In this assignment, you model and solve problems for mathematical programming. You need to

(1) Formulate MP models.
(2) Implement the MP models using Python and Gurobi.

1. Submission Instructions

Submit a PDF file describing mathematical programming formulations and optimal solutions to the problem instance. Also, submit a program (a Python script or a Jupyter notebook) using Gurobi to solve the problem instance. In the MP formulation, clearly define decision variables and state the objective function and constraints. For the problem instance, report the values of the objective and decision variables.

2. IP

A car factory crafts three distinct varieties of cars: the nimble "Sprint", the versatile "Voyager", and the majestic "Titan". For each of these models, the requirements for steel and labor hours, along with the revenue and variable costs per unit, are outlined in the accompanying table.

Car Model	Sprint	Voyager	Titan
Steel per Unit (tons)	1.5	3	5
Labor Time per Unit (hours)	280	250	320
Revenue per Unit (k$)	11	14	16
Variable Costs per Unit (k$)	8	10	11

At the factory, the monthly availability of steel is 600t and monthly total labor hours are 60,000h.

Question 1: assuming an absence of fixed costs, develop a monthly production plan to maximize the profit of factory. Build the model formulation and solve the model with Gurobi.

Question 2: under certain limitations, if a certain model of car is to be produced, at least 70 units must be manufactured. How should the optimal production plan be changed? Build the model formulation and solve the model with Gurobi.

Question 3: based on **Q1**, we now know that once producing a certain model or a combination of models, an overall fixed cost will be incurred as the table shows.

Model to Produce	{S}	{V}	{T}	{S,V}	{S,T}	{V,T}	{S,V.T}
Overall Fixed Cost (k$)	180	240	240	300	420	400	450

For instance, the fixed cost for producing only the "Sprint" is $180k, while for producing just the "Voyager" it stands at $240k. If the decision is made to manufacture both the "Sprint" and "Voyager" but not the "Titan", the total fixed cost amounts to $300k. Build the model formulation and solve the model with Gurobi.

3. Dynamic Programming

Formulate and solve problem 7 from DP problem set. You can solve the problem either by hand or using python.