# Lab12 Solution

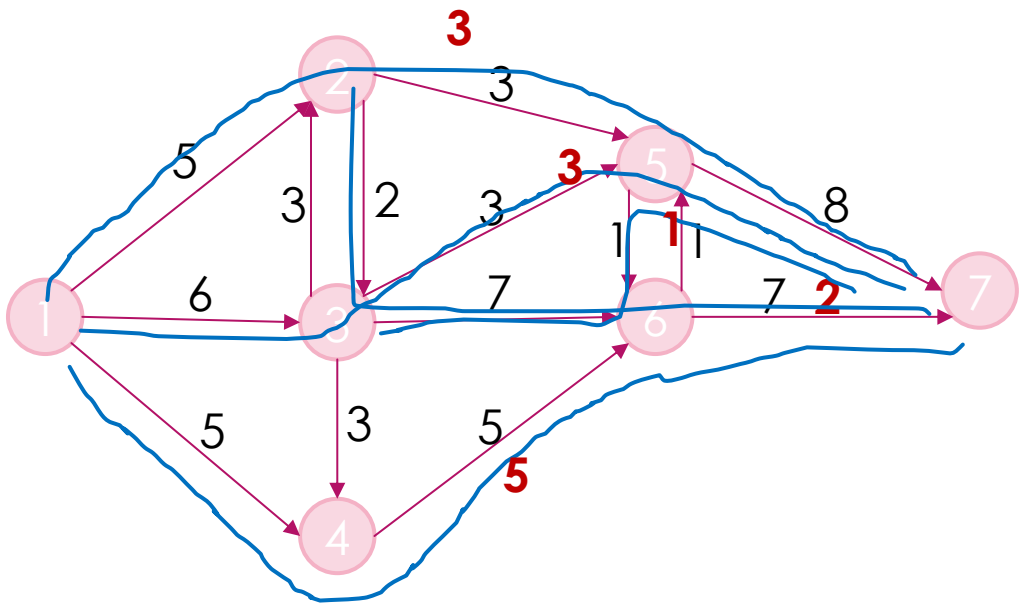
YAO ZHAO

# Lab12.A: Flowwwww

- Given a graph with $N$ nodes and $M$ directed edges with capacity.
- Find the maximum flow from node $S$ to node $T$.

## Sample Input

```
7 14 1 7
1 2 5
1 3 6
1 4 5
2 3 2
2 5 3
3 2 2
3 4 3
3 5 3
3 6 7
4 6 5
5 6 1
6 5 1
5 7 8
6 7 7
```




1→4→6→7: 5
1→2→5→7: 3
1→2→3→6→7: 2
1→3→5→7: 3
1→3→6→5→7: 1

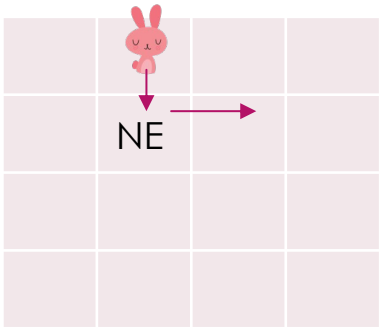
Sample Output

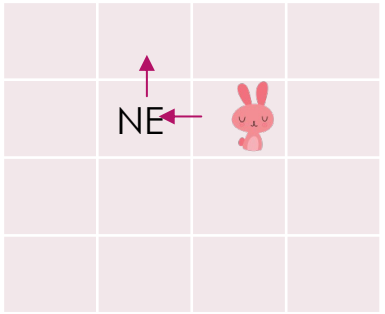
**14**

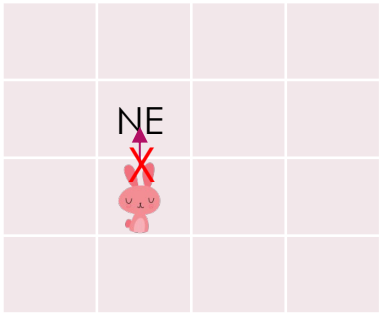
# Lab12.B: Live Forever

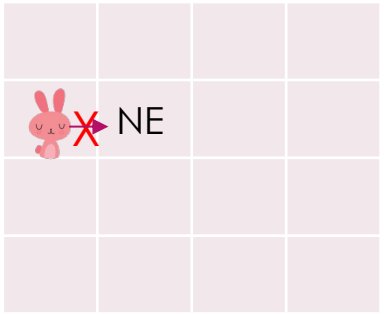
- $A$ bunnies, who were seeking for the meaning of life, reached the upper border of a mysterious forest which can be seen as a $N \times M$ grid. The forest was dangerous: some areas were occupied by beasts and the border of it was blanked with mists. Up in the sky, they saw a MAN with golden light, who was know as justin_cao. He said, **"On the other side of forest shall you find B doors of eternal. Each bunny who crosses a door shall be granted with eternal life. But remember, once a door is crossed by a bunny, it would be closed forever! May justin_cao bless you all."**
- FluffyBunny wants to help the bunnies. She knows that the bunnies are very dumb: each bunny will start at a fixed position at the border and go straight on, so it is likely for them to step out of the border of the forest or run into the beast areas. Luckily, she has four types of curled tubes:
  - NE-tubes: make the bunnies coming from above go rightward, and make the bunnies coming from right go upward. Coming from left or below is illegal.
  - NW-tubes: make the bunnies coming from above go leftward, and make the bunnies coming from left go upward. Coming from right or below is illegal.
  - SE-tubes: make the bunnies coming from below go rightward, and make the bunnies coming from right go downward. Coming from left or above is illegal.
  - SW-tubes: make the bunnies coming from below go leftward, and make the bunnies coming from left go downward. Coming from right or above is illegal.
- For each safe cell, FluffyBunny can choose to place **exactly one tube** listed above, or to leave it blank. If FluffyBunny leaves it blank, bunnies coming from all directions will go straight ahead.
- Now FluffyBunny wonders if it is possible to guide each bunnies into different eternal doors.

NE-tubes: make the bunnies coming from above go rightward, and make the bunnies coming from right go upward. Coming from left or below is illegal.

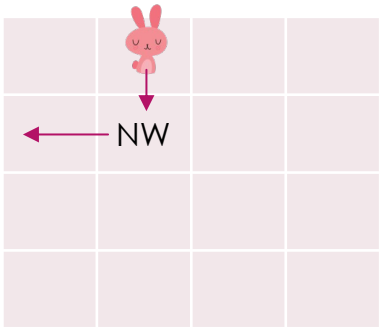


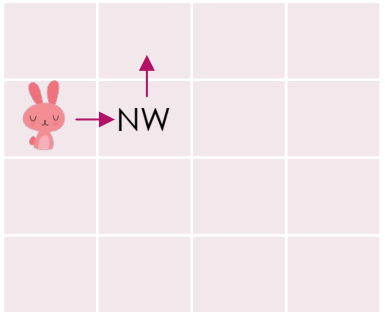



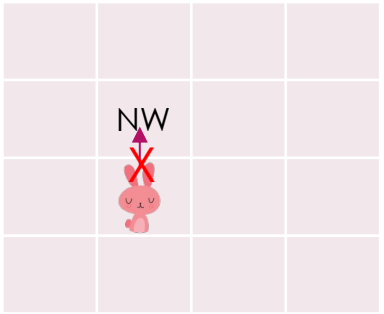



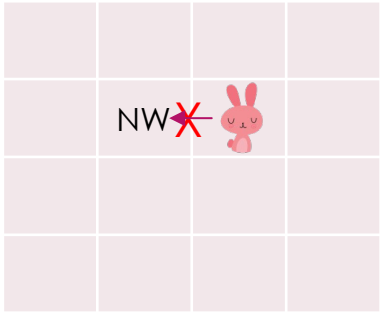



NW-tubes: make the bunnies coming from above go leftward, and make the bunnies coming from left go upward. Coming from right or below is illegal.

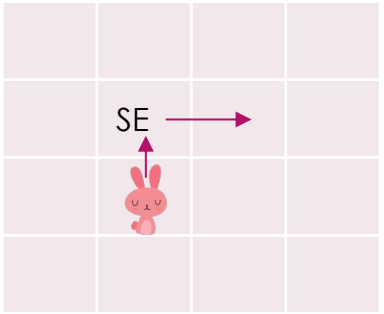


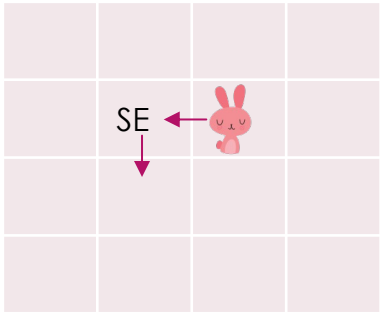



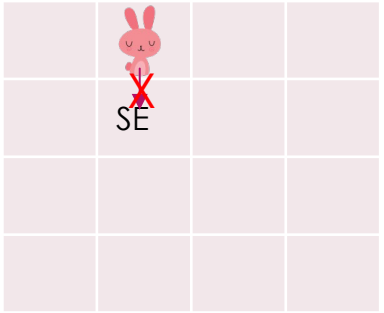



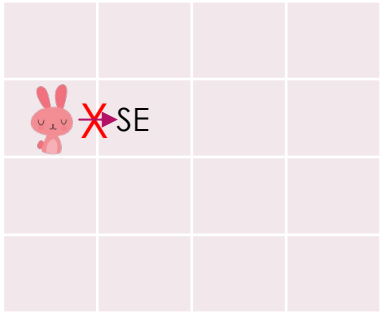



SE-tubes: make the bunnies coming from below go rightward, and make the bunnies coming from right go downward. Coming from left or above is illegal.

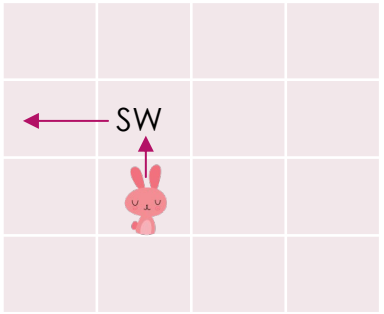


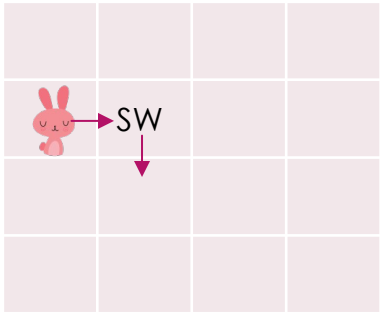



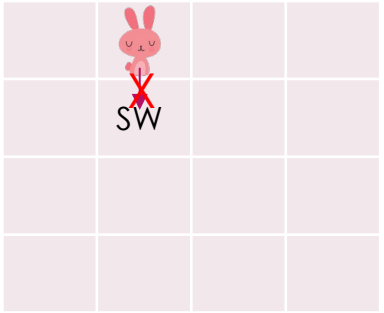



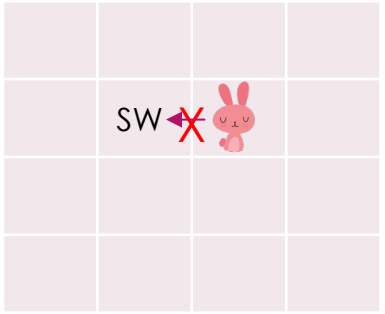



SW-tubes: make the bunnies coming from below go leftward, and make the bunnies coming from left go downward. Coming from right or above is illegal.



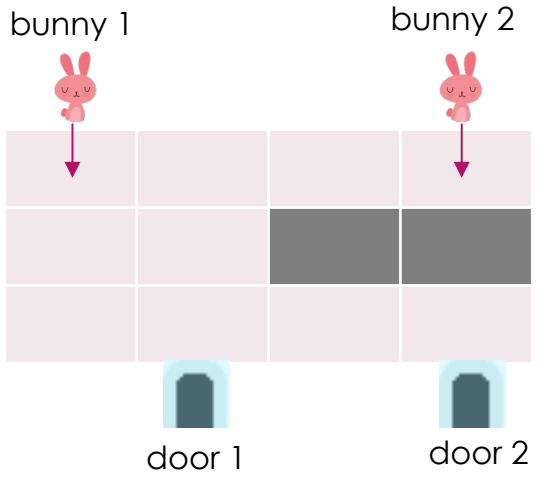
**Sample Input**

2

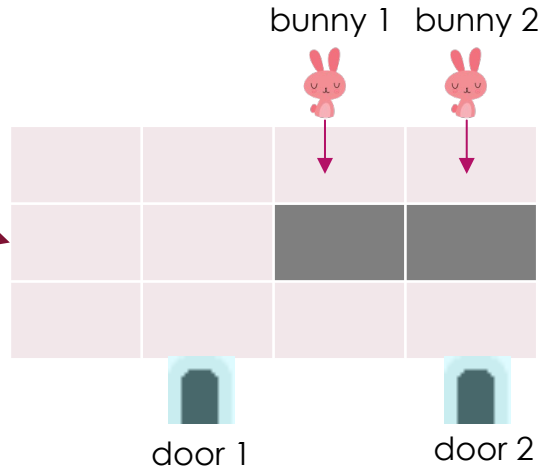
3 4 2 2
0000
0011
0000
1 4
2 4

3 4 2 2
0000
0011
0000
3 4
2 4

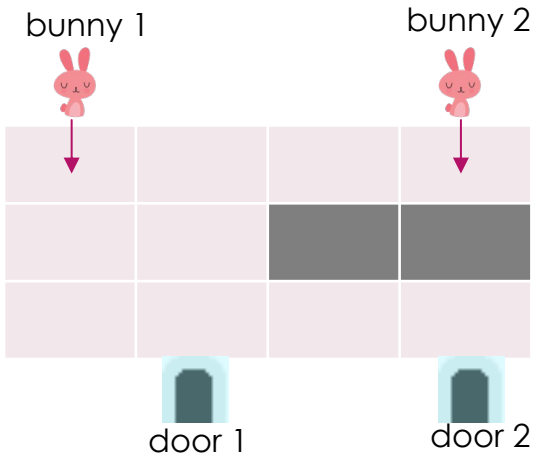
case1

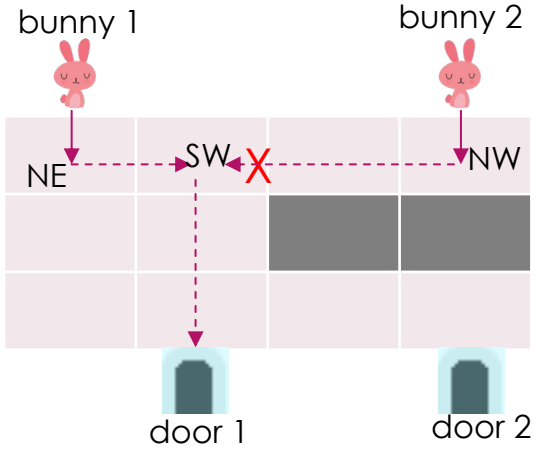



case2

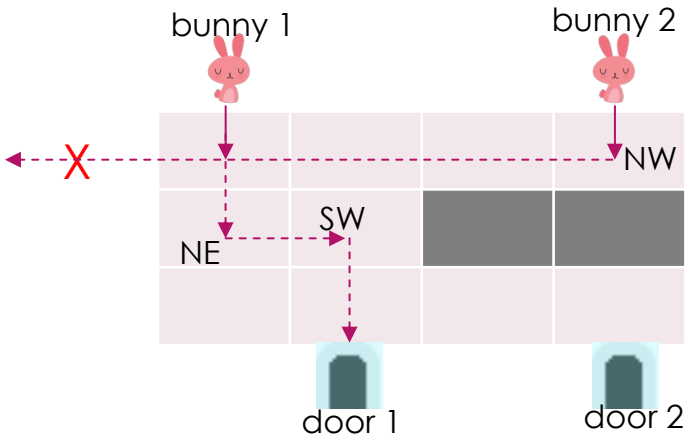


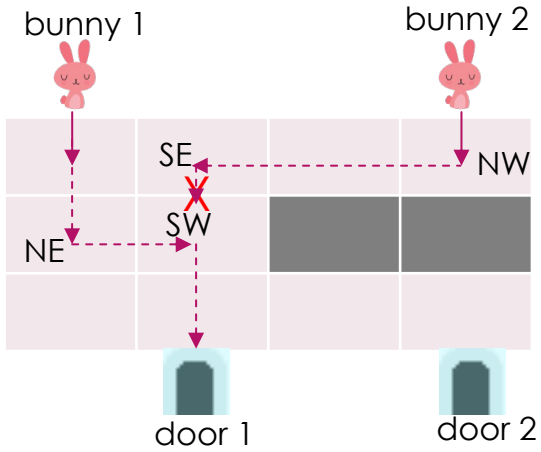
case1



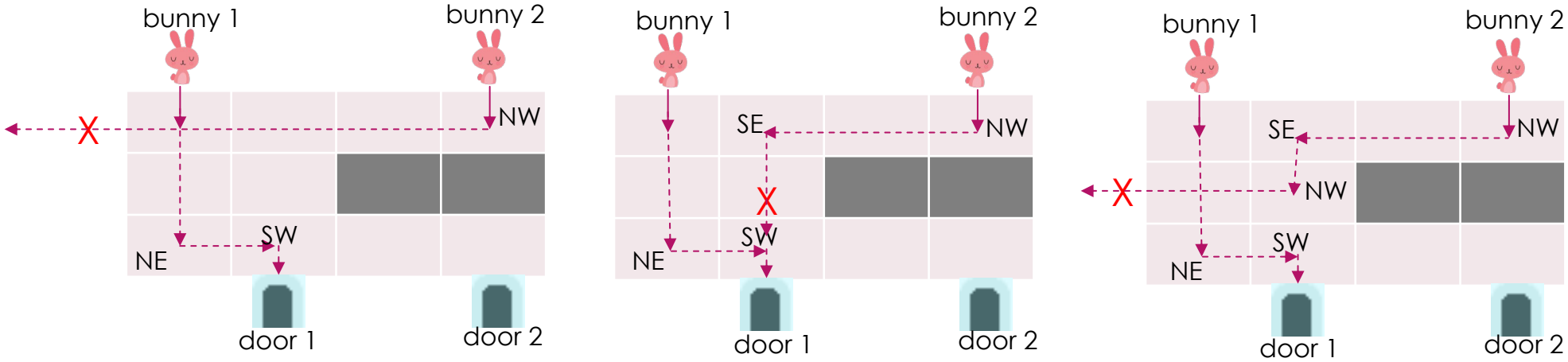

Bunny1: (1,1)→(1,2)→(2,2)→(3,2)
Bunny2: X



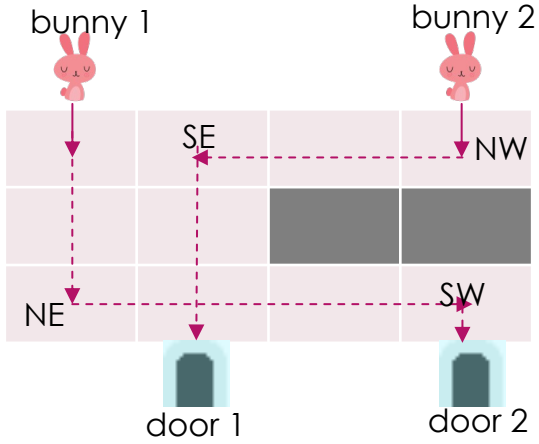




Bunny1: (1,1)→(2,1)→(2,2)→(3,2)
Bunny2: X

Bunny1: (1,1)→(2,1)→(3,1)→(3,2)→door1
Bunny2: X

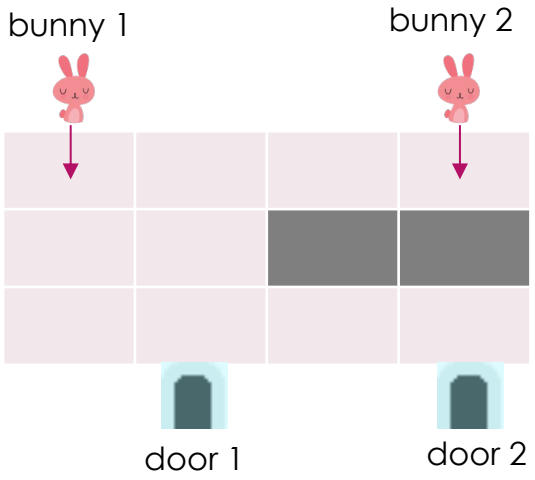


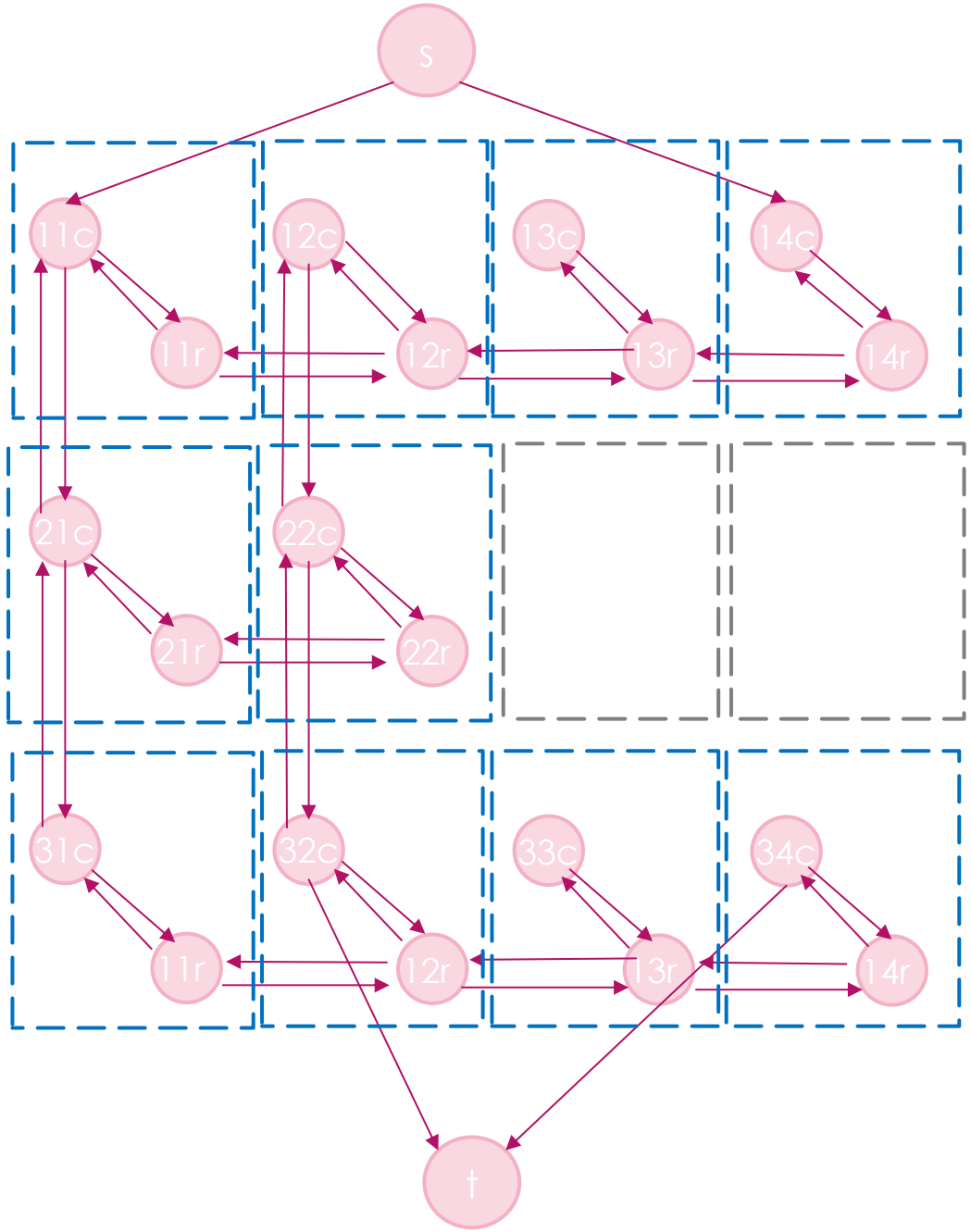

Bunny1: (1,1)→(2,1)→(3,1)→(3,2)→(3,3)→(3,4)→door2
Bunny2: (1,4)→(1,3)→(1,2)→(2,2)→(3,2)→door1



**Hint:**

All bunnies don’t go through the same edge on their path from start to door.


bunny 1
bunny 2
door 1
door 2


s
11c
12c
13c
14c
11r
12r
13r
14r
21c
22c
21r
22r
31c
32c
33c
34c
11r
12r
13r
14r
t