

Think about c^d as edge cost.

Compute $\bar{d}^k(v)$ w/ft dists. c^d .

$$\bar{d}^k(v) = d^k(v) + d(v_i) - d(v)$$

$$\bar{d}^n(v) - \bar{d}^k(v) = d^n(v) + d(v_i) - d(v) - (d^k(v) + d(v_i) - d(v)) = d^n(v) - d^k(v)$$

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Suffice to show

$$0 = \min_v \max_k \left(\frac{\bar{d}^n(v) - \bar{d}^k(v)}{n-k} \right)$$

$$\forall v \max_k \bar{d}^n(v) - \bar{d}^k(v) \geq 0$$

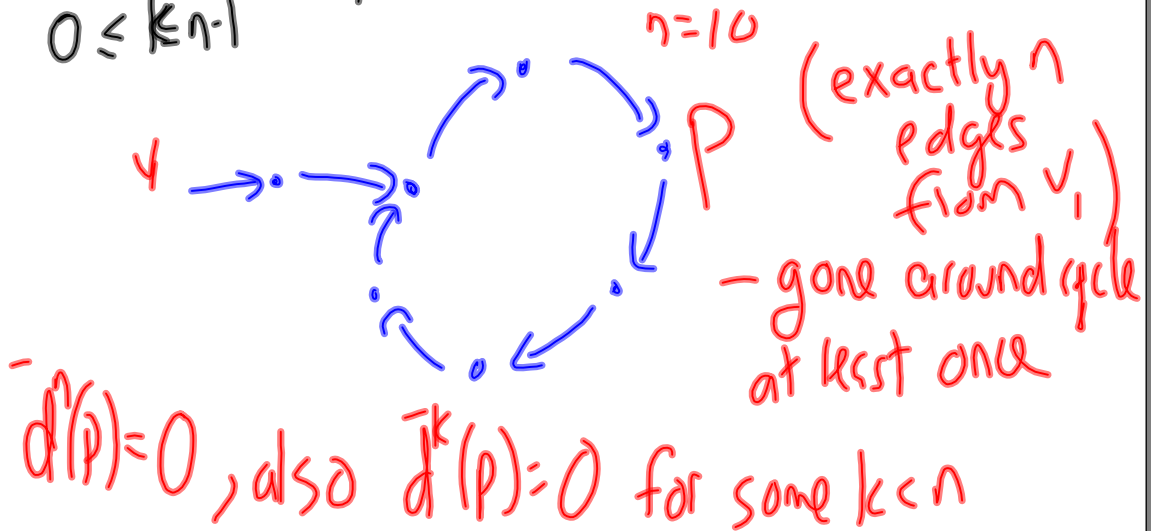
for some k length of sp.

$$\bar{d}^k(v) \leq \bar{d}^n(v)$$

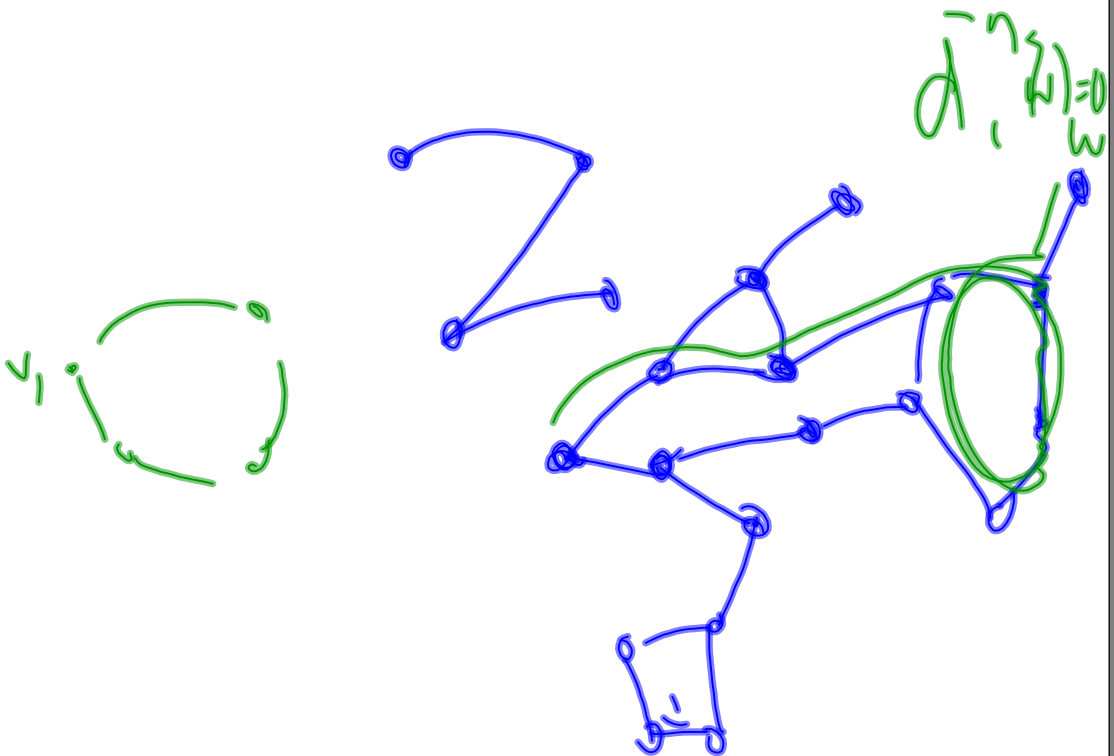
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2(i) Show that for some vertex p

$$\max_{0 \leq k < n-1} \bar{d}^n(p) - \bar{d}^k(p) = 0$$



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2) $\mu^* \neq 0$ Suppose we add Δ to every edge

$$C'(v,w) = c(v,w) + \Delta$$

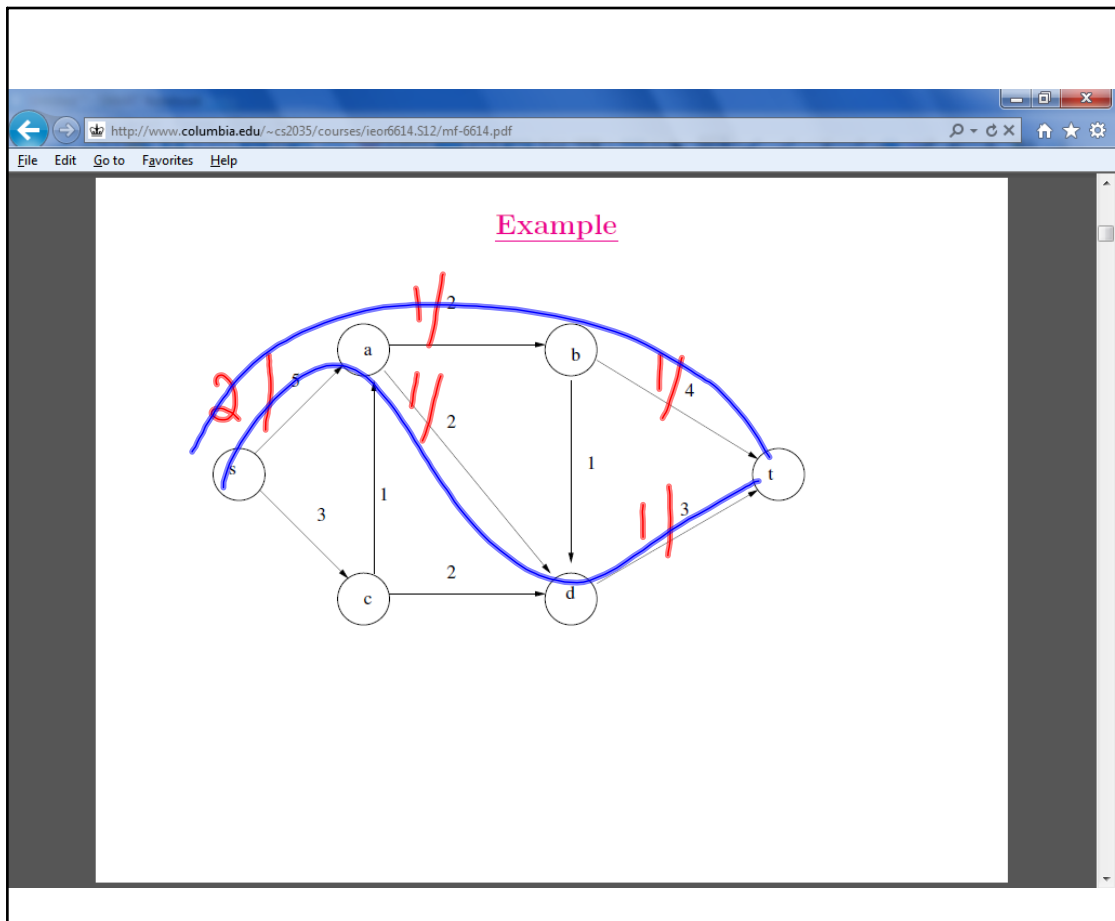
$$\mu(w) = \frac{\sum c(v,w)}{|w|} = \frac{\sum c'(v,w)}{|w|}$$

$$= \frac{\sum c(v,w) + |w|\Delta}{|w|}$$

$$= \mu(w) + \Delta$$

. Use $c'(v,w) = c(v,w) - \mu^*$, use case 1.

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Example is a max flow problem

The diagram illustrates a max flow problem with the following structure:

- Source:** A green circle labeled 'source'.
- Reservations:** Two nodes: 'Sports' and 'Afternoon', each with a capacity of 50.
- Ad Placements:** Three nodes: 'sports and afternoon' (capacity 40), 'sports and non-afternoon' (capacity 40), and 'non-sports and afternoon' (capacity 40).
- Sink:** A green circle labeled 'sink'.

Handwritten red annotations indicate flow values and capacities on the edges:

- From source to Sports: flow 40, capacity 50.
- From source to Afternoon: flow 40, capacity 50.
- From Sports to sports and afternoon: flow 30, capacity inf.
- From Sports to sports and non-afternoon: flow 10, capacity inf.
- From Afternoon to sports and afternoon: flow 20, capacity inf.
- From Afternoon to sports and non-afternoon: flow 10, capacity inf.
- From Afternoon to non-sports and afternoon: flow 40, capacity inf.
- From sports and afternoon to sink: flow 30, capacity 40.
- From sports and non-afternoon to sink: flow 30, capacity 40.
- From non-sports and afternoon to sink: flow 40, capacity 40.

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