Workshop1. Linear Regression, Hypothesis Testing & Papers

UNAM – FE   Econometrics I

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What is a **variable?**

A variable is a characteristic that can be measured and can assume different values.

Height, *age*, *income*, *province* or *country of birth*, *grades* obtained at school and *type of housing* are all examples of variables.

Variables

Variables

Variables may be classified into **two** main **categories**

Categorical

A categorical variable (also called qualitative variable) refers to a characteristic that cannot be quantifiable.

Nominal

A nominal variable is one that **describes** a name, label or category without natural order.

Ordinal

An ordinal variable is a variable whose values are **defined by an order** relation between the different categories.

Numeric

A numeric variable (also called quantitative variable) is a quantifiable characteristic whose values are numbers

Continuous

A discrete variable can assume only a **finite number** of real values within a given interval.

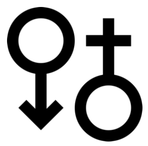
Discrete

A variable is said to be continuous if it can assume an **infinite number** of real values within a given interval.

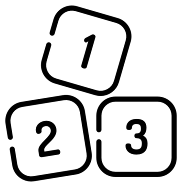
Variables

Variables

- Categorical



  - Nominal
    - Men, women
    - Green, Red, Blue
  - Ordinal
    - Small, Medium, Large
    - A, B, C (Grades)
- Numeric



  - Continuous
    - 1, 2 ,3
    - 26 students
  - Discrete
    - Age
    - Weight

But really…what is **econometrics**?

What is **econometrics**?

“[Econometrics]… is the unification of statistics, economic theory and mathematics.”

-Ragnar Frisch

“Econometrics is based upon the development of statistical methods for estimating economic relationships, testing economic theories, and evaluating and implementing government and business policy.”

-Jeffrey Wooldridge

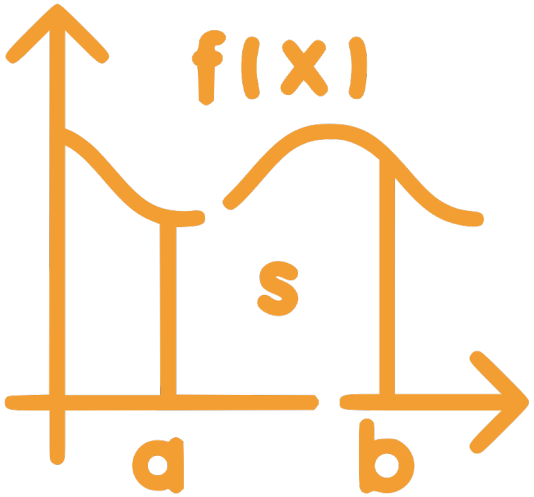
“[Econometrics is the]…social science in which the tools of economic theory mathematics, and statistical inference are applied to the analysis of economic phenomena”

-Arthur Golberger

What is **econometrics** about?

It is about the application of…

Economics theory

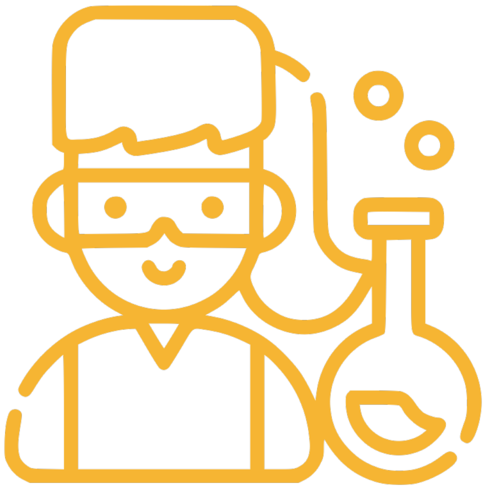


Maths

Statistical techniques

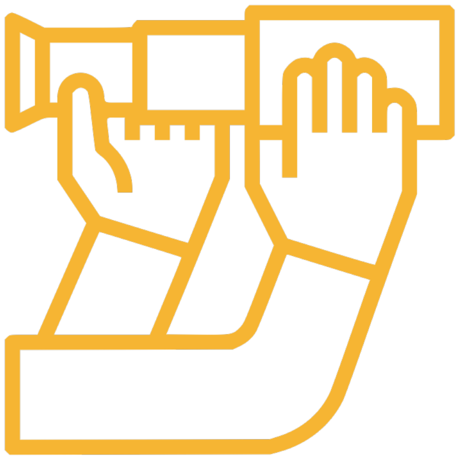
What is **econometrics** for?

Three main **functions**



To **test** theories or hypothesis

To **estimate**



To **forecast**

3 MAIN STAGES

Method of **econometrics**

Researching stages

Method of **econometrics**

1

Theoretical foundation

Establish economic theory

Demand theory

The quantity demanded of a product Y its a function that depends on

$$P_i = Price\ per\ unit\ of\ good\ X$$

$$I_i = Consumers'\ Income$$

$$S_i = Price\ of\ another\ good$$

Method of **econometrics**

1

Theoretical foundation

State equation

Explicit or linear

$$y = b_0 + b_1 P_i + b_1 I_i + b_1 S_i$$

Stochastic

$$y = b_0 + b_1 P_i + b_1 I_i + b_1 S_i + u$$

Method of **econometrics**

2

Data collection - modelling

Data for dependent and independents variables

Bloomberg

INEGI

THE WORLD BANK

UNITED STATES · FEDERAL RESERVE SYSTEM ·

Method of **econometrics**

2

Data collection - modelling

Empirical estimation

Logistic regression

Linear regression

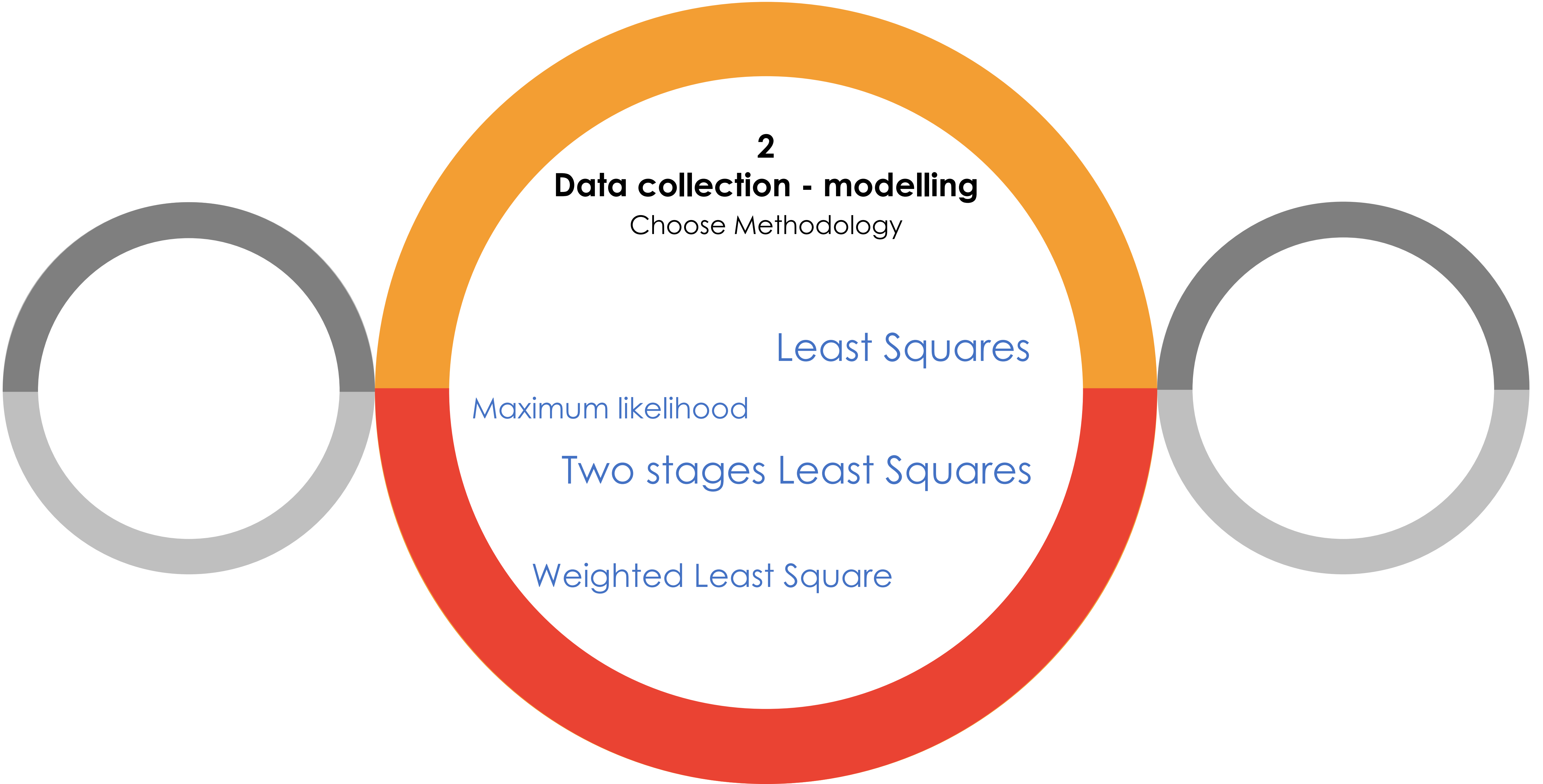
Polinomial regression

Multivariate regression

Non-linear regression

Robust regression

Method of **econometrics**



2

Data collection - modelling

Choose

Language/Software

Method of **econometrics**

3
Evaluation

A priori economic criteria

Sign and seize of parameters

Here you either

reject

accept

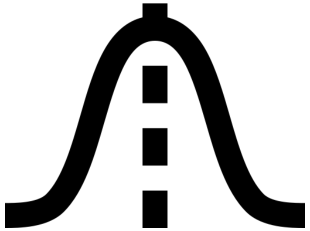
the model

Method of **econometrics**

3

Evaluation

Statistical criteria



The dispersion of every estimated coefficient around the parameter must be close enough to create confidence on estimation

Method of **econometrics**

3

Evaluation

Econometrical criteria

We as econometricians love tests, they indicate us if the assumptions under the model are satisfied

Whats is a **mathematical** model

cm. growth per day

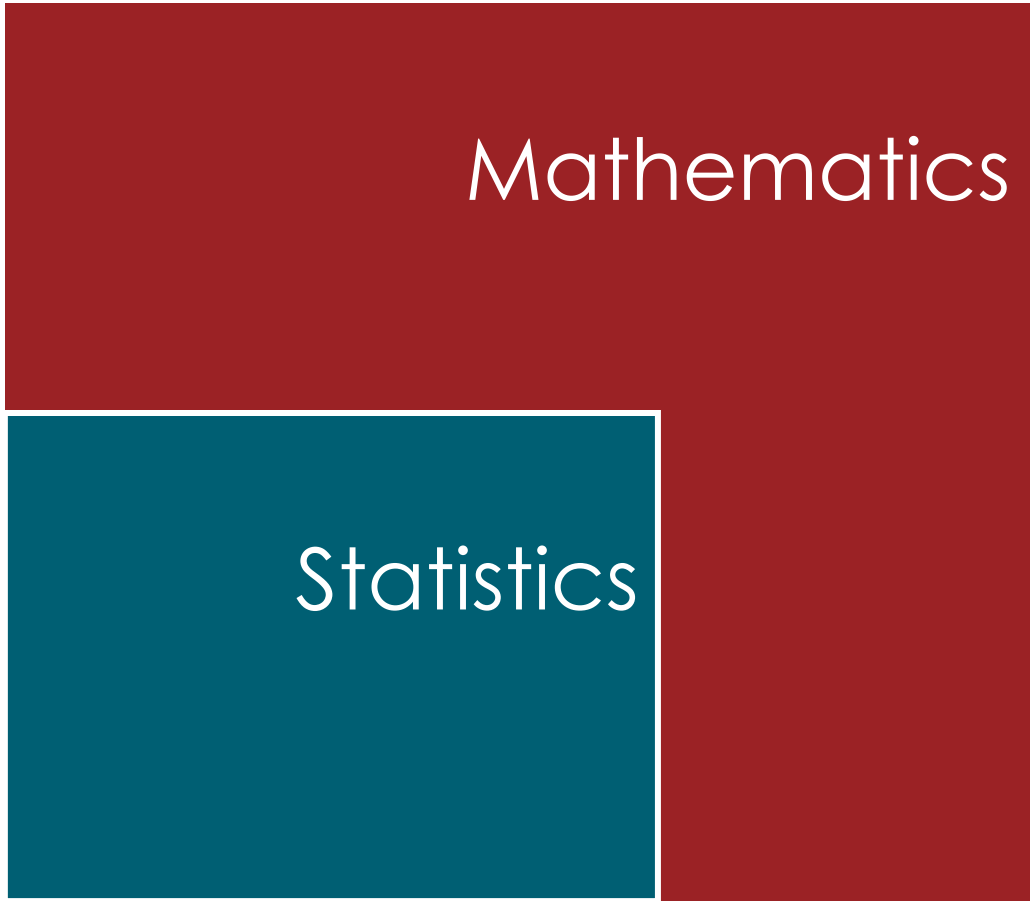
$$\underline{y} = \overline{0.03X}$$

Days I want to know

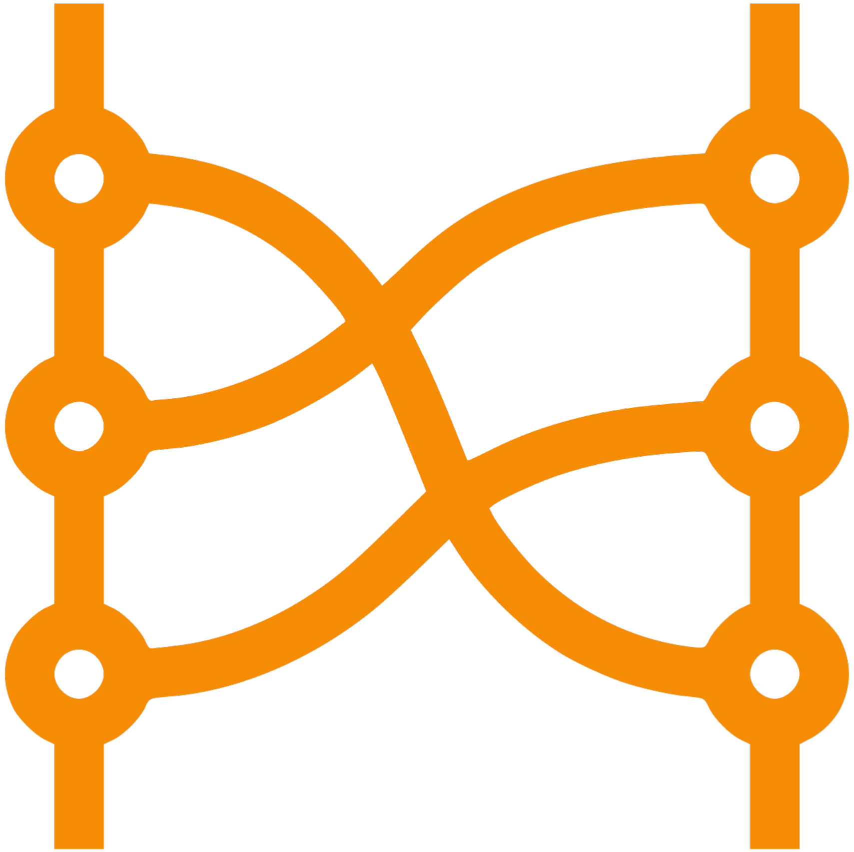
Whats is a **mathematical** model

Plant 1		
	Width	Height
Day 1	0.3	1.4
Day 2	0.4	1.4
Day 3	0.6	15

Plant 2		
	Width	Height
Day 1	0.4	1.2
Day 2	0.5	1.3
Day 3	0.5	13

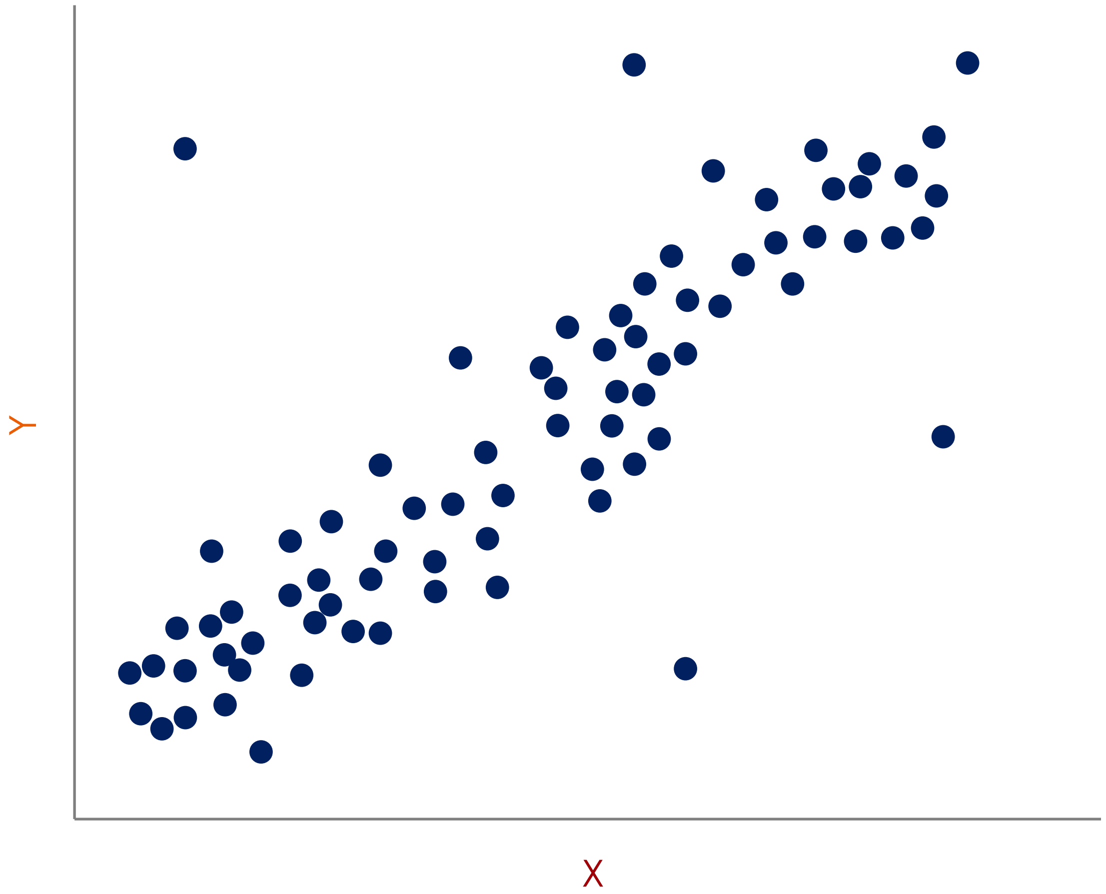


Whats is an **econometric** model



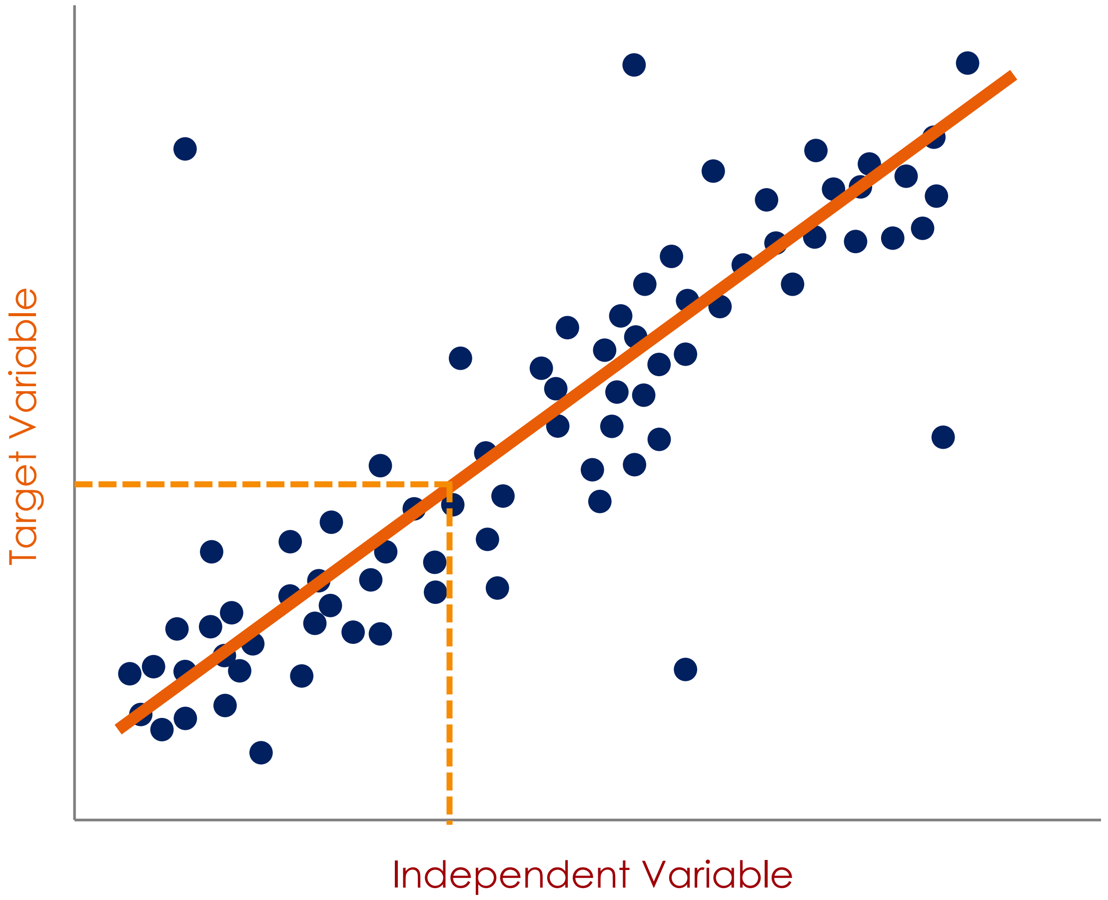
It is a mathematical model that tries to explain a linear or non linear relationship under the context of an economic phenomenon

What is a **scatter**?



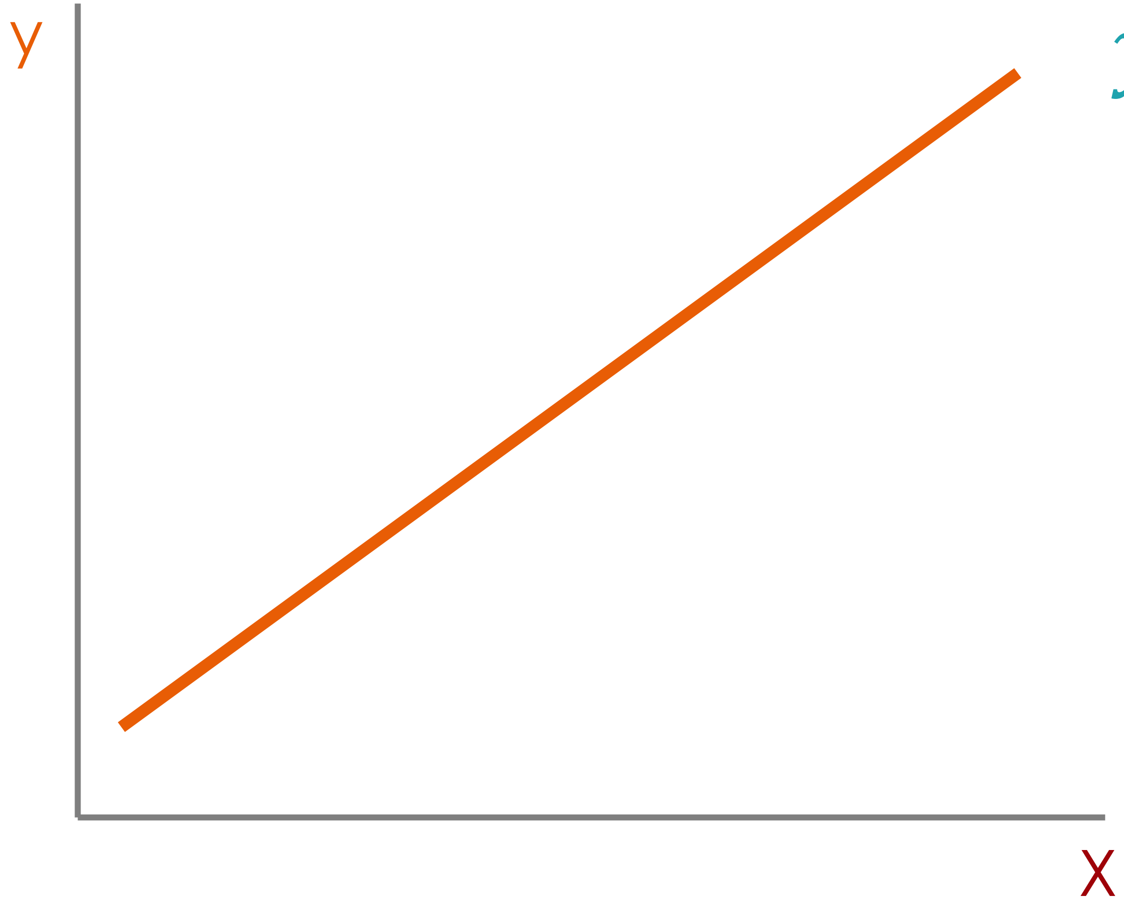
It is the relationship between a dependent variable and one or more explanatory variables

What is a **linear** regression?



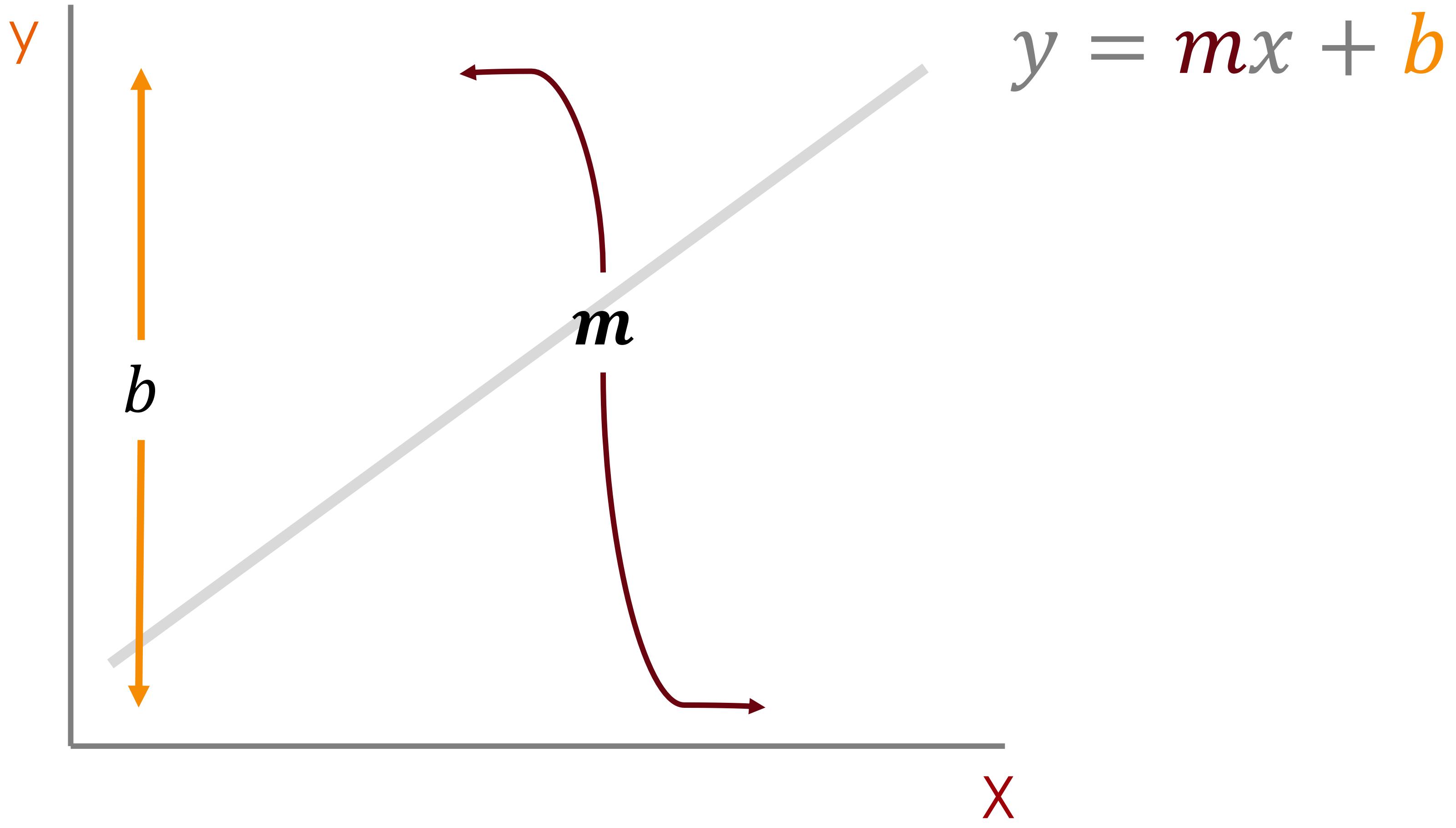
The line that best fit to predict y-values for any x-values

Do you remember the **equation** for a **straight line**?

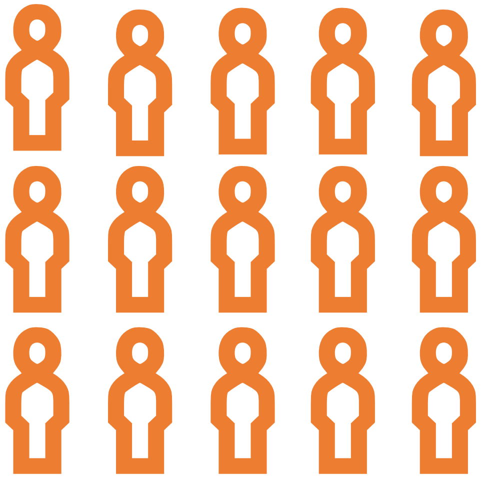


$$y = mx + b$$

It changes given the b and m values

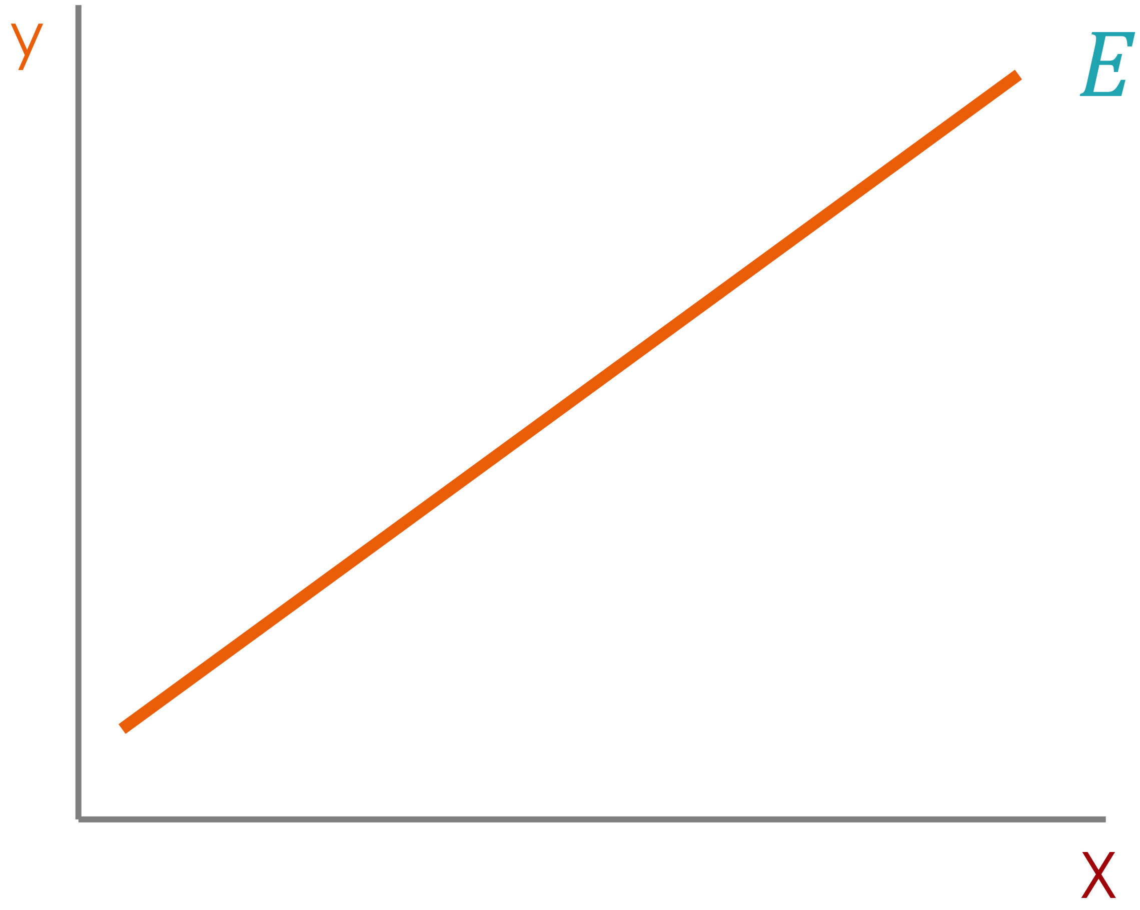


Population **regression function** vs Sample **regression function**



Population **regression function**

In econometrics, that equation turns into this



$$E(Y|X_i) = \beta_1 + \beta_2 X_i$$

Now, the regression is **estimated**, **linear** and **mathematical**

Population **regression function**

$$E(Y|X_i) = \boxed{\beta_1} + \boxed{\beta_2} X_i$$

Regression coefficients

Intercept

$$E(Y|X_i) = \boxed{\beta_1} + \boxed{\beta_2} X_i$$

Slope

Population **regression function**

Intercept

$$E(Y|X_i) = \boxed{\beta_1} + \boxed{\beta_2} X_i$$

Slope

What is the **intercept**?

Intercept

$$E(Y|X_i) = \boxed{\beta_1} + \beta_2 X_i$$

What is the intercept?

It is the expected mean value when all $X = 0$

What is the **intercept**?

$$E(Y|X_i) = \beta_1 + \boxed{\beta_2} X_i$$

Slope

What is the slope?

It measures the change in the mean conditional value of Y for a change in X

"How much you can expect Y to change as X increases"

$$E(Y|X_i) = \beta_1 + 2\,X_i$$

If the **slope** is 2, it means that if the value of X **increases** by 1 then the value of Y **incresaes** by 2

Population **regression function**

This equation that is **conditional**

$$E(Y|X_i) = \beta_1 + \beta_2 X_i$$

turns into this

$$Y_1 = \beta_1 + \beta_2 X_i + \mu_i$$

Now we add more characteristics

$$Y = \beta_0 + \beta_1 \overbrace{X_1}^{\text{variable}} + \beta_2 \underbrace{X_2}_{\text{variable}} + u_i$$

Or this

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + u_i$$

Where

- β_0 is the intercept
- β_1 is the change in y with respect to x_1, *ceteris paribus*
- β_i is the change in y with respect to x_i, *ceteris paribus*

$$Y_1 = \beta_1 + \beta_2 \; X_i + \boxed{\mu_i}$$

Stochastic Term

Random

Error term

Error term

$$Y_1 = \beta_1 + \beta_2 \; X_i + \mu_i$$

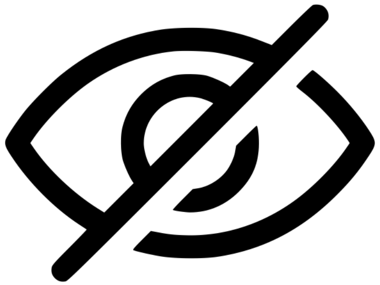
Systemic or deterministic

Non-systemic or noise

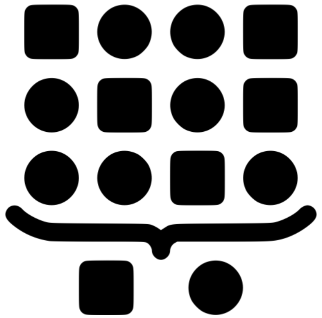
$$Y_1 = \beta_1 + \beta_2 \ X_i + \boxed{\mu_i}$$

One or **more** of the following:

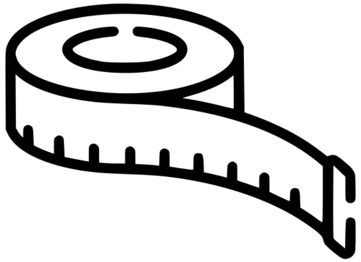
Not specified variables that may impact in the model



Even when all significant variables are included in the model, there is an **intrinsic random factor** that **cannot be explained**



Measurement errors



We estimate coefficient from data using OLS

O Ordinary
L Least
S Squares

$$E(Y|X_i) = \boxed{\beta_1} + \boxed{\beta_2} X_i$$

Regression coefficients

$$Y_t = (a + bX_i) + e_i$$

or

$$Y_t = (b_0 + bX_i) + e$$

where

a or b_0 are ordinate axis

b or b_1 slope or gradient, both are regression coefficients

e is the residual term that represents the difference between the observed value and the predicted one

Visit the following **webpage**

Example

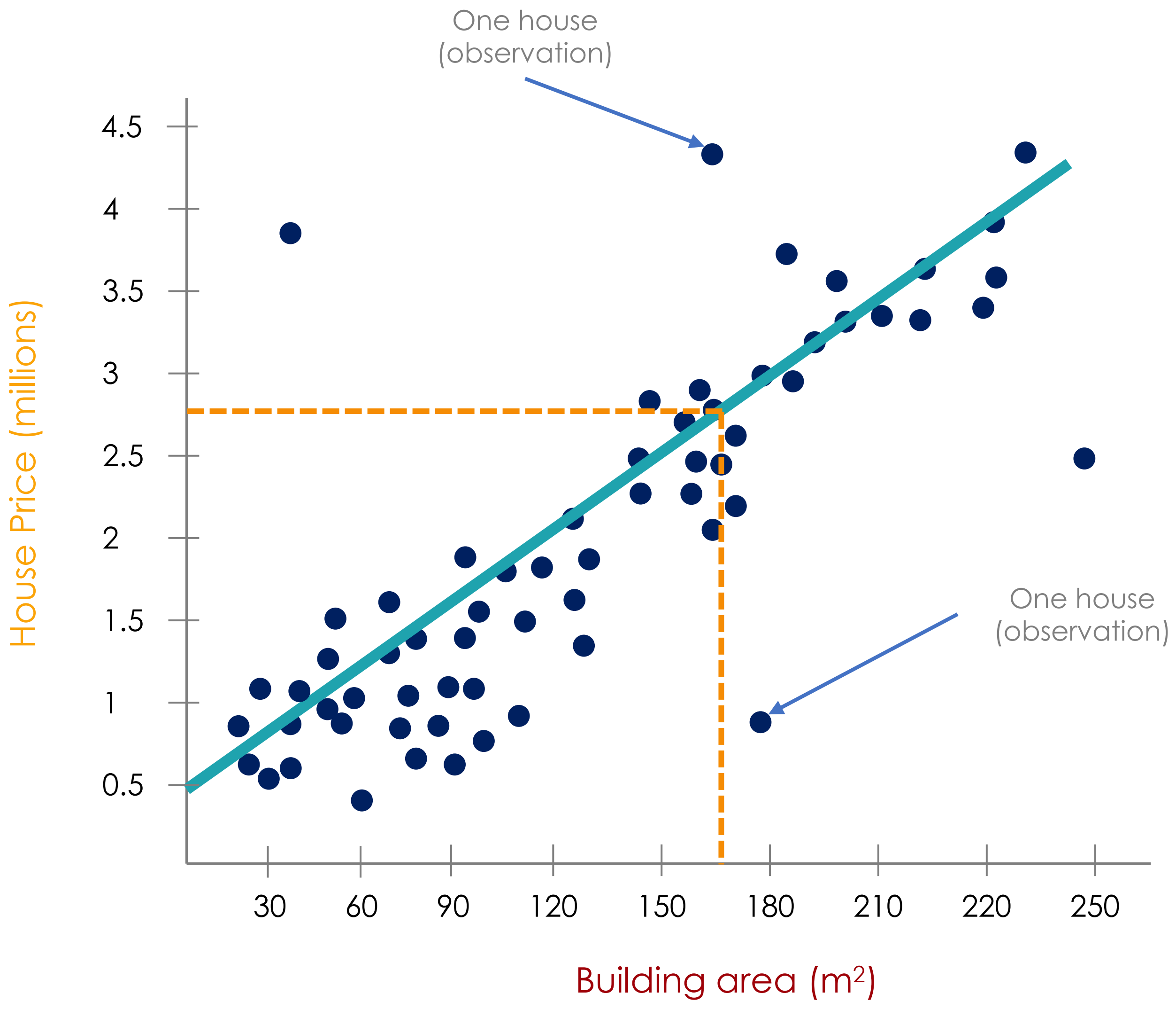
Target: Predict house prices

Independent variable: Building area

Dependent variable: House price

Each blue point is a single house with a known area and corresponding house price

You give me the area (m²) and I will give you the price given my regression



Example

The line of best fit is described as:

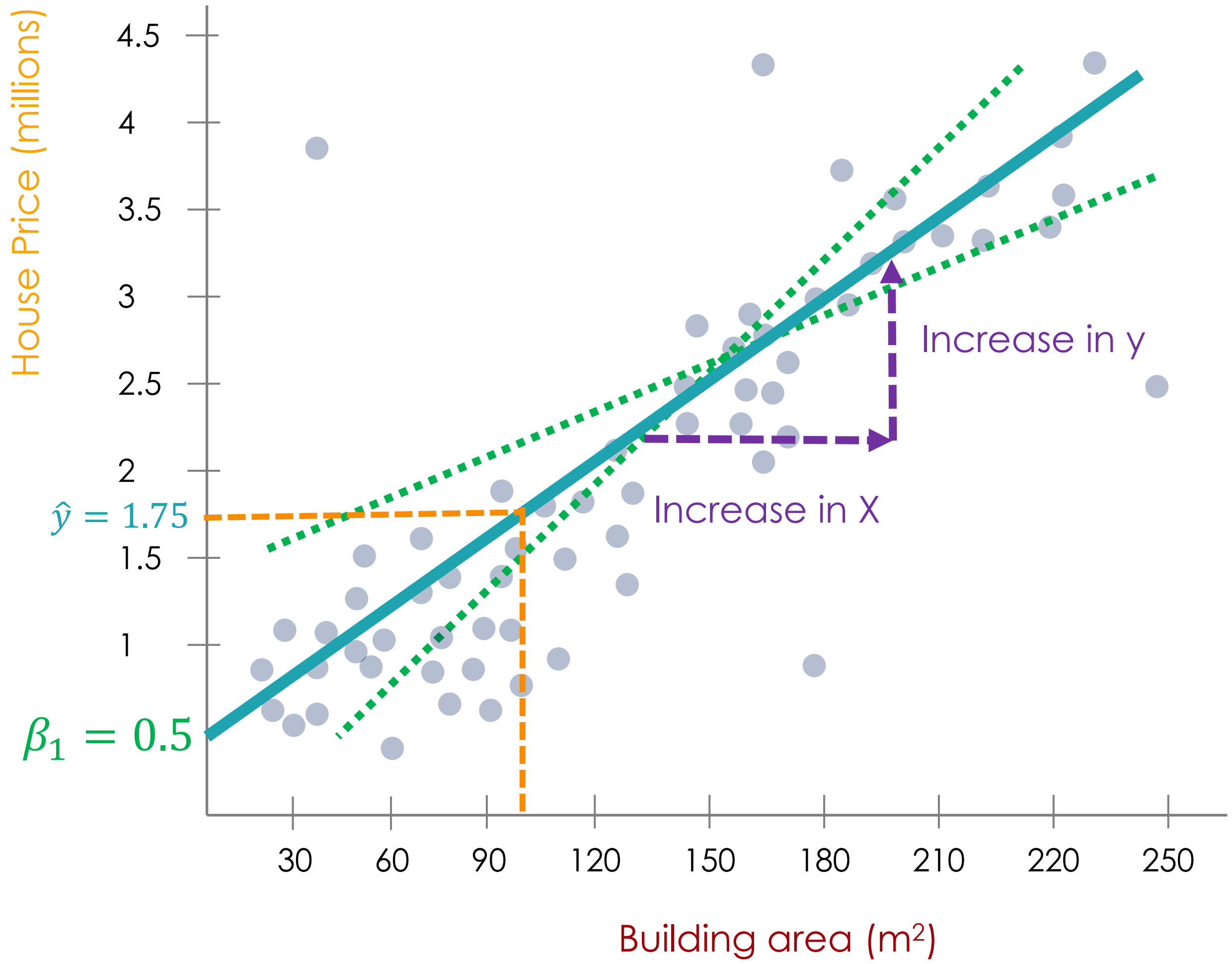
$$\hat{y} = \beta_0 x + \beta_1$$

β_0 and β_1 are the parameters (or coefficients) that define the regression line

β_0 is the intercept

β_1 is the slope

Question: ¿How can we find the optimal line?



Example

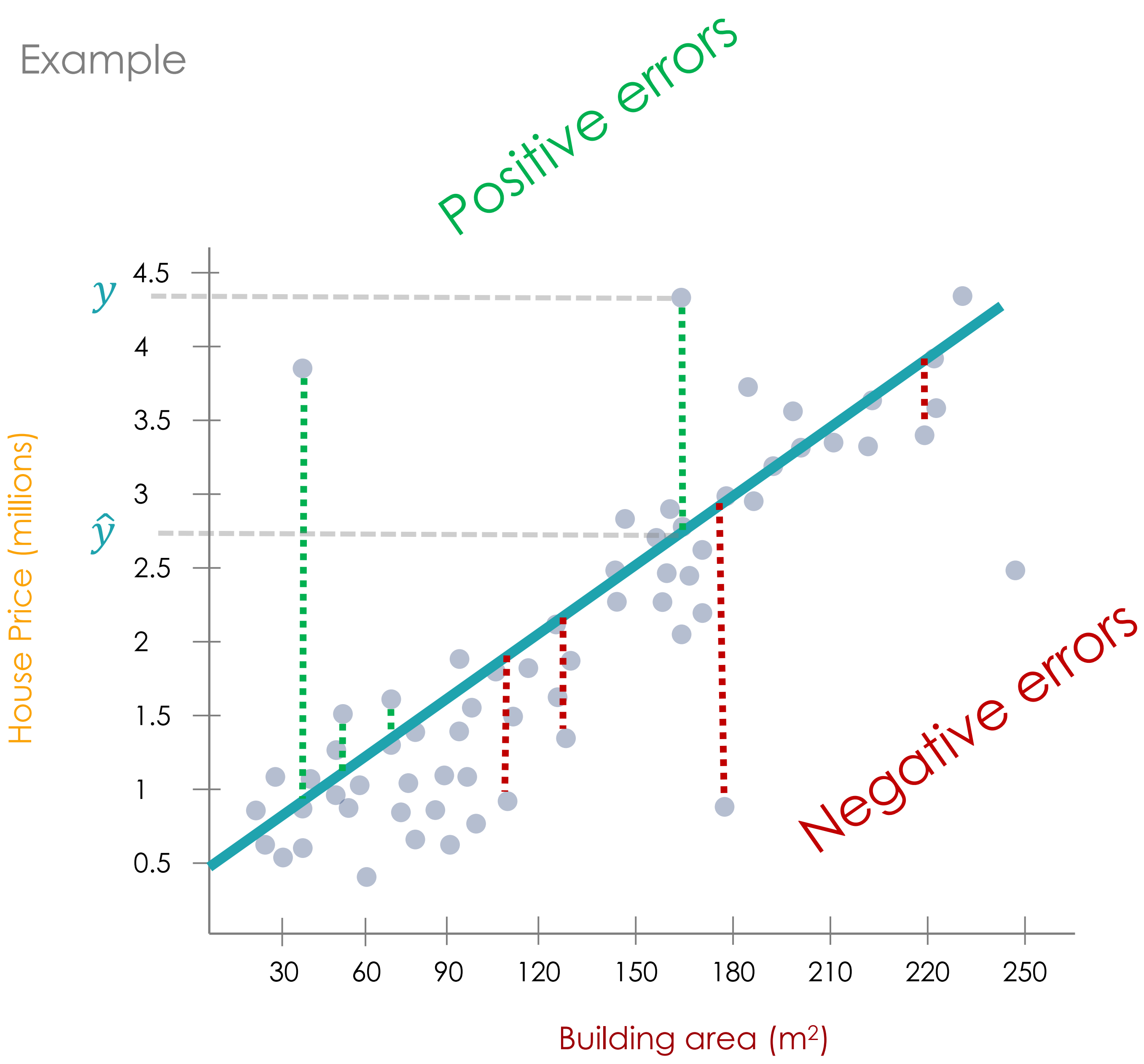
Question: ¿How can we find the optimal line?

By minimizing the sum square errors (SSE) also known as the sum of square residuals

Errors, or residuals are the differece between the observed and predicted values of the data (vertifcal lines on the chart)

In OLS, we square each error to remove negative values. We then add all squared errors together.

$$SSE = \sum (y_i - \hat{y}_i)^2$$



Example

The blue line has the following equation

$$\hat{y} = 0.7x + 0.5$$

Then errors can be calculated as:

$$y_i - \hat{y_i} = y_i \; - \big((0.7 \times x) + 0.5\big) = error$$

$$y_1 - \widehat{y_1} = 0.3 - \big((0.7 \times 60) + 0.5\big) =$$

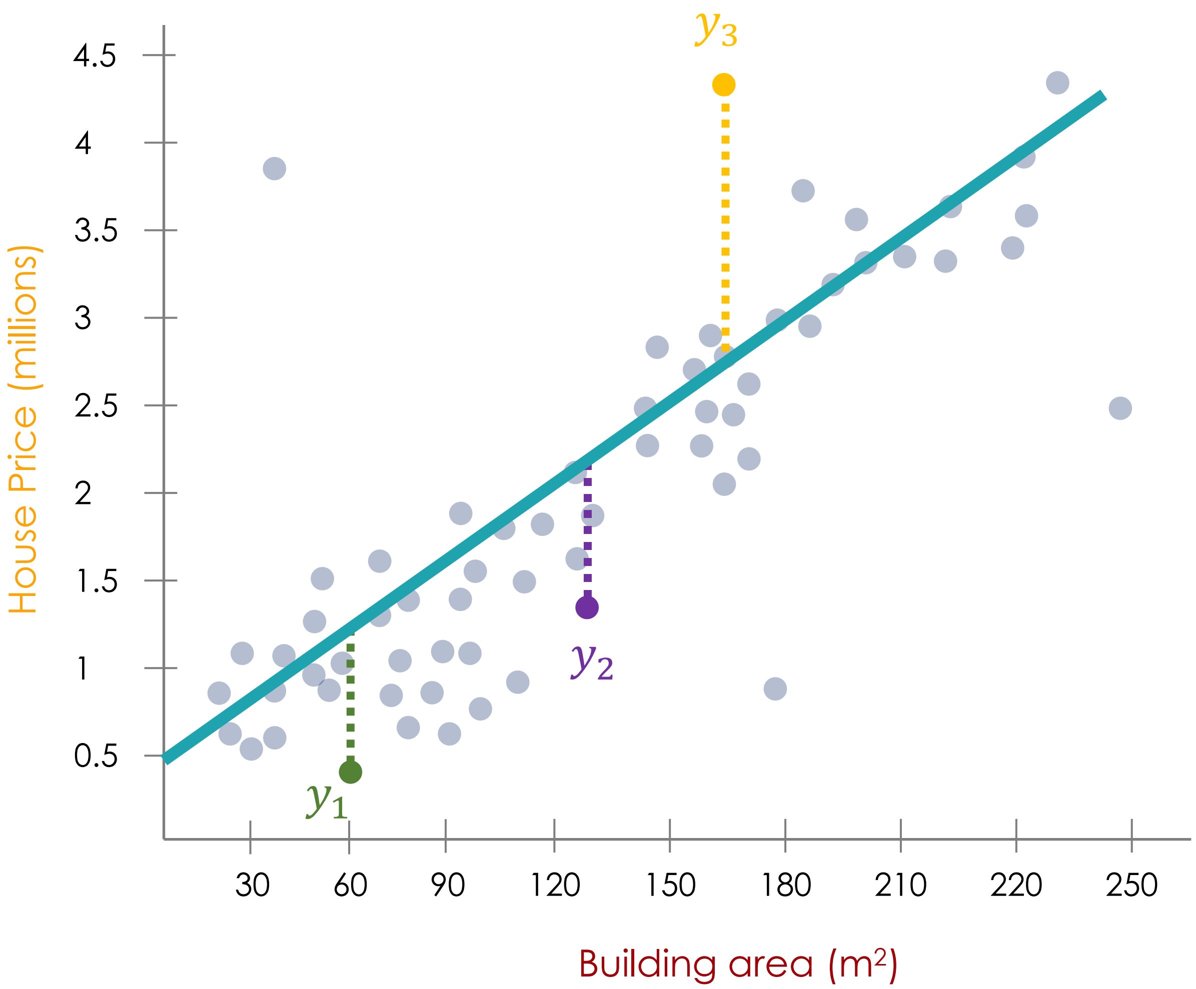
$$y_2 - \widehat{y_2} = 1.2 - \big((0.7 \times 60) + 0.5\big) =$$

$$y_2 - \widehat{y_3} = 4.4 - \big((0.7 \times 60) + 0.5\big) =$$

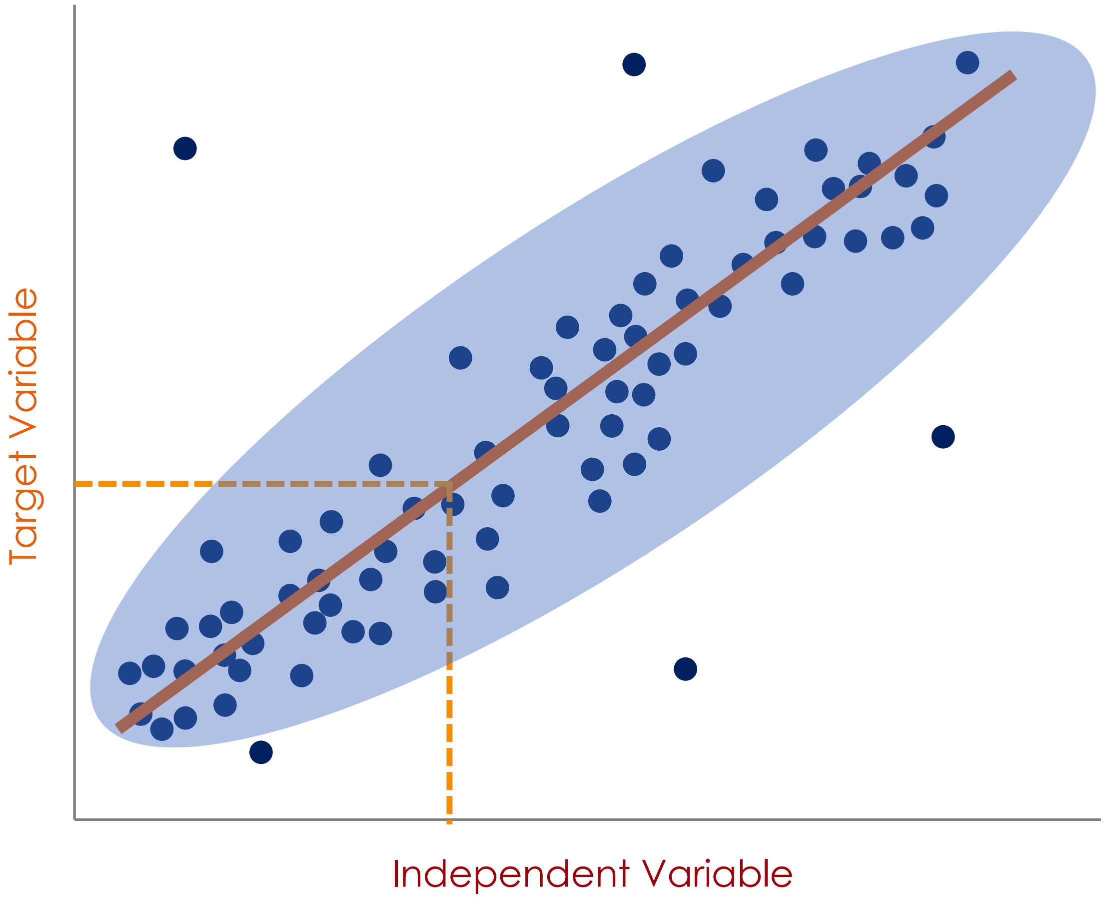
...

Then, the sum of square errors is…

$$SSE = ()^2 +$$



To **consider**



Some random variation
cannot be explained

Linear problems

Non-Linear problems

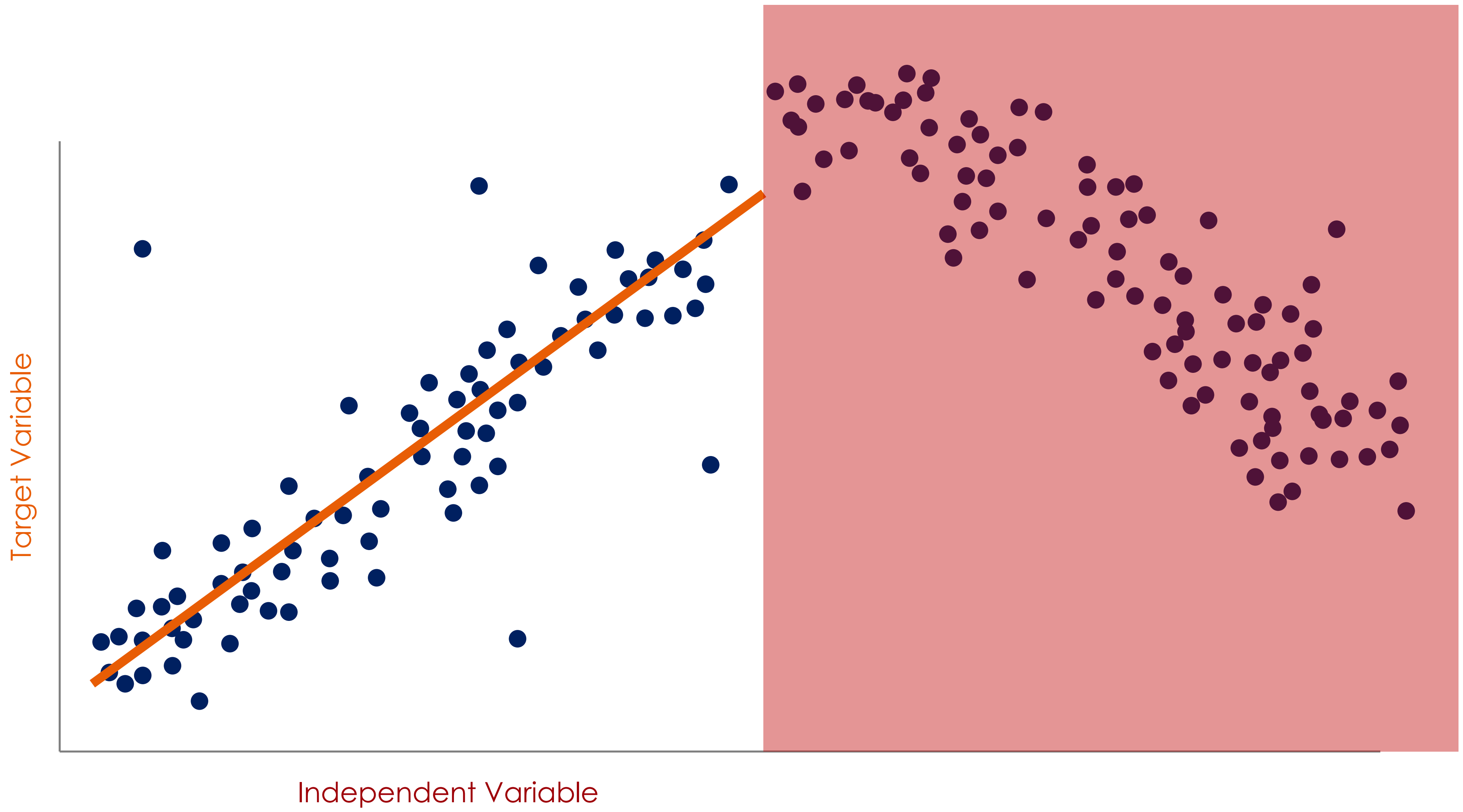
Linear problems are the **exception**!

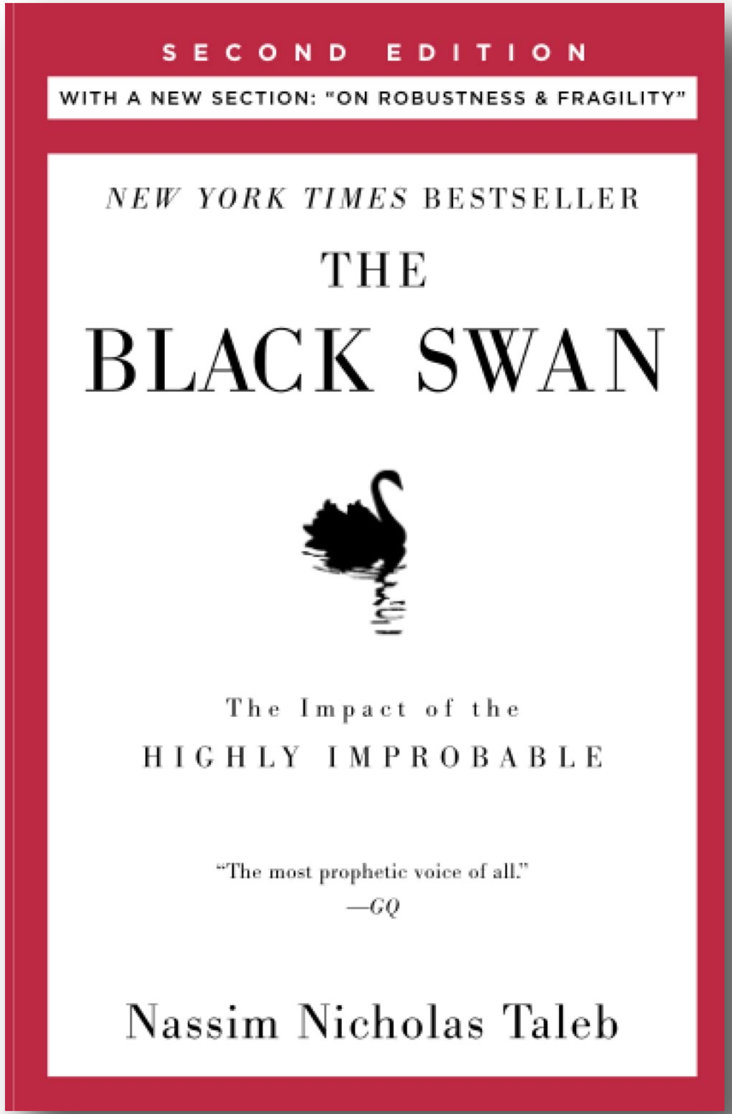
Almost all economics problems are **non-linear**.

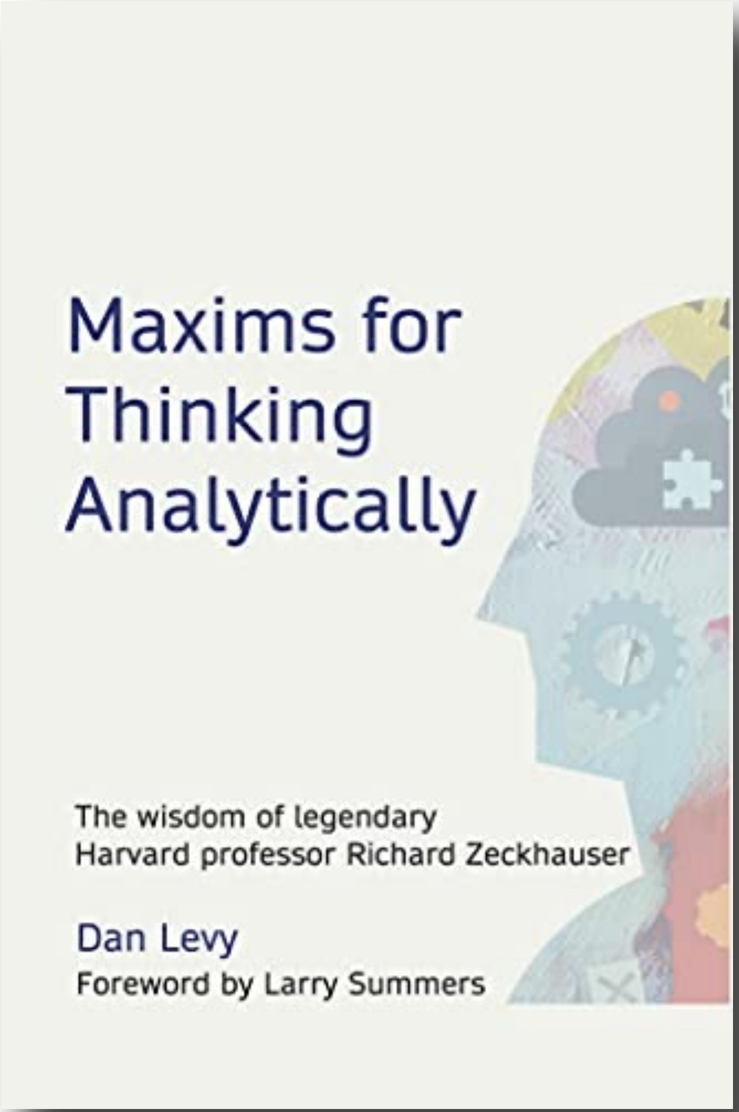
Non-Linear problems

Linear problems

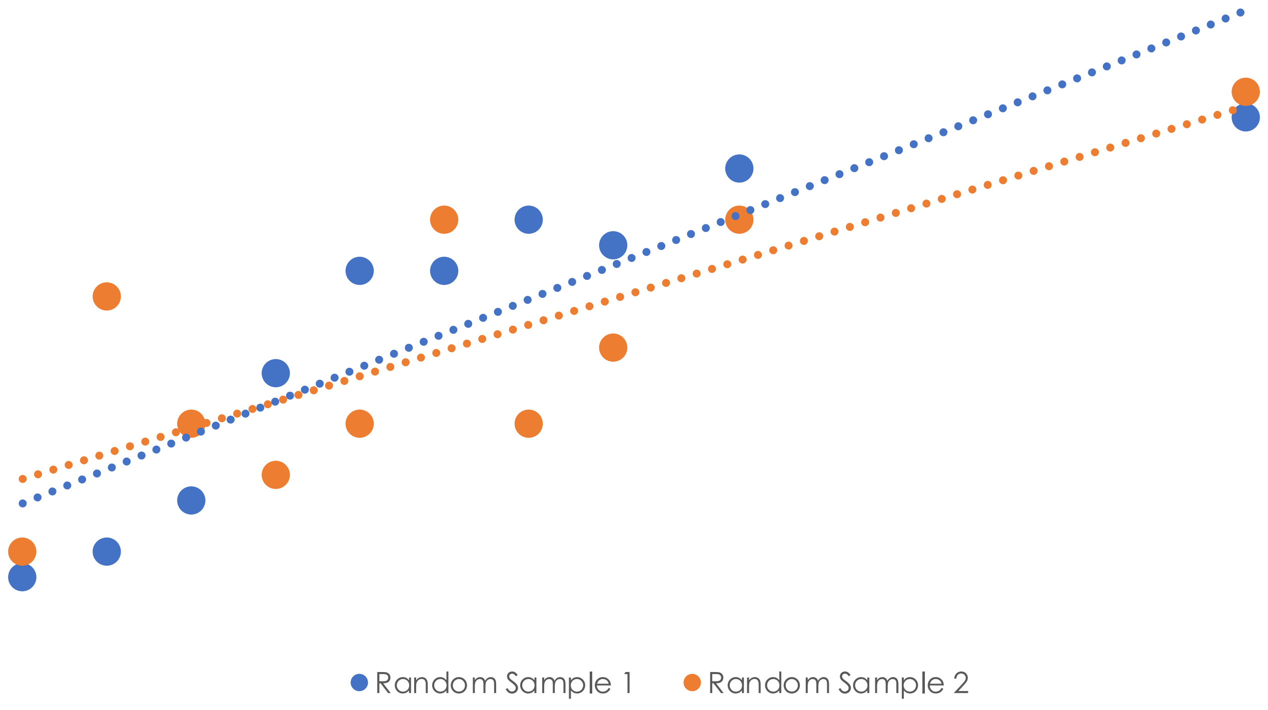
To **consider**




SECOND EDITION
WITH A NEW SECTION: "ON ROBUSTNESS & FRAGILITY"
NEW YORK TIMES BESTSELLER
THE
BLACK SWAN
The Impact of the
HIGHLY IMPROBABLE
"The most prophetic voice of all."
—GQ
Nassim Nicholas Taleb


Maxims for
Thinking
Analytically
The wisdom of legendary
Harvard professor Richard Zeckhauser
Dan Levy
Foreword by Larry Summers

Sample **regression function**



When we cannot access to the whole universe of data, we use the sample regression function in order to estimate the population regression function

Now, we want to add more variables, to make our model more complex

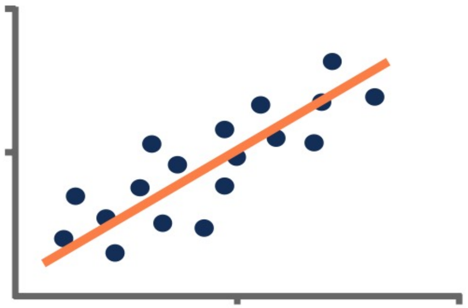
What can we do?

We use Multiple Linear Regression which is more suitable for a *ceteri paribus* analysis due to its convenience to control the rest of factors that affect simultaneously to the dependent variable

Types of **linear regression**?

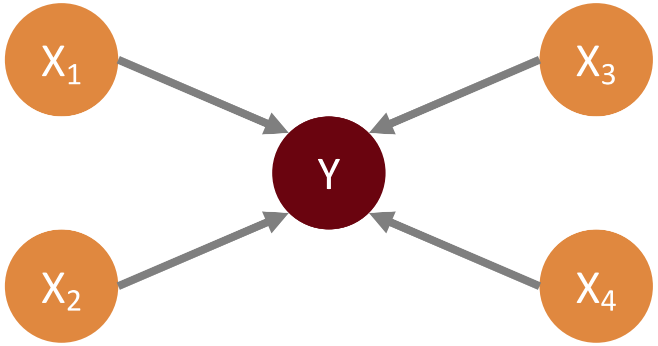
Simple Linear Regression

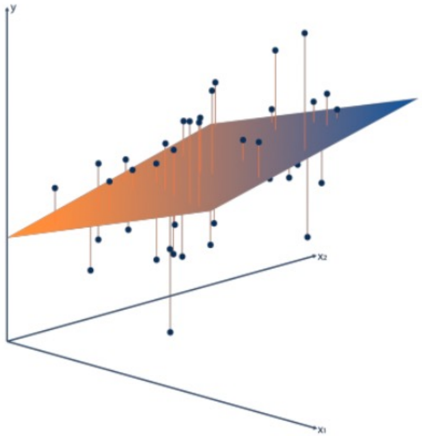
Independet variable predicted using only **one** independent variable



Multiple Linear Regression

Independet variable predicted using **multiple** independent variables





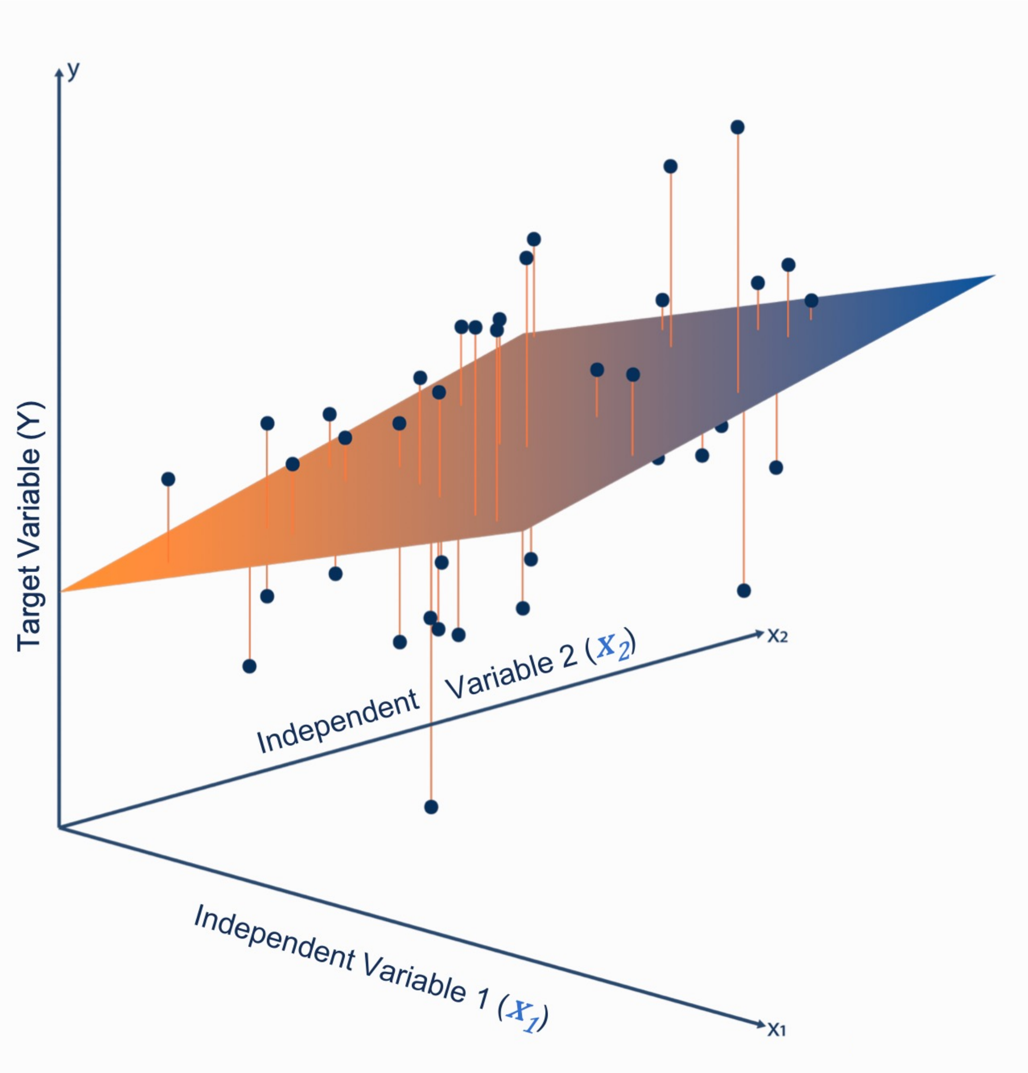
Multiple Linear Regression

Due to the lack of explanability that one variable provides, we need to use Multiple Linear Regression, using any number of independent variables

$$\hat{y} = \theta_0 + \theta_1 x_1 + \theta_2 x_2 + \cdots + \theta_p x_p$$

When we have two independent variables, we are fitting a plane to data, not a straight line

Again, we use OLS to solve $p + 1$ simultaneous equations using matrix algebra for the best fit parameter values



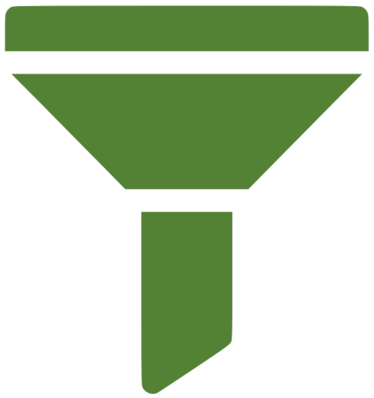
Keep it **simple**

House Price =

Location | Size | Conservation | Services | Security

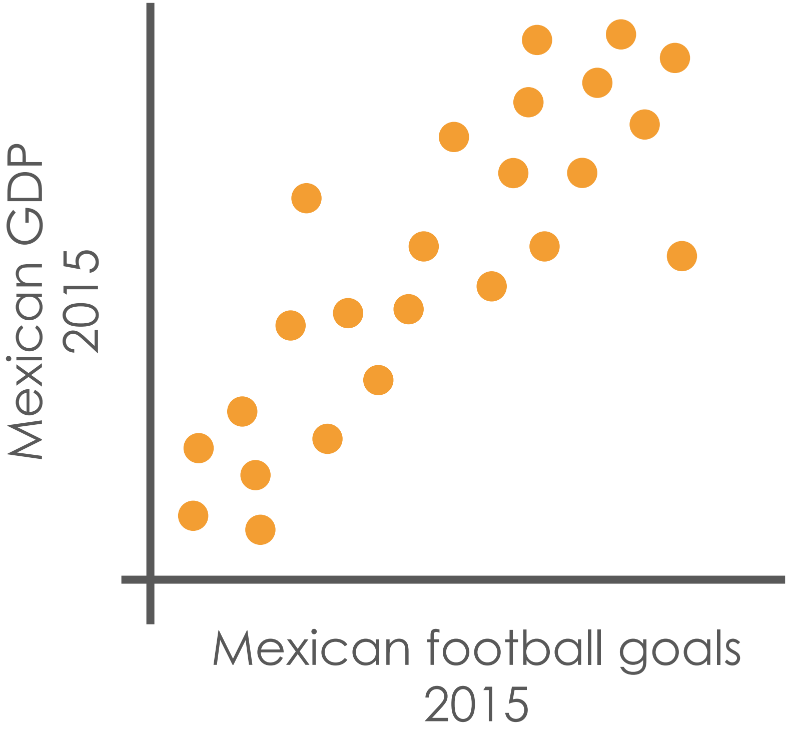
Color | Garage | No. Bathrooms | Land

Green area | Country



Parsimony

House Price = Size | Conservation



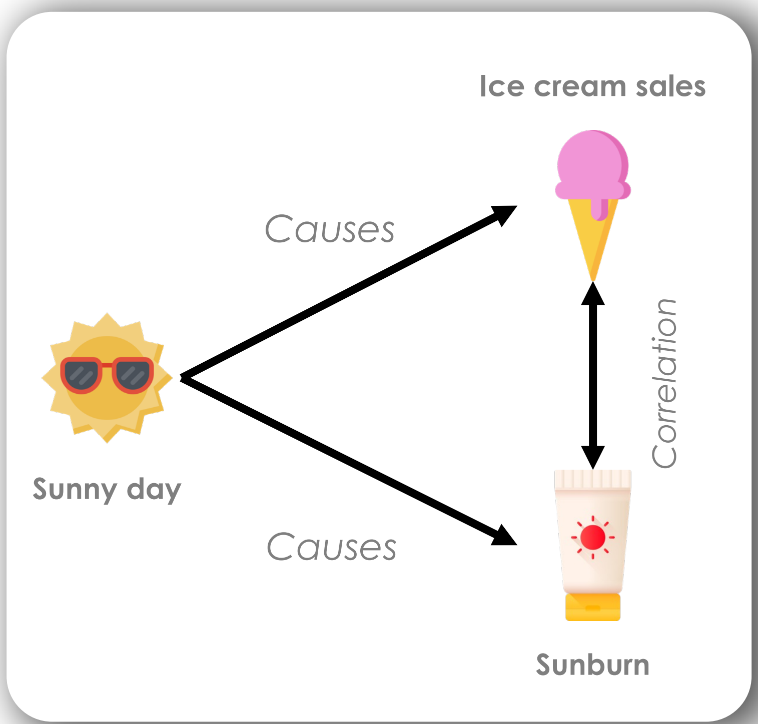
Notice that the regression does not mean there is a cause-effect implication

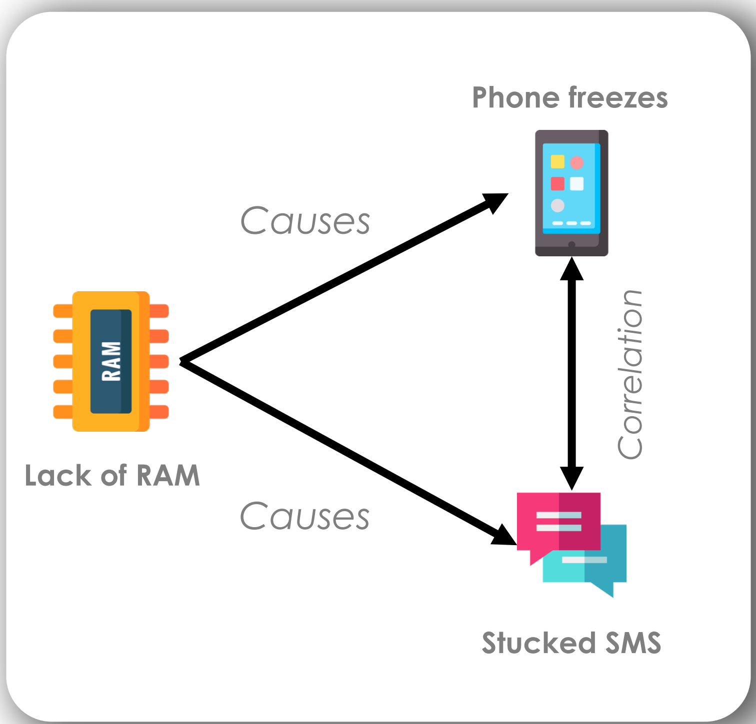
This means you can run regressions on your software, it's free, but that does not necessarily indicate it has a theoretical background

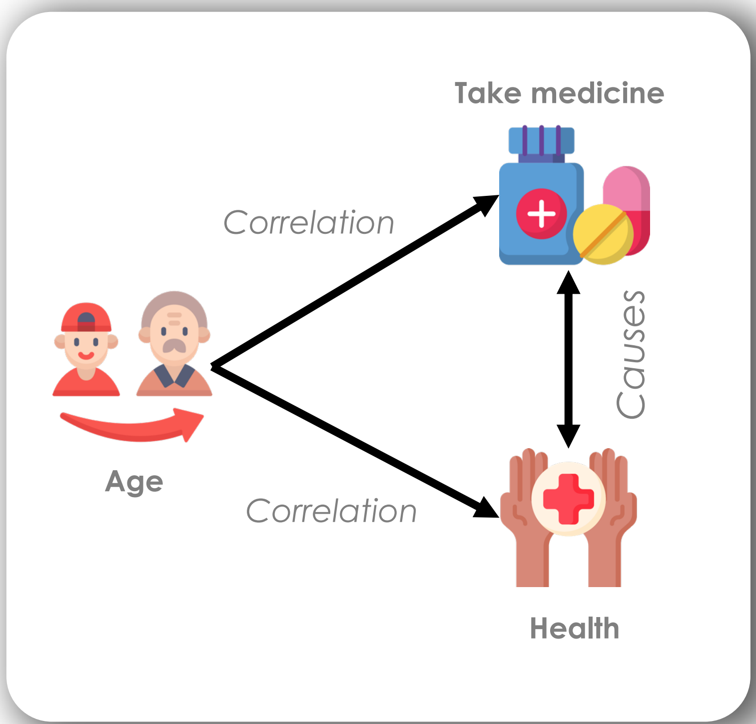
Correlation does not imply causation

Cum hoc ergo propter hoc

Correlation **vs** Causalty





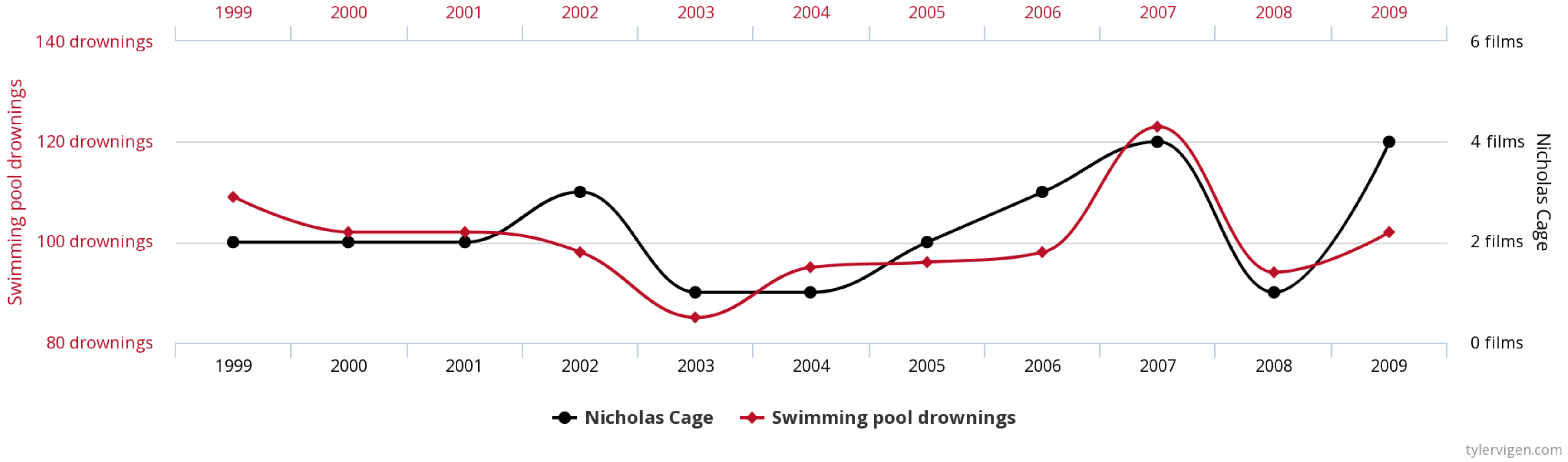


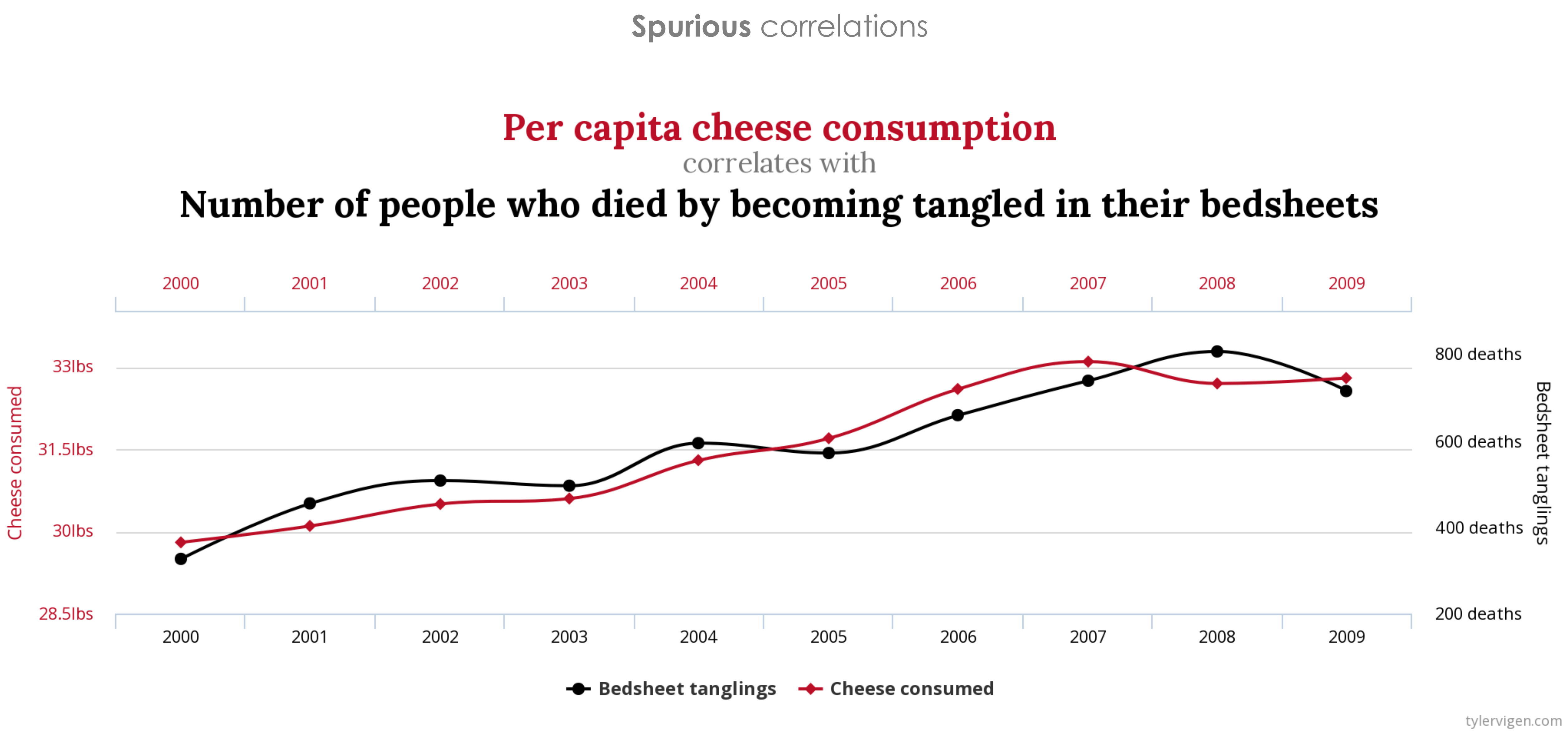
Spurious correlations

Number of people who drowned by falling into a pool

correlates with

Films Nicolas Cage appeared in



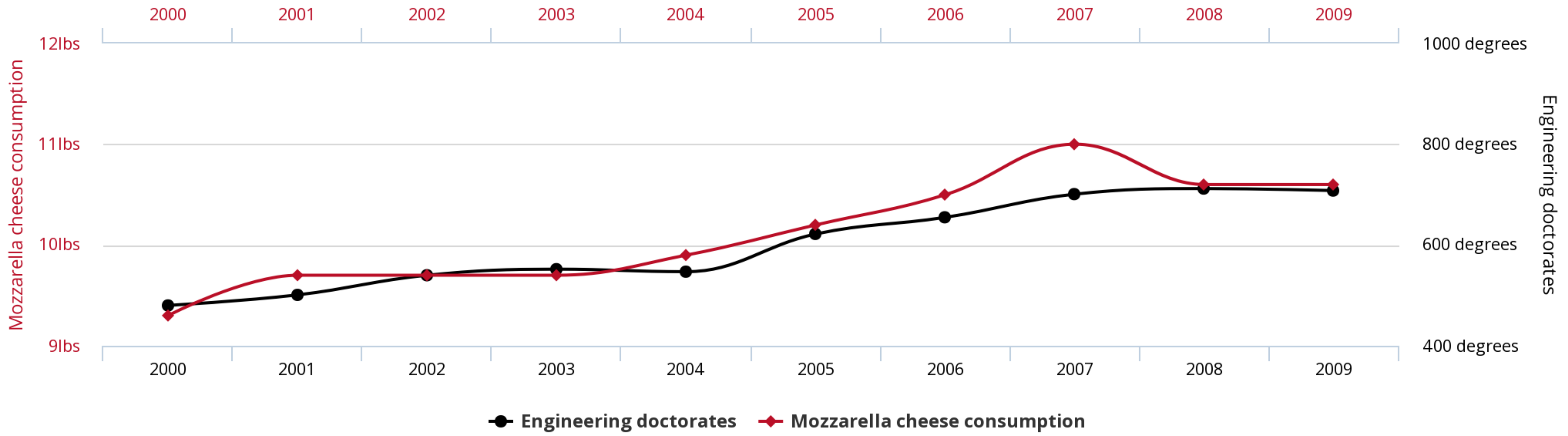

Spurious correlations
Per capita cheese consumption
correlates with
Number of people who died by becoming tangled in their bedsheets
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Cheese consumed
33lbs
31.5lbs
30lbs
28.5lbs
800 deaths
600 deaths
400 deaths
200 deaths
Bedsheet tanglings
Bedsheet tanglings
Cheese consumed
tylervigen.com

Spurious correlations

Per capita consumption of mozzarella cheese

correlates with

Civil engineering doctorates awarded



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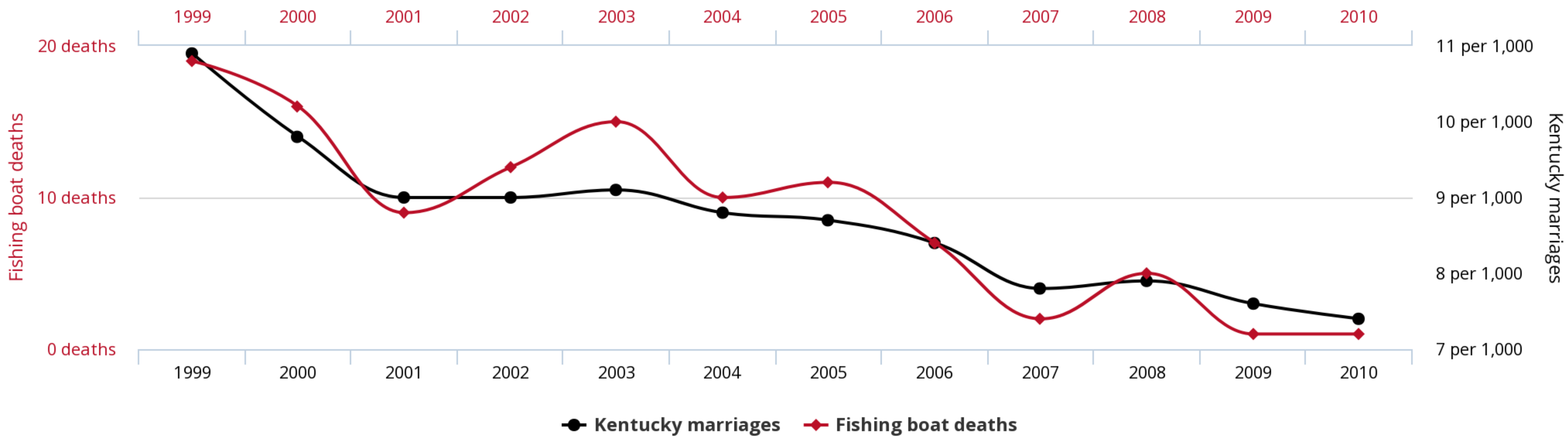
Spurious correlations

People who drowned after falling out of a fishing boat
correlates with
Marriage rate in Kentucky



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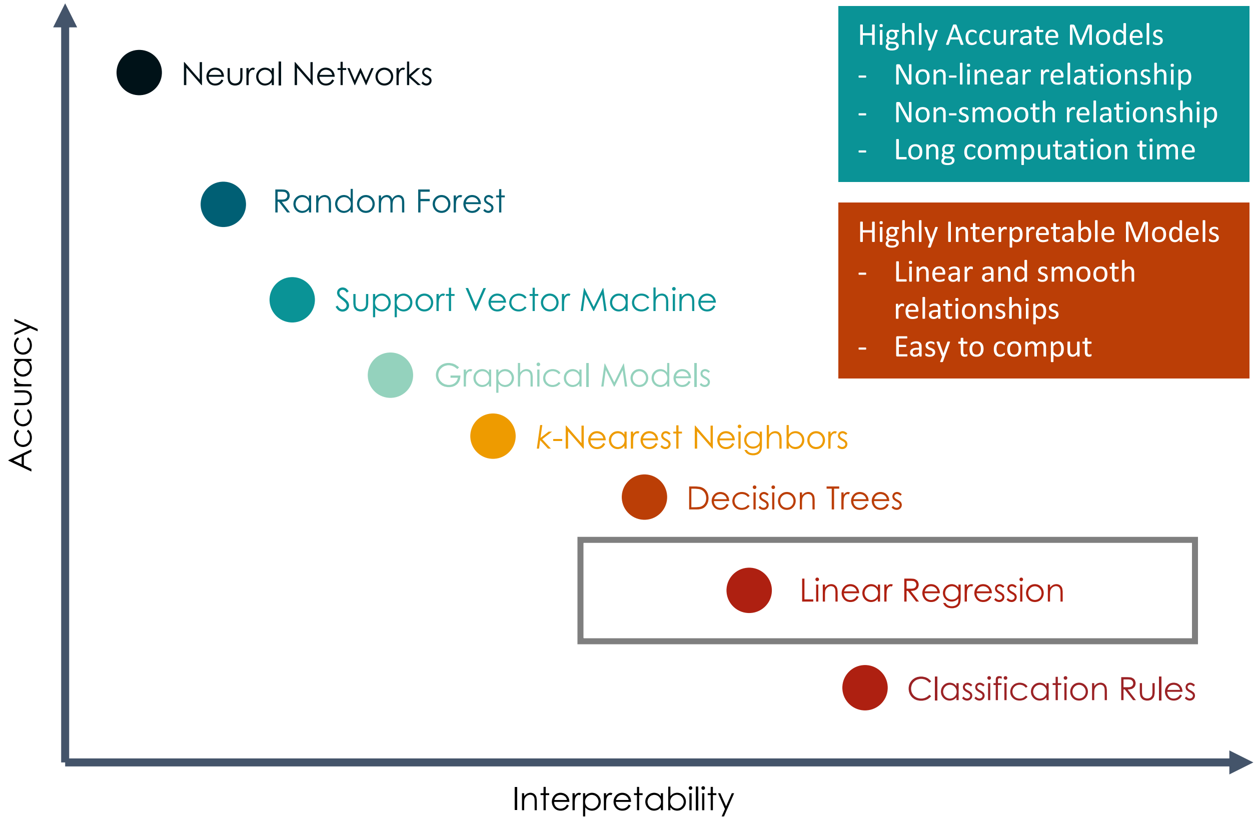
Why models fail?



Based on Machine Learning for 5G/B5G Mobile and Wireless Communications: Potential, Limitations, and Future Directions

Do you remember that we said we love testing?

The important task is not to obtain it because a software can easily make it for you but to interpret it. This is the next step right after running your regression.

The smaller the p.value the more evidence we have against H_0

The smaller the p.value the more evidence we have against H_0

or

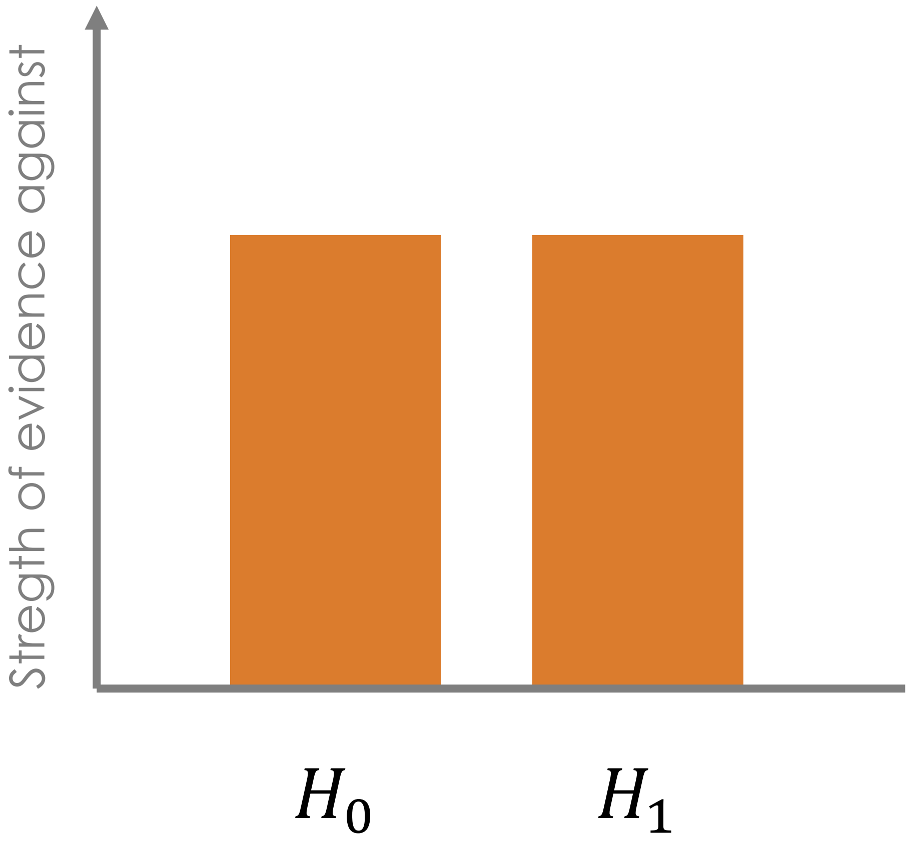
If p.value is "very" small, then we have more evidence to reject the null hypothesis

All depends on the significance level, which you may have heard about…

That number you always declare

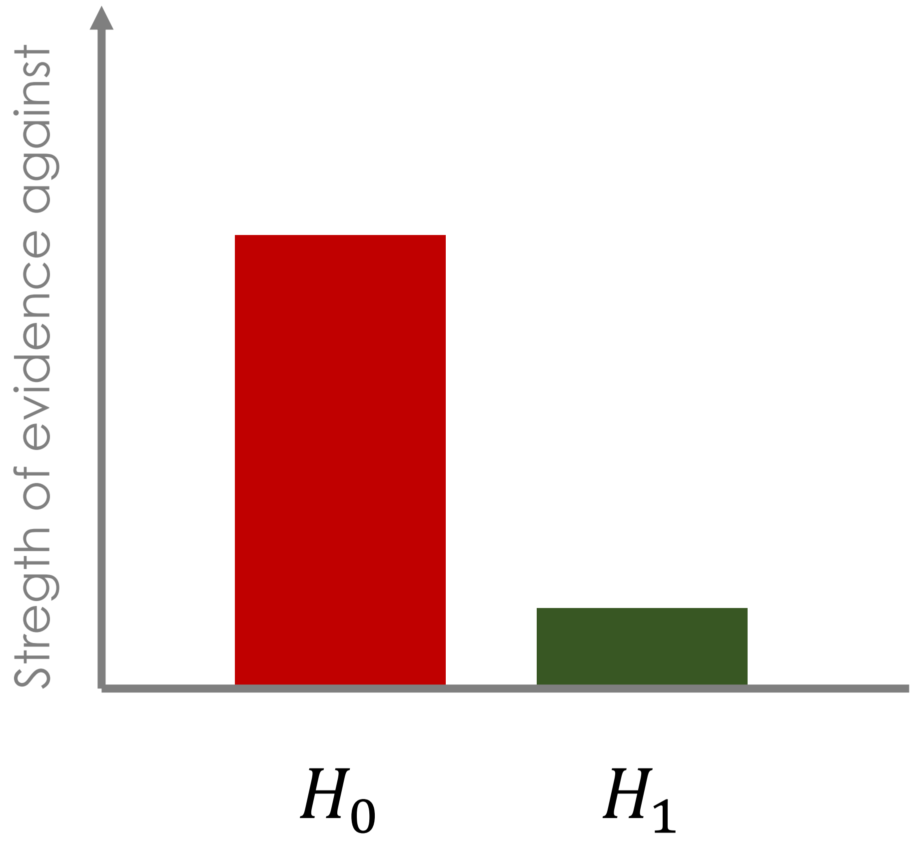
10% *5%* *1%*

Hypothesis testing



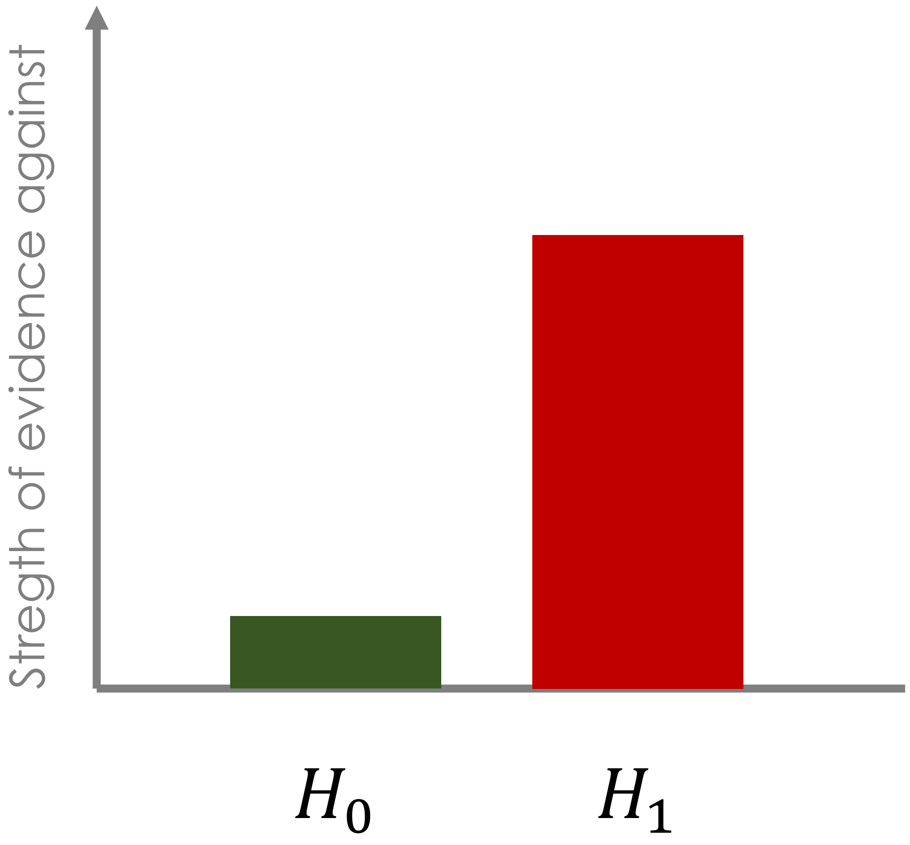
Suppose that your software outputs a p.value of 0.0001 and you have a significance level of 5%

Hypothesis testing



Suppose that your software outputs a p.value of 0.0001 and you have a significance level of 5%

Your p.value is "small" or at least less than the significance level value then your evidence against the null hypothesis increases (*you accept the alternative one*)

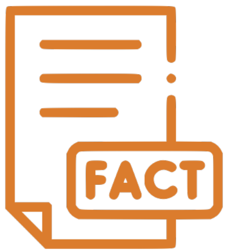


Now suppose that your software outputs a p.value of 0.07 and you have a significance level of 5%

Your p.value is not "small" or at least it is more than the significance level value. Then your evidence against the null hypothesis decreases (you do not *accept* the alternative one)

You can state your own hypothesis testing

Information you already have and you want to reject



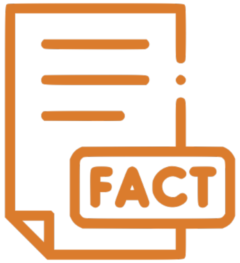
H_0

What you desire

H_1

And then you state your significance level

Example



A school report shows that the average age in a class is 12

$$H_0: \mu \geq 12$$

but…

You suspect it is less than 12

$$H_1: \mu < 12$$

p.value outputs 0.06 and we have a significance value of 5%, then we do not have enough evidence to reject the null hypothesis, so it is clear that school is right

We now that you may have heard about z-test, t-test, R^2 and all that stuff, and that those may be confusing

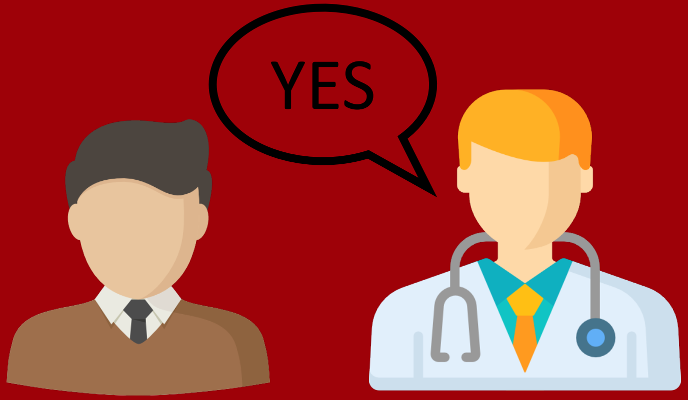
We want you to memorize this table

Normally Distributed?	Variance known?	Small Sample?	Large Sample?
Yes	Yes	z	z
Yes	No	t	t or z
No	Yes	n/a	z
No	No	n/a	t or z

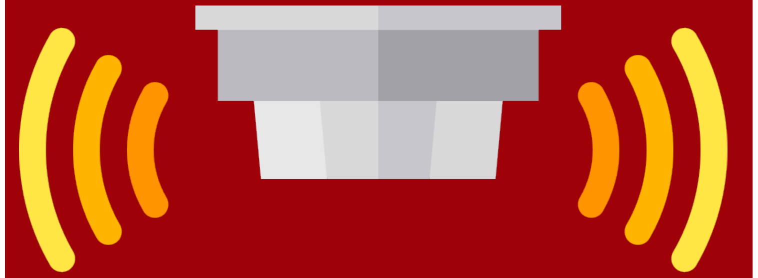
Type I & **Type** II Errors

	Null hypothesis is TRUE	Null hypothesis is FALSE
Reject null hypothesis	**Type I Error (False Positive)**	**Correct! (True Positive)**
Fail to reject null hypothesis	**Correct! (True Negative)**	**Type II Error (False Negative)**

Are you **pregnant**?

	Null hypothesis is TRUE	Null hypothesis is FALSE
Reject null hypothesis		
Fail to reject null hypothesis		

Are you **pregnant**?

	Null hypothesis is TRUE	Null hypothesis is FALSE
Reject null hypothesis		
Fail to reject null hypothesis		

We are going to use t-test because we already have the population mean

$$t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$$

where

μ population mean
$\bar{x}$ mean from distribution
n size of sample
s standar error from size

constant

$$H_0: a = 0$$

$$H_a: a \neq 0$$

slope

$$H_0: b = 0$$

$$H_a: b \neq 0$$

constant

$$H_0: a = 0$$

$$H_a: a \neq 0$$

slope

$$H_0: b = 0$$

$$H_a: b \neq 0$$

What do we want to reject?

We want to reject the null hypothesis and to confirm that coefficients are significative (it means that are different from zero)

What can we do if we want to evaluate the explanatory ability that a group of independent variables have over the variation of dependent variable

$$F = \frac{\frac{SSR}{k}}{\frac{SSE}{n-k-1}}$$

where

SSR Sum of squared regression
k Degrees of Freedom
SSE Sum of squared error
n total number of obs

constant

$$H_0: F = 0$$

$$H_a: F \neq 0$$

constant

$$H_0: F = 0$$

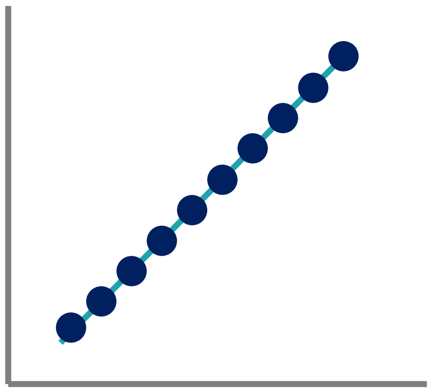
$$H_a: F \neq 0$$

What do we want to reject?

We want to reject the null hypothesis and to confirm that our model fits the data better than using only the intercept (the null hypothesis states that the model with no independent variables fits the data well)

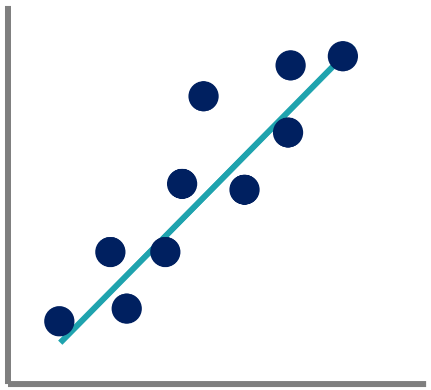
Finally, in order to know how well our model is when putting it inside reality, we use R^2 which is the proportion of variance in the dependent variable given a bunch of independent variables (or maybe just one)

$R^2 = 1$



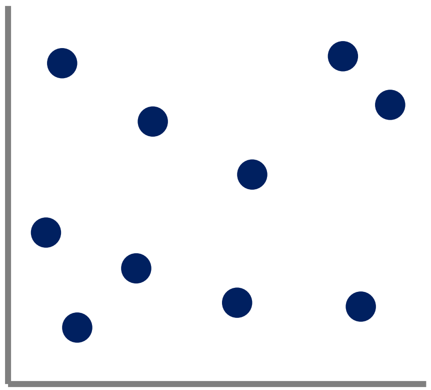
X fully explain Y

$R^2 = 0.86$



X fully explain 86% of change in Y

$R^2 = 0$



X cannot explain Y

Statistical tests

Coefficient of Determination

$$R^2 = 1 - \frac{SSE}{TSS}$$

SSE/TSS show how much variance there is in our model as a fraction of the total variation in the target

Note that independet variables in models with high R^2 explain most of the variance present in data

R^2 will never decrease by adding new variables, but it can lead to overfitting

Adjusted R^2

$$\bar{R}^2 = 1 - \frac{SSE/(n-p-1)}{TSS/(n-1)}$$

n number of datapoints
p number of independet variables

Adjusted R^2 only increases when a new variables is added and imporves the model by more than would be expected due to random chance

Adjusted R^2 decreases when an added variable does not improve model

Adjusted $R^2 <$ R^2

It allows comparison between models with different numbers of independent variables

How to read **regression** coefficients

$$P = 77000 + 80X_1 + 9200X_2$$

P – House price

X_1 - Building area

X_2 - House condition

- There is a **base price** of $77,000
- On **average**, for every extra m^2 we **add**, the house price increases by $80
- For every **condition point** we **add**, the house price increases by $9,200

How to read **regression** coefficients

We can scale independet variables before runninng regression in order to compare cofficients, like standarization, which follows a normal distribution with mean zero and unit variance.

$$Z = \frac{x_i - \bar{x}}{\sigma}$$

$$P = 11320 + 41766X_1 + 30047X_2$$

P – House price

X_1 - Building area

X_2 - House condition

$$P = 11320 + 41766X_1 + 30047X_2$$

P – House price

X_1 - Building area

X_2 - House condition

Now, we can compare which variable contributes more for predicting house price for a single unitless increment in the independent variable, such as building area


Curriculum in Cardiology

Statistics

Linear Regression Analysis Study

Khushbu Kumari, Suniti Yadav

Department of Anthropology, University of Delhi, New Delhi, India

Abstract

Linear regression is a statistical procedure for calculating the value of a dependent variable from an independent variable. Linear regression measures the association between two variables. It is a modeling technique where a dependent variable is predicted based on one or more independent variables. Linear regression analysis is the most widely used of all statistical techniques. This article explains the basic concepts and explains how we can do linear regression calculations in SPSS and excel.

Keywords: Continuous variable test, excel and SPSS analysis, linear regression

Introduction

The concept of linear regression was first proposed by Sir Francis Galton in 1894. Linear regression is a statistical test applied to a data set to define and quantify the relation between the considered variables. Univariate statistical tests such as Chi-square, Fisher's exact test, *t*-test, and analysis of variance (ANOVA) do not allow taking into account the effect of other covariates/confounders during analyses (Chang 2004). However, partial correlation and regression are the tests that allow the researcher to control the effect of confounders in the understanding of the relation between two variables (Chang 2003).

In biomedical or clinical research, the researcher often tries to understand or relate two or more independent (predictor) variables to predict an outcome or dependent variable. This may be understood as how the risk factors or the predictor variables or independent variables account for the prediction of the chance of a disease occurrence, i.e., dependent variable. Risk factors (or dependent variables) associate with biological (such as age and gender), physical (such as body mass index and blood pressure [BP]), or lifestyle (such as smoking and alcohol consumption) variables with the disease. Both correlation and regression provide this opportunity to understand the "risk factors-disease" relationship (Gaddis and Gaddis 1990). While correlation provides a quantitative way of measuring the degree or strength of a relation between two variables, regression analysis mathematically describes this relationship. Regression analysis allows predicting the value of a dependent variable based on the value of at least one independent variable.

In correlation analysis, the correlation coefficient "r" is a dimensionless number whose value ranges from −1 to +1. A value toward −1 indicates inverse or negative relationship, whereas towards +1 indicate a positive relation. When there is a normal distribution, the Pearson's correlation is used, whereas, in nonnormally distributed data, Spearman's rank correlation is used.

The linear regression analysis uses the mathematical equation, i.e., y = mx + c, that describes the line of best fit for the relationship between y (dependent variable) and x (independent variable). The regression coefficient, i.e., r^2 implies the degree of variability of y due to x.[1-8]

Significance of Linear Regression

The use of linear regression model is important for the following reasons:

a. Descriptive – It helps in analyzing the strength of the association between the outcome (dependent variable) and predictor variables
b. Adjustment – It adjusts for the effect of covariates or the confounders

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DOI: 10.4103/jpcs.jpcs_8_18

How to cite this article: Kumari K, Yadav S. Linear regression analysis study. J Pract Cardiovasc Sci 2018;4:33-6.

How to read a

paper

How to read a **paper**

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Conclusion

The techniques for testing the relationship between two variables are correlation and linear regression. Correlation quantifies the strength of the linear relationship between a pair of variables, whereas regression expresses the relationship in the form of an equation. In this article, we have used simple examples and SPSS and excel to illustrate linear regression analysis and encourage the readers to analyze their data by these techniques.

Begin with:

Abstract

Keywords

Authors

Introduction

Conclusion

Note:
· Reset your expectations, do not worry if you do not understand the first time

f. All the values of “y” are independent from each other, though dependent on “x.”

Table 6: Summary output

Regression statistics	Values	Explanation
Multiple *R*	0.96332715	Correlation coefficient: 1 means perfect correlation and 0 means none
R^2	0.927999198	Coefficient of determination: How many points fall on the regression line. Here, 92% points fall within the line
Adjusted R^2	0.891998797	Adjusted R^2: Adjusts for multiple variables, use with multiple variables
SE	516.3490153	
Observations	7	

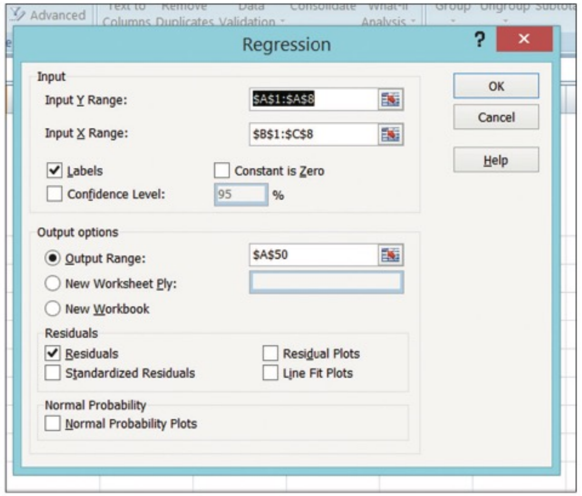

Figure 4: The regression screen. Choose Data > Data Analysis > Regression. Input y Range: A1:A8. Input X Range: B1:C8. Check Labels, Residuals, Output Range as A50.

How to read a **paper**

When you master that keep up with:

Technical language

Diagrams/graphs

Tables (data)

Results

Software

References

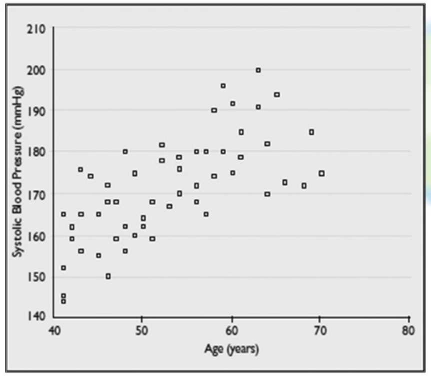

Figure 1: Scatter plot of systolic blood pressure versus age.

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Table 4: SPSS equation variables

Model	Coefficients[a] Unstandardised coefficients B	Std. error	Standardised coefficents Beta	*t*	Sig.	95% Confidence interval for B Lower bound	Upper bound
I (Constant)	115.706	7.999	0.696	14.465	0.000	99.662	131.749
Age (years)	1.051	0.149		7.060	0.000	0.752	1.350

[a]Dependent variable: Systolic blood pressure (mmHg)

Note:

- Highlight key concepts
- Look through references

How to read a **paper**

How to Calculate Linear Regression?

Linear regression can be tested through the SPSS statistical software (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.) in five steps to analyze data using linear regression. Following is the procedure followed Tables 1-4:

Click Analyze > Regression > Linear > then select Dependent and Independent variable > OK (enter).

Example 1 – Data (n = 55) on the age and the SBP were collected and linear regression model would be tested to predict BP with age. After checking the normality assumptions for both variables, bivariate correlation is tested (Pearson's correlation = 0.696, $P < 0.001$) and a graphical scatter plot is helpful in that case [Figure 2].

Now to check the linear regression, put SBP as the dependent and age as the Independent variable.

This indicates the dependent and independent variables included in the test.

Pearson's correlation between SBP and age is given ($r = 0.696$). $R^2 = 0.485$ which implies that only 48.5% of the SBP is explained by the age of a person.

The ANOVA table shows the "usefulness" of the linear regression model with $P < 0.05$.

Finally:

Read it more than once

Check details

Replicate it

Note:

· Look for technicalities you don't understand

How to read a **paper**

Read the paper titled "How to Read a Paper"

How to Read a Paper

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but you may know the characteristics between them

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ELSEVIER

· Author (well-known)
· Long process to be accepted and published
· Peer reviewed (peer to peer)

White papers

arXiv

· Author (Anonymity)
· Anyone can submit a paper
· Community review

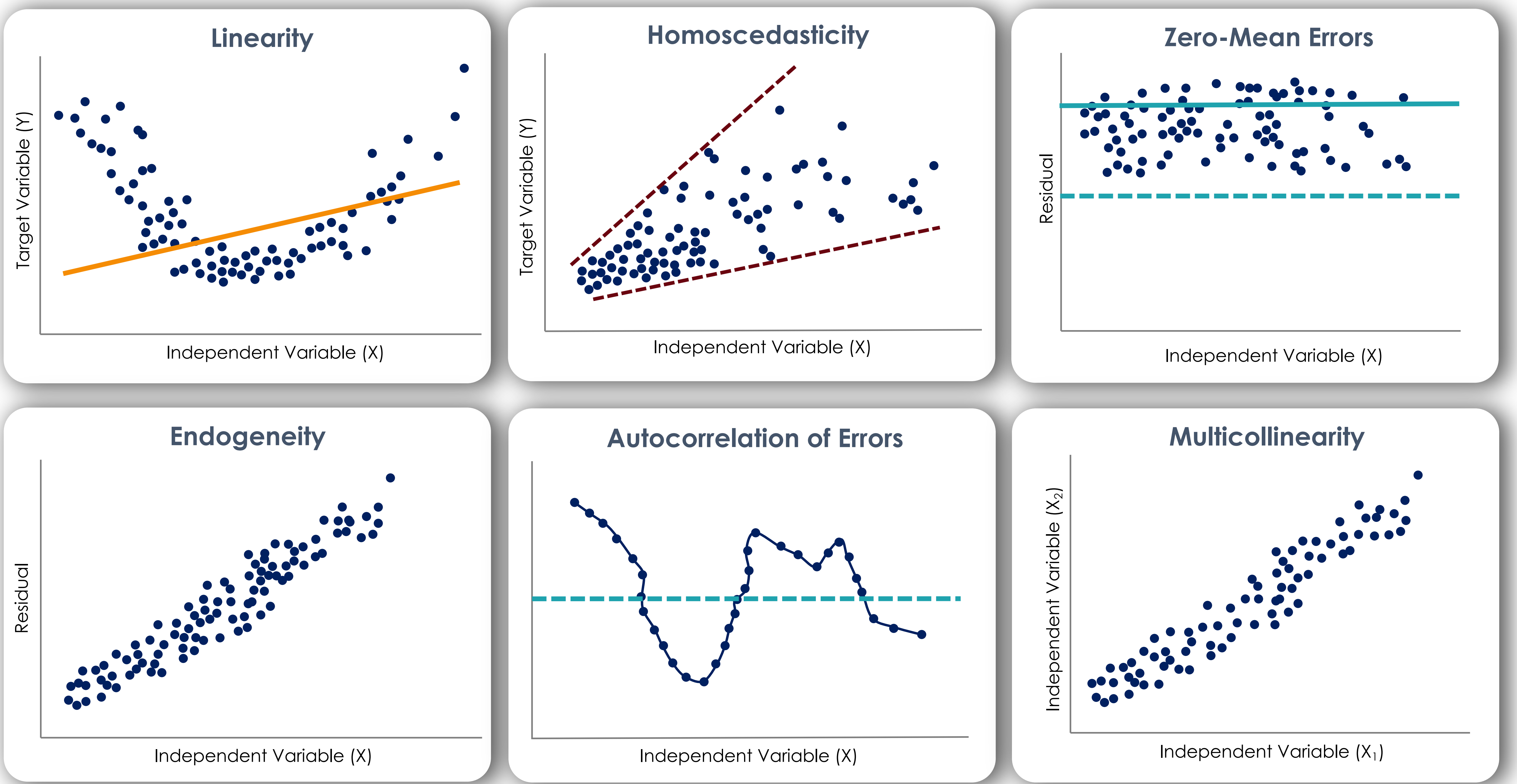
White papers

arXiv

Even when the article or paper is not peer to peer review that does not mean there is no quality in them

Gregory Perelman submitted an article in ArXiv with the resolution of the Poincaré conjecture (one of the millennium problems)

OLS Assumptions



Terminology

y Dependent variable	x Explanatory variable
Explained variable	Independent variable
Predictand	Predictor
Regressand	**Regressor**
Response	Stimulus
Endogenous	Exogenous
Outcome	Convariate
Controlled variable	Control variable

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