IE 507, Modeling and Computation Lab : Lab 5 : 7/Sept/2022
Instructions:
Deadline for submitting files on Moodle: 8 Sept, 1130 PM
Deadline for late submission of files on Moodle: Saturday, 10 Sept, 8 PM

Please follow the general instructions given below
- The name for submission should be YOURROLLNUMBER_IE_507_Lab5.pdf
- Please post your doubts in Moodle so that TAs can clarify.

We will practice some formulations of discrete optimization problems and their solution through some heuristics.

Some of these problems may be possible to model as Mixed Integer Linear programmes, but in some practical situations, that may not be needed (or possible to do). Often, simple, good quality heuristics are also available and we will try to see a few examples.

Exercise: Berlin Tram Map colouring problem. [10 marks] See the pdf file in moodle representing the tram network in the city of Berlin. The tram routes in the city are M1, M2, M4, M5, M6, M8, M10, 12, M13, 16, M17, 18, 21, 27, 37, 50, 60, 61, 62, 63, 67, 68. You can observe that when tram routes intersect at any point in the tram network, they have different colours. This makes is possible to easily track the route of a tram through the network (please try out what would be the difficulty if all routes were depicted with the same colour). The question is how to do this with the minimum number of colours (so that they are all nice and distinct). Think of ways of doing this on your own.

The raw data is on moodle, in the form of the pdf map and the route intersection info (in csv format).

1. [R] Provide your specific solution for the Berlin tram routes. You need to specify the number of colours used and which colours are used for which routes.
2. [R] Explain your procedure in your own words (you may be asked about this in a short oral exam!), written in the form of a flow chart which can be implemented for larger problems.
3. [For extra credit] The TAs (Ankit and Gurkirat) have provided the template of python code for this decision. You can use this for developing your solution or write your own code to take the route intersection matrix as input and give the colour assignment to each route as output. If you do this, pl submit as YOURROLLNUMBER_IE_507_Lab5_code.pdf
4. Will your procedure work if route information is provided to you one at a time? This means that routes are specified one at a time and you can only check whether they intersect with the routes already given to you (i.e. you don't know the entire route information at the beginning).
5. [R] If we have n routes and there is a route that intersects the other $n - 1$ routes, then we need n colours to represent the map. True or false? If true, provide a proof, if false, provide a counterexample.
6. Those interested can try a math programming (integer programming) formulation for this decision.

Also for those interested, the Berlin bus network map is a much bigger one and will require much more effort to colour.