Introduction to Optimization Through the Lens of Data Science Course Exercises

Exercises - Section 4: Lecture 12 - Multiple Subscripts - Questions

Just like the tradition of using letters at the start of the alphabet for data and using letters at the end of the alphabet for variables, the tradition for subscripts is to start with i, then j, k, et cetera. However, there are exceptions, especially when the letter chosen might have meaning; for example, "t" is a common subscript to refer to time. Different modelers will use different notation, so don't worry if yours is different from someone else's.

Suppose we have the following notation for a rental car fleet planning model:

ENGLISH	MATH	GUROBIPY
Car types: i=1 (small), i=2	i	i
(midsize), i =3 (luxury), i =4		
(SUV), i =5 (minivan)		
Rental locations (100 locations,	j	Ċ
so <i>j</i> =1,2,,100)		
Forecasted annual rental	D_{ij}	D = { (i, j) : d for i in
demand for car type i at	_	range(1, 6) for j in range(1, 101)}
location <i>j</i> (forecasted data)		
Cost per car for car type i	C_i	C = {i: c for i in
(known data; same cost		range(1, 6)}
regardless of location)		
Number of cars of type i to	X_{ij}	x= model.addVars([(i, j)
purchase for location j		<pre>for i in range(1, 6) for j in range(1, 101)],</pre>
(variable)		name="x")

Fill in the table below, using the notation above to describe each of the following quantities mathematically and in Python.

QUESTION	MATH	GUROBIPY
1. Forecasted rental demand for		
luxury cars at location 75		
2. Forecasted rental demand for		
SUVs at location 31		
3. Cost per SUV		
4. Number of small cars to		
purchase at location 12		



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	5. Constraint: Need to purchase		
	at least 20 small cars at location		
ļ	12		
	6. Constraint: Can't purchase		
	more than 30 small cars at		
ļ	location 12		
	7. Forecasted demand for		
	midsize cars and minivans at		
ŀ	location 31		
	8. Forecasted demand for		
	midsize cars and minivans at locations 31-40		
ŀ	9. Forecasted rental demand for		
	cars (not SUVs or minivans) at locations 1-50		
ŀ	10. Total cars to purchase above		
	midsize at location 4		
l	11. Total luxury cars to purchase	1	
	across all locations		
Ì	12. Total vehicles to purchase		
	(across all locations)		
Ì	13. Cost of midsize cars		
	purchased at location 1		
İ	14. Cost of SUVs purchased at		
	location 96		
İ	15. Cost of midsize cars and		
	minivans purchased at location		
	96		
ĺ	16. Cost of SUVs and minivans		
l	purchased at locations 90-100		
	17. Cost of all cars (not SUVs or		
	minivans) purchased across all		
ļ	locations		
	18. Cost of all vehicles purchased		
ļ	across all locations		
	19. Average purchase cost of all		
	cars (not SUVs or minivans) at		
l	location 20		
	20. Average purchase cost of all		
ŀ	vehicles at all locations		
	21. Forecasted purchase cost per		
-	rental of SUVs at location 17		
	22. Forecasted purchase cost per		
	rental of minivans across		
١	locations 1-10	<u> </u>	1



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23. Forecasted purchase cost per rental over all vehicles at location 17	
24. Forecasted purchase cost per	
rental over all vehicles at all	
locations	

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