How To Get Rich?

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Motivation

Why did we choose this topic?

What did we want to find?

What did our work process look like?

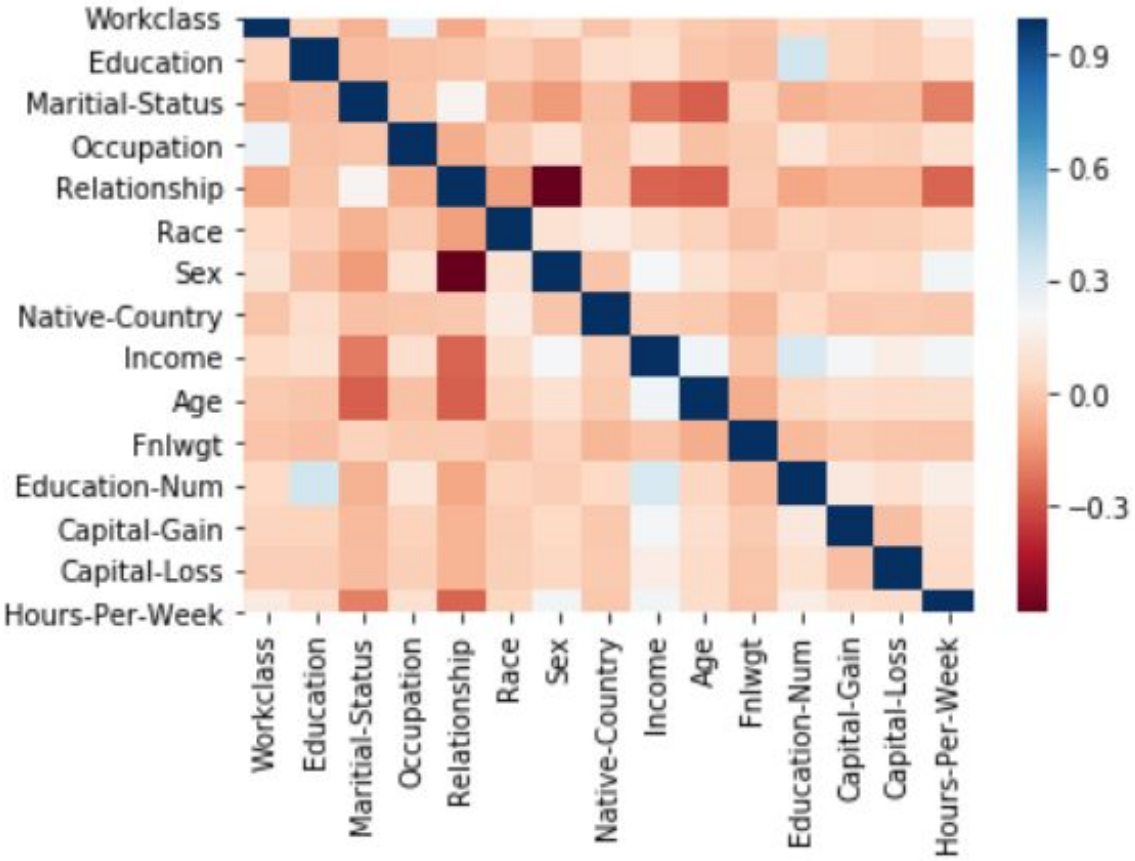
Data Preprocessing

39	State-gov	77516	Bachelors	13	Never-mar	Adm-cleric	Not-in-fam	White	Male	2174	0	40	United-Sta	<=50K
50	Self-emp-r	83311	Bachelors	13	Married-ci	Exec-mana	Husband	White	Male	0	0	13	United-Sta	<=50K
38	Private	215646	HS-grad	9	Divorced	Handlers-c	Not-in-fam	White	Male	0	0	40	United-Sta	<=50K
53	Private	234721	11th	7	Married-ci	Handlers-c	Husband	Black	Male	0	0	40	United-Sta	<=50K
28	Private	338409	Bachelors	13	Married-ci	Prof-specia	Wife	Black	Female	0	0	40	Cuba	<=50K
37	Private	284582	Masters	14	Married-ci	Exec-mana	Wife	White	Female	0	0	40	United-Sta	<=50K
49	Private	160187	9th	5	Married-sp	Other-serv	Not-in-fam	Black	Female	0	0	16	Jamaica	<=50K
52	Self-emp-r	209642	HS-grad	9	Married-ci	Exec-mana	Husband	White	Male	0	0	45	United-Sta	>50K
31	Private	45781	Masters	14	Never-mar	Prof-specia	Not-in-fam	White	Female	14084	0	50	United-Sta	>50K
42	Private	159449	Bachelors	13	Married-ci	Exec-mana	Husband	White	Male	5178	0	40	United-Sta	>50K
37	Private	280464	Some-colle	10	Married-ci	Exec-mana	Husband	Black	Male	0	0	80	United-Sta	>50K
30	State-gov	141297	Bachelors	13	Married-ci	Prof-specia	Husband	Asian-Pac-	Male	0	0	40	India	>50K
23	Private	122272	Bachelors	13	Never-mar	Adm-cleric	Own-child	White	Female	0	0	30	United-Sta	<=50K
32	Private	205019	Assoc-acdr	12	Never-mar	Sales	Not-in-fam	Black	Male	0	0	50	United-Sta	<=50K
40	Private	121772	Assoc-voc	11	Married-ci	Craft-repai	Husband	Asian-Pac-	Male	0	0	40	?	>50K
34	Private	245487	7th-8th	4	Married-ci	Transport-	Husband	Amer-India	Male	0	0	45	Mexico	<=50K
25	Self-emp-r	176756	HS-grad	9	Never-mar	Farming-fi	Own-child	White	Male	0	0	35	United-Sta	<=50K
32	Private	186824	HS-grad	9	Never-mar	Machine-o	Unmarried	White	Male	0	0	40	United-Sta	<=50K
38	Private	28887	11th	7	Married-ci	Sales	Husband	White	Male	0	0	50	United-Sta	<=50K
43	Self-emp-r	292175	Masters	14	Divorced	Exec-mana	Unmarried	White	Female	0	0	45	United-Sta	>50K
40	Private	193524	Doctorate	16	Married-ci	Prof-specia	Husband	White	Male	0	0	60	United-Sta	>50K
54	Private	302146	HS-grad	9	Separated	Other-serv	Unmarried	Black	Female	0	0	20	United-Sta	<=50K
35	Federal-go	76845	9th	5	Married-ci	Farming-fi	Husband	Black	Male	0	0	40	United-Sta	<=50K
43	Private	117037	11th	7	Married-ci	Transport-	Husband	White	Male	0	2042	40	United-Sta	<=50K
59	Private	109015	HS-grad	9	Divorced	Tech-suppo	Unmarried	White	Female	0	0	40	United-Sta	<=50K
56	Local-gov	216851	Bachelors	13	Married-ci	Tech-suppo	Husband	White	Male	0	0	40	United-Sta	>50K
19	Private	168294	HS-grad	9	Never-mar	Craft-repai	Own-child	White	Male	0	0	40	United-Sta	<=50K

	39	State-gov	77516	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	2174	0	40	United-States	<=50K
0	50	Self-emp-not-inc	83311	Bachelors	13	Married-civ-spouse	Exec-managerial	Husband	White	Male	0	0	13	United-States	<=50K
1	38	Private	215646	HS-grad	9	Divorced	Handlers-cleaners	Not-in-family	White	Male	0	0	40	United-States	<=50K
2	53	Private	234721	11th	7	Married-civ-spouse	Handlers-cleaners	Husband	Black	Male	0	0	40	United-States	<=50K
3	28	Private	338409	Bachelors	13	Married-civ-spouse	Prof-specialty	Wife	Black	Female	0	0	40	Cuba	<=50K
4	37	Private	284582	Masters	14	Married-civ-spouse	Exec-managerial	Wife	White	Female	0	0	40	United-States	<=50K
5	49	Private	160187	9th	5	Married-spouse-absent	Other-service	Not-in-family	Black	Female	0	0	16	Jamaica	<=50K
6	52	Self-emp-not-inc	209642	HS-grad	9	Married-civ-spouse	Exec-managerial	Husband	White	Male	0	0	45	United-States	>50K
7	31	Private	45781	Masters	14	Never-married	Prof-specialty	Not-in-family	White	Female	14084	0	50	United-States	>50K
8	42	Private	159449	Bachelors	13	Married-civ-spouse	Exec-managerial	Husband	White	Male	5178	0	40	United-States	>50K
9	37	Private	280464	Some-college	10	Married-civ-spouse	Exec-managerial	Husband	Black	Male	0	0	80	United-States	>50K
10	30	State-gov	141297	Bachelors	13	Married-civ-spouse	Prof-specialty	Husband	Asian-Pac-Islander	Male	0	0	40	India	>50K
11	23	Private	122272	Bachelors	13	Never-married	Adm-clerical	Own-child	White	Female	0	0	30	United-States	<=50K
12	32	Private	205019	Assoc-acdm	12	Never-married	Sales	Not-in-family	Black	Male	0	0	50	United-States	<=50K
13	40	Private	121772	Assoc-voc	11	Married-civ-spouse	Craft-repair	Husband	Asian-Pac-Islander	Male	0	0	40	?	>50K
14	34	Private	245487	7th-8th	4	Married-civ-spouse	Transport-moving	Husband	Amer-Indian-Eskimo	Male	0	0	45	Mexico	<=50K
15	25	Self-emp-not-inc	176756	HS-grad	9	Never-married	Farming-fishing	Own-child	White	Male	0	0	35	United-States	<=50K
16	32	Private	186824	HS-grad	9	Never-married	Machine-op-inspct	Unmarried	White	Male	0	0	40	United-States	<=50K
17	38	Private	28887	11th	7	Married-civ-spouse	Sales	Husband	White	Male	0	0	50	United-States	<=50K

- Added column names
- Checked for missing values
- Converted to numerical values
- Found the outliers using interquartile range

Multiple Regression


Workclass
Education
Maritial-Status
Occupation
Relationship
Race
Sex
Native-Country
Income
Age
Fnlwgt
Education-Num
Capital-Gain
Capital-Loss
Hours-Per-Week
0.9
0.6
0.3
0.0
−0.3

Intercept and coefficients

```
The intercept for our model is -0.5802
The Coefficient for Workclass is -0.0018
The Coefficient for Education is -0.0038
The Coefficient for Maritial-Status is -0.023
The Coefficient for Occupation is 0.0016
The Coefficient for Relationship is -0.017
The Coefficient for Race is 0.014
The Coefficient for Sex is 0.1
The Coefficient for Native-Country is 6.4e-05
The Coefficient for Age is 0.0046
The Coefficient for Education-Num is 0.047
The Coefficient for Capital-Gain is 9.3e-06
The Coefficient for Capital-Loss is 0.00011
The Coefficient for Hours-Per-Week is 0.0036
```

OLS Regression Results

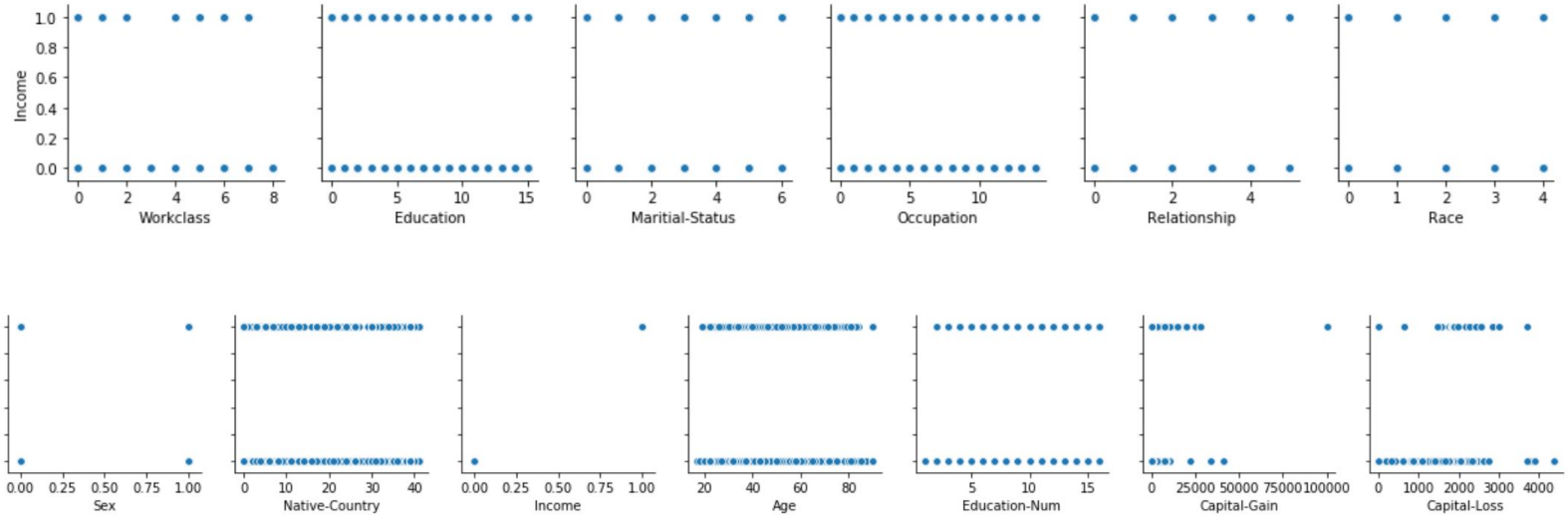
Dep. Variable:	Income	R-squared:	0.262
Model:	OLS	Adj. R-squared:	0.262
Method:	Least Squares	F-statistic:	825.5
Date:	Thu, 12 Nov 2020	Prob (F-statistic):	0.00
Time:	11:48:00	Log-Likelihood:	-13590.
No. Observations:	32560	AIC:	2.721e+04
Df Residuals:	32545	BIC:	2.734e+04
Df Model:	14		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	-0.5952	0.021	-28.649	0.000	-0.636	-0.554
Workclass	-0.0036	0.001	-2.433	0.015	-0.006	-0.001
Education	-0.0037	0.001	-6.485	0.000	-0.005	-0.003
Maritial-Status	-0.0239	0.001	-16.630	0.000	-0.027	-0.021
Occupation	0.0021	0.001	4.222	0.000	0.001	0.003
Relationship	-0.0153	0.002	-9.319	0.000	-0.019	-0.012
Race	0.0148	0.002	6.043	0.000	0.010	0.020
Sex	0.1035	0.005	19.160	0.000	0.093	0.114
Native-Country	-6.312e-06	0.000	-0.024	0.981	-0.001	0.001
Age	0.0047	0.000	29.403	0.000	0.004	0.005
Fnlwgt	6.706e-08	1.94e-08	3.455	0.001	2.9e-08	1.05e-07
Education-Num	0.0471	0.001	53.951	0.000	0.045	0.049
Capital-Gain	9.272e-06	2.8e-07	33.167	0.000	8.72e-06	9.82e-06
Capital-Loss	0.0001	5.09e-06	22.292	0.000	0.000	0.000
Hours-Per-Week	0.0036	0.000	20.343	0.000	0.003	0.004

Omnibus:	2971.366	Durbin-Watson:	2.001
Prob(Omnibus):	0.000	Jarque-Bera (JB):	3720.360
Skew:	0.814	Prob(JB):	0.00
Kurtosis:	2.698	Cond. No.	2.22e+06

OLS Regression Results

Non - linear relationship



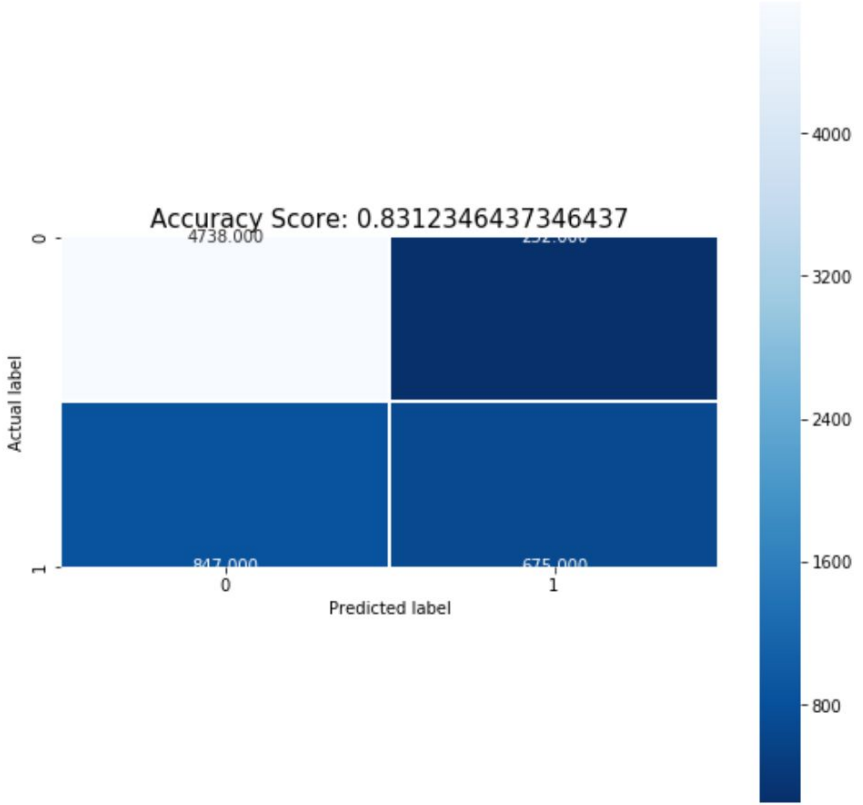
Logistic Regression

- **Confusion matrix**

```
array([[4738,  252],
       [ 847,  675]], dtype=int64)
```

- **Accuracy Score**

```
0.8312346437346437
```



Accuracy

	precision	recall	f1-score	support
0	0.85	0.95	0.90	4990
1	0.73	0.44	0.55	1522
accuracy			0.83	6512
macro avg	0.79	0.70	0.72	6512
weighted avg	0.82	0.83	0.82	6512

K-Means and Hierarchical Clustering

The Data So Far:

	Workclass	Education	Maritial-Status	Occupation	Relationship	Race	Sex	Native-Country	Income	Age	Education-Num	Capital-Gain	Capital-Loss	Hours-Per-Week
0	6	9	2	4	0	4	1	39	0	50	13	0	0	13
1	4	11	0	6	1	4	1	39	0	38	9	0	0	40
2	4	1	2	6	0	2	1	39	0	53	7	0	0	40
3	4	9	2	10	5	2	0	5	0	28	13	0	0	40
4	4	12	2	4	5	4	0	39	0	37	14	0	0	40
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
32555	4	7	2	13	5	4	0	39	0	27	12	0	0	38
32556	4	11	2	7	0	4	1	39	1	40	9	0	0	40
32557	4	11	6	1	4	4	0	39	0	58	9	0	0	40
32558	4	11	4	1	3	4	1	39	0	22	9	0	0	20
32559	5	11	2	4	5	4	0	39	1	52	9	15024	0	40

14 attributes

means:

Workclass	3.868796
Education	10.298249
Maritial-Status	2.611794
Occupation	6.572912
Relationship	1.446376
Race	3.665848
Sex	0.669195
Native-Country	36.718796
Income	0.240817
Age	38.581634
Education-Num	10.080590
Capital-Gain	1077.615172
Capital-Loss	87.306511
Hours-Per-Week	40.437469
dtype: float64	

variances:

Workclass	2.119583e+00
Education	1.497935e+01
Maritial-Status	2.268714e+00
Occupation	1.788283e+01
Relationship	2.581786e+00
Race	7.204897e-01
Sex	2.213797e-01
Native-Country	6.121328e+01
Income	1.828298e-01
Age	1.860671e+02
Education-Num	6.618831e+00
Capital-Gain	5.454418e+07
Capital-Loss	1.623817e+05
Hours-Per-Week	1.524637e+02
dtype: float64	

PCA

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14
0	0.462956	-0.339835	0.077813	-0.679753	0.471427	0.156030	-0.297900	-1.923694	-0.753053	1.337059	0.097912	-1.459951	-1.504416	0.232419
1	0.565247	-0.736502	0.323068	-0.670153	0.424562	0.123653	-1.005439	0.300293	-0.045800	0.237645	1.262745	-0.131694	-0.092552	0.227132
2	-0.063610	-2.785778	0.316906	1.207720	0.472513	0.176105	-0.113421	-0.527691	1.866890	0.133657	-0.272449	-0.329151	-0.766067	-0.029340
3	-1.947225	1.136443	-1.264851	4.125724	-0.247434	0.526482	-1.078404	0.801313	-1.507991	-1.019436	0.529795	-0.331118	-0.711749	0.602179
4	-1.312459	2.190579	0.362760	-0.280111	0.860473	0.550972	-0.633968	0.797110	-0.368523	-0.208467	-0.232667	-0.294319	-0.822201	0.896415
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
32555	-1.623407	1.204123	-1.234905	-0.104398	1.480340	0.922646	0.183357	0.509974	0.009671	-1.456025	0.518314	-0.101822	-0.569992	0.619677
32556	1.501742	-0.390396	0.261677	-0.356967	0.024659	-0.188867	0.189864	-0.298795	-0.030828	-0.300455	-0.026956	-0.812252	1.207602	-0.441513
32557	-2.036807	0.677838	0.836284	-0.243847	0.498208	0.114641	0.385641	-0.064853	-0.349757	0.848114	-2.529436	0.888944	0.240170	0.589741
32558	-1.814360	-0.031788	0.169398	-1.014923	-0.661759	-0.748845	0.550092	-0.255220	-0.461419	1.009650	0.364968	-1.121754	0.266247	0.814218
32559	-0.117196	1.596024	0.893891	0.814259	2.703352	0.178646	0.914891	0.853360	-0.222851	0.703187	-0.648029	-0.429524	1.362349	0.551483

```
Variances = [2.39926508, 1.44148584, 1.26526999, 1.13964582, 1.04076953, 1.02380759, 0.9735611 , 0.85948076, 0.84646794, 0.76488965, 0.69279312, 0.65122761, 0.52203703, 0.37972894]
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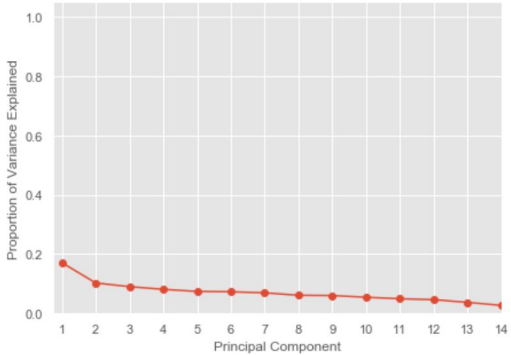
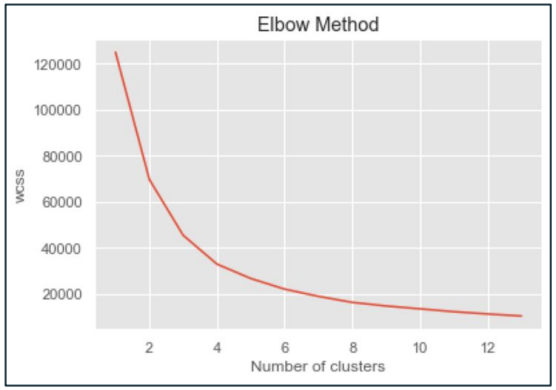
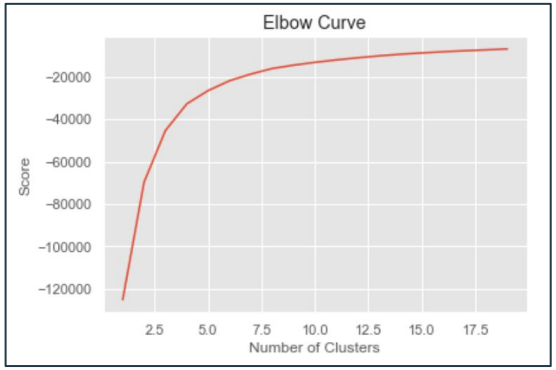


	PC1	PC2
0	0.462956	-0.339835
1	0.565247	-0.736502
2	-0.063610	-2.785778
3	-1.947225	1.136443
4	-1.312459	2.190579
...	...	...
32555	-1.623407	1.204123
32556	1.501742	-0.390396
32557	-2.036807	0.677838
32558	-1.814360	-0.031788
32559	-0.117196	1.596024

K-Means






```
For n_clusters=2, The Silhouette Coefficient is 0.42330051043783395
For n_clusters=3, The Silhouette Coefficient is 0.4753867510721339
For n_clusters=4, The Silhouette Coefficient is 0.42841889785735293
For n_clusters=5, The Silhouette Coefficient is 0.4435039368610043
For n_clusters=6, The Silhouette Coefficient is 0.39624900373567445
For n_clusters=7, The Silhouette Coefficient is 0.4030649801247899
For n_clusters=8, The Silhouette Coefficient is 0.38805541881738415
For n_clusters=9, The Silhouette Coefficient is 0.3707888943766242
For n_clusters=10, The Silhouette Coefficient is 0.38470758461805193
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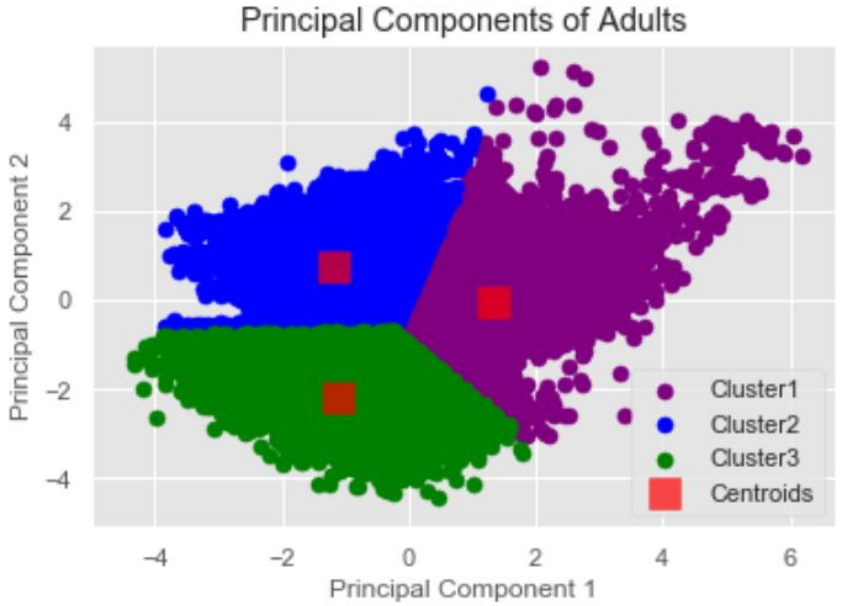
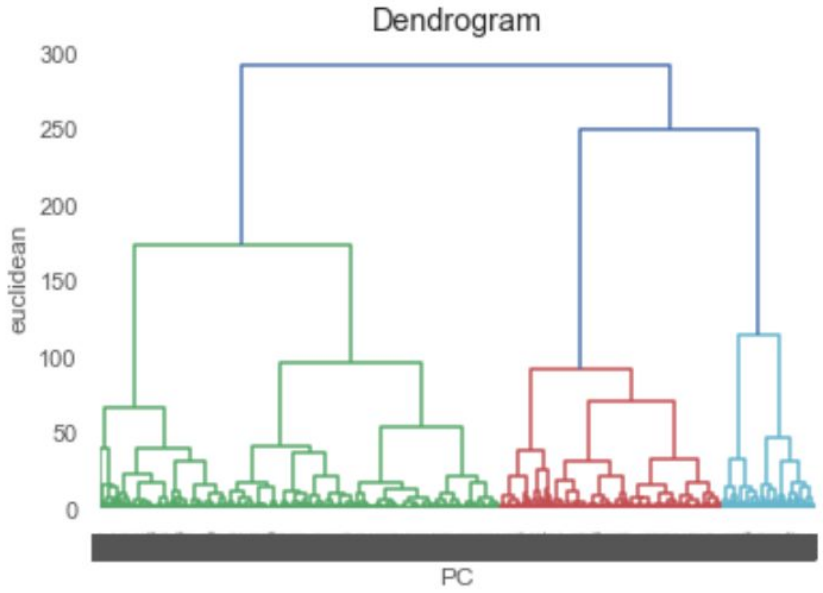
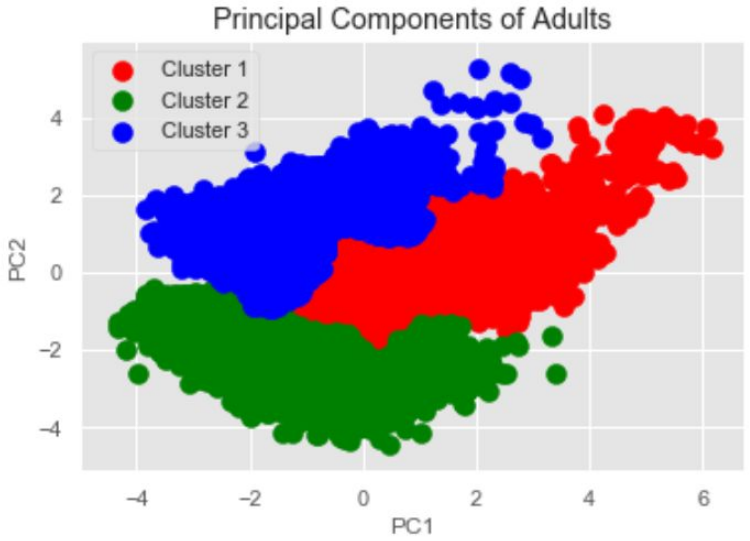
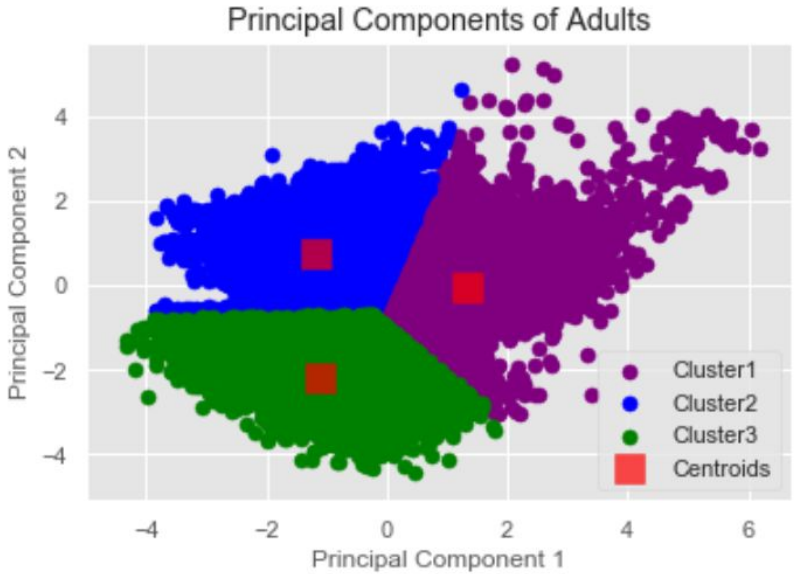


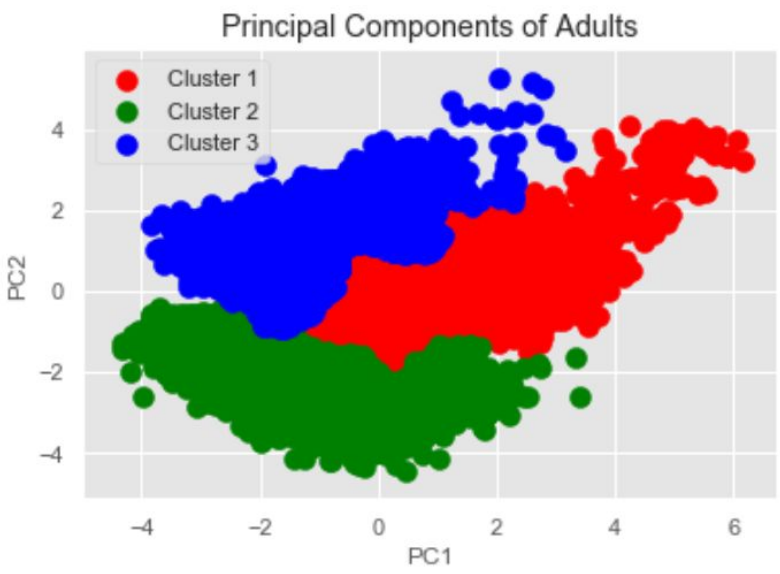
Hierarchical Clustering:





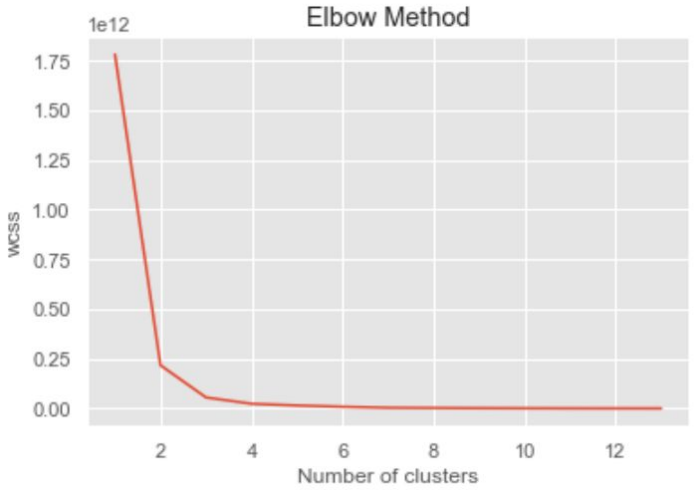
K-Means and Hierarchical:





Interpretation issues due to unnecessary PCA

	Workclass	Education	Maritial-Status	Occupation	Relationship	Race	Sex	Native-Country	Income	Age	Education-Num	Capital-Gain	Capital-Loss	Hours-Per-Week
0	6	9	2	4	0	4	1	39	0	50	13	0	0	13
1	4	11	0	6	1	4	1	39	0	38	9	0	0	40
2	4	1	2	6	0	2	1	39	0	53	7	0	0	40
3	4	9	2	10	5	2	0	5	0	28	13	0	0	40
4	4	12	2	4	5	4	0	39	0	37	14	0	0	40




```
For n_clusters=2, The Silhouette Coefficient is 0.986216325344319
For n_clusters=3, The Silhouette Coefficient is 0.9376088842254818
For n_clusters=4, The Silhouette Coefficient is 0.930204495310775
For n_clusters=5, The Silhouette Coefficient is 0.9319795245204494
For n_clusters=6, The Silhouette Coefficient is 0.9259120706341673
For n_clusters=7, The Silhouette Coefficient is 0.9524809678699202
For n_clusters=8, The Silhouette Coefficient is 0.9533397493211551
For n_clusters=9, The Silhouette Coefficient is 0.9548775273971718
For n_clusters=10, The Silhouette Coefficient is 0.9564792909805154
For n_clusters=11, The Silhouette Coefficient is 0.9567385241351869
For n_clusters=12, The Silhouette Coefficient is 0.9554632944103004
For n_clusters=13, The Silhouette Coefficient is 0.9529239180835452
```

	Workclass	Education	Maritial-Status	Occupation	Relationship	Race	Sex	Native-Country	Income	Age	Education-Num	Capital-Gain	Capital-Loss	Hours-Per-Week	Cluster
0	6	9	2	4	0	4	1	39	0	50	13	0	0	13	0
1	4	11	0	6	1	4	1	39	0	38	9	0	0	40	0
2	4	1	2	6	0	2	1	39	0	53	7	0	0	40	0
3	4	9	2	10	5	2	0	5	0	28	13	0	0	40	0
4	4	12	2	4	5	4	0	39	0	37	14	0	0	40	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
32555	4	7	2	13	5	4	0	39	0	27	12	0	0	38	0
32556	4	11	2	7	0	4	1	39	1	40	9	0	0	40	0
32557	4	11	6	1	4	4	0	39	0	58	9	0	0	40	0
32558	4	11	4	1	3	4	1	39	0	22	9	0	0	20	0
32559	5	11	2	4	5	4	0	39	1	52	9	15024	0	40	0

Cluster1:

	Workclass	Education	Maritial-Status	Occupation	Relationship	Race	Sex	Native-Country	Income	Age	Education-Num	Capital-Gain	Capital-Loss	Hours-Per-Week
6	6	9	2	4	0	4	1	39	0	50	13	0	0	13
4	4	11	0	6	1	4	1	39	0	38	9	0	0	40
4	4	1	2	6	0	2	1	39	0	53	7	0	0	40
4	4	9	2	10	5	2	0	5	0	28	13	0	0	40
4	4	12	2	4	5	4	0	39	0	37	14	0	0	40
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4	4	7	2	13	5	4	0	39	0	27	12	0	0	38
4	4	11	2	7	0	4	1	39	1	40	9	0	0	40
4	4	11	6	1	4	4	0	39	0	58	9	0	0	40
4	4	11	4	1	3	4	1	39	0	22	9	0	0	20
5	5	11	2	4	5	4	0	39	1	52	9	15024	0	40

Cluster2:

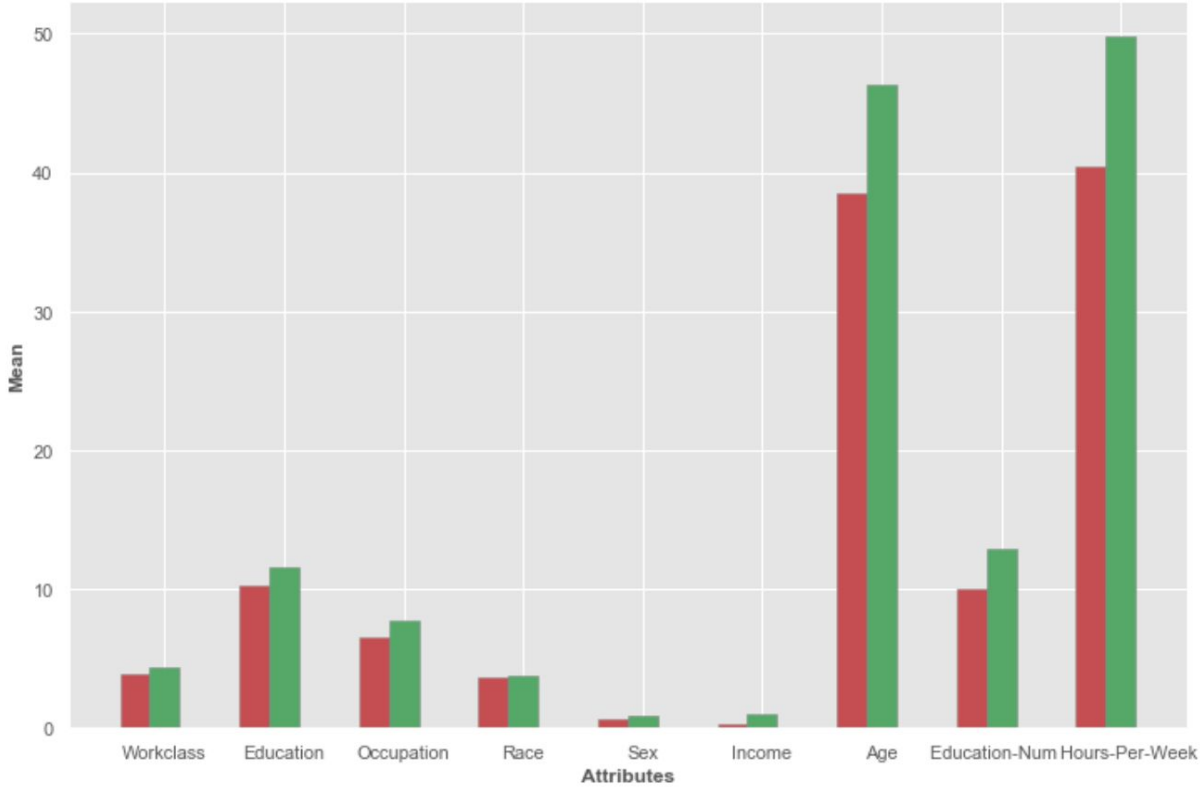
	Workclass	Education	Maritial-Status	Occupation	Relationship	Race	Sex	Native-Country	Income	Age	Education-Num	Capital-Gain	Capital-Loss	Hours-Per-Week
5	5	14	2	10	0	4	1	39	1	54	15	99999	0	60
4	4	11	2	4	0	1	1	24	1	52	9	99999	0	40
5	5	11	2	12	0	4	1	39	1	53	9	99999	0	40
4	4	9	2	4	0	4	1	39	1	52	13	99999	0	50
4	4	14	2	10	0	4	1	39	1	46	15	99999	0	60
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4	4	12	2	4	0	4	1	39	1	47	14	99999	0	55
5	5	14	2	4	0	4	1	39	1	43	15	99999	0	40
4	4	9	2	4	0	4	1	0	1	66	13	99999	0	55
4	4	14	2	4	0	4	1	39	1	47	15	99999	0	40
2	2	11	2	3	0	4	1	39	1	57	9	99999	0	40

Cluster1:

Workclass	3.866115
Education	10.292213
Occupation	6.567050
Race	3.665628
Sex	0.668251
Income	0.237091
Age	38.543471
Education-Num	10.066665
Hours-Per-Week	40.391531
dtype: float64	

Cluster2:

Workclass	4.415094
Education	11.528302
Occupation	7.767296
Race	3.710692
Sex	0.861635
Income	1.000000
Age	46.358491
Education-Num	12.918239
Hours-Per-Week	49.798742
dtype: float64	



Naive Bayes and Random Forest

Naive Bayes Accuracy:

Classification Report:

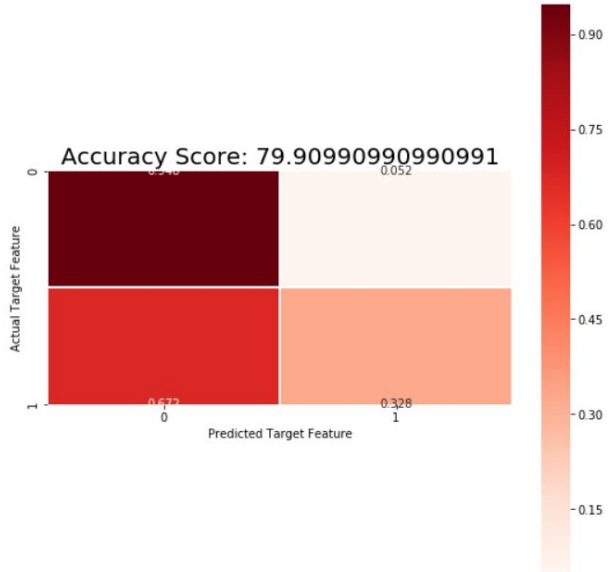
	precision	recall	f1-score	support
0	0.82	0.95	0.88	6194
1	0.67	0.34	0.45	1946
accuracy			0.80	8140
macro avg	0.75	0.64	0.66	8140
weighted avg	0.78	0.80	0.78	8140

Accuracy of Naive Bayes predictions: 80.54054054054053

Accuracy: 0.801

Standard Deviation: 0.0056387775176976 01

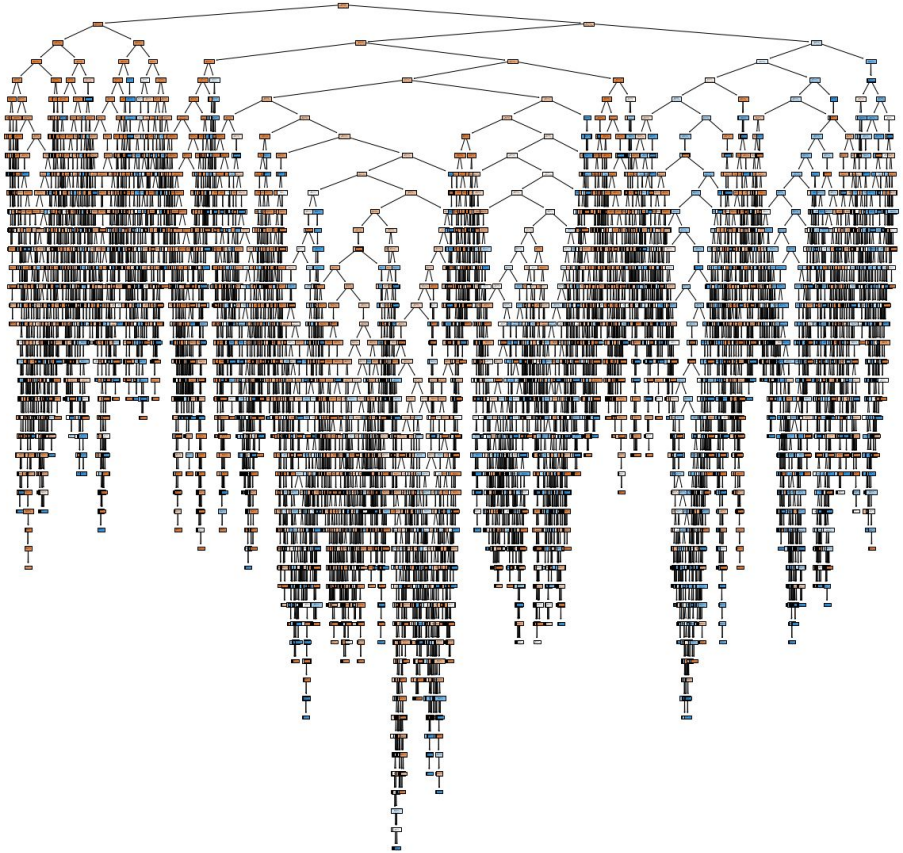
Confusion Matrix:




```
Confusion Matrix Normalized:
[[0.88188296 0.11811704]
 [0.88246269 0.11753731]]

Confusion Matrix Not Normalized:
[[16336  2188]      TrueNeg     FalsePos
 [ 5203   693]]     FalseNeg    TruePos
```

Random Forest Decision Trees:



Random Forest Accuracy

```
Accuracy: 0.801
Standard Deviation:  0.005638777517697601
```

```
Mean Absolute Error:  0.2 degrees
```

Conclusion:

- Improve algorithms by comparing with results from other algorithms
- Remove unnecessary features
  - Fwnlgnt
  - Native_Country
- Best Algorithms
  - Naive Bayes
  - Logistic Regression
- Worst Algorithms
  - Multivariable Linear Regression