Homework 1

Solving Permutation Flowshop Scheduling Problem using Trajectory-based Metaheuristics

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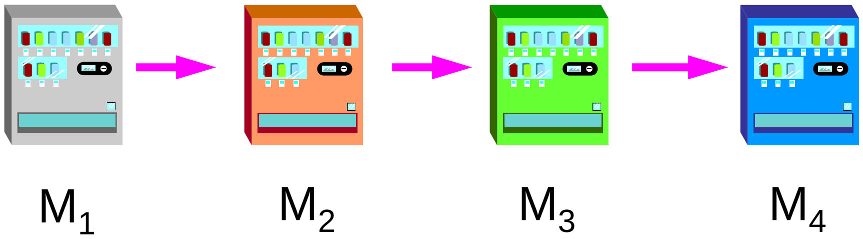
https://moodle3.ntnu.edu.tw/course/view.php?id=41610

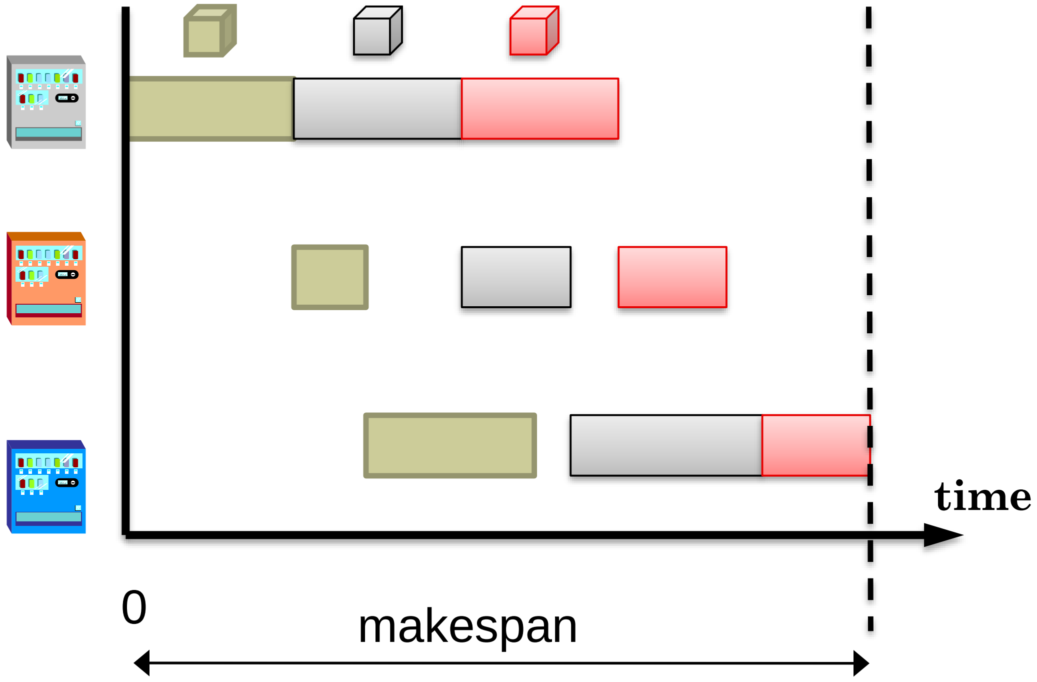
Permutation Flowshop Scheduling

- Problem definition
  - There are m machines and n jobs.
  - Each machine can process only one job at a time.
  - Each job is processed by machine $1, 2, 3, \ldots, m$ in order.
  - Each machine except the first one processes jobs in a FIFO order.



Permutation Flowshop Scheduling

- Objective
  - Find the schedule with the shortest makespan.

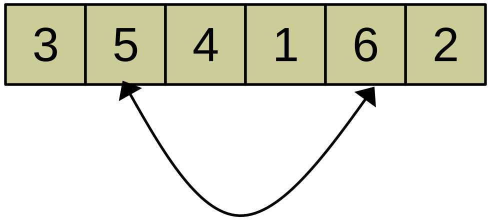


Algorithms

- Tested algorithms
  - iterative improvement
  - simulated annealing
  - tabu search

- Common parts of the tested algorithms
  - permutation-based encoding
    - a string of integers 1, 2, …, n
  - swap neighborhood
    - swap two arbitrary jobs

e.g.



3	5	4	1	6	2

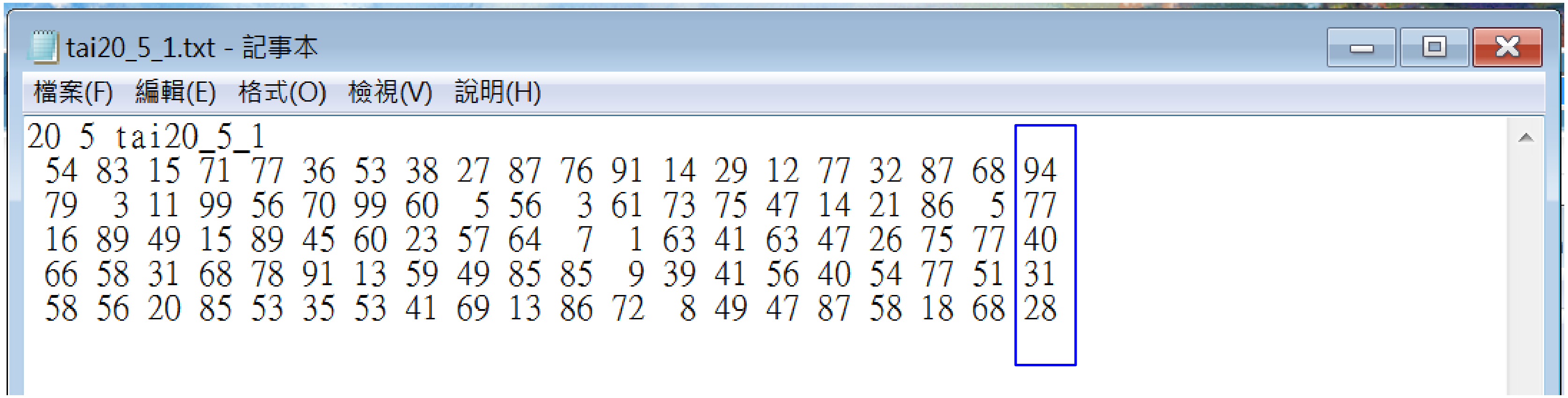
Requirements

- Nine instances from Taillard (1993) will be given on moodle.
  - $n = \{20, 50, 100\} \times m = \{5, 10, 20\}$
- Solve the nine problem instances using three kinds of metaheuristics.
- Each instance should be solved by each algorithm for at least 20 times.

Taillard, E. (1993). Benchmarks for basic scheduling problems. *European Journal ofOperational Research*, 64, 278–285.

Requirements

20×5: 20 jobs and 5 machines



```
20 5 tai20_5_1
 54 83 15 71 77 36 53 38 27 87 76 91 14 29 12 77 32 87 68 94
 79  3 11 99 56 70 99 60  5 56  3 61 73 75 47 14 21 86  5 77
 16 89 49 15 89 45 60 23 57 64  7  1 63 41 63 47 26 75 77 40
 66 58 31 68 78 91 13 59 49 85 85  9 39 41 56 40 54 77 51 31
 58 56 20 85 53 35 53 41 69 13 86 72  8 49 47 87 58 18 68 28
```

Processing times of the 20th job on the five machines.

Taillard, E. (1993). Benchmarks for basic scheduling problems. *European Journal ofOperational Research*, 64, 278–285.

Documentation

- Algorithm description
  - For each algorithm, you need to give detailed descriptions.
  - For example, the cooling schedule of SA and the tabu structure of TS should certainly be presented clearly.

- Experimental setting
  - The values of parameters (e.g. initial temperature, epoch length, tabu tenure, etc.) in the experiments should be provided.

Documentation

- Experimental results
  - The best-, average-, and worst-case performance over 20 (or more) runs should be given.
  - Computer environment and average computation time should be provided, too.
- Comparison between II, SA, and TS
  - Compare them in terms of solution quality, computational efficiency, simplicity, robustness, etc.

Documentation

- You are encouraged to do more experiments.
  - Difficulty of problem instances
    - Run a random search with equal computational effort and see how much difference between random search and your algorithms is.
    - Run the iterative improvement for a large number of times (say 1,000,000) and record the number of local optima and size of basin of attraction.
    - Define a distance between solutions and check if there exists the "big valley" structure.
    - Discuss how the three algorithms perform differently on instances with different sizes.
    - Intensification or diversification? Which is more important?

Documentation

- You are encouraged to do more experiments.
  - Performance analysis
    - Try different setting of cooling schedule and tabu list and see how the performance varies.
    - Examine which parameters are more critical to the algorithm performance.
    - Examine which algorithm is more sensitive to the parameters.
    - Draw the “makespan vs. iteration” plot and see how the algorithms converge and which algorithm converges faster.

Grading

- Correctness
  - Define the problem and objective correctly.
  - Describe the algorithm correctly.
  - Verify your results.
  - Interpret the results and draw the conclusions correctly.
    - Do not make any claim without evidence.
    - Use the experimental results to support your claim.
- Clarity
  - Describe your ideas, algorithms, and experiments in detail.
- Carefulness
  - fonts, notations, figures, tables, references, etc.
- Completeness
  - how much effort you spent on this project

Problem 1:

Making Wrong Conclusions

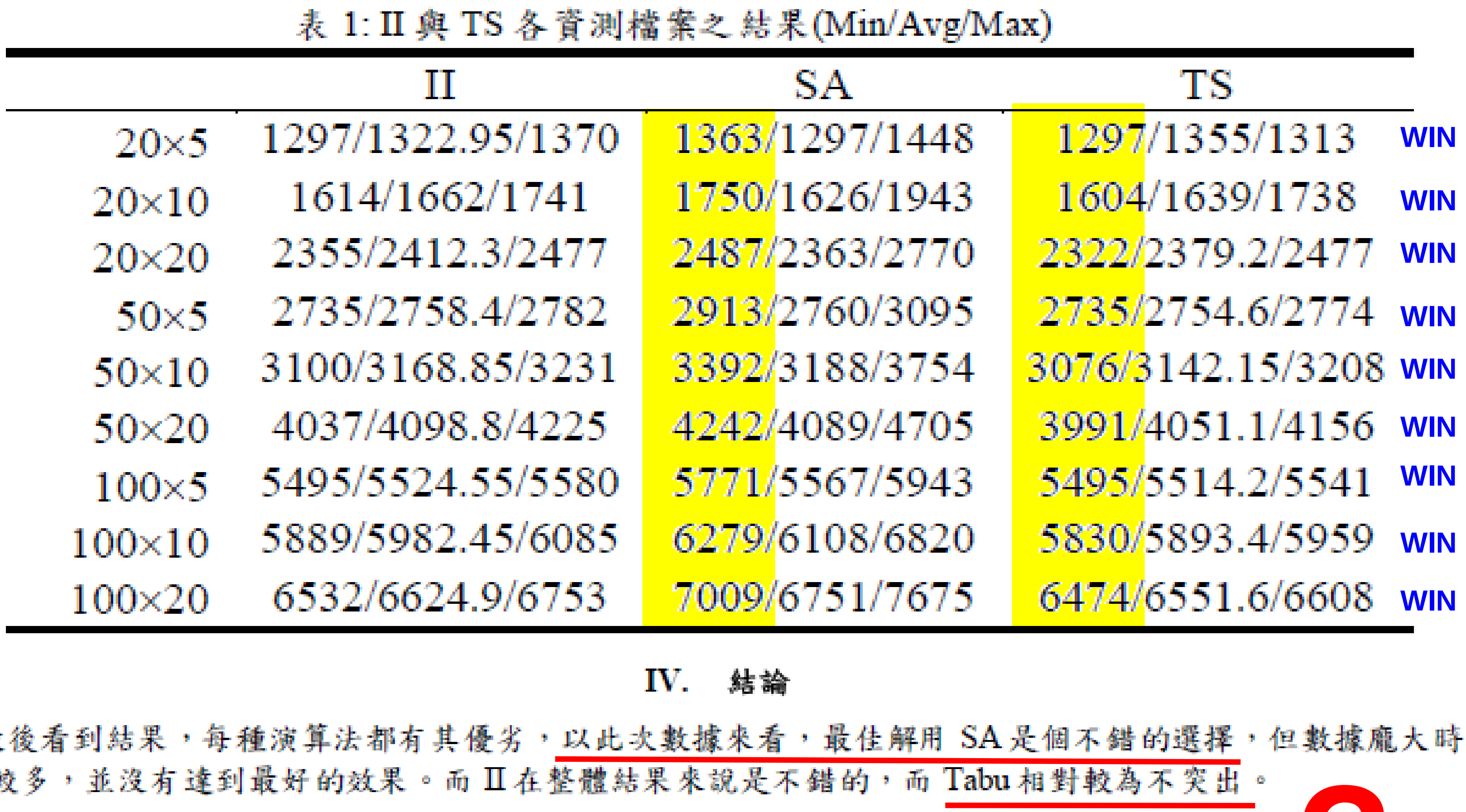


表 1: II 與 TS 各資測檔案之結果(Min/Avg/Max)

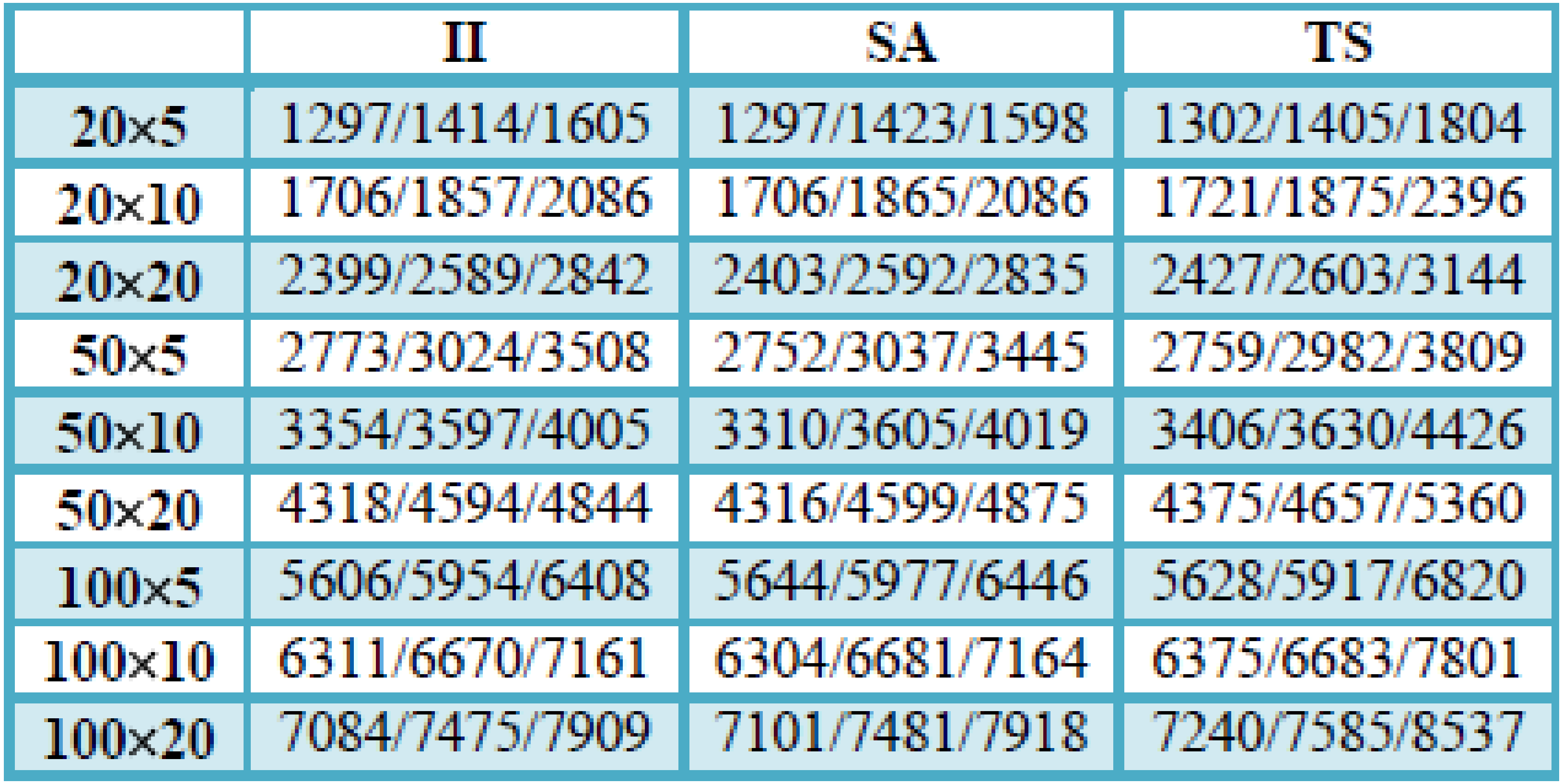
	II	SA	TS	
20×5	1297/1322.95/1370	1363/1297/1448	1297/1355/1313	WIN
20×10	1614/1662/1741	1750/1626/1943	1604/1639/1738	WIN
20×20	2355/2412.3/2477	2487/2363/2770	2322/2379.2/2477	WIN
50×5	2735/2758.4/2782	2913/2760/3095	2735/2754.6/2774	WIN
50×10	3100/3168.85/3231	3392/3188/3754	3076/3142.15/3208	WIN
50×20	4037/4098.8/4225	4242/4089/4705	3991/4051.1/4156	WIN
100×5	5495/5524.55/5580	5771/5567/5943	5495/5514.2/5541	WIN
100×10	5889/5982.45/6085	6279/6108/6820	5830/5893.4/5959	WIN
100×20	6532/6624.9/6753	7009/6751/7675	6474/6551.6/6608	WIN

IV. 結論

最後看到結果，每種演算法都有其優劣，以此次數據來看，最佳解用 SA是個不錯的選擇，但數據龐大時，可能由於參數較多，並沒有達到最好的效果。而 II 在整體結果來說是不錯的，而 Tabu 相對較為不突出。

?

Problem 2:
Presentation



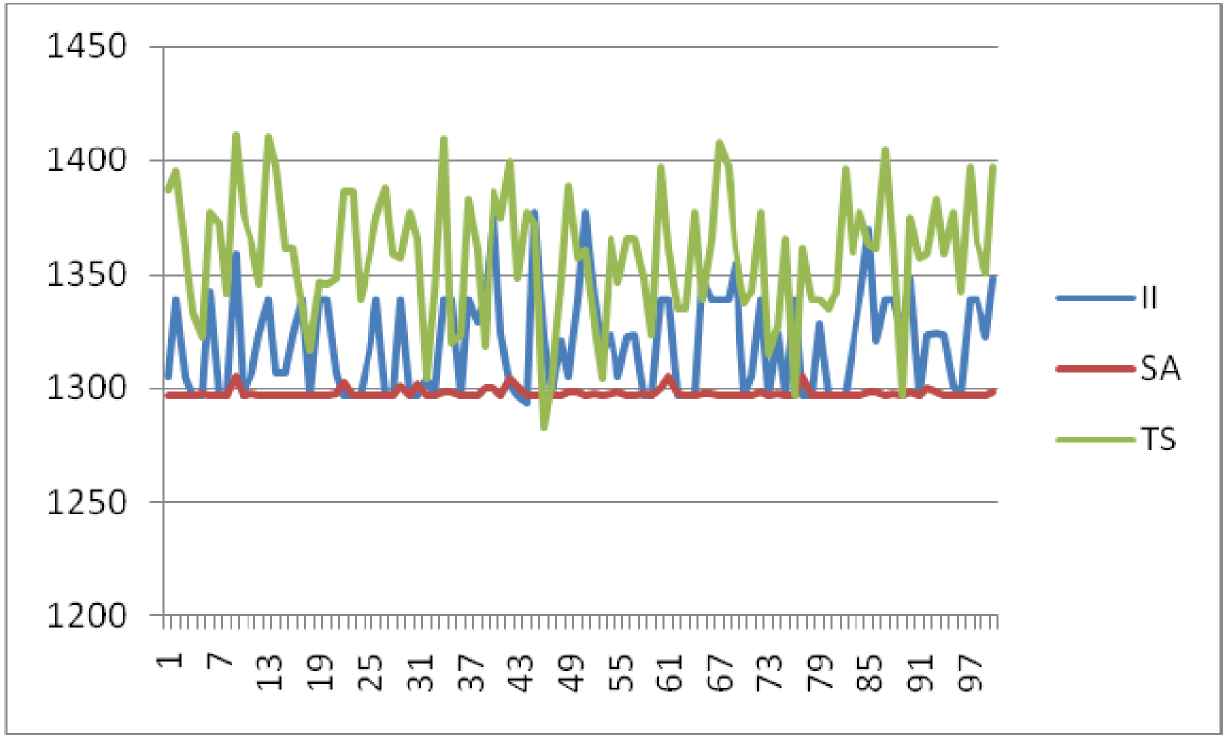
	II	SA	TS
20×5	1297/1414/1605	1297/1423/1598	1302/1405/1804
20×10	1706/1857/2086	1706/1865/2086	1721/1875/2396
20×20	2399/2589/2842	2403/2592/2835	2427/2603/3144
50×5	2773/3024/3508	2752/3037/3445	2759/2982/3809
50×10	3354/3597/4005	3310/3605/4019	3406/3630/4426
50×20	4318/4594/4844	4316/4599/4875	4375/4657/5360
100×5	5606/5954/6408	5644/5977/6446	5628/5917/6820
100×10	6311/6670/7161	6304/6681/7164	6375/6683/7801
100×20	7084/7475/7909	7101/7481/7918	7240/7585/8537

Which one is better?

Problem 2:

Presentation

- Colors of curves are similar, and it’s hard to distinguish them in a black-and-white copy.



Problem 4:

Typesetting

For MS Word users:

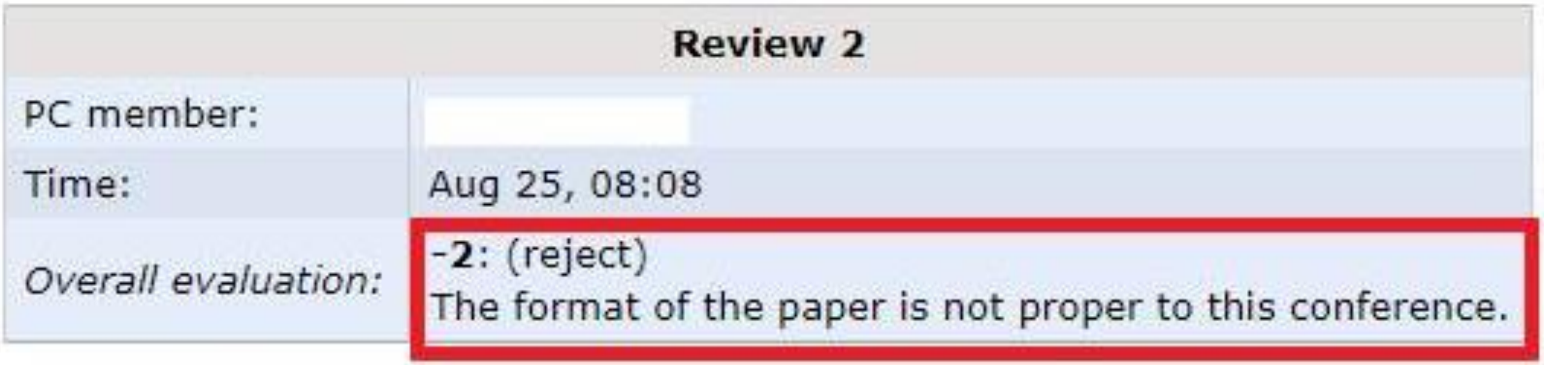
- Mathematic symbols (x, y, z) should be italicized.
- Constants should not be italicized. ($x = 1$)
- Type superscripts x^1 and subscripts y_2 correctly.
- Learn how to use "插入符號".

*	×
‘	′
<=	≤
a	α
-	−

Problem 4:

Typesetting

- Avoid typos. These “minor” mistakes make readers lose confidence in your research results.
- Use consistent font, format, style, and wording in the whole document.



Review 2	
PC member:	[redacted]
Time:	Aug 25, 08:08
Overall evaluation:	**-2**: (reject) The format of the paper is not proper to this conference.

Submission

- Deadline: 2024/3/28 23:59
- The package “MHPS2024-HW1-TeamX.rar” should include
  - a directory called “code,” containing the source code.
  - a document called “MHPS2024-HW1-TeamX.pdf.”
- Submit the package on moodle by the team member with the smallest ID.