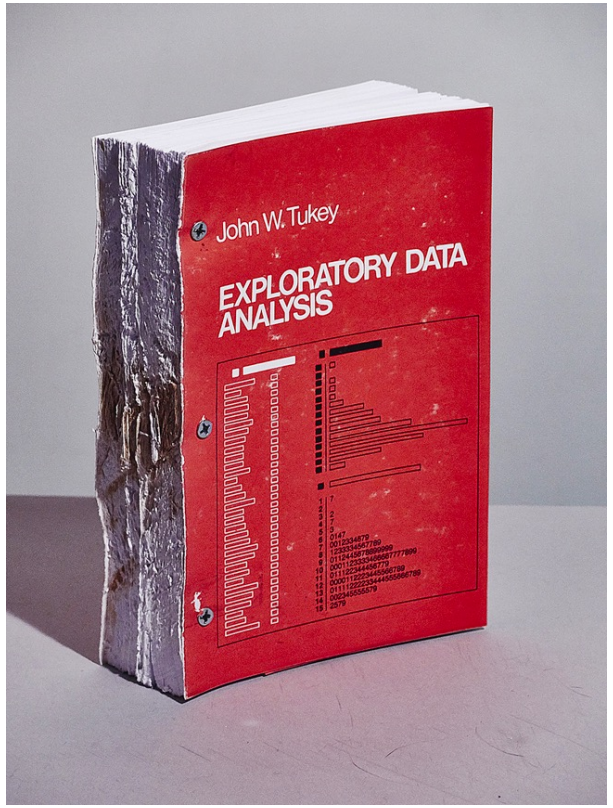
Your options in Data Science

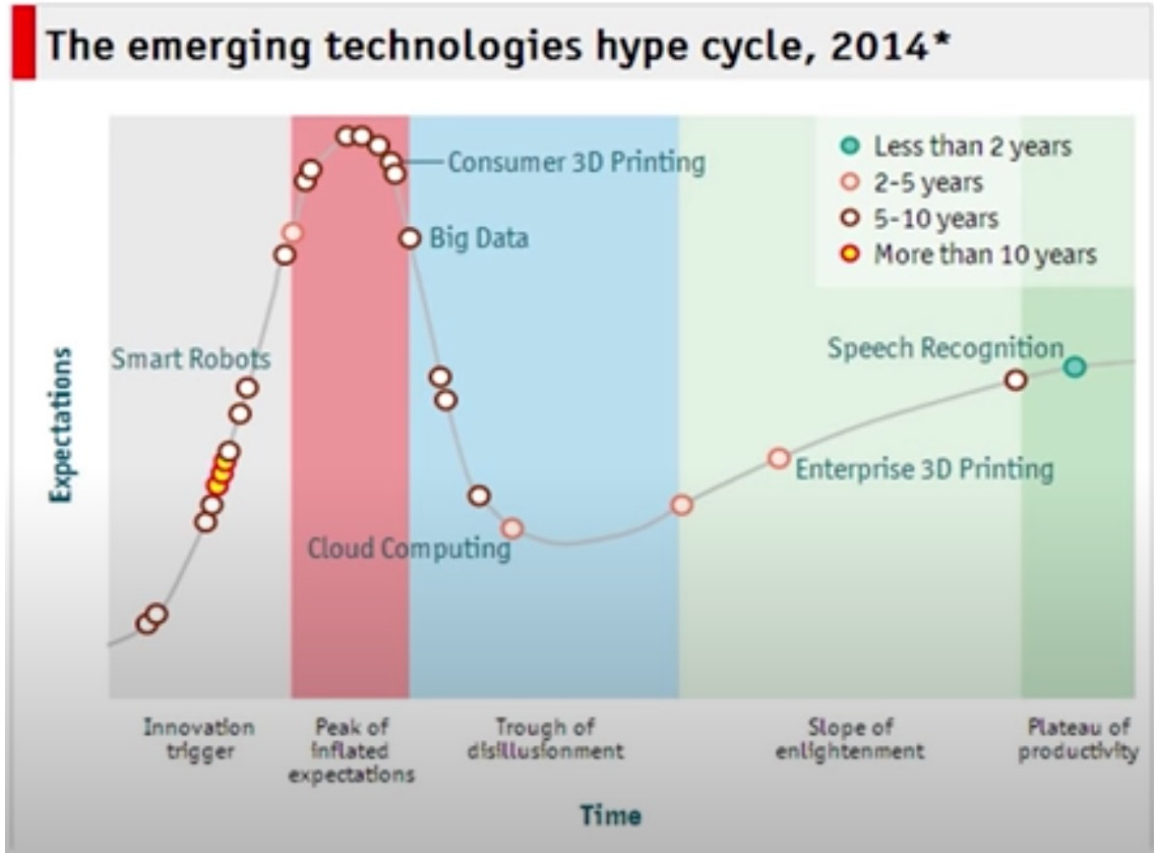
MAXIMOVSAKAYA ANASTASIA

A little about history



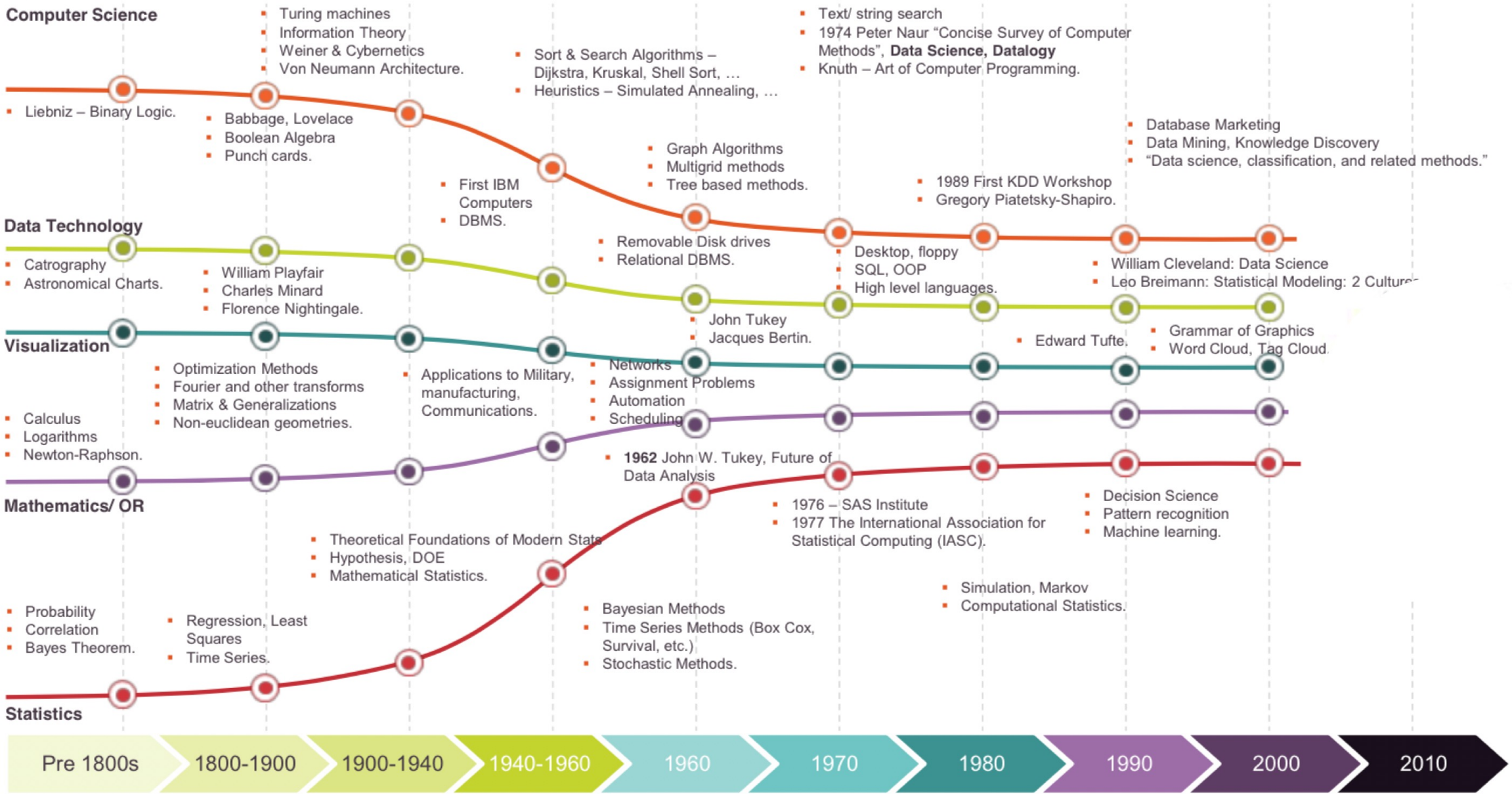
In the 1960s and 1970s, the American mathematician John W. Turkey published a series of papers where he suggested making hypotheses based on data.

Gartner Hype Cycle 2014

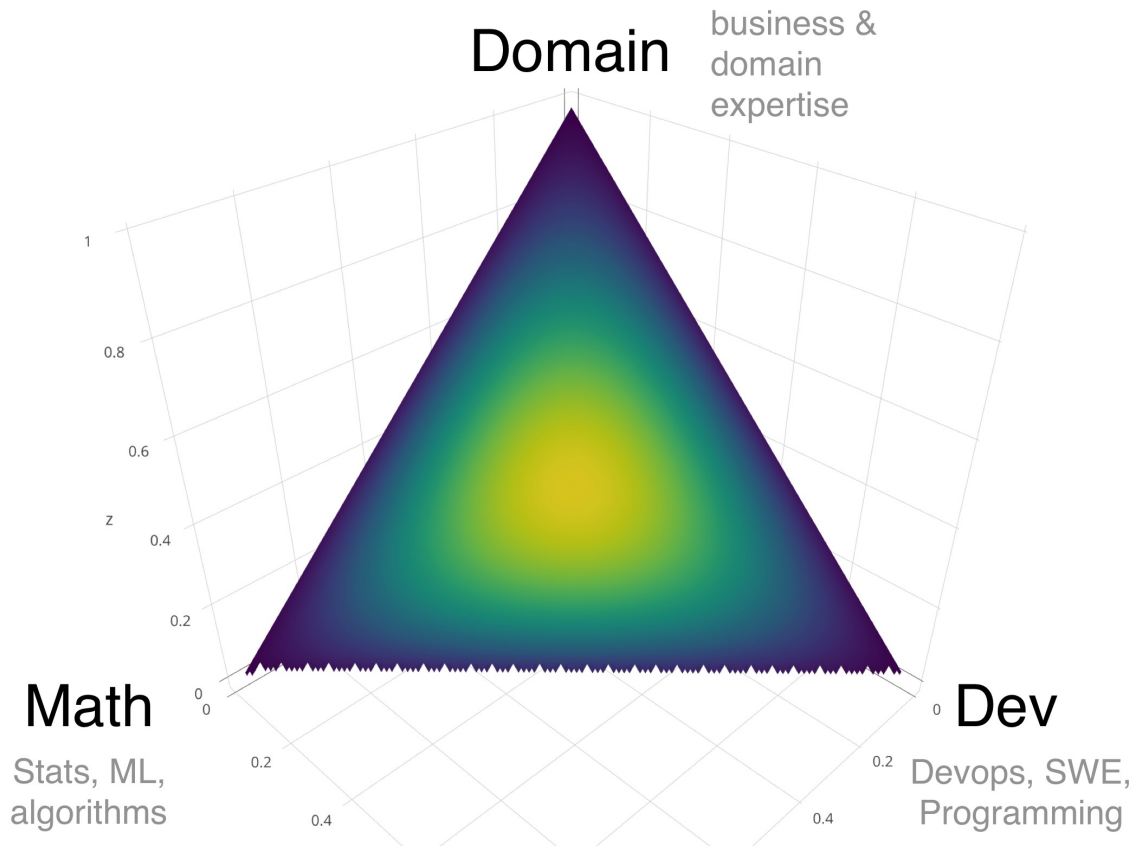


In 2015, Gartner excluded the Big Data area. Why?

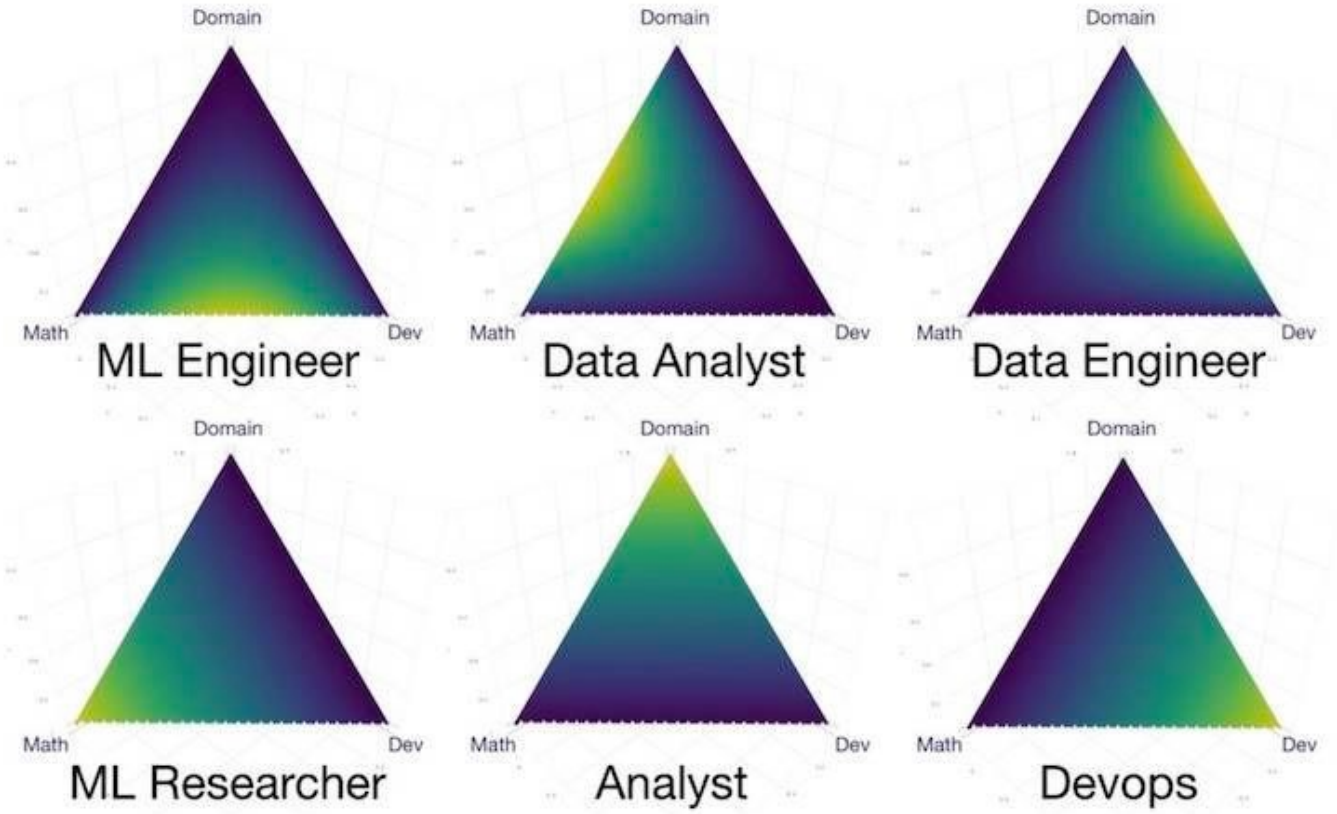
Do data scientists really exist?


Computer Science
Liebniz – Binary Logic.
Turing machines
Information Theory
Weiner & Cybernetics
Von Neumann Architecture.
Babbage, Lovelace
Boolean Algebra
Punch cards.
Sort & Search Algorithms – Dijkstra, Kruskal, Shell Sort, …
Heuristics – Simulated Annealing, …
First IBM Computers
DBMS.
Graph Algorithms
Multigrid methods
Tree based methods.
Text/ string search
1974 Peter Naur "Concise Survey of Computer Methods", Data Science, Datalogy
Knuth – Art of Computer Programming.
1989 First KDD Workshop
Gregory Piatetsky-Shapiro.
Database Marketing
Data Mining, Knowledge Discovery
"Data science, classification, and related methods."
Data Technology
Catrography
Astronomical Charts.
William Playfair
Charles Minard
Florence Nightingale.
Removable Disk drives
Relational DBMS.
Desktop, floppy
SQL, OOP
High level languages.
William Cleveland: Data Science
Leo Breimann: Statistical Modeling: 2 Culture
Visualization
John Tukey
Jacques Bertin.
Edward Tufte.
Grammar of Graphics
Word Cloud, Tag Cloud
Optimization Methods
Fourier and other transforms
Matrix & Generalizations
Non-euclidean geometries.
Applications to Military, manufacturing, Communications.
Networks
Assignment Problems
Automation
Scheduling
Calculus
Logarithms
Newton-Raphson.
Mathematics/ OR
1962 John W. Tukey, Future of Data Analysis
1976 – SAS Institute
1977 The International Association for Statistical Computing (IASC).
Decision Science
Pattern recognition
Machine learning.
Theoretical Foundations of Modern Stats
Hypothesis, DOE
Mathematical Statistics.
Simulation, Markov
Computational Statistics.
Probability
Correlation
Bayes Theorem.
Regression, Least Squares
Time Series.
Bayesian Methods
Time Series Methods (Box Cox, Survival, etc.)
Stochastic Methods.
Statistics
Pre 1800s
1800-1900
1900-1940
1940-1960
1960
1970
1980
1990
2000
2010

Career tracks in DS

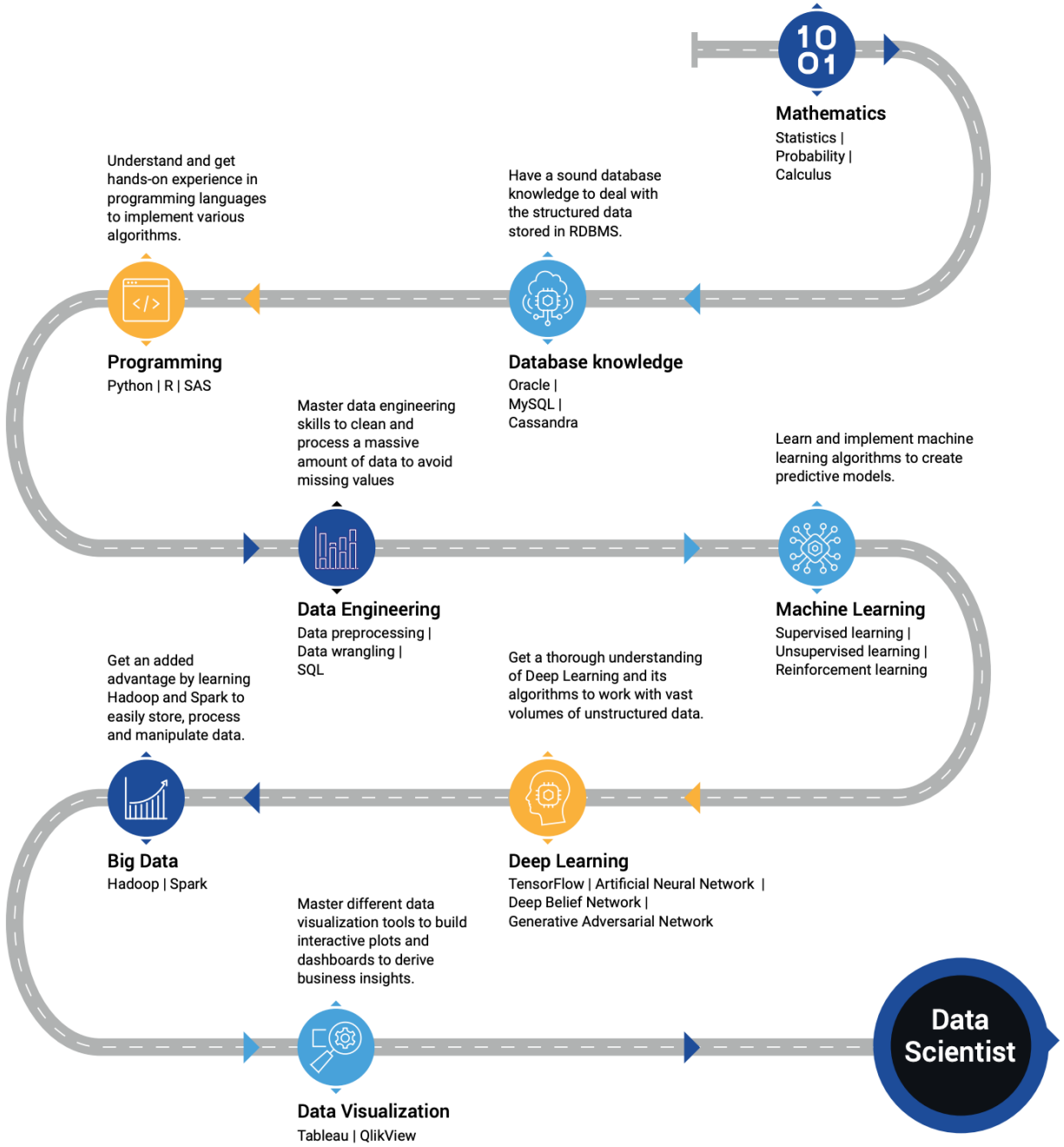


Career tracks in DS



Top skills

1. Data mining
2. Data visualization
3. Python
4. Probability Theory and Statistics
5. Machine learning
6. Deep learning
7. SQL
8. Docker and containerization
9. Cloud services
10. Databases


Mathematics
Statistics | Probability | Calculus
Have a sound database knowledge to deal with the structured data stored in RDBMS.
Understand and get hands-on experience in programming languages to implement various algorithms.
Database knowledge
Oracle | MySQL | Cassandra
Programming
Python | R | SAS
Master data engineering skills to clean and process a massive amount of data to avoid missing values
Learn and implement machine learning algorithms to create predictive models.
Data Engineering
Data preprocessing | Data wrangling | SQL
Machine Learning
Supervised learning | Unsupervised learning | Reinforcement learning
Get an added advantage by learning Hadoop and Spark to easily store, process and manipulate data.
Get a thorough understanding of Deep Learning and its algorithms to work with vast volumes of unstructured data.
Big Data
Hadoop | Spark
Deep Learning
TensorFlow | Artificial Neural Network | Deep Belief Network | Generative Adversarial Network
Master different data visualization tools to build interactive plots and dashboards to derive business insights.
Data Visualization
Tableau | QlikView
Data Scientist

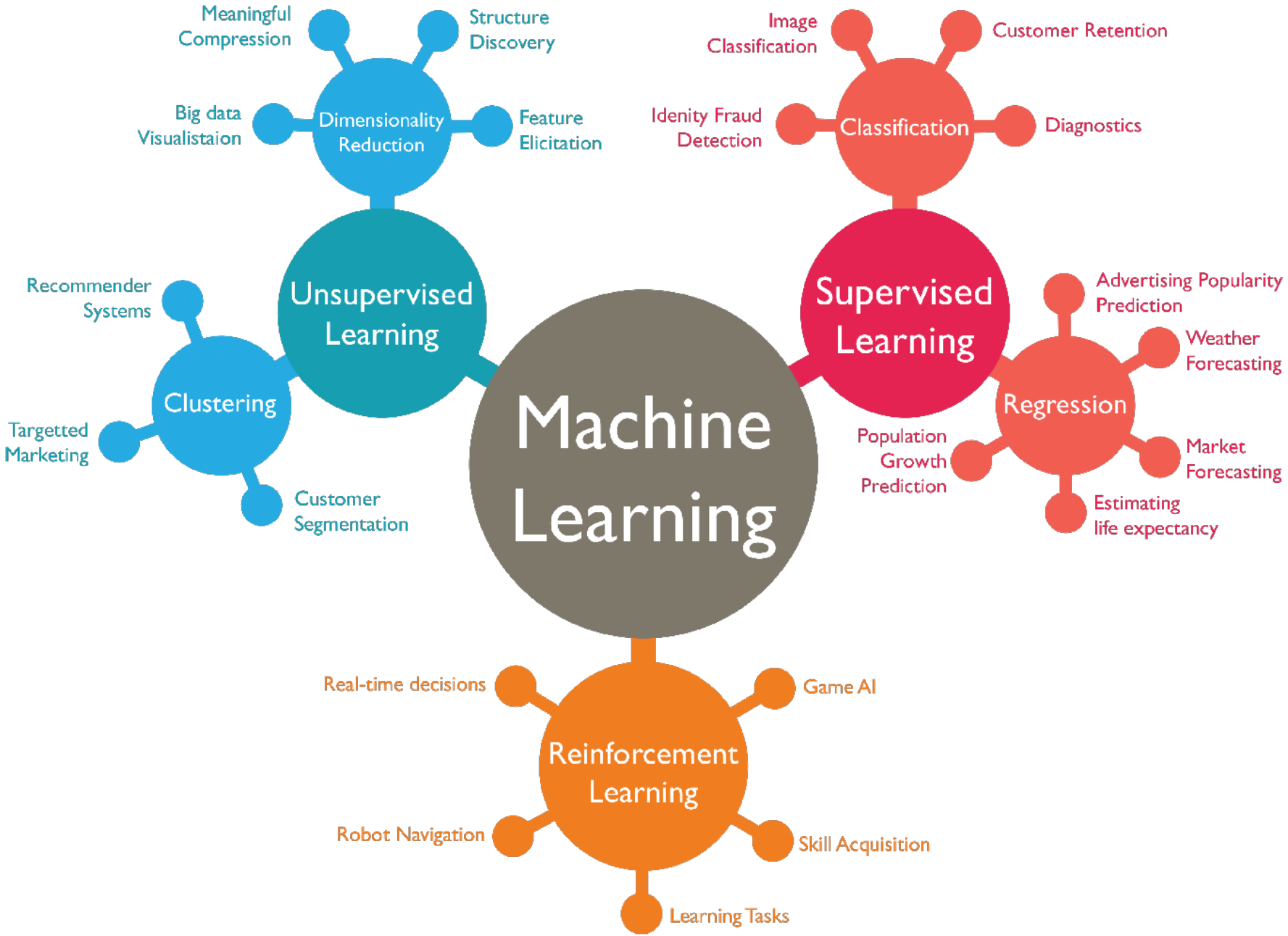
Terminology and interviews

ML system design intro

1. Problem statement
2. KPI and limitations
3. Baseline (heuristics or a simple model)
4. Defining the task
5. Data
6. Modelling
7. Metrics and validation
8. Problems
9. Deployment

Case study

- The client is a restaurant chain that wants to open a new spot
- Several accommodation options
- You need to choose the one that will bring the most profit


Machine Learning
Unsupervised Learning
Dimensionality Reduction
Meaningful Compression
Structure Discovery
Big data Visualistaion
Feature Elicitation
Clustering
Recommender Systems
Targetted Marketing
Customer Segmentation
Supervised Learning
Classification
Image Classification
Customer Retention
Idenity Fraud Detection
Diagnostics
Regression
Advertising Popularity Prediction
Weather Forecasting
Population Growth Prediction
Market Forecasting
Estimating life expectancy
Reinforcement Learning
Real-time decisions
Game AI
Robot Navigation
Skill Acquisition
Learning Tasks

Case study

- x – object, what we are making a prediction for (restaurant location)
- $\mathbb{X}$ – object space (all possible restaurant locations)
- y – target variable, what we predict (restaurant profit)
- $\mathbb{Y}$ – decision space, all response values (all real numbers)

Training sample

- We collect many objects with a known value of the target variable
- Existing restaurants, their indicative description and profit

Features

- An object is an abstract entity, and computers work with numbers
- Feature - the numerical characteristic of the object

Types of features:

- Numeric
- Binary (0/1)
- Categorical
- Features with a complex internal structure

Features

- An object is an abstract entity, and computers work with numbers.
- Features - the numerical characteristic of the object

- What features should we collect for this task?

Possible answers

- Location
- Number of cars passing by per day
- Distance to the nearest competitor
- Average cost per square meter of housing nearby
- The average age of residents of the nearest quarters
- and so on

How to encode location data

- We have coordinates - longitude and latitude
- It is not very likely that there is a relationship between these two numbers and the target variable - profit
- What should we do?

How to encode location data

- We have coordinates - longitude and latitude
- We generate features based on this data (feature generation)

- What examples of features can you think of?

How to encode location data

- We have coordinates - longitude and latitude
- We generate features based on this data (feature generation)

Some examples:

- distance from the city center, from the nearest metro station
- if restaurants in different countries - time zones
- and so on

Modelling

- $a(x)$ – algorithm, model (a function that predicts the answer for any object)
- Maps $\mathbb{X}$ to $\mathbb{Y}$ (object space to decision space)

Metrics

- After the previous steps, we have a model that produces profit predictions for restaurants.
- Now it is necessary to evaluate the quality of the obtained predictions
- For this, metrics are used - measures of the quality of the algorithm on the sample
- Selected based on business requirements

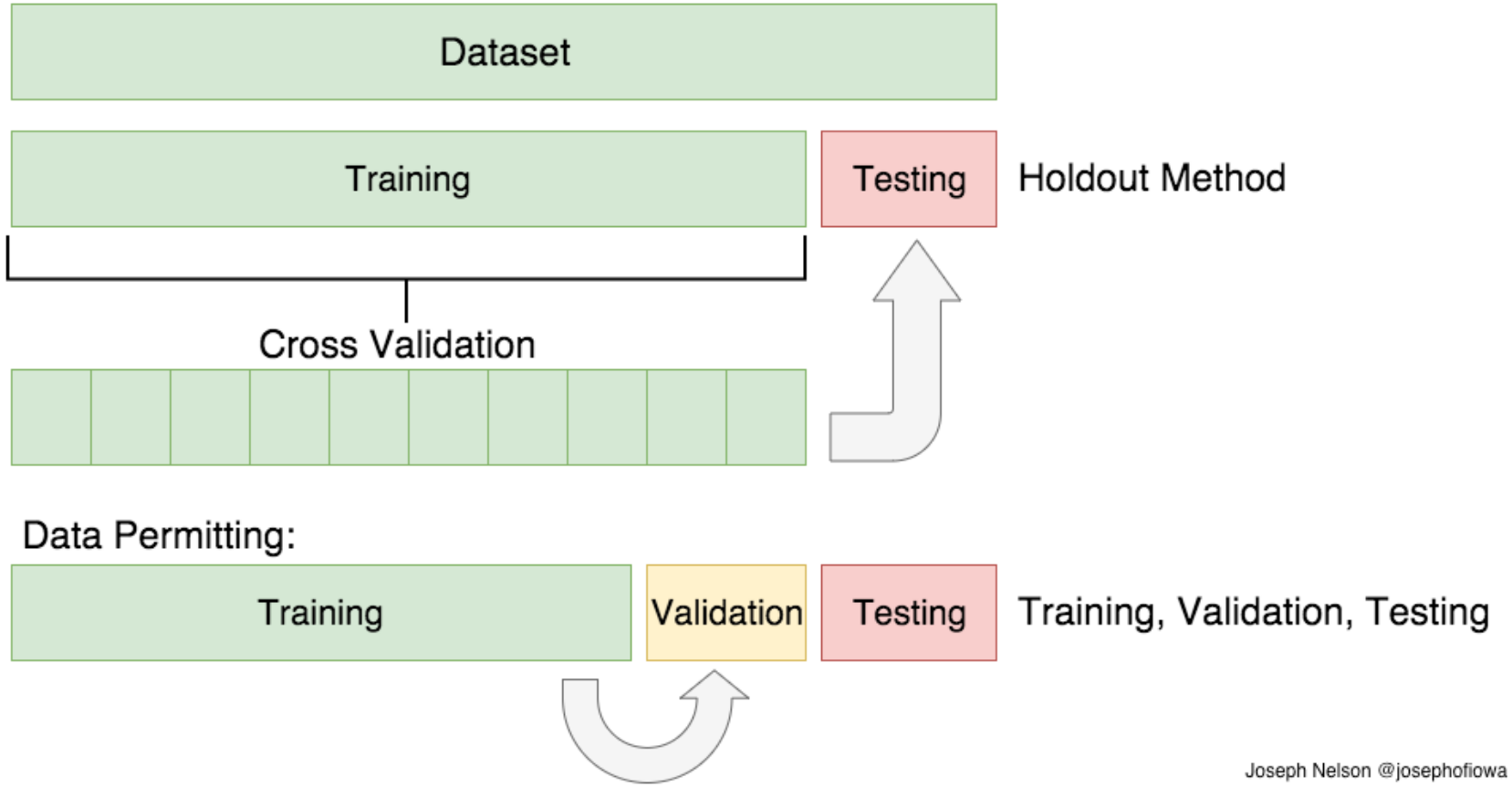
Example of a metric for regression

Mean Squared Error:

$$\mathrm{MSE}(a, X) = \frac{1}{\ell} \sum_{i=1}^{\ell} (a(x_i) - y_i)^2$$

- The less the better

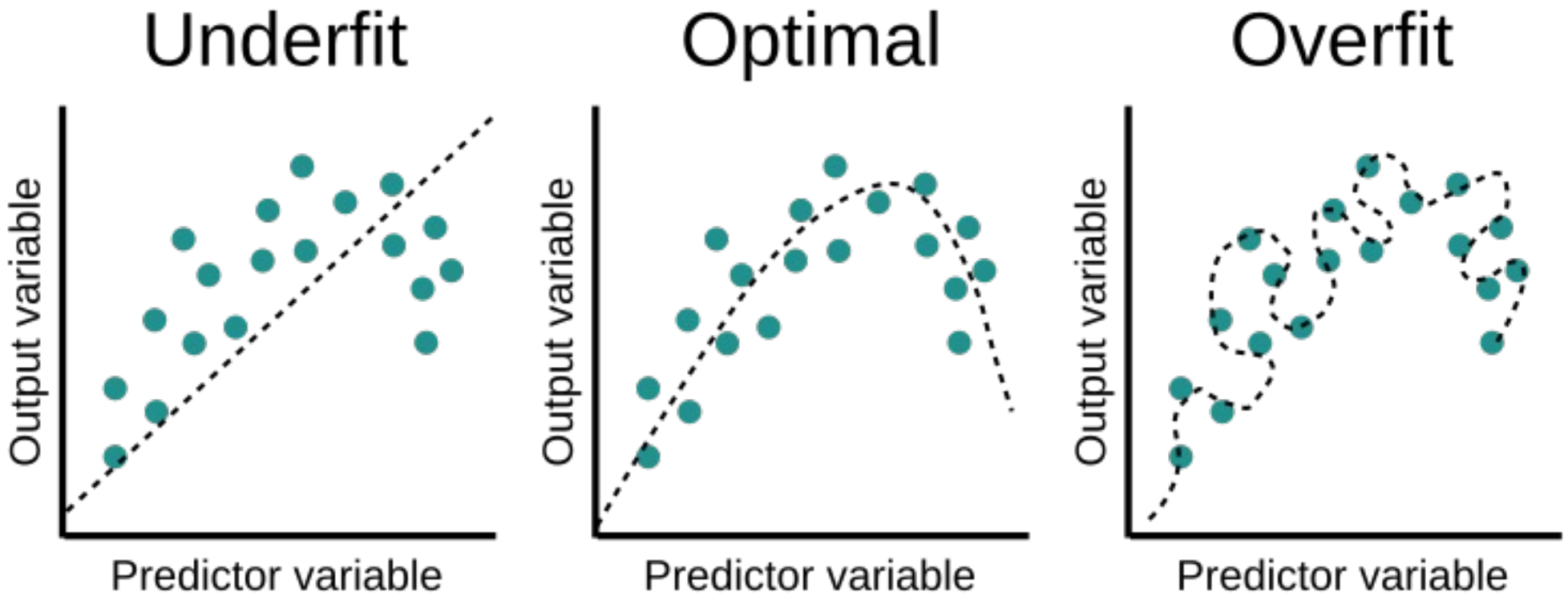
Validation


Dataset
Training
Testing
Holdout Method
Cross Validation
Data Permitting:
Training
Validation
Testing
Training, Validation, Testing
Joseph Nelson @josephofiowa

Training the model

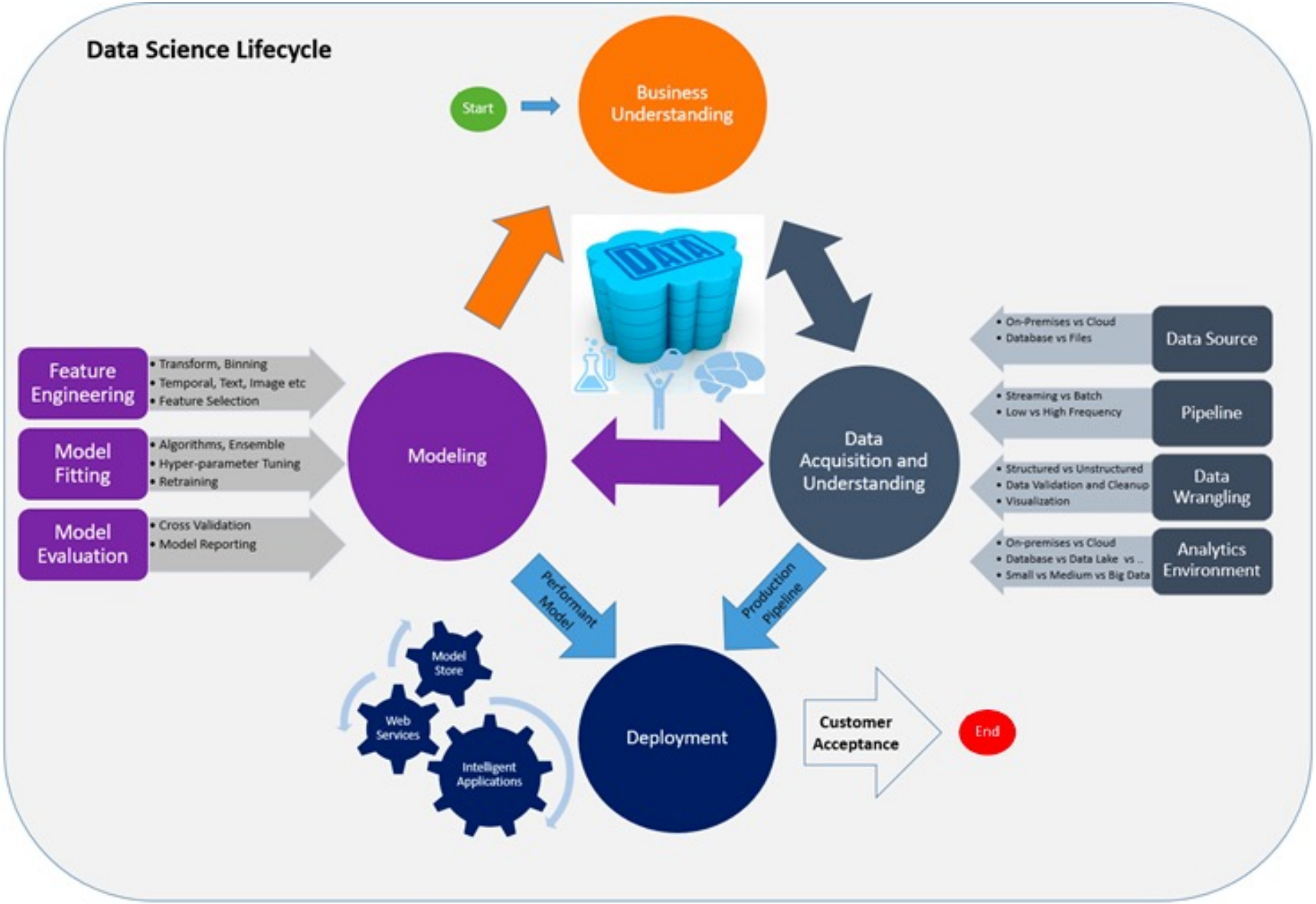
- Training is a search for the optimal algorithm in terms of quality
- Having a training sample and a quality functional (metric), we select an appropriate algorithm from a certain family of algorithms
- Important criteria: quality that meets business requirements, sustainability of results, in some cases - interpretability

Overfitting and underfitting



Data science project lifecycle

1. Definition of the task and target metric
2. Data collection
3. Data preprocessing and EDA (exploratory data analysis)
4. Generation of additional features
5. Selection and validation of models
6. As a rule, return to point 2 or 3


Data Science Lifecycle
Start
Business Understanding
DATA
Data Acquisition and Understanding
Modeling
Feature Engineering
• Transform, Binning
• Temporal, Text, Image etc
• Feature Selection
Model Fitting
• Algorithms, Ensemble
• Hyper-parameter Tuning
• Retraining
Model Evaluation
• Cross Validation
• Model Reporting
• On-Premises vs Cloud
• Database vs Files
Data Source
• Streaming vs Batch
• Low vs High Frequency
Pipeline
• Structured vs Unstructured
• Data Validation and Cleanup
• Visualization
Data Wrangling
• On-premises vs Cloud
• Database vs Data Lake vs ..
• Small vs Medium vs Big Data
Analytics Environment
Performant Model
Production Pipeline
Model Store
Web Services
Intelligent Applications
Deployment
Customer Acceptance
End

Regression

- Regression is a class of supervised learning problems, when it is necessary to predict the target variable for a certain set of object features.
- The task of regression is to find dependencies between defining variables and the defined variable if it is a continuous number. For example, to determine the cost of a house by its area.
- The target value is any real number.
- The task of linear regression is to find such a relationship if it is linear.

Classification

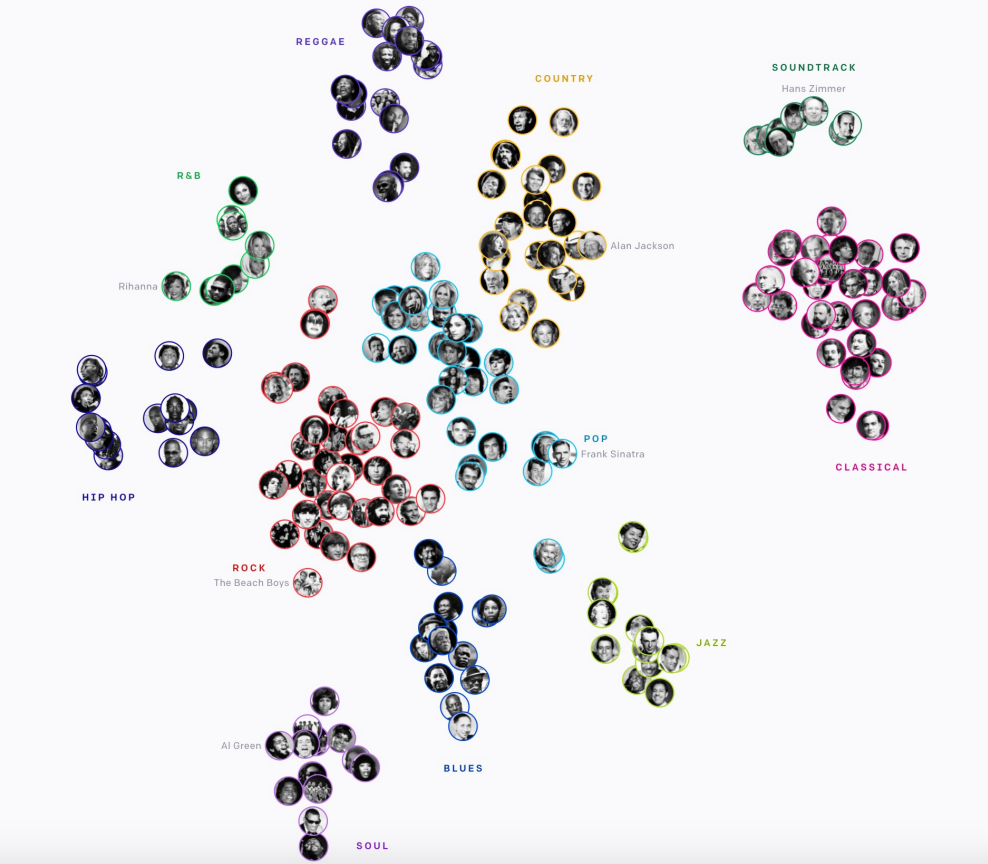
- Classification is a class of supervised learning tasks, when, according to a certain set of features of an object, it is necessary to predict its belonging to a certain class.
- The task of classification is to find dependencies between defining variables and the defined variable, if it belongs to a fixed set of values. For example, to determine whether a person will return a loan or not (binary classification) or to determine the scientific field of an article (multi-class classification).
- The target value is a class (one from a fixed set).
- There is also a multiclass classification with overlapping classes.

Clustering

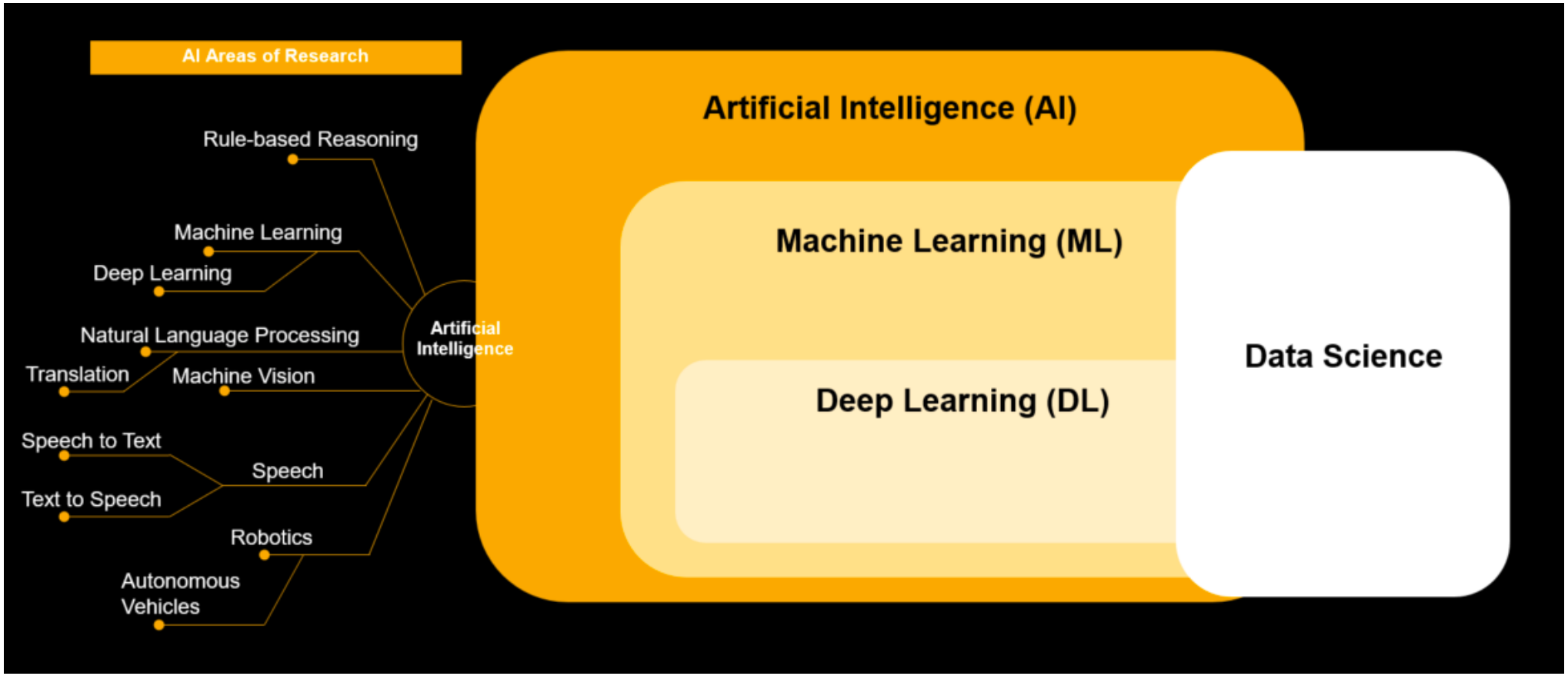
- Clustering is a type of unsupervised learning tasks, objects are divided into groups that have certain properties. Within the same cluster, objects must be similar
- Similarity is determined by a measure of distance
- Example: Euclidean Distance - Geometric Distance in Multidimensional Space

$$\rho(x, x') = \sqrt{\sum_{i}^{N} (x_i - x'_i)^2}$$

Example



https://openai.com/blog/jukebox/


AI Areas of Research
Rule-based Reasoning
Machine Learning
Deep Learning
Natural Language Processing
Translation
Machine Vision
Speech to Text
Speech
Text to Speech
Robotics
Autonomous Vehicles
Artificial Intelligence
Artificial Intelligence (AI)
Machine Learning (ML)
Deep Learning (DL)
Data Science

Specializations

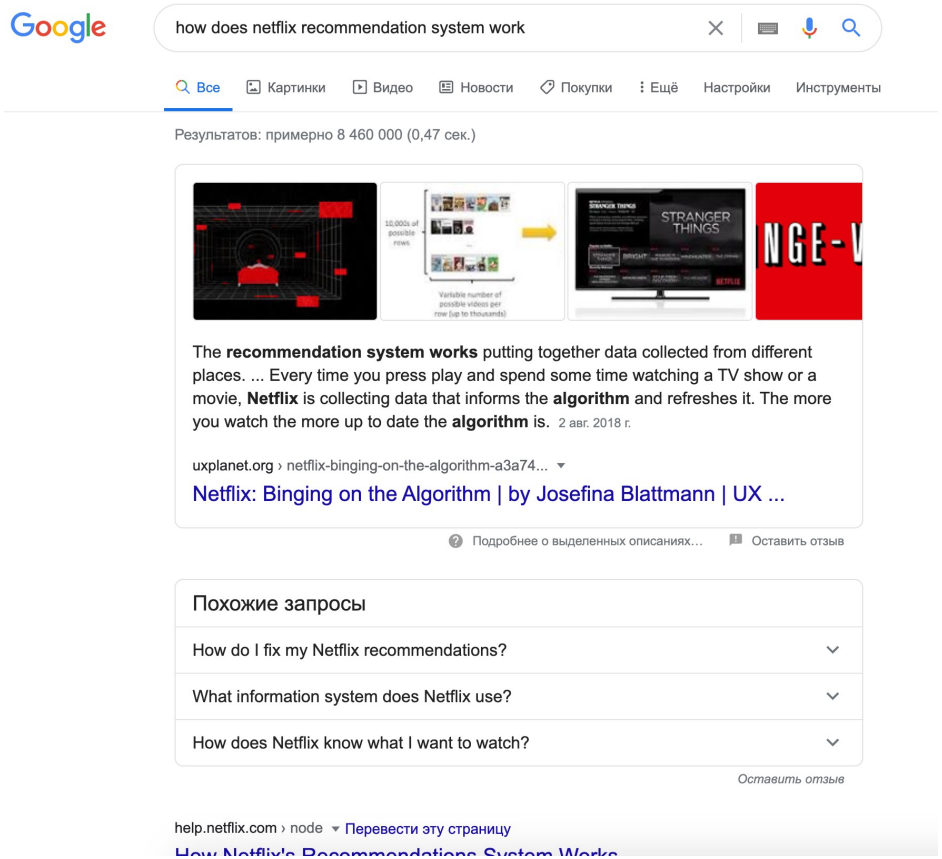
Recommender systems

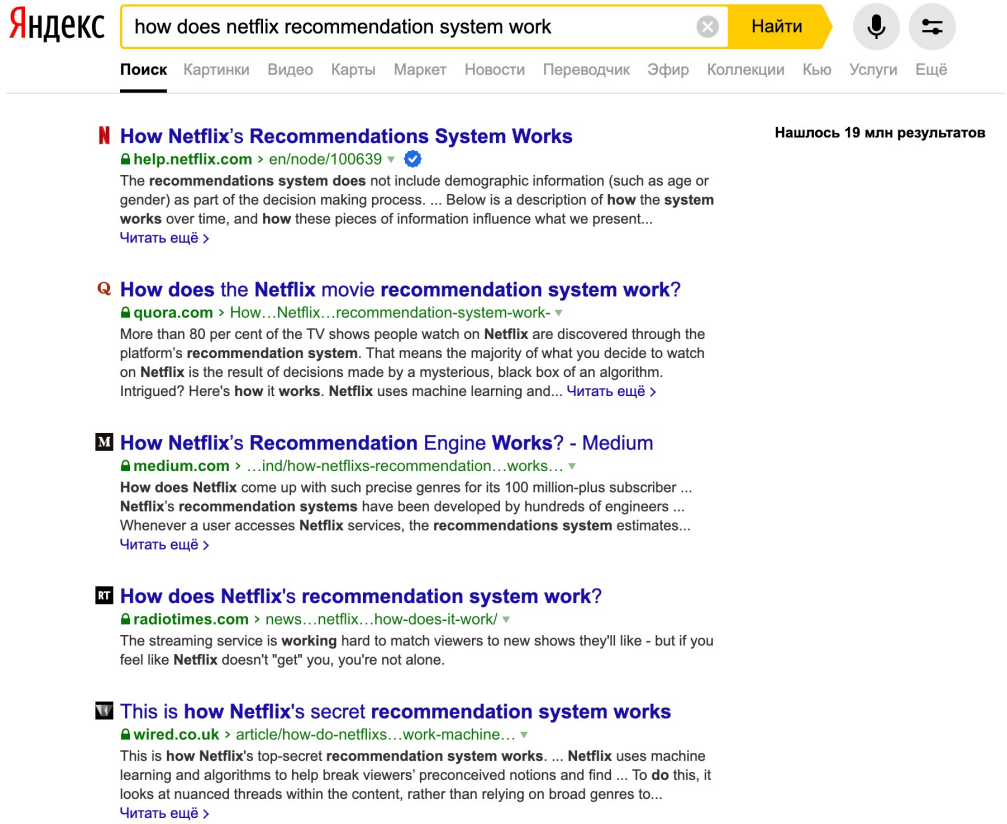
- We predict what will be interesting to the user based on information about his profile
- Examples: Netflix, Amazon, Youtube

NLP – Natural Language Processing

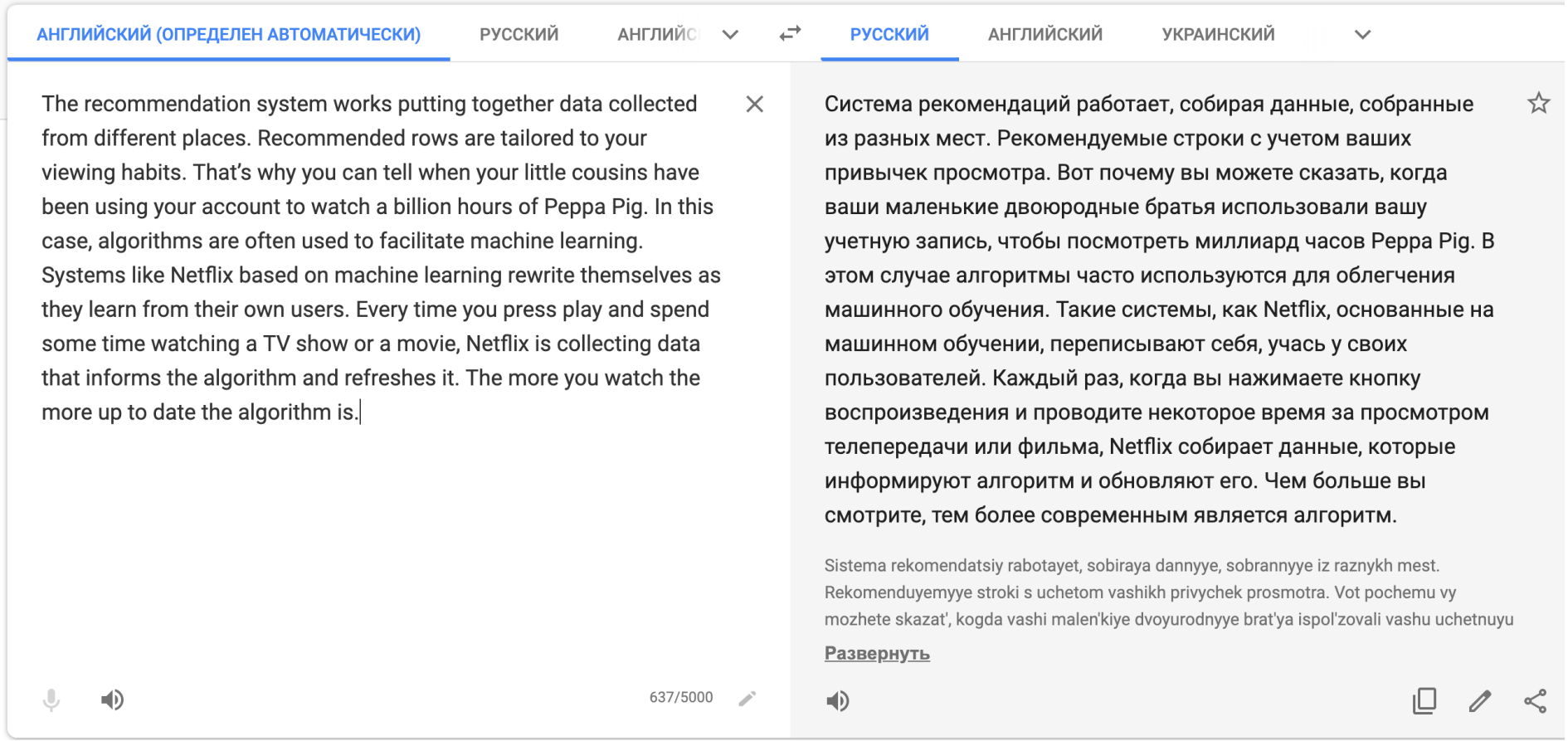
- Working with natural language

NLP + ranking


Google
how does netflix recommendation system work
Все
Картинки
Видео
Новости
Покупки
Ещё
Настройки
Инструменты
Результатов: примерно 8 460 000 (0,47 сек.)
STRANGER THINGS
The recommendation system works putting together data collected from different places. ... Every time you press play and spend some time watching a TV show or a movie, Netflix is collecting data that informs the algorithm and refreshes it. The more you watch the more up to date the algorithm is. 2 авг. 2018 г.
uxplanet.org › netflix-binging-on-the-algorithm-a3a74...
Netflix: Binging on the Algorithm | by Josefina Blattmann | UX ...
Подробнее о выделенных описаниях...
Оставить отзыв
Похожие запросы
How do I fix my Netflix recommendations?
What information system does Netflix use?
How does Netflix know what I want to watch?
Оставить отзыв
help.netflix.com › node
Перевести эту страницу


Яндекс
how does netflix recommendation system work
Найти
Поиск
Картинки
Видео
Карты
Маркет
Новости
Переводчик
Эфир
Коллекции
Кью
Услуги
Ещё
Нашлось 19 млн результатов
How Netflix's Recommendations System Works
help.netflix.com › en/node/100639
The recommendations system does not include demographic information (such as age or gender) as part of the decision making process. ... Below is a description of how the system works over time, and how these pieces of information influence what we present...
Читать ещё ›
How does the Netflix movie recommendation system work?
quora.com › How…Netflix…recommendation-system-work-
More than 80 per cent of the TV shows people watch on Netflix are discovered through the platform's recommendation system. That means the majority of what you decide to watch on Netflix is the result of decisions made by a mysterious, black box of an algorithm. Intrigued? Here's how it works. Netflix uses machine learning and... Читать ещё ›
How Netflix's Recommendation Engine Works? - Medium
medium.com › …ind/how-netflixs-recommendation…works…
How does Netflix come up with such precise genres for its 100 million-plus subscriber ... Netflix's recommendation systems have been developed by hundreds of engineers ... Whenever a user accesses Netflix services, the recommendations system estimates...
Читать ещё ›
How does Netflix's recommendation system work?
radiotimes.com › news…netflix…how-does-it-work/
The streaming service is working hard to match viewers to new shows they'll like - but if you feel like Netflix doesn't "get" you, you're not alone.
This is how Netflix's secret recommendation system works
wired.co.uk › article/how-do-netflixs…work-machine…
This is how Netflix's top-secret recommendation system works. ... Netflix uses machine learning and algorithms to help break viewers' preconceived notions and find ... To do this, it looks at nuanced threads within the content, rather than relying on broad genres to...
Читать ещё ›

NLP


АНГЛИЙСКИЙ (ОПРЕДЕЛЕН АВТОМАТИЧЕСКИ)
РУССКИЙ
АНГЛИЙС
РУССКИЙ
АНГЛИЙСКИЙ
УКРАИНСКИЙ
The recommendation system works putting together data collected from different places. Recommended rows are tailored to your viewing habits. That's why you can tell when your little cousins have been using your account to watch a billion hours of Peppa Pig. In this case, algorithms are often used to facilitate machine learning. Systems like Netflix based on machine learning rewrite themselves as they learn from their own users. Every time you press play and spend some time watching a TV show or a movie, Netflix is collecting data that informs the algorithm and refreshes it. The more you watch the more up to date the algorithm is.
637/5000
Система рекомендаций работает, собирая данные, собранные из разных мест. Рекомендуемые строки с учетом ваших привычек просмотра. Вот почему вы можете сказать, когда ваши маленькие двоюродные братья использовали вашу учетную запись, чтобы посмотреть миллиард часов Peppa Pig. В этом случае алгоритмы часто используются для облегчения машинного обучения. Такие системы, как Netflix, основанные на машинном обучении, переписывают себя, учась у своих пользователей. Каждый раз, когда вы нажимаете кнопку воспроизведения и проводите некоторое время за просмотром телепередачи или фильма, Netflix собирает данные, которые информируют алгоритм и обновляют его. Чем больше вы смотрите, тем более современным является алгоритм.
Sistema rekomendatsiy rabotayet, sobiraya dannyye, sobrannyye iz raznykh mest. Rekomenduyemyye stroki s uchetom vashikh privychek prosmotra. Vot pochemu vy mozhete skazat', kogda vashi malen'kiye dvoyurodnyye brat'ya ispol'zovali vashu uchetnuyu
Развернуть

Information retrieval

Frank Rosenblatt (July 11, 1928 – July 11, 1971) was an American psychologist notable in the field of artificial intelligence.
...

Frank Rosenblatt

Born	Frank RosenblattJuly 11, 1928 New Rochelle, New York, U.S.
Died	July 11, 1971 (aged 43) Chesapeake Bay
Alma mater	Cornell University
Known for	Perceptron

Ещё 1 строка

https://en.wikipedia.org › wiki › Frank_Rosenblatt

Frank Rosenblatt - Wikipedia

О выделенных описаниях • Оставить отзыв

In the request I wrote a name, in response I got a card with key information

NLP – Natural Language Processing

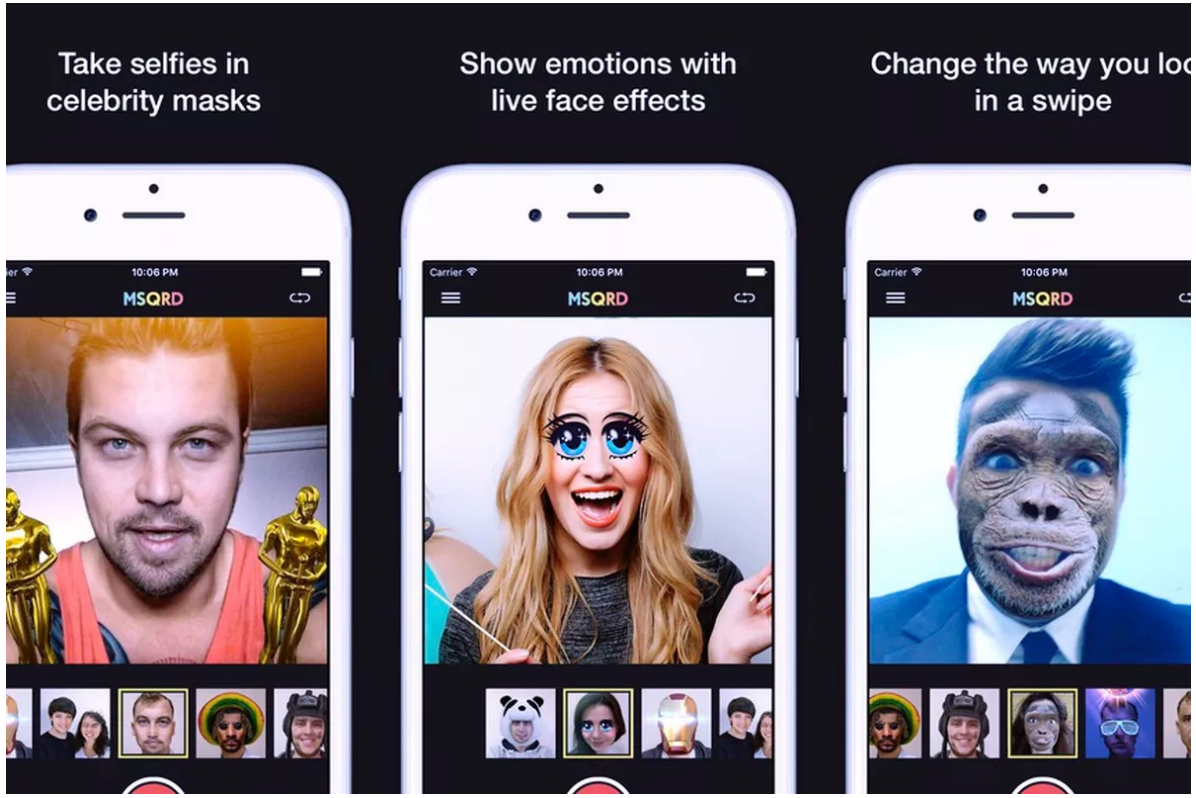
- Machine translation, chat bots, spam filter, search engine suggestions
- And in conjunction with speech recognition - Siri, Alexa

CV – computer vision

- We want to understand what is happening in the image
- Turing test for computer vision problems: answer any question about an image that a person can answer

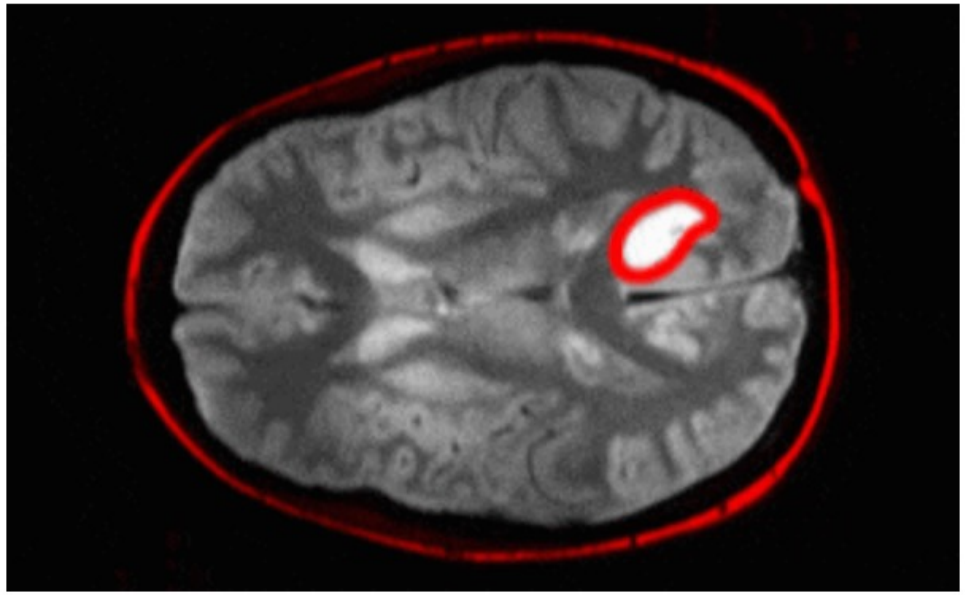

traffic light
traffic light
traffic light
traffic light
traffic light
bus
truck
car
car
car
truck
truck
person
handbag
person
person
person
person
person

CV applications



CV applications

CV applications



Detection of a brain tumor