# Big data project

Kick-off

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LIÈGE université

# Today

- What is data science?
- Methodology to solve a data science problem
- Topics for this year
- Course organization
- Evaluation

# The data science era

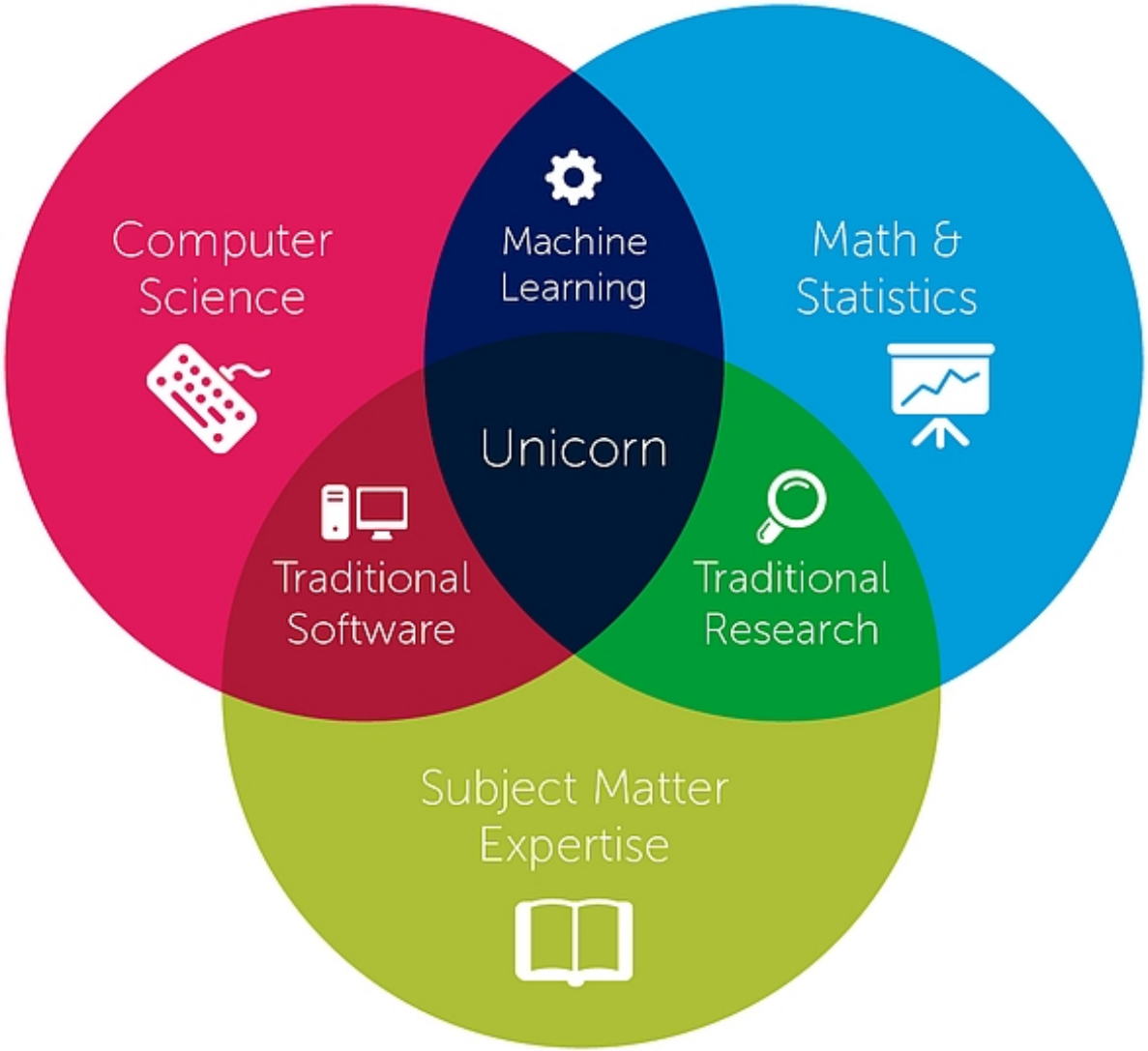
Big data? Data science?

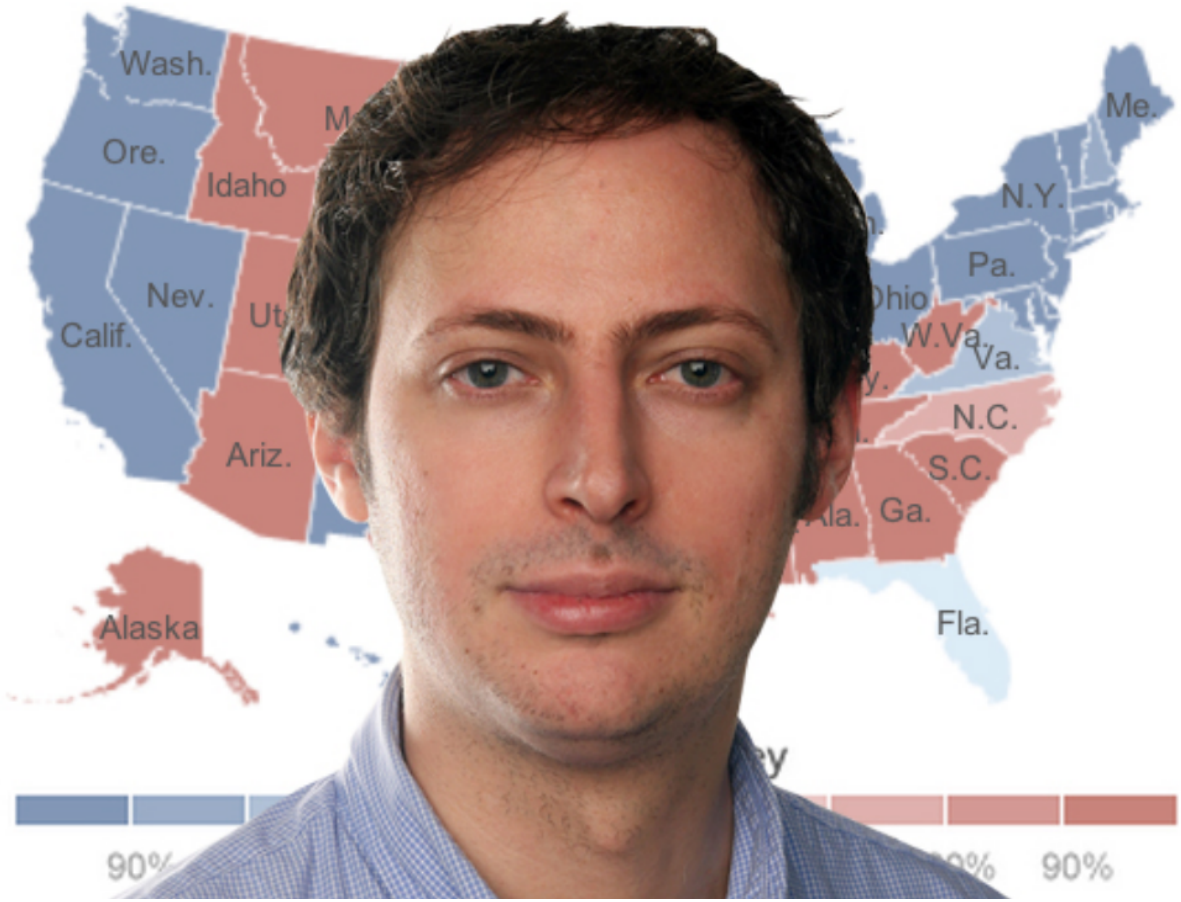
*"A data scientist is someone who knows more statistics than a computer scientist and more computer science than a statistician."*

Josh Blumenstock

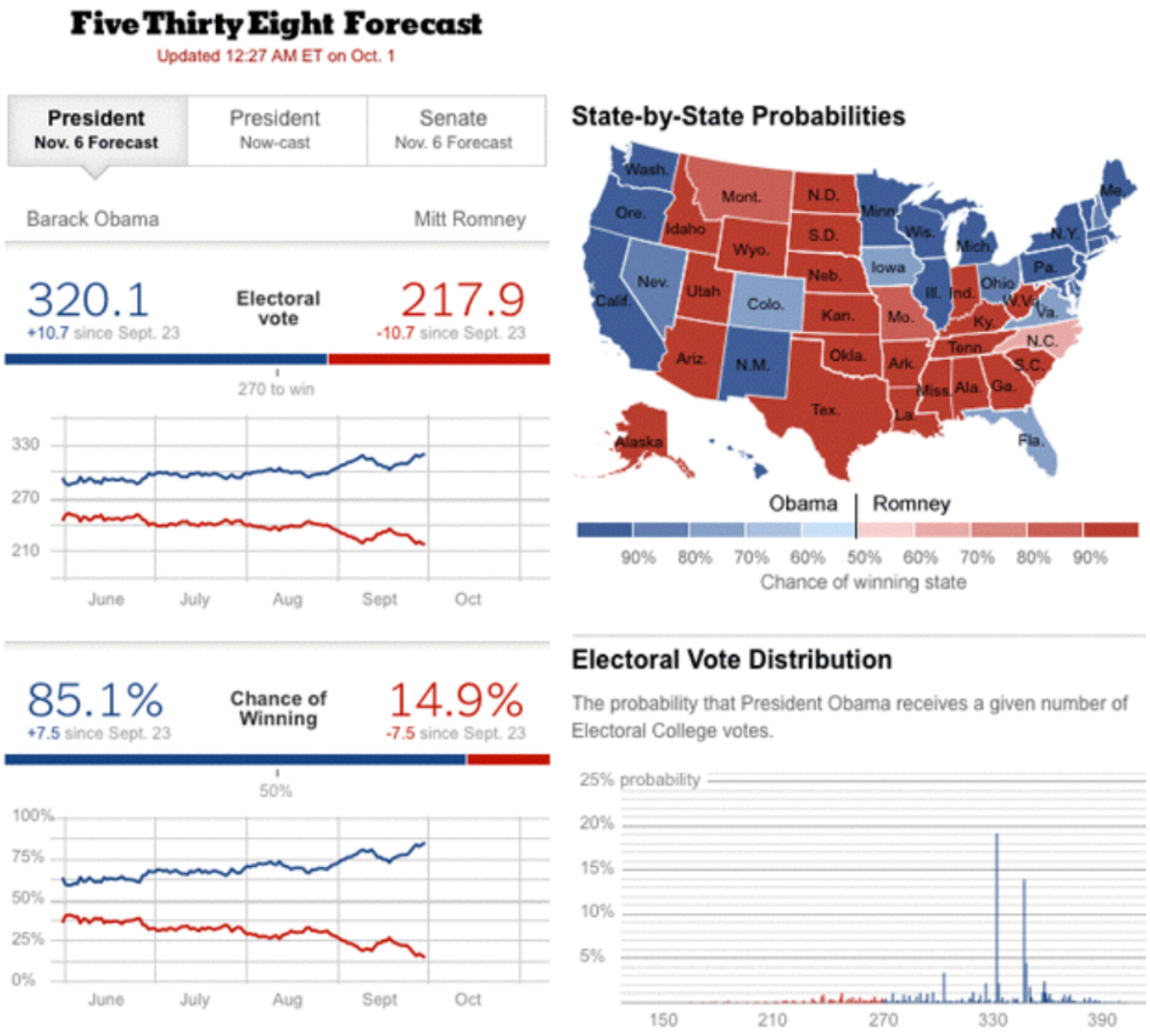
*"Data scientist = statistician + programmer + coach + storyteller + artist"*

Shlomo Aragmon


Computer Science
Machine Learning
Math & Statistics
Unicorn
Traditional Software
Traditional Research
Subject Matter Expertise


Wash.
Ore.
Idaho
Nev.
Calif.
Ariz.
Alaska
Me.
N.Y.
Pa.
W.Va.
Va.
N.C.
S.C.
Ga.
Fla.
90%
90%

*Nate Silver*




*"Nate Silver won the election" - Harvard Business Review*


analysis
data
knowledge

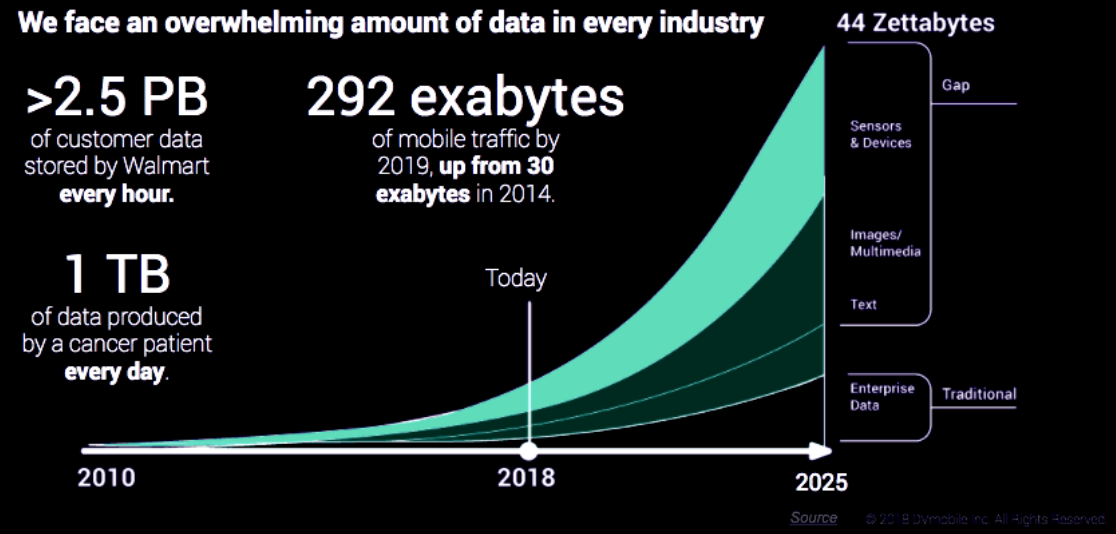
*Haven't we be doing data analysis forever?*

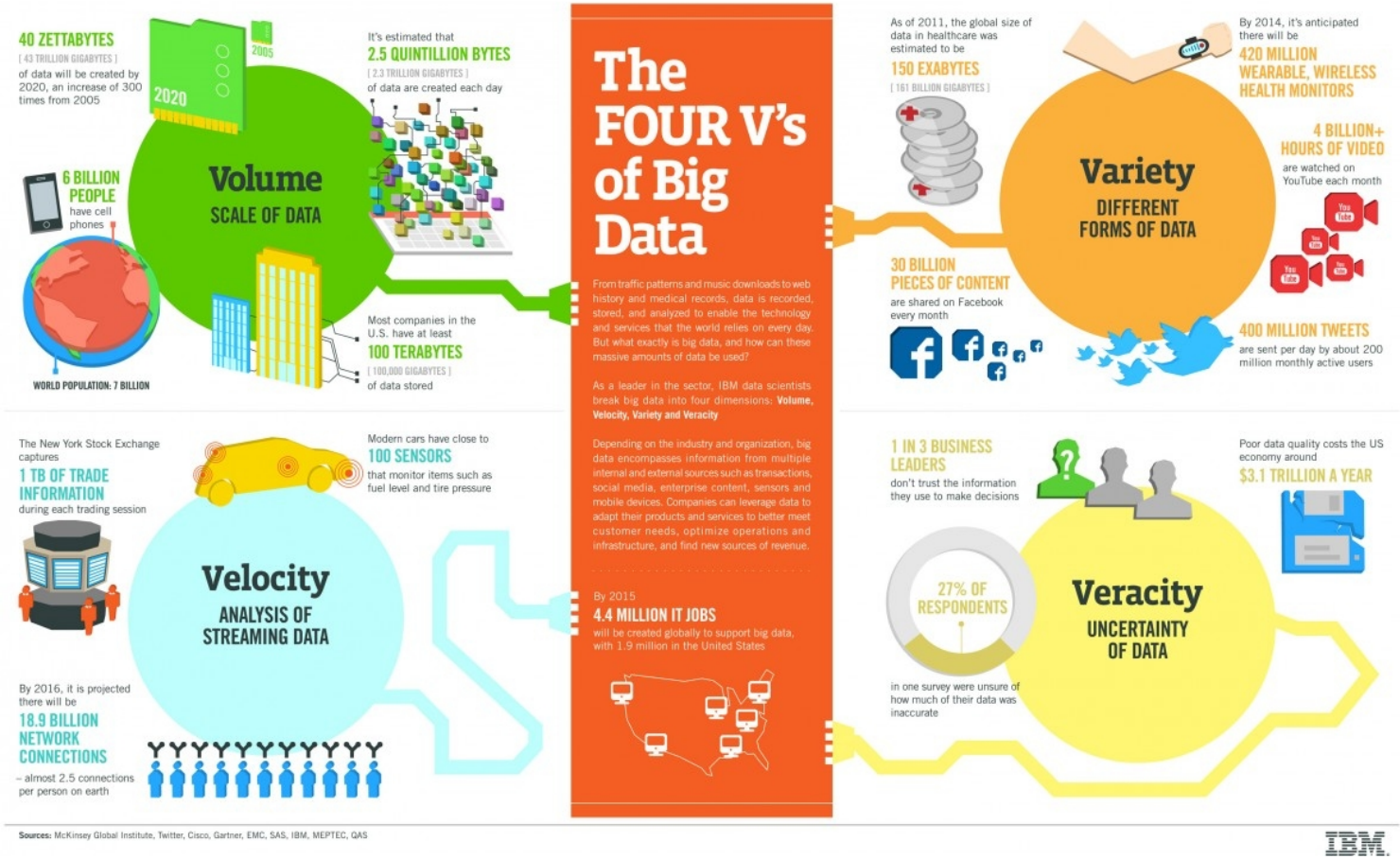
*"Every two days now we create as much information as we did from the dawn of civilization up until 2003, according to Schmidt. That's something like five exabytes of data, he says.*

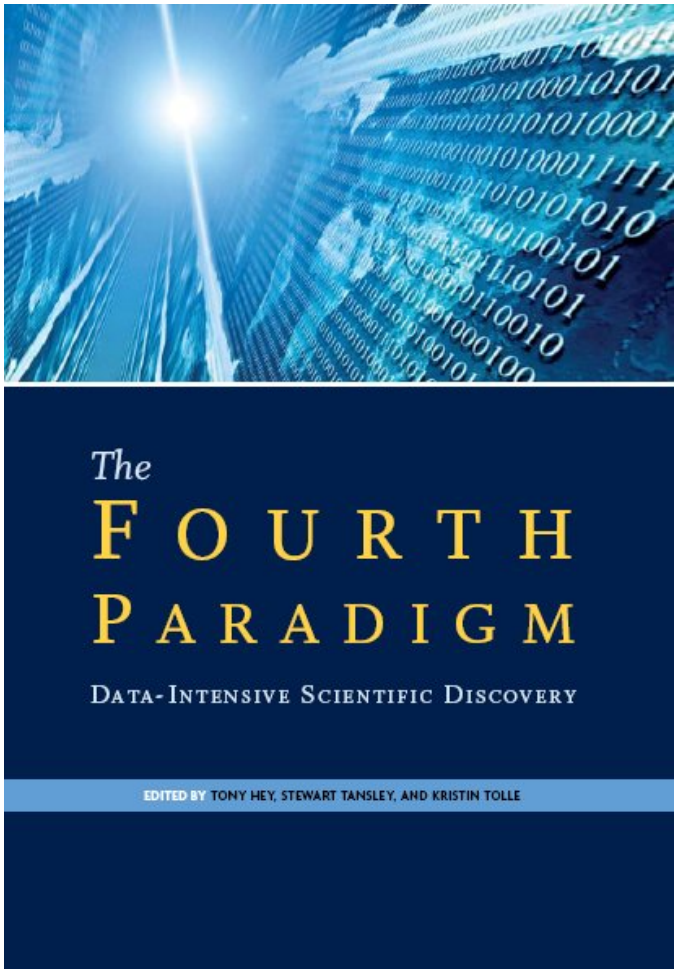
*Let me repeat that: we create as much information in two days now as we did from the dawn of man through 2003.*

Eric Schmidt, 2010.

# 1 Zettabyte (ZB) = 1 Trillion Gigabytes (GB)




40 ZETTABYTES
[ 43 TRILLION GIGABYTES ]
of data will be created by 2020, an increase of 300 times from 2005
2005
2020
It's estimated that
2.5 QUINTILLION BYTES
[ 2.3 TRILLION GIGABYTES ]
of data are created each day
6 BILLION PEOPLE
have cell phones
WORLD POPULATION: 7 BILLION
Volume
SCALE OF DATA
Most companies in the U.S. have at least
100 TERABYTES
[ 100,000 GIGABYTES ]
of data stored
The New York Stock Exchange captures
1 TB OF TRADE INFORMATION
during each trading session
Modern cars have close to
100 SENSORS
that monitor items such as fuel level and tire pressure
Velocity
ANALYSIS OF STREAMING DATA
By 2016, it is projected there will be
18.9 BILLION NETWORK CONNECTIONS
– almost 2.5 connections per person on earth
The FOUR V's of Big Data
From traffic patterns and music downloads to web history and medical records, data is recorded, stored, and analyzed to enable the technology and services that the world relies on every day. But what exactly is big data, and how can these massive amounts of data be used?
As a leader in the sector, IBM data scientists break big data into four dimensions: Volume, Velocity, Variety and Veracity
Depending on the industry and organization, big data encompasses information from multiple internal and external sources such as transactions, social media, enterprise content, sensors and mobile devices. Companies can leverage data to adapt their products and services to better meet customer needs, optimize operations and infrastructure, and find new sources of revenue.
By 2015
4.4 MILLION IT JOBS
will be created globally to support big data, with 1.9 million in the United States
As of 2011, the global size of data in healthcare was estimated to be
150 EXABYTES
[ 161 BILLION GIGABYTES ]
By 2014, it's anticipated there will be
420 MILLION WEARABLE, WIRELESS HEALTH MONITORS
Variety
DIFFERENT FORMS OF DATA
4 BILLION+ HOURS OF VIDEO
are watched on YouTube each month
30 BILLION PIECES OF CONTENT
are shared on Facebook every month
400 MILLION TWEETS
are sent per day by about 200 million monthly active users
1 IN 3 BUSINESS LEADERS
don't trust the information they use to make decisions
Poor data quality costs the US economy around
$3.1 TRILLION A YEAR
27% OF RESPONDENTS
in one survey were unsure of how much of their data was inaccurate
Veracity
UNCERTAINTY OF DATA
Sources: McKinsey Global Institute, Twitter, Cisco, Gartner, EMC, SAS, IBM, MEPTEC, QAS
IBM.




*"Increasingly, scientific breakthroughs will be powered by advanced computing capabilities that help researchers manipulate and explore massive datasets.*

*The speed at which any given scientific discipline advances will depend on how well its researchers collaborate with one another, and with technologists, in areas of eScience such as databases, workflow management, visualization, and cloud computing technologies."*

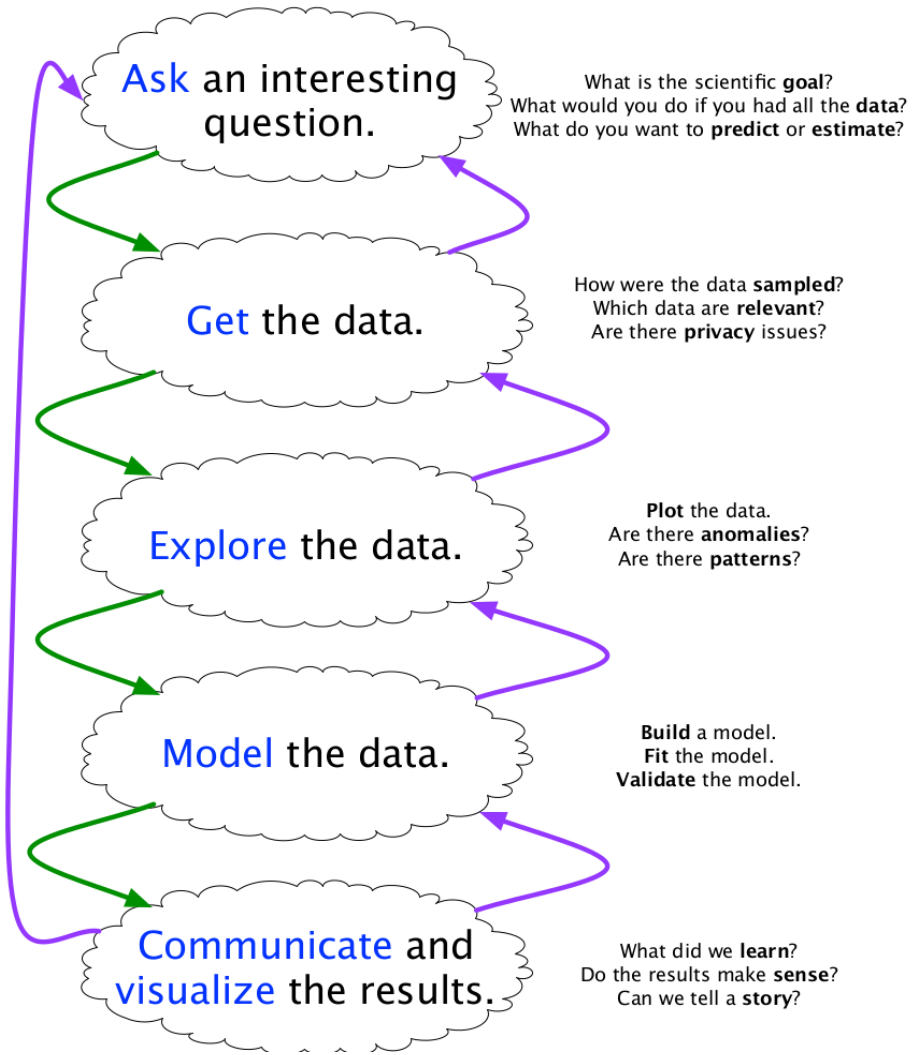
*"By 2018, the US could face a shortage of up to 190,000 workers with analytical skills."*

McKinsey Global Institute

*"The ability to take data – to be able to understand it, to process it, to extract value from it, to visualize it, to communicate it's going to be a hugely important skill in the next decades, not only at the professional level but even at the educational level for elementary school kids, for high school kids, for college kids. Because now we really do have essentially free and ubiquitous data."*

Hal Varian, Chief Economist, Google

# The data science pipeline


Ask an interesting question.
What is the scientific goal?
What would you do if you had all the data?
What do you want to predict or estimate?
Get the data.
How were the data sampled?
Which data are relevant?
Are there privacy issues?
Explore the data.
Plot the data.
Are there anomalies?
Are there patterns?
Model the data.
Build a model.
Fit the model.
Validate the model.
Communicate and visualize the results.
What did we learn?
Do the results make sense?
Can we tell a story?

In practice, the data science process involves several steps:

- Understanding and formalizing the problem
- Defining a model
- Collecting, cleaning and storing data
- Choosing a technology
- Analyzing the results
- Storytelling and visualization
- Iterate

## Understanding and formalizing

- What is it that I really want to answer?
- Why do I want an answer to this question?
- Do I understand the problem?

## Defining a model

- How do I answer?
- What are my assumptions?
- What statistical model do I consider?
- What algorithm shall I use?

## Collecting, cleaning and storing data

- What data do I need for fitting my model?
- How large this data should be?
- Where do I collect this data?
- Is data cleaning necessary?
- How do I store the data?

## Choosing a technology

- What tools do I need?
- What technology shall I use?
- Is a laptop enough, or shall I use a large-scale distributed system?
- How do I make my analysis reproducible?

## Analyzing the results

- How do I analyze the results of the model?
- How do I assess the significance of the results?
- To what do I compare?
- What are the conclusions?
- Is this convincing?
- Does this corroborate with previous studies or intuition?

## Storytelling and visualization

- How do I present my results?
- How do I make interpretable visualizations?
- How do I present my results to a non-technical audience?
- How do I make my results and conclusions as simple as possible, but not simpler?

## Iterate, iterate, iterate

- Is this conclusive?
- Am I going in the right direction?
- Shall I go back and define a new model?
- ... or collect new or more data?
- ... or use other tools?

# Your project this year

(Pick one!)

*Who will win the 2019 French Open?*

*Is global warming for real?*

*Is the University an example to follow in terms of electricity consumption?*

# Organization

# Instructors

This project is mentored by:

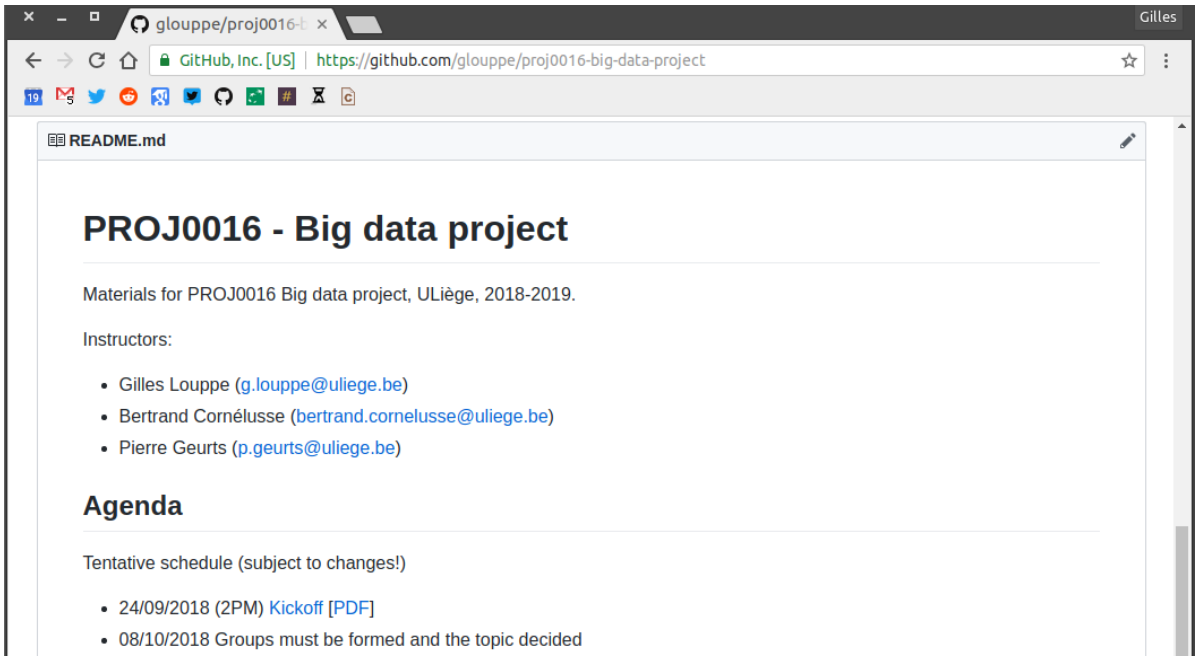
- Prof. Gilles Louppe (g.louppe@uliege.be)
- Prof. Bertrand Cornélusse (bertrand.cornelusse@uliege.be)
- Prof. Pierre Geurts (p.geurts@uliege.be)

Each group will be assigned a mentor. Feel free to contact your mentor for any question.



# Materials

Slides and other materials are available at github.com/glouppe/proj0016-big-data-project.



# Groups

The project is carried out in groups of 3 students.

The topic should be selected and the groups should be formed by October 8.

- Notify us by email.
- If you are alone, send us an email too!
- Register your group on the submission platform.

# Reviews

We will meet on every last Monday of the month to review your progress.

- Oral presentation of your ongoing progress.
  - 10mn
  - Q&A
  - Everyone must present at least once
- Short report
  - 4 pages max
  - To be submitted on the Thursday before the review day, on the submission platform.
  - Check deadlines for report submission.

The goal is to give you feedback on technical progress and project management.

# Seminars

The project is complemented by seminars by local and external speakers.

- Topics: big data, data science, visualization, communication, domain-specific presentations, etc.
- Presence at the seminars and intermediate reviews is mandatory.

# Final deliverables

The final deliverables of your project should consist in:

- a final comprehensive report of your study
- reproducible scripts for the collection, analysis and visualization of your data

# Agenda

- 24/09/2018 (2PM) Kick-off
- 24/09/2018 (4PM) Seminar: Written communication, Patricia Tossings
- 08/10/2018 Groups must be formed and the topic decided
- 29/10/2018 (2PM) Project review #1: Pre-analysis, literature review
- 26/11/2018 (2PM) Project review #2: Data collection #1
- 17/12/2018 (2PM) Project review #3: Data analysis #1
- 25/02/2019 (9AM) Project review #4: Data collection #2
- 25/03/2018 (9AM) Project review #5: Data analysis #2
- 29/04/2018 (9AM) Project review #6: Further improvements.
- 13/05/2018 (9AM) Project public defense and final report

Seminars will be announced later.

# Evaluation

# Evaluation

The evaluation will be based on:

- the intermediate review meetings (progress achieved, quality of project management) (6x 5%)
- the quality of the final report (15%)
- the quality of the final oral defense (15%)
- the overall study (40%)
    - the originality, methodology, clarity, reproducibility and technological choices of the solution will be mainly assessed.

We will notify your score individually after each intermediate review stage.

## Regularization

- Absence of a group at a review: 0 to this review for the group.
- Delay in submitting a report: -1% per day.
- Absence of a group member at a review: individual 0 for the review.
- Absence of a group member at a seminar: individual -5% on the total of the year.

## How to report

- One of the outcomes of the project is to learn how to communicate / report orally and in written form.
- You have to be on time so that we can provide feedback : reports on Thursday 23:59 before review. Hard deadline!
- Create your own template and always use the same for the intermediate review stages.
  - If you make incremental reports, make sure you highlight what is new.
  - If not, introduce a status of your past reports at the beginning.
- Use a strict methodology: follow the steps of slide 18.
  - briefly report what you did for each step.
  - provide approximate percentage of completion for each step.
- Identify which group member is responsible for what.
- For oral presentations, stick to the allocated time slot.
- Use recommendations of seminars on communication skills

## How to work efficiently

- Make small iterations first but try to go/project over all the steps.
- Write what you do. It will help you being on time for your reports.
- Share the work between group members and give precise responsibilities.
- Mandatory use of Github or alikes and share with your mentor.
- Mandatory use of a Trello board and share with your mentor.
- If you want to use a cloud based service to store data, run computations, etc: fine, but please report pros and cons and what guided your choice.

Let's get to work!