HW1

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1.Introduction

- Multilayer perceptron is also a kind of NN with fully connected.
- Activation function is to make the linear model change to non-linear model, it is the main point of NN.
- For training an Neuron Network, we always need to use optimal function and Backpropagation.
- Optimal function is take a good way to minimize the loss function.(Here we use gradient descent.)
- Backpropagation is a way to compute the gradient of loss function to update the bias and weight.

2.Experiment setups

A. Sigmoid functions

1. It is a activation function
2. Formula:

$$S(x) = \frac{1}{1 + e^{-x}}$$

2.Experiment setups

B. Neural network

- Inputs : X is a (n,2).
- First hidden layer : neuron number = 4, $z1 = x * w1$, $a1 = \sigma(z1)$
- Second hidden layer : neuron number = 4, $z2 = a1 * w2$, $a2 = \sigma(z2)$
- Output layer : y_pred, $z3 = a2 * w3$, $ypred = a3 = \sigma\ z3$
- Weight 1 : matrix (2, 4)
- Weight 2 : matrix (4, 4)
- Weigth 3 : matrix (4, 1)

2.Experiment setups

C. Backpropagation

Loss function: $MSE = \frac{\sum_1^n (y_{pred} - y)^2}{n} = L(\theta)$

Gradient of weight1 =

$$\nabla(w_3) = \frac{\partial L}{\partial w_3} = \frac{\partial L}{\partial y_{pred}} \frac{\partial y_{pred}}{\partial z_3} \frac{\partial z_3}{\partial w_3}$$
$$= (y - y_{pred}) * diffsigmoid(z_3) * a_2$$
$$= \frac{\partial L}{\partial z_3} * a_2$$

Update: $w_i = w_i - lr * \nabla(w_i)$

Gradient of weight2 =

$$\nabla(w_2) = \frac{\partial L}{\partial w_2} = \frac{\partial L}{\partial y_{pred}} \frac{\partial y_{pred}}{\partial z_3} \frac{\partial z_3}{\partial a_2} \frac{\partial a_2}{\partial z_2} \frac{\partial z_2}{\partial w_2}$$
$$= \frac{\partial L}{\partial z_3} * w_3 * diffsigmoid(z_2) * a_1$$
$$= \frac{\partial L}{\partial z_2} * a_1$$

$diffsigmoid(z_i) = sigmoid(z_i) * (1 - sigmoid(z_i))$

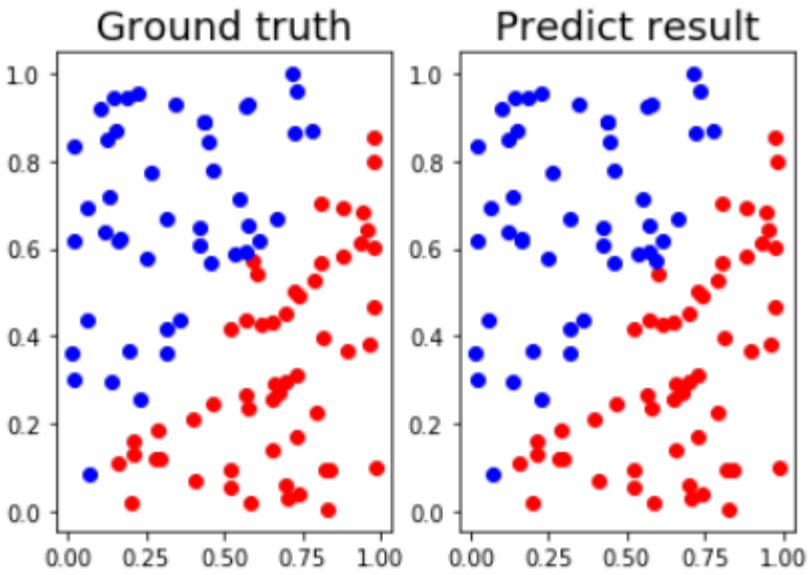
Gradient of weight1 =

$$\nabla(w_1) = \frac{\partial L}{\partial w_1} = \frac{\partial L}{\partial z_2} \frac{\partial z_2}{\partial a_1} \frac{\partial a_1}{\partial z_1} \frac{\partial z_1}{\partial w_1}$$
$$= \frac{\partial L}{\partial z_2} * w_2 * diffsigmoid(z_1) * a_1$$

3.Results of your testing

A. Screenshot and comparison figure

linear



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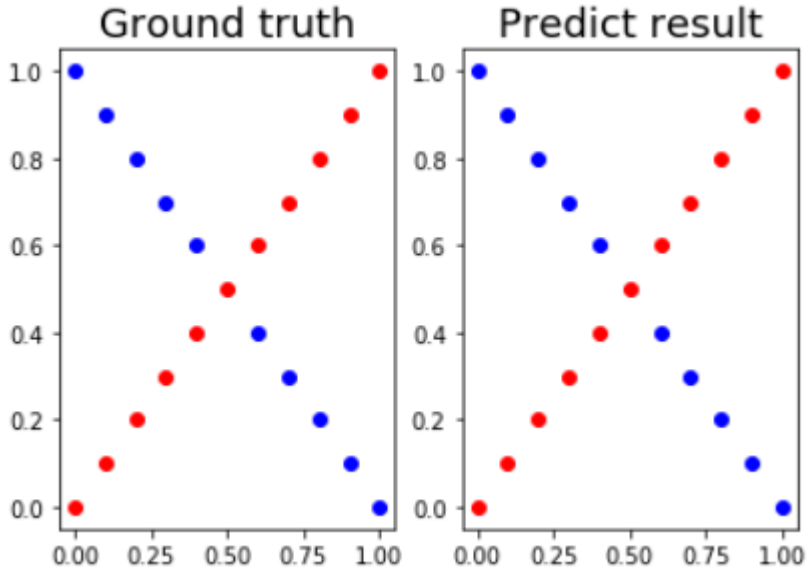
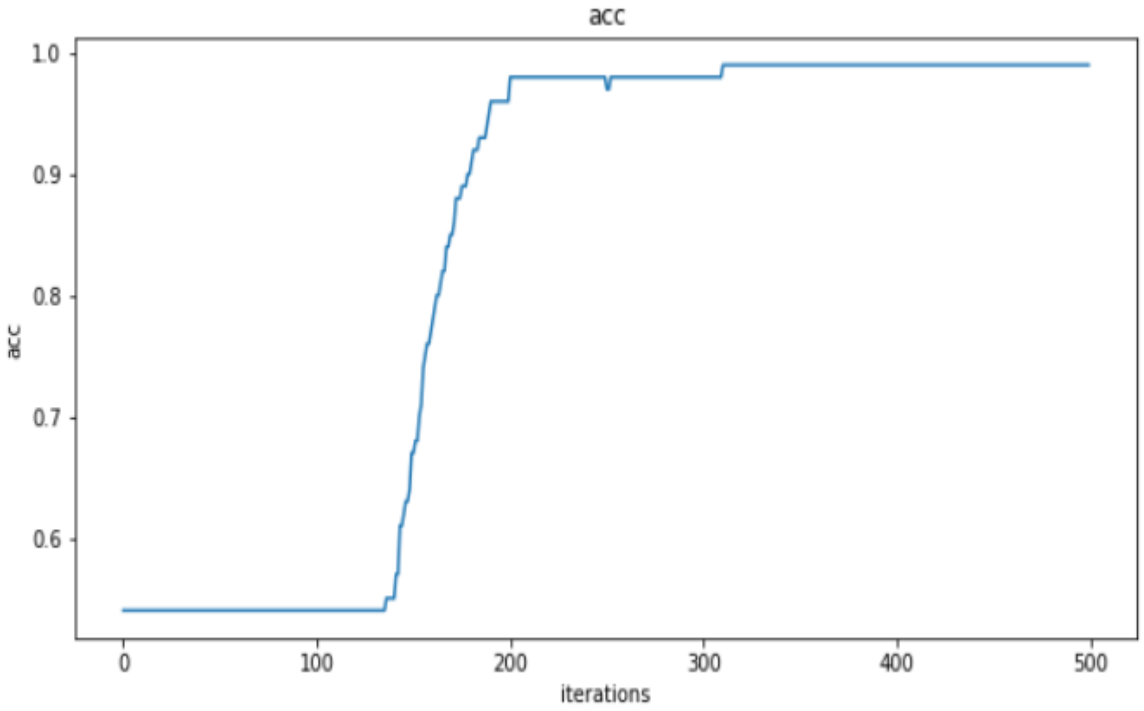


3.Results of your testing

B. Show the accuracy of your prediction

linear



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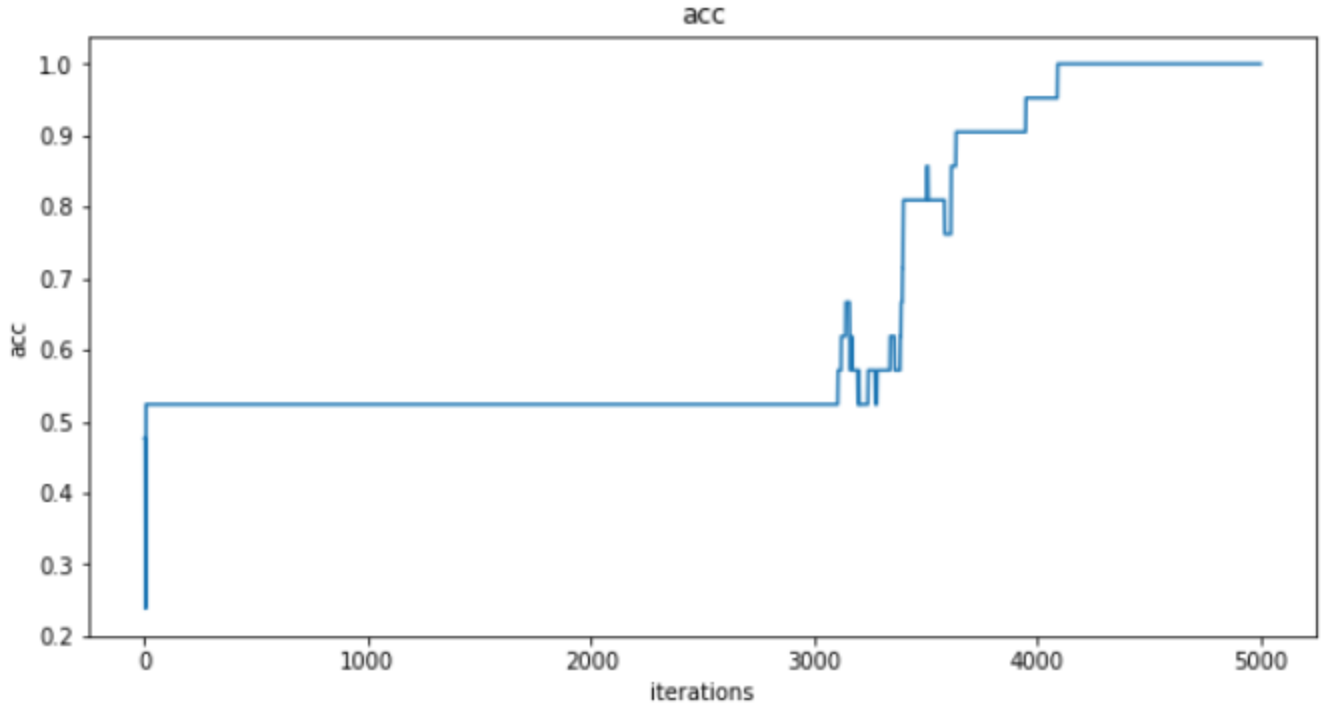
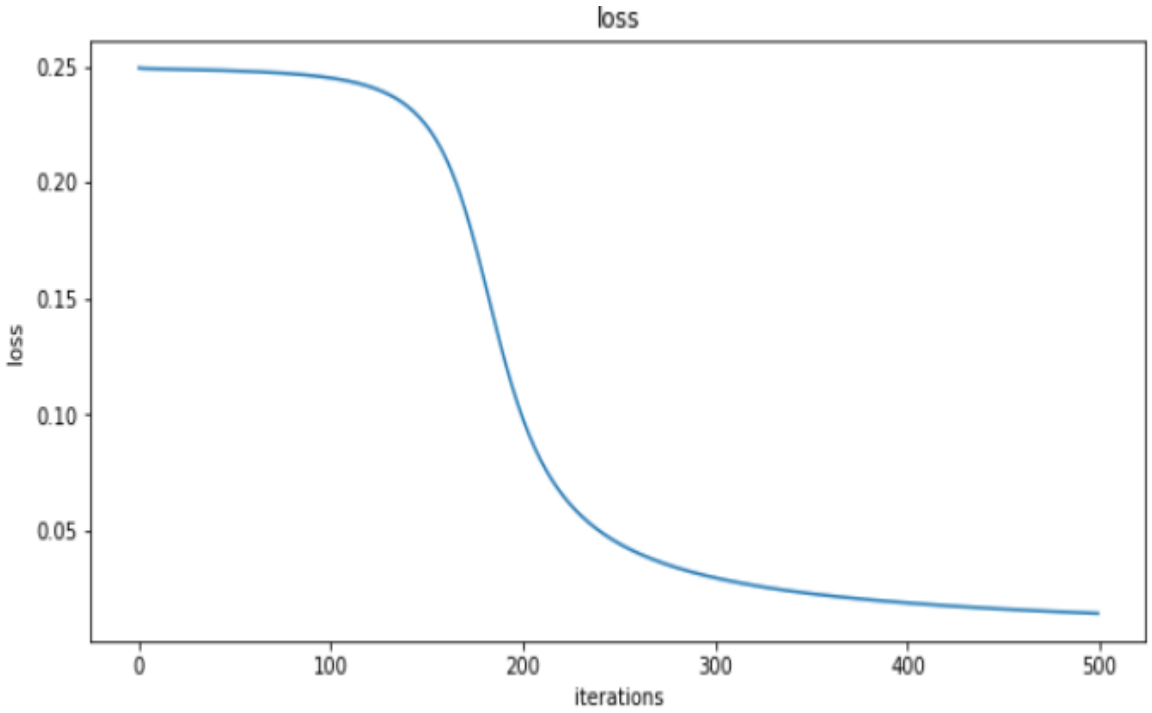


3.Results of your testing

C. Learning curve (loss, epoch curve)

linear



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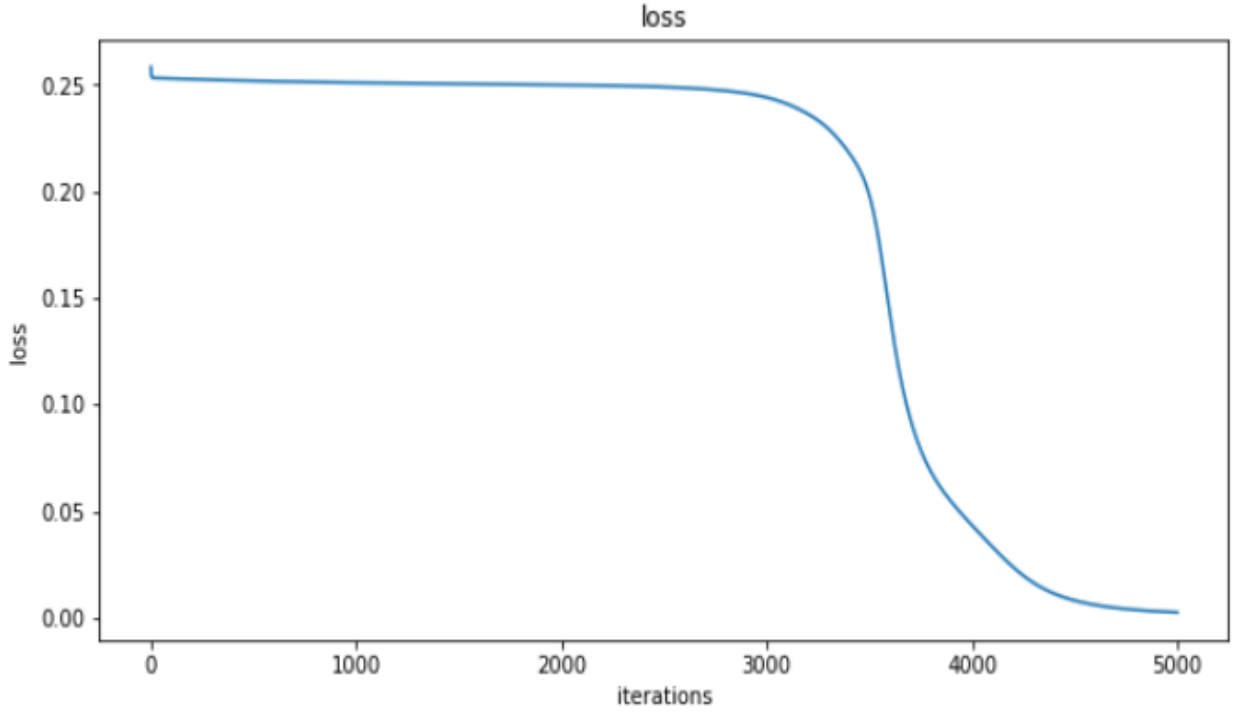
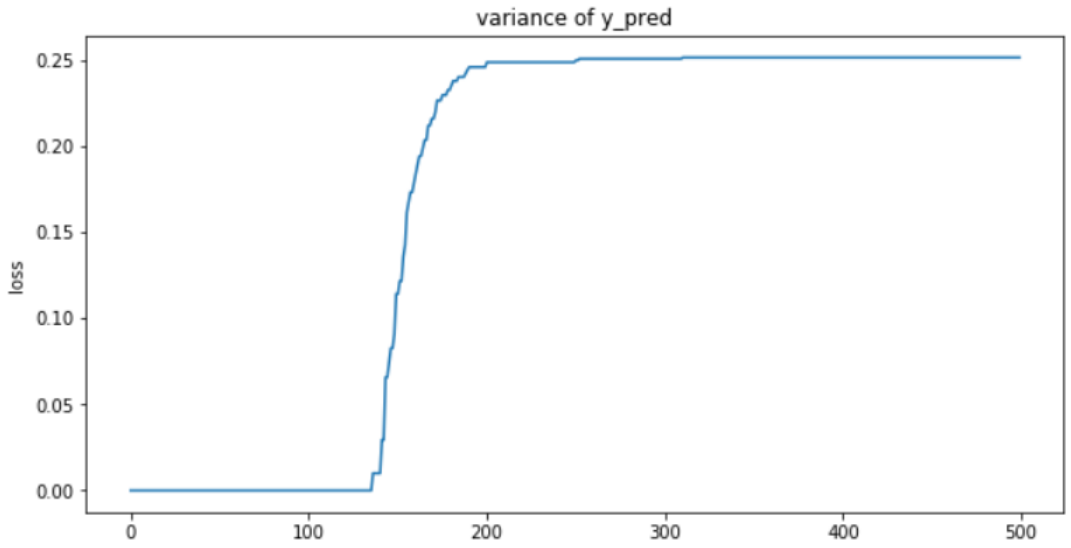


3.Results of your testing

D. anything you want to present

Variance of y_pred

linear



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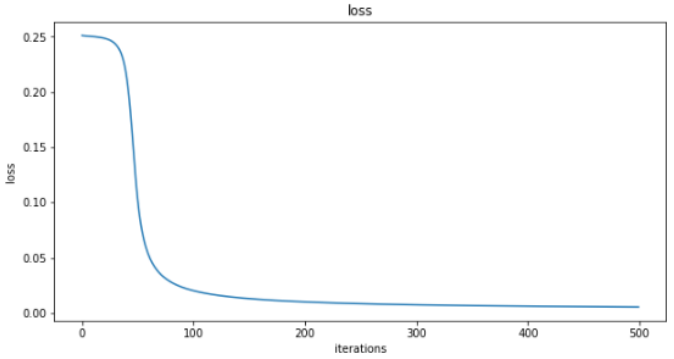
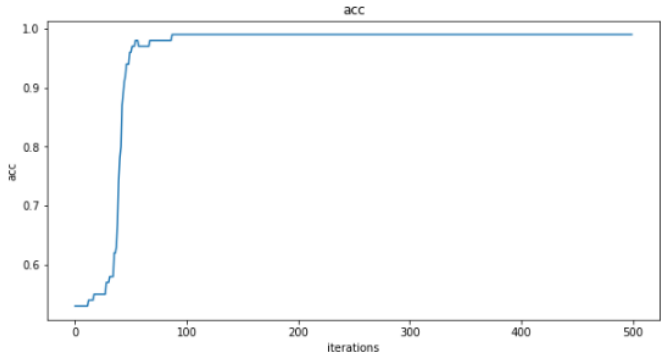
4. Discussion

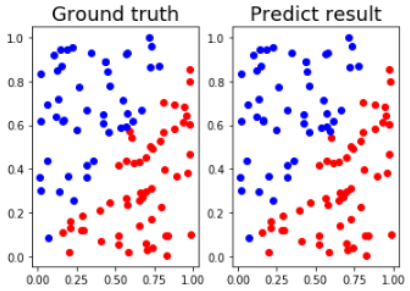
A. Try different learning rates

SET LR = 0.2

linear







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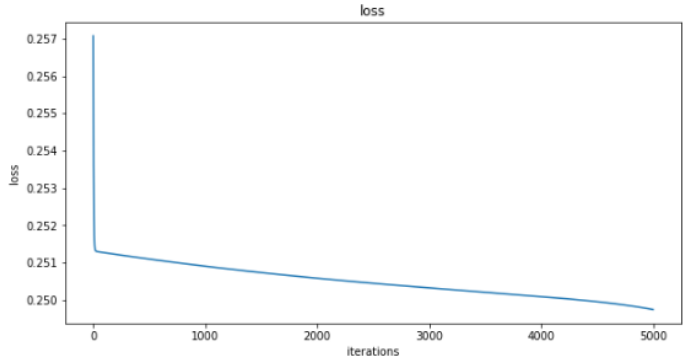
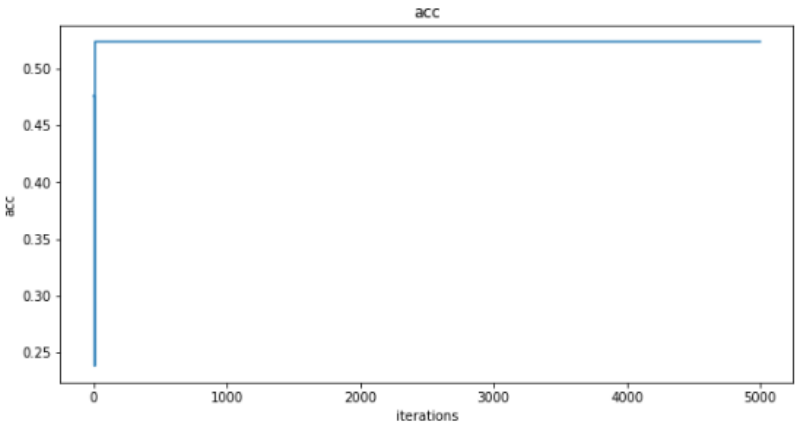
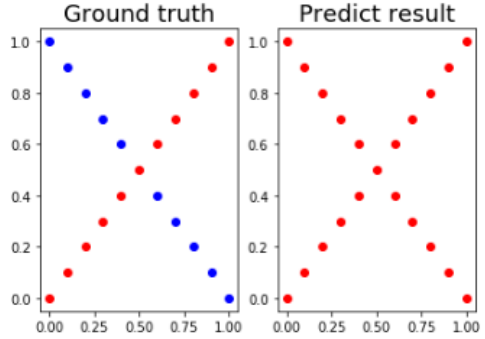


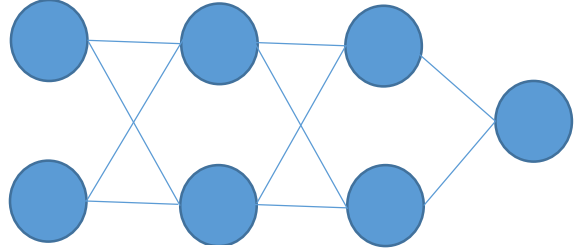




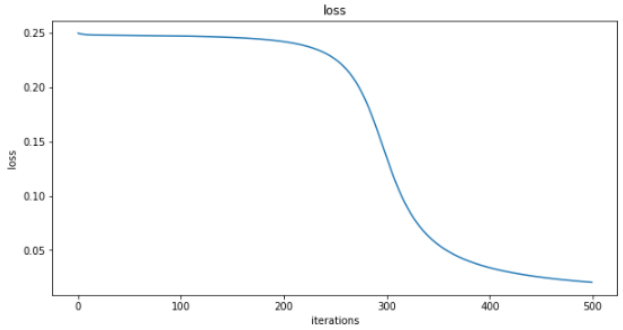
4. Discussion

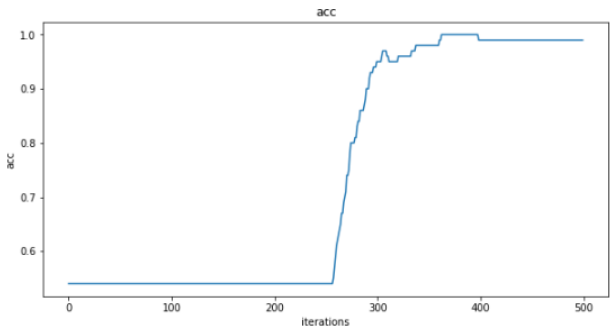
B. Try different numbers of hidden units

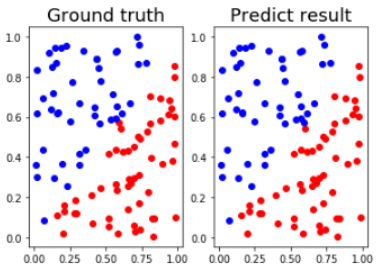
Model structure:



linear







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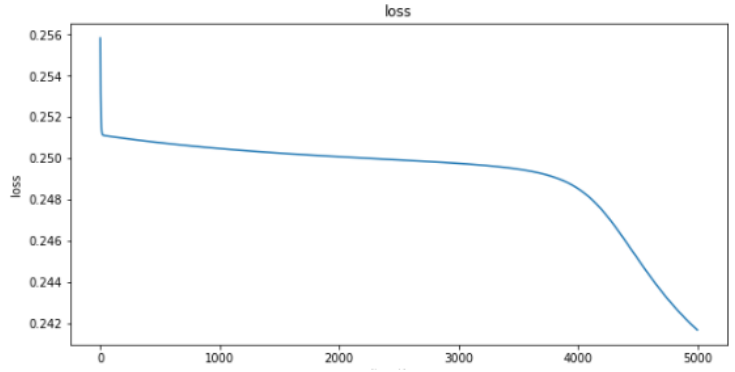
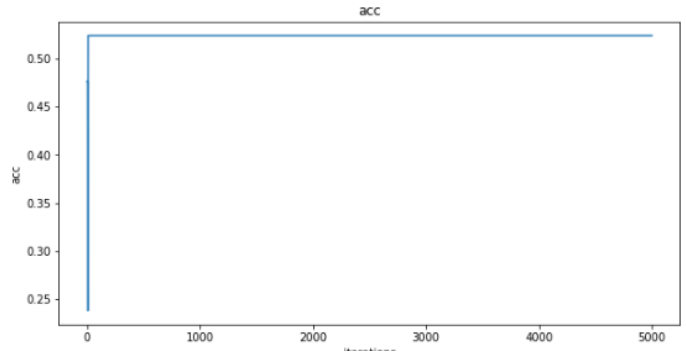
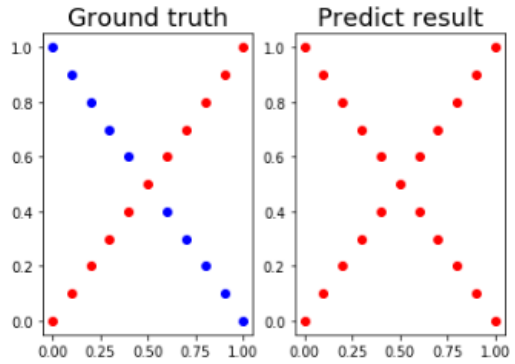


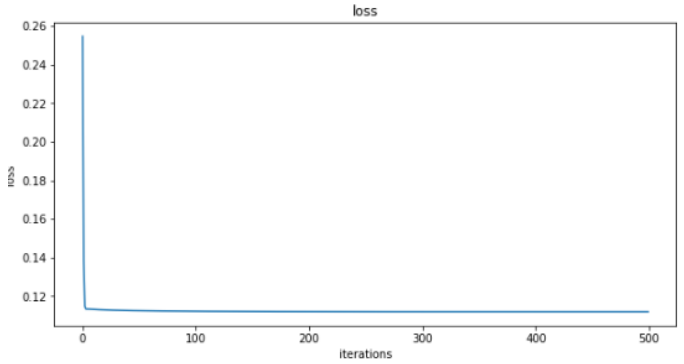


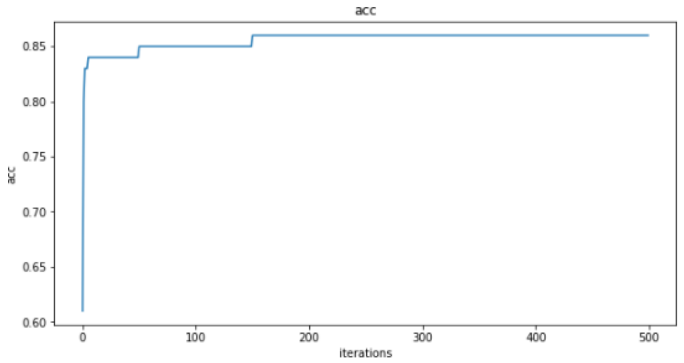


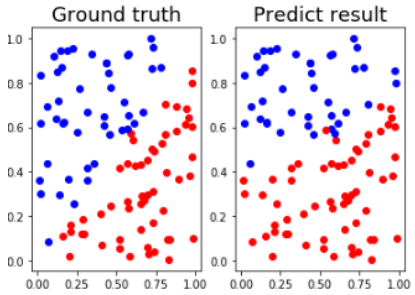
4. Discussion

C. Try without sigmoid function

linear







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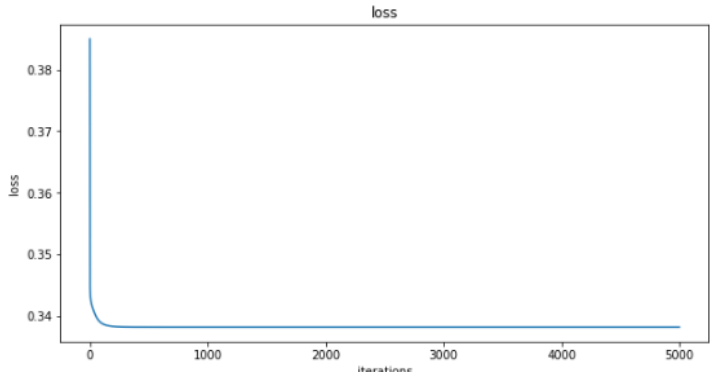
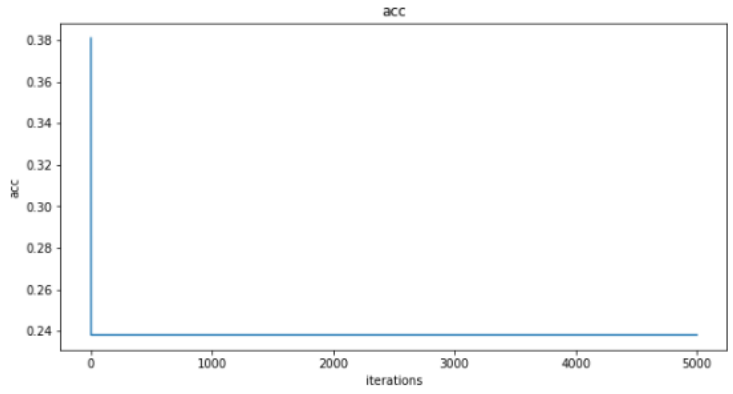
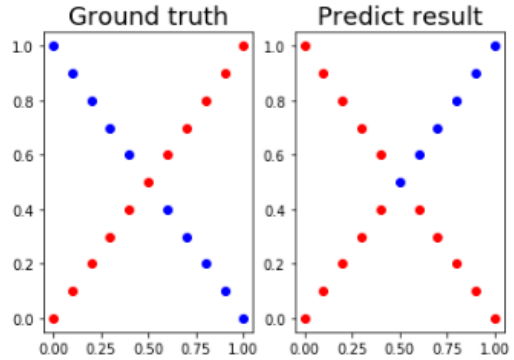


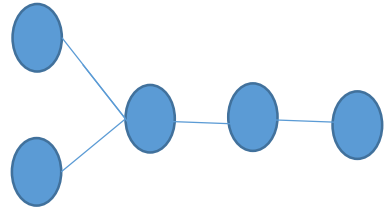




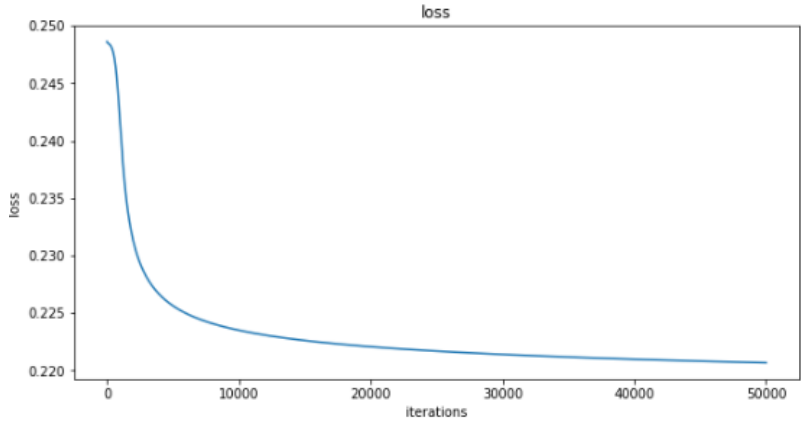
4. Discussion

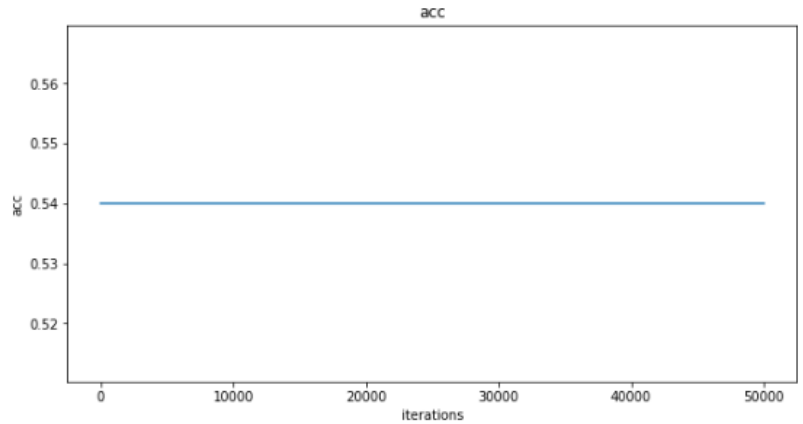
D. Anything you want to share

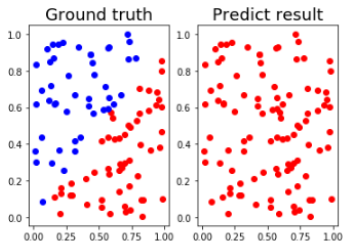
Try Model structure:



linear







XOR