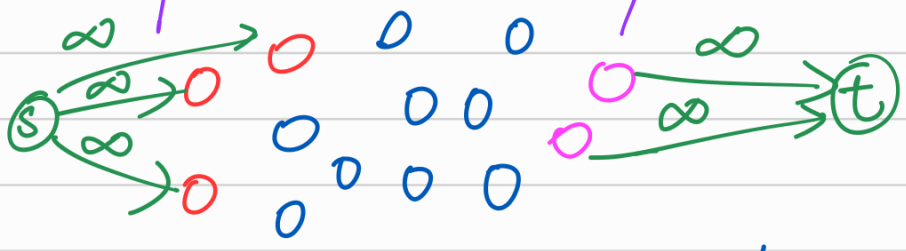
"Generalisations and Applications of Max Flow"

① Multiple src Multiple sink.



② 

③ Bipartite Matching — give 1 weight to each edge, connect all set A vertices to s & all set B to t.

④ Circulation with Demand —

i) $f(x,y) \leq c(x,y)$ $\quad f_{in}(v) - f_{out}(v) = d(v)$

ii) $d(v) < 0 \Rightarrow$ factory $\quad d(v) > 0 \Rightarrow$ village

iii) $$\sum_{d(u)<0} -d(u) = \sum_{d(u)>0} d(u) = D$$

iv) Make a super source and super sink.
Edges (s,u) of $wt = -d(u)$ if $d(u) < 0$
edges (v,t) of $wt = d(v)$ if $d(v) > 0$

⑤ Edge Disjoint Paths
assign each of them capacity as 1.

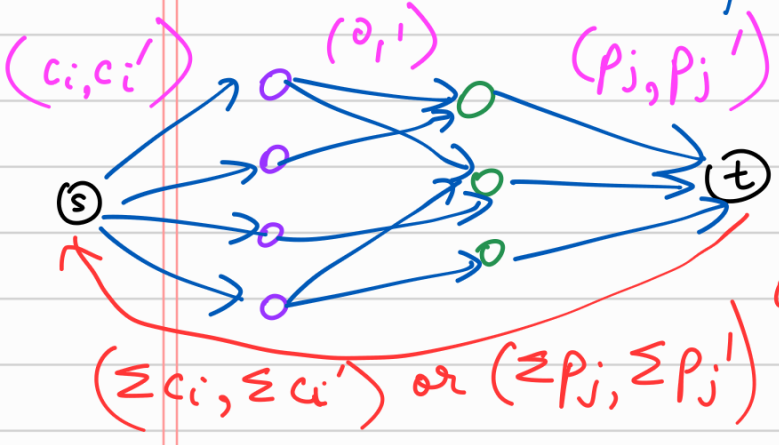
⑥ Flow with lower bound + Survey Design

$f_{in}(v) = f_{out}(v)$ $\quad l(x,y) \le f(x,y) \le c(x,y)$

i) $v \in V^*$ $\quad d(v) = \sum_{(v,z)\in E} l(v,z) - \sum_{(u,v)\in E} l(u,v)$

ii) $(x,y) \in E^*$ $\quad c^*(x,y) = c(x,y) - l(x,y)$

Assume we have given a flow $f(x,y) = l(x,y)$ on each edge. Now we check if a circ with demand is possible in above (V^*, E^*) st demand & capacity constraint is satisfied.

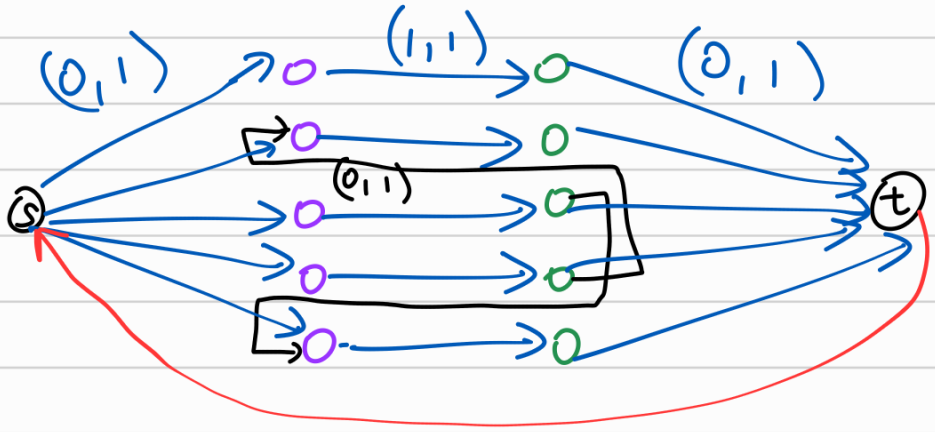


DO NOT FORGET THAT EDGE $t \to s$

(7) Airline Problem

n cities, m flights, $(s(i), d(i), dep(i), arr(i))$

add directed edge from $d(i)$ to $s(j)$ if $dstn(i) = s(j)$ and $arr(i) < dep(j)$



bin search on K to get min

$(0,K)$

In a loop we can reduce the flow along all

edges of the loop to 0. The flow from s to t is still K.