Data Science 101

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INSTITUTE FOR MACHINE
LEARNING AND ANALYTICS

Data Science 101 - Outline

- What is “Data Science ?”
- Key Skills for Data Scientists
- Data Science Work Flow
- Python for Data Science
- Case Study I: predicting supermarket sales

What is Data Science?

Simple Question: What is Data Science?

What is Data Science?

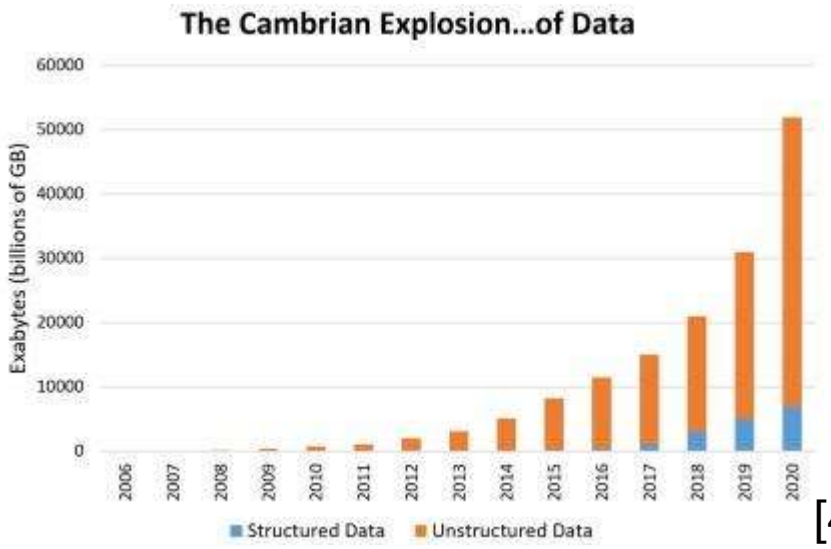
Simple Question: What is Data Science?

→ many different answers

(all right in some way)

What is Data Science?

Historic motivation



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Multiplying Factor	SI Prefix	Scientific Notation	Name
1 000 000 000 000 000 000 000 000	Yotta (Y)	10^{24}	1 septillion
1 000 000 000 000 000 000 000	Zetta (Z)	10^{21}	1 sextillion
1 000 000 000 000 000 000	Exa (E)	10^{18}	1 quintillion
1 000 000 000 000 000	Peta (P)	10^{15}	1 quadrillion
1 000 000 000 000	Tera (T)	10^{12}	1 trillion
1 000 000 000	Giga (G)	10^{9}	1 billion
1 000 000	Mega (M)	10^{6}	1 million
1 000	kilo (k)	10^{3}	1 thousand
0 001	milli (m)	10^{-3}	1 thousandth
0 000 001	micro (u)	10^{-6}	1 millionth
0 000 000 001	nano (n)	10^{-9}	1 billionth
0 000 000 000 001	pico (p)	10^{-12}	1 trillionth
0 000 000 000 000 001	femto (f)	10^{-15}	1 quadrillionth
0 000 000 000 000 000 001	atto (a)	10^{-18}	1 quintillionth
0 000 000 000 000 000 000 001	zepto (z)	10^{-21}	1 sextillionth
0 000 000 000 000 000 000 000 001	yocto (y)	10^{-24}	1 septillionth

[4]

What is Data Science?

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Historic motivation

Leads to many new questions:

- ***Where is this data coming from?***
- ***What are we going to do with it?***
- ***Who is going to do it?***

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Leads to many new questions:

- ***Where is this data coming from?***
  - ***Internet of Things (IoT: sensors every where)***
  - ***Industry 4.0 (connecting everything)***
  - ***Big Data (storing all the information you can in the hope generate gain)***
  - ***Social Media (and other internet services)***

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  - ***Analyze the past***
  - ***Predict the future (at least try to)***
  - ***Machine Learning (data driven computing)***
  - ***AI (what ever that is)***

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Biggest Buzz-Words in IT

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Leads to many new questions:

- ***Where is this data coming from?***
- ***What are we going to do with it?***
- ***Who is going to do it?*** → ***Data Science !***

What is Data Science?

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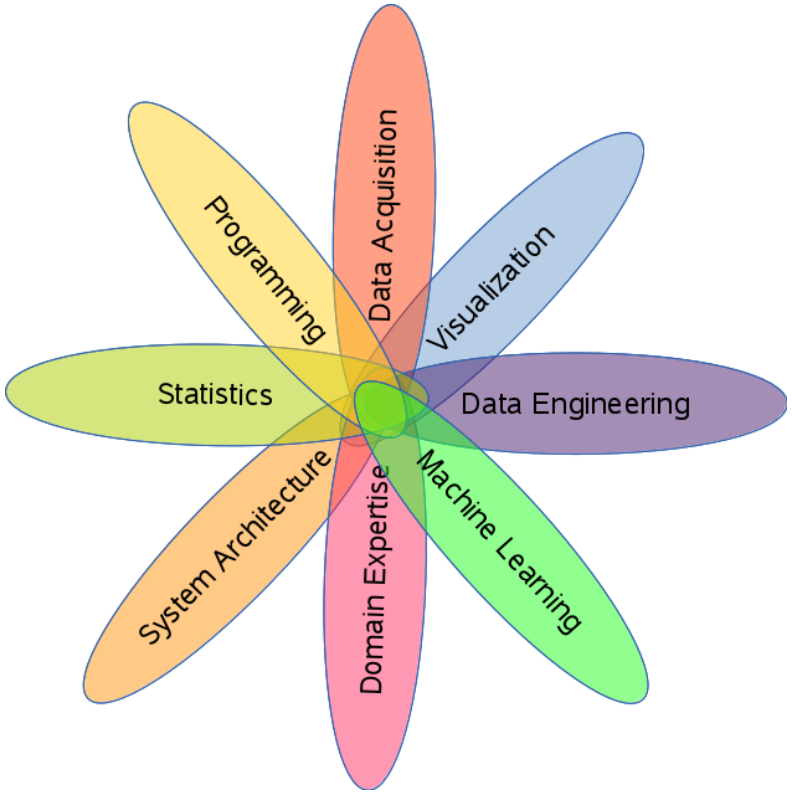
Motivation by tasks:

What is expected of Data Science?

What are typical tasks / applications?



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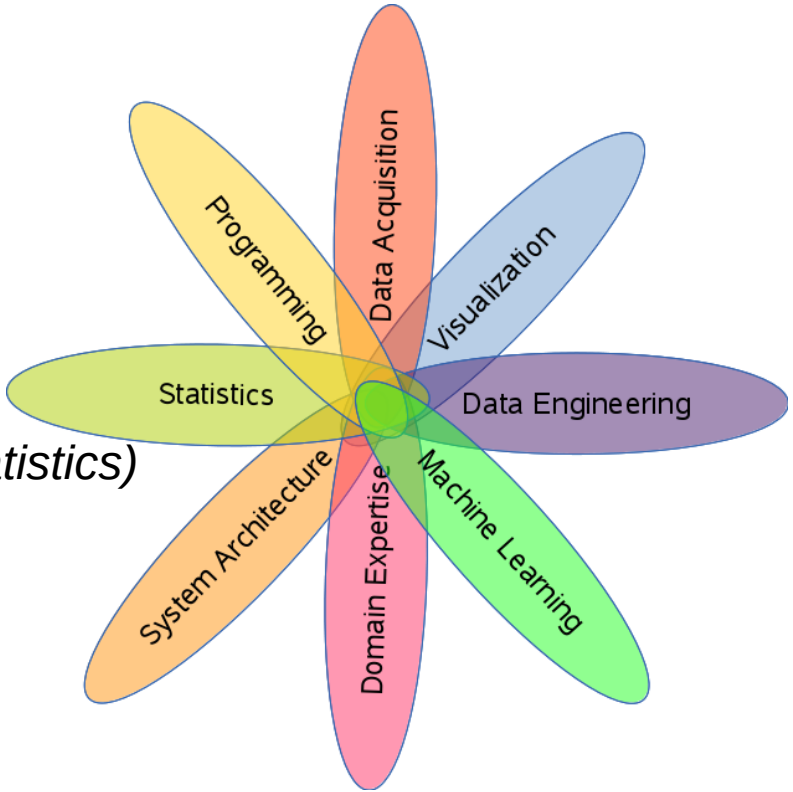
Typical Data Science Tasks:

- *Data Acquisition*
- *Data cleaning*
- *Storing data and making it accessible*
- *Selecting and pre-processing data*
- *Structuring and describing data (Descriptive Statistics)*
- *Exploration and Inference (Learning)*
- *Modeling and Abstraction*
- *Verification*
- *Visualization and Reporting*



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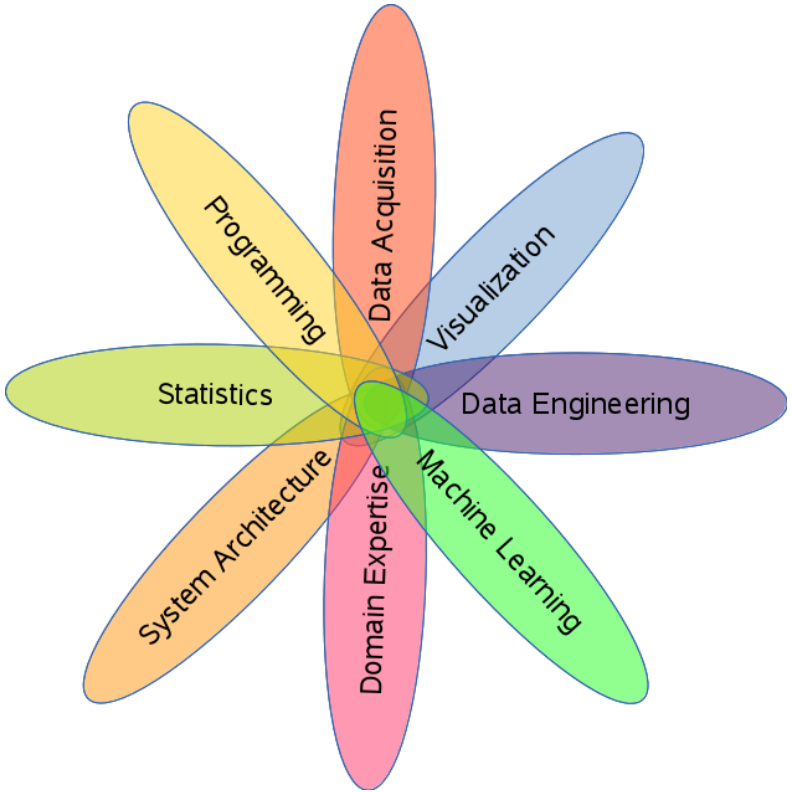
Motivation by tasks:

What is expected of Data Science?

What are typical tasks / applications?

→ **Data Science as mesh-up of many tasks and skills**



What is Data Science?

Data Science – Science of data?

Definition of Data:

Wikipedia:

Data (/ˈdeɪtə/ DAY-tə, /ˈdætə/ DA-tə, or /ˈdɑːtə/ DAH-tə) is a set of values of qualitative or quantitative variables; restated, pieces of data are individual pieces of information. Data is measured, collected and reported, and analyzed, whereupon it can be visualized using graphs or images. Data as a general concept refers to the fact that some existing information or knowledge is represented or coded in some form suitable for better usage or processing.

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Scientific perspectives at data:

- **Looking at Data like a Statistician, you see the world in terms of**
  - Variables (sets)
  - (joint) Distributions
  - Densities
  - Correlations
  - Likelihoods
  - Hypothesis

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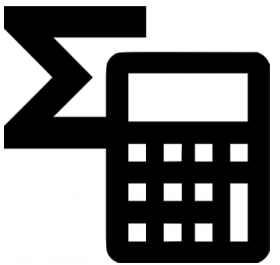
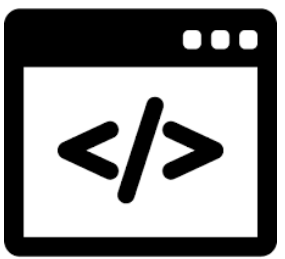
Scientific perspectives at data:

- **Looking at Data like a Mathematician, data forms**
  - Structures (Algebras, Sets, Groups, Graphs ...)
  - Spaces (i.e. high-dimensional Eucledian space)
  - Change (i.e. expressed in differential equations)
  - in practice: a lot of numerical optimization



- **Looking at Data like a Computer Scientist [Programmer]**
  - you think in data structures
  - algorithms and their efficiency
  - levels of abstraction
  - use cases (reusability)
  - parallelization



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Scientific perspectives at data:

- **Looking at Data like a Data Engineer, you see**
  - Databases
  - Storage
  - System Architectures

- **Looking at Data like a Hacker, you think about**
  - how to get the data (from devices, web databases, streams ...)
  - how to extract the data (from binaries, proprietary formats ...)
  - how to use data in unconventional ways

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Scientific perspectives at data:

- **Looking at Data like a Visual Artist, you think about**
  - how to visualize the key information hidden in the data
  - how to depict change
  - how to setting data into relation
  - how to present complex problems

- **Looking at Data as a Domain Expert**
  - Domain knowledge is important to set data in the correct meta-relation
    - i.e. helps to ask the "right" questions
    - helps to avoid trivial miss-interpretations (due to missing meta data/information)
  - But, domain knowledge also might be misleading and preventing data-driven discoveries

Key Skills for Data Science

Just be:

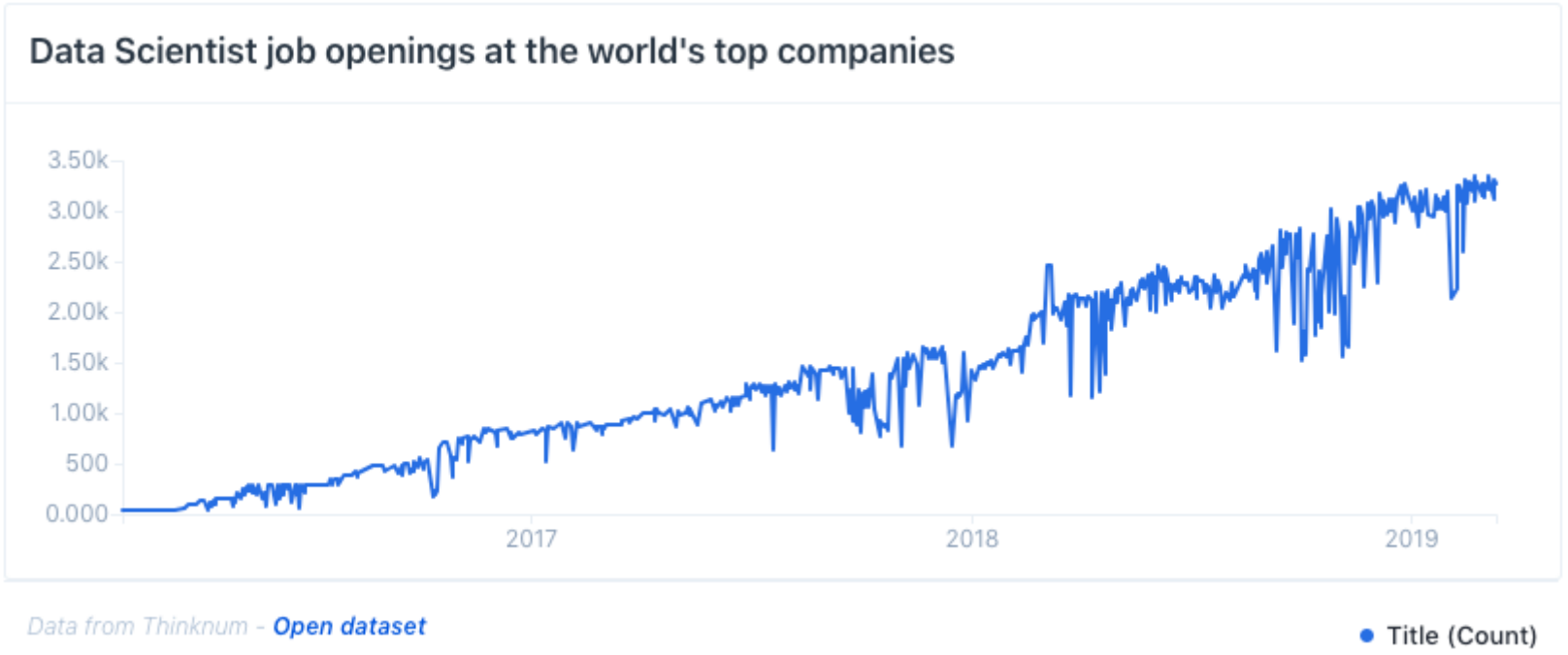
- A Statistician
- Mathematician
- Programmer
- Engineer
- Hacker
- Artist
- And Expert in many domains :-)

Key Skills for Data Science

On top of that:

- Very good communication skills
  - Presenting your work
  - Getting information from domain experts
- Be a quick learner
  - Adaption to new domains
  - Fast moving field (e.g. machine learning)

Job Opportunities Data Science



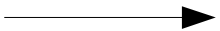
https://media.thinknum.com/articles/massive-increase-in-demand-for-data-science-jobs-in-2019/

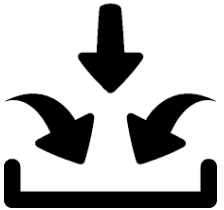
Data Science Workflow

Start: Hypothesis
Idea
Problem setting

Need: Basic understanding of the problem → Domain knowledge

Data Science Workflow



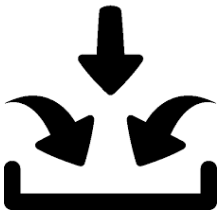


Start: Hypothesis

Collect Data

Data Science Workflow

Start: Hypothesis



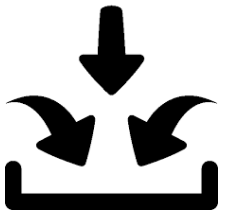
Collect Data

Exploratory Data Analytics (EDA)

- Visualize
- Pre-process
- clean

Data Science Workflow

Start: Hypothesis



Collect Data

Exploratory Data Analytics (EDA)

- Visualize
- Pre-process
- clean

Feature Engineering

Model building

- ML
- Statistic

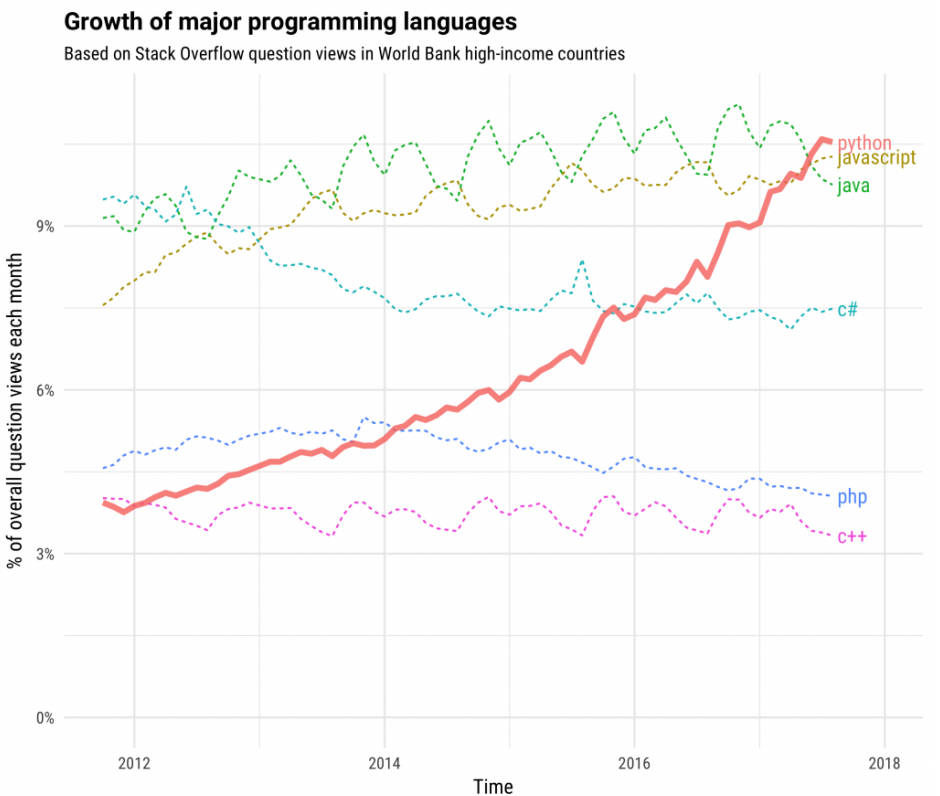
Python for Data Science

- We will use Python (more exactly tools with python interface) for this course

- Python is the most dominant language used in Data Science, Dats Analytics and Machine Learning to day

- Alternatives: R, Julia and Matlab

Python for Data Science



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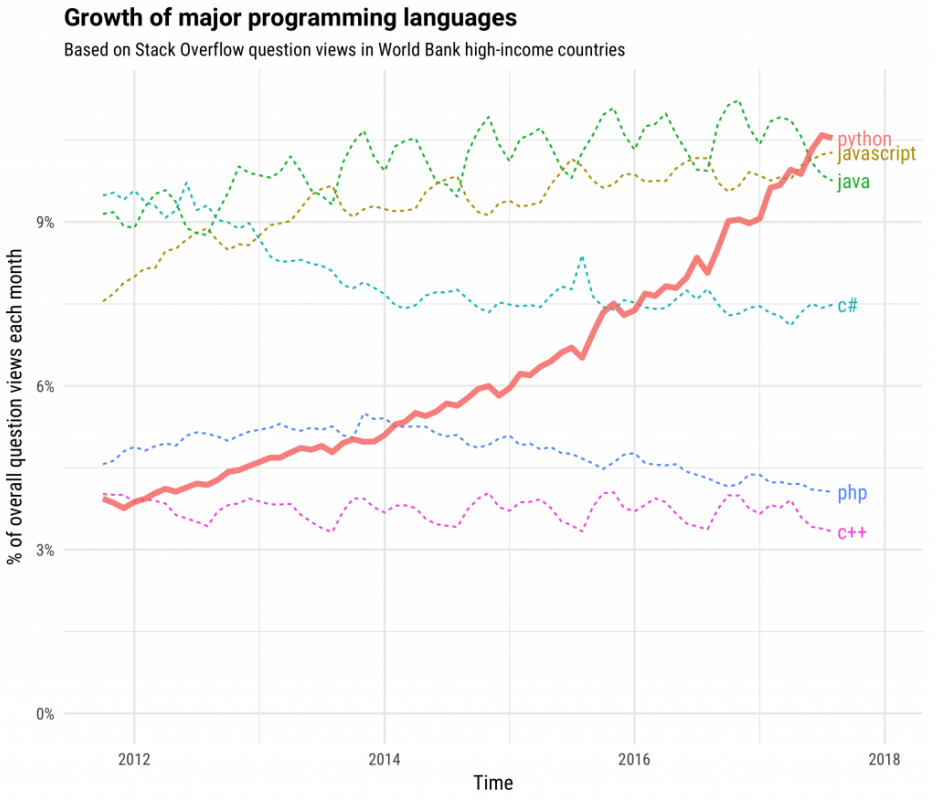
Python for Data Science

- Triggered by ML + Data Science
- Python pushes convergence of technologies:
  - HPC
  - Cloud
  - Big-Data



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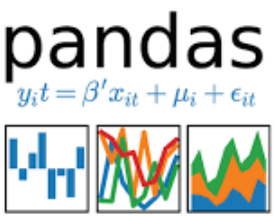
Python for Data Science

- Very low entry barrier (easy to learn)
- Quite universal in programming approaches
- Easy to interface existing high peformance libs
- Huge Community
- **Libraries !!!**
- **Python as „glue code“ for rapid development and markup**



Python for Data Science

https://www.anaconda.com/distribution/

Install on you local computer

- Easy installation on Linux/Mac/Win
  - See Howto in Moodle
  - User space install (no admin needed)
- Conda Python package management
  - Simple install/update/sharing of software
- All open source!

Python for Data Science

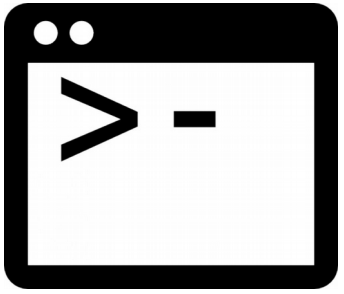
NOTE:

There are two versions of Python:

Python2 and Python3

Support for Python2 ended 31.12.19

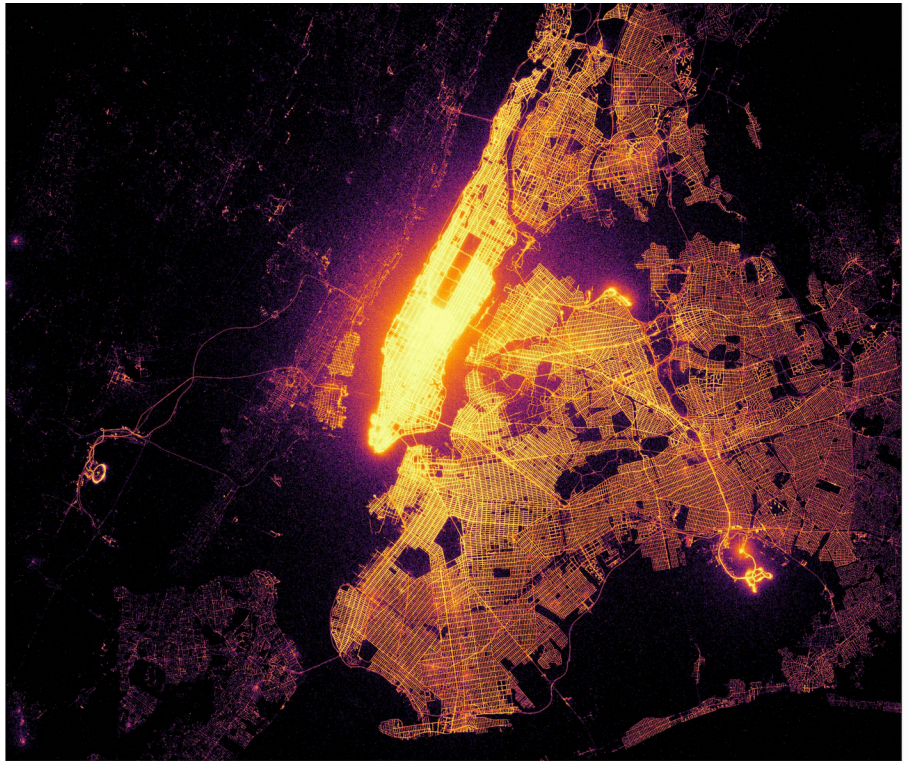
→ get started with Python3!



Interactive Python Introduction

→ Lab session Friday

Case Study I

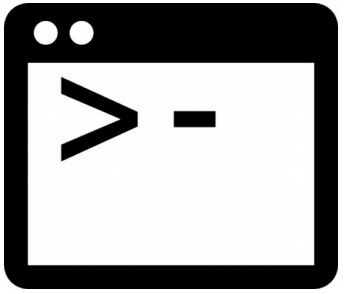


New York Taxi fare prediction

https://www.kaggle.com/c/new-york-city-taxi-fare-prediction/overview

Image: https://towardsdatascience.com/if-taxi-trips-were-fireflies-1-3-billion-nyc-taxi-trips-plotted-b34e89f96cfa

Case Study I



Case Study I:

→ demo on Colab

Literature

[1] free icons taken from https://www.flaticon.com

[2] https://stackoverflow.blog/2017/09/06/incredible-growth-python/

[3] https://datahack.analyticsvidhya.com/contest/practice-problem-bigmart-sales-prediction/

[4] https://www.eetimes.com/author.asp?section_id=36&doc_id=1330462#