

MULTI SEQUENCE LEARNING (NUMBERS/IMAGE/ ALPHABETS)

Gaurav Honnavara Manjunath - 1384178

Harish Palanivel - 1392283

Athkar Praveen Prajwal - 1394663

OBJECTIVE

The primary objective of this project is to examine the HTM prediction Engine and understand Multi sequence Learning for the Sequence of Numbers.

By using Multi sequence Learning as a reference model, Multi sequence Learning for a Sequence of Alphabets and Image Data sets needs to be developed, including the training and prediction phase and configuring HTM parameters for improving accuracy




TABLE OF CONTENTS

INTRODUCTION

METHODOLOGY

ENCODING

**WORKING OF
SPATIAL POOLER**

**IMPLEMENTATION
(LEARNING &
PREDICTION PHASE)**

RESULTS

CONCLUSION

INTRODUCTION



Medical Science and ML engineers were working on the understanding of cortex for temporal pattern recognition.

HTM (Hierarchical Temporal Memory) has been proposed for sequence learning.

HTM is a biomimetics model based on the principle of memory predictions

METHODOLOGY - DATASETS

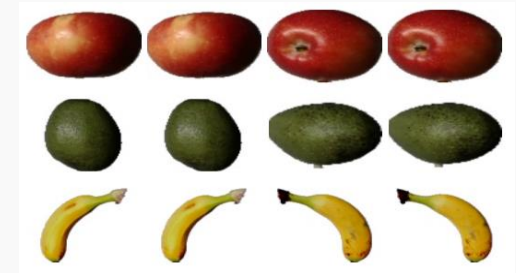
NUMBERS

Labels	Sequence
Multiples of 2	{2,4,6,8,10,12,14,16}
Multiples of 3	{3,6,9,12,15,18,21,24}
Multiples of 5	{5,10,15,20,25,30,35,40}
Multiples of 7	{7,14,21,28,35,42,49}
Multiples of 11	{11,22,33,44}

ALPHABETS

Sequence	Labels
AIGKFLHSAKKFGKAFVGEIMNS	mod. active
FAKIIAKIAKIAKKIL	inactive - exp
FAKKLAKKLKKLAKKLAKKWKL	mod. active
FAKLLAKALKKLL	very active
....

IMAGE



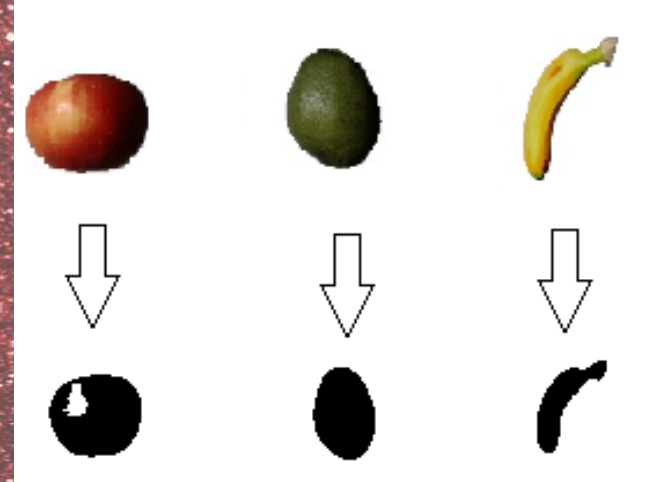
ENCODING

Numbers and Alphabets use Scalar encoder



Encoded Data row

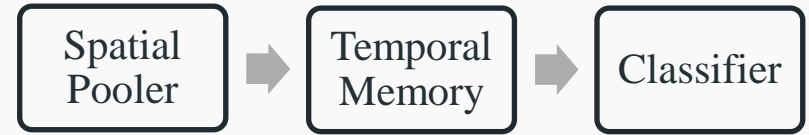
Images use HTM Image encoder



Binarized Image

WORKING OF SPATIAL POOLER

- Creates SDR Input
- Columns that are not active is not learnt
- Each pattern that is appeared as input is compared with the database



IMPLEMENTATION (LEARNING & PREDICTION PHASE)

For Numbers and Alphabets

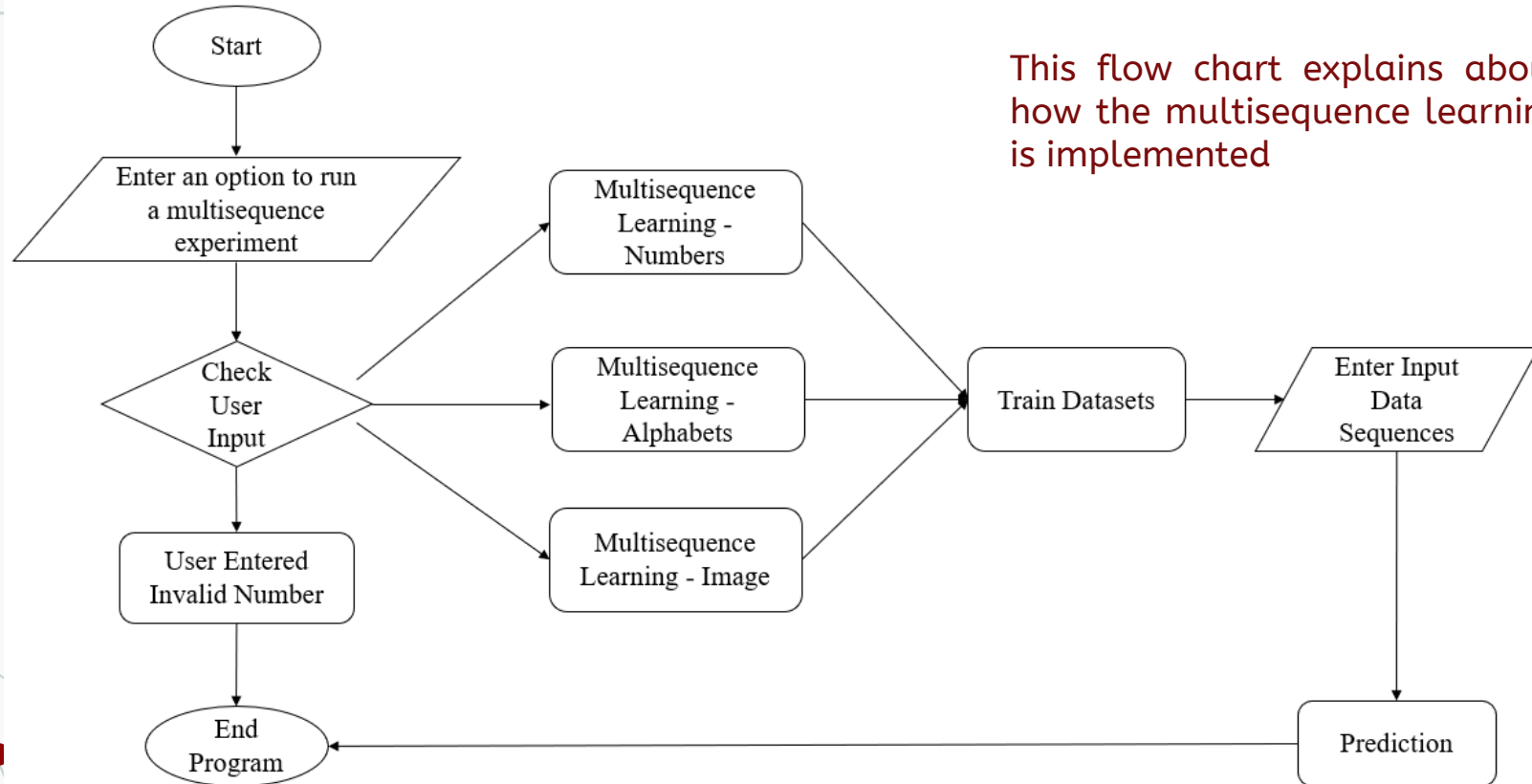
- Fetches datasets and train using Spatial Pooler by using scalar encoder
- Homeostatic Plasticity Controller is used for Stability
- Spatial Pooler trains each sequence for several iterations until it reaches stable state

For Image

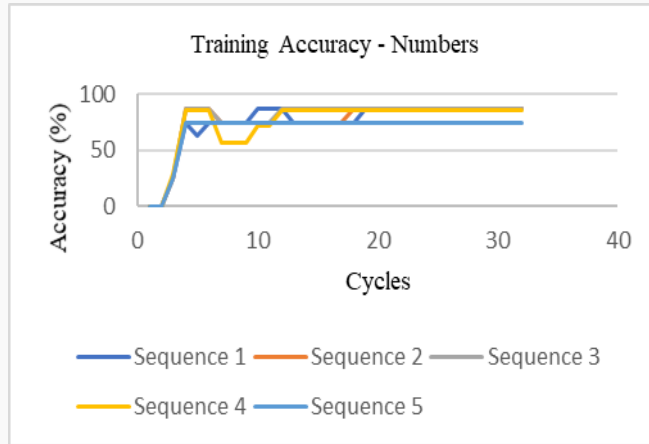
- The datasets are fetched as .jpg file and is binarized using Encoder
- Homeostatic Plasticity Controller is used for Stability
- Spatial Pooler is used to train the binarized datasets for several iterations until spatial pooler reaches stable state

FLOW CHART

This flow chart explains about how the multisequence learning is implemented



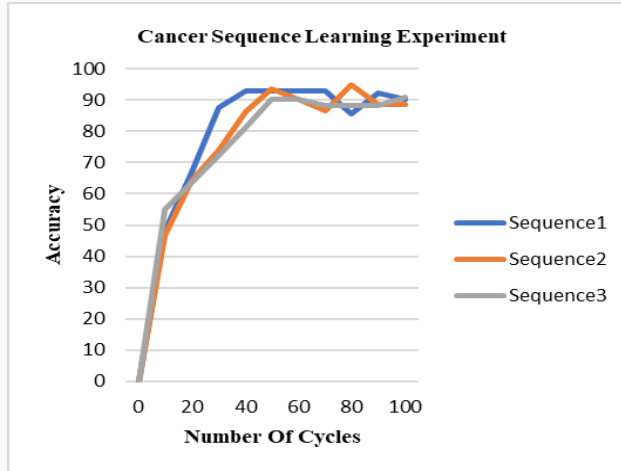
RESULTS - NUMBERS



The graph represents the accuracy for the trained sequence of numbers and figure shows prediction

```
8
3
9
11
13
17
19
1
Entered Number are :
2 5 8 3 9 11 13 17 19 1
-----Start of PredictNextElement Function-----
Predicted Sequence: TwoMultiple, predicted next element 8
Predicted Sequence: ThreeMultiple, predicted next element 15
Invalid Match.....
Predicted Sequence: ThreeMultiple, predicted next element 12
Invalid Match.....
Predicted Sequence: ElevenMultiple, predicted next element 1.0
Invalid Match.....
Invalid Match.....
Invalid Match.....
Invalid Match.....
-----End of PredictNextElement -----
F:\Frankfurt University Of Applied Sciences\Software Engineering(VS)\Final Project\sc
cess 24584) exited with code 0.
```

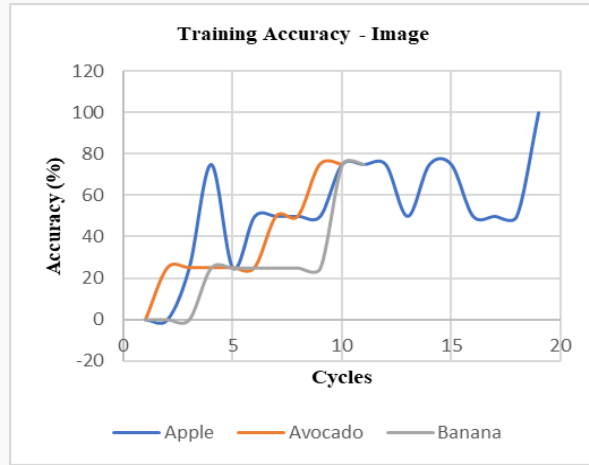
RESULTS - ALPHABETS



```
R,inactive - virtual
----- R,inactive - virtual -----
----- A,inactive - virtual -----
Ready to Predict.....
Enter Cancer Sequence: *note format->AAAAVV (AlphabeticSequence)
NDPQKRA
Enter Next Sequence :
GLFDVIAKVASVIKKL
Predicted Class : mod. active      votes: 6
Predicted Class : inactive - exp   votes: 8
Enter Next Sequence :
KWKSFATKFKSAKKTVLHTALKAISS
Predicted Class : mod. active      votes: 10
Predicted Class : very active      votes: 2
Predicted Class : inactive - exp   votes: 2
Enter Next Sequence :
KWKLFKKIKFLHSAKKF
Predicted Class : mod. active      votes: 10
Predicted Class : very active      votes: 2
Predicted Class : inactive - exp   votes: 2
```

The graph represents the accuracy for the trained sequences of alphabets and figure shows prediction

RESULTS - IMAGES



The graph represents the accuracy for the trained series of Images and figure shows prediction

```
Predicted Sequence: Apple
Input Image to Predict :
"\SimpleMultiSequenceLearning\Testing Files\Avocado_1.jpg"
Predicted Sequence: Avocado

Input Image to Predict :
"\SimpleMultiSequenceLearning\Testing Files\Banana_3.jpg"
Predicted Sequence: Banana

Input Image to Predict :
"\SimpleMultiSequenceLearning\Testing Files\Apple_1.jpg"
Predicted Sequence: Apple

Input Image to Predict :
"\SimpleMultiSequenceLearning\Testing Files\Banana_4.jpg"
Predicted Sequence: Banana

Input Image to Predict :
"\SimpleMultiSequenceLearning\Testing Files\Cauliflower.jpg"
Invalid Match.....

Input Image to Predict :
"\SimpleMultiSequenceLearning\Testing Files\Ginger_root.jpg"
Invalid Match.....

Input Image to Predict :
```

CONCLUSION

In this project, the implementation was on different types of input data sets like numbers, alphabets and images. These input datasets are encoded using scalar encoder and Image encoder to store respective trained datasets.

By using Prediction algorithm, the input that is given is predicted by comparing with the trained data sets.

We performed Multi Sequence Learning for a different sequence of data sets and could achieve up to 87.5% of accuracy in the Training Phase.

Additionally the inputs data sets can be modified for any sequence of numbers, alphabets and images as per the requirements to identify their categories

REFERENCES

- Keele, "“Sequence learning,” - B. A. C. G. J. D. S. W.," 1998. [Online]. Available: <https://pubmed.ncbi.nlm.nih.gov/21227209>
- "D. V. B. Michael D Mauk, “Sequence learning,”," 2004. [Online]. Available: <https://pubmed.ncbi.nlm.nih.gov/15217335>
- "B. H. J. L. R. .Rabiner, “An introduction to hidden markov models,”," 1986. [Online]. Available: http://ai.stanford.edu/~pabbeel/depth_qual/Rabiner_Juang_hmms.pdf.
- Hawkins, "J. C. S. A. J. , “Continuous online sequence learning with an unsupervised neural network model,”," 2016. [Online]. Available: <https://pubmed.ncbi.nlm.nih.gov/27626963>
- S. A. J. Hawkins, "“Why neurons have thousands of synapses, a theory of sequence memory in neocortex,”," 2016. [Online]. Available: <https://www.frontiersin.org/articles/10.3389/fncir.2016.00023/full>.

**THANK YOU
TEAM NOOBIES**