

ASSIGNMENTS

Question one

Two engineers separately developed empirical models to predict the user perception of a certain type of civil engineering system using an index ranging from 0.0 (poor) to 5.0 (excellent), as a function of the number of explanatory variables that represent certain system attributes. In order to test their models in a later year, a third engineer sampled 10 similar systems and collected data on the explanatory factors (the vector of X variables) and actual user perceptions (the response variable) of each system. Then, each of the two models was used to estimate the expected user perception for each system. Their results are provided below. Determine which model provides a better description of user perception.

OBS #	A	B	C	D	E	F	G	H	I	J
Y Obs	4.133	2.122	0.499	3.962	3.904	4.812	0.100	6.487	0.699	3.151
Model 1	4.046	0.975	0.163	4.453	3.234	4.630	0.715	6.500	0.512	3.042
Model 2	4.86	0.854	2.541	5.524	4.002	5.214	0.002	4.251	0.468	3.254

Hint: use Root Mean Square Error, RMSE and Percentage Difference, PD.

$$\text{RMSE} = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (\hat{y}_i - y_i)^2}$$

$$\text{PD} = 100 \times \frac{(\hat{y}_i - y_i)^2}{y_i}$$

Question two

The table below shows the chloride concentration in soils measured by an environmental engineer at different locations and the corresponding average corrosion index observed for underground water pipes at those locations. Develop a linear model to describe the influence of chloride concentration on the corrosion of underground water pipes. Use your model to predict the expected corrosion of a pipe at a location that has a chloride content of 2.1 units.

Observation	1	2	3	4	5	6	7	8	9	10
Concentration (units), X	0.3	0.5	1.0	1.4	1.7	1.9	2.5	2.8	3.2	3.5
Corrosion Index (0–10 scale), Y	2.1	4.0	3.8	3.9	6.1	7.2	5.9	7.9	9.6	7.8

Question three

The table below, which illustrates the task of modeling at the system preservation phase, shows the increase in the condition of a system in response to the maintenance effort (man-hours/ft² of surface area). Develop a model that describes the effectiveness of system maintenance efforts in the given units.

Effort (Man-hours/ft²), X	2.24	1.41	1.73	2.83	2.24	2.45	2.65	2.00	3.00	2.83
Effectiveness (increase in system condition), Y	8.36	3.67	5.75	20.45	8.61	10.88	19.93	4.55	20.05	37.63

Question four

The table below shows the demand for a civil engineering system at the needs assessment phase. The data shows the population (in 100,000s) of different cities in a country and their average household income (\$100s per year) and the demand for water. Develop a model separately with and without an interaction term between population and household income and ascertain whether an interaction effect exists. Interpret the interaction term.

City	Xanjin	Puerto	Maleki	Arlington	Duhai	Lascala	Vostok	Shiziko	Kwanju	Tamale	Dia	Xarano
Population	3.3	5.1	11.0	4.2	10.1	13.8	8.8	6.2	7.8	9.1	2.5	12.1
Average income	0.1	0.5	0.6	0.9	0.2	0.2	0.9	0.5	0.8	0.1	0.3	0.6
Demand	0.48	3.20	6.61	3.89	2.11	3.38	7.26	3.75	6.03	1.40	0.61	7.95