Aprendizagem Aplicada à Segurança

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University of Aveiro

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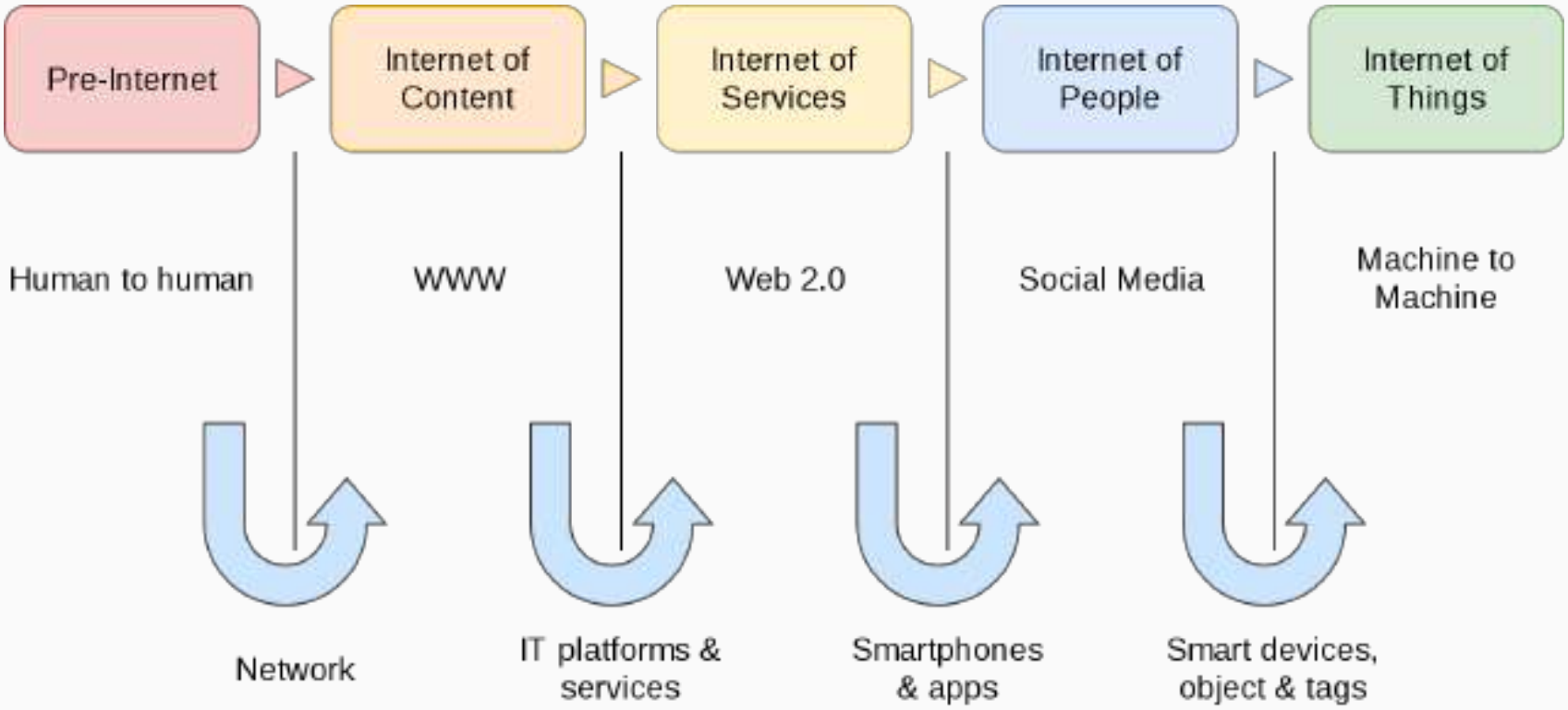
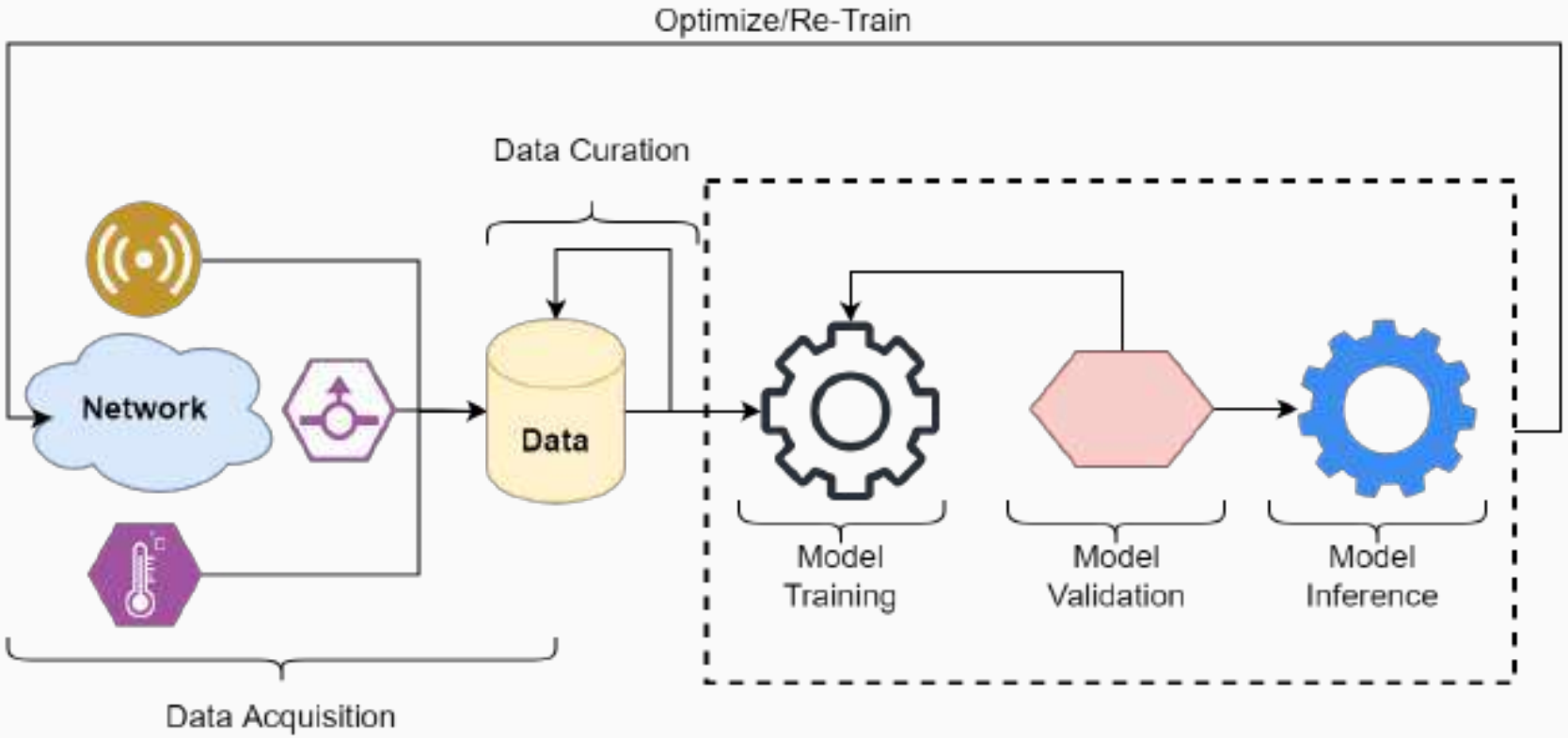
Class Introduction

- Given the evolution of the threats
- And the complexity of the systems
- AI/ML are gaining traction as a usefull tool

Class Introduction



Class Introduction



Grading i

- 50% Theory + 50% Practice
- Discrete: 25% Mid-term Exam + 25% Final Exam + 20% Project Idea + 30% Project
- Final: 50% Final Exame + 50% Project

Class Schedule i

Date	Class	Topic
15/09/2023	1	Introduction
22/09/2023	2	
29/09/2023	3	SPAM Detector
06/10/2023	4	
13/10/2023	5	
20/10/2023	6	Anomaly Detection
27/10/2023	7	
03/11/2023	8	Mid-term Exam
10/11/2023	9	
17/11/2023	10	Malware Analysis
24/11/2023	11	
01/12/2023	12	
08/12/2023	13	Project
15/12/2023	14	
22/12/2023	15	

Environment i

Bibliography i

- All of the books are available here: *https://learning.oreilly.com/*

[1] S. Halder and S. Ozdemir, *Hands-On Machine Learning for Cybersecurity: Safeguard your system by making your machines intelligent using the Python ecosystem*. Packt Publishing Ltd, 2018.

[2] C. Chio and D. Freeman, *Machine Learning and Security*. O'Reilly, 2018.

Bibliography ii

[3] A. Parisi, *Hands-On Artificial Intelligence for Cybersecurity: Implement smart AI systems for preventing cyber attacks and detecting threats and network anomalies*. Packt Publishing Ltd, 2019.

[4] E. Tsukerman, *Machine Learning for Cybersecurity Cookbook*. Packt Publishing Ltd, 2019.

[5] J. P. Mueller and R. Stephens, *Machine Learning Security Principles*. Packt Publishing Ltd, 2019.

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SPAM

- The term “spam” is internet slang that refers to unsolicited commercial email (UCE).
- The first reported case of spam occurred in 1898, when the New York Times reported unsolicited messages circulating in association with an old swindle.
- The term “spam” was coined in 1994, based on a now-legendary Monty Python’s Flying Circus sketch, where a crowd of Vikings sings progressively louder choruses of “SPAM! SPAM! SPAM!”

SPAM


1
THE SPANISH PRISONER
The New York Times reports of unsolicited messages circulating in association with an old swindle.
1898
2
POST MAIL
Advertisement based on unsolicited content has been mailed to our doors by Post Mail services for over a century!
Early 1900s
3
ARPANET
The first reported case of email spam is attributed to Digital Equipment Corporation and circulated to 400 ARPANET users.
1978
4
THE EMAIL EPIDEMIC
A growing fraction of emails is spam. Platforms and ISPs start investing in spam filtering techniques.
Mid 1990s
5
SEARCH ENGINES
Web content spam and link farms are common forms of spamdexing, the manipulation of Web search result ranking.
1995
6
SOCIAL NETWORKS
The rise of Facebook, Twitter, and Reddit leads to new opportunities for spammers to reach billions of Social Web users.
2000s
7
FAKE REVIEWS
Giants of e-commerce like Amazon and Alibaba fight the manipulation of product popularity by opinion spam.
Early 2000s
8
PHISHING
Social engineering and disguise may allow attackers to trick victims into revealing sensitive information. Ransomware are used to extort funds from the victims.
Mid 2000s
9
SOCIAL BOTS
Millions of accounts operated by software populate social media to carry out nefarious spam campaigns.
Early 2010s
10
FALSE NEWS
Spam Websites are created to deliberately propagate false news related to politics, public health, and social issues.
Mid 2010s
AI SPAM
Systems based on AI can manipulate reality, producing indistinguishable alternatives. AIs can also be target of manipulation and spam to elicit behaviors of the AI system or of its users.
2018+

SPAM

Dear Sir,
I am prince [illegible] from Nigeria. Your help would be very appreciated.
I want to transfer all of my fortune outside if Nigeria due to a frozen account,
If you could be so kind and transfer small sum of 3 500 USD to my account,
I would be able to unfreeze my account and transfer my money outside of
Nigeria. To repay your kindness, I will send 1 000 000 USD to your account.

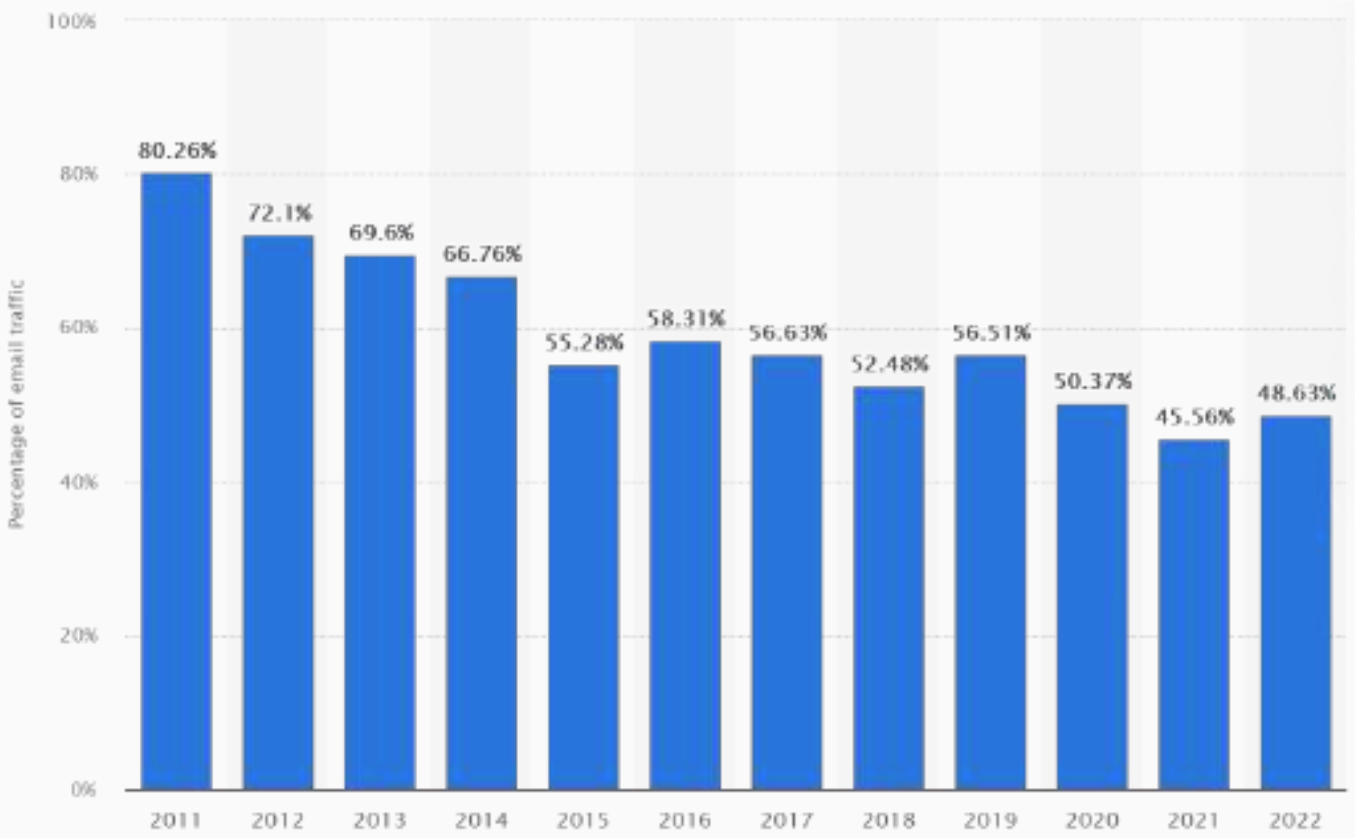
Please contact me to proceed

Prince [illegible]

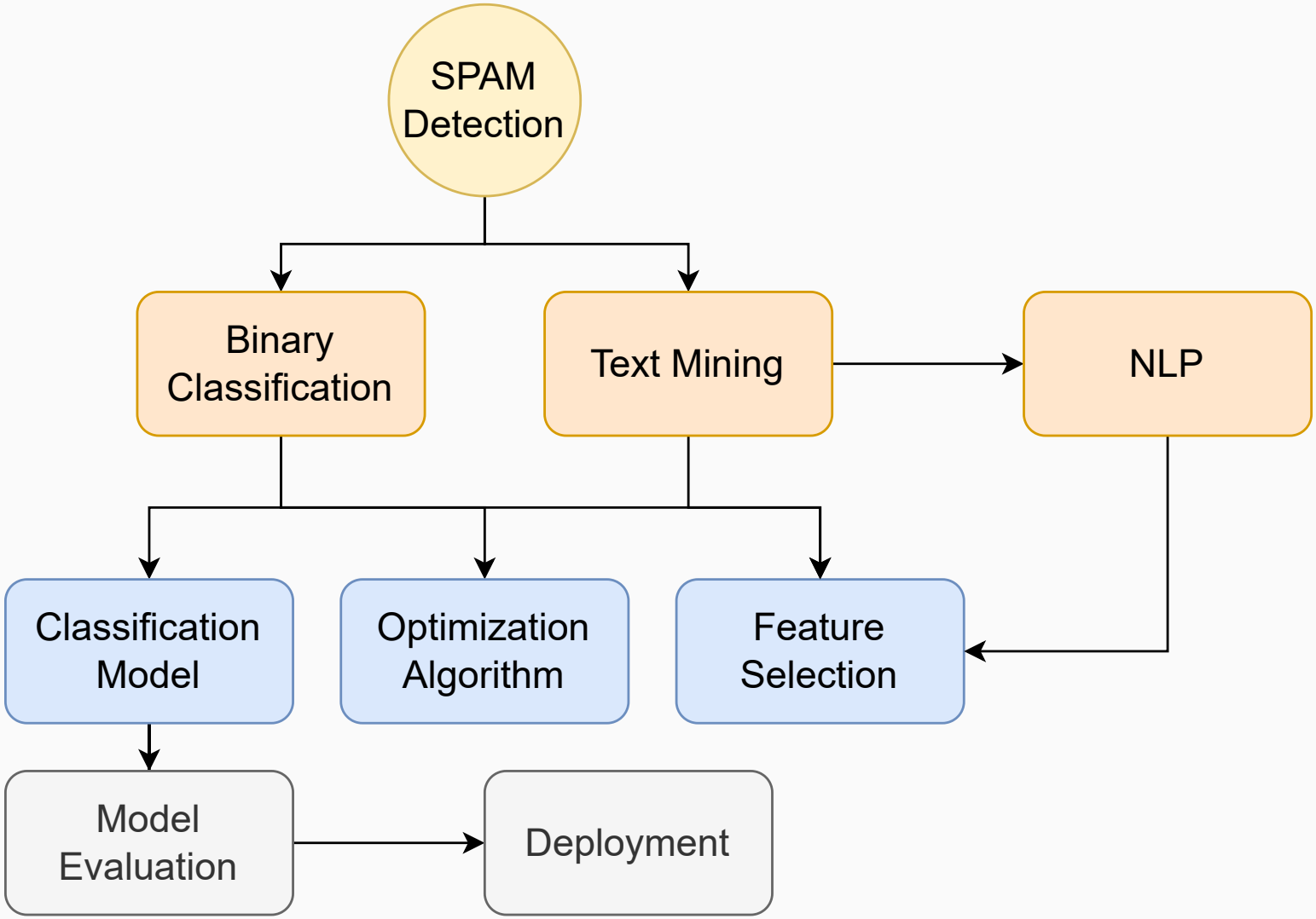
Fight against SPAM

- *Huge* list of *https://en.wikipedia.org/wiki/Anti-spam_techniques*
- From common sense to *Bayesian spam filtering*
- Unfortunately it is a costly battle

Fight against SPAM

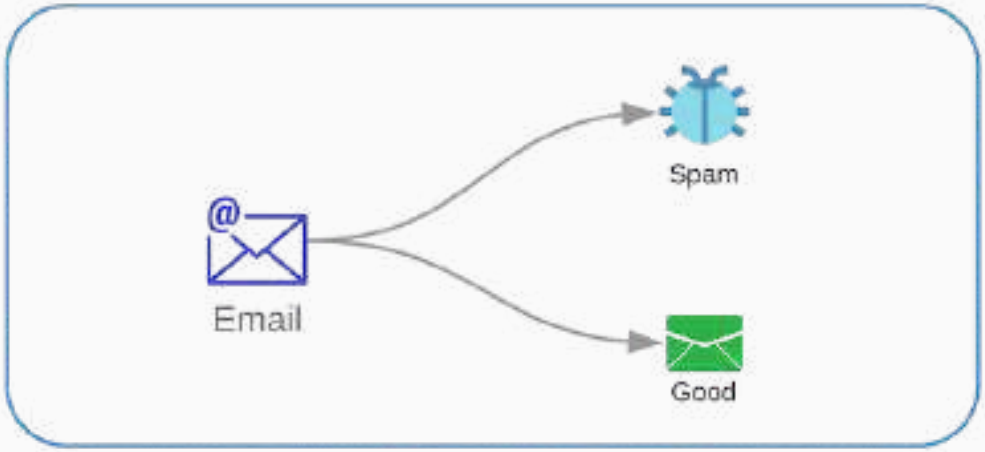


SPAM Detection



Binary Classification

- Binary classification is the task of classifying the elements of a set into two groups (each called class) on the basis of a classification rule.
- For this application one message can either be spam or ham.



Binary classification

Text Mining

- Text mining is the process of deriving high-quality information from text.
- Combines concepts from Machine Learning, Linguistic and statistical analysis.
- In this area we will explore the methods used to rank words/tokens and the BoW model.

Bag of Words (Bow) model

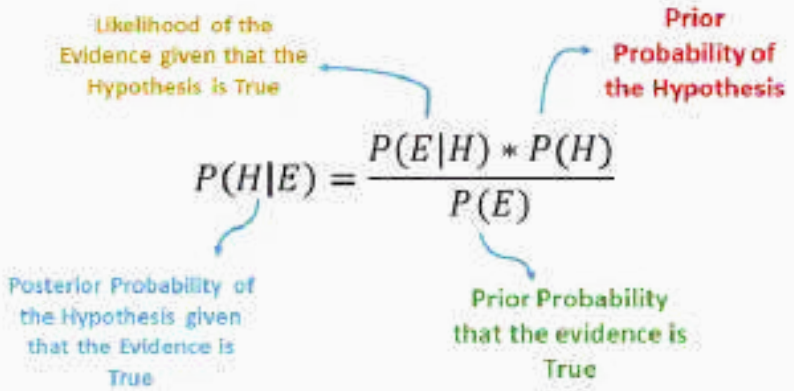
	the	red	dog	cat	eats	food
1. the red dog →	1	1	1	0	0	0
2. cat eats dog →	0	0	1	1	1	0
3. dog eats food →	0	0	1	0	1	1
4. red cat eats →	0	1	0	1	1	0

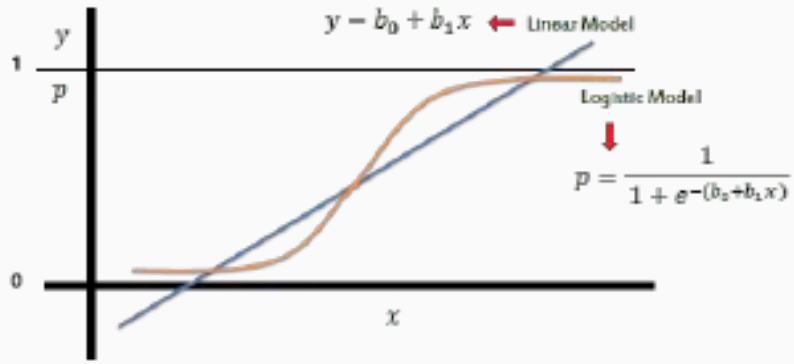
Natural Language Processing (NLP)

- NLP gives the computers the ability to understand text.
- Combines *Sintax* and *Semantic* into the analysis.
- One famous exemples are the Large Language Models (LLMs) that power OpenAI Chat GPT.

Classification Model

- SPAM detection is “considered” a toy example.
- As such, we will explore two of the simples learning models: Naive Bayes and Logistic Regression.





Model Evaluation

- Classification model can be evaluated using a confusing matrix
- The simplest methods to evaluate a model is throuhgh accuracy: $acc = \frac{TP+TN}{TN+TN+FP+FN}$

	Predicted Positive	Predicted Negative	
Actual Positive	**TP** *True Positive*	**FN** *False Negative*	Sensitivity $\frac{TP}{(TP+FN)}$
Actual Negative	**FP** *False Positive*	**TN** *True Negative*	Specificity $\frac{TN}{(TN+FP)}$
	Precision $\frac{TP}{(TP+FP)}$	Negative Predictive Value $\frac{TN}{(TN+FN)}$	Accuracy $\frac{TP+TN}{(TP+TN+FP+FN)}$

Model Evaluation