# FINAL PROJECT FOR MODERN OPTIMIZATION METHODS FALL SEMESTER 2021

The main goal of this final project is to learn new algorithms on top of those learnt from the lecture, and to gain the ability to judge and compare these new algorithms to the existing ones. Here is a list of components that will be required in the final project.

1. **A Revision on Traveler Salesman Problem.** *(10 points)* The first part of this project needs you to review the famous Traveler Salesman Problem (TSP). It is a classic optimization problem that many metaheuristic algorithms try to implement. In this section, please write down the following:

   (a) What is TSP?

   (b) What are the difficulties in TSP?

   (c) What are the applications of TSP in real life?

2. **Data Collection.** *(10 points)* It is well-known that 7-Eleven is the most abundant convenient store in Taiwan. The logistic among all stores is always very complicated. Now we only focus on all 36 7-Eleven stores in Nangang District, Taipei City, and look for the optimal path through these 36 stores, so that the delivery van can ship the goods in the shortest path. First, we need to collect the data. Follow the following steps below.

   (a) Go to the following website: https://emap.pcsc.com.tw/emap.aspx. Gather all addresses of Nangang 7-Eleven stores.

   (b) Go to Google Map and measure the pairwise store distances, and form a distance matrix.

   (c) Consider a complete graph with 36 nodes, each is a convenient store and the edge between two nodes contains the distance information.

   Then the question becomes how to draw a line to pass through all 36 nodes on this graph, so that the distance is the shortest.

3. **An Implementation of Known Metaheuristic Methods.** *(40 points)* In this course, we learn many metaheuristic algorithms and all these methods can be implemented in TSP. In this section, please implement the following algorithms in TSP.

   (a) Hill Climbing.

   (b) Random Walk.

   (c) Genetic Algorithm.

   (d) Simulated Annealing.

   (e) Tabu Search.

   (f) Particle Swarm Optimization (the standard one, not the SIB).

   (g) Ant Colony Optimization.

   For each algorithm, remember to state all necessary information, including the particle definition, objective function, goal, constraints, etc.

4. **Method Comparison.** *(30 points)* Now each of you will have 7 methods on hand. Please run them in TSP of 7-Eleven convenient stores in Nangang and answer the following questions.

(a) Write down all parameters of 7 methods and state why you choose these values (so please choose reasonable values).

(b) Provide the results of 7 methods on TSP of 7-Eleven convenient stores. You need to provide 7 lists of store names in order, and provide 7 maps with the routes.

(c) Draw the progress plot by overlapping the results of all 7 methods. Note: some are single-state methods and some are population-based methods.

5. **Conclusion.** *(10 points)* In the last part of this final project, please provide the following information:

   (a) Summarize your comparison results on 7 methods.

   (b) State the advantages and disadvantages of all 7 methods shown in this application to TSP.

   (c) State at least one potential improvement on the best method to make the algorithm even better on this TSP application.

   (d) Suggest a potential memetic algorithm by combining two good methods from the 7 methods that is suitable for improving the result of TSP.

6. **Find New Method by Yourself.** *(Bonus 20 points)* A bonus score will be given if you do the following:

   (a) In fact, there exists many metaheuristic optimization methods nowadays, see Wikipedia for the complete list. Among them, try to pick one method that is not learnt from the course.

   (b) Write your own program code for the new metaheuristic method you picked.

   (c) Apply the new metaheuristic method to TSP. Provide its result on TSP of 7-Eleven convenient stores like those in Q4.

   (d) Add the result of new metaheuristic method to the progress plot. Note: the new method you pick is not necessarily the best method among all, but it cannot be the worst method.