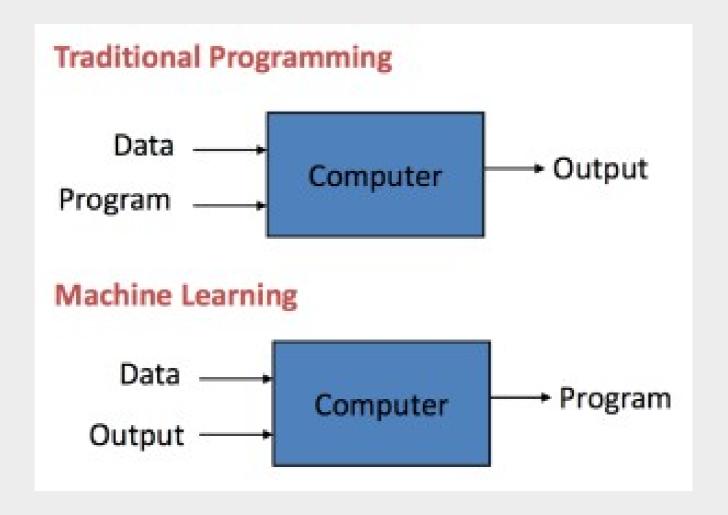
Can
Neural Networks
solve 2+2?

Marusic Diana

# Cum am învățat despre rețelele neuronale? (Path to Machine Learnng)

- 12 ani am început să scriu programe în C care sămi rezolve problemele la matematică
- 2015 mănușă inteligentă ce recunoaște gesturile la concursul Intel ISEF
- 2017-2018 curs de Inteligență Artificială la Universitatea din București
- 2018 curs opțional de Machine Learning cu Python la Universitatea din București (Sparktech)
- Decembrie 2018 locul 2 la Textract hackathon (București)
- Prezent UTM și continui să învăț despre Machine Learning

## Machine Learning



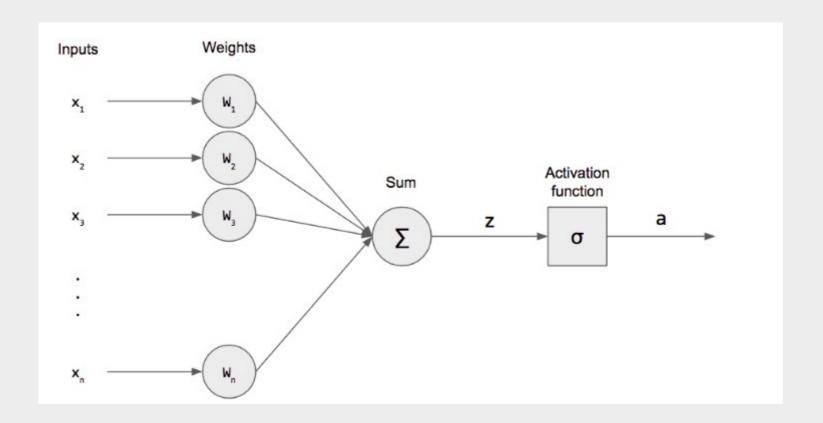
#### Primele articole

• 1943 – primul articol despre reţele neuronale (McCulloch & Pitts): http://www.cse.chalmers.se/~coquand/AUTOMATA/mcp.pdf

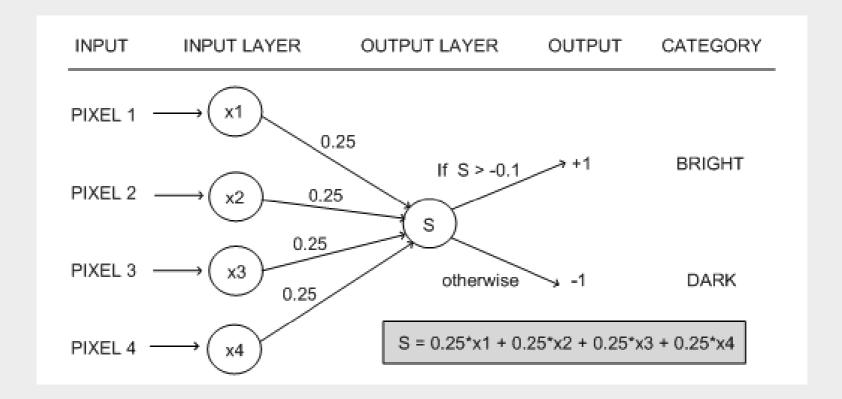
 1958 – perceptronul lui Frank Rosenblatt

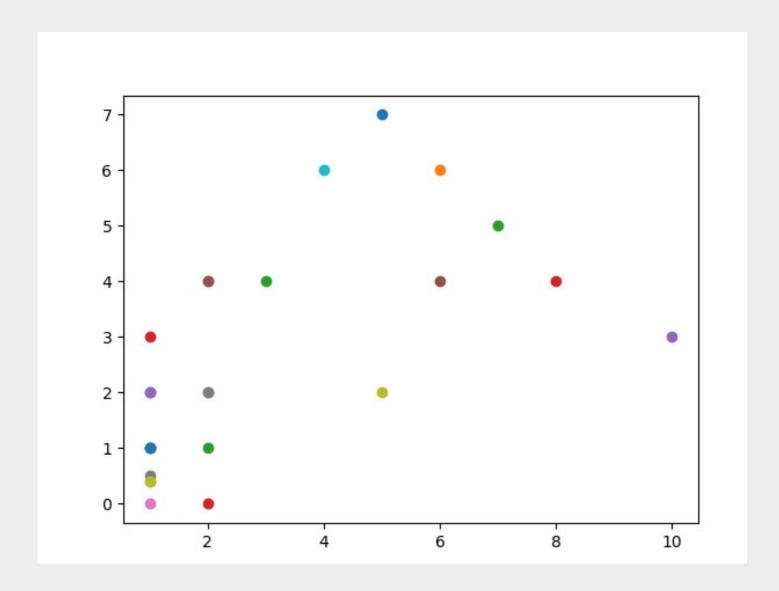
 $\label{lem:http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.335.3398\&rep=rep1\&type=pdf$ 

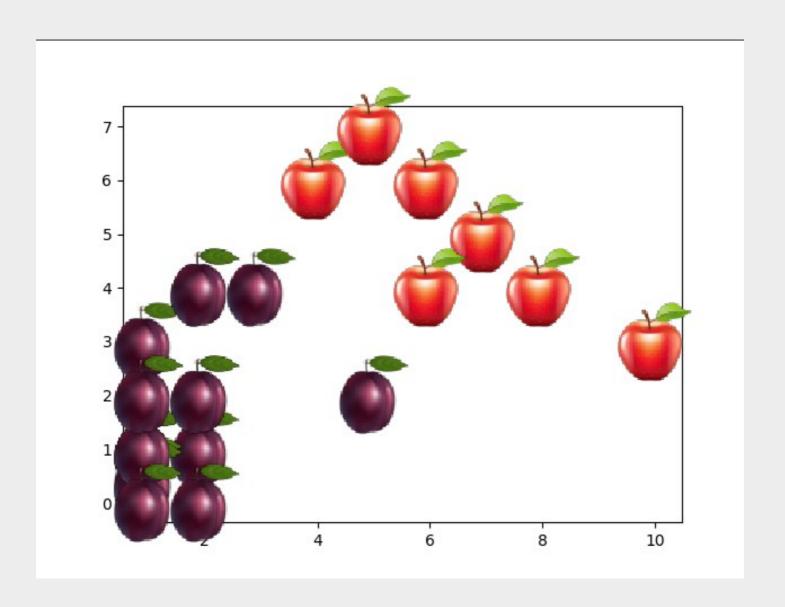
• primul model operațional cu capabilități de învățare, capabil să soluționeze probleme de clasificare

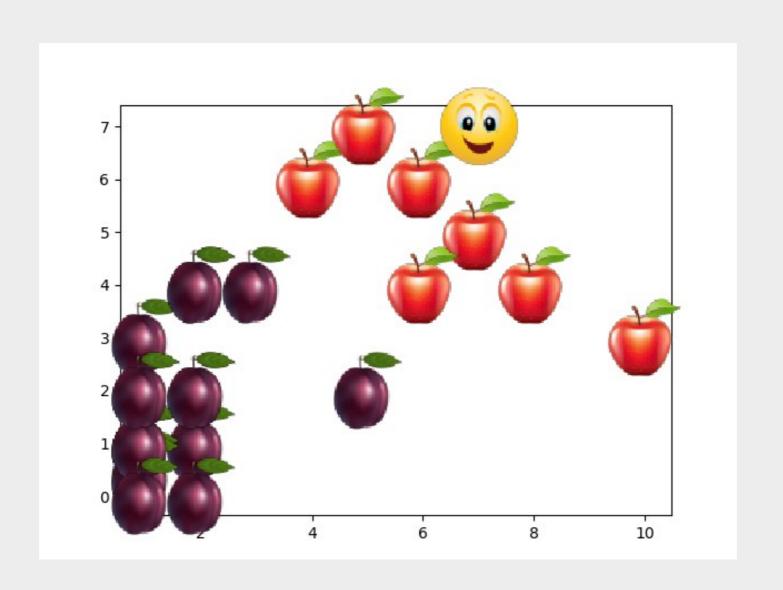


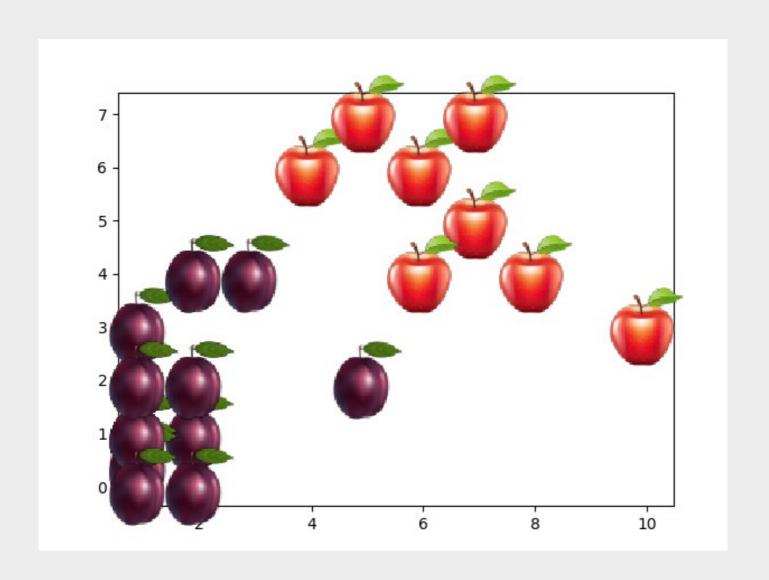
## Exemplu

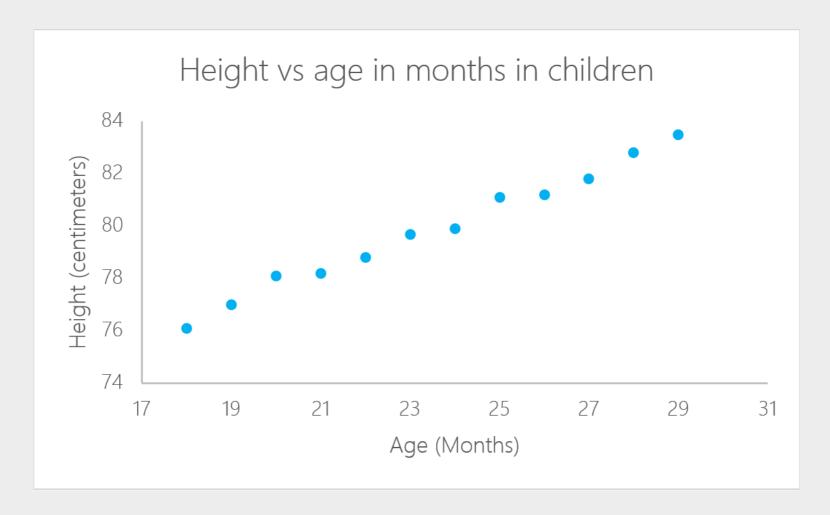












#### THE NEW YORK TIMES, TUESDAY, JULY 8, 1958.

### NEW NAVY DEVICE LEARNS BY DOING

Psychologist Shows Embryo of Computer Designed to Read and Grow Wiser

WASHINGTON, July 7 (UPI)

The Navy revealed the embryo of an electronic computer
today that it expects will be
able to walk, talk, see, write,
reproduce itself and be conscious of its existence,

The service said it would use this principle to build the first of its Perceptron thinking machines that will be able to read and write. It is expected to be finished in about a year at a cost of \$100,000.

Dr. Frank Rosenblatt, designer of the Perceptron, conducted the demonstration. He said the machine would be the first device to think as the human brain. As do human beings, Perceptron will make mistakes at first, but will grow wiser as it gains experience, he said.

Dr. Rosenblatt, a research psychologist at the Cornell Aeronautical Laboratory, Buffalo, said Perceptrons might be fired to the planets as mechanical space explorers.

The Navy said the perceptron would be the first non-living mechanism "capable of receiving, recognizing and identifying its surroundings without any human training or control."

The "brain" is designed to

The "brain" is designed to remember images and information it has perceived itself. Ordinary computers remember only what is fed into them on punch cards or magnetic tape.

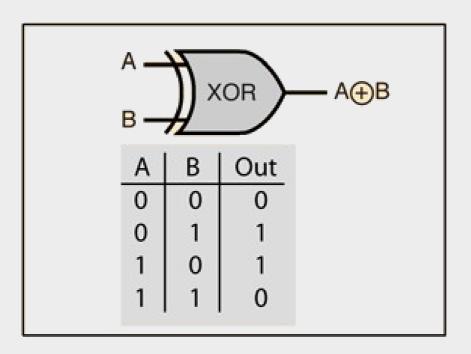
Later Perceptrons will be able to recognize people and call out their names and instantly translate speech in one language to speech or writing in another language, it was predicted.

Mr. Rosenblatt said in principle it would be possible to build brains that could reproduce themselves on an assembly line and which would be conscious of their existence.



# Stagnarea rețelelor neuronale -Minsky și Papert (1969)

 Reţelele cu 1 singur strat nu erau capabile să proceseze circuitul XOR (Exclusive OR)

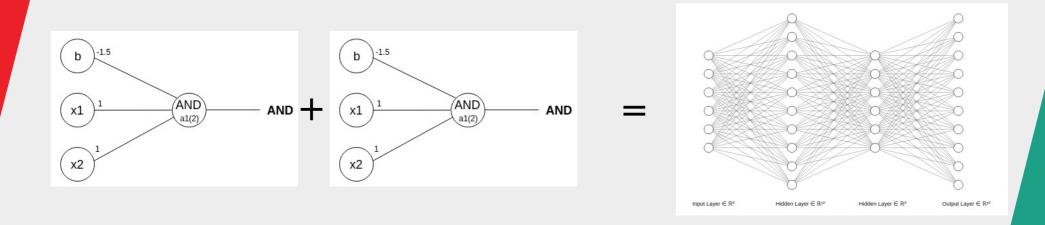


# Stagnarea rețelelor neuronale -Minsky și Papert (1969)

 Puterea de calcul – timpul necesar pentru antrenarea reţelelor neuronale voluminoase



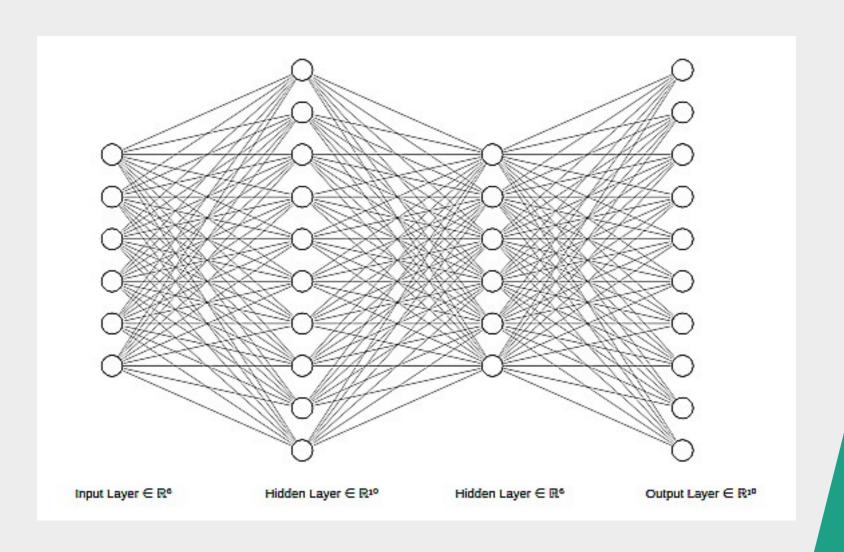
# Rețea Neuronală Artificială (A<mark>NN)</mark> Multi Layer Perceptron (MLP)



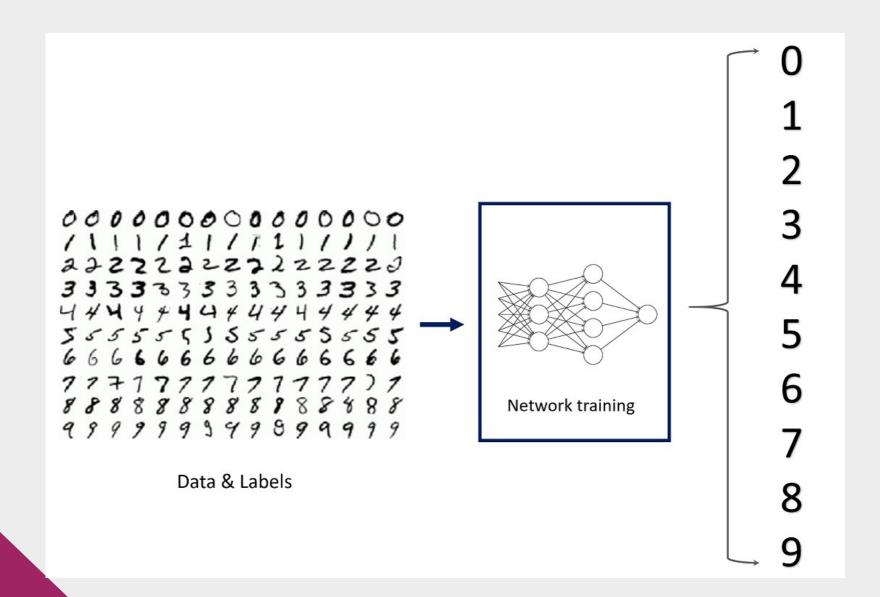
## Rețea Neuronală Artificială (AN<mark>N)</mark>

- Ansamblu de elemente de procesare simple (perceptroni), puternic interconectate şi operând în paralel,
- urmăresc să interacționeze cu mediul înconjurător într-un mod asemănător creierelor biologice
- prezintă capacitatea de a învăța

# Rețea Neuronală Artificială (A<mark>NN)</mark> Multi Layer Perceptron (MLP)

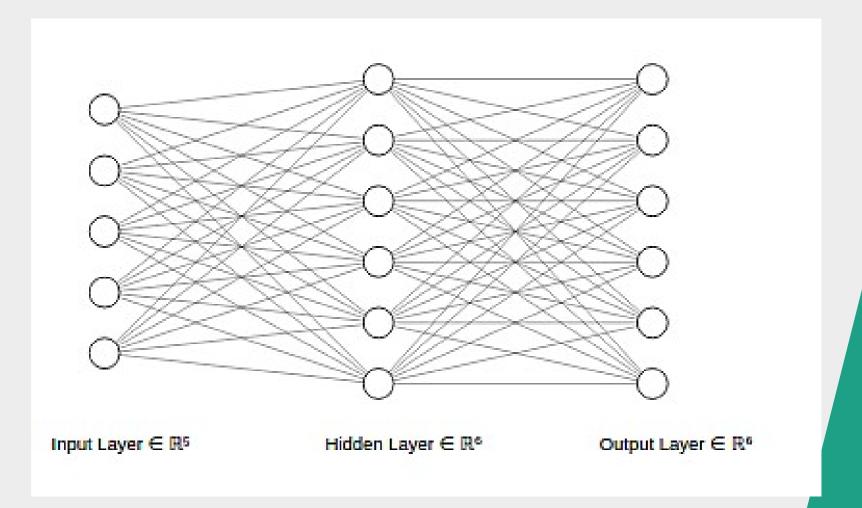


## Recunoaştere cifre (MNIST)



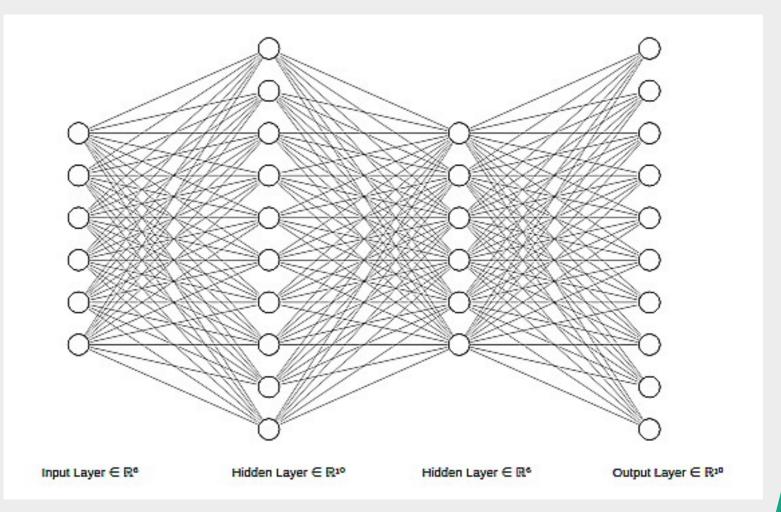
## (Shallow) Neural Network

#### 3 straturi



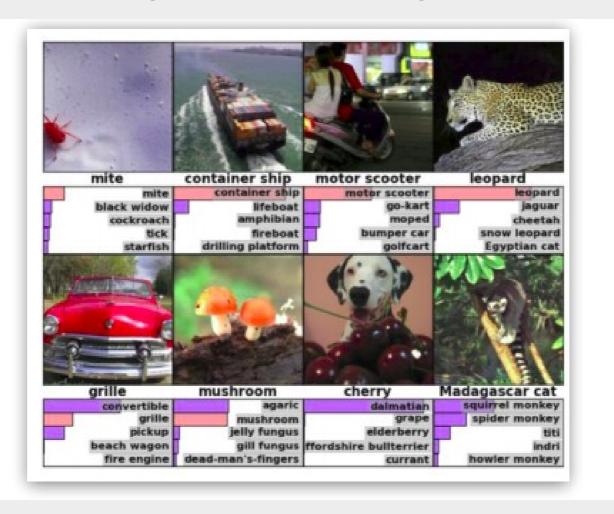
## Deep Neural Network

• Mai mult de 3 straturi

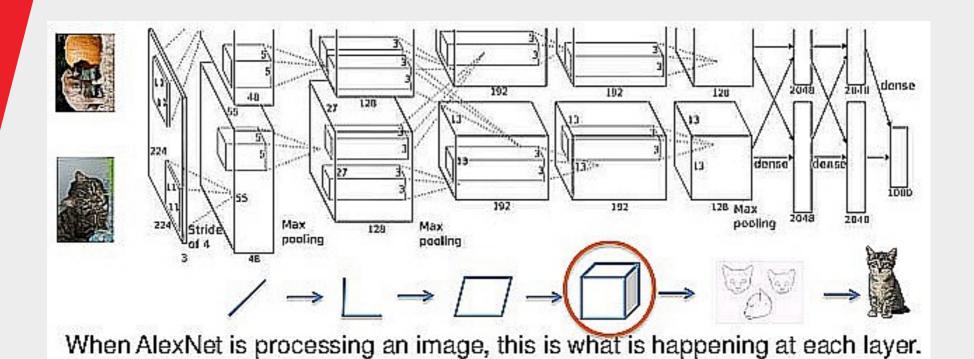


# ImageNet Image Recognition Challenge

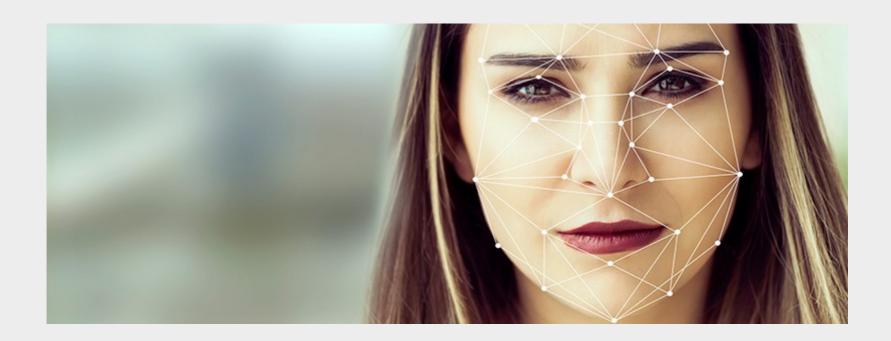
• 1.2 million images of 1000 categories.



#### AlexNet

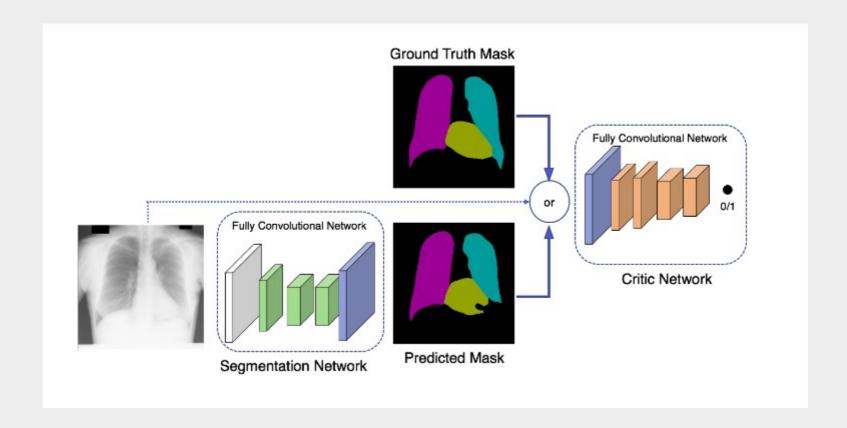


## Recunoașterea fețelor

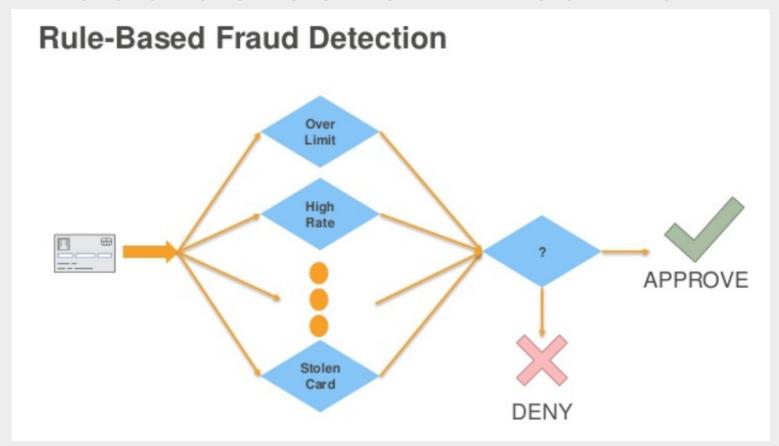


https://us.norton.com/internetsecurity-iot-how-facial-recognition-soft ware-works.html

## Imagistica medicală



### Fraud detection in banks



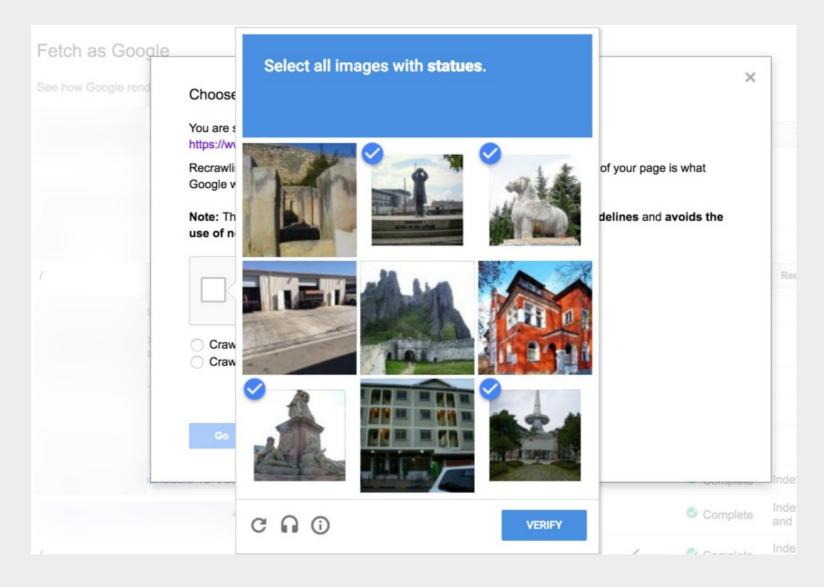
Surse: Amazon Web Services. "Fraud Detection with Amazon Machine Learning on AWS." 22 Sept. 2017.
 Reading.

https://digital.hbs.edu/platform-rctom/submission/paypals-use-of-machine-learning-to-enhance-fraud-detectionand-more/

# Self-driving cars



# Google CAPTCHA

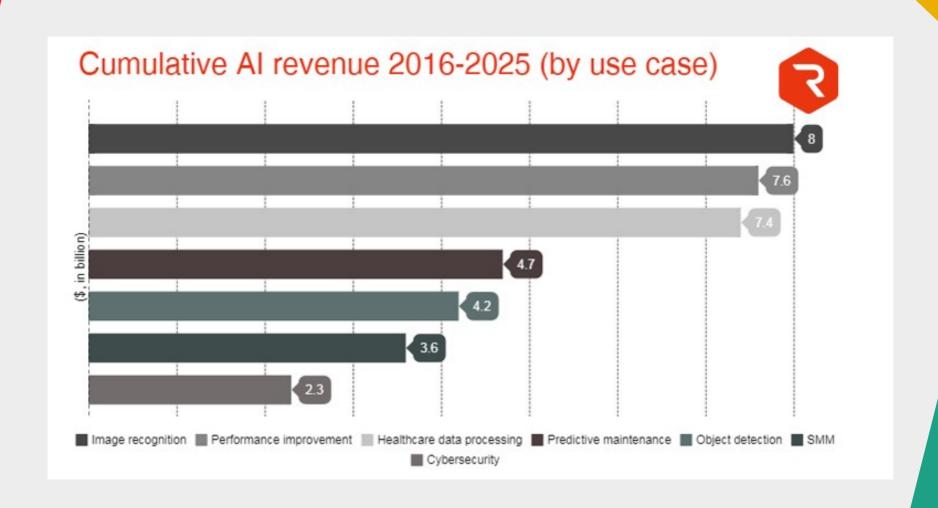


## Marketing

- Segmentarea clienţilor după caracteristici de bază: demografia, statutul economic, locaţia, pattern-urile de cumpărare, atitudinea faţă de anumite produse
- Gruparea automată a clienţilor cu caracteristici similare
- Recomandări de produse



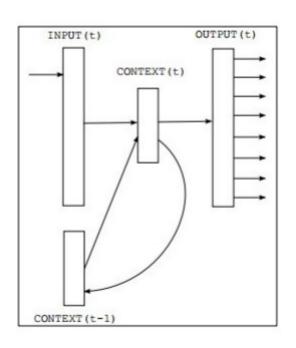
# Aplicaţii



# Rețele Neuronale Recurente (RNN)

## Rețele Neuronale Recurente

**Recurrent Networks** are good at modeling sequences...



Word-level language model. Similar to:

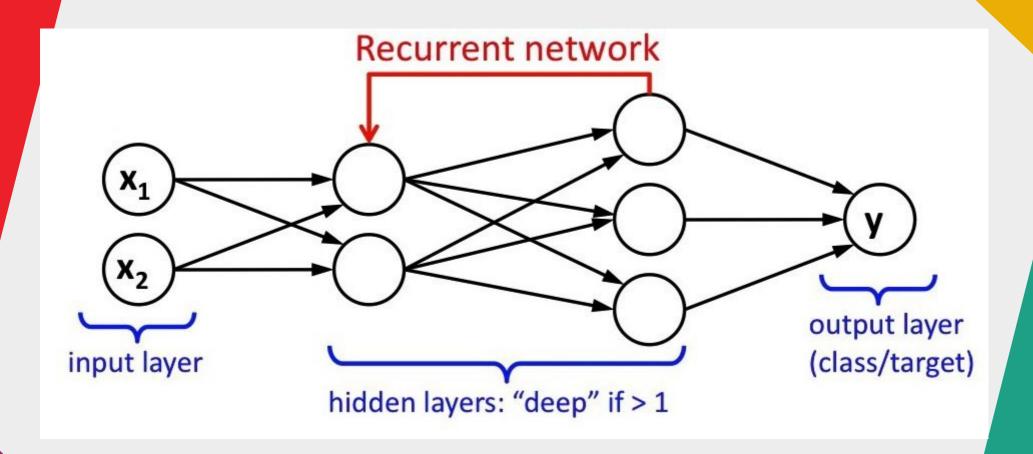


Recurrent Neural Network Based Language Model [Tomas Mikolov, 2010]

## Rețele Neuronale Recurente

- David Rumelhart 1986
- Tip de reţea neuronală, în care conexiunile dintre elemente creează o secvenţă direcţionată
- Modelează secvenţe

## Rețele Neuronale Recurente



# Studiu de caz: Adunarea numerelor cu ajutorul Rețelelor Neuronale Recurente (RNN)

#### Task

Să construim o rețea neuronală recurentă care să învețe să adune numere

#### Idei

- Rețea de tip encoder-decoder
- Vom lucra cu numere de 3 cifre
- Pentru numerele cu mai putin de 3 cifre
  - padding cu 0 (002, 005, 035 etc)
- Vom codifica fiecare cifră şi vom obţine tablouri de 0 și 1

$$2 + 2 = 4$$

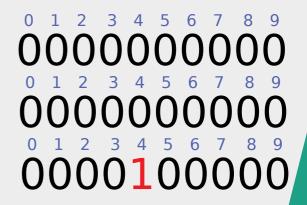
0010000000 + 001000000 = 00001000000

$$002 + 002 = 004$$

```
0010000000 + 001000000 = 00001000000
```

$$002 + 002 = 004$$

```
0010000000 + 001000000 = 00001000000
```



$$125 + 102 = 227$$

```
\begin{array}{c} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ \end{array}
```

## Tehnologii

- Python
- Tensorflow
- Keras
- Sklearn
- Matplotlib





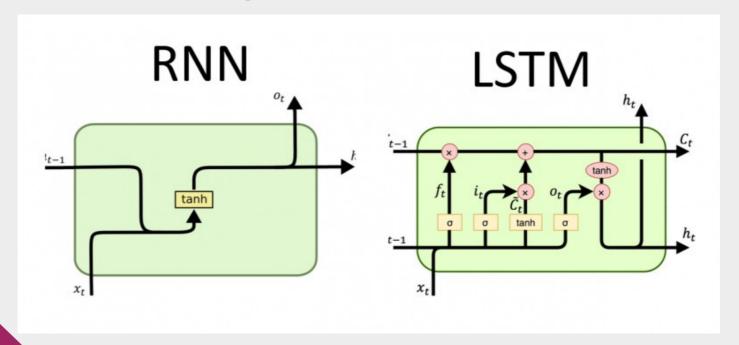
matplotliba



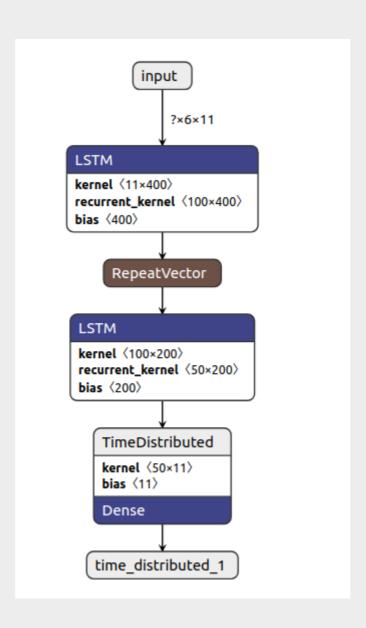


#### **LSTM**

- Tip de Reţea Neuronală Recurentă
- Poate procesa şi secvenţe de date (voce sau video de ex.), nu doar imagini
- Se utilizează pentru secvenţe conectate



# Arhitectura reţelei



## Arhitectura rețelei

## Arhitectura rețelei

```
Layer (type)
                              Output Shape
                                                         Param #
lstm 1 (LSTM)
                              (None, 100)
                                                         44800
repeat_vector_1 (RepeatVecto (None, 3, 100)
lstm_2 (LSTM)
                              (None, 3, 50)
                                                         30200
time_distributed_1 (TimeDist (None, 3, 11)
                                                         561
Total params: 75,561
Trainable params: 75,561
Non-trainable params: 0
```

#### **Antrenare**

```
Epoch 2/50
32/5000 [....... - acc: 0.145] - ETA: 7s - loss: 2.2991 - acc: 0.145
64/5000 [....... - acc: 0.114
128/5000 [...... - acc: 0.114
160/5000 [...... - acc: 0.106
224/5000 [>...... - acc: 0.107
256/5000 [>...... - acc: 0.108
288/5000 [>...... - acc: 0.104
320/5000 [>...... - acc: 0.103
352/5000 [=>....... - acc: 0.103
416/5000 [=>...... - acc: 0.105
448/5000 [=>...... - acc: 0.110
480/5000 [=>...... - acc: 0.109
512/5000 [==>...... - acc: 0.109
544/5000 [==>...... - acc: 0.109
576/5000 [==>....... acc: 0.108
608/5000 [==>...... - acc: 0.105
640/5000 [==>...... - acc: 0.105
```

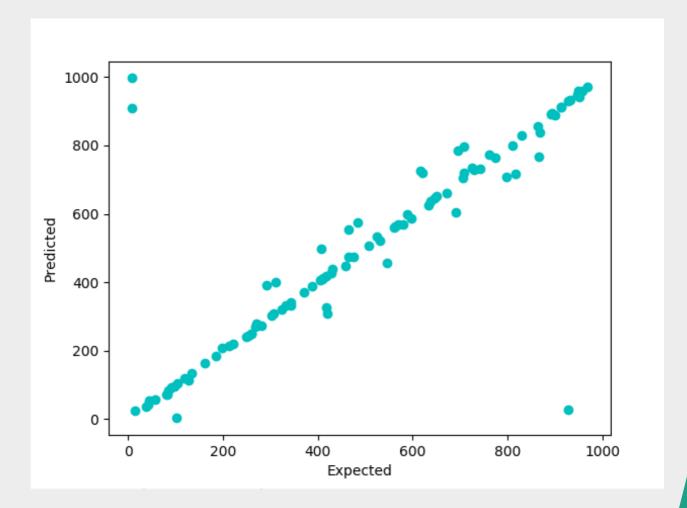
## Rezultate - train set

• Epochs: 100

Accuracy: 100%

## Rezultate - Test set

Accuracy: 68%



## Problema?

Problema?

Overfitting

Soluţia?

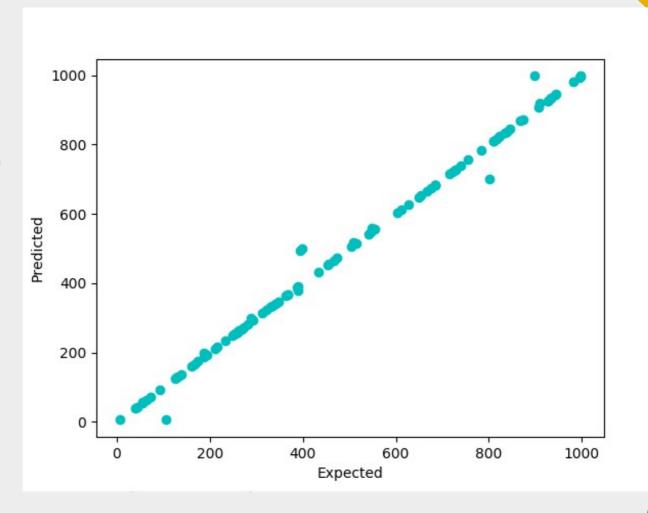
# Early stopping

## Rezultate - test set

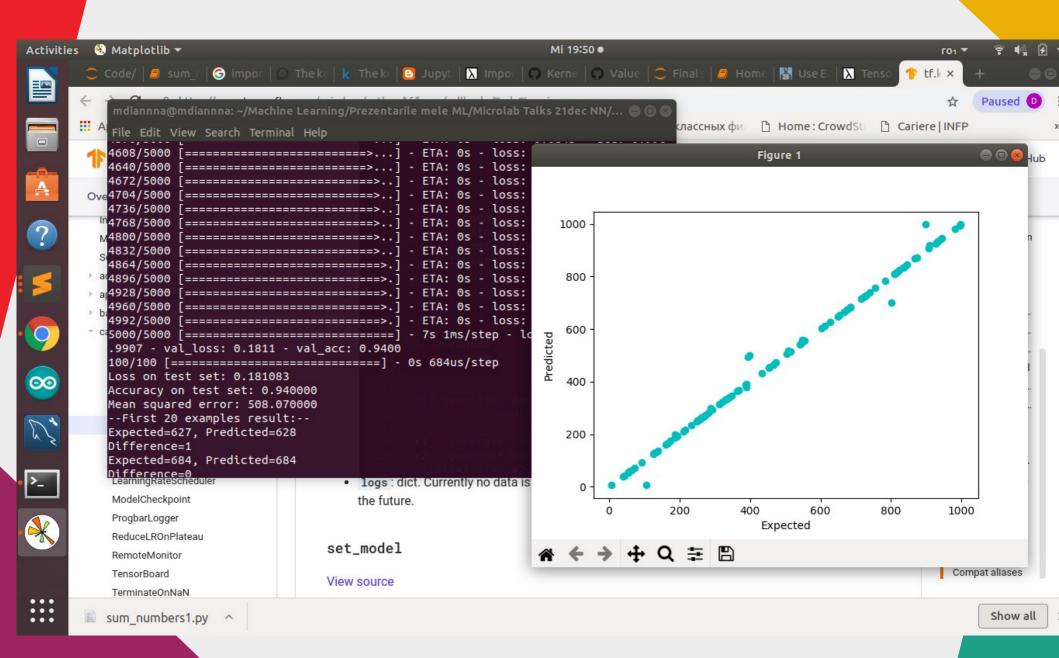
Accuracy: 94%

Loss: 0.181

MSE: 508.07



## Sum numbers with RNN





Aplicaţii reale ale Reţelelor Neuronale Recurente

# Image captioning



"girl in pink dress is jumping in air."

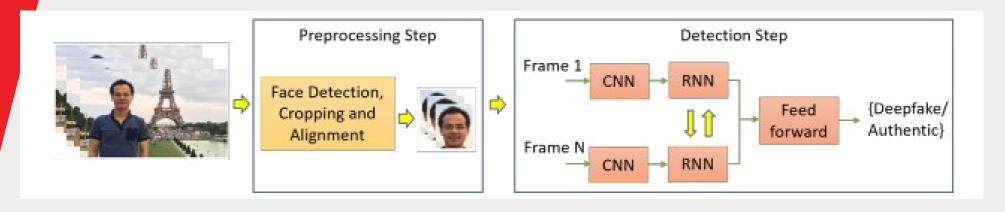


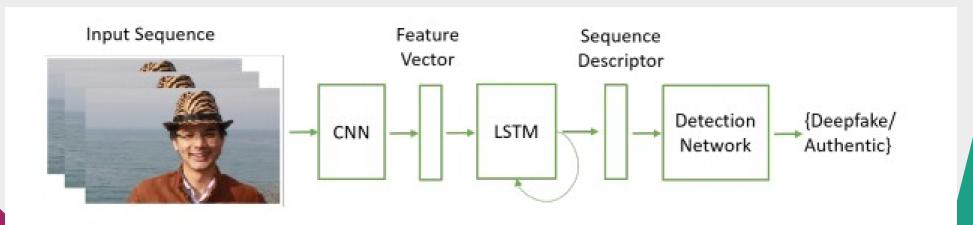
"black and white dog jumps over bar."



"man in blue wetsuit is surfing on wave."

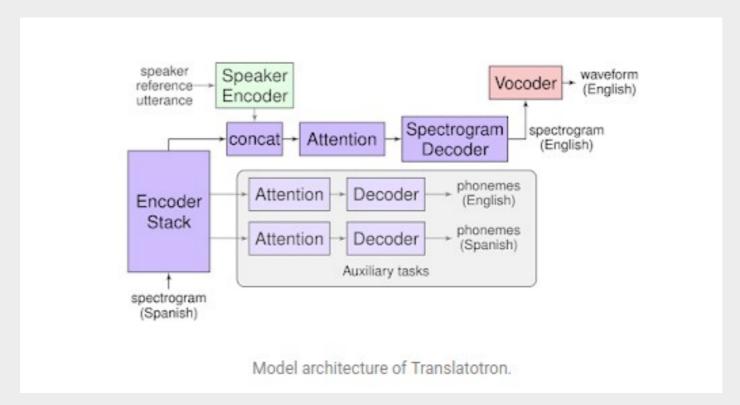
## Fake Video Detection





# Google Translotron

Google Translate menţine vocea



github.com/mdiannna/ MicrolabTalksNN21

marusicdiana@gmail.com

Mulţumesc pentru atenţie!