Министерство науки и высшего образования РФ

Национальный исследовательский университет ИТМО

Факультет Программной инженерии и компьютерных технологий

По дисциплине:
Системы искусственного интеллекта

Лабораторная работа №4.

«Study of the neural network»

Вариант 3

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Группа: P33201

Санкт–Петербург

2022 год.

I. Описание задания

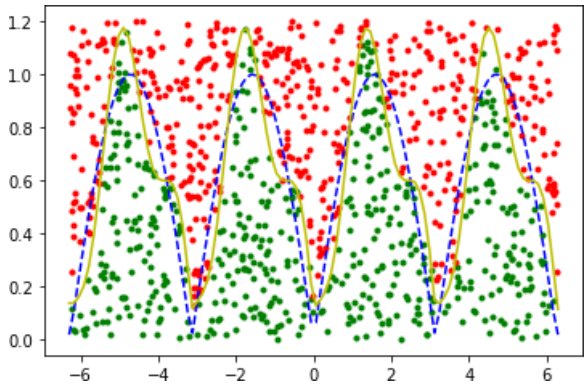
There are 2 parts of work in files named Lab1-Part1 and Lab1-Part2 respectively. Both parts represent work with collections of training and test data.

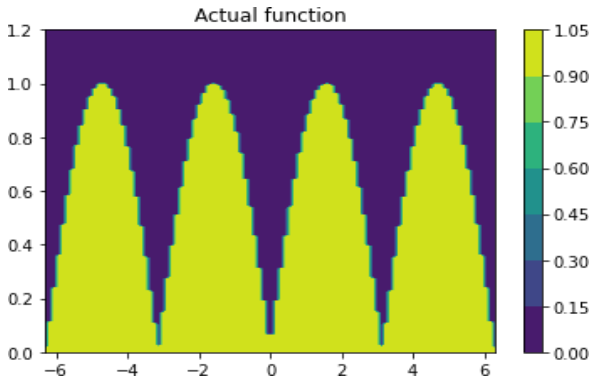
Part 1 represent recognition of basic math functions with illustrations of neural net vision of the functions for training.

Part 2 represent recognition of simple images for making following work.

Data usage represented at https://keras.io/datasets/ and depends on variant.

Var	Part1 func	Part2 data	Hyperparameters
3	Absolute(Sin(x)) X: -6.3 … 6.3 Y: 0 … 1.2	Handwritten digits	Regularization L2, output layer activation type.





There are represented such hyperparameters as:

- Layer count;
- Neurons count per layer (actually it's not hyperparameter but structure parameter);
- Learn rate;
- Regularization L1 and L2;
- Output layer activation type;
- Layer activation type;
- Loss function type;
- Epoch count.

1. By changing these hyperparameters try to reach max accuracy value(at least 0.95) for Part2 model with fixed epoch count 20;

2. Change 1st hyperparameter's value from min to max with minimal step depends on your variant;

3. Show impact on result using graphs;

4. Describe impact of each hyperparameter on accuracy;
5. Set hyperparameter value back to one which produced max accuracy;
6. Repeat 2-5 steps for second hyperparameter.

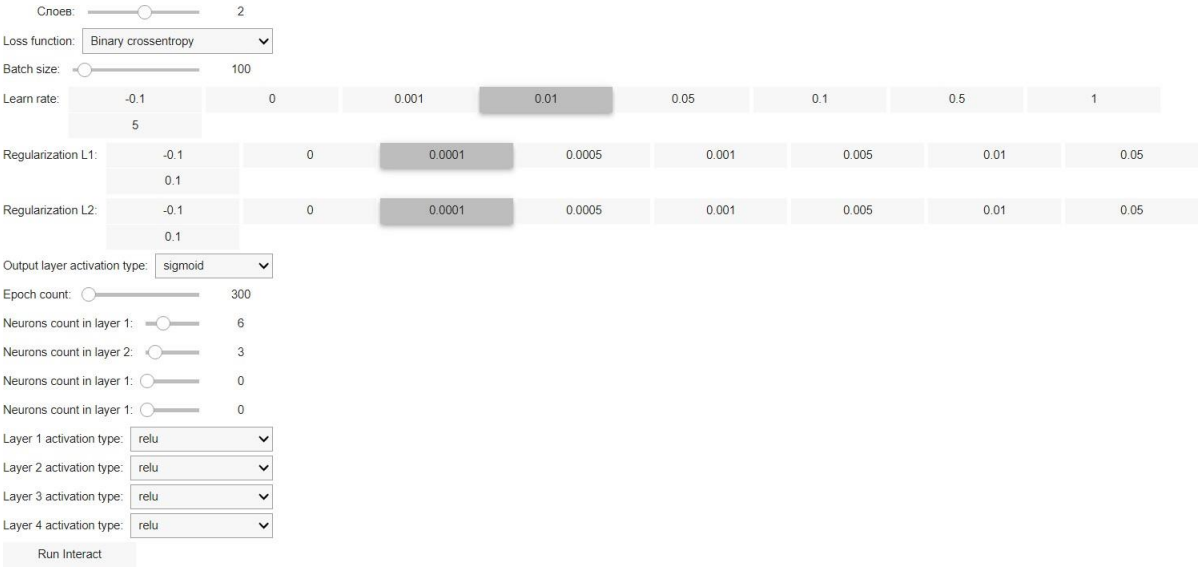
Make a report including:

- Each hyperparameter description and its impact on accuracy;
- Hyperparameters' values which were used to reach accuracy value 0.95;
- Graphs for these hyperparameters' values;

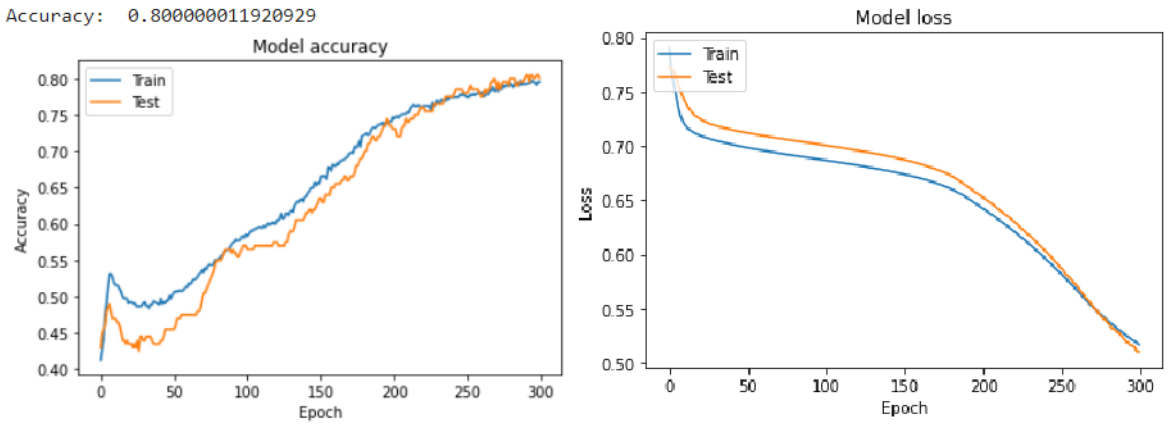
II. Выполнение

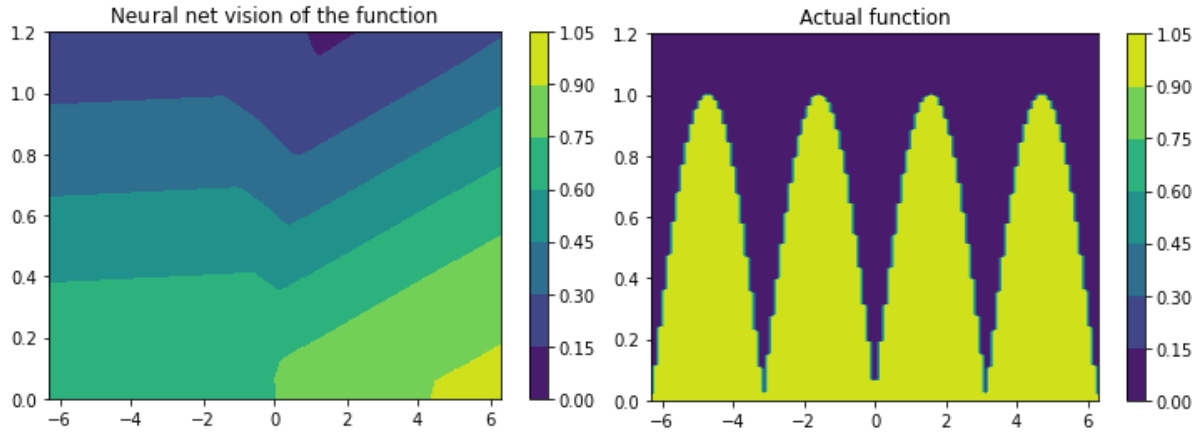
1. Часть 1

a. Hyperparameters



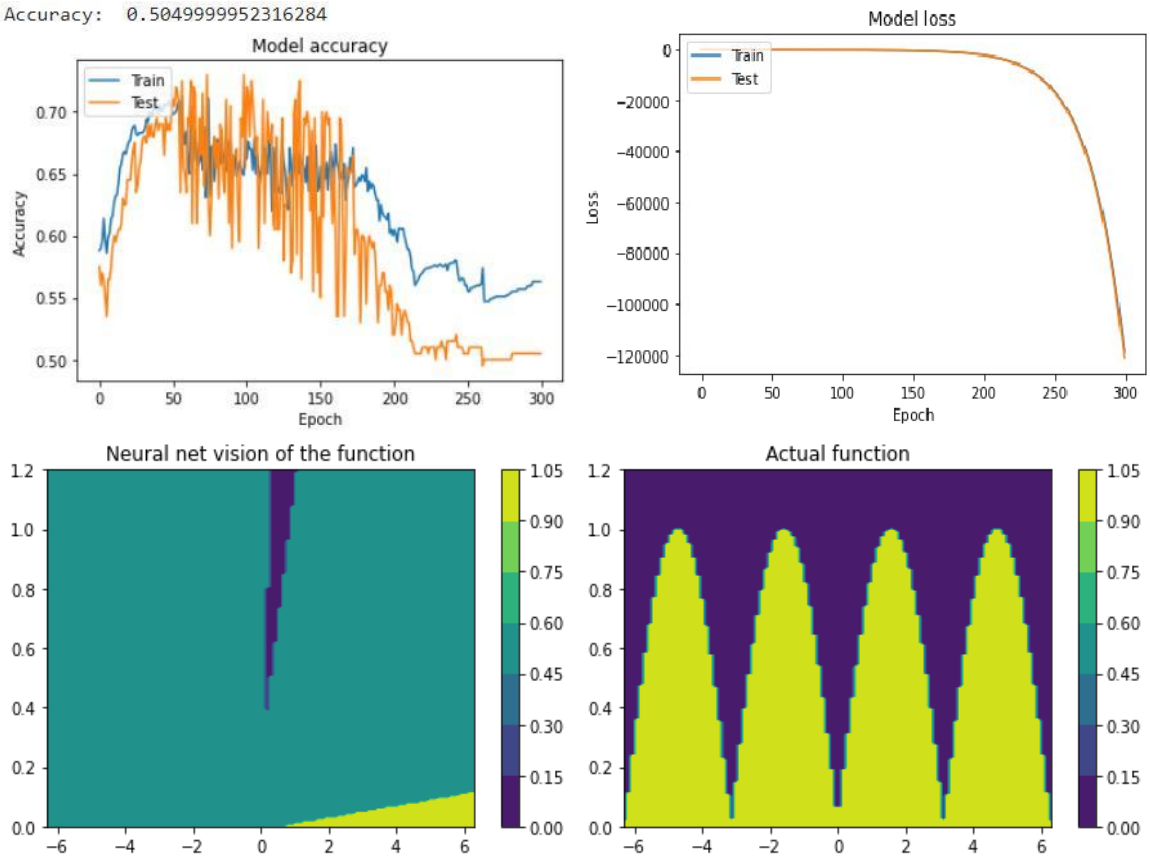
Граф для этих параметров:





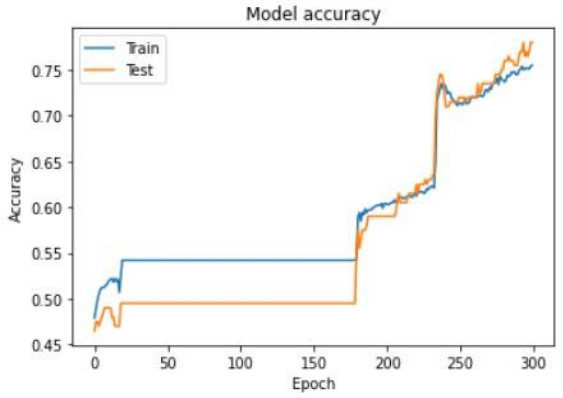
b. Изменеие L2

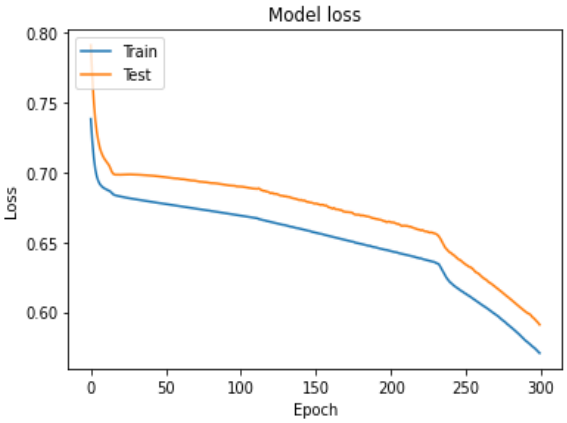
+) L2=-0.1

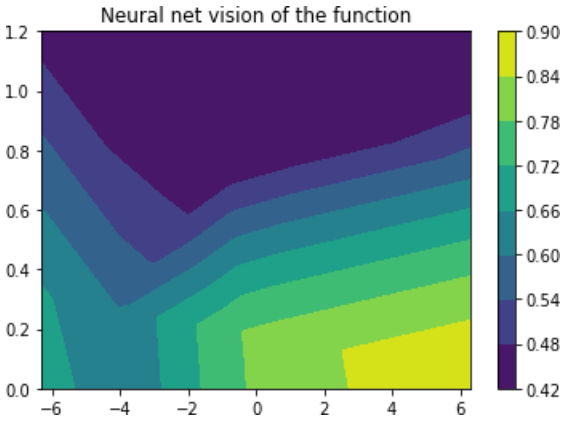


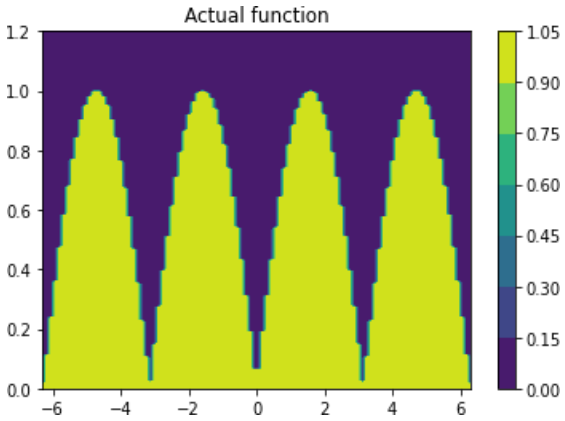
+) L2=0

```
Accuracy:  0.7799999713897705
```



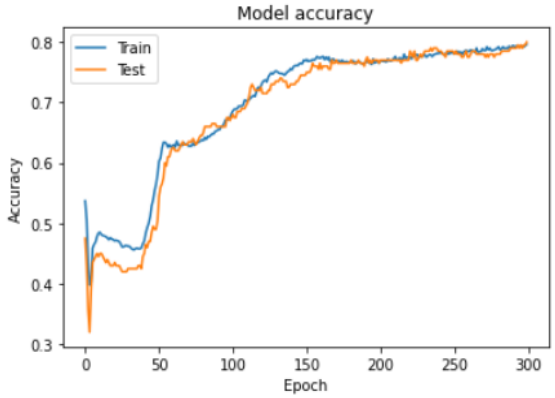


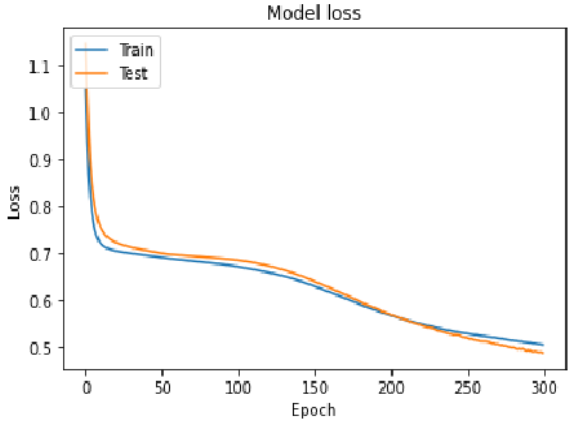


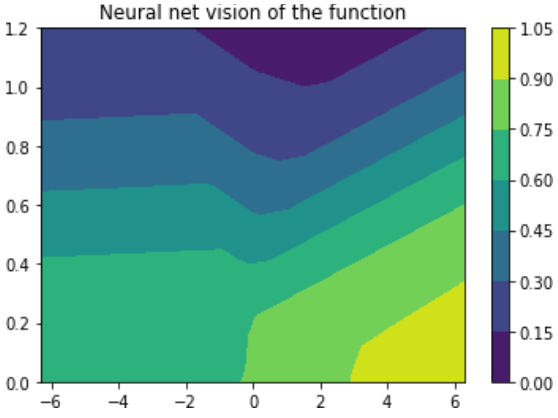


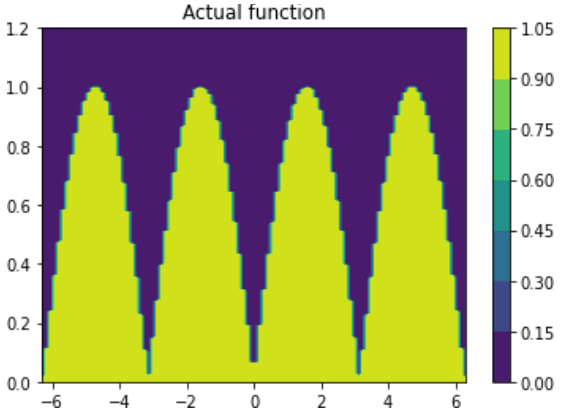
+) L2=0.0005

```
Accuracy:  0.800000011920929
```



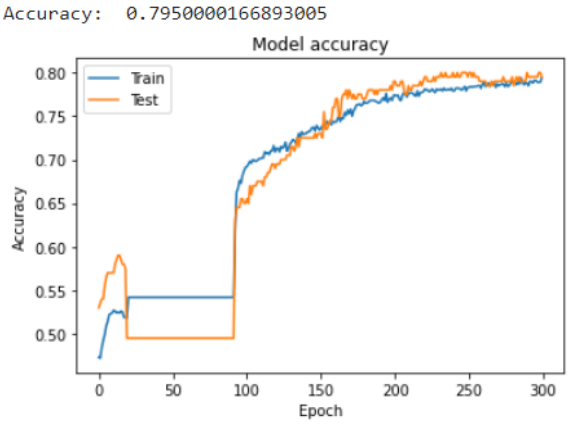


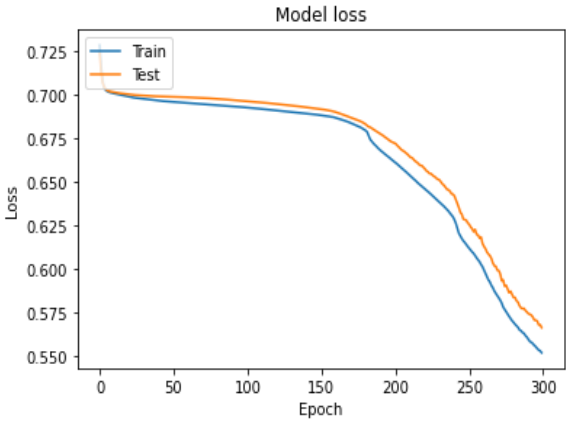


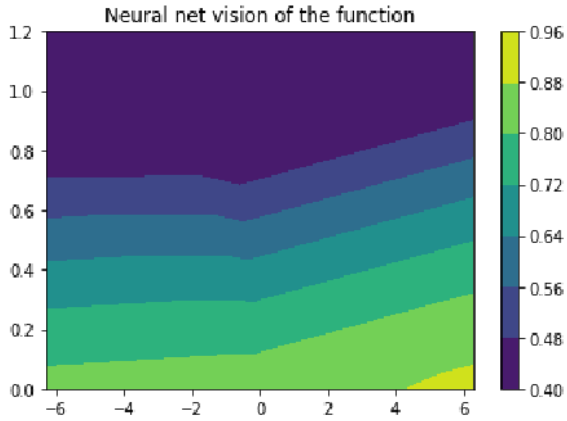


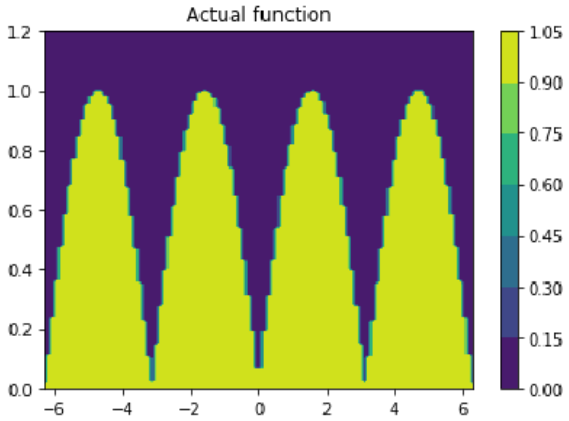
+) L2=0.001

```
Accuracy:  0.7950000166893005
```



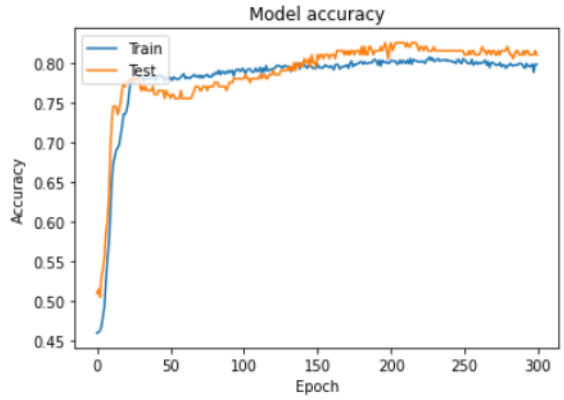


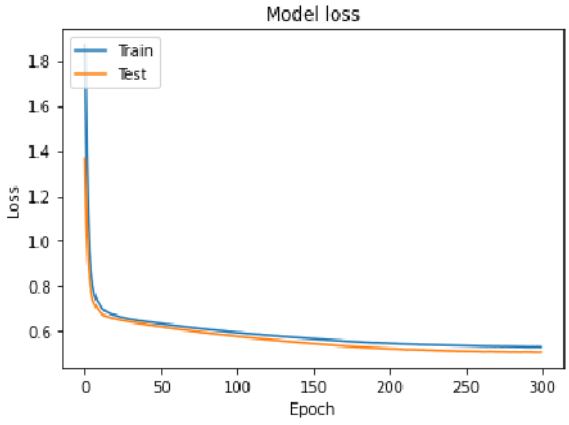


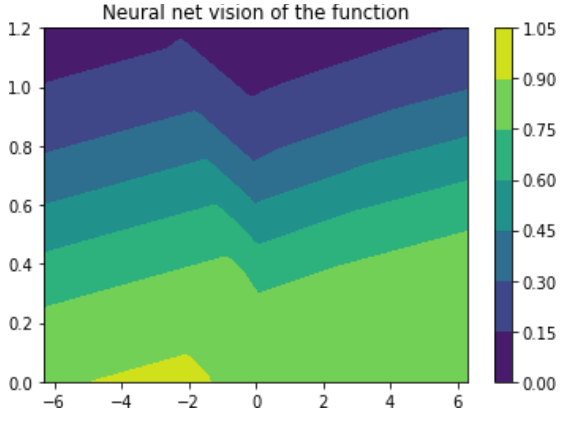


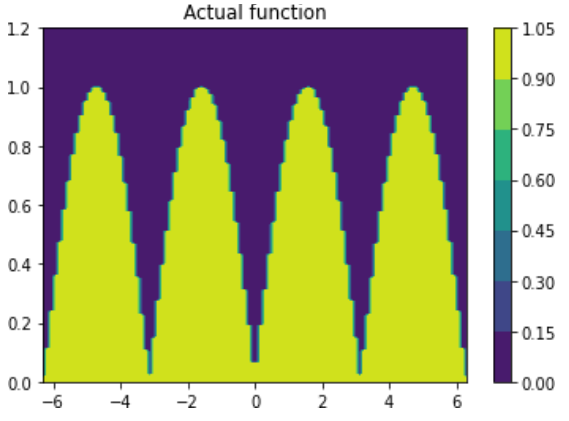
+) L2=0.005

```
Accuracy:  0.8100000023841858
```



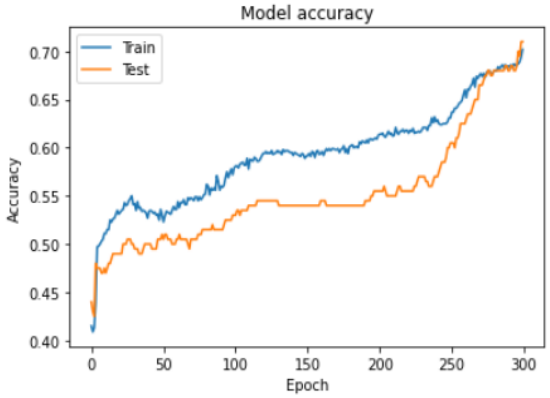


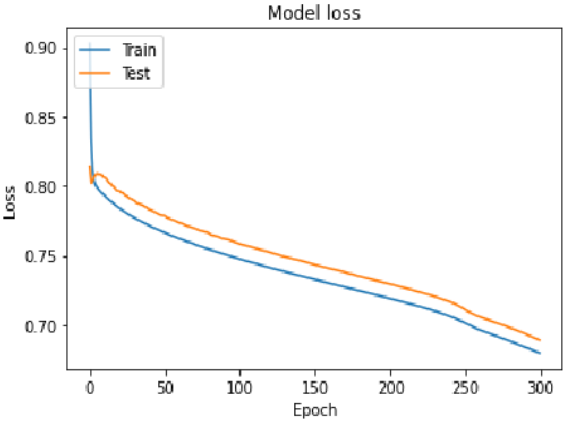


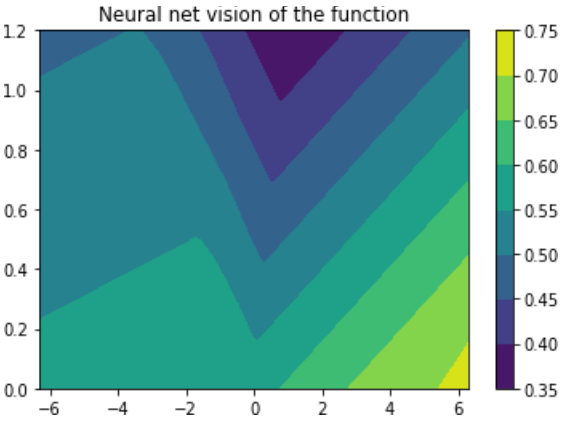


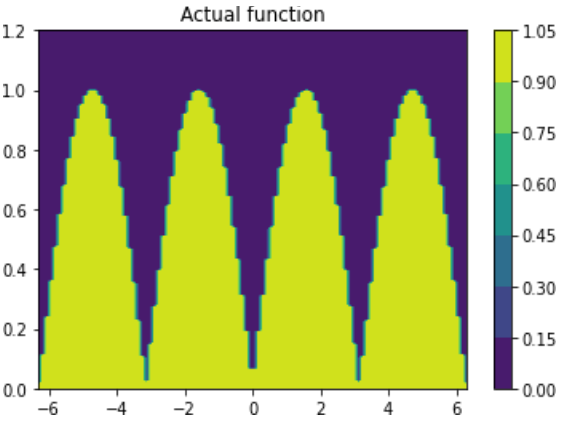
+) L2=0.01

```
Accuracy:  0.7099999785423279
```



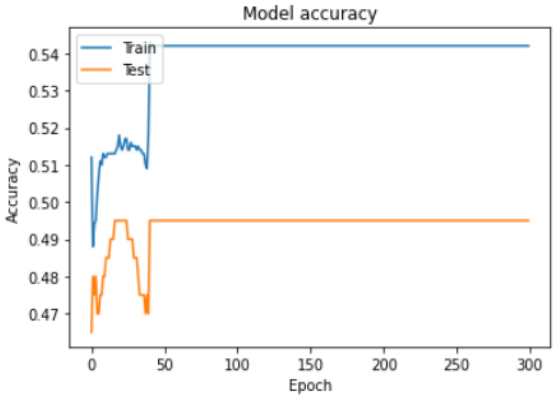


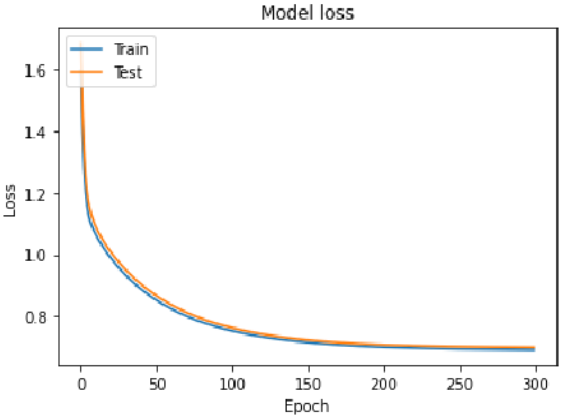


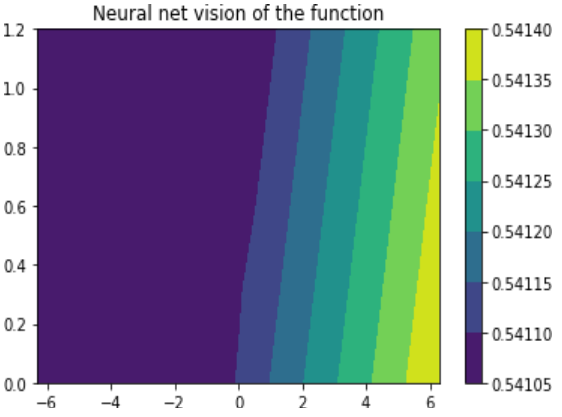


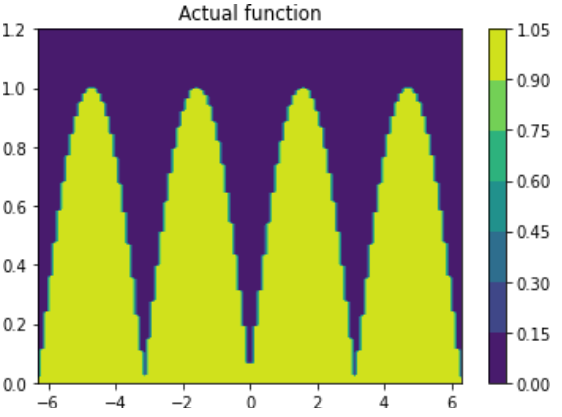
+) L2=0.05

```
Accuracy:  0.4950000047683716
```

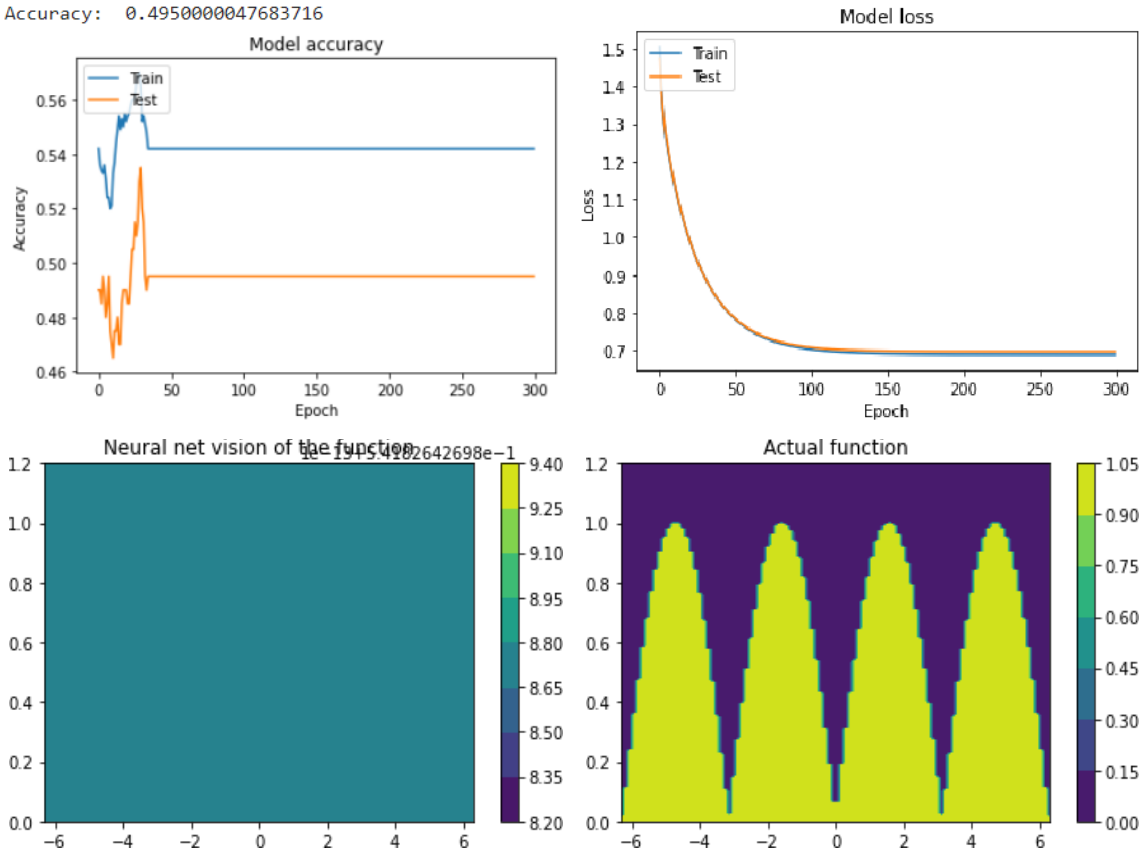






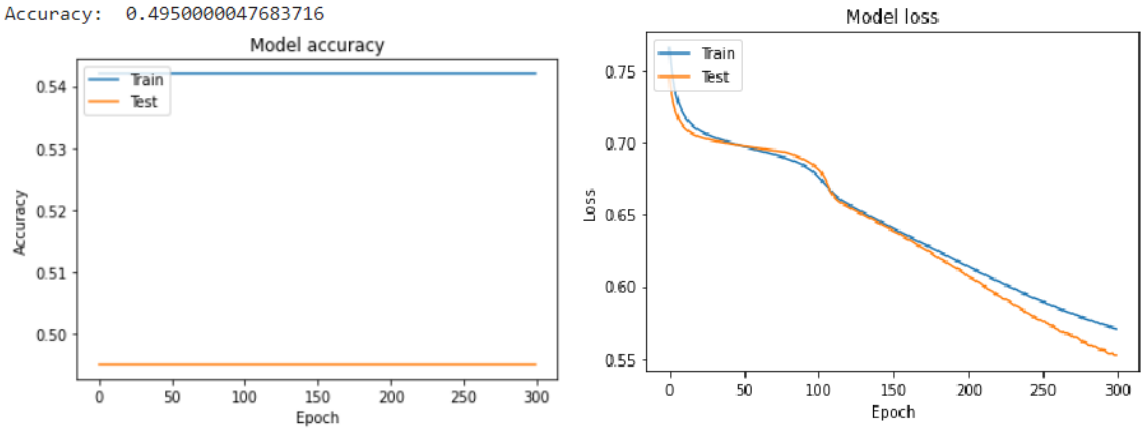


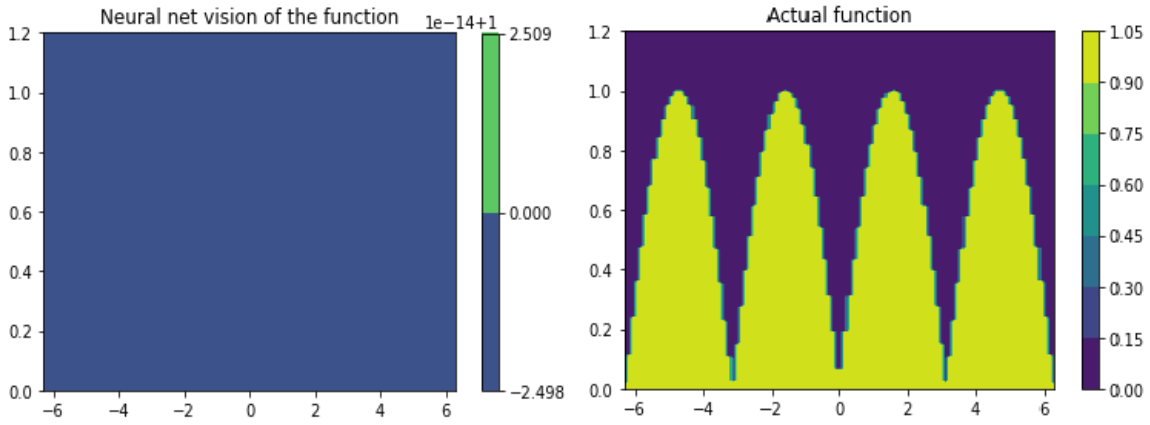
+) L2=0.1



c. Изменение Output layer activation function

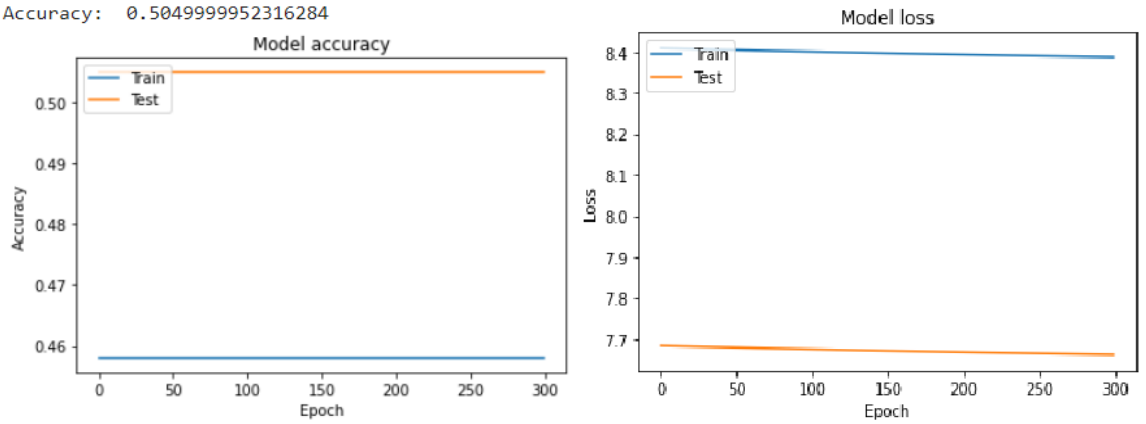
+) Softmax

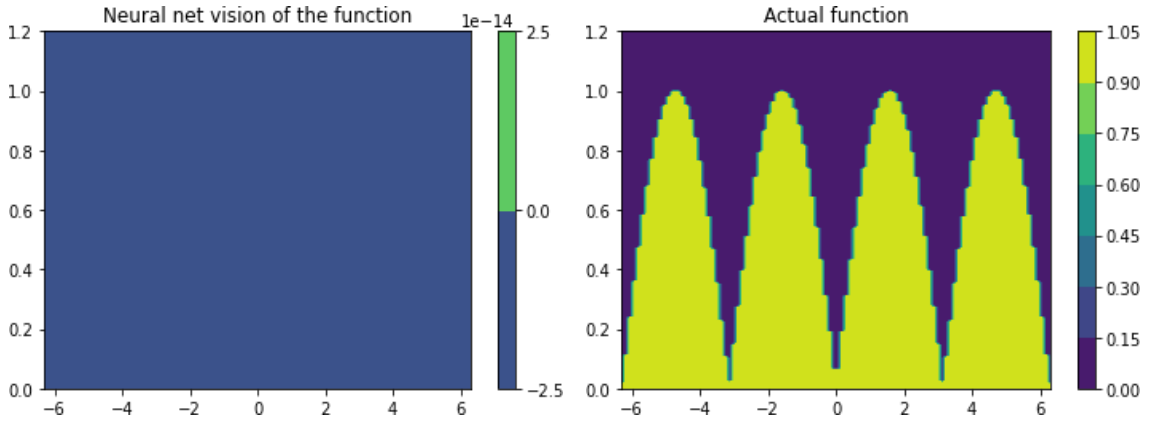




+) ReLU

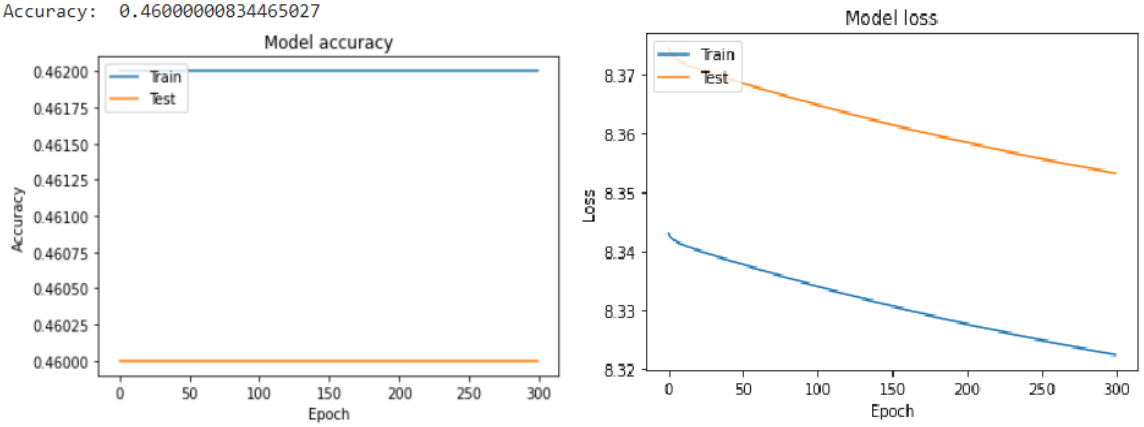
```
Accuracy:  0.5049999952316284
```

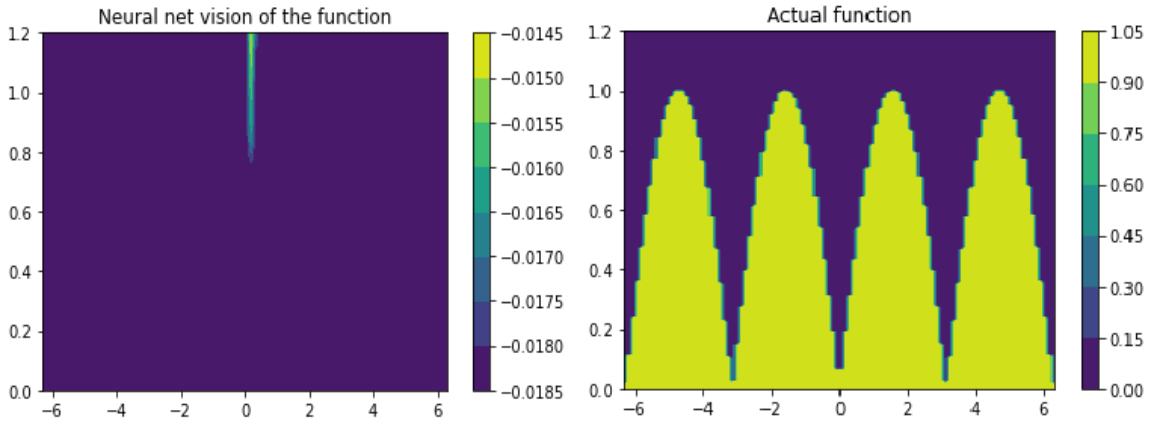




+) Tanh

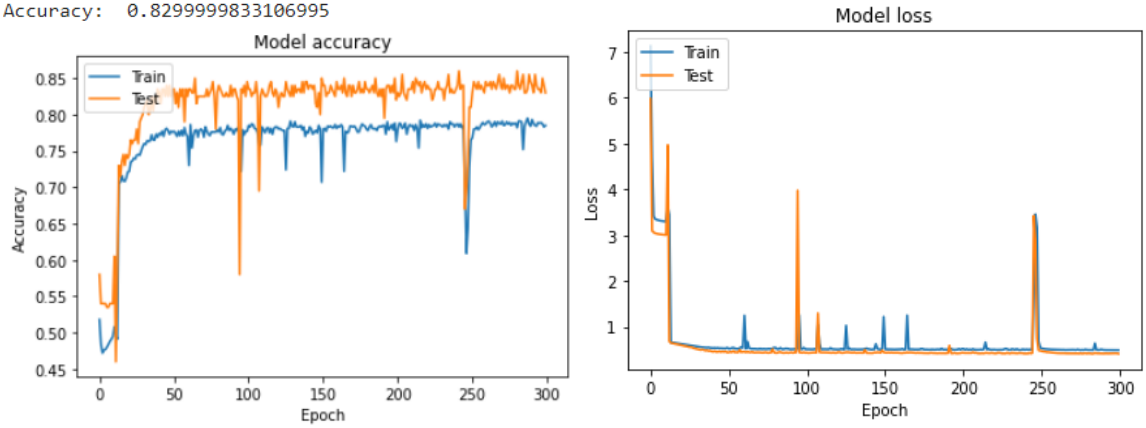
```
Accuracy:  0.46000000834465027
```

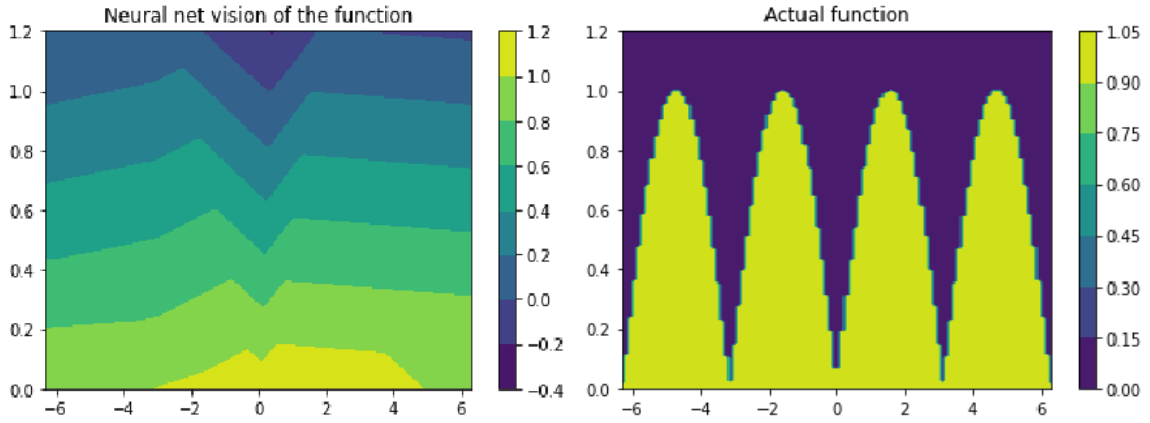




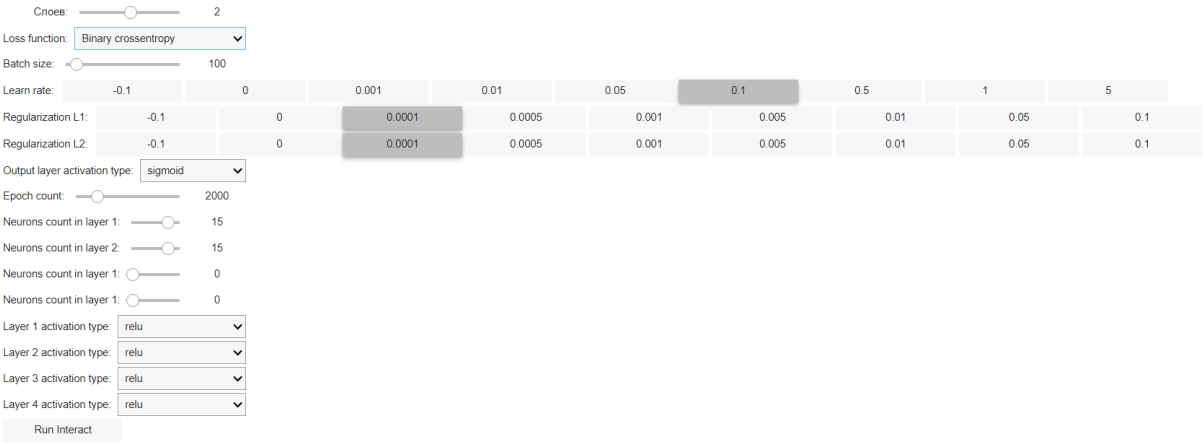
+) Linear

```
Accuracy:  0.8299999833106995
```

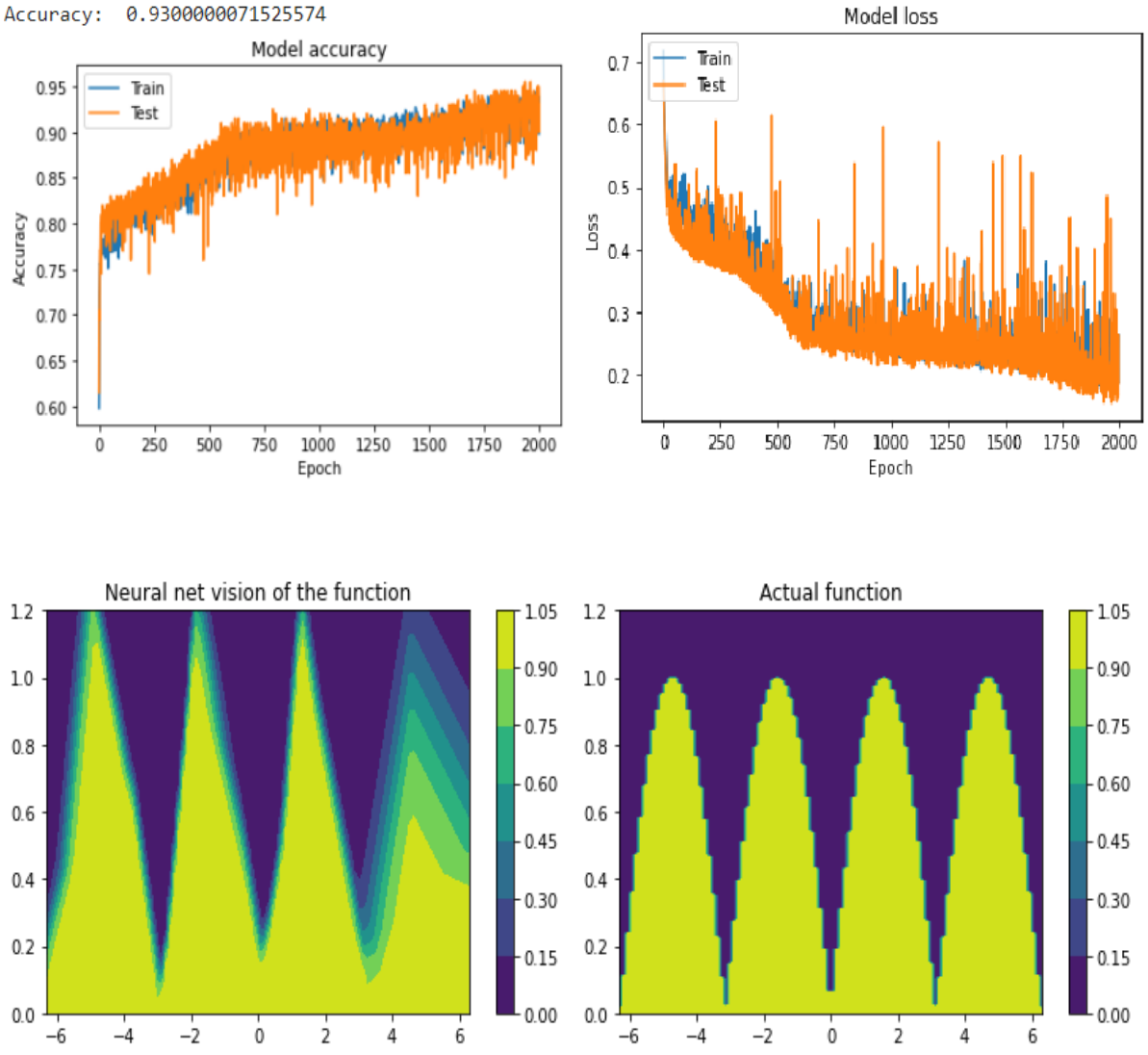




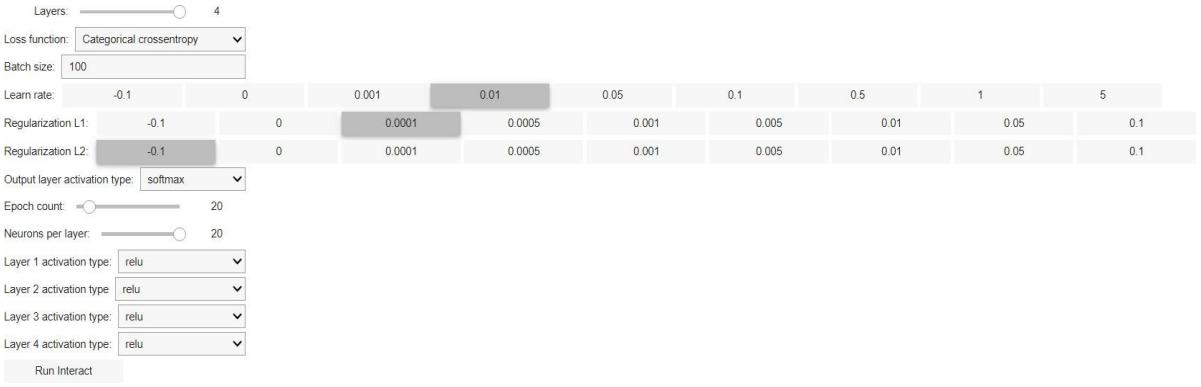
Нейронная сеть с лучшим гиперпараметром:



Результат:

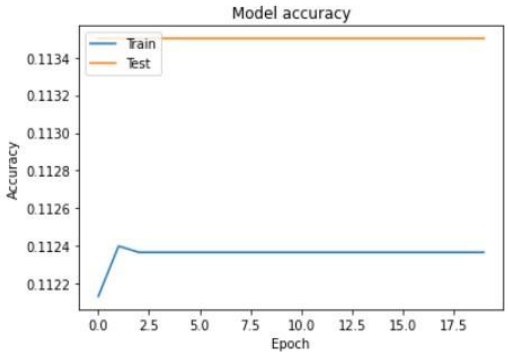
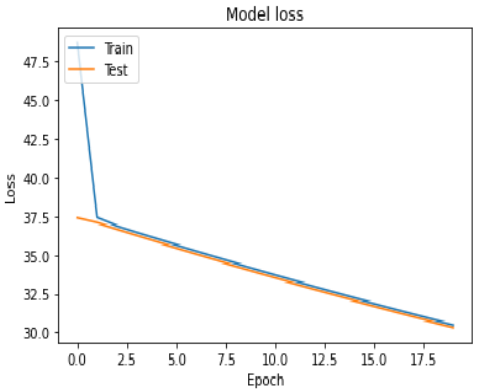
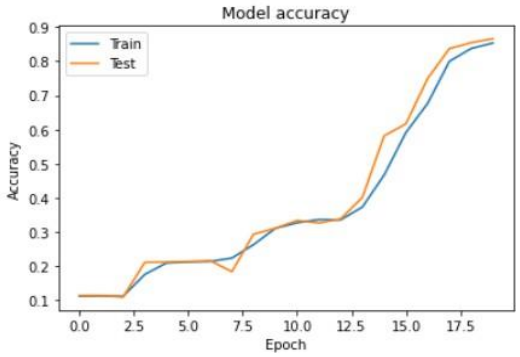
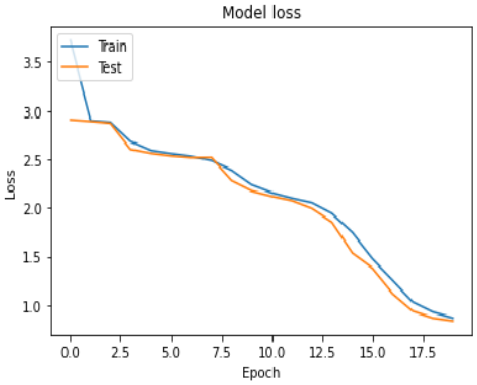
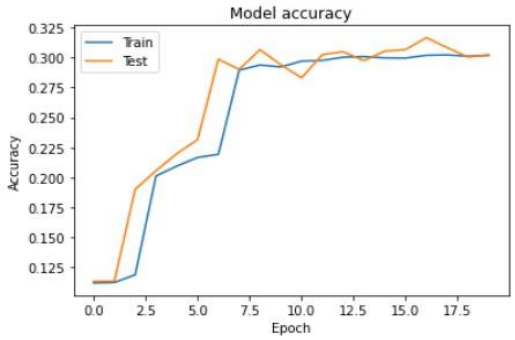
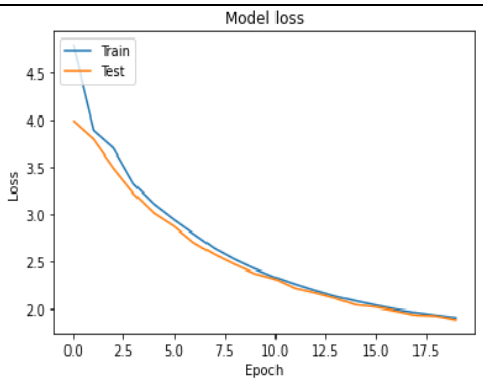
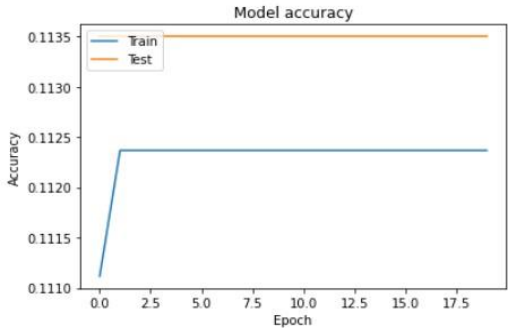
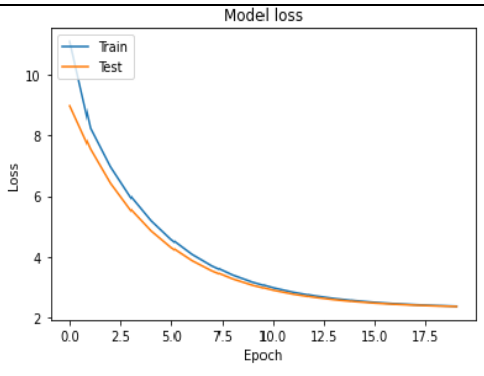


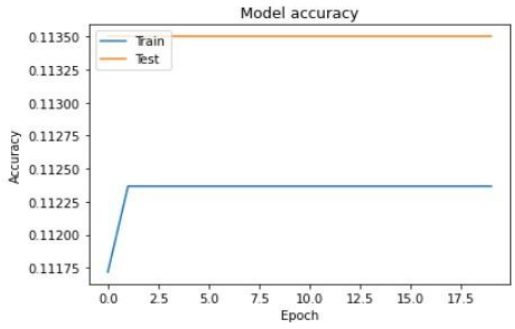
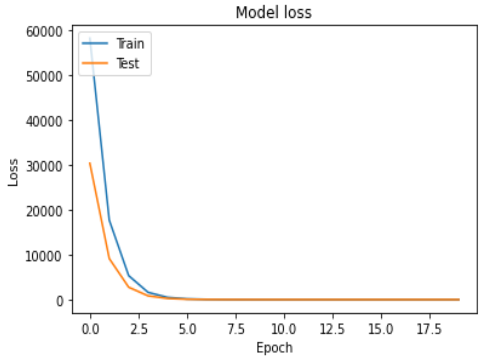
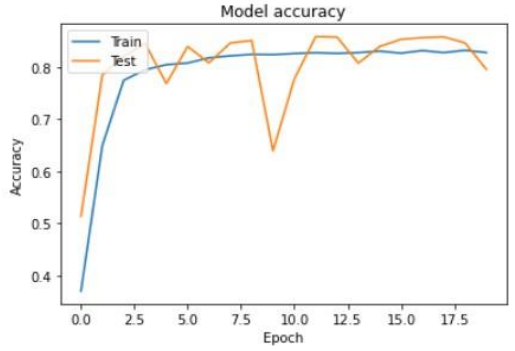
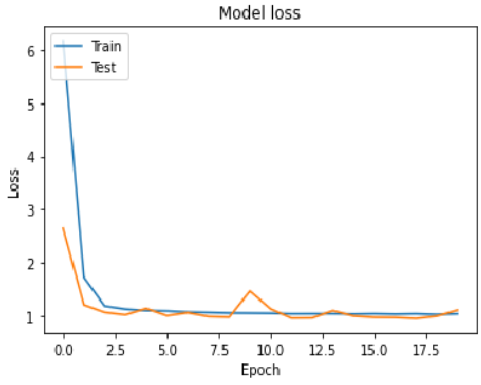
2. Часть 2



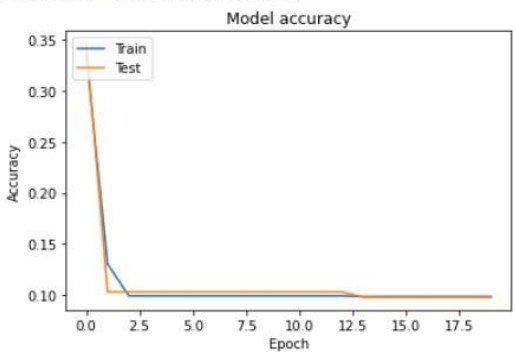
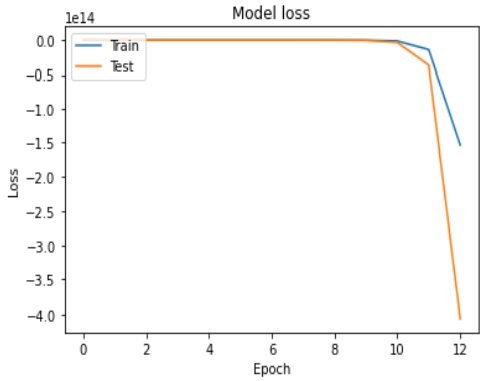
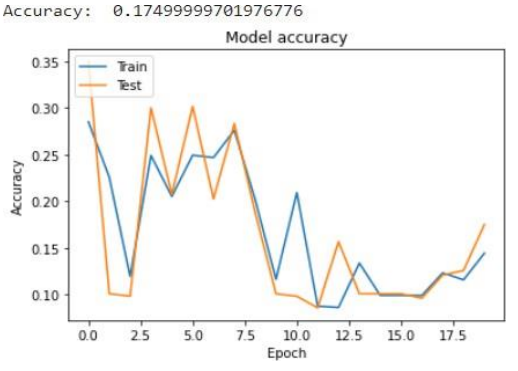
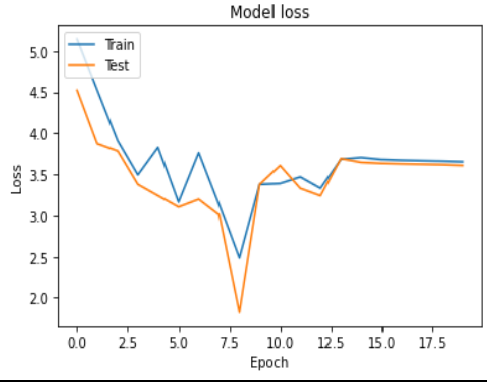
+) Output layer activation: **Softmax**

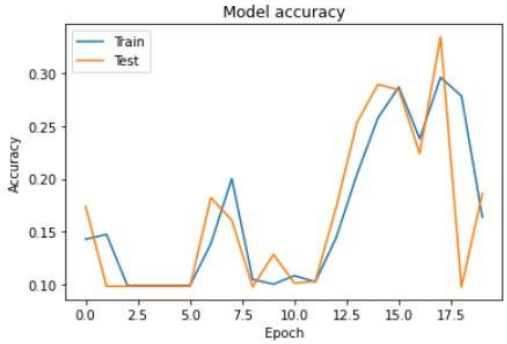
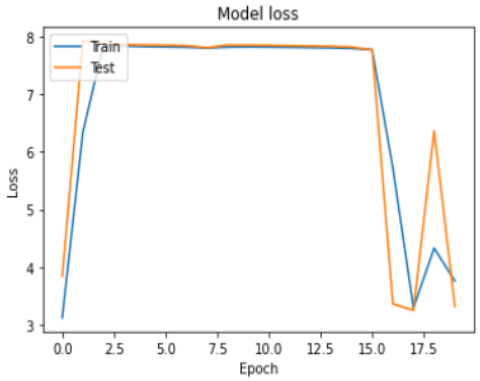
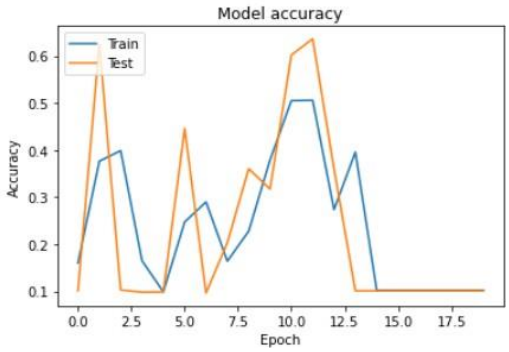
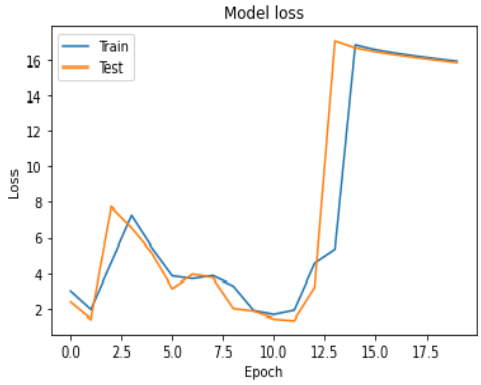
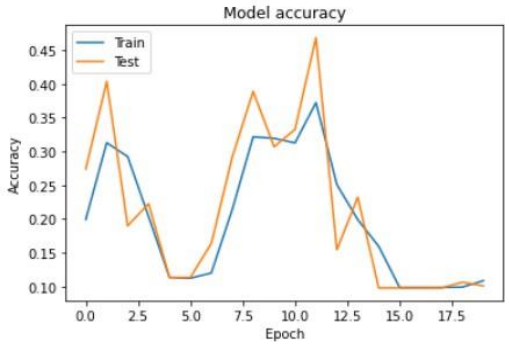
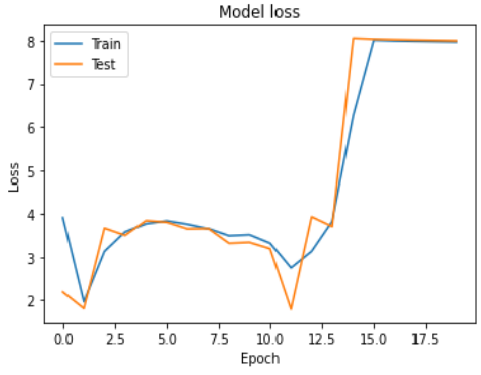
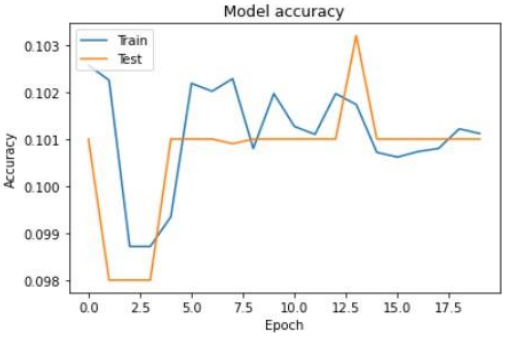
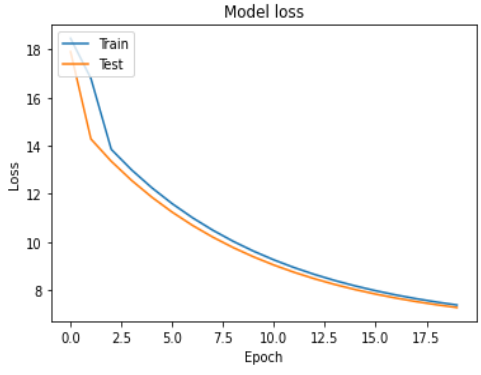
Softmax		
L2=-0.1	Accuracy: 0.11349999904632568 Model accuracy Train Test Accuracy Epoch	1e33 Model loss Train Test Loss Epoch
L2=0	Accuracy: 0.11349999904632568 Model accuracy Train Test Accuracy Epoch	Model loss Train Test Loss Epoch
L2=0.0001	Accuracy: 0.8474000096321106 Model accuracy Train Test Accuracy Epoch	Model loss Train Test Loss Epoch

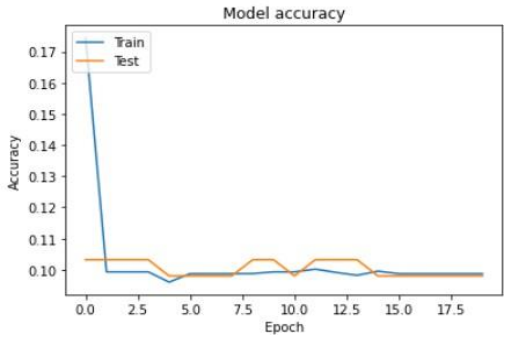
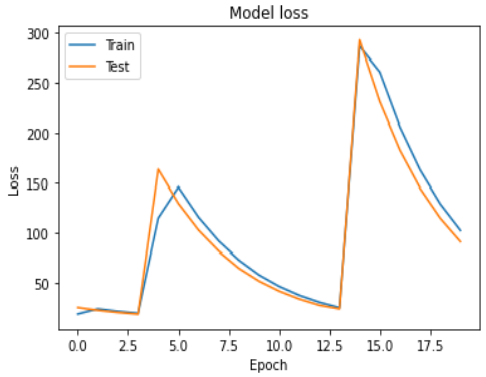
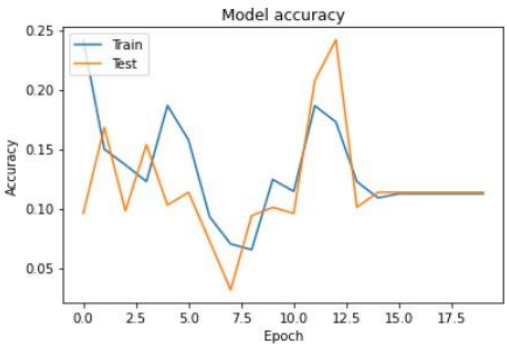
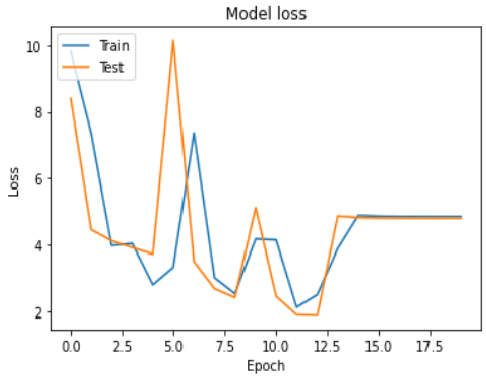
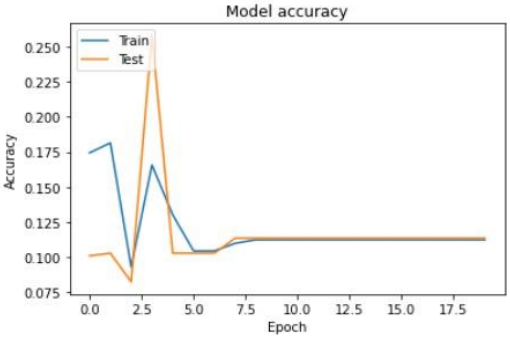
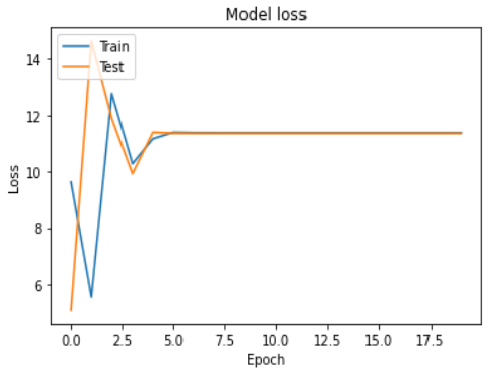
L2=0.0005	Accuracy: 0.11349999904632568 	
L2=0.001	Accuracy: 0.866100013256073 	
L2=0.005	Accuracy: 0.30230000615119934 	
L2=0.01	Accuracy: 0.11349999904632568 	

L2=0.05	Accuracy: 0.11349999904632568 	
L2=0.1	Accuracy: 0.7950999736785889 	

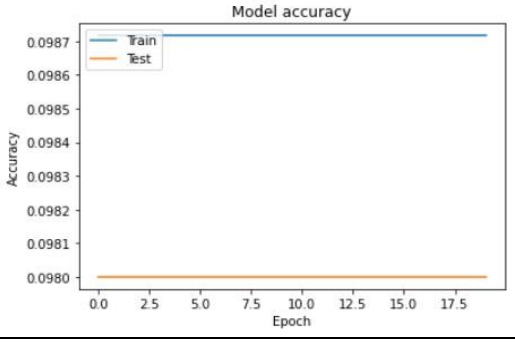
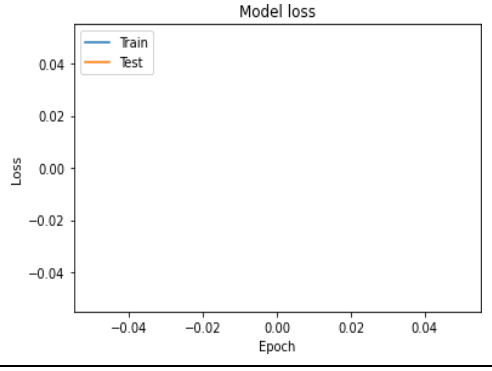
+) Output layer activation: **ReLU**

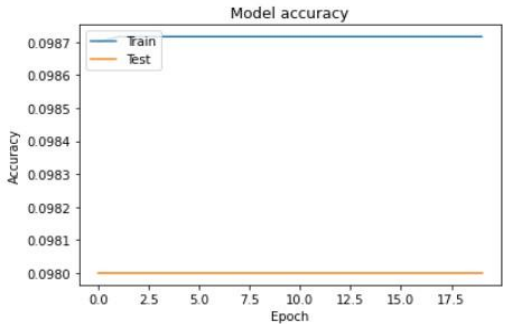
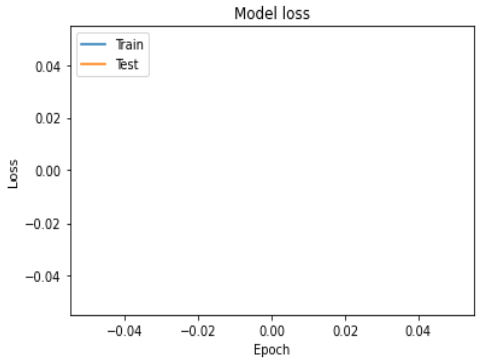
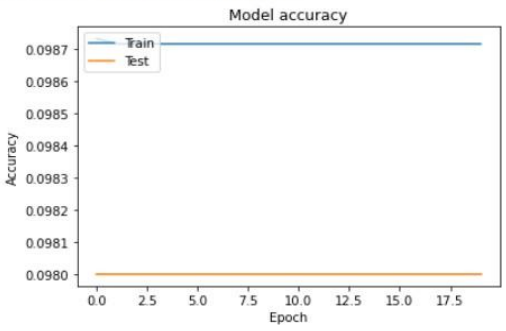
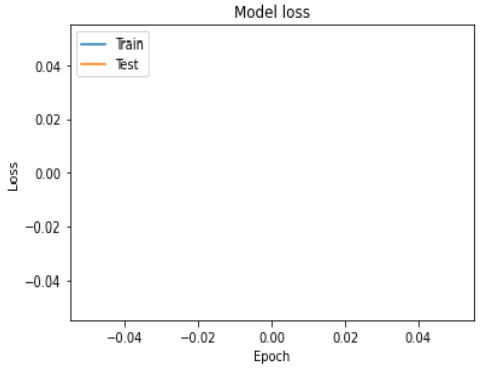
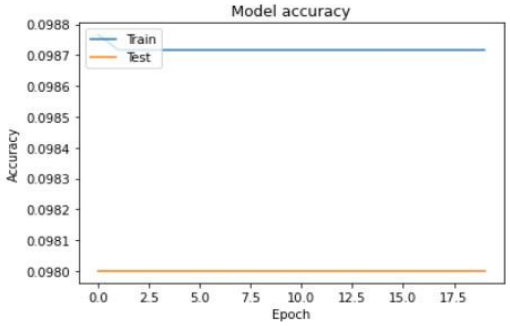
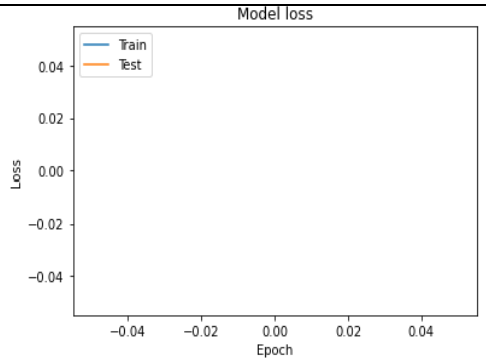
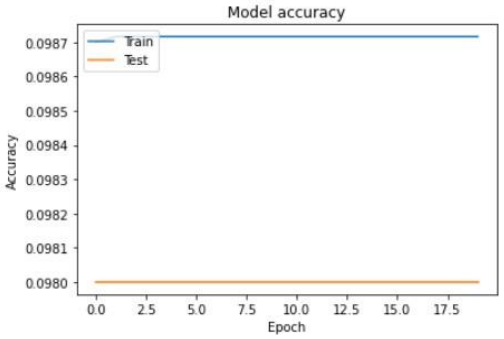
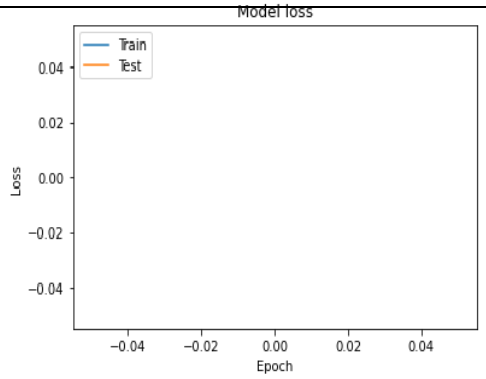
ReLU		
L2=-0.1	Accuracy: 0.09799999743700027 	
L2=0	Accuracy: 0.17499999701976776 	

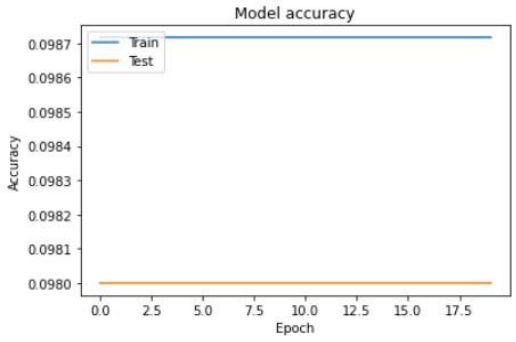
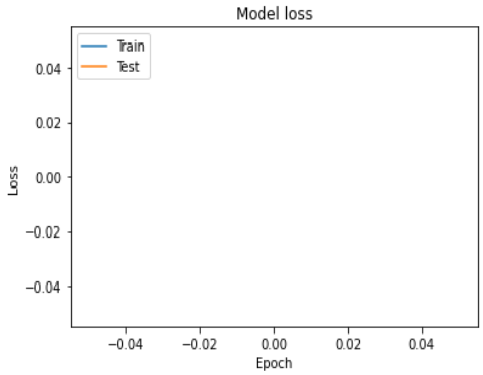
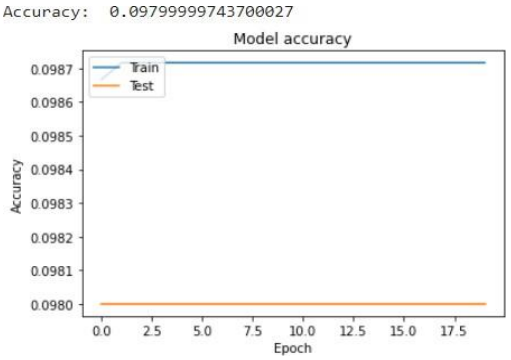
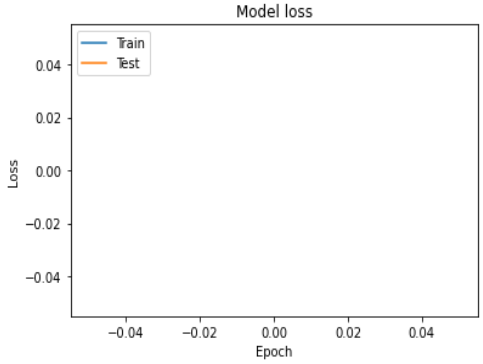
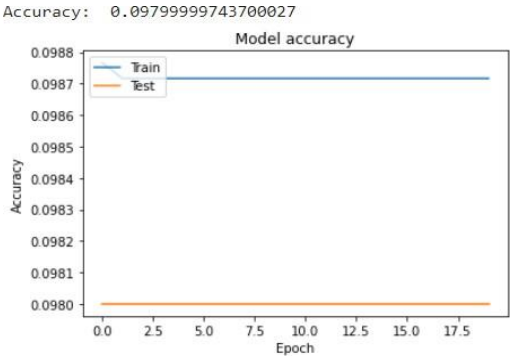
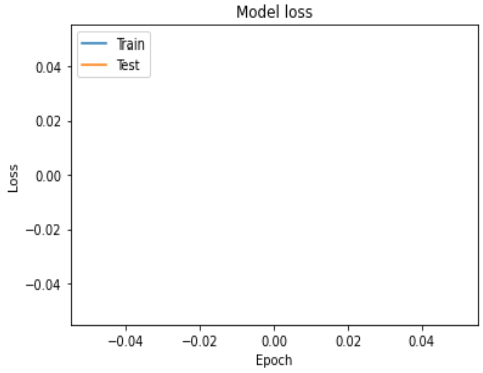
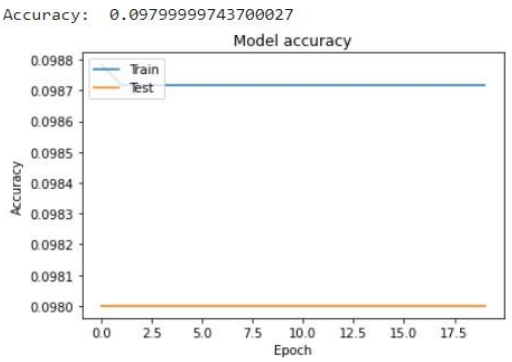
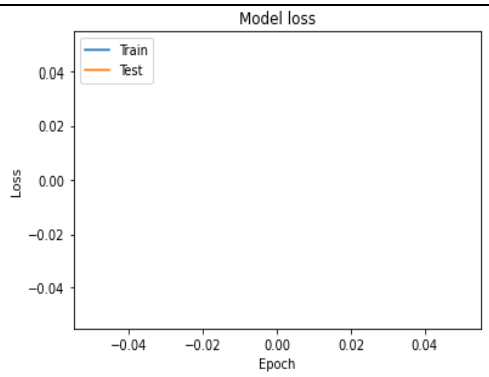
L2=0.0001	Accuracy: 0.1860000044107437 	
L2=0.0005	Accuracy: 0.10100000351667404 	
L2=0.001	Accuracy: 0.10100000351667404 	
L2=0.005	Accuracy: 0.10100000351667404 	

L2=0.01	Accuracy: 0.09799999743700027 	
L2=0.05	Accuracy: 0.11349999904632568 	
L2=0.1	Accuracy: 0.11349999904632568 	

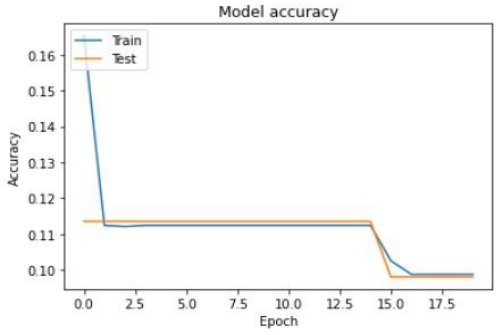
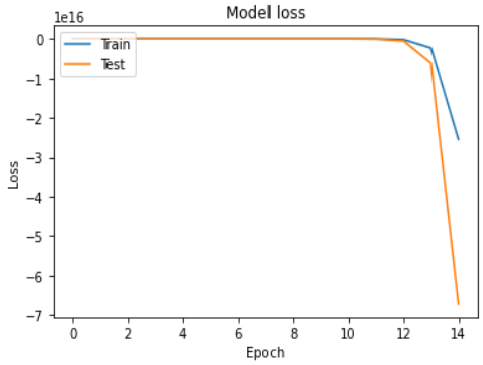
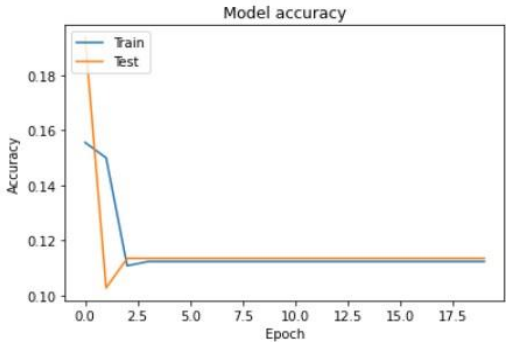
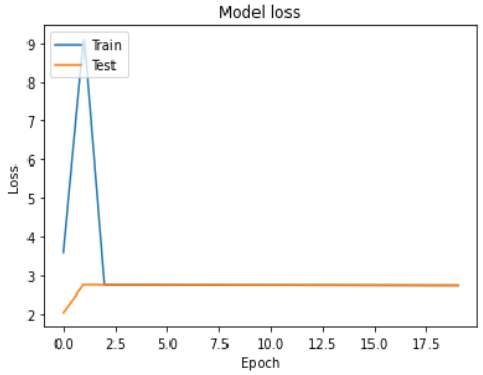
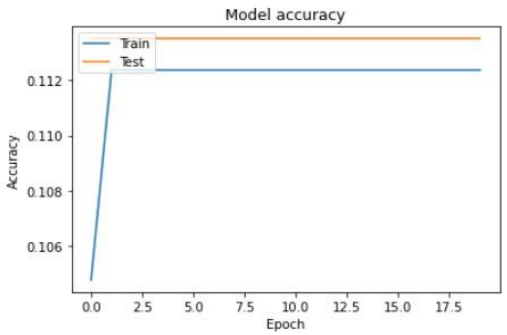
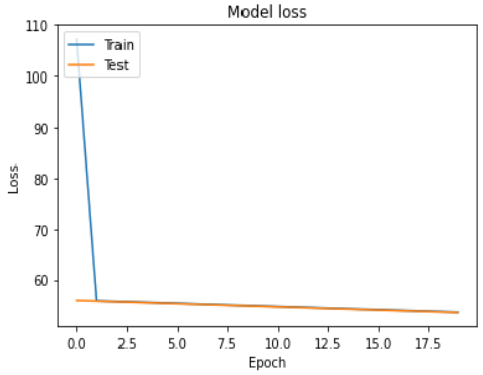
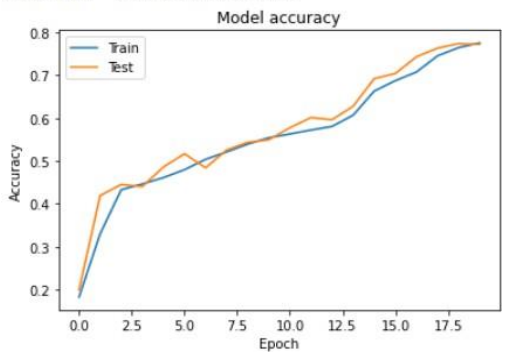
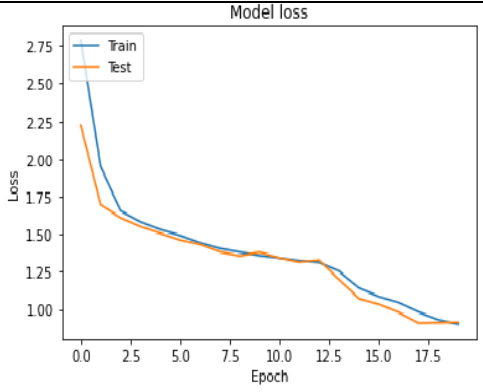
+) Output layer activation: **Tanh**

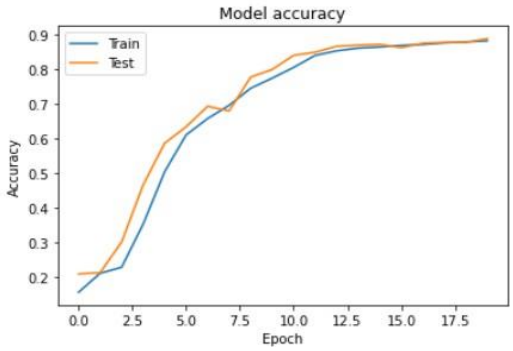
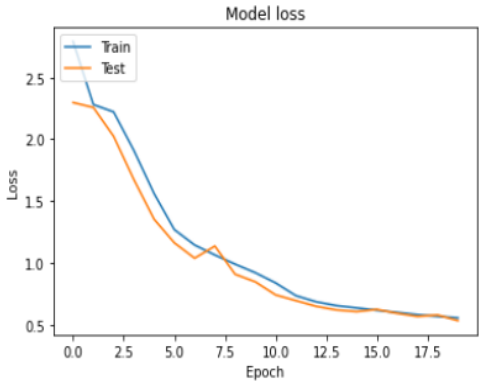
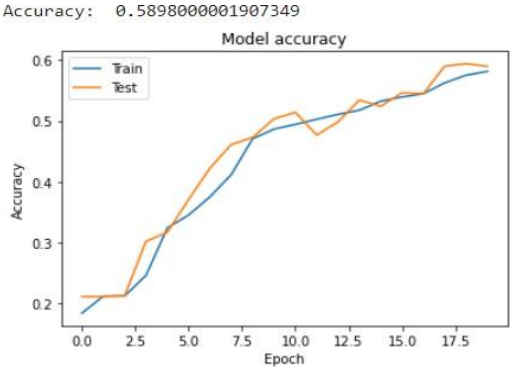
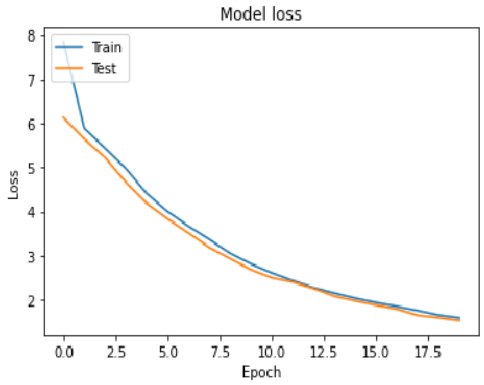
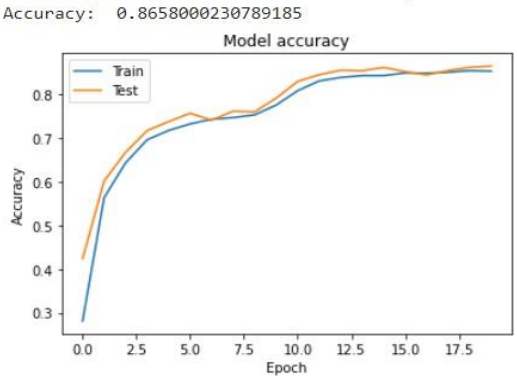
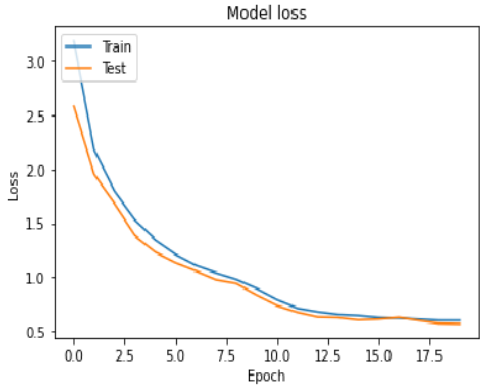
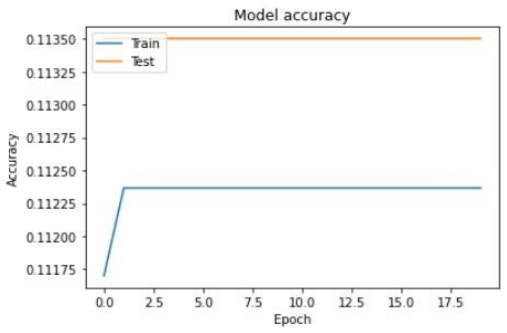
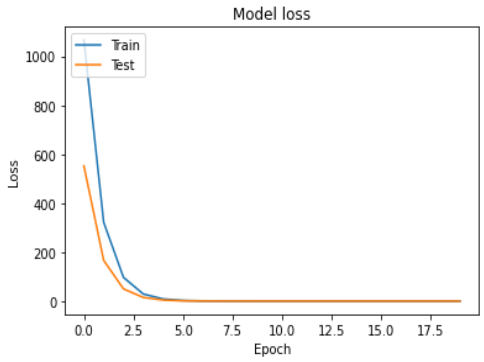
Tanh		
L2=-0.1	Accuracy: 0.09799999743700027 	

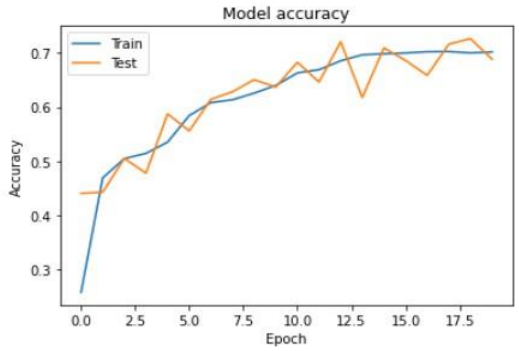
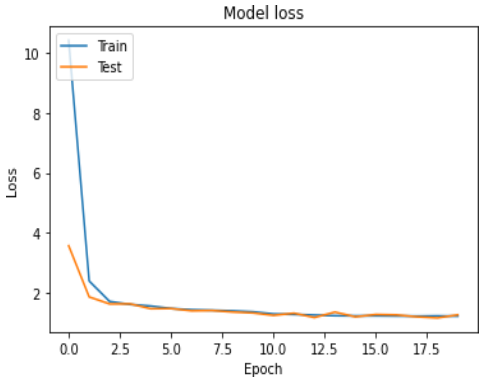
L2=0	Accuracy: 0.09799999743700027 	
L2=0.0001	Accuracy: 0.09799999743700027 	
L2=0.0005	Accuracy: 0.09799999743700027 	
L2=0.001	Accuracy: 0.09799999743700027 	

L2=0.005	Accuracy: 0.09799999743700027 	
L2=0.01	Accuracy: 0.09799999743700027 	
L2=0.05	Accuracy: 0.09799999743700027 	
L2=0.1	Accuracy: 0.09799999743700027 	

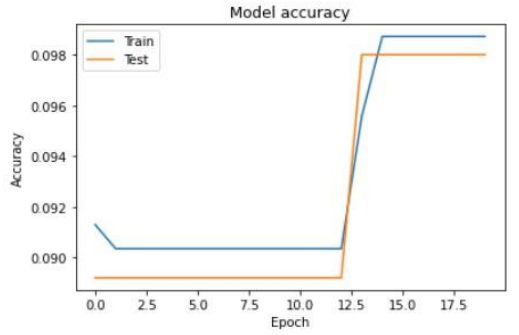
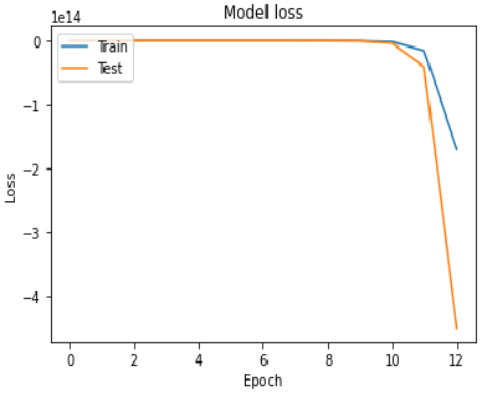
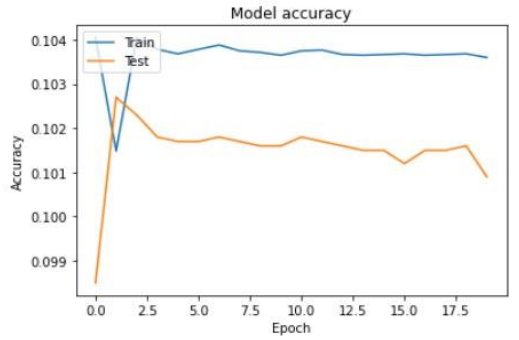
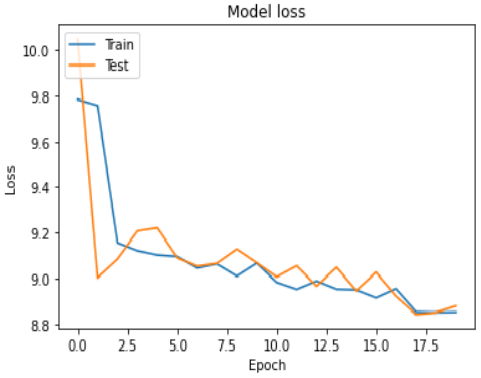
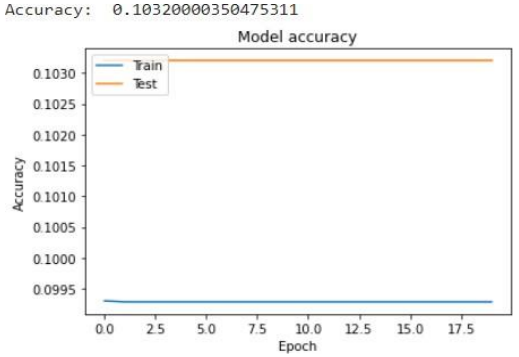
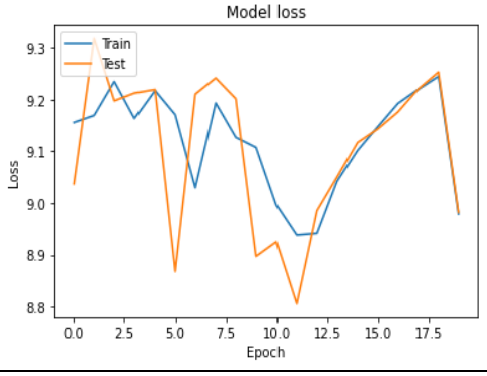
+) Output layer activation: **Sigmoid**

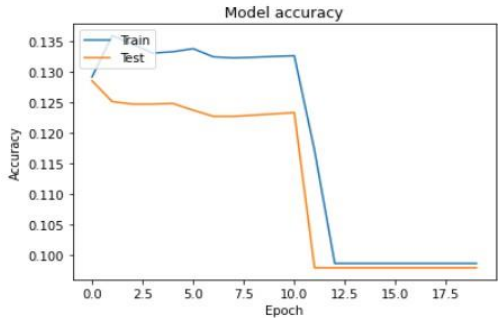
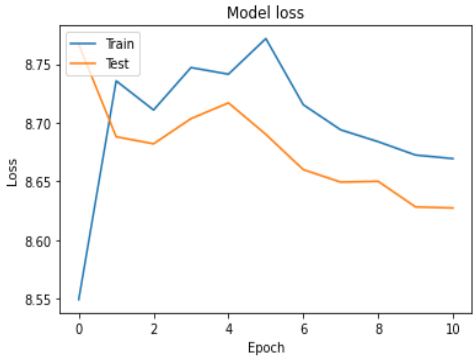
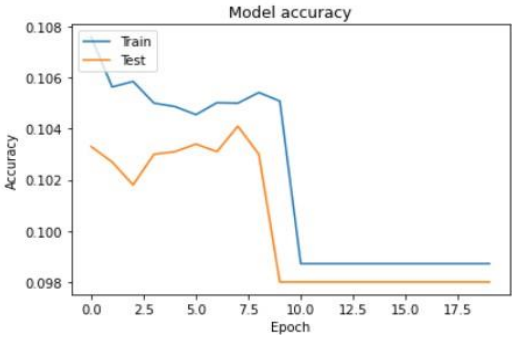
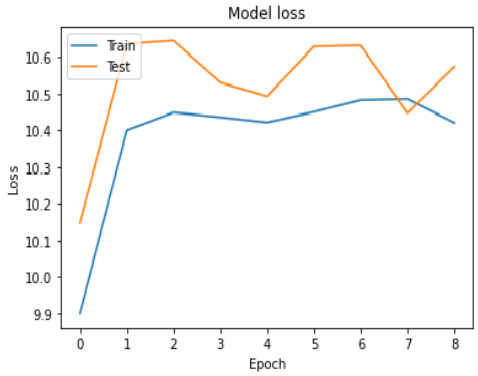
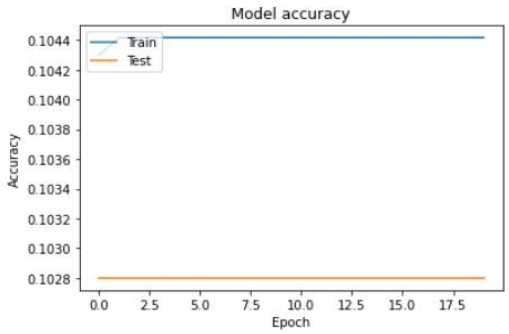
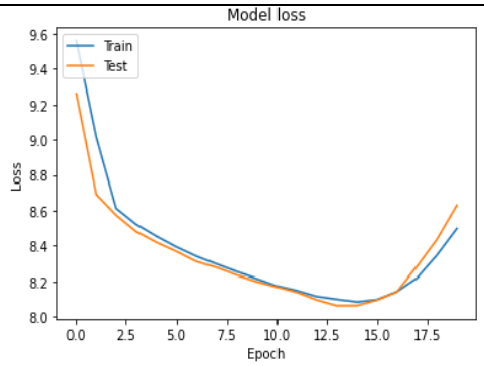
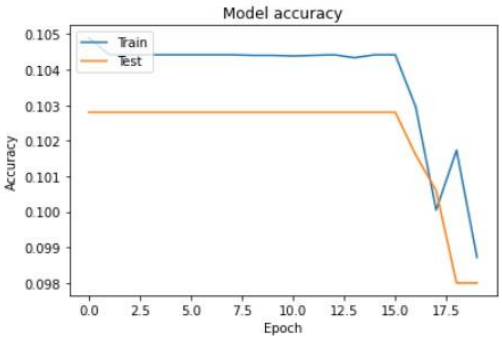
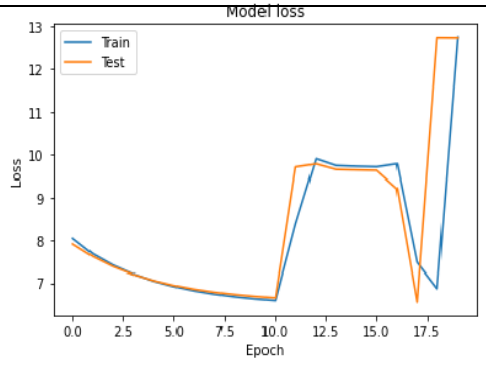
Sigmoid		
L2=-0.1	Accuracy: 0.09799999743700027 	
L2=0	Accuracy: 0.11349999904632568 	
L2=0.0001	Accuracy: 0.11349999904632568 	
L2=0.0005	Accuracy: 0.7720999717712402 	

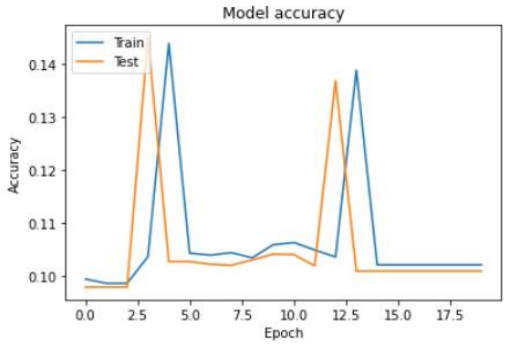
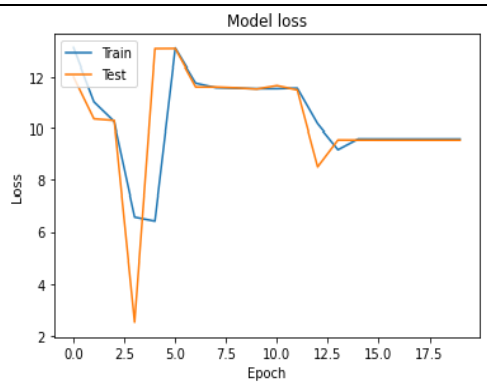
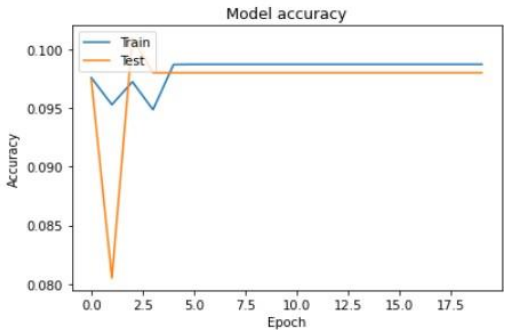
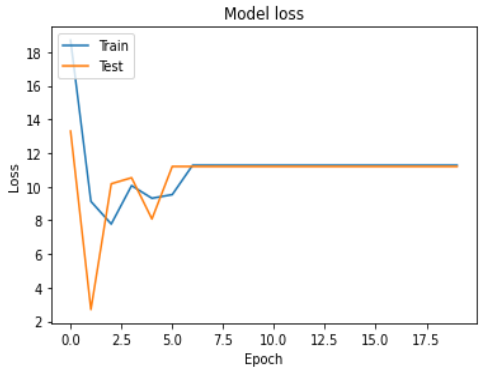
L2=0.001	Accuracy: 0.8892999887466431 	
L2=0.005	Accuracy: 0.5898000001907349 	
L2=0.01	Accuracy: 0.8658000230789185 	
L2=0.05	Accuracy: 0.11349999904632568 	

L2=0.1	Accuracy: 0.6886000037193298 	

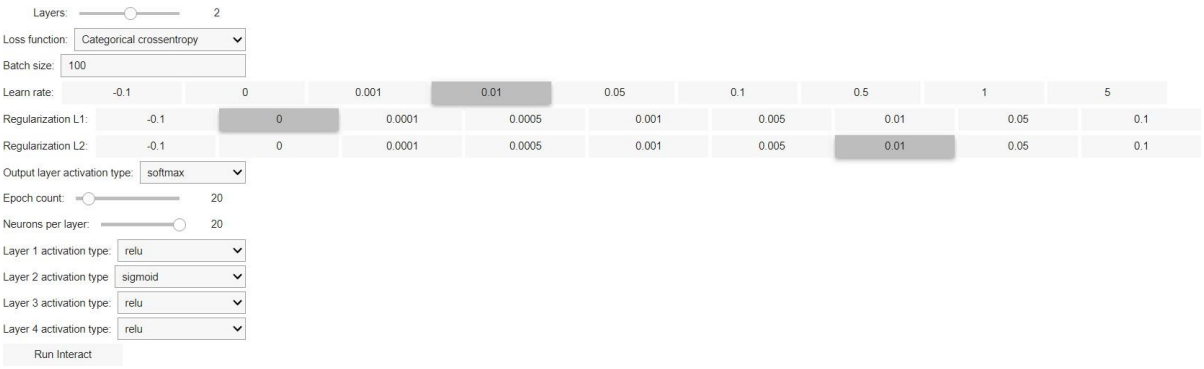
+) Output layer activation: **Linear**

Linear		
L2=-0.1	Accuracy: 0.09799999743700027 	
L2=0	Accuracy: 0.10090000182390213 	
L2=0.0001	Accuracy: 0.10320000350475311 	

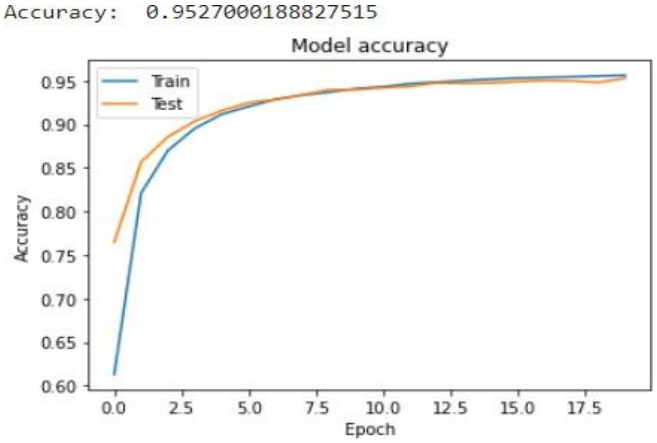
L2=0.0005	Accuracy: 0.09799999743700027 	
L2=0.001	Accuracy: 0.09799999743700027 	
L2=0.005	Accuracy: 0.10279999673366547 	
L2=0.01	Accuracy: 0.09799999743700027 	

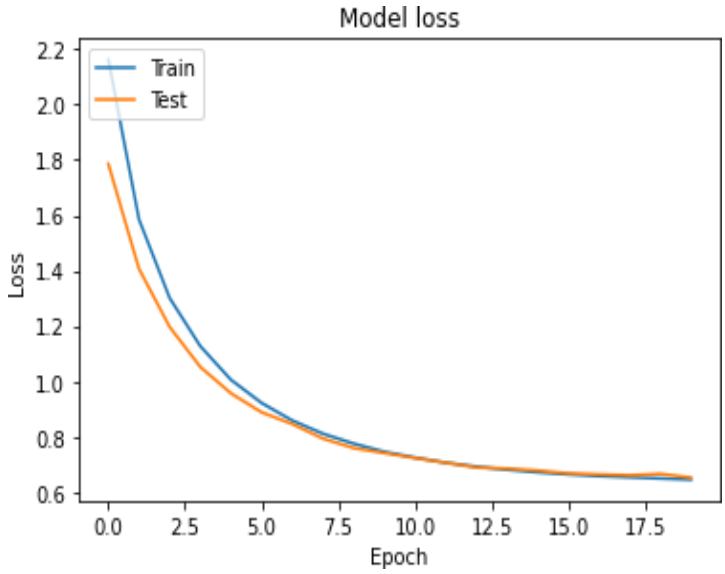
L2=0.05	Accuracy: 0.10100000351667404 	
L2=0.1	Accuracy: 0.09799999743700027 	

Лучшие гиперпараметры для точности более 0.95:



и результат:





Комментарий: Поскольку MNIST — это проблема классификации, использование функции softmax для вывода дает наилучшие результаты. Кроме того, увеличение лямбда для регуляризации L2 может привести к тому, что модель получит много штрафов на тренировочном наборе.

III. Вывод

При выпольнению лабораторной работы я потратил много времени на настройку гиперпараметров модели с максимально возможной точностью. На самом деле это было не так просто, так как комбинаций много, поэтому выбор одного требовал внимания.