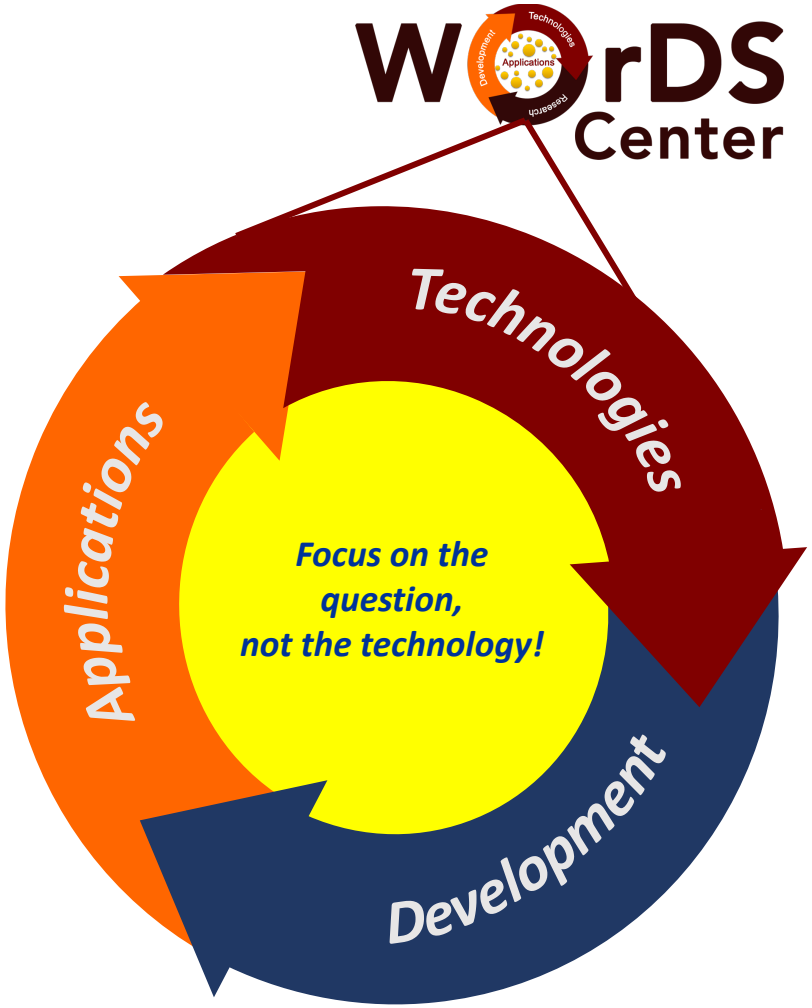
A Short Introduction to Data Science and its Applications

Aug 11, 2023

Shweta Purawat

Director of Product Management
Workflows for Data Science Center of Excellence and WIFIRE Lab
University of California, San Diego



Workflows for Data Science Center of Excellence at SDSC

http://WorDS.sdsc.edu

Research and Development Mission:

- *Methodology and tool innovation to enable collaborative workflow-driven science*
- *Create solutions on top of big data and advanced computing platforms.*

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UC San Diego
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“Big” Data, Data Science and “AI”, Cyberinfrastructure, and Their Applications

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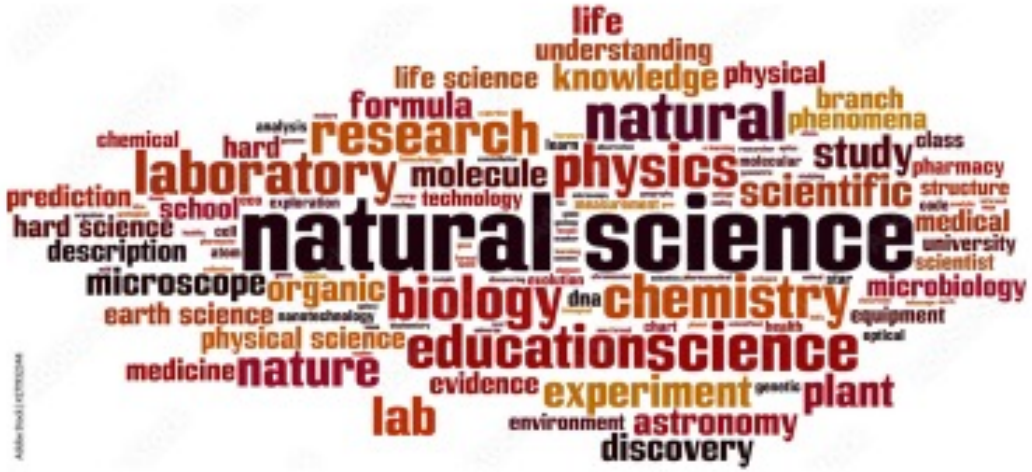
Knowledge Management for Scientific Application Using Polystore



Subhasis Dasgupta, Ph.D.

Assistant Scientist, University of California San Diego

Spatial Data Science for COVID-19 analysis and modeling.

Johnny Lei
Computational and Data Researcher,
UCSD

What is Data Science?

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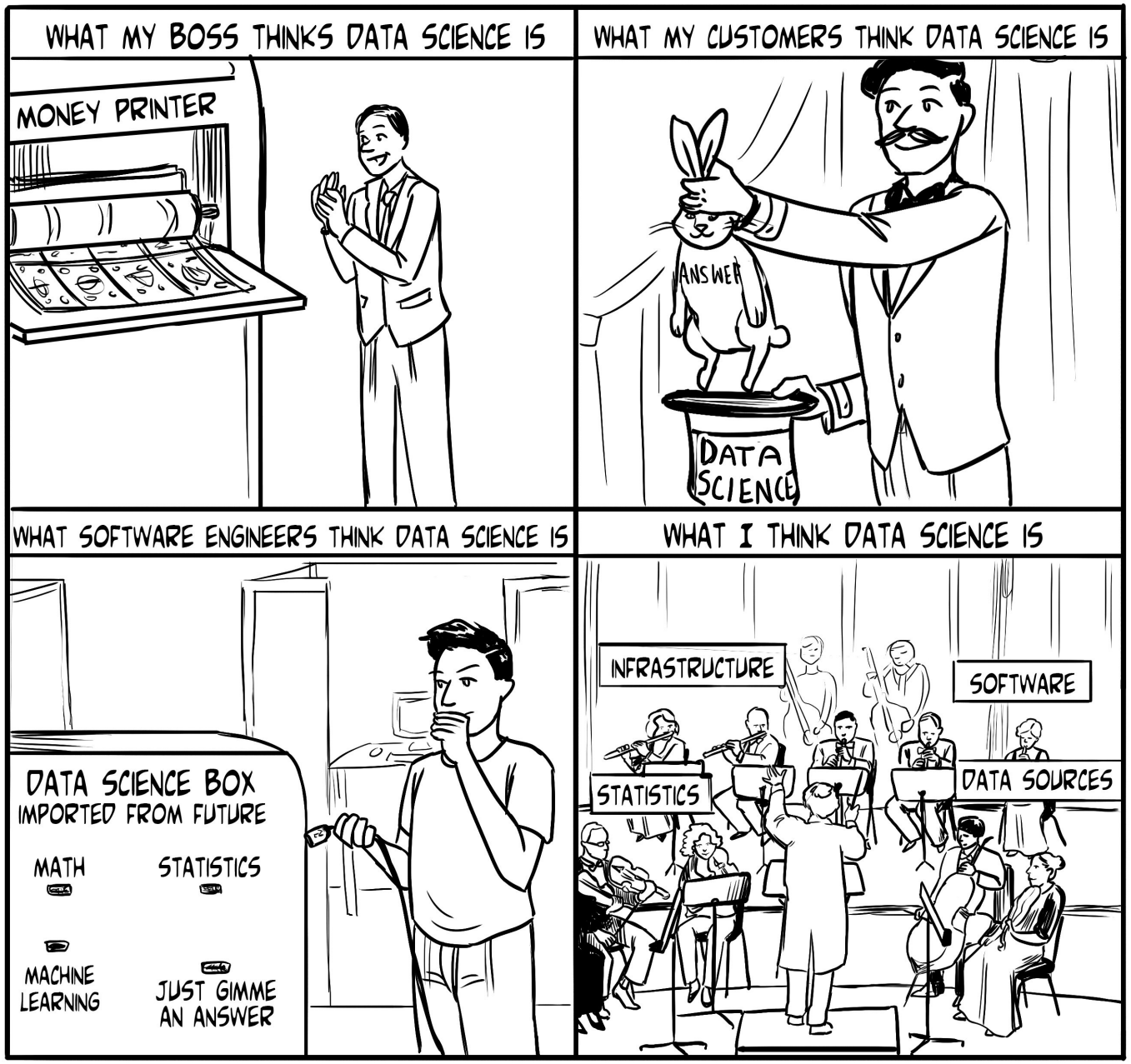
İlkay Altıntaş, PhD (ialtintas@ucsd.edu)



So, what exactly is data science?

Image Source:

Think Like a Data Scientist,
a book by Brian Godsey.
https://www.manning.com/books/think-like-a-data-scientist

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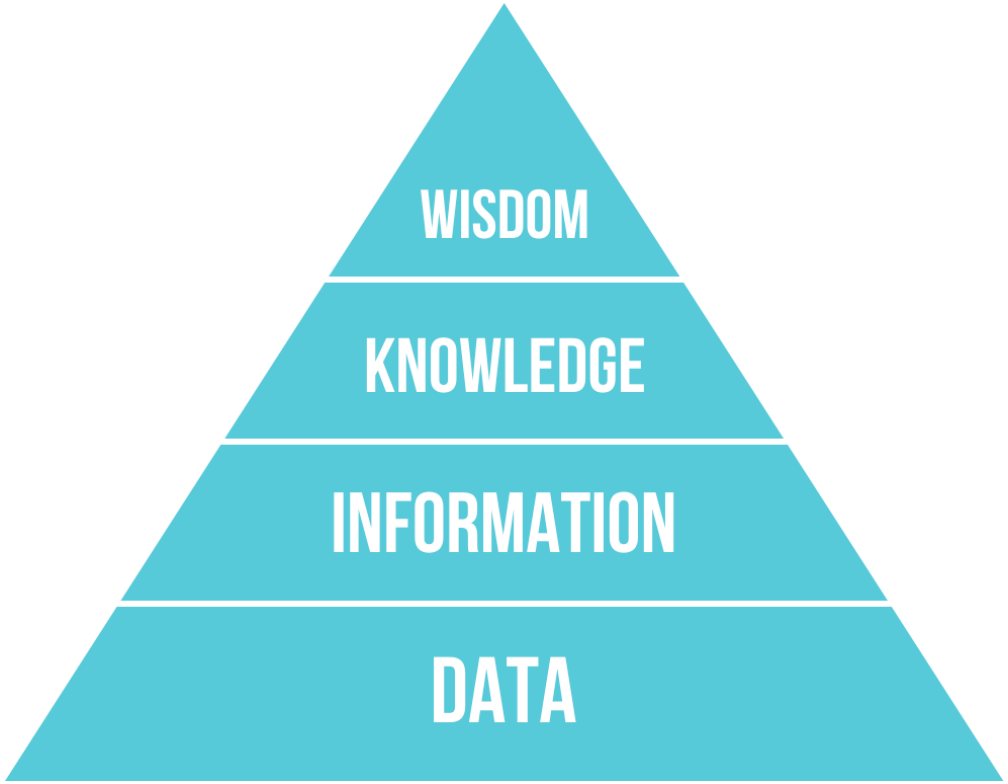
What is data?



data: */ˈdadə,ˈdādə/*
facts and statistics collected together for reference or analysis.

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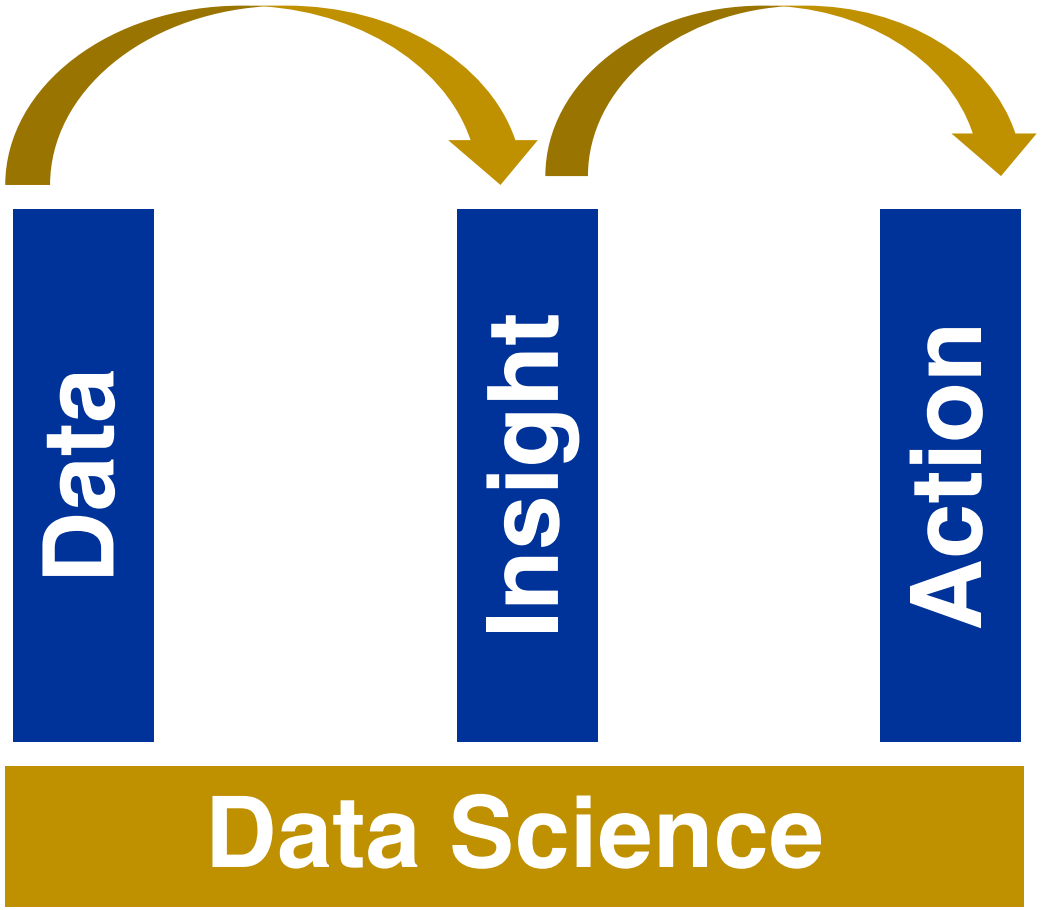
The Ultimate Goal of Data Science



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Where is the science in data science?

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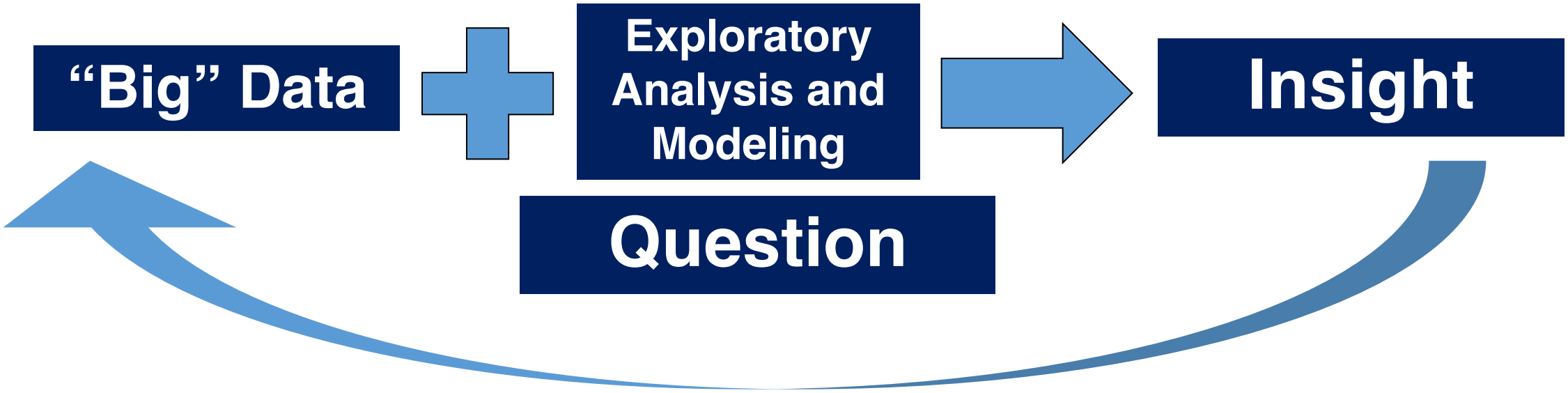
Generating Insights from Data



Insight = Data Product

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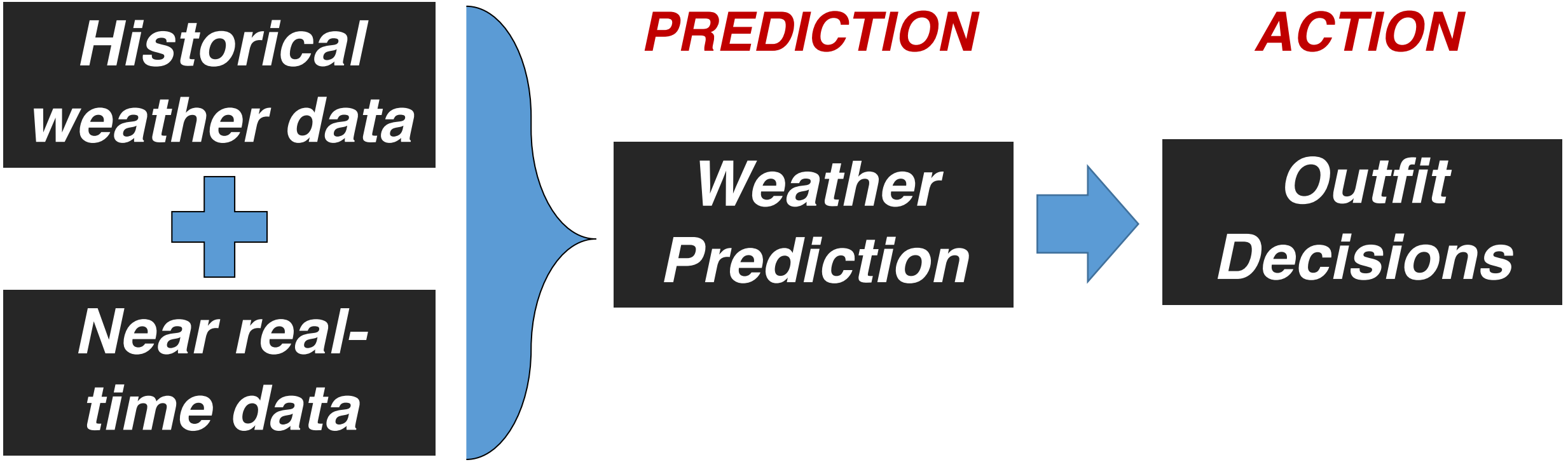
Example: Weather Forecast to Actions



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Systems and models

that help us to

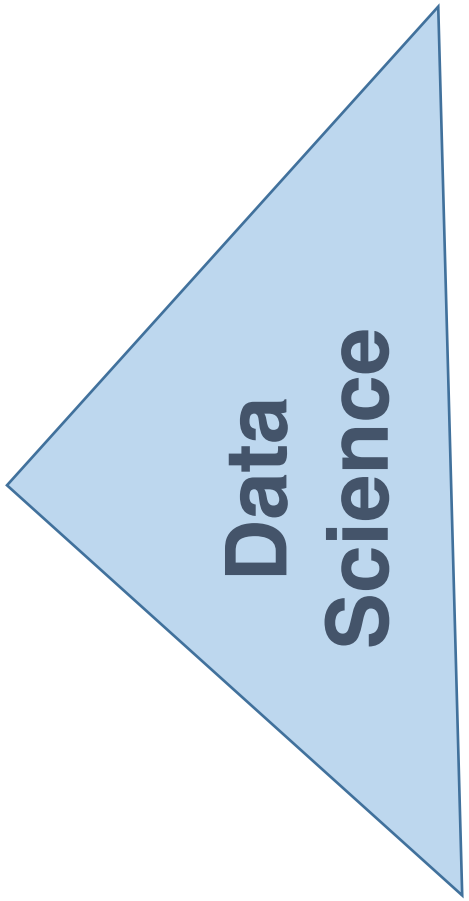
understand data

in order to

gain insights *and*

make predictions

leading to action for impact.



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Data Science is “IMPACT” Science!

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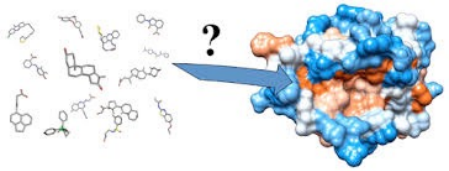
Data Science in Everyday Life

- Finance
- Healthcare
- Entertainment
- Travel
- Shopping
- …

Personalized Precision Medicine

Smart Manufacturing

Computer-Aided Drug Discovery



Smart Cities

Disaster Resilience and Response

Smart Grid and Energy Management

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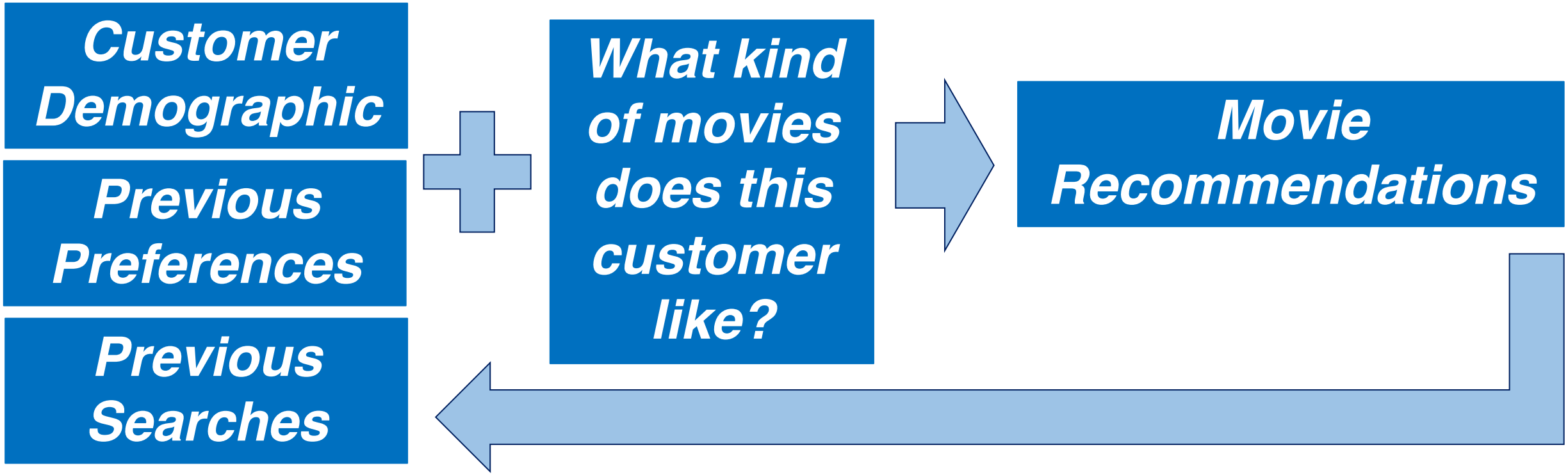
Entertainment Industry: Movie Recommendations



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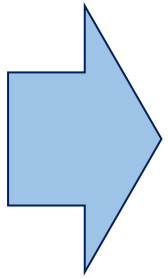
Entertainment Industry: Movie Recommendations

PREDICTION

What kind of movies do customers like?



ACTION

What movies to produce and market?

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Example Industry: Smart Healthcare

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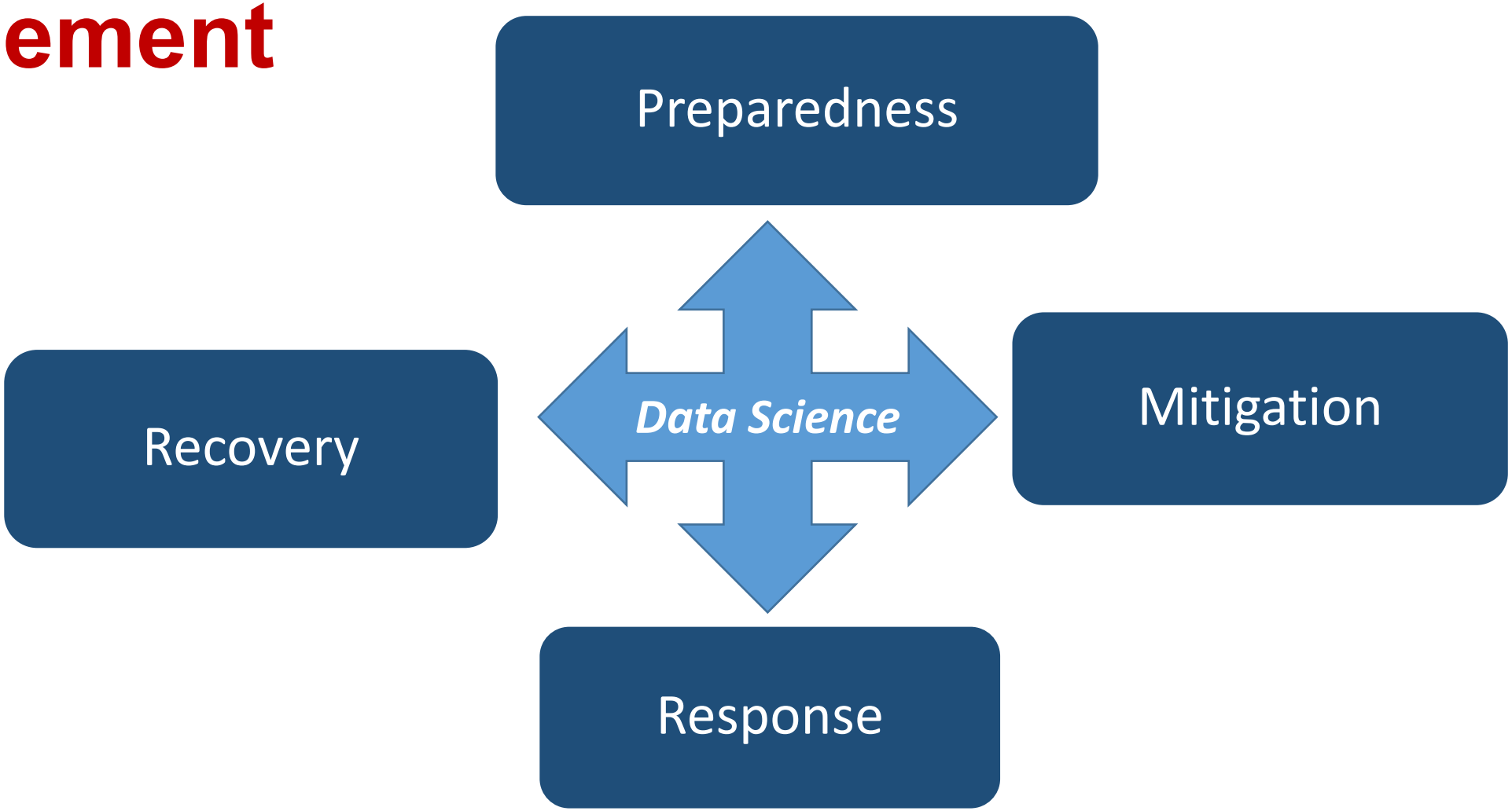
Safety: Data Science for Emergency Management



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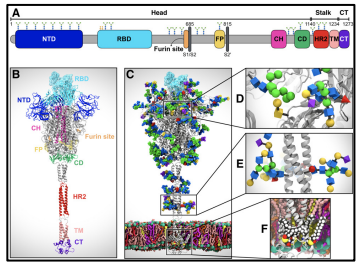
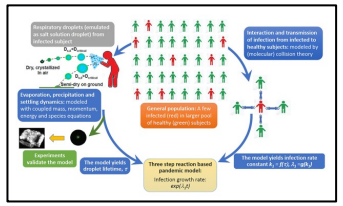
Data Science Impact to Fight COVID-19

- Disease data
- Virus models
- Wearables
- Public health surveys
- Social media
- Contact data
- …





- Spread modeling
- Understanding the virus
- Drug design
- Vaccine development
- Economical impact
- Mental health
- …

https://www.tacc.utexas.edu/-/sugar-coating-locks-and-loads-coronavirus-for-infection

https://phys.org/news/2020-06-respiratory-droplet-motion-evaporation-covid-type.html

- Decision-support
- Policy making
- Vaccine
- Treatment
- Cure
- …

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Why are we talking about data science and AI now?

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Why is data science so popular?

The Computing Continuum

IoT/Edge → Fog → HPC/Cloud/Instrument

Size	Nano	Micro	Milli	Server	Fog	Campus	Facility
Example	Adafruit Trinket	Particle.io Boron	Array of Things	Linux Box	Co-located Blades	1000-node cluster	Datacenter
Memory	0.5K	256K	8GB	32GB	256G	32TB	16PB
Network	BLE	WiFi/LTE	WiFi/LTE	1 GigE	10GigE	40GigE	N*100GigE
Cost	$5	$30	$600	$3K	$50K	$2M	$1000M

Count = 10^9 Size = 10^1 … Count = 10^1 Size = 10^9

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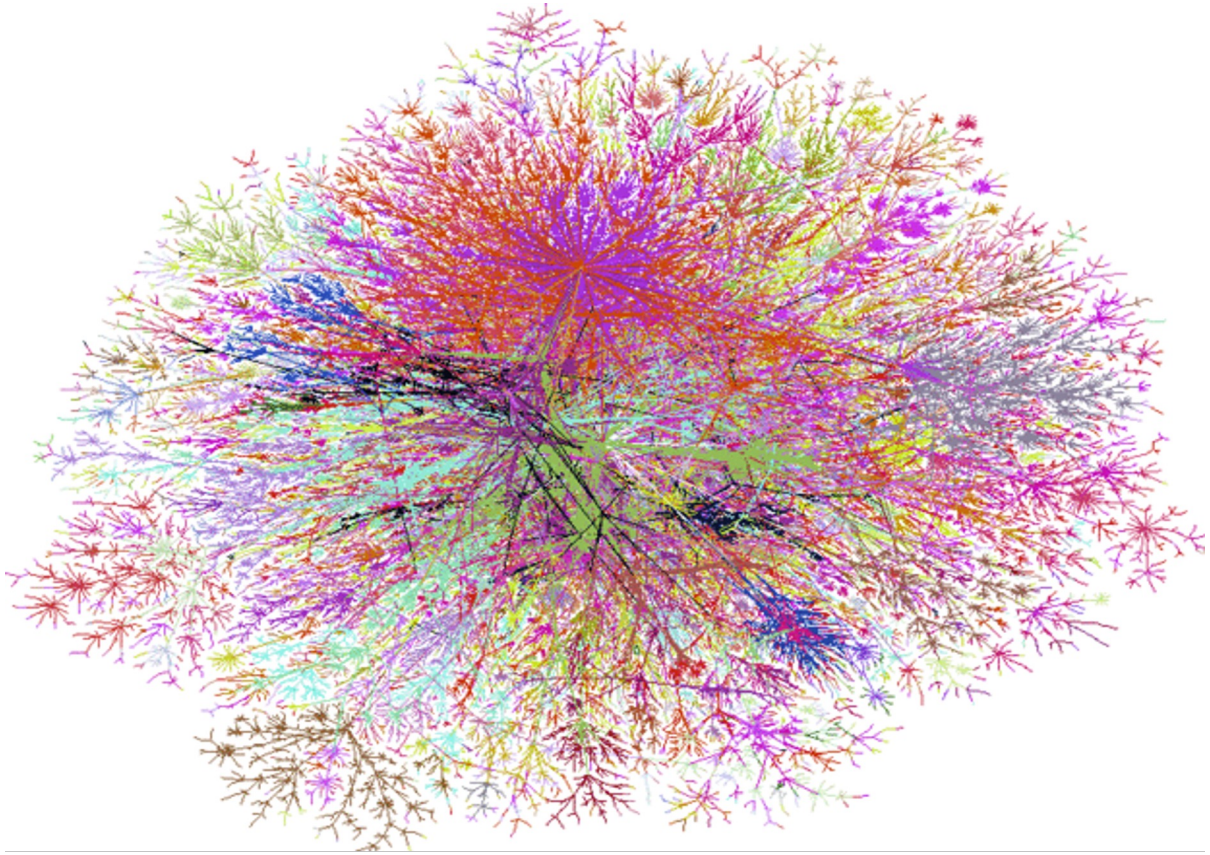
What is Big Data?



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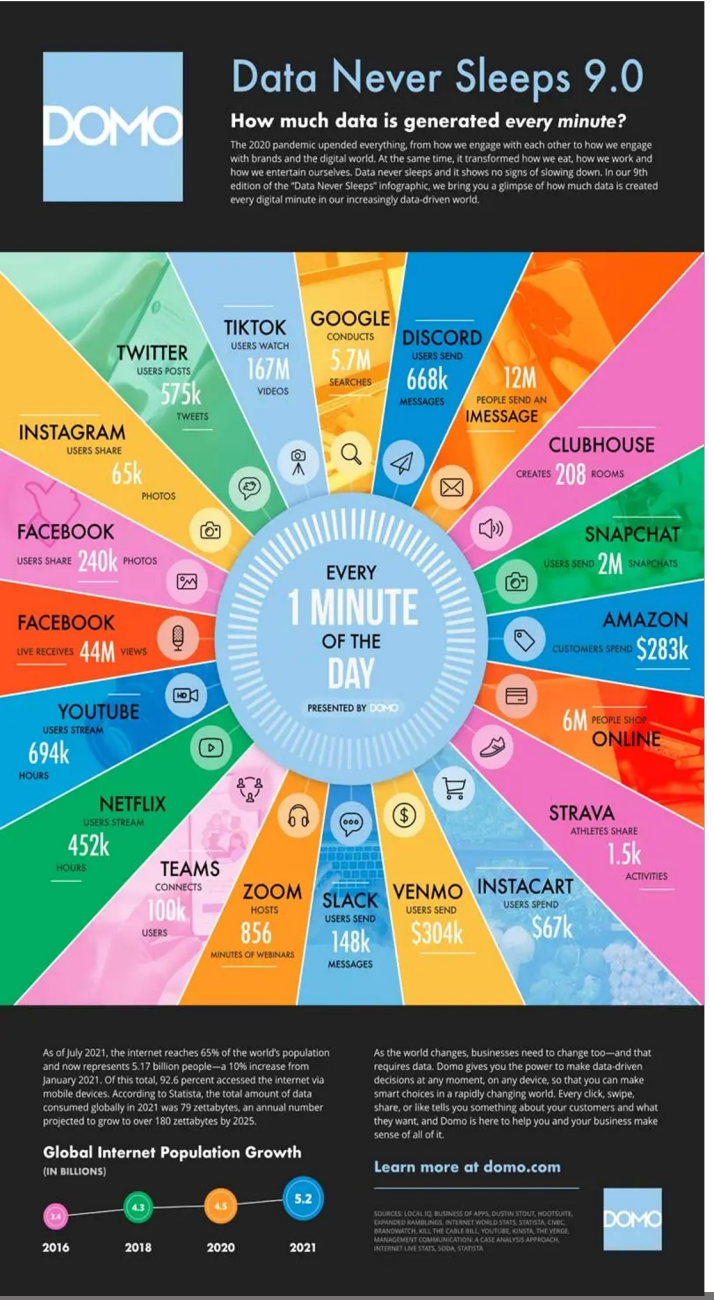

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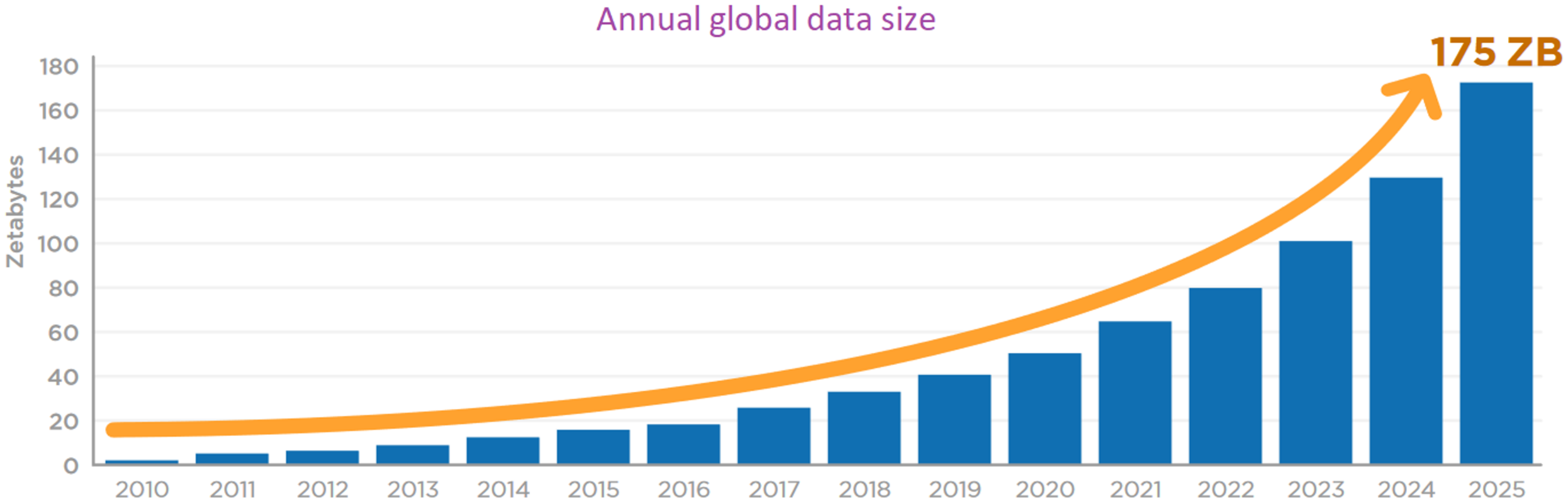

https://www.datanami.com/2022/01/11/big-growth-forecasted-for-big-data/

175 ZB = 175 Trillion GB!

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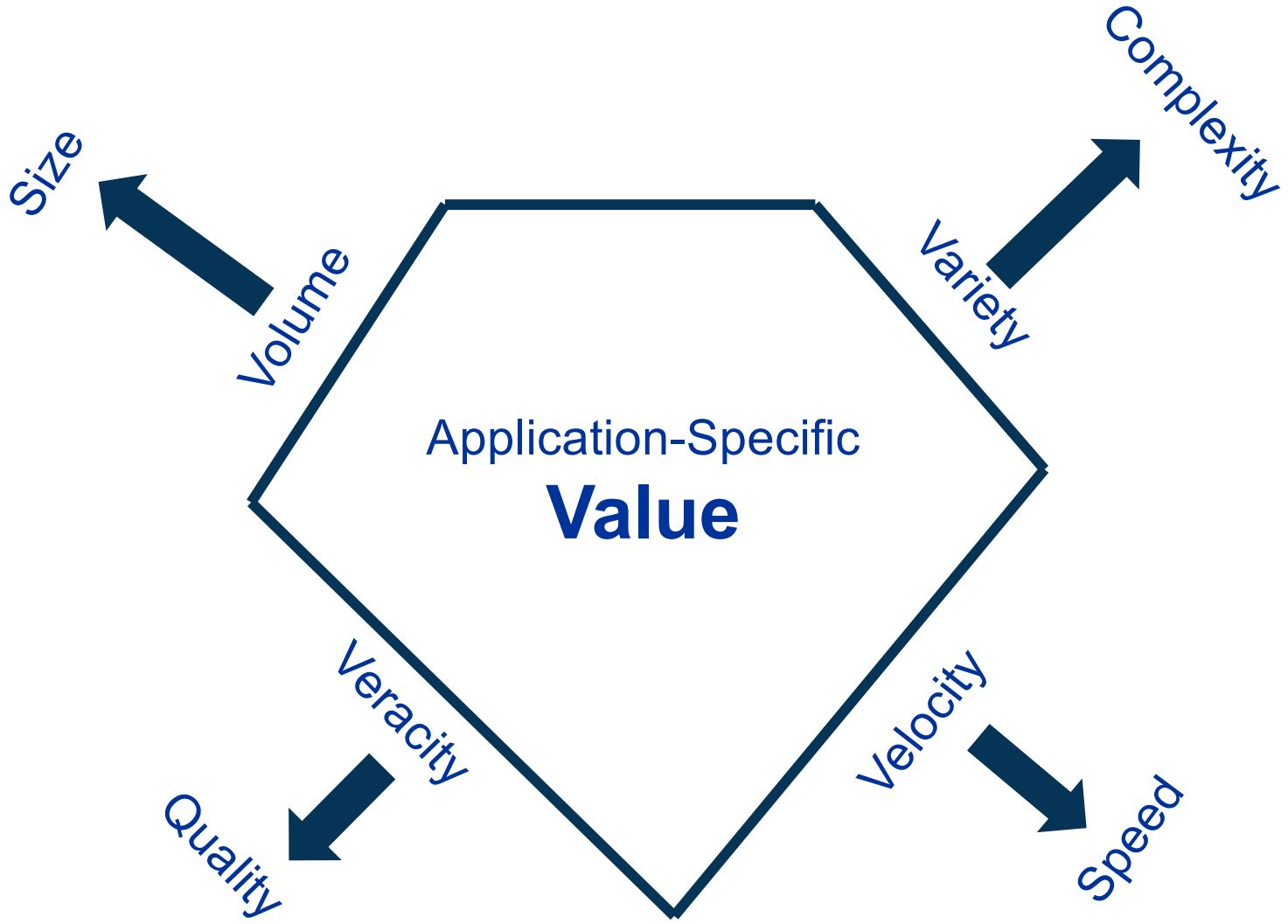
V's of Big Data



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Data Science:

Finding connections in big data…

… and applications using the connections for a purpose.

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How does data science happen?

or

How to manage data science projects?

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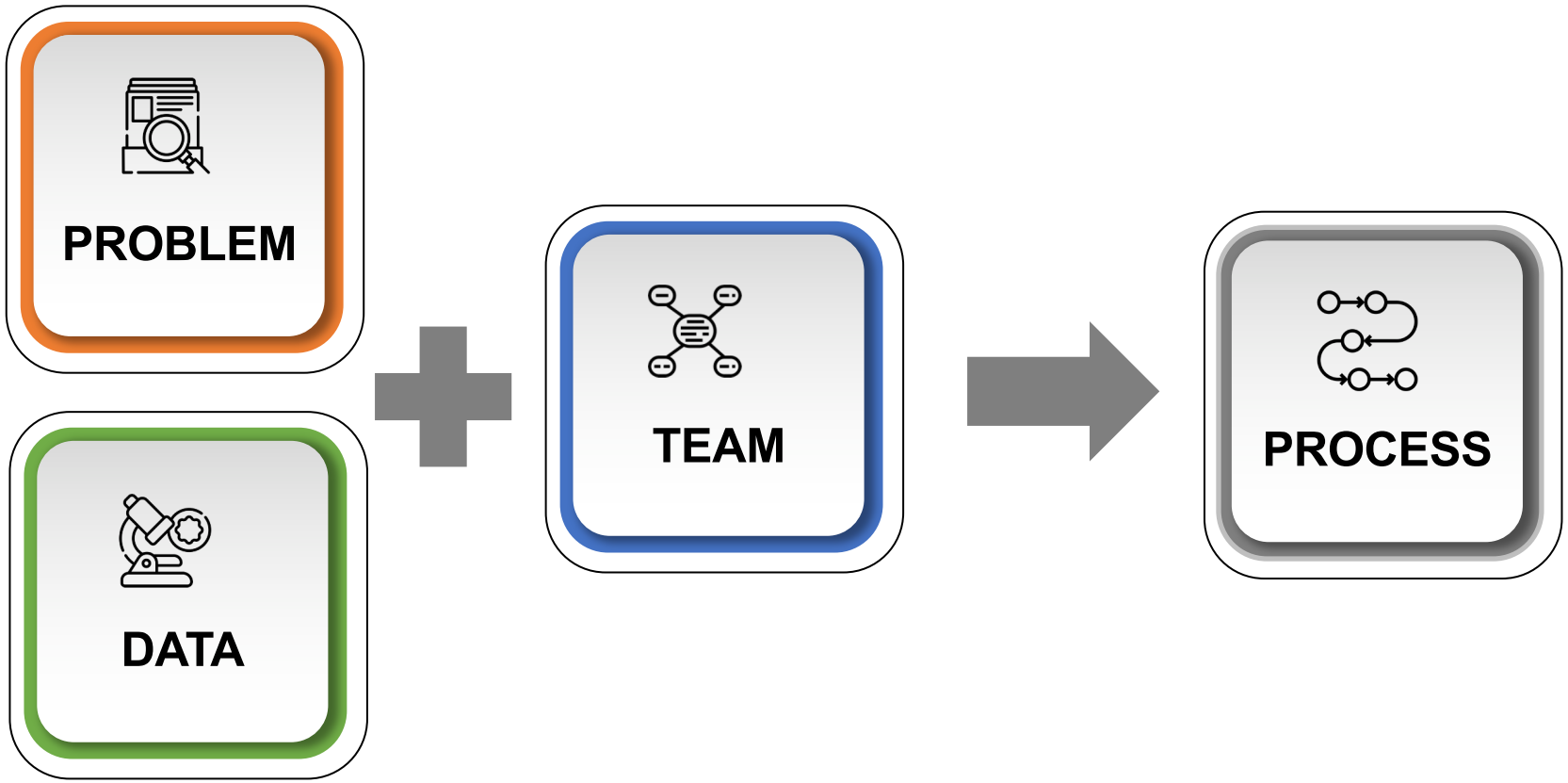
Dimensions of Data Science



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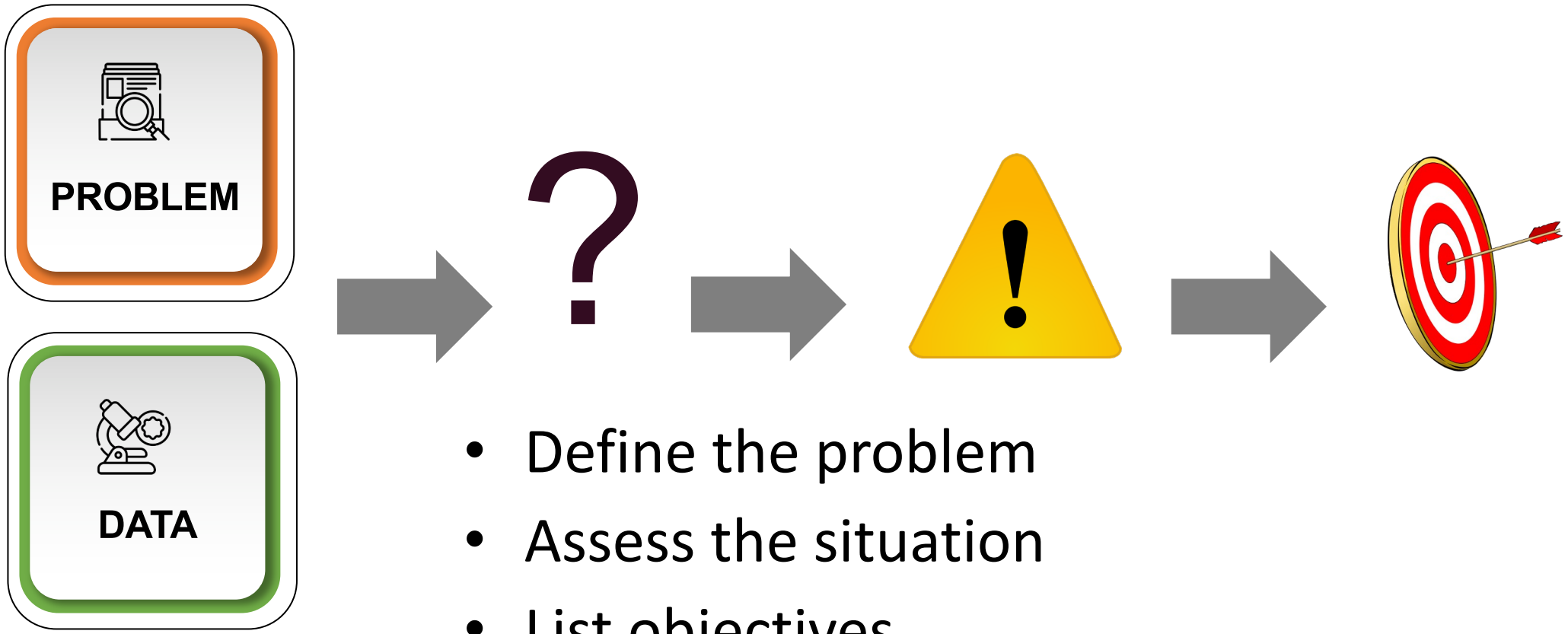
Asking the Right Question



- Define the problem
- Assess the situation
- List objectives

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Data Science Process

- Data engineering
- Data analysis
- Machine learning
- Scalable computing

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Phases of the Data Science Process

- **BUILD**
- **EXPLORE**
- **SCALE**

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What is a Data Scientist?

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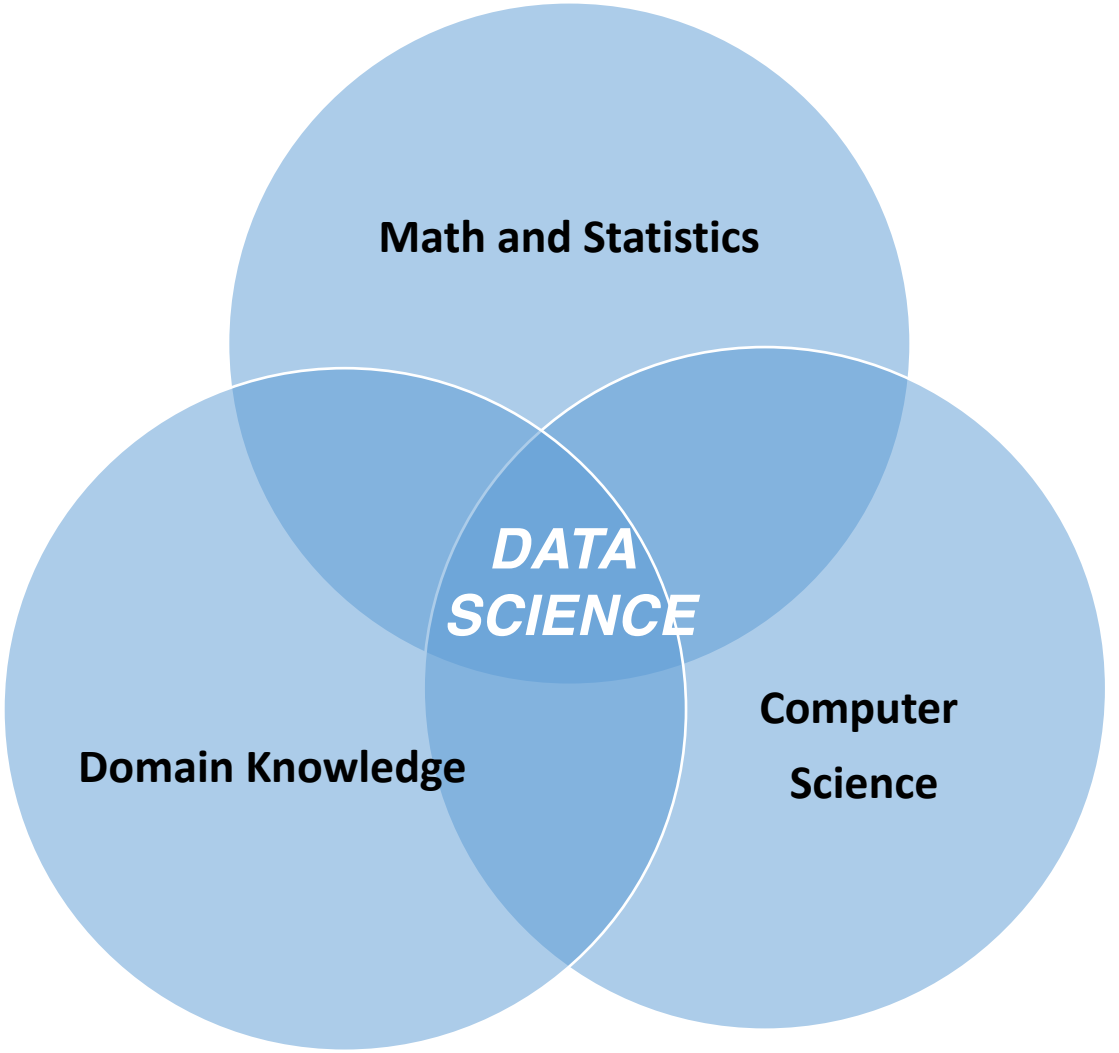
Data science is multidisciplinary.



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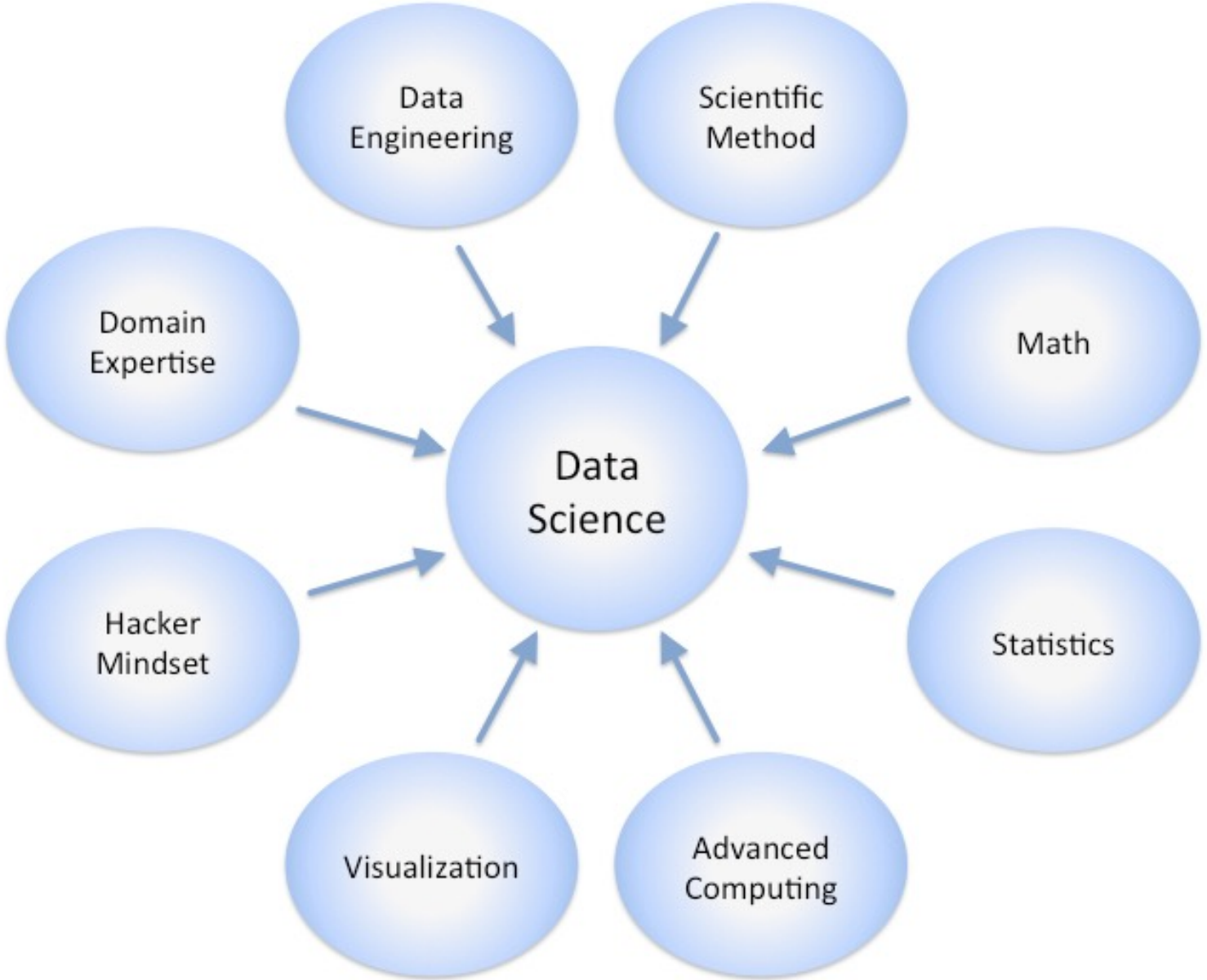

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MODERN DATA SCIENTIST

Data Scientist, the sexiest job of 21th century requires a mixture of multidisciplinary skills ranging from an intersection of mathematics, statistics, computer science, communication and business. Finding a data scientist is hard. Finding people who understand who a data scientist is, is equally hard. So here is a little cheat sheet on who the modern data scientist really is.

MATH & STATISTICS

- Machine learning
- Statistical modeling
- Experiment design
- Bayesian inference
- Supervised learning: decision trees, random forests, logistic regression
- Unsupervised learning: clustering, dimensionality reduction
- Optimization: gradient descent and variants

PROGRAMMING & DATABASE

- Computer science fundamentals
- Scripting language e.g. Python
- Statistical computing package e.g. R
- Databases SQL and NoSQL
- Relational algebra
- Parallel databases and parallel query processing
- MapReduce concepts
- Hadoop and Hive/Pig
- Custom reducers
- Experience with xaaS like AWS

DOMAIN KNOWLEDGE & SOFT SKILLS

- Passionate about the business
- Curious about data
- Influence without authority
- Hacker mindset
- Problem solver
- Strategic, proactive, creative, innovative and collaborative

COMMUNICATION & VISUALIZATION

- Able to engage with senior management
- Story telling skills
- Translate data-driven insights into decisions and actions
- Visual art design
- R packages like ggplot or lattice
- Knowledge of any of visualization tools e.g. Flare, D3.js, Tableau

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Marketing DISTILLERY

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Data science is “WE” science!

- Team collaboration
- Curiosity
- Respect

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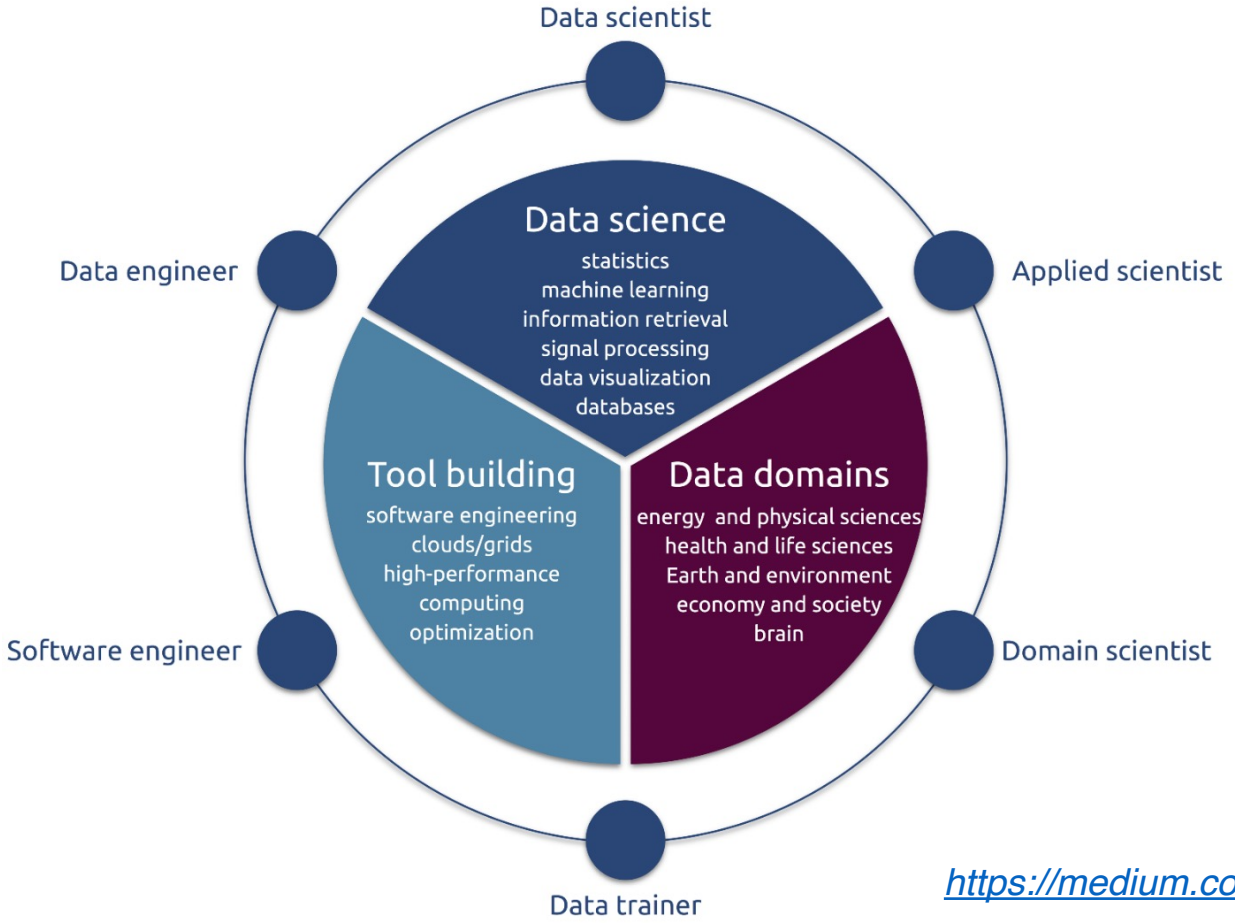
Expertise and Skills often overlap between different data science roles.



The data science ecosystem: activities and actors

- Data engineer
- Data analyst
- Methods expert
- Scalability and operations expert
- Business manager
- Business analyst
- Scientist
- Visualization and dashboard developer
- Solution architect
- Story teller/coordinator
- Project manager

https://medium.com/@balazskegl/the-data-science-ecosystem-678459ba6013

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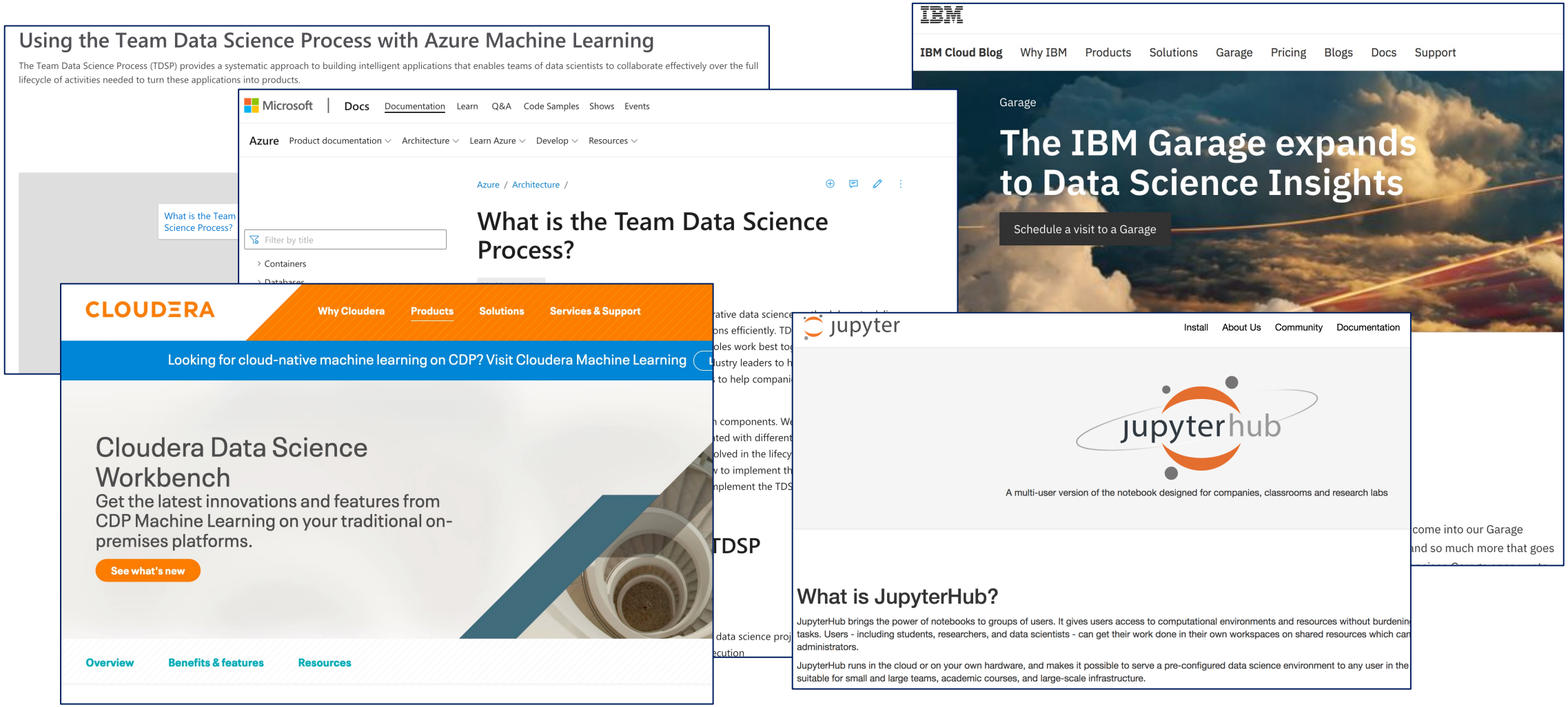
Team Data Science Environments



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Worldwide, Mar 2023 compared to a year ago:

Rank	Change	Language
1		Python
2		Java
3		JavaScript
4		C/C++
5		C#
6		PHP
7		R
8	↑	TypeScript
9	↑	Swift
10	↓↓	Objective-C

Source: PYPL

Top Data Science Programming Languages

https://pypl.github.io/PYPL.html

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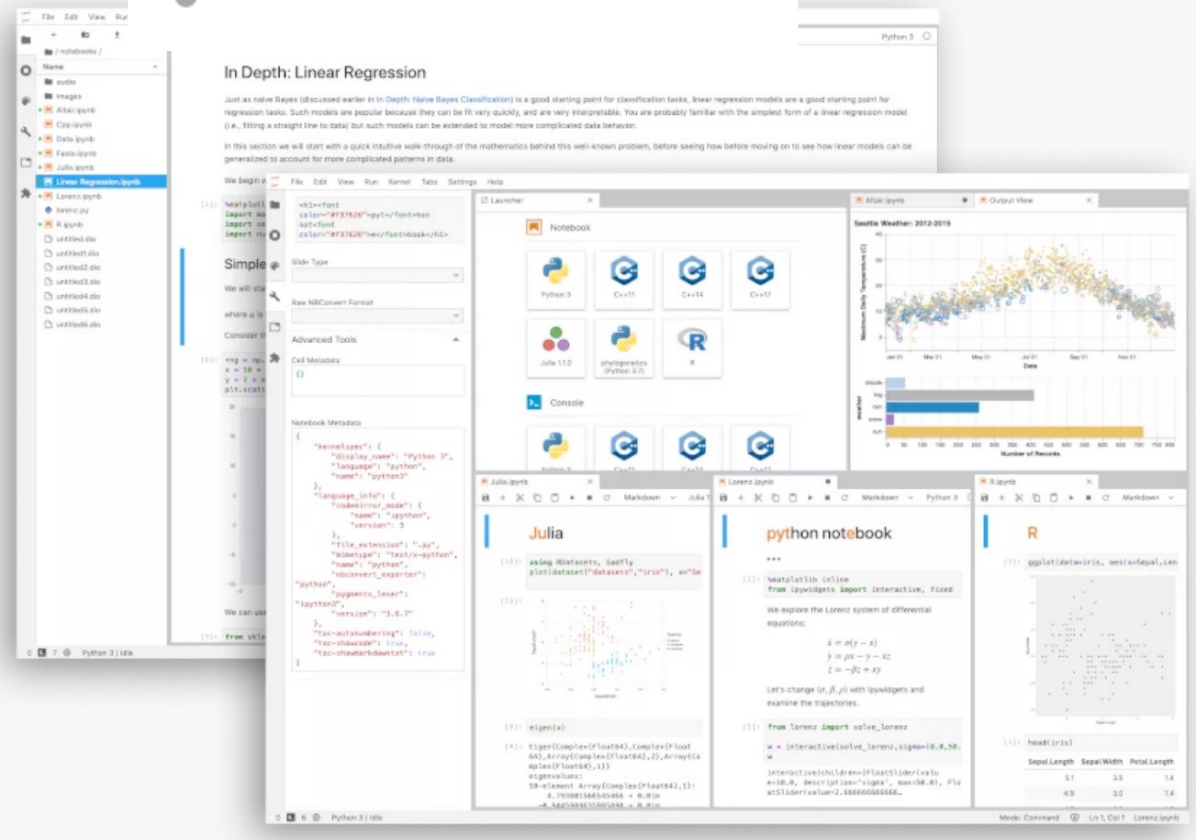
Jupyter Notebooks and JupyterLab



https://jupyter.org/

JupyterLab: A Next-Generation Notebook Interface

JupyterLab is the latest web-based interactive development environment for notebooks, code, and data. Its flexible interface allows users to configure and arrange workflows in data science, scientific computing, computational journalism, and machine learning. A modular design invites extensions to expand and enrich functionality.

Try it in your browser | Install JupyterLab

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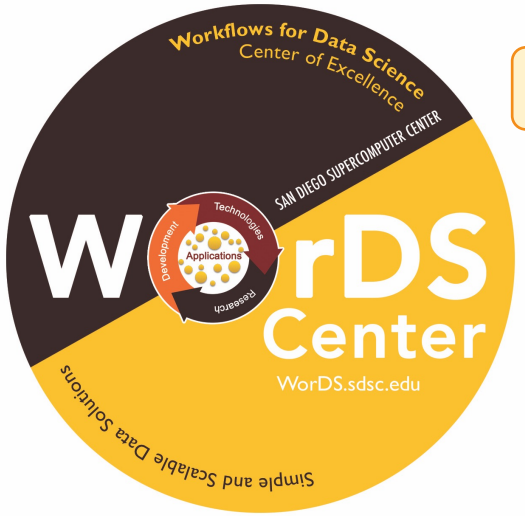

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