#Importing tensorflow and keras library

```
In [1]: import tensorflow as tf
```

```
In [2]: import keras
```

```
Using TensorFlow backend.
```

```
In [3]: import pandas
        import sklearn
        import matplotlib
        import pandas as pd
```

#Read Dataset

```
In [4]: df = pd.read_csv('dlprj1.csv')
```

```
In [5]: df
```

Out[5]:

	Latitude	Longitude	Slope-gradient	Slope-aspect	PGA-Magnitude	Dist-active-fault	Land-cover	strata-unit	Class
0	140.847700	38.914299	81.32	55.19	7.64	2.692589e+00	1	4	1
1	140.844412	38.912714	81.32	55.19	7.64	2.692589e+00	1	4	1
2	140.851338	38.912466	81.32	55.19	7.64	2.692589e+00	1	4	1
3	140.851296	38.898872	58.88	34.62	7.03	2.692589e+00	1	5	1
4	140.861927	38.906827	73.66	48.76	7.52	2.692589e+00	1	4	1
...	...	...	...	...	...	...	...	...	...
349483	142.050235	39.951233	32.97	31.25	7.16	-3.400000e+38	9	0	0
349484	142.051676	39.960073	32.91	31.19	7.16	-3.400000e+38	9	0	0

#Pre-processing and scaling

```
In [10]: from sklearn import preprocessing
```

```
In [11]: min_max_scaler = preprocessing.MinMaxScaler()
```

```
In [12]: X_scale = min_max_scaler.fit_transform(X)
```

```
In [13]: X_scale
```

```
Out[13]: array([[0.89186774, 0.83691274, 0.34047099, ..., 1.        , 0.        ,
                 0.28571429],
                [0.89157391, 0.83669608, 0.34047099, ..., 1.        , 0.        ,
                 0.28571429],
                [0.89219281, 0.83666213, 0.34047099, ..., 1.        , 0.        ,
                 0.28571429],
                ...,
                [0.99959065, 0.98103351, 0.12002182, ..., 0.        , 0.72727273,
                 0.        ],
                [0.99965508, 0.98163751, 0.11965812, ..., 0.        , 0.72727273,
                 0.        ],
                [0.99971953, 0.98224151, 0.11965812, ..., 0.        , 0.72727273,
                 0.        ]])
```

Training and test data splitting.

70% training 30 % testing; 50% validation

In [14]:
```
from sklearn.model_selection import train_test_split
```

In [15]:
```
X_train, X_val_and_test, Y_train, Y_val_and_test = train_test_split(X_scale, Y, test_size=0.3)
```

In [16]:
```
X_val, X_test, Y_val, Y_test = train_test_split(X_val_and_test, Y_val_and_test, test_size=0.5)
```

In [17]:
```
print(X_train.shape, X_val.shape, X_test.shape, Y_train.shape, Y_val.shape, Y_test.shape)
```

```
(244641, 8) (52423, 8) (52424, 8) (244641,) (52423,) (52424,)
```

#Applying Convolution,Maxpooling Model Creation

In [20]:
```
model = Sequential()
#K.set_image_dim_ordering('th')
model.add(Convolution2D(30, 5, 5, border_mode= 'valid' , input_shape=(1, 28, 28),activation= 'relu' ))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Convolution2D(15, 3, 3, activation= 'relu' ))
model.add(MaxPooling2D(pool_size=(2, 2)))
```

```
WARNING:tensorflow:From E:\Anaconda3\envs\Intuitive-deep-learning\lib\site-packages\keras\backend\tensor
name tf.get_default_graph is deprecated. Please use tf.compat.v1.get_default_graph instead.

E:\Anaconda3\envs\Intuitive-deep-learning\lib\site-packages\ipykernel_launcher.py:5: UserWarning: Update
the Keras 2 API: `Conv2D(15, (3, 3), activation="relu")`
  """
```

In [21]:
```
model = Sequential([
    Dense(8, activation='relu', input_shape=(8,)),
    Dense(16, activation='relu'),
    Dense(16, activation='relu'),
    Dense(16, activation='relu'),
    Dense(1, activation='sigmoid'),
    ])
```

#Model Compilation:

In [22]:
```
model.compile(optimizer='sgd',
              loss='binary_crossentropy',
              metrics=['accuracy'])
```

```
WARNING:tensorflow:From E:\Anaconda3\envs\Intuitive-deep-learning\lib\site-packages\keras\optimizers.py:790: The name tf.train.
Optimizer is deprecated. Please use tf.compat.v1.train.Optimizer instead.

WARNING:tensorflow:From E:\Anaconda3\envs\Intuitive-deep-learning\lib\site-packages\keras\backend\tensorflow_backend.py:3376: T
he name tf.log is deprecated. Please use tf.math.log instead.

WARNING:tensorflow:From E:\Anaconda3\envs\Intuitive-deep-learning\lib\site-packages\tensorflow_core\python\ops\nn_impl.py:183:
where (from tensorflow.python.ops.array_ops) is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
```

#Fitting Model ;Batch size=100,epochs =5

```
In [23]: hist = model.fit(X_train, Y_train,
                          batch_size=100, epochs=5,
                          validation_data=(X_val, Y_val))
```

```
WARNING:tensorflow:From E:\Anaconda3\envs\Intuitive-deep-learning\lib\site-packages\keras\backend\tensorflow_backend.py:206: Th
e name tf.variables_initializer is deprecated. Please use tf.compat.v1.variables_initializer instead.

244641/244641 [==============================] - 5s 22us/step - loss: 0.1626 - acc: 0.9683 - val_loss: 0.1330 - val_acc: 0.9700
Epoch 2/5
244641/244641 [==============================] - 5s 20us/step - loss: 0.1272 - acc: 0.9689 - val_loss: 0.1144 - val_acc: 0.9700
Epoch 3/5
244641/244641 [==============================] - 5s 21us/step - loss: 0.1023 - acc: 0.9687 - val_loss: 0.0864 - val_acc: 0.9690
Epoch 4/5
244641/244641 [==============================] - 5s 19us/step - loss: 0.0833 - acc: 0.9705 - val_loss: 0.0781 - val_acc: 0.9730
Epoch 5/5
244641/244641 [==============================] - 5s 21us/step - loss: 0.0782 - acc: 0.9727 - val_loss: 0.0754 - val_acc: 0.9749
```

#Model evaluate and Model Summary

```
In [25]: model.evaluate(X_test, Y_test)[1]
```

```
52424/52424 [==============================] - 1s 21us/step
```

```
Out[25]: 0.9729322447733862
```

```
In [26]: model.summary()
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_1 (Dense)              (None, 8)                 72
_________________________________________________________________
dense_2 (Dense)              (None, 16)                144
_________________________________________________________________
dense_3 (Dense)              (None, 16)                272
_________________________________________________________________
dense_4 (Dense)              (None, 16)                272
_________________________________________________________________
dense_5 (Dense)              (None, 1)                 17
=================================================================
Total params: 777
```

#predict test probability

```
In [28]: # predict probabilities for test set
         yhat_probs = model.predict(X_test,verbose=0)
```

```
In [29]: print(yhat_probs)
```

```
[[0.07902193]
 [0.00526717]
 [0.0016492 ]
 ...
 [0.00604126]
 [0.6135472 ]
 [0.0077664 ]]
```

#Finding Accuracy,Precision,Recall,F1 score

In [35]:
```
# accuracy: (tp + tn) / (p + n)
accuracy = accuracy_score(Y_test, yhat_classes)
print('Accuracy: %f' % accuracy)
```

```
Accuracy: 0.972932
```

In [36]:
```
# precision tp / (tp + fp)
precision = precision_score(Y_test, yhat_classes)
print('Precision: %f' % precision)
```

```
Precision: 0.602728
```

In [37]:
```
# recall: tp / (tp + fn)
recall = recall_score(Y_test, yhat_classes)
print('Recall: %f' % recall)
# f1: 2 tp / (2 tp + fp + fn)
f1 = f1_score(Y_test, yhat_classes)
print('F1 score: %f' % f1)
```

```
Recall: 0.425904
F1 score: 0.499118
```

#Kappa Score

In [38]:
```
#Cohen suggested the Kappa result be interpreted as follows:
#values ≤ 0 as indicating no agreement and
#0.01–0.20 as none to slight, 0.21–0.40 as fair,
#0.41– 0.60 as moderate, 0.61–0.80 as substantial,
#0.81–1.00 as almost perfect agreement

# kappa
kappa = cohen_kappa_score(Y_test, yhat_classes)
print('Cohens kappa: %f' % kappa)
# ROC AUC
auc = roc_auc_score(Y_test, yhat_probs)
print('ROC AUC: %f' % auc)
```

```
Cohens kappa: 0.485630
ROC AUC: 0.934259
```

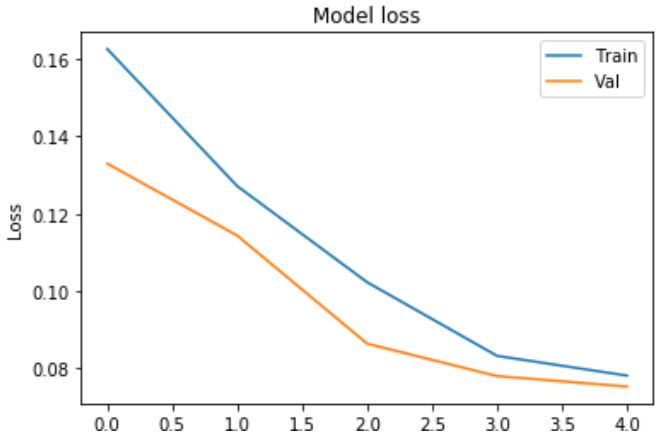
#Confusion matrix

In [39]:
```
# confusion matrix
matrix = confusion_matrix(Y_test, yhat_classes)
print(matrix)
```

```
[[50298   466]
 [  953   707]]
```

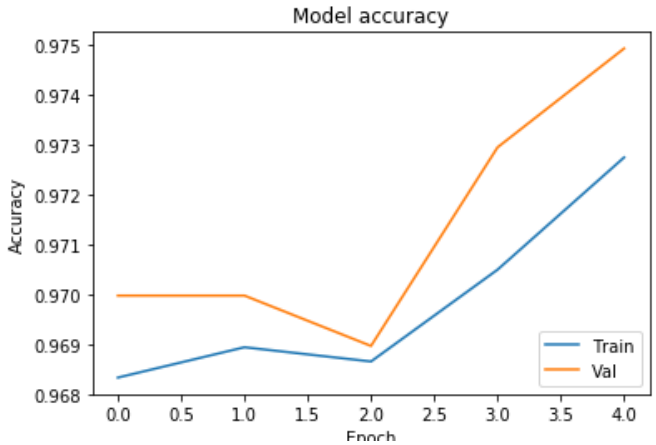
#Model Loss

In [41]:
```
plt.plot(hist.history['loss'])
plt.plot(hist.history['val_loss'])
plt.title('Model loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['Train', 'Val'], loc='upper right')
plt.show()
```



#Model Accuracy

In [42]:
```
plt.plot(hist.history['acc'])
plt.plot(hist.history['val_acc'])
plt.title('Model accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['Train', 'Val'], loc='lower right')
plt.show()
```



#ROC curve

In [49]:
```
# plot the roc curve for the model
pyplot.plot(ns_fpr, ns_tpr, linestyle='--', label='No Skill')
pyplot.plot(lr_fpr, lr_tpr, marker='.', label='Logistic')
# axis labels
pyplot.xlabel('False Positive Rate')
pyplot.ylabel('True Positive Rate')
```

Out[49]:
```
Text(0, 0.5, 'True Positive Rate')
```