HERBICIDE SELECTION

PROBLEM DESCRIPTION

Construct a neural network that is capable of recommending a herbicide and the appropriate application rate for that herbicide for a given field situation. The user will be expected to supply the following information:

1.	Soil organic matter content	possibilities will be	<2% 2-4% >4%
2.	Crop to be planted	possibilities will be	corn or soybeans
3.	Existing weed problem	possibilities will be	broadleaf, or grass

The problem of recommending a herbicide has been simplified greatly in order to keep it manageable as a classroom example. Information concerning the herbicides and their application guidelines are contained in the following table.

The crops of concern are corn and soybeans and the weeds are grass and broadleaf. The following truth table should aid development of the necessary rules:

Herbicide	Weed	Crop	Organic Matter		
			<2%	2-4%	>4%
Sencor	broadleaf	C or S	Do Not Use	3/4 pt/ac	3/4 pt/ac
Lasso	broadleaf or grass	C or S	2 qt/ac	1 qt/ac	0.5 qt/ac
Bicep	broadleaf or grass	corn	1.5 qt/ac	2.5 qt/ac	3 qt/ac

After the development of the neural network, please provide the following questions:

1. Identify inputs and outputs.
2. Find an appropriate way to code the data.
3. Report the network configuration.
4. Plot the training process.
5. Report an example propagation for a field with 2corn, 3% organic matter, and both grass and broadleaf weed problem.

SOLUTION

1. The inputs are types of herbicide, weed, crop and content of organic matter; the outputs are the recommendation of a herbicide and amount to apply.

2. Use the binary coding for inputs and thermometer coding for outputs:

Table 1. Herbicide code

Option	*Sencor*	*Lasso*	*Bicep*	*Code*
1	None	2 qt/ac	1.5 qt/ac	0 1
2	3/4 pt/ac	1 qt/ac	2.5/qt/ac	1 0
3	3/4 pt/ac	0.5 qt/ac	3 qt/ac	1 1

Table 2. Weed code

Weed	*Abbreviation*	*Code*
broadleaf	B	0
grass & broadleaf	B&G	1

Table 3. Crop code

Crop	*Abbreviation*	*Code*
Corn	C	0
Soybeans	S	1

Table 4. Organic matter content code

Content	*Code*
<2%	0 0
2-4%	0 1
>4%	1 0

3. The network was configued as:

LAYER : 0 -- input layer
NODES : 4 -- 1st neuron for weeds; 2nd for crops;
-- 3rd and 4th for organic matter
TARGET : 2

LAYER : 1 -- output layer
NODES : 6 -- output has six neurons (output <0,1>, <2,3> and <4,5>
-- corresponding to Sencor, Lasso and Bicep)

LAYER : 2 -- hidden layer
NODES : 10
TARGET : 1

4. Propagation and training process are documented as follows:

Propagation:

Given grass and broadleafs in a corn field with 3% organic matter, which herbicide do we choose? We get an input vector *v(1, 0, 0, 1)* after encoding the problem with reference to Tables 1 through 4. The input is propagated through the net and the output shown in Figure 2. An output with a value over 0.5 means *one* and *zero* otherwise. We now know that after decoding the output, *u (0, 0, 1, 0, 1, 0),* we can use Lasso with the amount of 1 qt/ac or Bicep at 2.5 qt/ac to get rid of the weeds in the field.

```
NETS Choice(m = menu)? p

      Enter input for node 0: 1

      Enter input for node 1: 0

      Enter input for node 2: 0

      Enter input for node 3: 1

The Outputs are:
     for node 0 the value   0.004
     for node 1 the value   0.008
     for node 2 the value   0.910
     for node 3 the value   0.093
     for node 4 the value   0.939
     for node 5 the value   0.180

NETS Choice(m = menu)?
```

Figure 2. The propagation result of an input vector (1, 0, 0, 1).

Training process:

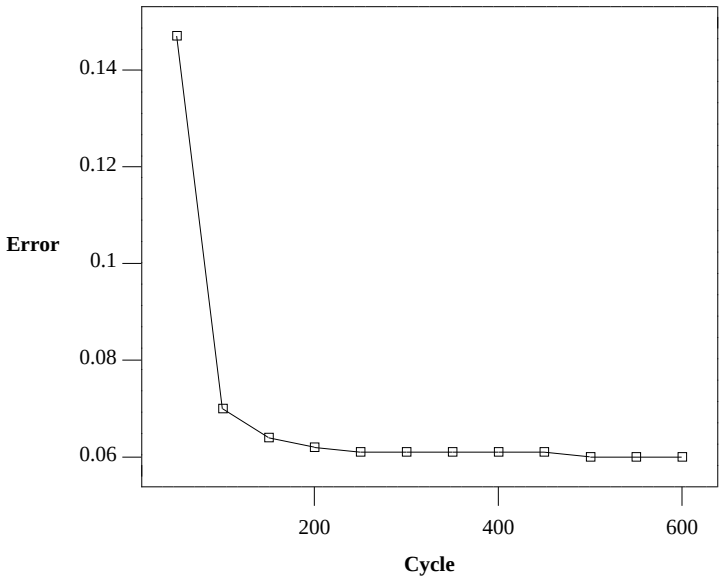

Figure 1. **RMS** error for herbicide selection.