

Problem Set 2.3: Analyzing Bivariate Data with Linear Models

1. Vitruvian Man (also called Canon of Proportions) is a famous drawing by Leonardo da Vinci that shows the proportions of man based on the Vitruvian text, "On Symmetry: in Temples and in the Human Body". Open the CODAP file called "Vitruvian Man". It contains a collection of ordered pairs of measurements of the picture shown. The independent variable will be wingspan in cm (to the nearest tenth). The dependent variable will be height (without shoes) in cm (to the nearest tenth).

a) "Analyze the Data" - Save your CODAP folder which includes your scatter plot, curve fit to the data, and residual plot.

Model: $y - 170.2 = 0.77(x - 175)$

Residuals: model is appropriate b/c no clear pattern. model will be pretty accurate b/c residuals are medium to small.
 $12/35 \approx 34\%$

b) Write a sentence that explains the meaning of the slope of your linear model within the context.

$a = 0.77 \text{ cm (height) / cm (wingspan)}$

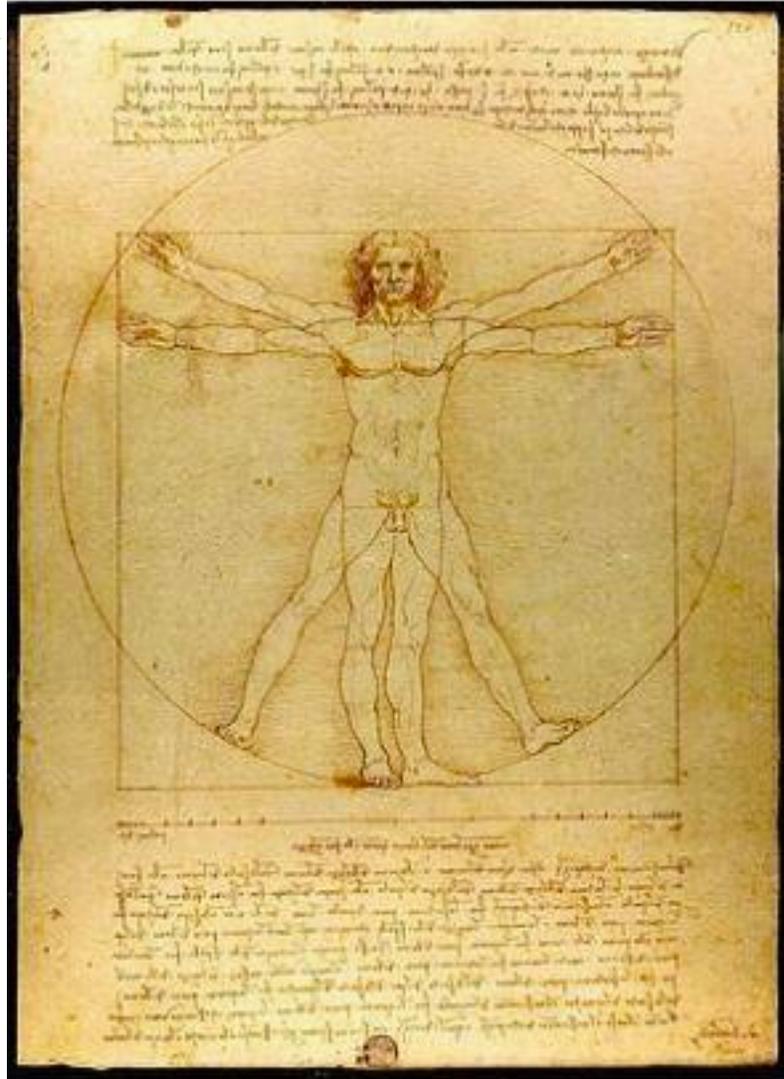
For every 1 cm in wingspan the height inc. by 0.77 cm.

c) Write a sentence that explains the meaning of the point (h,k) in your linear model within the context.

For a wingspan of 175 cm, the person is approximately 170.2 cm tall.

d) Measure your arm span. Use your model (the equation, not the graph) to predict your height? Show your algebraic work. How close was your model (what is the residual)?

Many different answers depending on your wingspan.



On Symmetry: In Temples and in the Human Body. Vitruvius, n.d. Web. 24 Apr. 2013.
 <http://faculty.txwes.edu/csmeller/human-experience/ExpData09/02GrecoRoman/GrRmRDs/mR_Vitruvius-Sym.html>.

Image source: Vitruvian Man. Gallerie dell'Accademia, n.d. Web. 4 Feb. 2013.
 <<http://www.gallerieaccademia.org/wp/wp-content/gallery/leonardo-luomo-vitruviano-fra-arte-e-scienza/leonardo.png>>.

2. Open the data set called "Car MPG Vs. Weight"

a) "Analyze the data" – Save your CODAP file which includes your scatter plot, curve fit to the data, and residual plot.

Model: $y - 27.6 = -0.0115(x - 3220)$

Residuals: Appropriate b/c residuals show no clear pattern.
Model is somewhat accurate b/c residuals are small.
3/30 ≈ 26%

b) Write a sentence that explains the meaning of the slope of your linear model within the context.

$$a = -0.0115 \text{ mpg/lbs.}$$

The fuel efficiency decreases by 0.0115 mpg for every pound the car goes up.

c) Use your model to predict what the Fuel Efficiency (MPG) would be for a car weighting 2700 pounds. Show your algebraic work.

$$\begin{aligned} y - 27.6 &= -0.0115(2700 - 3220) \\ y - 27.6 &= 5.75 \\ +27.6 & \quad +27.6 \end{aligned} \quad \rightarrow \quad y = \underline{33.35 \text{ mpg}}$$

d) According to the slope of your model, what is the effect on fuel efficiency of taking on a passenger in your car that weighs 175 pounds? Show your algebraic work.

$$175 \cdot (-0.0115) = \text{you can expect to lose } 2.0125 \text{ mpg.}$$

3. Open the data set called "CO₂ Annual 2000-2019"

Since the beginning of the industrial revolution there has been an ever increasing concentration of carbon dioxide (CO₂) in our atmosphere. High levels of CO₂ in our atmosphere result in a greenhouse effect, which has led to global warming. CO₂ concentration in air is usually measured in parts per million by volume (ppmv). Just prior to the industrial revolution CO₂ concentrations were about 280 ppmv. By 2008 CO₂ concentrations reached about 385 ppmv. There is a growing consensus among scientists that specialize in global warming that 450 ppmv is a threshold above which disastrous, irrevocable changes would affect the planet.

a) "Analyze the data" – Save your CODAP file which includes your scatter plot, curve fit to the data, and residual plot.

Model: $y - 390.7 = 2.216(x - 2010.89)$

Residuals: Residuals show a clear concave up pattern & thus the model is inappropriate.
Residuals are really small so the model should be very accurate.

3/40 ≈ 0.75 ⇒ 7.5%

b) Write a sentence that explains the meaning of the slope of your linear model within the context.

$$a = 2.216 \text{ ppmv/year.}$$

The CO₂ is rising 2.216 ppmv for every year.

c) According to your model, in what year will CO₂ concentration reach 450 ppmv? Show your algebraic work.

$$\begin{aligned} 450 - 390.7 &= 2.216(x - 2010.89) \\ 59.3 &= 2.216(x - 2010.89) \\ 26.759 &= x - 2010.89 \\ +2010.89 & \quad +2010.89 \end{aligned} \quad \rightarrow \quad \text{year } \underline{2037}$$

$x = 2037.65$

Sources:
Fight Global Warming. Global Warming: Facts, Consequences, and Solutions.
<http://www.fightglobalwarming.com/content.cfm?contentID=5113>, 2/21/2009.

Inter Press Service. CLIMATE CHANGE: Oceans Passing Critical CO₂ Threshold.
<http://ipsnews.net/news.asp?idnews=44836>, 2/21/2009.

The Christian Science Monitor. A Key Threshold is Crossed.
<http://www.csmonitor.com/2007/1011/p11s01-wqj.html>, 2/21/2009.

4. Open the data set called "Tried Marijuana before age 13"

The number of teenagers that have tried marijuana before age 13 has been decreasing since 1999.

a) "Analyze the data" - Save your CODAP file which includes your scatter plot, curve fit to the data, and residual plot.

Model: $y - 8.69 = -0.21(x - 2008)$

Residuals: NO clear pattern \therefore thus model is appropriate
Residuals are medium \therefore thus model should be somewhat accurate.

$1.8/5 \approx 0.36$ or 36%

b) Write a sentence that explains the meaning of the slope of your linear model within the context.

$a = -0.21$ %/year

The # of kids below age 13 who have tried marijuana is dec. by .21% each year.

c) According to your model, how long will it take the percent of teenagers who try marijuana before age 13 to drop 3%? Show your algebra.

$3 - 8.69 = -0.21(x - 2018)$

$-5.69 = -0.21(x - 2018)$

$27.095 = x - 2018$

+2018

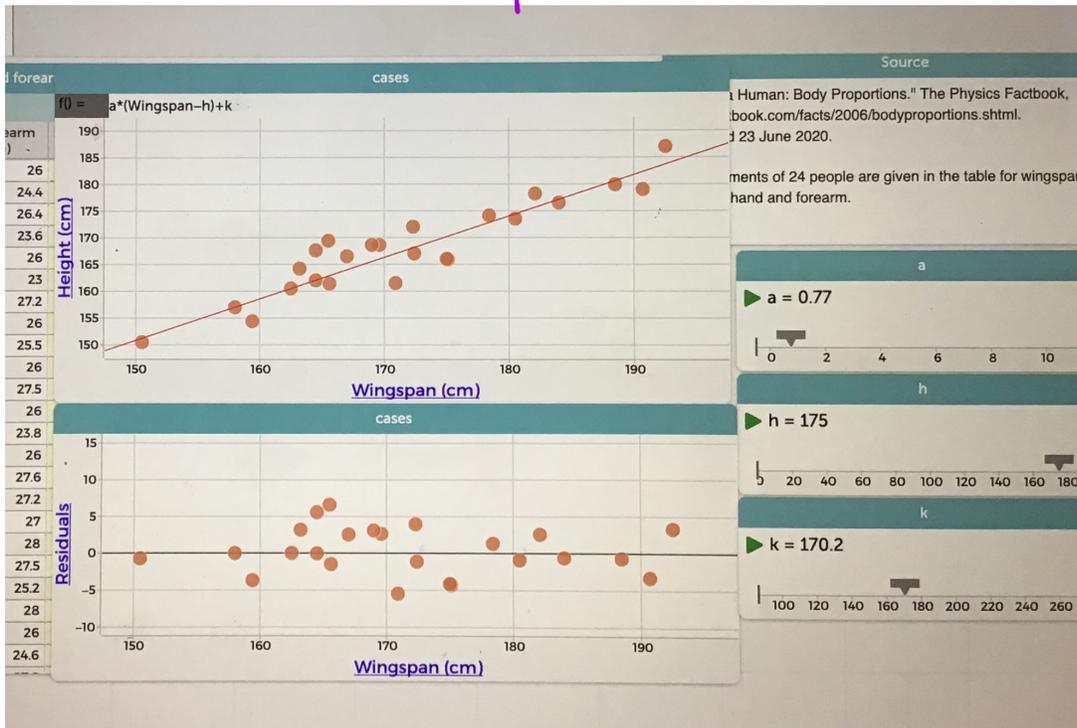
+2018

$x = 2045.09$

year \rightarrow 2045

Source: "Trends in the Prevalence of Marijuana, Cocaine, and Other Illegal Drug Use National YRBS: 1991—2017." The national Youth Risk Behavior Survey, www.cdc.gov/healthyyouth/data/yrbs/pdf/trends/2017_us_drug_trend_yrbs.pdf. Accessed 25 June 2020.

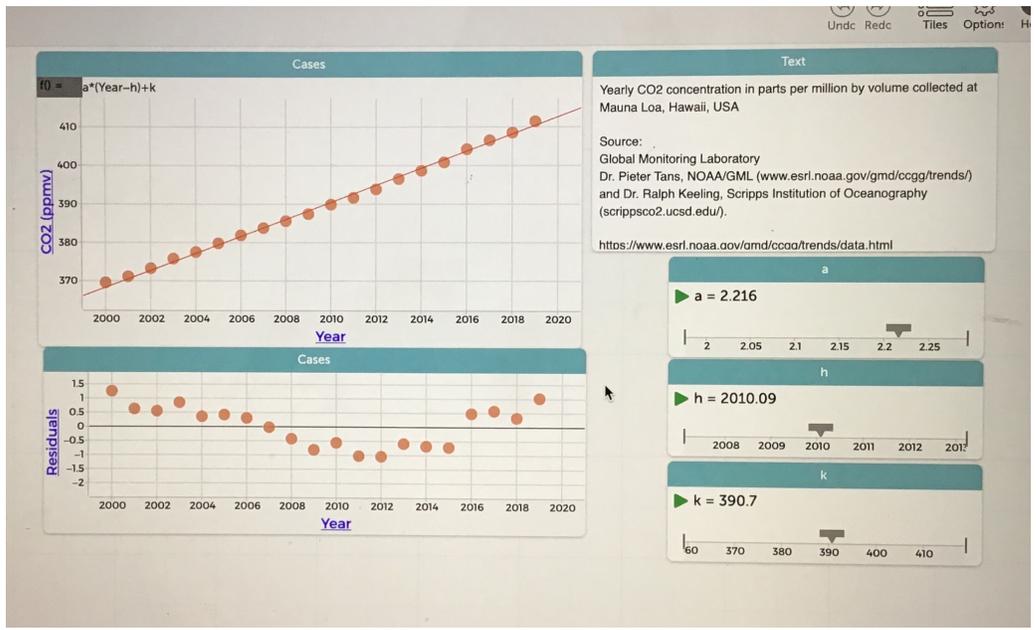
Vitruvian man codap



Car mpg vs. Weight



CO2 annual 2000-2019



Tried marijuana before 13

