6.6A – Regression Models

Example 1: A tire is inflated to 400 kilopascals (kPa) and over the next few hours it goes down until the tire is quite flat. The following data is collected.

Time (min)	0	5	10	15	20	25	30	35	40	45
Pressure (kPa)	400	335	295	255	210	195	170	150	135	115

Without actually plotting the data, sketch what you think the graph of tire pressure P against time t should look like.

Now enter the data into your calculator, sketch the relationship and examine various equations to model the tire pressure.

	Linear Model $L(x) = mx + b$	Quadratic Model $Q(x) = a(x - h)^2 + k$	Exponential Model $E(x) = a \times b^{x-h} + k$
Actual Equation	$L(t) = -6.0t + 361$	$Q(t) = -0.1t^2 - 10.7t + 392$	$E(t) = 385\ (0.973)^t$
Correlation coefficient	$R^2 = 0.949$	$R^2 = 0.996$	$R^2 = 0.995$
Considerations?	*Would it zero?*	*Would it increase?*	

Equation of the Best Fit Model: ⟶

a) Is the quadratic model a valid choice if you consider the entire domain of the quadratic function and the long term trend of the data in this context?

b) Using each the 3 "best" models, predict the pressure remaining in the tire after 1 hour. How do your predictions compare? Which of the 3 gives the most reasonable prediction? Justify your answer.

L(60) = Q(60) = E(60) =

c) Using each of the 3 "best" models, determine how long it will take before the tire pressure drops below 23 kPA?

d) Justify, in detail, why you think the model you obtained is the best model for the data in this scenario.

6.6A – Regression Models Practice Questions

1. Johanna is pumping up her bicycle tire and monitoring the pressure every 5 pumps of the air pump. Her data is shown below. Determine the algebraic model that best represents this data and use your model to determine how many pumps it will take to inflate the tire to the recommended pressure of 65 psi.

Number of Pumps	Tire Pressure (psi)
0	14
5	30
10	36
15	41
20	46
25	49

2. The following tables document European and North American population over the past 250a.

Europe	
Year	Population (in millions)
1750	163
1800	203
1850	276
1900	408
1950	547
2000	729

North America	
Year	Population (in millions)
1750	2
1800	7
1850	26
1900	82
1950	172
2000	305

a) Find the average rate of change in European population from 1750 to 1800.
b) Find the average rate of change in European population from 1950 to 2000.
c) Compare and comment on your answers from a & b.
d) Find the average rate of change in North American population from 1800 to 1850.
e) Find the average rate of change in North American population from 1950 to 2000.
f) Compare and comment on your answers from e & f.
g) From 1800 to 1850 the average rate of change for populations was greater in Europe than in North America, however the change in North American population was far more dramatic. Explain.
h) Find equations to model both populations.
i) Use equations to predict both populations in 2050.
j) If the growth trends continue and the models hold true, when will the populations be the same?
k) Find instant rate of change for both both populations in 1900, 1950 & 2000

Answers 1. exponential model $y = 19.3\,(1.0448)^t$ $r = 0.889$
cubic polynomial model $y= 0.003185t^3-0.16873t^2+3.6259t+14$ $r = 0.995$ (using this 33 pumps)
2. a) 0.8m/a **b)** 3.79m/a **c)** 5 fold increase **d)** 0.38m/a **e)** 2.77 m/a **f)** 7 fold increase
g) The rate is higher because many more people where added to the population. But from a percent point of view North America growth was much more significant; it is just that they started with smaller numbers.
h) $E(y)=0.003006(1.006221)^y$, $NA(y)=6.8x10^{-16}(1.02071)^y$ good correlation for both **i)** 999B, ? B **j)** around 2039 which seems a bit early? **k)** Europe (2.45, 3.36, 4.61) North America (1.16, 3.32, 9.47) instant rate of growth is increasing much faster in North America