Introduction to NLP

Software Engineering Decision Supports Lab

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Goals of NLP tutorial by SEDS lab (today)

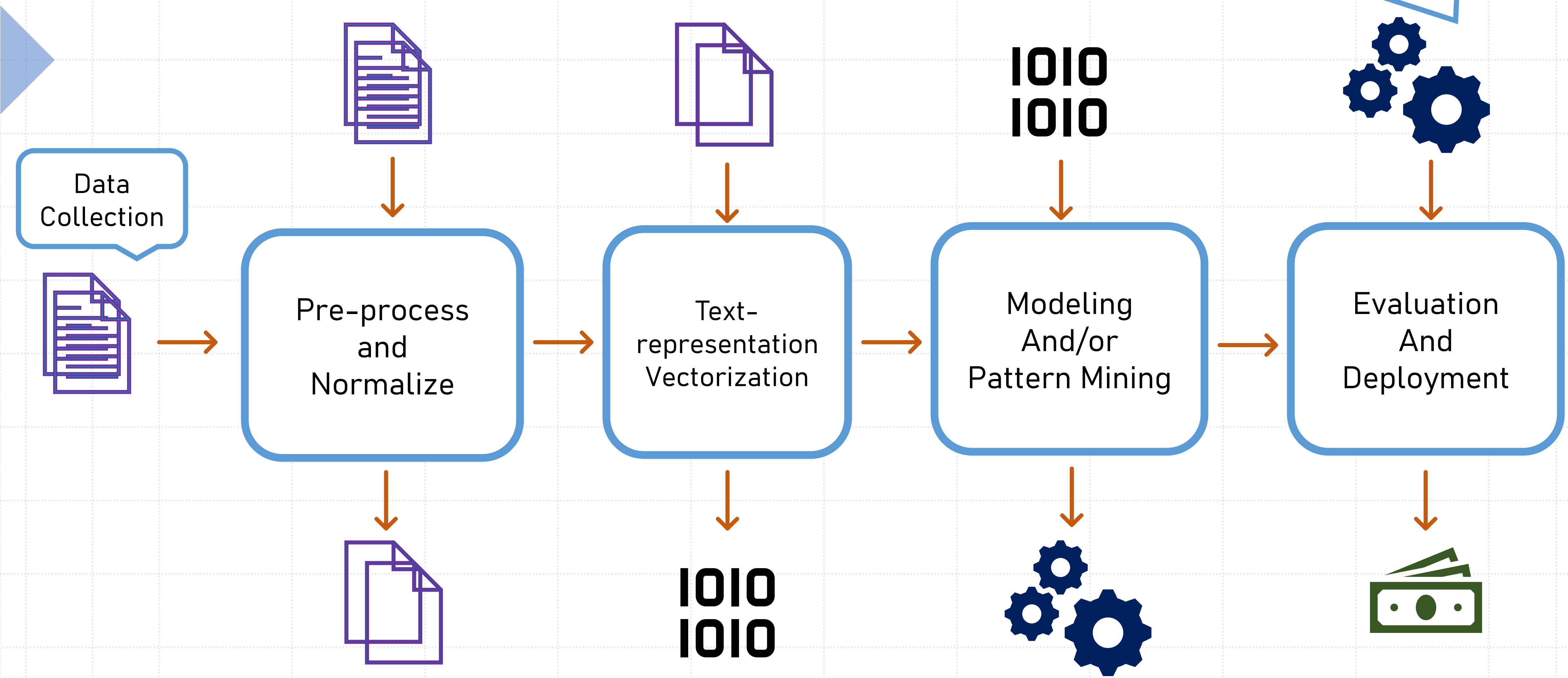
- General understanding of NLP,
  - Applications, use cases
  - Workflow
  - General tools
- Build a sentiment analysis tool Together!
  - Explaining each part
  - Implementing them

Applications of NLP

- Email Filters
- Fraud Detection
- Search Results
- Predictive Text
- Language translation
- Data and Text analysis
- More …

- Requirements Elicitation
- Sentiment Analysis
- Opinion Mining
- Text Summarization
- Context Analysis
- Decision Support

NLP general workflow



Sentiment Analysis
Classification (spam, fraud, …)
Language Generation
More …

Data Collection

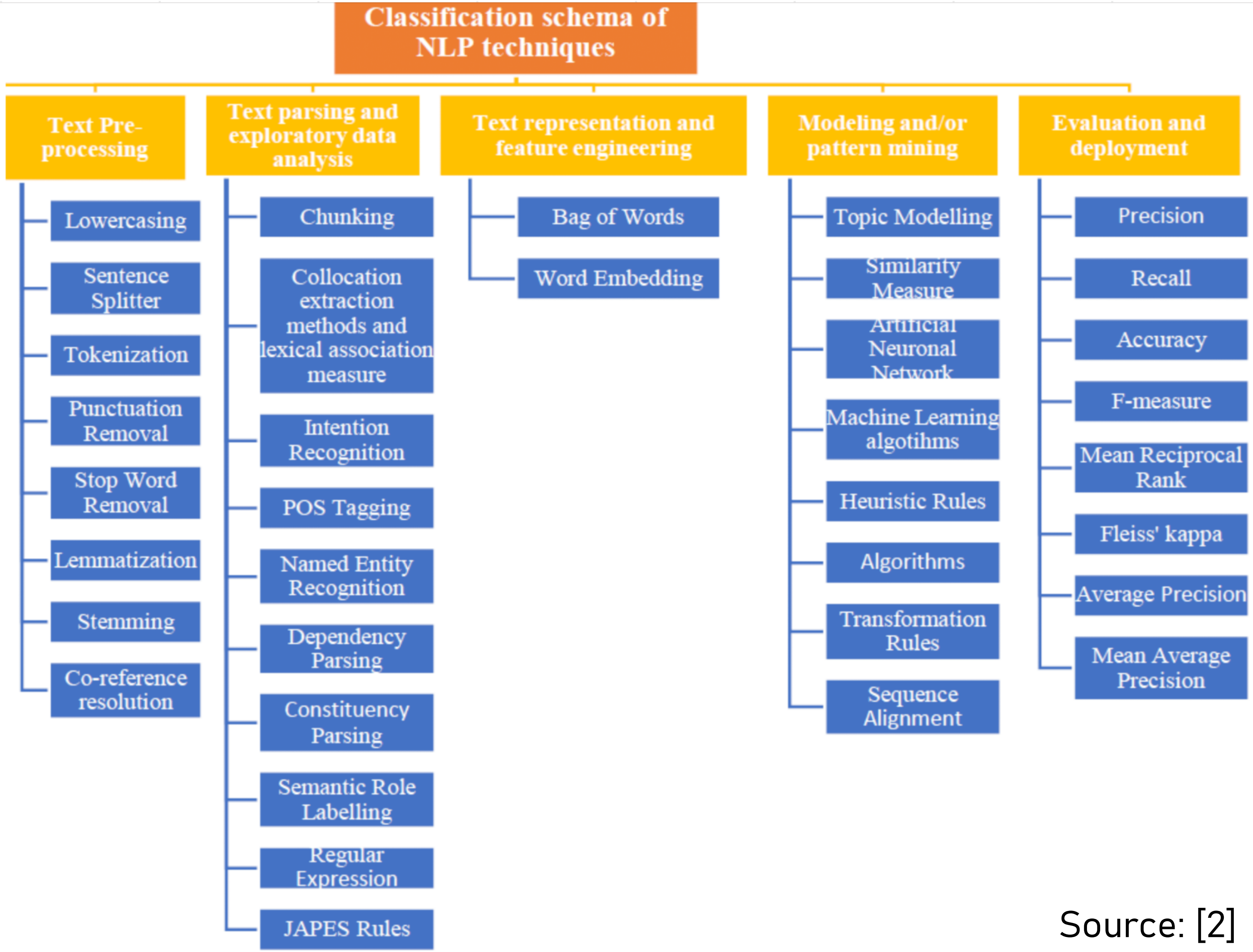
Pre-process and Normalize

Text-representation Vectorization

Modeling And/or Pattern Mining

Evaluation And Deployment

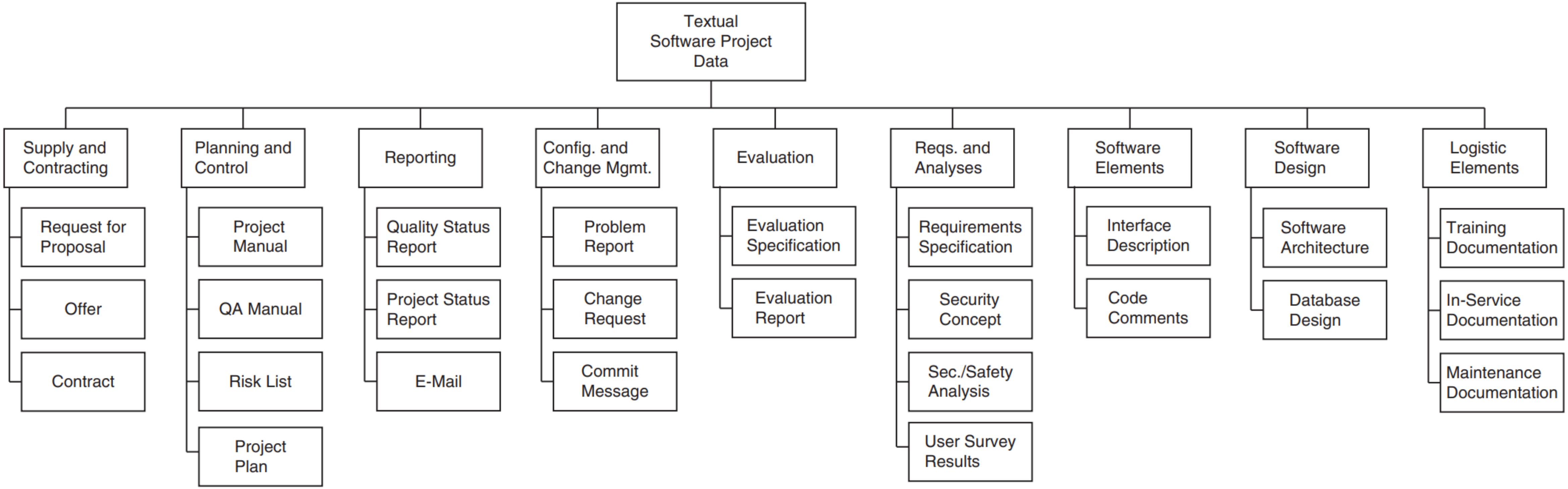
Classification schema of NLP techniques



- Classification schema of NLP techniques
  - Text Pre-processing
    - Lowercasing
    - Sentence Splitter
    - Tokenization
    - Punctuation Removal
    - Stop Word Removal
    - Lemmatization
    - Stemming
    - Co-reference resolution
  - Text parsing and exploratory data analysis
    - Chunking
    - Collocation extraction methods and lexical association measure
    - Intention Recognition
    - POS Tagging
    - Named Entity Recognition
    - Dependency Parsing
    - Constituency Parsing
    - Semantic Role Labelling
    - Regular Expression
    - JAPES Rules
  - Text representation and feature engineering
    - Bag of Words
    - Word Embedding
  - Modeling and/or pattern mining
    - Topic Modelling
    - Similarity Measure
    - Artificial Neuronal Network
    - Machine Learning algotihms
    - Heuristic Rules
    - Algorithms
    - Transformation Rules
    - Sequence Alignment
  - Evaluation and deployment
    - Precision
    - Recall
    - Accuracy
    - F-measure
    - Mean Reciprocal Rank
    - Fleiss' kappa
    - Average Precision
    - Mean Average Precision

Source: [2]

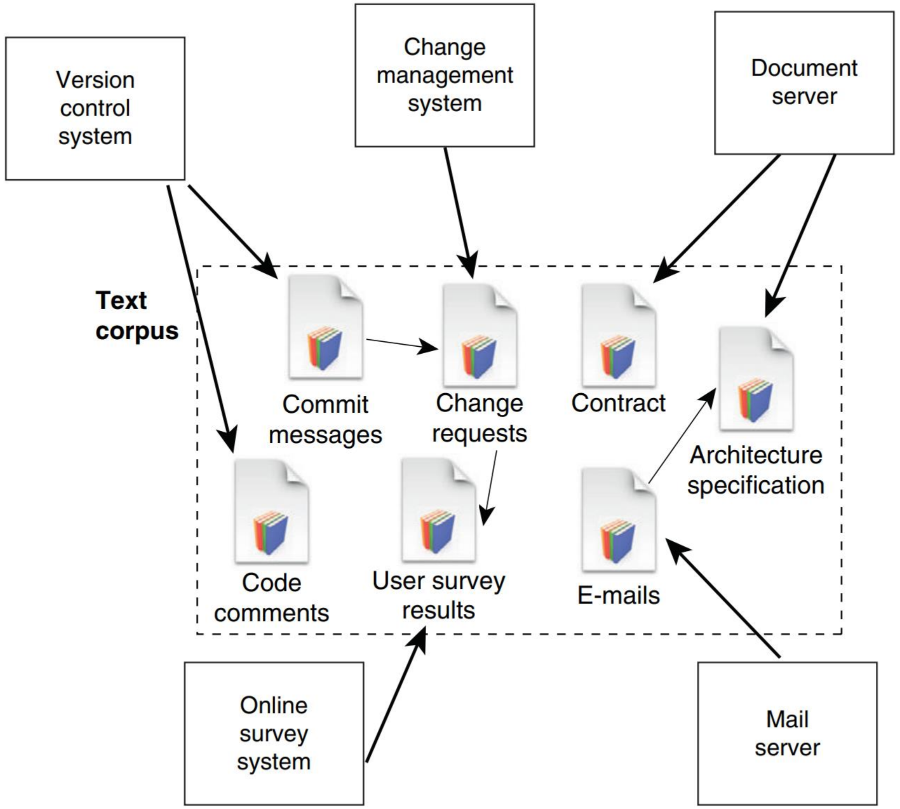
Textual Data in Software Projects



Source: [1]

Textual Data Retrieval

- API's
- Enterprise Resource Planning (ERP) systems
- Version Control history
- Communications
  - Email
  - Chat
- Surveys



Source of image: [1]

Let’s Start Coding

Text-Preprocessing

Text Parsing and Exploratory data analysis

- Named Entity Recognition
- Part-Of-Speech (POS) Tagging

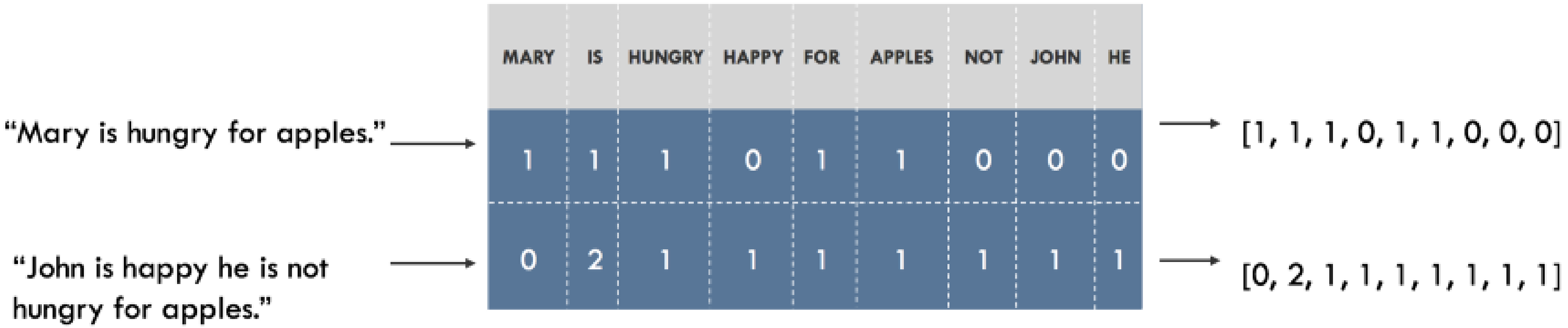
Let’s See some examples in the existing general purpose NLP tools:

- IBM’s NLP tool set called Watson (link)
- Google’s NLP API (link)

Text representation – Vectorizing

- A few Text Representation and Vectorization methods:
  - **Bag of Words (BoW)**
  - N-Gram (extension of BoW)
  - **TF-IDF**
  - Word2Vec
  - Doc2Vec
  - BERT

Bag of Words



	MARY	IS	HUNGRY	HAPPY	FOR	APPLES	NOT	JOHN	HE	
“Mary is hungry for apples.”	1	1	1	0	1	1	0	0	0	[1, 1, 1, 0, 1, 1, 0, 0, 0]
“John is happy he is not hungry for apples.”	0	2	1	1	1	1	1	1	1	[0, 2, 1, 1, 1, 1, 1, 1, 1]

Source: https://blog.insightdatascience.com/how-to-solve-90-of-nlp-problems-a-step-by-step-guide-fda605278e4e

- Why this is NOT a good text representation?

Term Frequency-Inverse Document Frequency (TF-IDF)

- Why TF-IDF?
- What is it?
  - Creates a document-term matrix; one row per document, one column per word in the corpus
  - Generates a weighting for each word/document pair intended to reflect how important a given word is to the document within the context of its frequency within a larger corpus

$$\text{M tweets}\left\{\overbrace{\begin{array}{ccccc} 0.27 & 0.23 & \dots & 0.77 & 0.68 \\ 0.86 & 0.96 & \dots & 0.3 & 0.83 \\ \dots & \dots & \dots & \dots & \dots \\ 0.18 & 0.71 & \dots & 0.87 & 0.63 \\ 0.68 & 0.29 & \dots & 0.61 & 0.92 \end{array}}^{\text{N words}}\right.$$

$$w_{i,j} = tf_{i,j} \times log(\frac{N}{df_i})$$

$w_{i,j}$ = weighting of word i for document j

$tf_{i,j}$ = number of times i occurs in j divided by the total number of terms in j

df_i = number of documents containing word i

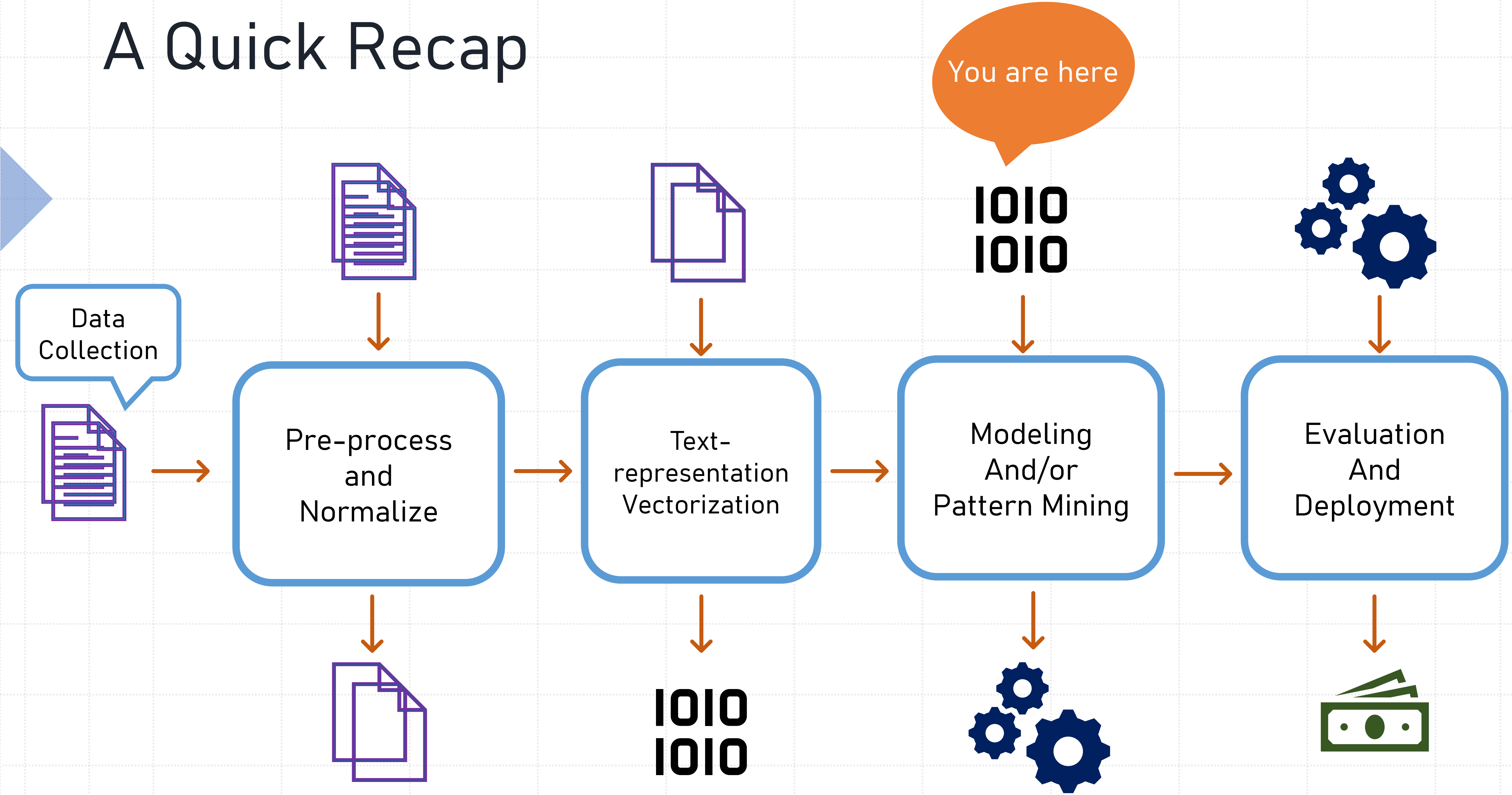
N = total number of documents

Let's Continue Coding

TF-IDF

Vectorization

A Quick Recap



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Data Collection

Pre-process and Normalize

Text-representation Vectorization

Modeling And/or Pattern Mining

Evaluation And Deployment

Modeling and/or Pattern mining

- Machine Learning:
  - NVIDIA, 2016: Practice of using algorithms to parse data, learn from it, and then make a determination or prediction about something in the world. [3]

- Two broad types of ML
  - Supervised Learning

    Inferring a function from a labeled training data to make predictions on unseen data

    Example: Predict whether any given tweet has a positive or negative emotion

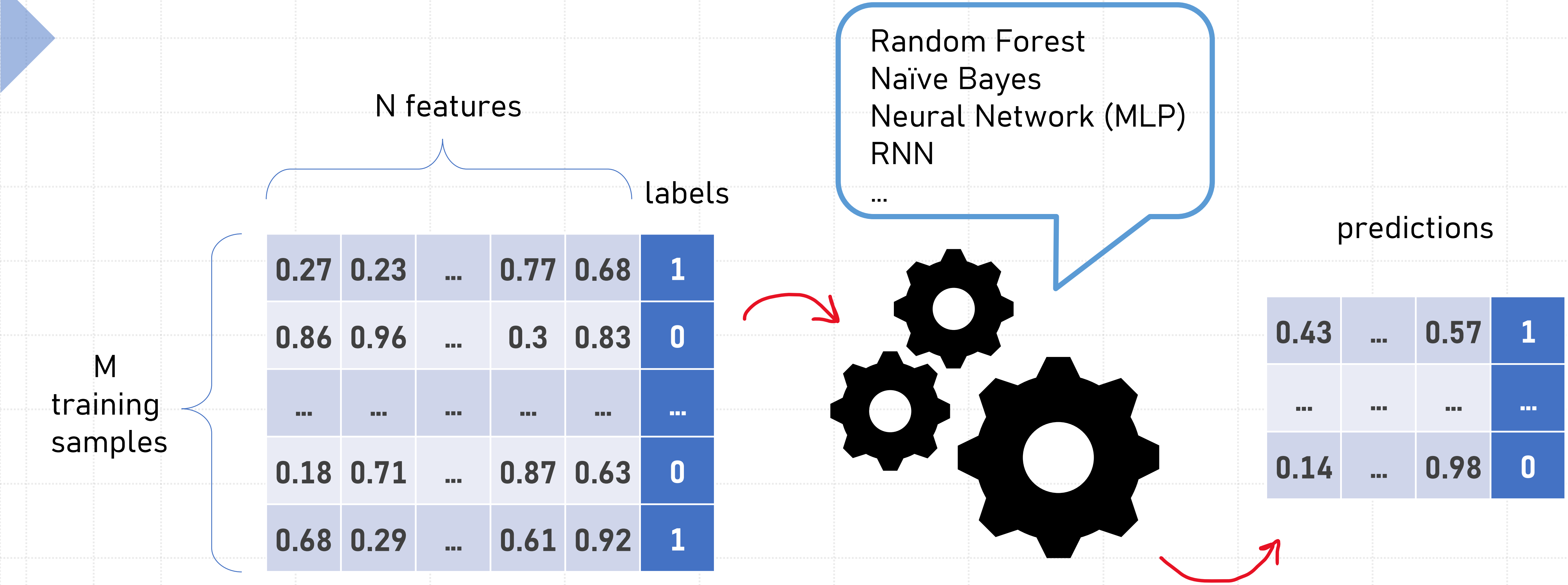
  - Unsupervised Learning

    Deriving structure from data where we don't know the effect of any of the variables

    Example: Based on the content of a tweet, group similar tweets together in distinct folders

Modeling and/or Pattern mining

Supervised Learning and pattern mining



N features

labels

M training samples

0.27	0.23	…	0.77	0.68	1
0.86	0.96	…	0.3	0.83	0
…	…	…	…	…	…
0.18	0.71	…	0.87	0.63	0
0.68	0.29	…	0.61	0.92	1

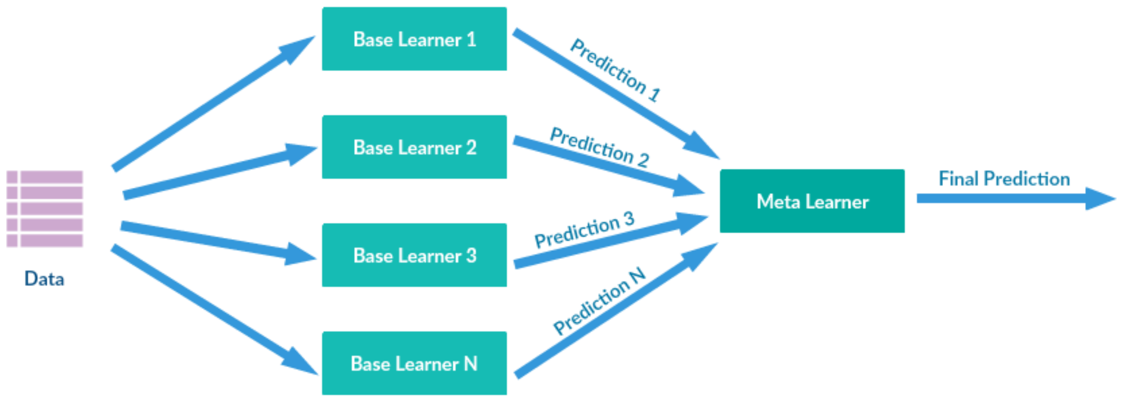
Random Forest
Naïve Bayes
Neural Network (MLP)
RNN
…

predictions

0.43	…	0.57	1
…	…	…	…
0.14	…	0.98	0

Random Forest

- Why Random Forest?
- Ensemble Methods



Source: https://medium.com/geekculture/the-power-of-ensemble-96cd2621c2de

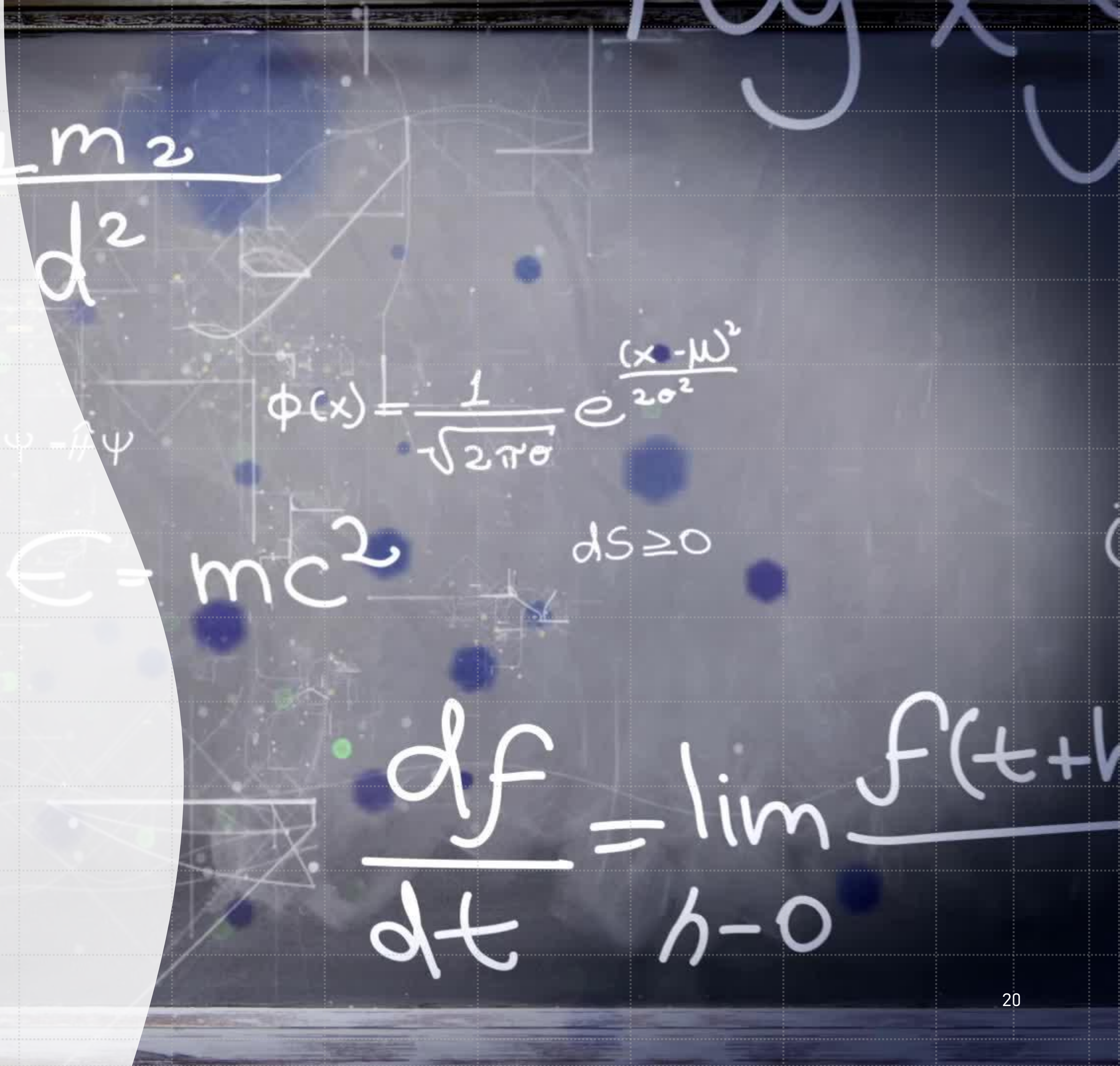
- Can be used for classification or regression
- Handles outliers, missing values, etc.
- Less likely to overfit

- Random Forest
  - **Ensemble learning method**
  - A collection of **decision trees**
  - **aggregates the predictions**
  - A simple voting method for decision trees (DT):

  70 DTs vote for **Positive** > 30 DTs for Negative

Let's Continue and Finish Coding

Modeling and Pattern Mining



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