CSIE 5452, Spring 2025: Homework 2

Due April 1 (Tuesday) at Noon

When you submit your homework, select the corresponding page(s) of each question. Points will be deducted if no appropriate intermediate step is provided.

1 Simulated Annealing for Priority Assignment (40pts)

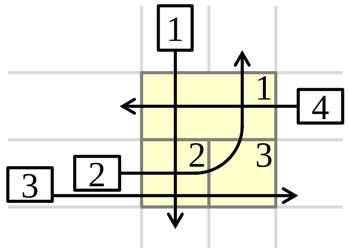
Please download the benchmark "input.dat" from NTU COOL. In the benchmark, the first number is n, the number of messages. The second number is τ. Each of the following lines contains the priority (P_i), the transmission time (C_i), and the period (T_i) of each message. Now, you are asked to use the Simulated Annealing to decide the priority of each message. The requirements are:

- The objective is to minimize the summation of the worst-case response times of all messages.
- The priority of each message must be an integer in the range $[0, n-1]$.
- The priority of each message must be unique.
- The worst-case response time of each message must be smaller than or equal to the period of each message.
- The given priorities are the initial solution in the Simulated Annealing.
- We expect the total runtime less than 15 seconds.

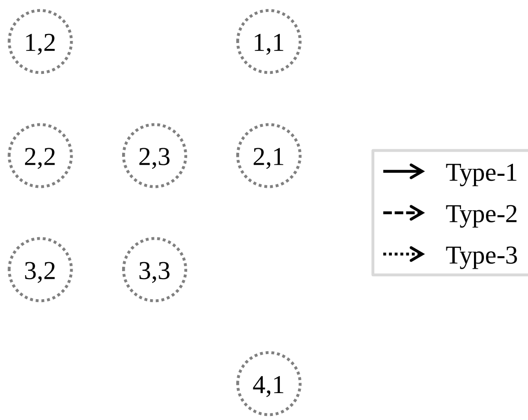
You are required to do three things in your submission:

1. You should print out n numbers (one number per line) representing the priorities of those messages. Note that you need to follow the message ordering in the benchmark, *e.g.*, the first number in the list is the priority of the first message in the benchmark.
2. You should print out 1 number representing your objective value (best one during your run).
3. You should also print out your source codes. We may ask you to provide your source codes which must be the same as those on your printout. If the worst-case response times above are correct but the source codes are clearly wrong implementation, it is regarded as academic dishonesty.

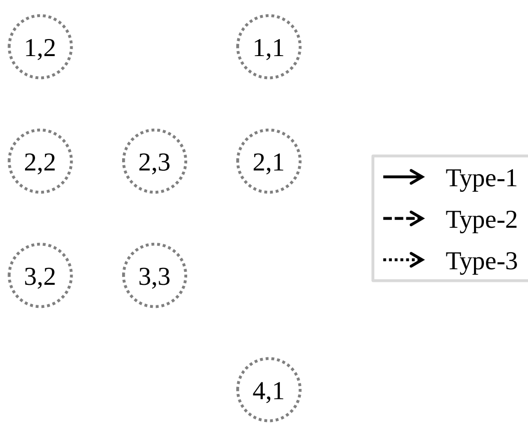
2 Intersection Management: Part I (20pts)



1. (8pts) Given the scenario in the figure above, follow the legend and draw the corresponding timing conflict graph.



2. (12pts) Following 1., given that Vehicle 4 enters Conflict Zone 1 before Vehicles 1 and 2, find a DEADLOCK solution which has no cycle in the corresponding timing conflict graph. Follow the legend and draw the corresponding timing conflict graph. Explain why there is a deadlock.



3 Intersection Management: Part II (8pts)

In the lecture, we introduced the *timing conflict graph* G to model the intersection management problem. We can remove some edges in G to get an acyclic graph G' as the solution of the problem. However, we need to build and verify the corresponding *resource conflict graph* H' of G': if H' is acyclic, then there is no deadlock in the solution G'. Please explain what will happen in the special case that the whole intersection is modeled as one single conflict zone. How will you solve the special case?

4 Intersection Management: Part III (8pts)

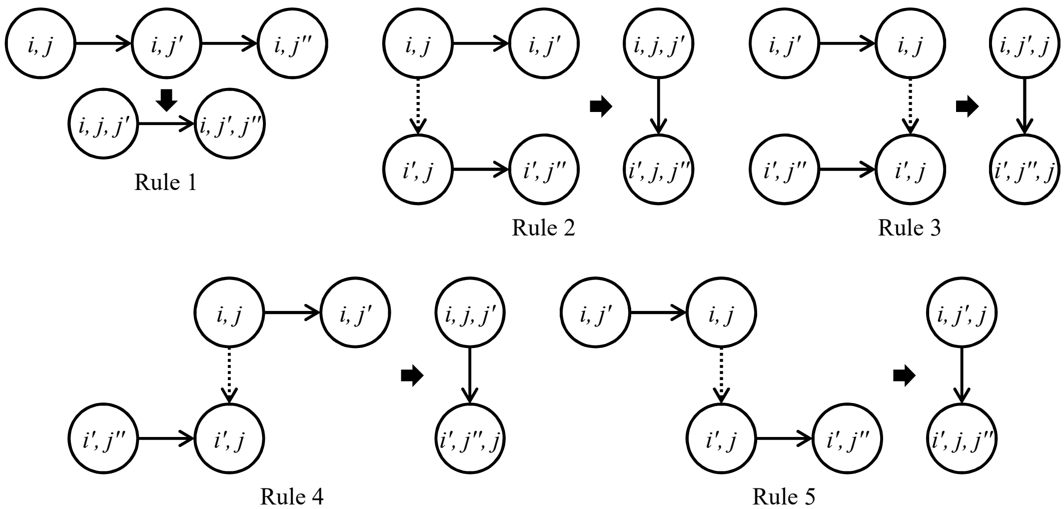


Figure 1: The construction rules.

In the lecture, we introduced the construction rules from the *timing conflict graph* to the *resource conflict graph*, as shown in Figure 1. With some conditions, we can use only two rules and ignore the other three rules for deadlock-freeness verification. Explain the conditions, identify the two rules, and discuss the benefits. Note: we are not looking for a specific intersection scenario nor a specific timing conflict graph; what we are looking for is: given "any" timing conflict graph, we can use only two rules for some part of it.

5 Realization of Level-X Autonomy (24pts)

In your opinion, when will be level-3/level-4/level-5 autonomy become realized? There will be no correct answers to these questions, and you can also answer them from many different perspectives including technology, cost, regulation, law, and human comfort. However, you should justify your answers with some explanation (*e.g.*, few sentences for each level). (This question will be graded by a letter grade with default grade A.)

1. (8pts) Level 3.
2. (8pts) Level 4.
3. (8pts) Level 5.