

# An Introduction To Machine Learning Sorcery

(Part 1: Fuzzy Logic & Neural Networks)<sup>a</sup>

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<sup>a</sup>Available @ <https://github.com/a-mhamdi/isetbz/>



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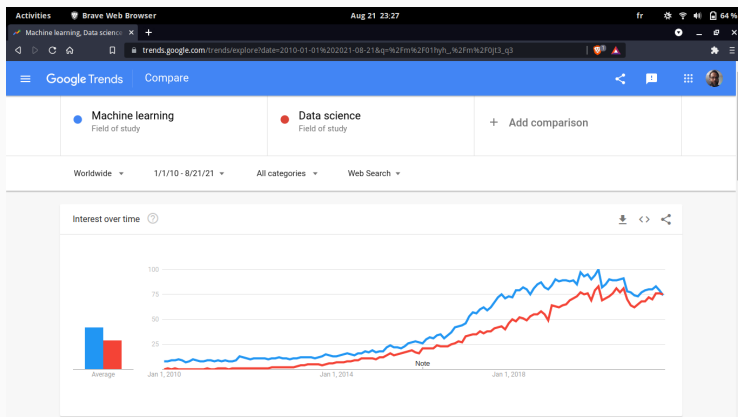
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## **An overview**

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# TRENDS



“Numbers represent search interest relative to the highest point on the chart for the given region and time.

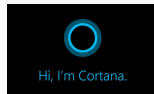
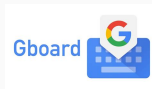
- A value of 100 is the peak popularity for the term;
- A value of 50 means that the term is half as popular;
- A score of 0 means there was not enough data for this term.”

# GLOBAL DATA TRAFFIC



Update on the internet in real time is available [here](#).

## TOP USES



## LITERATURE REVIEW (1/3)

[Mit97]

“The field of machine learning is concerned with the question of how to construct computer programs that automatically improve with experience.”

Mitchell, T. (1997) *Machine Learning*. **McGraw-Hill International Editions. McGraw-Hill.**

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## LITERATURE REVIEW (2/3)

[Woj12]

“Machine learning (ML) is a scientific discipline that concerns developing learning capabilities in computer systems. Machine learning is one of central areas of Artificial Intelligence (AI). It is an interdisciplinary area that combines results from statistics, logic, robotics, computer science, computational intelligence, pattern recognition, data mining, cognitive science, and more.”

Wojtusiak, J. (2012) Machine learning. In *Encyclopedia of the Sciences of Learning*, pages 2082–2083. Springer US.

## LITERATURE REVIEW (3/3)

[ENM15]

“Machine learning is an evolving branch of computational algorithms that are designed to emulate human intelligence by learning from the surrounding environment. They are considered the working horse in the new era of the so-called big data. Techniques based on machine learning have been applied successfully in diverse fields ranging from pattern recognition, computer vision, spacecraft engineering, finance, entertainment, and computational biology to biomedical and medical applications. [...] The ability of machine learning algorithms to learn from current context and generalize into unseen tasks would allow improvements in both the safety and efficacy of radiotherapy practice leading to better outcomes.”

El Naqa, I. and Murphy, M. J. (2015) *What Is Machine Learning?*, pages 3–11. **Springer International Publishing.**

Machine Learning is a branch of computer science, focuses on automation of intelligent behavior.  
Some definitions can be categorized into four frames.

## SYSTEMS THAT THINK LIKE HUMANS

[Bel78]

“[The automation of] activities that we associate with human thinking, activities such as decision-making, problem-solving, learning...”

Bellman, R. E. *An Introduction to Artificial Intelligence: Can Computers Think?* **Boyd & Fraser Publishing Company.**

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[Hau89]

“The exciting new effort to make computers think[...] *machines with minds*, in the full and literal sense”

Haugeland, J. (1989). *Artificial Intelligence: The Very Idea*. **A Bradford book. MIT Press.**

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## SYSTEMS THAT THINK RATIONALLY

[CMM85]

“The study of mental faculties through the use of computational models.”

Charniak, E., McDermott, D., and McDermott, D. V. (1985). *Introduction to Artificial Intelligence*. Addison-Wesley series in computer science and information processing. Addison-Wesley.

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[Win92]

“The study of the computations that make it possible to perceive, reason, and act.”

Winston, P. H. (1992). *Artificial Intelligence*. A-W Series in Computer Science. Addison-Wesley Publishing Company.

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## SYSTEMS THAT ACT LIKE HUMANS

[Kur92]

“The art of creating machines that perform functions that require intelligence when performed by people.”

Kurzweil, R. (1992). *The Age of Intelligent Machines*. **Viking**.

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[RK91]

“The study of how to make computers do things at which, at the moment, people are better.”

Rich, E. and Knight, K. (1991). *Artificial Intelligence*. **Artificial Intelligence Series. McGraw-Hill**.

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## SYSTEMS THAT ACT RATIONALLY

[Sch90]

“A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes.”

Schalkoff, R. J. (1990). *Artificial Intelligence: An Engineering Approach*. **McGraw-Hill Computer science series**. McGraw-Hill.

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[LS93]

“The branch of computer science that is concerned with the automation of intelligent behavior.”

Luger, G. F. and Stubblefield, W. A. *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*. **Artificial intelligence**. Benjamin/Cummings Publishing Company.

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# DEBRIEF

**Arthur Samuel (1959)**

Machine Learning: Field of study that gives computers the ability to learn without being explicitly programmed.

**Tom Mitchell (1998)**

Well-posed Learning Problem: A computer is said to learn from experience  $\mathcal{E}$  with respect to some task  $\mathcal{T}$  and some performance measure  $\mathcal{P}$ , if its performance on  $\mathcal{T}$ , as measured by  $\mathcal{P}$ , improves with experience  $\mathcal{E}$  [Mit97].

**Task #1**

Suppose your email program watches which emails you do or do not mark as spam, and based on that learns how to better filter spam. What is the task  $\mathcal{T}$  in this setting?

1. Classifying emails as spam or not spam;
2. Watching you label emails as spam or not spam;
3. The number (or fraction) of emails correctly classified as spam/not spam;
4. None of the above-this not a machine learning problem.



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# PROGRAMMING LANGUAGES



```
python3
+ 13 python3
Python 3.10.6 (main, Aug 10 2022, 11:40:04) [GCC 11.3.0] on linux
Type "help", "copyright", "credits" or "license()" for more information.
>>> print('Hello, World!')
Hello, World!
>>> |
```



```
~julia/julia
+ 13 julia
Documentation: https://docs.julialang.org
Type "?" for help, "P?" for Pkg help.
Version 1.6.3 (2021-09-23)

julia> println("Hello, World!")
Hello, World!

julia>
```

## DEVELOPMENT ENVIRONMENTS

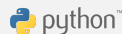


▲ \$ docker-compose up

▼ \$ docker-compose down



## REQUIRED PACKAGES



VALID ONLY FOR...

- A full list is available @ <https://pypi.org/>

Numpy



Matplotlib



Pandas



Scikit — learn



Keras



```
$ pip install virtualenv
$ virtualenv - --version
$ virtualenv «virtualenv_name»
$ source «virtualenv_name»/bin/activate # ACTIVATE
$ deactivate # DEACTIVATE
```

```
> pip install virtualenv
> virtualenv - --version
> virtualenv «virtualenv_name»
> «virtualenv_name»\Scripts\activate :: ACTIVATE
> deactivate :: DEACTIVATE
```





# SOURCE CONTROL MANAGEMENT (SCM)

The screenshot shows the GitHub interface for the repository 'a-mhamdi/cosnip'. The browser address bar displays 'github.com/a-mhamdi/cosnip/tree/main/Python/ml'. The repository name 'a-mhamdi / cosnip' is shown with a 'Public' badge. Navigation tabs include 'Code', 'Issues', 'Pull requests', 'Actions', 'Projects', 'Wiki', 'Security', 'Insights', and 'Settings'. The 'Code' tab is active, showing a file tree for the 'main' branch at the path 'cosnip / Python / ml /'. The tree lists files and folders with their last update dates and commit history.

File/Folder	Last Update	Commit History
..		
.vscode	update codes	7 months ago
exported-matf	update codes	7 months ago
to-test	update codes	7 months ago
clf-ann.ipynb	update codes	7 months ago
clf-ann.ipynb	update codes	7 months ago
clf-svm.ipynb	update codes	7 months ago
cnn-build.py	di and gui-ml files	6 months ago
gui-ml.py	di and gui-ml files	6 months ago
linear-regression.ipynb	update codes	7 months ago
mnist-cnn.ipynb	update codes	7 months ago
tuto-ml.ipynb	update codes	12 months ago

<https://github.com/a-mhamdi/cosnip/tree/main/Python/ml>



# CONTINUOUS INTEGRATION (CI)

The screenshot shows the Docker Hub repository for 'abmhamdi/pyml'. The repository is an image, updated 8 days ago, with 2 pulls. The description states it is a Python environment for ML labs at ISETBZ. The 'Overview' tab is selected, showing a 'PYML' section with a description: 'A convenient way to run machine learning labs on various platform using Docker.' It includes a status bar showing 'PYML CI: passing', 'docker starts: 0', 'docker pulls: 2', and 'version: v1.2'. The text explains that the repository contains a Dockerfile for creating an image for machine learning labs, using Python and Jupyter Notebook, with Ubuntu as the host OS. A note mentions that the latest image is built upon every push to the repo.

**PYML**

A convenient way to run machine learning labs on various platform using Docker.

PYML CI: passing | docker starts: 0 | docker pulls: 2 | version: v1.2

The repository contains the Dockerfile I use to create an image where students can run the labs of Machine Learning. I opted for Python as the main programming language, and for Jupyter Notebook as the main development environment. The host OS is Ubuntu.

The latest image is built upon every push to this repo. Every update is available at dockerhub via abmhamdi/pyml

**Docker Pull Command**

```
docker pull abmhamdi/pyml
```

<https://hub.docker.com/repository/docker/abmhamdi/pyml>

## Fuzzy Logic

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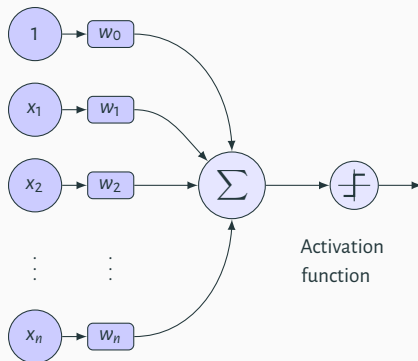


## Neural Networks

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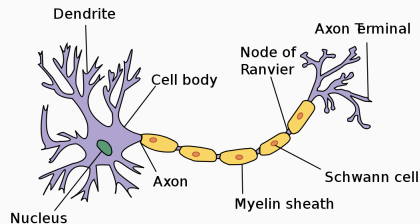
# FUNDAMENTAL UNIT OF A NEURAL NETWORK <sup>(1/2)</sup>

Artificial neuron



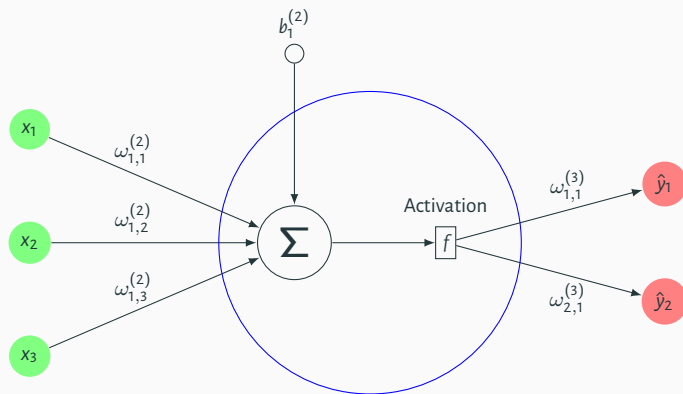
Inputs    Weights

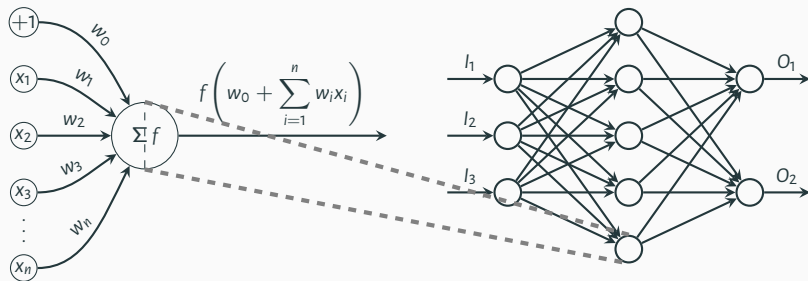
Biological neuron



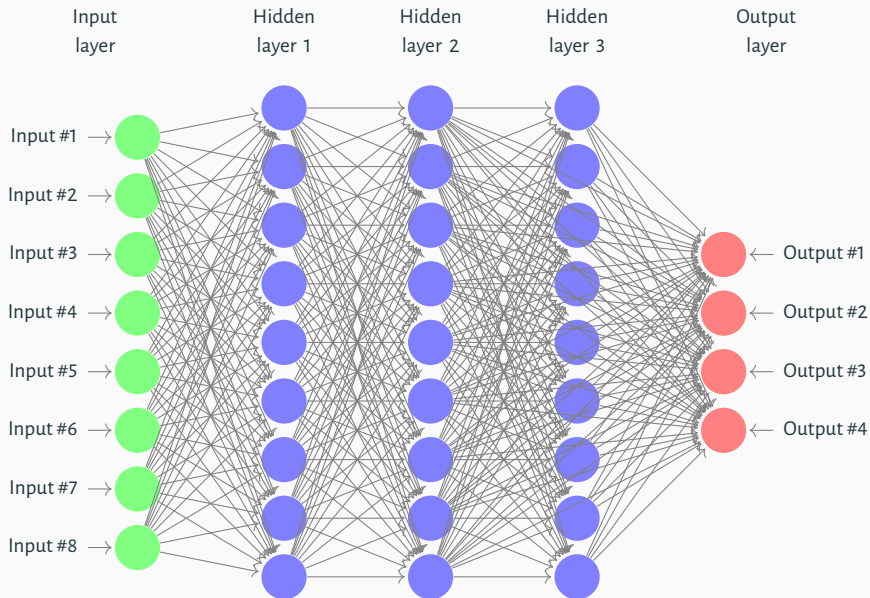
[https://id.wikipedia.org/wiki/Sel\\_saraf](https://id.wikipedia.org/wiki/Sel_saraf)

## FUNDAMENTAL UNIT OF A NEURAL NETWORK <sup>(2/2)</sup>





## MULTILAYER PERCEPTRON (MLP)



## FURTHER READING

### References

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- [Bel78] R. E. Bellman. *An Introduction to Artificial Intelligence: Can Computers Think?* Boyd & Fraser Publishing Company, Jan. 1, 1978 (cit. on p. 12).
- [CMM85] E. Charniak, D. McDermott, and D. V. McDermott. *Introduction to Artificial Intelligence*. Addison-Wesley series in computer science and information processing. Addison-Wesley, 1985 (cit. on p. 13).
- [ENM15] I. El Naqa and M. J. Murphy. “What Is Machine Learning?” In: *Machine Learning in Radiation Oncology: Theory and Applications*. Ed. by I. El Naqa, R. Li, and M. J. Murphy. Cham: Springer International Publishing, 2015, pp. 3–11. doi: 10.1007/978-3-319-18305-3\_1 (cit. on p. 10).
- [GBC16] I. Goodfellow, J. Bengio, and A. Courville. *Deep Learning*. MIT Press Ltd, Nov. 18, 2016. 800 pp.
- [Hau89] J. Haugeland. *Artificial Intelligence: The Very Idea*. A Bradford book. MIT Press, 1989 (cit. on p. 12).
- [JPM21] L. M. John Paul Mueller. *Machine Learning For Dummies*. Wiley John + Sons, Apr. 8, 2021. 464 pp.
- [Kur92] R. Kurzweil. *The Age of Intelligent Machines*. Viking, 1992 (cit. on p. 14).
- [LS93] C. F. Luger and W. A. Stubblefield. *Artificial Intelligence: Structures and Strategies for*