CIS 315
Mar 8
flow

augmentation
flow

augmentation

doe
3. The following flow graph $G$ has some flow assignments already made. Use the Ford-Fulkerson method to continue the process of deriving the maximum flow from $s$ to $t$. Show the residual graph $G_f$, find an augmenting path in $G_f$, and then update the flow in $G$. One step should be enough to find the max-flow.
flights
min # of planes
path cover

4 - 2

f_1 \rightarrow f_2 \rightarrow f_3 \rightarrow f_4

4 - 3

\text{deg} \ #\text{planes} = \ #\text{flights} \\
\text{match}\text{ness}
boxing

put a box inside a box

monotone remaining

\[ b_i \rightarrow b_j \]

\[ b_n \rightarrow b_n \]
Problem I
Waif Until Dark

"Waif Until Dark" is a daycare center specializing in children of households where both parents work during the day. In order to keep the little monsters ... that is, darlings ... occupied, the center has a set of toys that the kiddies can play with. Some of these toys belong to one of several categories – sports toys, musical toys, dolls, etc. In order to save wear and tear on these types of toys, the teachers allow only certain numbers of toys of each category to be used during playtime. Of course, kids being kids, not all of the toys are liked by everyone, so sometimes it’s difficult to make sure every kid has a toy they like. Given all of these constraints, the CEO of Waif has come to you to write a little program to determine the maximum number of these monsters (let’s be honest here) who can be satisfied.

Input

Input starts with a line containing three integers $n \ m \ p$ indicating the number of children, the number of toys and the number of toy categories $(1 \leq n, m \leq 100, 0 \leq p \leq m)$. Both children and toys are numbered starting at 1. After this line are $n$ lines of the form $k \ i_1 \ i_2 \ldots \ i_k \ (1 \leq k, i_1, i_2, \ldots i_k \leq m)$; the $j^{th}$ of these lines indicates that child $j$ is willing to play with toys $i_1$ through $i_k$. Next are $p$ lines of the form $l \ t_1 \ t_2 \ldots \ t_l \ r \ (1 \leq r \leq l \leq m, 1 \leq t_1, t_2, \ldots t_l \leq m)$; the $j^{th}$ of these lines indicates that toys $t_1$ through $t_l$ are in category $j$ and that at most $r$ of these toys can be used. Toys can be in at most one category and any toy not listed in these $p$ lines is not in any toy category and all of them can be used. No toy number appears more than once on any line.

Output

Display the maximum number of children that can be satisfied with a toy that they like.

<table>
<thead>
<tr>
<th>Sample Input 1</th>
<th>Sample Output 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 3 1</td>
<td>2</td>
</tr>
<tr>
<td>2 1 2</td>
<td></td>
</tr>
<tr>
<td>2 1 2</td>
<td></td>
</tr>
<tr>
<td>1 3</td>
<td></td>
</tr>
<tr>
<td>1 3</td>
<td></td>
</tr>
<tr>
<td>2 1 2 1</td>
<td></td>
</tr>
</tbody>
</table>
The context can be described as a tree structure. The nodes represent different levels of a hierarchy. The diagram shows a branching pattern with various connections and labels. The labels include numbers and symbols that indicate the relationships between the nodes. The specific details of the connections and nodes are not clearly visible due to the handwriting style. However, it appears to be a complex diagram, possibly related to a mathematical or logical problem.
circulation with demands

Each node $v$ has demand $d(v)$. If $d(v) < 0$, then $v$ is a supply node. $d(v) > 0$ means $v$ is a demand node. question: Is there a valid circulation (a flow), with supply and demand matching up within the edge capacities?

network $G$