ME2281: Assignment on Artificial Intelligence

Introduction

This is an individual project where each individual member must conduct calculation steps given in the **problem definition** and the **implementation** individually though you may share your ideas of how to write the program and how to conduct test cases. In addition, the final discussion should be written individually. Each individual has to submit different reports and the report writing format and what is to include in the report is also given in the **implementation**. **Do not start** conducting the assignment until you read the whole document.

Expected Learning Outcome

The knowledge of using artificial neural network and genetic algorithm combined is expected. It is also expected to conduct the assignment using a computer program (**without any logical errors**) with the awareness of all the assumptions made. However, it is not expected to obtain a good result and you **will not lose any marks** for obtaining **poor result**. You need to conduct the work **accurately** for the artificial neural network that you have constructed and conduct the simulation with training using genetic algorithm **irrespective of the result**. Each group must conduct the same problem using different number of hidden nodes and genetic parameters. There are mainly two groups, and each group consists of five or six members in a group.

Problem Definition

It is required to identify typed letters using image capturing and artificial neural network. This is to be achieved by training an ANN to train the letters T, C and H, so that it gets trained for any orientation shown in Fig 1. A captured image consists of nine pixels capturing 3X3 area. Take the inputs as 1 if there is an image or 0 otherwise and the order of the inputs as shown in Fig 1.

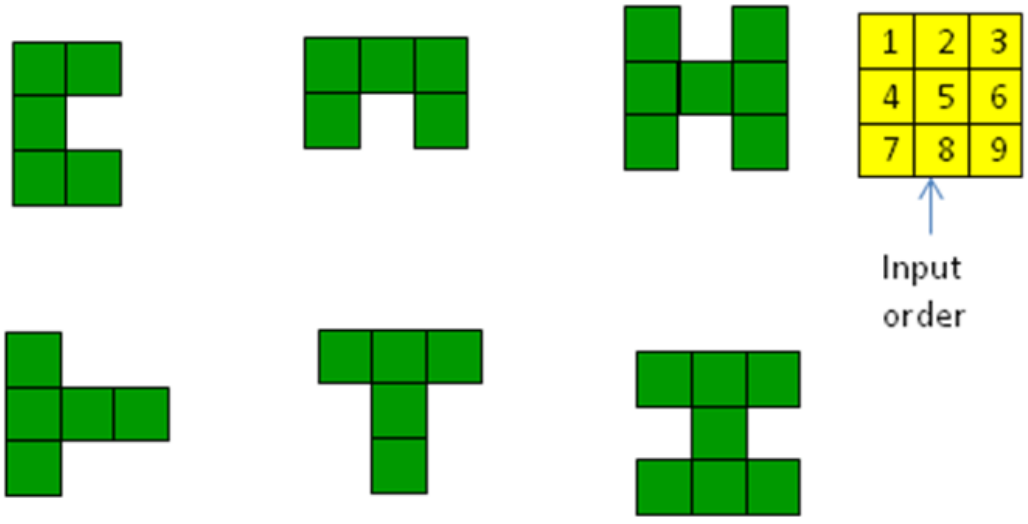


Fig 1: Different Orientations

For all pictures consider it as a nine inputs array with 3 rows and 3 columns. If a captured image does not cover 3X3 area (for example letter C), image is left justified if it does not cover 3 columns and it is justified to upper position if it does not cover 3 rows. Therefore, the input vector for the correct combination of the letter C given in Fig.1 should be {1 1 0 1 0 0 1 1 0}. Take the input order 1 to 9 as given in Fig 1.

The number of outputs are equal to 2 and the expected output is as follows:

The input pattern	Output 01	Output 02
Any orientation of letter C	1	0
Any orientation of letter T	0	1
Any orientation of letter H	1	1
None of the above	0	0

Steps to follow.

1. Select the number of nodes for the hidden layer in your artificial neural network given in Annex B for your index number. For the hidden nodes and the output nodes you must select the processing function as step processing functions.
2. Calculate the number of weights between the input layer and the hidden layer and the hidden layer and the output layer. Also, find the number of thresholds required for the hidden layer and the output layer.
3. Give random values for the weightages and thresholds in the given range in Annex A that is common for both group 01 and group 02.
4. Each group is given four input patterns for training in Annex A. Use them according to the given order. First take letter C and check the error, adjust weightages and use that weightage for the next pattern that is letter T.
5. With your random values obtain the phenotype values for weightages and thresholds, then calculate the output for each input combination given for the training in Annex A.
6. Obtain the output for each input pattern and compare it with the desired output using the same weightages and thresholds.
7. In order to use a genetic algorithm to train your network, you need to train the weightages and thresholds. One solution is one individual. Considering these factors and taking the number of bits per variable as 12, decide on the code length (the number of bits of an individual).
8. Generate initial generation for 30 individuals.
9. Select a suitable phenotype to genotype coding values.
10. Find the phenotype variables for each individual in the initial population.
11. Select a suitable fitness function for the individual considering that, lesser the total error at the output for all combinations given for the training, higher the fitness value.
12. Calculate the fitness values of all individuals in the initial population and rank them.
13. Select parents to the method mentioned in Annex A for your group, conduct crossover and mutation operations for the given parameters in Annex B for your index number. Select 13 pairs of parents with the given parent selection method for your group in Annex A. Produce 26 offspring.
14. Select 26 offspring and the best elite 4 (4 highest fitness value individuals) from the old generation for the next generation.
15. Evaluate and rank the next generation.
16. Repeat this work for 1000 generations.
17. After the training, use the different combinations of inputs that are given for your group in Annex A and check your result for each combination for testing and validation. (without more training)
18. Compare the error obtained after the training and the error obtained for the different combination in 17.

Methodology

1. You need to conduct this work using a computer program and conduct test cases to avoid logical errors using manually, spreadsheets or another program. (Example: You may use MATLAB command prompt/ spreadsheet/MATLAB program or manual calculation to check your feed forward artificial network function correctness of the output for given inputs). You need to conduct this program using either Python, C or C++. It is advisable to conduct "test cases" for each user-defined functions and user-defined classes/objects. You cannot use MATLAB toolbox or similar tools to conduct the main task. However, you may use it separately to check the "test cases".
2. You need to show all your work including how you have conducted "Test cases" and attach programs. Spreadsheet used or/and show manual workings as well in an annex.
3. Write a report as explained under report format.
4. You have to write an individual discussion.
5. You need to submit different reports where you can include your annexes separately, Excel sheet and the discussion.

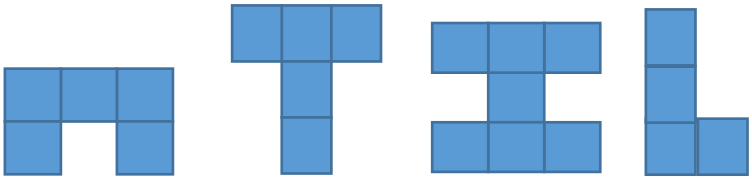
Report Format

1. Write a cover page including the title "Artificial Neural Network Assignment: ME2281" and indicate your name and the index number.
2. Content page giving a table of contents.
3. Write the problem definition including the values that you need to place.
4. Show how to calculate the outputs and the errors for given input combinations with your working steps 1 to 6.
5. State your code length and show how you obtain it and clearly mention the genotype to phenotype coding function and the fitness function explaining any reasons as appropriate.
6. Explain how you obtain the random values for weightages and thresholds for the initial generation (You can use it randomly with your own choice or generate a computer program) Explain each step of the calculation with your part. Give the tabulated result for the five generations, giving the trained values of weightages, thresholds, the calculated output, the desired output and error for all combinations and your fitness value.
7. Draw a graph of fitness value Vs number of generations. Give your final result including the weightages, thresholds, errors and outputs in a tabulated format.
8. Use the given input patterns to check your result without conducting training. Show the result of the calculated output, desired output and the error in a table format for all combinations.
9. Write a discussion about your result around one page and not exceeding more than two pages. Write down what you have learnt and clearly mention what you have learnt in the lecture and what addition knowledge or skills you have gained through this exercise. You cannot share this discussion with your group partners whereas the other part of the report you may share and exchange your ideas.
   Optional: You may write about your results and may write any reasons for getting good or poor result (Note: It is o.k. to have poor result and it is not expected to get good result)
10. Give your program codes, Excel sheets calculations that you have used in an annex to the report. Submit the main report, annexes and the program as different files.

Annex A: The information relevant to groups

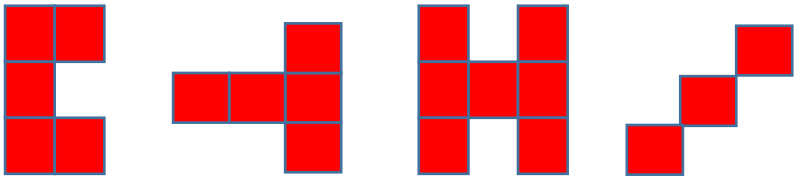
Group 01		Group 02	
Index	Name	Index	Name
220053K	AYYASH M.A.A.	220328J	KOTTAGE P.K.
220119U	DHIVIYAMAINAN H.	220422R	NAYANAJITH S.D.K.
220174G	GALLAGE S.T.D.	220456A	PEMASIRI H.M.I.D.
220275R	JAYATHILAKE U.G.H.M.	220638J	THEJASVENAN T
220279H	JAYAWARDANA M.A.	220644A	THILAKARATHNA M.K.C.S.
		220695E	WICKRAMAGE Y.N.

Group 01 (parent selection -The best individual out of randomly selected 3)
Input combinations to train as images in different combinations



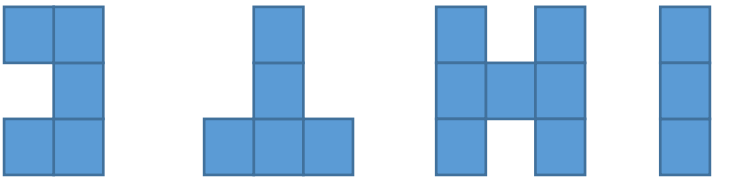
Letter C Letter T Letter H None

Input combinations to check or validate your results after training



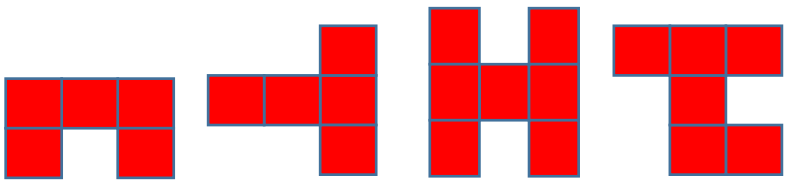
Letter C Letter T Letter H None

Group 02(parent selection -The best two individuals pair out of randomly selected 5)
Input combinations to train as images in different combinations



Letter C Letter T Letter H None

Input combinations to check or validate your results after training



Letter C Letter T Letter H None

weightage range = -1 to +1 and threshold range is 0 to +1 (for both groups)

Annex B: The information relevant to each student

Index number	No of hidden nodes	Crossover rate	Crossover type	Mutation rate
220053K	5	0.8	1 point	0.01
220119U	6	0.85	2 points	0.005
220174G	7	0.9	1 point	1/Code Length
220275R	8	0.95	2 points	1/(2* Code length)
220279H	9	0.8	1 point	0.01
220328J	5	0.85	2 points	0.005
220422R	6	0.9	1 point	1/Code Length
220456A	7	0.95	2 points	1/(2* Code length)
220638J	8	0.8	1 point	0.01
220644A	9	0.85	2 points	1/Code Length
220695E	10	0.9	1 point	1/(2* Code length)