University course timetabling

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The university course timetabling problem is an optimization problem where a set of events needs to be scheduled in time slots for students, lecturers and located in the appropriate room while maintaining the constraints.

The general constraints for course timetabling problem can be classified into two types which are hard constraints and soft constraints.

Examples of hard constraints

- H1: No student can be assigned to more than one course at the same time.
- H2: The room should satisfy the features required by the course.
- H3: The number of students attending the course should be less than or equal to the capacity of the room.
- H4: No more than one course is allowed at a timeslot in each room.

Useful algorithms

most of the nature-inspired algorithms depend on their convergence rate and convergence rate depends on the fitness function and algorithmic parameters. So, it will be better that we can apply **Genetic algorithm** vs **ant colony** vs **bee algo** or any **hybrid algo**, after the anlyzing the proper differences among these.

- ACO
- BCO
- GA
- Hybrid algorithm

Ant Colony Optimization(ACO)

ACO algorithm is inspired from the foraging behavior of real ant colonies.

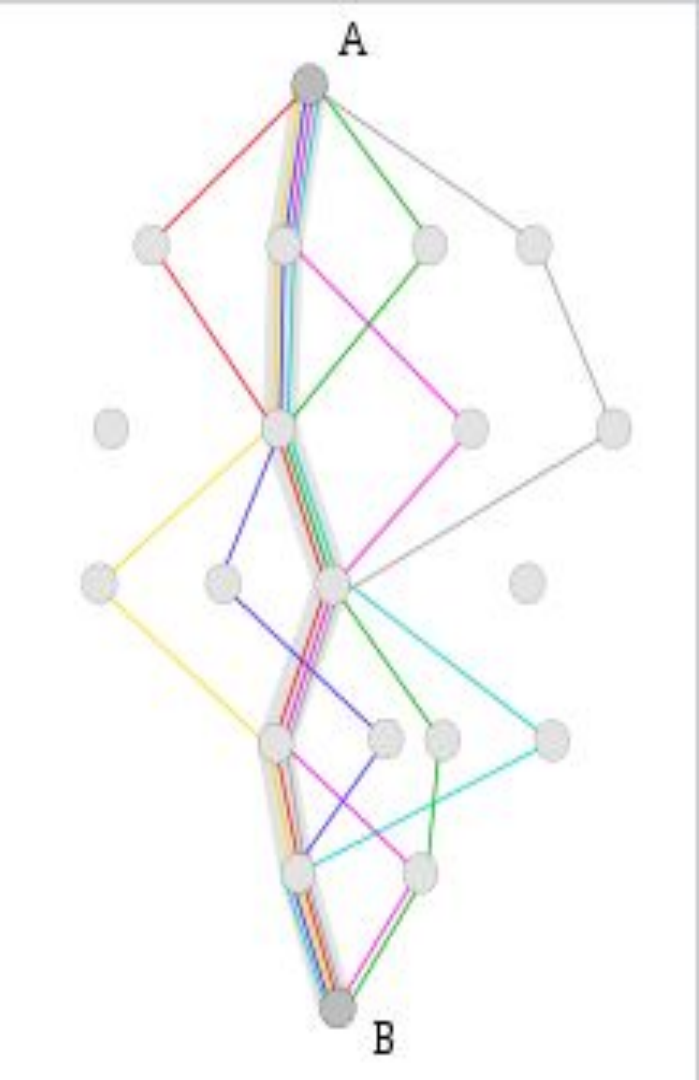
how does CAO work?

In ACO algorithm artificial ants successfully construct solution based on the global information (pheromones) and local information. The pheromone then acts as a probabilistic model for the construction of solutions and is constantly amplified by ants built with high quality solutions. Hence, pheromone evaporation surpasses premature convergence to a poor local optimum.

What problems can be solved with this algorithm?

discrete optimization problem and other combinatorial problems for example:

- travelling salesman problem (TSP)
- graph coloring
- scheduling problems
- vehicle routing problems


A
B

$$P_{ij}^{k} = \frac{[\tau_{ij}]^{\alpha}[\eta_{ij}]^{\beta}}{\sum_{l \in N_i^k}[\tau_{il}]^{\alpha}[\eta_{il}]^{\beta}}, j \in N_i^k$$

- P: transition probability that the ant k, currently at node i will choose and move to the next node j
- τ: the pheromone trail value on the edge connecting to node i to node j
- η: the heuristic value of that edge and $\eta_{ij} = 1/d_{ij}$
- α and β are the parameters that determine the relative influence of pheromone trail and the heuristic information
- Ni k is a set of all nodes that remains to be visited when the ant k is at i

Bee Colony Optimization (BCO)

The honey bee algorithm, also known as slow theme optimization (BCO), is a nature-inspired algorithm based on the search of bees.

how does BCO work?

The algorithm includes three categories of bees:

1. Bees Employed: These bees explore the space to find possible solutions to the problem. These solutions are candidates for the problem. Bees evaluate these solutions using an objective function and transmit information about the quality of the found solutions to other bees.

2. Onlooker Bees: Onlooker bees do not look for solutions directly; they choose solutions based on information provided by worker bees. The probability of choosing a solution is determined based on its quality. Onlooker bees then They evaluate solutions and perform local searches to increase their quality.

3. Scout Bees: These bees have their emphasis on variety and exploration. If the probing bee realizes that a solution is not suitable or optimal, it leaves that solution and randomly examines a new solution. Exploratory bees maintain diversity in the number of solutions and prevent the orphan algorithm from getting stuck in non-optimal solutions.

Genethic Algorithm

a special type of evolutionary algorithm that uses biological techniques such as inheritance, biological mutation, and Darwin's principles of selection to find the optimal formula for prediction.

how does Genetic Algorithm work?

A very famous scenario where genetic algorithms can be used is the process of building a timeline or scheduling a timeline. Consider that you are trying to provide a weekly timetable for classes in a college for a particular category. We need to arrange the classes and provide the timetable so that there are no conflicts between the classes. Here our task is to search for the timetable. is optimal. Encoding details into a chromosome:

You can encode classes as a binary pattern for a chromosome.

You can give binary values for any value in any entity. You can change the encoding pattern as you like.

<Data Mining, STG3, Monday, Hall D, 8.00AM>

Data Mining - 0000
STG3 - 00011
Monday - 000
Hall D - 1010
8.00AM - 1000

Chromosome - **000000011000010101000**

Hybrid Algorithm

a type of optimization algorithm that combines two or more different optimization techniques to improve the overall performance of the optimization process.

how does Hybrid Algorithm work?

The idea behind the Hybrid algorithm is to take advantage of the strengths of each individual optimization technique and combine them in a way that can overcome their weaknesses. The general steps for implementing a Hybrid algorithm in optimization are as follows:

1. Choose the optimization techniques to be combined
2. Define the optimization problem
3. Implement the individual optimization techniques
4. Combine the optimization techniques
5. Evaluate the performance

Overall, the Hybrids algorithm is a flexible approach that can be customized to fit the specific requirements of a university course timetabling problem. It combines local and global search algorithms to efficiently explore the solution space and find high-quality timetables.

Conclusion

Finally, choosing the algorithm can be very effective in continuing the project. As a result, we should do more research on various solution methods and find the most optimal ones according to the problem.