DIRECT MARKETING CAMPAIGN!TARGETING!HOUSE HOLD INCOME >$50K

Xinyi Zheng, Enkelejda Gjergji, Parag Garg

Executive Summary

FOR OUR PROJECT, WE USED CENSUS DATA TO BUILD AND ANALYZE FOUR DIFFERENT MODELS TO PREDICT HOUSEHOLDS' INCOME GREATER THAN $50K PER YEAR. THESE HOUSEHOLDS WILL BE TARGETED WITH A $25 MILLION DIRECT MARKETING CAMPAIGN.

THE FOLLOWINGS ARE SOME OF THE PREDICTORS THAT CAN DETERMINE THE PROBABILITY OF HOUSEHOLD INCOME BEING GREATER THAN $50K / YEAR!!

PREDICTORS : **AGE, WORK CLASS, EDUCATION_NUM, MARTIAL STATUS, OCCUPATION, RELATIONSHIP, RACE, SEX , NATIVE COUNTRY**
!

STATISTICAL DESCRIPTION OF SAMPLE

US Census dataset contains **6,179,373,392** records. **Central Limit Theorem** and **Stratified Sampling** methods are employed to conduct the analysis, producing a **sample of 617,940 observations and 15 variables.**

❑ Outliers in numeric variables

Outlier column	Outlier count
hours-per-week	166,184
capital-loss	27,953
capital-gain	48,220
fnlwgt	18,689
age	2,608

❑ Two ways of imputing missing values

Age, capital-loss, capital-gain -> **Most frequent value**

Hours-per-week, Fnlwgt -> **Rounded mean**

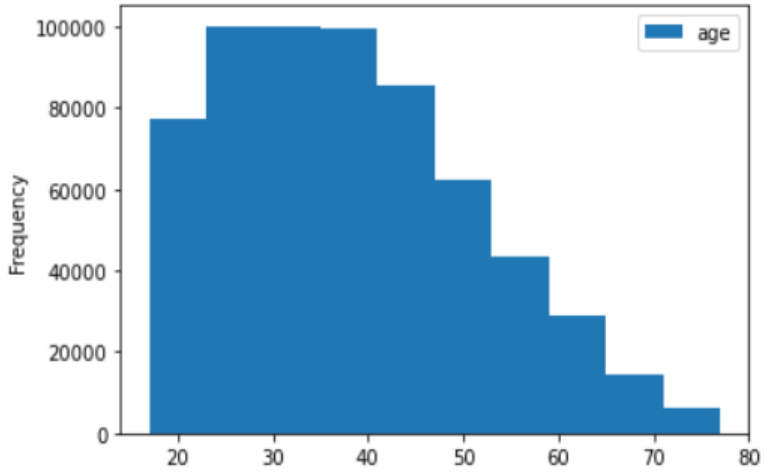
❑ Numeric variable treated as categorical

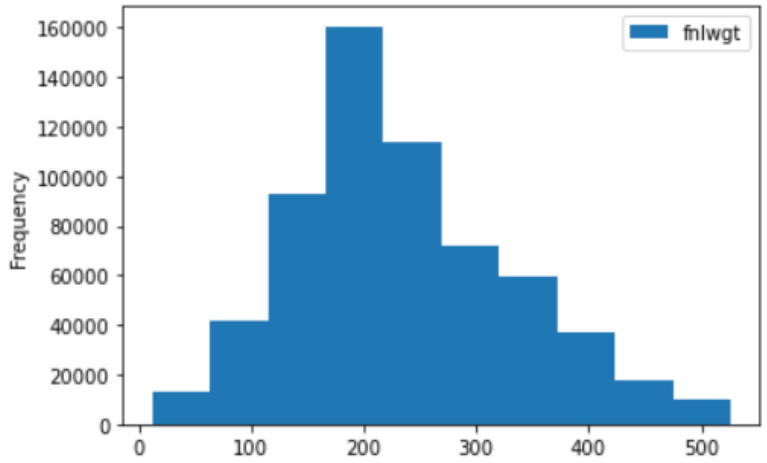
Education - num

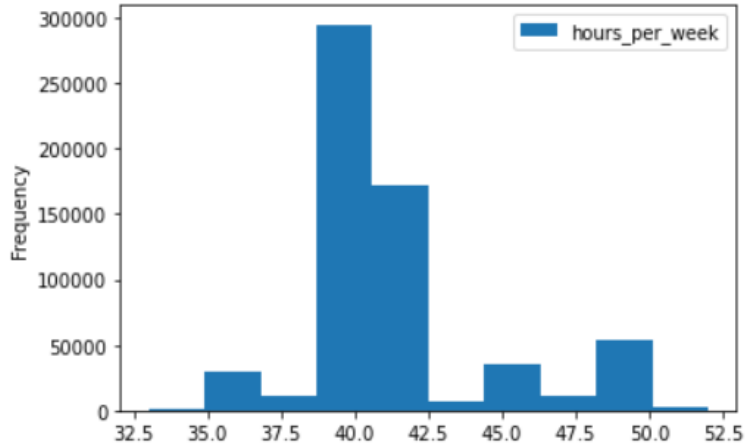
Table of statistics for numeric variables

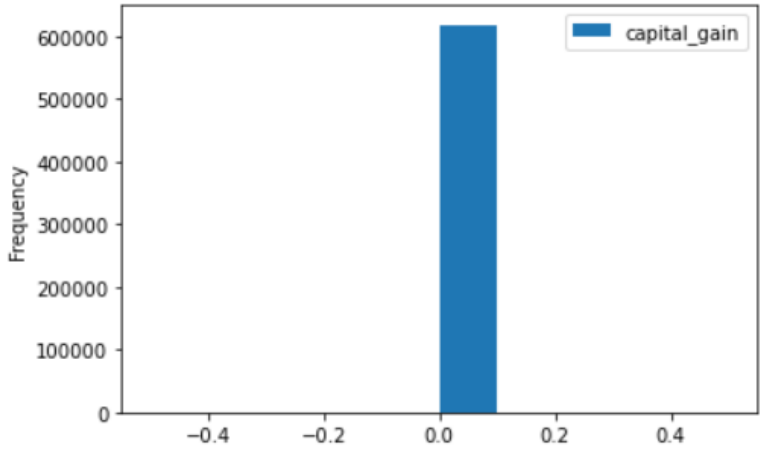
	age	fnlwgt	capital_gain	capital_loss	hours_per_week
min	17.000000	14.000000	0.000000	0.000000	1.000000
max	90.000000	1485.000000	99999.000000	4356.000000	99.000000
median	36.000000	218.000000	0.000000	0.000000	40.000000
mean	38.001809	248.516893	1072.274849	84.930678	40.311770
std	13.450175	129.310778	7401.243733	396.647930	12.102392
skew	0.593938	2.159925	11.957578	4.647479	0.199459
kurt	-0.117323	10.880462	154.558202	20.835491	2.959620
missing values	0.000000	0.000000	0.000000	0.000000	0.000000

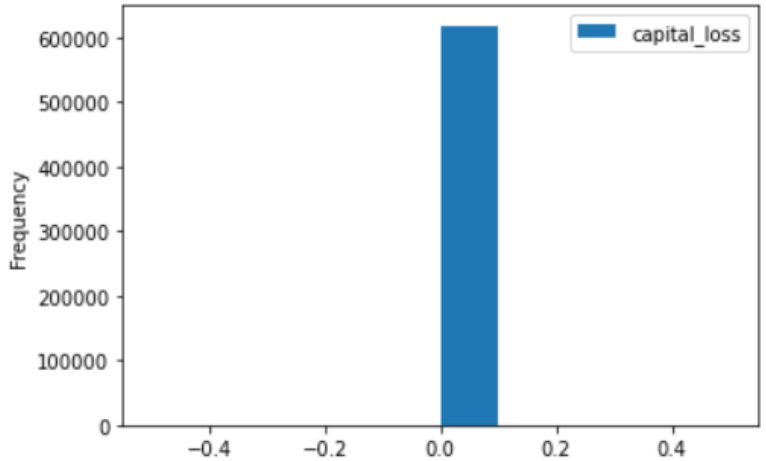
HISTOGRAMS OF NUMERIC!VARIABLES



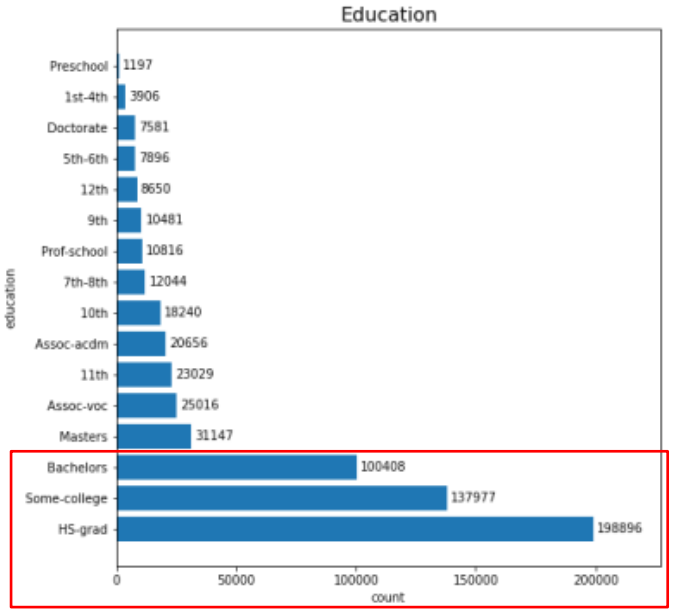




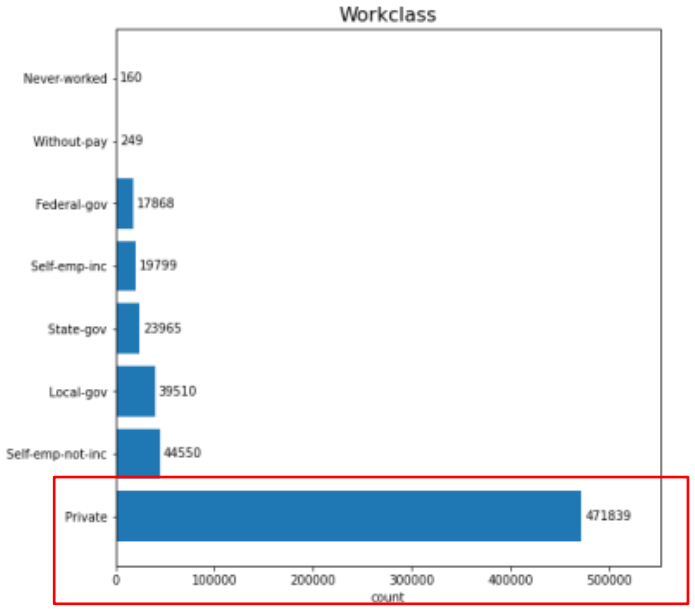


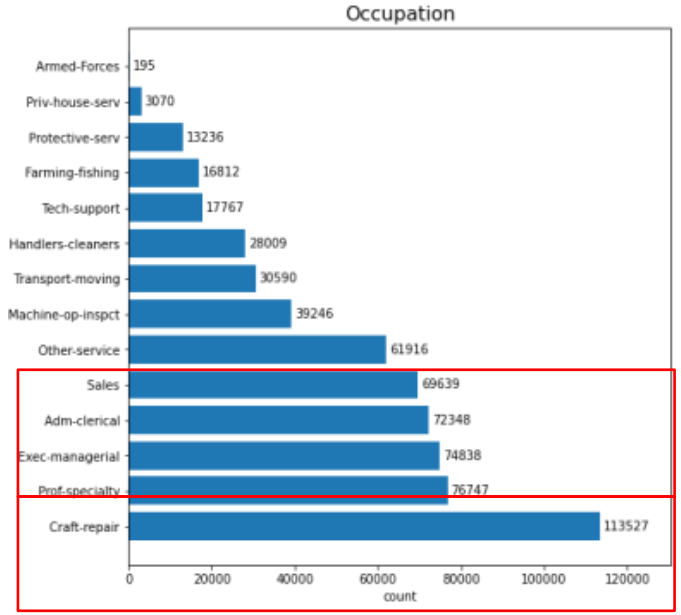


EXPLORATORY DATA ANALYSIS

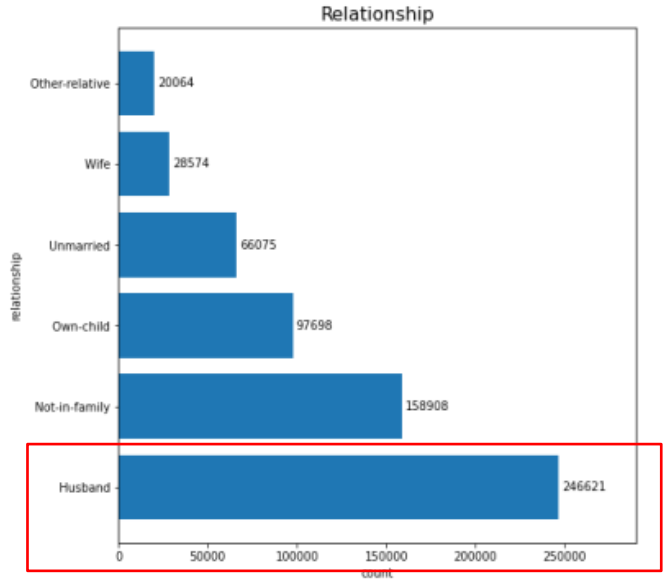


Top buckets: ***Bachelor holders***, those with ***some college*** *and* ***HS-grad***



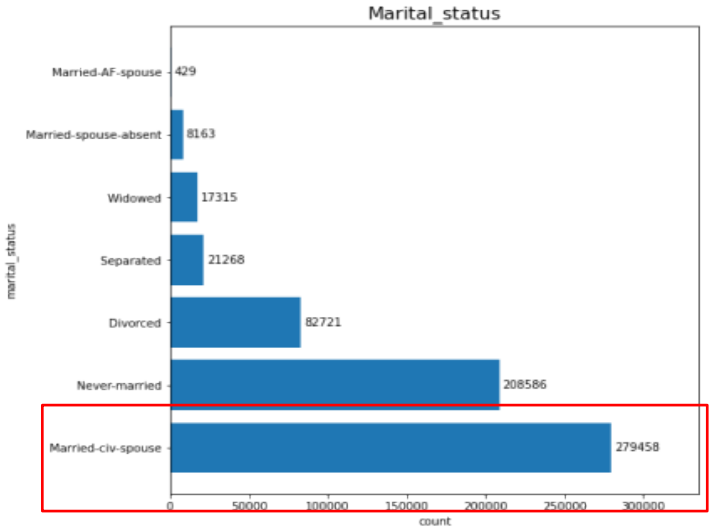


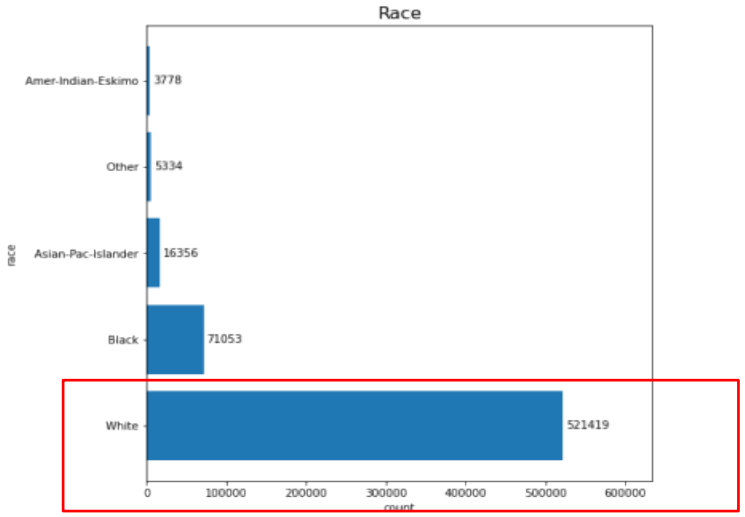
Top buckets: ***Craft – repair****;* Almost even split between ***pro-specialty, exec-managerial, admin-clerical, sales and other services***

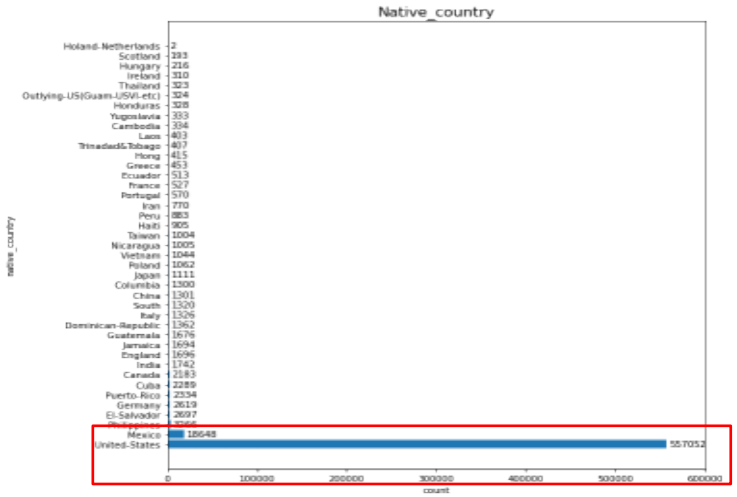


Top bucket: ***Husband***

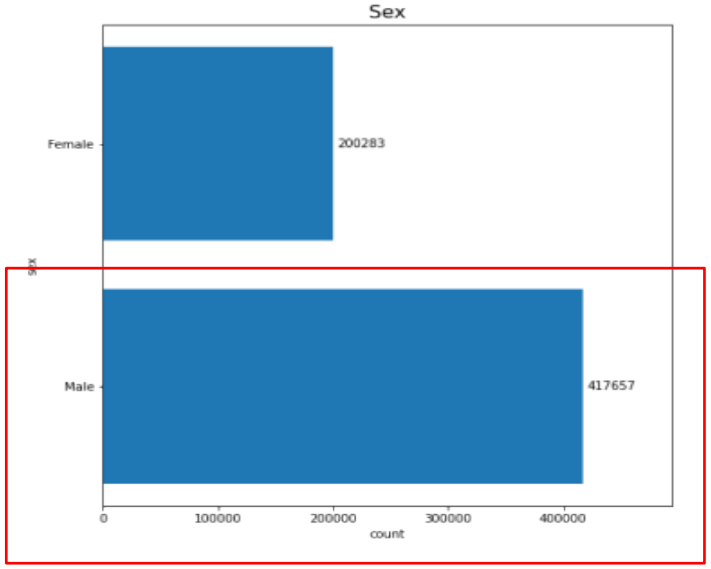
EXPLORATORY DATA ANALYSIS CONTINUED

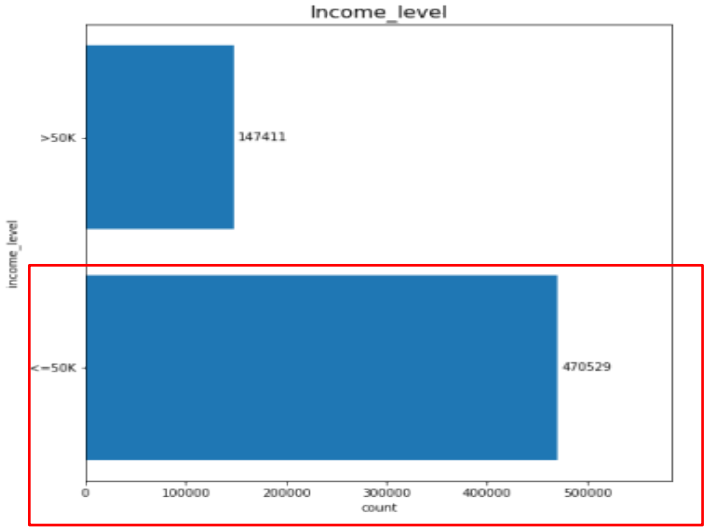






Top bucket: ***Married-civilian-spouse***





Top buckets: ***White Male, US Natives***

MODEL 1 - NAÏVE BAYES

- Naïve Bayes model 's Area Under Curve is **88.4%** and True Positive rate is **74%**.
- 14 predictors are used to predict Income: Age, Fnlwgt, Capital-gain, Capital-loss, Hours-per-week, work class , Education, Education – num, Marital Status, Occupation, Relationship, Race , Sex , Native Country.
- The finding is that Naïve Bayes model can use US Census data to predict whether income exceeds $50K/yr. well

MODEL 2 – LOGISTIC REGRESSION

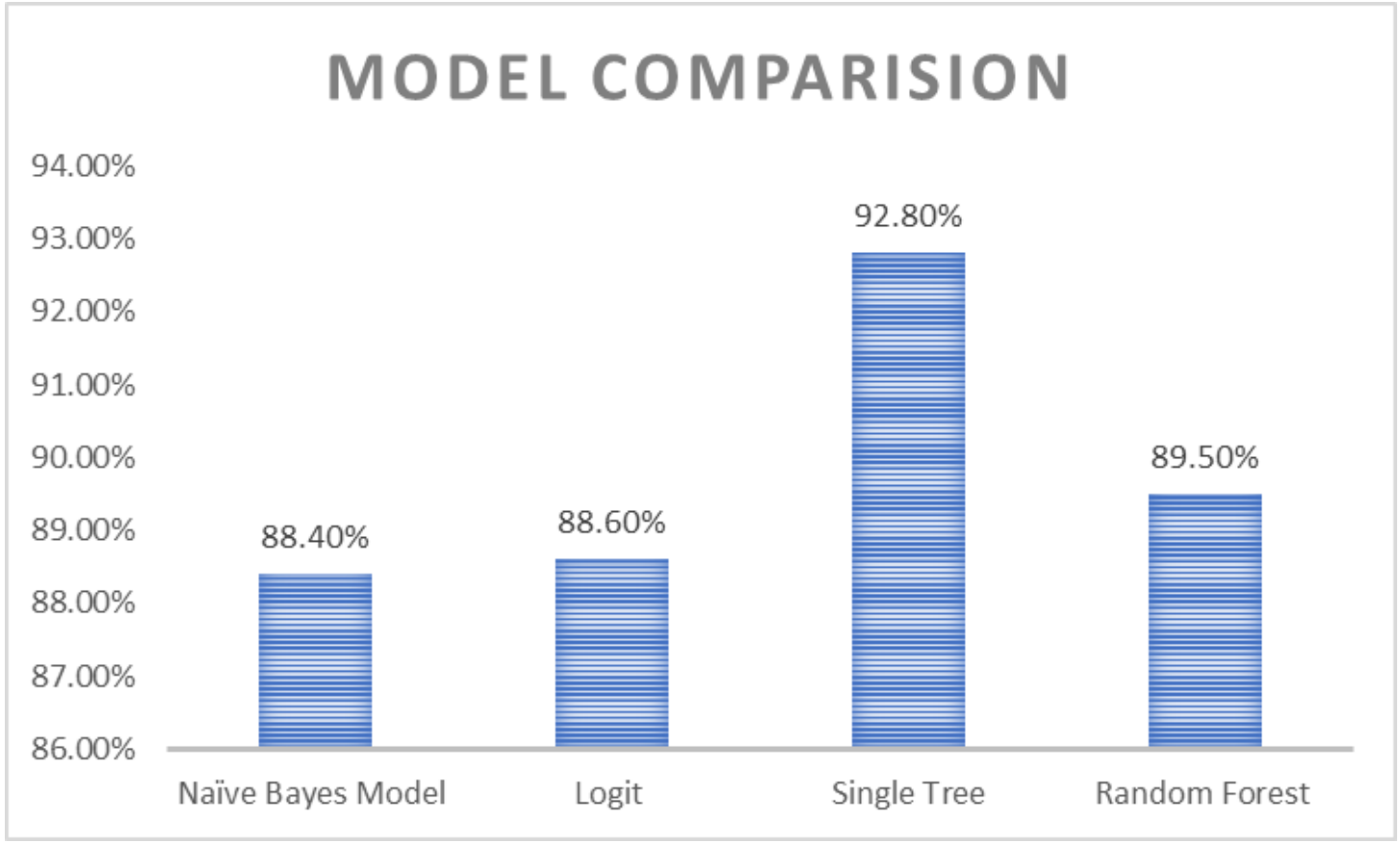
- Logistic Regression's Area Under Curve is **88.6%** and True Positive rate is **57%**
- The same 14 predictors are tested to predict Income, only 4 predictors have a significant relationship with Income: Age, Hours-per-week, Marital-status, Race
- The finding is that Logistic Regression model can use US Census data to predict whether income exceeds $50K/yr well and people who are older, used to get married and whose race is white or Asian-Pac-Islander are more likely to earn over $50K/yr

MODEL 3 – DECISION TREE

- Decision Tree's Area Under Curve is **92.8%** and True Positive rate is **93%**
- Relationship, Education-num, Marital-status are top 3 most useful variables for decision rules to predict Income
- The finding is that Decision Tree model can use US Census data to predict whether income exceeds $50K/yr well
- The person whose occupation is "Prof-specialty", native-country is "United-States", age is between 30.5 and 61.5, education-year is "15" and relationship is "Husband", is more likely to have an income >50k

MODEL 4 – RANDOM FOREST

- Random forest's Area Under Curve is **89.5%** and True Positive rate is **94%**
- Marital-status, Relationship, Education, Education-num are top 4 most useful variables for decision rules to predict Income
- The finding is that Random Forest model can use US Census data to predict whether income exceeds $50K/yr well and Marital-status is identified as an important variable in Logit Regression, Single Tree and Random Forest



MODELS' COMPARISON AND RECOMMENDATIONS

- Following Models are used in our Analysis in terms of prediction :-

- A) Naïve Bayes Model – 88.4%
- B) Logit Model – 88.60%
- C) Single Tree Model – 92.80%
- D) Random Forest – 89.5%
- According to the analysis, it is concluded that the Single Tree Model has the highest Arear Under the Curve percentage.

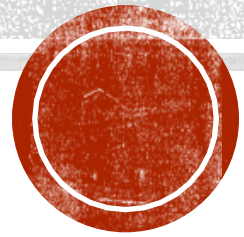
CONCLUSION!

- Age & Native Country - People who are **35.5** and **61.5** years and older
- Education_num - **15 years of education**
- Relationship - **Husband**
- Occupation - **Prof.-Specialty**

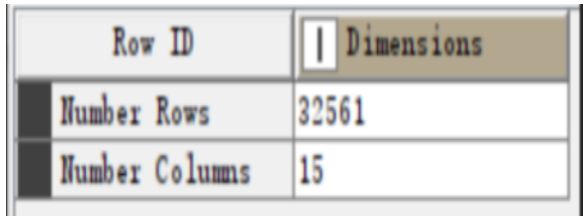
RECOMMENDATIONS!

- Target the Age Group Between 30 years old and 60
- Target people who marked their relationship as “Husband” and marital status “Married”
- People who have achieved higher education – Bachelors and more

APPENDIX!

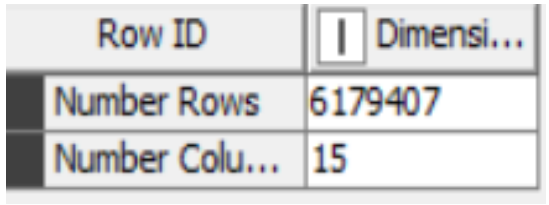


Q1: HOW MANY OBSERVATIONS (ROWS) AND HOW MANY VARIABLES (COLUMNS) ARE THERE IN THE RAW DATA?



Row ID	Dimensions
Number Rows	32561
Number Columns	15

Before reproduction



Row ID	Dimensi...
Number Rows	6179407
Number Colu...	15

After reproduction

STATISTICAL !DESCRIPTION OF!DATA (IN NUMERIC AND CATEGORICAL)!

NUMERIC	CATEGORICAL
Age	Workclass
Fnlwgt	Education
Capital-gain	Education-num
Capital-loss	Marital-status
Hours-per-week	Occupation
	Relationship
	Race
	Sex
	Native-country
	Income

Row ID	S Column Name	S Column Type
age	age	Number (integer)
workclass	workclass	String
fnlwgt	fnlwgt	Number (integer)
education	education	String
education-num	education-num	Number (integer)
marital-status	marital-status	String
occupation	occupation	String
relationship	relationship	String
race	race	String
sex	sex	String
capital-gain	capital-gain	Number (integer)
capital-loss	capital-loss	Number (integer)
hours-per-week	hours-per-week	Number (integer)
native-country	native-country	String
income	income	String

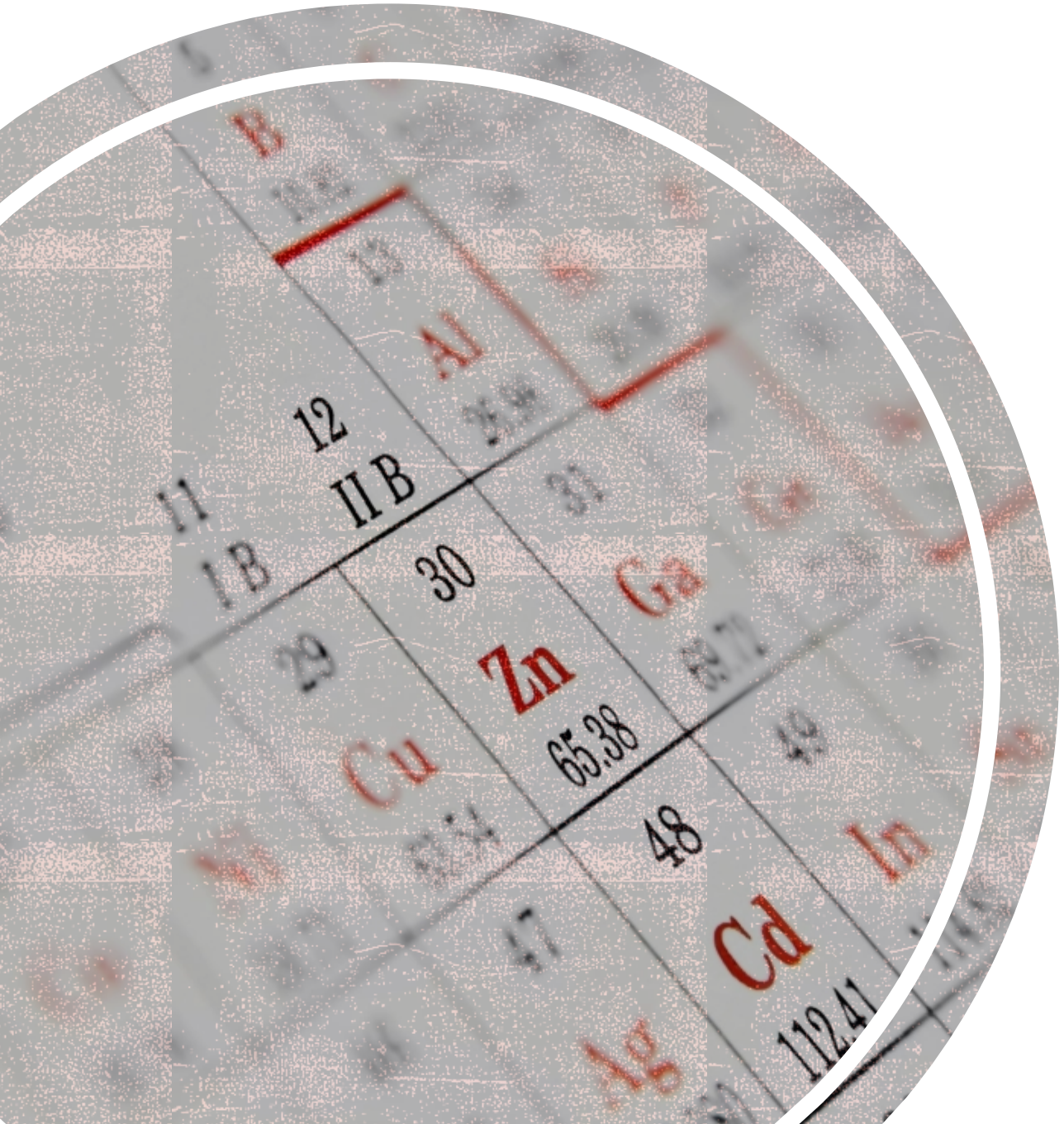
Q2: PRODUCE A TABLE OF VARIABLES SHOWING THEIR TYPES.

- We observed that there are :

6 variables as an int64

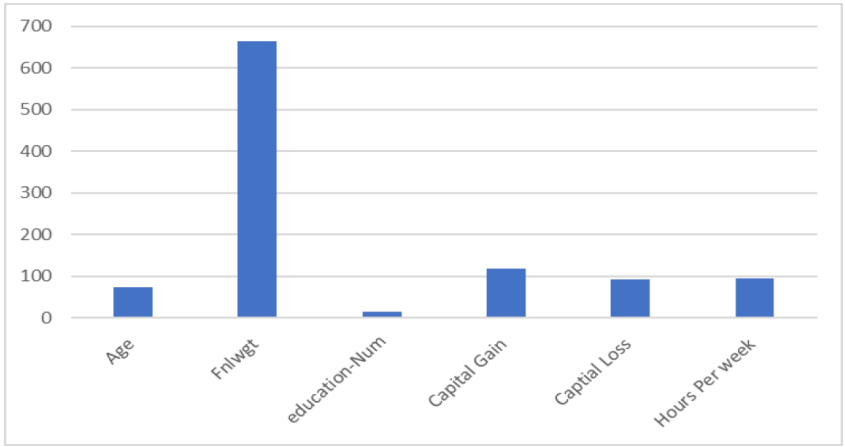
9 variables as an object

6 numeric variables and 9 categorical variables.



Q3: SOME OF THE VARIABLES APPEAR TO BE NUMERIC BUT SHOULD BE TREATED AS CATEGORICAL. YOUR BEST CLUE IS WHETHER A VARIABLE HAS ONLY A FEW DISCRETE VALUES. WHICH NUMERIC VARIABLES SHOULD BE TREATED AS CATEGORICAL?

- Since educucation-num only has a few distinct values, it should be treated as a categorical. After this change, there are now 5 numeric variables and 10 categorical variables.



Q4: FOR NUMERIC VARIABLES, PRODUCE A TABLE OF STATISTICS INCLUDING MISSING VALUES, MIN, MAX, MEDIAN, MEAN, STANDARD DEVIATION, SKEWNESS AND KURTOSIS.

Row ID	S Column	D Min	D Max	D Mean	D Std. deviation	D Variance	D Skewness	D Kurtosis	D Overall sum	D Median	I Row count
age	age	17	90	37.991	13.452	180.967	0.594	−0.127	23,476,338	36	617940
fnlwgt	fnlwgt	12	1,485	248.458	129.37	16,736.542	2.133	10.594	153,532,173	218	617940
education-num	education...	1	16	10.015	2.618	6.852	−0.36	0.653	6,188,596	10	617940
capital-gain	capital-gain	0	99,999	1,083.049	7,421.357	55,076,53...	11.904	153.363	669,259,192	0	617940
capital-loss	capital-loss	0	4,356	84.406	395.608	156,505.675	4.664	20.986	52,157,680	0	617940
hours-per-week	hours-per...	1	99	40.312	12.099	146.389	0.214	3.022	24,910,604	40	617940

Q5: HOW MANY OUTLIERS ARE PRESENT IN EACH NUMERIC VARIABLE? SHOW THE TALLIES IN A TABLE. SET THEM TO MISSING.

S Outlier ...	I Membe...	I Outlier ...	D Lower ...	D Upper ...
age	6179407	26732	-3	77
fnlwgt	6179407	184651	-45.5	526.5
capital-gain	6148732	479390	0	0
capital-loss	6179407	281762	0	0
hours-per-w...	6179407	1666477	32.5	52.5

There are outliers present in all 5 numeric variables which is now set to missing.

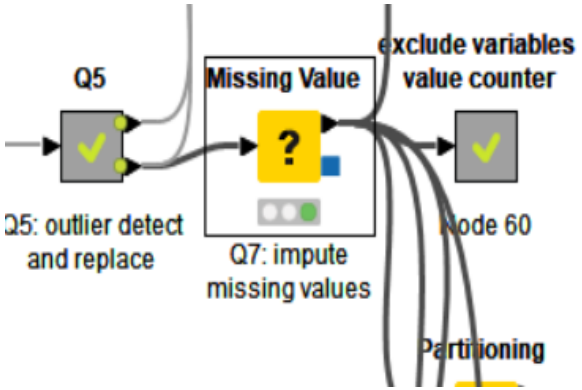
Q6: COUNT THE UNIQUE VALUES OF EACH CATEGORICAL VARIABLE, INCLUDING MISSING VALUES. ARE THERE ANY UNUSUAL VALUES IN ANY OF THE CATEGORICAL VARIABLES?

Row ID	S Row0
workclass (Un...	State-gov(239009), Self-emp-not-inc(446198), Private(4375003), Federal-gov(177820), Local-gov(394822), ?(346139), Self-emp-inc(196394), Without-pay(2440), Never-worked(1582)
education (Un...	Bachelors(1007005), HS-grad(1990368), 11th(229045), Masters(309876), 9th(104065), Some-college(1376186), Assoc-acdm(206375), Assoc-voc(251446), 7th-8th(121493), Doctora...
education-nu...	13(1007005), 9(1990368), 7(229045), 14(309876), 5(104065), 10(1376186), 12(206375), 11(251446), 4(121493), 16(77106), 15(106932), 3(77413), 6(183643), 2(40204), 1(12032...
marital-status...	Never-married(2087316), Married-civ-spouse(2796937), Divorced(825539), Married-spouse-absent(80737), Separated(211614), Married-AF-spouse(4327), Widowed(172937)
occupation (U...	Adm-clerical(724014), Exec-managerial(749790), Handlers-cleaners(280034), Prof-specialty(767104), Other-service(621478), Sales(696737), Craft-repair(787586), Transport-moving(...
relationship (...	Not-in-family(1587372), Husband(2468038), Wife(285148), Own-child(979045), Unmarried(658632), Other-relative(201172)
race (Unique ...	White(5209899), Black(712338), Asian-Pac-Islander(166166), Amer-Indian-Eskimo(37577), Other(53427)
sex (Unique c...	Male(4178696), Female(2000711)
native-countr...	United-States(5456824), Cuba(23395), Jamaica(17186), India(16851), ?(112699), Mexico(186308), South(13083), Puerto-Rico(23085), Honduras(3324), England(16410), Canada(21...
income (Uniqu...	<=50K(4705296), >50K(1474111)

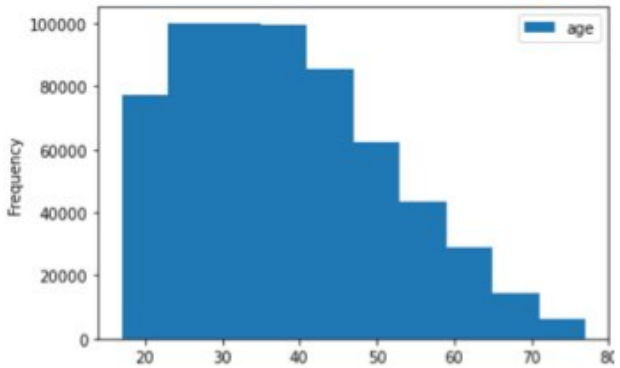
We found some missing value as "?" And we replace it by using NAN

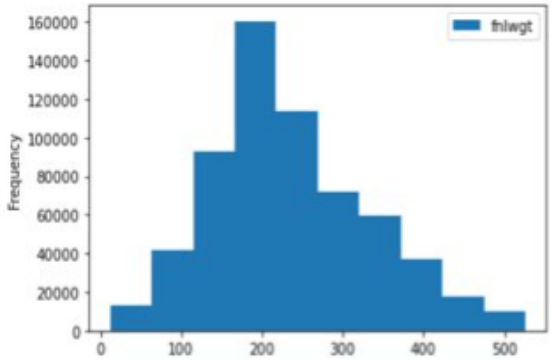
Q7: IMPUTE THE MISSING VALUES. BE SURE TO EXPLAIN HOW YOU DID THAT IN YOUR PRESENTATION.

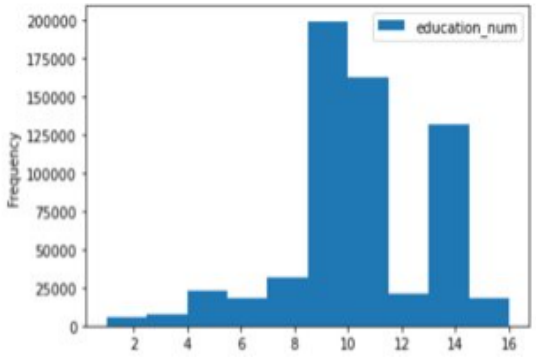
I age	S workclass	I fnlwgt	S education	S educati...	S marital-...	S occupa...	S relation...	S race	S sex	I capital-...	I capital-l...	I hours-p...	S native-...	S income
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K
39	State-gov	78	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	0	0	40	United-States	<=50K

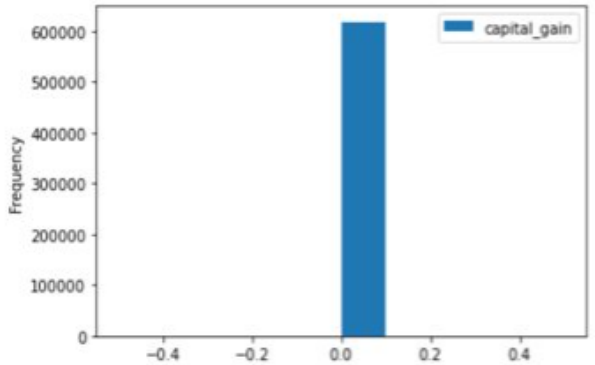


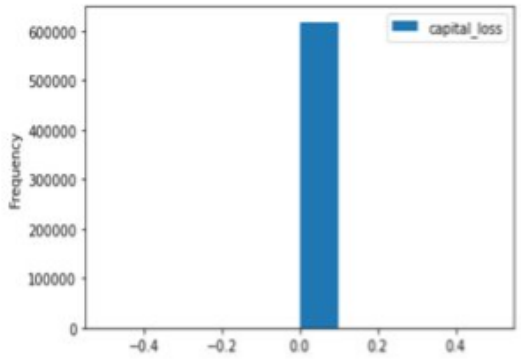
Q8: PRODUCE A HISTOGRAM OR BOXPLOT FOR EACH OF THE NUMERIC VARIABLES.

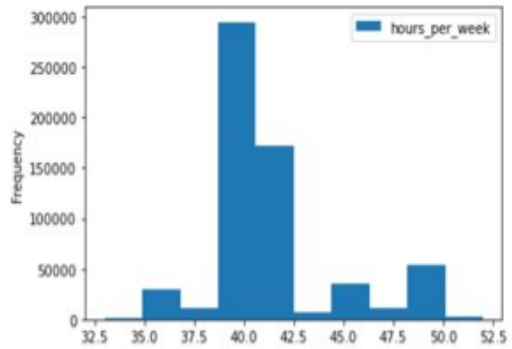




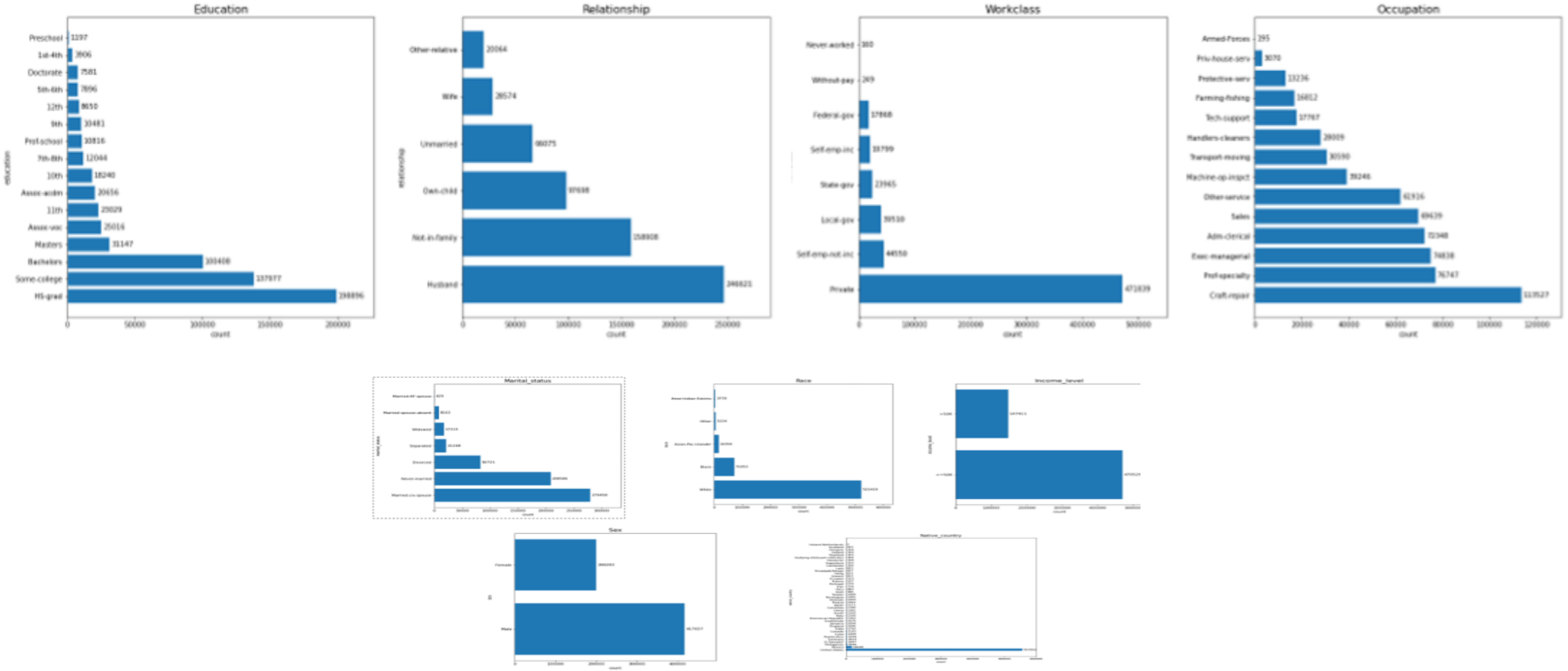




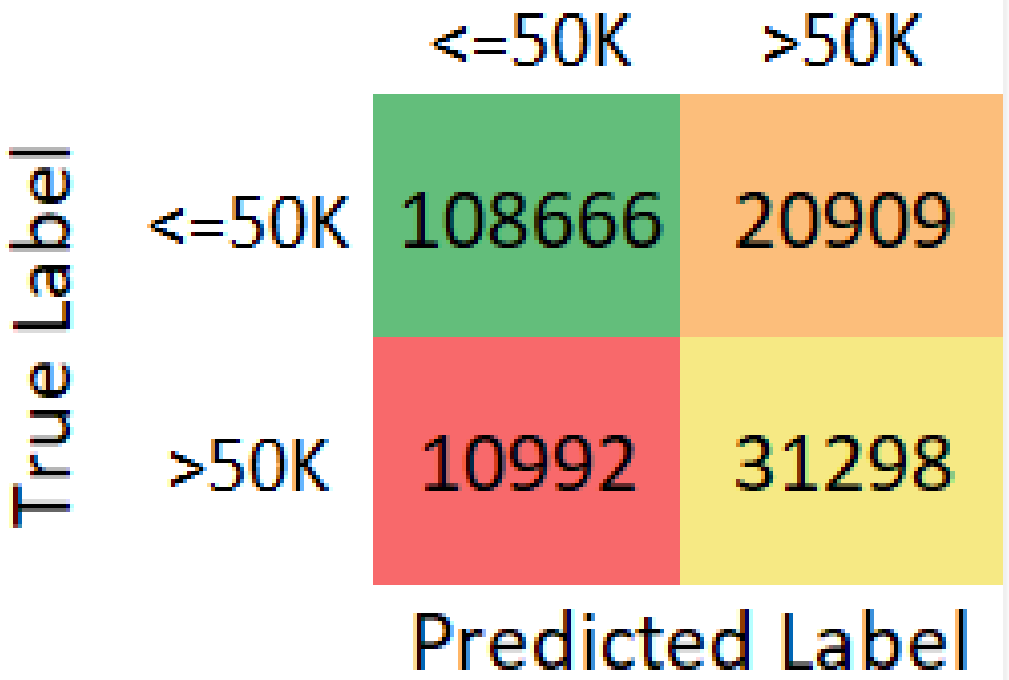


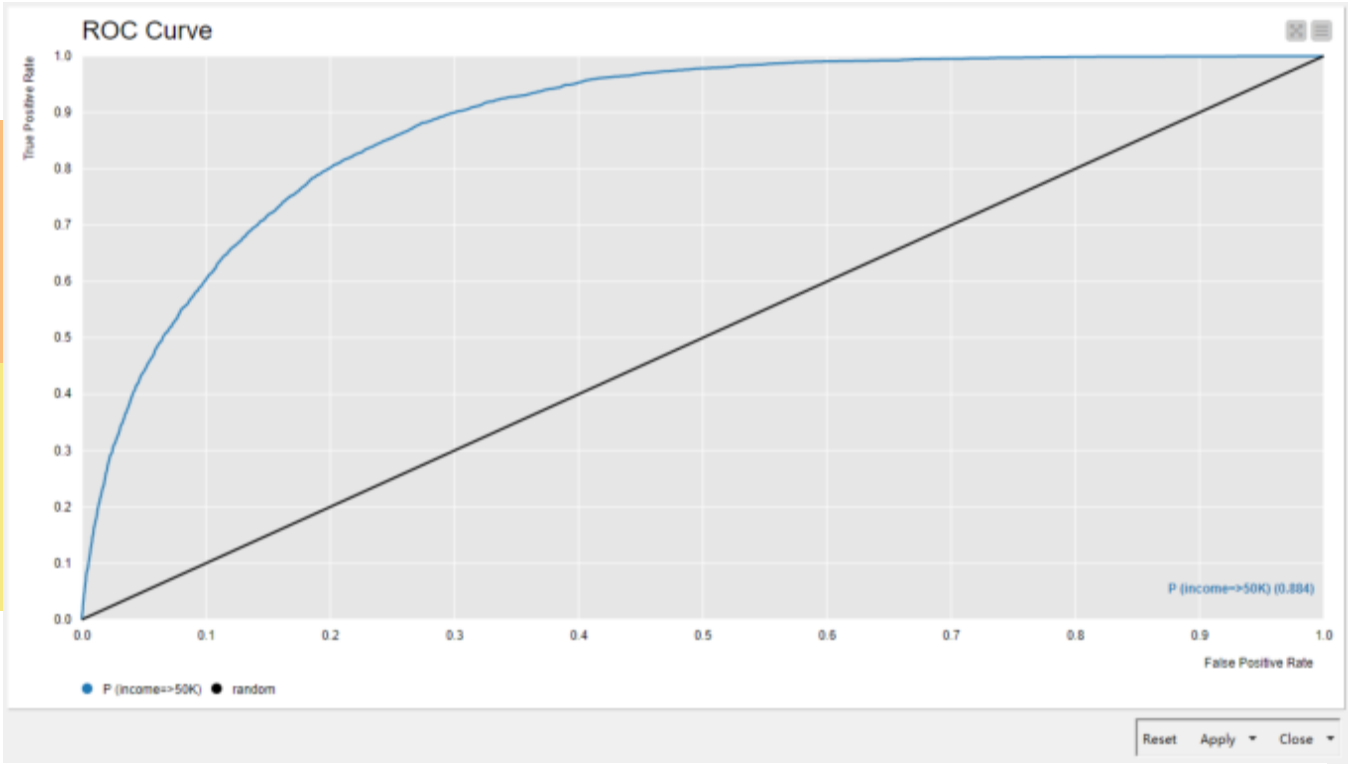


Q9: PRODUCE A BAR CHART FOR EACH OF THE CATEGORICAL VARIABLES SHOWING THE COUNTS FOR EACH UNIQUE VALUE



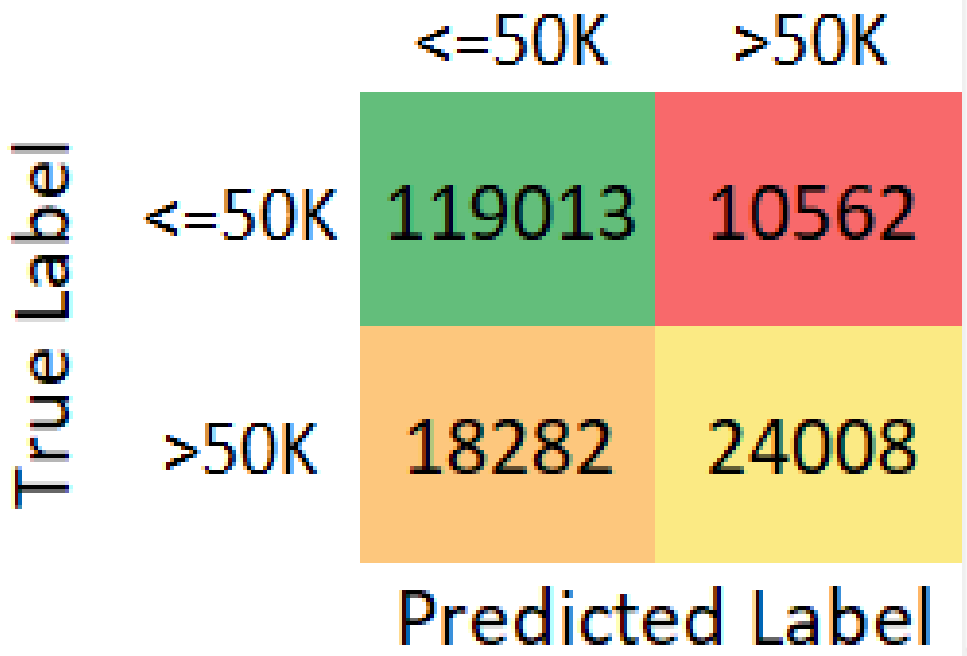
QUES 10 : MODEL 1 - NAÏVE BAYES CONFUSION TABLE / ROC CURVE! / METRICS

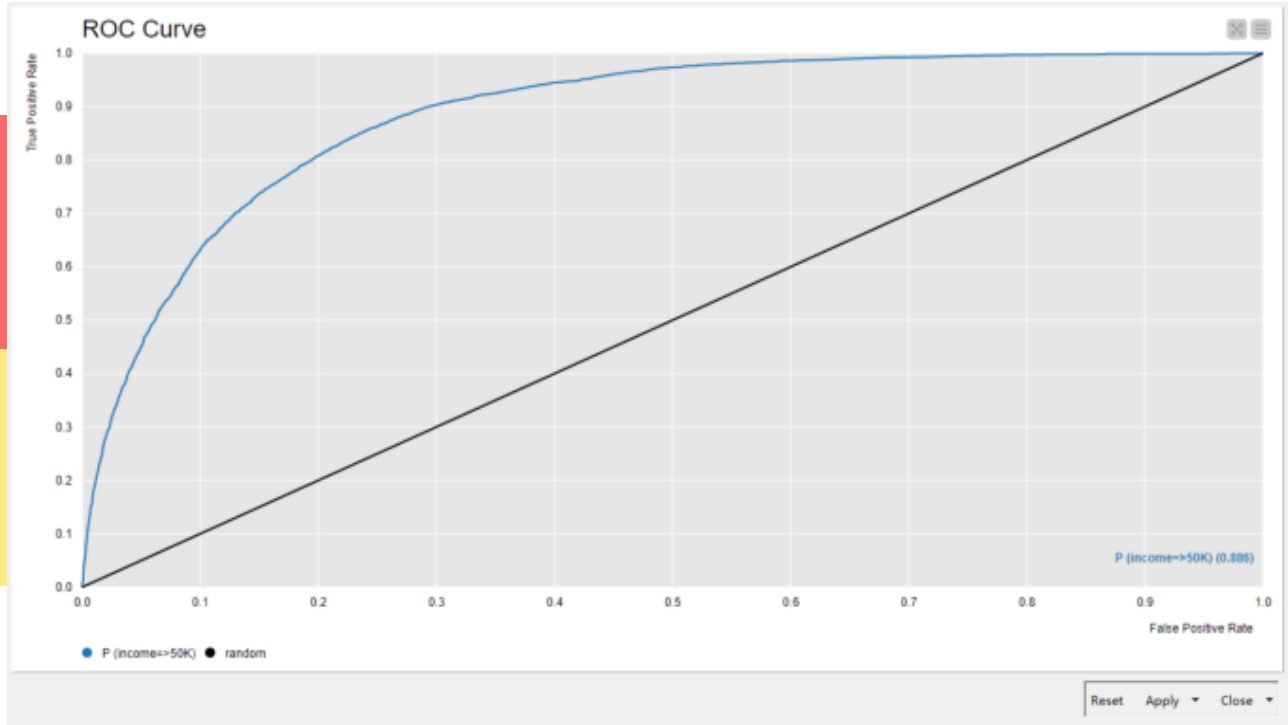




RowID	TruePositives	FalsePositives	TrueNegatives	FalseNegatives	Recall	Precision	Sensitivity	Specificity	F-measure	Accuracy	Cohen's kappa
>50K	31298	20909	108666	10992	0.74	0.60	0.74	0.84	0.66		
<=50K	108666	10992	31298	20909	0.84	0.91	0.84	0.74	0.87		
Overall										0.81	0.54

QUES 11: MODEL 2 - LOGISTIC REGRESSION
CONFUSION TABLE / ROC CURVE! / METRICS



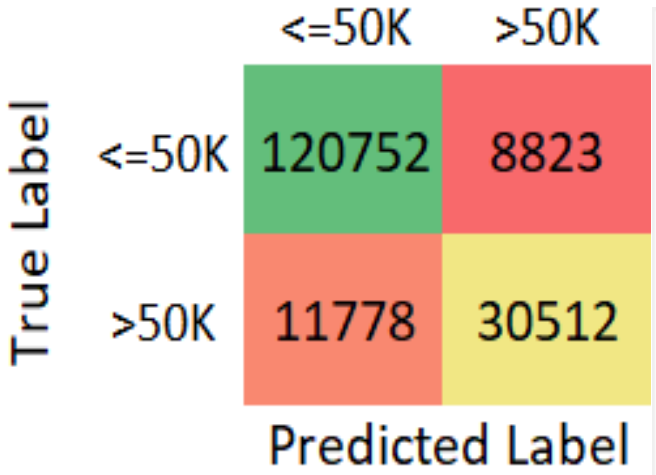


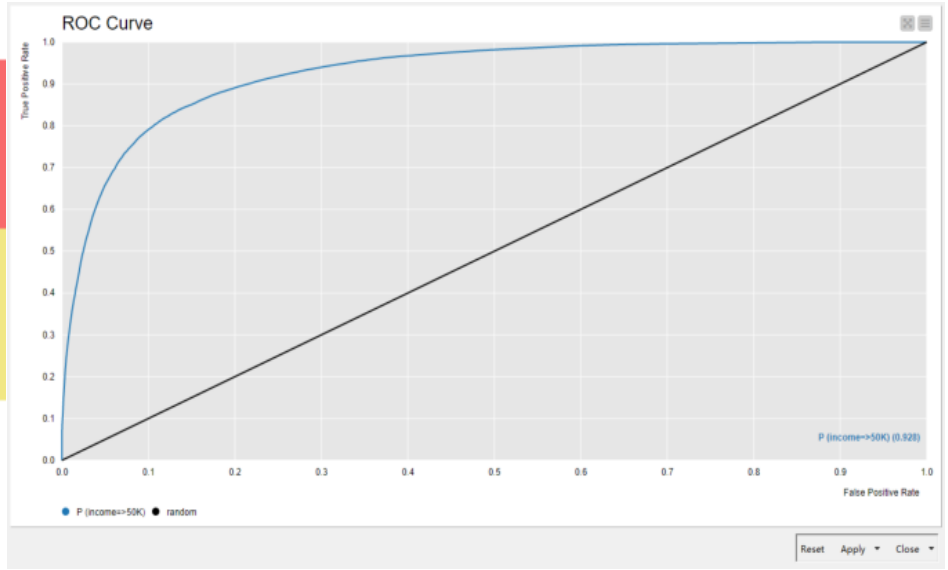
RowID	TruePositives	FalsePositives	TrueNegatives	FalseNegatives	Recall	Precision	Sensitivity	Specificity	F-measure	Accuracy	Cohen's kappa
>50K	24008	10562	119013	18282	0.57	0.69	0.57	0.92	0.62		
<=50K	119013	18282	24008	10562	0.92	0.87	0.92	0.57	0.89		
Overall										0.83	0.52

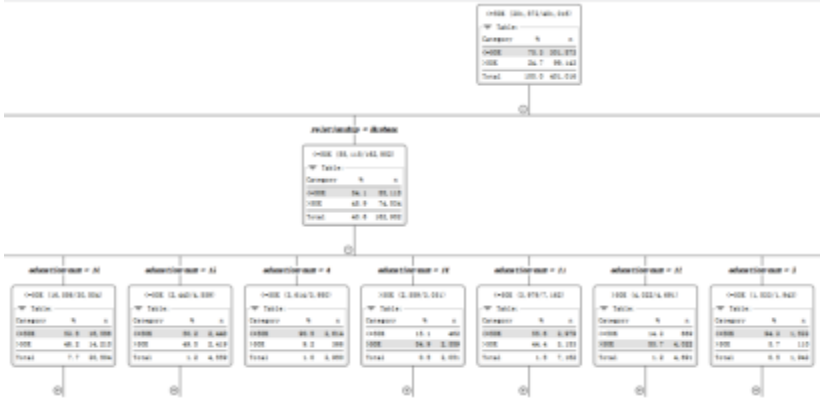
QUES 11 : MODEL 2 – LOGISTIC REGRESSION COEFFICIENTS

Row ID	S Logit	S Variable	D Coeff.	D Std. Err.	D z-score	D ▲ P>|z|
Row1	<=50K	age	-0.028	0	-61.598	0
Row2	<=50K	fnlwgt	-0	0	-8.39	0
Row3	<=50K	hours-per-week	-0.067	0.001	-51.421	0
Row27	<=50K	Divorced_marital-status	-0.362	0.022	-16.695	0
Row29	<=50K	Separated_marital-status	-0.357	0.04	-9.013	0
Row52	<=50K	White_race	-0.105	0.018	-5.742	0
Row28	<=50K	Married-spouse-absent_marital-status	-0.34	0.062	-5.47	0
Row54	<=50K	Amer-Indian-Eskimo_race	0.358	0.073	4.934	0
Row30	<=50K	Married-AF-spouse_marital-status	-0.467	0.141	-3.319	0.001
Row53	<=50K	Asian-Pac-Islander_race	-0.149	0.056	-2.68	0.007
Row31	<=50K	Widowed_marital-status	-0.111	0.042	-2.631	0.009
Row55	<=50K	Other_race	0.164	0.075	2.184	0.029
Row87	<=50K	Outlying-US(Guam-USVI-etc)_native...	13.83	8,701.044	0.002	0.999
Row25	<=50K	Preschool_education	13.077	9,072.319	0.001	0.999
Row97	<=50K	Constant	7.37	6,842.552	0.001	0.999
Row96	<=50K	Holand-Netherlands_native-country	6.423	8,701.052	0.001	0.999
Row10	<=50K	Without-pay_workclass	13.553	20,580.814	0.001	0.999
Row72	<=50K	Cambodia_native-country	-2.61	8,702.801	-0	1
Row20	<=50K	Doctorate_education	-2.64	9,075.185	-0	1
Row21	<=50K	Prof-school_education	-2.522	9,066.361	-0	1
Row14	<=50K	Masters_education	-1.845	9,061.882	-0	1
Row71	<=50K	Columbia_native-country	1.581	8,702.801	0	1
Row11	<=50K	Bachelors_education	-1.432	9,066.548	-0	1
Row22	<=50K	5th-6th_education	1.196	9,064.162	0	1
Row68	<=50K	Philippines_native-country	-1.134	8,702.801	-0	1
Row65	<=50K	Canada_native-country	-1.118	8,702.801	-0	1

QUES 12 : MODEL 3 – DECISION TREE CONFUSION TABLE / ROC CURVE! / METRICS





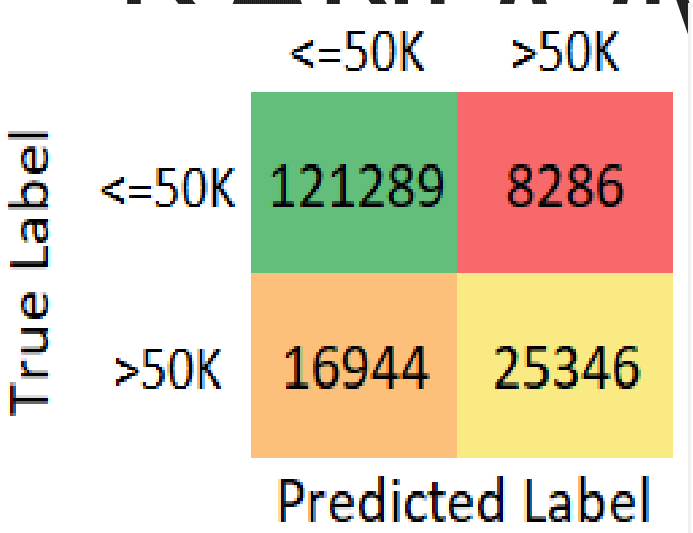


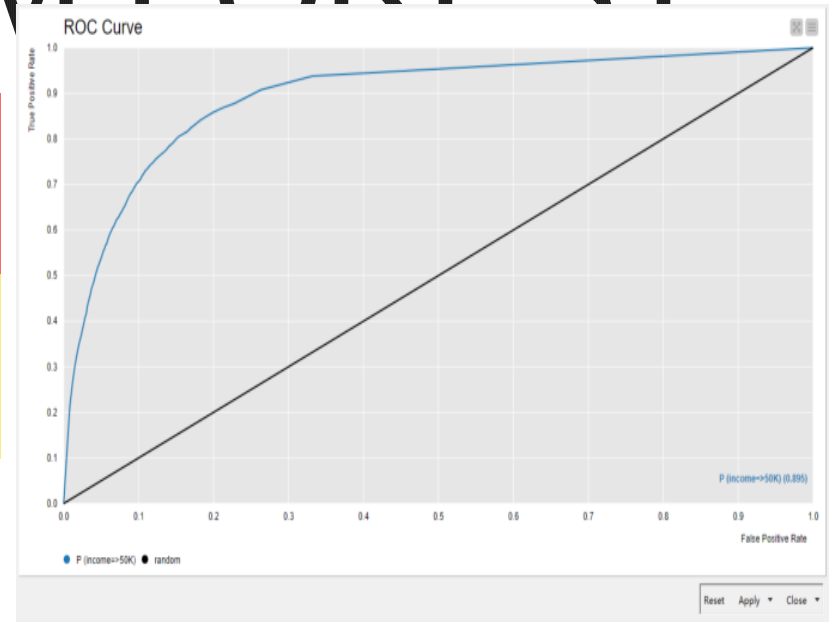
RowID	TruePositives	FalsePositives	TrueNegatives	FalseNegatives	Recall	Precision	Sensitivity	Specificity	F-measure	Accuracy	Cohen's kappa
>50K	120752	11778	30512	8823	0.93	0.91	0.93	0.72	0.92		
<=50K	30512	8823	120752	11778	0.72	0.78	0.72	0.93	0.75		
Overall										0.88	0.67

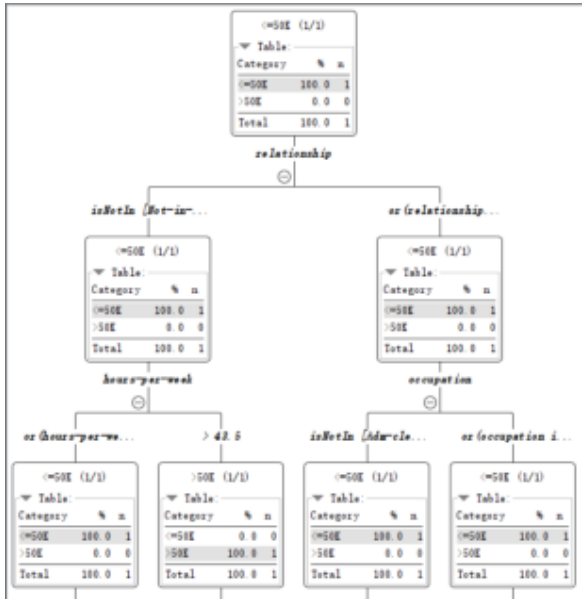
QUES 12 : MODEL 3 – DECISION TREE IMPORTANT VARIABLES/DECISION RULES

Row ID	Condition	Outcome	Record count	Number of correct
Row1286	$marital-status$ = "Never-married" AND $relationship$ = "Own-child"	<=50K	53,170	52,780
Row1360	$native-country$ = "United-States" AND $education-num$ = "9" AND $rela...	<=50K	14,450	14,037
Row1	$hours-per-week$ <= 44.5 AND age <= 29.5 AND $education-num$ = "13" ...	<=50K	6,693	6,407
Row93	$occupation$ = "Adm-clerical" AND $education-num$ = "9" AND $relations...	<=50K	5,620	5,488
Row109	$occupation$ = "Other-service" AND $education-num$ = "9" AND $relation...	<=50K	4,902	4,839
Row204	$occupation$ = "Adm-clerical" AND $education-num$ = "10" AND $relation...	<=50K	4,813	4,693
Row648	$workclass$ = "Private" AND age <= 34.5 AND $occupation$ = "Craft-re...	<=50K	4,122	3,450
Row1458	$education-num$ = "9" AND $native-country$ = "United-States" AND $rela...	<=50K	4,106	4,037
Row1013	$education-num$ = "4" AND $relationship$ = "Husband"	<=50K	3,980	3,614
Row110	$occupation$ = "Sales" AND $education-num$ = "9" AND $relationship$ = ...	<=50K	3,668	3,496
Row1411	$occupation$ = "Adm-clerical" AND $education-num$ = "10" AND $relation...	<=50K	3,610	3,555
Row1086	$occupation$ = "Prof-specialty" AND $native-country$ = "United-States"...	>50K	3,063	2,842
Row113	$occupation$ = "Machine-op-inspct" AND $education-num$ = "9" AND $rela...	<=50K	3,044	3,011
Row220	$occupation$ = "Other-service" AND $education-num$ = "10" AND $relatio...	<=50K	2,847	2,802
Row751	$workclass$ = "Private" AND $occupation$ = "Exec-managerial" AND $educ...	>50K	2,788	2,563
Row240	$marital-status$ = "Never-married" AND $education-num$ = "12" AND $rel...	<=50K	2,638	2,411
Row305	$education-num$ = "6" AND $relationship$ = "Not-in-family"	<=50K	2,566	2,548
Row118	age <= 36.5 AND $workclass$ = "Private" AND $occupation$ = "Craft-re...	<=50K	2,397	2,359
Row341	age > 43.5 AND $race$ = "White" AND age <= 66.5 AND age > 28.5 A...	>50K	2,333	2,141
Row233	age <= 50.5 AND $occupation$ = "Craft-repair" AND $education-num$ = ...	<=50K	2,199	2,106
Row111	$occupation$ = "Transport-moving" AND $education-num$ = "9" AND $relat...	<=50K	2,153	2,034
Row1252	$occupation$ = "Other-service" AND $relationship$ = "Wife"	<=50K	2,116	1,732
Row221	age <= 40.5 AND $occupation$ = "Sales" AND $education-num$ = "10" AN...	<=50K	2,045	2,024
Row1485	$native-country$ = "Mexico" AND $relationship$ = "Other-relative"	<=50K	1,855	1,855
Row107	$occupation$ = "Handlers-cleaners" AND $education-num$ = "9" AND $rela...	<=50K	1,848	1,841
Row1472	$education-num$ = "10" AND $native-country$ = "United-States" AND $rel...	<=50K	1,801	1,739
Row1016	$native-country$ = "United-States" AND $occupation$ = "Prof-specialty"...	>50K	1,791	1,550
Row1387	$education-num$ = "7" AND $relationship$ = "Unmarried"	<=50K	1,773	1,725
Row1446	$workclass$ = "Private" AND $education-num$ = "11" AND $relationship$ ...	<=50K	1,739	1,680
Row497	$hours-per-week$ <= 43.0 AND age <= 44.5 AND $occupation$ = "Handler...	<=50K	1,667	1,509
Row337	$fnlwgt$ <= 266.0 AND $hours-per-week$ <= 46.0 AND age <= 43.5 AND $...	>50K	1,662	1,323
Row364	$fnlwgt$ <= 202.5 AND age > 32.5 AND age <= 65.0 AND $fnlwgt$ <= 4...	>50K	1,492	1,190
Row1453	$education-num$ = "6" AND $relationship$ = "Unmarried"	<=50K	1,444	1,374
Row1339	$marital-status$ = "Separated" AND $relationship$ = "Own-child"	<=50K	1,374	1,374

QUES 12 : MODEL 4 – RANDOM FOREST







RowID	TruePositives	FalsePositives	TrueNegatives	FalseNegatives	Recall	Precision	Sensitivity	Specificity	F-measure	Accuracy	Cohen's kappa
>50K	121289	16944	25346	8286	0.94	0.88	0.94	0.60	0.91		
<=50K	25346	8286	121289	16944	0.60	0.75	0.60	0.94	0.67		
Overall										0.85	0.58

QUES 12 : MODEL 4 – RANDOM FOREST IMPORTANT VARIABLES/DECISION RULES

Row ID	#splits (le...	#splits (level 1)	#splits (level 2)	#candidates (level 0)	#candidates (level 1)	#candidates (level 2)
marital-status	25	25	40	30	47	87
relationship	20	30	43	20	39	88
education	14	23	55	19	36	84
education-num	11	23	65	21	37	95
age	7	20	52	22	37	86
workclass	5	10	19	29	44	74
occupation	5	21	52	16	29	83
sex	5	11	12	18	38	80
hours-per-week	5	22	31	24	61	93
native-country	2	8	17	24	40	87
race	1	5	8	23	51	87
fnlwgt	0	2	5	19	47	80
capital-gain	0	0	0	20	51	85
capital-loss	0	0	0	15	43	91

QUES 13 : COMPARISION!

	Naive Bayes(>50K)	Logistic Regression(>50K)	Single Tree(>50K)	Random Forest(>50K)
Accuracy	0.814383382	0.832170599	0.880132662	0.853198732
Missclassification Rate	0.185616618	0.167829401	0.119867338	0.146801268
True Positve Ratio	0.740080397	0.56769922	0.721494443	0.599337905
False Positive Ratio	0.174739675	0.081512637	0.068091839	0.063947521
Specificity	0.838633996	0.866841473	0.931908161	0.936052479
Precision	0.599498152	0.694474978	0.775695945	0.753627498
Prevalence	0.303767492	0.201146249	0.228871498	0.195688476