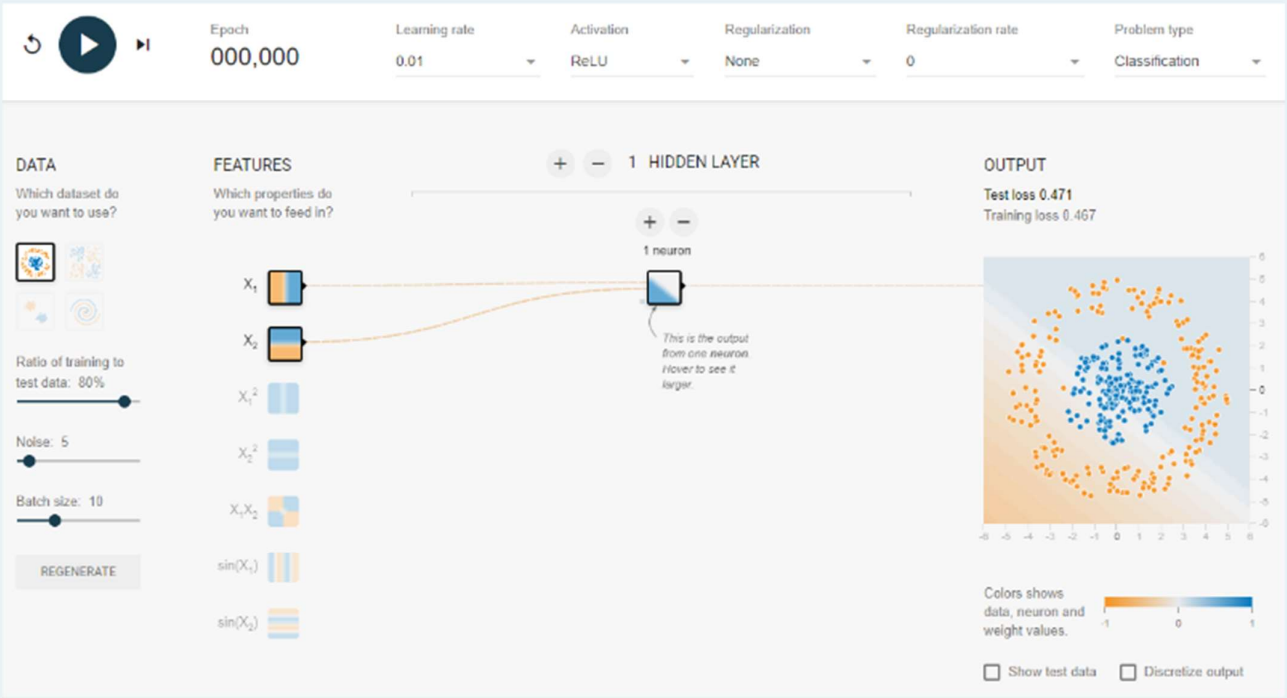
Exercise 4.1

The Tensorflow playground in https://playground.tensorflow.org/ can be used to illustrate components of artificial neural network without programming.

Initialize the playground as follows:

- Data is the one in upper left corner. Ratio of training to test data is 80%. Noise is 5 and batch size is 10.
- Features are X_1 and X_2.
- One hidden layer with one neuron in it. Activation is ReLU.
- Learning rate is 0.01.
- Problem type is Classification.



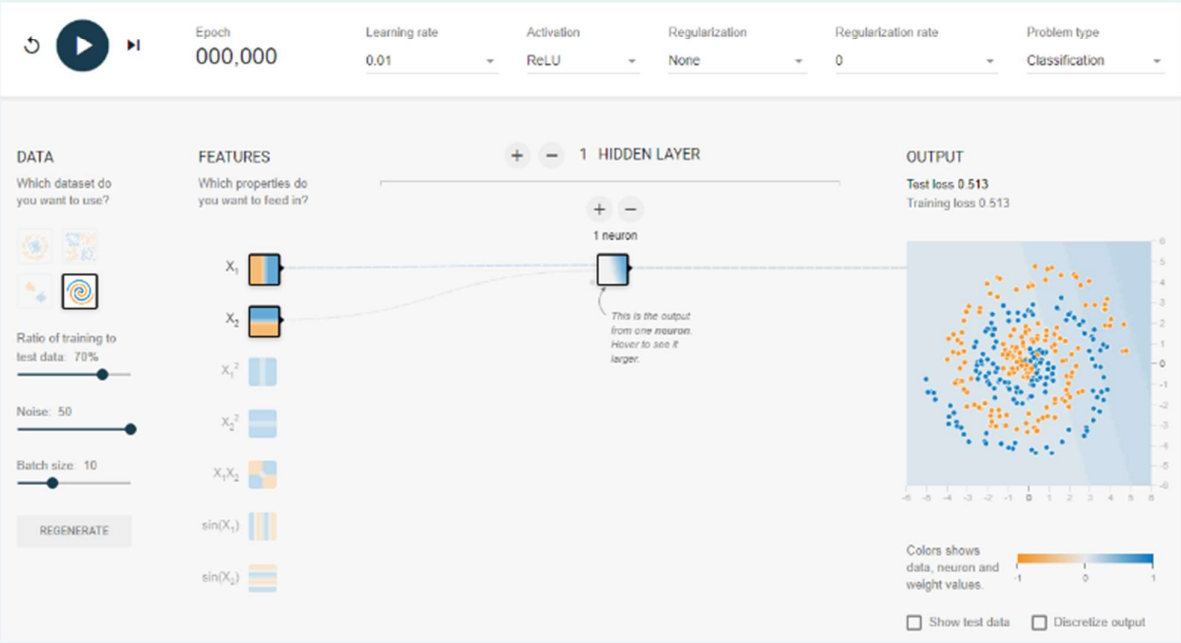
Using about 500 epochs, how many neurons in hidden layer are needed to achieve Test loss that is less than 0.05?

Exercise 4.2

The Tensorflow playground in https://playground.tensorflow.org/ can be used to illustrate components of artificial neural network without programming.

Initialize the playground as follows:

- Data is the one in lower right corner, i.e. the spiral shaped data. Ratio of training to test data is 70%. Noise is 50 and batch size is 10.
- Features are X_1 and X_2.
- One hidden layer with one neuron in it. Activation is ReLU.
- Regularization is None and Regularization rate is 0.
- Learning rate is 0.01.
- Problem type is Classification.



Change the architecture of the model. You can do one or more of following changes: add features, add neurons, add layers, change activation function, change the learning rate and add regularization with regularization rate. Notice that you are not allowed to change the data setting.

Try to get the lowest Test loss that you achieve with your model with at most 1000 epochs.

Return a picture (screenshot) of your model. Note that the number of epochs in the picture has to be under 1000. The scoring of the task depends on the size of the Test loss value. Full marks are awarded if the Test loss is less than 0.2.

Exercise 4.3

Suppose we have the following layers in artificial neural network:

- input layer with 30 values (identity neurons)
- hidden layer with 20 neurons
- hidden layer with 9 neurons
- hidden layer with 4 neurons
- output layer with 2 neurons

Neurons in hidden or output layer use a bias term.

How many parameters does the neural network have?

Exercise 4.4

Suppose you have an artificial neural network that has 8 neurons in output layer with softmax activation function. With a specific input the outputs of these neurons before activation are the following $[0.56, 2.3, 6.2, 2.7, 7.4, 3.2, 0.82, 3.7]$.

Which of these values have a final output 0.011 when rounded to three decimals, i.e. produces the probability 1,10% ?