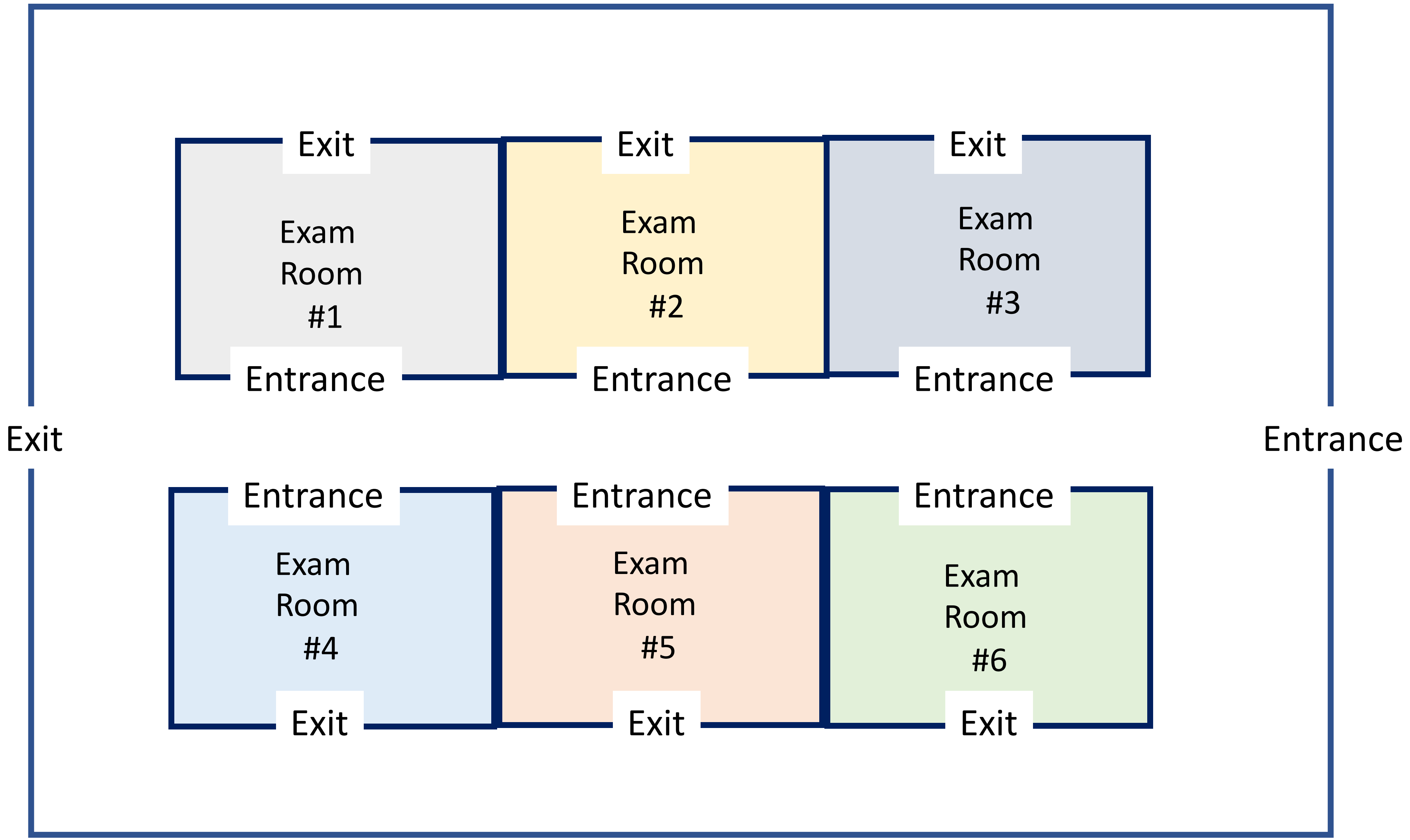
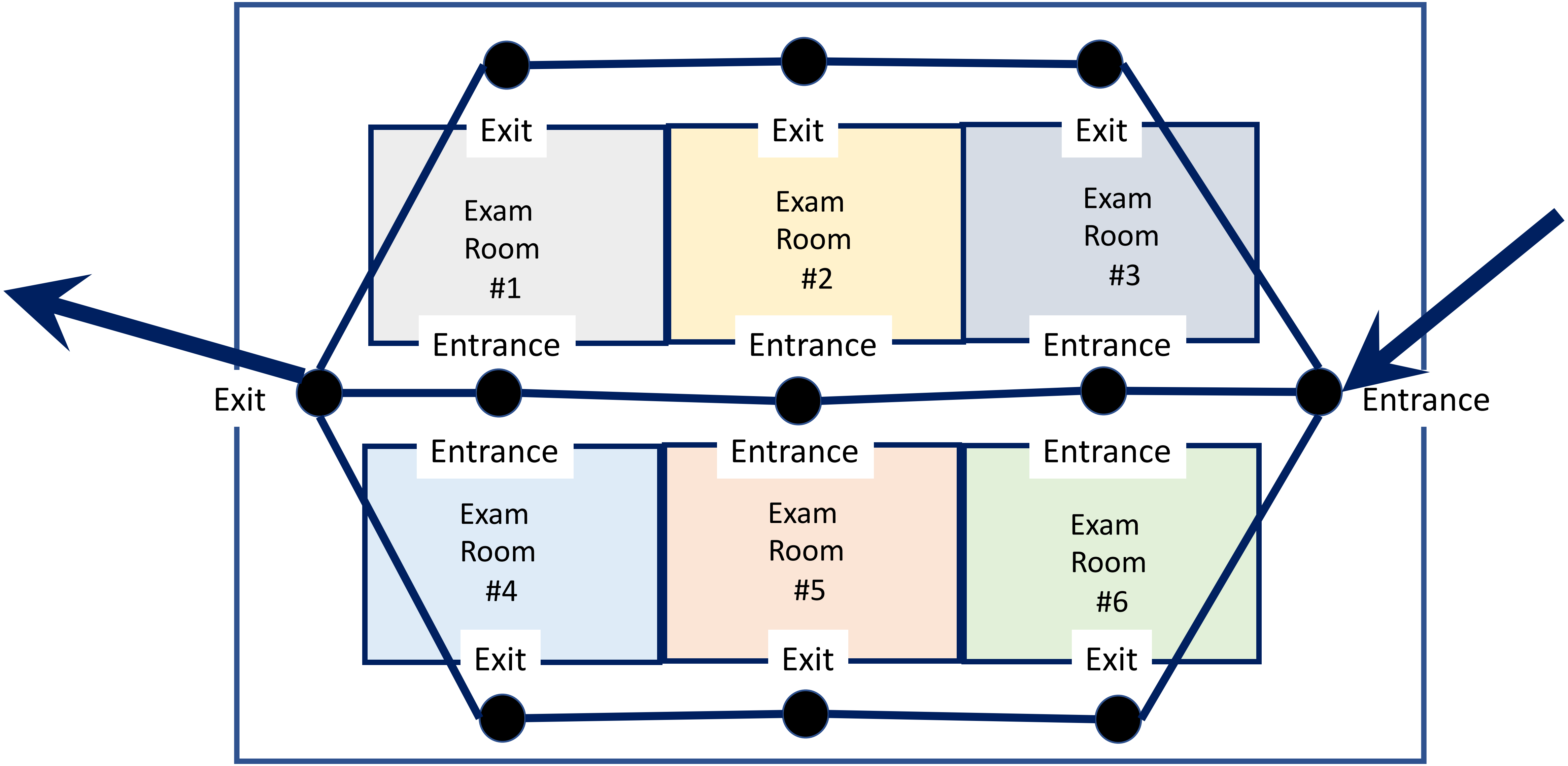
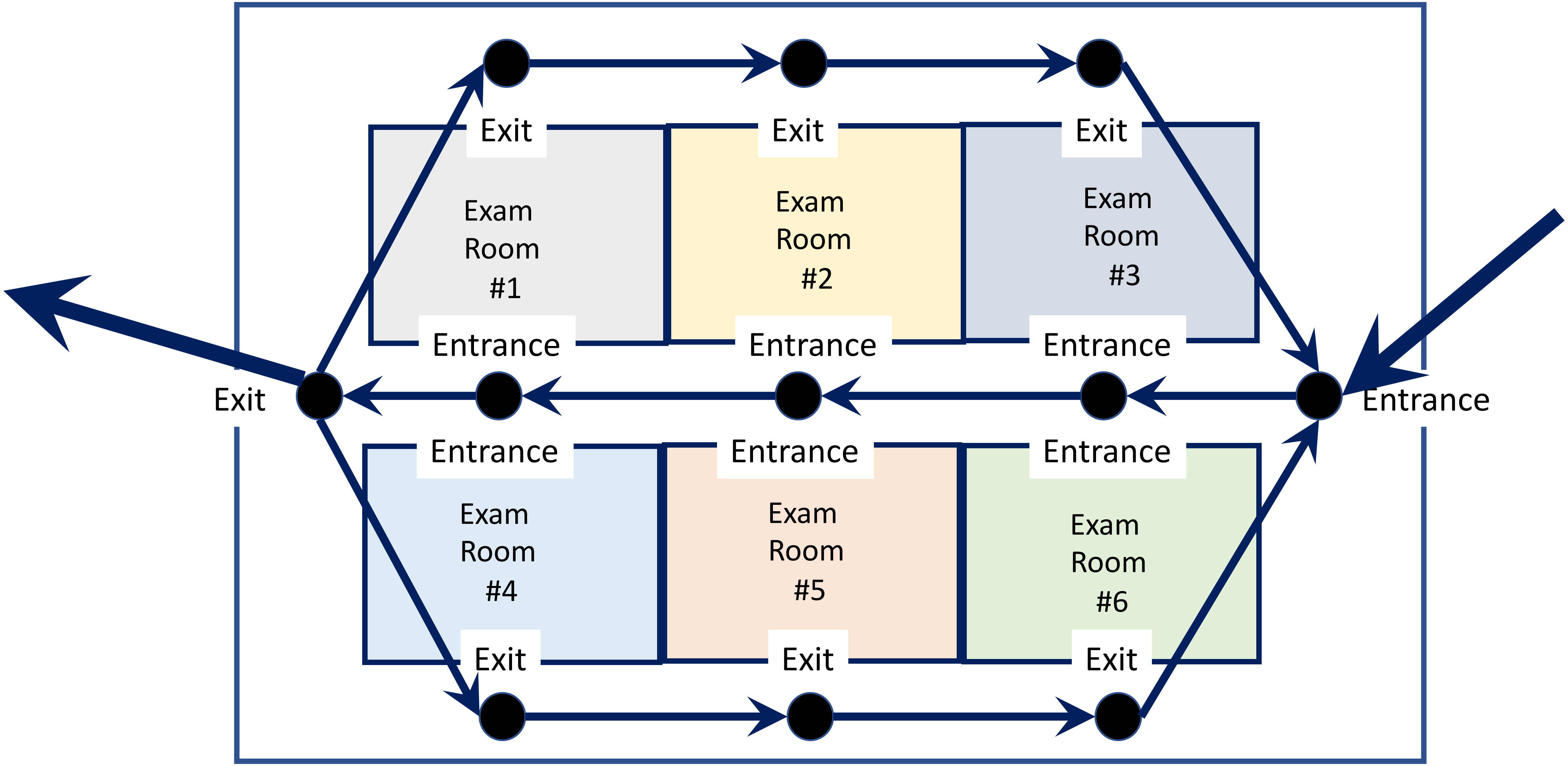
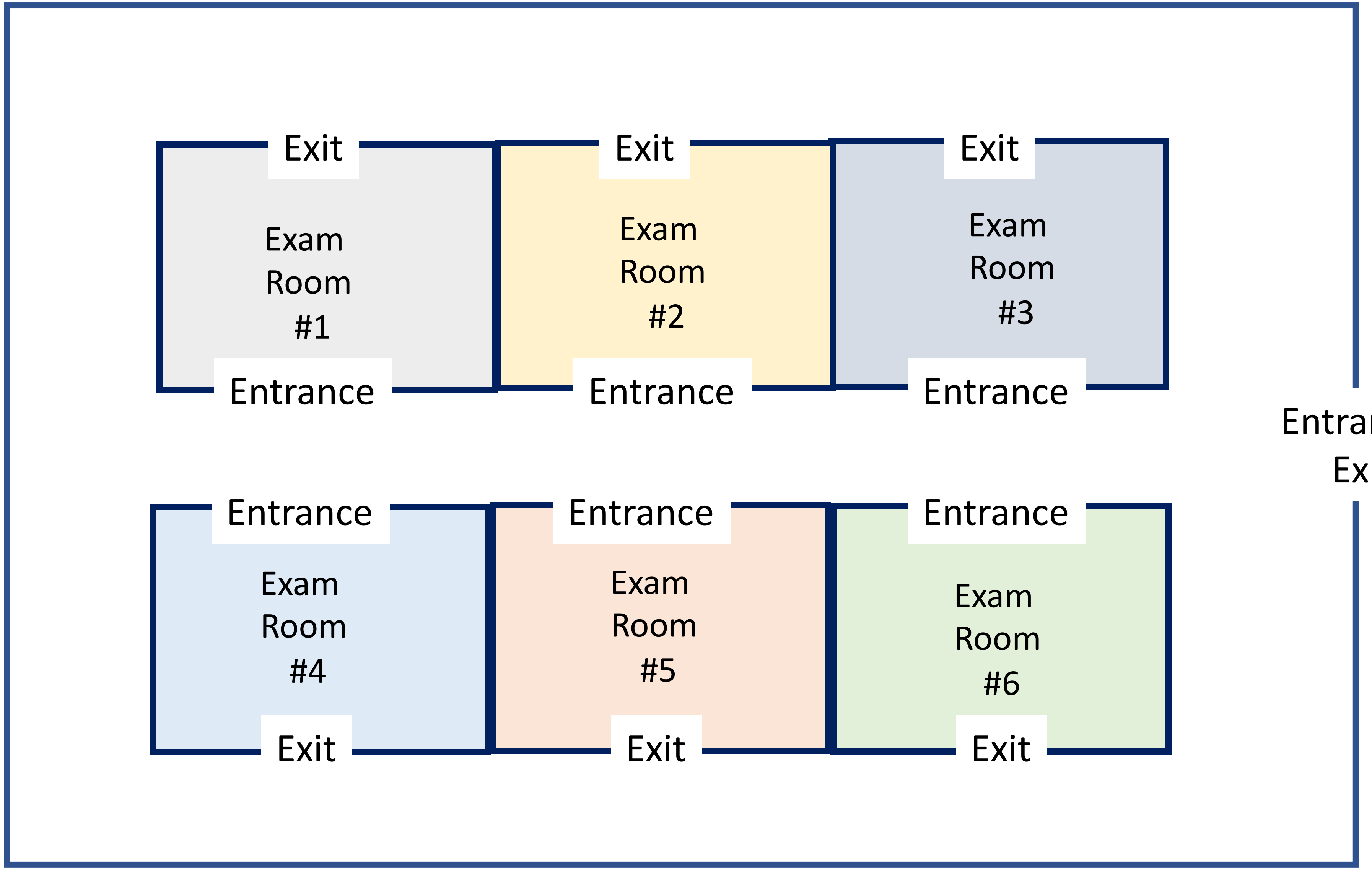
Project – Part I


Exit
Exit
Exit
Exam Room #1
Exam Room #2
Exam Room #3
Entrance
Entrance
Entrance
Exit
Entrance
Entrance
Entrance
Entrance
Exam Room #4
Exam Room #5
Exam Room #6
Exit
Exit
Exit

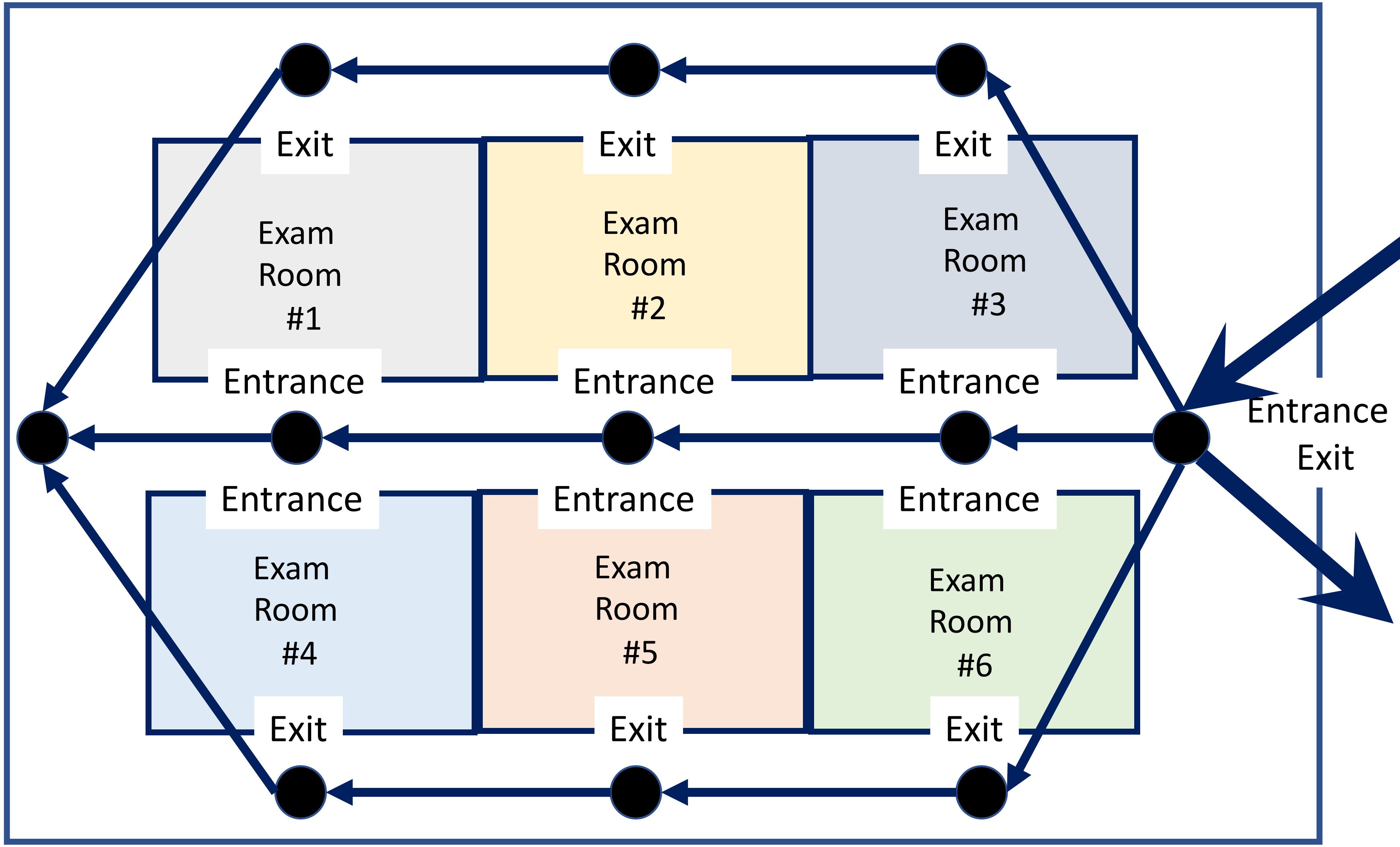

Exit
Exit
Exit
Exam Room #1
Exam Room #2
Exam Room #3
Entrance
Entrance
Entrance
Exit
Entrance
Entrance
Entrance
Entrance
Exam Room #4
Exam Room #5
Exam Room #6
Exit
Exit
Exit

One possible solution: it is not unique



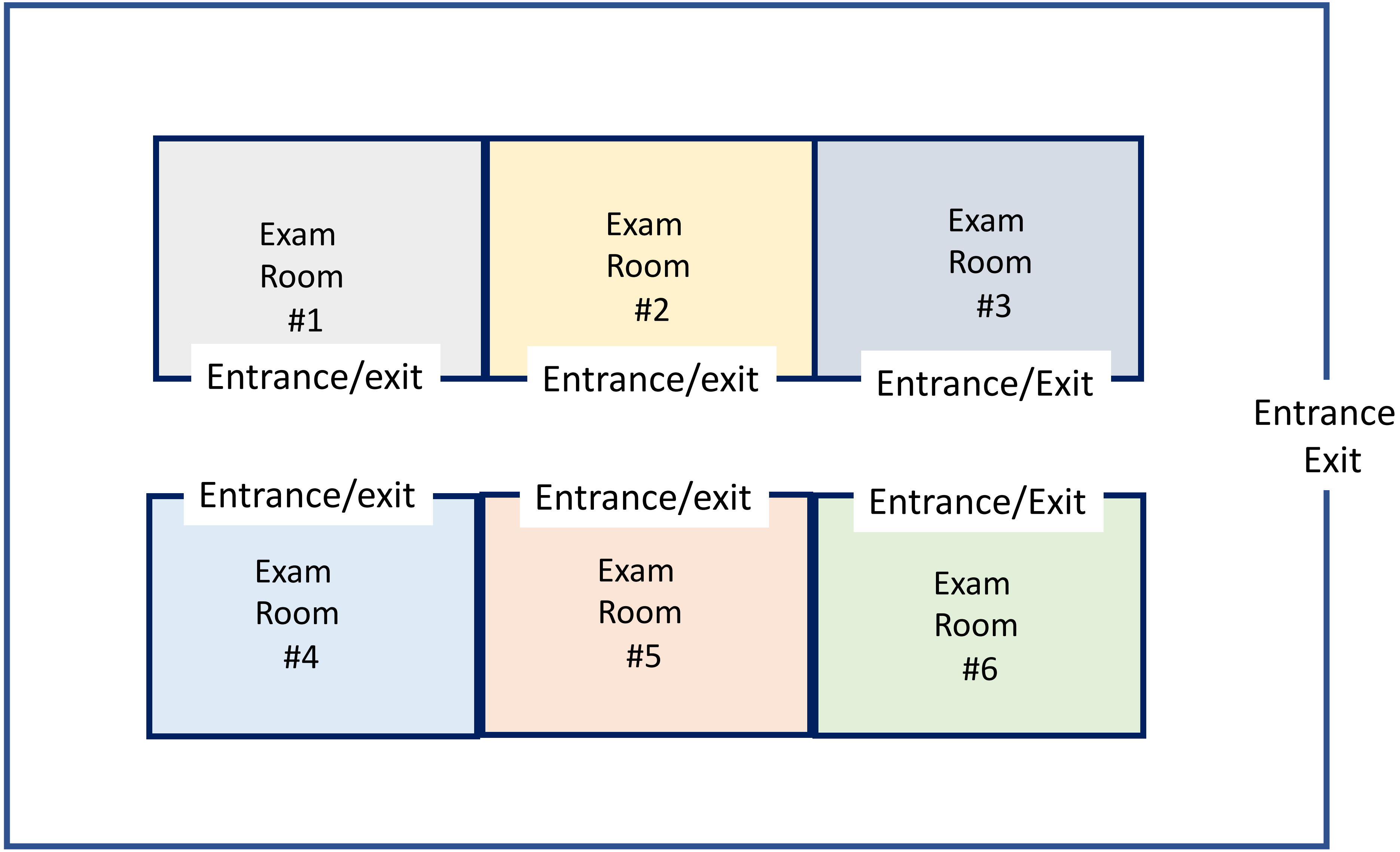

Exit
Exit
Exit
Exam Room #1
Exam Room #2
Exam Room #3
Entrance
Entrance
Entrance
Entrance
Exit
Entrance
Entrance
Entrance
Exam Room #4
Exam Room #5
Exam Room #6
Exit
Exit
Exit

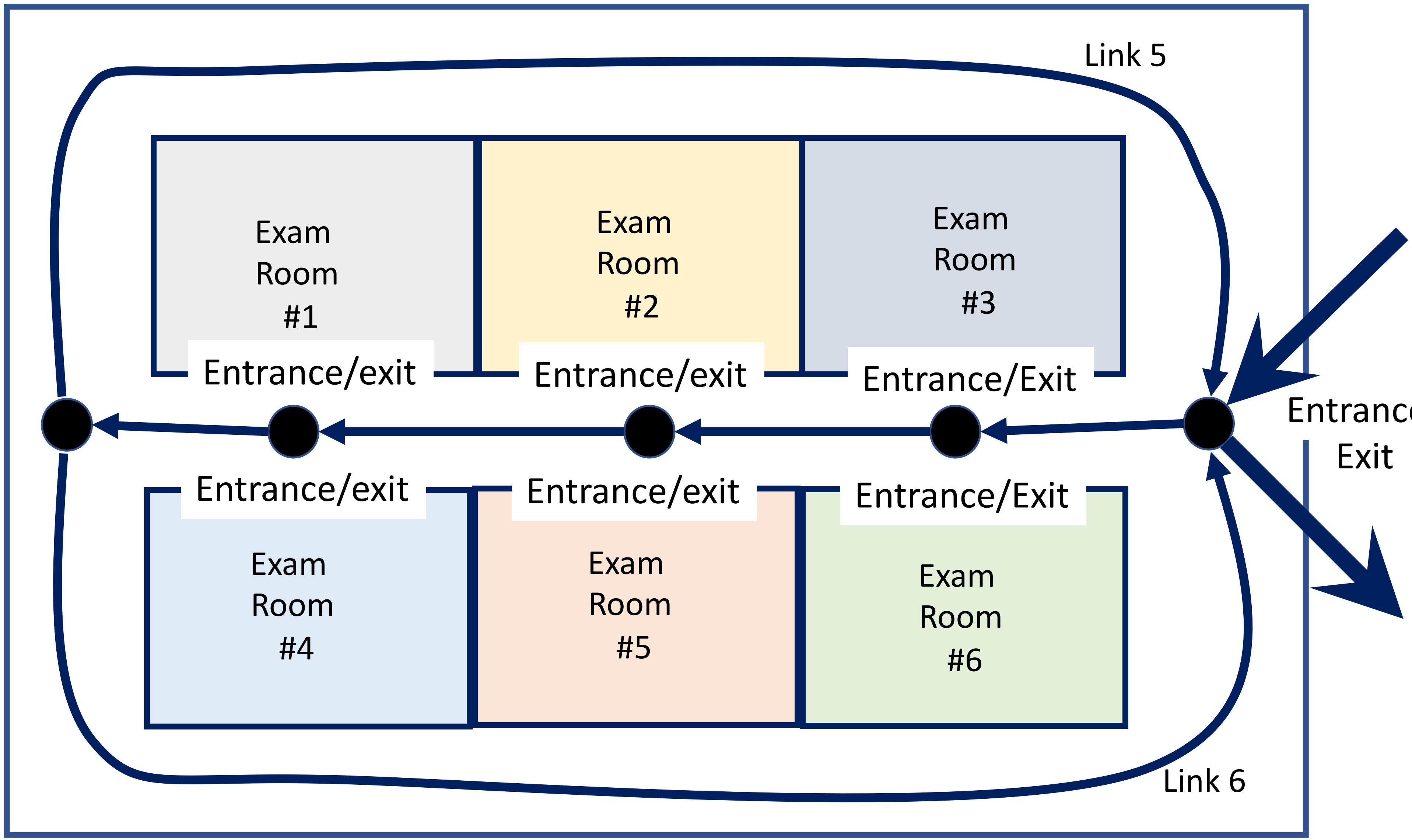
One possible solution: it is not unique

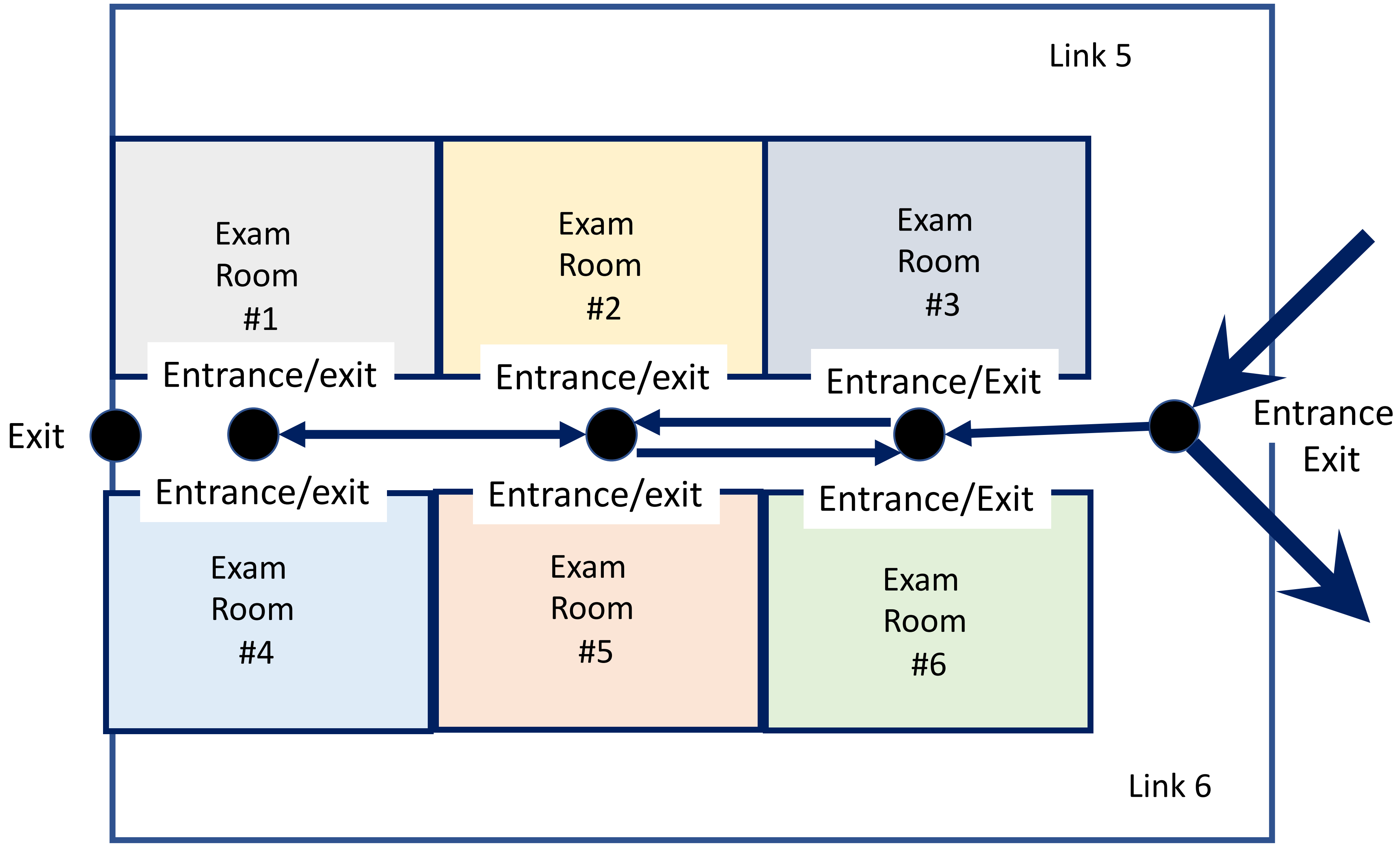


Comments

- You can see different link directions on slides 5 and 2: both are valid, but one is better than the other one.
- How can you make sure you will get solution of slide 2 rather than the solution of slide 5?


Exam Room #1
Entrance/exit
Exam Room #2
Entrance/exit
Exam Room #3
Entrance/Exit
Entrance Exit
Entrance/exit
Exam Room #4
Entrance/exit
Exam Room #5
Entrance/Exit
Exam Room #6

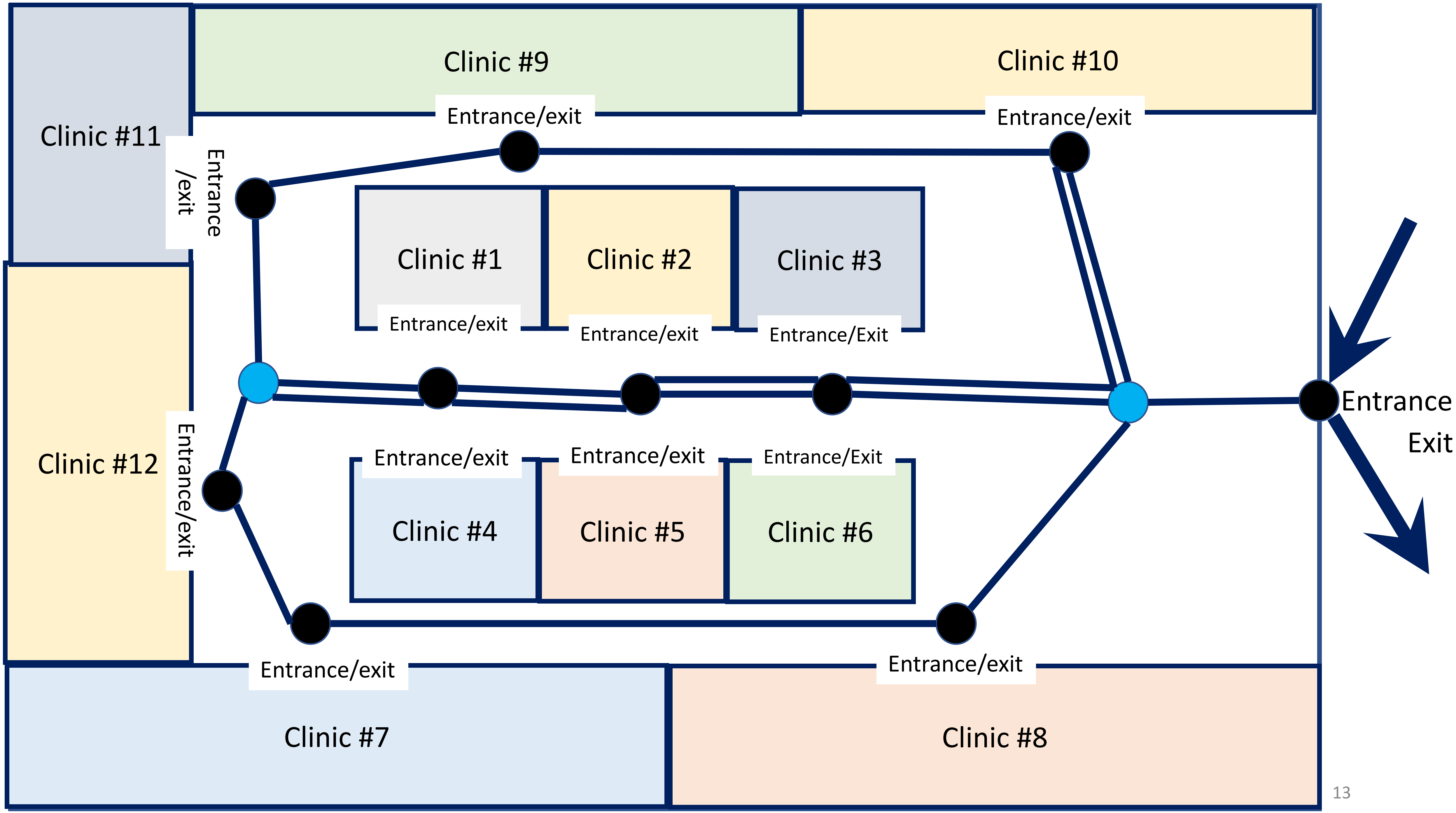

Link 5
Exam
Room
#1
Exam
Room
#2
Exam
Room
#3
Entrance/exit
Entrance/exit
Entrance/Exit
Entrance
Exit
Entrance/exit
Entrance/exit
Entrance/Exit
Exam
Room
#4
Exam
Room
#5
Exam
Room
#6
Link 6


Link 5
Exam Room #1
Exam Room #2
Exam Room #3
Entrance/exit
Entrance/exit
Entrance/Exit
Exit
Entrance
Exit
Entrance/exit
Entrance/exit
Entrance/Exit
Exam Room #4
Exam Room #5
Exam Room #6
Link 6

Comments

- What is the interest of keeping both links 5 and 6?

Project – Part II



Clinic #9
Entrance/exit
Clinic #10
Entrance/exit
Clinic #11
Entrance /exit
Clinic #1
Entrance/exit
Clinic #2
Entrance/exit
Clinic #3
Entrance/Exit
Entrance
Exit
Clinic #12
Entrance/exit
Entrance/exit
Entrance/exit
Entrance/Exit
Clinic #4
Clinic #5
Clinic #6
Entrance/exit
Entrance/exit
Clinic #7
Clinic #8

Paper #1

ARTICLE

Finding paths with minimum shared edges

Authors: Masoud T. Omran, Jörg-Rüdiger Sack, Hamid Zarrabi-Zadeh Authors Info & Claims

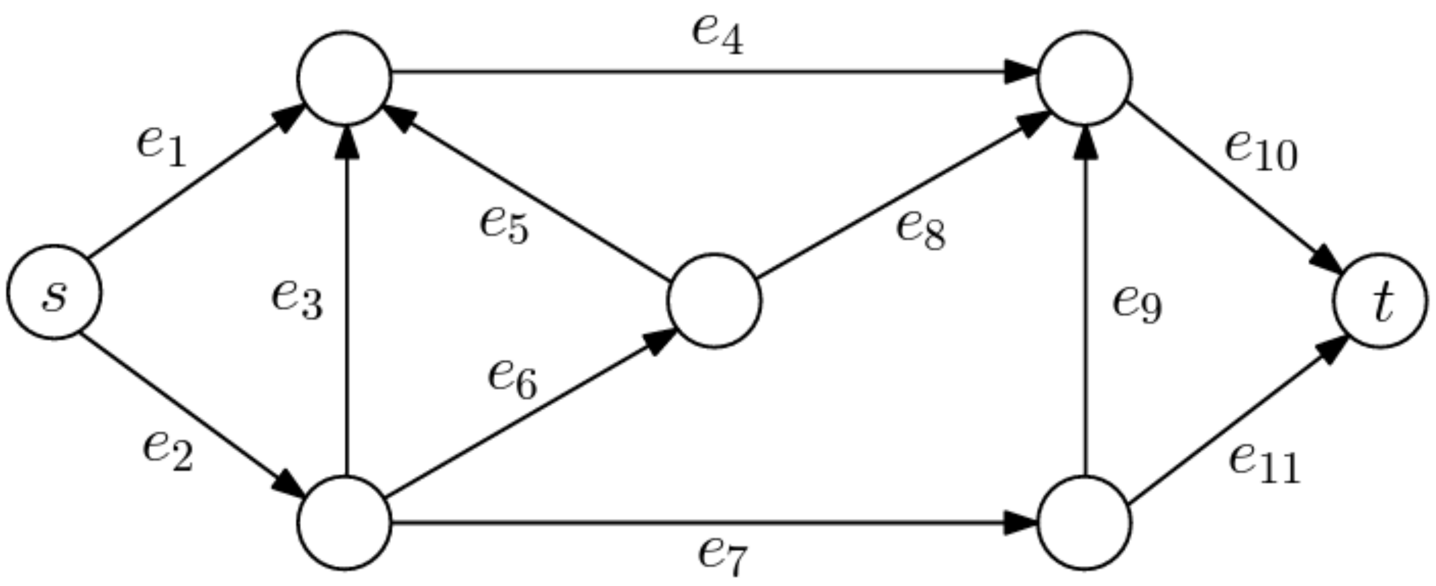
COCOON'11: Proceedings of the 17th annual international conference on Computing and combinatorics • August 2011

• Pages 567–578

Shared Link

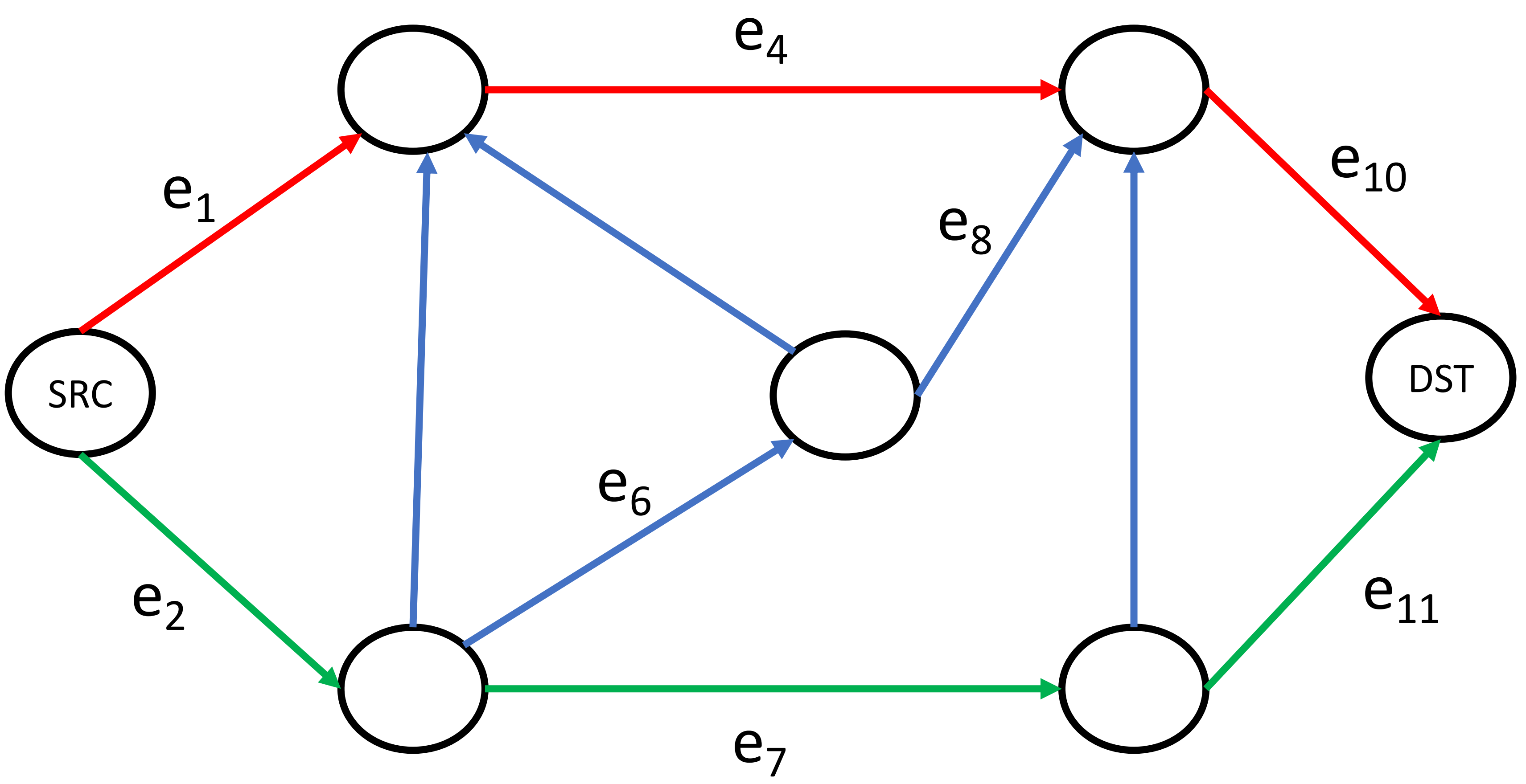
- Given a graph G, two special nodes v_{SRC} and v_{DST} in G, and a number k, find k paths from v_{SRC} to v_{DST} in G so as to minimize the number of links shared among the paths.

A graph G with six possible (*s*,*t*)-paths, denoted by π_1 to π_6



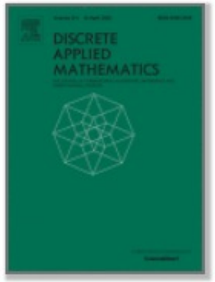
$$\pi_1 = \langle e_1, e_4, e_{10} \rangle$$
$$\pi_2 = \langle e_2, e_7, e_{11} \rangle$$
$$\pi_3 = \langle e_2, e_6, e_8, e_{10} \rangle$$
$$\pi_4 = \langle e_2, e_3, e_4, e_{10} \rangle$$
$$\pi_5 = \langle e_2, e_7, e_9, e_{10} \rangle$$
$$\pi_6 = \langle e_2, e_6, e_5, e_4, e_{10} \rangle$$

A graph G with six possible (s,t)-paths, denoted by π_1 to π_6



$\pi_1 = (e_1, e_4, e_{10})$
$\pi_2 = (e_2, e_7, e_{11})$
$\pi_6 = (e_2, e_6, e_8, e_{10})$
2 shared links

Paper #2



Discrete Applied Mathematics

Volume 116, Issue 3, 15 February 2002, Pages 271-278

Note

A note on orientations of mixed graphs

Esther M. Arkin [1, a], Refael Hassin [b]

Concept of essential edge

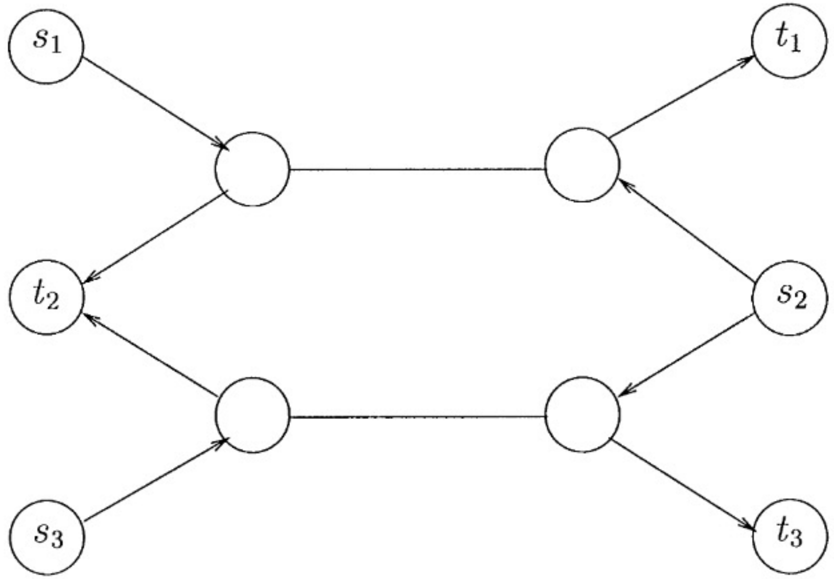


Fig. 2. A graph with no *P*-orientation and no essential edge.

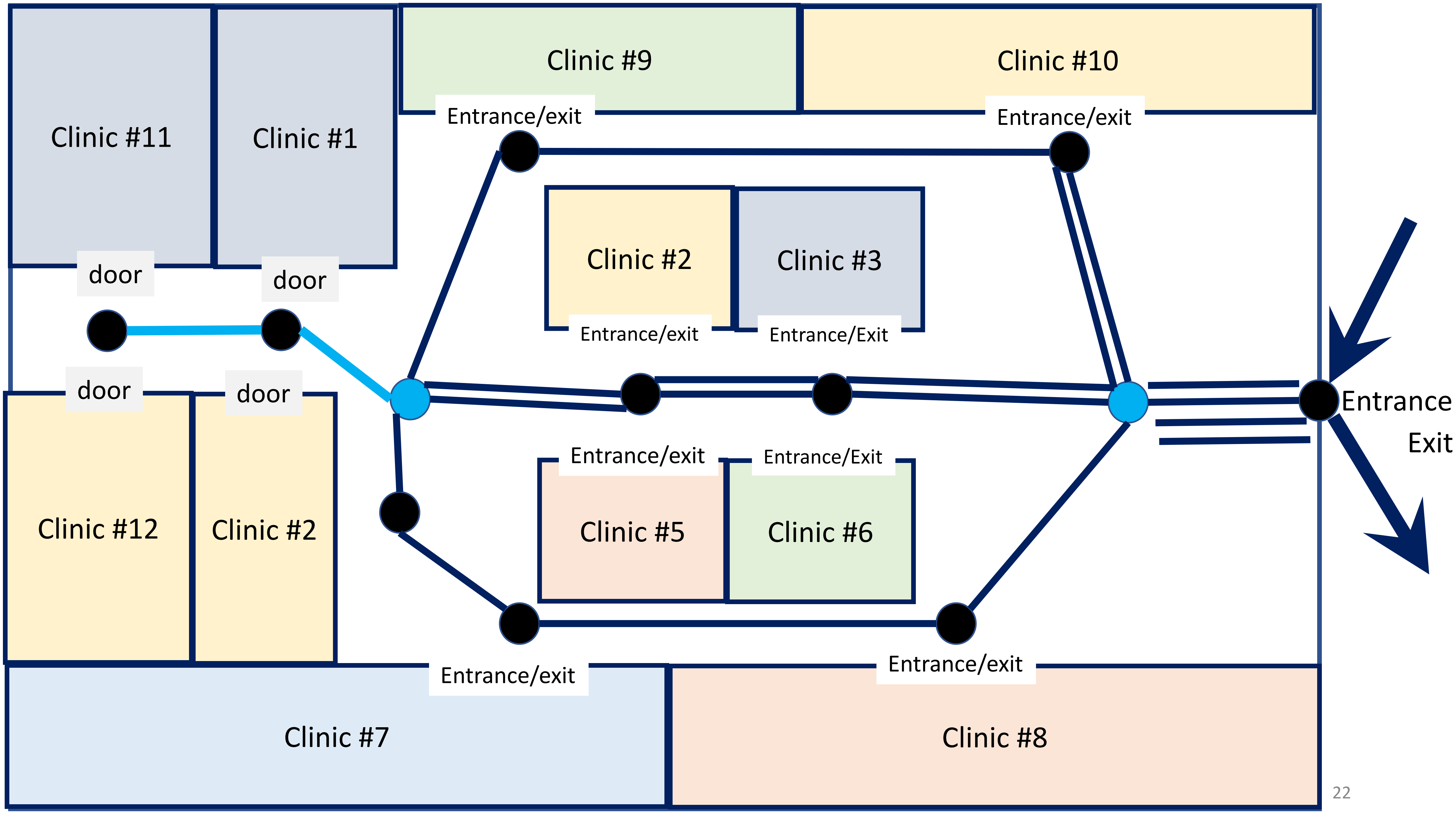
- In the project: use essential edge for "alternating" edge, i.e., edge used in both directions, with waiting areas at their endpoints.
- Since edge cannot be used in both directions at any given time, it slows down the circulation of people in the corridor

Maximize throughput

- General definition
  - Throughput = rate of production or the rate at which something is processed.
- Often used in the context of networking
  - Rate of *successful* messages or packets delivery over a communication channel.
- In the context of the project
  - Number of people reaching their destination per time unit

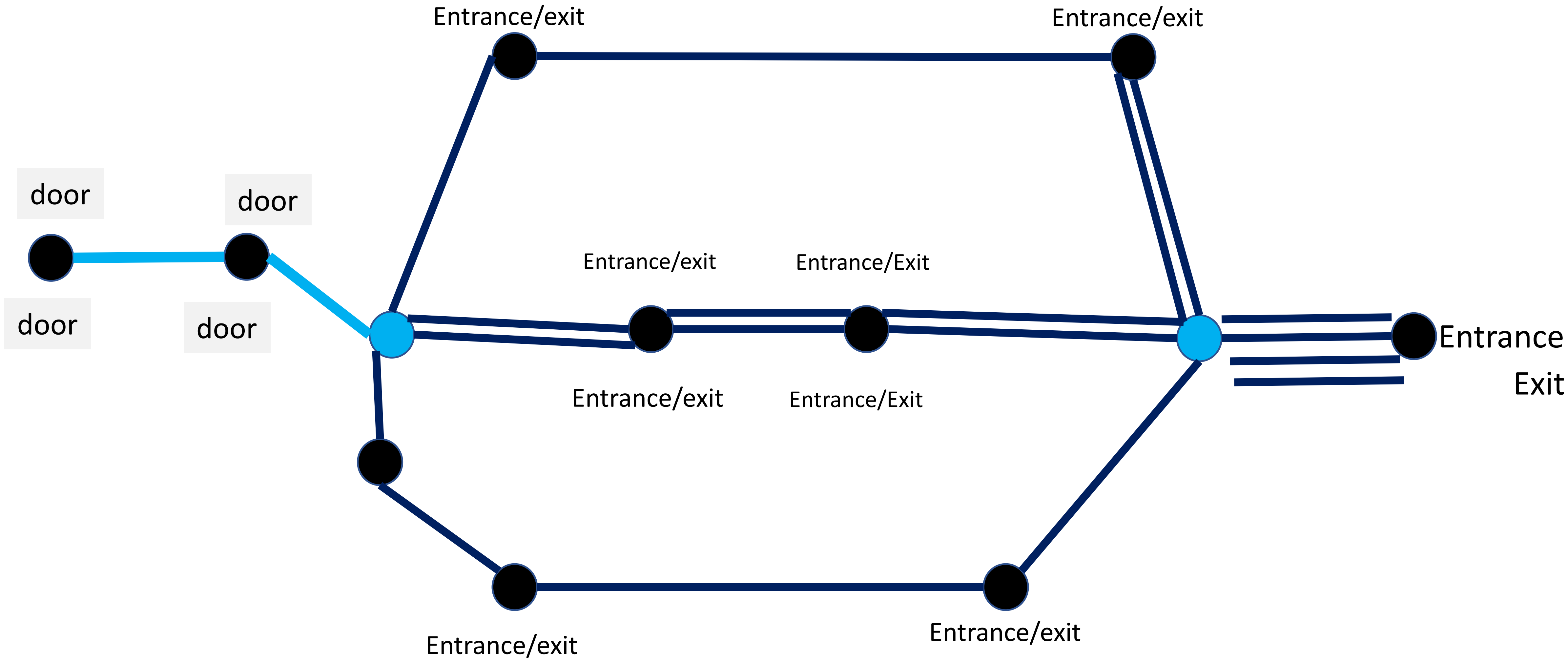
Maximizing the throughput

- Minimize the number of shared links: they correspond to convergent flows and therefore to a source of flow slowdown
- Minimize the number of edges with no fixed orientation: they correspond to links with waiting areas at their origin
- Example of next slide
  - Blue edges are alternating edges
- **Assumption**: these are waiting areas (e.g., buffers) with sufficient capacity at the location of converging flows



Clinic #11
Clinic #1
Clinic #9
Entrance/exit
Clinic #10
Entrance/exit
door
door
Clinic #2
Entrance/exit
Clinic #3
Entrance/Exit
door
door
Entrance
Exit
Entrance/exit
Entrance/Exit
Clinic #12
Clinic #2
Clinic #5
Clinic #6
Entrance/exit
Entrance/exit
Clinic #7
Clinic #8

Project Part II - Input 1: undirected graph

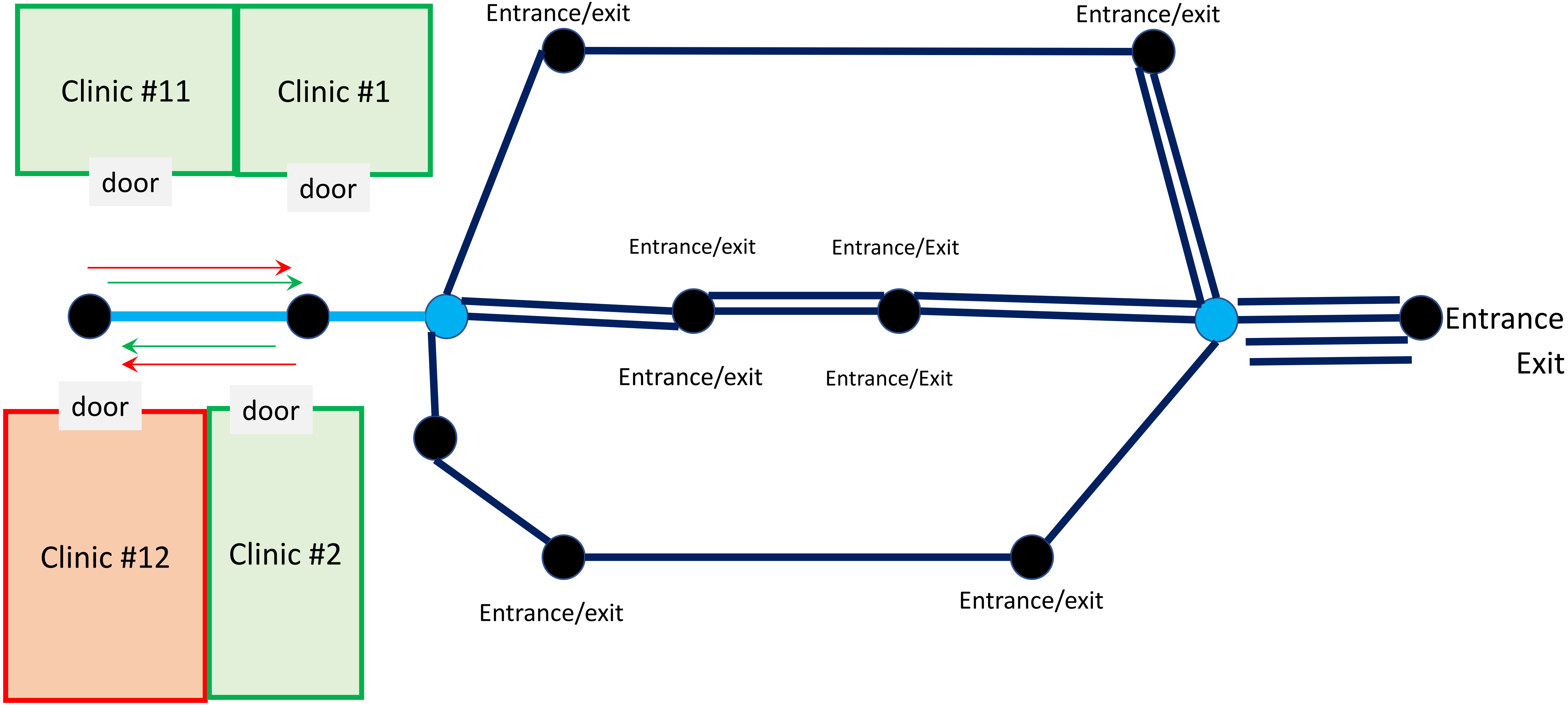


Project Part II – Input 2: two node pair sets

- SD_1 (origin/destination of non COVID patients): large number of node pairs, usually in both directions.
- Examples: (hospital main entrance, eye clinic), (eye clinic, hospital exit), (hospital main entrance, vaccination area), …

- SD_2 (origin/destination of COVID patients): very limited number of node pairs, usually in both directions.
- Examples: (emergency, X-ray), (X-ray, emergency), (emergency, COVID ward 1), (emergency, COVID ward 2).

Project Part II - Edge $\hookrightarrow$ 2 – color alternating edge



The blue edge will be used alternately either way, either COVID/non-COVID