Homework 02

CUNY MSDS DATA 609

Duubar Villalobos Jimenez mydvtech@gmail.com

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Problems

The below problems are taken from the text book:

A First Course in Mathematical Modeling, 5th Edition. Frank R. Giordano, William P. Fox, Steven B. Horton. ISBN-13: 9781285050904.

Exercise #12 Page Page 69.

A company with a fleet of trucks faces increasing maintenance costs as the age and mileage of the trucks increase.

Solution

Question: What will be the total maintenance cost for a truck?

List the variables that affect the behavior you have identified.

The variables that affect the behavior from the given sentence are:

[MAINTENANCE_COST, YEAR_BUILD, TRUCK_MILAGE]

Also, we could consider some other variables that could affect the maintenance costs, such as:

[DRIVER_EXPERTISE, TRAFFIC_CONDITIONS, ROAD_CONDITIONS, ROUTE_HAS_STEEP_HILLS, TRUCK_TYPE, TRUCK_WEIGHT, NUMBER_OF_GEARS, NUMBER_OF_AXES, OIL_CHANGE_FREQUENCY, BREAKING_FREQUENCY, TIRE_CONDITION, N_DAYS_FROM_LAST_MAINTENANCE, MAINTENANCE_PARTS_COST, MAINTENANCE_JOB_DESCRIPTION, MAINTENANCE_LABOR_COST, N_HOURS_MAINTENANCE_LABOR]

Which variables will be neglected completely?

I consider that the following variables will be neglected.

[DRIVER_GENDER, DRIVER_AGE, MAX_LOAD]

Which might be considered as constants initially?

The variables that I would consider as constants in an initial form will be:

[DRIVER_EXPERTISE, TRAFFIC_CONDITIONS, ROAD_CONDITIONS, OIL_CHANGE_FREQUENCY, MAINTENANCE_LABOR_COST, N_HOURS_MAINTENANCE_LABOR]

Can you identify any submodels you would want to study in detail?

I believe that we could construct some sub models as follows:

BREAKING_FREQUENCY = f(ROAD_CONDITIONS, ROUTE_HAS_STEEP_HILLS, NUMBER_OF_GEARS)

OIL_CHANGE_FREQUENCY = f(YEAR_BUILD, TRUCK_MILAGE, NUMBER_OF_GEARS)

TIRE_CONDITION = f(DRIVER_EXPERTISE, BREAKING_FREQUENCY, ROAD_CONDITIONS, ROUTE_HAS_STEEP_HILLS, NUMBER_OF_AXES)

MAINTENANCE_LABOR_COST = f(N_HOURS_MAINTENANCE_LABOR)

Identify any data you would want collected.

I would like to collect:

[YEAR_BUILD, TRUCK_MILAGE, DRIVER_EXPERTISE, TRAFFIC_CONDITIONS, ROAD_CONDITIONS, ROUTE_HAS_STEEP_HILLS, TRUCK_TYPE, TRUCK_WEIGHT, NUMBER_OF_GEARS, NUMBER_OF_AXES, N_DAYS_FROM_LAST_MAINTENANCE, MAINTENANCE_PARTS_COST, MAINTENANCE_JOB_DESCRIPTION, MAINTENANCE_LABOR_COST, N_HOURS_MAINTENANCE_LABOR]

Exercise #11 Page Page 79.

Determine whether the data set supports the stated proportionality model.

$y \propto x^3$

y	x
0	1
1	2
2	3
6	4
14	5
24	6
37	7
58	8
82	9
114	10

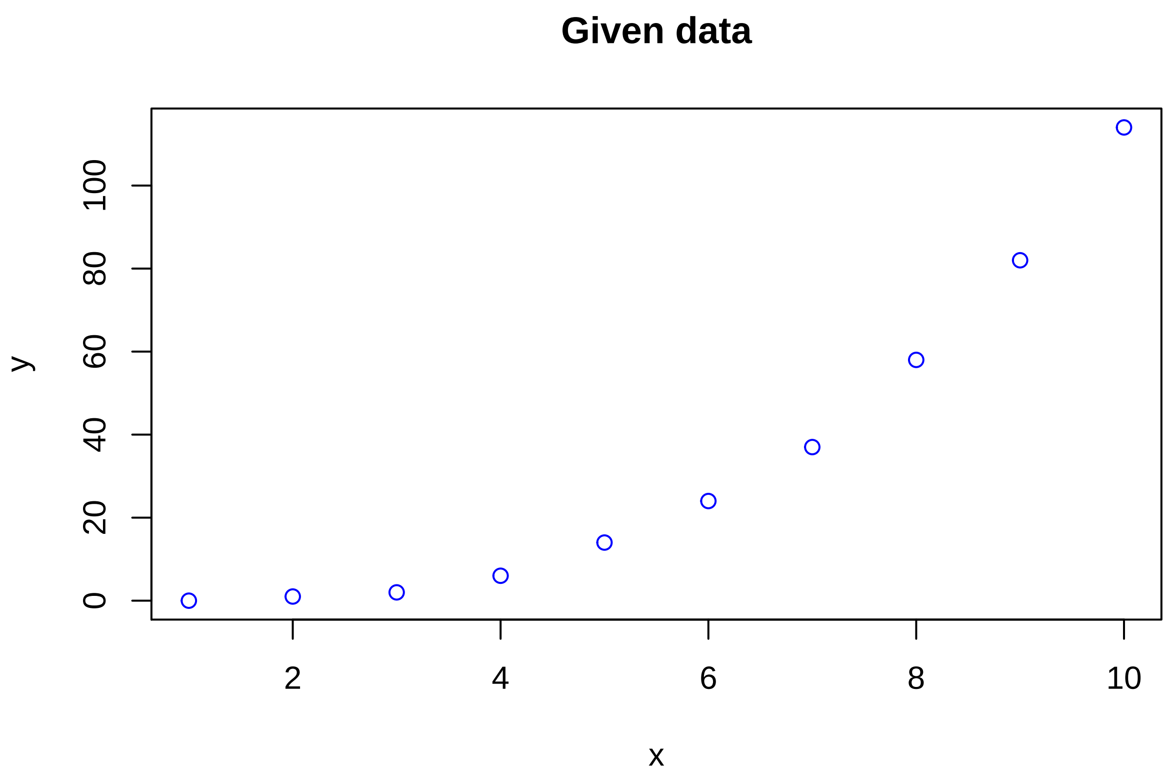
Table 1:

Solution

In order to support a proportionality model; it must satisfy as follows:

$y = kx^3$ for a constant k.

Let's plot our given data as it is:

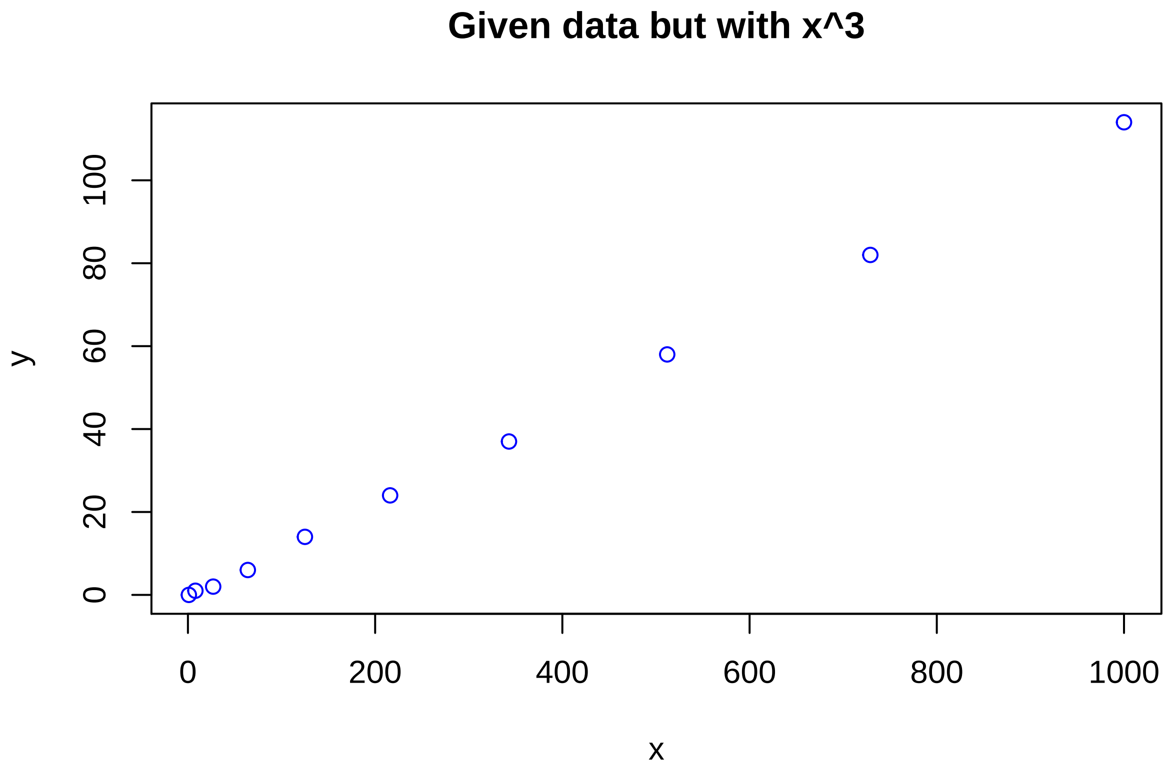


Now, let's calculate x^3.

y	x	x^3
0	1	1
1	2	8
2	3	27
6	4	64
14	5	125
24	6	216
37	7	343
58	8	512
82	9	729
114	10	1000

Table 2:

Now, let's plot again and see it's behavior.



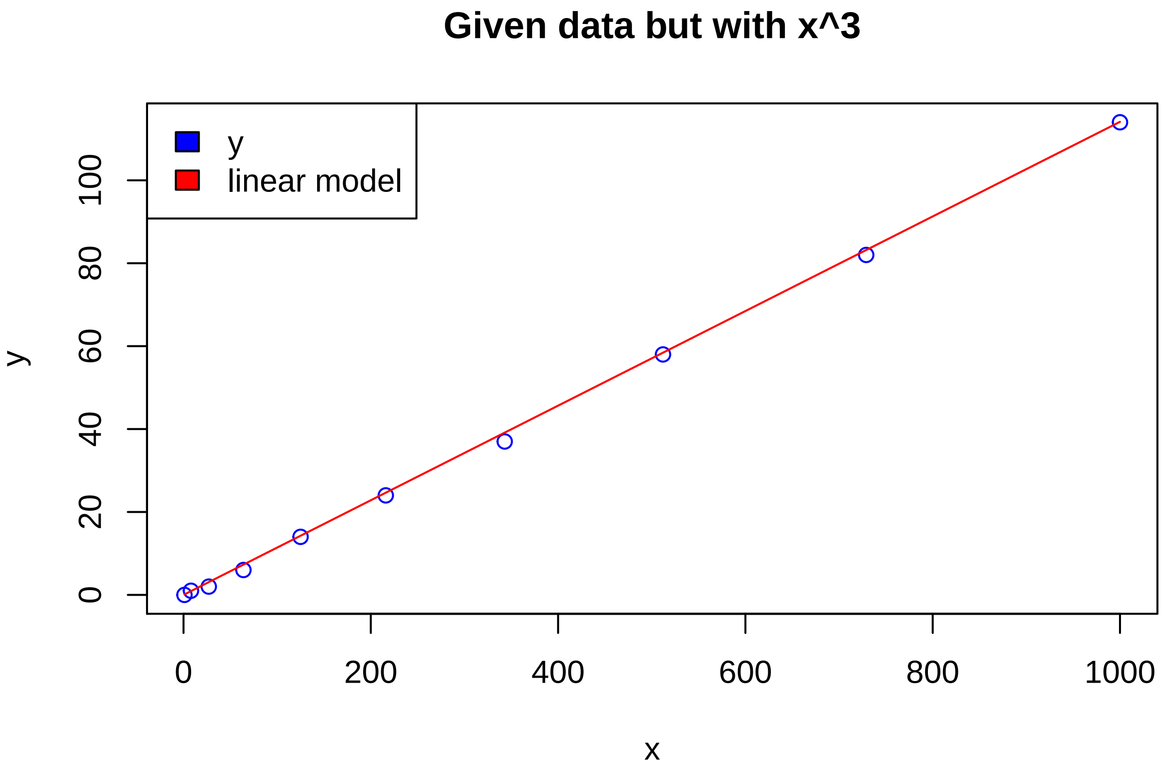
As we can see, there now seems to be some sort of linearity; hence we could calculate our slope as follows:

$k = \frac{114-0}{1000-1} = \frac{114}{999}$

From here, we could deduce that our model will be something similar to:

$y = \frac{114}{999}x^3$

Let's plot our linear model and see if it actually follows the points.

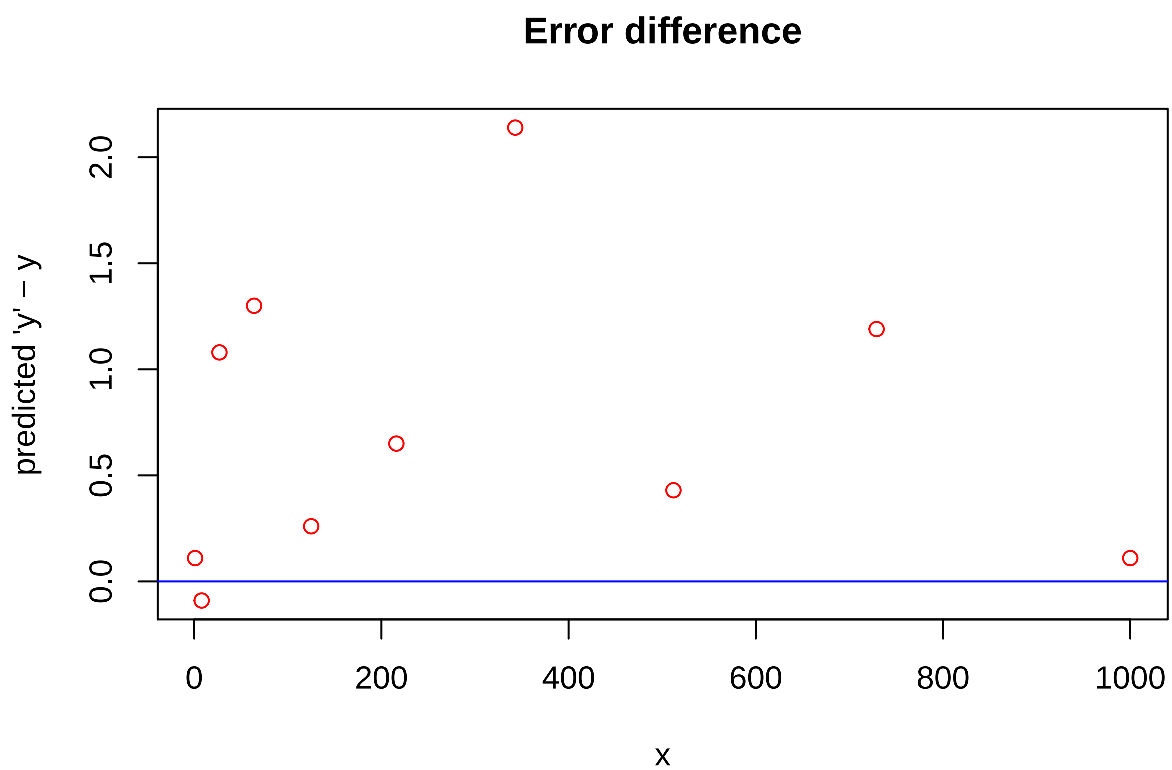


From the above visual it seems that our linear model follows all points very accurate.

Now, I will find the predicted y value rounded to two decimals and compare them to our given data in order to obtain an Error difference.

y	x	x^3	predicted y	Error
0	1	1	0	0
1	2	8	1	-0
2	3	27	3	1
6	4	64	7	1
14	5	125	14	0
24	6	216	25	1
37	7	343	39	2
58	8	512	58	0
82	9	729	83	1
114	10	1000	114	0

Table 3: Error shows no decimals, but calculations made to two decimals.



From the above graph, we can find out that our maximum error difference is about 2.14.

END.