Experience of using Spreadsheets as a bridge in the understanding of AI techniques

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Abstract. Spreadsheets have and are being used as valuable tools in variety of subjects including Engineering. Providing a tool for simulating and exploring models. In this paper their role in allowing students to explore two AI approaches, basic neuron and a simple genetic algorithm, is considered.

Keywords. Spreadsheet, artificial intelligence, teaching

1 Introduction

Spreadsheets have, and are being, used as valuable tools in variety of subjects including Engineering, eg, Varley et al [1]. Providing a tool for simulating and exploring models, including in the teaching neural networks. The author noticed, some students were struggling with some of the basic AI concepts, so an approach based around using spreadsheets to allow the students to build up the concepts in stages was investigated; it was hoped this would improve understanding.

2 Approach

The overall approach was to use a spreadsheet to build up the basic principles of two AI approaches – a neuron and Genetic Algorithms.

2.1 Single Neuron

Difference with in this approach to Varley et al[1] is the goal is subtly different, in that theirs was, primarily to provide a tool understand the application of the neurons. In this approach, the goal was to be embedded the theory and to use in building up the neuron

itself from the basic parts; building the system from this lower level, to see the underlying mechanism.

The first stage was to build a single neuron to do Boolean basic operations, (excepting Exclusive OR) through the stages of:

- Setting the inputs
- Setting the weights
- Calculating the weighted sum
- Passing the result through a hard-limiter.

Enabling them to trial different weights and experiment with their effects with something they have developed.

The next stage was to repeat the previous actions and then add in the Delta Rule equation (1) to demonstrate training.

$$\Delta Wi = (\text{learning coefficient})Xi(d - \text{y}) \quad (1)$$

Where Wi weight, Xi input before weighting; d expected output and y actual output. The stages involved were:

- Repeat the previous actions
- Produce the change in weights for each weight
- Add the old weight and change in weight to obtain the new weight
- Essentially cut and paste to see the training in action.

2.2 Genetic Algorithm

This activity takes the form of the game played in pairs usually. The goal to simulate a genetic algorithm with dice to produce the random elements and tournament selection to select the 'parents'.

1. A spreadsheet, roll two dice six times. Fill in the first two columns of the spreadsheet with these numbers. These form the six individuals in the population giving the X and Y values to minimise the equation (1)

$$(X-3)^2+(Y-2)^2 \quad (2)$$

2. The fitness scores should be calculated automatically in a third column.
3. 1st Parent: Roll two dice, if the numbers are same reroll one die until the numbers are different. Use the two values to select the 1st parent, take the solution with the best (lowest value in this case) fitness of the two numbers. Take the X part of the selected parent and it forms the X part of the new child.
4. 2nd Parent: Roll two dice, if numbers are the same or appear in 1st parent, reroll until you get two different numbers (including different to the 1st parent), take the solution with the best (lowest value in this case) fitness of the two numbers Take the Y part of the selected parent and it forms the Y part of the new child.

5. Mutation: Roll a die for each part of the child solutions. If the roll is 1, roll another die and replace the appropriate element with the new number – even if the same as the previous value.
6. (optional) Copy the average into the table and the lowest value to keep track of the values.
7. Copy the child solutions after mutation into the spreadsheet and repeat steps 1-6 up to 10 times

3 Examples

3.1 Neural Networks

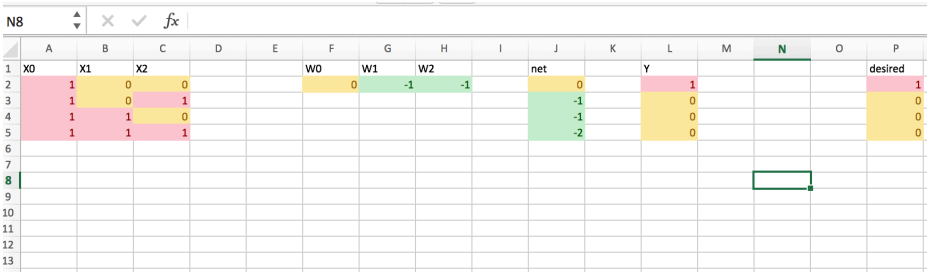

Fig. 1. Single Neuron

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	X0	X1	x2	desired	learning co	W0	w1	w2		net	Y		ChangeW0	ChangeW1	ChangeW2
2	1	0	0	0	0.5	2	2	5		2	1		-0.5	0	0
3	1	0	1	0		1.5	2	5		6.5	1		-0.5	0	-0.5
4	1	1	0	0		1	2	4.5		3	1		-0.5	-0.5	0
5	1	1	1	1		0.5	1.5	4.5		6.5	1		0	0	0
6	1	0	0	0		0.5	1.5	4.5		0.5	1		-0.5	0	0
7	1	0	1	0		0	1.5	4.5		4.5	1		-0.5	0	-0.5
8	1	1	0	0		-0.5	1.5	4		1	1		-0.5	-0.5	0
9	1	1	1	1		-1	1	4		4	1		0	0	0
10	1	0	0	0		-1	1	4		-1	0		0	0	0
11	1	0	1	0		-1	1	4		3	1		-0.5	0	-0.5
12	1	1	0	0		-1.5	1	3.5		-0.5	0		0	0	0
13	1	1	1	1		-1.5	1	3.5		3	1		0	0	0
14	1	0	0	0		-1.5	1	3.5		-1.5	0		0	0	0
15	1	0	1	0		-1.5	1	3.5		2	1		-0.5	0	-0.5
16	1	1	0	0		-2	1	3		-1	0		0	0	0
17	1	1	1	1		-2	1	3		2	1		0	0	0
18	1	0	0	0		-2	1	3		-2	0		0	0	0
19	1	0	1	0		-2	1	3		1	1		-0.5	0	-0.5
20	1	1	0	0		-2.5	1	2.5		-1.5	0		0	0	0
21	1	1	1	1		-2.5	1	2.5		1	1		0	0	0
22	1	0	0	0		-2.5	1	2.5		-2.5	0		0	0	0
23	1	0	1	0		-2.5	1	2.5		0	1		-0.5	0	-0.5
24	1	1	0	0		-3	1	2		-2	0		0	0	0
25	1	1	1	1		-3	1	2		0	1		0	0	0
26	1	0	0	0		-3	1	2		-3	0		0	0	0
27	1	0	1	0		-3	1	2		-1	0		0	0	0
28	1	1	0	0		-3	1	2		-2	0		0	0	0
29	1	1	1	1		-3	1	2		0	1		0	0	0
30															

Fig. 2. Training a single neuron.

Feedback from a number of students has been it “helped them to see the principles”, the rest of the module feedback, when commented upon this approach, was positive but most students did not feedback anything on the approach.

The videos are available at [2,3] on YouTube, at the time of writing there had been on 3115 views for the video of the single neuron in action and 6510 views for the training a single neuron video.

3.2 Genetic Algorithms

Figure 3 shows an example of a spreadsheet set up to

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	X	Y		Fitness Score		Parent 1	Parent 2		new child X	new child Y		after mutation		X	Y
2				37											
3				37											
4				37											
5				37											
6				37											
7				37											
8															
9			Average	37											
10															
11	Generation		Average		Best Result X	Best Result X									
12	1														
13	2														
14	3														
15															
16															

Fig. 3. Genetic Algorithm Game

Though overall the feedback was positive, one area of contention was the relationship between the dice rolls and interpreting for parent selection. Some students when rushing interpret the number on the dice to the exact row, so a dice roll of 2 would be interpreted as the individual solution on row 2 when done quickly instead of the individual on row 3 as the second individual. A video explaining the 'game' is available at [4]

4 Conclusion

Why not go straight to writing code for a neuron? In short, no reason, but experience with a number of students suggests this spreadsheet route is a little more accessible and the stages are built up incrementally. It also suits courses where not all students have developed skills in a common programming language, so all are at the same point with this.

The Genetic Algorithm game approach was investigated as, the author believes, some students find the ideas a little confusing and this staged approach appears to help. The game being played in groups of two or three, means discussion is encouraged to happen. One improvement is add numbers down the side to give labels to individual solution.

5 References

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