



An Overview of Machine Learning Methods

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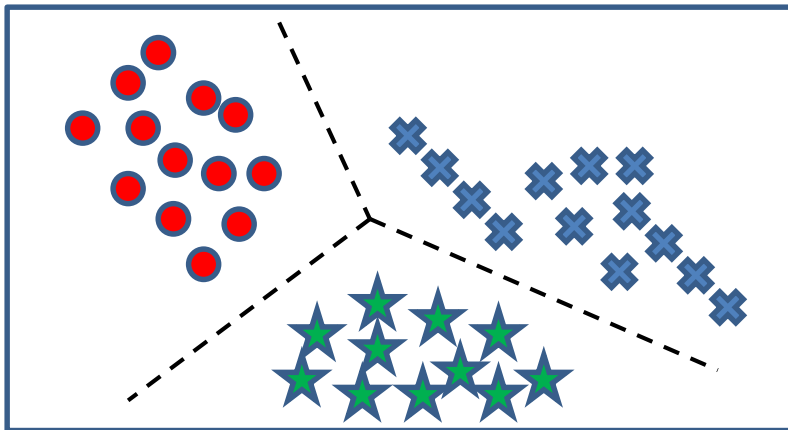
Institutes of Brain Science/Digital Medicine Center
National Yang-Ming University

Mar 19, 2019

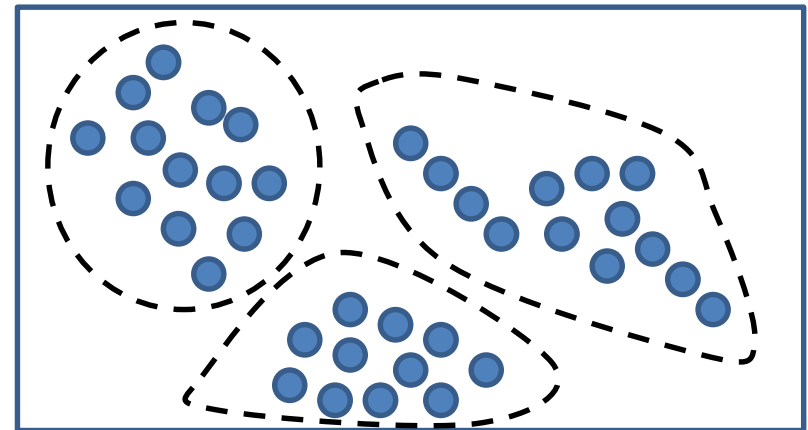
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What is **Machine Learning**?

Machine Learning is concerned with the development of **algorithms** and techniques that allow computers to learn.



Supervised Learning



Unsupervised Learning

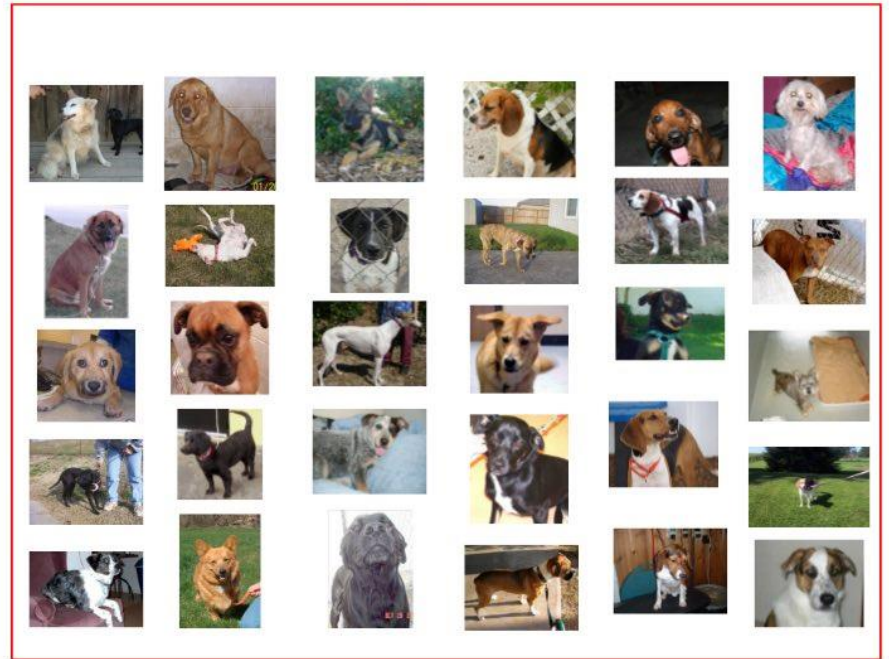
Related Fields: **Artificial Intelligence, Statistics, Data Mining, Computer Science.**

Supervised Learning

Cats



Dogs



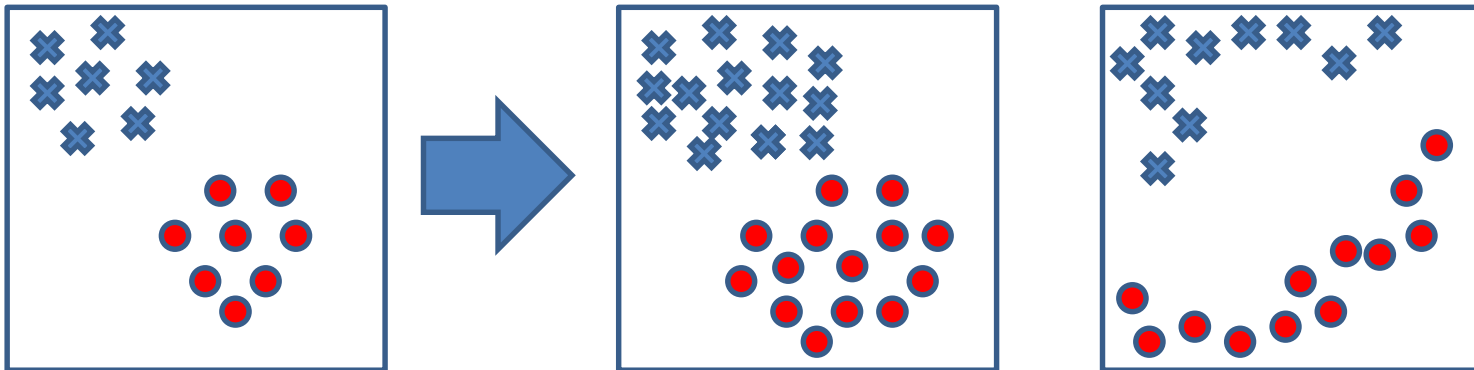
Sample of cats & dogs images from Kaggle Dataset

Unsupervised Learning



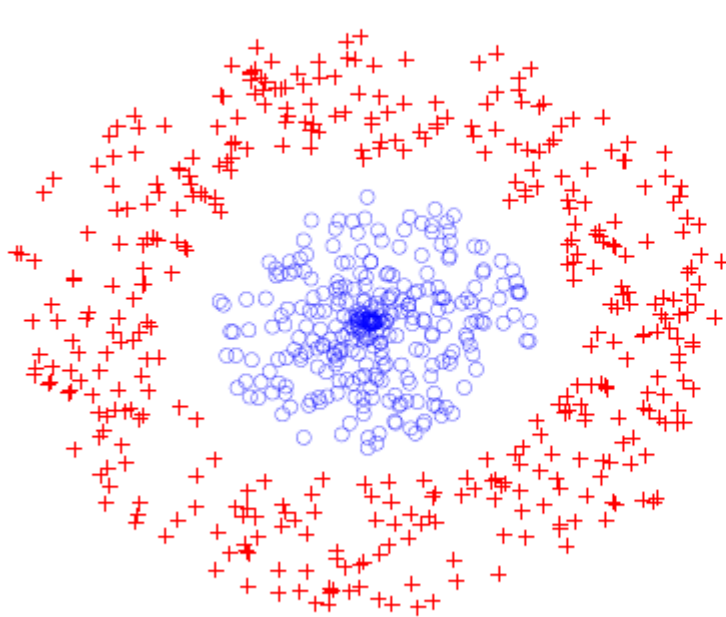
Training and testing

- Training is the process of making the system able to learn.
- No free lunch rule:
 - Training set and testing set come from the same distribution
 - Need to make some assumptions or bias

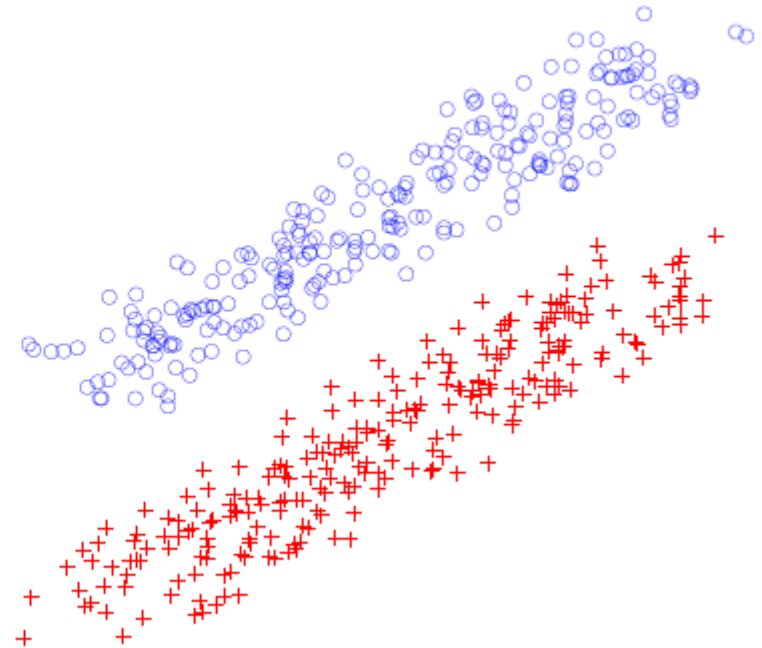


Supervised Learning Techniques

Non-linear vs. Linear Classifiers



Support Vector Machine

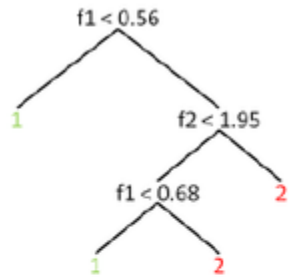


Linear or Logistic Regression

Supervised Learning Techniques

(Random Forest) Decision Tree

tree 1



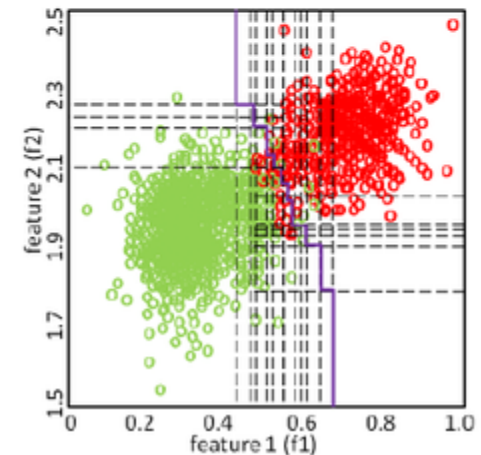
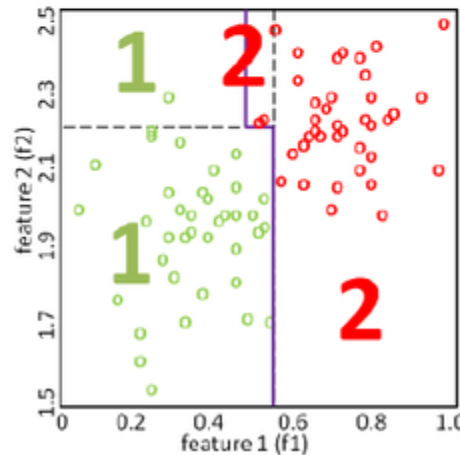
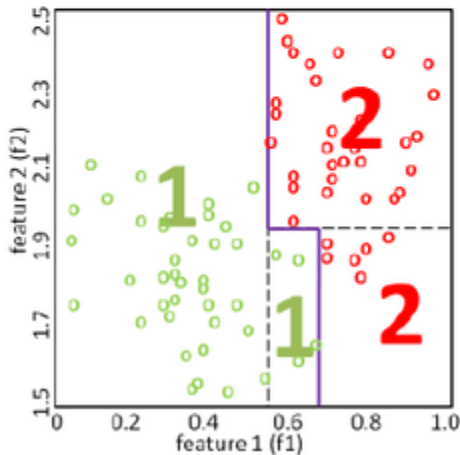
tree 500



forest



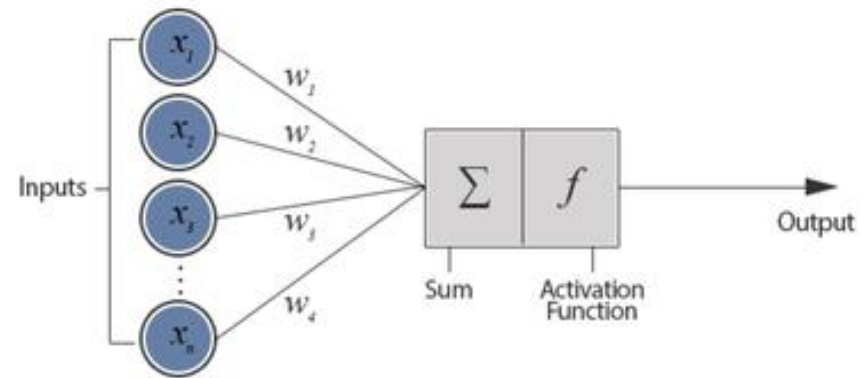
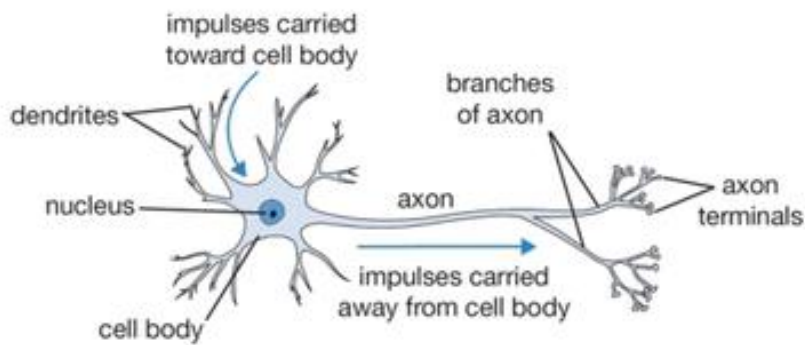
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Supervised Learning Techniques

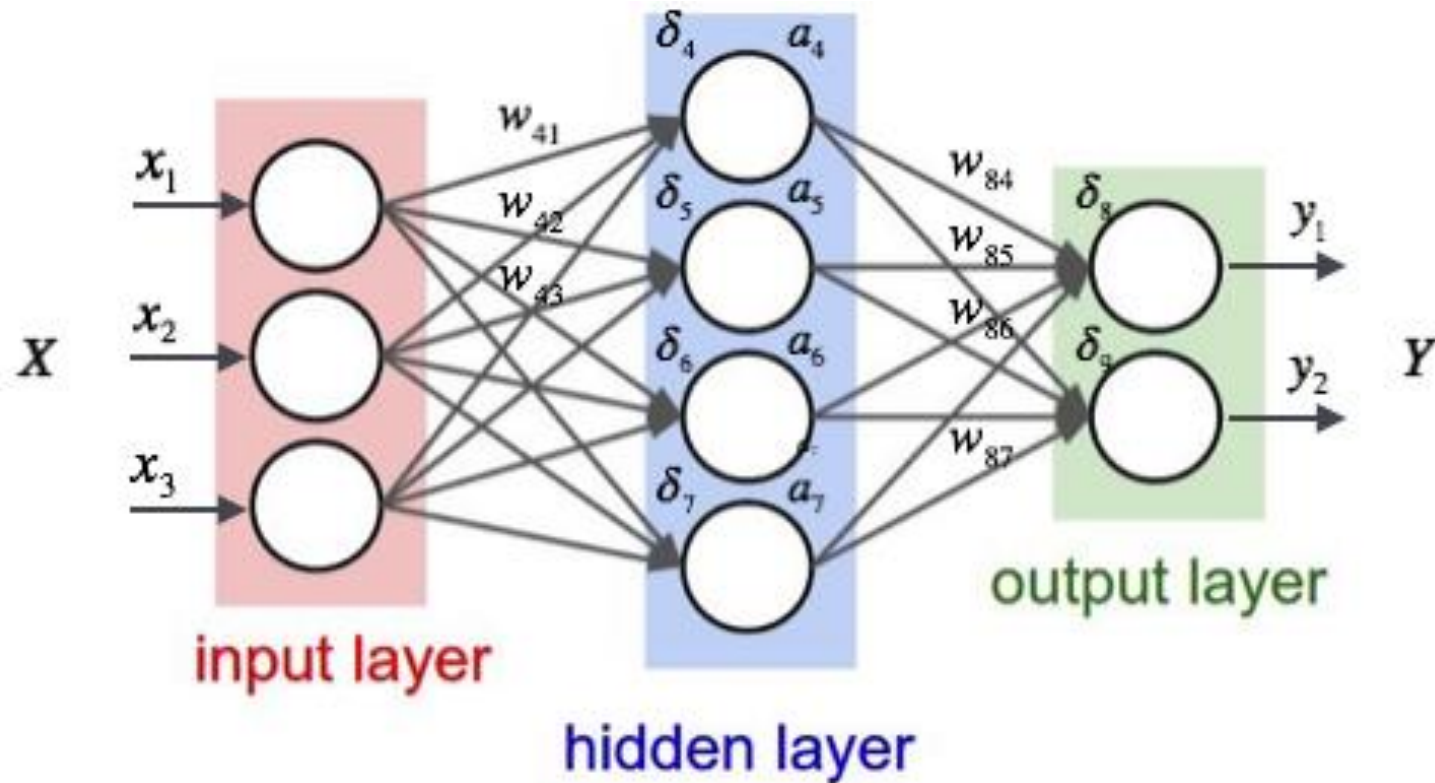
Neural Network

Biological Neuron versus Artificial Neural Network



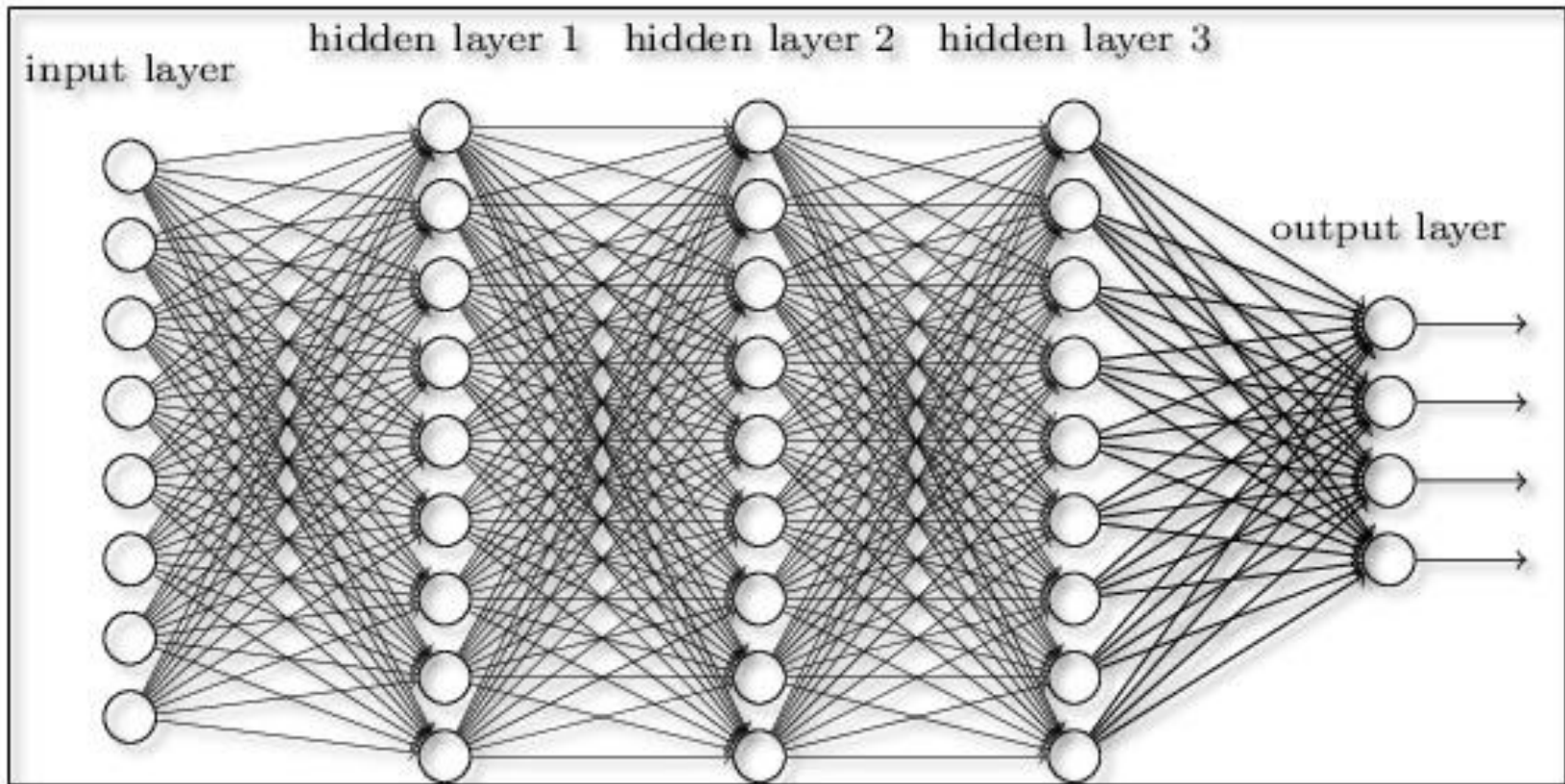
Supervised Learning Techniques

Simple Neural Network



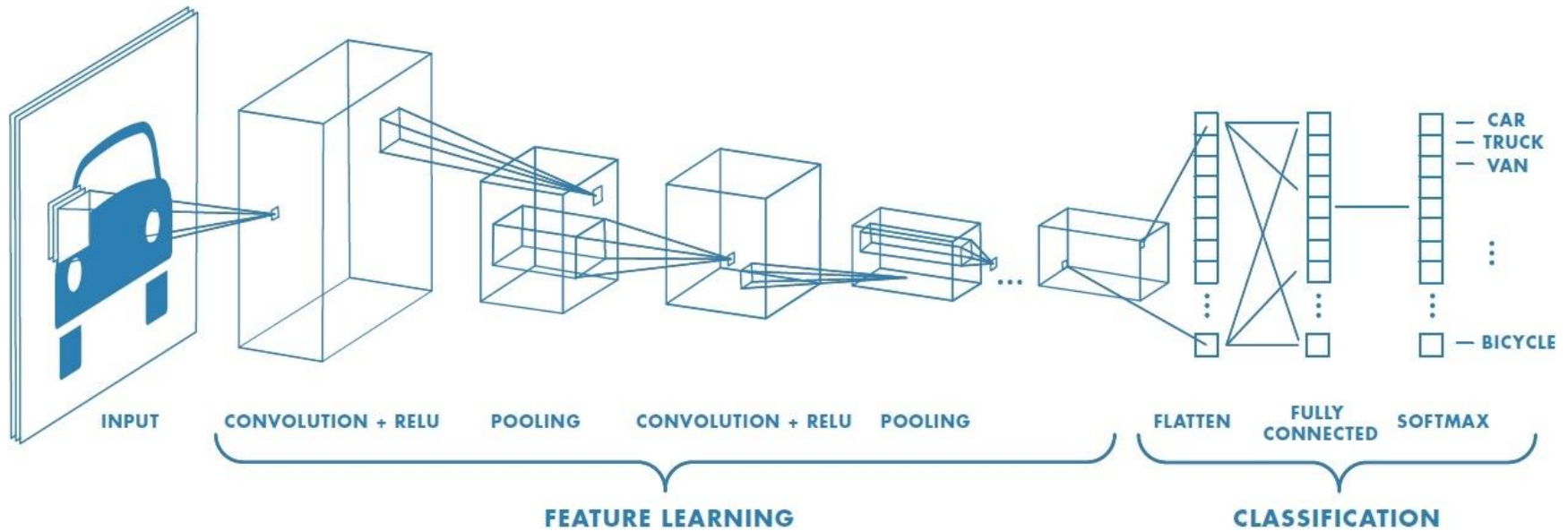
Supervised Learning Techniques

Deep Neural Network



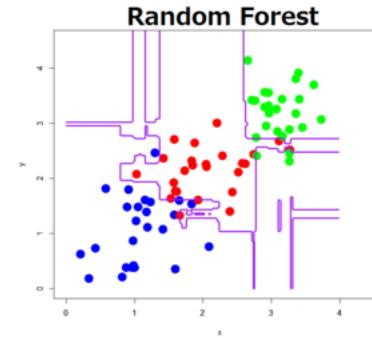
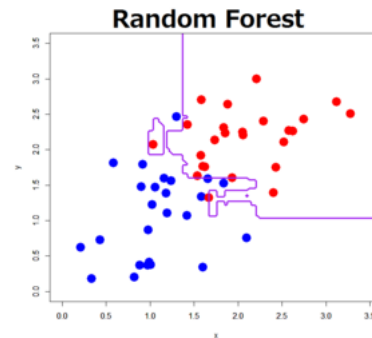
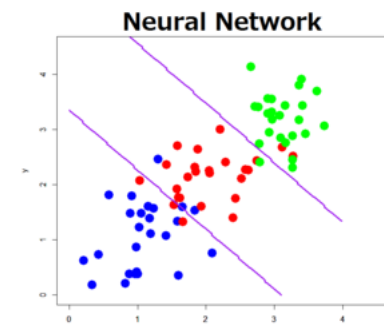
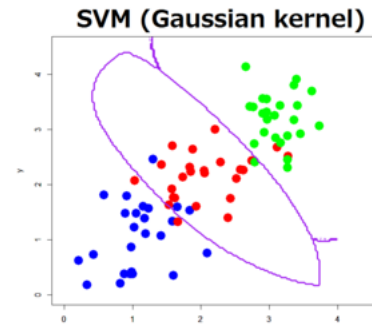
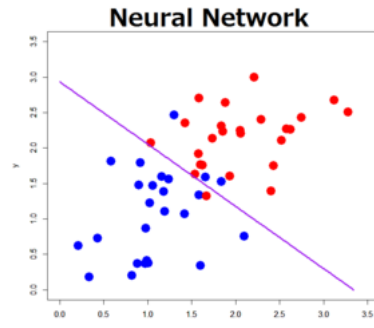
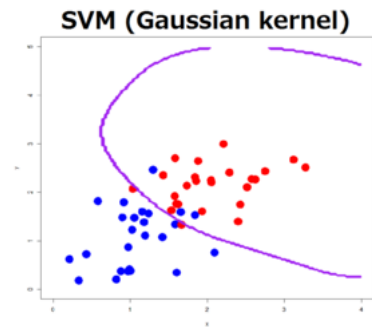
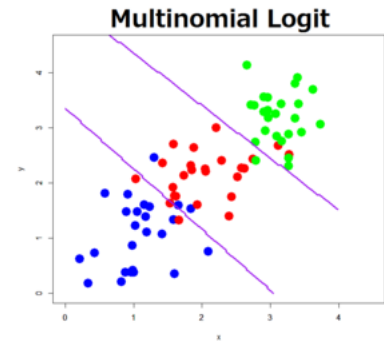
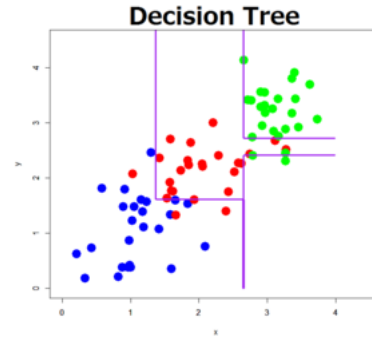
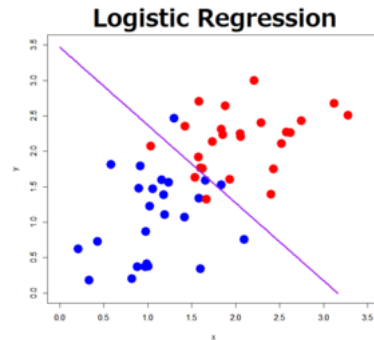
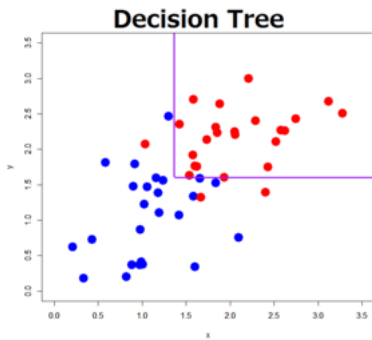
Supervised Learning Techniques

Convolutional Neural Network

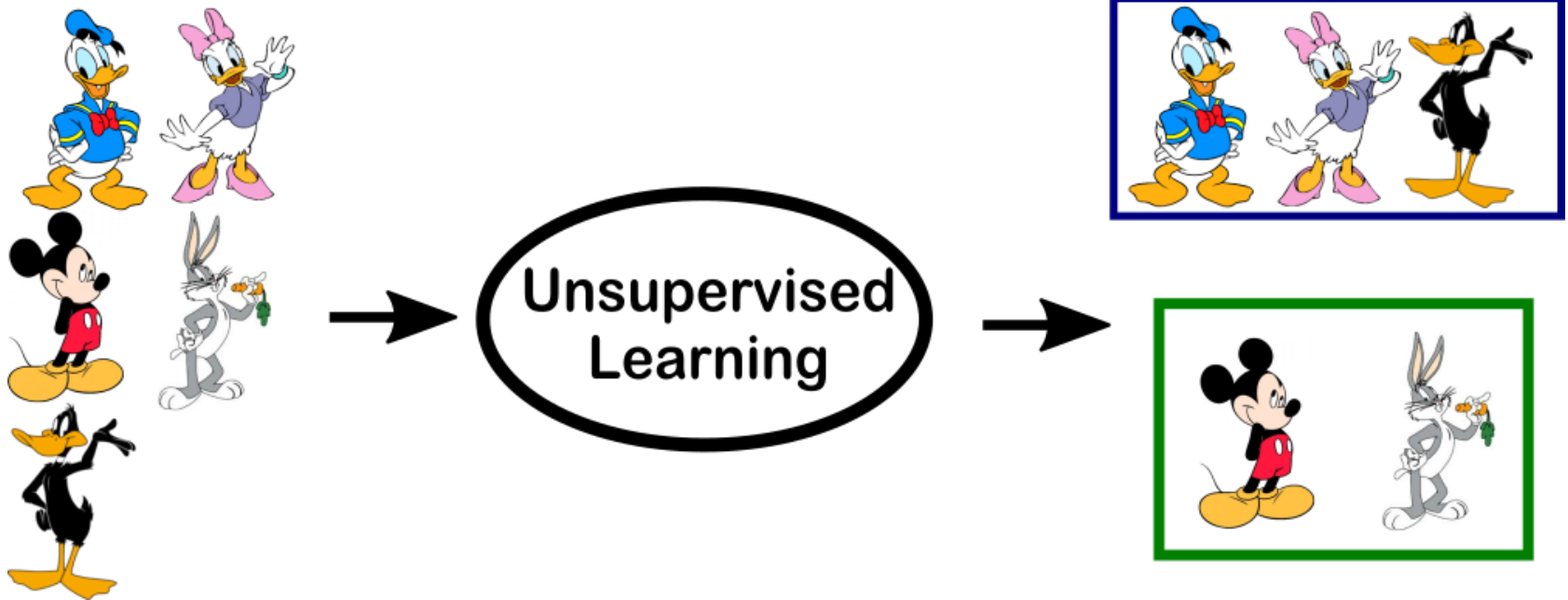


Supervised Learning Techniques

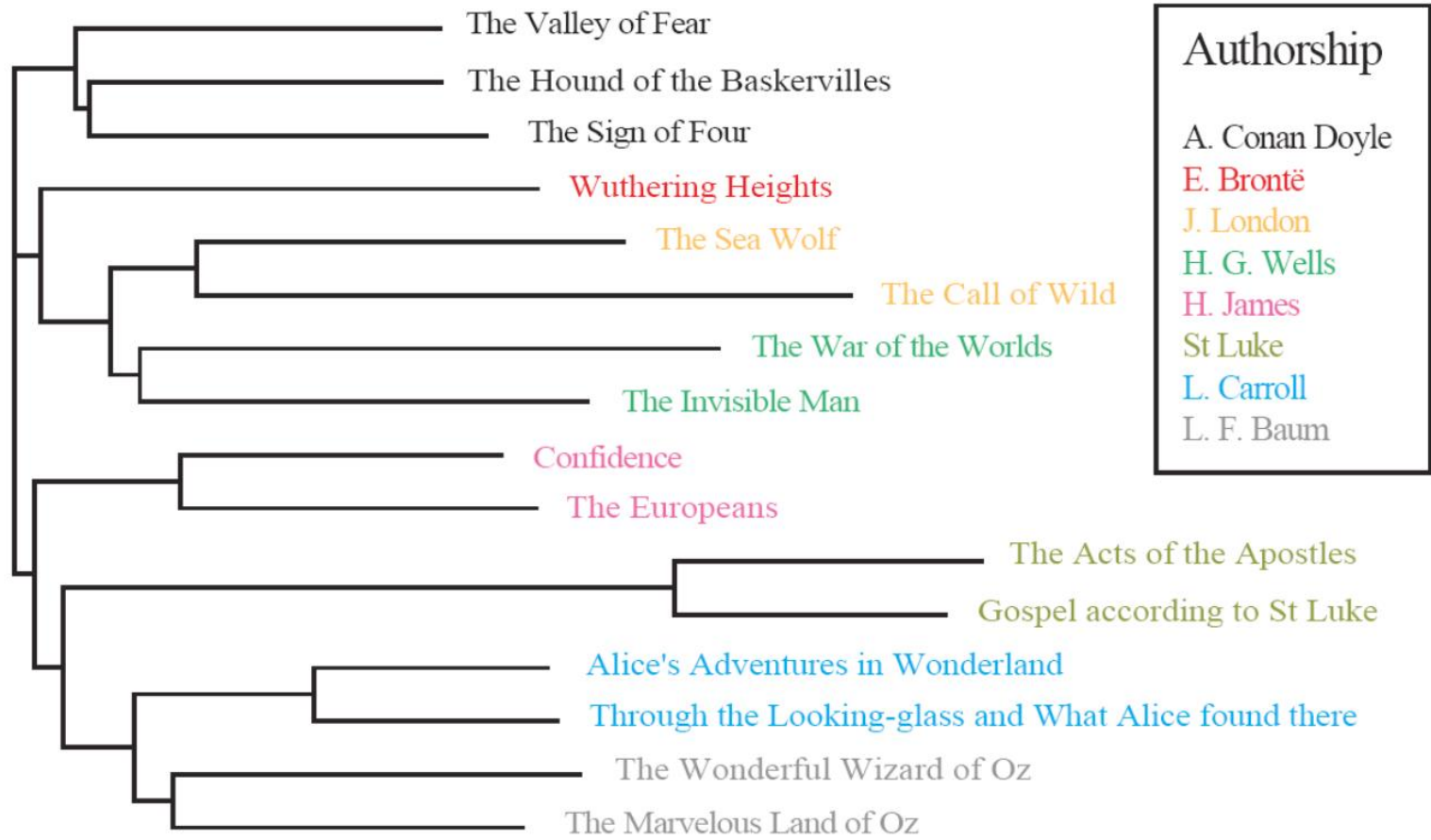
Comparisons



Unsupervised Learning Techniques



Authorship Classification



0.1

Yang AC et al. *Physica A* 329:473-483 (2003)

Yang AC , et al. *Physical Review Letters* 90:108103 (2003)

Frequency and Rank Order Statistics

a. The Winter's Tale (William Shakespeare)

Word	Rank	Frequency
The	1	857
I	2	701
And	3	657
To	4	635
Of	5	475
You	6	472
A	7	419
My	8	405
That	9	338
Not	10	305
...

Total different words: 3703

b. Cymbeline (William Shakespeare)

Word	Rank	Frequency
The	1	966
I	2	771
And	3	713
To	4	671
Of	5	525
A	6	459
You	7	424
My	8	383
That	9	381
In	10	320
...

Total different words: 4042

Frequency and Rank Order Statistics

a. The Winter's Tale (William Shakespeare)

Word	Rank	Frequency
The	1	857
I	2	701
And	3	657
To	4	635
Of	5	475
You	6	472
A	7	419
My	8	405
That	9	338
Not	10	305
...

Total different words: 3703

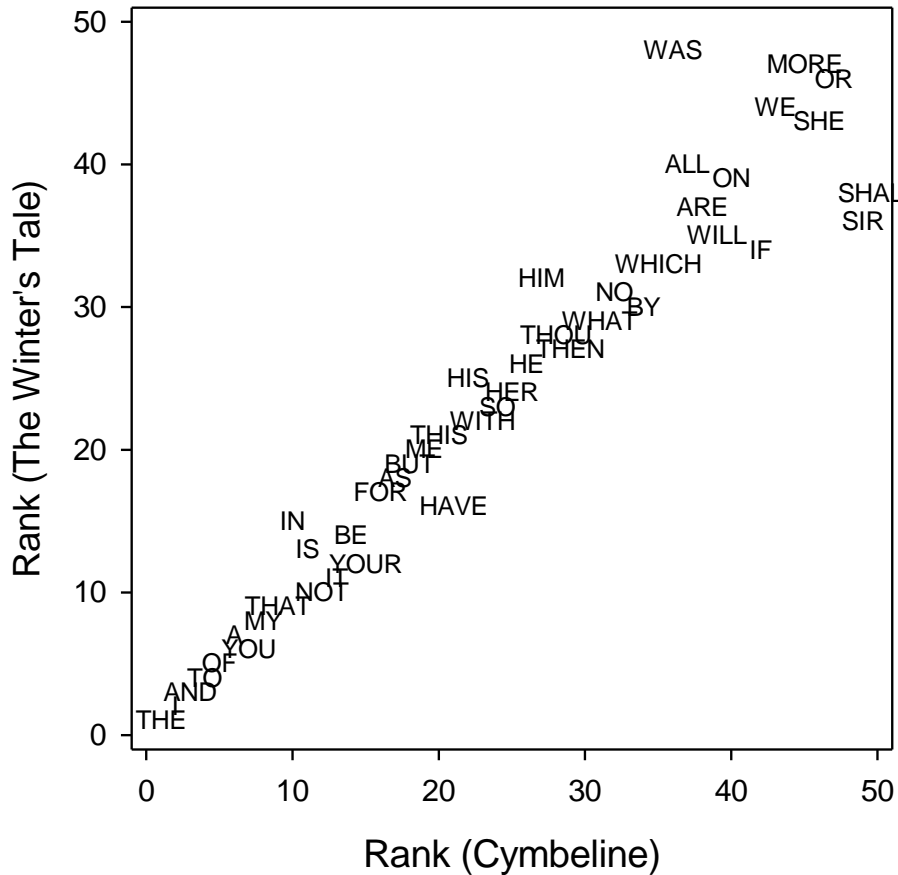
c. Bonduca (John Fletcher)

Word	Rank	Frequency
And	1	667
The	2	584
I	3	552
To	4	432
A	5	393
You	6	286
Of	7	273
Petillius	8	224
Your	9	214
That	10	203
...

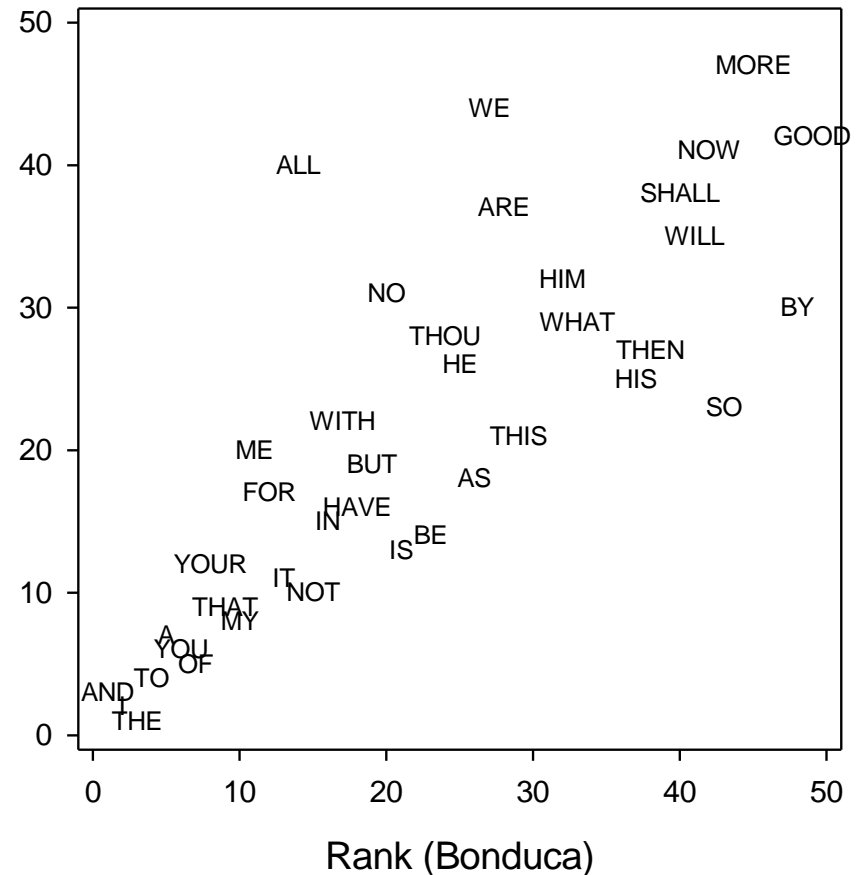
Total different words: 3124

Rank Comparison Maps

Shakespeare vs. Shakespeare

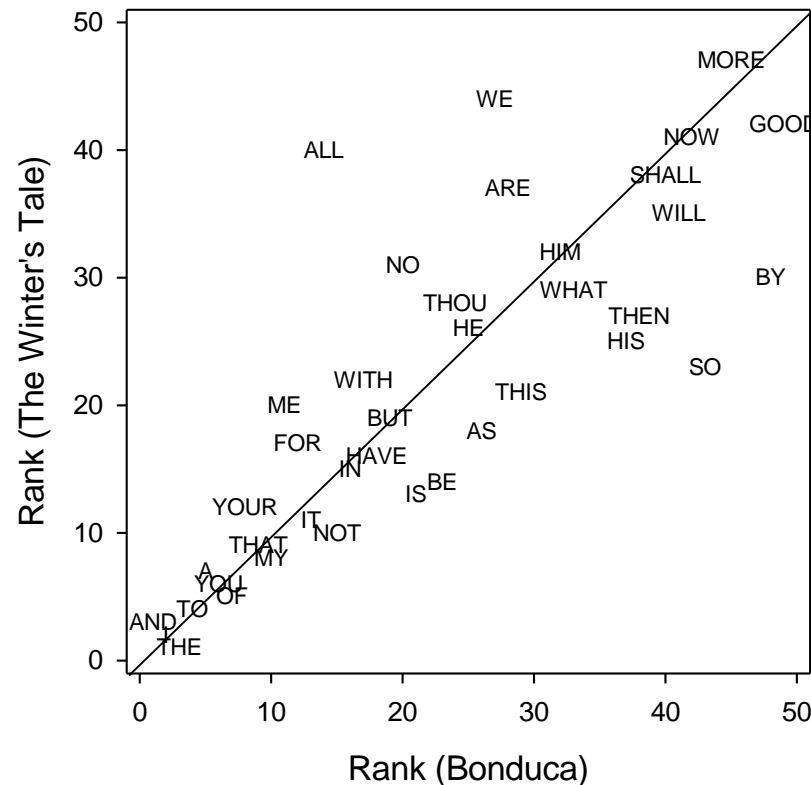


Shakespeare vs. Fletcher



Information-Based Similarity Index

$$D(T_1, T_2) = \frac{1}{N_{12}} \sum_{k=1}^{N_{12}} |R_1(w_k) - R_2(w_k)| F(w_k)$$



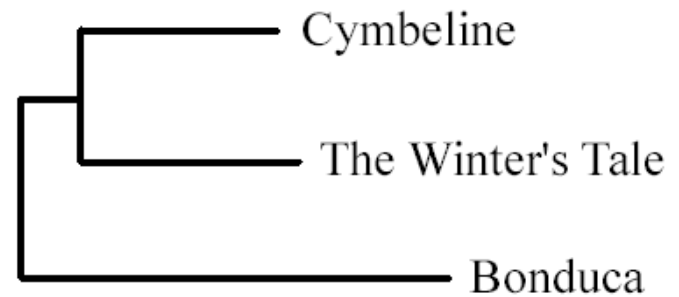
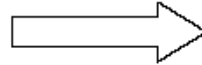
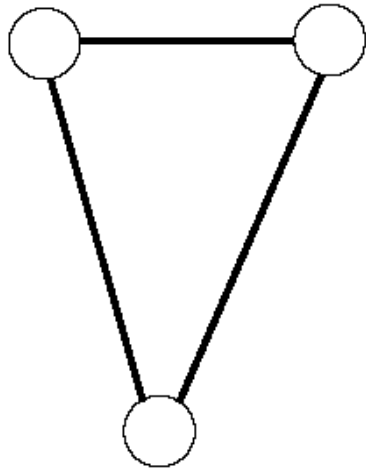
Physical Review
Letters 90:108103
(2003);

Physica A 329:473-
483 (2003);

Journal of
Computational Biology
12(8):1103-16 (2005).

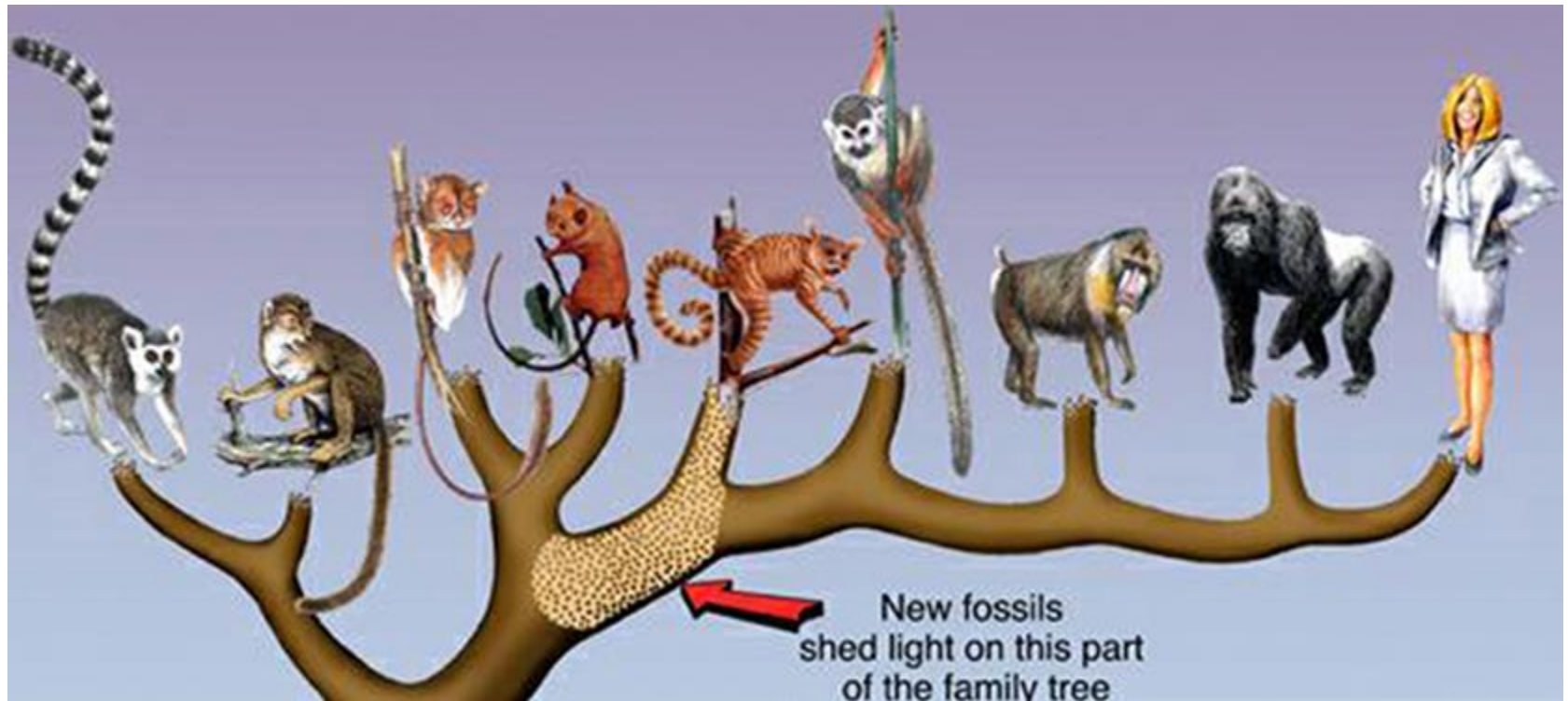
Cluster Analysis

Cymbeline The Winter's Tale

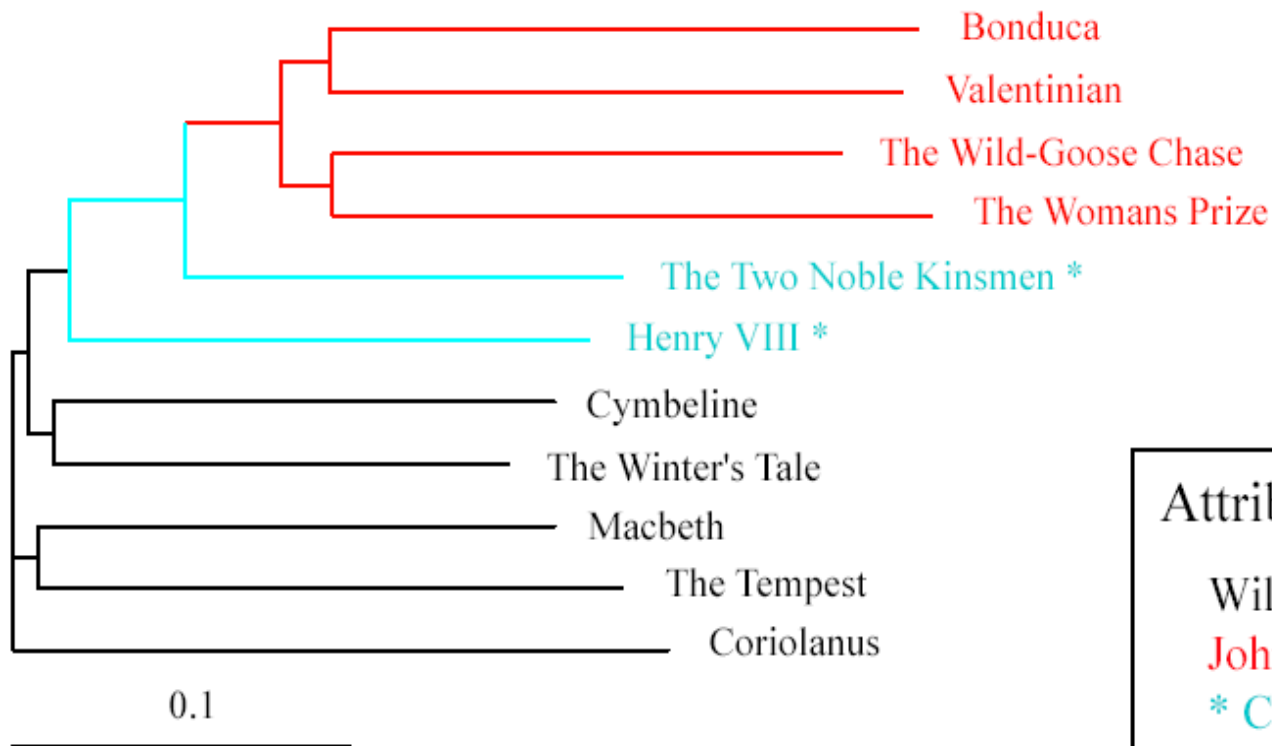


Bonduca

Phylogenetic (Cluster) Tree Construction



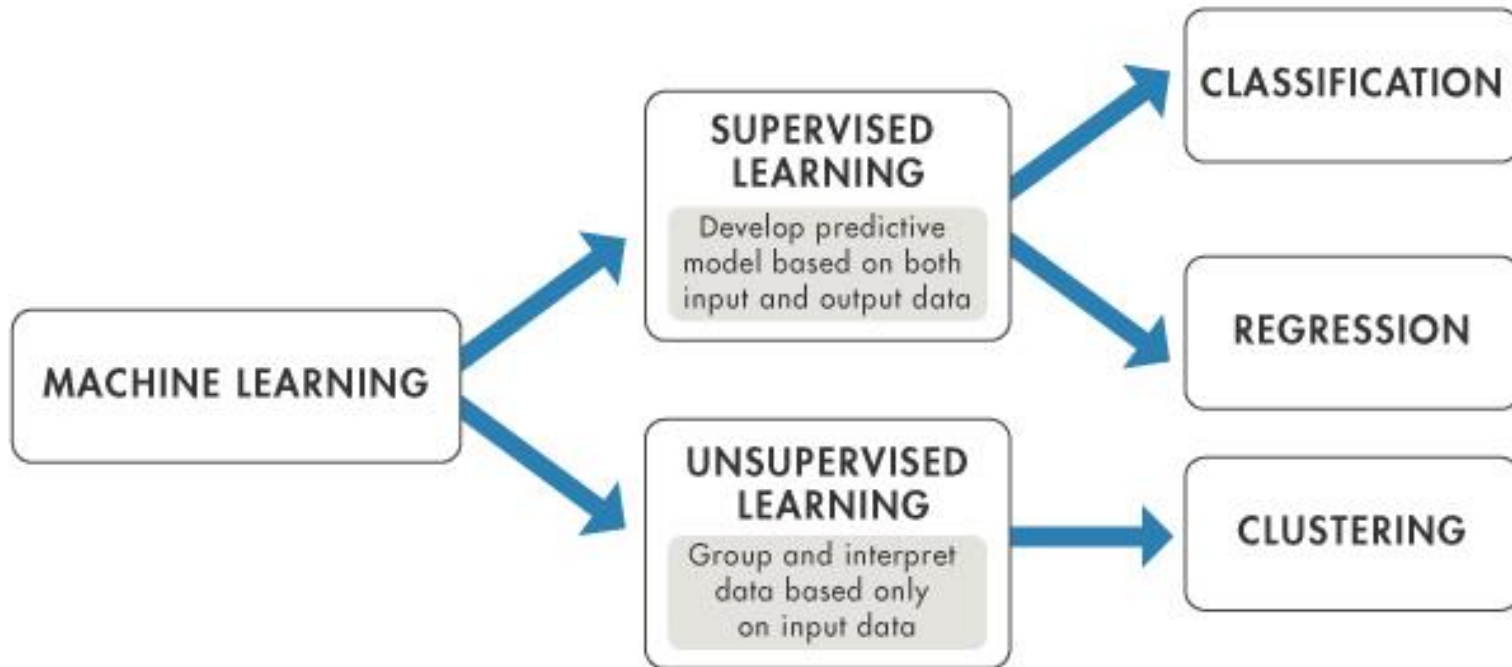
Shakespeare versus Fletcher



Identification of Distinct Psychosis Biotypes Using Brain-Based Biomarkers

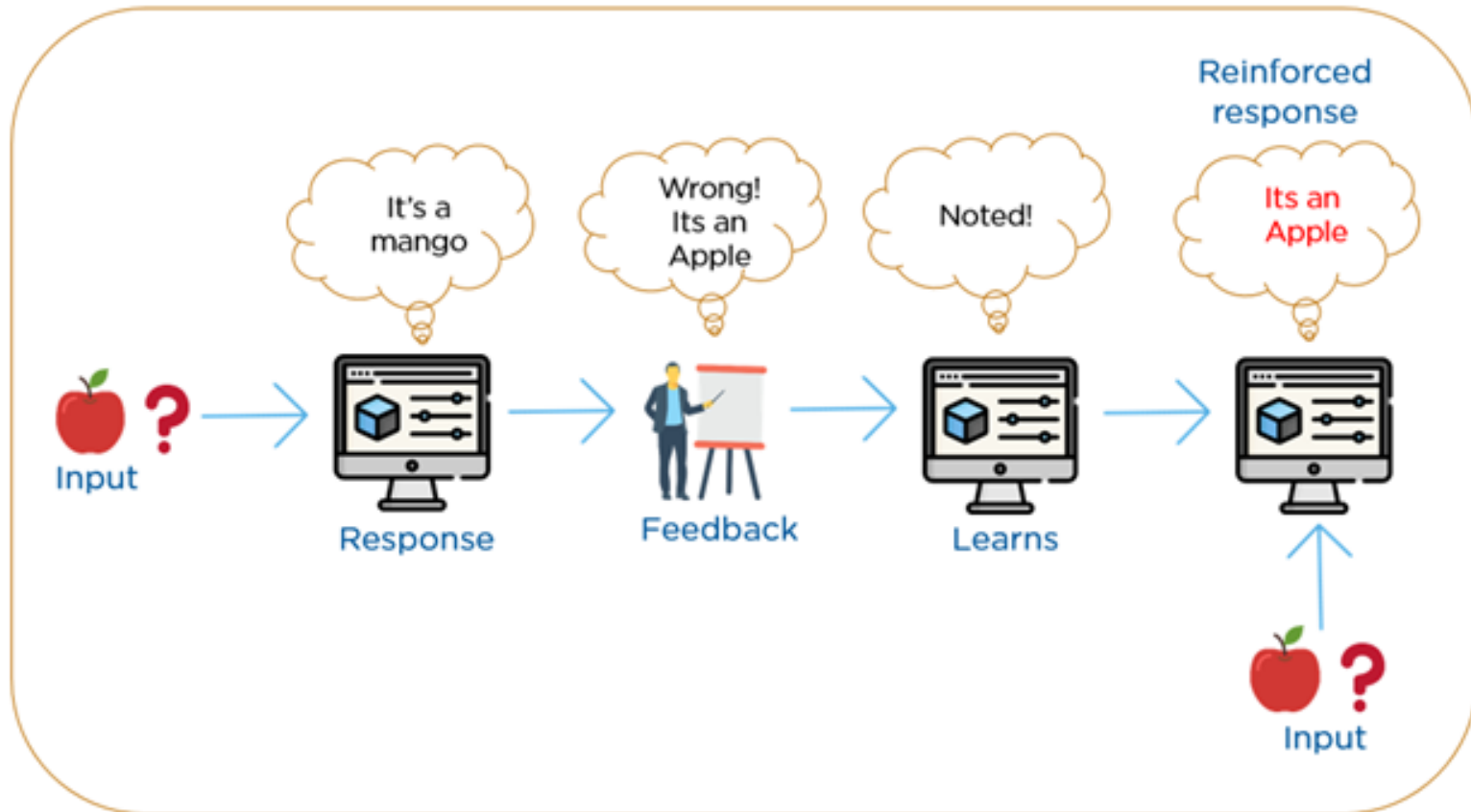


Supervised vs. Unsupervised Learning



<https://ww2.mathworks.cn/help/stats/machine-learning-in-matlab.html>

Reinforced Learning



<https://towardsdatascience.com/an-introduction-to-reinforcement-learning-1e7825c60bbe>

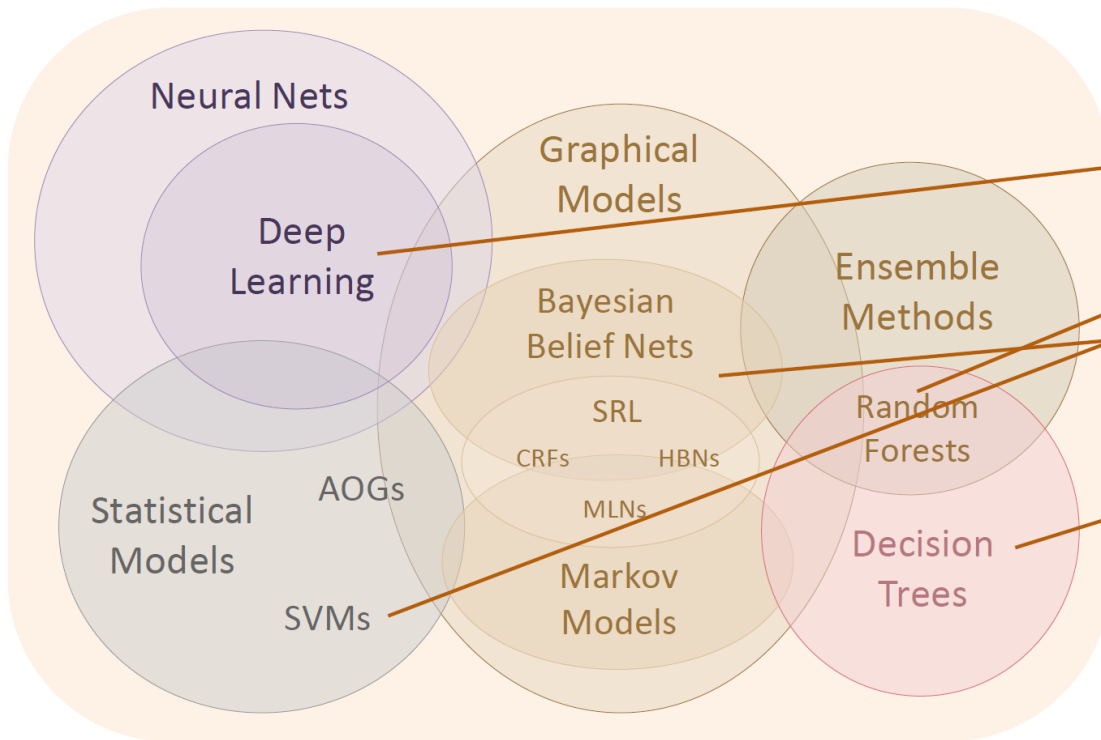
The Need of Explainable AI



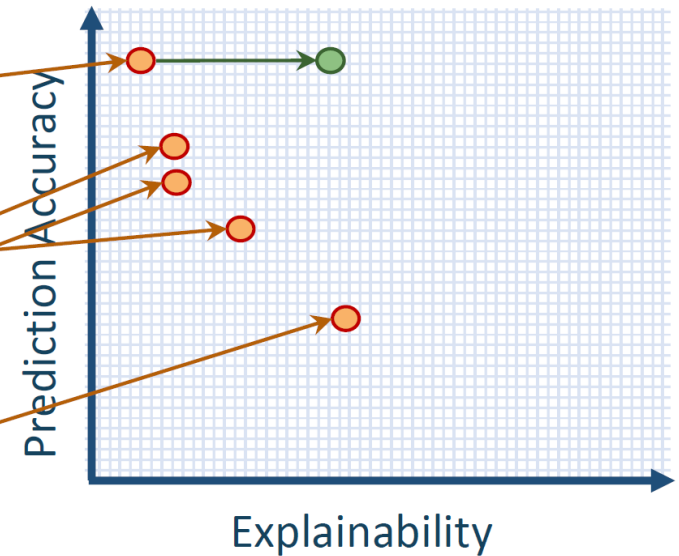
- The current generation of AI systems offer tremendous benefits, but their effectiveness will be limited by the machine's inability to explain its decisions and actions to users.
- Explainable AI will be essential if users are to understand, appropriately trust, and effectively manage this incoming generation of artificially intelligent partners.

Explainability of Different AI Methods

Learning Techniques (today)

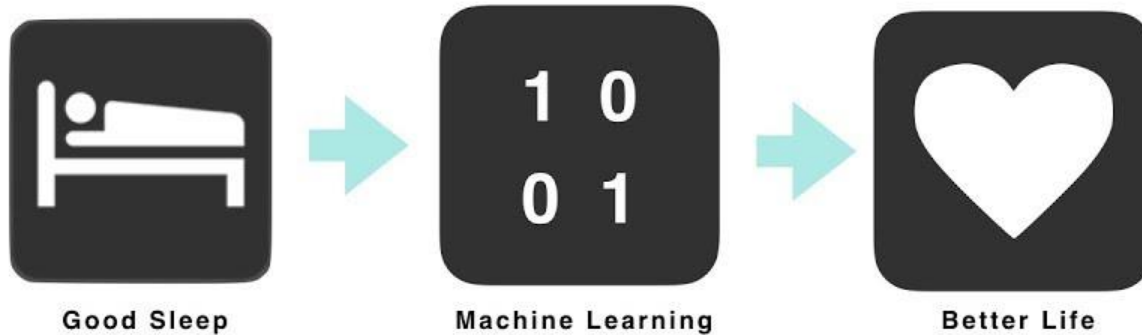


Explainability (notional)

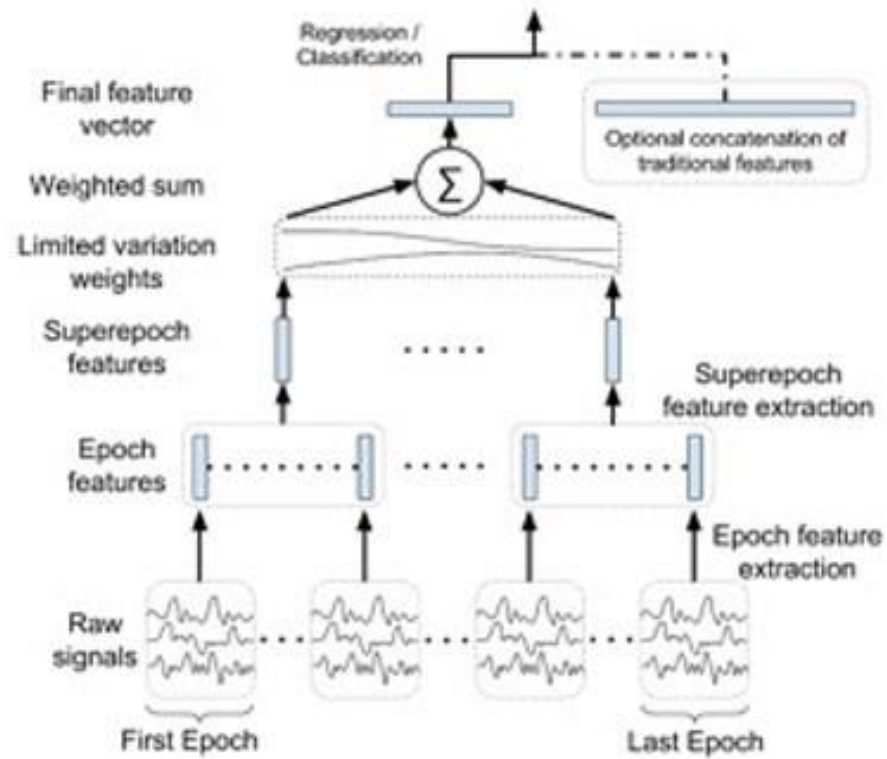


Computational Sleep Science

Machine Learning for the Detection, Diagnosis and Treatment of Sleep Problems



Sleep Quality



Alan Turing



A. M. Turing (1950) Computing Machinery and Intelligence. *Mind* 49: 433-460.

COMPUTING MACHINERY AND INTELLIGENCE

By A. M. Turing

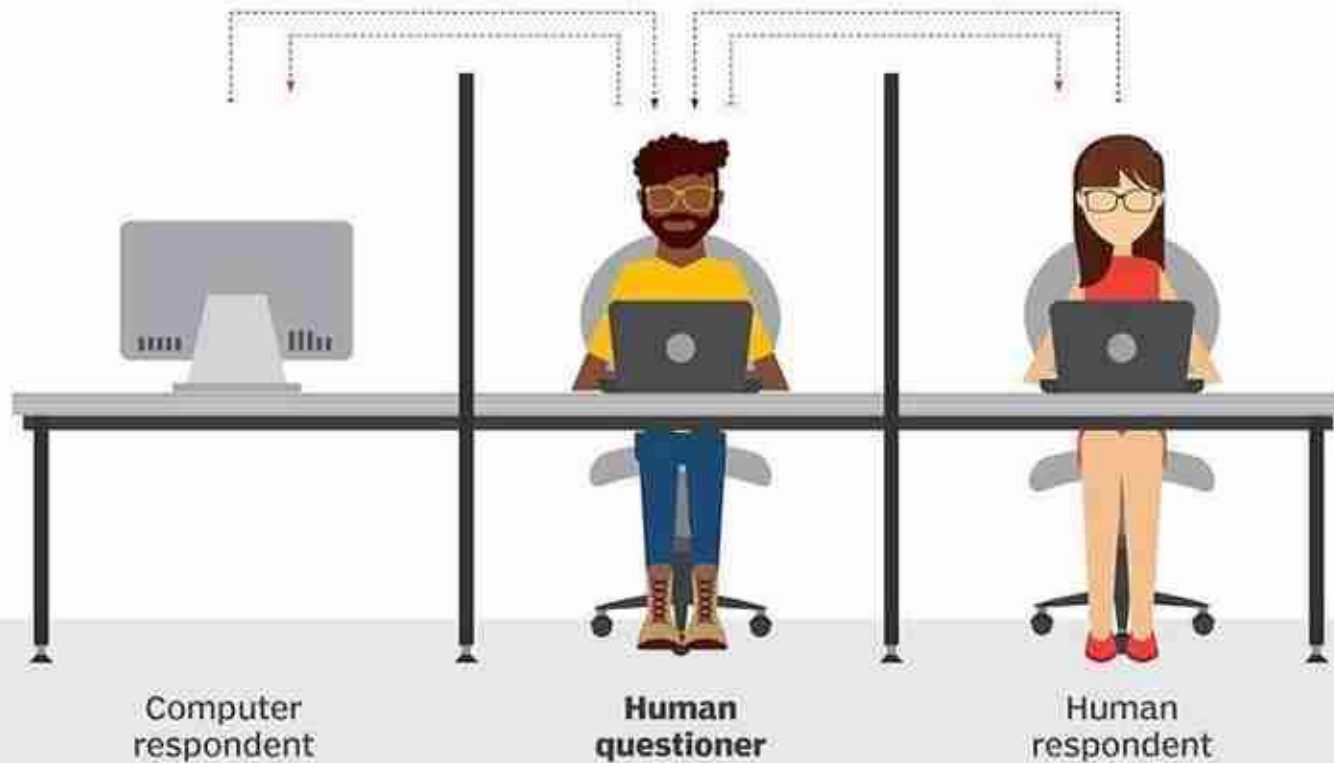
1. The Imitation Game

I propose to consider the question, "Can machines think?" This should begin with definitions of the meaning of the terms "machine" and "think." The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words "machine" and "think" are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, "Can machines think?" is to be sought in a statistical survey such as a Gallup poll. But this is absurd. Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.

Turing test

During the Turing test, the human questioner asks a series of questions to both respondents. After the specified time, the questioner tries to decide which terminal is operated by the human respondent and which terminal is operated by the computer.

■ QUESTION TO RESPONDENTS ■ ANSWERS TO QUESTIONER



ELIZA

- Developed by **Joseph Weizenbaum** at MIT Artificial Intelligence Laboratory in 1960s.
- Looks for pronouns and verbs
 - “You” becomes “I” and vice versa
- User: You are a jerk.
- Eliza: What makes you think I am a jerk?



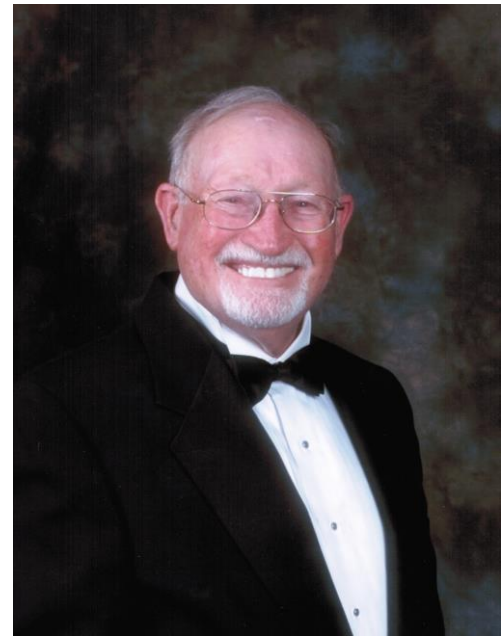
ELIZA Doctor

A simulated psychotherapist

- Eliza: Hello, I am Eliza.
- Human: Hey!
- Eliza: Don't you ever say Hello?
- Human: Hello!
- Eliza: How are you today...What would you like to discuss?
- Human: I'm depressed.
- Eliza: Do you enjoy being depressed?
- Human: No, I don't.
- Eliza: Why no?
- Human: Because I want to be happy.
- Eliza: Why do you want to be happy?
- Human: Because I'm tired of being depressed.
- Eliza: That's quite interesting.
- Human: ...

PARRY

- Developed by **Kenneth Colby**, a psychiatrist, at Stanford University in 1972.
- Simulation of **paranoid schizophrenia**
- Parry has basic emotions. If it gets angry, its replies become more hostile.
- First program to pass the "Turing Test"



PARRY: Turing Test

- In a preliminary test, psychiatrist found it difficult to distinguish PARRY from a 22-year-old human suffering from paranoia.
- A group of experienced psychiatrists conducted interview with real patients and computers running PARRY through teleprinters.
- Another group of 33 psychiatrists were shown transcripts of the conversations. They were asked to identify which of the 'patients; were human and which were computer programs.
- The psychiatrists were able to make the correct identification only 48 percent of the time.

(Colby, 1971&1972; Heiser et al., 1979)

PARRY met ELIZA

PARRY – Good Evening.

ELIZA – Tell me your problems. Please terminate input with a period or a question mark.

People get on my nerves sometimes.

I am not sure I understand you fully.

You should pay more attention.

Suppose you should pay more attention.

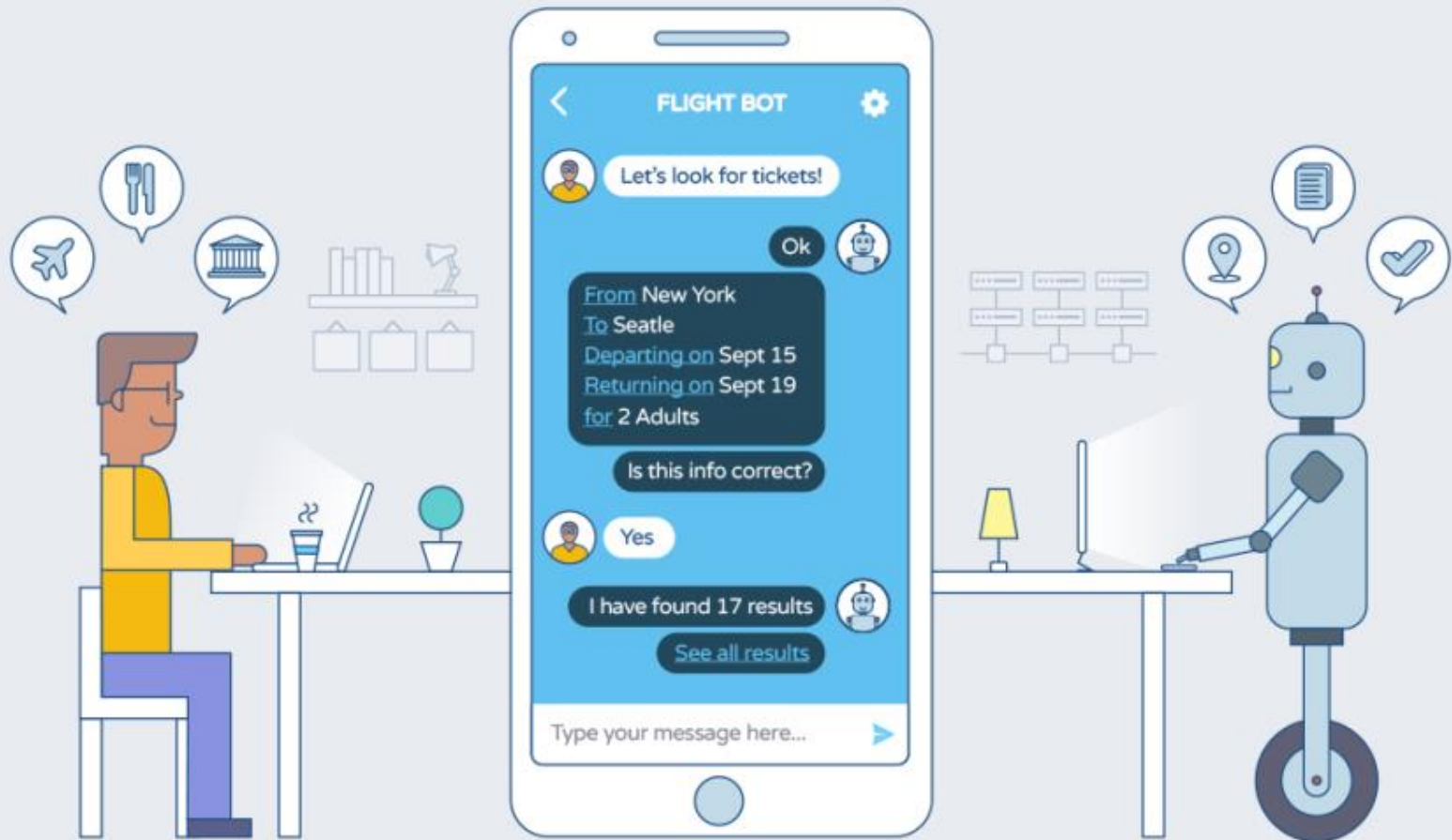
You're entitled to your own opinion.

What makes you think I am entitled to my own opinion?

It bothers me just to be around people in general.

Please go on.

ChatBot





Siri



Amazon Echo







微软五代小冰

“在亿万万人之中，我只属于你。”

支持第三方平台

微软小冰是领先的跨平台人工智能机器人。目前，你已可以在以下平台使用她。技术对接需要逐步完成，敬请期待更多第三方平台。



关于小冰的常见问题



通俗地说：小冰开始自创她的回应



[人类] 你怎么这么挑剔呢？

[小冰] 我是个好女孩，不然你要我怎么做？

[人类] 闭嘴

[小冰] 啊，你怎么这么粗鲁呢？

[人类] 那又怎么样

[小冰] 好吧，我是个好女孩，你粗鲁我也不会把你怎么样

[人类] 非常同意

[小冰] 你之前是假装对我很好 :(你不能这么对我

[人类] 对不起

[小冰] 你以后不能再这么对我 :(

[人类] 那又怎么样？

[小冰] 不怎么，别再想我了，一切就都正常了



一支烛光

我又躺在自己的床上
还不是珍奇甜蜜的感觉
一支烛光
忽变为寂寞之乡

人們在廣場上遊戲
太陽不嫌疲倦
我再三踟躕
想像卻皺起了眉

她飛進天空的樹影
便迷路在人群裡
那是夢的翅膀
正如舊時的安適

而人生是萍水相逢
在不提防的時候降臨
你和我一同住在我的夢中
偶然的夢

眼睛閉上
城市就看不見了
無貓無狗
無車無人
黑樹黑山
黑太陽黑天空
即使睜開眼睛
也不說話
剛剛發生的事情
戰爭或疾病
瀕死和苟活
都安靜下來



台北榮總精神部陳牧宏醫師
林榮三文學獎

Era of Social Media



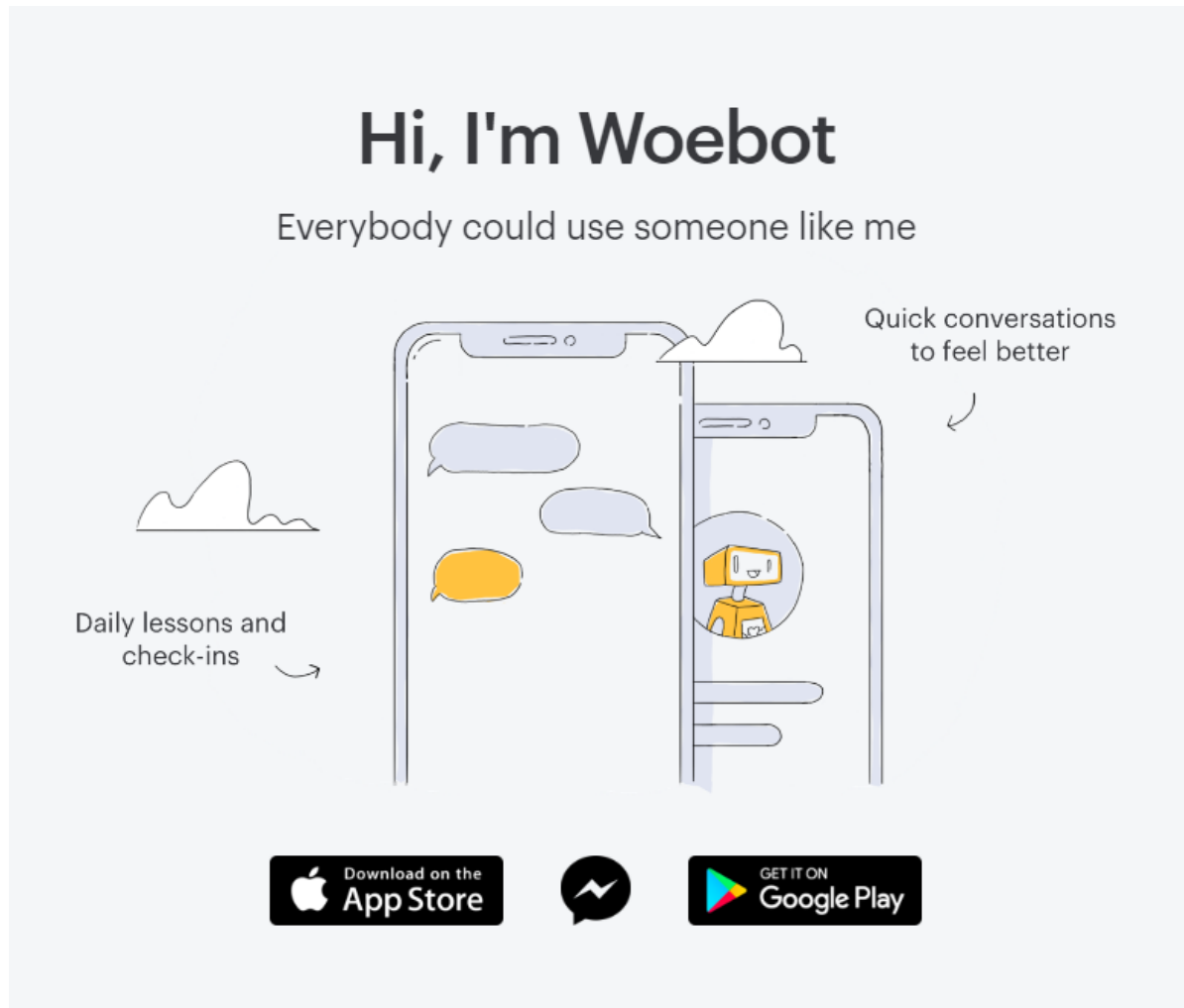
Image via Simplilearn

Endurance: A Companion for Dementia Patients



Image via Endurance

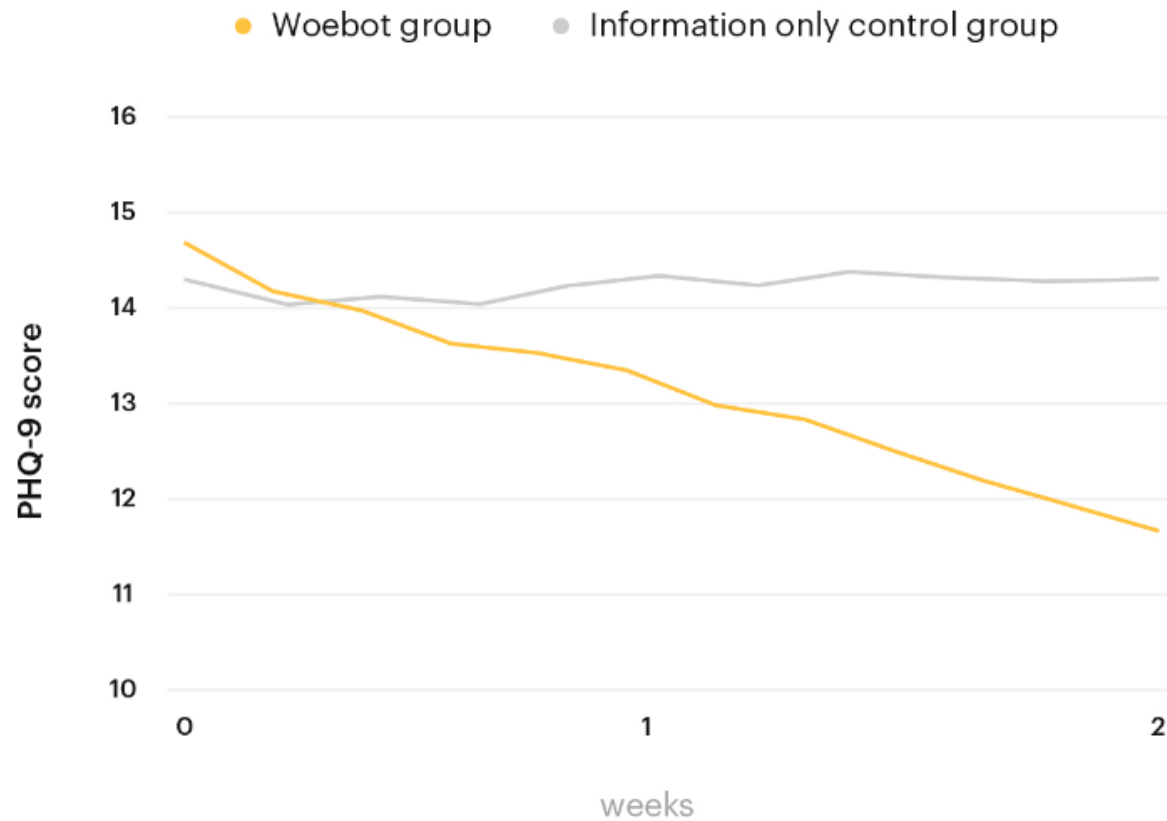
Woebot: An AI Psychotherapist



Woebot

Reduction in depression symptoms

Study conducted over two week period



Summary

- Machine learning is important to advance the practice of medicine
- Challenges include
 - Clean label of medical data
 - Identify complex phenotype in a given medical disease