# MOD500 Decision Analysis with Artificial Intelligence Support

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# Decision trees learning

It is a simple model for supervised classification

Each decision nodes performs a Boolean test (binary split version)

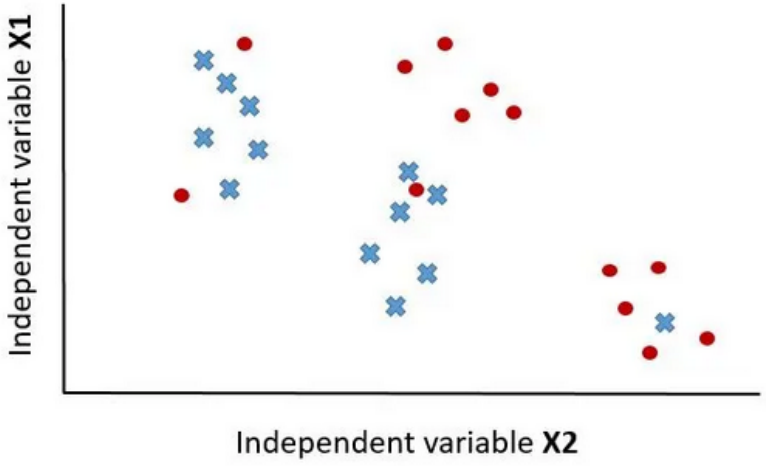
They are build out of DATA!

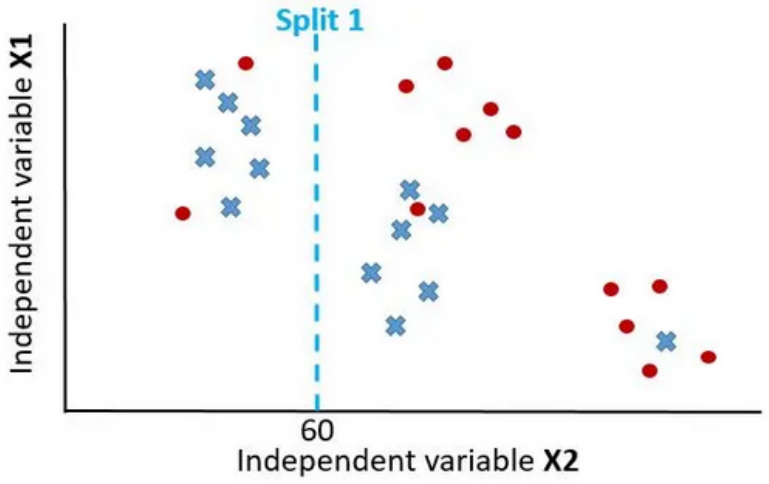
At each split, we perform the slip that reduce entropy the most.

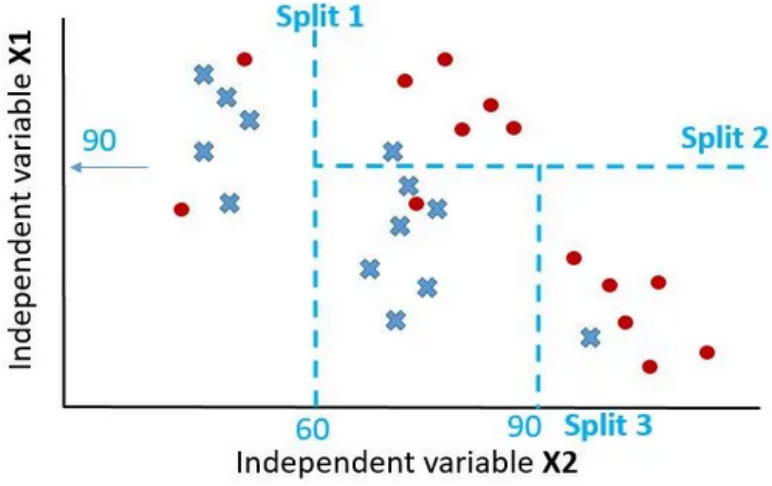
**REMINDER**

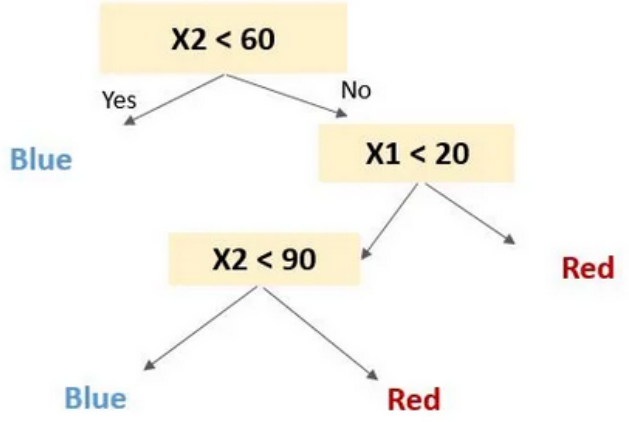
We need to provide a label!

# Decision tree outcome



# Decision trees

## Pseudo-code

- Compute the entropy of each feature (myopic approach)
- Pick the feature with the maximum entropy
- For each value of the selected feature, compute the entropy of the new population
- Compute the Information Gain by splitting the dataset
- Repeat for the number of desired splits

# Decision trees in Python

```
"""
MOD500 tutorial: Decision tree minimal example

"""
import numpy as np
from matplotlib import pyplot as plt

from sklearn.datasets import load_iris
from sklearn.tree import DecisionTreeClassifier, plot_tree

iris = load_iris()
X = iris.data
y = iris.target

clf = DecisionTreeClassifier(max_leaf_nodes=10,
                             criterion='entropy')
clf.fit(X, y)

plot_tree(clf, proportion=True, filled=True)

plt.show()
```

# Tutorial [4]

Generate (at least) 4 different probability distributions

Make a meaningful label, and then make a decision tree from the data generated

(Use the given template to sort out Python programming part if you need)

# Language models

A language model is a probability distribution over sequences of words [1].

Jurafsky and Martin: Speech and Language Processing, 2023

P(Twinkle twinkle little star, how I wonder what you are.) = 0.99
P(Twinkle twinkle little moon, how I wonder what you are.) = 0.75
P(Twinkle twinkle little star, how I what you are.) = 0.3 P(Are you what I wonder I how star, little twinkle, twinkle.) = 0.02

# Vector representations

## Vector representation

- tokenization
- word2vec

| | aardvark | ... | computer | data | result | pie | sugar | ... |
|---|---|---|---|---|---|---|---|---|
| **cherry** | 0 | ... | 2 | 8 | 9 | 442 | 25 | ... |
| **strawberry** | 0 | ... | 0 | 0 | 1 | 60 | 19 | ... |
| **digital** | 0 | ... | 1670 | 1683 | 85 | 5 | 4 | ... |
| **information** | 0 | ... | 3325 | 3982 | 378 | 5 | 13 | ... |

# Sparse Vector representations

| | aardvark | ... | computer | data | result | pie | sugar | ... |
|---|---|---|---|---|---|---|---|---|
| **cherry** | 0 | ... | 2 | 8 | 9 | 442 | 25 | ... |
| **strawberry** | 0 | ... | 0 | 0 | 1 | 60 | 19 | ... |
| **digital** | 0 | ... | 1670 | 1683 | 85 | 5 | 4 | ... |
| **information** | 0 | ... | 3325 | 3982 | 378 | 5 | 13 | ... |

Table of co-occurrences of the words in Wikipedia

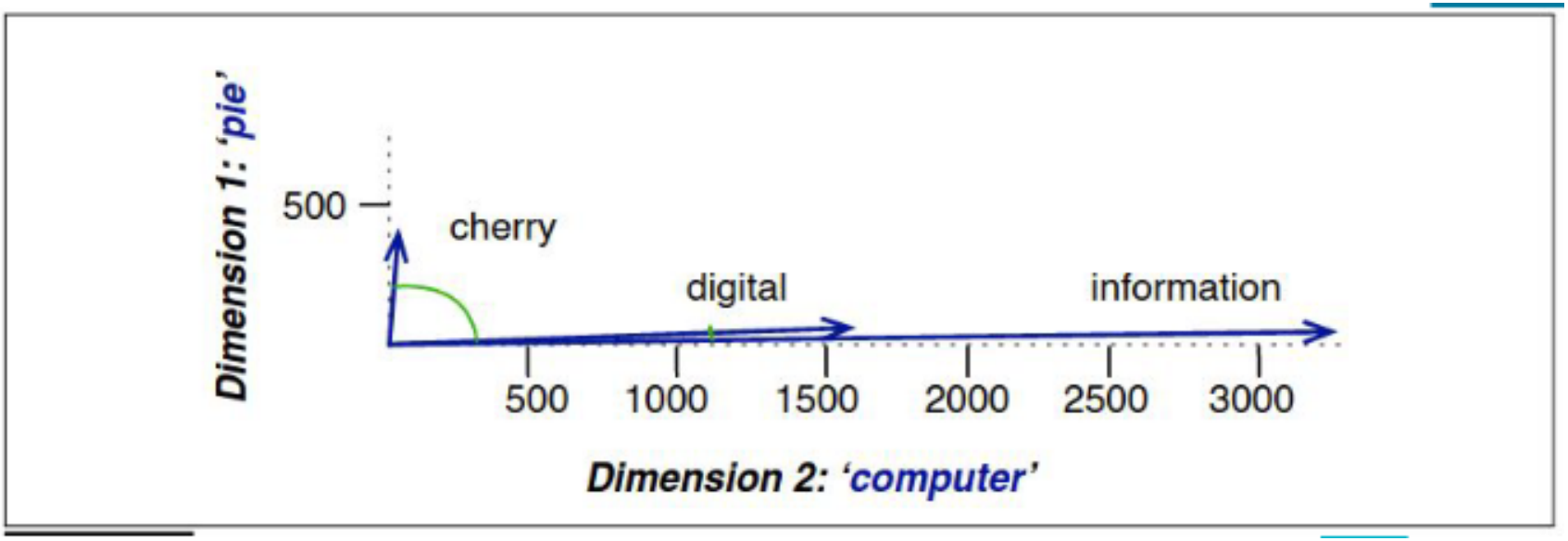
Cherry picking is the act of pointing to individual cases that seem to confirm a particular position while ignoring a significant portion of similar cases or data that may contradict that position.

- One dimension for each word $->$ long
- Many values are 0 $->$ sparse

# Vector similarity

## Metric alert

How close are two words?



# Transformers

- A neural network designed to explicitly take into account the long-range dependencies between words
- Sequence-to-sequence models that transform an input vectors (x1, ..., xn) to some output vectors (y1, ..., yn) of the same length
- Transformers are made up of stacks of transformer blocks.
- Attention allows to directly extract and use information from arbitrarily long contexts

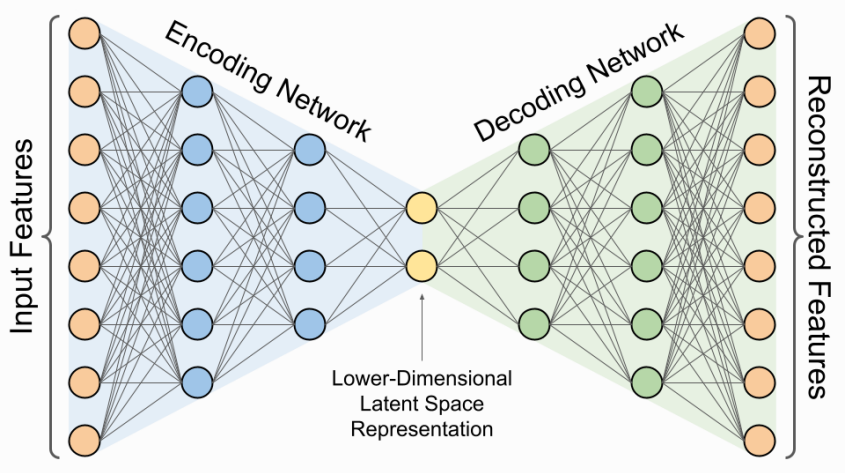
# Encode & decode

## Encoder model

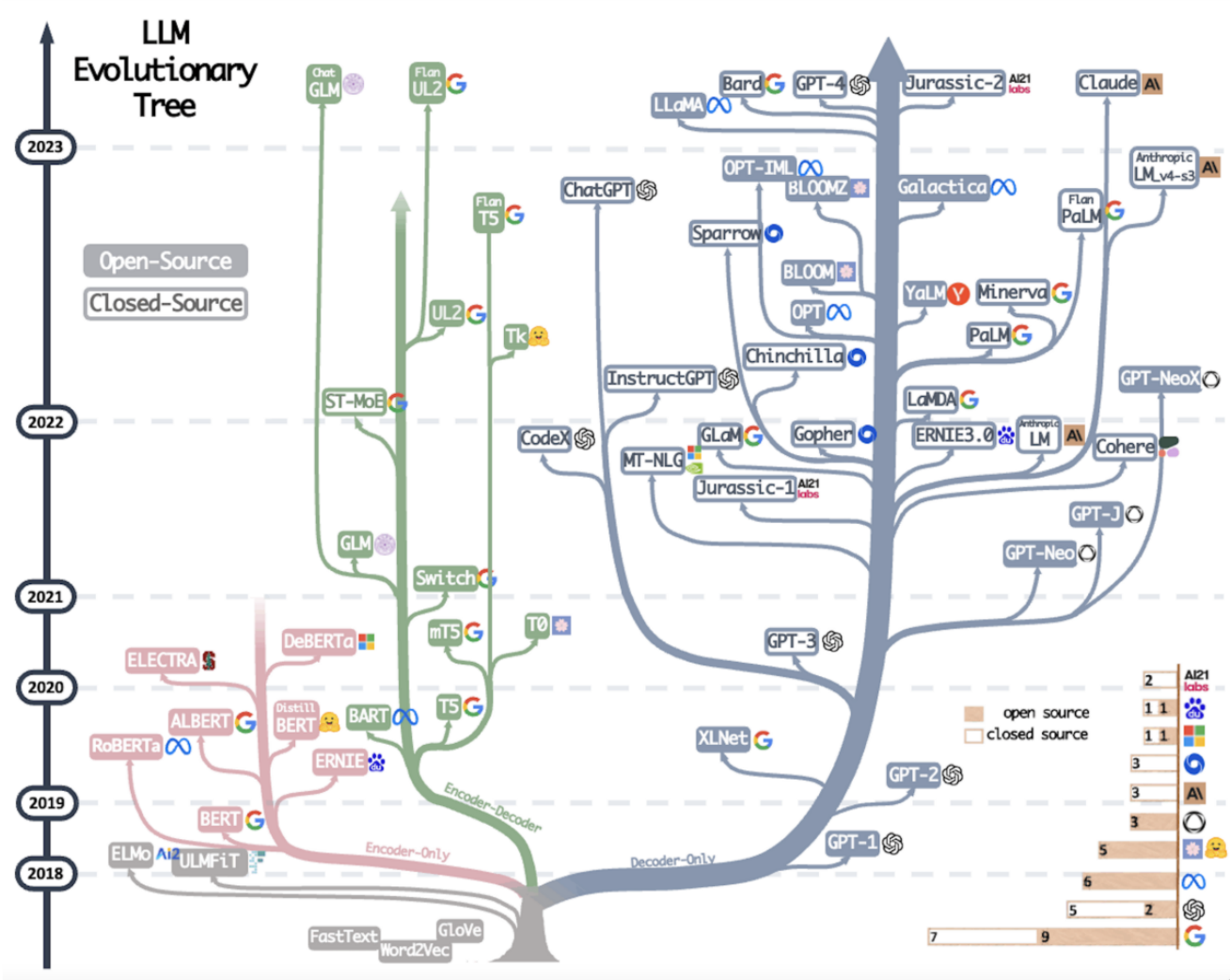
From an input sequence to a contextualised representation of each input element

## Decoder model

From contextualised representations to a task-specific output sequence



# LLMs


LLM Evolutionary Tree
2023
2022
2021
2020
2019
2018
Open-Source
Closed-Source
Chat GLM
Flan UL2
Bard
GPT-4
Jurassic-2
Claude
LLaMA
OPT-IML
BLOOMZ
Galactica
Anthropic LM_v4-s3
ChatGPT
Flan T5
Sparrow
Flan PaLM
BLOOM
YaLM
Minerva
UL2
OPT
Tk
PaLM
Chinchilla
InstructGPT
GPT-NeoX
LaMDA
ST-MoE
CodeX
GLaM
Gopher
ERNIE3.0
Anthropic LM
Cohere
MT-NLG
Jurassic-1
GPT-J
GLM
GPT-Neo
Switch
mT5
T0
DeBERTa
GPT-3
ELECTRA
ALBERT
Distill BERT
BART
T5
XLNet
RoBERTa
ERNIE
GPT-2
BERT
Encoder-Decoder
ELMo
ULMFiT
Encoder-Only
Decoder-Only
GPT-1
FastText
GloVe
Word2Vec
open source
closed source

# Learn more!

- Speech and Language Processing, Chapter 9 (Transformers) and 10 (Large Language Models), Dan Jurafsky and James H. Martin 17
- The Illustrated Transformer, Jay Alammar