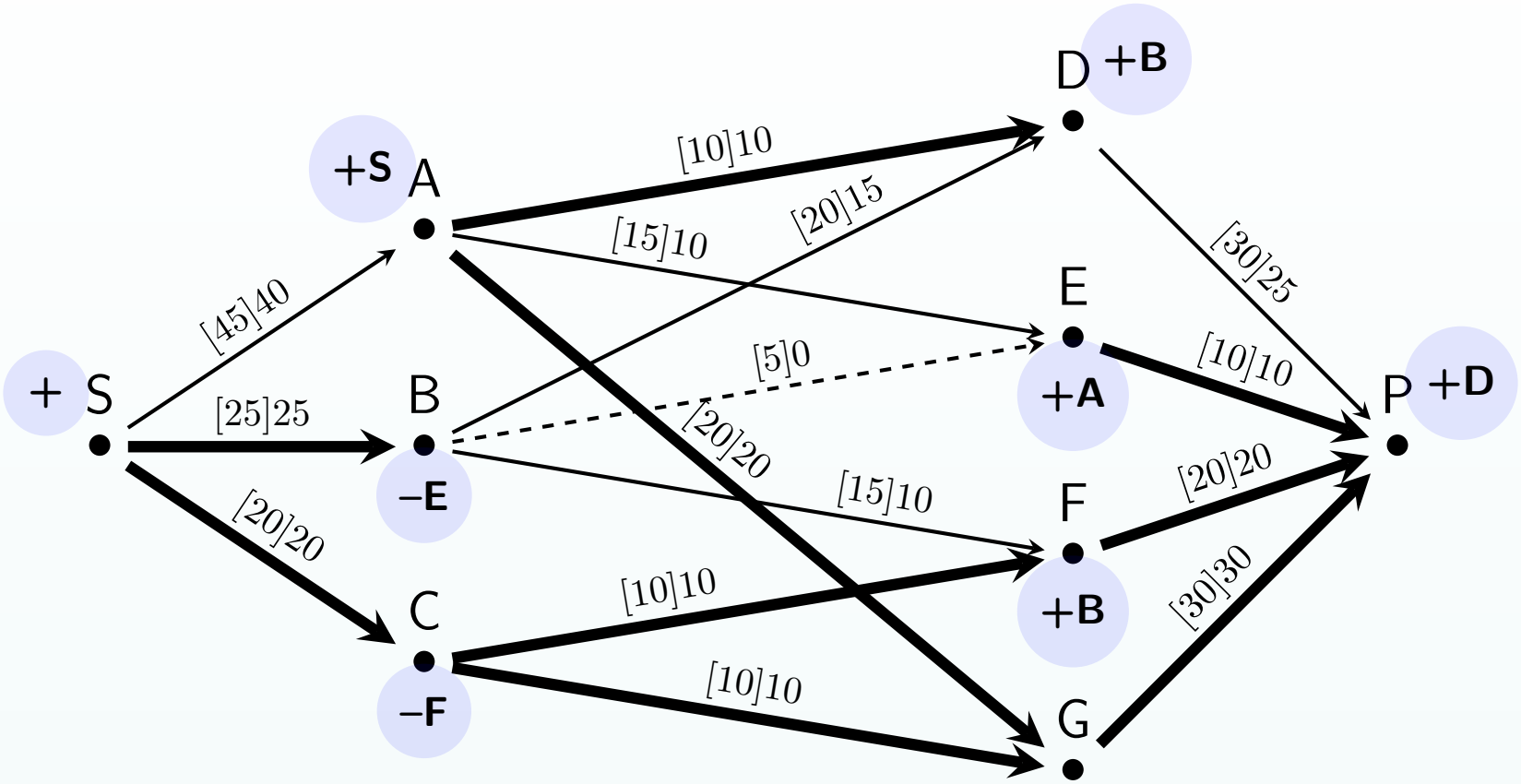


Maximum flow



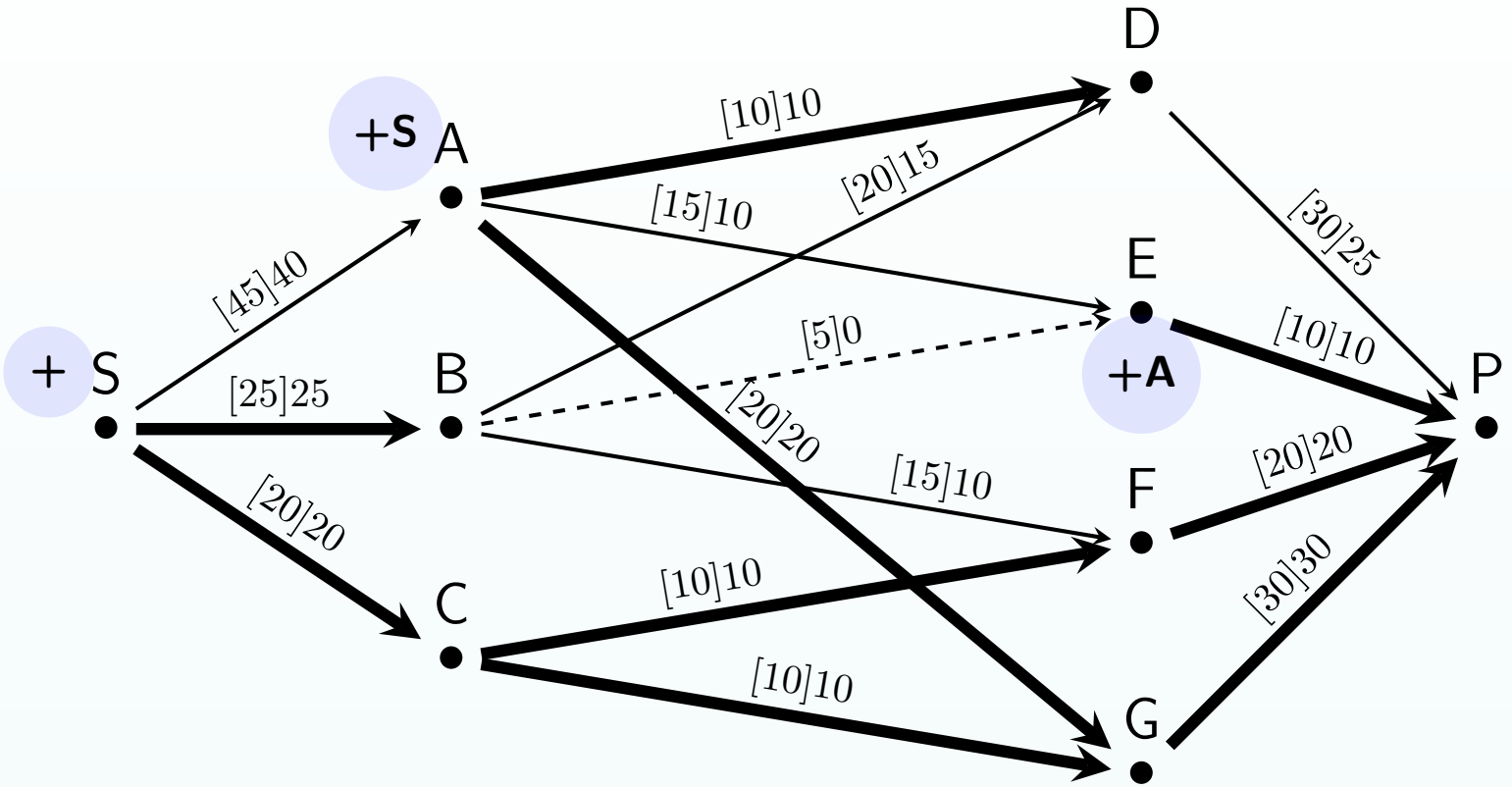
- Augmenting path (S, A, E, B, D, P)

Maximum flow



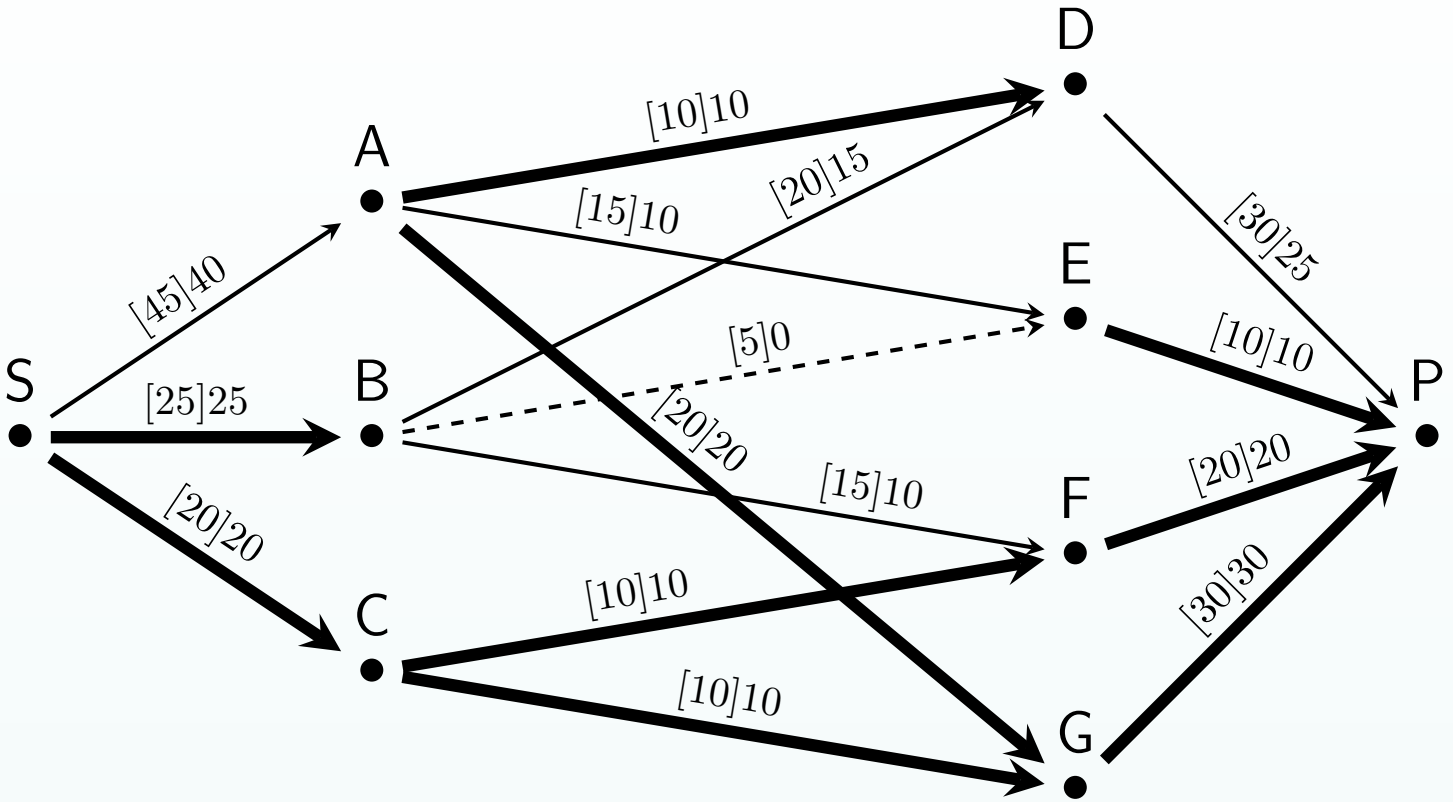
- Augmenting path (S, A, E, B, D, P) : $\delta = 5$

Maximum flow



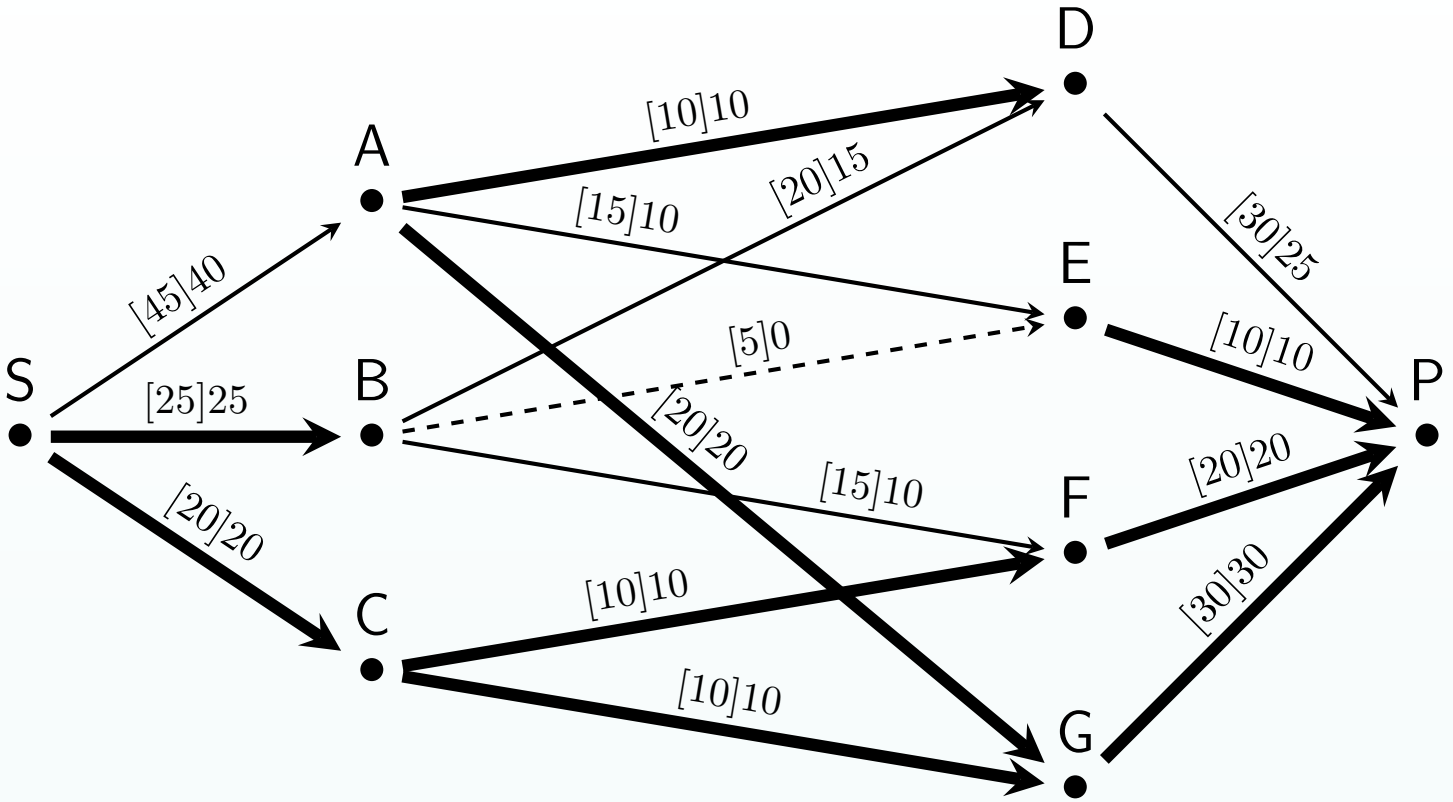
- No more augmenting path

Maximum flow



- Maximum flow: $\varphi = 85$

Minimum possible additions



Adding an arc with a capacity of 5 on one of the three paths:

- (A, B)
- (A, D)
- (E, D)

Conclusions

- The initial flow is $\varphi = 80$
- The maximum flow is $\varphi = 85$
- The validation of preferential needs can't be achieved without changing the network
- 3 optimal amendments are identified

Graph Theory in OR – Application exercise 2: Water supply

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March 6, 2015

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`http://www.damien-leprovost.fr/enseignements/graphs.2015.ex2.pdf`