Measurement scales

Measurement scales

- Nominal scale
  - Bus #; Gender?
- Ordinal scale
  - House numbers; Rank in class
- Interval scale
  - Complex, maybe Grades
- Ratio scale
  - Heart rate; any measure in %

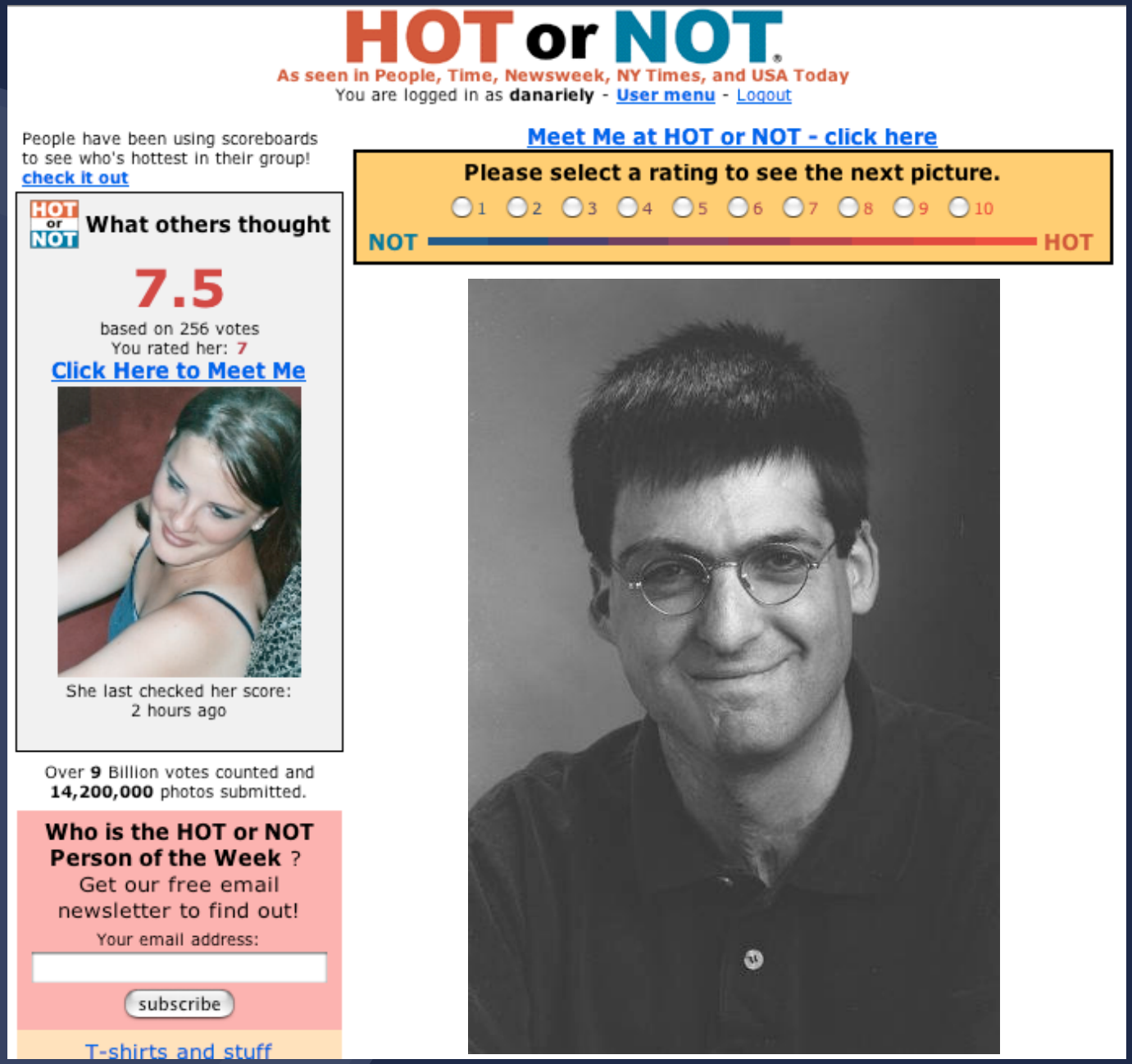
Scales & Statistics

- Can you take an average of a nominal scale?
  - Gender
  - Apartment number
  - Ice-cream flavor
- Think about the meaning of the measurements!

What scale is this?

Courtesy of hotornot.com. Used with permission.

What scale is this?

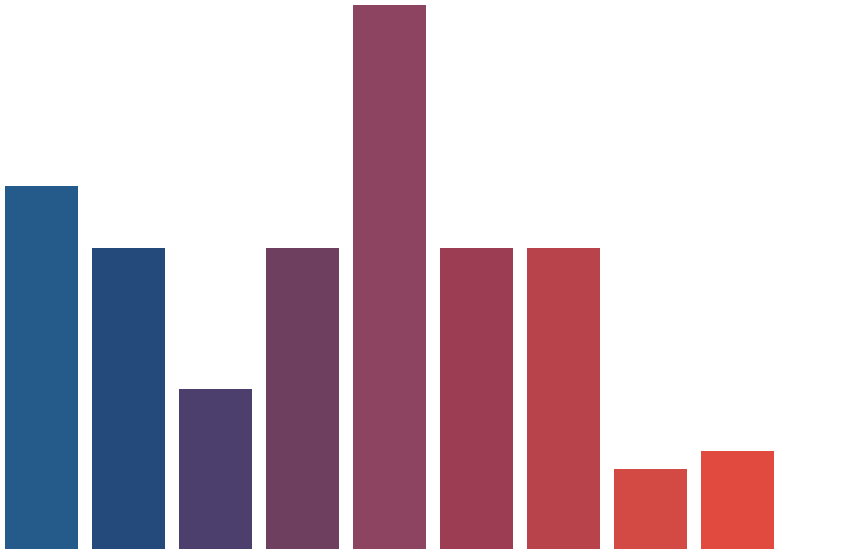


Courtesy of hotornot.com. Used with permission.

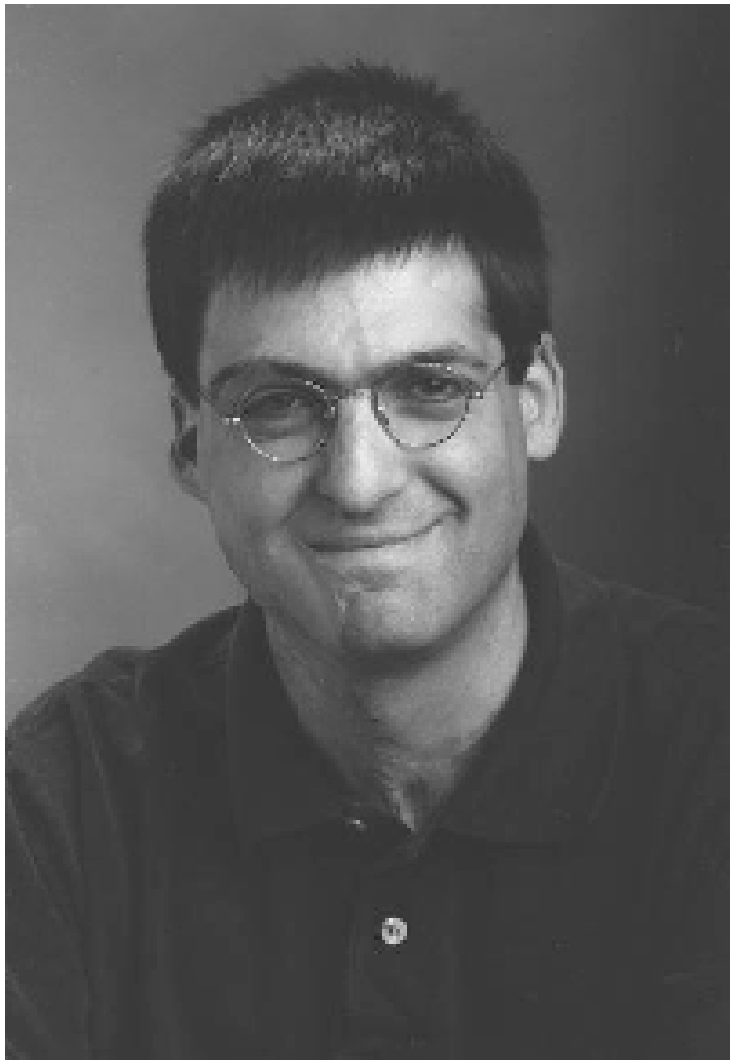
Outcomes

6.6

You are hotter than 62% of men on this site!



122 people have rated you



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What scales do we have?

- In most cases when asking people for their opinions researchers behave as if they have ratio scales, wishing they had interval scales but in fact in most cases we only have ordinal scales
- Luckily many of the statistical tools we use are not very sensitive to the violation of this assumption

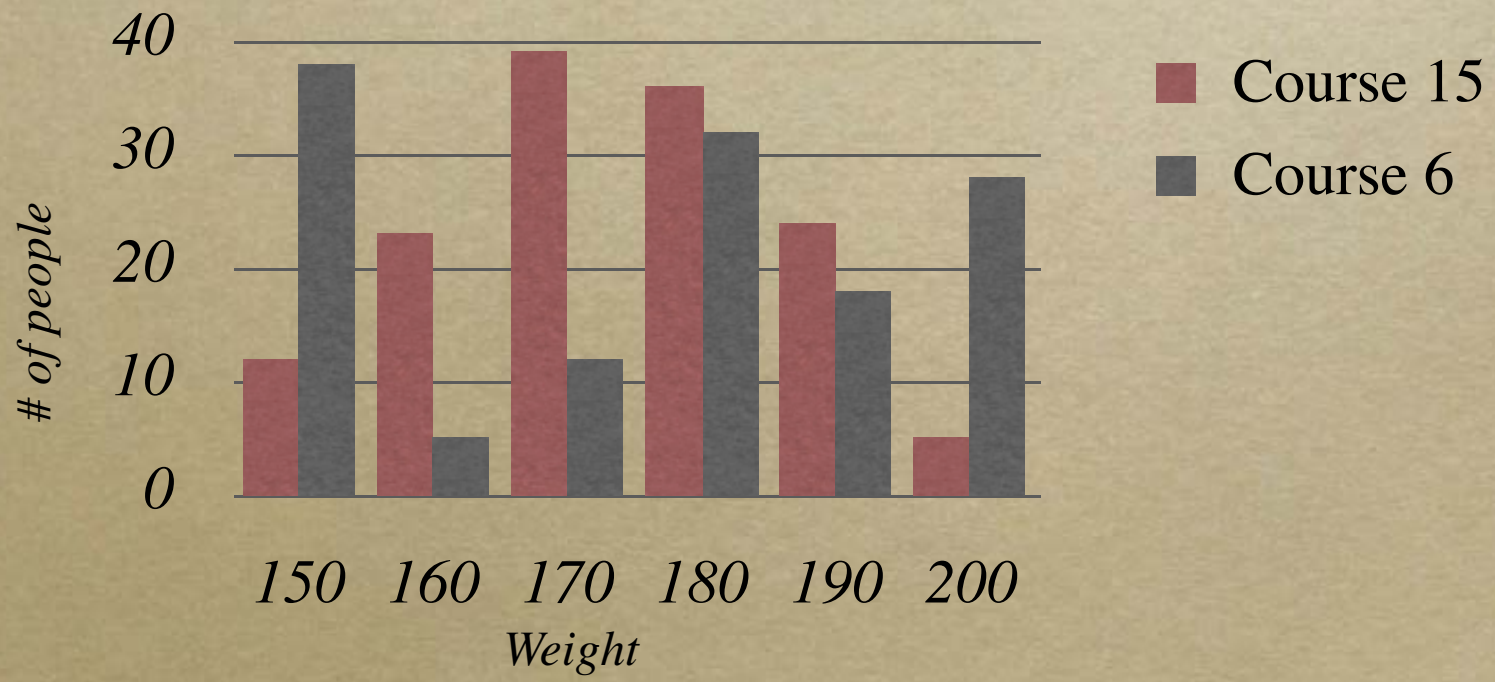
Granularity of scales

- It is important to use measurement scales that people find meaningful
- If people can distinguish only 3 (7) levels, there is not much use in a 100 point scale

Descriptive statistics

The goal of statistics is to

- Report data in meaningful ways
- Make predictions about future events

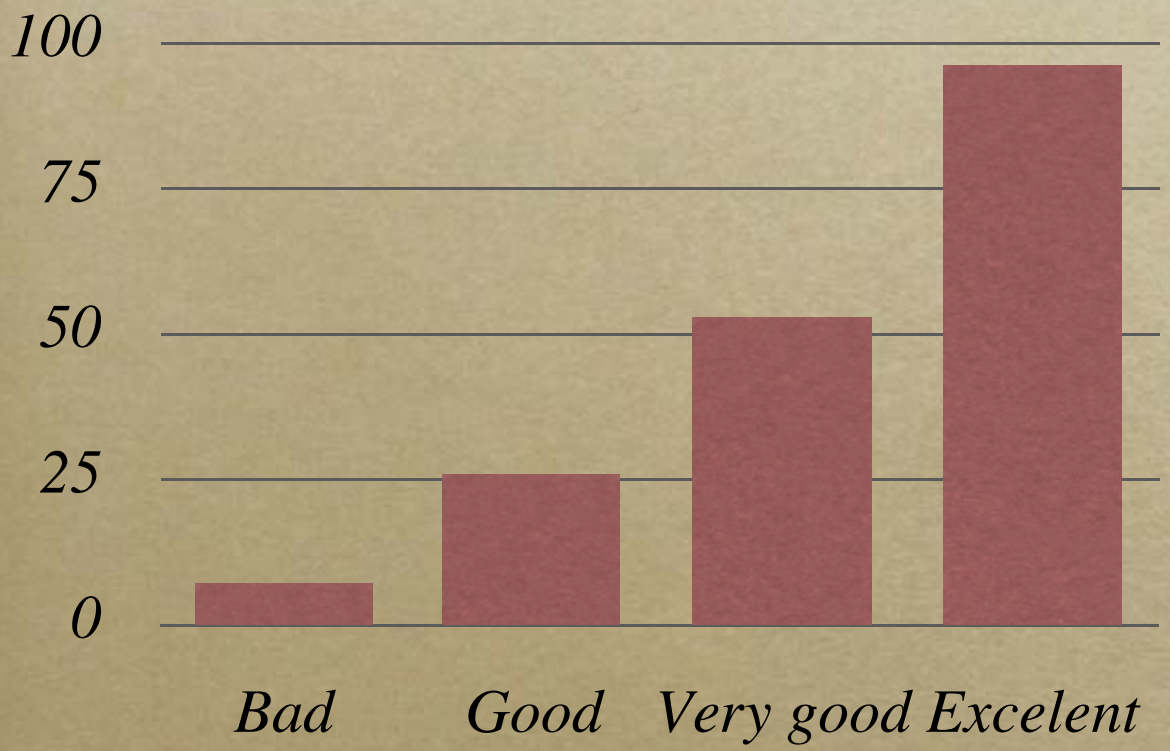


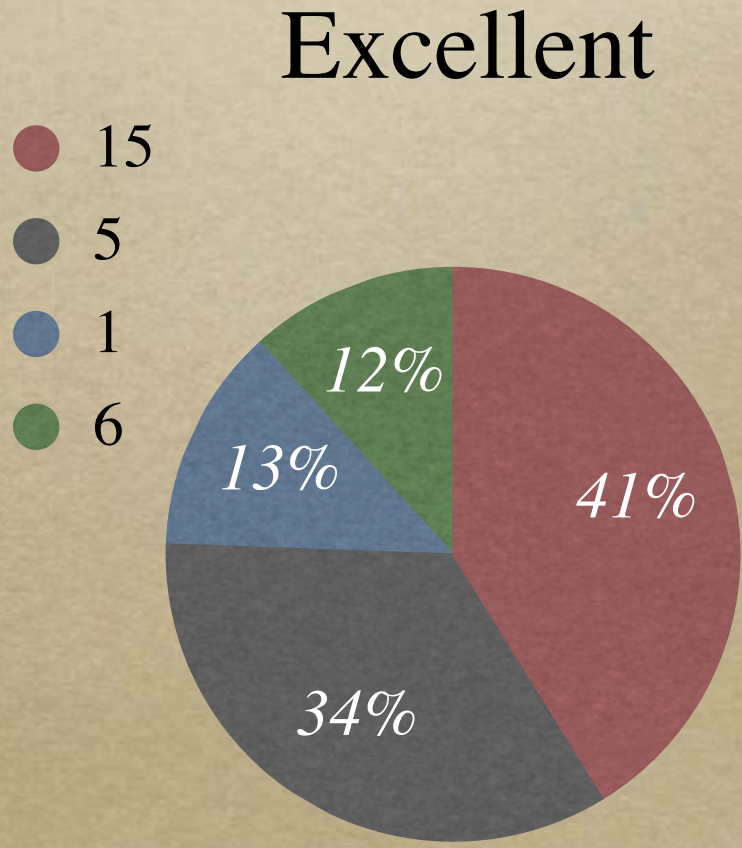
Describing a state

- Descriptive statistics
  - Capturing a picture of the data)
- This was the origin of statistics
  - Started for gambling

First some descriptive statistics

How do you like 15.301?





Central tendencies

- Representing central tendencies of distributions is a very efficient way to understand something about it.
- Mode
- Median
- Mean

The Mode

- The most "popular" frequent occurring instance in the sample.
  - This is the only central tendency that can be used with a nominal scale
- The mode is sensitive to aggregation of categories
  - Age 18 vs age 18-21
- Sometimes there are multiple modes
  - Bimodal distributions

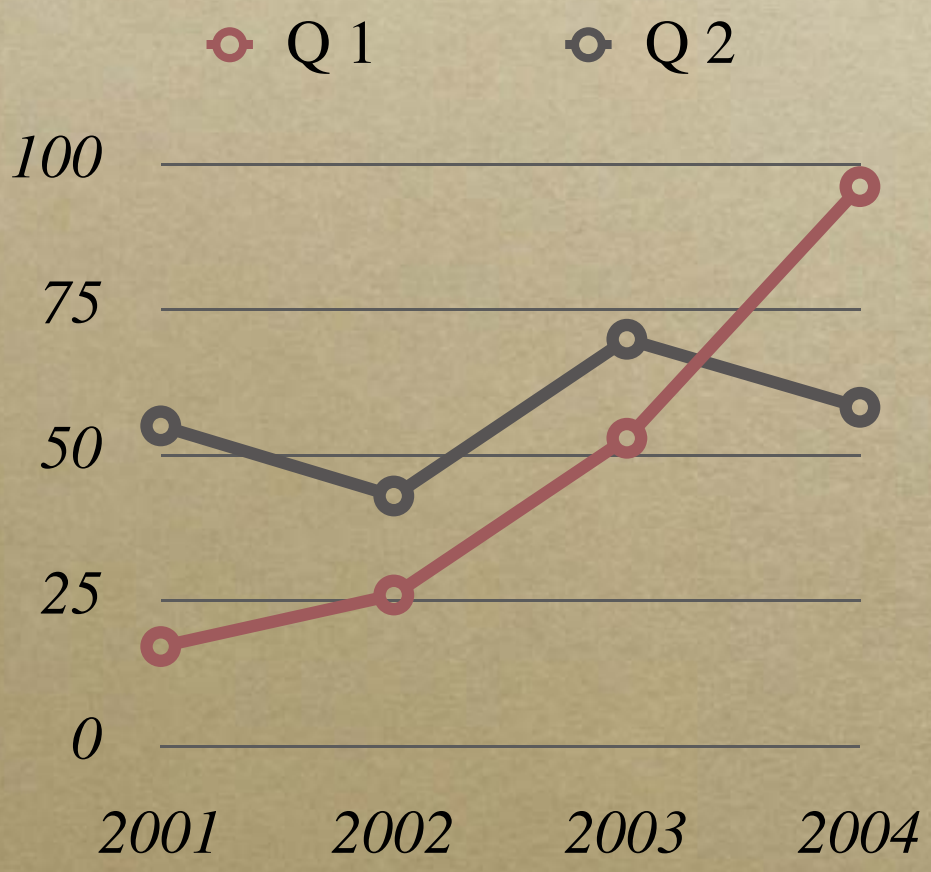
The Median

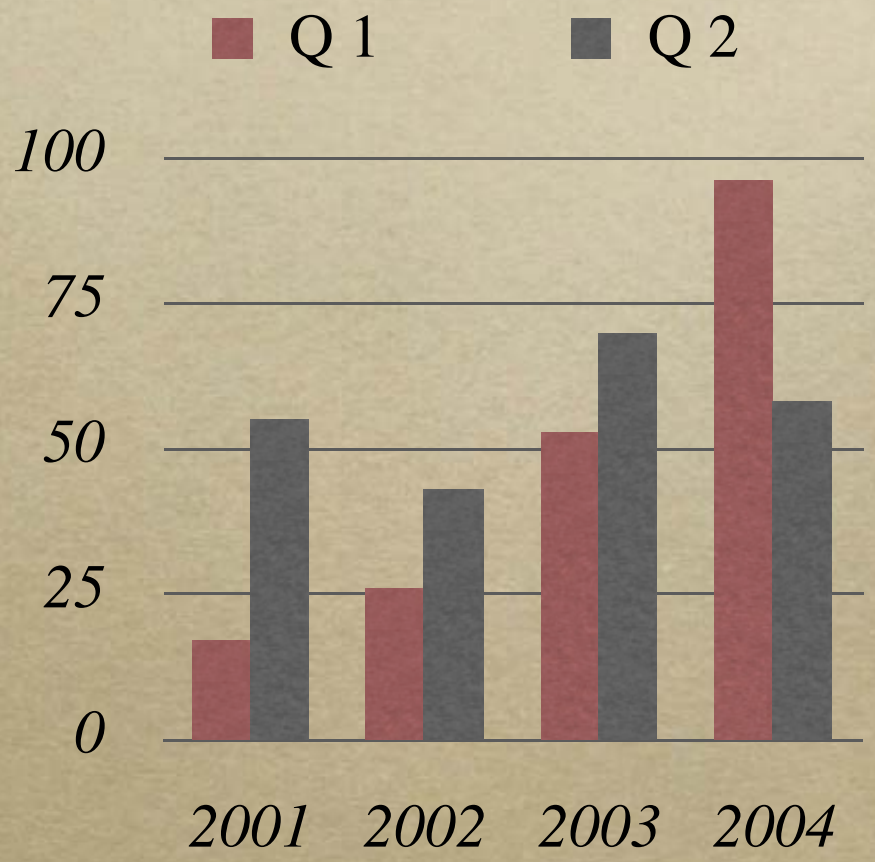
- The median is a value which 1/2 of the values are above it and 1/2 below
- After sorting the values by magnitude, the median is at the (n+1)/2 location
- 123, 85, 34, 20, 18, 15, 14 ➜ ?
- 123, 85, 34, 20, 18, 15 ➜ ?
- When data is grouped, calculating the mode is a bit more complex

The Mean

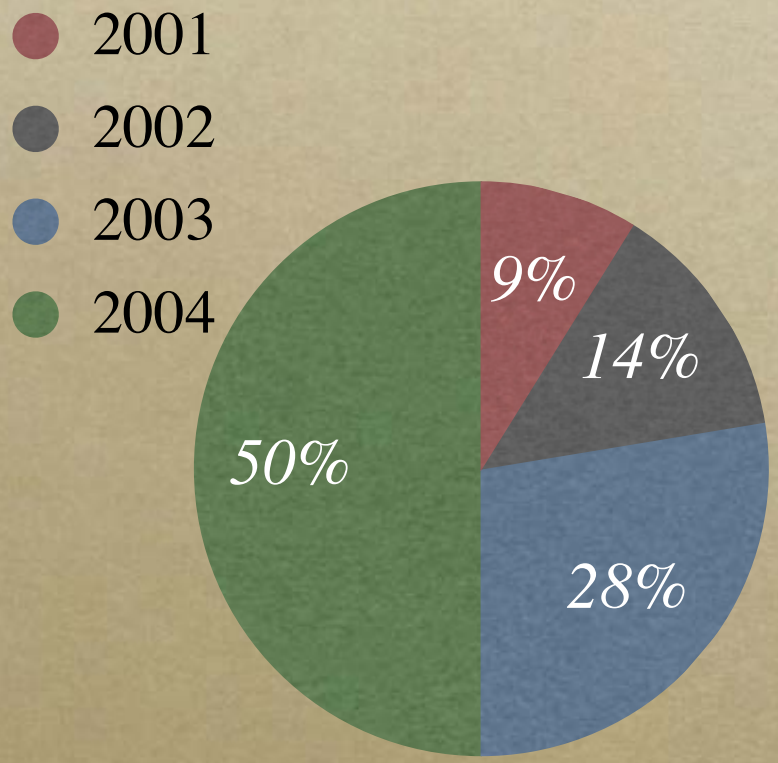
- Mean = $(\sum Xi) /n$
- The most important statistic
- Used for many other computations
- Stable
  - Smallest mean square deviations from it
- Sensitive to extreme values
- Not “well behaved’ in non-standard distributions

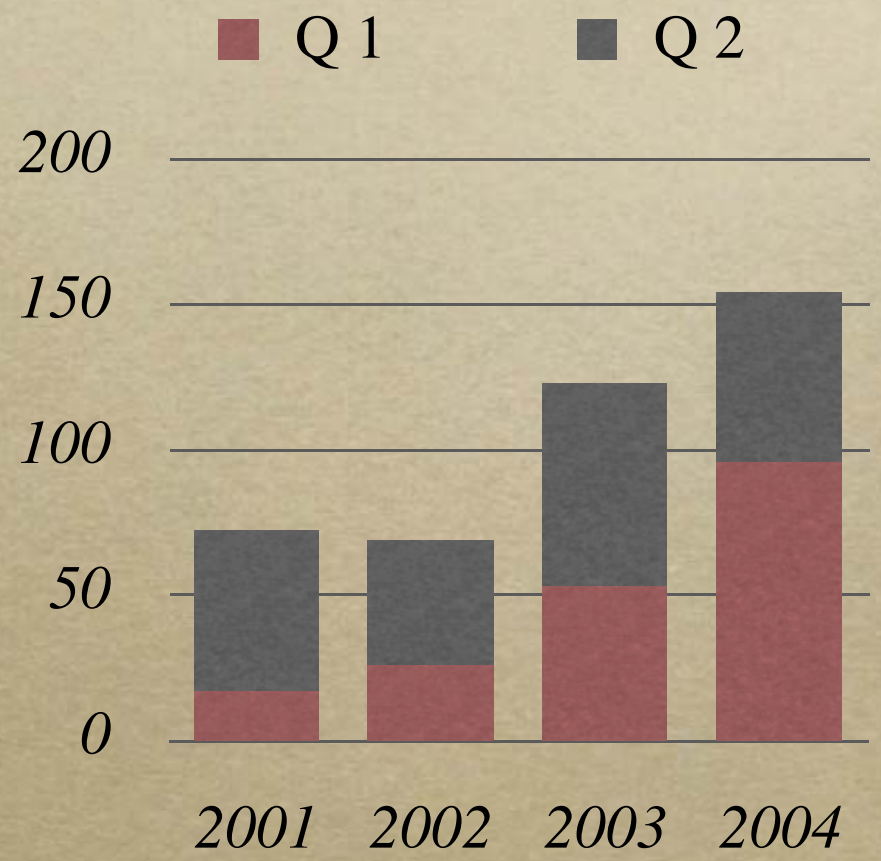
Plots I


Q 1
Q 2
100
75
50
25
0
2001
2002
2003
2004


Q 1
Q 2
100
75
50
25
0
2001
2002
2003
2004

Plots II

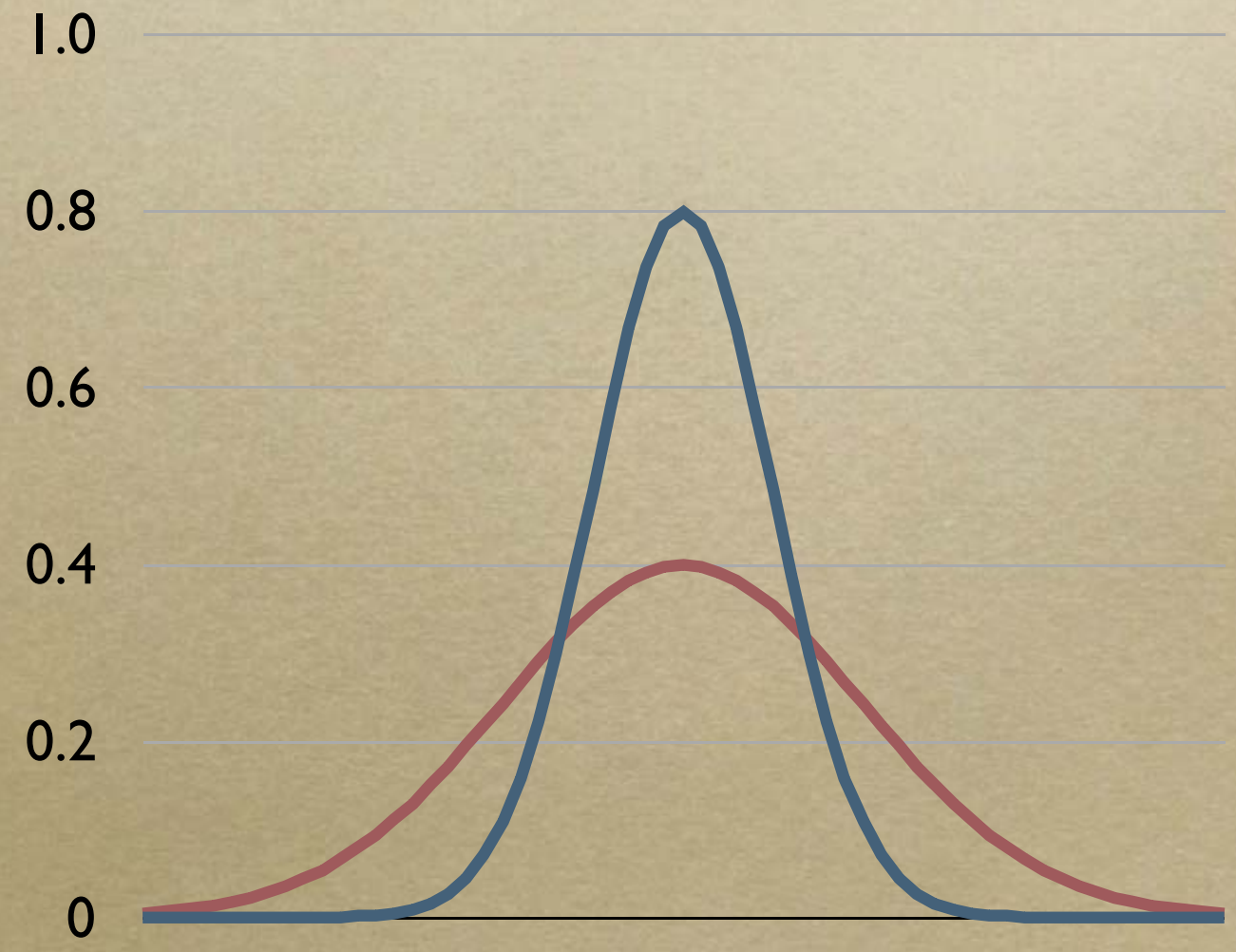

2001
2002
2003
2004
9%
14%
28%
50%


Q 1
Q 2
200
150
100
50
0
2001
2002
2003
2004

Location of central tendencies

Normal

- Mean
- Mode
- Median



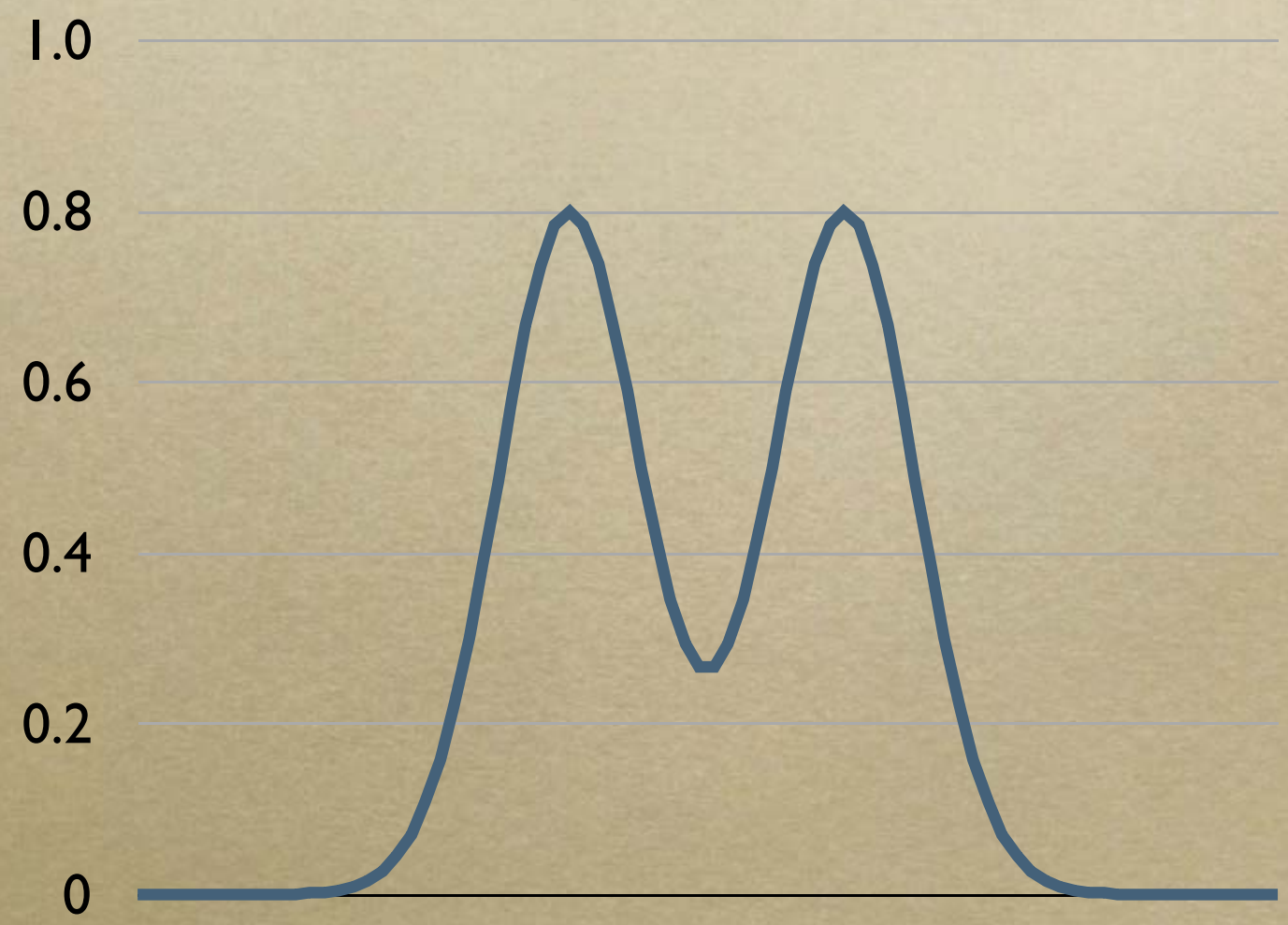
Location of central tendencies

Bimodal

Mean

Mode

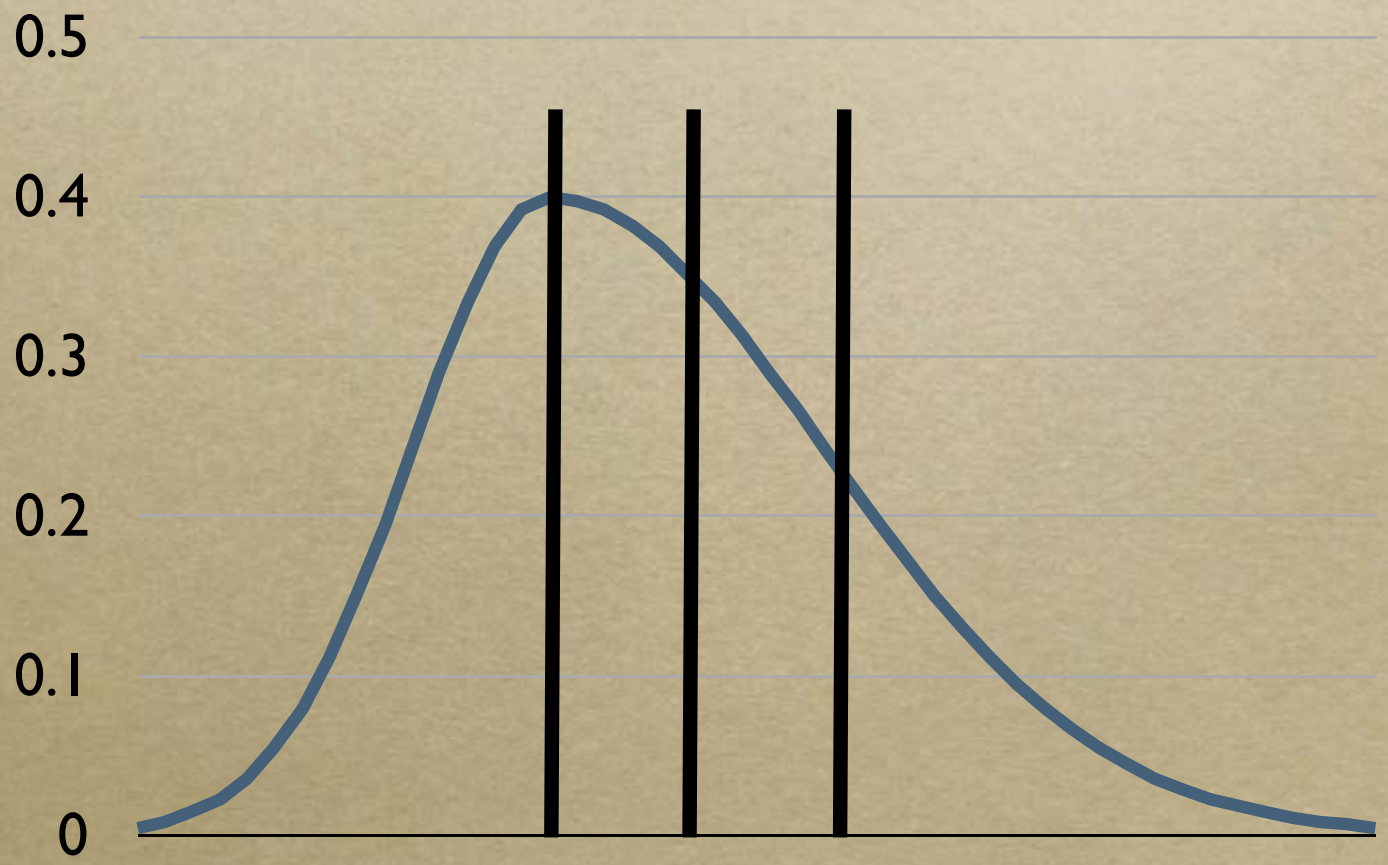
Median



Location of central tendencies

Skew to right

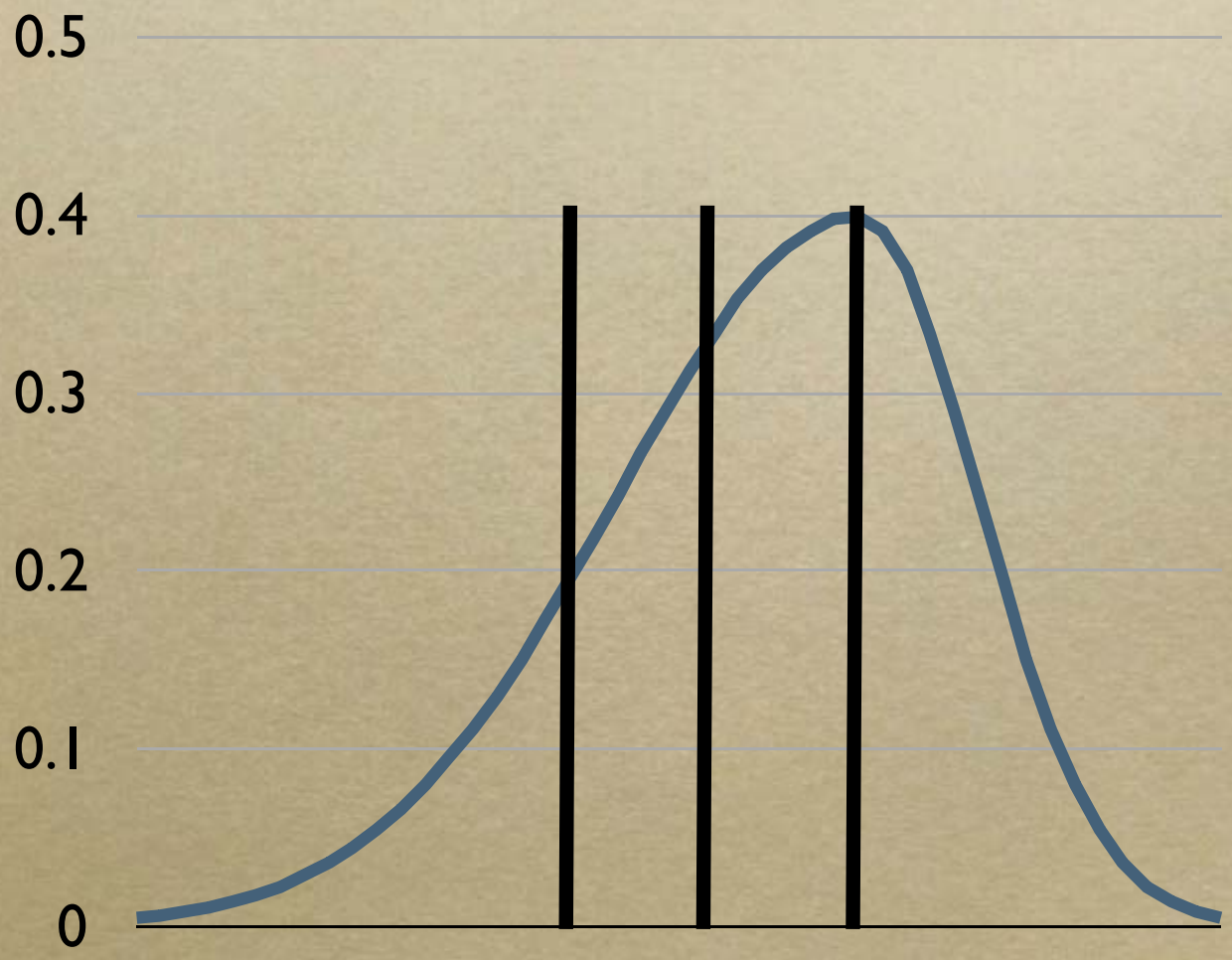
Mean
Mode
Median



Location of central tendencies

Skew to left

Mean
Mode
Median



Distribution descriptors

- The Range
  - The range is (Max - Min)
  -
  -
- Interquartile range
  - Calculating is similar to median
  - Q3-Q1 (1/2 of the observations)

Variation I

- Variance (σ^2)
  - $\Sigma(Xi-\mu)^2/(n)$
  - $\Sigma(Xi-\mu)^2/(n-1)$
- Standard deviation (σ)
  - Square root of variance
  - Standard deviation is in the same units as the distribution

Variation II

- Variance (σ ^2) is:
  - insensitive to transformations consisting of adding a constant.
  - sensitive to transformations consisting of multiplying by a constant.

When to use

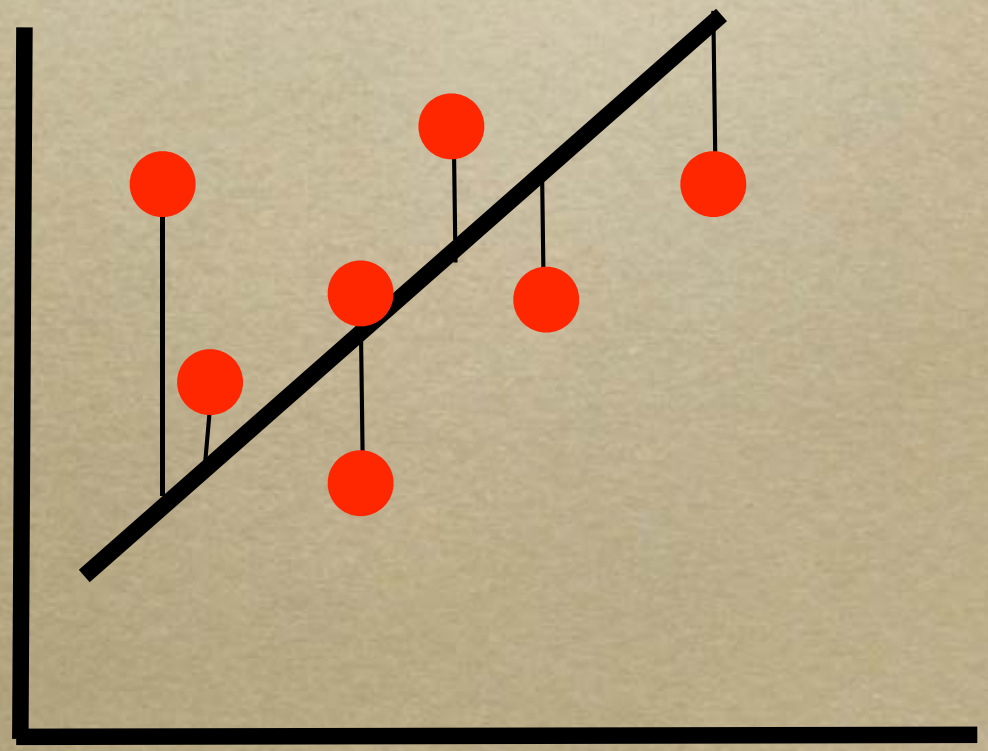
- When should you use the:
- Mean
- Mode
- Median

The Correlation

- **The relationship between 2 variables does not have to be linear**
  - **But in many cases they are**
- **Positive and negative correlations**

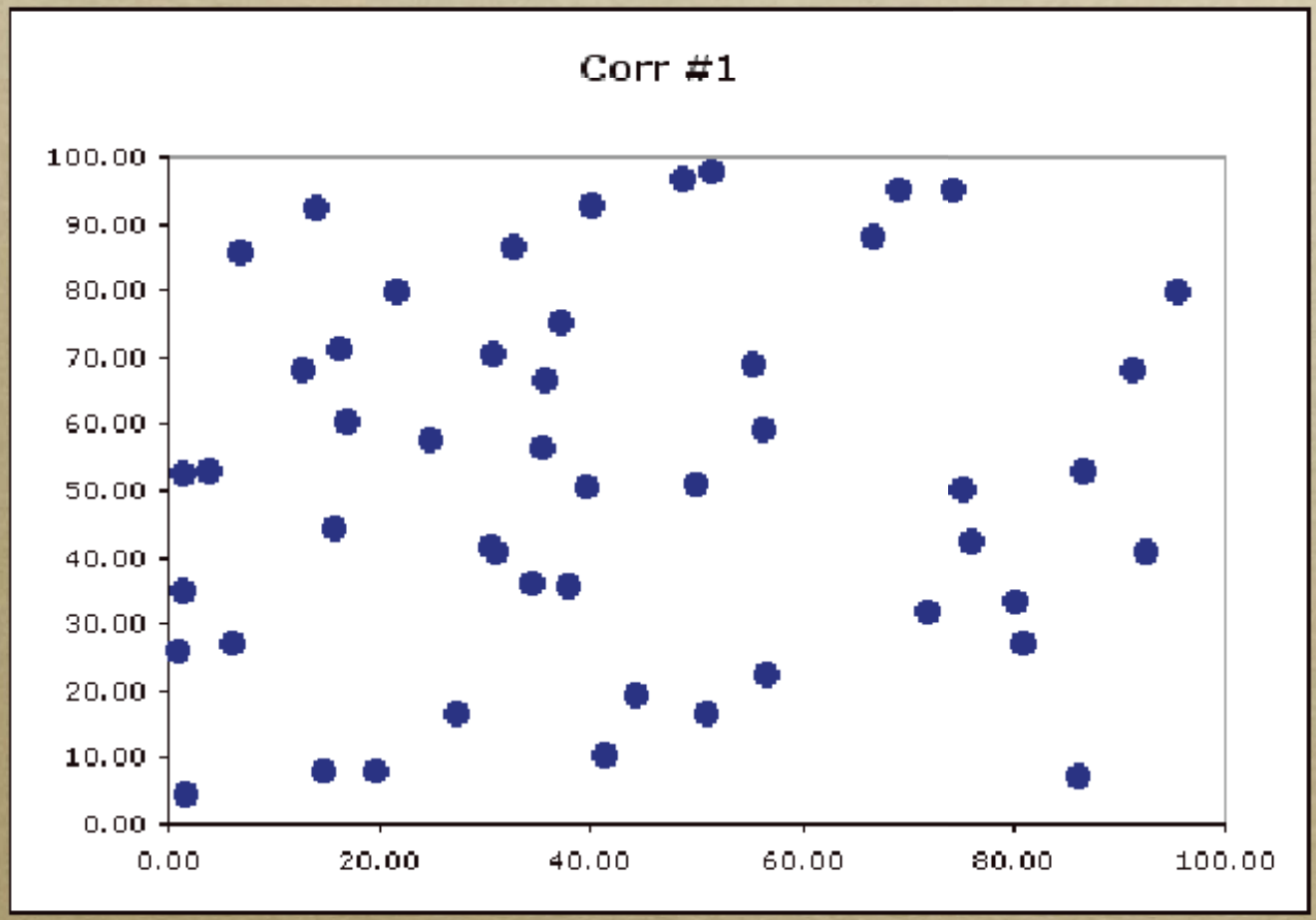
What is a correlation?

- What line to pick?
  - Sum of all deviations from the line is 0
  - The sum of square deviations of the points from the line is minimal.



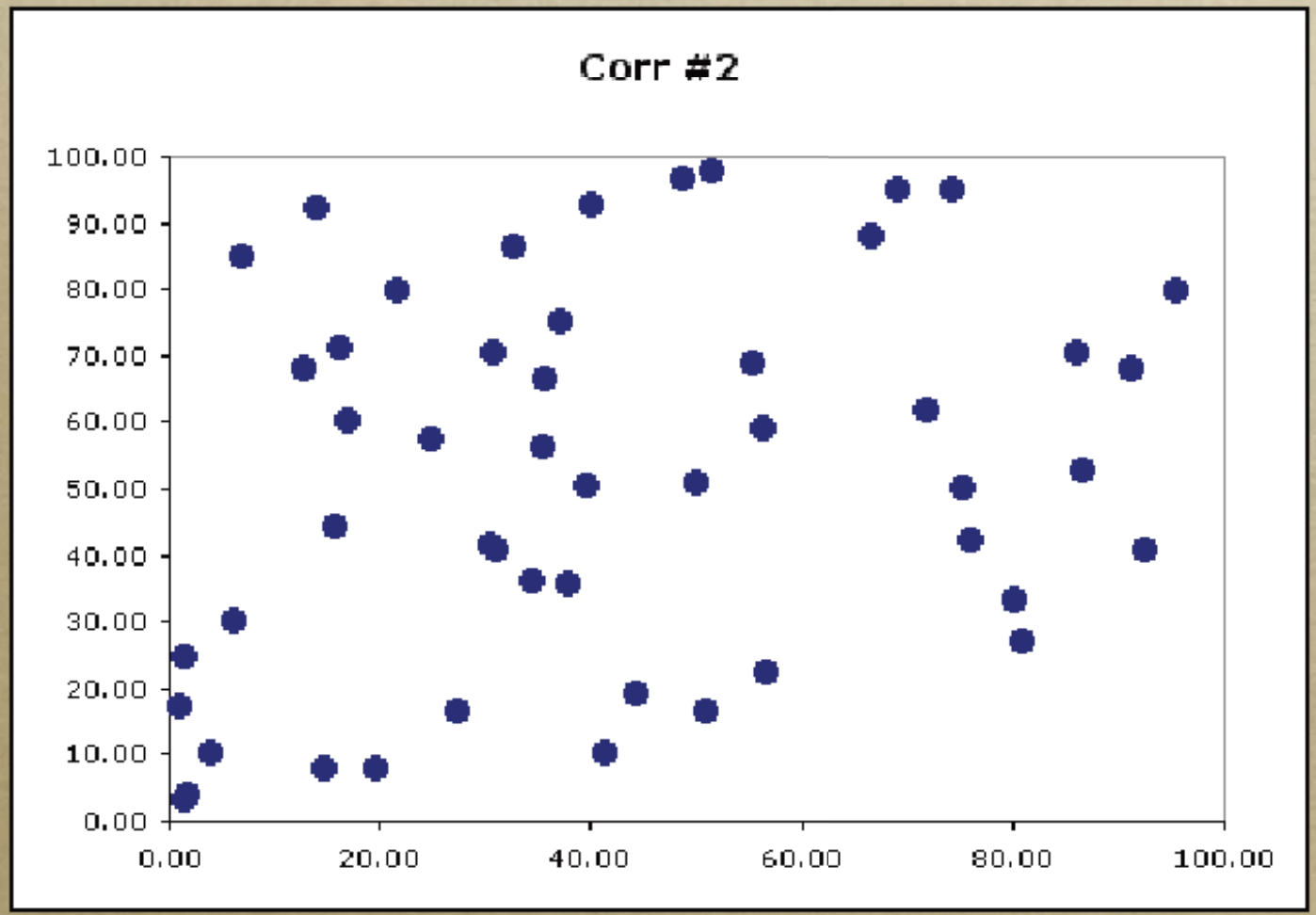
Estimating correlations in scatter grams

What is the correlation here?



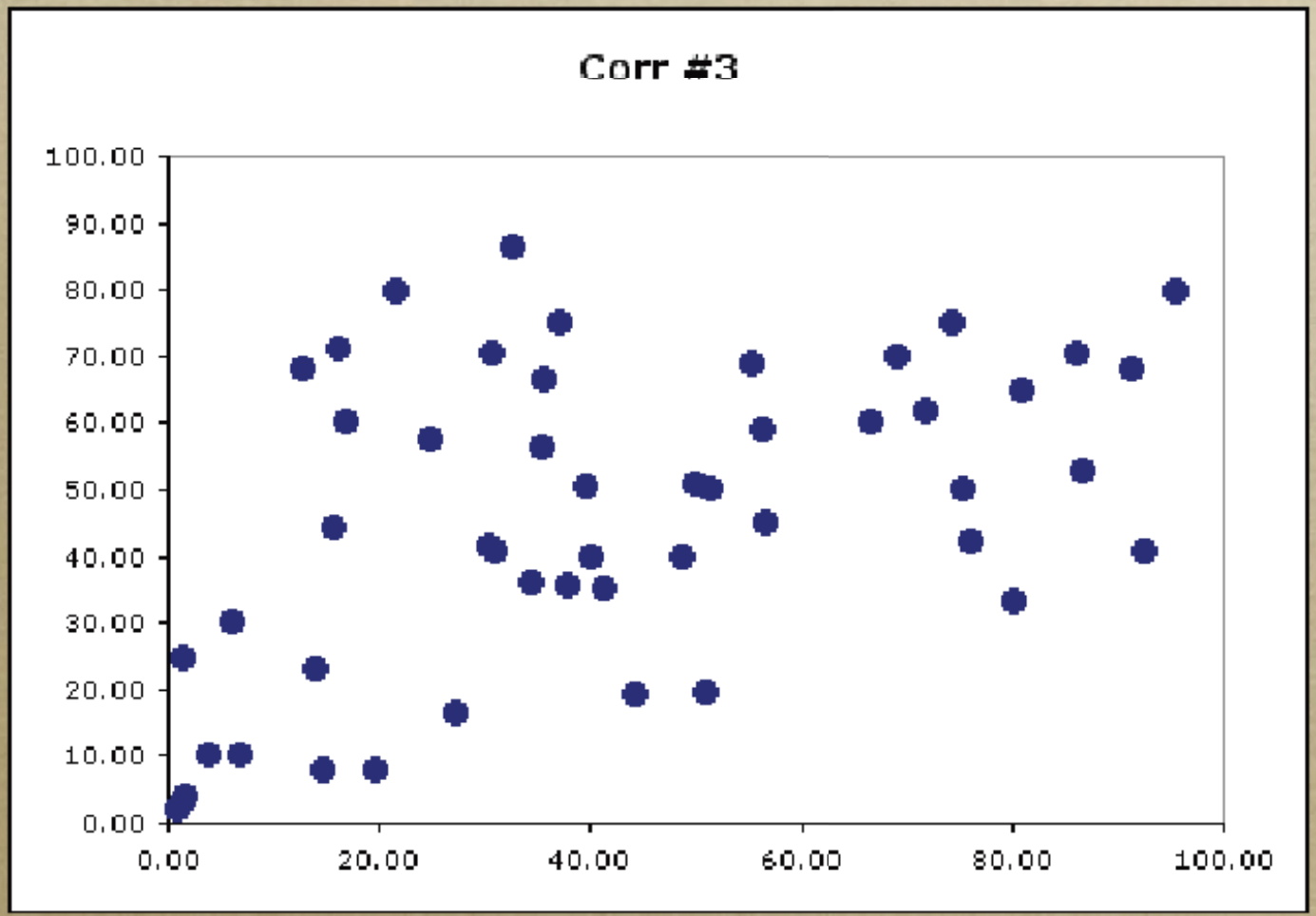
Estimating correlations in scatter grams

What is the correlation here?



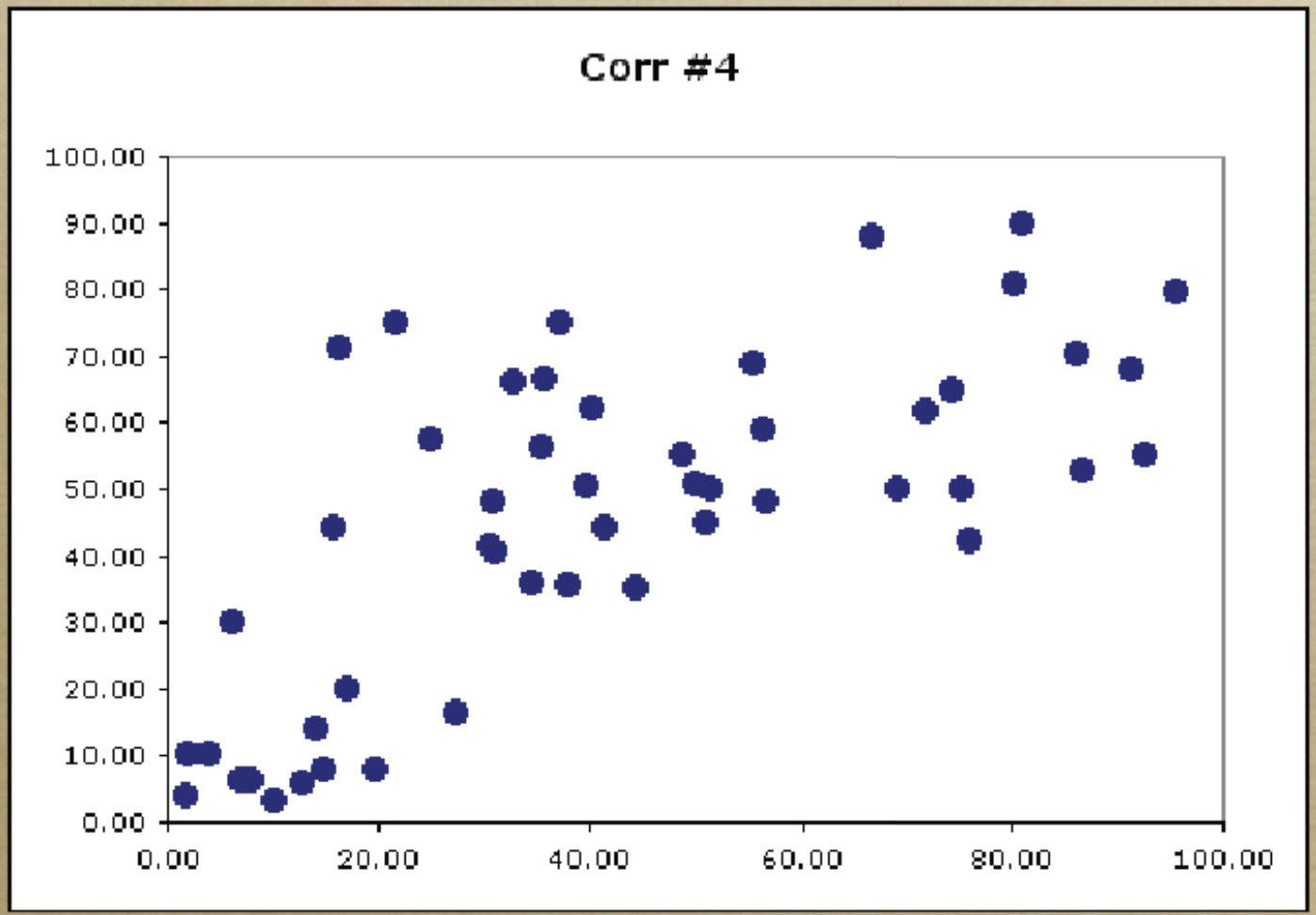
Estimating correlations in scatter grams

What is the correlation here?



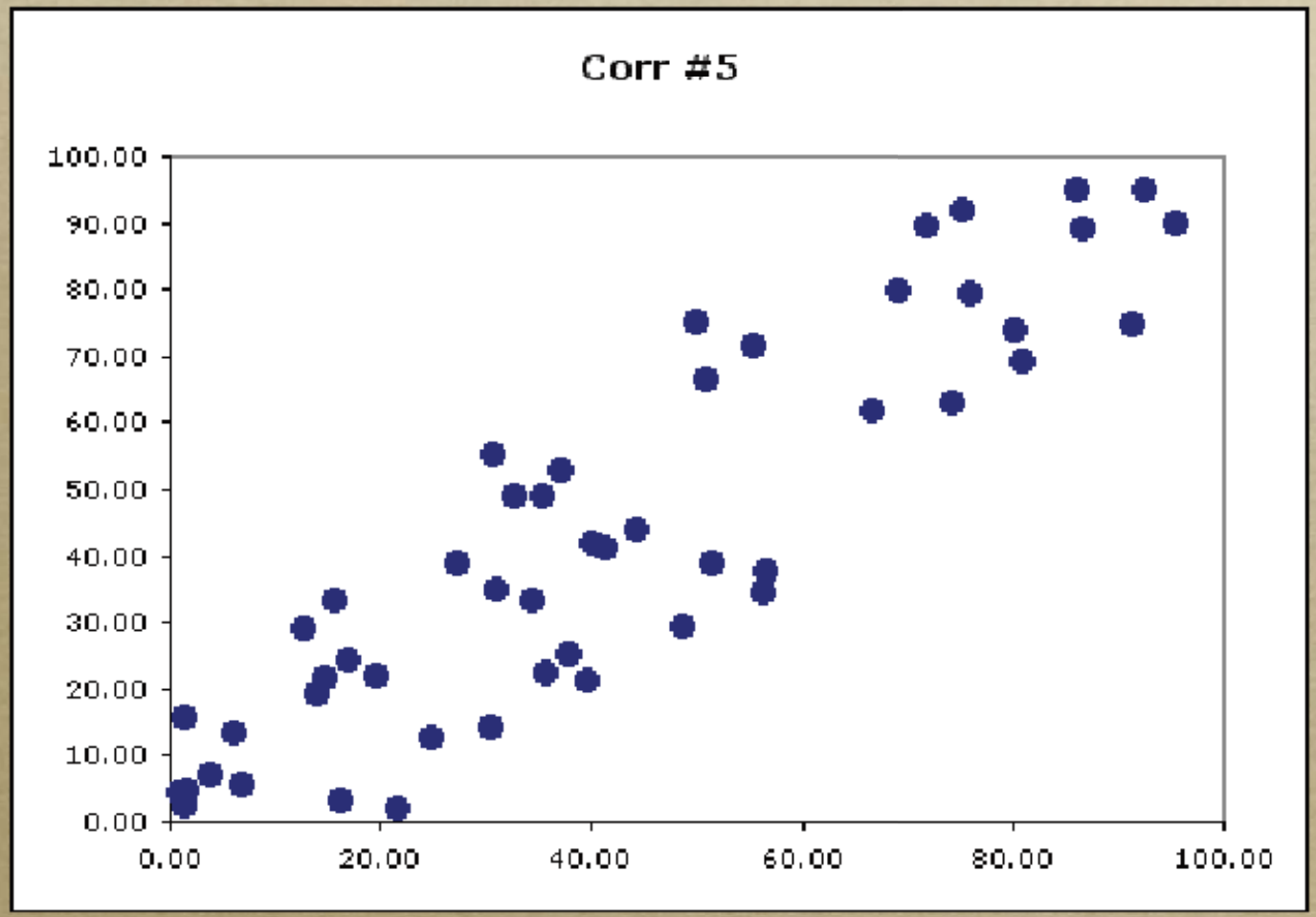
Estimating correlations in scatter grams

What is the correlation here?



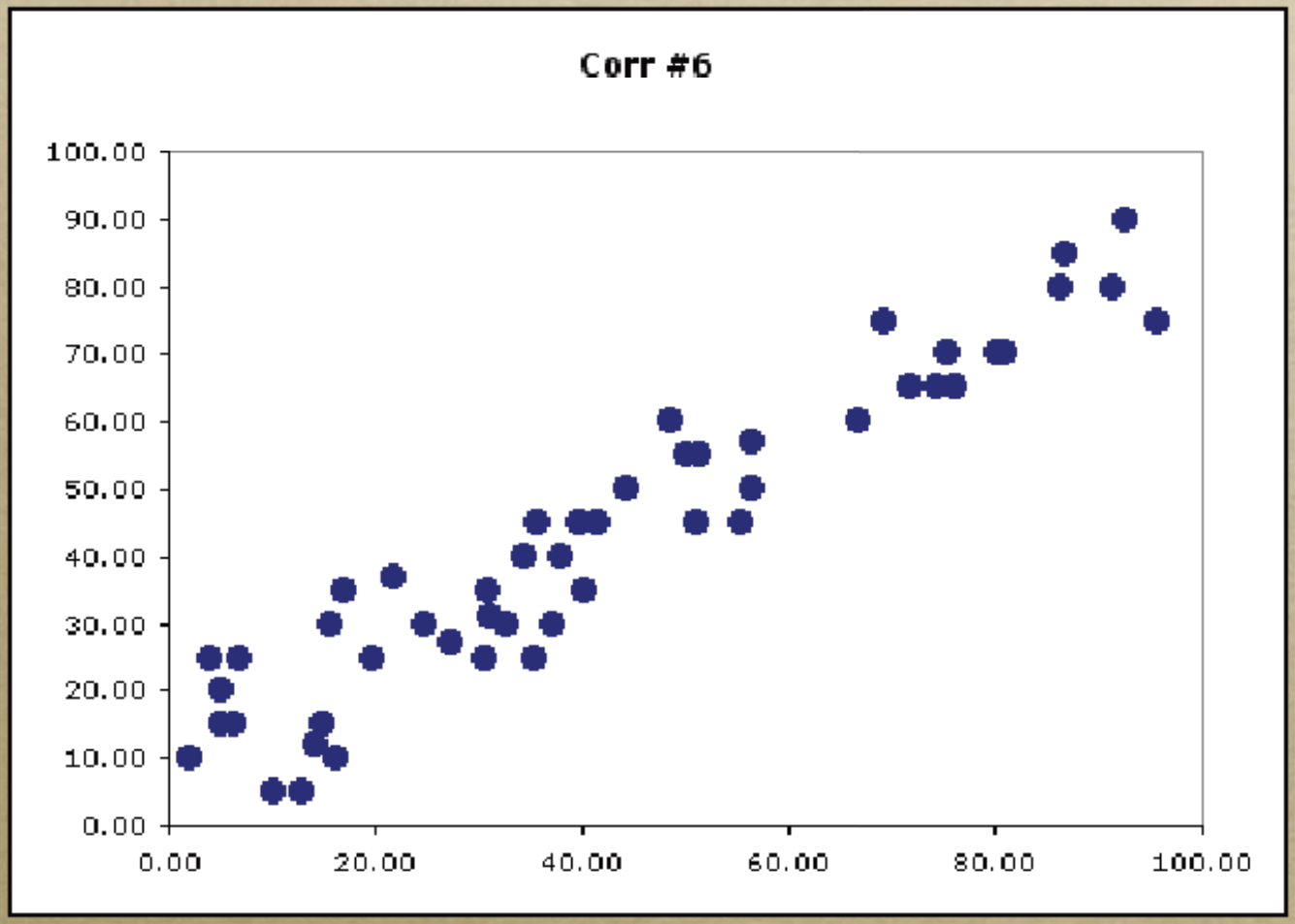
Estimating correlations in scatter grams

What is the correlation here?



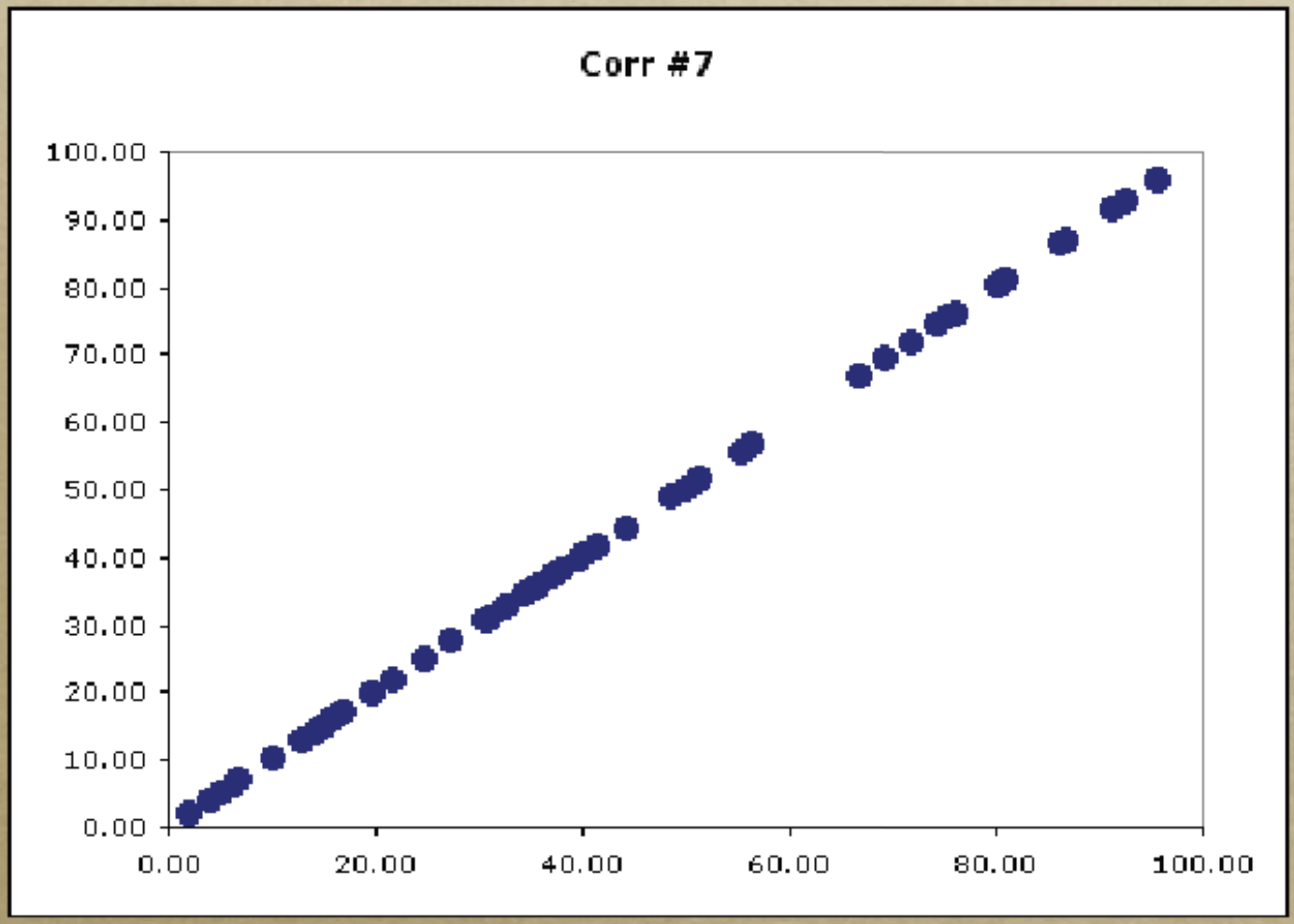
Estimating correlations in scatter grams

What is the correlation here?



Estimating correlations in scatter grams

What is the correlation here?



The correlations were:

- 1 ↣ 0.1
- 2 ↣ 0.3
- 3 ↣ 0.5
- 4 ↣ 0.7
- 5 ↣ 0.9
- 6 ↣ 0.99
- 7 ↣ 01

Types of measurements

Two types of measures

- Subjective
  - Introspection
  - Intuitions
  - Opinions
  -
- Objective
  - Behavioral
  - What people actually do

Two types of measures

- Examples:
  - How much do you enjoy this class?
  - Who came to class today?
  -
  - Subjective vs. objective: which is better? Why?

Objective measures

Objective measures

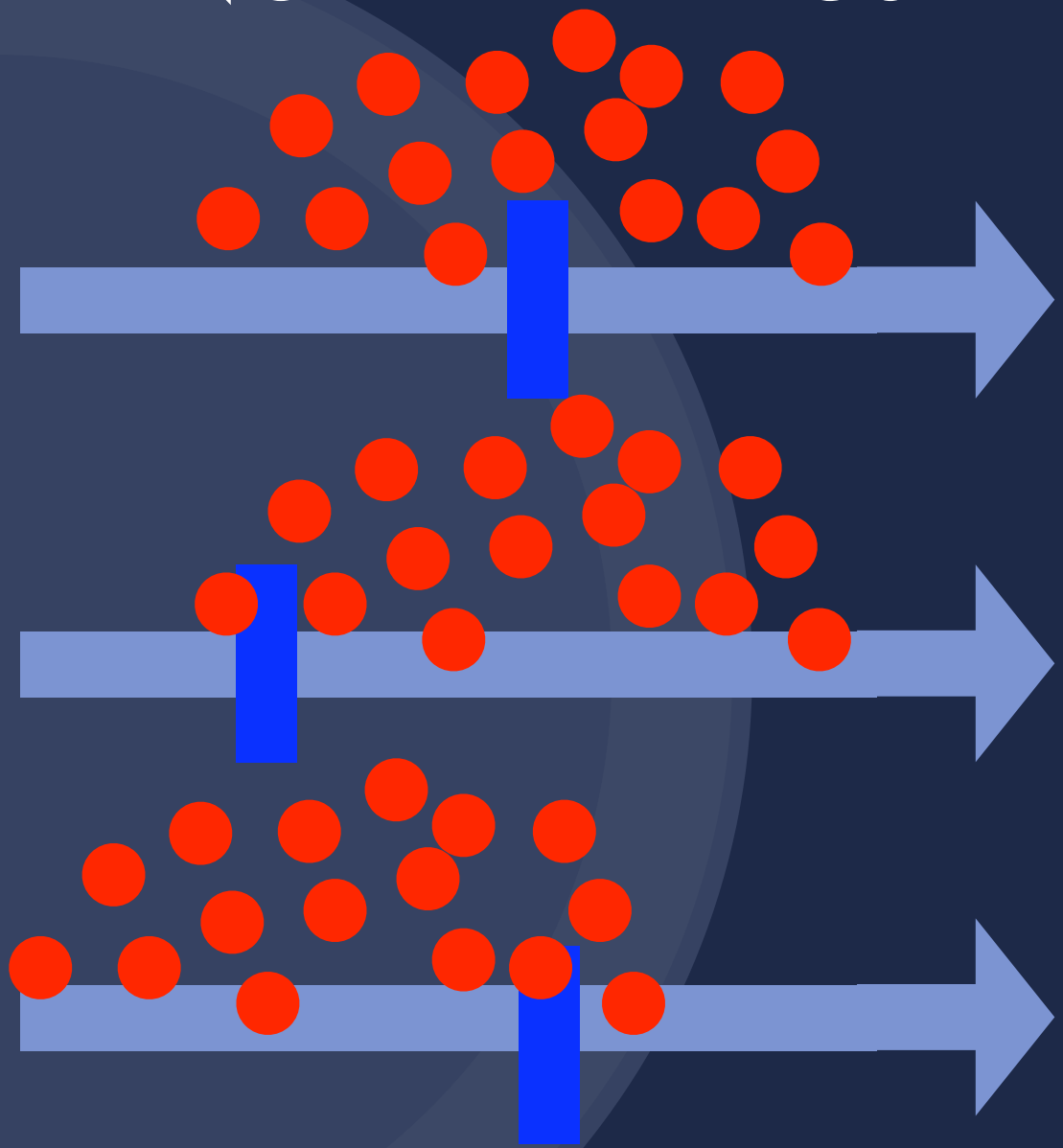
- Observing behavior (parking, men's room)
- Choice
- Payments, bids, etc
- Time in task
-
- Limited to things we can observe
- "Statistically expensive" in many cases (choice)
- Usually harder to get

Partial objective measures

- We can ask people for the their opinions but ask them to use objective scales.
  - How much time have you used for action X
  - How much will you pay
  - How much energy will you expand

Statistically expensive?

No Yes



Subjective measures

Subjective measures

- Intentions
  - What would you do
  - What would others do
- Attitudes
  - How much do you like X?
- Verbal reports
  - On-line introspections

Quantitative subjective measures

- Quantitative ≠ objective
- Likert scales (1-7; 1-10; 1-100)
- Guttman scale
  - A yes no response to a continuum of questions that are ordinal
- Hypothetical choice
- Ranking

Subjective measures I

- Very popular
- Cheap
- Can tell us things we cannot observe (why..)
-
- Depend on interpretation
- Intuitions & not behavior
- Depends on the extend to which people can introspect

Subjective measures II

- Social desirability demands
  - How often do you cheat?
  - Would you steal if you were sure no one will catch you?
  - Would you rather watch “the piano” or Rambo?
  -
- Demand characteristics (effects)
  - Do you agree that red is a nice color?

Types of measurement summary I

- Objective and subjective measurements
- Each has its advantages and disadvantages
- Beware of subjective measures if your goal is to predict behavior

Types of measurement summary II

- Subjective vs. objective (behavioral measures)
  - The main question is what are people able to report
  - Sensitivity to scales, order, etc.
  - Response language
- The constructive view
  - Do people have preferences?
  - Inferences of attitudes from questions / answers

One more issue …

Fresh-Samantha Paradox

Flavor	Mean ranking	% Market
Carrot	2.7	33%
Orange carrot	3.0	0%
Orange	2.3	33%
Soy shake	2.0	33%

People ranked each from 1 (worse) to 4 (best).

How could you explain this paradox?

Fresh-Samantha Paradox

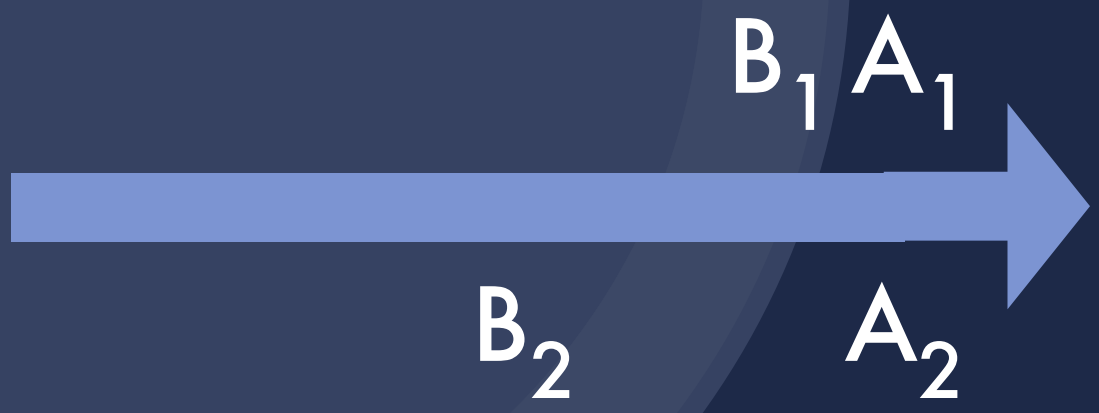
Group	1st	2nd	3rd	4th
Group A	Carrot	Orange carrot	Orange	Soy shake
Group B	Orange	Orange carrot	Carrot	Soy shake
Group C	Soy shake	Orange carrot	Carrot	Orange

Ranking (or ratings) do not always translate to behavior?

The 2nd best problem

The 2nd best problem

- It is hard to infer from ratings or ranking choice
- At the same time it is hard to infer relative location from choice



Measurements

- Objective measures are usually easier to make inferences from
- But, even with objective measures it is important to think what is measured and how it relates to the question of interest

Descriptive stats

- A compact way to represent the main essence about the data
- What is this main essence depends on the measurements and on the data
- Each method has +s and -s
- There are no rules for what method to pick – do your best! it is your responsibility