조건 ***: epochs = 1000*** 고정

1. model.add() 내의 activation 함수 변경

- relu 일때의 결과

```
47/47 [==============================] - 0s 2ms/step - loss: 0.3277 - accuracy: 0.8723
Epoch 991/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3293 - accuracy: 0.8830
Epoch 992/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3296 - accuracy: 0.8702
Epoch 993/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3483 - accuracy: 0.8702
Epoch 994/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3372 - accuracy: 0.8702
Epoch 995/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3577 - accuracy: 0.8681
Epoch 996/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3476 - accuracy: 0.8702
Epoch 997/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3289 - accuracy: 0.8723
Epoch 998/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3705 - accuracy: 0.8723
Epoch 999/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3592 - accuracy: 0.8745
Epoch 1000/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.3313 - accuracy: 0.8745
```

- sigmoid 일때의 결과

```
47/47 [==============================] - 0s 3ms/step - loss: 0.2574 - accuracy: 0.9000
Epoch 991/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2576 - accuracy: 0.9064
Epoch 992/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.2594 - accuracy: 0.9064
Epoch 993/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.2598 - accuracy: 0.9043
Epoch 994/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.2559 - accuracy: 0.9000
Epoch 995/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2552 - accuracy: 0.9106
Epoch 996/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2570 - accuracy: 0.9043
Epoch 997/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2560 - accuracy: 0.8957
Epoch 998/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2609 - accuracy: 0.8979
Epoch 999/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2563 - accuracy: 0.9043
Epoch 1000/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2554 - accuracy: 0.9021
```

activation을 relu로 두었을 때 가장 무난한 성능을 보인다.

2. model.compile() 내의 loss 옵션 변경

- binary_crossentropy

```
47/47 [==============================] - 0s 2ms/step - loss: 0.3277 - accuracy: 0.8723
Epoch 991/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3293 - accuracy: 0.8830
Epoch 992/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3296 - accuracy: 0.8702
Epoch 993/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3483 - accuracy: 0.8702
Epoch 994/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3372 - accuracy: 0.8702
Epoch 995/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3577 - accuracy: 0.8681
Epoch 996/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3476 - accuracy: 0.8702
Epoch 997/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3289 - accuracy: 0.8723
Epoch 998/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3705 - accuracy: 0.8723
Epoch 999/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3592 - accuracy: 0.8745
Epoch 1000/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.3313 - accuracy: 0.8745
```

- mean_squared_error

```
47/47 [==============================] - 0s 2ms/step - loss: 0.0875 - accuracy: 0.9021
Epoch 991/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.0905 - accuracy: 0.9021
Epoch 992/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.0897 - accuracy: 0.9000
Epoch 993/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.0957 - accuracy: 0.8830
Epoch 994/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.0998 - accuracy: 0.8936
Epoch 995/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.0980 - accuracy: 0.8851
Epoch 996/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.0907 - accuracy: 0.8915
Epoch 997/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.1038 - accuracy: 0.8787
Epoch 998/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.0956 - accuracy: 0.8915
Epoch 999/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.0885 - accuracy: 0.8979
Epoch 1000/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.0882 - accuracy: 0.9021
<keras.src.callbacks.History at 0x7862bdf31390>
```

mean_squared_error는 평균 제곱 계열의 평균 제곱 오차, binary_crossentropy는 교차 엔트로피 계역의 이항 교차 엔트로피를 의미한다. mean_squared_error에 비해 binary_crossentropy를 loss로 사용했을 때 loss값이 확연히 줄어든다.

(binary_crossentropy : 예측 값이 참과 거짓 둘 중 하나인 형식에 사용한다.)

3. 입력층의 노드 개수 변경

- 노드 개수 : 10개

```
47/47 [==============================] - 0s 2ms/step - loss: 0.3684 - accuracy: 0.8596
Epoch 991/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3771 - accuracy: 0.8660
Epoch 992/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3662 - accuracy: 0.8638
Epoch 993/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3852 - accuracy: 0.8553
Epoch 994/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3665 - accuracy: 0.8617
Epoch 995/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3797 - accuracy: 0.8511
Epoch 996/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3784 - accuracy: 0.8681
Epoch 997/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3706 - accuracy: 0.8617
Epoch 998/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.4104 - accuracy: 0.8574
Epoch 999/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3858 - accuracy: 0.8617
Epoch 1000/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3636 - accuracy: 0.8596
```

- 노드 개수 : 30개

```
47/47 [==============================] - 0s 2ms/step - loss: 0.3277 - accuracy: 0.8723
Epoch 991/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3293 - accuracy: 0.8830
Epoch 992/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3296 - accuracy: 0.8702
Epoch 993/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3483 - accuracy: 0.8702
Epoch 994/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3372 - accuracy: 0.8702
Epoch 995/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3577 - accuracy: 0.8681
Epoch 996/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3476 - accuracy: 0.8702
Epoch 997/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3289 - accuracy: 0.8723
Epoch 998/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3705 - accuracy: 0.8723
Epoch 999/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3592 - accuracy: 0.8745
Epoch 1000/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.3313 - accuracy: 0.8745
```

- 노드 개수 : 50개

```
47/47 [==============================] - 0s 2ms/step - loss: 0.2789 - accuracy: 0.8979
Epoch 991/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2985 - accuracy: 0.8830
Epoch 992/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2797 - accuracy: 0.8894
Epoch 993/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2976 - accuracy: 0.8787
Epoch 994/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2940 - accuracy: 0.8851
Epoch 995/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.2871 - accuracy: 0.8915
Epoch 996/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.2914 - accuracy: 0.8830
Epoch 997/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2820 - accuracy: 0.8872
Epoch 998/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2989 - accuracy: 0.8872
Epoch 999/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2989 - accuracy: 0.8872
Epoch 1000/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2981 - accuracy: 0.8872
```

입력층의 노드 개수를 늘릴수록 오차가 줄고 정확도가 높아진다.

4. 은닉층의 층 개수를 추가

- 은닉층 X

```
47/47 [==============================] - 0s 2ms/step - loss: 0.3277 - accuracy: 0.8723
Epoch 991/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3293 - accuracy: 0.8830
Epoch 992/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3296 - accuracy: 0.8702
Epoch 993/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3483 - accuracy: 0.8702
Epoch 994/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3372 - accuracy: 0.8702
Epoch 995/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3577 - accuracy: 0.8681
Epoch 996/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3476 - accuracy: 0.8702
Epoch 997/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3289 - accuracy: 0.8723
Epoch 998/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3705 - accuracy: 0.8723
Epoch 999/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3592 - accuracy: 0.8745
Epoch 1000/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.3313 - accuracy: 0.8745
```

- 은닉층 1개 추가

```
model.add(Dense(10, activation='relu')
```

```
47/47 [==============================] - 0s 2ms/step - loss: 0.2537 - accuracy: 0.8872
Epoch 991/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2891 - accuracy: 0.8830
Epoch 992/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.2636 - accuracy: 0.8851
Epoch 993/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.2862 - accuracy: 0.8894
Epoch 994/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2791 - accuracy: 0.8830
Epoch 995/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2929 - accuracy: 0.8894
Epoch 996/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2707 - accuracy: 0.8915
Epoch 997/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3110 - accuracy: 0.9021
Epoch 998/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3092 - accuracy: 0.8872
Epoch 999/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2718 - accuracy: 0.8936
Epoch 1000/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.2656 - accuracy: 0.8915
```

- 은닉층 2개 추가

```
model.add(Dense(20, activation='relu'))
model.add(Dense(10, activation='relu'))
```

```
47/47 [==============================] - 0s 2ms/step - loss: 0.3216 - accuracy: 0.9021
Epoch 991/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.3700 - accuracy: 0.8787
Epoch 992/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2900 - accuracy: 0.9085
Epoch 993/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2839 - accuracy: 0.9043
Epoch 994/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.2563 - accuracy: 0.9106
Epoch 995/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2462 - accuracy: 0.9128
Epoch 996/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2367 - accuracy: 0.9170
Epoch 997/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2469 - accuracy: 0.9213
Epoch 998/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2447 - accuracy: 0.9149
Epoch 999/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2576 - accuracy: 0.8979
Epoch 1000/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.2414 - accuracy: 0.9128
<keras.src.callbacks.History at 0x7863bde557b0>
```

은닉층을 많이 추가할수록 오차가 줄어들고, 정확도가 높아진다.

마지막 실제 결과 화면

```
47/47 [==============================] - 0s 3ms/step - loss: 0.1595 - accuracy: 0.9468
Epoch 991/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.1645 - accuracy: 0.9404
Epoch 992/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.2537 - accuracy: 0.9149
Epoch 993/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.2030 - accuracy: 0.9298
Epoch 994/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.2377 - accuracy: 0.9255
Epoch 995/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.2313 - accuracy: 0.9362
Epoch 996/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.2098 - accuracy: 0.9298
Epoch 997/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.1841 - accuracy: 0.9298
Epoch 998/1000
47/47 [==============================] - 0s 3ms/step - loss: 0.1710 - accuracy: 0.9447
Epoch 999/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.1481 - accuracy: 0.9532
Epoch 1000/1000
47/47 [==============================] - 0s 2ms/step - loss: 0.1493 - accuracy: 0.9511
<keras.src.callbacks.History at 0x7862bd2150f0>
```