Test of Operations Research - Mathematics Degree
December 5, 2022

1. **Solve the following problem using the Symplex method:**

   An automobile company produces four types of cars. The manufacturing process includes three stages: assembly, painting and inspection. In the following month, 800 working hours are available for assembly, 1,000 working hours are available for painting and 340 man-hours for inspection. The profits of the individual cars and the hours of each machine necessary for the production of the various models are shown in the following table:

	Car 1	**Car 2**	**Car 3**	**Car 4**
Profit (in Euro)	800	1400	3000	5000
Hours of Assembly	1	2	10	6
Hours of Painting	1.5	2	4	5
Hours of Inspection	0.5	0.6	1	2

   The company wants to maximize its profits.

2. **Write the formulation and the dual problem of the following one:**

   A fashion house must organize the transport service of the latest collection from the tailors to the ateliers. The clothes are available in 4 different centers and must be transported to 3 ateliers located in Milan, Rome and Catania, respectively. The table below summarizes the distance (km) between the centers and ateliers, as well as the transport cost of a dress for each kilometer (the transport cost of a dress is therefore given by the product of the cost per kilometer and the distance), from each center:

	Milan	**Rome**	**Catania**	**Cost**
Center 1	14	19	54	0.2
Center 2	12	31	45	0.26
Center 3	16	45	60	0.19
Center 4	21	44	46	0.29

   To each atelier it is necessary to bring the following minimum quantity of clothes:

	Milan	**Rome**	**Catania**
Clothes	28	58	25

   while in each center the following quantity of clothes is available:

	Center 1	**Center 2**	**Center 3**	**Center 4**
Clothes	34	38	35	22

   Construct a PL model that allows us to minimize the transport costs.

3. **Formulate the following problem:**

   During any 6-hour period of the day, the General Hospital Emergency Department needs at least the following number of nurses:

Time period	**Number of Nurses**
Midnight - 6 a.m.	12
6 a.m. - Noon	8
Noon - 6 p.m.	6
6 p.m. - Midnight	15

   Nurses can work shifts of 12 consecutive hours or 18 consecutive hours and are paid €12 per hour for each of the first 12 hours of the day they work and €18 per hour for each of the following 6 hours worked in a day. Formulate and solve a LP that can be used to minimize the cost to meet the hospital's daily requirements.

4. **Formulate the following problem:**

   An investor must choose how to invest his capital of 10,000 euros. He must choose how to divide the investment between 5 distinct types: Bank account, Government bonds, Bonds, Shares and Futures. Each of the 5 proposed investments offers an annual rate and presents a percentage of risk; moreover, to diversify the portfolio, the budget (in Euros) allocated to each investment must be between a minimum and a maximum value, that is:

	Rate of return	**Risk percentage**	**Min. invest.**	**Max. invest.**
Bank Account	2.5%	5%	0	1500
Government Bonds	6.5%	8.5%	1000	5000
Bonds	8.7%	12.4%	1000	5000
Shares	18.7%	20%	500	4000
Futures	11.7%	14%	0	4000

   The investment in Bank Accounts and in Government Bonds together must be at least 1/3 of the investment in Shares. The total risk percentage must not exceed 11.5.

   Create a PL model that allows us to determine the investment that maximizes the annual rate of return.