Instruction

# Description

* This objective of this file is to instruct you how to solve bi-level network design problem using GA in Matlab.
* This course does not require you to code GA yourself. However, you should be able to use it as tool box to solve problem.
* This folder contains four folders each folder corresponding a small tasks which will be explained in the next section.
* The bilevel modelling is one of the core elements for this course. So it is essential you have a conceptual undertanding of it.

# Self-study Examples and Exercises

## **Example 1 Code & decode GA**

Objective

* Know how to decode binary GA presentation to variables

Code

* Study the code “Example 1 decode GA”

Small Exercise

Given [1,0,1,0,1,1,1,0,0,1]

1. If it represents a integer value, what it is ?
2. If it represents a continuous value between 4 and 8, what it is ?

## **Example 2 familiar with basic MATLAB GA syntax**

Objective

* Use the basic syntax of GA

Code

* Folder “Basic GA”

Small Exercise

Solve the following function with constraints that x is integer



You need to change the fitness function.

## **Example 3 Simple bilevel**

Objective

* Understand the basic bilevel structure and how it can be solved by GA

Code

* Folder “Simple Bilevel”
* Problem (example will be introduced in the course)



where



Small Exercise

* How to add additional boundary constraints for  and 

## **Example 4 Simple bilevel network Design**

Objective

* Solve simple bilevel network design problem

Code

* Folder “network design”
* Problem description for this example
  + You are given a network containing 4 nodes and 12 links, the weights represent the travel times associated with the 12 links.
  + The objective of the model is to select 4 links to form transit network, such that total travel times of A-C, A-B, and A-D is minimum. In other words, we need to find the shortest travel time between these pairs of nodes.
  + The way I code is to create 4 variables. Each variable is a integer between 1 to 12, representing which link is selected.

Small Exercise

* In the given example, I only consider demand. Now you need to work out how to consider demand. The following demand values are known.
* Node A –> B: 50 passengers
* Node A –> C: 60 passengers
* Node A –> D: 25 passengers
* Instead of only building 4 links. You can build as many links as possible. However, the operation cost on every link is $50
* Assume passengers only use the shortest path, design a network that minimize the total cost including passengers travel time cost and operation cost.

# Remarks on the extensions

* You could consider more complicated assignment model in the lower level by changing the lower level problem
* You can consider frequency as variable in the network design problem.

# Reference

* About Genetic algorithm (GA): <https://en.wikipedia.org/wiki/Genetic_algorithm>
* Matlab help documents <https://se.mathworks.com/help/gads/ga.html>