Simple statistics I

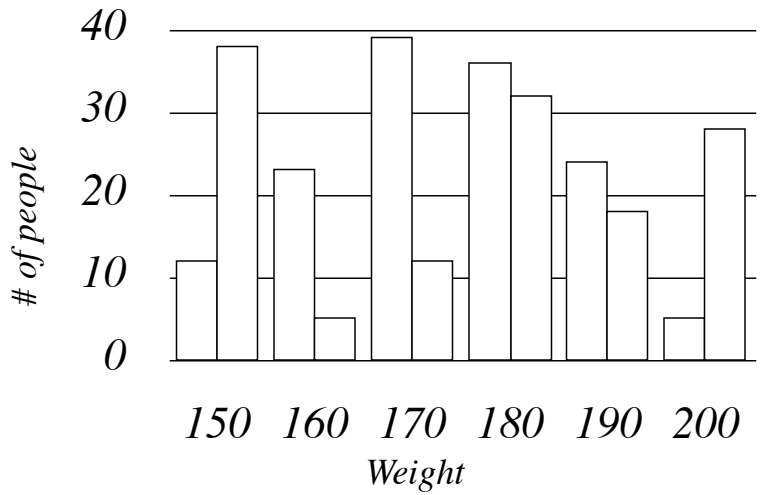
Statistics

Figures often beguile me, particularly when I have the arranging of them myself; in which case the remark attributed to Disraeli would often apply with justice and force: "There are three kinds of lies: lies, damned lies, and statistics."

Autobiography of Mark Twain

The goal of statistics is to

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



Course 15

Course 6

Statistics has 3+ components

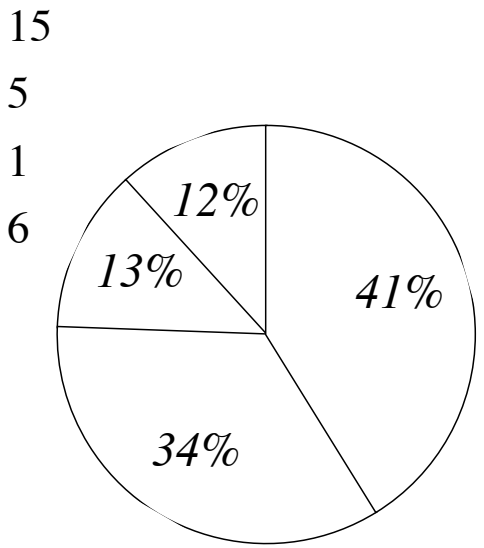
- *Data analysis*
- ***Descriptive statistics***
  - ***Probability calculations***
- *Statistical inference*
  - *Inferential statistics*
- *Models ....*

Describing a state

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

First some descriptive statistics

- *15.301 is the "best class ever"?*



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 mode is at the (n+1)/2 location*
- *123, 85, 34, 20, 18, 15, 14 ➜ 20*
- *123, 85, 34, 20, 18, 15 ➜ (20 + 34)/2 = 27*
- *When data is grouped, calculating the mode is a bit more complex*

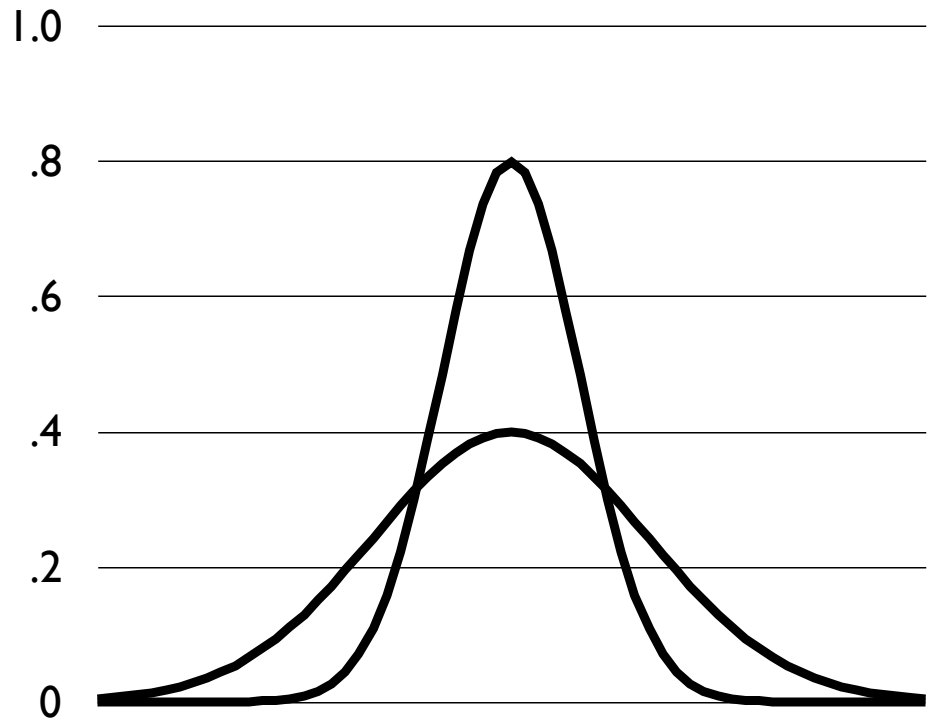
The Mean

- *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*

Location of central tendencies

Normal

Mean
Mode
Median



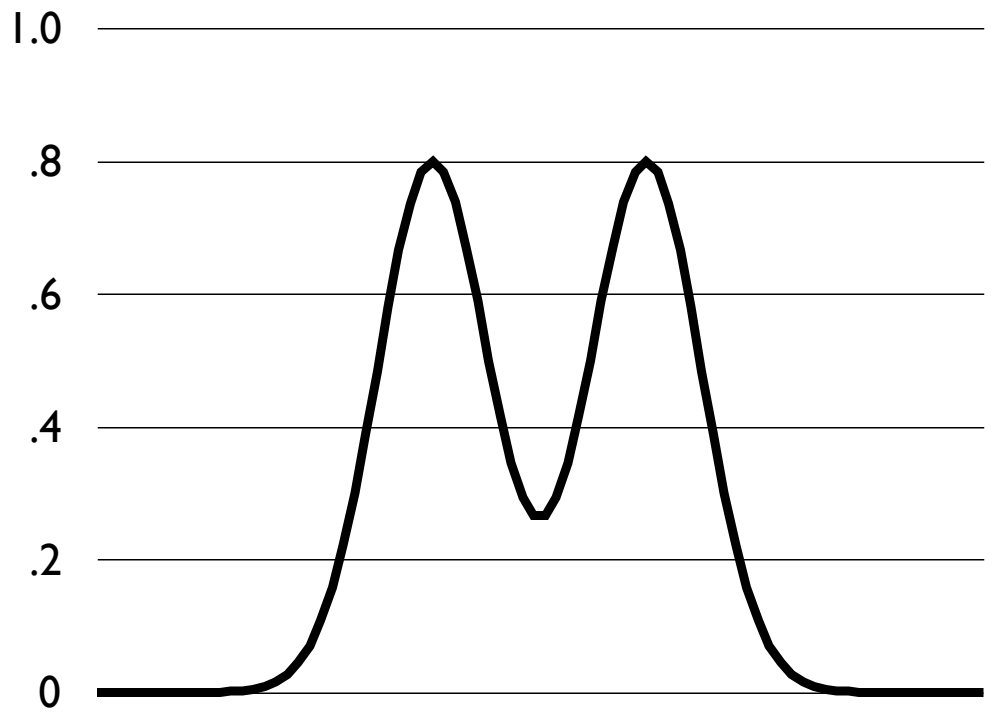
Location of central tendencies

Bimodal

Mean

Mode

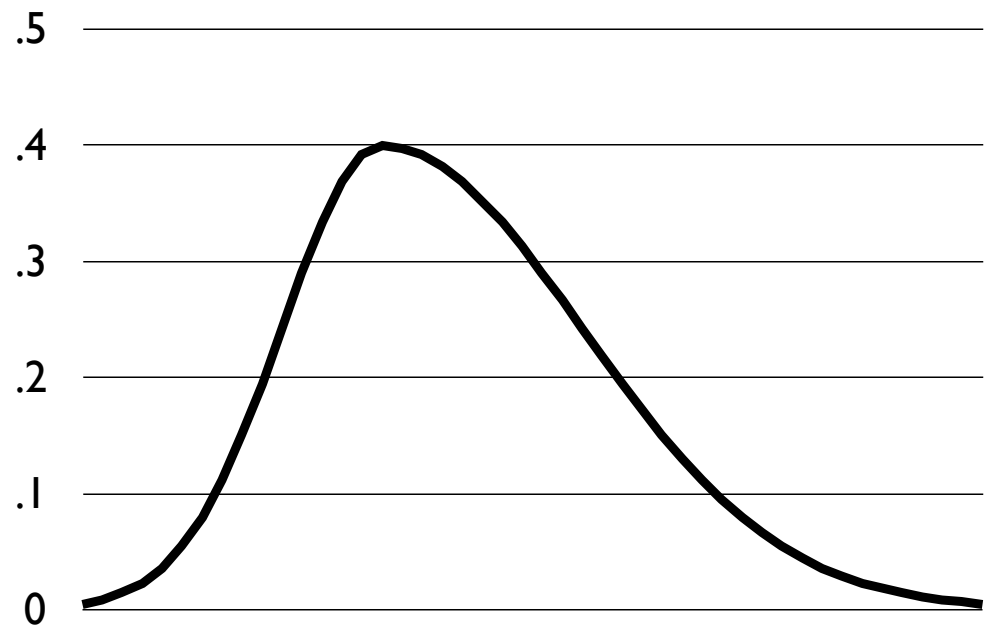
Median



Location of central tendencies

Skew to right

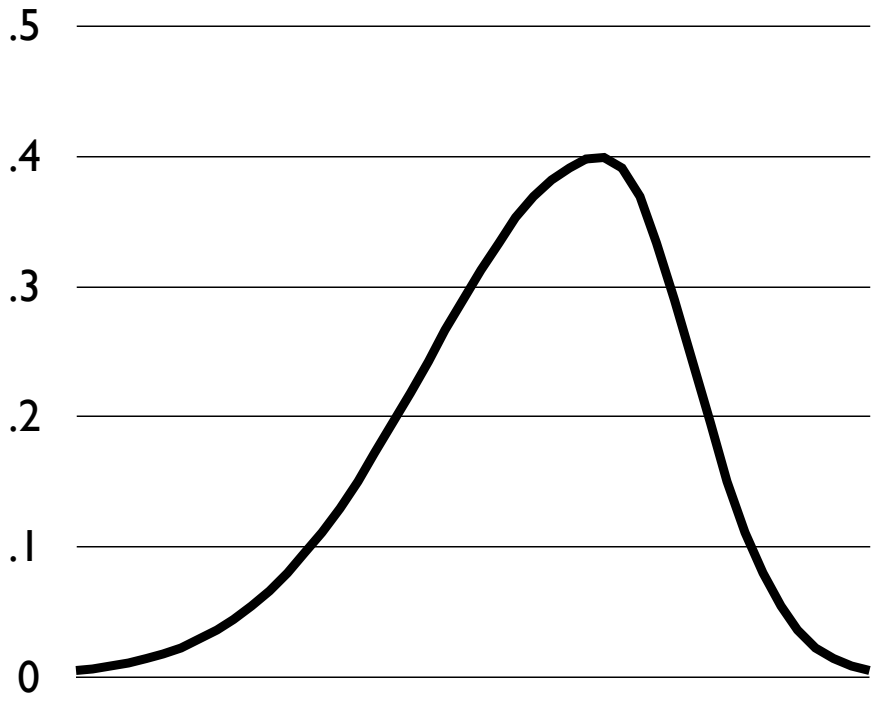
Mean
Mode
Median



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 (□^2)*
  - *Σ(Xi-□)^2/(n)*
  - *Σ(Xi-□)^2/(n-1)*
- *Standard deviation (□)*
  - *Square root of variance*
  - *Standard deviation is in the same units as the distribution*

Variation II

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

Describing scores:

- *Z scores*

  $z = (r - \square) / \square$

  $\square = 0$, $\square = 1$

- *T scores*

  $\square = 50$, $\square = 10$

  SAT, GRE etc.

Confidence in estimates?

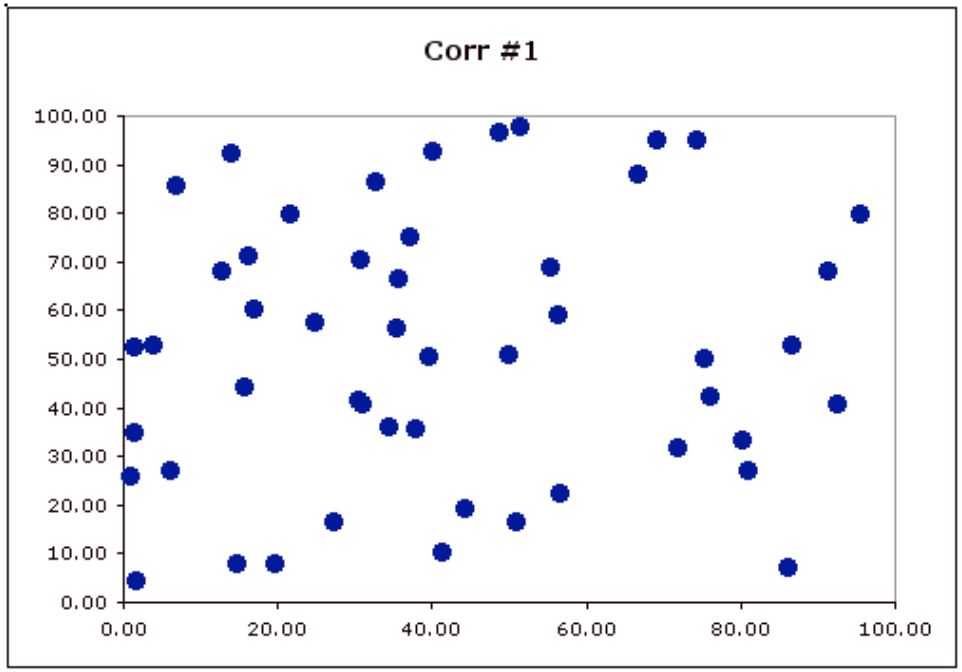
- ***How sure can we be that we know the mean of the distribution, for example?***
- ***Standard error of the mean***
  - □^2 / ***Square root of N***

The Correlation

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

Estimating correlations in scatter grams

- ***What is the correlation here?***



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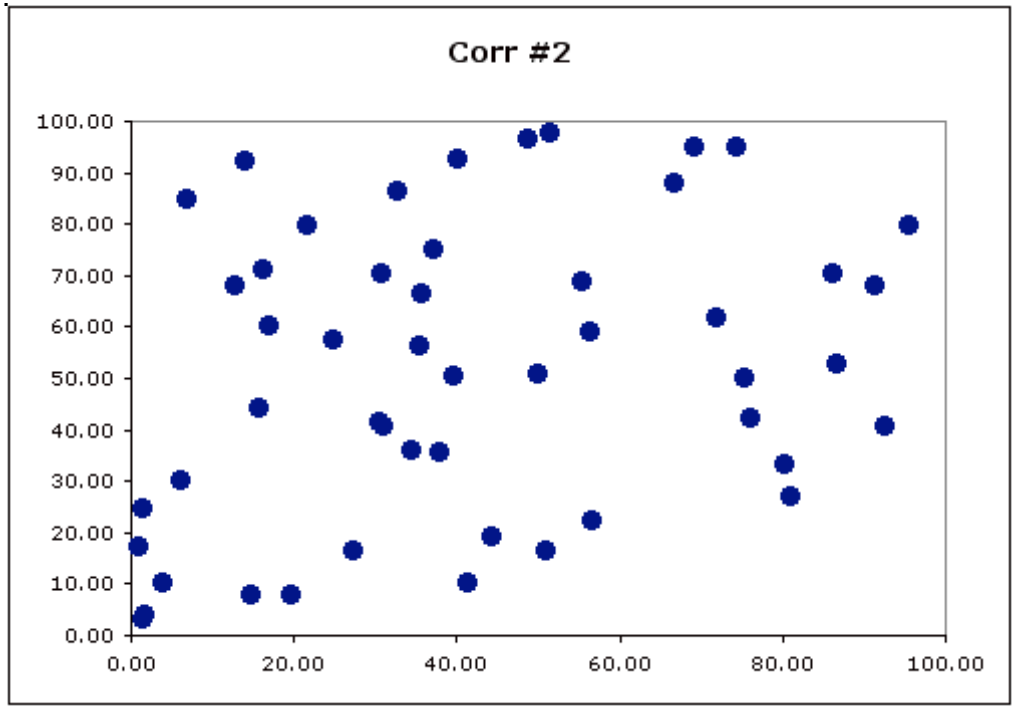

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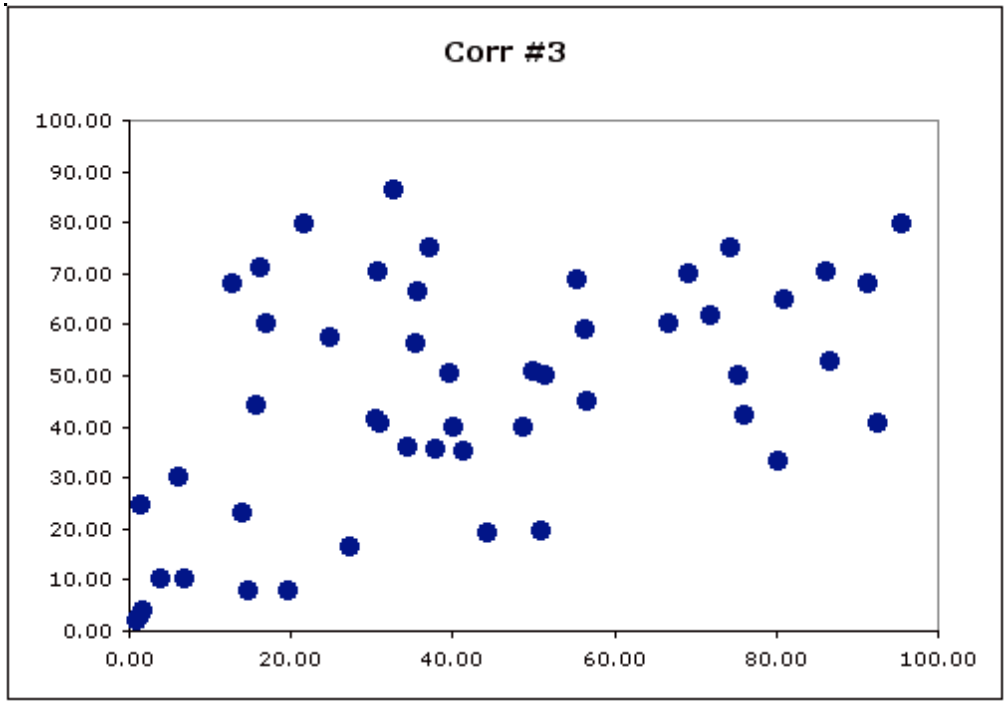

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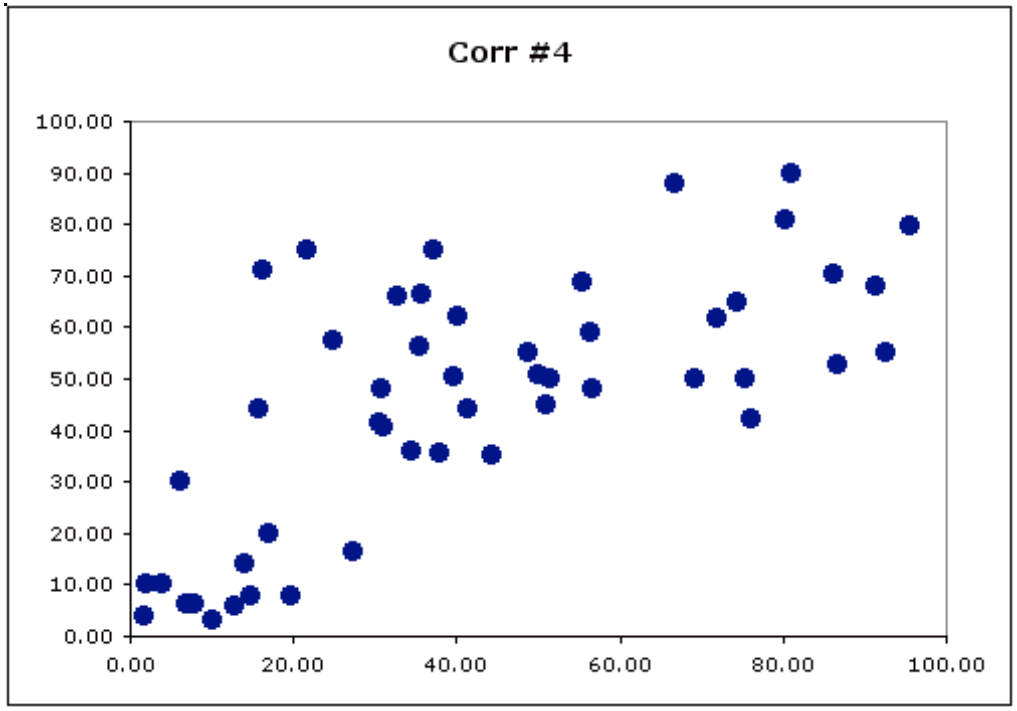

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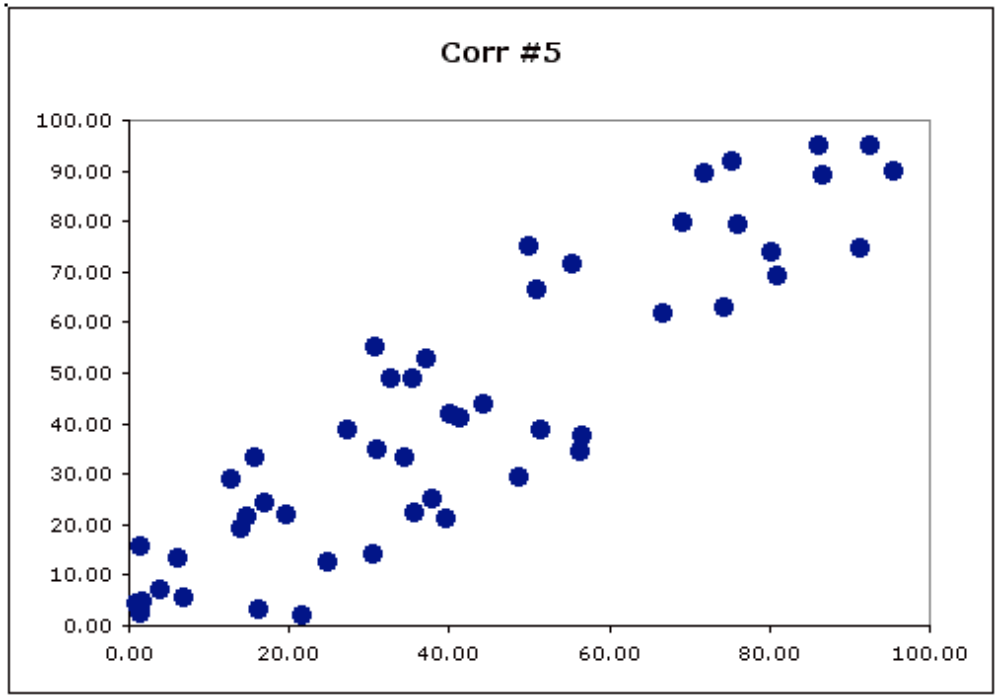

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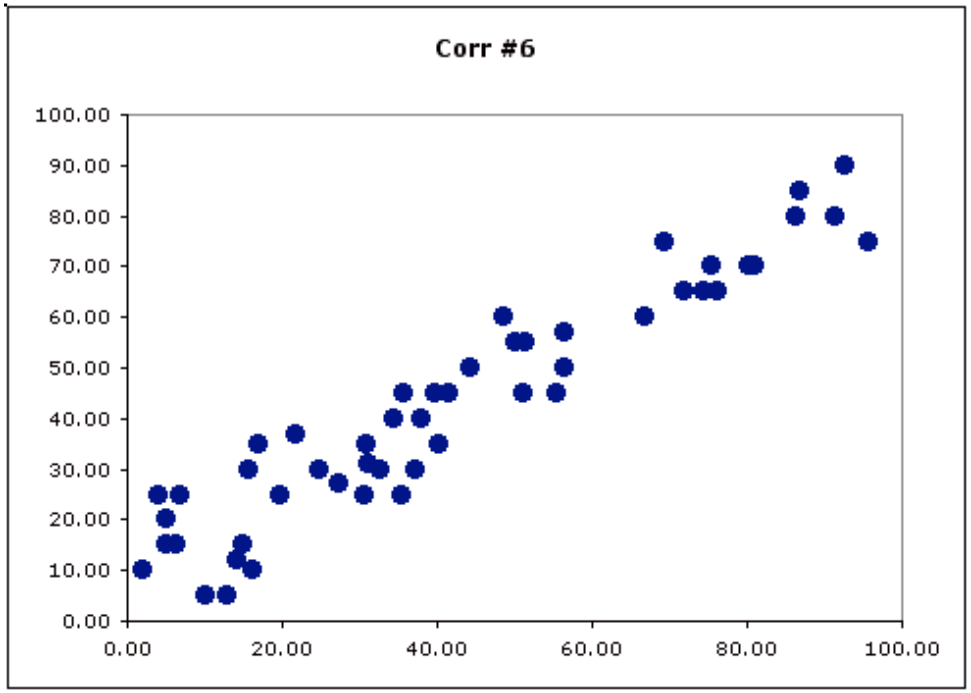

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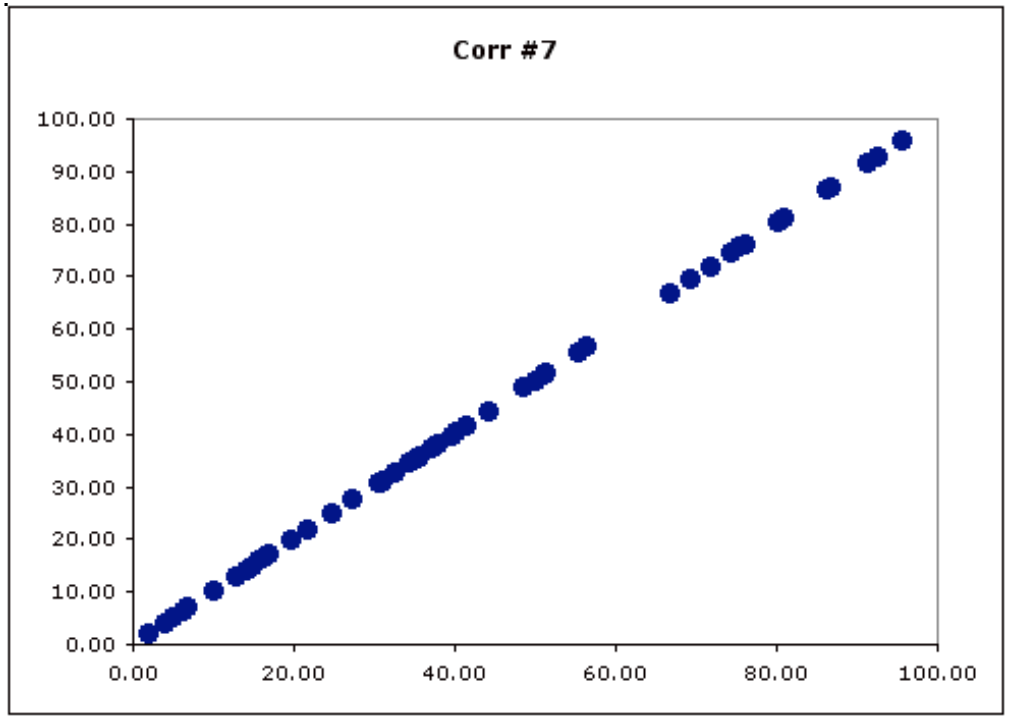

The correlations were:

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

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.*
- *R = Sxy / Sx * Sy*
  - *The relationship of their joint standard deviation to their individual standard deviation*
- *R^2 is the amount of explained variance*

Summary

- *One of the main usages of statistics is to describe data*
  - *Central tendencies: Mean, Mode, Median*
  - *Distribution tendencies: Variance, IQR, Correlations*