Assignment #2

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1. Page 69, #12 *A company with a fleet of trucks faces increasing maintenance costs as the age and milage of the trucks increase.*

Problem: are maintenance costs so high on older trucks that it makes sense to replace them with new ones at a certain age?

Variables to study and data to collect:
* truck make / model
* milage
* age of truck
* maintenance costs
* new truck costs

Neglect:
* routes
* drivers
* actual maintenance done

Initial Constants:
*make/model, break into cohorts later on in analysis

Submodels:
* association of age and milage
* association of maintenance costs and milage

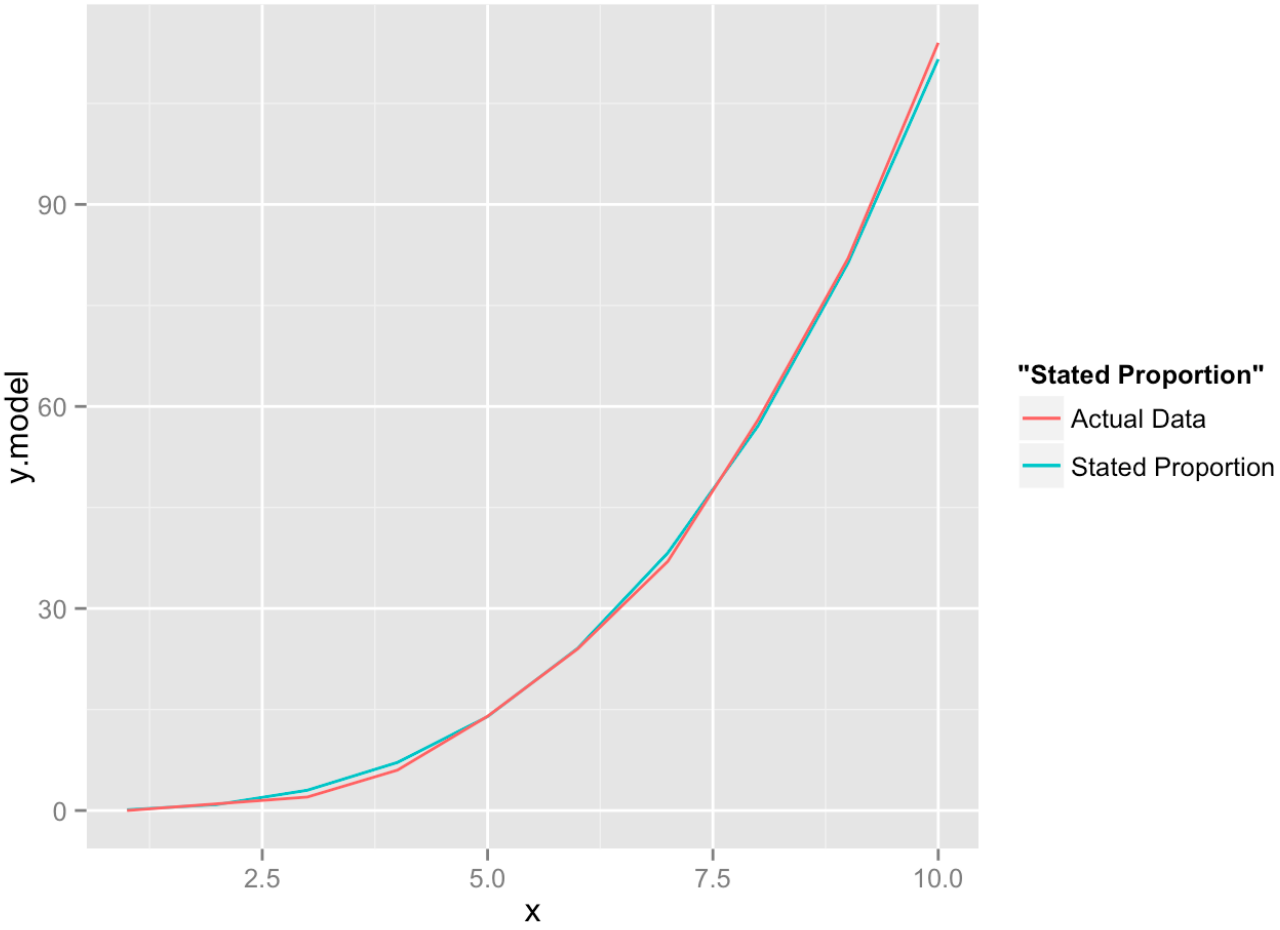
Data to collect:
* maintenance logs per truck
* financal analysis of

2.

$$y \propto x^3$$

```
y <- c(0,1,2,6,14,24,37,58,82,114)
x <- 1:10
x.model <- x^3

k = median(y/x.model)
# I also tried the mean, median results in a better fit.

y.model <- k *x.model

modelset <- as.data.frame(cbind(x, y, y.model))
```

```
library(ggplot2)

ggplot(modelset, aes(x)) +
  geom_line(aes(y = y.model, colour = "Stated Proportion")) +
  geom_line(aes(y = y, colour = "Actual Data"))
```



The dataset supports the proportionality.

3.

Lumber Cutters Using diameter of tree in inches at waist height, develop a model that predicts board feet of lumber produced by that tree as a function of diameter in inches.

```
#radius of a pine tree in inches
x <- c(17, 19, 20, 23, 25, 28, 32, 38, 39, 41)/2

#board feet divided by 10
y <- c( 19, 25, 32, 57, 71, 113, 123, 252, 259, 294) * 10
```

Consider two separate assumptions allowing each to lead to a model.

i. Assume that all trees are right-circular cylinders and are approximately the same height.

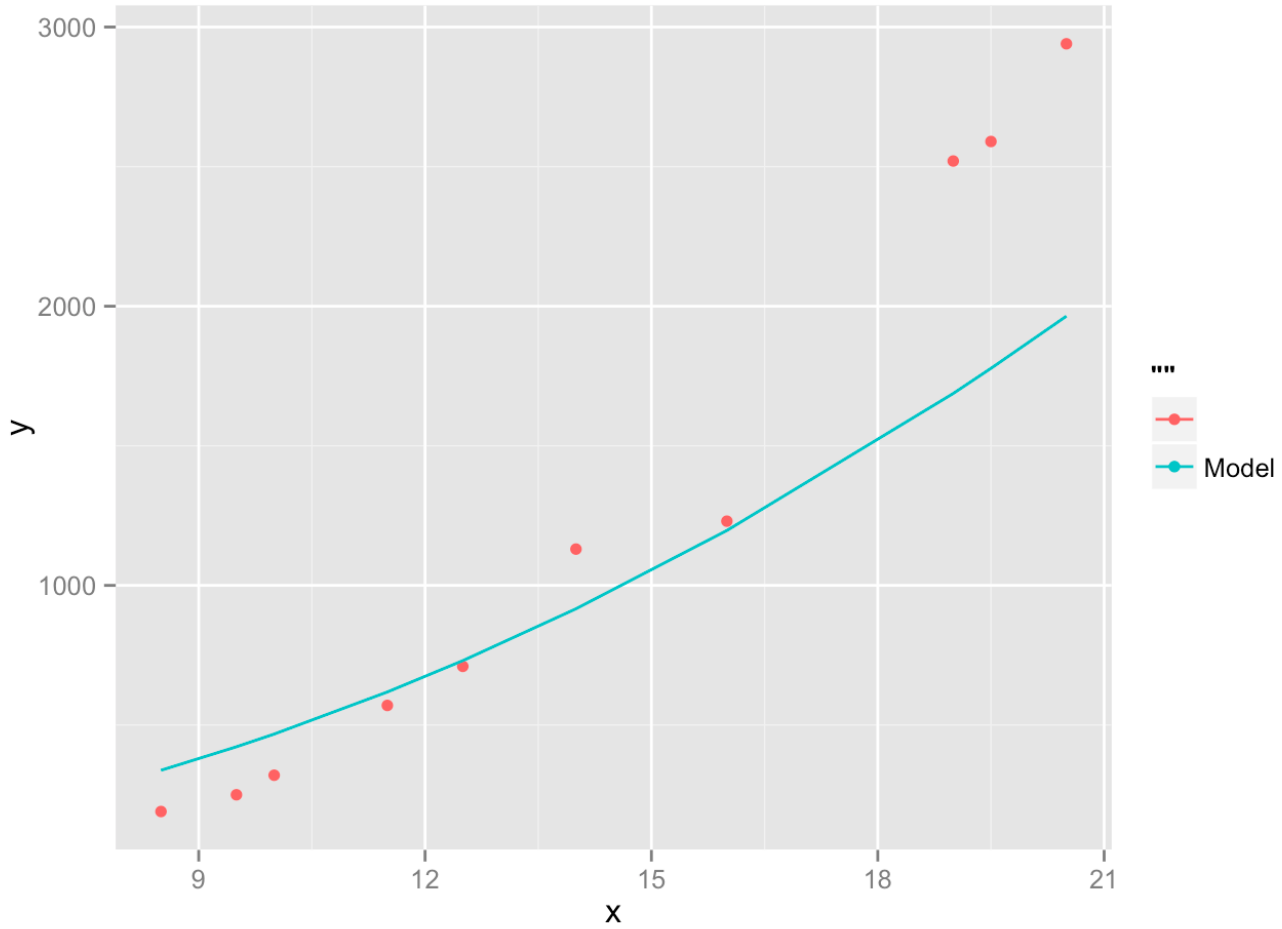
When creating lumbar boards from a tree, you can increase the foot-length produced two ways - by having longer trees and having wider trees that allow more rectangular boards to fit within a circular

cross-section of the tree. Therefore, we can hypothesize that board-feet is proportional to volume: $V = \pi r^2 h$.

In this case, we assume that all the trees are the same height and set h = 1. The resulting model is $V = k\pi(r)^2 = k(r)^2$.

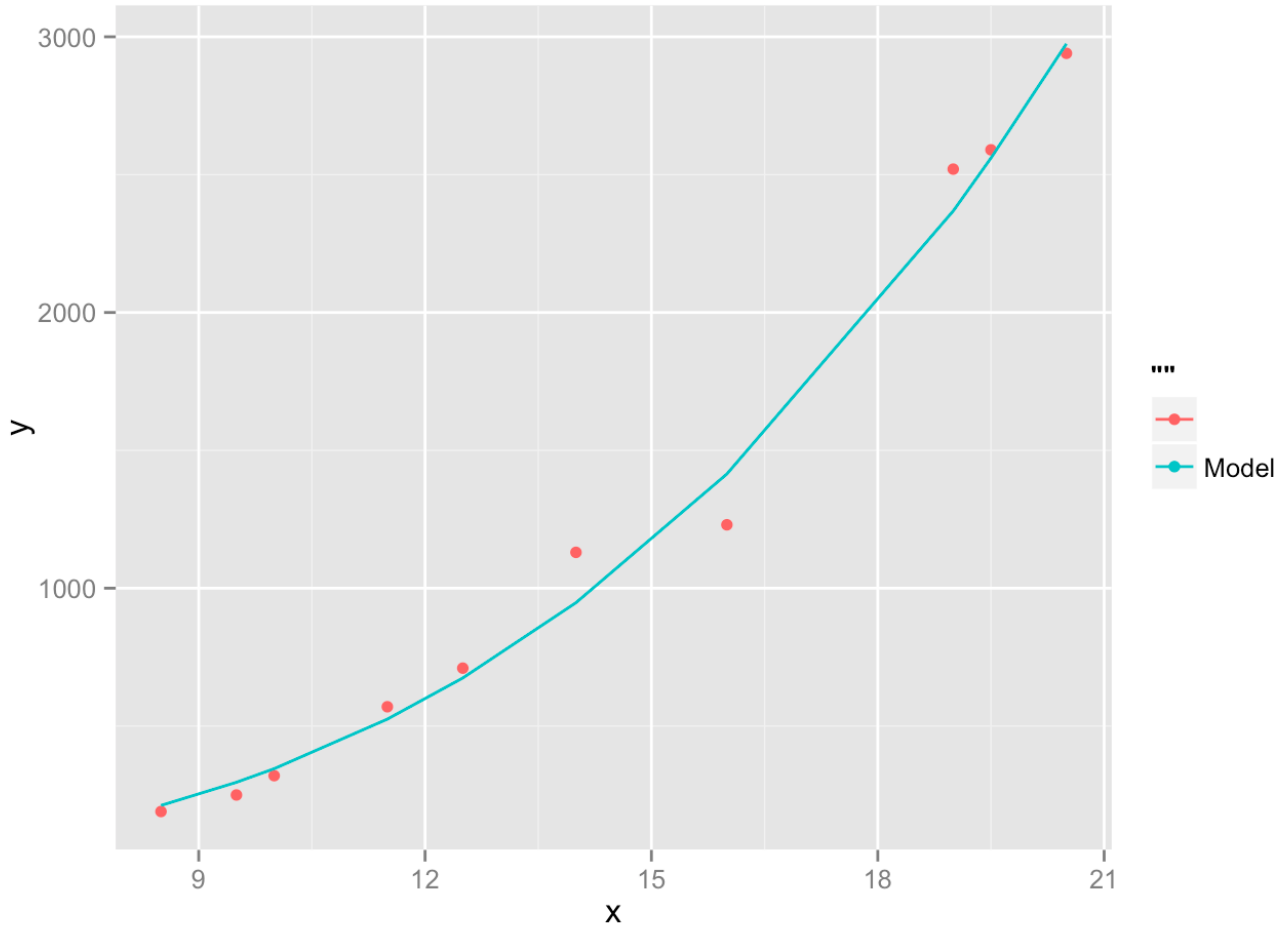
According to Wikipedia a board foot of lumber has a volume of $144in^3$.

```
y.vol <- y*144
r.sqrd <- x**2

k <- median(y.vol / r.sqrd)

vol.model <- k * r.sqrd / 144

model.equal.length <- as.data.frame(cbind(y, x, vol.model))

ggplot(model.equal.length, aes(x)) +
  geom_point(aes(y = y, colour = "")) +
  geom_line(aes(y = vol.model, colour = "Model"))
```



ii. Assume that all trees are right-circular cylinders and that the height of the tree is proportional to the diameter.

```
y.vol <- y*144
r.sqrd <- x**3

k <- median(y.vol / r.sqrd)

vol.model <- k * r.sqrd / 144

model.equal.length <- as.data.frame(cbind(y, x, vol.model))

ggplot(model.equal.length, aes(x)) +
  geom_point(aes(y = y, colour = "")) +
  geom_line(aes(y = vol.model, colour = "Model"))
```



4. *Discuss several factors we completely ignored in our anlaysis of the gasoline milage problem.*

Intermittent factors effect gas milage and are particularly tough to model. Headwind/tailwind and topography can increase or decrease gas milage depending on their configuration. So, your milage on the drive into the mountains may be worse than your drive back home.

Vehicle weight can have an effect since F=ma, increasing the mass of the car means increasing the amount of force it takes to move it.

One very interesting factor to me is summer versus winter fuel blend. Every spring the price of gasoline jumps as refineries switch over to the more expensive summer blend (I've actually done the seasonal

decomposition to prove it!). The summmer blend has a higher evaporation point but it contains 1.7% more energy per gallon than the winter blend, meaning all else equal your gas milage will be better in the summer.

See: http://newsroom.aaa.com/2013/06/what-is-the-difference-between-summer-and-winter-blend-gasoline/

5. To test the assumption of constant inner core density, you could take a sample of the targeted population and messure body fat percentage directly using calipers or electronic-resistance measurements, then compare these results to those given in the table. The difference between the two may be attributed to inner core density. However, in order to take care of confounding variables such as leg density, you would also need to take measurements of things like thigh circumfrence and waist circumfrence to check for their association with body fat percentage.