Project topics

February 27, 2025

1 AI for Cooking

Consider a hostel kitchen that provides (sumptuous!!) food for a large number of people. In the kitchen, different food items are prepared for various type of meals (veg, non-veg, Jain, etc.). The workers in the kitchen needs artificial intelligence based guidance for preparation of lunch. Assume that you have the following information:

- Number of people opted for veg, non-veg and Jain meals
- For each meal the items are known (For example, veg-meal consists of rice, roti, dal, sabji, etc., non-veg meal will have rice, roti, dal, chicken, etc.)
- For each food item (such as rice or sabji or any other), you have been given a directed acyclic graph that specifies the different subtasks to prepare the item. Each node in the graph indicates a subtask (like cleaning of item, cut vegetable, etc.). The edge in the graph denotes the dependency among the subtasks. One can proceed for a subtask only when all predecessors of it have been completed. For each node you have the following information - operation id (P_i) (unique), list of resources (like knife, pan, stove, etc.) needed to execute $[R_{i1}, R_{i2}, \ldots]$, time required for a batch of n number of people (t_i, n_i). You can assume batch sizes will be multiple of some number. For example, n can take values 50, 100, 150, etc. Suppose you need to execute a subtask (P_i) for 80 people and the required time is specified as (20, 50). Then one needs to spend total of 40 minutes to finish the job. These two instance of P_i can also be executed paralley provided sufficient number of cooks are available. Also, these two instances can be executed at two different time points. Execution of these two instances need not be consecutive. You can organize all jobs in batchwise manner. (See Fig. 1)
- Two food items can share some subtasks. For example, to make sabji and chicken, you need to *cut potatoes* (P_i). Two subtasks from two different DAGs having the same operation id can be combined to execute that task.
- You have a fixed set of resources which are known a priory.
- You have m number of cooks. Everyone is capable of executing any subtask. For each subtask, at least one person should be allocated.

Your job is to come with an efficient schedule that minimizes the finish time of preparation of foods. Additionally, you can consider other objectives such as near-balanced load for all cooks, or any other suitable metric.

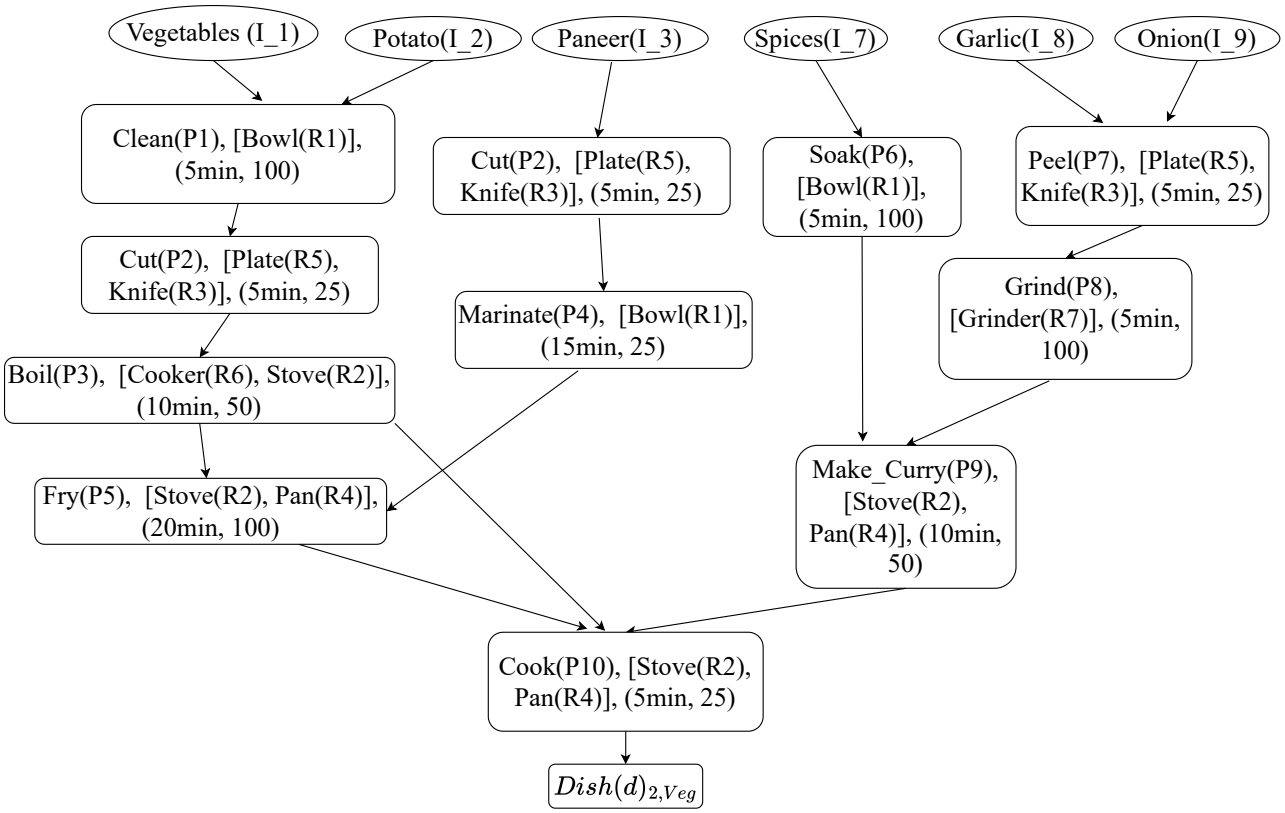

Figure 1: DAG for preparation of a food item

2 Electric Vehicle Routing Problem (EVRP)

Consider a city network as shown in Fig. 2. There is a warehouse/depot from where different items are delivered across the cities. The items are also picked up from different parts of the city and delivered to the depot. In the figure the blue nodes denote a customer location. Two labels at each such node specify the pick-up and delivery amount (kgs) in that node. The labels (black) across the edges denotes the distance between two nodes. The depot owns k number of homogeneous electric vehicles using which the pick-up and delivery demands are managed. Assume that each vehicle has a weight carrying capacity of W. These vehicles start their journey from the depot and at the end it comes back to the depot. Assume that all vehicles have full charge initially, E say. If a vehicle moves d distance with an weight of w then it consumes $\alpha \times d \times w$ amount of energy, α is some constant known a priory. A vehicle needs to visit some charging station or depot before the charge level falls below 15% of the full capacity. Assume that each charging station has m number of charging ports. It means that in a charging station at a time at most m number of vehicles can be charged simultaneously. If there are more than m vehicles at a charging station then some vehicle has to wait to get it charged. You can assume that the charging station follows first-cum-first serve policy for charging. The charging rate at a charging station is constant, therefore the amount of time is spent for charging depends on much charge a vehicle takes. A vehicle can decide how much charge it has to take, that is no need to charge the vehicle to full capacity.

The goal is to come up with routing plan of the vehicles that optimizes the total energy consumed by all vehicles. Apart from this, you can add any other optimization criteria such as minimizing the total distance traveled, minimizing the finish time, etc.

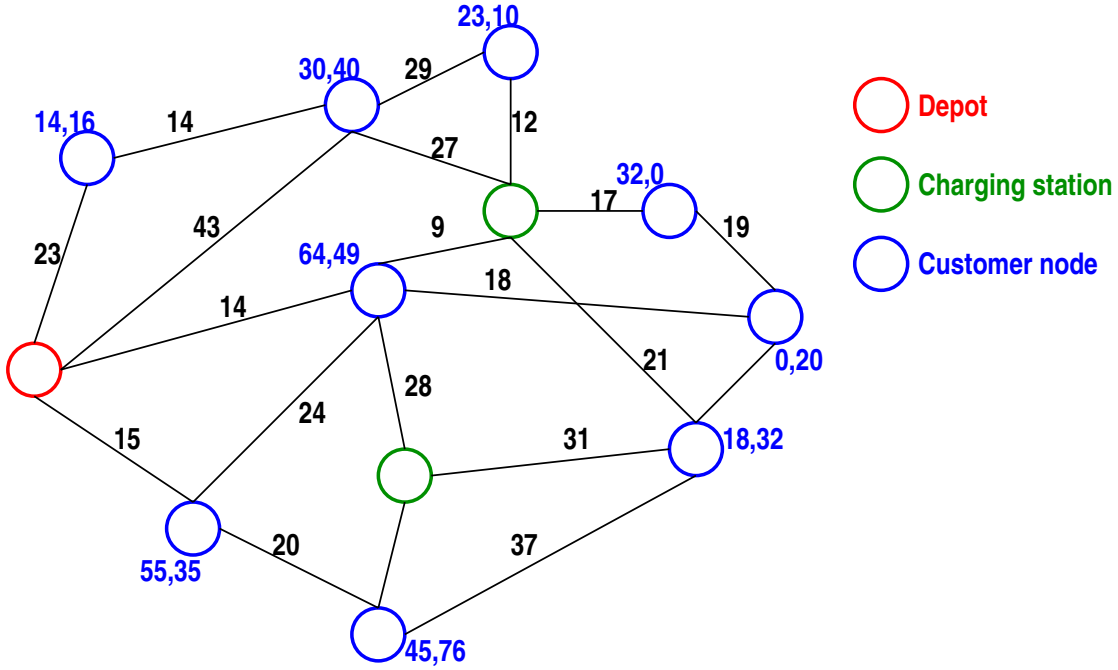

Figure 2: EVRP

3 Time Table generation

Consider the generation of time table for Spring Semester of IIT Patna. In this semester, IIT runs a set of courses that include core, elective, practical, etc. Once the students have been registered, the academic section can provide you the list of students and the subjects in which they are registered. The department can provide you the list of faculty members and the subjects taught by a faculty members. Additionally, CETC office provides you details of class rooms. Your job is to come up with a time table for the whole institute.

Following are the given information:

1. Student & the subjects in which he/she is enrolled (number of subjects for students can vary):
   Roll-No, S1, S2, S3, S4, S5
2. Details of each subject (Subject code, Lecture, Tutorial, Practical, and optional Lab-location for Practical):
   S1, L, T, P, [Lab-location]
3. Faculty details (Employee-id and list of subjects the faculty is teaching. A subject can be taught by no more than 2 faculty members)
   Employee-ID, S1, S2
4. Room details (Room number and seating capacity)
   Room-No, Capacity
5. Class must be held between 0800 and 1800 hours with 1300-1400 as lunch break.
6. Subject having L=3 can be held in 1+1+1 or 1+2 format. It means either one lecture on 3 days or 1 single and 1double lectures on two days.
7. Subject having P=3 or 2 should be held consecutively on the same day.
8. Subject having L-T as 3-1 can be held 1+1+1+1 or 1+2+1 or 2+2 format.

Your job is to generate a time table for the institute for all students that does not have any conflict. Quality of the time table can be analyzed based on the following parameters

- Number of gaps between lectures for all students
- Switching of rooms for consecutive lectures for all students
- Avoiding 0800 and 1700 hours class
- You can add any other suitable quality measures

Inputs for 1, 2, 3, 4 should be taken in CSV format. You need to read multiple files.

4 General guideline

- Need to develop optimal algorithm - search / CSP based
- Propose meta-heuristic algorithms
- Propose heuristic algorithms
- Need to submit a report highlighting the problem statement, methodology, and comparative study of different methods
- Need to upload 15-20 minutes presentation video
- Other details will be provided in the class
- Submission can be done in group with no more than 4 students. The tentative deadline for submission is 10th April.