



Programming Assignment 3

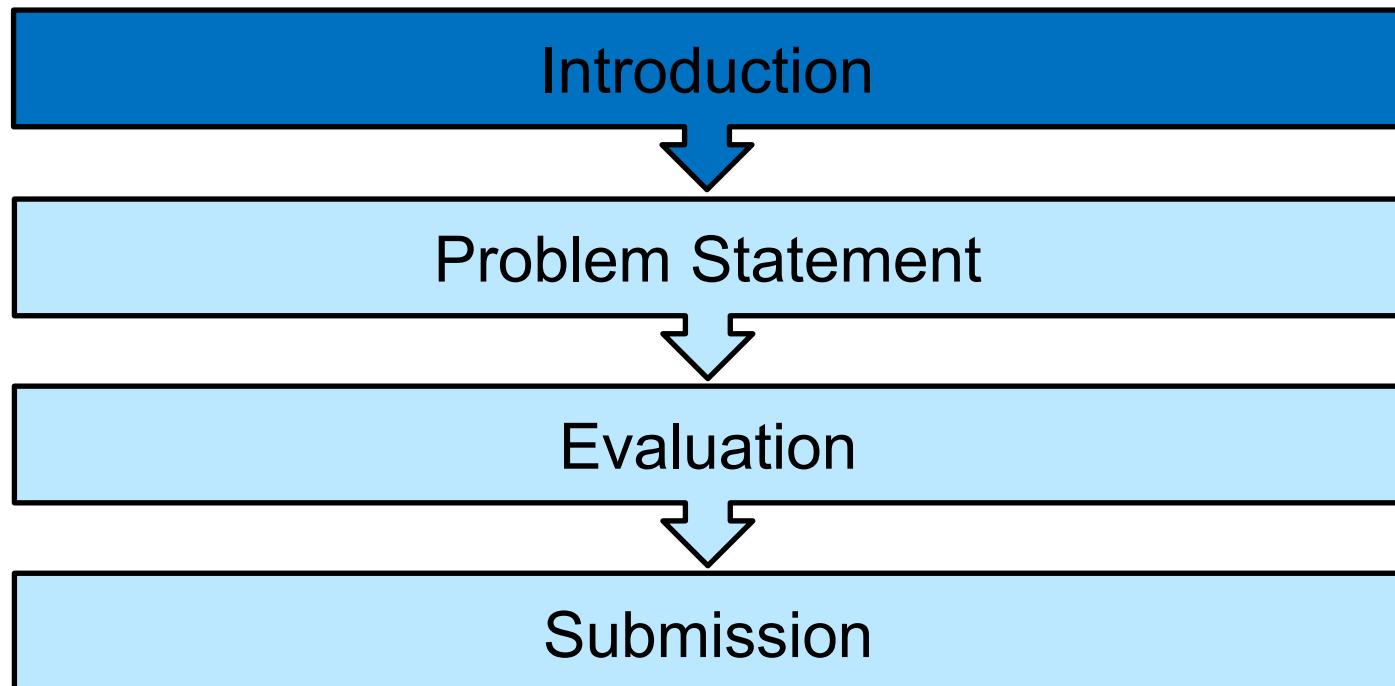
Maze Router with A* search

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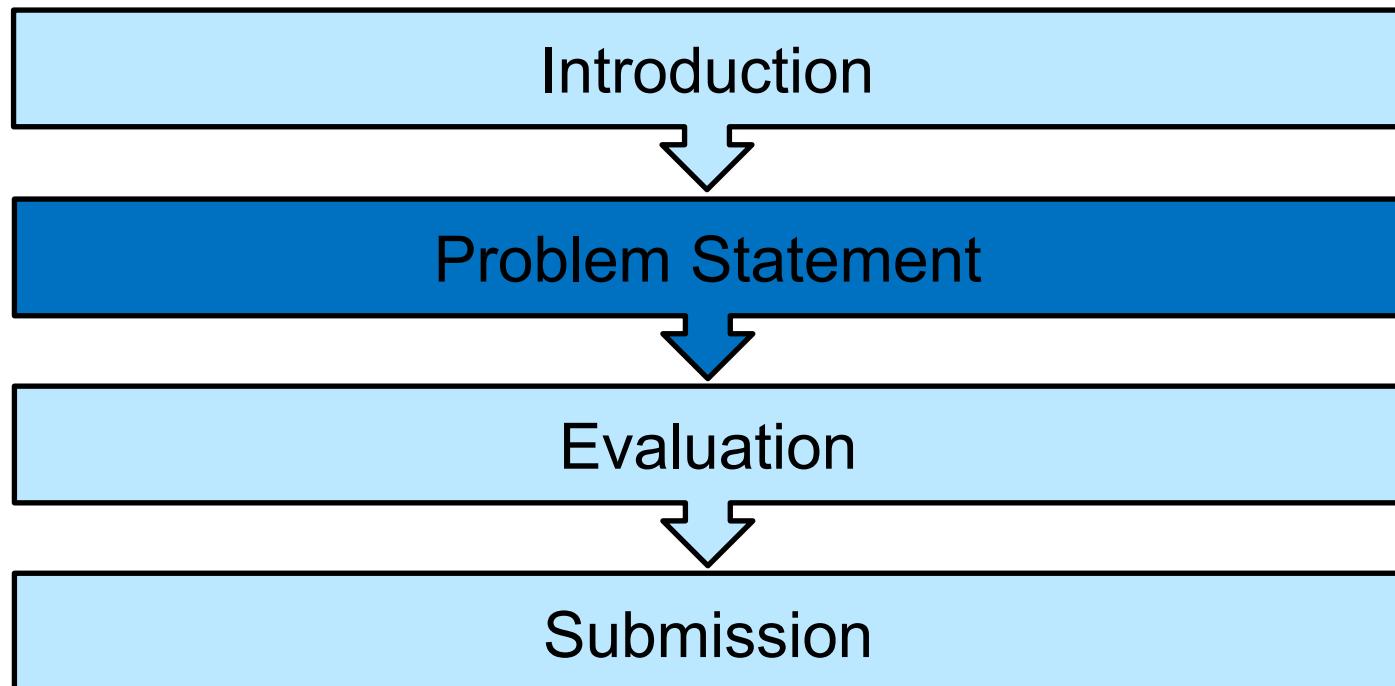
Outline



Multi-Net Routing

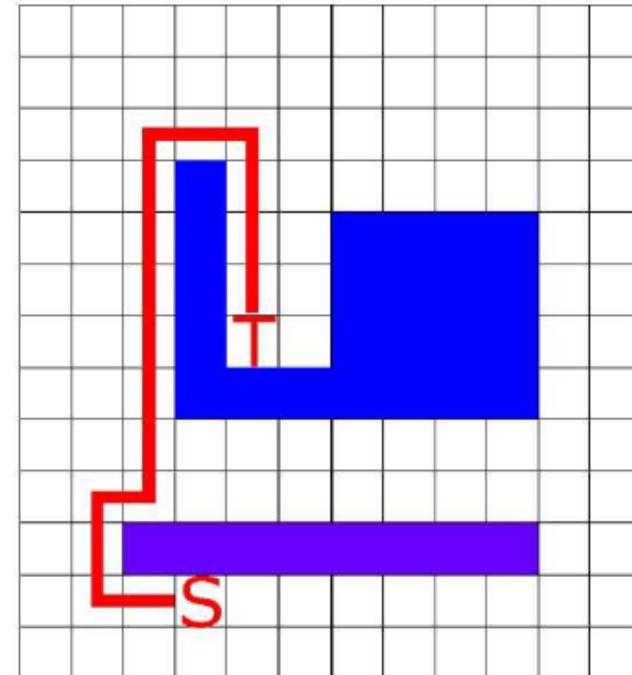
- Net Ordering Problem:
 - Early nets might block the only viable paths for later nets, leading to unrouteable designs even if a solution exists.
- Rip-up and Reroute

Outline



Problem Statement

- Given a gridded routing region, you need to implement a 2D maze router to solve the routing problem



Input/Output file format

- .in file:

- Grid size
- Blocks: block numbers & their vertices coordinates
- Nets: net numbers & each nets' source and target

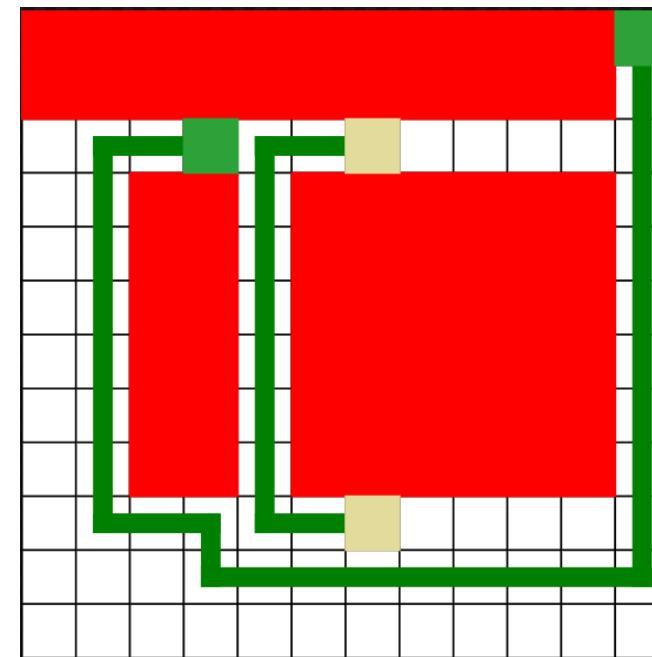
```
1  .row 12    // grid size
2  .col 12
3
4  .block 3    // Number of blocks
5  2 3 3 8    // LeftDownX RightUpX LeftDownY RightUpY
6  5 10 3 8
7  0 10 10 11
8
9  .net 2      // Number of nets
10 net1 3 9 11 11 // sourceX sourceY targetX targetY
11 net2 6 2 6 9
```

Input/Output file format

- .out file(goal):

- Net name should correctly correspond to .in file
- Grid usage: the total number of grids occupied by its path, not including source and target grid
- To express the path, take net1 for example, it starts at source (3, 9), and each line of output denotes a line segment, and finally it connects target (11, 11)

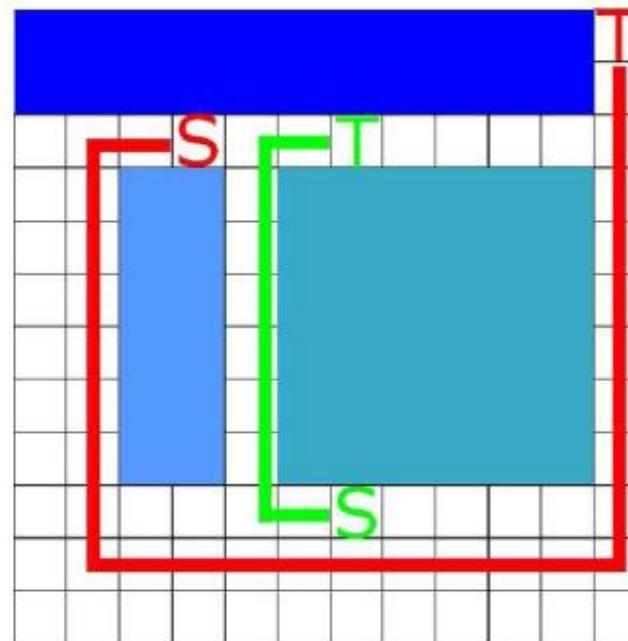
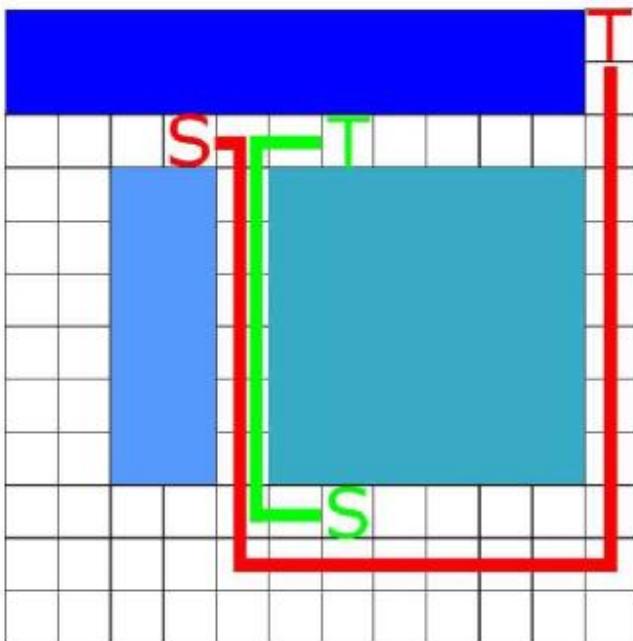
```
1  net1 30    // grid usage
2  begin
3  3 9 1 9    // sourceX sourceY targetX targetY
4  1 9 1 2
5  1 2 3 2
6  3 2 3 1
7  3 1 7 1
8  7 1 7 2
9  7 2 11 2
10 11 2 11 11
11 end
12 net2 11
13 begin
14 6 2 4 2
15 4 2 4 9
16 4 9 6 9
17 end
18
```



Problem Statement

- Constraint

- The block area can't be passed through
- There will be multiple nets, and all nets should be connected
- Each grid is available only for one path



Sample Code

- We have provided sample code including:
 - pa3.cpp: there is the framework of code
 - routing.h: the prototype of data structure like “Point”, “Net”, and “Maze”, and functions
 - routing.cpp: function implementation
- In routing.cpp, you need to implement functions as follows:
 - `bool route_net_a_star(int net_idx);`
 - `set<int> route_force(int net_idx);`
 - `void rip_up_net(int net_idx);`
 - `void commit_net(int net_idx);`
- There are reference steps and function usage in the comment of the code template

Sample Code

- Decompress with: `tar xvf PA3.tar`
- You are free to modify the code of the files to derive the correct output file
- However, I will test your codes and generate output files by the same commands:
 - `make pa3`
 - `./pa3 [input file] [output file]`
- Therefore, please check your code will run properly by these commands. If you want to add other files, make sure that your makefile will compile correctly by command “`make pa3`”

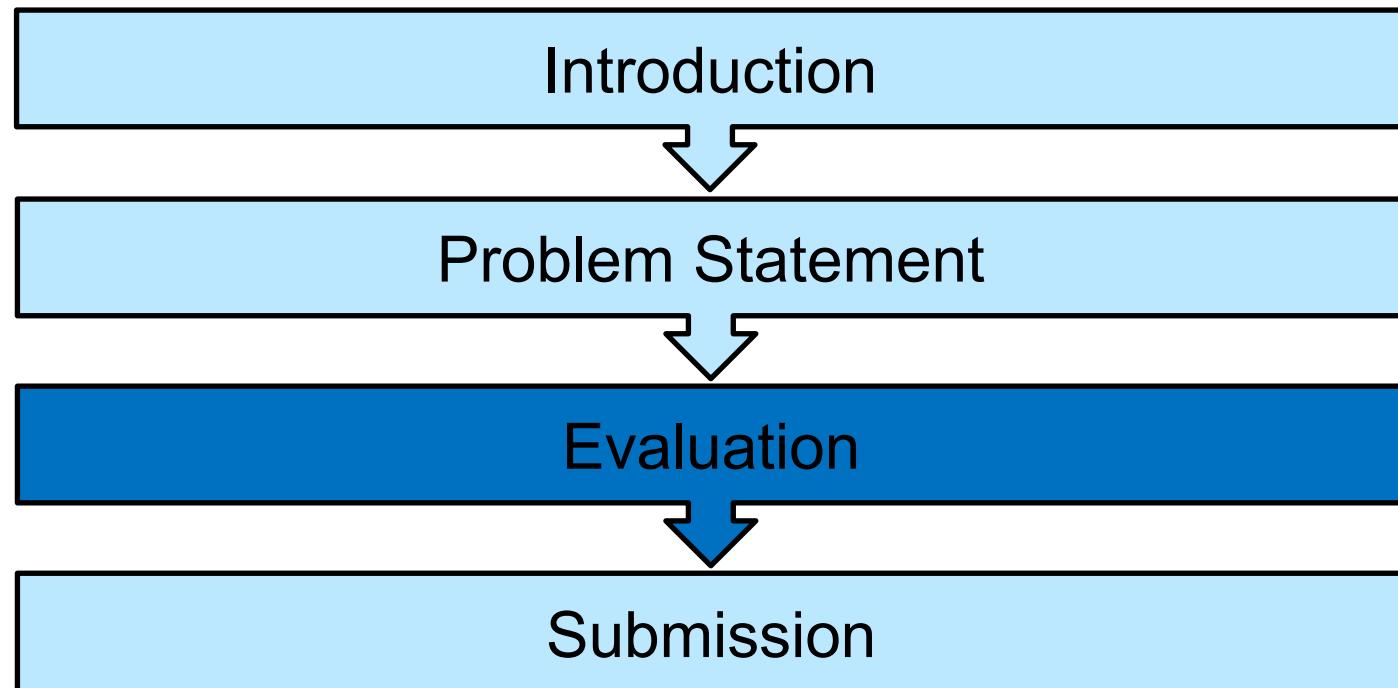
Script usage

- To compile:
 - Execute the command: make pa3
- Usage of the binary
 - ./pa3 public/[case1.in] public/[case1.out]
- To generate the .svg image, helping you debug and check routing result
 - ./draw public/[case1.in] public/[case1.out]
 - Check the output in the console to ensure the grid usage corresponding to each path is correct

```
net0 0 205 204
net1 0 45 44
net2 0 59 58
net3 0 19 18
```

```
net0 1 204 204
net1 1 44 44
net2 1 58 58
net3 1 18 18
```

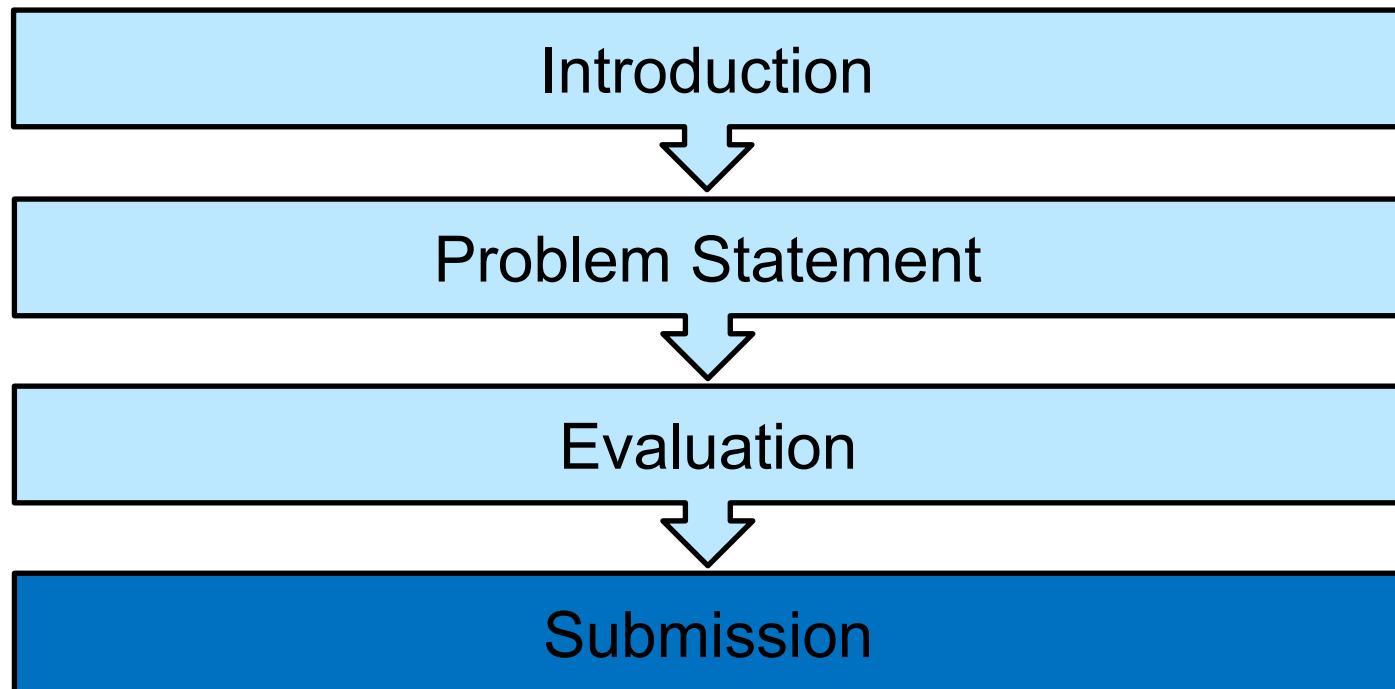
Outline



Evaluation

- For each case, the runtime limit is two mins
- Connect all the nets correctly:
 - Public case: 40%
 - Private case: 40%
- The performance score only counts when all cases are correct
- Performance (grid usage) 20%:
 - The fewer grid you use, the higher score you get
 - $\frac{\text{optimal grid usage}}{\text{your grid usage}} * 20\%$

Outline



Submission

- Rename your directory: `mv PA3 [student_ID]_PA3`
 - The student ID must be lowercase
- Your directory should only include:
 - `pa3.cpp`
 - `routing.cpp`
 - `routing.h`
 - `makefile`
 - Other `.cpp`, `.h` if you need

Submission

- Compress your directory:
 - `tar cvf [student_ID]_PA3.tar [student_ID]_PA3`
- Submit the .tar file on NTU COOL

Submission

- No plagiarism
- Penalty for late submission: 20% per day
- Deadline: December 3, 2025, 23:59
- If you have any question, please contact:
 - Po-Ying Tseng ([bowen0921@gmail.com](mailto:b Bowen0921@gmail.com))
 - Office hours: Fri. 12:30~13:20 @ BL-407, by appointment



Thank You!