

Bocconi



***LA MATEMATICA
NELL'ERA DEI DATI***

***ORIENTAMATICA
3 MARZO 2023***

B | Università
Bocconi
MILANO

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Data Science

Globalization and increased connectivity make available to citizens, to corporations and scientists an amount of data unthinkable a few years ago.

Increased connectivity is changing the way we work and communicate

We register a **large increase in the use of computers in everyday life**, with new societal phenomena, entrepreneurial opportunities and **new professions**

A data driven economy is awaiting us and an adequate skill basis is needed to turn the **new opportunities into successful careers**



Data Driven Economy and Big Data

Big Data is high-volume, high-velocity and high-variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making (Source: Gartner)

Information

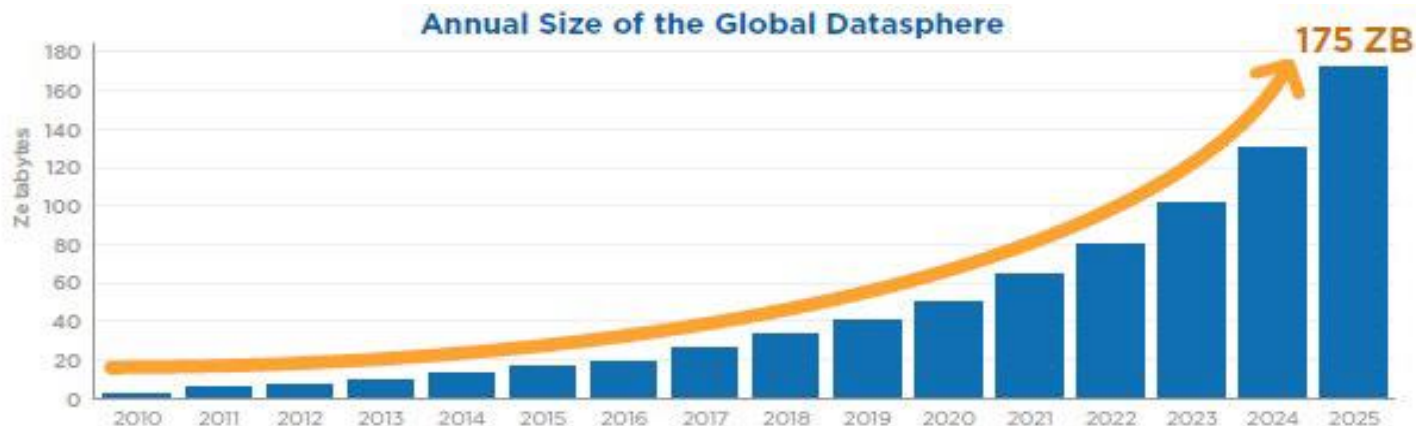
- The amount of information and quantity of data that mankind has generated in the first months of this year are bigger than the quantity it has generated in the past century

Advantages

- The incredible amount of information and data generated by new technologies can bring competitive advantages for companies and institutions



How many data?



Source: Data Age 2025, IDC White Paper – #US44413318

Big Data Application Fields: some examples



- City traffic
- Revenue Management
- Online Forecasts
- Political elections
- Personalized advertising
- Purchasing recommendations
- Cross selling
- Online Auctions
- Geolocalization Healthcare/medical research
- Fraud detection

Communication of the EC to the European Parliament July 2 2014

JOBS

4.4 million
jobs by 2015 - *Gartner*



"McKinsey predicts that companies will struggle to find Big Data talent due to a shortage in well-trained people."

Players

- Several players to create added value from the availability of big data

Big Data

- EC document on cloud computing: big data and correlated services will reach **16,9 billion USD value** in 2015, with an average growth rate of **40%**, seven times higher the rate of growth of technology market

UK

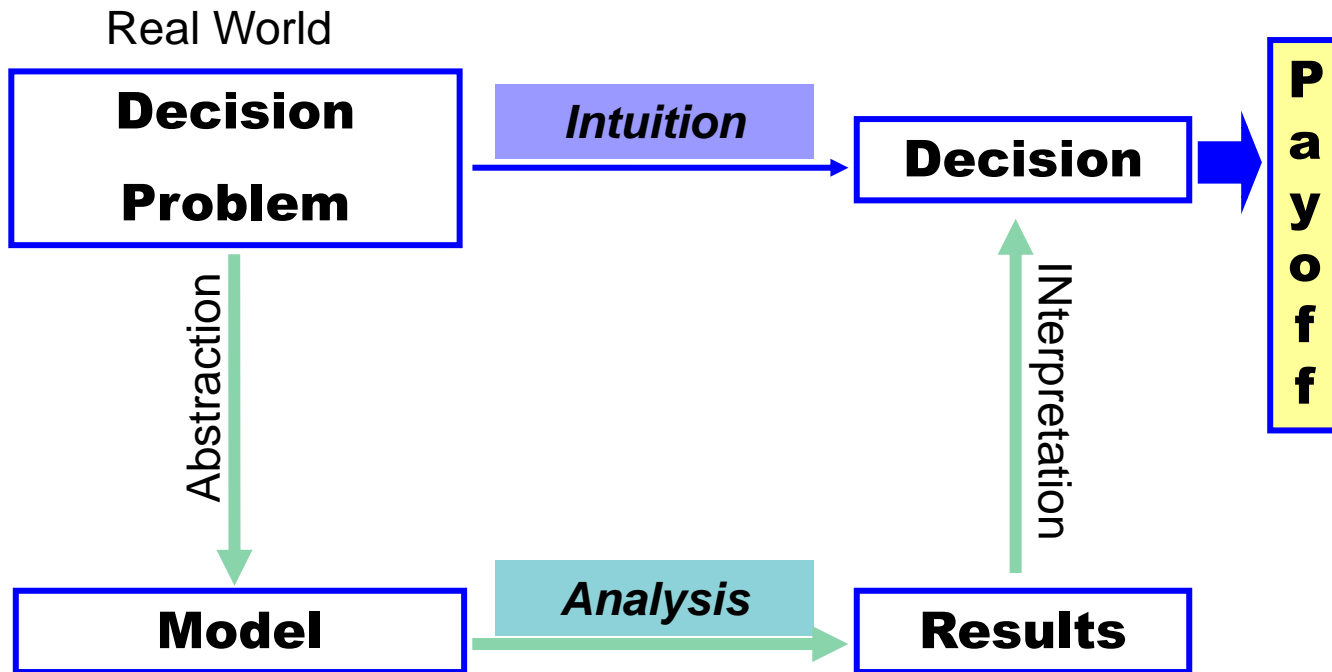
- In the UK number of big data specialists working in big firms will increase by 240% (Source: SAS report)

Adequate Skill Base, EU Document



- *An adequate skills base:* The competence base addresses descriptive and predictive data analytics, data visualisation, artificial intelligence and decision-making software tools and algorithms
- The EU document encourages *close cooperation between players* (i.e., industry and universities) to achieve the sharing of the desired competences
- *The training of professionals* who can perform in-depth thematic analysis, exploit machine findings, derive insight from data and use them for improved decision-making is considered crucial

Decision Making Process



A Quote

“By modeling various alternatives for future system design, Federal Express has, in effect, made its mistakes on paper. Computer modeling works; it allows us to examine many different alternatives and it forces the examination of the entire problem.”

**Frederick W. Smith, Chairman and CEO of
Federal Express Corporation**

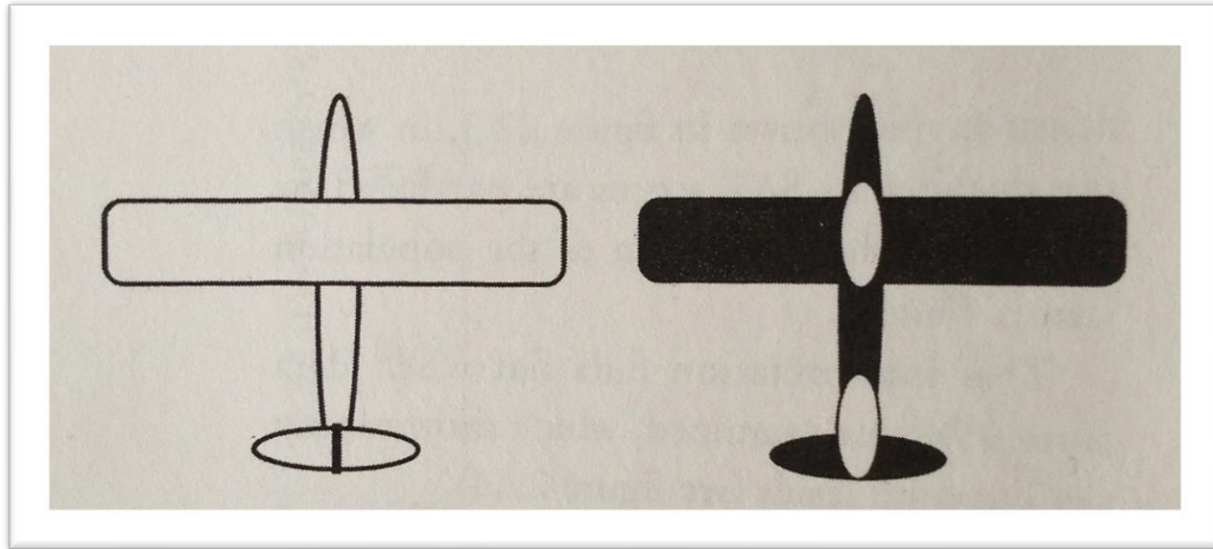
Algorithms can fail

- From the Google Flue case



... to Abraham Wald

Wald's Planes



Eratostene di Cirene (276 a.c. – 194 a.c.)

- Eratosthenes of Cyrene:
mathematician, astronomer and
geographer of ancient Greece
- Librarian of Alexandria in Egypt
- Calculated for first earth circumference
and earth axis inclination*
- ... Invented an algorithm to find prime
numbers!!!



Eratostene's Algorithm

— We want to find the prime numbers in the first (say) 20 natural numbers

1 2 3 ~~4~~ 5 ~~6~~ 7 ~~8~~ 9 ~~10~~ 11 ~~12~~ 13 ~~14~~ 15 ~~16~~ 17 ~~18~~ 19 ~~20~~

1 2 3 5 ~~7~~ ~~9~~ 11 ~~13~~ ~~15~~ 17 ~~19~~

1 2 3 5 7 11 13 17 19

Lotsa Pasta



Lotsa Pasta

—Is a small manufacturer and produces:

- ziti



- a special wheat macaroni



The problem in words

Lotsa Pasta is developing a production plan for next week. Each ton of ziti that is produced requires 7 pounds of a special wheat germ. Each ton of the macaroni requires 4 pounds of the wheat germ.

The company currently has 28 pounds of wheat germ in stock and will not be able to purchase any additional wheat germ in time for next week's production. All other ingredients are readily available and will not influence the amount of each product that will be produced.

Labor is also required to produce each product.

This production plan should:

- maximize total weekly profit;

- not use more than 90 hours of labor;

- not use more than 28 pounds of wheat germ;

Let W be the tons of wheat macaroni to produce next week. Only 90 hours of labor are available next week.

Ziti has a profit margin of \$350 per ton.

Wheat macaroni has a profit margin of \$300 per ton.

The pasta business is booming, and Lotsa Pasta can sell all of the pasta it makes.

Determine a production plan that specifies how many tons of wheat macaroni and ziti to produce next week.

From text to Equations

How do we decide?

$$\max \quad 300W + 350Z$$

subject to:

$$20W + 10Z \leq 90 \quad \text{labor hour restriction}$$

$$4W + 7Z \leq 28 \quad \text{wheat germ availability}$$

$$W + Z \geq 1 \quad \text{produce at least one ton of pasta}$$

$$3W \geq Z \quad \text{at most 3 tons of ziti per ton of macaroni}$$

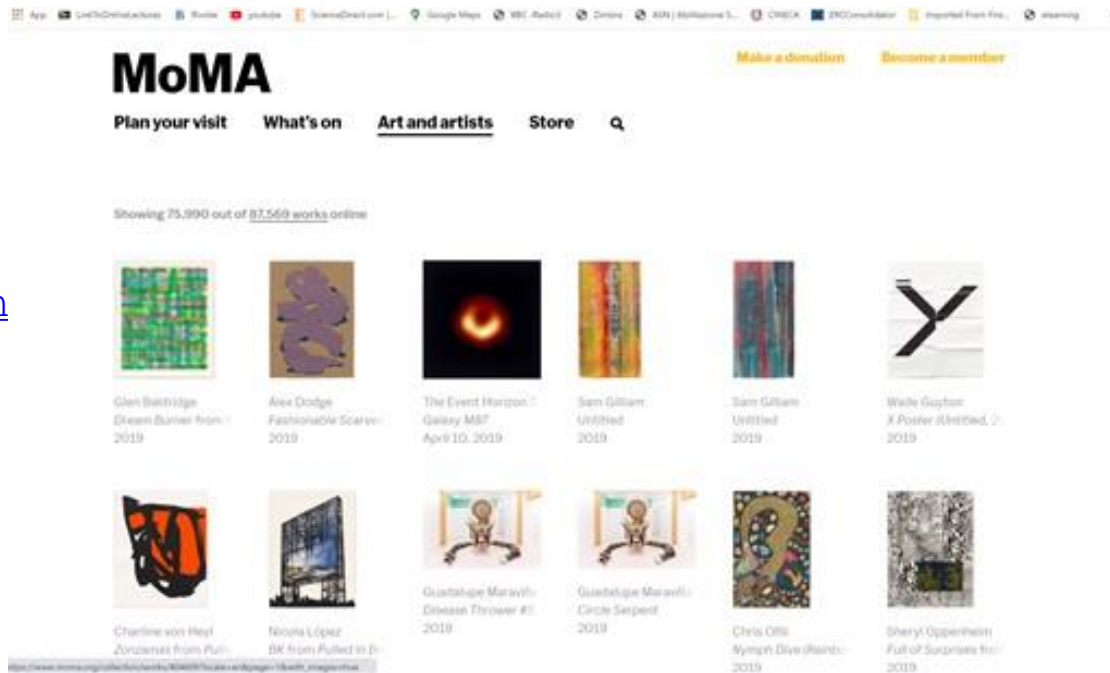
$$W \geq 0, Z \geq 0$$

From Equations to Solution

Lotsa Pasta						
Decision variable definitions:						
W = number of tons of wheat macaroni to produce next week.						
Z = number of tons of ziti to produce next week.						
Decision variables:						
	W	Z				
tons produced	3.50	2.00				
Objective function:						
			Total Profit			
profit/ton	\$300	\$350	\$1,750.00			
Constraints:						
			Lhs	Type	Rhs	Units
Labor	20	10	90	<=	90	hours
Wheat germ	4	7	28	<=	28	pounds
Min. production	1	1	5.5	>=	1	tons
Product mix	3	-1	8.5	>=	0	tons

DATA SCIENCE LAB

- MoMA, Museum of Modern Art, NY
- <https://www.moma.org/collection/>
- <https://www.kaggle.com/momanyc/museum-collection>



Data Science at Bocconi

- Data science at Bocconi is a major intellectual discipline across economics, physical and statistical sciences that relies on the method of **artificial intelligence, computer science, mathematics, statistics**, as well as on the rigorous thinking of economic and physical modelling

BACHELOR IN ECONOMICS, MANAGEMENT AND COMPUTER SCIENCE



Program structure: 4 pillars

Economics

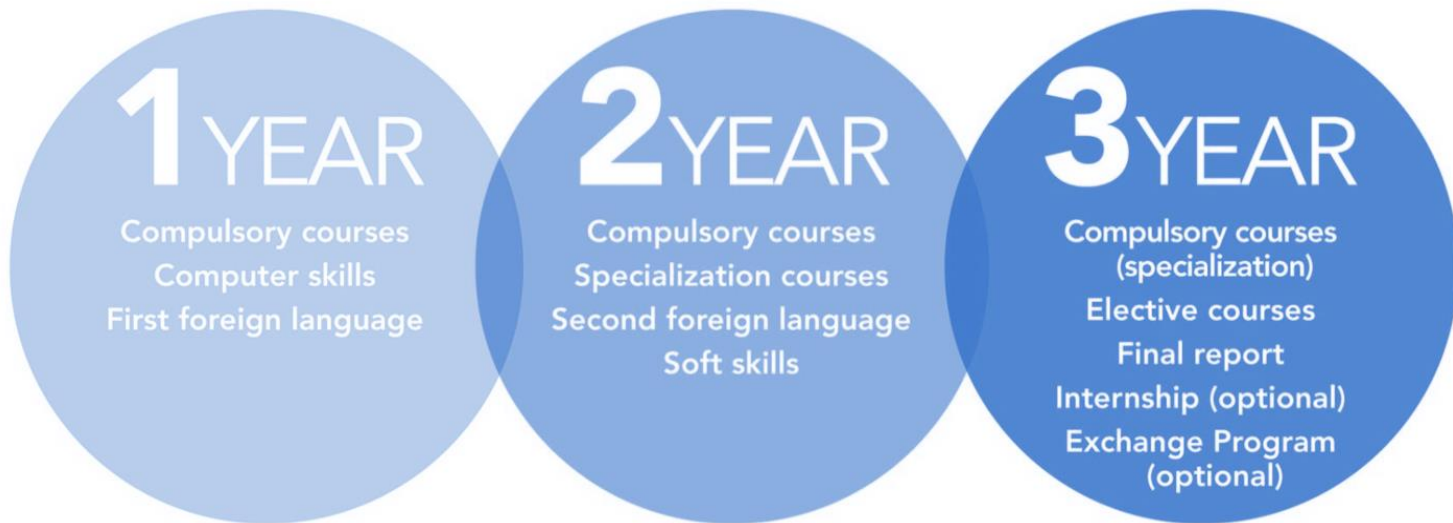
Management

Quantitative tools
(mathematics and
statistics)

Computer science
and informatics



The Study Path



Study plan

1° Year

1° Sem

- Microeconomics
- Mathematics and Statistics (Module 1 – Mathematics)
- Principles of Management

2° Sem

- Mathematics and Statistics (Module 2 – Statistics)
- Fundamentals of Computer Science
- Accounting
- Fundamentals of Information Technology Law
- First foreign language

2° Year

- Advanced Mathematics and Statistics (Module 1 - Applied Mathematics)
- Macroeconomics
- Fundamentals of Computer Programming
- European and International Information Law and Data Economy
- Technological Innovation Seminars 1

- Advanced Mathematics and Statistics (Module 2 -Advanced Statistical Methods)
- Machine Learning
- Econometrics
- Principles of Finance
- Technological Innovation Seminars 2
- Second foreign language

Study plan

3° Year

1° Sem

- Big Data and Databases
- Computational Microeconomics (Module 1 - Game Theory)
- Marketing Analytics
- Elective 1

2° Sem

- Computational Microeconomics (Module 2 - Mechanism Design)
- Information Systems Management
- Elective 2
- Elective 3 or internship
- Final Paper

Electives such as

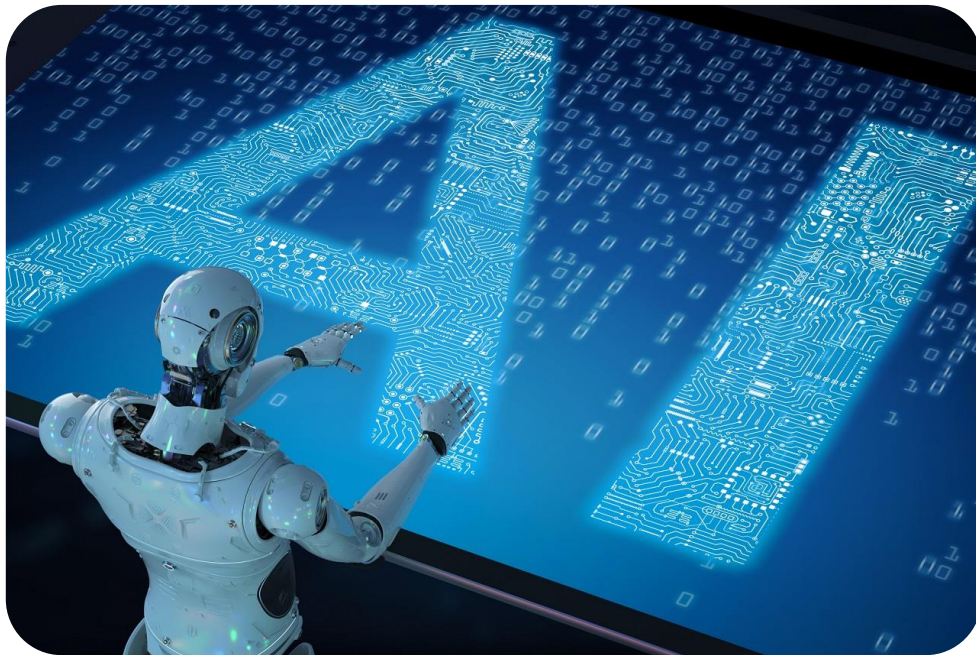
- Social media and branding
- Big data and public policy,
- Theoretical computer science,
- Logics and algorithms
- Advanced computer programming

Ad hoc **seminars** offered in collaboration with partner companies (Google, Cisco, IBM, SAS, Facebook, Oracle, HP, ...)

Some Recent Facts and Links

- BEMACS students winner of a prestigious IBM international coding competition:
- <https://www.youtube.com/watch?v=7FZYWSU2dZo&feature=youtu.be>

- BEMACS Lecture with Professor Alfio Quarteroni
- <https://www.youtube.com/watch?v=e-2o0hhKsLw>



Be Cool
BE-MACS!

WWW.UNIBOCCONI.EU/BEMACS

THANK YOU FOR YOUR ATTENTION!