

Annual Income Classification

May 16, 2018

First, we want to fit the data with a logistic model.

```
In [1]: import numpy as np
import pandas as pd
import matplotlib
import matplotlib.pyplot as plt

In [3]: names = ['age', 'workclass', 'fnlwgt', 'education', 'education-num', 'marital-status', 'occupation', 'relationship', 'race', 'sex', 'capital-gain', 'capital-loss', 'hours-per-week', 'native-country', 'income']
df = pd.read_csv('adult_data.txt', header=None, delim_whitespace=True, names=names, na_val=0)
df_test = pd.read_csv('adult_test.txt', header=None, delim_whitespace=True, names=names, na_val=0)
df.dropna()
df_test.dropna()
df.head(6)
df_test.head(6)
```

```
Out[3]:
```

	age	workclass	fnlwgt	education	education-num	marital-status	occupation	relationship	race	sex	capital-gain	capital-loss	hours-per-week	native-country	income
0	25	Private	226802	11th	7	Never-married	Machine-op-inspct	Own-child	Black	Male	0	0	40	United-States	<=50K.
1	38	Private	89814	HS-grad	9	Married-civ-spouse	Farming-fishing	Husband	White	Male	0	0	50	United-States	<=50K.
2	28	Local-gov	336951	Assoc-acdm	12	Married-civ-spouse	Protective-serv	Husband	White	Male	0	0	40	United-States	>50K.
3	44	Private	160323	Some-college	10	Married-civ-spouse	Machine-op-inspct	Husband	Black	Male	7688	0	40	United-States	>50K.
4	18	NaN	103497	Some-college	10	Never-married	NaN	Own-child	White	Female	0	0	30	United-States	<=50K.
5	34	Private	198693	10th	6	Never-married	Other-service	Not-in-family	White	Male	0	0	30	United-States	<=50K.

```
In [4]: print(df.dtypes)
```

```
age                int64
workclass          object
fnlwgt            int64
education          object
education-num      int64
marital-status     object
occupation         object
relationship       object
race              object
sex               object
capital-gain       int64
capital-loss       int64
hours-per-week     int64
native-country     object
income            object
dtype: object
```

Some of the features are categorical, so we need to encode them with either one-hot coding or linear encoder.

```
In [5]: # One-hot coding
```

```
from sklearn.preprocessing import LabelEncoder
ohc_category = ['workclass', 'education', 'marital-status', 'occupation', 'relationship',
               , 'native-country']
le_category=['sex', 'income']
```

```
df_ohc_train = pd.get_dummies(df, columns=ohc_category)
df_ohc_test = pd.get_dummies(df_test, columns=ohc_category)
```

```
In [6]: # linear encoder
```

```
df_le_train = df_ohc_train.copy()
df_le_test = df_ohc_test.copy()
for item in le_category:
    df_le_train[item] = LabelEncoder().fit_transform(df_le_train[item]) #bug
    df_le_test[item] = LabelEncoder().fit_transform(df_le_test[item])
```

```
In [7]: # get training data and labels
```

```
X_train_df = df_le_train.drop(['income'], axis=1)
X_train = np.array(X_train_df)
y_train = np.array(df_le_train['income'])
```

```
# get test data and labels
```

```
X_test = np.array(df_le_test.drop(['income'], axis=1))
y_test = np.array(df_le_test['income'])
```

```
In [8]: print(X_train_df.dtypes)
```

```
X_train_df.head(6)
```

age	int64
fnlwgt	int64
education-num	int64
sex	int64
capital-gain	int64
capital-loss	int64
hours-per-week	int64
workclass_Federal-gov	uint8
workclass_Local-gov	uint8
workclass_Never-worked	uint8
workclass_Private	uint8
workclass_Self-emp-inc	uint8
workclass_Self-emp-not-inc	uint8
workclass_State-gov	uint8
workclass_Without-pay	uint8
education_10th	uint8
education_11th	uint8
education_12th	uint8
education_1st-4th	uint8
education_5th-6th	uint8
education_7th-8th	uint8
education_9th	uint8
education_Assoc-acdm	uint8
education_Assoc-voc	uint8
education_Bachelors	uint8
education_Doctorate	uint8
education_HS-grad	uint8
education_Masters	uint8
education_Preschool	uint8
education_Prof-school	uint8
	...
native-country_Germany	uint8
native-country_Greece	uint8
native-country_Guatemala	uint8
native-country_Haiti	uint8
native-country_Honduras	uint8
native-country_Hong	uint8
native-country_Hungary	uint8
native-country_India	uint8
native-country_Iran	uint8
native-country_Ireland	uint8
native-country_Italy	uint8
native-country_Jamaica	uint8
native-country_Japan	uint8
native-country_Laos	uint8
native-country_Mexico	uint8
native-country_Nicaragua	uint8
native-country_Outlying-US (Guam-USVI-etc)	uint8

```

native-country_Peru                uint8
native-country_Philippines         uint8
native-country_Poland              uint8
native-country_Portugal            uint8
native-country_Puerto-Rico         uint8
native-country_Scotland            uint8
native-country_South              uint8
native-country_Taiwan              uint8
native-country_Thailand            uint8
native-country_Trinidad&Tobago    uint8
native-country_United-States       uint8
native-country_Vietnam             uint8
native-country_Yugoslavia          uint8
Length: 103, dtype: object

```

```

Out[8]:   age  fnlwtg  education-num  sex  capital-gain  capital-loss  \
0    39   77516             13    1         2174           0
1    50   83311             13    1           0           0
2    38  215646              9    1           0           0
3    53  234721              7    1           0           0
4    28  338409             13    0           0           0
5    37  284582             14    0           0           0

      hours-per-week  workclass_Federal-gov  workclass_Local-gov  \
0                40                   0                0
1                13                   0                0
2                40                   0                0
3                40                   0                0
4                40                   0                0
5                40                   0                0

      workclass_Never-worked  ...  native-country_Portugal  \
0                0          ...                0
1                0          ...                0
2                0          ...                0
3                0          ...                0
4                0          ...                0
5                0          ...                0

      native-country_Puerto-Rico  native-country_Scotland  native-country_South  \
0                0                0                0
1                0                0                0
2                0                0                0
3                0                0                0
4                0                0                0
5                0                0                0

```

	native-country_Taiwan	native-country_Thailand	\
0	0	0	
1	0	0	
2	0	0	
3	0	0	
4	0	0	
5	0	0	

	native-country_Trinidad&Tobago	native-country_United-States	\
0	0	1	
1	0	1	
2	0	1	
3	0	1	
4	0	0	
5	0	1	

	native-country_Vietnam	native-country_Yugoslavia
0	0	0
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0

[6 rows x 103 columns]

We will train the model with all data in the trainin set and test the model with the test data.

```
In [9]: nsamples_tr = X_train.shape[0]
        nsamples_ts = X_test.shape[0]
        nfeatures = X_train.shape[1]

        print('Number of samples for training = %d' % nsamples_tr)
        print('Number of samples for test = %d' % nsamples_ts)
        print('Number of features = %d' % nfeatures)
```

Number of samples for training = 32560

Number of samples for test = 16281

Number of features = 103

```
In [14]: # data normalization
        Xtr_mean = np.mean(X_train,axis=0)
        Xtr_std = np.std(X_train,axis=0)
        Xtr_s = (X_train-Xtr_mean)/Xtr_std[None,:]
        Xts_s = (X_test-Xtr_mean[None,:])/Xtr_std[None,:]
```

We also want to select a best order for this logistic model. So we decide to transform the numerous features to higher orders and compare accuracy. We didn't transform those OHC features since they are binary.

```
In [13]: # num_category stores features that are continuous
num_category = ['age', 'fnlwgt', 'education-num', 'capital-gain', 'capital-loss', 'hours-p

# get columns index of num_category
ind_num = np.zeros((1,6))
for ind,item in enumerate(num_category):
    ind_num[0,ind] = int(X_train_df.columns.get_loc(item))

print(ind_num)

[[0. 1. 2. 4. 5. 6.]]
```

```
In [15]: # extract columns
Xtr_num = np.zeros((nsamples_tr,6))
Xts_num = np.zeros((nsamples_ts,6))

for i,ind in enumerate(ind_num[0]):
    ind = int(ind)
    Xtr_num[:,i] = Xtr_s[:,ind]
    Xts_num[:, i] = Xts_s[:, ind]
```

Regarding order of transformed features, we will use order 2 to 10. For each of the new training set, a higher order will be included. For example, the original data set only includes the features in num_category of 1st order. The data set with 2nd order includes the features in num_category of both 1st and 2nd order. The data set with 3rd order includes the features of 1st, 2nd and 3rd order. The highest order will have features of 1st to 10th order.

This processing step is done to both training data and test data. Transformed features are stored in add_Xtr and add_Xts.

```
In [16]: # transform features with continuous values
# to different orders
add_Xtr = np.zeros((nsamples_tr,54))
add_Xts = np.zeros((nsamples_ts,54))
order_v = [2,3,4,5,6,7,8,9,10]
for i,order in enumerate(order_v):
    Xtri = Xtr_num**i
    add_Xtr[:,(i*6):(i*6+6)] = Xtri

    Xtsi = Xts_num ** i
    add_Xts[:, (i * 6):(i * 6 + 6)] = Xtsi
```

```
In [17]: # create model
from sklearn import linear_model
acc = np.zeros((10,2))
logreg = linear_model.LogisticRegression(C=1e5)
logreg.fit(Xtr_s,y_train)

yhat_tr = logreg.predict(Xtr_s)
```

```

acc_tr = np.mean(yhat_tr == y_train)
print("Accuracy of the classifier on training data = %f" % acc_tr)

yhat_ts = logreg.predict(Xts_s)
acc_ts = np.mean(yhat_ts == y_test)
print("Accuracy of the classifier on test data = %f" % acc_ts)

acc[0,:]=[acc_tr,acc_ts]

```

Accuracy of the classifier on training data = 0.853317
Accuracy of the classifier on test data = 0.852589

This is the accuracy for the original data. Then we train our model with higher order of numerous features in num_category and test its accuracy.

```

In [18]: # add transformed features of different order to training data
for ind,order in enumerate(order_v):
    addXtr = add_Xtr[:,:(ind*6+6)]
    addXts = add_Xts[:, :(ind * 6 + 6)]
    Xtr_i = np.hstack((Xtr_s,addXtr))
    Xts_i = np.hstack((Xts_s, addXts))
    logregi = linear_model.LogisticRegression(C=1e5)
    logregi.fit(Xtr_i, y_train)

    yhati_tr = logregi.predict(Xtr_i)
    acci_tr = np.mean(yhati_tr == y_train)
    acc[ind+1,0] = acci_tr

    yhati_ts = logregi.predict(Xts_i)
    acci_ts = np.mean(yhati_ts == y_test)
    acc[ind + 1, 1] = acci_ts

```

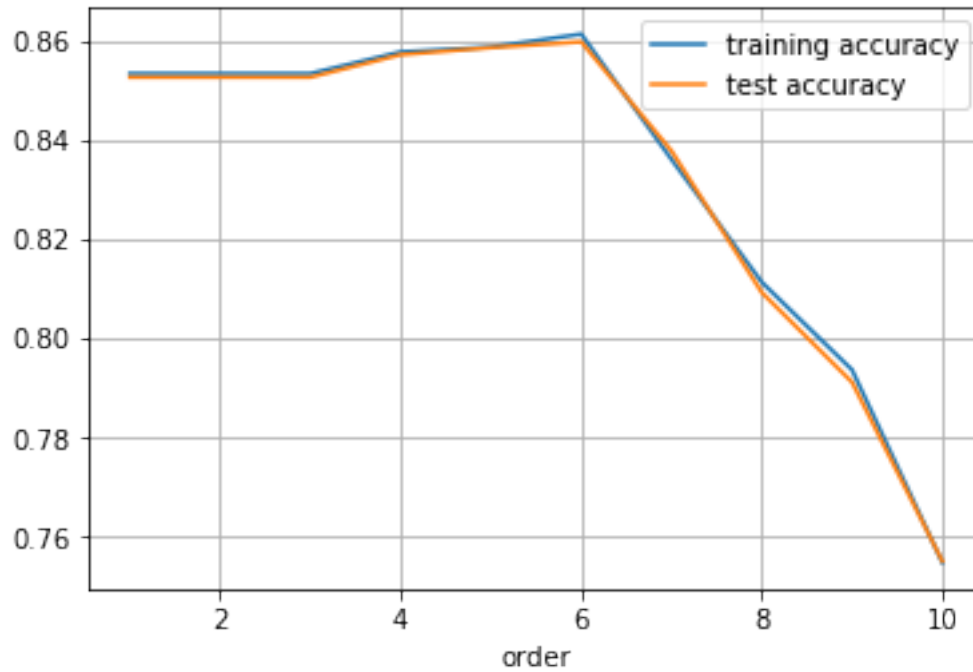
Then we plot accuracy vs. order of numerous features to see the performance of model using different order of features.

```

In [19]: # plot accuracy vs order
x_v = [1,2,3,4,5,6,7,8,9,10]
plt.plot(x_v,acc[:,0])
plt.plot(x_v,acc[:,1])
plt.xlabel('order')
plt.legend(['training accuracy','test accuracy'])
plt.grid()
plt.show()

print(acc)

```



```
[[0.85331695 0.85258891]
 [0.85331695 0.85258891]
 [0.85331695 0.85258891]
 [0.85767813 0.85713408]
 [0.85866093 0.85854677]
 [0.8612715  0.85971378]
 [0.8360258  0.83772496]
 [0.81130221 0.80922548]
 [0.79364251 0.79116762]
 [0.75485258 0.75511332]]
```

As we can see, the highest accuracy is achieved at order of 6 and decreases as the order increases. There is probably overfitting when order is too high.

SVM on annual income classification

May 16, 2018

```
In [1]: import numpy as np
import pandas as pd
import matplotlib
import matplotlib.pyplot as plt
%matplotlib inline

In [2]: names = ['age', 'workclass', 'fnlwgt', 'education', 'education-num', 'marital-status', 'o',
'capital-gain', 'capital-loss', 'hours-per-week', 'native-country', 'income']
df_train = pd.read_csv('adult.data.txt', index_col=False, delim_whitespace=True, names=names)
df_test = pd.read_csv('adult_test.txt', index_col=False, delim_whitespace=True, names=names)
df_train.dropna()
df_test.dropna()
```

```
Out[2]:
```

	age	workclass	fnlwgt	education	education-num	\
0	25	Private	226802	11th	7	
1	38	Private	89814	HS-grad	9	
2	28	Local-gov	336951	Assoc-acdm	12	
3	44	Private	160323	Some-college	10	
5	34	Private	198693	10th	6	
7	63	Self-emp-not-inc	104626	Prof-school	15	
8	24	Private	369667	Some-college	10	
9	55	Private	104996	7th-8th	4	
10	65	Private	184454	HS-grad	9	
11	36	Federal-gov	212465	Bachelors	13	
12	26	Private	82091	HS-grad	9	
14	48	Private	279724	HS-grad	9	
15	43	Private	346189	Masters	14	
16	20	State-gov	444554	Some-college	10	
17	43	Private	128354	HS-grad	9	
18	37	Private	60548	HS-grad	9	
20	34	Private	107914	Bachelors	13	
21	34	Private	238588	Some-college	10	
23	25	Private	220931	Bachelors	13	
24	25	Private	205947	Bachelors	13	
25	45	Self-emp-not-inc	432824	HS-grad	9	
26	22	Private	236427	HS-grad	9	
27	23	Private	134446	HS-grad	9	
28	54	Private	99516	HS-grad	9	

29	32	Self-emp-not-inc	109282	Some-college	10
30	46	State-gov	106444	Some-college	10
31	56	Self-emp-not-inc	186651	11th	7
32	24	Self-emp-not-inc	188274	Bachelors	13
33	23	Local-gov	258120	Some-college	10
34	26	Private	43311	HS-grad	9
...
16248	25	Private	242136	HS-grad	9
16249	31	Private	112115	HS-grad	9
16250	49	Self-emp-inc	77132	HS-grad	9
16252	60	Private	117909	Assoc-voc	11
16253	39	Private	229647	Bachelors	13
16254	38	Private	149347	Masters	14
16255	43	Local-gov	23157	Masters	14
16256	23	Private	93977	HS-grad	9
16257	73	Self-emp-inc	159691	Some-college	10
16258	35	Private	176967	Some-college	10
16259	66	Private	344436	HS-grad	9
16260	27	Private	430340	Some-college	10
16261	40	Private	202168	Prof-school	15
16262	51	Private	82720	HS-grad	9
16263	22	Private	269623	Some-college	10
16264	64	Self-emp-not-inc	136405	HS-grad	9
16266	55	Private	224655	HS-grad	9
16267	38	Private	247547	Assoc-voc	11
16268	58	Private	292710	Assoc-acdm	12
16269	32	Private	173449	HS-grad	9
16270	48	Private	285570	HS-grad	9
16271	61	Private	89686	HS-grad	9
16272	31	Private	440129	HS-grad	9
16273	25	Private	350977	HS-grad	9
16274	48	Local-gov	349230	Masters	14
16275	33	Private	245211	Bachelors	13
16276	39	Private	215419	Bachelors	13
16278	38	Private	374983	Bachelors	13
16279	44	Private	83891	Bachelors	13
16280	35	Self-emp-inc	182148	Bachelors	13

	marital-status	occupation	relationship \
0	Never-married	Machine-op-inspct	Own-child
1	Married-civ-spouse	Farming-fishing	Husband
2	Married-civ-spouse	Protective-serv	Husband
3	Married-civ-spouse	Machine-op-inspct	Husband
5	Never-married	Other-service	Not-in-family
7	Married-civ-spouse	Prof-specialty	Husband
8	Never-married	Other-service	Unmarried
9	Married-civ-spouse	Craft-repair	Husband
10	Married-civ-spouse	Machine-op-inspct	Husband

11	Married-civ-spouse	Adm-clerical	Husband
12	Never-married	Adm-clerical	Not-in-family
14	Married-civ-spouse	Machine-op-inspct	Husband
15	Married-civ-spouse	Exec-managerial	Husband
16	Never-married	Other-service	Own-child
17	Married-civ-spouse	Adm-clerical	Wife
18	Widowed	Machine-op-inspct	Unmarried
20	Married-civ-spouse	Tech-support	Husband
21	Never-married	Other-service	Own-child
23	Never-married	Prof-specialty	Not-in-family
24	Married-civ-spouse	Prof-specialty	Husband
25	Married-civ-spouse	Craft-repair	Husband
26	Never-married	Adm-clerical	Own-child
27	Separated	Machine-op-inspct	Unmarried
28	Married-civ-spouse	Craft-repair	Husband
29	Never-married	Prof-specialty	Not-in-family
30	Married-civ-spouse	Exec-managerial	Husband
31	Widowed	Other-service	Unmarried
32	Never-married	Sales	Not-in-family
33	Married-civ-spouse	Protective-serv	Husband
34	Divorced	Exec-managerial	Unmarried
...
16248	Divorced	Machine-op-inspct	Not-in-family
16249	Never-married	Machine-op-inspct	Not-in-family
16250	Married-civ-spouse	Exec-managerial	Husband
16252	Married-civ-spouse	Prof-specialty	Husband
16253	Never-married	Tech-support	Not-in-family
16254	Married-civ-spouse	Prof-specialty	Husband
16255	Married-civ-spouse	Exec-managerial	Husband
16256	Never-married	Machine-op-inspct	Own-child
16257	Divorced	Exec-managerial	Not-in-family
16258	Married-civ-spouse	Protective-serv	Husband
16259	Widowed	Sales	Other-relative
16260	Never-married	Sales	Not-in-family
16261	Married-civ-spouse	Prof-specialty	Husband
16262	Married-civ-spouse	Craft-repair	Husband
16263	Never-married	Craft-repair	Own-child
16264	Widowed	Farming-fishing	Not-in-family
16266	Separated	Priv-house-serv	Not-in-family
16267	Never-married	Adm-clerical	Unmarried
16268	Divorced	Prof-specialty	Not-in-family
16269	Married-civ-spouse	Handlers-cleaners	Husband
16270	Married-civ-spouse	Adm-clerical	Husband
16271	Married-civ-spouse	Sales	Husband
16272	Married-civ-spouse	Craft-repair	Husband
16273	Never-married	Other-service	Own-child
16274	Divorced	Other-service	Not-in-family
16275	Never-married	Prof-specialty	Own-child

16276	Divorced	Prof-specialty	Not-in-family
16278	Married-civ-spouse	Prof-specialty	Husband
16279	Divorced	Adm-clerical	Own-child
16280	Married-civ-spouse	Exec-managerial	Husband

	race	sex	capital-gain	capital-loss	hours-per-week	\
0	Black	Male	0	0	40	
1	White	Male	0	0	50	
2	White	Male	0	0	40	
3	Black	Male	7688	0	40	
5	White	Male	0	0	30	
7	White	Male	3103	0	32	
8	White	Female	0	0	40	
9	White	Male	0	0	10	
10	White	Male	6418	0	40	
11	White	Male	0	0	40	
12	White	Female	0	0	39	
14	White	Male	3103	0	48	
15	White	Male	0	0	50	
16	White	Male	0	0	25	
17	White	Female	0	0	30	
18	White	Female	0	0	20	
20	White	Male	0	0	47	
21	Black	Female	0	0	35	
23	White	Male	0	0	43	
24	White	Male	0	0	40	
25	White	Male	7298	0	90	
26	White	Male	0	0	20	
27	Black	Male	0	0	54	
28	White	Male	0	0	35	
29	White	Male	0	0	60	
30	Black	Male	7688	0	38	
31	White	Female	0	0	50	
32	White	Male	0	0	50	
33	White	Male	0	0	40	
34	White	Female	0	0	40	
...	
16248	Black	Male	0	0	40	
16249	White	Male	0	0	40	
16250	White	Male	0	0	40	
16252	White	Male	7688	0	40	
16253	White	Female	0	1669	40	
16254	White	Male	0	0	50	
16255	White	Male	0	1902	50	
16256	White	Male	0	0	40	
16257	White	Female	0	0	40	
16258	White	Male	0	0	40	
16259	White	Female	0	0	8	

16260	White	Female	0	0	45
16261	White	Male	15024	0	55
16262	White	Male	0	0	40
16263	White	Male	0	0	40
16264	White	Male	0	0	32
16266	White	Female	0	0	32
16267	Black	Female	0	0	40
16268	White	Male	0	0	36
16269	White	Male	0	0	40
16270	White	Male	0	0	40
16271	White	Male	0	0	48
16272	White	Male	0	0	40
16273	White	Female	0	0	40
16274	White	Male	0	0	40
16275	White	Male	0	0	40
16276	White	Female	0	0	36
16278	White	Male	0	0	50
16279	Asian-Pac-Islander	Male	5455	0	40
16280	White	Male	0	0	60

	native-country	income
0	United-States	<=50K.
1	United-States	<=50K.
2	United-States	>50K.
3	United-States	>50K.
5	United-States	<=50K.
7	United-States	>50K.
8	United-States	<=50K.
9	United-States	<=50K.
10	United-States	>50K.
11	United-States	<=50K.
12	United-States	<=50K.
14	United-States	>50K.
15	United-States	>50K.
16	United-States	<=50K.
17	United-States	<=50K.
18	United-States	<=50K.
20	United-States	>50K.
21	United-States	<=50K.
23	Peru	<=50K.
24	United-States	<=50K.
25	United-States	>50K.
26	United-States	<=50K.
27	United-States	<=50K.
28	United-States	<=50K.
29	United-States	<=50K.
30	United-States	>50K.
31	United-States	<=50K.

```

32    United-States  <=50K.
33    United-States  <=50K.
34    United-States  <=50K.
...
16248 United-States  <=50K.
16249 United-States  <=50K.
16250      Canada    >50K.
16252 United-States  >50K.
16253 United-States  <=50K.
16254 United-States  >50K.
16255 United-States  >50K.
16256 United-States  <=50K.
16257 United-States  <=50K.
16258 United-States  <=50K.
16259 United-States  <=50K.
16260 United-States  <=50K.
16261 United-States  >50K.
16262 United-States  <=50K.
16263 United-States  <=50K.
16264 United-States  <=50K.
16266 United-States  <=50K.
16267 United-States  <=50K.
16268 United-States  <=50K.
16269 United-States  <=50K.
16270 United-States  <=50K.
16271 United-States  <=50K.
16272 United-States  <=50K.
16273 United-States  <=50K.
16274 United-States  <=50K.
16275 United-States  <=50K.
16276 United-States  <=50K.
16278 United-States  <=50K.
16279 United-States  <=50K.
16280 United-States  >50K.

```

```
[15060 rows x 15 columns]
```

```

In [3]: from sklearn.preprocessing import LabelEncoder
        # Hint: Now use a for loop over the elements in `le_category` and update df_le #TODO
        encoder = LabelEncoder()

        ohc_category = ['workclass', 'relationship'
                        , 'native-country', 'occupation']
        le_category=['sex', 'income', 'education', 'race', 'marital-status']

        df_ohc_train = pd.get_dummies(df_train, columns=ohc_category)
        df_ohc_test = pd.get_dummies(df_test, columns=ohc_category)

```

```

df_le_train = df_ohc_train.copy()
df_le_test = df_ohc_test.copy()
for i in range(len(le_category)):
    df_le_train[le_category[i]] =encoder.fit_transform(df_le_train[le_category[i]])
    df_le_test[le_category[i]] =encoder.fit_transform(df_le_test[le_category[i]])

df_le_test.head(6)

```

```

Out[3]:
   age  fnlwgt  education  education-num  marital-status  race  sex  \
0    25  226802         1             7             4     2    1
1    38   89814        11             9             2     4    1
2    28  336951         7            12             2     4    1
3    44  160323        15            10             2     2    1
4    18  103497        15            10             4     4    0
5    34  198693         0             6             4     4    1

   capital-gain  capital-loss  hours-per-week  ...  \
0             0             0             40    ...
1             0             0             50    ...
2             0             0             40    ...
3          7688             0             40    ...
4             0             0             30    ...
5             0             0             30    ...

   occupation_Farming-fishing  occupation_Handlers-cleaners  \
0                             0                             0
1                             1                             0
2                             0                             0
3                             0                             0
4                             0                             0
5                             0                             0

   occupation_Machine-op-inspct  occupation_Other-service  \
0                             1                             0
1                             0                             0
2                             0                             0
3                             1                             0
4                             0                             0
5                             0                             1

   occupation_Priv-house-serv  occupation_Prof-specialty  \
0                             0                             0
1                             0                             0
2                             0                             0
3                             0                             0
4                             0                             0
5                             0                             0

```

	occupation_Protective-serv	occupation_Sales	occupation_Tech-support \
0	0	0	0
1	0	0	0
2	1	0	0
3	0	0	0
4	0	0	0
5	0	0	0

	occupation_Transport-moving
0	0
1	0
2	0
3	0
4	0
5	0

[6 rows x 79 columns]

```
In [4]: X_df_train = np.array(df_le_train.drop(['income'],axis=1))
y_train = np.array(df_le_train['income'])
X_df_test = np.array(df_le_test.drop(['income'],axis=1))
y_test = np.array(df_le_test['income'])
```

```
nsamples,nfeatures=X_df_train.shape
print (' number of Train samples:{0} and number of features :{1}'.format(nsamples,nfeatures))
nsamples,nfeatures=X_df_test.shape
print (' number of Test samples:{0} and number of features :{1}'.format(nsamples,nfeatures))
```

```
number of Train samples:32560 and number of features :78
number of Test samples:16281 and number of features :78
```

```
In [5]: Xtr_mean = np.mean(X_df_train,axis=0)
Xtr_std = np.std(X_df_train,axis=0)
Xtr_scale = (X_df_train-Xtr_mean)/Xtr_std[None,:]
Xts_scale = (X_df_test-Xtr_mean[None,:])/Xtr_std[None,:]
```

```
In [6]: from sklearn import svm
C_test= [0.1,0.5,1]
gam_test = [0.005,0.01,0.05,0.1]
nC = len(C_test)
ngam = len(gam_test)
acc = np.zeros((nC,ngam))
for i,c in enumerate(C_test):
    for j,g in enumerate(gam_test):
        svc = svm.SVC(probability=False, kernel="rbf", C=c, gamma=g,verbose=11)
        svc.fit(Xtr_scale,y_train)
```



```

        yhat_ts = svc.predict(Xts_scale)
        acc[i,j]=np.mean(yhat_ts == y_test)

[LibSVM] [LibSVM] [LibSVM] [LibSVM] [LibSVM] [LibSVM] [LibSVM] [LibSVM] [LibSVM] [LibSVM] [LibSVM] [LibSVM]

In [7]: print(acc)

[[0.84343714 0.84503409 0.8381549  0.82740618]
 [0.85123764 0.8522818  0.84613967 0.84024323]
 [0.85412444 0.85510718 0.84810515 0.84294577]]

In [9]: position=np.argmax(acc)
        m, n = divmod(position, 4)
        print('greatest accuracy using RBF is',acc[m,n])
        print('optimal C is',C_test[m])
        print('optimal gamma is',gam_test[n])

greatest accuracy is 0.8551071801486395
optimal C is 1
optimal gamma is 0.01

In [11]: for i,c in enumerate(C_test):
        for j,g in enumerate(gam_test):
            svc = svm.SVC(probability=False, kernel="sigmoid", C=c, gamma=g,verbose=11)
            svc.fit(Xtr_scale,y_train)
            yhat_ts = svc.predict(Xts_scale)
            acc[i,j]=np.mean(yhat_ts == y_test)

[LibSVM] [LibSVM] [LibSVM] [LibSVM] [LibSVM] [LibSVM] [LibSVM] [LibSVM] [LibSVM] [LibSVM] [LibSVM] [LibSVM]

In [12]: print(acc)

[[0.84626251 0.84847368 0.78342854 0.76303667]
 [0.85191327 0.84681531 0.77808488 0.77747067]
 [0.85166759 0.8352681  0.77857625 0.77089859]]

In [13]: position=np.argmax(acc)
        m, n = divmod(position, 4)
        print('greatest accuracy using sigmoid is',acc[m,n])
        print('optimal C is',C_test[m])
        print('optimal gamma is',gam_test[n])

greatest accuracy using sigmoid is 0.8519132731404705
optimal C is 0.5
optimal gamma is 0.005

```

In []: The SVM using RBF kernel, C=1, gamma=0.01 yields highest accuracy.

```
In [14]: svc = svm.SVC(probability=False, kernel="rbf", C=1, gamma=0.01, verbose=11)
svc.fit(Xtr_scale, y_train)
yhat_ts = svc.predict(Xts_scale)
acc1= np.mean(yhat_ts == y_test)
print('Accuaracy = {0:f}%'.format(100*acc1))
l=0
m=0
n=0
for i in range(y_test.shape[0]):
    if y_test[i]==0:
        l+=1
        if yhat_ts[i]==1:
            m+=1
print('{0:f}% of the people earn less than 50ks are classified as those earn more than 50ks'.format(l/(l+m)))
print('{0:d} people earn less than 50ks in total in test data'.format(l))
l=0
for i in range(y_test.shape[0]):
    if y_test[i]==1:
        l+=1
        if yhat_ts[i]==0:
            n+=1
print('{0:f}% of the people earn more than 50ks are classified as those earn less than 50ks'.format(l/(l+n)))
print('{0:d} people earn more than 50ks in total in test data'.format(l))
```

[LibSVM]Accuaracy = 85.510718%

6.151990% of the people earn less than 50ks are classified as those earn more than 50ks

12435 people earn less than 50ks in total in test data

41.445658% of the people earn more than 50ks are classified as those earn less than 50ks

3846 people earn more than 50ks in total in test data

NN_classification

May 16, 2018

```
In [1]: import numpy as np
import pandas as pd
import matplotlib
import matplotlib.pyplot as plt
%matplotlib inline
```

First, we want to fit the data with a logistic model.

```
In [2]: names = ['age', 'workclass', 'fnlwgt', 'education', 'education-num', 'marital-status', 'o',
'capital-gain', 'capital-loss', 'hours-per-week', 'native-country', 'income']
df_train = pd.read_csv('adult.data.txt', index_col=False, delim_whitespace=True, names=names)
df_test = pd.read_csv('adult.test.txt', index_col=False, delim_whitespace=True, names=names)
df_train.dropna()
df_test.dropna()
```

```
Out[2]:
```

	age	workclass	fnlwgt	education	education-num	\
0	25	Private	226802	11th	7	
1	38	Private	89814	HS-grad	9	
2	28	Local-gov	336951	Assoc-acdm	12	
3	44	Private	160323	Some-college	10	
5	34	Private	198693	10th	6	
7	63	Self-emp-not-inc	104626	Prof-school	15	
8	24	Private	369667	Some-college	10	
9	55	Private	104996	7th-8th	4	
10	65	Private	184454	HS-grad	9	
11	36	Federal-gov	212465	Bachelors	13	
12	26	Private	82091	HS-grad	9	
14	48	Private	279724	HS-grad	9	
15	43	Private	346189	Masters	14	
16	20	State-gov	444554	Some-college	10	
17	43	Private	128354	HS-grad	9	
18	37	Private	60548	HS-grad	9	
20	34	Private	107914	Bachelors	13	
21	34	Private	238588	Some-college	10	
23	25	Private	220931	Bachelors	13	
24	25	Private	205947	Bachelors	13	
25	45	Self-emp-not-inc	432824	HS-grad	9	
26	22	Private	236427	HS-grad	9	

27	23	Private	134446	HS-grad	9
28	54	Private	99516	HS-grad	9
29	32	Self-emp-not-inc	109282	Some-college	10
30	46	State-gov	106444	Some-college	10
31	56	Self-emp-not-inc	186651	11th	7
32	24	Self-emp-not-inc	188274	Bachelors	13
33	23	Local-gov	258120	Some-college	10
34	26	Private	43311	HS-grad	9
...
16248	25	Private	242136	HS-grad	9
16249	31	Private	112115	HS-grad	9
16250	49	Self-emp-inc	77132	HS-grad	9
16252	60	Private	117909	Assoc-voc	11
16253	39	Private	229647	Bachelors	13
16254	38	Private	149347	Masters	14
16255	43	Local-gov	23157	Masters	14
16256	23	Private	93977	HS-grad	9
16257	73	Self-emp-inc	159691	Some-college	10
16258	35	Private	176967	Some-college	10
16259	66	Private	344436	HS-grad	9
16260	27	Private	430340	Some-college	10
16261	40	Private	202168	Prof-school	15
16262	51	Private	82720	HS-grad	9
16263	22	Private	269623	Some-college	10
16264	64	Self-emp-not-inc	136405	HS-grad	9
16266	55	Private	224655	HS-grad	9
16267	38	Private	247547	Assoc-voc	11
16268	58	Private	292710	Assoc-acdm	12
16269	32	Private	173449	HS-grad	9
16270	48	Private	285570	HS-grad	9
16271	61	Private	89686	HS-grad	9
16272	31	Private	440129	HS-grad	9
16273	25	Private	350977	HS-grad	9
16274	48	Local-gov	349230	Masters	14
16275	33	Private	245211	Bachelors	13
16276	39	Private	215419	Bachelors	13
16278	38	Private	374983	Bachelors	13
16279	44	Private	83891	Bachelors	13
16280	35	Self-emp-inc	182148	Bachelors	13

	marital-status	occupation	relationship \
0	Never-married	Machine-op-inspct	Own-child
1	Married-civ-spouse	Farming-fishing	Husband
2	Married-civ-spouse	Protective-serv	Husband
3	Married-civ-spouse	Machine-op-inspct	Husband
5	Never-married	Other-service	Not-in-family
7	Married-civ-spouse	Prof-specialty	Husband
8	Never-married	Other-service	Unmarried

9	Married-civ-spouse	Craft-repair	Husband
10	Married-civ-spouse	Machine-op-inspct	Husband
11	Married-civ-spouse	Adm-clerical	Husband
12	Never-married	Adm-clerical	Not-in-family
14	Married-civ-spouse	Machine-op-inspct	Husband
15	Married-civ-spouse	Exec-managerial	Husband
16	Never-married	Other-service	Own-child
17	Married-civ-spouse	Adm-clerical	Wife
18	Widowed	Machine-op-inspct	Unmarried
20	Married-civ-spouse	Tech-support	Husband
21	Never-married	Other-service	Own-child
23	Never-married	Prof-specialty	Not-in-family
24	Married-civ-spouse	Prof-specialty	Husband
25	Married-civ-spouse	Craft-repair	Husband
26	Never-married	Adm-clerical	Own-child
27	Separated	Machine-op-inspct	Unmarried
28	Married-civ-spouse	Craft-repair	Husband
29	Never-married	Prof-specialty	Not-in-family
30	Married-civ-spouse	Exec-managerial	Husband
31	Widowed	Other-service	Unmarried
32	Never-married	Sales	Not-in-family
33	Married-civ-spouse	Protective-serv	Husband
34	Divorced	Exec-managerial	Unmarried
...
16248	Divorced	Machine-op-inspct	Not-in-family
16249	Never-married	Machine-op-inspct	Not-in-family
16250	Married-civ-spouse	Exec-managerial	Husband
16252	Married-civ-spouse	Prof-specialty	Husband
16253	Never-married	Tech-support	Not-in-family
16254	Married-civ-spouse	Prof-specialty	Husband
16255	Married-civ-spouse	Exec-managerial	Husband
16256	Never-married	Machine-op-inspct	Own-child
16257	Divorced	Exec-managerial	Not-in-family
16258	Married-civ-spouse	Protective-serv	Husband
16259	Widowed	Sales	Other-relative
16260	Never-married	Sales	Not-in-family
16261	Married-civ-spouse	Prof-specialty	Husband
16262	Married-civ-spouse	Craft-repair	Husband
16263	Never-married	Craft-repair	Own-child
16264	Widowed	Farming-fishing	Not-in-family
16266	Separated	Priv-house-serv	Not-in-family
16267	Never-married	Adm-clerical	Unmarried
16268	Divorced	Prof-specialty	Not-in-family
16269	Married-civ-spouse	Handlers-cleaners	Husband
16270	Married-civ-spouse	Adm-clerical	Husband
16271	Married-civ-spouse	Sales	Husband
16272	Married-civ-spouse	Craft-repair	Husband
16273	Never-married	Other-service	Own-child

16274	Divorced	Other-service	Not-in-family
16275	Never-married	Prof-specialty	Own-child
16276	Divorced	Prof-specialty	Not-in-family
16278	Married-civ-spouse	Prof-specialty	Husband
16279	Divorced	Adm-clerical	Own-child
16280	Married-civ-spouse	Exec-managerial	Husband

	race	sex	capital-gain	capital-loss	hours-per-week	\
0	Black	Male	0	0	40	
1	White	Male	0	0	50	
2	White	Male	0	0	40	
3	Black	Male	7688	0	40	
5	White	Male	0	0	30	
7	White	Male	3103	0	32	
8	White	Female	0	0	40	
9	White	Male	0	0	10	
10	White	Male	6418	0	40	
11	White	Male	0	0	40	
12	White	Female	0	0	39	
14	White	Male	3103	0	48	
15	White	Male	0	0	50	
16	White	Male	0	0	25	
17	White	Female	0	0	30	
18	White	Female	0	0	20	
20	White	Male	0	0	47	
21	Black	Female	0	0	35	
23	White	Male	0	0	43	
24	White	Male	0	0	40	
25	White	Male	7298	0	90	
26	White	Male	0	0	20	
27	Black	Male	0	0	54	
28	White	Male	0	0	35	
29	White	Male	0	0	60	
30	Black	Male	7688	0	38	
31	White	Female	0	0	50	
32	White	Male	0	0	50	
33	White	Male	0	0	40	
34	White	Female	0	0	40	
...	
16248	Black	Male	0	0	40	
16249	White	Male	0	0	40	
16250	White	Male	0	0	40	
16252	White	Male	7688	0	40	
16253	White	Female	0	1669	40	
16254	White	Male	0	0	50	
16255	White	Male	0	1902	50	
16256	White	Male	0	0	40	
16257	White	Female	0	0	40	

16258	White	Male	0	0	40
16259	White	Female	0	0	8
16260	White	Female	0	0	45
16261	White	Male	15024	0	55
16262	White	Male	0	0	40
16263	White	Male	0	0	40
16264	White	Male	0	0	32
16266	White	Female	0	0	32
16267	Black	Female	0	0	40
16268	White	Male	0	0	36
16269	White	Male	0	0	40
16270	White	Male	0	0	40
16271	White	Male	0	0	48
16272	White	Male	0	0	40
16273	White	Female	0	0	40
16274	White	Male	0	0	40
16275	White	Male	0	0	40
16276	White	Female	0	0	36
16278	White	Male	0	0	50
16279	Asian-Pac-Islander	Male	5455	0	40
16280	White	Male	0	0	60

	native-country	income
0	United-States	<=50K.
1	United-States	<=50K.
2	United-States	>50K.
3	United-States	>50K.
5	United-States	<=50K.
7	United-States	>50K.
8	United-States	<=50K.
9	United-States	<=50K.
10	United-States	>50K.
11	United-States	<=50K.
12	United-States	<=50K.
14	United-States	>50K.
15	United-States	>50K.
16	United-States	<=50K.
17	United-States	<=50K.
18	United-States	<=50K.
20	United-States	>50K.
21	United-States	<=50K.
23	Peru	<=50K.
24	United-States	<=50K.
25	United-States	>50K.
26	United-States	<=50K.
27	United-States	<=50K.
28	United-States	<=50K.
29	United-States	<=50K.

```

30    United-States    >50K.
31    United-States    <=50K.
32    United-States    <=50K.
33    United-States    <=50K.
34    United-States    <=50K.
...
16248 United-States    <=50K.
16249 United-States    <=50K.
16250      Canada      >50K.
16252 United-States    >50K.
16253 United-States    <=50K.
16254 United-States    >50K.
16255 United-States    >50K.
16256 United-States    <=50K.
16257 United-States    <=50K.
16258 United-States    <=50K.
16259 United-States    <=50K.
16260 United-States    <=50K.
16261 United-States    >50K.
16262 United-States    <=50K.
16263 United-States    <=50K.
16264 United-States    <=50K.
16266 United-States    <=50K.
16267 United-States    <=50K.
16268 United-States    <=50K.
16269 United-States    <=50K.
16270 United-States    <=50K.
16271 United-States    <=50K.
16272 United-States    <=50K.
16273 United-States    <=50K.
16274 United-States    <=50K.
16275 United-States    <=50K.
16276 United-States    <=50K.
16278 United-States    <=50K.
16279 United-States    <=50K.
16280 United-States    >50K.

```

```
[15060 rows x 15 columns]
```

Some of the features are categorical, so we need to encode them with either one-hot coding or linear encoder.

```

In [3]: from sklearn.preprocessing import LabelEncoder
        # Hint: Now use a for loop over the elements in `le_category` and update df_le #TODO
        encoder = LabelEncoder()

        ohc_category = ['workclass', 'relationship'
                        , 'native-country', 'occupation']

```



```

le_category=['sex','income','education','race','marital-status']

df_ohc_train = pd.get_dummies(df_train,columns=ohc_category)
df_ohc_test = pd.get_dummies(df_test,columns=ohc_category)

df_le_train = df_ohc_train.copy()
df_le_test = df_ohc_test.copy()
for i in range (len(le_category)):
    df_le_train[le_category[i]] =encoder.fit_transform(df_le_train[le_category[i]])
    df_le_test[le_category[i]] =encoder.fit_transform(df_le_test[le_category[i]])

df_le_test.head(6)

```

```

Out[3]:

```

	age	fnlwgt	education	education-num	marital-status	race	sex	\
0	25	226802	1	7	4	2	1	
1	38	89814	11	9	2	4	1	
2	28	336951	7	12	2	4	1	
3	44	160323	15	10	2	2	1	
4	18	103497	15	10	4	4	0	
5	34	198693	0	6	4	4	1	

	capital-gain	capital-loss	hours-per-week	...	\
0	0	0	40	...	
1	0	0	50	...	
2	0	0	40	...	
3	7688	0	40	...	
4	0	0	30	...	
5	0	0	30	...	

	occupation_Farming-fishing	occupation_Handlers-cleaners	\
0	0	0	
1	1	0	
2	0	0	
3	0	0	
4	0	0	
5	0	0	

	occupation_Machine-op-inspct	occupation_Other-service	\
0	1	0	
1	0	0	
2	0	0	
3	1	0	
4	0	0	
5	0	1	

	occupation_Priv-house-serv	occupation_Prof-specialty	\
0	0	0	

1	0	0
2	0	0
3	0	0
4	0	0
5	0	0

	occupation_Protective-serv	occupation_Sales	occupation_Tech-support \
0	0	0	0
1	0	0	0
2	1	0	0
3	0	0	0
4	0	0	0
5	0	0	0

	occupation_Transport-moving
0	0
1	0
2	0
3	0
4	0
5	0

[6 rows x 79 columns]

We will train the model with all data in the trainin set and test the model with the test data.

```
In [4]: X_df_train = np.array(df_le_train.drop(['income'],axis=1))
        y_train = np.array(df_le_train['income'])
        X_df_test = np.array(df_le_test.drop(['income'],axis=1))
        y_test = np.array(df_le_test['income'])

        nsamples,nfeatures=X_df_train.shape
        print (' number of Train samples:{0} and number of features :{1}'.format(nsamples,nfeatures))
        nsamples,nfeatures=X_df_test.shape
        print (' number of Test samples:{0} and number of features :{1}'.format(nsamples,nfeatures))

number of Train samples:32560 and number of features :78
number of Test samples:16281 and number of features :78
```

```
In [5]: import keras
        from sklearn import preprocessing
        from keras.models import Model, Sequential
        from keras.layers import Dense, Activation

        Xtr_mean = np.mean(X_df_train,axis=0)
        Xtr_std = np.std(X_df_train,axis=0)
        Xtr_scale = (X_df_train-Xtr_mean)/Xtr_std[None,:]
        Xts_scale = (X_df_test-Xtr_mean[None,:])/Xtr_std[None,:]
```

```
F:\Tool_for_Study\lib\site-packages\h5py\__init__.py:34: FutureWarning: Conversion of the second argument of
from ._conv import register_converters as _register_converters
Using TensorFlow backend.
```

number of outputs = 2 since there is a class over income over 50K and another class with below 50K

```
In [6]: import keras.backend as K
```

```
In [7]: K.clear_session()
nin = Xtr_scale.shape[1] # dimension of input data
nh = 100 # number of hidden units
nout = int(2) # number of outputs = 2 since there is a class over income over 50K and another class with below 50K
model = Sequential()
model.add(Dense(nh, input_shape=(nin,), activation='sigmoid', name='hidden'))
model.add(Dense(nout, activation='softmax', name='output'))
print(model.summary())
from keras import optimizers
opt = optimizers.Adam(lr=0.02, beta_1=0.9, beta_2=0.999, epsilon=1e-08, decay=0.0)
model.compile(optimizer=opt, loss='sparse_categorical_crossentropy', metrics=['accuracy'])
hist = model.fit(Xtr_scale, y_train, epochs=30, batch_size=100, validation_data=(Xts_scale, y_test))
tr_accuracy = hist.history['acc']
val_accuracy = hist.history['val_acc']
loss = hist.history['loss']
val_loss = hist.history['val_loss']

plt.subplot(1,2,1)
plt.plot(tr_accuracy)
plt.plot(val_accuracy)
plt.grid()
plt.xlabel('epochs')
plt.ylabel('accuracy')
plt.legend(['training accuracy', 'validation accuracy'])

plt.subplot(1,2,2)
plt.plot(loss)
plt.plot(val_loss)
plt.grid()
plt.xlabel('epochs')
plt.ylabel('loss')
plt.legend(['training loss', 'validation loss'])
```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/30
32560/32560 [=====] - 1s 23us/step - loss: 0.3464 - acc: 0.8383 - val.
Epoch 2/30
32560/32560 [=====] - 0s 14us/step - loss: 0.3276 - acc: 0.8492 - val.
Epoch 3/30
32560/32560 [=====] - 0s 14us/step - loss: 0.3168 - acc: 0.8532 - val.
Epoch 4/30
32560/32560 [=====] - 0s 14us/step - loss: 0.3102 - acc: 0.8558 - val.
Epoch 5/30
32560/32560 [=====] - 0s 14us/step - loss: 0.3094 - acc: 0.8564 - val.
Epoch 6/30
32560/32560 [=====] - 0s 14us/step - loss: 0.3041 - acc: 0.8592 - val.
Epoch 7/30
32560/32560 [=====] - 0s 14us/step - loss: 0.3042 - acc: 0.8584 - val.
Epoch 8/30
32560/32560 [=====] - 0s 14us/step - loss: 0.2998 - acc: 0.8619 - val.
Epoch 9/30
32560/32560 [=====] - 0s 13us/step - loss: 0.3006 - acc: 0.8614 - val.
Epoch 10/30
32560/32560 [=====] - 0s 14us/step - loss: 0.2960 - acc: 0.8616 - val.
Epoch 11/30
32560/32560 [=====] - 0s 14us/step - loss: 0.2934 - acc: 0.8632 - val.
Epoch 12/30
32560/32560 [=====] - 0s 14us/step - loss: 0.2899 - acc: 0.8644 - val.
Epoch 13/30
32560/32560 [=====] - 0s 14us/step - loss: 0.2890 - acc: 0.8655 - val.
Epoch 14/30
32560/32560 [=====] - 0s 14us/step - loss: 0.2854 - acc: 0.8676 - val.
Epoch 15/30
32560/32560 [=====] - 0s 14us/step - loss: 0.2854 - acc: 0.8658 - val.
Epoch 16/30
32560/32560 [=====] - 0s 14us/step - loss: 0.2840 - acc: 0.8668 - val.
Epoch 17/30
32560/32560 [=====] - 0s 14us/step - loss: 0.2805 - acc: 0.8708 - val.
Epoch 18/30
32560/32560 [=====] - 0s 14us/step - loss: 0.2769 - acc: 0.8707 - val.
Epoch 19/30
32560/32560 [=====] - 0s 14us/step - loss: 0.2762 - acc: 0.8697 - val.
Epoch 20/30
32560/32560 [=====] - 0s 13us/step - loss: 0.2732 - acc: 0.8713 - val.
Epoch 21/30

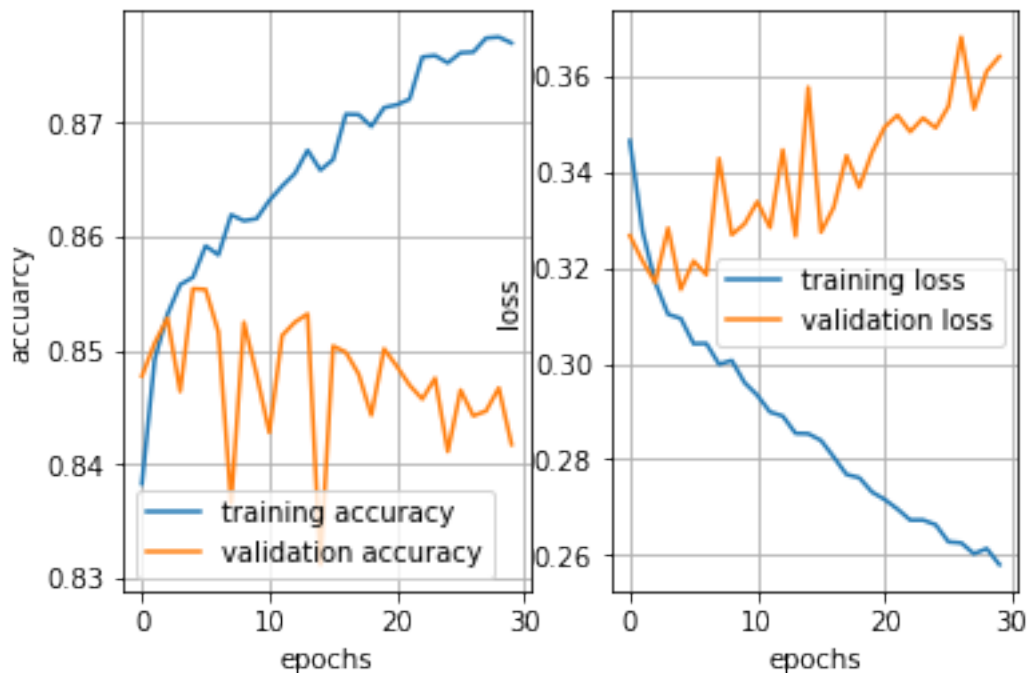
```

```

32560/32560 [=====] - 0s 14us/step - loss: 0.2717 - acc: 0.8716 - val.
Epoch 22/30
32560/32560 [=====] - 0s 13us/step - loss: 0.2697 - acc: 0.8721 - val.
Epoch 23/30
32560/32560 [=====] - 0s 13us/step - loss: 0.2674 - acc: 0.8758 - val.
Epoch 24/30
32560/32560 [=====] - 0s 13us/step - loss: 0.2674 - acc: 0.8759 - val.
Epoch 25/30
32560/32560 [=====] - 0s 14us/step - loss: 0.2664 - acc: 0.8753 - val.
Epoch 26/30
32560/32560 [=====] - 0s 13us/step - loss: 0.2628 - acc: 0.8762 - val.
Epoch 27/30
32560/32560 [=====] - 0s 14us/step - loss: 0.2626 - acc: 0.8762 - val.
Epoch 28/30
32560/32560 [=====] - 0s 14us/step - loss: 0.2604 - acc: 0.8775 - val.
Epoch 29/30
32560/32560 [=====] - 0s 14us/step - loss: 0.2614 - acc: 0.8775 - val.
Epoch 30/30
32560/32560 [=====] - 0s 13us/step - loss: 0.2581 - acc: 0.8770 - val.

```

Out[7]: <matplotlib.legend.Legend at 0x183996f02b0>



So we first test learning rate and beta_2 vs acc

In [8]: *##hyper parameters*

```

acc =np.zeros((10,10))
for i in range (10):
    for j in range (10):
        K.clear_session()
        nin = Xtr_scale.shape[1] # dimension of input data
        nh = 100 # number of hidden units
        nout = int(2) # number of outputs = 2 since there is a class over income o
        model = Sequential()
        model.add(Dense(nh, input_shape=(nin,), activation='sigmoid', name='hidden'))
        model.add(Dense(nout, activation='softmax', name='output'))
        print (model.summary())
        from keras import optimizers
        opt = optimizers.Adam(lr=0.01*i ,beta_1=0.1*j, beta_2=0.999, epsilon=1e-08, de
        model.compile(optimizer=opt,
                        loss='sparse_categorical_crossentropy',
                        metrics=['accuracy'])
        hist = model.fit(Xtr_scale, y_train, epochs=5, batch_size=100, validation_data=
        acc[i][j]= hist.history['acc'][0]

plt.subplot(1,2,1)
plt.plot(np.arange(10)*0.01,acc [:,0])
plt.grid()
plt.xlabel('learning rate')
plt.ylabel('accuarcy')

plt.subplot(1,2,2)
plt.plot(np.arange(10)*0.1,acc [0,:])
plt.plot()
plt.grid()
plt.xlabel('beta_1')
plt.ylabel('accuarcy')

```

```

-----
Layer (type)              Output Shape              Param #
=====
hidden (Dense)            (None, 100)              7900
-----
output (Dense)            (None, 2)                202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 22us/step - loss: 0.5681 - acc: 0.7564 - val.
Epoch 2/5

```

```

32560/32560 [=====] - 0s 14us/step - loss: 0.5681 - acc: 0.7564 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.5681 - acc: 0.7564 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.5681 - acc: 0.7564 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.5681 - acc: 0.7564 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 22us/step - loss: 0.5413 - acc: 0.7587 - val.
Epoch 2/5
32560/32560 [=====] - 1s 16us/step - loss: 0.5413 - acc: 0.7587 - val.
Epoch 3/5
32560/32560 [=====] - 0s 15us/step - loss: 0.5413 - acc: 0.7587 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.5413 - acc: 0.7587 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.5413 - acc: 0.7587 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.5682 - acc: 0.7575 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.5682 - acc: 0.7575 - val.
Epoch 3/5

```

```

32560/32560 [=====] - 0s 14us/step - loss: 0.5682 - acc: 0.7575 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.5682 - acc: 0.7575 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.5682 - acc: 0.7575 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.6106 - acc: 0.7588 - val.
Epoch 2/5
32560/32560 [=====] - 0s 15us/step - loss: 0.6106 - acc: 0.7588 - val.
Epoch 3/5
32560/32560 [=====] - 0s 15us/step - loss: 0.6106 - acc: 0.7588 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.6106 - acc: 0.7588 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.6106 - acc: 0.7588 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 22us/step - loss: 0.7952 - acc: 0.3088 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.7952 - acc: 0.3088 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.7952 - acc: 0.3088 - val.
Epoch 4/5

```


32560/32560 [=====] - 0s 14us/step - loss: 0.7952 - acc: 0.3088 - val.
Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.7952 - acc: 0.3088 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 25us/step - loss: 0.6886 - acc: 0.5658 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.6886 - acc: 0.5658 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.6886 - acc: 0.5658 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.6886 - acc: 0.5658 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.6886 - acc: 0.5658 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 1.1104 - acc: 0.2429 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 1.1104 - acc: 0.2429 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 1.1104 - acc: 0.2429 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 1.1104 - acc: 0.2429 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 1.1104 - acc: 0.2429 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 24us/step - loss: 0.5925 - acc: 0.7501 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.5925 - acc: 0.7501 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.5925 - acc: 0.7501 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.5925 - acc: 0.7501 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.5925 - acc: 0.7501 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 1.6983 - acc: 0.2408 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 1.6983 - acc: 0.2408 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 1.6983 - acc: 0.2408 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 1.6983 - acc: 0.2408 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 1.6983 - acc: 0.2408 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
 Trainable params: 8,102
 Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.7531 - acc: 0.4188 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.7531 - acc: 0.4188 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.7531 - acc: 0.4188 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.7531 - acc: 0.4188 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.7531 - acc: 0.4188 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
 Trainable params: 8,102
 Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 24us/step - loss: 0.3502 - acc: 0.8359 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3262 - acc: 0.8479 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3213 - acc: 0.8500 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3145 - acc: 0.8547 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3109 - acc: 0.8565 - val.

Layer (type)	Output Shape	Param #
--------------	--------------	---------

```

hidden (Dense)                (None, 100)                7900
-----
output (Dense)                (None, 2)                  202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 22us/step - loss: 0.3491 - acc: 0.8369 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3251 - acc: 0.8481 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3179 - acc: 0.8528 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3134 - acc: 0.8536 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3085 - acc: 0.8556 - val.
-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)                (None, 100)                7900
-----
output (Dense)                (None, 2)                  202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 26us/step - loss: 0.3472 - acc: 0.8392 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3260 - acc: 0.8493 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3185 - acc: 0.8518 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3129 - acc: 0.8543 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3080 - acc: 0.8561 - val.
-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)                (None, 100)                7900
-----

```

```

output (Dense)                (None, 2)                202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3441 - acc: 0.8393 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3259 - acc: 0.8492 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3173 - acc: 0.8513 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3131 - acc: 0.8534 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3079 - acc: 0.8570 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 22us/step - loss: 0.3434 - acc: 0.8396 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3248 - acc: 0.8490 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3179 - acc: 0.8515 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3122 - acc: 0.8556 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3076 - acc: 0.8568 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 22us/step - loss: 0.3447 - acc: 0.8389 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3266 - acc: 0.8476 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3186 - acc: 0.8528 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3139 - acc: 0.8532 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3092 - acc: 0.8570 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 22us/step - loss: 0.3452 - acc: 0.8391 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3273 - acc: 0.8482 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3197 - acc: 0.8508 - val.

Epoch 4/5

32560/32560 [=====] - 0s 15us/step - loss: 0.3159 - acc: 0.8520 - val.

Epoch 5/5

32560/32560 [=====] - 0s 15us/step - loss: 0.3126 - acc: 0.8541 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 22us/step - loss: 0.3439 - acc: 0.8383 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3247 - acc: 0.8494 - val.

Epoch 3/5

32560/32560 [=====] - 0s 15us/step - loss: 0.3198 - acc: 0.8514 - val.

Epoch 4/5

32560/32560 [=====] - 0s 15us/step - loss: 0.3147 - acc: 0.8543 - val.

Epoch 5/5

32560/32560 [=====] - 0s 15us/step - loss: 0.3105 - acc: 0.8573 - val.

Layer (type)	Output Shape	Param #
=====		
hidden (Dense)	(None, 100)	7900

output (Dense)	(None, 2)	202
=====		

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 22us/step - loss: 0.3425 - acc: 0.8393 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3260 - acc: 0.8494 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3191 - acc: 0.8515 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3129 - acc: 0.8555 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3095 - acc: 0.8560 - val.

Layer (type)	Output Shape	Param #
=====		
hidden (Dense)	(None, 100)	7900

output (Dense)	(None, 2)	202
=====		

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 22us/step - loss: 0.3454 - acc: 0.8385 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3228 - acc: 0.8510 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3177 - acc: 0.8519 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3118 - acc: 0.8563 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3085 - acc: 0.8567 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3543 - acc: 0.8367 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3293 - acc: 0.8474 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3215 - acc: 0.8517 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3132 - acc: 0.8550 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3110 - acc: 0.8568 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples


```

Epoch 1/5
32560/32560 [=====] - 1s 24us/step - loss: 0.3574 - acc: 0.8363 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3259 - acc: 0.8483 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3186 - acc: 0.8527 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3132 - acc: 0.8554 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3099 - acc: 0.8574 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3505 - acc: 0.8370 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3276 - acc: 0.8472 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3192 - acc: 0.8533 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3140 - acc: 0.8550 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3107 - acc: 0.8564 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 25us/step - loss: 0.3491 - acc: 0.8374 - val.

```

```

Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3254 - acc: 0.8490 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3179 - acc: 0.8537 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3123 - acc: 0.8546 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3085 - acc: 0.8567 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 22us/step - loss: 0.3489 - acc: 0.8367 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3265 - acc: 0.8502 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3156 - acc: 0.8534 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3110 - acc: 0.8556 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3079 - acc: 0.8585 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 22us/step - loss: 0.3470 - acc: 0.8372 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3250 - acc: 0.8489 - val.

```

Epoch 3/5
 32560/32560 [=====] - 0s 14us/step - loss: 0.3162 - acc: 0.8533 - val.
 Epoch 4/5
 32560/32560 [=====] - 0s 14us/step - loss: 0.3096 - acc: 0.8585 - val.
 Epoch 5/5
 32560/32560 [=====] - 0s 14us/step - loss: 0.3080 - acc: 0.8568 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
 Trainable params: 8,102
 Non-trainable params: 0

None
 Train on 32560 samples, validate on 16281 samples
 Epoch 1/5
 32560/32560 [=====] - 1s 25us/step - loss: 0.3465 - acc: 0.8392 - val.
 Epoch 2/5
 32560/32560 [=====] - 0s 14us/step - loss: 0.3261 - acc: 0.8487 - val.
 Epoch 3/5
 32560/32560 [=====] - 0s 15us/step - loss: 0.3208 - acc: 0.8494 - val.
 Epoch 4/5
 32560/32560 [=====] - 0s 14us/step - loss: 0.3132 - acc: 0.8545 - val.
 Epoch 5/5
 32560/32560 [=====] - 0s 15us/step - loss: 0.3102 - acc: 0.8564 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
 Trainable params: 8,102
 Non-trainable params: 0

None
 Train on 32560 samples, validate on 16281 samples
 Epoch 1/5
 32560/32560 [=====] - 1s 23us/step - loss: 0.3451 - acc: 0.8387 - val.
 Epoch 2/5
 32560/32560 [=====] - 0s 14us/step - loss: 0.3284 - acc: 0.8482 - val.
 Epoch 3/5
 32560/32560 [=====] - 0s 15us/step - loss: 0.3182 - acc: 0.8539 - val.

```

Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3149 - acc: 0.8562 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3111 - acc: 0.8575 - val.

-----
Layer (type)              Output Shape              Param #
=====
hidden (Dense)            (None, 100)              7900
-----
output (Dense)            (None, 2)                202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 26us/step - loss: 0.3492 - acc: 0.8355 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3290 - acc: 0.8479 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3207 - acc: 0.8525 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3133 - acc: 0.8549 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3099 - acc: 0.8572 - val.

-----
Layer (type)              Output Shape              Param #
=====
hidden (Dense)            (None, 100)              7900
-----
output (Dense)            (None, 2)                202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 22us/step - loss: 0.3528 - acc: 0.8379 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3268 - acc: 0.8494 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3184 - acc: 0.8525 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3119 - acc: 0.8542 - val.

```

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3101 - acc: 0.8571 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3653 - acc: 0.8328 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3323 - acc: 0.8483 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3257 - acc: 0.8511 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3247 - acc: 0.8533 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3195 - acc: 0.8540 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3583 - acc: 0.8341 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3318 - acc: 0.8467 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3234 - acc: 0.8497 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3214 - acc: 0.8525 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3217 - acc: 0.8530 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3564 - acc: 0.8359 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3336 - acc: 0.8477 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3224 - acc: 0.8518 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3226 - acc: 0.8519 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3226 - acc: 0.8541 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3542 - acc: 0.8360 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3298 - acc: 0.8490 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3268 - acc: 0.8524 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3167 - acc: 0.8526 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3184 - acc: 0.8530 - val.

Layer (type)	Output Shape	Param #
--------------	--------------	---------

hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3550 - acc: 0.8377 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3301 - acc: 0.8485 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3236 - acc: 0.8503 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3196 - acc: 0.8518 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3182 - acc: 0.8529 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3539 - acc: 0.8346 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3274 - acc: 0.8488 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3209 - acc: 0.8522 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3167 - acc: 0.8541 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3149 - acc: 0.8554 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900

```
-----
output (Dense)                (None, 2)                202
=====
```

```
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
```

```
-----
None
```

```
Train on 32560 samples, validate on 16281 samples
```

```
Epoch 1/5
```

```
32560/32560 [=====] - 1s 21us/step - loss: 0.3496 - acc: 0.8367 - val.
```

```
Epoch 2/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3288 - acc: 0.8477 - val.
```

```
Epoch 3/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3208 - acc: 0.8518 - val.
```

```
Epoch 4/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3158 - acc: 0.8522 - val.
```

```
Epoch 5/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3148 - acc: 0.8548 - val.
```

```
-----
Layer (type)                Output Shape              Param #
=====
hidden (Dense)              (None, 100)              7900
```

```
-----
output (Dense)              (None, 2)                202
=====
```

```
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
```

```
-----
None
```

```
Train on 32560 samples, validate on 16281 samples
```

```
Epoch 1/5
```

```
32560/32560 [=====] - 1s 24us/step - loss: 0.3525 - acc: 0.8368 - val.
```

```
Epoch 2/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3292 - acc: 0.8476 - val.
```

```
Epoch 3/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3249 - acc: 0.8501 - val.
```

```
Epoch 4/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3188 - acc: 0.8531 - val.
```

```
Epoch 5/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3140 - acc: 0.8562 - val.
```

```
-----
Layer (type)                Output Shape              Param #
=====
hidden (Dense)              (None, 100)              7900
```

```
-----
output (Dense)              (None, 2)                202
=====
```



```

=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3521 - acc: 0.8360 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3253 - acc: 0.8485 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3184 - acc: 0.8526 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3168 - acc: 0.8545 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3144 - acc: 0.8566 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 24us/step - loss: 0.3495 - acc: 0.8373 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3247 - acc: 0.8487 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3183 - acc: 0.8519 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3173 - acc: 0.8541 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3138 - acc: 0.8560 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====

Total params: 8,102

```

Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3766 - acc: 0.8324 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3469 - acc: 0.8452 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3371 - acc: 0.8476 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3360 - acc: 0.8500 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3315 - acc: 0.8529 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3675 - acc: 0.8349 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3370 - acc: 0.8468 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3369 - acc: 0.8482 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3318 - acc: 0.8507 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3358 - acc: 0.8509 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 25us/step - loss: 0.3636 - acc: 0.8330 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3359 - acc: 0.8453 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3321 - acc: 0.8494 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3320 - acc: 0.8490 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3281 - acc: 0.8514 - val.

Layer (type)	Output Shape	Param #
=====		
hidden (Dense)	(None, 100)	7900

output (Dense)	(None, 2)	202
=====		

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3620 - acc: 0.8364 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3359 - acc: 0.8470 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3302 - acc: 0.8501 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3349 - acc: 0.8513 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3251 - acc: 0.8533 - val.

Layer (type)	Output Shape	Param #
=====		
hidden (Dense)	(None, 100)	7900

output (Dense)	(None, 2)	202
=====		

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 24us/step - loss: 0.3567 - acc: 0.8369 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3332 - acc: 0.8466 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3311 - acc: 0.8494 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3240 - acc: 0.8523 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3287 - acc: 0.8514 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 22us/step - loss: 0.3579 - acc: 0.8352 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3314 - acc: 0.8487 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3282 - acc: 0.8499 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3289 - acc: 0.8500 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3212 - acc: 0.8529 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

```

32560/32560 [=====] - 1s 21us/step - loss: 0.3552 - acc: 0.8362 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3325 - acc: 0.8481 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3297 - acc: 0.8487 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3236 - acc: 0.8531 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3262 - acc: 0.8515 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 22us/step - loss: 0.3546 - acc: 0.8367 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3327 - acc: 0.8471 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3265 - acc: 0.8509 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3273 - acc: 0.8496 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3203 - acc: 0.8532 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3559 - acc: 0.8354 - val.
Epoch 2/5

```

```

32560/32560 [=====] - 0s 14us/step - loss: 0.3321 - acc: 0.8475 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3257 - acc: 0.8499 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3278 - acc: 0.8495 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3214 - acc: 0.8511 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3560 - acc: 0.8340 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3278 - acc: 0.8481 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3281 - acc: 0.8497 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3243 - acc: 0.8512 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3225 - acc: 0.8532 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3915 - acc: 0.8247 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3549 - acc: 0.8423 - val.
Epoch 3/5

```

```

32560/32560 [=====] - 0s 14us/step - loss: 0.3464 - acc: 0.8467 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3414 - acc: 0.8487 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3494 - acc: 0.8486 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3775 - acc: 0.8329 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3584 - acc: 0.8449 - val.
Epoch 3/5
32560/32560 [=====] - 1s 16us/step - loss: 0.3464 - acc: 0.8465 - val.
Epoch 4/5
32560/32560 [=====] - 0s 15us/step - loss: 0.3632 - acc: 0.8484 - val.
Epoch 5/5
32560/32560 [=====] - 0s 15us/step - loss: 0.3496 - acc: 0.8498 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 22us/step - loss: 0.3844 - acc: 0.8302 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3413 - acc: 0.8471 - val.
Epoch 3/5
32560/32560 [=====] - 0s 15us/step - loss: 0.3514 - acc: 0.8469 - val.
Epoch 4/5

```

32560/32560 [=====] - 0s 14us/step - loss: 0.3504 - acc: 0.8447 - val.
Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3462 - acc: 0.8494 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3677 - acc: 0.8344 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3507 - acc: 0.8441 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3400 - acc: 0.8460 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3391 - acc: 0.8481 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3403 - acc: 0.8491 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 22us/step - loss: 0.3662 - acc: 0.8329 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3403 - acc: 0.8442 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3367 - acc: 0.8482 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3391 - acc: 0.8490 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3429 - acc: 0.8472 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3773 - acc: 0.8312 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3407 - acc: 0.8479 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3375 - acc: 0.8472 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3290 - acc: 0.8499 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3406 - acc: 0.8476 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3612 - acc: 0.8364 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3365 - acc: 0.8440 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3364 - acc: 0.8473 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3306 - acc: 0.8490 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3313 - acc: 0.8514 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
 Trainable params: 8,102
 Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3668 - acc: 0.8361 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3356 - acc: 0.8459 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3376 - acc: 0.8467 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3377 - acc: 0.8486 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3298 - acc: 0.8485 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
 Trainable params: 8,102
 Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 24us/step - loss: 0.3572 - acc: 0.8363 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3384 - acc: 0.8455 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3374 - acc: 0.8485 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3351 - acc: 0.8483 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3279 - acc: 0.8498 - val.

Layer (type)	Output Shape	Param #
--------------	--------------	---------

```

hidden (Dense)                (None, 100)                7900
-----
output (Dense)                (None, 2)                  202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3645 - acc: 0.8348 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3359 - acc: 0.8453 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3348 - acc: 0.8463 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3295 - acc: 0.8475 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3313 - acc: 0.8508 - val.
-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)                (None, 100)                7900
-----
output (Dense)                (None, 2)                  202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 24us/step - loss: 0.3989 - acc: 0.8293 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3735 - acc: 0.8445 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3772 - acc: 0.8430 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3778 - acc: 0.8429 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3840 - acc: 0.8443 - val.
-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)                (None, 100)                7900
-----

```

```

output (Dense)                (None, 2)                202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3945 - acc: 0.8327 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3577 - acc: 0.8437 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3670 - acc: 0.8446 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3586 - acc: 0.8450 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3820 - acc: 0.8459 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3859 - acc: 0.8282 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3591 - acc: 0.8430 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3627 - acc: 0.8426 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3581 - acc: 0.8458 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3625 - acc: 0.8465 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 24us/step - loss: 0.3786 - acc: 0.8301 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3543 - acc: 0.8424 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3476 - acc: 0.8455 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3580 - acc: 0.8451 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3549 - acc: 0.8462 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3752 - acc: 0.8307 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3552 - acc: 0.8421 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3567 - acc: 0.8449 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3422 - acc: 0.8472 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3476 - acc: 0.8488 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 25us/step - loss: 0.3764 - acc: 0.8327 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3475 - acc: 0.8455 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3404 - acc: 0.8472 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3524 - acc: 0.8459 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3449 - acc: 0.8462 - val.

Layer (type)	Output Shape	Param #
=====		
hidden (Dense)	(None, 100)	7900

output (Dense)	(None, 2)	202
=====		

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3659 - acc: 0.8319 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3490 - acc: 0.8423 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3439 - acc: 0.8458 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3497 - acc: 0.8468 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3416 - acc: 0.8466 - val.

Layer (type)	Output Shape	Param #
=====		
hidden (Dense)	(None, 100)	7900

output (Dense)	(None, 2)	202
=====		

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3656 - acc: 0.8356 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3432 - acc: 0.8427 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3449 - acc: 0.8462 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3423 - acc: 0.8442 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3388 - acc: 0.8471 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3649 - acc: 0.8334 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3338 - acc: 0.8476 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3402 - acc: 0.8447 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3397 - acc: 0.8466 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3344 - acc: 0.8459 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3661 - acc: 0.8365 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3433 - acc: 0.8455 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3373 - acc: 0.8468 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3408 - acc: 0.8471 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3339 - acc: 0.8499 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.4138 - acc: 0.8261 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3798 - acc: 0.8428 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3891 - acc: 0.8399 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3971 - acc: 0.8391 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3954 - acc: 0.8436 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3978 - acc: 0.8287 - val.

```



```

Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3826 - acc: 0.8402 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3849 - acc: 0.8412 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3731 - acc: 0.8429 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3914 - acc: 0.8423 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.4007 - acc: 0.8288 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3727 - acc: 0.8404 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3794 - acc: 0.8414 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3785 - acc: 0.8416 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3644 - acc: 0.8459 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3929 - acc: 0.8314 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3746 - acc: 0.8393 - val.

```

Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3564 - acc: 0.8438 - val.

Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3725 - acc: 0.8413 - val.

Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3738 - acc: 0.8442 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 23us/step - loss: 0.3894 - acc: 0.8302 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3573 - acc: 0.8421 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3639 - acc: 0.8413 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3589 - acc: 0.8459 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3624 - acc: 0.8438 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3784 - acc: 0.8309 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3653 - acc: 0.8410 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3624 - acc: 0.8412 - val.

```

Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3567 - acc: 0.8446 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3611 - acc: 0.8453 - val.

-----
Layer (type)              Output Shape              Param #
=====
hidden (Dense)            (None, 100)              7900
-----
output (Dense)            (None, 2)                202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3679 - acc: 0.8340 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3525 - acc: 0.8401 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3538 - acc: 0.8416 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3601 - acc: 0.8421 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3505 - acc: 0.8446 - val.

-----
Layer (type)              Output Shape              Param #
=====
hidden (Dense)            (None, 100)              7900
-----
output (Dense)            (None, 2)                202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 24us/step - loss: 0.3673 - acc: 0.8342 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3541 - acc: 0.8402 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3640 - acc: 0.8427 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3478 - acc: 0.8456 - val.

```

Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3392 - acc: 0.8473 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3724 - acc: 0.8327 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3495 - acc: 0.8428 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3419 - acc: 0.8442 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3410 - acc: 0.8446 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3451 - acc: 0.8458 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5
32560/32560 [=====] - 1s 25us/step - loss: 0.3763 - acc: 0.8293 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3471 - acc: 0.8438 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3535 - acc: 0.8424 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3395 - acc: 0.8452 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3442 - acc: 0.8458 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.4341 - acc: 0.8252 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4286 - acc: 0.8368 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4070 - acc: 0.8398 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4339 - acc: 0.8369 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4332 - acc: 0.8392 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.4560 - acc: 0.8248 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4033 - acc: 0.8365 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4000 - acc: 0.8392 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3999 - acc: 0.8408 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4045 - acc: 0.8412 - val.

Layer (type)	Output Shape	Param #
--------------	--------------	---------

hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.4105 - acc: 0.8264 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3940 - acc: 0.8372 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3933 - acc: 0.8380 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4087 - acc: 0.8408 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3928 - acc: 0.8434 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.4042 - acc: 0.8290 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3974 - acc: 0.8355 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3970 - acc: 0.8414 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3950 - acc: 0.8409 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3901 - acc: 0.8429 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900

```
-----
output (Dense)                (None, 2)                202
=====
```

```
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
```

```
-----
None
```

```
Train on 32560 samples, validate on 16281 samples
```

```
Epoch 1/5
```

```
32560/32560 [=====] - 1s 21us/step - loss: 0.3940 - acc: 0.8296 - val.
```

```
Epoch 2/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3706 - acc: 0.8378 - val.
```

```
Epoch 3/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3792 - acc: 0.8400 - val.
```

```
Epoch 4/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3844 - acc: 0.8387 - val.
```

```
Epoch 5/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3796 - acc: 0.8400 - val.
```

```
-----
Layer (type)                Output Shape              Param #
=====
hidden (Dense)              (None, 100)              7900
```

```
-----
output (Dense)              (None, 2)                202
=====
```

```
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
```

```
-----
None
```

```
Train on 32560 samples, validate on 16281 samples
```

```
Epoch 1/5
```

```
32560/32560 [=====] - 1s 20us/step - loss: 0.4013 - acc: 0.8283 - val.
```

```
Epoch 2/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3742 - acc: 0.8377 - val.
```

```
Epoch 3/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3710 - acc: 0.8388 - val.
```

```
Epoch 4/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3680 - acc: 0.8415 - val.
```

```
Epoch 5/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3827 - acc: 0.8375 - val.
```

```
-----
Layer (type)                Output Shape              Param #
=====
hidden (Dense)              (None, 100)              7900
```

```
-----
output (Dense)              (None, 2)                202
=====
```

```

=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3861 - acc: 0.8282 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3650 - acc: 0.8372 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3706 - acc: 0.8406 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3574 - acc: 0.8423 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3664 - acc: 0.8415 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3837 - acc: 0.8308 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3573 - acc: 0.8396 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3549 - acc: 0.8421 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3622 - acc: 0.8427 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3668 - acc: 0.8424 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====

Total params: 8,102

```


Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3752 - acc: 0.8321 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3630 - acc: 0.8399 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3563 - acc: 0.8406 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3656 - acc: 0.8406 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3529 - acc: 0.8426 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3808 - acc: 0.8299 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3550 - acc: 0.8382 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3578 - acc: 0.8411 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3475 - acc: 0.8424 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3437 - acc: 0.8443 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.4631 - acc: 0.8246 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4332 - acc: 0.8358 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4357 - acc: 0.8400 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.4561 - acc: 0.8365 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.4466 - acc: 0.8389 - val.

Layer (type)	Output Shape	Param #
=====		
hidden (Dense)	(None, 100)	7900

output (Dense)	(None, 2)	202
=====		

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 20us/step - loss: 0.4726 - acc: 0.8246 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4873 - acc: 0.8352 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4772 - acc: 0.8339 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4482 - acc: 0.8379 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4375 - acc: 0.8378 - val.

Layer (type)	Output Shape	Param #
=====		
hidden (Dense)	(None, 100)	7900

output (Dense)	(None, 2)	202
=====		

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.4380 - acc: 0.8256 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4407 - acc: 0.8323 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4406 - acc: 0.8365 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4478 - acc: 0.8356 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4302 - acc: 0.8362 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 23us/step - loss: 0.4205 - acc: 0.8255 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3935 - acc: 0.8370 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4389 - acc: 0.8330 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4179 - acc: 0.8362 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.4030 - acc: 0.8397 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

```

32560/32560 [=====] - 1s 21us/step - loss: 0.4122 - acc: 0.8259 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3822 - acc: 0.8386 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3833 - acc: 0.8385 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.4005 - acc: 0.8381 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.4206 - acc: 0.8373 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 24us/step - loss: 0.3922 - acc: 0.8281 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3864 - acc: 0.8362 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3794 - acc: 0.8390 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3930 - acc: 0.8389 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3875 - acc: 0.8385 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.4171 - acc: 0.8277 - val.
Epoch 2/5

```

```

32560/32560 [=====] - 0s 14us/step - loss: 0.3769 - acc: 0.8354 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3667 - acc: 0.8411 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3851 - acc: 0.8377 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3793 - acc: 0.8390 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

None

```

```

Train on 32560 samples, validate on 16281 samples

```

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3848 - acc: 0.8290 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3806 - acc: 0.8374 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3820 - acc: 0.8386 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3683 - acc: 0.8421 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3704 - acc: 0.8395 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

None

```

```

Train on 32560 samples, validate on 16281 samples

```

```

Epoch 1/5
32560/32560 [=====] - 1s 24us/step - loss: 0.3806 - acc: 0.8309 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3644 - acc: 0.8379 - val.
Epoch 3/5

```

```

32560/32560 [=====] - 0s 13us/step - loss: 0.3688 - acc: 0.8385 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3625 - acc: 0.8404 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3640 - acc: 0.8434 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```
None
```

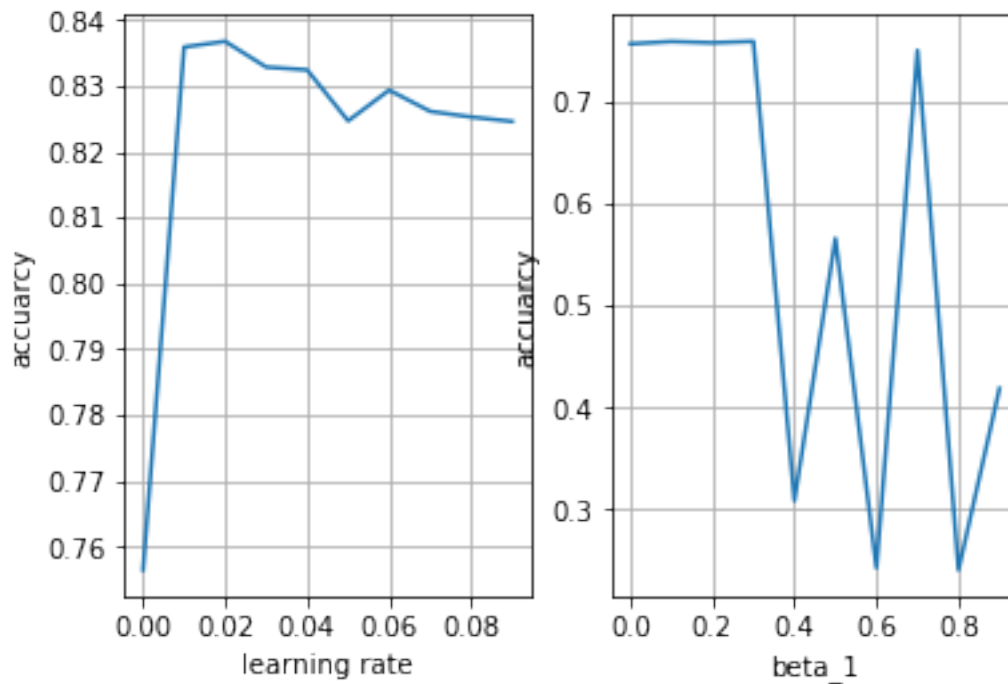
```
Train on 32560 samples, validate on 16281 samples
```

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.4025 - acc: 0.8260 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3494 - acc: 0.8418 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3607 - acc: 0.8371 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3604 - acc: 0.8395 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3570 - acc: 0.8416 - val.

```

```
Out[8]: Text(0,0.5,'accuarcy')
```



Now we try to using different beta_2 and epsilon to see what going change on the acc

```
In [9]: acc = np.zeros((10,10))
        for i in range (10):
            for j in range (10):
                K.clear_session()
                nin = Xtr_scale.shape[1] # dimension of input data
                nh = 100 # number of hidden units
                nout = int(2) # number of outputs = 2 since there is a class over income o
                model = Sequential()
                model.add(Dense(nh, input_shape=(nin,), activation='sigmoid', name='hidden'))
                model.add(Dense(nout, activation='softmax', name='output'))
                print (model.summary())
                from keras import optimizers
                opt = optimizers.Adam(lr=0.01 ,beta_1=0.1, beta_2=0.1*i, epsilon=0.01*j, decay:
                model.compile(optimizer=opt,
                              loss='sparse_categorical_crossentropy',
                              metrics=['accuracy'])
                hist = model.fit(Xtr_scale, y_train, epochs=5, batch_size=100, validation_data:
                acc[i][j]= hist.history['acc'][0]

plt.subplot(1,2,1)
plt.plot(np.arange(10)*0.01,acc[:,0])
plt.grid()
plt.xlabel('beta_2')
```

```

plt.ylabel('accuracy')

plt.subplot(1,2,2)
plt.plot(np.arange(10)*0.1,acc [0,:])
plt.plot()
plt.grid()
plt.xlabel('epsilon')
plt.ylabel('accuracy')

```

```

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 24us/step - loss: nan - acc: 0.7598 - val_loss: nan
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: nan - acc: 0.7592 - val_loss: nan
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: nan - acc: 0.7592 - val_loss: nan
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: nan - acc: 0.7592 - val_loss: nan
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: nan - acc: 0.7592 - val_loss: nan

```

```

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 22us/step - loss: 0.3500 - acc: 0.8346 - val_loss: nan
Epoch 2/5

```



```

32560/32560 [=====] - 0s 13us/step - loss: 0.3304 - acc: 0.8454 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3303 - acc: 0.8457 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3263 - acc: 0.8465 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3253 - acc: 0.8479 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 22us/step - loss: 0.3540 - acc: 0.8344 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3285 - acc: 0.8473 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3264 - acc: 0.8476 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3254 - acc: 0.8490 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3249 - acc: 0.8490 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3576 - acc: 0.8312 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3274 - acc: 0.8472 - val.
Epoch 3/5

```

```

32560/32560 [=====] - 0s 13us/step - loss: 0.3262 - acc: 0.8475 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3236 - acc: 0.8492 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3228 - acc: 0.8496 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3629 - acc: 0.8282 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3298 - acc: 0.8455 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3258 - acc: 0.8495 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3229 - acc: 0.8497 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3221 - acc: 0.8507 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3674 - acc: 0.8283 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3300 - acc: 0.8460 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3257 - acc: 0.8478 - val.
Epoch 4/5

```

32560/32560 [=====] - 0s 13us/step - loss: 0.3230 - acc: 0.8491 - val.
Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3219 - acc: 0.8491 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3683 - acc: 0.8269 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3310 - acc: 0.8455 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3258 - acc: 0.8494 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3230 - acc: 0.8498 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3225 - acc: 0.8496 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3757 - acc: 0.8207 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3308 - acc: 0.8455 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3255 - acc: 0.8486 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3237 - acc: 0.8499 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3224 - acc: 0.8489 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3822 - acc: 0.8183 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3330 - acc: 0.8443 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3279 - acc: 0.8475 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3243 - acc: 0.8488 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3231 - acc: 0.8490 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 23us/step - loss: 0.3810 - acc: 0.8209 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3331 - acc: 0.8443 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3278 - acc: 0.8482 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3242 - acc: 0.8481 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3229 - acc: 0.8491 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
 Trainable params: 8,102
 Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3535 - acc: 0.8333 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3337 - acc: 0.8467 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3294 - acc: 0.8490 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3266 - acc: 0.8500 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3267 - acc: 0.8520 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
 Trainable params: 8,102
 Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3515 - acc: 0.8346 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3304 - acc: 0.8461 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3280 - acc: 0.8469 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3258 - acc: 0.8485 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3256 - acc: 0.8464 - val.

Layer (type)	Output Shape	Param #
--------------	--------------	---------

```

hidden (Dense)                (None, 100)                7900
-----
output (Dense)                (None, 2)                  202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3554 - acc: 0.8338 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3292 - acc: 0.8453 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3256 - acc: 0.8501 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3245 - acc: 0.8492 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3249 - acc: 0.8495 - val.
-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)                (None, 100)                7900
-----
output (Dense)                (None, 2)                  202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3591 - acc: 0.8306 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3292 - acc: 0.8469 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3256 - acc: 0.8491 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3244 - acc: 0.8488 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3233 - acc: 0.8487 - val.
-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)                (None, 100)                7900
-----

```

```

output (Dense)                (None, 2)                202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 24us/step - loss: 0.3613 - acc: 0.8288 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3301 - acc: 0.8463 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3261 - acc: 0.8482 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3239 - acc: 0.8490 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3234 - acc: 0.8484 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3646 - acc: 0.8287 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3302 - acc: 0.8448 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3254 - acc: 0.8475 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3236 - acc: 0.8490 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3222 - acc: 0.8495 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3814 - acc: 0.8189 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3318 - acc: 0.8455 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3268 - acc: 0.8471 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3235 - acc: 0.8489 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3224 - acc: 0.8503 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 24us/step - loss: 0.3750 - acc: 0.8222 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3328 - acc: 0.8443 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3272 - acc: 0.8477 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3240 - acc: 0.8474 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3224 - acc: 0.8497 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3814 - acc: 0.8197 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3329 - acc: 0.8445 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3273 - acc: 0.8476 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3241 - acc: 0.8489 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3229 - acc: 0.8499 - val.

Layer (type)	Output Shape	Param #
=====		
hidden (Dense)	(None, 100)	7900

output (Dense)	(None, 2)	202
=====		

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 25us/step - loss: 0.3847 - acc: 0.8168 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3345 - acc: 0.8437 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3281 - acc: 0.8472 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3250 - acc: 0.8494 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3231 - acc: 0.8504 - val.

Layer (type)	Output Shape	Param #
=====		
hidden (Dense)	(None, 100)	7900

output (Dense)	(None, 2)	202
=====		

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3543 - acc: 0.8332 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3345 - acc: 0.8448 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3293 - acc: 0.8479 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3275 - acc: 0.8511 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3260 - acc: 0.8499 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3491 - acc: 0.8353 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3301 - acc: 0.8456 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3285 - acc: 0.8479 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3269 - acc: 0.8475 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3235 - acc: 0.8479 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3550 - acc: 0.8353 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3292 - acc: 0.8467 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3264 - acc: 0.8475 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3257 - acc: 0.8476 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3244 - acc: 0.8476 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 22us/step - loss: 0.3597 - acc: 0.8304 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3284 - acc: 0.8461 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3260 - acc: 0.8478 - val.
Epoch 4/5
32560/32560 [=====] - 0s 15us/step - loss: 0.3249 - acc: 0.8483 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3233 - acc: 0.8475 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 22us/step - loss: 0.3646 - acc: 0.8288 - val.

```

```

Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3307 - acc: 0.8455 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3255 - acc: 0.8482 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3238 - acc: 0.8487 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3229 - acc: 0.8500 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

None

```

```

Train on 32560 samples, validate on 16281 samples

```

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3739 - acc: 0.8232 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3312 - acc: 0.8445 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3258 - acc: 0.8485 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3239 - acc: 0.8488 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3228 - acc: 0.8488 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

None

```

```

Train on 32560 samples, validate on 16281 samples

```

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3715 - acc: 0.8260 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3309 - acc: 0.8452 - val.

```

Epoch 3/5
 32560/32560 [=====] - 0s 13us/step - loss: 0.3261 - acc: 0.8487 - val.
 Epoch 4/5
 32560/32560 [=====] - 0s 13us/step - loss: 0.3233 - acc: 0.8499 - val.
 Epoch 5/5
 32560/32560 [=====] - 0s 13us/step - loss: 0.3226 - acc: 0.8490 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
 Trainable params: 8,102
 Non-trainable params: 0

None
 Train on 32560 samples, validate on 16281 samples
 Epoch 1/5
 32560/32560 [=====] - 1s 21us/step - loss: 0.3725 - acc: 0.8230 - val.
 Epoch 2/5
 32560/32560 [=====] - 0s 14us/step - loss: 0.3317 - acc: 0.8435 - val.
 Epoch 3/5
 32560/32560 [=====] - 0s 13us/step - loss: 0.3262 - acc: 0.8484 - val.
 Epoch 4/5
 32560/32560 [=====] - 0s 13us/step - loss: 0.3238 - acc: 0.8475 - val.
 Epoch 5/5
 32560/32560 [=====] - 0s 13us/step - loss: 0.3226 - acc: 0.8493 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
 Trainable params: 8,102
 Non-trainable params: 0

None
 Train on 32560 samples, validate on 16281 samples
 Epoch 1/5
 32560/32560 [=====] - 1s 24us/step - loss: 0.3878 - acc: 0.8163 - val.
 Epoch 2/5
 32560/32560 [=====] - 0s 13us/step - loss: 0.3330 - acc: 0.8446 - val.
 Epoch 3/5
 32560/32560 [=====] - 0s 13us/step - loss: 0.3275 - acc: 0.8467 - val.

```

Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3244 - acc: 0.8486 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3227 - acc: 0.8494 - val.

-----
Layer (type)              Output Shape              Param #
=====
hidden (Dense)            (None, 100)              7900
-----
output (Dense)            (None, 2)                202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3828 - acc: 0.8219 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3335 - acc: 0.8443 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3274 - acc: 0.8482 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3244 - acc: 0.8480 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3228 - acc: 0.8498 - val.

-----
Layer (type)              Output Shape              Param #
=====
hidden (Dense)            (None, 100)              7900
-----
output (Dense)            (None, 2)                202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3510 - acc: 0.8380 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3325 - acc: 0.8460 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3294 - acc: 0.8494 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3256 - acc: 0.8509 - val.

```

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3241 - acc: 0.8531 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3490 - acc: 0.8354 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3301 - acc: 0.8459 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3288 - acc: 0.8460 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3268 - acc: 0.8479 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3232 - acc: 0.8488 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3629 - acc: 0.8302 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3286 - acc: 0.8472 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3263 - acc: 0.8472 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3244 - acc: 0.8493 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3235 - acc: 0.8496 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 24us/step - loss: 0.3577 - acc: 0.8328 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3289 - acc: 0.8471 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3257 - acc: 0.8484 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3236 - acc: 0.8489 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3234 - acc: 0.8496 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3672 - acc: 0.8289 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3295 - acc: 0.8464 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3253 - acc: 0.8476 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3239 - acc: 0.8471 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3224 - acc: 0.8494 - val.

Layer (type)	Output Shape	Param #
--------------	--------------	---------


```

=====
hidden (Dense)                (None, 100)                7900
-----
output (Dense)                (None, 2)                  202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3609 - acc: 0.8296 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3304 - acc: 0.8450 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3257 - acc: 0.8468 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3240 - acc: 0.8490 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3227 - acc: 0.8504 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)                (None, 100)                7900
-----
output (Dense)                (None, 2)                  202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3690 - acc: 0.8264 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3314 - acc: 0.8445 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3259 - acc: 0.8479 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3238 - acc: 0.8481 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3223 - acc: 0.8500 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)                (None, 100)                7900

```

```
-----
output (Dense)                (None, 2)                202
=====
```

```
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
```

```
-----
None
```

```
Train on 32560 samples, validate on 16281 samples
```

```
Epoch 1/5
```

```
32560/32560 [=====] - 1s 21us/step - loss: 0.3779 - acc: 0.8197 - val.
```

```
Epoch 2/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3326 - acc: 0.8444 - val.
```

```
Epoch 3/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3269 - acc: 0.8483 - val.
```

```
Epoch 4/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3240 - acc: 0.8492 - val.
```

```
Epoch 5/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3221 - acc: 0.8504 - val.
```

```
-----
Layer (type)                Output Shape              Param #
=====
hidden (Dense)              (None, 100)              7900
```

```
-----
output (Dense)              (None, 2)                202
=====
```

```
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
```

```
-----
None
```

```
Train on 32560 samples, validate on 16281 samples
```

```
Epoch 1/5
```

```
32560/32560 [=====] - 1s 24us/step - loss: 0.3783 - acc: 0.8189 - val.
```

```
Epoch 2/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3317 - acc: 0.8446 - val.
```

```
Epoch 3/5
```

```
32560/32560 [=====] - 0s 14us/step - loss: 0.3268 - acc: 0.8497 - val.
```

```
Epoch 4/5
```

```
32560/32560 [=====] - 0s 14us/step - loss: 0.3240 - acc: 0.8499 - val.
```

```
Epoch 5/5
```

```
32560/32560 [=====] - 0s 14us/step - loss: 0.3220 - acc: 0.8489 - val.
```

```
-----
Layer (type)                Output Shape              Param #
=====
hidden (Dense)              (None, 100)              7900
```

```
-----
output (Dense)              (None, 2)                202
=====
```

```

=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3845 - acc: 0.8194 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3339 - acc: 0.8437 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3274 - acc: 0.8479 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3243 - acc: 0.8483 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3223 - acc: 0.8490 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 24us/step - loss: 0.3480 - acc: 0.8371 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3315 - acc: 0.8468 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3278 - acc: 0.8499 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3250 - acc: 0.8518 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3228 - acc: 0.8530 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====

Total params: 8,102

```

Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3486 - acc: 0.8362 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3307 - acc: 0.8454 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3293 - acc: 0.8464 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3264 - acc: 0.8478 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3248 - acc: 0.8482 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 24us/step - loss: 0.3523 - acc: 0.8328 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3295 - acc: 0.8468 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3262 - acc: 0.8475 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3247 - acc: 0.8491 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3237 - acc: 0.8501 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

```

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3573 - acc: 0.8337 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3292 - acc: 0.8461 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3253 - acc: 0.8485 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3244 - acc: 0.8482 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3226 - acc: 0.8513 - val.

```

```

-----
Layer (type)              Output Shape              Param #
=====
hidden (Dense)            (None, 100)              7900
-----
output (Dense)            (None, 2)                202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 24us/step - loss: 0.3666 - acc: 0.8267 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3289 - acc: 0.8467 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3252 - acc: 0.8493 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3234 - acc: 0.8490 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3220 - acc: 0.8505 - val.

```

```

-----
Layer (type)              Output Shape              Param #
=====
hidden (Dense)            (None, 100)              7900
-----
output (Dense)            (None, 2)                202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

-----
None

```

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3707 - acc: 0.8242 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3308 - acc: 0.8445 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3261 - acc: 0.8485 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3246 - acc: 0.8485 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3231 - acc: 0.8481 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3693 - acc: 0.8276 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3316 - acc: 0.8453 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3263 - acc: 0.8481 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3236 - acc: 0.8489 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3226 - acc: 0.8501 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

```

32560/32560 [=====] - 1s 24us/step - loss: 0.3736 - acc: 0.8225 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3321 - acc: 0.8447 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3264 - acc: 0.8488 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3236 - acc: 0.8508 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3221 - acc: 0.8507 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3881 - acc: 0.8163 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3335 - acc: 0.8438 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3272 - acc: 0.8469 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3246 - acc: 0.8486 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3225 - acc: 0.8490 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 24us/step - loss: 0.3831 - acc: 0.8206 - val.
Epoch 2/5

```

```

32560/32560 [=====] - 0s 13us/step - loss: 0.3340 - acc: 0.8437 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3276 - acc: 0.8472 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3246 - acc: 0.8499 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3229 - acc: 0.8499 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

None

```

```

Train on 32560 samples, validate on 16281 samples

```

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3498 - acc: 0.8357 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3312 - acc: 0.8473 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3254 - acc: 0.8504 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3236 - acc: 0.8523 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3206 - acc: 0.8530 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

```

None

```

```

Train on 32560 samples, validate on 16281 samples

```

```

Epoch 1/5
32560/32560 [=====] - 1s 25us/step - loss: 0.3503 - acc: 0.8367 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3305 - acc: 0.8458 - val.
Epoch 3/5

```



```

32560/32560 [=====] - 0s 14us/step - loss: 0.3274 - acc: 0.8479 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3248 - acc: 0.8474 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3228 - acc: 0.8499 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3565 - acc: 0.8341 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3290 - acc: 0.8464 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3262 - acc: 0.8482 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3248 - acc: 0.8482 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3231 - acc: 0.8484 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 25us/step - loss: 0.3569 - acc: 0.8332 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3288 - acc: 0.8467 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3257 - acc: 0.8491 - val.
Epoch 4/5

```

32560/32560 [=====] - 0s 13us/step - loss: 0.3231 - acc: 0.8494 - val.
Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3227 - acc: 0.8502 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3649 - acc: 0.8295 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3288 - acc: 0.8462 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3256 - acc: 0.8485 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3232 - acc: 0.8494 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3223 - acc: 0.8502 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3669 - acc: 0.8285 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3298 - acc: 0.8453 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3251 - acc: 0.8492 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3233 - acc: 0.8489 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3221 - acc: 0.8506 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3695 - acc: 0.8254 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3307 - acc: 0.8451 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3258 - acc: 0.8477 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3235 - acc: 0.8479 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3218 - acc: 0.8480 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3761 - acc: 0.8212 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3318 - acc: 0.8442 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3272 - acc: 0.8474 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3238 - acc: 0.8486 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3228 - acc: 0.8497 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
 Trainable params: 8,102
 Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 24us/step - loss: 0.3740 - acc: 0.8245 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3319 - acc: 0.8432 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3266 - acc: 0.8493 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3241 - acc: 0.8491 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3225 - acc: 0.8504 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
 Trainable params: 8,102
 Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3853 - acc: 0.8187 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3342 - acc: 0.8421 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3280 - acc: 0.8475 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3249 - acc: 0.8487 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3237 - acc: 0.8490 - val.

Layer (type)	Output Shape	Param #
--------------	--------------	---------

```

hidden (Dense)                (None, 100)                7900
-----
output (Dense)                (None, 2)                  202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3494 - acc: 0.8382 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3296 - acc: 0.8469 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3249 - acc: 0.8496 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3214 - acc: 0.8526 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3198 - acc: 0.8546 - val.
-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)                (None, 100)                7900
-----
output (Dense)                (None, 2)                  202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3478 - acc: 0.8356 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3302 - acc: 0.8461 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3269 - acc: 0.8459 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3248 - acc: 0.8490 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3237 - acc: 0.8494 - val.
-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)                (None, 100)                7900
-----

```

```

output (Dense)                (None, 2)                202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3659 - acc: 0.8268 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3288 - acc: 0.8470 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3263 - acc: 0.8473 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3257 - acc: 0.8485 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3242 - acc: 0.8495 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3588 - acc: 0.8308 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3283 - acc: 0.8464 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3251 - acc: 0.8484 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3246 - acc: 0.8478 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3240 - acc: 0.8482 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3595 - acc: 0.8326 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3296 - acc: 0.8463 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3250 - acc: 0.8486 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3241 - acc: 0.8490 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3231 - acc: 0.8501 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 24us/step - loss: 0.3638 - acc: 0.8290 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3296 - acc: 0.8462 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3247 - acc: 0.8501 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3234 - acc: 0.8501 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3221 - acc: 0.8496 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 20us/step - loss: 0.3698 - acc: 0.8260 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3304 - acc: 0.8448 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3252 - acc: 0.8478 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3234 - acc: 0.8500 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3224 - acc: 0.8496 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 24us/step - loss: 0.3762 - acc: 0.8245 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3328 - acc: 0.8437 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3266 - acc: 0.8482 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3238 - acc: 0.8498 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3228 - acc: 0.8489 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 22us/step - loss: 0.3846 - acc: 0.8197 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3329 - acc: 0.8446 - val.

Epoch 3/5

32560/32560 [=====] - 0s 15us/step - loss: 0.3271 - acc: 0.8474 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3239 - acc: 0.8491 - val.

Epoch 5/5

32560/32560 [=====] - 0s 15us/step - loss: 0.3224 - acc: 0.8500 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 25us/step - loss: 0.3876 - acc: 0.8179 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3354 - acc: 0.8435 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3289 - acc: 0.8456 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3254 - acc: 0.8480 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3230 - acc: 0.8506 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3492 - acc: 0.8361 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3284 - acc: 0.8490 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3231 - acc: 0.8510 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3195 - acc: 0.8544 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3173 - acc: 0.8545 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 24us/step - loss: 0.3511 - acc: 0.8350 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3314 - acc: 0.8456 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3281 - acc: 0.8476 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3259 - acc: 0.8486 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3235 - acc: 0.8489 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3559 - acc: 0.8342 - val.

```

```

Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3296 - acc: 0.8451 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3257 - acc: 0.8477 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3255 - acc: 0.8486 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3233 - acc: 0.8479 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3574 - acc: 0.8307 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3291 - acc: 0.8460 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3255 - acc: 0.8490 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3235 - acc: 0.8502 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3232 - acc: 0.8501 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3644 - acc: 0.8277 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3289 - acc: 0.8461 - val.

```

Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3258 - acc: 0.8483 - val.

Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3244 - acc: 0.8490 - val.

Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3228 - acc: 0.8494 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3661 - acc: 0.8278 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3287 - acc: 0.8453 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3253 - acc: 0.8490 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3227 - acc: 0.8492 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3220 - acc: 0.8501 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3760 - acc: 0.8219 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3322 - acc: 0.8451 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3271 - acc: 0.8476 - val.

```

Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3241 - acc: 0.8490 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3230 - acc: 0.8510 - val.

-----
Layer (type)              Output Shape              Param #
=====
hidden (Dense)            (None, 100)              7900
-----
output (Dense)            (None, 2)                202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3796 - acc: 0.8219 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3317 - acc: 0.8444 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3259 - acc: 0.8469 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3239 - acc: 0.8490 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3222 - acc: 0.8497 - val.

-----
Layer (type)              Output Shape              Param #
=====
hidden (Dense)            (None, 100)              7900
-----
output (Dense)            (None, 2)                202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 24us/step - loss: 0.3752 - acc: 0.8225 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3328 - acc: 0.8435 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3271 - acc: 0.8485 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3244 - acc: 0.8493 - val.

```

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3226 - acc: 0.8496 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3893 - acc: 0.8160 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3338 - acc: 0.8434 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3278 - acc: 0.8471 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3253 - acc: 0.8484 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3233 - acc: 0.8485 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 24us/step - loss: 0.3491 - acc: 0.8358 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3276 - acc: 0.8471 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3205 - acc: 0.8532 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3171 - acc: 0.8558 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3135 - acc: 0.8561 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3521 - acc: 0.8339 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3311 - acc: 0.8453 - val.

Epoch 3/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3290 - acc: 0.8469 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3260 - acc: 0.8468 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3252 - acc: 0.8469 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 24us/step - loss: 0.3545 - acc: 0.8350 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3282 - acc: 0.8468 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3271 - acc: 0.8475 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3241 - acc: 0.8477 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3244 - acc: 0.8497 - val.

Layer (type)	Output Shape	Param #
--------------	--------------	---------

```

=====
hidden (Dense)                (None, 100)                7900
-----
output (Dense)                (None, 2)                  202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3633 - acc: 0.8283 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3296 - acc: 0.8445 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3257 - acc: 0.8479 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3244 - acc: 0.8487 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3242 - acc: 0.8494 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)                (None, 100)                7900
-----
output (Dense)                (None, 2)                  202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 22us/step - loss: 0.3603 - acc: 0.8299 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3294 - acc: 0.8463 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3246 - acc: 0.8493 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3232 - acc: 0.8489 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3228 - acc: 0.8499 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)                (None, 100)                7900

```



```
-----
output (Dense)                (None, 2)                202
=====
```

```
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
```

```
-----
None
```

```
Train on 32560 samples, validate on 16281 samples
```

```
Epoch 1/5
```

```
32560/32560 [=====] - 1s 24us/step - loss: 0.3685 - acc: 0.8255 - val.
```

```
Epoch 2/5
```

```
32560/32560 [=====] - 0s 14us/step - loss: 0.3298 - acc: 0.8454 - val.
```

```
Epoch 3/5
```

```
32560/32560 [=====] - 0s 14us/step - loss: 0.3257 - acc: 0.8463 - val.
```

```
Epoch 4/5
```

```
32560/32560 [=====] - 0s 14us/step - loss: 0.3238 - acc: 0.8488 - val.
```

```
Epoch 5/5
```

```
32560/32560 [=====] - 0s 14us/step - loss: 0.3226 - acc: 0.8500 - val.
```

```
-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
```

```
-----
output (Dense)              (None, 2)                  202
=====
```

```
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0
```

```
-----
None
```

```
Train on 32560 samples, validate on 16281 samples
```

```
Epoch 1/5
```

```
32560/32560 [=====] - 1s 21us/step - loss: 0.3674 - acc: 0.8267 - val.
```

```
Epoch 2/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3298 - acc: 0.8460 - val.
```

```
Epoch 3/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3251 - acc: 0.8493 - val.
```

```
Epoch 4/5
```

```
32560/32560 [=====] - 0s 14us/step - loss: 0.3234 - acc: 0.8491 - val.
```

```
Epoch 5/5
```

```
32560/32560 [=====] - 0s 13us/step - loss: 0.3216 - acc: 0.8488 - val.
```

```
-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
```

```
-----
output (Dense)              (None, 2)                  202
=====
```

```

=====
Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 25us/step - loss: 0.3845 - acc: 0.8173 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3323 - acc: 0.8450 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3267 - acc: 0.8485 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3237 - acc: 0.8489 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3228 - acc: 0.8488 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3728 - acc: 0.8260 - val.
Epoch 2/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3326 - acc: 0.8451 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3275 - acc: 0.8476 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3247 - acc: 0.8484 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3232 - acc: 0.8501 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden (Dense)              (None, 100)                7900
-----
output (Dense)              (None, 2)                  202
=====

Total params: 8,102

```

Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 24us/step - loss: 0.3901 - acc: 0.8135 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3334 - acc: 0.8439 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3280 - acc: 0.8473 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3253 - acc: 0.8498 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3234 - acc: 0.8492 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3519 - acc: 0.8343 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3261 - acc: 0.8494 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3185 - acc: 0.8513 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3134 - acc: 0.8562 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3101 - acc: 0.8569 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 25us/step - loss: 0.3534 - acc: 0.8335 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3304 - acc: 0.8457 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3286 - acc: 0.8468 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3246 - acc: 0.8492 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3244 - acc: 0.8494 - val.

Layer (type)	Output Shape	Param #
=====		
hidden (Dense)	(None, 100)	7900

output (Dense)	(None, 2)	202
=====		

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3558 - acc: 0.8346 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3298 - acc: 0.8460 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3270 - acc: 0.8459 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3246 - acc: 0.8487 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3247 - acc: 0.8488 - val.

Layer (type)	Output Shape	Param #
=====		
hidden (Dense)	(None, 100)	7900

output (Dense)	(None, 2)	202
=====		

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3599 - acc: 0.8307 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3292 - acc: 0.8473 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3257 - acc: 0.8482 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3238 - acc: 0.8491 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3232 - acc: 0.8474 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3666 - acc: 0.8281 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3291 - acc: 0.8460 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3254 - acc: 0.8478 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3237 - acc: 0.8487 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3226 - acc: 0.8494 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102

Trainable params: 8,102

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

```

32560/32560 [=====] - 1s 21us/step - loss: 0.3709 - acc: 0.8257 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3295 - acc: 0.8451 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3257 - acc: 0.8493 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3238 - acc: 0.8489 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3229 - acc: 0.8488 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 26us/step - loss: 0.3721 - acc: 0.8261 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3307 - acc: 0.8459 - val.
Epoch 3/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3259 - acc: 0.8472 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3231 - acc: 0.8494 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3218 - acc: 0.8521 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3766 - acc: 0.8230 - val.
Epoch 2/5

```

```

32560/32560 [=====] - 0s 13us/step - loss: 0.3321 - acc: 0.8443 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3264 - acc: 0.8478 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3242 - acc: 0.8478 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3226 - acc: 0.8502 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 21us/step - loss: 0.3862 - acc: 0.8161 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3322 - acc: 0.8447 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3267 - acc: 0.8470 - val.
Epoch 4/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3244 - acc: 0.8485 - val.
Epoch 5/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3225 - acc: 0.8505 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

```

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 24us/step - loss: 0.3909 - acc: 0.8177 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3353 - acc: 0.8438 - val.
Epoch 3/5

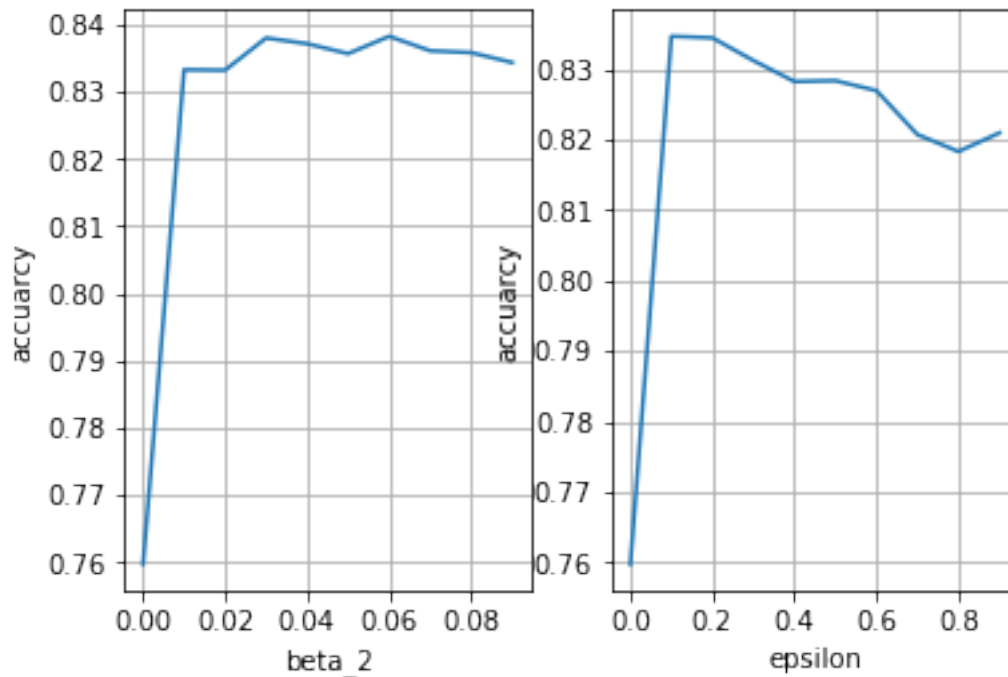
```

```

32560/32560 [=====] - 0s 14us/step - loss: 0.3280 - acc: 0.8462 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3248 - acc: 0.8494 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3230 - acc: 0.8500 - val.

```

```
Out[9]: Text(0,0.5,'accuarcy')
```



then we try to find out what the effect of hidden units on the acc

```

In [16]: acc =np.zeros((10,10))
         for i in range (10):
             K.clear_session()
             nin = Xtr_scale.shape[1] # dimension of input data
             nh = 10*i+10 # number of hidden units
             nout = int(2) # number of outputs = 2 since there is a class over income over
             model = Sequential()
             model.add(Dense(nh, input_shape=(nin,), activation='sigmoid', name='hidden'))
             model.add(Dense(nout, activation='softmax', name='output'))
             print (model.summary())
             from keras import optimizers
             opt = optimizers.Adam(lr=0.02 ,beta_1=0.9, beta_2=0.999, epsilon=1e-08, decay=0.0)
             model.compile(optimizer=opt,loss='sparse_categorical_crossentropy',metrics=['accu
             hist = model.fit(Xtr_scale, y_train, epochs=5, batch_size=100, validation_data=(X
             acc[i][0]= hist.history['acc'][0]

```



```
plt.plot(np.arange(10)*10+10,acc [:,0])
plt.grid()
plt.xlabel('hidden nodes number')
plt.ylabel('accuarcy')
```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 10)	790
output (Dense)	(None, 2)	22

Total params: 812
Trainable params: 812
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 19us/step - loss: 0.3432 - acc: 0.8379 - val.

Epoch 2/5

32560/32560 [=====] - 0s 12us/step - loss: 0.3226 - acc: 0.8519 - val.

Epoch 3/5

32560/32560 [=====] - 0s 12us/step - loss: 0.3161 - acc: 0.8540 - val.

Epoch 4/5

32560/32560 [=====] - 0s 11us/step - loss: 0.3115 - acc: 0.8549 - val.

Epoch 5/5

32560/32560 [=====] - 0s 12us/step - loss: 0.3107 - acc: 0.8550 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 20)	1580
output (Dense)	(None, 2)	42

Total params: 1,622
Trainable params: 1,622
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 20us/step - loss: 0.3494 - acc: 0.8328 - val.

Epoch 2/5

32560/32560 [=====] - 0s 12us/step - loss: 0.3224 - acc: 0.8502 - val.

Epoch 3/5

```

32560/32560 [=====] - 0s 12us/step - loss: 0.3156 - acc: 0.8542 - val.
Epoch 4/5
32560/32560 [=====] - 0s 12us/step - loss: 0.3117 - acc: 0.8547 - val.
Epoch 5/5
32560/32560 [=====] - 0s 12us/step - loss: 0.3087 - acc: 0.8575 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 30)	2370
output (Dense)	(None, 2)	62

```

Total params: 2,432
Trainable params: 2,432
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 19us/step - loss: 0.3459 - acc: 0.8364 - val.
Epoch 2/5
32560/32560 [=====] - 0s 12us/step - loss: 0.3219 - acc: 0.8516 - val.
Epoch 3/5
32560/32560 [=====] - 0s 12us/step - loss: 0.3156 - acc: 0.8543 - val.
Epoch 4/5
32560/32560 [=====] - 0s 12us/step - loss: 0.3091 - acc: 0.8567 - val.
Epoch 5/5
32560/32560 [=====] - 0s 12us/step - loss: 0.3068 - acc: 0.8559 - val.

```

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 40)	3160
output (Dense)	(None, 2)	82

```

Total params: 3,242
Trainable params: 3,242
Non-trainable params: 0

```

None

Train on 32560 samples, validate on 16281 samples

```

Epoch 1/5
32560/32560 [=====] - 1s 20us/step - loss: 0.3418 - acc: 0.8417 - val.
Epoch 2/5
32560/32560 [=====] - 0s 12us/step - loss: 0.3216 - acc: 0.8502 - val.
Epoch 3/5
32560/32560 [=====] - 0s 12us/step - loss: 0.3156 - acc: 0.8554 - val.
Epoch 4/5

```

32560/32560 [=====] - 0s 12us/step - loss: 0.3082 - acc: 0.8578 - val.
Epoch 5/5

32560/32560 [=====] - 0s 12us/step - loss: 0.3068 - acc: 0.8576 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 50)	3950
output (Dense)	(None, 2)	102

Total params: 4,052

Trainable params: 4,052

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 20us/step - loss: 0.3414 - acc: 0.8409 - val.

Epoch 2/5

32560/32560 [=====] - 0s 12us/step - loss: 0.3203 - acc: 0.8511 - val.

Epoch 3/5

32560/32560 [=====] - 0s 12us/step - loss: 0.3140 - acc: 0.8530 - val.

Epoch 4/5

32560/32560 [=====] - 0s 12us/step - loss: 0.3081 - acc: 0.8576 - val.

Epoch 5/5

32560/32560 [=====] - 0s 12us/step - loss: 0.3053 - acc: 0.8583 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 60)	4740
output (Dense)	(None, 2)	122

Total params: 4,862

Trainable params: 4,862

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 20us/step - loss: 0.3489 - acc: 0.8374 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3250 - acc: 0.8503 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3170 - acc: 0.8525 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3118 - acc: 0.8552 - val.

Epoch 5/5

32560/32560 [=====] - 0s 15us/step - loss: 0.3093 - acc: 0.8561 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 70)	5530
output (Dense)	(None, 2)	142

Total params: 5,672

Trainable params: 5,672

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 27us/step - loss: 0.3418 - acc: 0.8406 - val.

Epoch 2/5

32560/32560 [=====] - 1s 16us/step - loss: 0.3220 - acc: 0.8504 - val.

Epoch 3/5

32560/32560 [=====] - 0s 15us/step - loss: 0.3155 - acc: 0.8540 - val.

Epoch 4/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3094 - acc: 0.8568 - val.

Epoch 5/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3066 - acc: 0.8576 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 80)	6320
output (Dense)	(None, 2)	162

Total params: 6,482

Trainable params: 6,482

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 21us/step - loss: 0.3487 - acc: 0.8388 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3244 - acc: 0.8491 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3194 - acc: 0.8518 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3139 - acc: 0.8539 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3101 - acc: 0.8555 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 90)	7110
output (Dense)	(None, 2)	182

Total params: 7,292
Trainable params: 7,292
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 25us/step - loss: 0.3456 - acc: 0.8400 - val.

Epoch 2/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3223 - acc: 0.8511 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3151 - acc: 0.8542 - val.

Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3110 - acc: 0.8563 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3086 - acc: 0.8564 - val.

Layer (type)	Output Shape	Param #
hidden (Dense)	(None, 100)	7900
output (Dense)	(None, 2)	202

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 22us/step - loss: 0.3459 - acc: 0.8391 - val.

Epoch 2/5

32560/32560 [=====] - 0s 14us/step - loss: 0.3238 - acc: 0.8491 - val.

Epoch 3/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3197 - acc: 0.8509 - val.

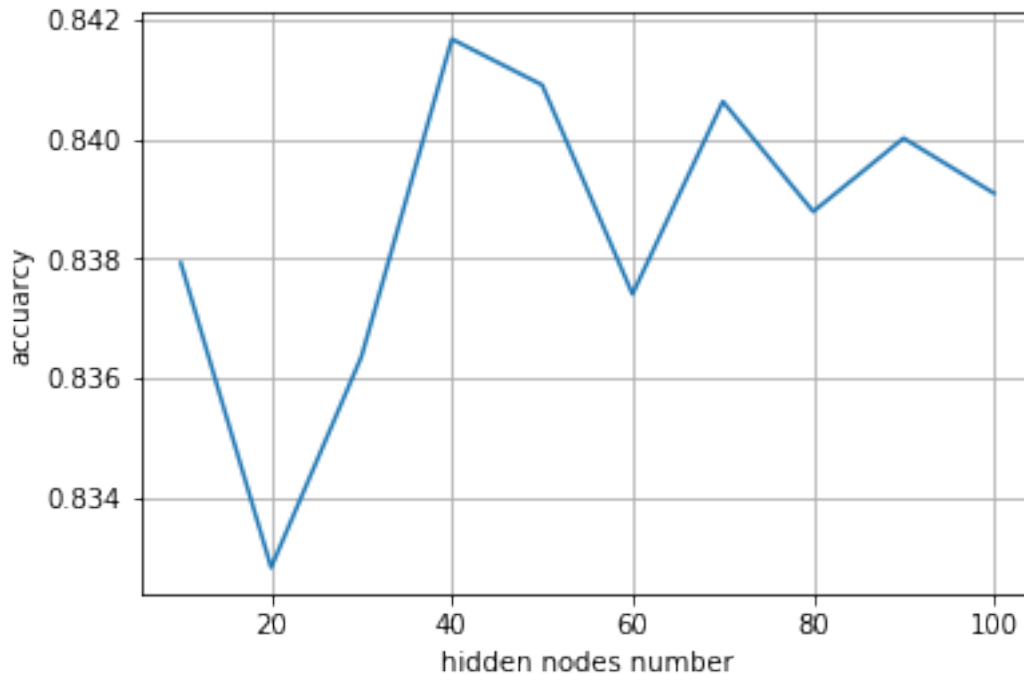
Epoch 4/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3129 - acc: 0.8543 - val.

Epoch 5/5

32560/32560 [=====] - 0s 13us/step - loss: 0.3097 - acc: 0.8561 - val.

Out[16]: Text(0,0.5,'accuarcy')



finanlly we try to using different layer number to test the acc

```
In [24]: acc = np.zeros((10,10))
         for i in range (1,10):
             K.clear_session()
             nin = Xtr_scale.shape[1] # dimension of input data
             nh = 100 # number of hidden units
             nout = int(2) # number of outputs = 2 since there is a class over income over
             model = Sequential()
             for j in range (i):
                 model.add(Dense(nh, input_shape=(nin,), activation='sigmoid', name='hidden'+str(j)))
             model.add(Dense(nout, activation='softmax', name='output'))
             print (model.summary())
             from keras import optimizers
             opt = optimizers.Adam(lr=0.02 ,beta_1=0.9, beta_2=0.999, epsilon=1e-08, decay=0.01)
             model.compile(optimizer=opt,loss='sparse_categorical_crossentropy',metrics=['accuracy'])
             hist = model.fit(Xtr_scale, y_train, epochs=5, batch_size=100, validation_data=(Xval_scale, yval))
             acc[i][0]= hist.history['acc'][0]

         plt.plot(np.arange(10),acc [:,0])
         plt.grid()
         plt.xlabel('layer number ')
         plt.ylabel('accuarcy')
```

Layer (type)

Output Shape

Param #

```

=====
hidden0 (Dense)                (None, 100)                7900
-----
output (Dense)                 (None, 2)                   202
=====

Total params: 8,102
Trainable params: 8,102
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 22us/step - loss: 0.3505 - acc: 0.8368 - val.
Epoch 2/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3240 - acc: 0.8483 - val.
Epoch 3/5
32560/32560 [=====] - 0s 13us/step - loss: 0.3188 - acc: 0.8517 - val.
Epoch 4/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3153 - acc: 0.8542 - val.
Epoch 5/5
32560/32560 [=====] - 0s 14us/step - loss: 0.3087 - acc: 0.8573 - val.

-----
Layer (type)                Output Shape                Param #
=====
hidden0 (Dense)             (None, 100)                7900
-----
hidden1 (Dense)             (None, 100)                10100
-----
output (Dense)              (None, 2)                   202
=====

Total params: 18,202
Trainable params: 18,202
Non-trainable params: 0

-----
None
Train on 32560 samples, validate on 16281 samples
Epoch 1/5
32560/32560 [=====] - 1s 31us/step - loss: 0.3525 - acc: 0.8383 - val.
Epoch 2/5
32560/32560 [=====] - 1s 18us/step - loss: 0.3201 - acc: 0.8525 - val.
Epoch 3/5
32560/32560 [=====] - 1s 17us/step - loss: 0.3129 - acc: 0.8556 - val.
Epoch 4/5
32560/32560 [=====] - 1s 17us/step - loss: 0.3082 - acc: 0.8577 - val.
Epoch 5/5
32560/32560 [=====] - 1s 17us/step - loss: 0.3046 - acc: 0.8583 - val.

-----
Layer (type)                Output Shape                Param #

```

hidden0 (Dense)	(None, 100)	7900
hidden1 (Dense)	(None, 100)	10100
hidden2 (Dense)	(None, 100)	10100
output (Dense)	(None, 2)	202

Total params: 28,302

Trainable params: 28,302

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 31us/step - loss: 0.3739 - acc: 0.8252 - val.

Epoch 2/5

32560/32560 [=====] - 1s 20us/step - loss: 0.3221 - acc: 0.8503 - val.

Epoch 3/5

32560/32560 [=====] - 1s 20us/step - loss: 0.3147 - acc: 0.8522 - val.

Epoch 4/5

32560/32560 [=====] - 1s 20us/step - loss: 0.3093 - acc: 0.8559 - val.

Epoch 5/5

32560/32560 [=====] - 1s 20us/step - loss: 0.3069 - acc: 0.8561 - val.

Layer (type)	Output Shape	Param #
hidden0 (Dense)	(None, 100)	7900
hidden1 (Dense)	(None, 100)	10100
hidden2 (Dense)	(None, 100)	10100
hidden3 (Dense)	(None, 100)	10100
output (Dense)	(None, 2)	202

Total params: 38,402

Trainable params: 38,402

Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 1s 36us/step - loss: 0.4000 - acc: 0.8171 - val.

Epoch 2/5

32560/32560 [=====] - 1s 23us/step - loss: 0.3328 - acc: 0.8455 - val.

Epoch 3/5
 32560/32560 [=====] - 1s 23us/step - loss: 0.3254 - acc: 0.8486 - val.
 Epoch 4/5
 32560/32560 [=====] - 1s 23us/step - loss: 0.3172 - acc: 0.8545 - val.
 Epoch 5/5
 32560/32560 [=====] - 1s 23us/step - loss: 0.3138 - acc: 0.8551 - val.

Layer (type)	Output Shape	Param #
hidden0 (Dense)	(None, 100)	7900
hidden1 (Dense)	(None, 100)	10100
hidden2 (Dense)	(None, 100)	10100
hidden3 (Dense)	(None, 100)	10100
hidden4 (Dense)	(None, 100)	10100
output (Dense)	(None, 2)	202

Total params: 48,502
 Trainable params: 48,502
 Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5
 32560/32560 [=====] - 1s 46us/step - loss: 0.5161 - acc: 0.7752 - val.
 Epoch 2/5
 32560/32560 [=====] - 1s 27us/step - loss: 0.3501 - acc: 0.8408 - val.
 Epoch 3/5
 32560/32560 [=====] - 1s 27us/step - loss: 0.3334 - acc: 0.8462 - val.
 Epoch 4/5
 32560/32560 [=====] - 1s 26us/step - loss: 0.3276 - acc: 0.8475 - val.
 Epoch 5/5
 32560/32560 [=====] - 1s 26us/step - loss: 0.3237 - acc: 0.8514 - val.

Layer (type)	Output Shape	Param #
hidden0 (Dense)	(None, 100)	7900
hidden1 (Dense)	(None, 100)	10100
hidden2 (Dense)	(None, 100)	10100
hidden3 (Dense)	(None, 100)	10100

hidden4 (Dense)	(None, 100)	10100

hidden5 (Dense)	(None, 100)	10100

output (Dense)	(None, 2)	202
=====		

Total params: 58,602
Trainable params: 58,602
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

32560/32560 [=====] - 2s 51us/step - loss: 0.4706 - acc: 0.7859 - val.

Epoch 2/5

32560/32560 [=====] - 1s 30us/step - loss: 0.3453 - acc: 0.8433 - val.

Epoch 3/5

32560/32560 [=====] - 1s 30us/step - loss: 0.3398 - acc: 0.8452 - val.

Epoch 4/5

32560/32560 [=====] - 1s 30us/step - loss: 0.3345 - acc: 0.8478 - val.

Epoch 5/5

32560/32560 [=====] - 1s 30us/step - loss: 0.3287 - acc: 0.8532 - val.

Layer (type)	Output Shape	Param #
=====		
hidden0 (Dense)	(None, 100)	7900

hidden1 (Dense)	(None, 100)	10100

hidden2 (Dense)	(None, 100)	10100

hidden3 (Dense)	(None, 100)	10100

hidden4 (Dense)	(None, 100)	10100

hidden5 (Dense)	(None, 100)	10100

hidden6 (Dense)	(None, 100)	10100

output (Dense)	(None, 2)	202
=====		

Total params: 68,702
Trainable params: 68,702
Non-trainable params: 0

None

Train on 32560 samples, validate on 16281 samples

Epoch 1/5

```

32560/32560 [=====] - 2s 58us/step - loss: 0.5668 - acc: 0.7541 - val.
Epoch 2/5
32560/32560 [=====] - 1s 33us/step - loss: 0.5524 - acc: 0.7592 - val.
Epoch 3/5
32560/32560 [=====] - 1s 35us/step - loss: 0.5529 - acc: 0.7592 - val.
Epoch 4/5
32560/32560 [=====] - 1s 34us/step - loss: 0.5528 - acc: 0.7592 - val.
Epoch 5/5
32560/32560 [=====] - 1s 34us/step - loss: 0.5531 - acc: 0.7592 - val.

```

Layer (type)	Output Shape	Param #
hidden0 (Dense)	(None, 100)	7900
hidden1 (Dense)	(None, 100)	10100
hidden2 (Dense)	(None, 100)	10100
hidden3 (Dense)	(None, 100)	10100
hidden4 (Dense)	(None, 100)	10100
hidden5 (Dense)	(None, 100)	10100
hidden6 (Dense)	(None, 100)	10100
hidden7 (Dense)	(None, 100)	10100
output (Dense)	(None, 2)	202

```

Total params: 78,802
Trainable params: 78,802
Non-trainable params: 0

```

```
None
```

```
Train on 32560 samples, validate on 16281 samples
```

```

Epoch 1/5
32560/32560 [=====] - 2s 63us/step - loss: 0.5668 - acc: 0.7575 - val.
Epoch 2/5
32560/32560 [=====] - 1s 37us/step - loss: 0.5530 - acc: 0.7592 - val.
Epoch 3/5
32560/32560 [=====] - 1s 37us/step - loss: 0.5535 - acc: 0.7592 - val.
Epoch 4/5
32560/32560 [=====] - 1s 37us/step - loss: 0.5541 - acc: 0.7592 - val.
Epoch 5/5
32560/32560 [=====] - 1s 37us/step - loss: 0.5536 - acc: 0.7592 - val.

```

Layer (type)	Output Shape	Param #
--------------	--------------	---------

```

=====
hidden0 (Dense)                (None, 100)                7900
-----
hidden1 (Dense)                (None, 100)                10100
-----
hidden2 (Dense)                (None, 100)                10100
-----
hidden3 (Dense)                (None, 100)                10100
-----
hidden4 (Dense)                (None, 100)                10100
-----
hidden5 (Dense)                (None, 100)                10100
-----
hidden6 (Dense)                (None, 100)                10100
-----
hidden7 (Dense)                (None, 100)                10100
-----
hidden8 (Dense)                (None, 100)                10100
-----
output (Dense)                 (None, 2)                  202
=====

```

```

Total params: 88,902
Trainable params: 88,902
Non-trainable params: 0

```

```

-----
None

```

```

Train on 32560 samples, validate on 16281 samples

```

```

Epoch 1/5

```

```

32560/32560 [=====] - 2s 63us/step - loss: 0.5627 - acc: 0.7565 - val.

```

```

Epoch 2/5

```

```

32560/32560 [=====] - 1s 40us/step - loss: 0.5530 - acc: 0.7592 - val.

```

```

Epoch 3/5

```

```

32560/32560 [=====] - 1s 40us/step - loss: 0.5529 - acc: 0.7592 - val.

```

```

Epoch 4/5

```

```

32560/32560 [=====] - 1s 40us/step - loss: 0.5533 - acc: 0.7592 - val.

```

```

Epoch 5/5

```

```

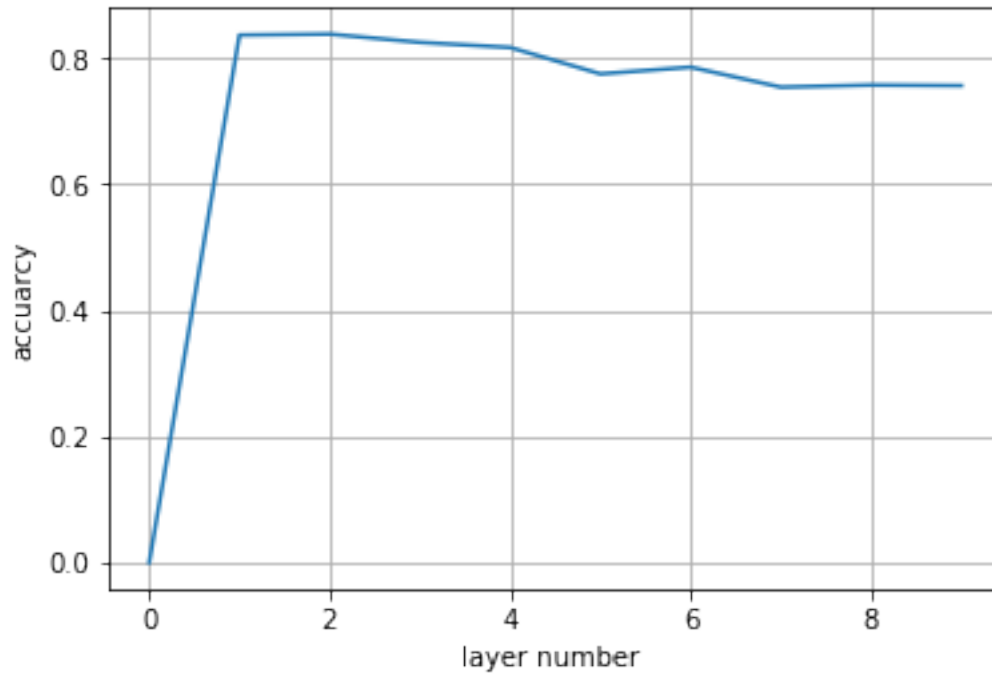
32560/32560 [=====] - 1s 40us/step - loss: 0.5531 - acc: 0.7592 - val.

```

```

Out[24]: Text(0,0.5,'accuarcy')

```



As the figure showing above, we found that maximum acc will be around 1 output layer with 0.02 learning rate 40 hidden layer, 0-0.3 beta_1 and 0.1 beta_2 and also with 0.01 the epsilon. Since the val_acc is very close to acc and both of them are around 85% for the maximum level, so it is hard to say NN is a best model for this classification. Since it takes us a lot of time to find every best parameter to use. The model may be too complex for this kind of simple classification.