

# INTRODUCTION TO DATA SCIENCE WITH PYTHON

## Introduction to Data Science

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2024-II



# Outline

1 Data Science Basic Concepts

2 What is to be a Data Scientist

3 Foundations of Python



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# What is Data Science?

- Data Science is an interdisciplinary field that uses scientific methods, processes, algorithms, and systems to extract knowledge and insights from structured and unstructured data.
  - It involves techniques and theories drawn from many fields within the context of mathematics, statistics, computer science, and information science.
  - Data Science process includes: data exploration, data cleaning, data analysis, visualization, building predictive models, and testing and deploying those models.
    - ↳ observation
    - ↳ question
    - ↳ test
    - ↳ analysis
  - It is primarily used to make decisions and predictions making of predictive causal analytics, prescriptive analytics, and machine learning.
    - ↳ best
    - ↳ deploy
  - It is about uncovering findings from data, and it's about surfacing hidden insights that can help enable companies to make smarter business decisions.
- Agile*



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- **Data Science** process includes: **data exploration**, **data cleaning**, **data analysis**, **visualization**, **building predictive models**, and **testing** and **deploying** those models.

- It is primarily used to **make decisions** and **strategic decision making** using **statistical** and **machine learning** causal analytics, prescriptive analytics, and machine learning.
- It is about **uncovering findings from data**, and it's **not** enough to **Dev Ops**, **ML Ops**, **LLM Ops**, **business decisions**, **error**, **learning**



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- ↗ Pivot  
↳ Only Foss



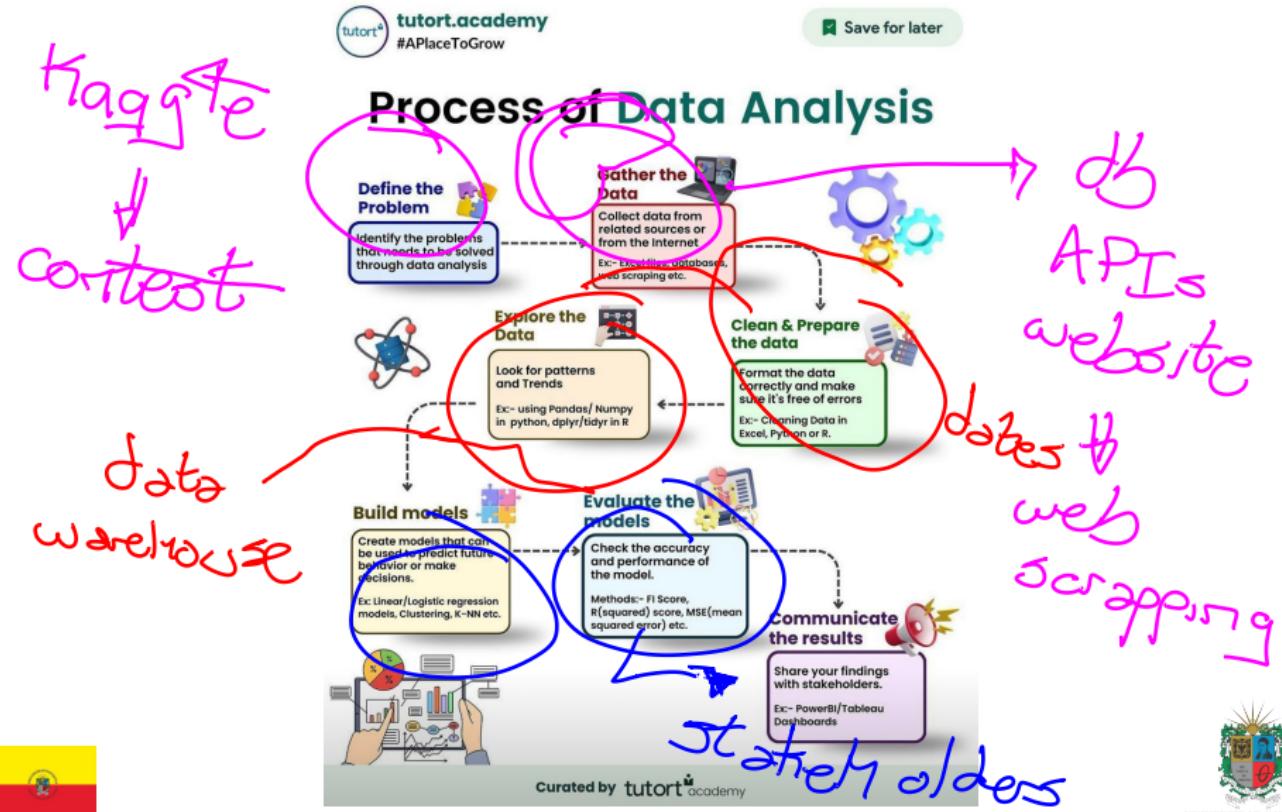
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*dark data*



## Process of Data Analysis



# Types of Data Analysis

**Forecasting**

## Different Types of Data Analysis

Averages  
Frequencies  
↓  
facts



### Descriptive Analysis

Summarizes basic data characteristics, like averages, frequencies, and distributions.

Answer "What happened?"



### Predictive Analysis

Forecasts future events or values based on historical data patterns.

Answer "What might happen next?"



### Diagnostic Analysis

Digs deeper, identifying factors influencing specific outcomes or trends.

Answer "Why did this happen?"



### Prescriptive Analysis

Recommends optimal actions based on predicted outcomes and potential impacts.

Answer "What should we do now?"



Alex

wrong factors

understand

the business

business intelligence



variables  
,  
what if?



# Data Systems & Big Data

- **Big Data** refers to ~~extremely large data sets~~ that may be analyzed computationally to reveal ~~patterns, trends, and associations~~, especially relating to ~~human behavior~~ and interactions.
- Data Systems are the mechanisms to store, retrieve, and send data. They are crucial for handling big data.
- Big Data is characterized by ~~Volume~~ (amount of data), ~~Velocity~~ (speed of data in and out), and ~~Variety~~ (range of data types and sources).
- Data Systems for Big Data include traditional databases (SQL), NoSQL databases (MongoDB, Cassandra), and distributed systems (Hadoop, Spark).



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*real-time*



# Data Systems & Big Data

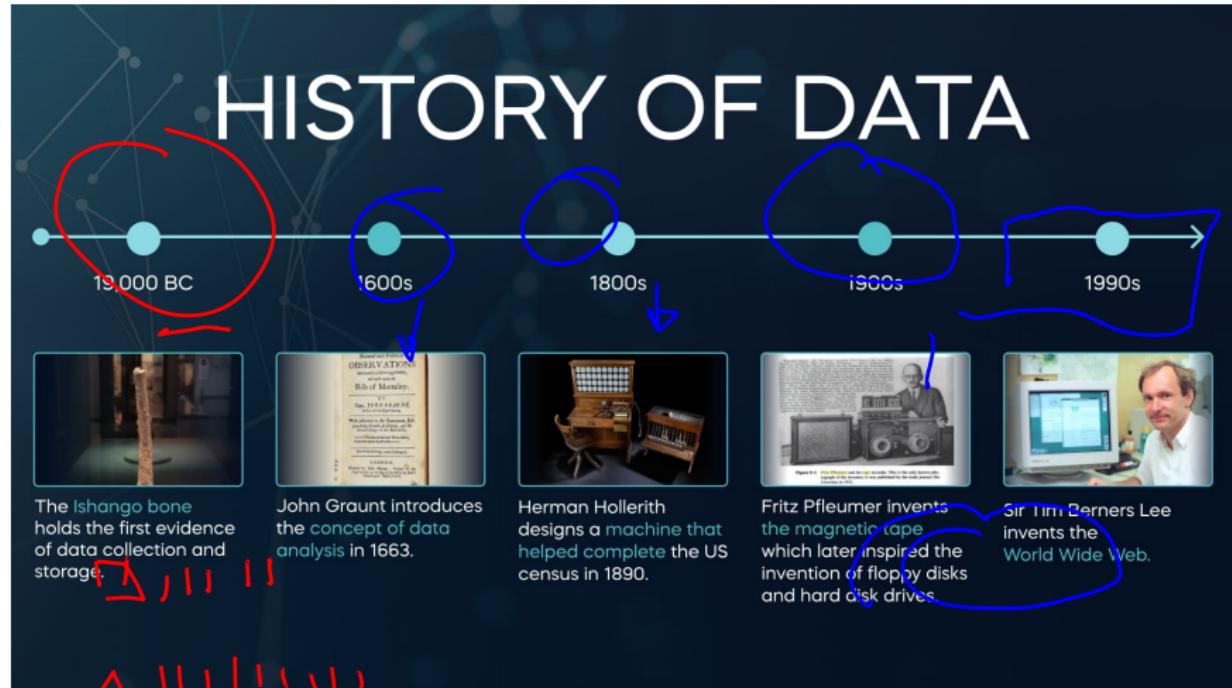
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• HDFS

Storage (drive)



# History of Data



# Data Lake Vs. Data Warehouse

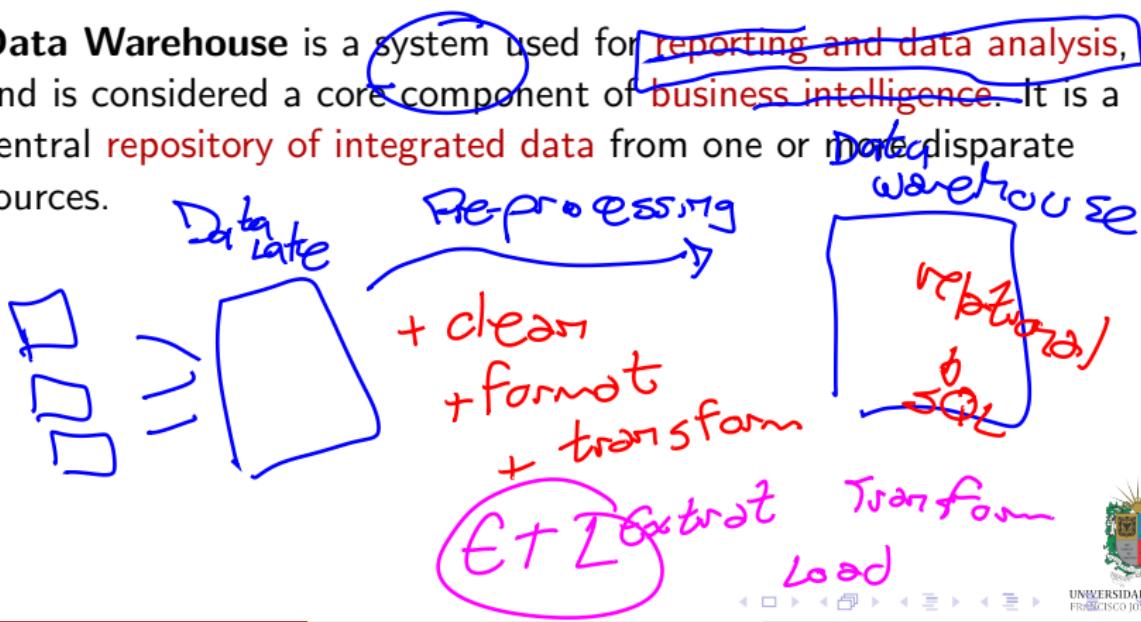
- **Data Lake** is a **storage repository** that holds a vast amount of **raw data** in its native format until it is needed. It is a place to **store every type of data in its native format** with no fixed limits on account size or file.

- **Data Warehouse** is a system used for reporting and data analysis, considered a core component of **business intelligence**. It is a **central repository of integrated data** from one or more disparate sources.



# Data Lake Vs. Data WareHouse

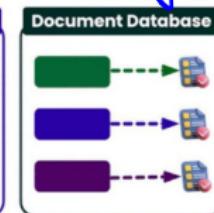
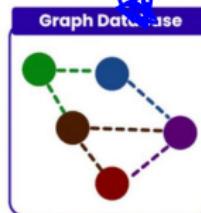
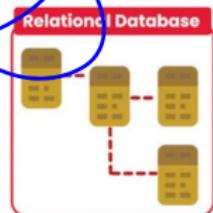
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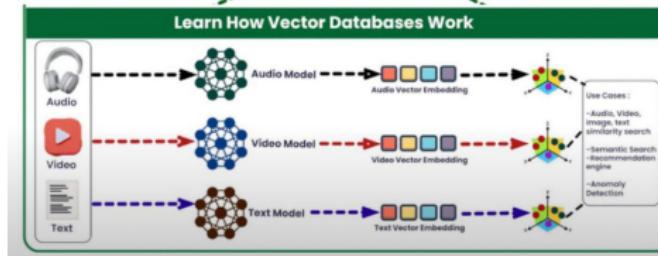
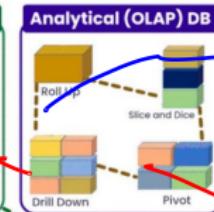
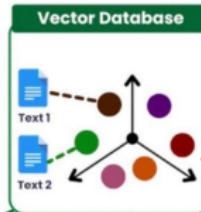
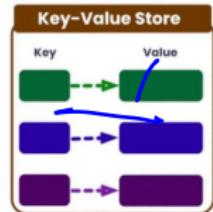
# Types of Database

~~NoSQL~~  
IMAP  
cols

How Many Types of Database  
Do You Know?



map  
dict  
hash



MongoDB

11

BSON

dog  
cat

car

OLAP



# Artificial Intelligence, Machine Learning, Deep Learning

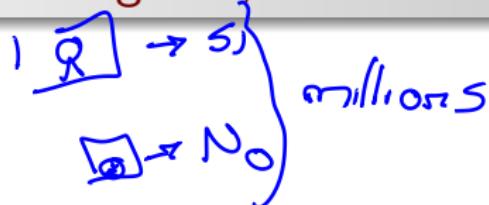
40<sup>s</sup> => Alan Turing



- **Artificial Intelligence (AI)** is the simulation of human intelligence processes by machines, especially computer systems.
- Machine Learning (ML) is a subset of AI that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.
  - ↳ play
  - ↳ cryptography
- Deep Learning (DL) is a subset of ML that uses neural networks with many layers. It is used to learn complex patterns in large amounts of data.



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*Learn with examples*

*Train*

*Machine can solve a problem*



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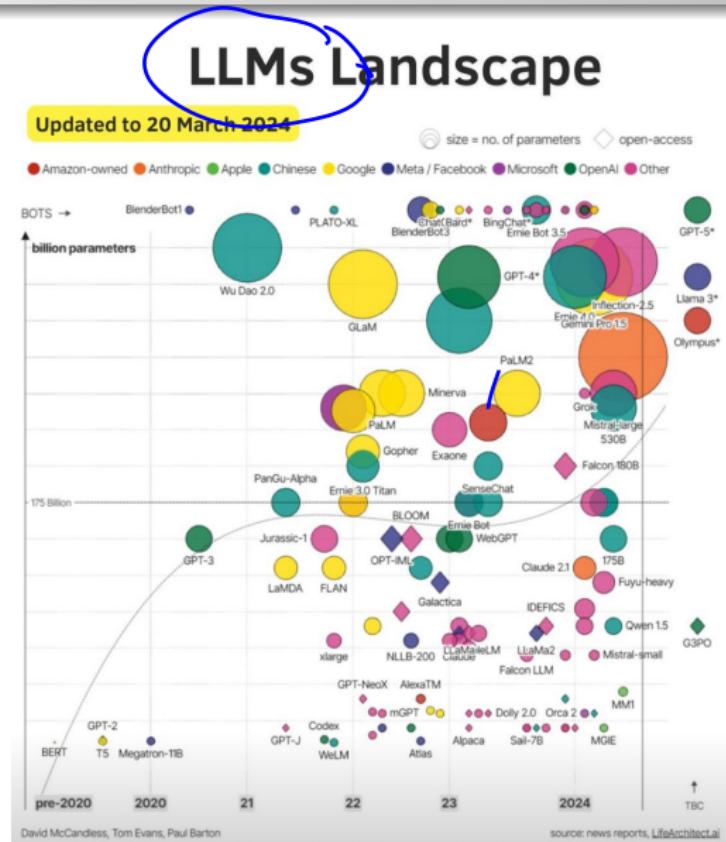


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Big Data



# Large Language Models



3 weeks  
2000<sup>0</sup>  
\$4 (6 P.D.)



# Data and MetaData

*Data Lake*

- **Data** refers to raw, unprocessed, and unorganized facts or details that alone might not make much sense or provide context.
- Metadata is data about data. It provides the who, what, where, when, why, and how of the data.
- Examples of metadata include file size, creation date, modified date, and file type for a digital file.
- Metadata helps in data discovery, organization, and interpretation.
- Metadata is crucial in data management practices like data governance, data cataloging, and data lineage.



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- Metadata is crucial in data management practices like **data governance**, **data cataloging**, and **dealing with A, B, C**.



↗ rows  
↗ empty  
disarr. button  
groups ↗ A  
↗ B  
↗ C



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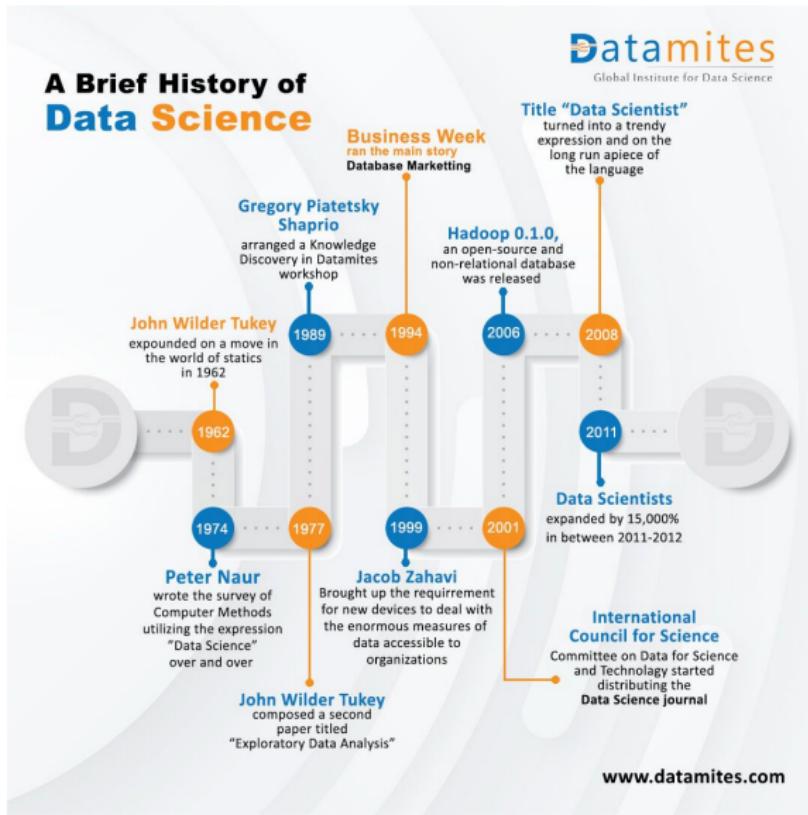


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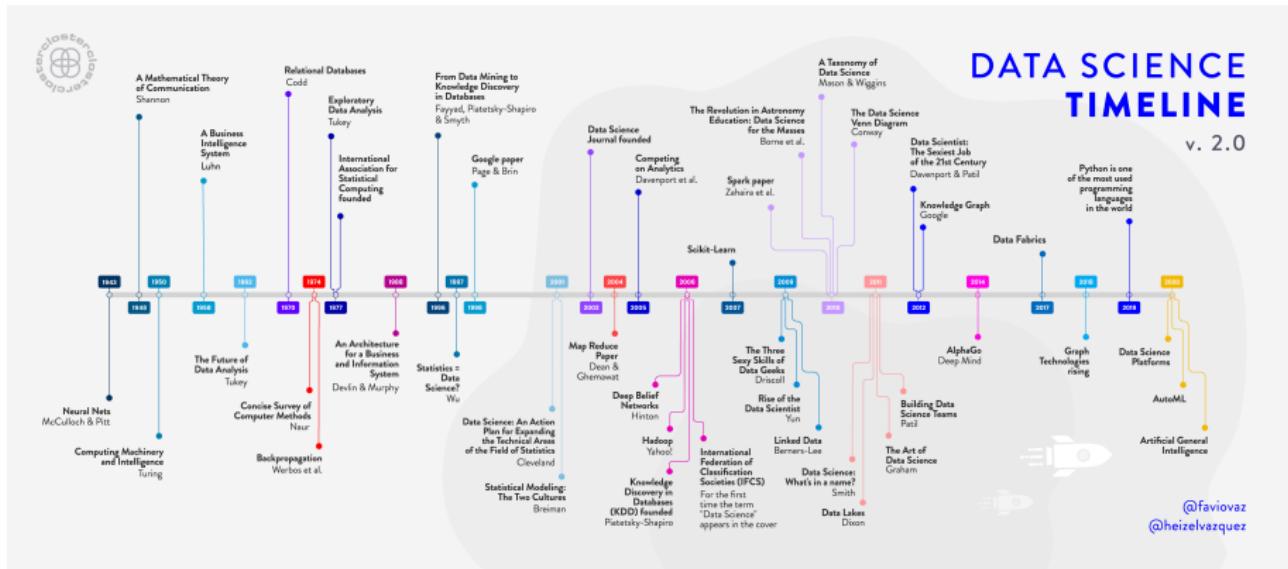
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# Brief History of Data Science



# Data Science Big Timeline



# Data Science in Industry

- **Data Science** is used in many industries to make decisions, optimize processes, and increase efficiency.
- **Data Science** is used in healthcare to predict patient outcomes, optimize treatment plans, and personalize medicine.
- **Data Science** is used in finance to detect fraud, predict stock prices, and automate trading.
- **Data Science** is used in retail to optimize pricing, forecast demand, and personalize marketing.
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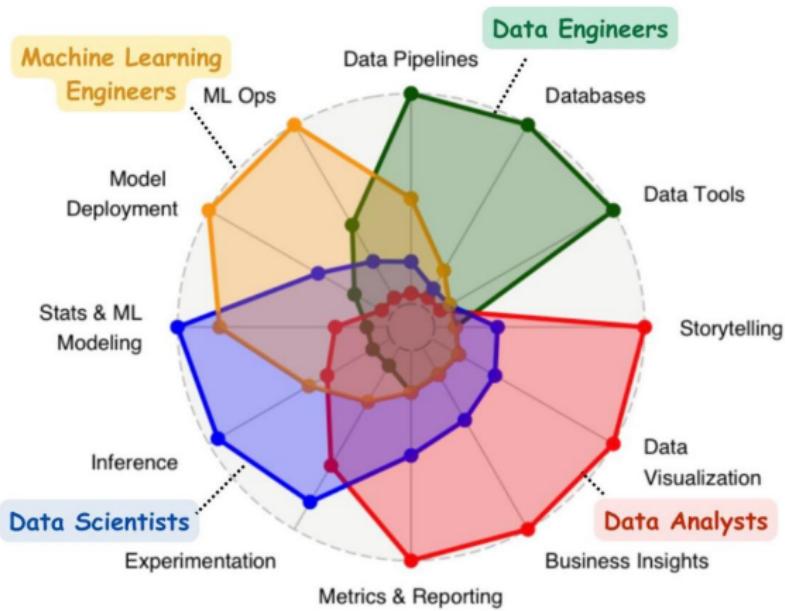
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# Tech Team — Roles

## Types of Data Roles - Where are you?



# Tech Team — Data Profiles

**WHICH PROFILE DESCRIBES YOU THE MOST?**

**ML ENGINEER**



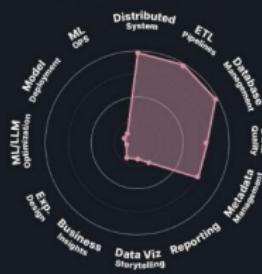
**DATA STEWARD**



**DATA SCIENTIST**



**DATA ENGINEER**



**ANALYTICS ENGINEER**



**DATA ANALYST**



# Data Scientist Responsibilities

- Collecting large sets of structured and unstructured data from **disparate sources**.
- Cleaning and validating the data to ensure **accuracy, completeness**, and uniformity.
- Analyzing the data to identify **patterns** and trends.
- Interpreting the data to discover solutions and **opportunities**.
- Communicating findings to stakeholders using **visualization** and other means.
- Developing, prototyping, and implementing **machine learning models**.
- Staying current on techniques and tools in the field, and continually **improving skills**.



# Artificial Intelligence Tech Ecosystem

## AI Infrastructure Tools open source

### AI FRAMEWORKS, TOOLS & LIBRARIES



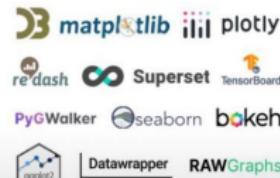
### AI MODELS



### LOGGING & MONITORING



### VISUALIZATION



### SEARCH



### COLLABORATION



@alexwang

# Data Science Python Tech Ecosystem

## Life is Short, I Use Python

<b>Data Manipulation</b> 			<b>Data Visualization</b> 		
<b>Statistical Analysis</b> 			<b>Machine Learning</b> 		
<b>Natural Language Processing</b> 			<b>Database Operations</b> 		
<b>Time Series Analysis</b> 			<b>Web Scraping</b> 		



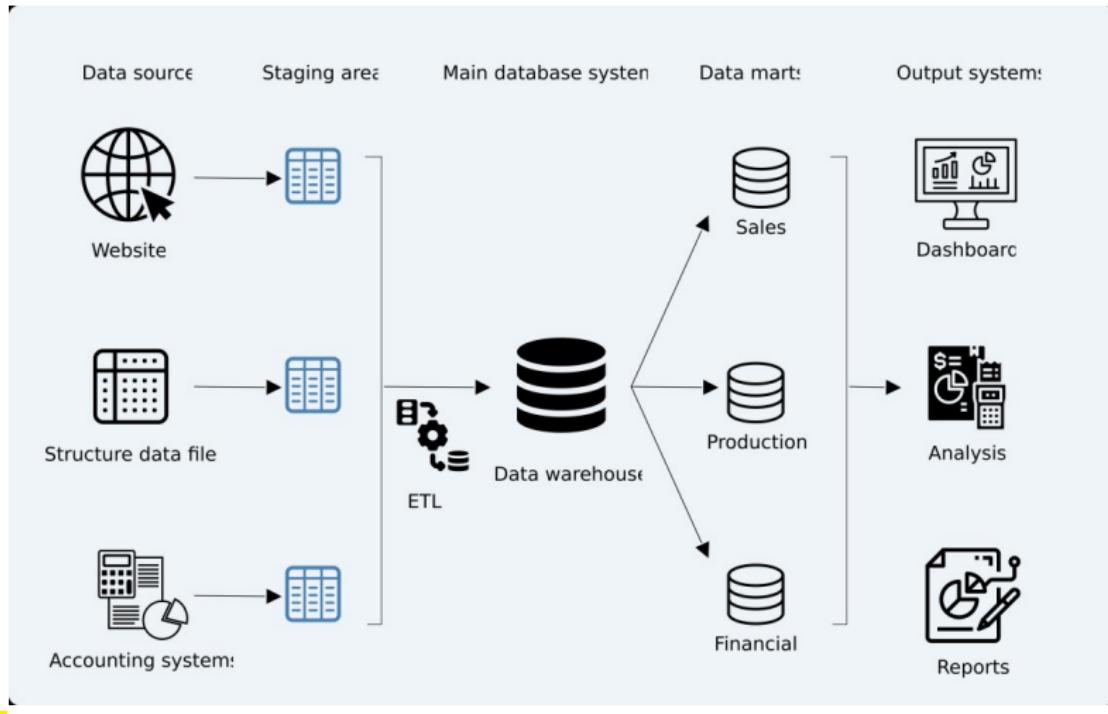
# Data Sources and Formats

## Data Definition Framework

		Data Format	
		Structured	Unstructured
Data Source	Internal	 <p><b>Human-Generated</b></p> <ul style="list-style-type: none"> <li>Survey ratings</li> <li>Aptitude testing</li> </ul> <p><b>Machine-Generated</b></p> <ul style="list-style-type: none"> <li>Web metrics from Web logs</li> <li>Product purchase from sales Records</li> <li>Process control measures</li> </ul>	    <p><b>Human-Generated</b></p> <ul style="list-style-type: none"> <li>Emails, letters, text messages</li> <li>Audio transcripts</li> <li>Customer comments</li> <li>Voicemails</li> <li>Corporate video/communications</li> <li>Pictures, illustrations</li> <li>Employee reviews</li> </ul>
	External	 <p><b>Human-Generated</b></p> <ul style="list-style-type: none"> <li>Number of Retweets, Facebook likes, Google Plus +1s</li> <li>Ratings on Yelp</li> <li>Patient ratings</li> </ul> <p><b>Machine-Generated</b></p> <ul style="list-style-type: none"> <li>GPS for tweets</li> <li>Time of tweet/updates/postings</li> </ul>	<p><b>Human-Generated</b></p> <ul style="list-style-type: none"> <li>Content of social media updates</li> <li>Comments in online forums</li> <li>Comments on Yelp</li> <li>Video reviews</li> <li>Pinterest images</li> <li>Surveillance video</li> </ul>



# Data Pipelines



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# Basic Definitions in Python

- **Python** is a **high-level**, **interpreted**, and **general-purpose** programming language.
- **High-level** means that **Python** is designed to be easy to read and write.
- **Interpreted** means that **Python** code is executed line by line, rather than being compiled into machine code.
- **Weakly typed** means that **Python** does not require you to declare the type of a variable.
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# Popular Developer Tools

**Life is Short, Use Dev Tools**



<b>Development Env</b>	<b>Diagramming</b>
VS Code   Visual Studio   IntelliJ IDEA   Notepad++   Vim   PyCharm   Jupyter Notebook	draw.io   excalidraw   mindmap   Mermaid   PlantUML   Microsoft Visio   Miro
<b>AI Tools</b>	<b>Hosting &amp; Deployment</b>
ChatGPT   GitHub Copilot   Tabnine   Claude   ollama   Midjourney   Stable Diffusion	aws   AWS   Cloudflare   Git Hub   Fly.io   Heroku   Digital Ocean
<b>Code Quality</b>	<b>Security</b>
Jest   ESLint   Selenium   sonarQube   FindBugs   Checkstyle	1Password   LastPass   OWASP   snyk   Nmap
<b>Note-taking</b>	<b>Design</b>
Notion   Markdown   Obsidian   Roam   Logseq   Tiddly Wiki	Figma   Sketch   Adobe Illustrator   Canva   Adobe Photoshop



# Virtual Environments

- **Virtual environments** are a way to create isolated spaces on your computer for **Python projects**.
- **Virtual environments** allow you to **install packages** and **dependencies** for a specific project without affecting other projects.
- **Virtual environments** are created using the **venv** module, which is included in the Python standard library.
- **Virtual environments** are activated using the **source** command in the terminal.
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# Variables and Memory Management

## Variables Definition

**Variables** are used to store data values. Python has no command for declaring a variable. A variable is created the moment you first assign a value to it.



# Conditionals

## Definition

**Conditionals** are used to execute different code blocks based on *different conditions*.

## Nested Conditionals

**Nested conditionals** are conditionals that are *inside* other conditionals.

## Elif Conditionals

**Elif conditionals** are used to check *multiple conditions*.



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# Loops and Range

## Loops Definition

**Loops** are used to execute a block of code *multiple times*.

## Range Definition

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The **range function** is used to generate a sequence of numbers.



# Lists

## Definition

A **list** is a collection of items that are *ordered* and *changeable*. **Lists** are defined by enclosing the items in square brackets.

### PYTHON LIST METHODS

- `.append( burger )` →
- `.count( burger )` → 2
- `.copy()` →
- `.index( French fries )` → 2
- `.reverse()` →
- `.remove( French fries )` →
- `.insert( 1, soda )` →
- `.pop( 1 )` →
- `.pop()` →



# Dictionaries

## Definition

A **dictionary** is a collection of items that are *unordered*, *changeable*, and *indexed*. Dictionaries are defined by enclosing the items in curly braces.



# Sets and Tuples

## Definition Sets

A **set** is a collection of items that are *unordered* and *unindexed*. **Sets** are defined by enclosing the items in curly braces.

## Definition Tuples

A **tuple** is a collection of items that are *ordered* and *unchangeable*. **Tuples** are defined by enclosing the items in parentheses.



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# Lists Comprehensions

## Definition

**List comprehensions** provide a concise way to create lists. Common applications are to make *new lists* where each element is the result of some operation applied to each member of another sequence or iterable, or to create a subsequence of those elements that satisfy a certain condition.



# Functions

## Definition

A **function** is a block of code that only runs when it is called. You can pass data, known as parameters, into a function. A **function** can return data as a result.

## Type of Functions

- **Built-in Functions**
- **User-defined Functions**
  - Variadic Functions
  - Recursive Functions



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# Python Iterators

## Definition

An **iterator** is an object that contains a *countable number of values*. An **iterator** is an object that can be iterated upon, meaning that you can traverse through all the values.

## Maps

The **map function** is used to apply a function to *all the items* in an input list.

## Filters

The **filter function** is used to *select items* from an input list that meet a certain condition.



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# Lambda Functions

## Definition

A **lambda function** is a small anonymous function. A **lambda function** can take any number of arguments, but can only have one expression.



# Classes and Objects

## Definition

Python is an *object-oriented programming* language. Almost everything in Python is an **object**, with its *properties* and *methods*. A **class** is like an object constructor, or a “blueprint” for creating objects.



# Outline

- 1 Data Science Basic Concepts
- 2 What is to be a Data Scientist
- 3 Foundations of Python



# Thanks!

## Questions?



Repo: <https://github.com/EngAndres/ud-public/tree/main/courses/data-science-introduction>

