*Approve prediction for multisequence learning*

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*Abstract*— Multisequence learning is the approach used to investigate implicit learning, where the model learns temporal patterns of sequences one by one during the course of the experiment and provide the matching sequences as the predicted output. Model also predict the next element of the predicted sequence. List of sequences with double data-type are stored in an excel file, which worked as an input sequence file for model to train itself by storing these values in temporal memory. This experiment demonstrates how to learn sequences using Predictor's own method and save all the sequences as a Dictionary object which is then considered as training data.

After that temporal memory will quickly learn cells for patterns and memorized the sequences. By using HtmClassifier's prediction method, where we have to pass one test data sequence, by comparing each value of test data sequence with the trained data, model will predict the which sequence data is matching with test data, it also predicts the next element of that sequence. This experiment also focuses on calculating the accuracy of matched sequences and writing the resulted accuracy into CSV file.

In this experiment the additional implemented functionality helps user to pass both input sequences and test data sequences through excel file, which helps user to modify the sequence values directly through an external file instead of adding code changes

Keywords—: HtmClassifier, Temporal Memory, Prediction.Introduction.

# Introduction

Hierarchical temporal memory (HTM) is a type of machine learning model inspired by the structure and

function of the neocortex in the human brain. Its purpose is to learn sequences of information and

make predictions based on them. The HTM model consists of several components, including an encoder,

a spatial pooler, a temporal memory, and an HTM classifier. Each element in a sequence is represented

by a Sparse Distributed Representation (SDR). The temporal memory learns the sequences of these SDRs

and makes predictions about future input SDRs.

During the learning phase, the temporal memory predicts the next element in the sequence at every step.

After the last prediction, a learning cycle ends and the temporal memory starts again with the same sequence.

The goal is for every cycle to have correct predictions for every element, resulting in an accuracy of 100%.

The aim is to achieve 100% accuracy for as many consecutive cycles as possible.

Sequence-to-sequence learning is a general framework used for machine translation, where the encoder maps

the input sequence to a fixed-length vector.

# Methods

In the existing method inputs were hardcoded so if user wants to change the input, then it’s necessary to change the input sequences from the code. so, to resolve the issue we have tested different methods to take the inputs from the file.

## GetInputFromTextFile( ):

Team has implemented *GetInputFromTextFile()* method to take the inputs from the Text file. We have tried 2 approaches to split the multiple input sequences by using comma ‘,’ to separate each digit of the input sequence and using special character at the end of each sequence for splitting it from other input sequences. In this case we used semi-colon ‘;’ to split. The significant issue we faced by using this approach is we had to add both comma ‘,’ and semi-colon ‘;’ at the end of each input sequence, which is not a feasible solution and by which text file also looks inappropriate.

To resolve issue, we faced in the first approach we used regular expression to split multiple sequences based on detecting the enter ‘/r/n’. Using this approach wherever we added enter for next input, is getting detected by our regular expression logic. For this we had to read all the rows together using *reader.ReadToEnd( )* method and then split it by detecting the enter keyword. This can cause an issue in real time working environment.

## GetInputFromCsvFile( ):

Team has implemented *GetInputFromCsvFile( )* method to take the inputs from the CSV file. CSV stands for "Comma-Separated Values". It is a file format used for storing and exchanging tabular data, such as spreadsheets or databases. In a CSV file, each line represents a row of data and each field within a row is separated by a comma. CSV files are simple and widely supported, making them a popular choice for data exchange between different systems and applications.

The problem with CSV file is we need to add one non double character at end of each row to terminate the row/sequence and take the next sequence. This can cause an issue in real time working environment.

## GetInputFromExcelFile( ):

In the *GetInputFromExcelFile( )* method we are using .xlsx file type to take the input sequences. Which are referred as training data sequences. Here we overcame the issues of the previous methods *GetInputFromCsvFile()* and *GetInputFromTextFile()* where we need to add any non-double value to terminate the row/sequence and to jump to the next row/sequence and any special in case of text file to jump over the next input sequence. To implement this feature we used the *string.IsNullOrWhiteSpace( )* property.

## GetSubSequencesInputFromExcelFile( ):

We have implmented the *GetSubSequencesInputFromExcelFile()* method to take the subsequence test input from the .xlsx file. We are passing the TestSubSequences to the SubSequences list of type double. After reading all the TestSubSequences we are returning SubSequences.

## Accuracy Logs:

We have used *StreamWriter*( ) class to create the file. If the file exists, It can be overwritten or appended to. If the file does not exist, this constructor creates a new file. The true flag appends to the file instead of overwriting it. Here we are generating logs for *sequenceKeyPair.Key* and *accuracy*. *Ex. Sequence: 1 is having accuracy 30%*

## Encoder Settings:

For encoder settings we have modified the value from 0-99. We have added input validation for the same in our *program.cs* file.

# Results

This Part of the text describes results of your works. There can only be mentioned references, MUST point back to Methods and Intro chapter. No more external references.

Code examples must be provided to demonstrate how to use the algorithm/module. Provide a reference to more unit tests, which show the same in more detail. Also provide all diagrams with comments and reference to unit tests, which generate diagrams.

# Discussion

Conclusion of your work should be precise and concise. How was the project, what is done, what is the result... There can be discussion on further work and direction.

# Ease of Use

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*a**b* 

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## Some Common Mistakes

* The word “data” is plural, not singular.
* The subscript for the permeability of vacuum **0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter “o”.
* In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
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## Figures and Tables

For adding object other than text (tables, equations, graphs, figures, code…), **there must be at least one cross reference** to it. Figure 1 is an example

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1. Table Type Styles

| Table Head | Table Column Head | | |
| --- | --- | --- | --- |
| Table column subhead | Subhead | Subhead |
| copy | More table copya |  |  |

1. Sample of a Table footnote. (*Table footnote*)



Figure 1 Example Figure Caption

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity “Magnetization”, or “Magnetization, M”, not just “M”. If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write “Magnetization (A/m)” or “Magnetization {A[m(1)]}”, not just “A/m”. Do not label axes with a ratio of quantities and units. For example, write “Temperature (K)”, not “Temperature/K”.

## Code References:

Referencing Code in your text should be avoided unless necessary. In such cases it can be inserted as a listing as shown in **Error! Reference source not found.**

Listing 1 Code Reference Example

Console.WriteLine(“Referencing code”, var);

// using tab can be replaced with 4 spaces

Do not pass code as image. When referring to variable in **Error! Reference source not found.**, italics should be used for example *var.* Code flows and logic should be presented better as Graph or Diagram instead of words.

Code Block which is too big to put in the textbox can be reference as Listing 2.

Listing 2 Unit Test [EncodeDateTimeTest](https://github.com/ddobric/neocortexapi/blob/0348ffb99739ddf8c8c3a875f8162a18073938ca/source/UnitTestsProject/EncoderTests/DateTimeEncoderExperimentalTests.cs#L34-L49)

public void EncodeDateTimeTest(int w, double r, …)

{

…

DateTimeEncoderExperimental encoder = new…

var result = encoder.Encode(input);

…

Assert.IsTrue(result.SequenceEqual(expected…

}

##### Acknowledgment *(Heading 5)*

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

##### References

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1. G. Eason, B. Noble, and I. N. Sneddon, “On certain integrals of Lipschitz-Hankel type involving products of Bessel functions,” Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551, April 1955. *(references)*
2. J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.
3. I. S. Jacobs and C. P. Bean, “Fine particles, thin films and exchange anisotropy,” in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.
4. K. Elissa, “Title of paper if known,” unpublished.
5. R. Nicole, “Title of paper with only first word capitalized,” J. Name Stand. Abbrev., in press.
6. Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, “Electron spectroscopy studies on magneto-optical media and plastic substrate interface,” IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].
7. M. Young, The Technical Writer’s Handbook. Mill Valley, CA: University Science, 1989.

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