Implement Neural Netwo

Predicting if a person would buy life insurnace based on his age using logistic re

Above is a binary logistic regression problem as there are only two possible outcomes (i.e. if perso

In [1]:
```
import numpy as np
import tensorflow as tf
from tensorflow import keras
import pandas as pd
from matplotlib import pyplot as plt
%matplotlib inline
```

In [2]:
```
df = pd.read_csv("insurance_data.csv")
df.head()
```

Out[2]:

	age	affordibility	bought_insurance
0	22	1	0
1	25	0	0
2	47	1	1
3	52	0	0
4	46	1	1

Split train and test set

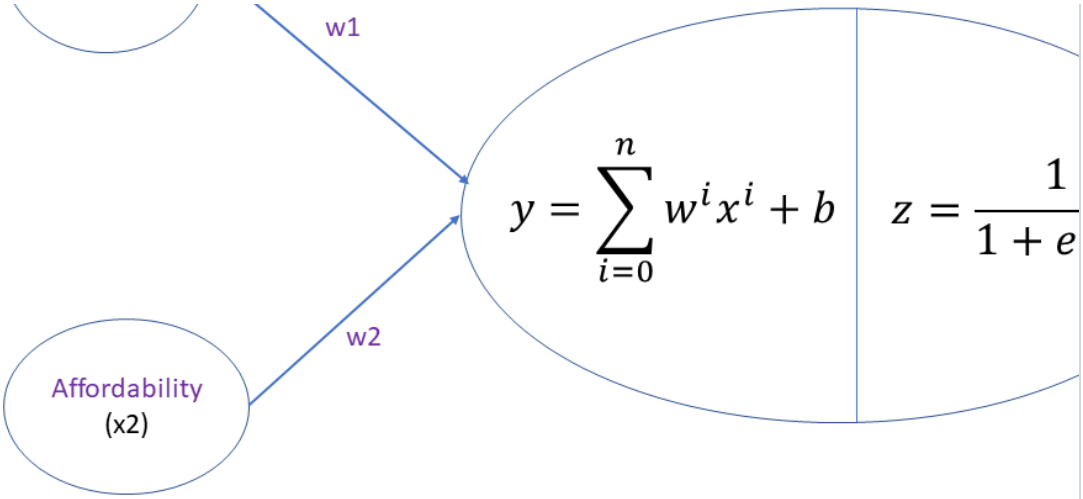
In [3]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(df[['age','affordibility']],df.b
```

Preprocessing: Scale the data so that both age and affordibility are in same scaling range

In [4]:
```
X_train_scaled = X_train.copy()
X_train_scaled['age'] = X_train_scaled['age'] / 100

X_test_scaled = X_test.copy()
X_test_scaled['age'] = X_test_scaled['age'] / 100
```

Model Building: First build a model in keras/tensorflow and see what weights and bias value gradient descent. Below is the architecture of our simple neural network



In [ ]:

```
model = keras.Sequential([
    keras.layers.Dense(1, input_shape=(2,), activation='sigmoid', kernel_initializer
])

model.compile(optimizer='adam',
              loss='binary_crossentropy',
              metrics=['accuracy'])

model.fit(X_train_scaled, y_train, epochs=5000)
```

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Epoch 1/5000
1/1 [==============================] - 0s 0s/step - loss: 0.7113 - accuracy: 0.5000
Epoch 2/5000
1/1 [==============================] - 0s 15ms/step - loss: 0.7110 - accuracy: 0.5000
Epoch 3/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.7106 - accuracy: 0.5000
Epoch 4/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.7102 - accuracy: 0.5000
Epoch 5/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.7098 - accuracy: 0.5000
Epoch 6/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.7094 - accuracy: 0.5000
Epoch 7/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.7091 - accuracy: 0.5000
Epoch 8/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.7087 - accuracy: 0.5000
Epoch 9/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.7083 - accuracy: 0.5000
Epoch 10/5000
1/1 [==============================] - 0s 0s/step - loss: 0.7079 - accuracy: 0.5000
Epoch 11/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.7076 - accuracy: 0.5000
Epoch 12/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.7072 - accuracy: 0.5000
Epoch 13/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.7068 - accuracy: 0.5000
Epoch 14/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.7065 - accuracy: 0.5000
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Epoch 15/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.7061 - accuracy: 0.5000
Epoch 16/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.7057 - accuracy: 0.5000
Epoch 17/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.7054 - accuracy: 0.5000
Epoch 18/5000
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Epoch 19/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.7046 - accuracy: 0.5000
Epoch 20/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.7043 - accuracy: 0.5000
Epoch 21/5000
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Epoch 22/5000
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Epoch 23/5000
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Epoch 24/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.7028 - accuracy: 0.5000
Epoch 25/5000
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Epoch 26/5000
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Epoch 27/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.7017 - accuracy: 0.5000
Epoch 28/5000
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Epoch 30/5000
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Epoch 31/5000
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Epoch 32/5000
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Epoch 34/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6993 - accuracy: 0.5000
Epoch 35/5000
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Epoch 41/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6969 - accuracy: 0.5000
Epoch 42/5000
1/1 [==============================] - 0s 998us/step - loss: 0.6965 - accuracy: 0.500
Epoch 43/5000
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1/1 [==============================] - 0s 2ms/step - loss: 0.6685 - accuracy: 0.5000
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Epoch 168/5000
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Epoch 171/5000
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Epoch 172/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6611 - accuracy: 0.5000
Epoch 173/5000
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Epoch 193/5000
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Epoch 202/5000
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Epoch 203/5000
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Epoch 204/5000
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1/1 [==============================] - 0s 2ms/step - loss: 0.6537 - accuracy: 0.5455
Epoch 212/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6535 - accuracy: 0.5455
Epoch 213/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6533 - accuracy: 0.5455
Epoch 214/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6531 - accuracy: 0.5455
Epoch 215/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6530 - accuracy: 0.5455
Epoch 216/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6528 - accuracy: 0.5455
Epoch 217/5000
1/1 [==============================] - 0s 4ms/step - loss: 0.6526 - accuracy: 0.5455
Epoch 218/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6525 - accuracy: 0.5455
Epoch 219/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6523 - accuracy: 0.5455
Epoch 220/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6521 - accuracy: 0.5455
Epoch 221/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6519 - accuracy: 0.5455
Epoch 222/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6518 - accuracy: 0.5455
Epoch 223/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6516 - accuracy: 0.5455
Epoch 224/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6515 - accuracy: 0.5455
Epoch 225/5000
1/1 [==============================] - 0s 308us/step - loss: 0.6513 - accuracy: 0.545
Epoch 226/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6511 - accuracy: 0.5455
Epoch 227/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6510 - accuracy: 0.5455
Epoch 228/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6508 - accuracy: 0.5455
```

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Epoch 229/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6506 - accuracy: 0.5455
Epoch 230/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6505 - accuracy: 0.5455
Epoch 231/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6503 - accuracy: 0.5455
Epoch 232/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6502 - accuracy: 0.5455
Epoch 233/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6500 - accuracy: 0.5455
Epoch 234/5000
1/1 [==============================] - 0s 931us/step - loss: 0.6498 - accuracy: 0.545
Epoch 235/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6497 - accuracy: 0.5455
Epoch 236/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6495 - accuracy: 0.5455
Epoch 237/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6494 - accuracy: 0.5455
Epoch 238/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6492 - accuracy: 0.5455
Epoch 239/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6491 - accuracy: 0.5455
Epoch 240/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6489 - accuracy: 0.5455
Epoch 241/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6488 - accuracy: 0.5455
Epoch 242/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6486 - accuracy: 0.5909
Epoch 243/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6485 - accuracy: 0.5909
Epoch 244/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6483 - accuracy: 0.5909
Epoch 245/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6482 - accuracy: 0.5909
Epoch 246/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6480 - accuracy: 0.5909
Epoch 247/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6479 - accuracy: 0.5909
Epoch 248/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6477 - accuracy: 0.5909
Epoch 249/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6476 - accuracy: 0.5909
Epoch 250/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6474 - accuracy: 0.5909
Epoch 251/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6473 - accuracy: 0.5909
Epoch 252/5000
1/1 [==============================] - 0s 5ms/step - loss: 0.6471 - accuracy: 0.5909
Epoch 253/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6470 - accuracy: 0.5909
Epoch 254/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6468 - accuracy: 0.5909
Epoch 255/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6467 - accuracy: 0.5909
Epoch 256/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6465 - accuracy: 0.5909
Epoch 257/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6464 - accuracy: 0.5909
Epoch 258/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6463 - accuracy: 0.5909
Epoch 259/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6461 - accuracy: 0.6364
```

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1/1 [==============================] - 0s 1ms/step - loss: 0.6461 - accuracy: 0.6364
Epoch 260/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6460 - accuracy: 0.63
Epoch 261/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6458 - accuracy: 0.6364
Epoch 262/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6457 - accuracy: 0.6364
Epoch 263/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6456 - accuracy: 0.6364
Epoch 264/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6454 - accuracy: 0.6364
Epoch 265/5000
1/1 [==============================] - ETA: 0s - loss: 0.6453 - accuracy: 0.63 - 0s 3
Epoch 266/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6452 - accuracy: 0.6364
Epoch 267/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6450 - accuracy: 0.6364
Epoch 268/5000
1/1 [==============================] - 0s 997us/step - loss: 0.6449 - accuracy: 0.636
Epoch 269/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6448 - accuracy: 0.6364
Epoch 270/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6446 - accuracy: 0.6364
Epoch 271/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6445 - accuracy: 0.6364
Epoch 272/5000
1/1 [==============================] - 0s 751us/step - loss: 0.6444 - accuracy: 0.636
Epoch 273/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6442 - accuracy: 0.6364
Epoch 274/5000
1/1 [==============================] - 0s 996us/step - loss: 0.6441 - accuracy: 0.636
Epoch 275/5000
1/1 [==============================] - 0s 998us/step - loss: 0.6440 - accuracy: 0.636
Epoch 276/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6438 - accuracy: 0.6364
Epoch 277/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6437 - accuracy: 0.6364
Epoch 278/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6436 - accuracy: 0.6364
Epoch 279/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6435 - accuracy: 0.6364
Epoch 280/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6433 - accuracy: 0.6364
Epoch 281/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6432 - accuracy: 0.6364
Epoch 282/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6431 - accuracy: 0.6364
Epoch 283/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6430 - accuracy: 0.63
Epoch 284/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6428 - accuracy: 0.6364
Epoch 285/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6427 - accuracy: 0.6364
Epoch 286/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6426 - accuracy: 0.6364
Epoch 287/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6425 - accuracy: 0.6364
Epoch 288/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6423 - accuracy: 0.63
Epoch 289/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6422 - accuracy: 0.6364
Epoch 290/5000
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Epoch 290/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6421 - accuracy: 0.6364
Epoch 291/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6420 - accuracy: 0.6364
Epoch 292/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6419 - accuracy: 0.6364
Epoch 293/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6417 - accuracy: 0.6364
Epoch 294/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6416 - accuracy: 0.63
Epoch 295/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6415 - accuracy: 0.6364
Epoch 296/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6414 - accuracy: 0.6364
Epoch 297/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6413 - accuracy: 0.6364
Epoch 298/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6411 - accuracy: 0.6364
Epoch 299/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6410 - accuracy: 0.6364
Epoch 300/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6409 - accuracy: 0.6364
Epoch 301/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6408 - accuracy: 0.6364
Epoch 302/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6407 - accuracy: 0.6364
Epoch 303/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6406 - accuracy: 0.63
Epoch 304/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6405 - accuracy: 0.6364
Epoch 305/5000
1/1 [==============================] - 0s 975us/step - loss: 0.6403 - accuracy: 0.636
Epoch 306/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6402 - accuracy: 0.6364
Epoch 307/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6401 - accuracy: 0.6364
Epoch 308/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6400 - accuracy: 0.6364
Epoch 309/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6399 - accuracy: 0.6364
Epoch 310/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6398 - accuracy: 0.6364
Epoch 311/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6397 - accuracy: 0.6364
Epoch 312/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6396 - accuracy: 0.6364
Epoch 313/5000
1/1 [==============================] - 0s 4ms/step - loss: 0.6395 - accuracy: 0.6364
Epoch 314/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6394 - accuracy: 0.6364
Epoch 315/5000
1/1 [==============================] - 0s 911us/step - loss: 0.6392 - accuracy: 0.636
Epoch 316/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6391 - accuracy: 0.6364
Epoch 317/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6390 - accuracy: 0.6364
Epoch 318/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6389 - accuracy: 0.6364
Epoch 319/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6388 - accuracy: 0.6364
Epoch 320/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6387 - accuracy: 0.6364
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Epoch 321/5000
1/1 [==============================] - 0s 4ms/step - loss: 0.6386 - accuracy: 0.6364
Epoch 322/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6385 - accuracy: 0.6364
Epoch 323/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6384 - accuracy: 0.6364
Epoch 324/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6383 - accuracy: 0.6364
Epoch 325/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6382 - accuracy: 0.6364
Epoch 326/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6381 - accuracy: 0.6364
Epoch 327/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6380 - accuracy: 0.6364
Epoch 328/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6379 - accuracy: 0.6364
Epoch 329/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6378 - accuracy: 0.6364
Epoch 330/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6377 - accuracy: 0.6364
Epoch 331/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6376 - accuracy: 0.6364
Epoch 332/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6375 - accuracy: 0.6364
Epoch 333/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6374 - accuracy: 0.6364
Epoch 334/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6373 - accuracy: 0.6364
Epoch 335/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6372 - accuracy: 0.6364
Epoch 336/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6371 - accuracy: 0.6364
Epoch 337/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6370 - accuracy: 0.6364
Epoch 338/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6369 - accuracy: 0.6364
Epoch 339/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6368 - accuracy: 0.6364
Epoch 340/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6367 - accuracy: 0.6364
Epoch 341/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6366 - accuracy: 0.6364
Epoch 342/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6365 - accuracy: 0.6364
Epoch 343/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6364 - accuracy: 0.6364
Epoch 344/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6363 - accuracy: 0.6364
Epoch 345/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6362 - accuracy: 0.6364
Epoch 346/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6361 - accuracy: 0.6364
Epoch 347/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6361 - accuracy: 0.6364
Epoch 348/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6360 - accuracy: 0.6364
Epoch 349/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6359 - accuracy: 0.6364
Epoch 350/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6358 - accuracy: 0.6364
Epoch 351/5000
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1/1 [==============================] - 0s 1ms/step - loss: 0.6357 - accuracy: 0.6364
Epoch 352/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6356 - accuracy: 0.6364
Epoch 353/5000
1/1 [==============================] - 0s 4ms/step - loss: 0.6355 - accuracy: 0.6364
Epoch 354/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6354 - accuracy: 0.6364
Epoch 355/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6353 - accuracy: 0.63
Epoch 356/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6352 - accuracy: 0.63
Epoch 357/5000
1/1 [==============================] - 0s 999us/step - loss: 0.6352 - accuracy: 0.636
Epoch 358/5000
1/1 [==============================] - 0s 4ms/step - loss: 0.6351 - accuracy: 0.6364
Epoch 359/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6350 - accuracy: 0.6364
Epoch 360/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6349 - accuracy: 0.6364
Epoch 361/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6348 - accuracy: 0.6364
Epoch 362/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6347 - accuracy: 0.6364
Epoch 363/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6346 - accuracy: 0.6364
Epoch 364/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6345 - accuracy: 0.6364
Epoch 365/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6345 - accuracy: 0.6364
Epoch 366/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6344 - accuracy: 0.6364
Epoch 367/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6343 - accuracy: 0.63
Epoch 368/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6342 - accuracy: 0.6364
Epoch 369/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6341 - accuracy: 0.6364
Epoch 370/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6340 - accuracy: 0.6364
Epoch 371/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6339 - accuracy: 0.6364
Epoch 372/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6339 - accuracy: 0.6364
Epoch 373/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6338 - accuracy: 0.6364
Epoch 374/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6337 - accuracy: 0.6364
Epoch 375/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6336 - accuracy: 0.6364
Epoch 376/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6335 - accuracy: 0.6364
Epoch 377/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6335 - accuracy: 0.6364
Epoch 378/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6334 - accuracy: 0.6364
Epoch 379/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6333 - accuracy: 0.6364
Epoch 380/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6332 - accuracy: 0.6364
Epoch 381/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6331 - accuracy: 0.6364
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Epoch 382/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6331 - accuracy: 0.6364
Epoch 383/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6330 - accuracy: 0.6364
Epoch 384/5000
1/1 [==============================] - 0s 999us/step - loss: 0.6329 - accuracy: 0.636
Epoch 385/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6328 - accuracy: 0.6364
Epoch 386/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6327 - accuracy: 0.6364
Epoch 387/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6327 - accuracy: 0.6364
Epoch 388/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6326 - accuracy: 0.6364
Epoch 389/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6325 - accuracy: 0.6364
Epoch 390/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6324 - accuracy: 0.6364
Epoch 391/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6323 - accuracy: 0.6364
Epoch 392/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6323 - accuracy: 0.6364
Epoch 393/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6322 - accuracy: 0.6364
Epoch 394/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6321 - accuracy: 0.6364
Epoch 395/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6320 - accuracy: 0.6364
Epoch 396/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6320 - accuracy: 0.6364
Epoch 397/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6319 - accuracy: 0.6364
Epoch 398/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6318 - accuracy: 0.6364
Epoch 399/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6317 - accuracy: 0.6364
Epoch 400/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6317 - accuracy: 0.6364
Epoch 401/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6316 - accuracy: 0.6364
Epoch 402/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6315 - accuracy: 0.6364
Epoch 403/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6314 - accuracy: 0.6364
Epoch 404/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6314 - accuracy: 0.6364
Epoch 405/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6313 - accuracy: 0.6364
Epoch 406/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6312 - accuracy: 0.6364
Epoch 407/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6312 - accuracy: 0.6364
Epoch 408/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6311 - accuracy: 0.6364
Epoch 409/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6310 - accuracy: 0.6364
Epoch 410/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6309 - accuracy: 0.6364
Epoch 411/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6309 - accuracy: 0.6364
Epoch 412/5000
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1/1 [==============================] - 0s 2ms/step - loss: 0.6308 - accuracy: 0.6364
Epoch 413/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6307 - accuracy: 0.6364
Epoch 414/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6307 - accuracy: 0.6364
Epoch 415/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6306 - accuracy: 0.6364
Epoch 416/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6305 - accuracy: 0.6364
Epoch 417/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6305 - accuracy: 0.6364
Epoch 418/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6304 - accuracy: 0.6364
Epoch 419/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6303 - accuracy: 0.6364
Epoch 420/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6302 - accuracy: 0.6364
Epoch 421/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6302 - accuracy: 0.6364
Epoch 422/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6301 - accuracy: 0.6364
Epoch 423/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6300 - accuracy: 0.6364
Epoch 424/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6300 - accuracy: 0.6364
Epoch 425/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6299 - accuracy: 0.6364
Epoch 426/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6298 - accuracy: 0.6364
Epoch 427/5000
1/1 [==============================] - 0s 4ms/step - loss: 0.6298 - accuracy: 0.6364
Epoch 428/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6297 - accuracy: 0.6364
Epoch 429/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6296 - accuracy: 0.6364
Epoch 430/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6296 - accuracy: 0.6364
Epoch 431/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6295 - accuracy: 0.6364
Epoch 432/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6294 - accuracy: 0.6364
Epoch 433/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6294 - accuracy: 0.6364
Epoch 434/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6293 - accuracy: 0.6364
Epoch 435/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6292 - accuracy: 0.6364
Epoch 436/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6292 - accuracy: 0.6364
Epoch 437/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6291 - accuracy: 0.6364
Epoch 438/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6290 - accuracy: 0.6364
Epoch 439/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6290 - accuracy: 0.6364
Epoch 440/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6289 - accuracy: 0.6364
Epoch 441/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6288 - accuracy: 0.6364
Epoch 442/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6288 - accuracy: 0.6364
```

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Epoch 443/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6287 - accuracy: 0.6364
Epoch 444/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6287 - accuracy: 0.6364
Epoch 445/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6286 - accuracy: 0.6364
Epoch 446/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6285 - accuracy: 0.6364
Epoch 447/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6285 - accuracy: 0.6364
Epoch 448/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6284 - accuracy: 0.6364
Epoch 449/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6283 - accuracy: 0.6364
Epoch 450/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6283 - accuracy: 0.6364
Epoch 451/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6282 - accuracy: 0.6364
Epoch 452/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6282 - accuracy: 0.6364
Epoch 453/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6281 - accuracy: 0.6364
Epoch 454/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6280 - accuracy: 0.6364
Epoch 455/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6280 - accuracy: 0.63
Epoch 456/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6279 - accuracy: 0.63
Epoch 457/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6278 - accuracy: 0.63
Epoch 458/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6278 - accuracy: 0.6364
Epoch 459/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6277 - accuracy: 0.6364
Epoch 460/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6277 - accuracy: 0.6364
Epoch 461/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6276 - accuracy: 0.6364
Epoch 462/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6275 - accuracy: 0.6364
Epoch 463/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6275 - accuracy: 0.6364
Epoch 464/5000
1/1 [==============================] - 0s 999us/step - loss: 0.6274 - accuracy: 0.636
Epoch 465/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6274 - accuracy: 0.6364
Epoch 466/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6273 - accuracy: 0.6364
Epoch 467/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6272 - accuracy: 0.6364
Epoch 468/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6272 - accuracy: 0.6364
Epoch 469/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6271 - accuracy: 0.6364
Epoch 470/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6271 - accuracy: 0.6364
Epoch 471/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6270 - accuracy: 0.6364
Epoch 472/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6269 - accuracy: 0.63
Epoch 473/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6269 - accuracy: 0.63
```

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1/1 [==============================] - 0s 1000us/step - loss: 0.6269 - accuracy: 0.63
Epoch 474/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6268 - accuracy: 0.6364
Epoch 475/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6268 - accuracy: 0.6364
Epoch 476/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6267 - accuracy: 0.6364
Epoch 477/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6267 - accuracy: 0.6364
Epoch 478/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6266 - accuracy: 0.6364
Epoch 479/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6265 - accuracy: 0.6364
Epoch 480/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6265 - accuracy: 0.6364
Epoch 481/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6264 - accuracy: 0.6364
Epoch 482/5000
1/1 [==============================] - 0s 504us/step - loss: 0.6264 - accuracy: 0.636
Epoch 483/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6263 - accuracy: 0.6364
Epoch 484/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6262 - accuracy: 0.6364
Epoch 485/5000
1/1 [==============================] - 0s 999us/step - loss: 0.6262 - accuracy: 0.636
Epoch 486/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6261 - accuracy: 0.6364
Epoch 487/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6261 - accuracy: 0.6364
Epoch 488/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6260 - accuracy: 0.6364
Epoch 489/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6260 - accuracy: 0.6364
Epoch 490/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6259 - accuracy: 0.6364
Epoch 491/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6259 - accuracy: 0.6364
Epoch 492/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6258 - accuracy: 0.6364
Epoch 493/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6257 - accuracy: 0.6364
Epoch 494/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6257 - accuracy: 0.6364
Epoch 495/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6256 - accuracy: 0.6364
Epoch 496/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6256 - accuracy: 0.6364
Epoch 497/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6255 - accuracy: 0.6364
Epoch 498/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6255 - accuracy: 0.6364
Epoch 499/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6254 - accuracy: 0.6364
Epoch 500/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6253 - accuracy: 0.6364
Epoch 501/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6253 - accuracy: 0.6364
Epoch 502/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6252 - accuracy: 0.6364
Epoch 503/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6252 - accuracy: 0.6364
Epoch 504/5000
```

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1/1 [==============================] - 0s 1000us/step - loss: 0.6251 - accuracy: 0.63
Epoch 505/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6251 - accuracy: 0.6364
Epoch 506/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6250 - accuracy: 0.6364
Epoch 507/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6250 - accuracy: 0.6364
Epoch 508/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6249 - accuracy: 0.6364
Epoch 509/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6249 - accuracy: 0.6364
Epoch 510/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6248 - accuracy: 0.6364
Epoch 511/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6247 - accuracy: 0.6364
Epoch 512/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6247 - accuracy: 0.6364
Epoch 513/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6246 - accuracy: 0.6364
Epoch 514/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6246 - accuracy: 0.6364
Epoch 515/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6245 - accuracy: 0.6364
Epoch 516/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6245 - accuracy: 0.6364
Epoch 517/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6244 - accuracy: 0.6364
Epoch 518/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6244 - accuracy: 0.6364
Epoch 519/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6243 - accuracy: 0.6818
Epoch 520/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6243 - accuracy: 0.6818
Epoch 521/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6242 - accuracy: 0.6818
Epoch 522/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6242 - accuracy: 0.6818
Epoch 523/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6241 - accuracy: 0.6818
Epoch 524/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6241 - accuracy: 0.6818
Epoch 525/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6240 - accuracy: 0.6818
Epoch 526/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6239 - accuracy: 0.6818
Epoch 527/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6239 - accuracy: 0.6818
Epoch 528/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6238 - accuracy: 0.6818
Epoch 529/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6238 - accuracy: 0.68
Epoch 530/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6237 - accuracy: 0.6818
Epoch 531/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6237 - accuracy: 0.6818
Epoch 532/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6236 - accuracy: 0.6818
Epoch 533/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6236 - accuracy: 0.6818
Epoch 534/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6235 - accuracy: 0.6818
```

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Epoch 535/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6235 - accuracy: 0.6818
Epoch 536/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6234 - accuracy: 0.6818
Epoch 537/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6234 - accuracy: 0.6818
Epoch 538/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6233 - accuracy: 0.6818
Epoch 539/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6233 - accuracy: 0.6818
Epoch 540/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6232 - accuracy: 0.6818
Epoch 541/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6232 - accuracy: 0.6818
Epoch 542/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6231 - accuracy: 0.6818
Epoch 543/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6231 - accuracy: 0.6818
Epoch 544/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6230 - accuracy: 0.6818
Epoch 545/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6230 - accuracy: 0.6818
Epoch 546/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6229 - accuracy: 0.6818
Epoch 547/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6229 - accuracy: 0.68
Epoch 548/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6228 - accuracy: 0.6818
Epoch 549/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6227 - accuracy: 0.6818
Epoch 550/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6227 - accuracy: 0.6818
Epoch 551/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6226 - accuracy: 0.6818
Epoch 552/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6226 - accuracy: 0.6818
Epoch 553/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6225 - accuracy: 0.6818
Epoch 554/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6225 - accuracy: 0.6818
Epoch 555/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6224 - accuracy: 0.6818
Epoch 556/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6224 - accuracy: 0.6818
Epoch 557/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6223 - accuracy: 0.6818
Epoch 558/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6223 - accuracy: 0.6818
Epoch 559/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6222 - accuracy: 0.6818
Epoch 560/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6222 - accuracy: 0.6818
Epoch 561/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6221 - accuracy: 0.6818
Epoch 562/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6221 - accuracy: 0.6818
Epoch 563/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6220 - accuracy: 0.6818
Epoch 564/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6220 - accuracy: 0.6818
Epoch 565/5000
```

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1/1 [==============================] - 0s 2ms/step - loss: 0.6219 - accuracy: 0.6818
Epoch 566/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6219 - accuracy: 0.6818
Epoch 567/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6218 - accuracy: 0.6818
Epoch 568/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6218 - accuracy: 0.6818
Epoch 569/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6217 - accuracy: 0.6818
Epoch 570/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6217 - accuracy: 0.6818
Epoch 571/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6216 - accuracy: 0.6818
Epoch 572/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6216 - accuracy: 0.6818
Epoch 573/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6215 - accuracy: 0.6818
Epoch 574/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6215 - accuracy: 0.6818
Epoch 575/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6214 - accuracy: 0.6818
Epoch 576/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6214 - accuracy: 0.6818
Epoch 577/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6213 - accuracy: 0.68
Epoch 578/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6213 - accuracy: 0.6818
Epoch 579/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6212 - accuracy: 0.6818
Epoch 580/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6212 - accuracy: 0.6818
Epoch 581/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6211 - accuracy: 0.6818
Epoch 582/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6211 - accuracy: 0.6818
Epoch 583/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6210 - accuracy: 0.6818
Epoch 584/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6210 - accuracy: 0.6818
Epoch 585/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6209 - accuracy: 0.6818
Epoch 586/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6209 - accuracy: 0.7273
Epoch 587/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6208 - accuracy: 0.7273
Epoch 588/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6208 - accuracy: 0.7273
Epoch 589/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6207 - accuracy: 0.7273
Epoch 590/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6207 - accuracy: 0.7273
Epoch 591/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6206 - accuracy: 0.7273
Epoch 592/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6206 - accuracy: 0.7273
Epoch 593/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6205 - accuracy: 0.7273
Epoch 594/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6205 - accuracy: 0.7273
Epoch 595/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6204 - accuracy: 0.7273
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Epoch 596/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6204 - accuracy: 0.7273
Epoch 597/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6203 - accuracy: 0.7273
Epoch 598/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6203 - accuracy: 0.7273
Epoch 599/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6202 - accuracy: 0.7273
Epoch 600/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6202 - accuracy: 0.7273
Epoch 601/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6201 - accuracy: 0.7273
Epoch 602/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6201 - accuracy: 0.7273
Epoch 603/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6200 - accuracy: 0.7273
Epoch 604/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6200 - accuracy: 0.7273
Epoch 605/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6200 - accuracy: 0.7273
Epoch 606/5000
1/1 [==============================] - 0s 999us/step - loss: 0.6199 - accuracy: 0.727
Epoch 607/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6199 - accuracy: 0.7273
Epoch 608/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6198 - accuracy: 0.7273
Epoch 609/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6198 - accuracy: 0.7273
Epoch 610/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6197 - accuracy: 0.7273
Epoch 611/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6197 - accuracy: 0.7273
Epoch 612/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6196 - accuracy: 0.7273
Epoch 613/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6196 - accuracy: 0.7273
Epoch 614/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6195 - accuracy: 0.7273
Epoch 615/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6195 - accuracy: 0.7273
Epoch 616/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6194 - accuracy: 0.7273
Epoch 617/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6194 - accuracy: 0.7273
Epoch 618/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6193 - accuracy: 0.7273
Epoch 619/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6193 - accuracy: 0.7273
Epoch 620/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6192 - accuracy: 0.7273
Epoch 621/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6192 - accuracy: 0.7273
Epoch 622/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6191 - accuracy: 0.7273
Epoch 623/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6191 - accuracy: 0.7273
Epoch 624/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6190 - accuracy: 0.7273
Epoch 625/5000
1/1 [==============================] - 0s 999us/step - loss: 0.6190 - accuracy: 0.727
Epoch 626/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6189 - accuracy: 0.7273
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1/1 [==============================] - 0s 2ms/step - loss: 0.6189 - accuracy: 0.7273
Epoch 627/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6189 - accuracy: 0.7273
Epoch 628/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6188 - accuracy: 0.7273
Epoch 629/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6188 - accuracy: 0.7273
Epoch 630/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6187 - accuracy: 0.7273
Epoch 631/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6187 - accuracy: 0.7273
Epoch 632/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6186 - accuracy: 0.7273
Epoch 633/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6186 - accuracy: 0.7273
Epoch 634/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6185 - accuracy: 0.7273
Epoch 635/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6185 - accuracy: 0.7273
Epoch 636/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6184 - accuracy: 0.7273
Epoch 637/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6184 - accuracy: 0.7273
Epoch 638/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6183 - accuracy: 0.7273
Epoch 639/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6183 - accuracy: 0.7273
Epoch 640/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6182 - accuracy: 0.7273
Epoch 641/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6182 - accuracy: 0.7273
Epoch 642/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6181 - accuracy: 0.7273
Epoch 643/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6181 - accuracy: 0.7273
Epoch 644/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6181 - accuracy: 0.7273
Epoch 645/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6180 - accuracy: 0.7273
Epoch 646/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6180 - accuracy: 0.7273
Epoch 647/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6179 - accuracy: 0.7273
Epoch 648/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6179 - accuracy: 0.7273
Epoch 649/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6178 - accuracy: 0.7273
Epoch 650/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6178 - accuracy: 0.7273
Epoch 651/5000
1/1 [==============================] - 0s 995us/step - loss: 0.6177 - accuracy: 0.727
Epoch 652/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6177 - accuracy: 0.7273
Epoch 653/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6176 - accuracy: 0.7273
Epoch 654/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6176 - accuracy: 0.7273
Epoch 655/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6175 - accuracy: 0.7273
Epoch 656/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6175 - accuracy: 0.7273
Epoch 657/5000
```

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Epoch 657/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6174 - accuracy: 0.7273
Epoch 658/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6174 - accuracy: 0.7273
Epoch 659/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6173 - accuracy: 0.72
Epoch 660/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6173 - accuracy: 0.7273
Epoch 661/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6172 - accuracy: 0.7273
Epoch 662/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6172 - accuracy: 0.7273
Epoch 663/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6171 - accuracy: 0.7273
Epoch 664/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6171 - accuracy: 0.7273
Epoch 665/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6170 - accuracy: 0.7273
Epoch 666/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6170 - accuracy: 0.7273
Epoch 667/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6169 - accuracy: 0.7273
Epoch 668/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6169 - accuracy: 0.7273
Epoch 669/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6168 - accuracy: 0.72
Epoch 670/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6168 - accuracy: 0.7273
Epoch 671/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6167 - accuracy: 0.7273
Epoch 672/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6167 - accuracy: 0.7273
Epoch 673/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6166 - accuracy: 0.7273
Epoch 674/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6166 - accuracy: 0.7273
Epoch 675/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6166 - accuracy: 0.7273
Epoch 676/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6165 - accuracy: 0.7273
Epoch 677/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6165 - accuracy: 0.7273
Epoch 678/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6164 - accuracy: 0.7273
Epoch 679/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6164 - accuracy: 0.7273
Epoch 680/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6163 - accuracy: 0.7273
Epoch 681/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6163 - accuracy: 0.7273
Epoch 682/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6162 - accuracy: 0.7273
Epoch 683/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6162 - accuracy: 0.7273
Epoch 684/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6161 - accuracy: 0.7273
Epoch 685/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6161 - accuracy: 0.7273
Epoch 686/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6160 - accuracy: 0.7273
Epoch 687/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6160 - accuracy: 0.7273
```

```
Epoch 688/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6159 - accuracy: 0.7273
Epoch 689/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6159 - accuracy: 0.7273
Epoch 690/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6158 - accuracy: 0.72
Epoch 691/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6158 - accuracy: 0.7273
Epoch 692/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6157 - accuracy: 0.7273
Epoch 693/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6157 - accuracy: 0.7273
Epoch 694/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6156 - accuracy: 0.7273
Epoch 695/5000
1/1 [==============================] - 0s 999us/step - loss: 0.6156 - accuracy: 0.727
Epoch 696/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6155 - accuracy: 0.7273
Epoch 697/5000
1/1 [==============================] - 0s 2ms/step - loss: 0.6155 - accuracy: 0.7273
Epoch 698/5000
1/1 [==============================] - 0s 4ms/step - loss: 0.6154 - accuracy: 0.7273
Epoch 699/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6154 - accuracy: 0.7273
Epoch 700/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6153 - accuracy: 0.7273
Epoch 701/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6153 - accuracy: 0.7273
Epoch 702/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6152 - accuracy: 0.7273
Epoch 703/5000
1/1 [==============================] - 0s 3ms/step - loss: 0.6152 - accuracy: 0.7273
Epoch 704/5000
1/1 [==============================] - 0s 1ms/step - loss: 0.6152 - accuracy: 0.7273
Epoch 705/5000
1/1 [==============================] - 0s 1000us/step - loss: 0.6151 - accuracy: 0.72
Epoch 706/5000
1/1 [==============================] - 0s 0s/step - loss: 0.6151 - accuracy: 0.7273
Epoch 707/5000
1/1 [==============================] - ETA: 0s - loss: 0.6150 - accuracy: 0.7273
```

Evaluate the model on test set

In [6]:
```
model.evaluate(X_test_scaled,y_test)
```

```
1/1 [==============================] - 0s 1ms/step - loss: 0.3550 - accuracy: 1.0000
```

Out[6]:
```
[0.35497748851776123, 1.0]
```

In [7]:
```
model.predict(X_test_scaled)
```

Out[7]:
```
array([[0.70548487],
       [0.3556955 ],
       [0.16827849],
       [0.47801173],
       [0.7260697 ],
       [0.8294984 ]], dtype=float32)
```

In [8]:
```
y_test
```

```
y_test
```

Out[8]:
```
2     1
10    0
21    0
11    0
14    1
9     1
Name: bought_insurance, dtype: int64
```

Now get the value of weights and bias from the model

In [9]:
```
coef, intercept = model.get_weights()
```

In [10]:
```
coef, intercept
```

Out[10]:
```
(array([[5.060867 ],
        [1.4086502]], dtype=float32),
 array([-2.9137027], dtype=float32))
```

This means w1=5.060867, w2=1.4086502, bias =-2.9137027

In [11]:
```
def sigmoid(x):
    import math
    return 1 / (1 + math.exp(-x))
sigmoid(18)
```

Out[11]:
```
0.9999999847700205
```

In [12]:
```
X_test
```

Out[12]:

	age	affordibility
2	47	1
10	18	1
21	26	0
11	28	1
14	49	1
9	61	1

Instead of model.predict, write our own prediction function that uses w1,w2 and bias

In [13]:
```
def prediction_function(age, affordibility):
    weighted_sum = coef[0]*age + coef[1]*affordibility + intercept
    return sigmoid(weighted_sum)

prediction_function(.47, 1)
```

Out[13]:
```
0.7054848693136117
```

In [14]:
```
prediction_function(.18, 1)
```

Out[14]: 0.35569549781937626

Now we start implementing gradient descent in plain python. Again the goal is to come up v computed these values internally using gradient descent

First write couple of helper routines such as sigmoid and log_loss

In [15]:
```
def sigmoid_numpy(X):
   return 1/(1+np.exp(-X))

sigmoid_numpy(np.array([12,0,1]))
```

Out[15]: array([0.99999386, 0.5 , 0.73105858])

In [16]:
```
def log_loss(y_true, y_predicted):
    epsilon = 1e-15
    y_predicted_new = [max(i,epsilon) for i in y_predicted]
    y_predicted_new = [min(i,1-epsilon) for i in y_predicted_new]
    y_predicted_new = np.array(y_predicted_new)
    return -np.mean(y_true*np.log(y_predicted_new)+(1-y_true)*np.log(1-y_predicted_n
```

All right now comes the time to implement our own custom neural network class !! yay !!!

In [22]:
```
class myNN:
    def __init__(self):
        self.w1 = 1
        self.w2 = 1
        self.bias = 0

    def fit(self, X, y, epochs, loss_thresold):
        self.w1, self.w2, self.bias = self.gradient_descent(X['age'],X['affordibilit
        print(f"Final weights and bias: w1: {self.w1}, w2: {self.w2}, bias: {self.bi

    def predict(self, X_test):
        weighted_sum = self.w1*X_test['age'] + self.w2*X_test['affordibility'] + sel
        return sigmoid_numpy(weighted_sum)

    def gradient_descent(self, age,affordability, y_true, epochs, loss_thresold):
        w1 = w2 = 1
        bias = 0
        rate = 0.5
        n = len(age)
        for i in range(epochs):
            weighted_sum = w1 * age + w2 * affordability + bias
            y_predicted = sigmoid_numpy(weighted_sum)
            loss = log_loss(y_true, y_predicted)

            w1d = (1/n)*np.dot(np.transpose(age),(y_predicted-y_true))
            w2d = (1/n)*np.dot(np.transpose(affordability),(y_predicted-y_true))

            bias_d = np.mean(y_predicted-y_true)
            w1 = w1 - rate * w1d
```

```
            w2 = w2 - rate * w2d
            bias = bias - rate * bias_d

            if i%50==0:
                print (f'Epoch:{i}, w1:{w1}, w2:{w2}, bias:{bias}, loss:{loss}')

            if loss<=loss_thresold:
                print (f'Epoch:{i}, w1:{w1}, w2:{w2}, bias:{bias}, loss:{loss}')
                break

        return w1, w2, bias
```

In [23]:
```
customModel = myNN()
customModel.fit(X_train_scaled, y_train, epochs=8000, loss_thresold=0.4631)
```

```
Epoch:0, w1:0.974907633470177, w2:0.948348125394529, bias:-0.11341867736368583, loss:
Epoch:50, w1:1.503319554173139, w2:1.108384790367645, bias:-1.2319047301235464, loss:
Epoch:100, w1:2.200713131760032, w2:1.2941584023238903, bias:-1.6607009122062801, los
Epoch:150, w1:2.8495727769689085, w2:1.3696895491572745, bias:-1.986105845859897, los
Epoch:200, w1:3.443016970881803, w2:1.4042218624465033, bias:-2.2571369883752723, los
Epoch:250, w1:3.982450494649576, w2:1.4239127329321233, bias:-2.494377365971801, loss
Epoch:300, w1:4.472179522095915, w2:1.438787986553552, bias:-2.707387811922373, loss:
Epoch:350, w1:4.917245868007634, w2:1.4525660781176122, bias:-2.901176333556766, loss
Epoch:366, w1:5.051047623653049, w2:1.4569794548473887, bias:-2.9596534546250037, los
Final weights and bias: w1: 5.051047623653049, w2: 1.4569794548473887, bias: -2.95965
```

In [47]:
```
coef, intercept
```

Out[47]:
```
(array([[5.060867 ],
        [1.4086502]], dtype=float32),
 array([-2.9137027], dtype=float32))
```

This shows that in the end we were able to come up with same value of w1,w2 and bias usin

In [24]:
```
X_test_scaled
```

Out[24]:

	age	affordibility
2	0.47	1
10	0.18	1
21	0.26	0
11	0.28	1
14	0.49	1
9	0.61	1

(1) Predict using custom model

In [25]:
```
customModel.predict(X_test_scaled)
```

Out[25]:
```
2     0.705020
10    0.355836
```

```
21    0.161599
11    0.477919
14    0.725586
9     0.828987
dtype: float64
```

(2) Predict using tensorflow model

In [26]:
```
model.predict(X_test_scaled)
```

Out[26]:
```
array([[0.70548487],
       [0.3556955 ],
       [0.16827849],
       [0.47801173],
       [0.7260697 ],
       [0.8294984 ]], dtype=float32)
```

Above you can compare predictions from our own custom model and tensoflow model. You