Unit 4: Regression and Prediction

1. Intro to Linear Regression

(Chapter 5.1)

11/14/2018

Quiz 7 - t-tests, paired data, and differences

Recap from Unit 3

In Unit 3, we learned to use distributions to answer questions like

- Is X different from what we would expect?
- Is X different from Y?
- Was there a change in X?

We did this for outcome variables that were categorical (e.g. atheist or not), or numerical (e.g. area). But our independent variables were always categorical.

In Unit 4, we'll talk about using distributions to understand the relationship between two numerical variables.

Recap from Unit 3

Categorical Predictor (e.g. Male or Female)		

Recap from Unit 3

	Categorical Outcome (e.g. Organ Donor or Not)	
Categorical Predictor (e.g. Male or Female)		

Recap from Unit 3

	Categorical Outcome (e.g. Organ Donor or Not)	
Categorical Predictor (e.g. Male or Female)	Are males more likely to be promoted than females? *Hypothesis test for two-proportions (3.2)*	

Recap from Unit 3

	Categorical Outcome (e.g. Organ Donor or Not)	Numeric Outcome (e.g. Income)
Categorical Predictor (e.g. Male or Female)	Are males more likely to be promoted than females? *Hypothesis test for two-proportions (3.2)*	

Recap from Unit 3

	Categorical Outcome (e.g. Organ Donor or Not)	Numeric Outcome (e.g. Income)
Categorical Predictor (e.g. Male or Female)	Are males more likely to be promoted than females? *Hypothesis test for two-proportions (3.2)*	Do males earn more money than females? *Hypothesis test for two means (3.4)*

Recap from Unit 3

	Categorical Outcome (e.g. Organ Donor or Not)	Numeric Outcome (e.g. Income)
Categorical Predictor (e.g. Male or Female)	Are males more likely to be promoted than females? *Hypothesis test for two-proportions (3.2)*	Do males earn more money than females? *Hypothesis test for two means (3.5)*
Numeric Predictor (e.g. Age)		

Recap from Unit 3

	Categorical Outcome (e.g. Organ Donor or Not)	Numeric Outcome (e.g. Income)
Categorical Predictor (e.g. Male or Female)	Are males more likely to be promoted than females? *Hypothesis test for two-proportions (3.2)*	Do males earn more money than females? *Hypothesis test for two means (3.5)*
Numeric Predictor (e.g. Age)	Are older people more likely to be promoted? *Logistic regression (not covered in this course)*	

Recap from Unit 3

	Categorical Outcome (e.g. Promoted or Not)	Numeric Outcome (e.g. Income)
Categorical Predictor (e.g. Male or Female)	Are males more likely to be promoted than females? *Hypothesis test for two-proportions (3.2)*	Do males earn more money than females? *Hypothesis test for two means (3.5)*
Numeric Predictor (e.g. Age)	Are older people more likely to be promoted? *Logistic regression (not covered in this course)*	Do older people earn more money? *Linear regression (today)*

Key ideas

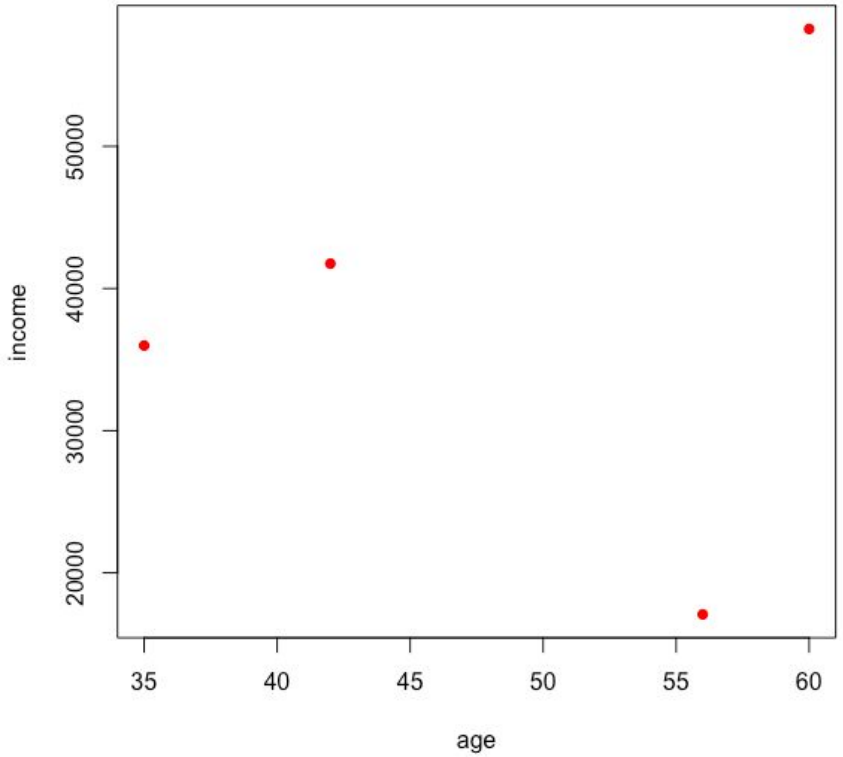
1. Correlation is a measure of the linear relationship between two factors.
2. We can use linear regression to estimate this correlation
3. A regression line is the line that minimizes the residuals between each point and the line.

Scatterplots

A **scatterplot** shows the relationship between two numeric variables.

Each dot represents a single observation (e.g. a single person).

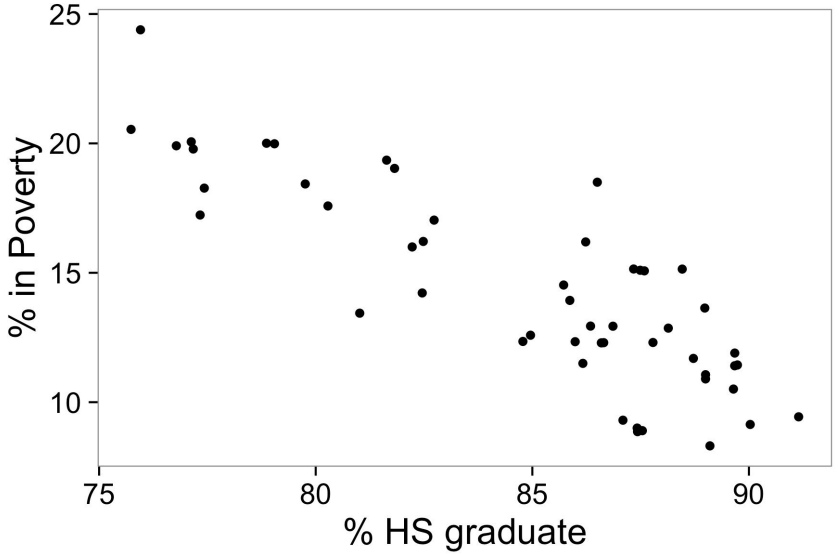
	Age	Income
Person 1	35	35,990
Person 2	42	41,750
Person 3	56	17,080
Person 4	60	58,255



Poverty and highschool graduation rate

This **scatterplot** shows the relationship between HS graduation rate in all 50 US states + DC and the percent of residents who live below the poverty line (income below $23,050 for a family of 4 in 2012).

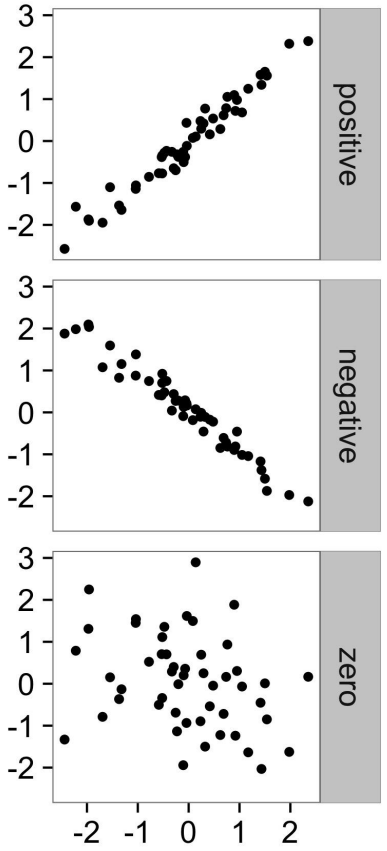
How would you describe this relationship?



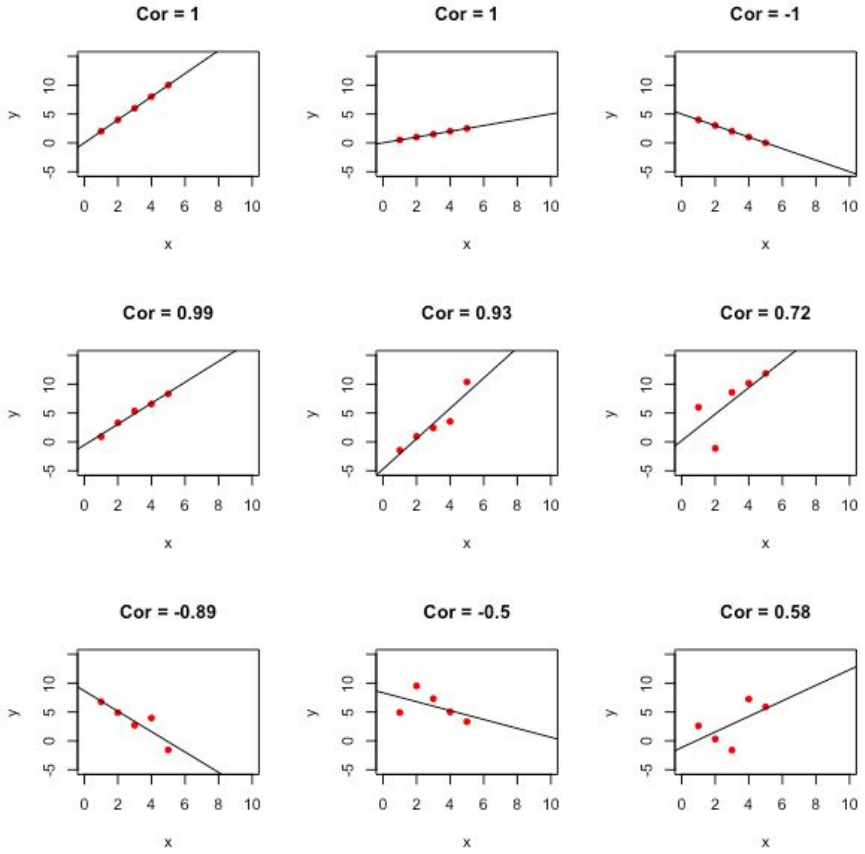
Quantifying the relationship between two numerical values

Correlation describes the strength of the **linear** association between two variables.

Correlation ranges from -1 (perfect negative) to +1 (perfect positive).
A value of 0 indicates no linear association.



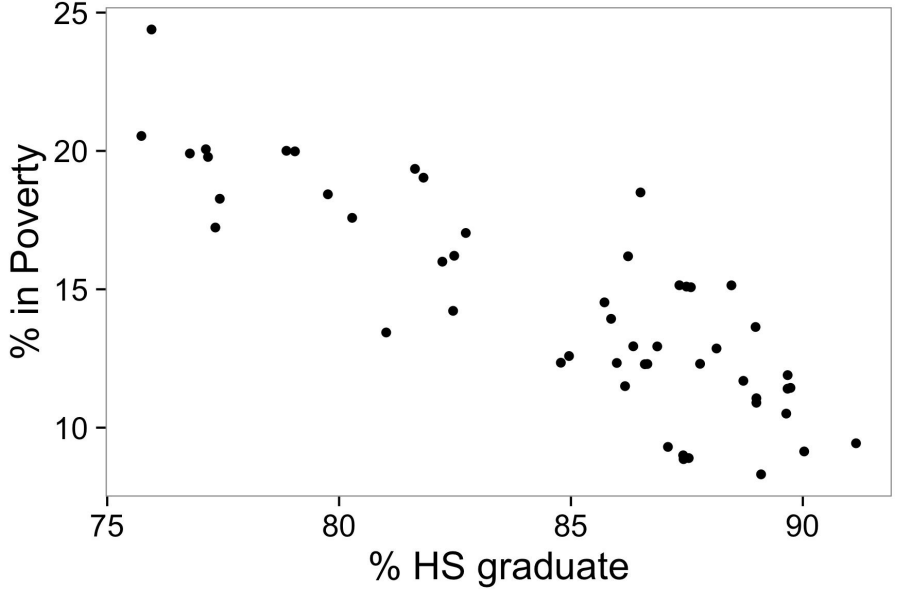
Quantifying the relationship between two numerical values



Guess the correlation

Which of these is your best guess for the correlation between poverty and high school graduation?

(a) .6
(b) -.85
(c) -.1
(d) .02
(e) -1.5



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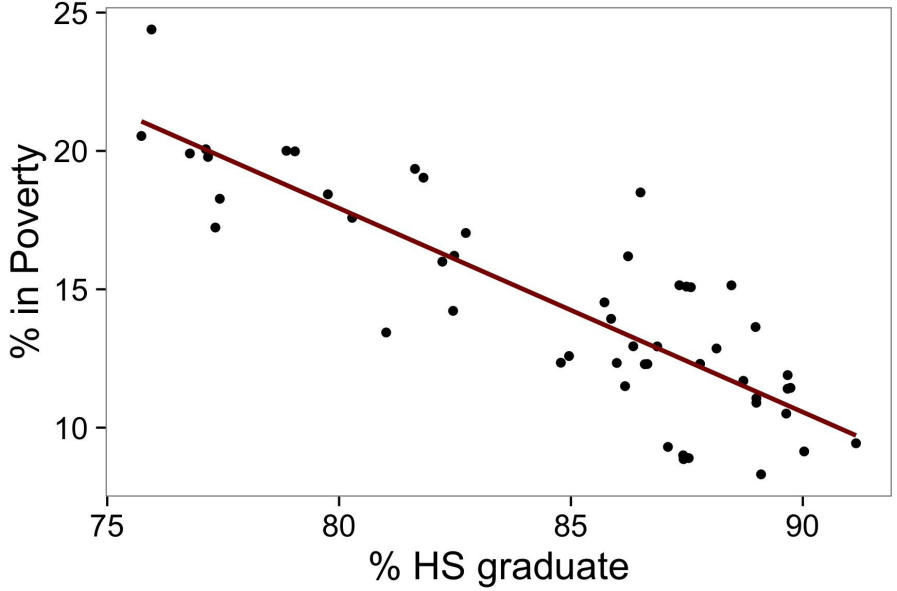
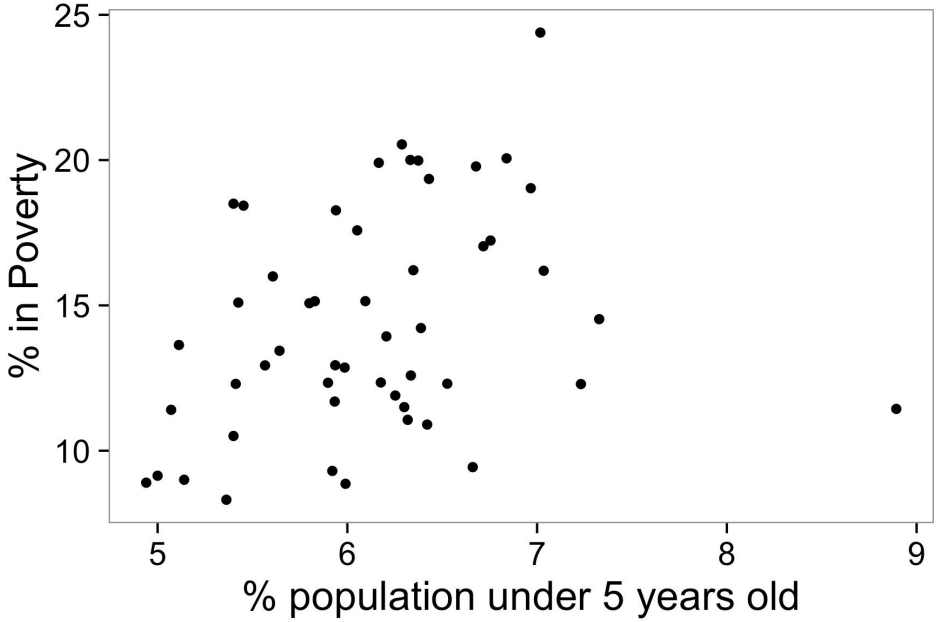


Guess the correlation

Which of these is your best guess for the correlation between poverty and and the proportion of the population under 5 years of age?

(a) 0.1
(b) -0.6
(c) -0.4
(d) 0.9
(e) 0.3



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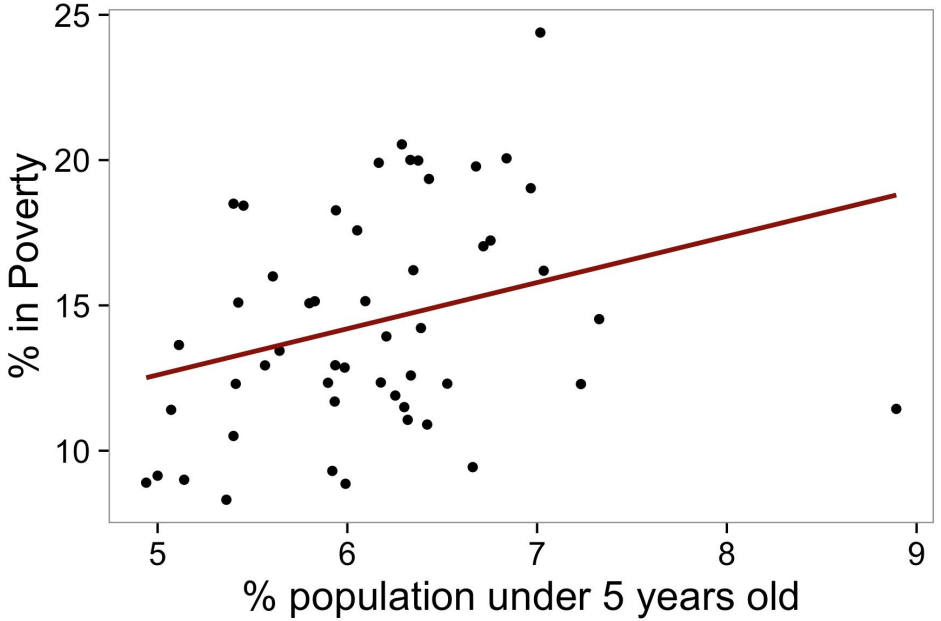
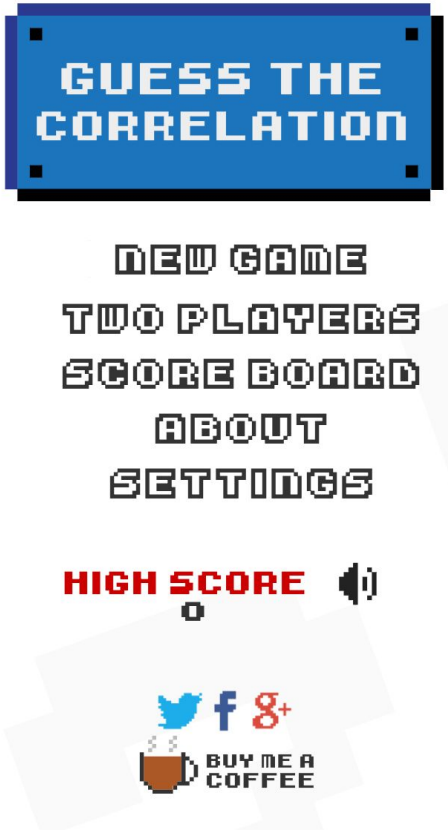
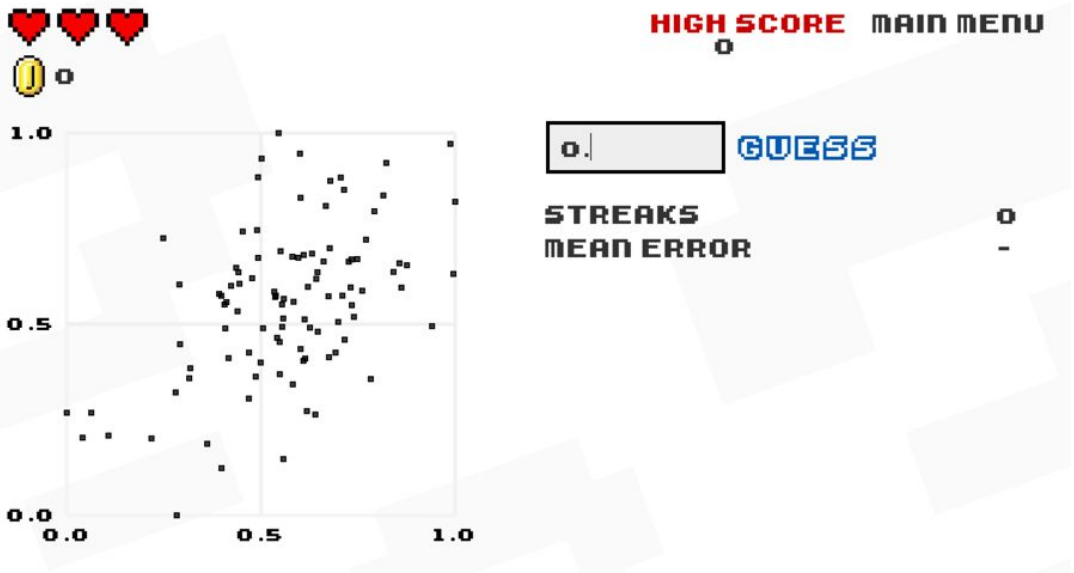
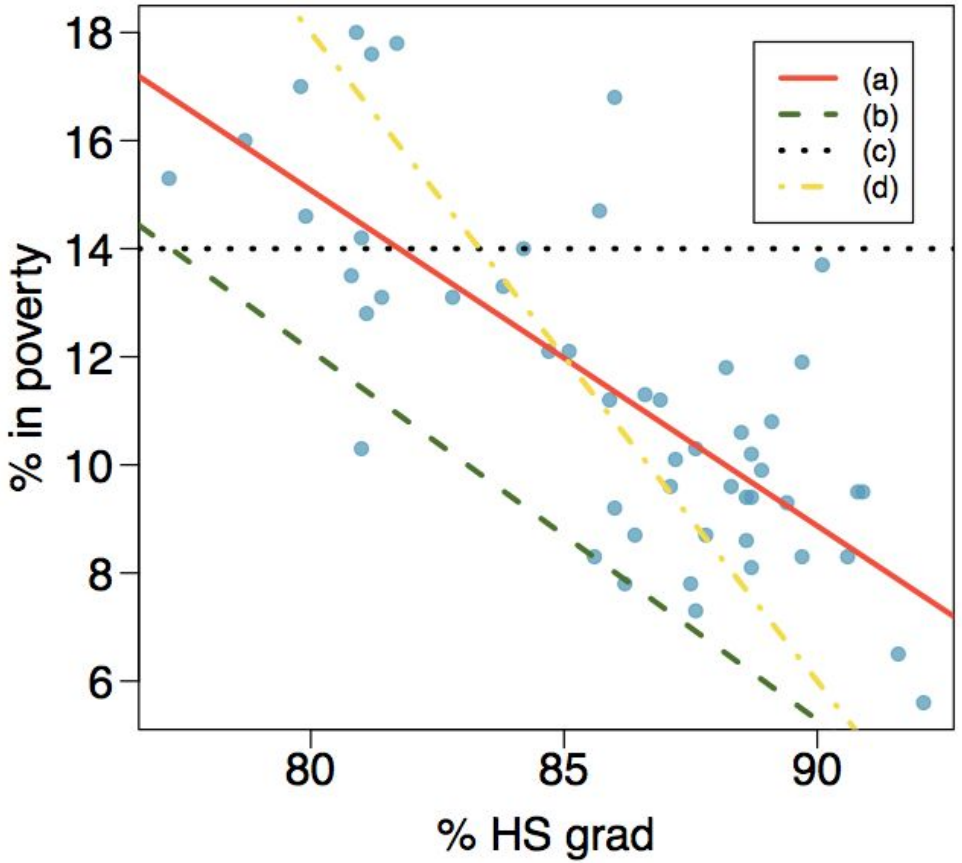


Play along at home: http://guessthecorrelation.com/





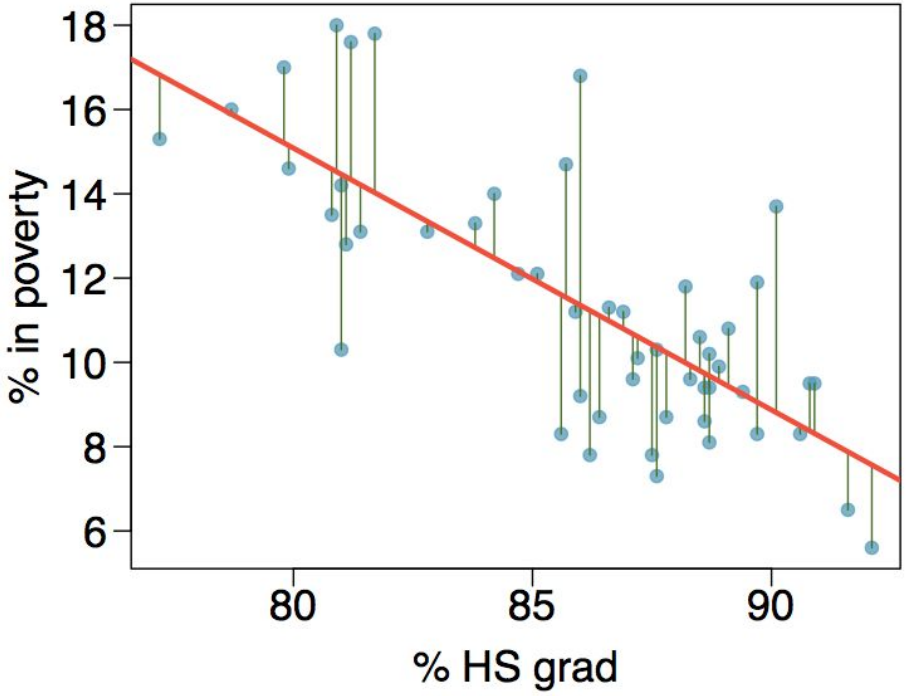
Which of these lines is the best representation of the trend?



How do figure out that we want line (a)?

We want to find the line that minimizes the **residuals**: the distances between each point and the line.

A **regression** model is a model that says that your data is composed of two things: A best-fit line + the residuals between each point and the line.



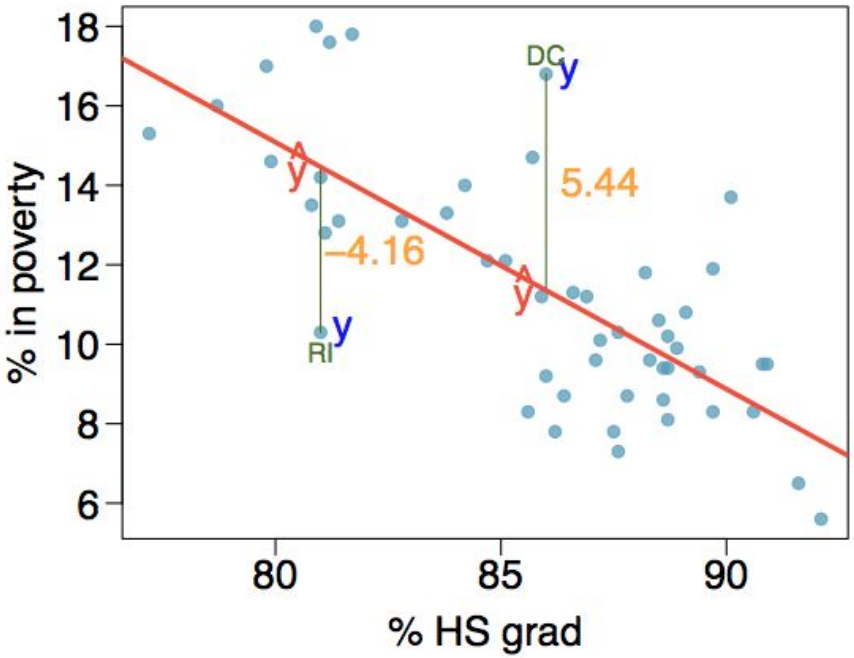
Residuals

A **residual** is the difference between the observed (y_i) and predicted $\hat{y}_i$.

$$e_i = y_i - \hat{y}_i$$

For example, percent living in poverty in **DC** is 5.44% more than predicted based on HS grad % alone.

Percent living in poverty in **RI** is 4.16% less than predicted.



Key ideas

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