

UNIVERSITATEA DIN BUCUREȘTI, FACULTATEA DE MATEMATICĂ ȘI INFORMATICĂ  
SPECIALIZAREA MATEMATICI APLICATE

# Matematici Aplicate în Artificial Neural Networks

Experimente practice  
LUCRARE DE LICENȚĂ

 Coord. științific: **Prof. Dr. IONEL POPESCU**

 Absolvent: **LAVINIA FLORENTINA PIEPTEA**

# AGENDA

 Noțiuni preliminare



Experimente practice:



Experimentul 1. Învățare clasică



Experimentul 2. Învățare pe imagini alterate



Experimentul 3. Învățare pe numere de două cifre



Rezultatele experimentelor



Concluzii



Bibliografie

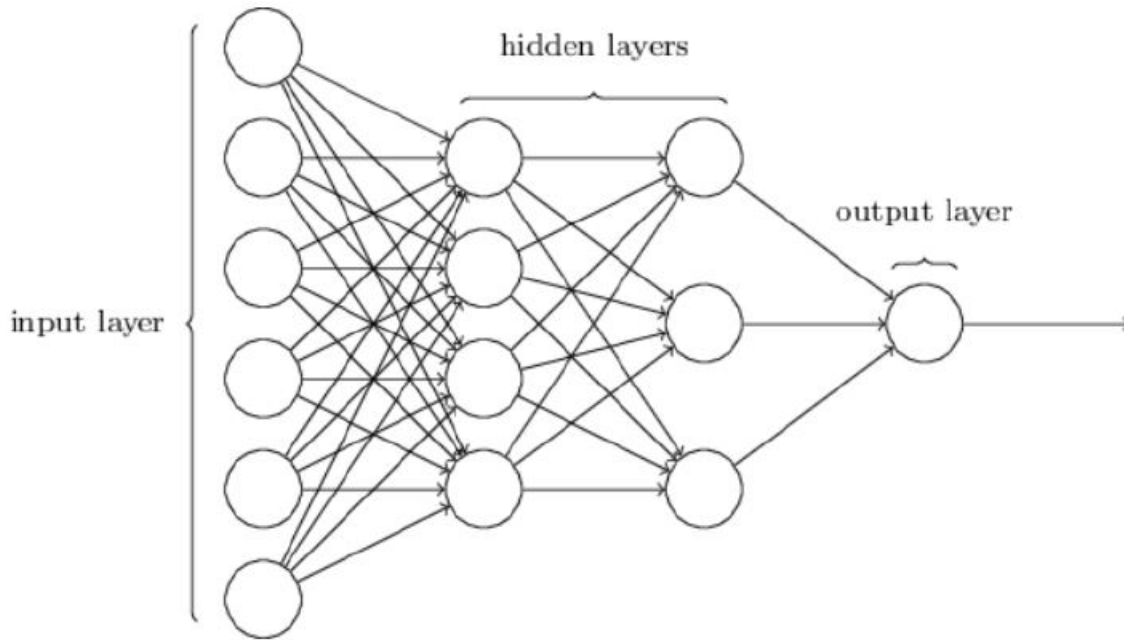


Întrebări

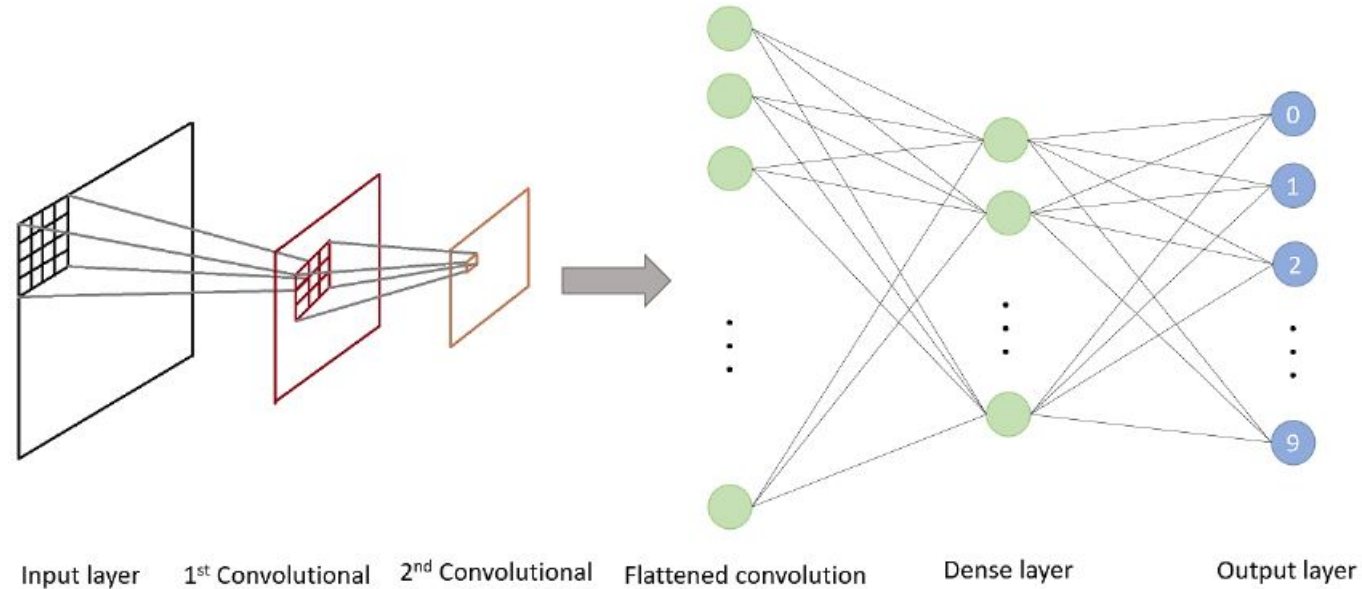


# Noțiuni preliminare

## 📌 Simple Neural Network (**NN**)



## 📌 Convolutional Neural Network (**CNN**)



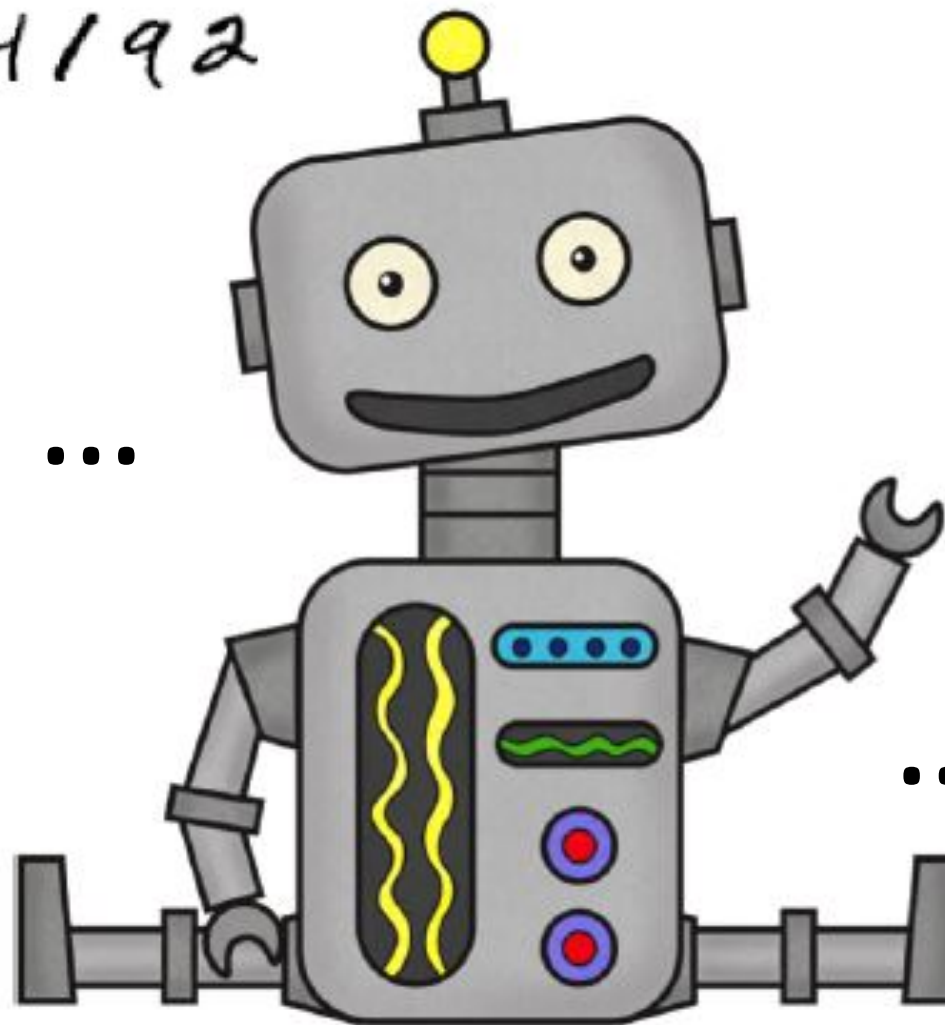


# Esperimento pratica

Dataset-ul MNIST

504192

...



...

**504192!**



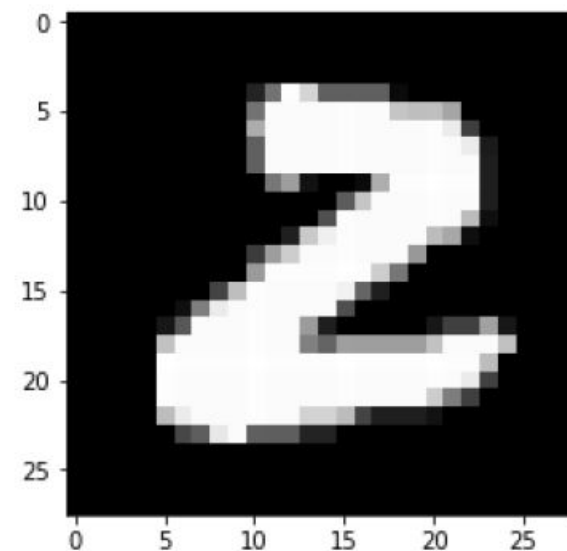


# Experimentul 1. Învățare clasică

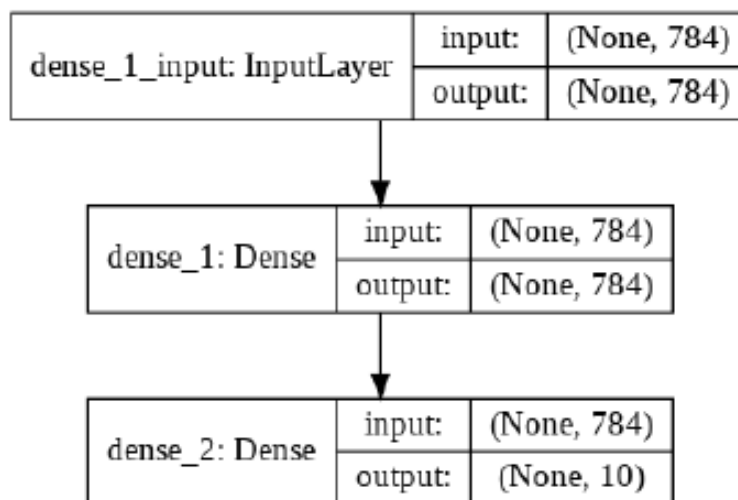
Am aplicat o metodă clasică de training a unui NN, fără nicio intervenție asupra inputului.

```
[ ] model = Sequential()  
model.add(Conv2D(32, (5, 5), input_shape=X_train_sc.shape[1:], activation='relu'))  
model.add(MaxPooling2D(pool_size=(2, 2)))  
model.add(Dropout(0.2))  
model.add(Flatten())  
model.add(Dense(128, activation='relu'))  
model.add(Dense(y_train_sc.shape[-1], activation='softmax'))  
model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy'])
```

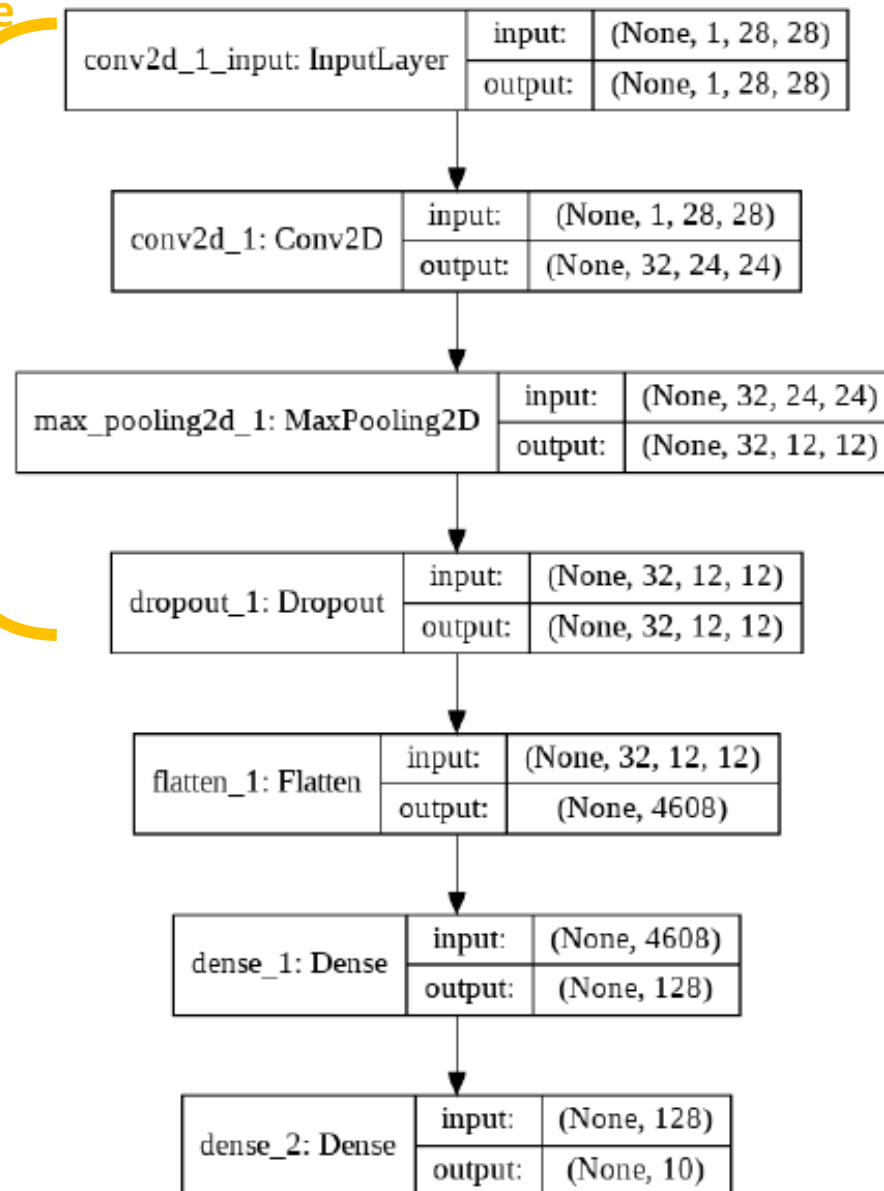
☞ Train (3000, 28, 28)  
Valid (3000, 28, 28)  
Test (10000, 28, 28)



## Simple NN – layers' model



## Convolutional NN – layers' model





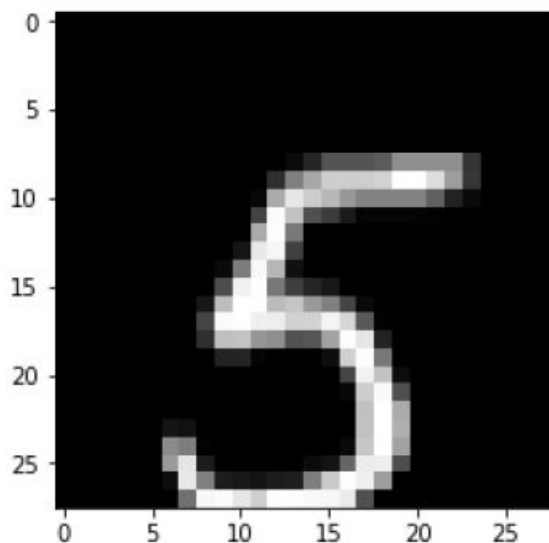
# Experimentul 2. Invățare pe imagini alterate

Am aplicat o metodă de alterare a inputului, pentru a pune in dificultate modelul.

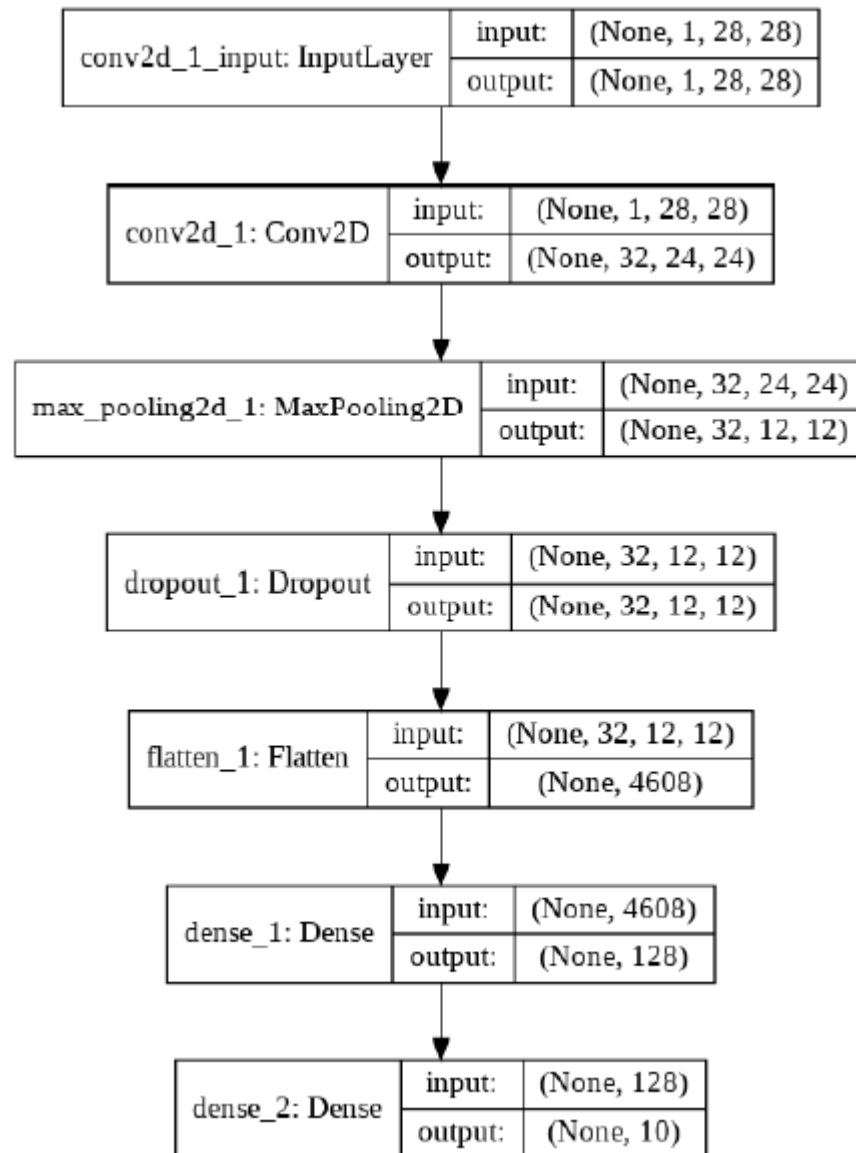
Tipurile de modificări sunt random, din următoarele categorii:

1. *Adăugare de zgomot*
2. *Rotire de 360° în jurul originii*
3. *Shiftare – stânga/dreapta/sus/jos*

```
Train (3000, 28, 28)  
Valid (3000, 28, 28)  
Test (10000, 28, 28)
```



## Convolutional NN – layers' model



# Experimentul 3. Învățare pe numere de două cifre

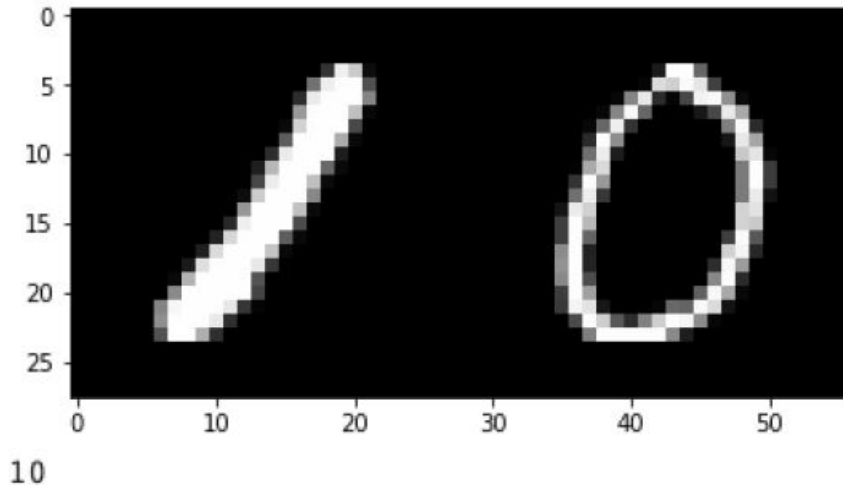
Prin acest experiment am testat o ipoteză ce s-a dovedit a avea rezultate remarcabile.

Am folosit o metodă originală de modificare adusă inputului: concatenarea a două imagini → număr de două cifre.

Procedeul:

*Fiecărei imagini din dataset i-am atașat la stânga o altă imagine cu 4 tipuri de scris random din fiecare cifră.*

```
Train (120000, 28, 56)  
Valid (30000, 28, 56)  
Test (10000, 28, 56)
```



## Convolutional NN – layers' model

conv2d_1_input: InputLayer	input:	(None, 1, 28, 56)
	output:	(None, 1, 28, 56)



conv2d_1: Conv2D	input:	(None, 1, 28, 56)
	output:	(None, 32, 24, 52)



max_pooling2d_1: MaxPooling2D	input:	(None, 32, 24, 52)
	output:	(None, 32, 12, 26)



dropout_1: Dropout	input:	(None, 32, 12, 26)
	output:	(None, 32, 12, 26)



flatten_1: Flatten	input:	(None, 32, 12, 26)
	output:	(None, 9984)



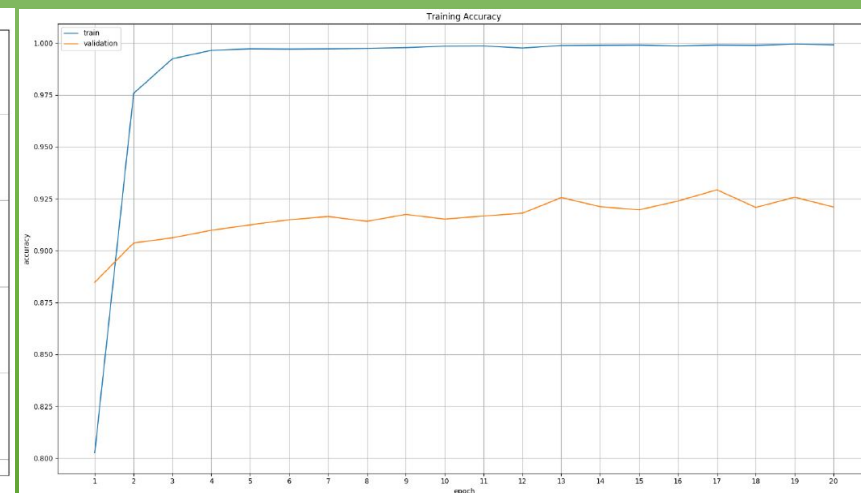
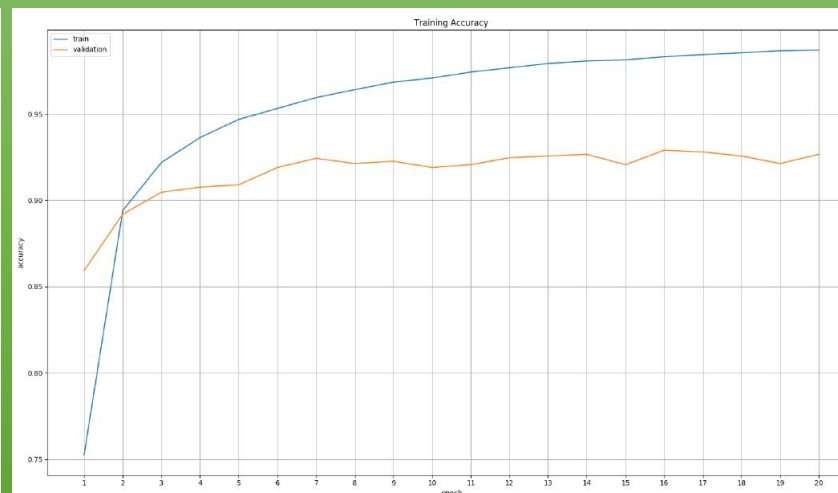
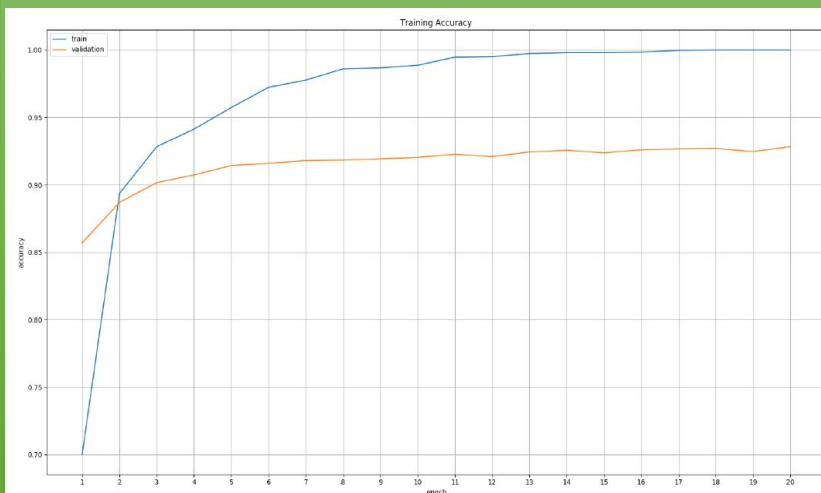
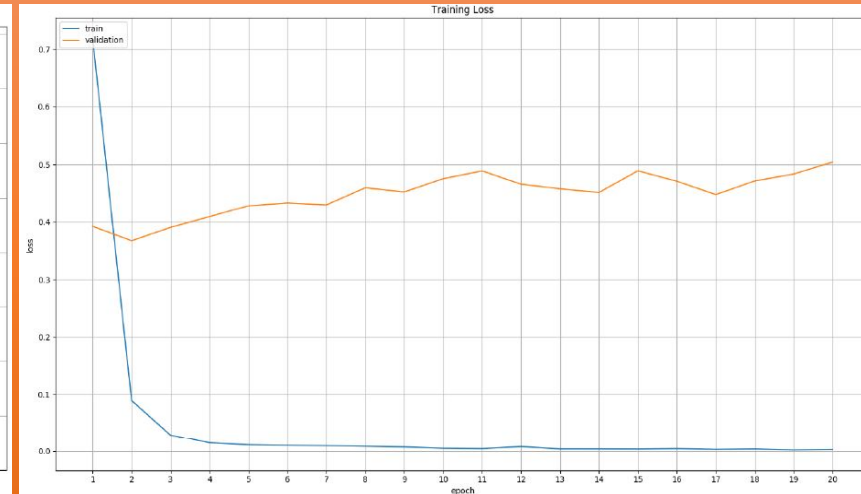
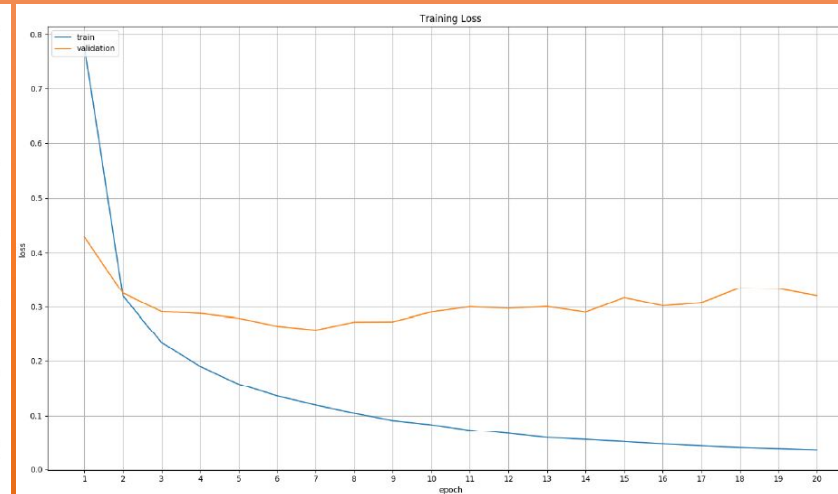
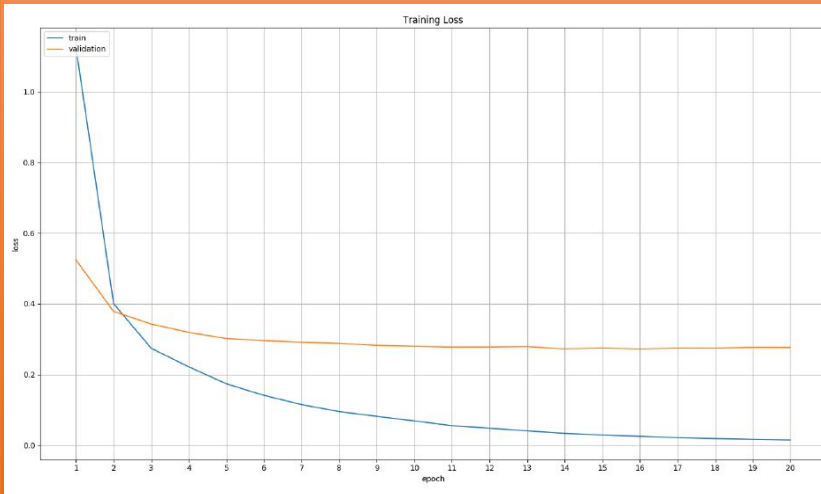
dense_1: Dense	input:	(None, 9984)
	output:	(None, 128)



dense_2: Dense	input:	(None, 128)
	output:	(None, 100)



# Rezultatele experimentelor



Casetele de încadrare:

- **GRAFICUL ERORII**
- **GRAFICUL ACURATEȚII**

Liniiile de pe grafic:

- **CURBA DE TRAIN**
- **CURBA DE VALIDATION**

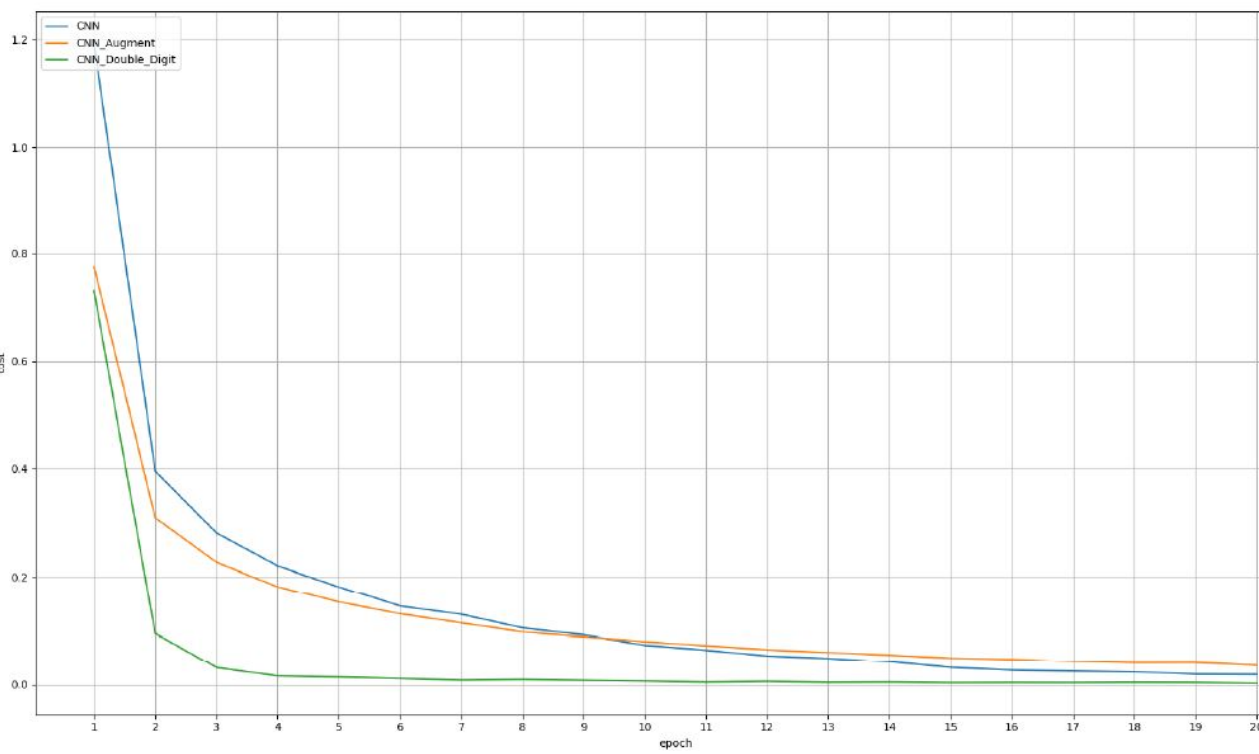




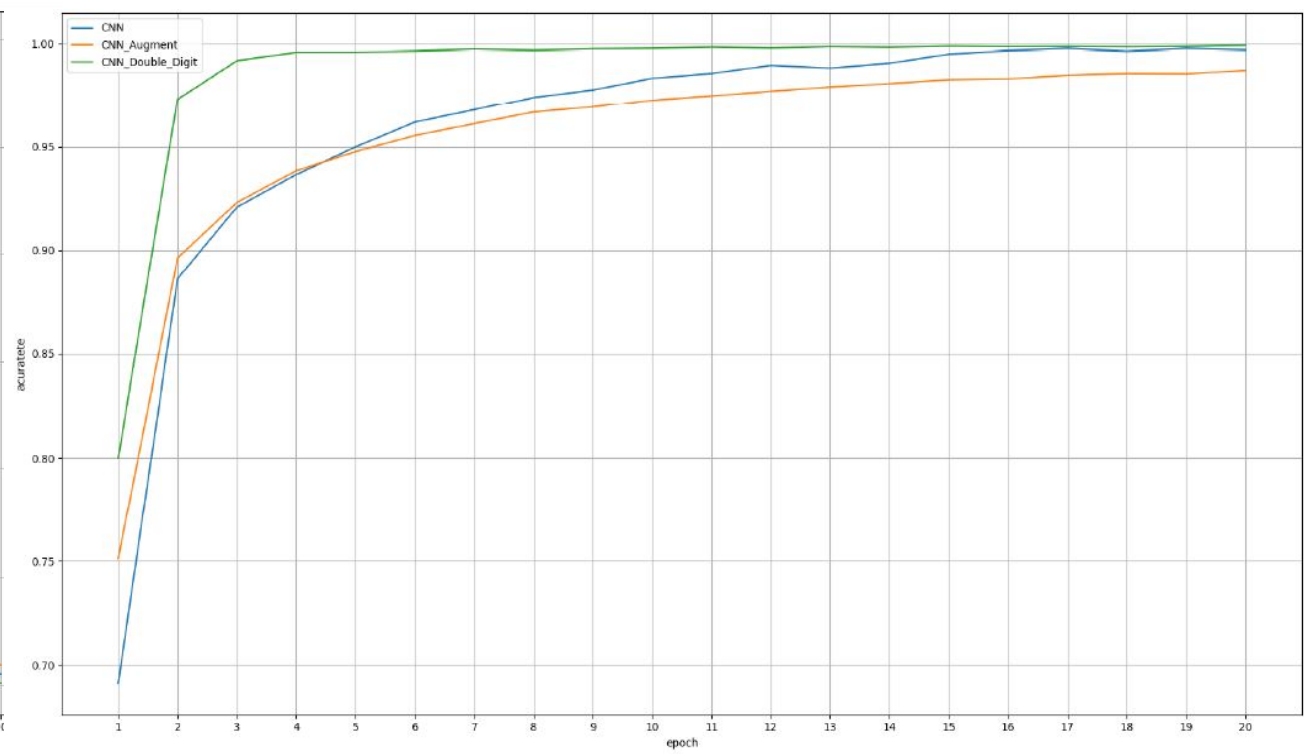
# Concluzii

- Rezultatele experimentului 1. Învățare clasică
- Rezultatele experimentului 2. Învățare pe imagini alterate
- Rezultatele experimentului 3. Învățare pe numere de două cifre

Curba de loss (eroare)



Curba de accuracy (acuratețe)



- [1] Tom Mitchell '*Machine Learning*'. (2018).
- [2] Catherine F. Higham Desmond J. Higham '*Deep Learning: An Introduction for Applied Mathematicians*'. (2018).
- [3] B. Hammer and T. Villmann '*Mathematical Aspects of Neural Networks*'. (2003).
- [4] ACC Coolen '*A Beginner's Guide to the Mathematics of Neural Networks*'. (2017).
- [5] Anthony L. Caterini '*A Novel Mathematical Framework for the Analysis of Neural Networks*'. (2017).
- [6] Weibo Liua, Zidong Wang, Xiaohui Liua, Nianyin Zengb, Yurong Liuc, Fuad E. Alsaadid '*A survey of deep neural network architectures and their applications*'. (2018).
- [7] Song Meia, Andrea Montanarib, c, 1, and Phan-Minh Nguyenc '*A mean field view of the landscape of two-layer neural networks*'. (2018).
- [8] S. Hochreiter. '*Untersuchungen zu dynamischen neuronalen Netzen. Diploma thesis, Institut f. Informatik, Technische*'. (Univ. Munich, 1991).
- [9] Hahnloser, R.; Sarpeshkar, R.; Mahowald, M. A.; Douglas, R. J.; Seung, H. S. '*Digital selection and analogue amplification coexist in a cortex-inspired silicon circuit*'. (2000).
- [10] Xavier Glorot, Antoine Bordes and Yoshua Bengio '*Deep sparse rectifier neural networks*'. (2011).
- [11] Ramachandran, Prajit; Barret, Zoph; Quoc, V. Le. '*Searching for Activation Functions*'. (October 16, 2017).
- [12] LeCun, Yann; Bengio, Yoshua; Hinton, Geoffrey '*Deep learning*'. (2015).
- [13] Aylien Ltd., Dublin rudr.sebastian@gmail.com '*An overview of gradient descent optimization algorithms*'. (2017).
- [14] Herbert Robbins; Sutton Monro '*A Stochastic Approximation Method*'. (1951).

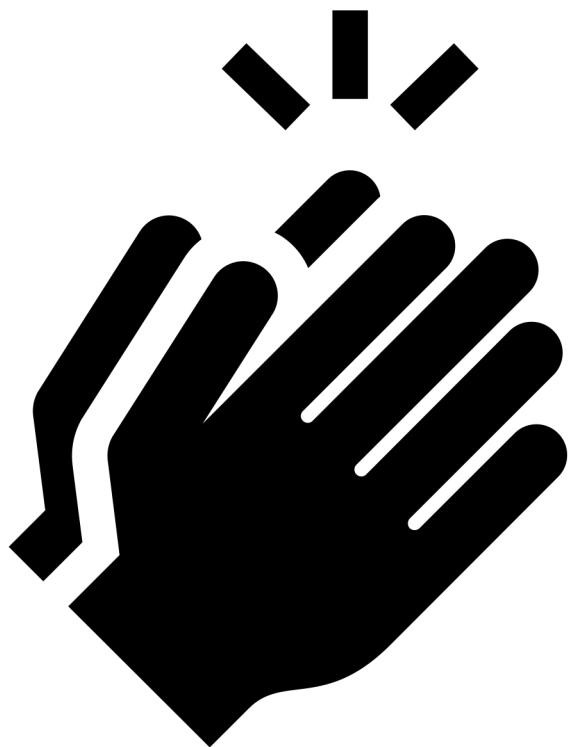


# Bibliografie

- [15] J. Kiefer and J. Wolfowitz '*Stochastic Estimation of the Maximum of a Regression Function*'. (1952).
- [16] Optimization Methods for Large-Scale Machine Learning '*Leon Bottou Frank E. Curtis† Jorge Nocedal‡*'. (Feb 2018).
- [17] Tianyou Chai, Roland R. Draxler '*Root mean square error (RMSE) or mean absolute error (MAE)*'. (2014).
- [18] Wan Zhu '*Classification of MNIST Handwritten Digit Database using Neural Network*'. (2012).
- [19] Using neural nets to recognize handwritten digits  
<http://neuralnetworksanddeeplearning.com/chap1.html>
- [20] Clipart  
<https://www.pinclipart.com/pindetail/homRTJcute-robot-clipart-3-by-tara-free-clipart/>
- [21] Medium  
<https://medium.com>

# Întrebări





Vă  
multumesc!