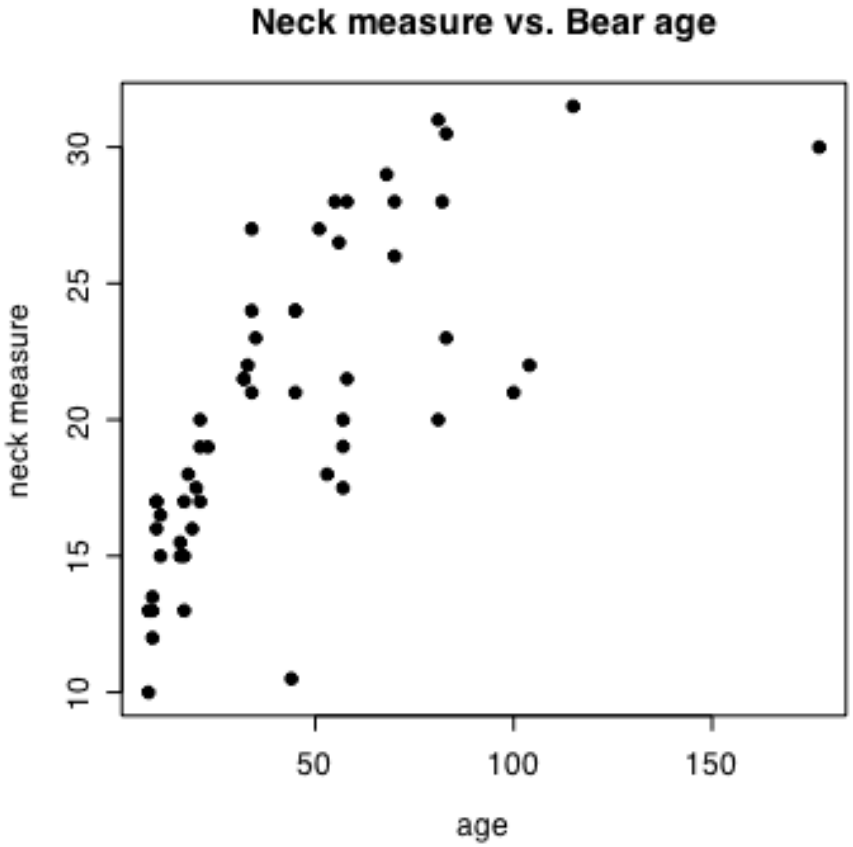
Chapter 7

- Scatterplots,
  Association,
  and Correlation

Scatterplots & Correlation

- Here, we see a **positive** relationship between a bear's age and its neck diameter.

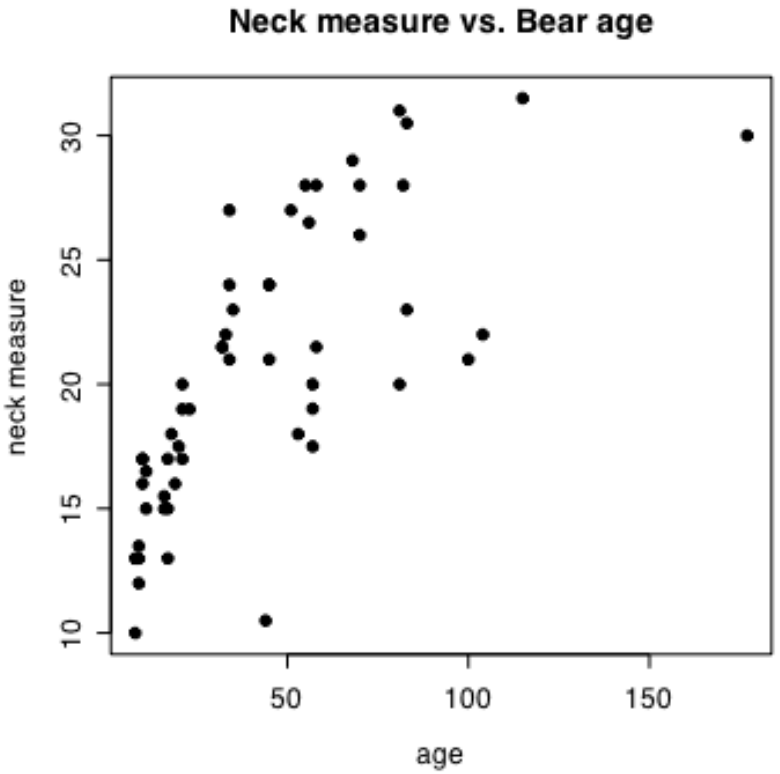


As a bear gets older, it tends to have a larger neck.

Scatterplots & Correlation

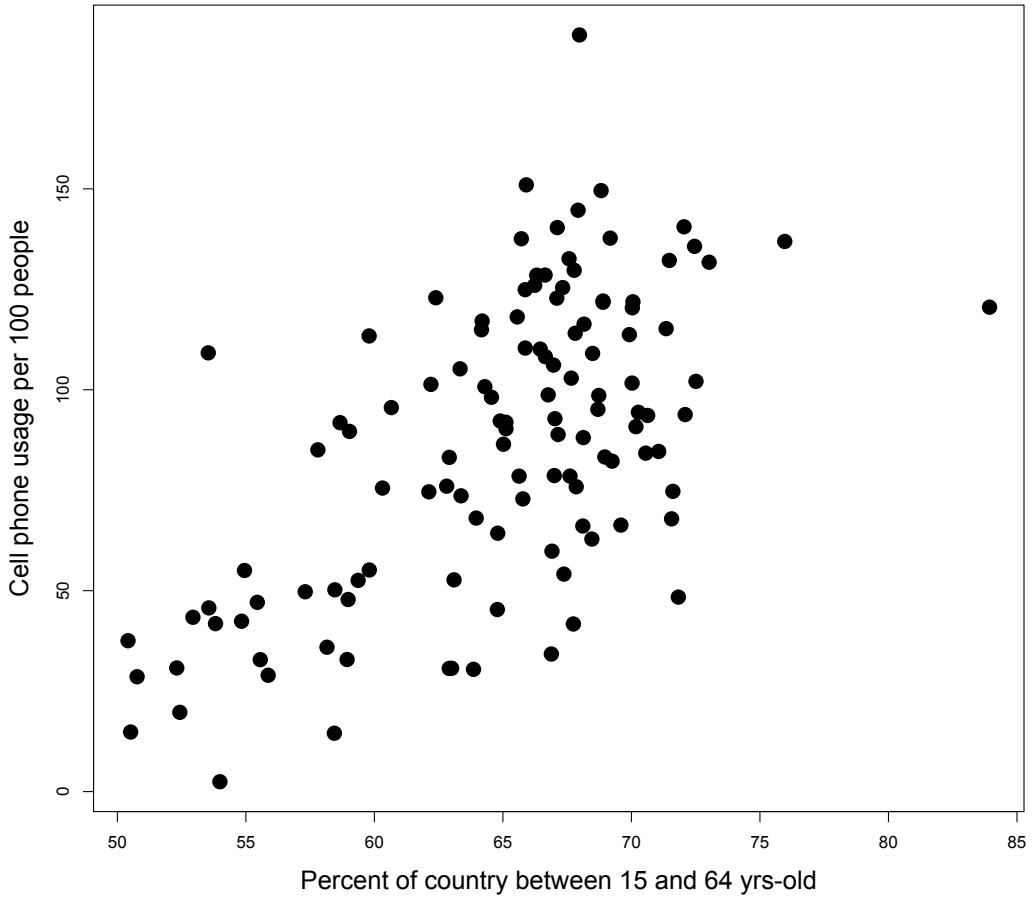
- Statistics is about … **variation**.

- Recognize, quantify and try to explain variation.
  - Variation in neck measurements can be explained, at least in part, by the age of the bear.
  - Older bear → Larger neck



Scatterplots & Correlation

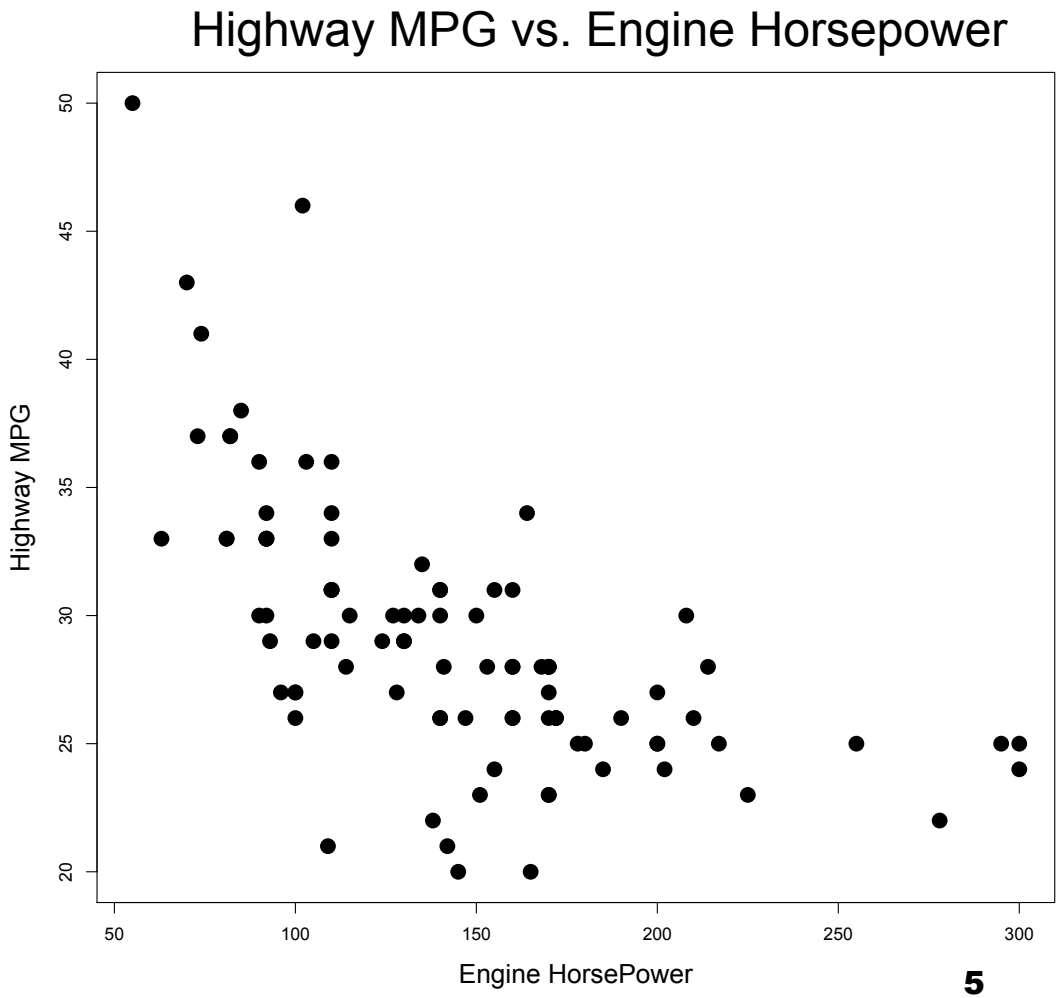
Cell phone usage vs. Percent of individuals in working age



- Data from 2008.
- These variables have a **positive** correlation…
  - A country with a larger percentage of people between 15-64 tends to have more cell phone users.

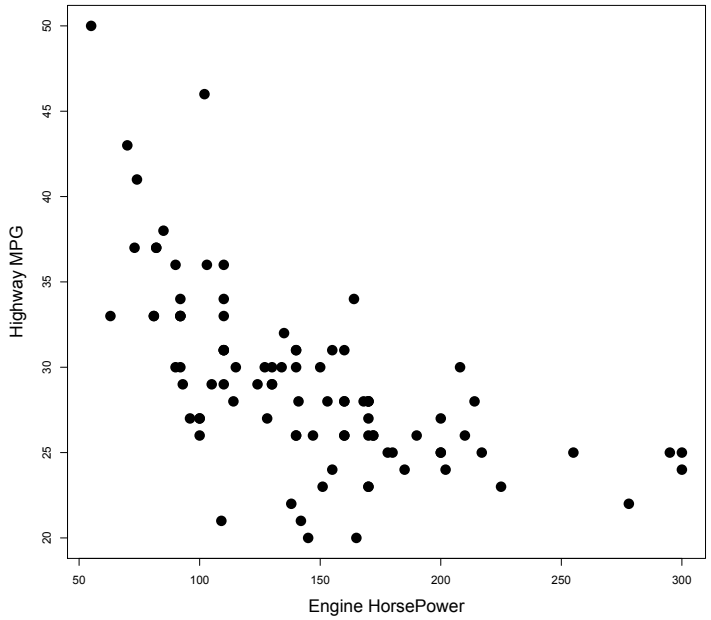
Scatterplots & Correlation

- Data from 1993.
- These variables have a **negative** correlation…
  - Vehicles with more horsepower tend to get lower Miles per gallon.
  - More horsepower→ Lower MPG



Scatterplots & Correlation

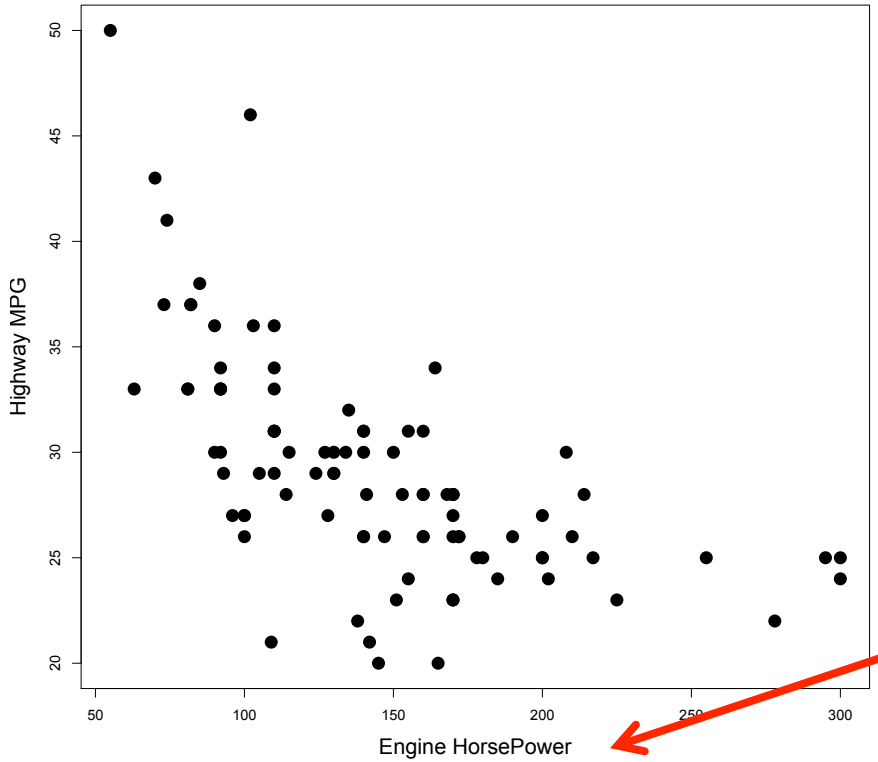
- When the two variables of interest are **continuous variables**, we can plot their relationship with a **scatterplot** (or scatter diagram).



- A scatterplot gives you a quick look at the general relationship between the variables.
- Each observation (vehicle) provides one point on the plot.

- Response variable – plotted on the vertical axis.
  - Also called the dependent variable.
- Explanatory variable – plotted on the horizontal axis.
  - Used to try to explain variation in the response variable.
  - Also called the independent variable.

HWY-mpg is the response variable



Here, we use Engine HPW to explain the variability in HWY-mpg.

Engine HPW is the explanatory variable

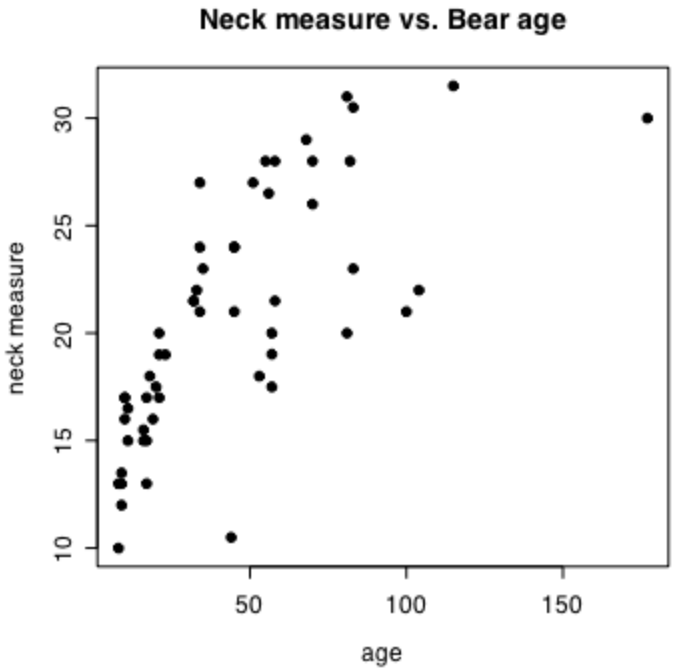
Correlation and Association

Definition

A **correlation** exists between two variables when higher values of one variable consistently go with higher values of another variable or when higher values of one variable consistently go with lower values of another variable.

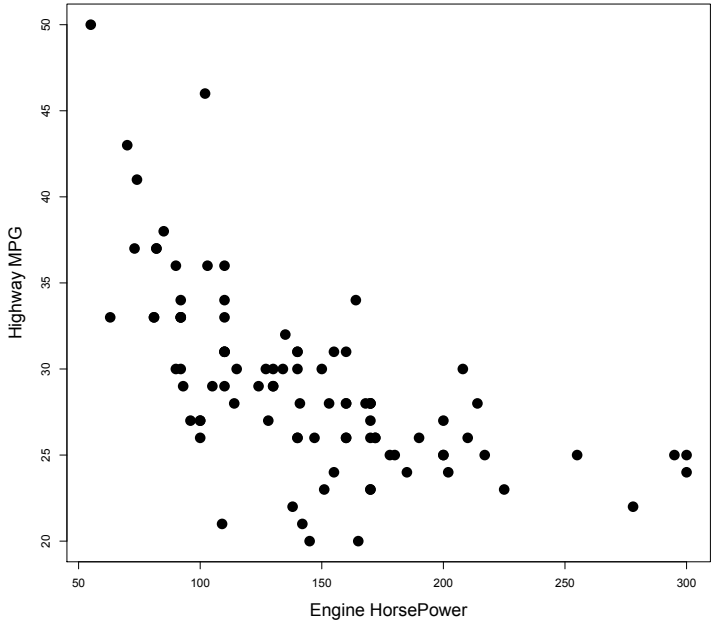
- When describing relationships, we use the terms correlation and association interchangeably. If variables are **correlated**, we say they are **associated**.

Positive Association
(correlation)



- Positive Association
  - Above average values of Age are associated with above average values of Neck Measure (age-high goes with neck-high)
  - Below average values of Age are associated with below average values of Neck Measure (age-low goes with neck-low)

Negative Association
(correlation)

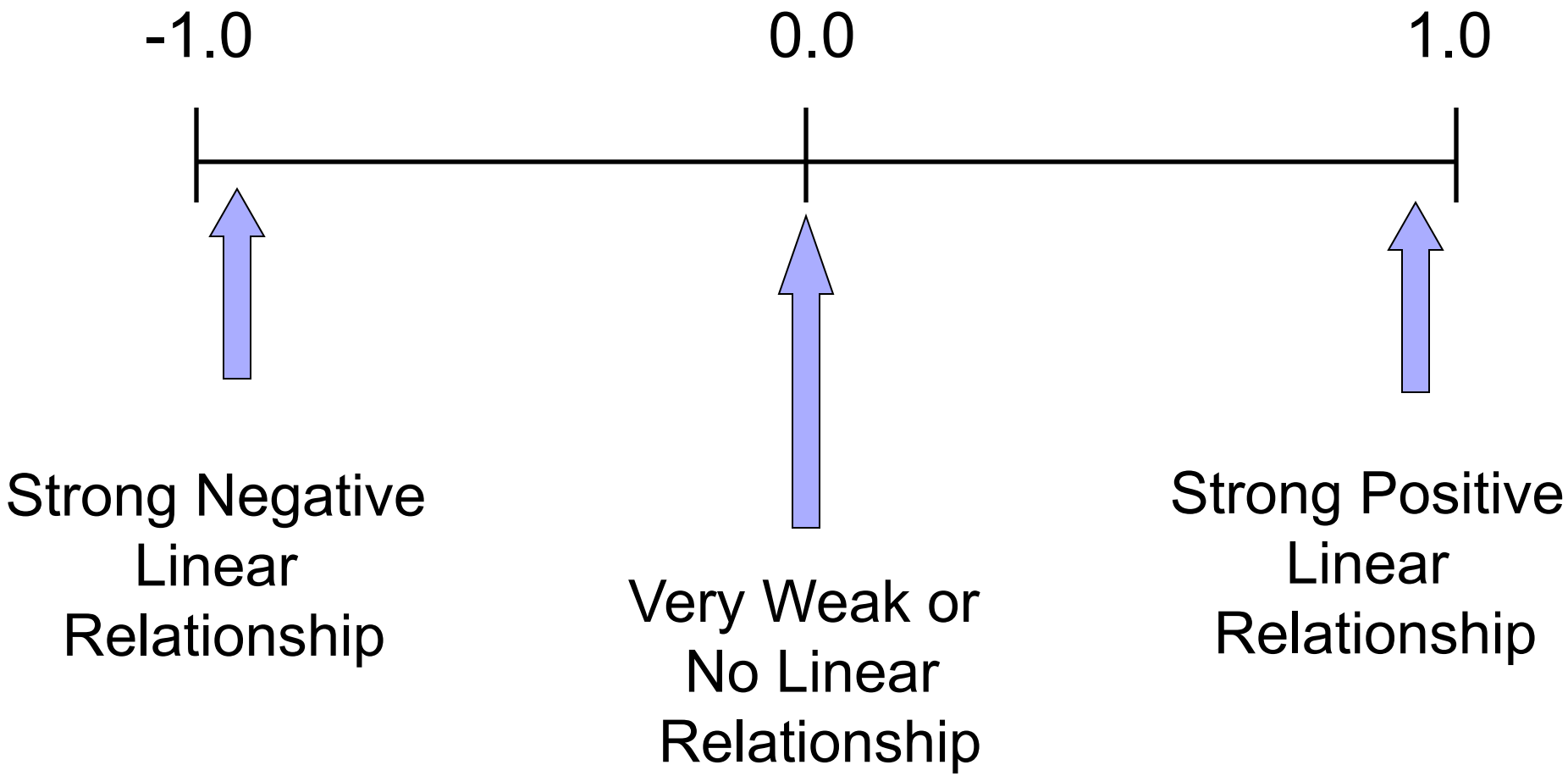


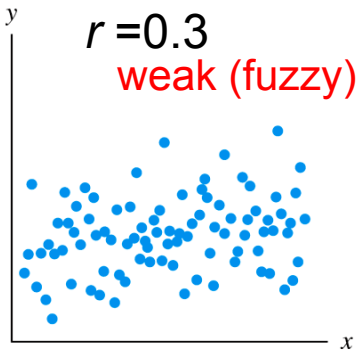
- Negative Association
  - Below average values of Engine HPW are associated with above average values of HWY-mpg (HPW-low goes with MPG-high).
  - Above average values of Engine HPW are associated with below average values of HWY-mpg (HPW-high goes with MPG-low).

Strength of Association

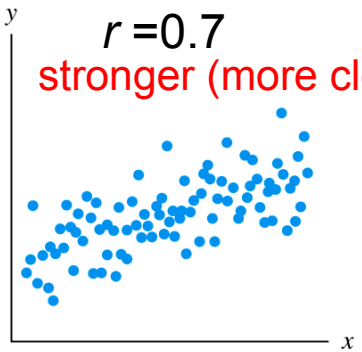
- Correlation applies only to **quantitative (continuous) variables**.
- Correlation measures the strength of **linear** association.
- The **correlation coefficient** (r) gives the direction of the linear association and quantifies the strength of the linear association between two quantitative variables.

Correlation Coefficient (*r*)

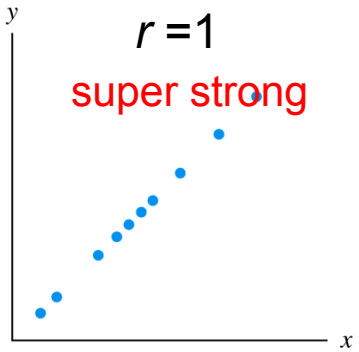




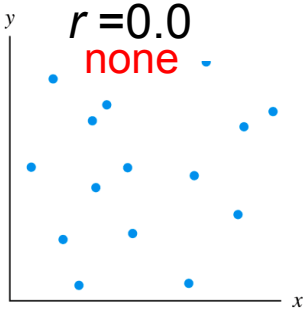
(a) Weak positive correlation between x and y



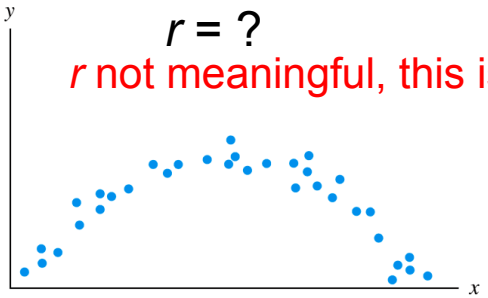
(b) Strong positive correlation between x and y



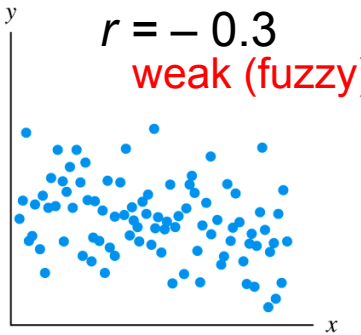
(c) Perfect positive correlation between x and y



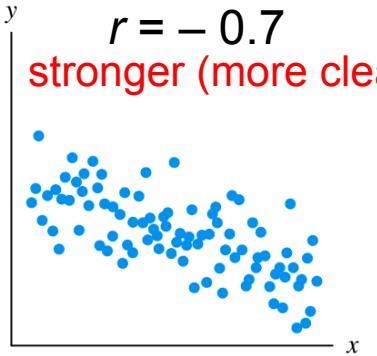
(g) No correlation between x and y



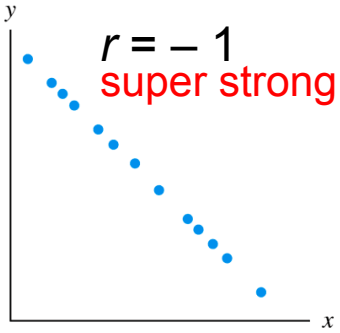
(h) Nonlinear correlation between x and y



(d) Weak negative correlation between x and y

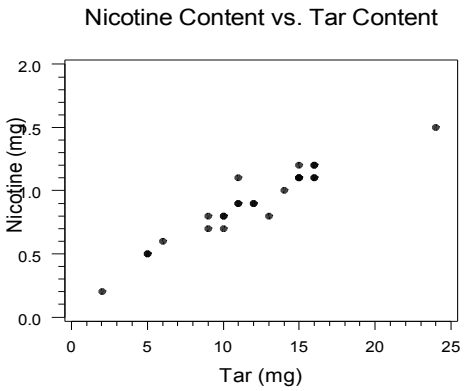


(e) Strong negative correlation between x and y



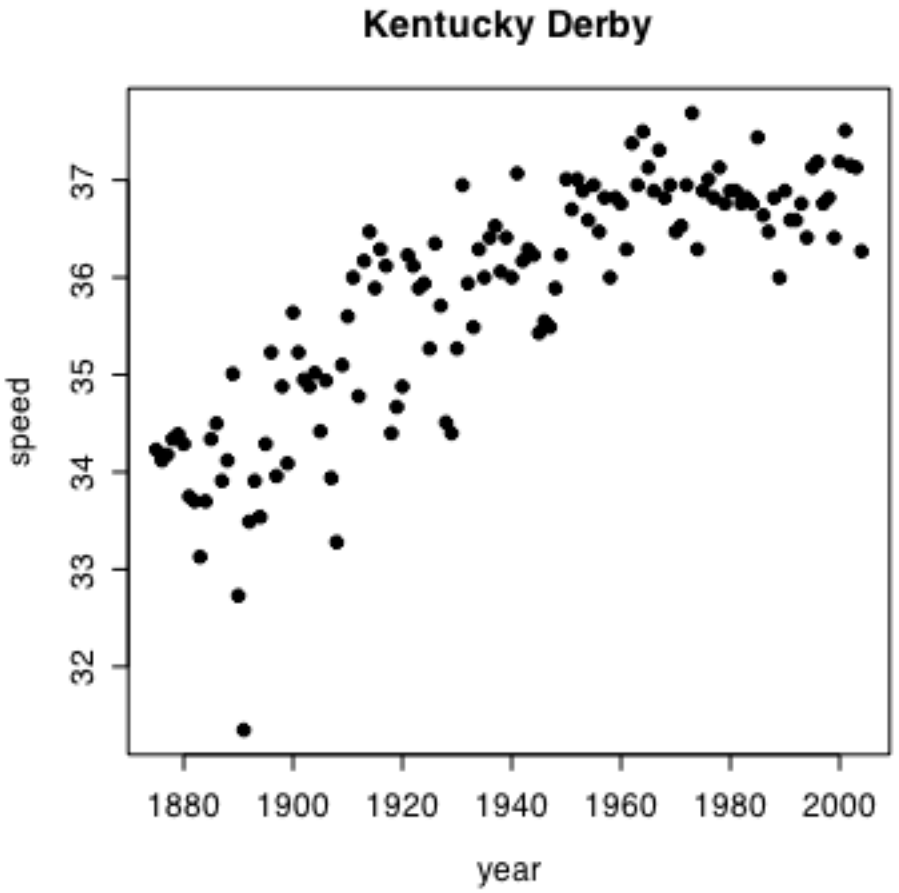
(f) Perfect negative correlation between x and y

Things to look for in a scatterplot



- 1. Direction of association
  - Positive or negative.
- 2. Form of association
  - Linear, curved, clustered, scattered (no relationship).
- 3. Strength of association
  - How closely the points follow a clear form.
- 4. Outliers
  - A point that lies outside of the general pattern.

Example



Direction _____

Form _____

Strength _____

Outliers? _____

Association vs. Causation

- The existence of an association does not equate to causation.
- To imply that a change in one variable **causes** a change in another is a *very* strong statement – use ‘association’ for our relationships in this class.