HOMEWORK1

I. INTRODUCTION

● _One-max Problem_ DEFINITION (Search Space)

One-max problem is a very simple problem where is to find a specific solution make maximum value of evaluation.
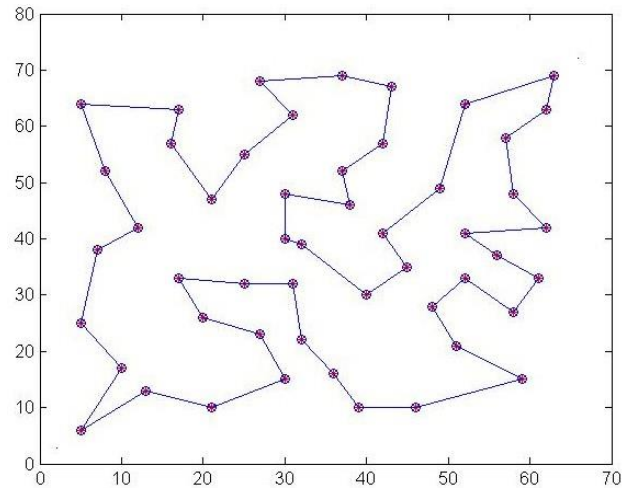
Here we give a search flow example of 10bit one-max problem:

- _10010 01101_: a random example of candidate solution
- _11010 01101_: find another candidate solution (chance 1 bit of origin candidate solution)
- …
- …
- _11111 11111_: a target example of solution (optimal solution)

So, we need to find the candidate solution in the Search space, trying to pick up the better or optimal solution using some _heuristic technique_, instead of exhausted search all the candidate solution.

- *Traveling Salesman Problem* DEFINITION (Search Space)

TSP is a problem in combinatorial optimization, we given a set of coordinates of cities, you need to find the shortest possible route that visit every city exactly once and returns to the starting point.

Figure above is a best solution of *eil51 dataset of TSP*, and here we give a search flow example of 10 cities of TSP:

- *1 10 9 5 6 4 2 3 7 8 1*: a random example of candidate solution
- *1 10 9 5 6 4 2 3 8 7 1*: find another candidate solution (exchange two cities or using other operator)
- …
- …
- *1 2 3 4 5 6 7 8 9 10 1*: a target example of solution (optimal solution that make minimum value of route distance)

Remarks: Each number represent the city

- _Hill Climbing_ DEFINITION (Search Algorithm)

Hill Climbing is a simple also essential part of metaheuristic algorithm. The spirit of the algorithm is that you just iteratively test new candidate solutions in the region of your current candidate, and adopt the new ones if they're better, this enable you to climb up the hill until you reach a local optimum.
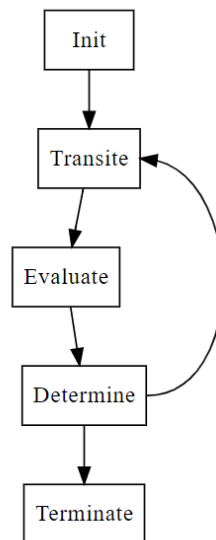
Here are several main operators of HC, also main spirit of meta-heuristic algorithm.

1. Initialization: give a random candidate solution of problem (one-max or TSP).

2. Transit: do some operation on origin candidate solution such as _bit-flip, bit-random-assign, two-bit-exchange, …etc._ you also can develop your own operator on _Transit stage_.

   Remark: normally we adopt bit-flip, bit-random-assign on one-max problem, and two-bit-exchange on TSP.

3. Evaluate: assessment of candidate solution, this operation will return the value of the specific candidate solution where will be used in the next stage.

4. Determine: return the better between origin and new candidate solution which produced by transit stage.

- **■** Flow Chart

```
          ┌──────┐
          │ Init │
          └──────┘
              │
              ▼
          ┌──────────┐
          │ Transite │◄─┐
          └──────────┘  │
              │         │
              ▼         │
          ┌──────────┐  │
          │ Evaluate │  │
          └──────────┘  │
              │         │
              ▼         │
          ┌───────────┐ │
          │ Determine │─┘
          └───────────┘
              │
              ▼
          ┌───────────┐
          │ Terminate │
          └───────────┘
```

Remarks: we do the loop until reach ideal solution or run out of iteration.

- **■** Pseudocode

  //INITILIZATION

  origin = random a candidate solution

  repeat

  　　// TRANSIT

  　　tmp = transit(origin)

  　　// EVALUATION and DETERMINE

  　　if evaluate(tmp) > evaluate(origin)

  　　　　origin = tmp

  until origin reach ideal solution or run out of iteration

II. Homework Requirement

- **There are _three_ option of homework:**
  - **Using Hill Climbing to solve one-max problem – (max score:10)**
  - **Using Hill Climbing to solve TSP – (max score:12)**
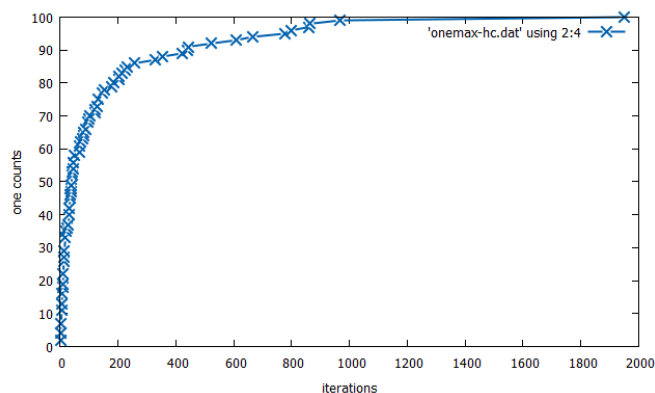   1. Programing language:
       - I.   C++
       - II. Java (IDE using eclipse)
       - III. Python

    2. You need to output the result of evaluation value w.r.t. iterations.

```
iteration value
0 3
1 6
2 11
3 15
4 18
5 21
6 26
7 29
8 31
9 34
10 37
11 39
12 42
13 44
```

[2] result of 100bit one-max problem using HC

3. (OPTIONAL) Plot the figure of relation between evaluation value and iterations.

[3] figure of 100bit one-max problem using HC

4. You need to Comment out in your code.

- **Do research on Hill Climbing and report it (500 words) –**
  (score range:6-10)
  You need to analyze the _Pros and Cons_ of _Hill Climbing search algorithm_ and _propose your own method_ to improve this algorithm. You can also read the paper about HC and report it.

III. Common Requirement

1. Pack your code or report as a compressed file _per group_ and name as "hw1_Group#" like (hw1_Group1), upload it by team leader when finished.

2. Contact TA while you encounter any problem
   - M083040036@student.nsysu.edu.tw　方祉�　助教
   - M083040069@student.nsysu.edu.tw　蕭哲瑋　助教
   - M083040072@student.nsysu.edu.tw　許嘉榮　助教