In [1]:
```python
from sklearn.utils import shuffle
from __future__ import division
import numpy as np
import scipy as sp
import pandas as pd
import csv
import random as rn

import matplotlib.pyplot as plt
```

In [47]:
```python
from sklearn.ensemble import GradientBoostingClassifier, RandomForestClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.decomposition import KernelPCA, PCA
from sklearn.linear_model import LogisticRegressionCV
from sklearn import svm, cross_validation, grid_search
from sklearn.metrics import accuracy_score
from sklearn.feature_selection import f_classif, RFECV, SelectKBest
from sklearn.model_selection import KFold
from sklearn.preprocessing import MinMaxScaler
```

In [3]:
```python
dataLoc = r'/home/jytay/Documents/cogs118a/project/ad-dataset/adult.csv'
skinDF = pd.read_csv(dataLoc)
```

In [4]:
```python
skinDF.head()
```

Out[4]:

	age	workclass	fnlwgt	education	education.num	marital.status	occupation	relati
0	90	?	77053	HS-grad	9	Widowed	?	Not-in
1	82	Private	132870	HS-grad	9	Widowed	Exec-managerial	Not-in
2	66	?	186061	Some-college	10	Widowed	?	Unma
3	54	Private	140359	7th-8th	4	Divorced	Machine-op-inspct	Unma
4	41	Private	264663	Some-college	10	Separated	Prof-specialty	Own-c

In [5]:
```python
# see number of Nan in columns
# https://machinelearningmastery.com/handle-missing-data-python/
print((skinDF[[1,6,-2]] == '?').sum())
```

```
workclass        1836
occupation       1843
native.country    583
dtype: int64
```

```
In [6]: row =skinDF.shape[0]
        col = skinDF.shape[1]
```

```
In [7]: skinDF = skinDF.replace('?',np.NaN)
```

```
In [8]: print((skinDF['workclass']== '?').sum())
```

```
0
```

```
In [9]: skinDF.head()
```

Out[9]:

	age	workclass	fnlwgt	education	education.num	marital.status	occupation	relati
0	90	NaN	77053	HS-grad	9	Widowed	NaN	Not-ir
1	82	Private	132870	HS-grad	9	Widowed	Exec-managerial	Not-ir
2	66	NaN	186061	Some-college	10	Widowed	NaN	Unma
3	54	Private	140359	7th-8th	4	Divorced	Machine-op-inspct	Unma
4	41	Private	264663	Some-college	10	Separated	Prof-specialty	Own-c

```
In [10]: skinDF = skinDF.dropna()
```

```
In [11]: skinDF.head()
```

Out[11]:

	age	workclass	fnlwgt	education	education.num	marital.status	occupation	relati
1	82	Private	132870	HS-grad	9	Widowed	Exec-managerial	Not-ir
3	54	Private	140359	7th-8th	4	Divorced	Machine-op-inspct	Unma
4	41	Private	264663	Some-college	10	Separated	Prof-specialty	Own-c
5	34	Private	216864	HS-grad	9	Divorced	Other-service	Unma
6	38	Private	150601	10th	6	Separated	Adm-clerical	Unma

```
In [12]: skinDF = shuffle(skinDF)
```

```
In [13]: skinDF.head()
```

Out[13]:

	age	workclass	fnlwgt	education	education.num	marital.status	occupation	
19630	24	Private	228960	Assoc-acdm	12	Never-married	Adm-clerical	C
5822	25	Local-gov	190057	Bachelors	13	Never-married	Prof-specialty	C
23382	26	Private	335533	HS-grad	9	Never-married	Craft-repair	C
27041	53	Private	151411	Bachelors	13	Married-civ-spouse	Prof-specialty	H
13862	27	Private	114967	9th	5	Married-civ-spouse	Craft-repair	H

```
In [14]: del skinDF['education']
```

```
In [15]: del skinDF['fnlwgt']
```

```
In [16]: del skinDF['capital.gain']
```

```
In [17]: del skinDF['capital.loss']
```

```
In [18]: del skinDF['age']
```

```
In [19]: del skinDF['hours.per.week']
```

```
In [20]: skinDF.head()
```

Out[20]:

	workclass	education.num	marital.status	occupation	relationship	race	sex	
19630	Private	12	Never-married	Adm-clerical	Own-child	White	Fema
5822	Local-gov	13	Never-married	Prof-specialty	Own-child	White	Fema
23382	Private	9	Never-married	Craft-repair	Own-child	White	Male
27041	Private	13	Married-civ-spouse	Prof-specialty	Husband	White	Male
13862	Private	5	Married-civ-spouse	Craft-repair	Husband	White	Male

In [21]:
```python
cols_to_transform = [ 'workclass', 'occupation',  'education.num', 'm
arital.status', 'race',\
                      'sex','native.country', 'relationship', 'income']
skinDF_with_dummies = pd.get_dummies(skinDF, columns = cols_to_transf
orm )
```

In [22]:
```python
CountryCol = [col for col in skinDF_with_dummies.columns if 'native.c
ountry' in col]
print(CountryCol)
```
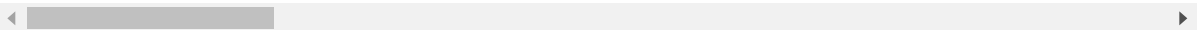
['native.country_Cambodia', 'native.country_Canada', 'native.country_
China', 'native.country_Columbia', 'native.country_Cuba', 'native.cou
ntry_Dominican-Republic', 'native.country_Ecuador', 'native.country_E
l-Salvador', 'native.country_England', 'native.country_France', 'nati
ve.country_Germany', 'native.country_Greece', 'native.country_Guatema
la', 'native.country_Haiti', 'native.country_Holand-Netherlands', 'na
tive.country_Honduras', 'native.country_Hong', 'native.country_Hungar
y', 'native.country_India', 'native.country_Iran', 'native.country_Ir
eland', 'native.country_Italy', 'native.country_Jamaica', 'native.cou
ntry_Japan', 'native.country_Laos', 'native.country_Mexico', 'native.
country_Nicaragua', 'native.country_Outlying-US(Guam-USVI-etc)', 'nat
ive.country_Peru', 'native.country_Philippines', 'native.country_Pola
nd', 'native.country_Portugal', 'native.country_Puerto-Rico', 'nativ
e.country_Scotland', 'native.country_South', 'native.country_Taiwan',
'native.country_Thailand', 'native.country_Trinadad&Tobago', 'native.
country_United-States', 'native.country_Vietnam', 'native.country_Yug
oslavia']

In [23]:
```python
skinDF_with_dummies.head()
```

Out[23]:

	workclass_Federal-gov	workclass_Local-gov	workclass_Private	workclass_Self-emp-inc	work emp
19630	0.0	0.0	1.0	0.0	0.0
5822	0.0	1.0	0.0	0.0	0.0
23382	0.0	0.0	1.0	0.0	0.0
27041	0.0	0.0	1.0	0.0	0.0
13862	0.0	0.0	1.0	0.0	0.0

5 rows × 100 columns

In [24]:
```
skinArray = skinDF_with_dummies.as_matrix()
skinArrayRF = skinDF

X = skinArray[:5000,:-1]
Y = skinArray[:5000,-1]

X_rf = skinArray[:5000,:-1]
Y_rf = skinArray[:5000,-1]

X.shape[1]
```

Out[24]: 99

In [25]:
```
skinDF_with_dummies.head()
```

Out[25]:

	workclass_Federal-gov	workclass_Local-gov	workclass_Private	workclass_Self-emp-inc	work emp
19630	0.0	0.0	1.0	0.0	0.0
5822	0.0	1.0	0.0	0.0	0.0
23382	0.0	0.0	1.0	0.0	0.0
27041	0.0	0.0	1.0	0.0	0.0
13862	0.0	0.0	1.0	0.0	0.0

5 rows × 100 columns

In [26]:
```
# first proportion : 20 80
X_train, X_test, Y_train, Y_test = cross_validation.train_test_split(
X,Y, train_size=.2)

X_trainRF,X_testRF,Y_trainRF, Y_testRF = cross_validation.train_test_
split(X,Y, train_size=.2)

# 2nd proportion : 40 60
X_train2, X_test2, Y_train2, Y_test2 = cross_validation.train_test_sp
lit(X,Y, train_size = .4)
X_trainRF2, X_testRF2, Y_trainRF2, Y_testRF2 = cross_validation.train
_test_split(X,Y,train_size = .4)

# 3rd proportion: 50 50
X_train3, X_test3, Y_train3, Y_test3 = cross_validation.train_test_sp
lit(X,Y, train_size = .5)
X_trainRF3, X_testRF3, Y_trainRF3, Y_testRF3 = cross_validation.train
_test_split(X,Y, train_size = .5)
```

In [27]:
```python
# Logit L1 for 20 80
logit_clf = LogisticRegressionCV(solver='liblinear', Cs=[.001,.01,.1,
1,10,100], cv=5, penalty='l1')
logit_clf.fit(X_train, Y_train)
log11_score = logit_clf.score(X_test, Y_test)
print(log11_score)
```

```
1.0
```

In [28]:
```python
# Logit L1  for 40 60
logit_clf = LogisticRegressionCV(solver='liblinear', Cs=[.001,.01,.1,
1,10,100], cv=5, penalty='l1')
logit_clf.fit(X_train2, Y_train2)
log12_score = logit_clf.score(X_test2, Y_test2)
print(log12_score)
```

```
1.0
```

In [29]:
```python
# Logit L1 for 50 50
logit_clf = LogisticRegressionCV(solver='liblinear', Cs=[.001,.01,.1,
1,10,100], cv=5, penalty='l1')
logit_clf.fit(X_train3, Y_train3)
log13_score = logit_clf.score(X_test3, Y_test3)
print(log13_score)
```

```
1.0
```

In [30]:
```python
# Logit l2 for 20 80
logit_clf = LogisticRegressionCV(solver='newton-cg', Cs=[.001,.01,.1,
1,10,100], cv=5,
                                  multi_class='multinomial', penalty=
'l2')
logit_clf.fit(X_train, Y_train)
log21_score = logit_clf.score(X_test, Y_test)
print(log21_score)
```

```
1.0
```

In [31]:
```python
# Logit l2 for 40 60
logit_clf = LogisticRegressionCV(solver='newton-cg', Cs=[.001,.01,.1,
1,10,100], cv=5,
                                  multi_class='multinomial', penalty=
'l2')
logit_clf.fit(X_train2, Y_train2)
log22_score = logit_clf.score(X_test2, Y_test2)
print(log22_score)
```

```
1.0
```

In [32]:
```python
# Logit l2 for 50 50
logit_clf = LogisticRegressionCV(solver='newton-cg', Cs=[.001,.01,.1,
1,10,100], cv=5,
                                    multi_class='multinomial', penalty=
'l2')
logit_clf.fit(X_train3, Y_train3)
log23_score = logit_clf.score(X_test3, Y_test3)
print(log23_score)
```

```
1.0
```

In [33]:
```python
# average values for L1 and L2 proportions
L1_logit_avg = (log11_score + log12_score + log12_score)/ 3
L2_logit_avg = (log21_score + log22_score + log23_score) / 3

print(L1_logit_avg)
print(L2_logit_avg)
```

```
1.0
1.0
```

In [35]:
```python
# Random Forests 20 80
rf_params = {"max_features":[6,8,12,14,16],
             "n_estimators":[1024,1300,1500]}
clf = RandomForestClassifier()
rf_clf = grid_search.GridSearchCV(clf, rf_params, cv=5, n_jobs=2)
rf_clf.fit(X_trainRF,Y_trainRF)
print(rf_clf.best_score_)
print(rf_clf.best_params_)

rf1_score = rf_clf.best_score_
rf1_bestParams = rf_clf.best_params_
```

```
1.0
{'n_estimators': 1024, 'max_features': 12}
```

In [38]:
```python
# Random Forests 40 60
rf_params = {"max_features":[1,2,4,8,12,14],
             "n_estimators":[200,300,400,1024]}
clf = RandomForestClassifier()
rf_clf = grid_search.GridSearchCV(clf, rf_params, cv=5, n_jobs=2)
rf_clf.fit(X_trainRF2,Y_trainRF2)
print(rf_clf.best_score_)
print(rf_clf.best_params_)
rf2_score = rf_clf.best_score_
rf2_bestParams = rf_clf.best_params_
```

```
1.0
{'n_estimators': 200, 'max_features': 8}
```

In [39]:
```
# Random Forests 50 50
rf_params = {"max_features":[1,2,4,8,12,14],
             "n_estimators":[700,900,1024,1300, 1500]}# avg score for
 each proportion of splitting

clf = RandomForestClassifier()
rf_clf = grid_search.GridSearchCV(clf, rf_params, cv=5, n_jobs=4)
rf_clf.fit(X_trainRF3,Y_trainRF3)
print(rf_clf.best_score_)
print(rf_clf.best_params_)

rf3_score = rf_clf.best_score_
rf3_bestParams = rf_clf.best_params_
```

```
1.0
{'n_estimators': 700, 'max_features': 8}
```

In [40]:
```
# avg score for each proportion of splitting

RF_avgScore = (rf1_score + rf2_score + rf3_score) / 3
print(RF_avgScore)
```

```
1.0
```

In [41]:
```
# KNN 20 80
knn_params = {"n_neighbors":[5,7,10,15,25,50,100,500]}
clf = KNeighborsClassifier()
knn_clf = grid_search.GridSearchCV(clf, knn_params, cv=5, n_jobs=4)
knn_clf.fit(X_train,Y_train);
print(knn_clf.best_score_)
knn_clf.best_params_

KNN_1score = knn_clf.best_score_
```

```
0.939
```

In [42]:
```
# KNN 40 60
knn_clf.fit(X_train2,Y_train2);
print(knn_clf.best_score_)
knn_clf.best_params_

KNN_2score = knn_clf.best_score_
```

```
0.9365
```

In [43]:
```
# KNN 50 50
knn_clf.fit(X_train3,Y_train3);
print(knn_clf.best_score_)
knn_clf.best_params_

KNN_3score = knn_clf.best_score_
```

```
0.9464
```

In [44]:
```python
# avg KNN score
KNN_avg = (KNN_1score + KNN_2score + KNN_3score)/3
print(KNN_avg)
```

0.9406333333333333

In [41]:
```python
# Gradient Boosting
gb_params = {"n_estimators":[512,1024],
             "learning_rate":[.01,.1]}
clf = GradientBoostingClassifier()
gb_clf = grid_search.GridSearchCV(clf, gb_params, cv=5, n_jobs=4)
gb_clf.fit(X_train,Y_train);
print(gb_clf.best_score_)
gb_clf.best_params_
GB_1score = gb_clf.best_score_
```

1.0

In [42]:
```python
gb_clf.fit(X_train2,Y_train2);
print(gb_clf.best_score_)
gb_clf.best_params_
GB_2score = gb_clf.best_score_
```

1.0

In [43]:
```python
gb_clf.fit(X_train3,Y_train3);
print(gb_clf.best_score_)
gb_clf.best_params_
GB_3score = gb_clf.best_score_
```

1.0

In [44]:
```python
# avg B score
GB_avg = (GB_1score + GB_2score + GB_3score) / 3
print(GB_avg)
```

1.0

In [48]:
```python
# code to speed up svm
# proportion 1
scaling = MinMaxScaler(feature_range=(-1,1)).fit(X_train)
X_train = scaling.transform(X_train)
X_test = scaling.transform(X_test)

#proportion 2
scaling = MinMaxScaler(feature_range=(-1,1)).fit(X_train2)
X_train2 = scaling.transform(X_train2)
X_test2 = scaling.transform(X_test2)

#proportion 3
scaling = MinMaxScaler(feature_range=(-1,1)).fit(X_train3)
X_train3 = scaling.transform(X_train3)
X_test3 = scaling.transform(X_test3)
```

In [49]:
```python
# SVM
svm_params = {'C':[0.01,1,10,100,500,700,1200,1500,1800], 'degree':[1
,2,3,4]}
clf = svm.SVC(kernel='poly')
svm_clf = grid_search.GridSearchCV(clf, svm_params, cv=5, n_jobs=4)
svm_clf.fit(X_train,Y_train)
print(svm_clf.best_score_)
svm_clf.best_params_
```

```
/home/jytay/anaconda3/lib/python3.5/site-packages/sklearn/svm/base.p
y:194: FutureWarning: The default value of gamma will change from 'au
to' to 'scale' in version 0.22 to account better for unscaled feature
s. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
  "avoid this warning.", FutureWarning)
/home/jytay/anaconda3/lib/python3.5/site-packages/sklearn/svm/base.p
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  "avoid this warning.", FutureWarning)
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  "avoid this warning.", FutureWarning)
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  "avoid this warning.", FutureWarning)
/home/jytay/anaconda3/lib/python3.5/site-packages/sklearn/svm/base.p
y:194: FutureWarning: The default value of gamma will change from 'au
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  "avoid this warning.", FutureWarning)
/home/jytay/anaconda3/lib/python3.5/site-packages/sklearn/svm/base.p
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  "avoid this warning.", FutureWarning)
/home/jytay/anaconda3/lib/python3.5/site-packages/sklearn/svm/base.p
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```

```
to' to 'scale' in version 0.22 to account better for unscaled feature
s. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
  "avoid this warning.", FutureWarning)
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  "avoid this warning.", FutureWarning)
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  "avoid this warning.", FutureWarning)
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  "avoid this warning.", FutureWarning)
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  "avoid this warning.", FutureWarning)
/home/jytay/anaconda3/lib/python3.5/site-packages/sklearn/svm/base.p
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to' to 'scale' in version 0.22 to account better for unscaled feature
s. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
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```

Out[49]: {'C': 1, 'degree': 1}

In [50]:
```python
# SVM 2
svm_params = {'C':[.01,1,10,100,500,700,1200,1500,1800], 'degree':[1,
2,3,4]}
clf = svm.SVC(kernel='poly')
svm_clf = grid_search.GridSearchCV(clf, svm_params, cv=5, n_jobs=4)
svm_clf.fit(X_train2,Y_train2)
print(svm_clf.best_score_)
svm_clf.best_params_
```

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Out[50]: {'C': 1, 'degree': 1}

In [51]:
```
# SVM 3
svm_params = {'C':[.01,1,10,100,500,700,1200,1500,1800], 'degree':[1,
2,3,4]}
clf = svm.SVC(kernel='poly')
svm_clf = grid_search.GridSearchCV(clf, svm_params, cv=5, n_jobs=4)
svm_clf.fit(X_train3,Y_train3)
print(svm_clf.best_score_)
svm_clf.best_params_
```

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Out[51]: {'C': 1, 'degree': 1}
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