🔺 **Exercises -** Section 2: Lecture 8 – Blending - Questions

(For Question 1, the English model is provided. For Questions 2 and 3, you'll need to create it.)

1. A polling firm uses data that has been collected in three ways: online surveys, phone surveys, and door-to-door surveys. The company has three clients asking for surveys at the same time: a political candidate, a peanut butter manufacturer, and a travel website. The table below shows the cost per person surveyed, the average age of the people surveyed, and the maximum number of people who can be surveyed by the firm's employees, for each survey type.

Survey type	Cost per person	Average age	Maximum number surveyed
Online	$1	29	10,000
Phone	$10	50	5,000
Door-to-door	$30	42	2,000

Each of the three clients requires a certain number of people to be surveyed, and has a desired average age range (i.e., the average age of the people surveyed must be between the minimum and maximum).

Client	Number of people surveyed	Minimum average age	Maximum average age
Political candidate	3,000	40	49
Peanut butter manufacturer	1,500	32	38
Travel website	2,000	35	55

Create mathematical and gurobipy models that the polling firm can use to minimize its cost of compiling survey data for the three clients. Solve the gurobipy model. [You do not need to require integer solutions; at this scale, the difference between rounding up or down is negligible.]

ENGLISH	MATH	GUROBIPY	`m=gp.Model("survey")`
<u>Data</u> Number of survey types Number of customers Cost per person for each survey type Average age of each survey type			

Maximum number of people surveyed for each survey type Number of people needed for each customer Minimum and maximum average ages for each customer		
Variables Number of people of each survey type used for each customer's survey		
Objective Minimize cost		
Constraints Maximum people surveyed of each type Minimum people surveyed for each customer Average age for each customer must be between minimum and maximum All numbers of people surveyed are non-negative		

2.   A paper recycling plant can recycle three types of paper: high-grade (laser printer paper, for example), newspaper, and telephone books. In the first stage of recycling, each type of paper is cleaned and then broken down into pulp. Pulp from high-grade paper has a quality rating of 95, newspaper pulp has a quality rating of 40, and telephone-book pulp has a quality rating of 65.

In the second stage, the plant manufactures newspaper, telephone-book paper, and high-grade paper out of the pulps. Newspaper requires an average quality rating of at least 35, telephone-book pulp requires an average quality rating of at least 60, and high-grade paper requires an average quality rating of at least 90. Furthermore, because people are used to a certain type of newspaper, it cannot have too high a quality; the average quality of newspaper can be no more than 50.

The recycling plant receives 100 tons of newspaper, 20 tons of telephone books, and 10 tons of high-grade paper each day to recycle. It is able to sell all of the paper products it produces, at a price of $10/ton of newspaper, $20/ton of telephone-book paper, and $40/ton of high-grade paper.

All paper that the plant receives must be recycled.

Create mathematical and gurobipy models that the paper recycling plant can use to maximize the money it receives from sales of recycled paper products. Solve the gurobipy model.

3.   A metallurgy company makes two grades of bronze – high grade and low grade. Both types of bronze are made by mixing copper and tin. High grade bronze must be between 65% and 85% copper (by weight), and low grade bronze must be between 45% and 60% tin. High grade bronze sells for $7 per pound, and low grade bronze sells for $6 per pound.

The metallurgy company obtains its copper and tin by extracting it from rock. There are two extraction processes: high yield and low yield. Each hour of high yield extraction requires 4 workers and 3 tons of rock, and produces 30 pounds of copper and 30 pounds of tin. Each hour of low yield extraction requires 3 workers and 2 tons of rock, and produces 25 pounds of copper and 15 pounds of tin. Each day, a total of 120 worker-hours and 100 tons of rock are available. All copper and tin produced each day can be converted into bronze.

Create mathematical and gurobipy models that the metallurgy company can use to maximize its revenue from the bronze it produces per day. (Assume all bronze produced can be sold.) Solve the gurobipy model.

NOTES: