

Multi-Criteria Decision Making

Car Buying Problem



Problem 1

Problem 1		
Car	Price	Mileage
A	10000	26000
B	15000	16000
C	11000	22600
D	12000	25000
E	11000	27000

Problem 1 – Solution 1

Problem 1 - Solution 1				
Car	Price (↓)	Mileage (↓)	Price+Mileage (↓)	Rank
A	10000	26000	36000	3
B	15000	16000	31000	1
C	11000	22600	33600	2
D	12000	25000	37000	4
E	11000	27000	38000	5

Problem 1 – Solution 2

Problem 1 - Solution 2						
Car	Price (↓)	Normalized Price	Mileage (↓)	Normalized Mileage	Total Score (↓)	Rank
A	10000	0.00	26000	0.91	0.91	2
B	15000	1.00	16000	0.00	1.00	3
C	11000	0.20	22600	0.60	0.80	1
D	12000	0.40	25000	0.82	1.22	5
E	11000	0.20	27000	1.00	1.20	4
Min	10000		16000			
Max	15000		27000			

Problem 2

Problem 2		
Car	Price	Miles Per Gallon (MPG)
A	10000	26.0
B	15000	16.0
C	11000	22.6
D	12000	25.0
E	11000	27.0

Problem 2 – Numerical Solution

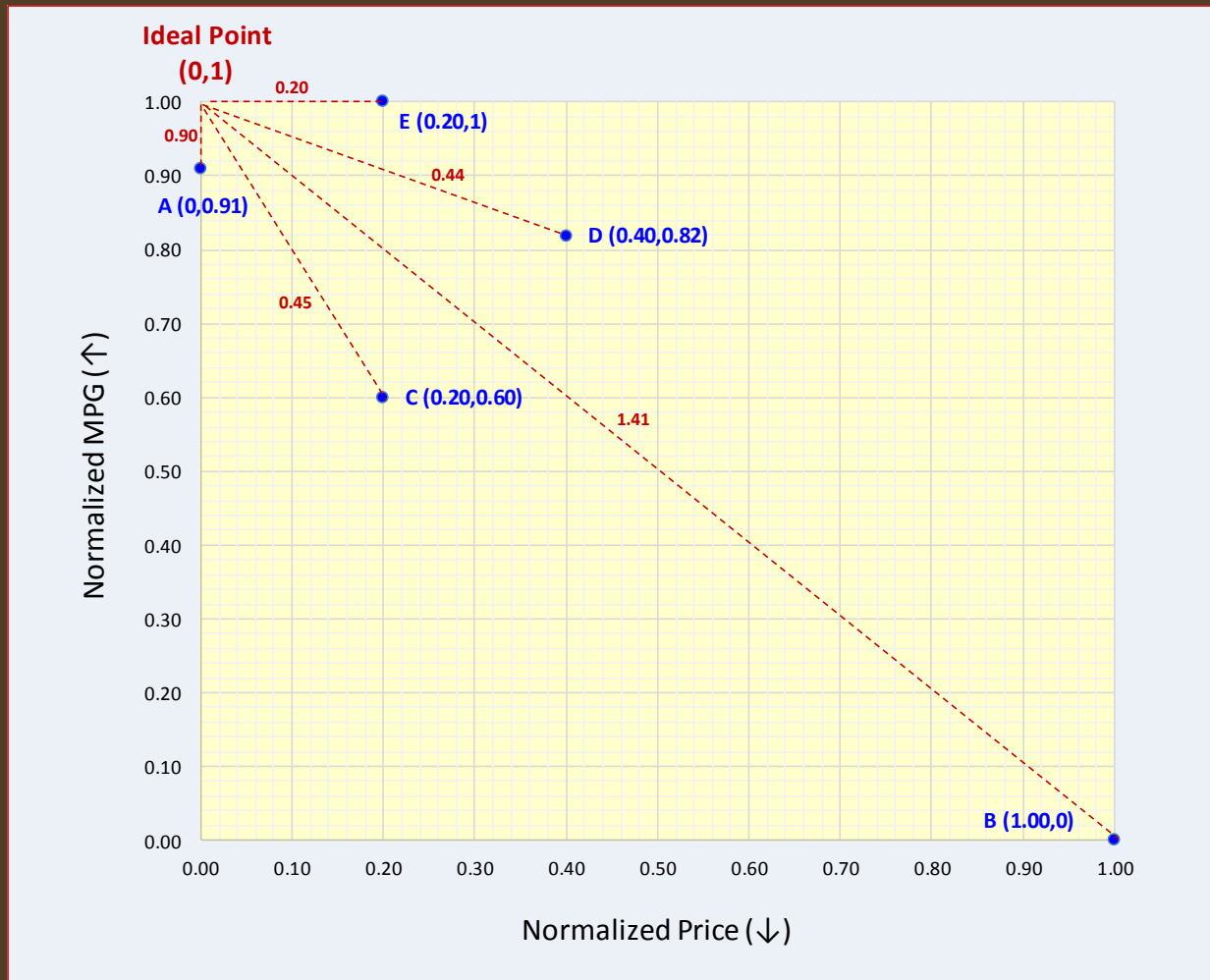
Problem 2 - Numerical Solution							
Car	Price (↓)	Normalized Price	Miles Per Gallon (MPG) (↑)	Reciprocal MPG (↓)	Normalized Reciprocal MPG	Total Score (↓)	Rank
A	10000	0.00	26.0	0.038	0.06	0.06	1
B	15000	1.00	16.0	0.063	1.00	2.00	5
C	11000	0.20	22.6	0.044	0.28	0.48	3
D	12000	0.40	25.0	0.040	0.12	0.52	4
E	11000	0.20	27.0	0.037	0.00	0.20	2
Min	10000			0.037			
Max	15000			0.063			

Problem 2 – Graphical Solution (Euclid)

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Car	Price (↓)	Normalized Price	Miles Per Gallon (MPG) (↑)	Normalized MPG	Euclidean Distance	Rank
A	10000	0.00	26.0	0.91	0.09	1
B	15000	1.00	16.0	0.00	1.41	5
C	11000	0.20	22.6	0.60	0.45	4
D	12000	0.40	25.0	0.82	0.44	3
E	11000	0.20	27.0	1.00	0.20	2
Min	10000		16			
Max	15000		27			

Car B is known as "dominated solution" according to the even swaps concept (<http://www.tavana.us/even-swaps.pdf>)

Problem 2 – Graphical Approach (Euclid)



Normalization

We often want to compare scores or values obtained on different scales. For example, how do we compare a 3.5 GPA with a score of 500 on a GRE exam? In order to do so, we need to “eliminate” the unit of measurement, this operation is called to ***normalization***. There are different types of normalization. The most common normalization originates from linear algebra and treats the data as a vector in a multidimensional space. In this context, to normalize the data is to transform the data vector into a new vector whose norm (i.e., length) is equal to one. This means to scale a variable to have a values between 0 and 1 using the following formula:

$$x_{new} = \frac{x - x_{min}}{x_{max} - x_{min}}$$

Euclidean Distance

The distance between two points (d) defined as the square root of the sum of the squares of the differences between the corresponding coordinates of the points. For example, in two-dimensional Euclidean geometry, the Euclidean distance between two points $a = (x_a, y_a)$ and $b = (x_b, y_b)$ is defined as:

$$d(a,b) = \sqrt{(x_a - x_b)^2 + (y_a - y_b)^2}$$

$$d(a,b) = \sqrt{(0.30 - 0.60)^2 + (0.70 - 0.30)^2}$$

$$d(a,b) = 0.50$$

