Insurance Charges Data Analysis

Final Data Analysis Project – Sekolah Data Pacmann

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Pacmann

Outline

1. Introduction
2. Dataset
3. Descriptive Statistic Analysis
4. Categorical Variable Analysis
5. Continuous Variable Analysis
6. Correlation Variable Analysis
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Introduction

Introduction

- Insurance companies need to take into account **every aspect of the client's data** to determine the **proper price** of the client's **insurance payment.**
- This insurance payment from the clients will be needed to **pay for health bills** to the **healthcare facility** (ex. hospital, clinics).
- Supervisors of a new insurance agency need help to know how is the **user's condition related** to the **insurance price**. He has some data regarding the user's condition and the insurance price in some regions.

Dataset

Dataset

- Dataset comprises **7 columns** and **1338 rows**
- There are **3 categorical data**: Gender, Smoker, and Region
- There are **4 numerical data**: Age, BMI, Children, and Charges

	age	sex	bmi	children	smoker	region	charges
0	19	female	27.900	0	yes	southwest	16884.92400
1	18	male	33.770	1	no	southeast	1725.55230
2	28	male	33.000	3	no	southeast	4449.46200
3	33	male	22.705	0	no	northwest	21984.47061
4	32	male	28.880	0	no	northwest	3866.85520
5	31	female	25.740	0	no	southeast	3756.62160

Descriptive Statistics Analysis

Analysis on Age

Age Distribution of Insurance User

Age Distribution : Smoker and Gender
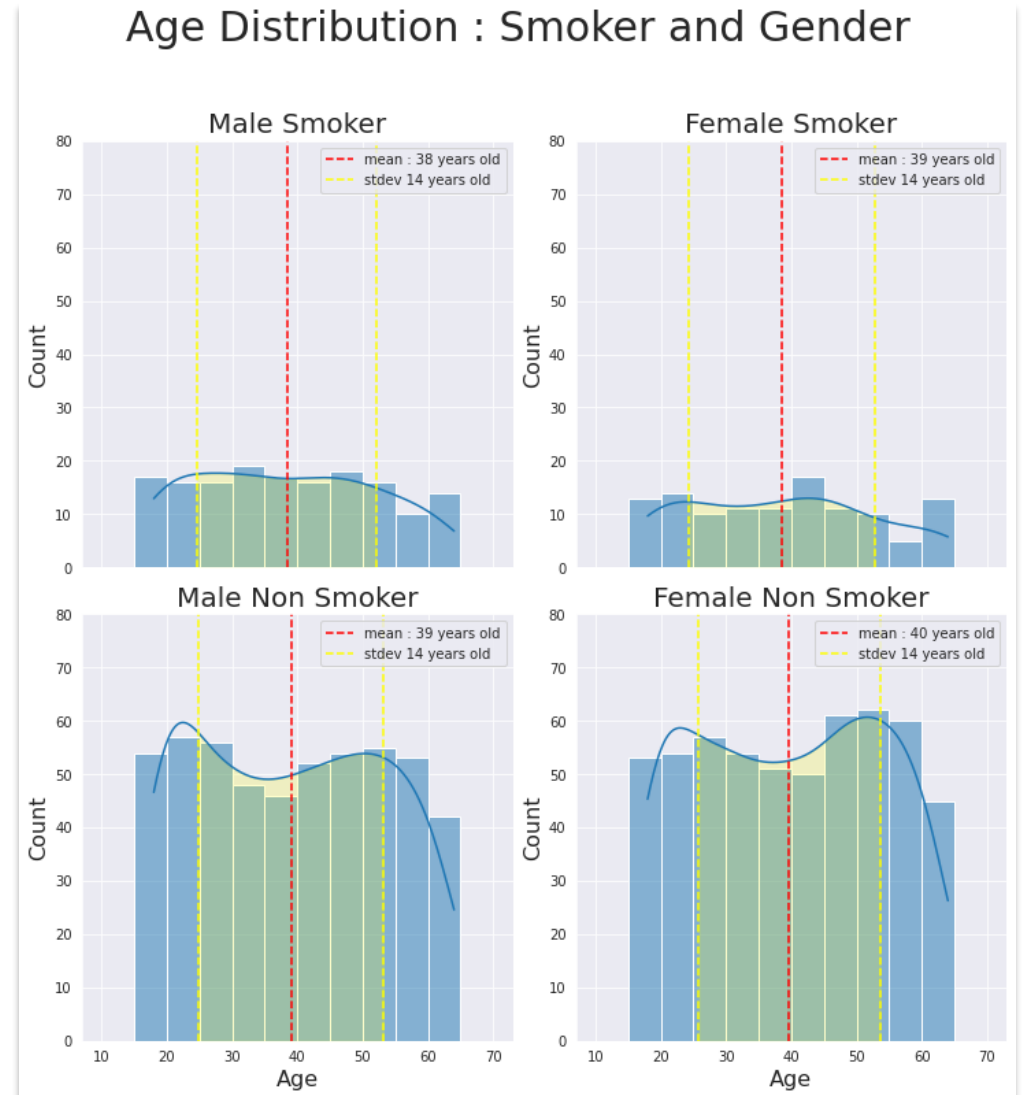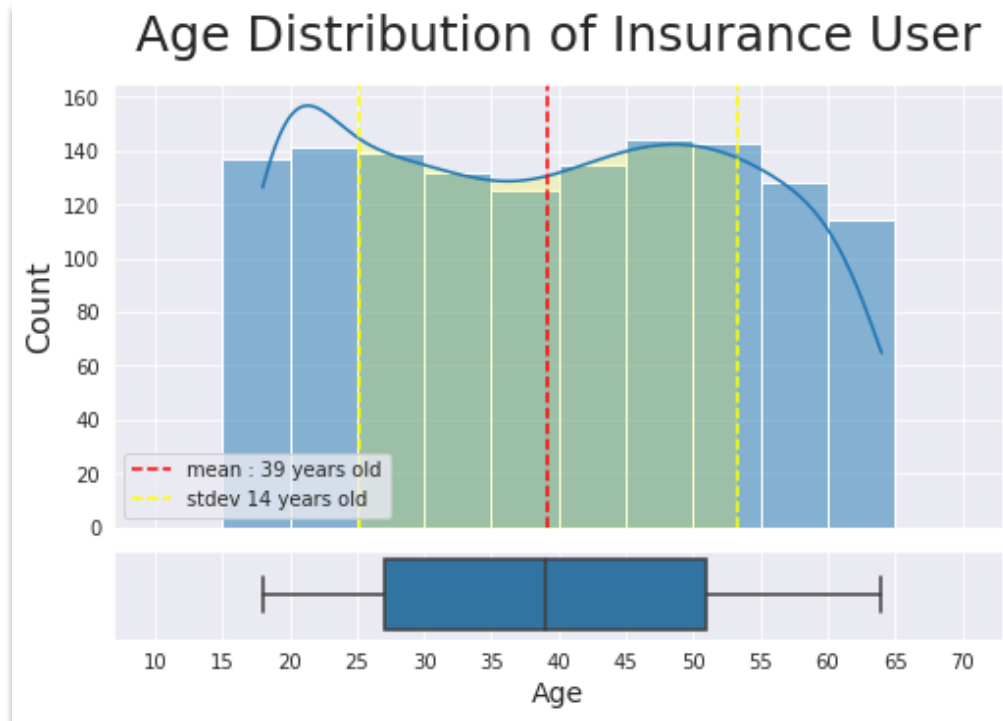
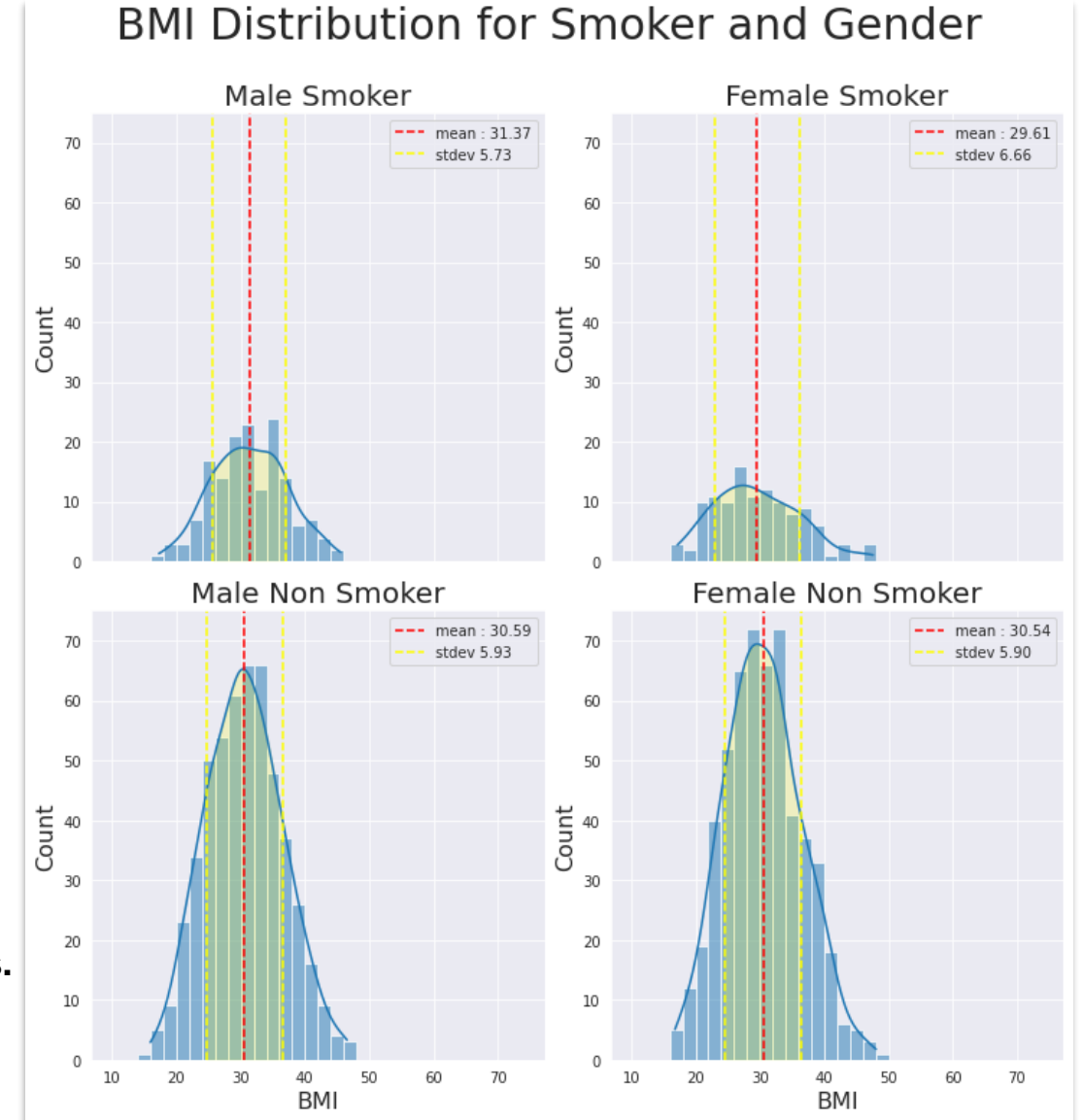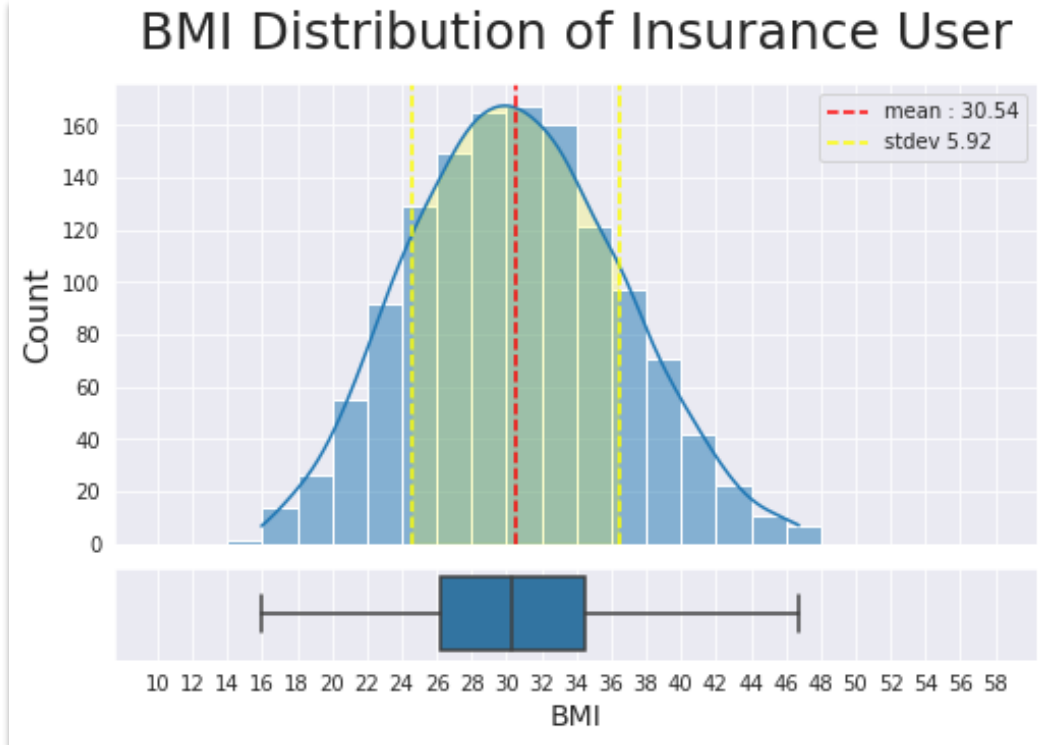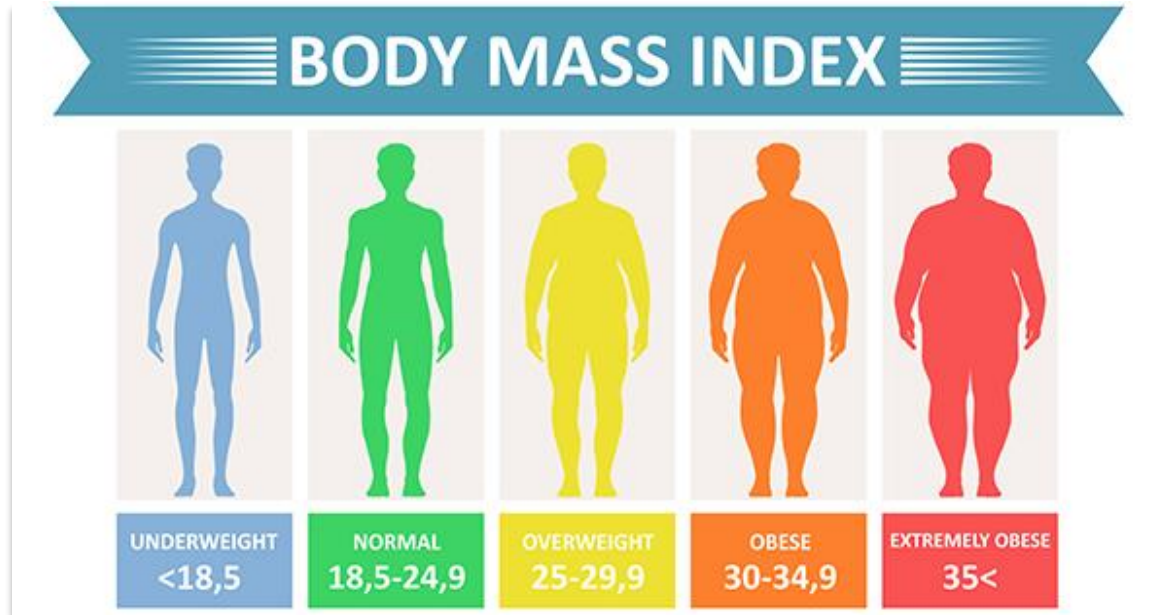## 💡 Insight.

- Insurance user age ranged **from 25 – 51 years old**.
- **Smoker** and **gender** variable are not affecting **age central tendencies.**
- The average age of females is larger than the average age of males by **one year.**
- Smoker people **proportion** is **less than** non-smoker people proportion.

Analysis on BMI

BMI Distribution of Insurance User
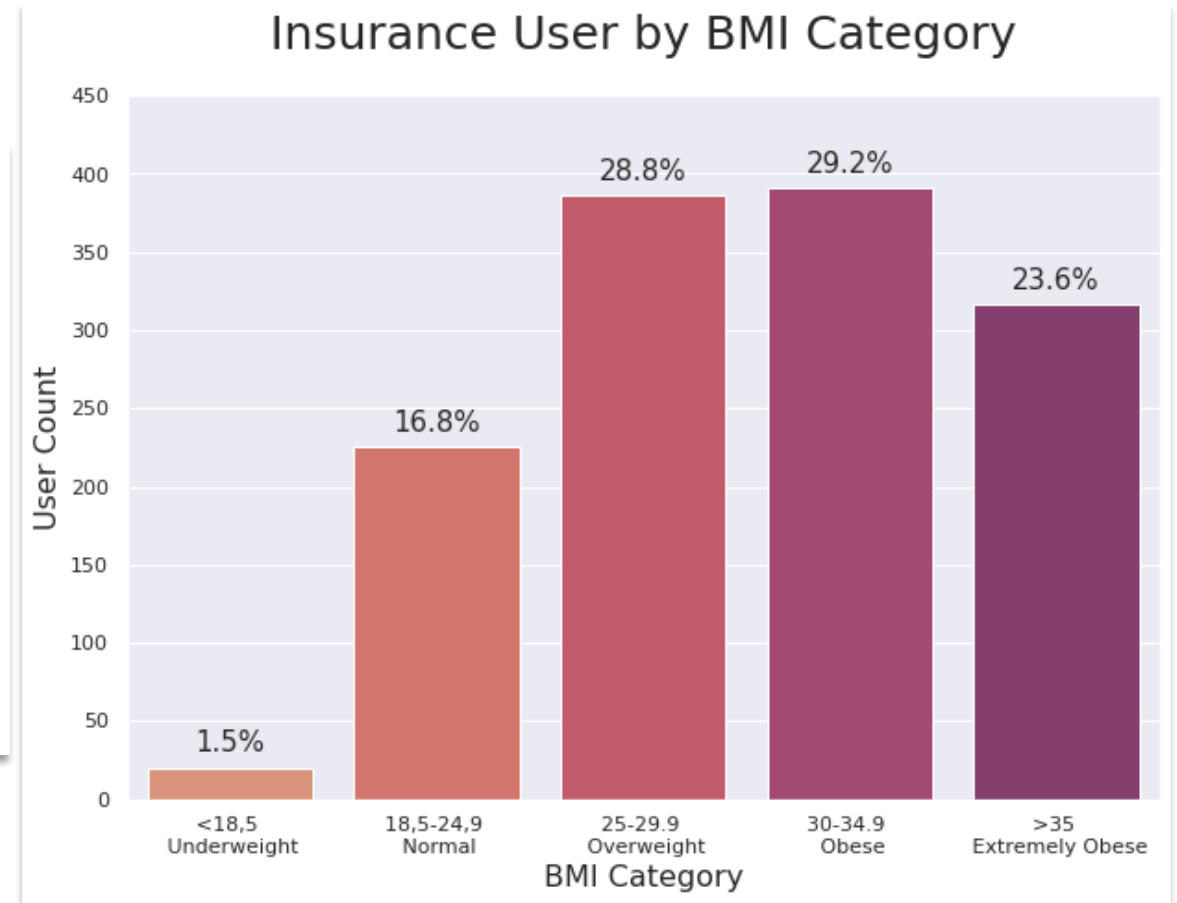

BMI Distribution for Smoker and Gender

💡 **Insight.**

- BMI of Insurance users is ranged **from 24.62 – 36.46**.
- **Smoker** and **gender** variable are not affecting **BMI central tendencies.**
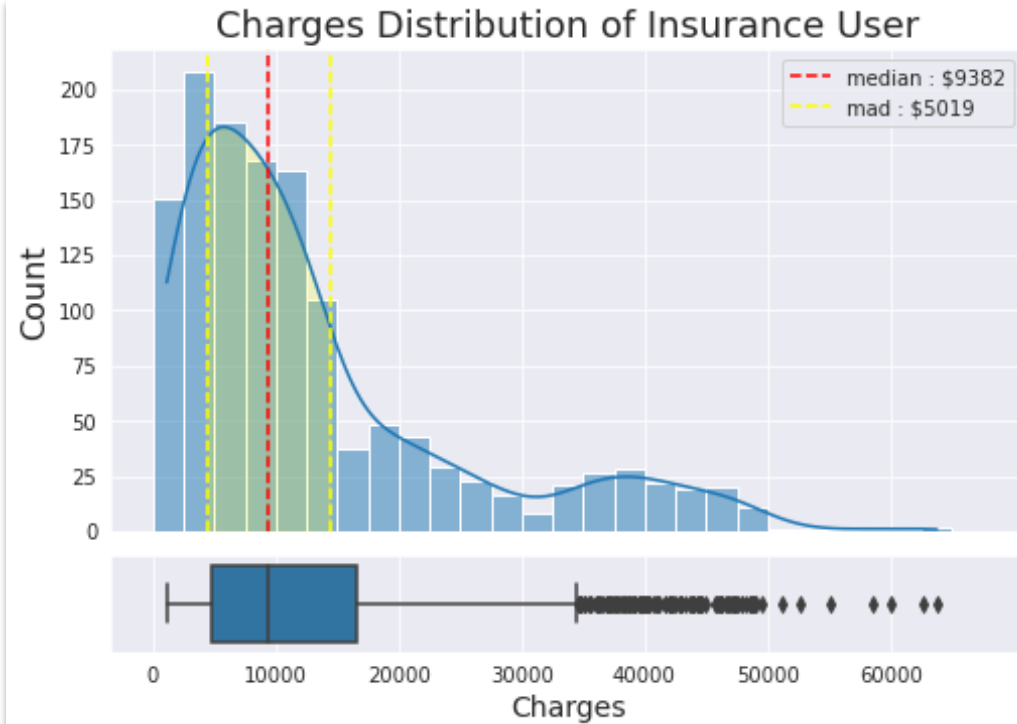- The mean of insurance users lies in **BMI Obese** category**.**

Analysis on BMI

BODY MASS INDEX

| UNDERWEIGHT <18,5 | NORMAL 18,5-24,9 | OVERWEIGHT 25-29,9 | OBESE 30-34,9 | EXTREMELY OBESE 35< |

Source : www.cdc.gov

Insurance User by BMI Category

1.5%   16.8%   28.8%   29.2%   23.6%

<18,5 Underweight | 18,5-24,9 Normal | 25-29.9 Overweight | 30-34.9 Obese | >35 Extremely Obese
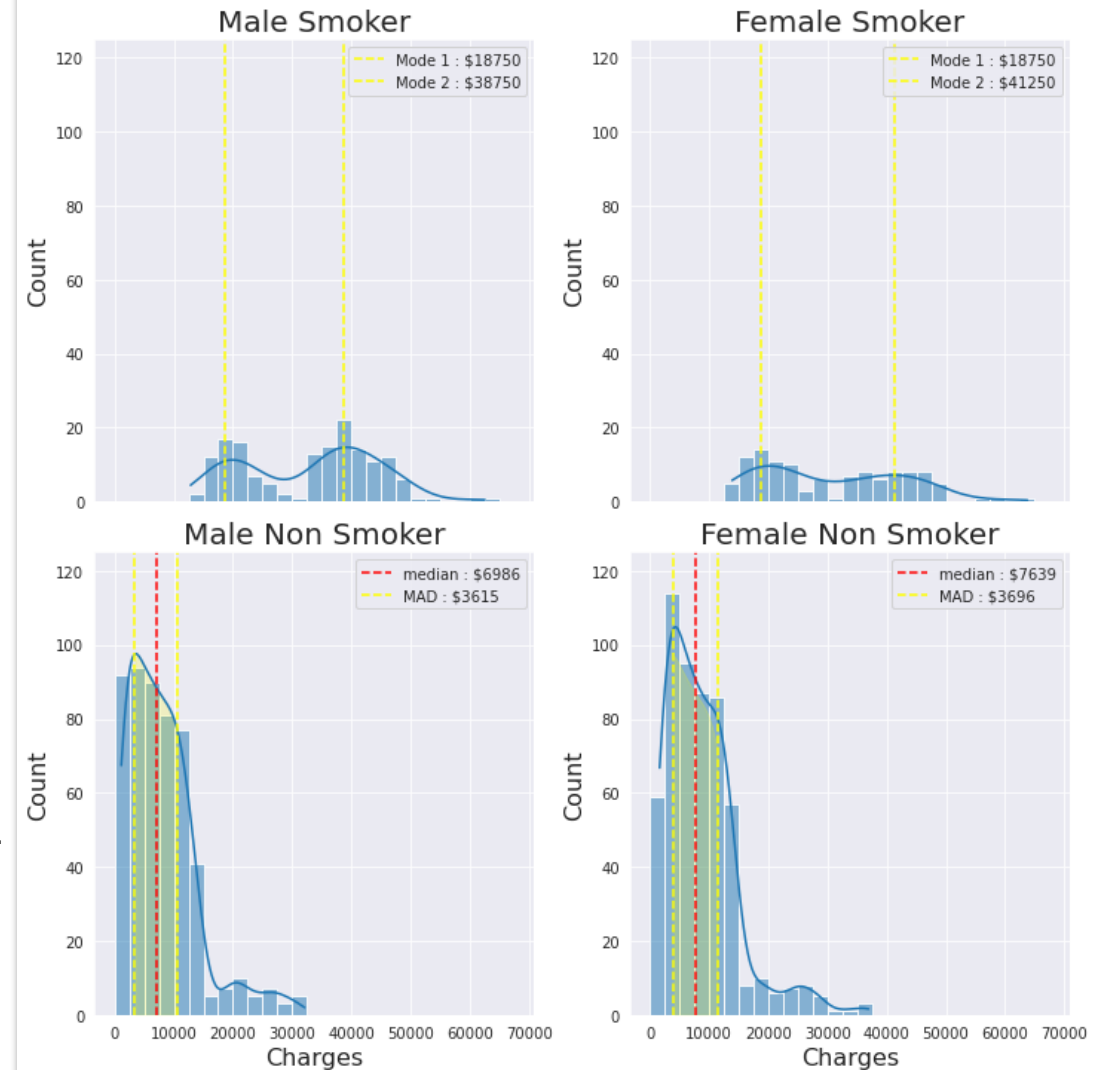
BMI Category

💡 **Insight.**

● **81,7%** of insurance users is having a BMI of **overweight to extremely obese.** this is the cause why the BMI **average of males, females, smokers, or non-smokers has an obese value.**
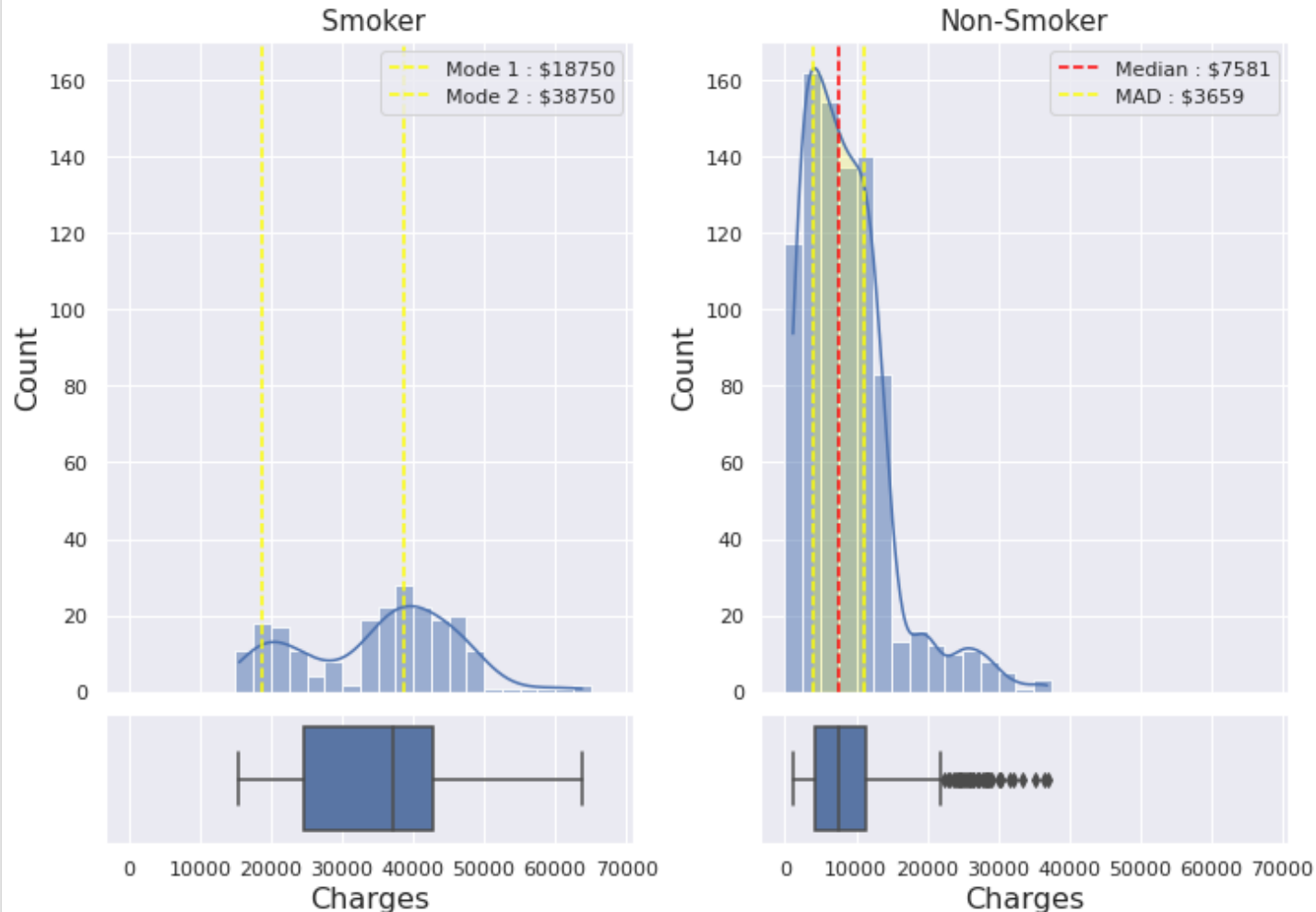
Analysis on Charges

Charges Distribution of Insurance User
- median : $9382
- mad : $5019

Charge Distribution for Smoker and Gender

Male Smoker
- Mode 1 : $18750
- Mode 2 : $38750

Female Smoker
- Mode 1 : $18750
- Mode 2 : $41250

Male Non Smoker
- median : $6986
- MAD : $3615

Female Non Smoker
- median : $7639
- MAD : $3696

💡 Insight.

- Overall insurance charges value is around **$4363 - $14401.**
- Smoker insurance charges are **more expensive** than non-smoker insurance charges.
- The central tendency of smoker insurance charge value is absolutely larger than **$18000**, whereas the central tendency of non-smoker insurance charge is less than **$10000**.
- For non-smoker people, Female insurance charges are more expensive than male insurance charges, but the difference is not larger than **$1000**.

Analysis on Charges

Overweight to Extremely Obese Charge for Smoker and Non-Smoker

💡 Insight.

● despite of BMI value, smoker insurance charges is still **more expensive** than non-smoker insurance charges.

Descriptive Statistic Analysis Summary

Insurance users come mainly from **productive people**, with age values ranging from **25 to 51 years old**, with an **average** value of **39-40 years old**. The unique part, is those productive people have an **average** value of **BMI** around **30** which lies in the category of **Obese**. After further analysis, I found that **87,1%** of the insurance user is having **BMI from Overweight to Extremely Obese**. This insurance user also covers people who smoke and don't smoke. Because of their habits, the insurance charge of those people will vary, the **most expensive** group of insurance user charges comes from those who **smoke**. The insurance charges for smokers are much more expensive than for non-smokers. The charges values for **smokers are larger than $18000** while charges for **non-smokers are less than $10000**.
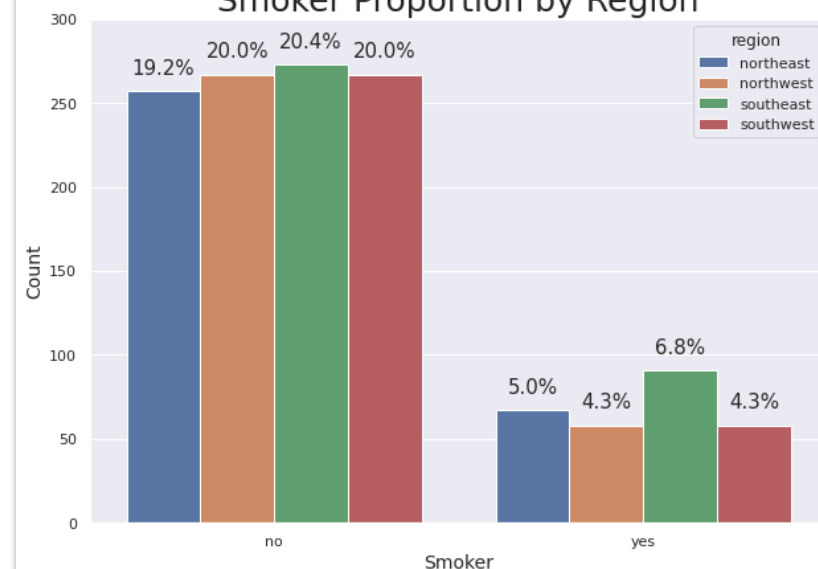
Categorical Variables Analysis

Region Analysis

User Proportion by Region
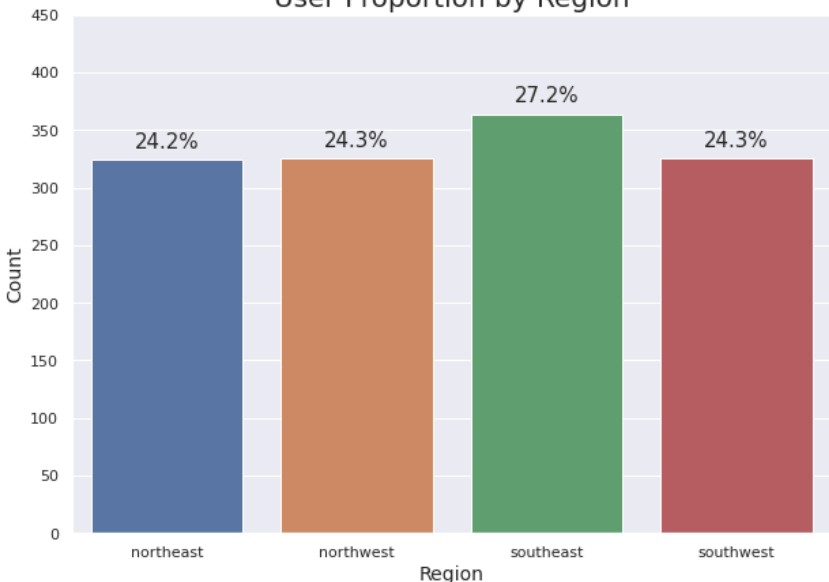
Gender Proportion by Region
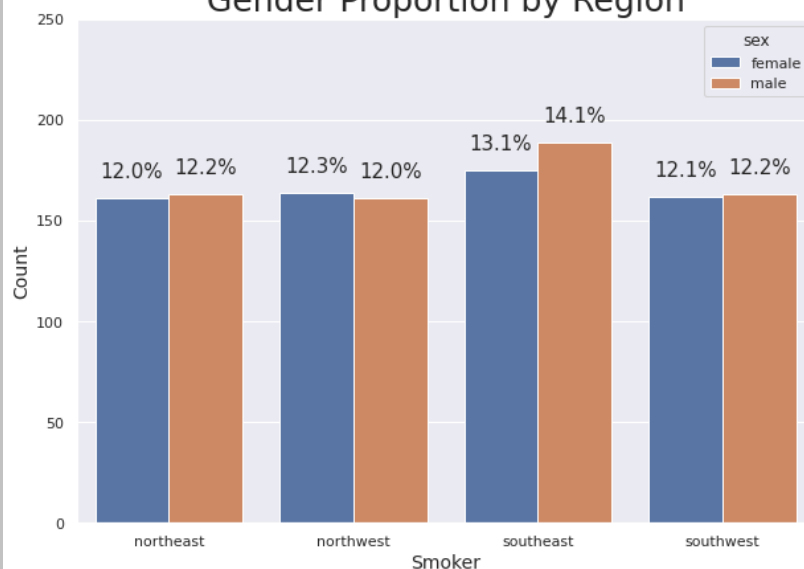
Smoker Proportion by Region

💡 Insight.

- **Northwest**, **southwest**, and **northeast** has the same proportion of user, bar plot showed that the value is 24.2% - 24.3%, whereas the **southeast** has the largest proportion at **27.2%.**
- Every region nearly has a **50:50** female to male ratio, except the **southeast** with a difference of **1%** in gender proportion.
- In **every region** proportion of **non-smokers** is **larger** than the proportion of **smokers**. The ratio of smokers to non-smokers is around **1:4**.
- **Southeast** has the largest proportion of smoker compared to other regions, whereas **northwest and southwest** has the **same head count of smokers**.

Region Analysis

Charges Distribution of Insurance User

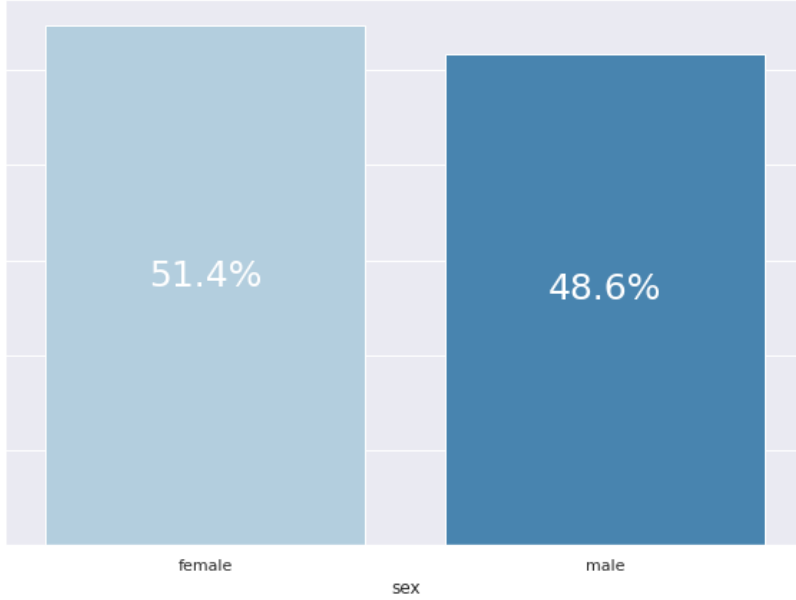Charge Distribution by Region
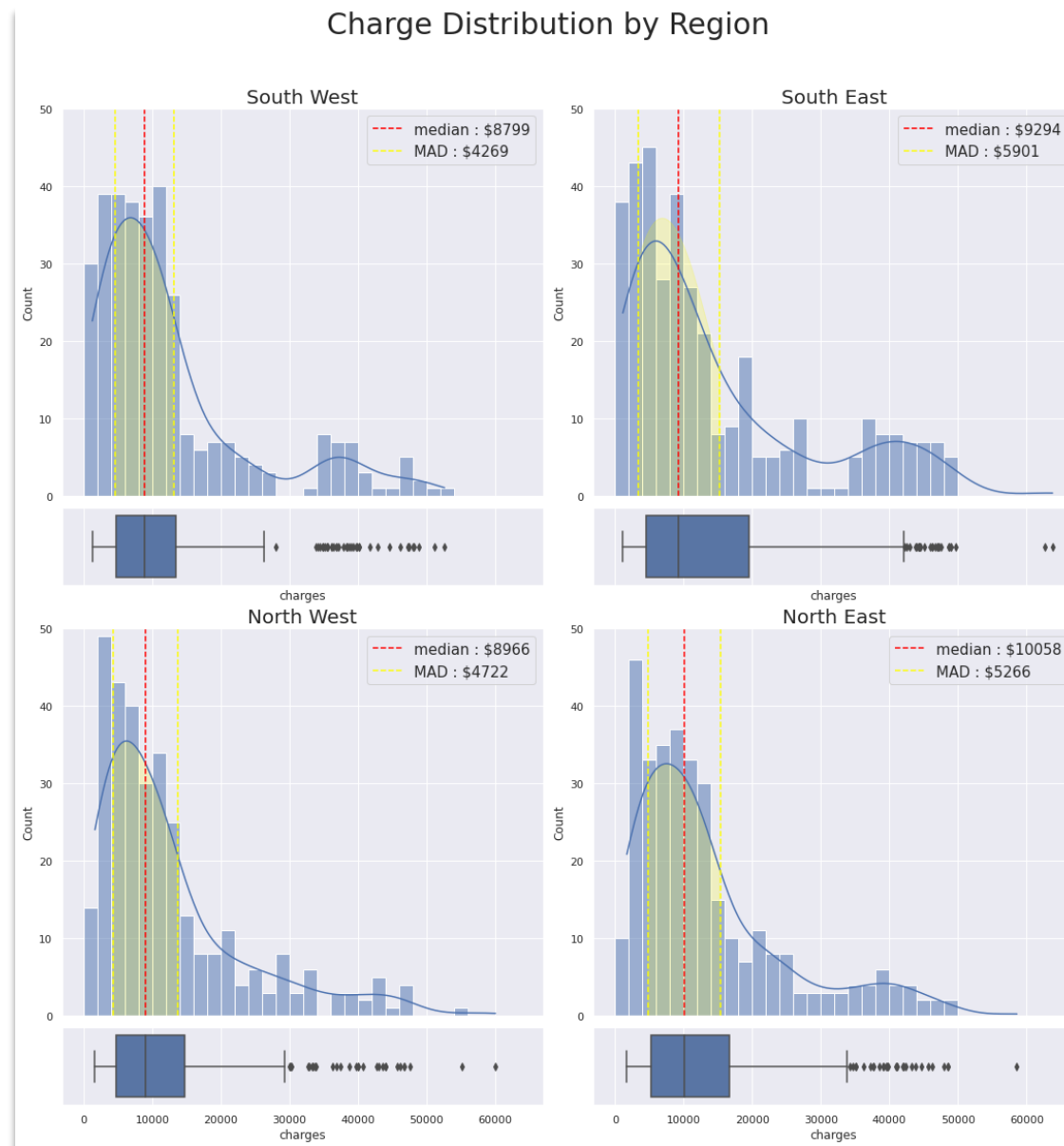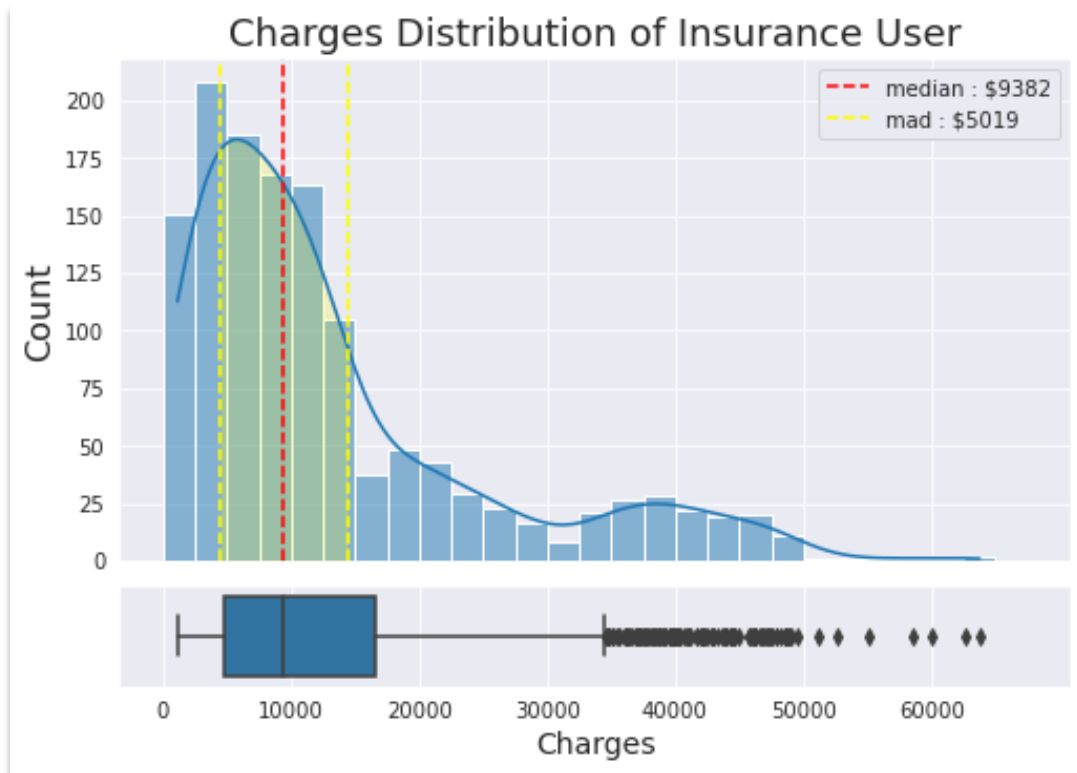
💡 **Insight.**

- Distribution charge from every region shaping similar shape, **positively skewed distribution**.

- North East became the most expensive charges with median **$10058**, and southwest became the cheapest charges with median **$8799**.

Smoker and Gender Analysis

Proportion of Gender in Non Smoker People

female 51.4% male 48.6%

Proportion of Smoker and Non Smoker

no 79.5% yes 20.5%
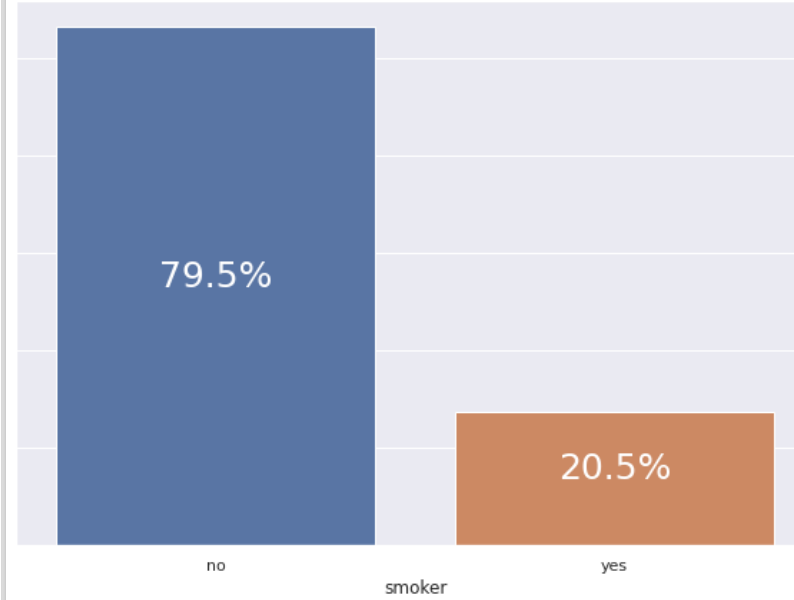
Proportion of Male & Female in Smoker People

female 42.0% male 58.0%
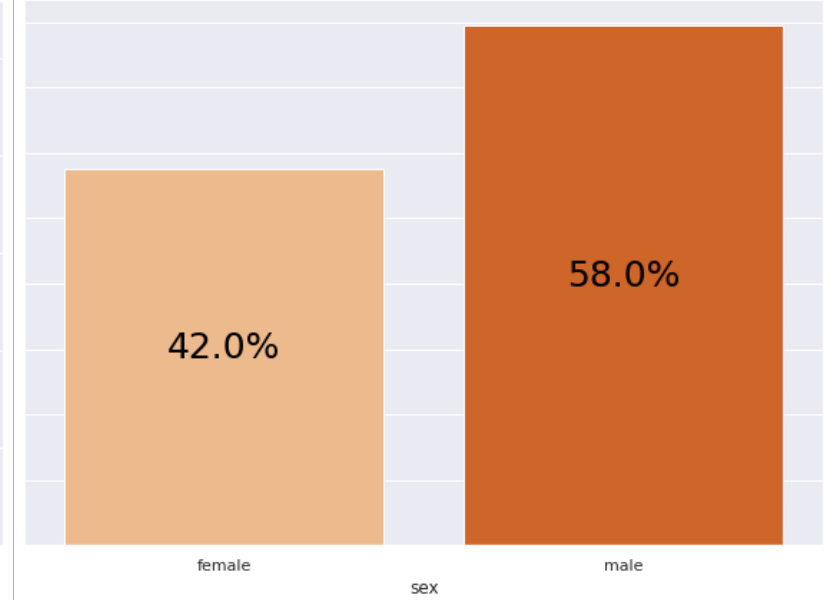
💡 **Insight.**

- Smoker proportion is much smaller than non-smoker proportion, **20.5% compare to 79.5%**.
- In the smoker group, the male has the largest proportion **58%** compared to female **42%**.
- In non-smoker group, female has the largest proportion **51.4%** compared to male **48.6%**.

Categorical Variable Analysis Summary

Every region has a nearly equal amount proportion of insurance users, **24.2-24.3%**, a slight difference exists in the southeast region with a proportion of **27,2%** of all insurance users. Every region also has a nearly equal amount of gender proportion between male and female, **50:50**, a slight difference also exists in the southeast region with a proportion difference of **1%** between male and female. The data confirm that the proportion of smoker people is less than non-smoker people, the ratio of the smoker and non-smokers in every region is around **1:4.** Within **s**moker people, the male proportion is larger than female, 58% compared to 42%, while in non-smoker people, the female proportion is larger than male, 51.4% compared to 48,6%**.** The northeast region became the region with the relatively expensive amount of insurance charge of around **$100508**, whereas the southwest region become the cheapest region with an insurance charge of around **$8799.**

Continuous Variables Analysis

Smoker Probability Charge Analysis

Smoker Charge Probability Density Plot
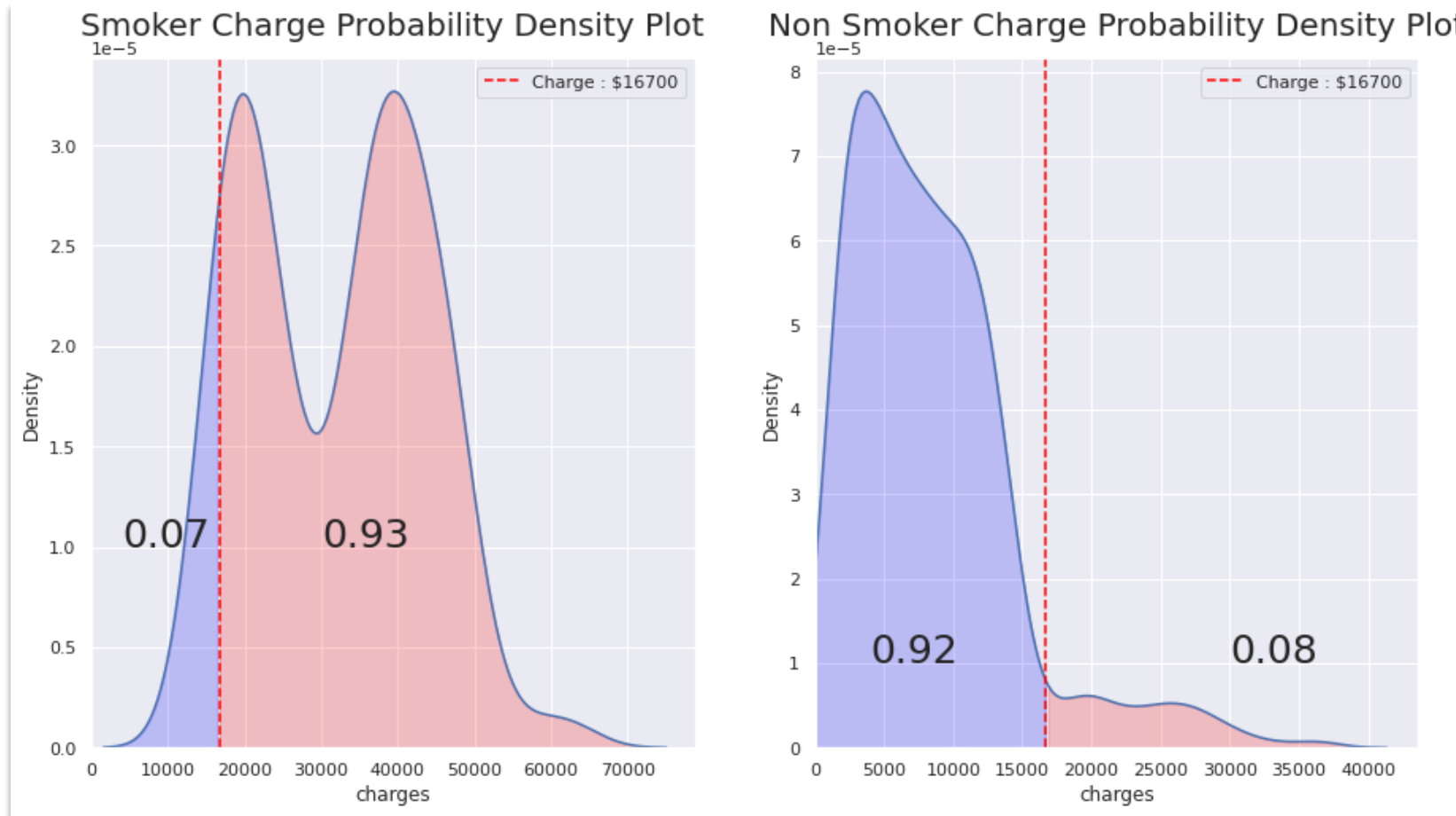
Non Smoker Charge Probability Density Plot

- It is **very possible** for **smokers** to get insurance charges **more than $16700,** the probability is **0.93**. And it is **rare** that **smokers** will get insurance **charges below $16700,** the probability is just **0.07.**

- it is **rare** for **non smokers** to have an insurance charge for **more than $16700**. But it is **common** for **non-smoker** to have insurance charges below **$16700**, the probability is **0.92**.
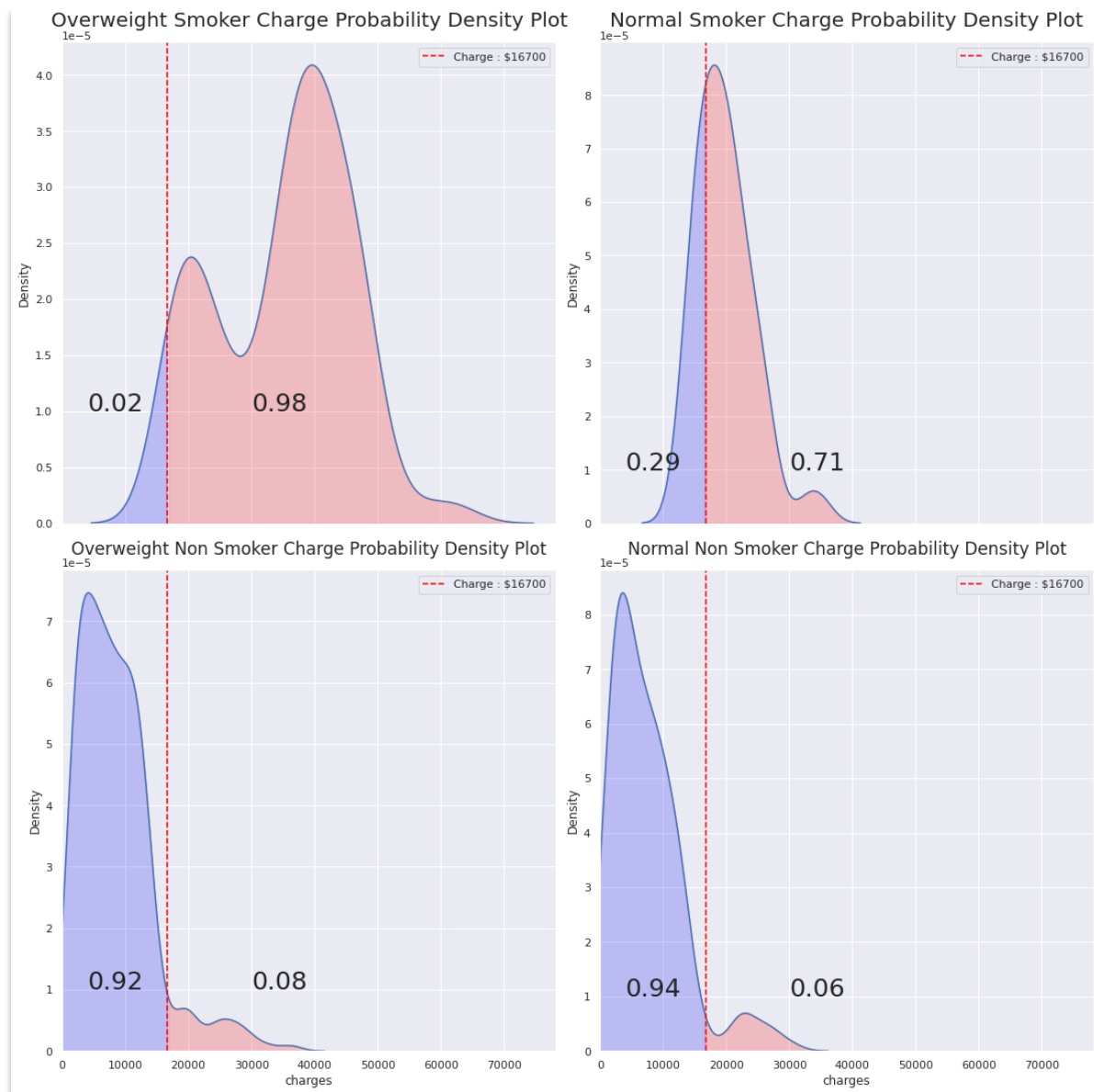
💡 **Insight.**

BMI Probability Charge Analysis

Overweight to Extremely Obese Charge Probability Density Plot

1e−5

- - - Charge : $16700

0.74   0.26

Density

charges

Underweight to Normal Charge Probability Density Plot

1e−5

- - - Charge : $16700

0.79   0.21

Density

charges

Insight.

- It is more possible for people with **BMI >= 25 (Overweight to Extremely Obese)** to get the insurance charge **below $16700** because the probability is **0.74**.

- Also It is more possible for people with **BMI < 25 (underweight to normal)** to get an insurance charge **below $16700** because the probability is **0.79**.

Smoker and BMI Probability Charge Analysis

Overweight Smoker Charge Probability Density Plot

Normal Smoker Charge Probability Density Plot

Overweight Non Smoker Charge Probability Density Plot

Normal Non Smoker Charge Probability Density Plot

💡 **Insight.**

- **smoking** really increases the probability of a person getting an insurance charge for **more than $16700**.
- **overweight** also increases the probability to get an insurance charge for **more than $16700** but **not as strong as smoking**.

Continuous Variable Analysis Summary

The **probability of a smoker** getting an insurance charge of **more than $16700** is very large, **more than 0.7**, without taking into account his/her BMI factor. **BMI Factor** also contributes to the expensiveness of insurance charges, but the effect is **not as strong** as if he/she **smokes**. For smokers, the difference of probability between a normal BMI smoker, and with overweight BMI smoker is **0.27,** while for non-smokers the difference of probability between a normal BMI smoker, and with overweight BMI smoker is just **0.02**, this difference is very significant, thus smoking is a great factor affecting the insurance charges.
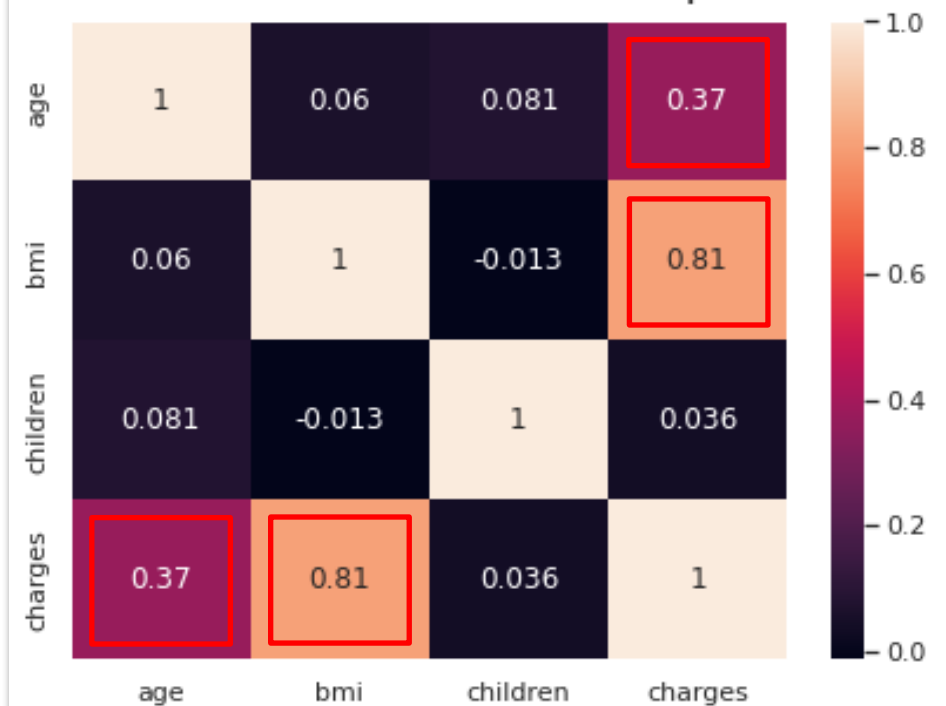
Correlation Analysis

Smoker Correlation Analysis

Pair plot of Charges, Children, BMI, and Age Data from Smoker
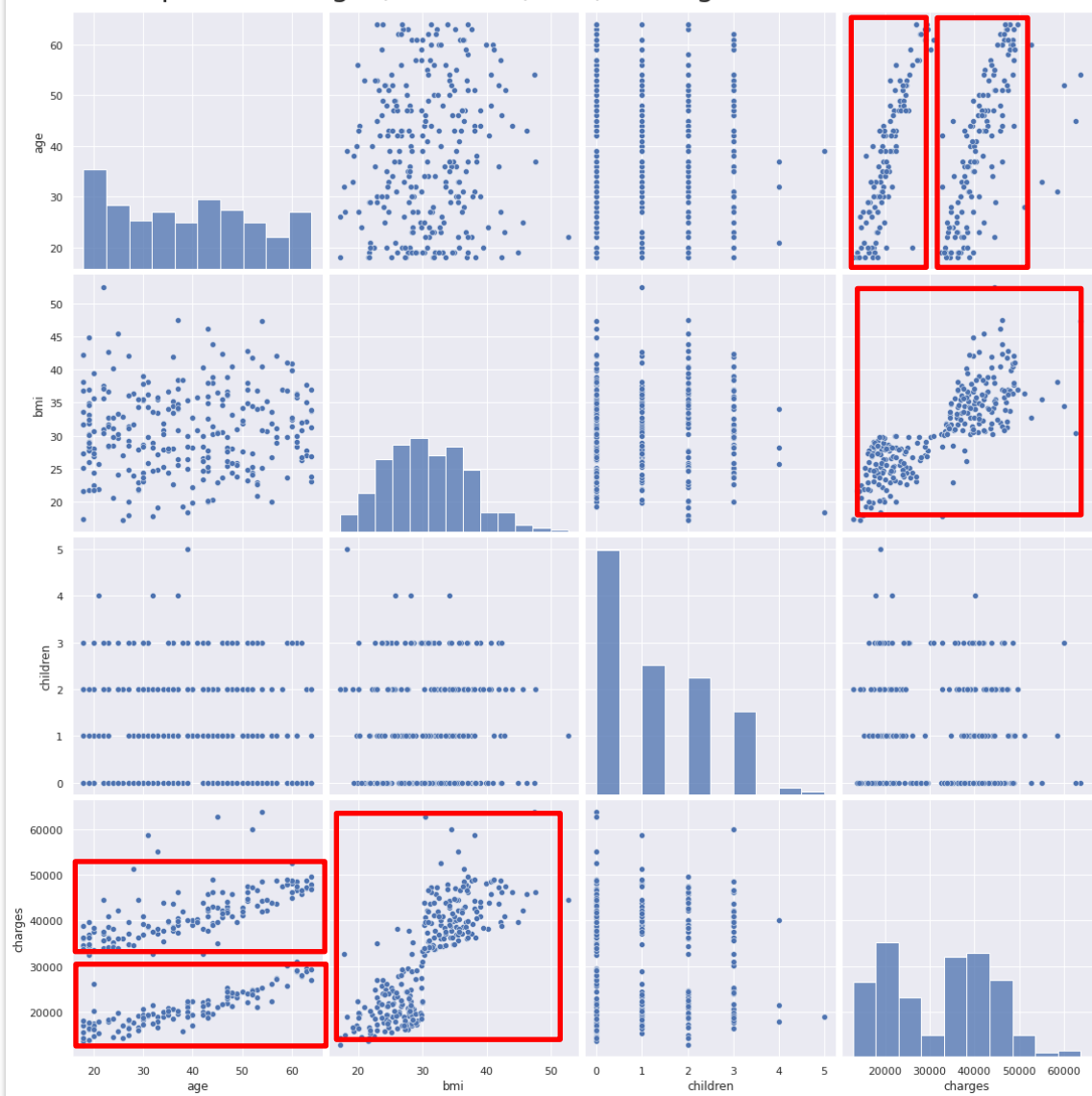
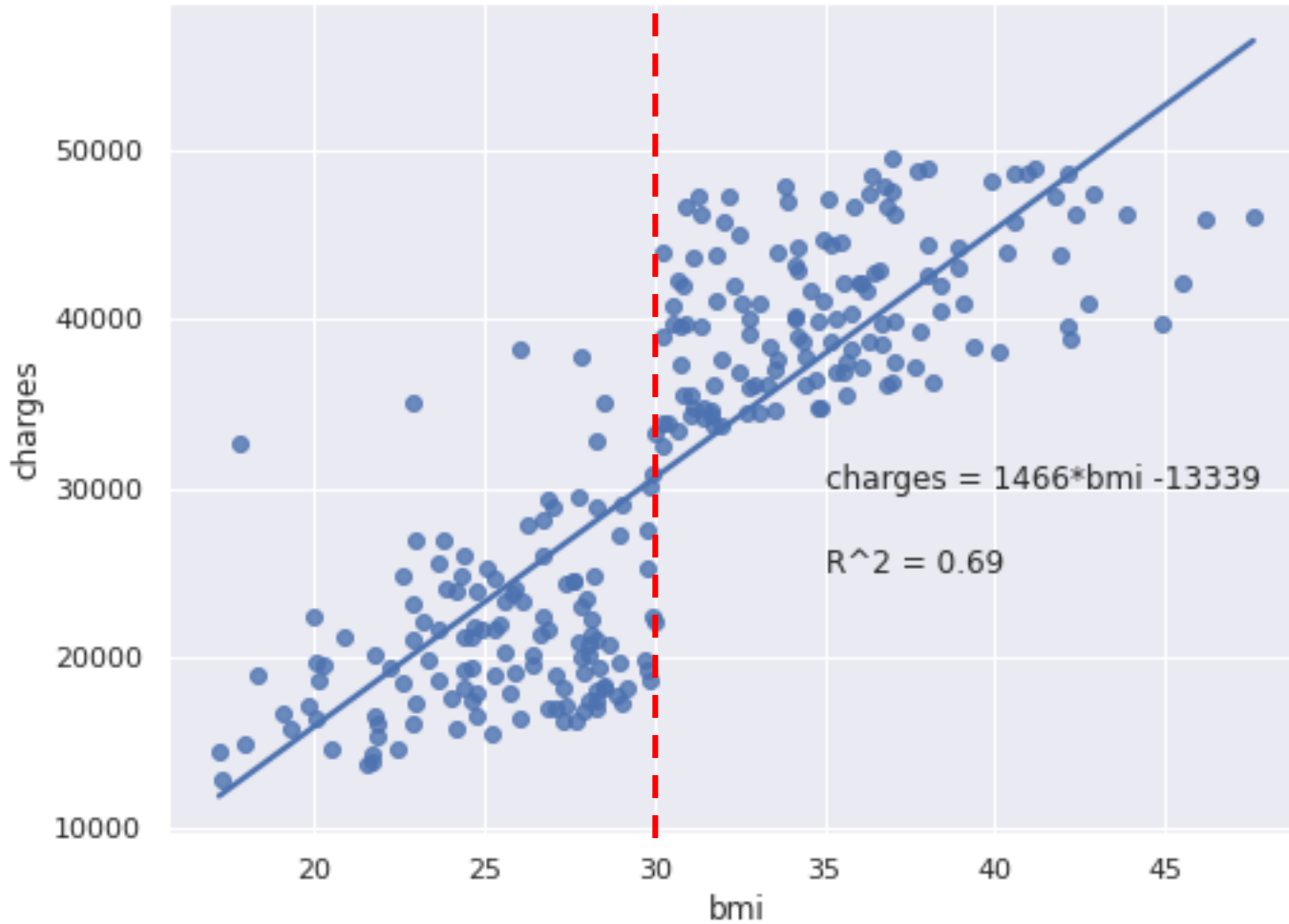

Smoker Correlation Map

💡 **Insight.**

- BMI and Charge has a strong correlation, **0.81**.
- there are positive weak correlation, **0.37**, between age and charges, but notice there are pattern in the scatter plot

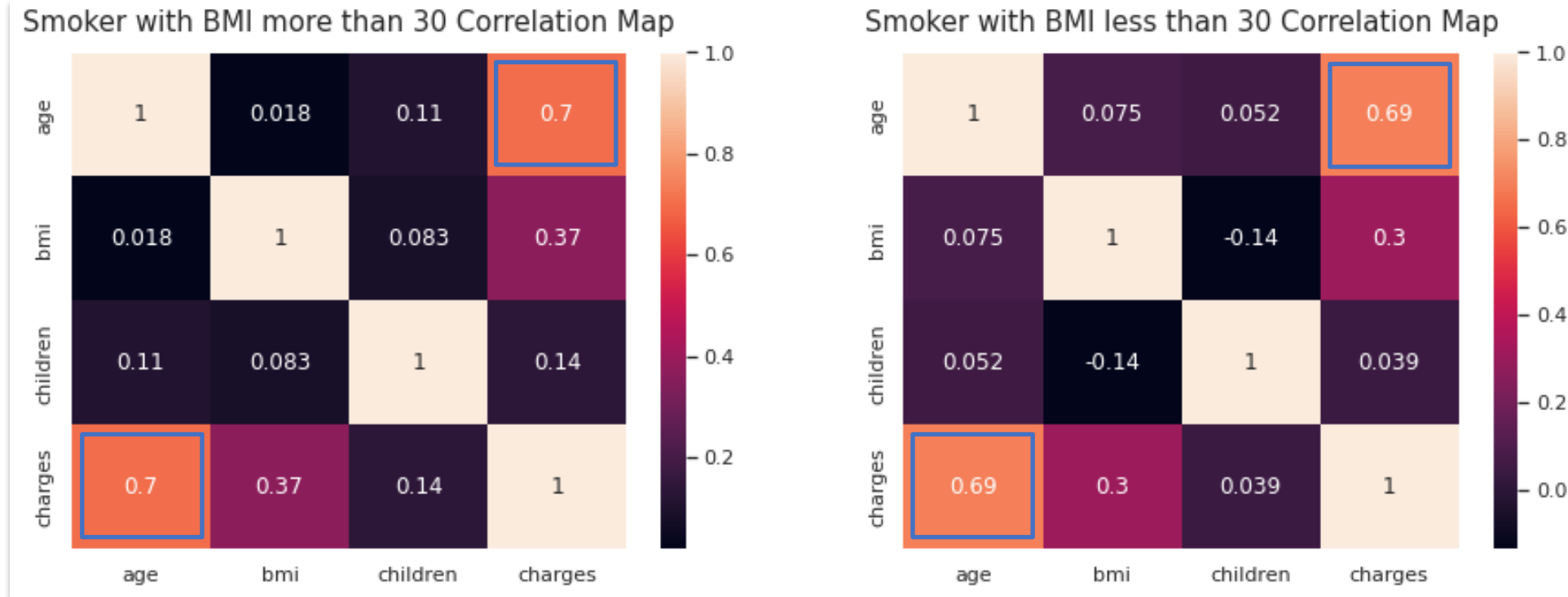# Smoker Correlation Analysis

Plot BMI vs charges of smoker

$$charges = 1466 \times bmi - 13339$$

$$R^2 = 0.69$$

💡 Insight.

- For smoker if the **BMI** of insurance user increase by **one value**, the **charges** will **increase by $1466**
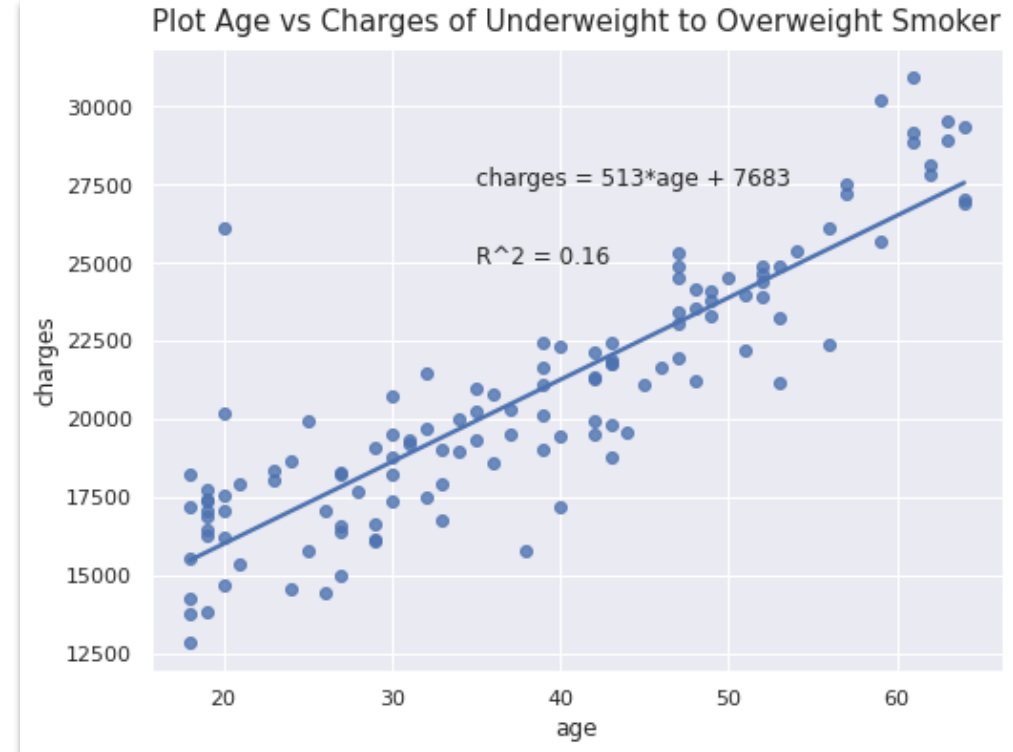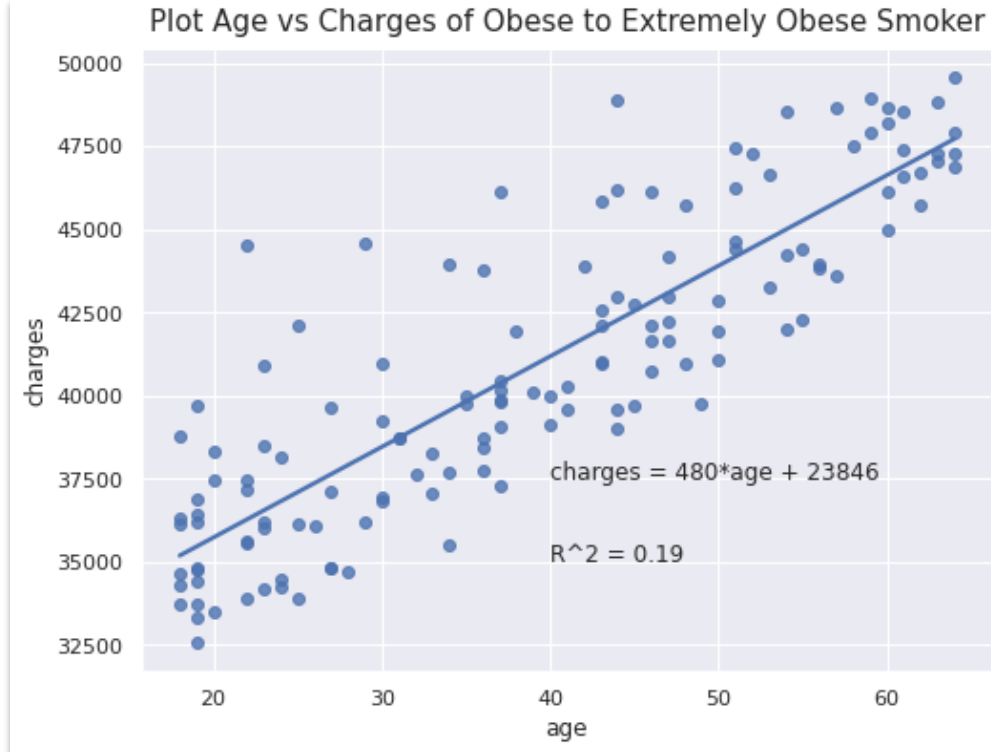
Smoker Correlation Analysis

💡 **Insight.**

- After separation using **BMI = 30** we could see that the **correlation value** from age and charge **increased** to **0.7**, this is a **strong correlation**. This could mean that there are indeed a relationship between **age and charges**.

Smoker Correlation Analysis

Plot Age vs Charges of Obese to Extremely Obese Smoker

$$charges = 480*age + 23846$$

$$R^2 = 0.19$$

Plot Age vs Charges of Underweight to Overweight Smoker

$$charges = 513*age + 7683$$

$$R^2 = 0.16$$

💡 Insight.

- For smokers with BMI > 30, if the age was **increased** by **one value**, there will be an **increase in insurance charges** by **$480**. With charges ranged from **$32500 to $50000**.

- For smokers with BMI <= 30, if the age was **increased** by **one value**, there will be an **increase in insurance charges** by **$513**. With charges ranged from **$12500 to 32500**. This finding confirms analysis before, people who smoke and have a high BMI tend to have an expensive insurance charge.

Non Smoker Correlation Analysis

Pair plot of Charges, Children, BMI, and Age Data from Non Smoker
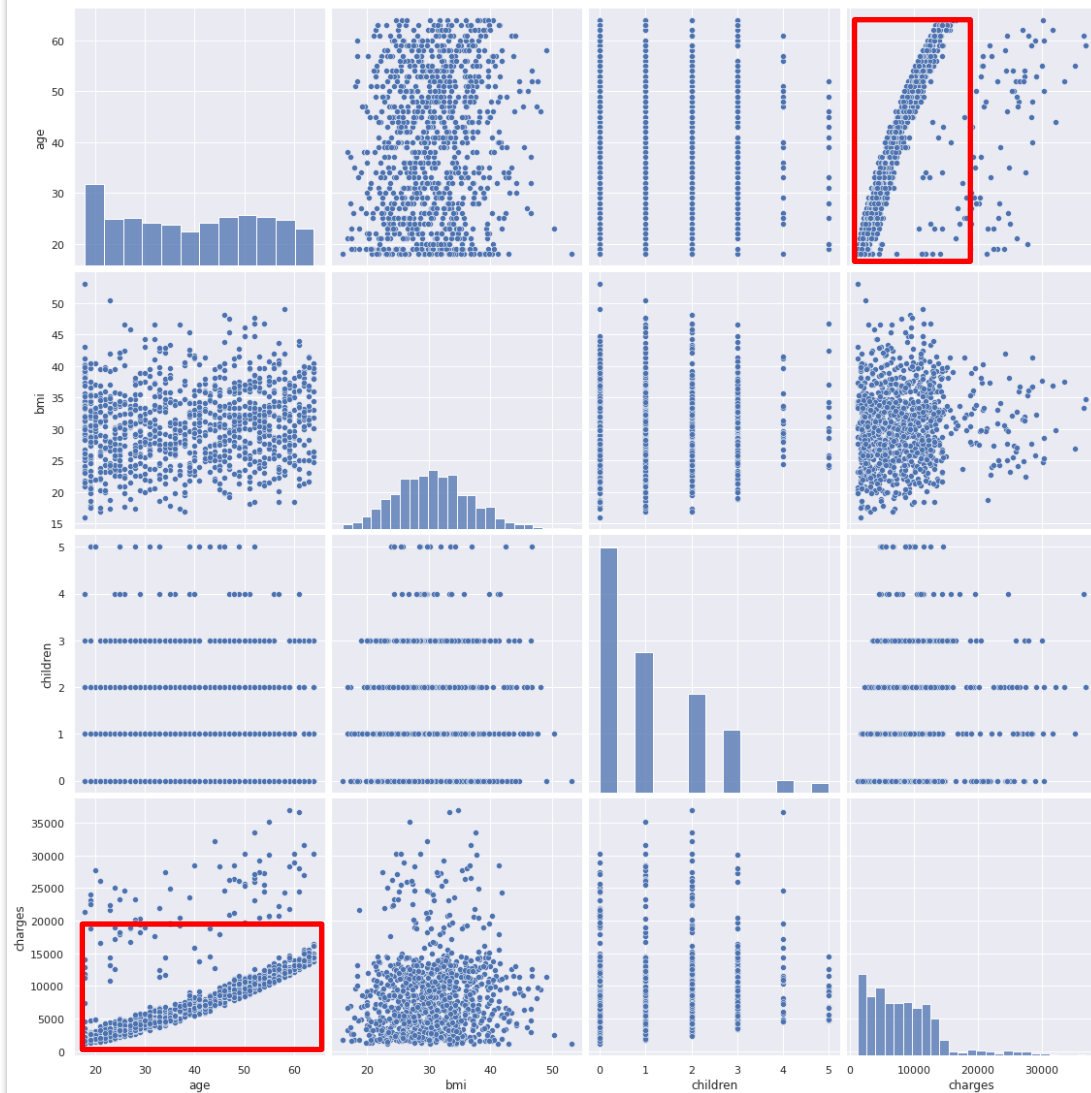
Non Smoker Correlation Map
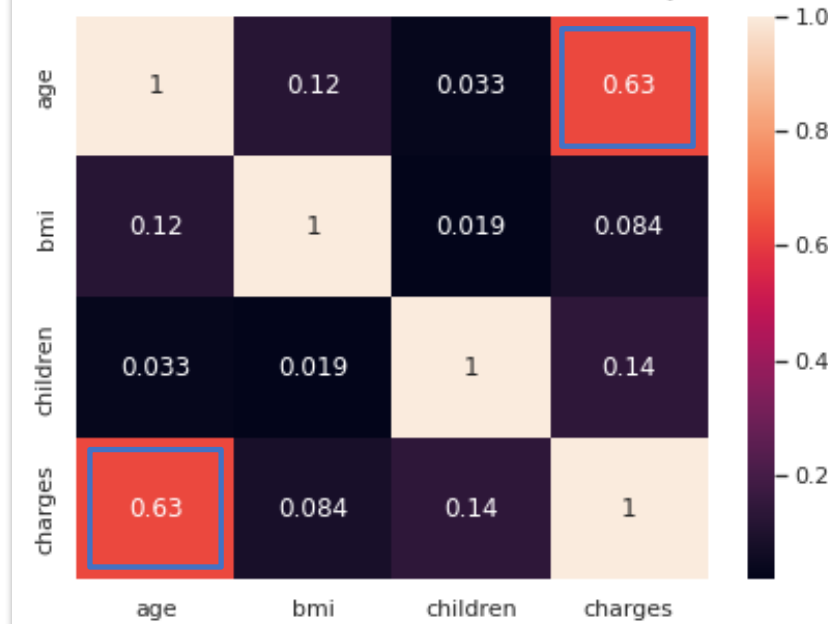
💡 **Insight.**

● there are positive strong correlation between **age vs charge** for non-smoker, with a correlation value of **0.63**

Non Smoker Correlation Analysis

Plot Age vs Charges of Non Smoker

charges = 70*age + 5040

R^2 = 0.01
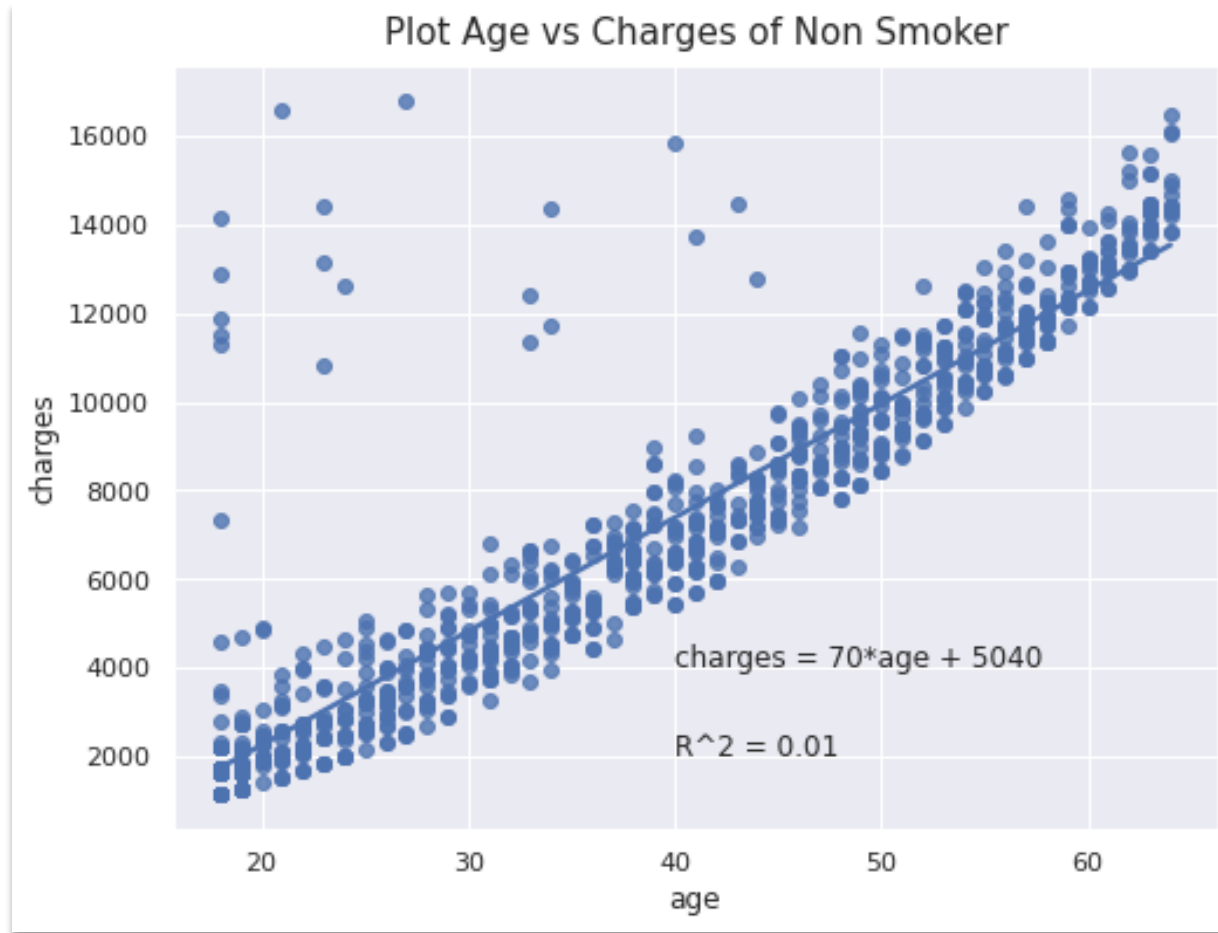
💡 **Insight.**

- For non-smokers, if the **age** increased by **one value**, there will be an increase in charge by **$70 dollars**, this is relatively a low value to smoker data. With charges value ranged from around **$1000 to $16000.**

- Compared to the smoker linear regression minimum value, non smoker indeed has cheaper insurance charge.

Correlation Analysis Summary

There is a correlation between smokers, non-smokers, BMI values, and age of insurance users to insurance charges that they have. Correlation analysis shows that people who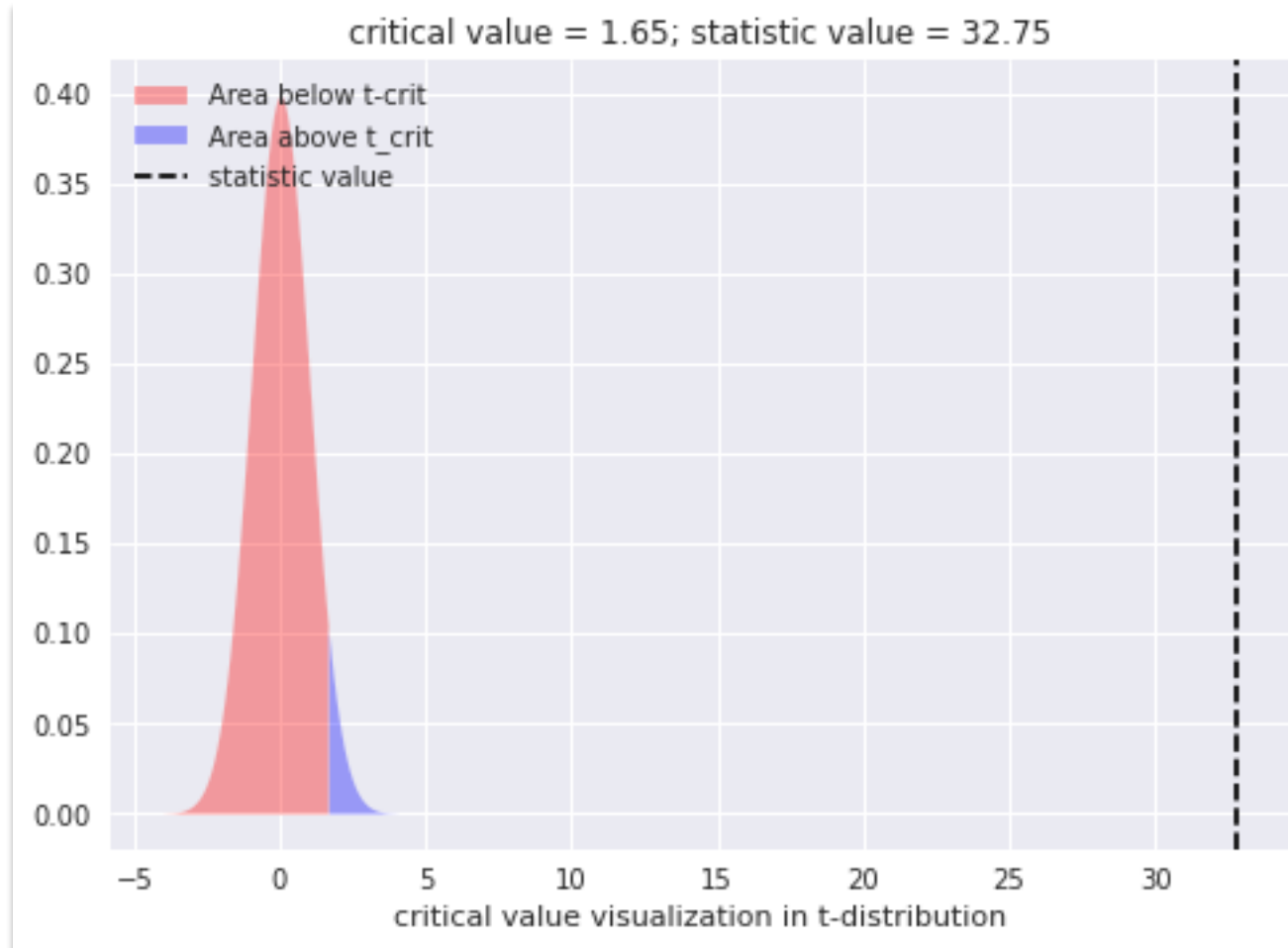 smoke and have a high value of BMI tend to have an expensive insurance charge, the minimum charge value for them is **$32500** and the value will increase by **$480** dollars if the insurance user gets older. Smoker with middle to low-value BMI will have relatively cheaper insurance charges than smokers with high BMI values, the minimum charge for them is **$12500** and the value will increase by **$513** dollars if the insurance user gets older. Non-smokers, compared to smokers, have really cheap charges, their minimum value is around **$1000** and the charges will increase by just **$70** dollars if they get older. Then we could know that smoking and BMI really affects the expense of insurance charge.

Hypothesis Testing

Smoker's charges are higher than non-smoker's

critical value = 1.65; statistic value = 32.75

Legend:
- Area below t-crit
- Area above t_crit
- -- statistic value

critical value visualization in t-distribution

$$H_0 : \mu_{Charge|Smoker} <= \mu_{Charge|Non-Smoker}$$
$$H_1 : \mu_{Charge|Smoker} > \mu_{Charge|Non-Smoker}$$

💡 **Insight.**

- **Reject H0**, hence in a population of insurance users, we are 95% confident that smoker's insurance charges are higher than non-smoker insurance charges

Insurance charges with BMI > 25 is higher than insurance charges with BMI < 25

critical value = 1.65; statistic value = 5.95

Legend:
- Area below t-crit
- Area above t_crit
- statistic value

x-axis: critical value visualization in t-distribution
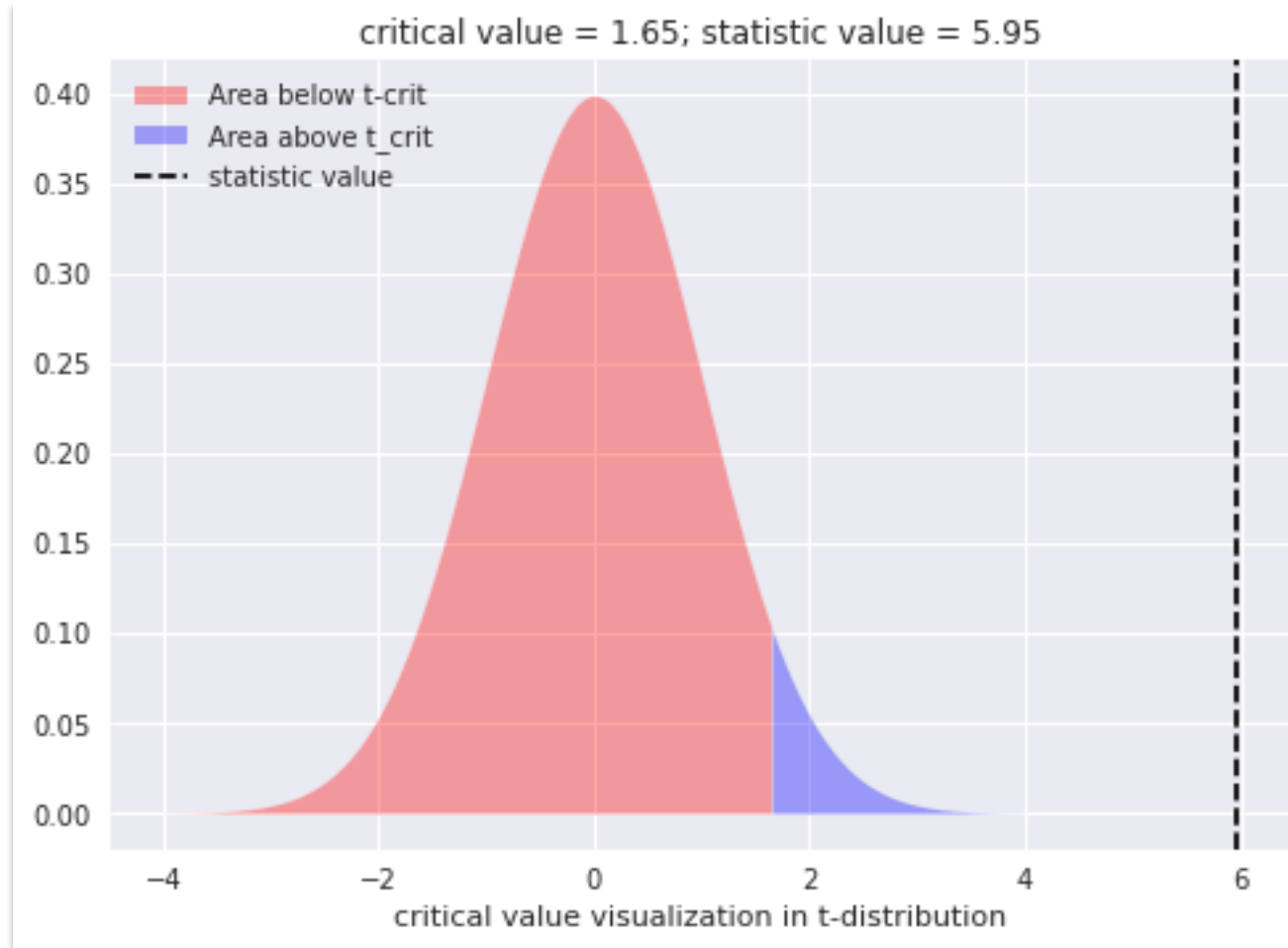
$$H_0 : \mu_{Charge|BMI>25} <= \mu_{Charge|BMI<=25}$$
$$H_1 : \mu_{Charge|BMI>25} > \mu_{Charge|BMI<=25}$$

💡 **Insight.**

- **Reject H0**, hence in a population of insurance users, we are 95% confident that users with BMI more than 25 will have more expensive charges than users with BMI less than 25.

Male and Female BMI is similar

critical value 1 = -1.96; critical value 2 = 1.96 ; statistic value = 1.7

Legend:
- Area below & above t-crit
- Area between t-crit
- statistic value

critical value visualization in t-distribution

$$H_0 : \mu_{BMI|Male} \neq \mu_{BMI|Female}$$
$$H_1 : \mu_{BMI|Male} = \mu_{BMI|Female}$$

💡 **Insight.**

- **Fail to Reject H0**. Hence we are 95% confident that there is not enough data/evidence to prove that in a population of insurance users Male BMI is similar to Female BMI.

Male insurance charges are higher than female insurance charges

critical value = 1.65; statistic value = 2.1

Legend:
- Area below t-crit
- Area above t_crit
- statistic value

x-axis: critical value visualization in t-distribution

$$H_0 : \mu_{Charge|Male} <= \mu_{Charge|Female}$$
$$H_1 : \mu_{Charge|Male} > \mu_{Charge|Female}$$

💡 **Insight.**

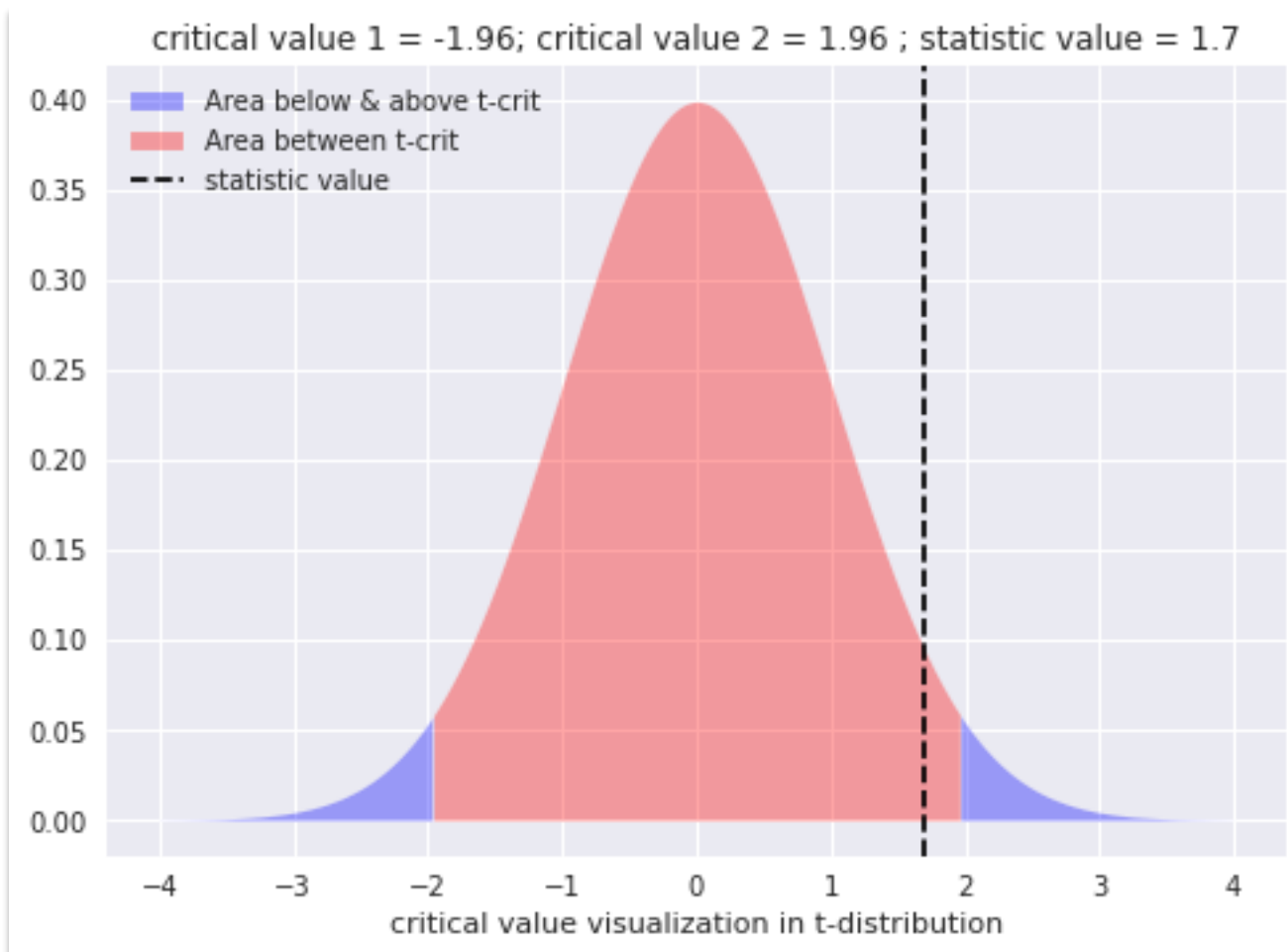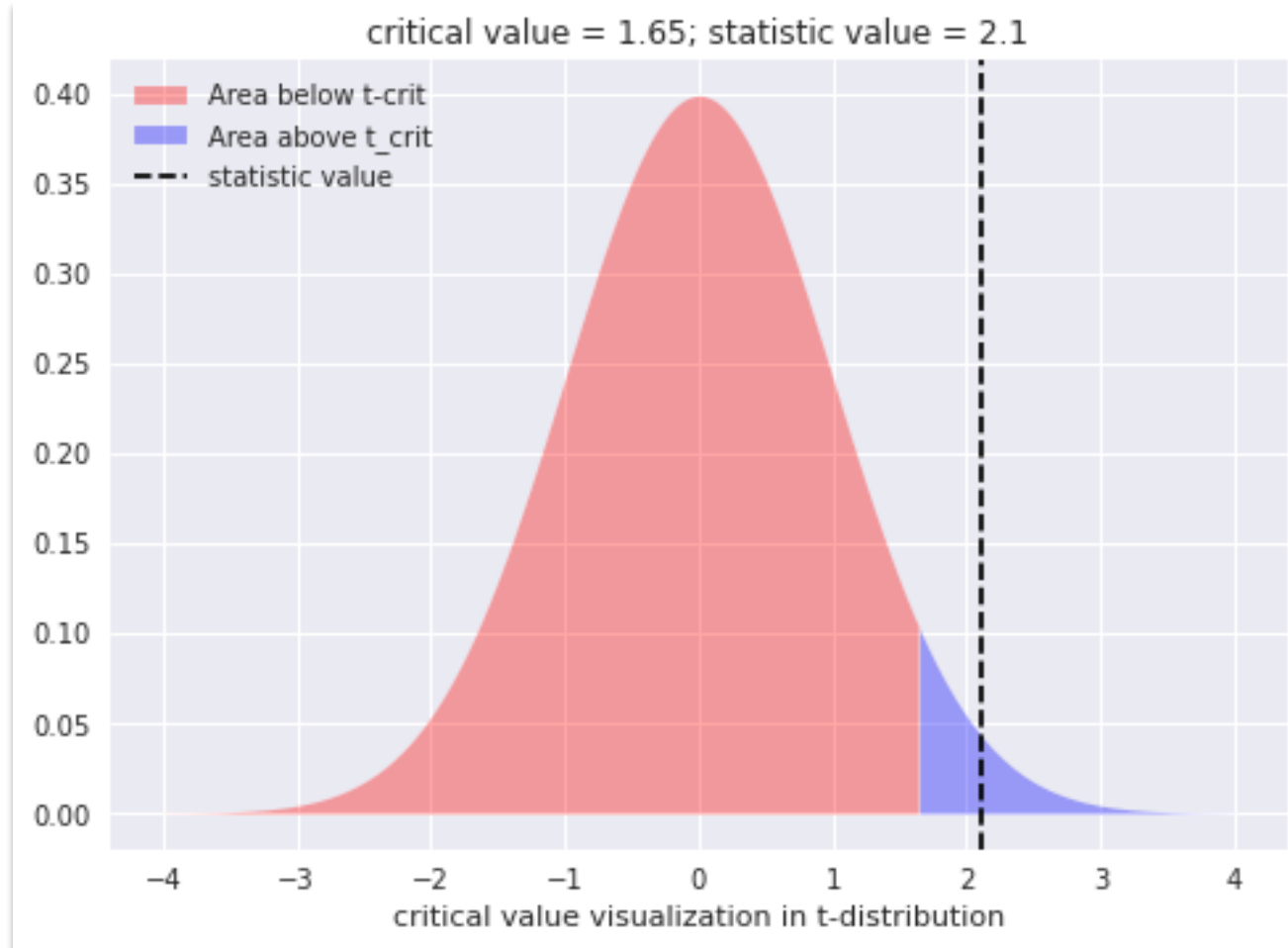- **Reject H0**, hence in a population of insurance users, we are 95% confident that male insurance charges are higher than female insurance charges.

Conclusion

Analysis Summary

There are **several factors** that affect insurance user charges determination like **smoking, BMI value, age, gender, region, and the number of children in a family**. Of those factors, the most **key factor** to determine **how expensive** insurance charges will users have is the **smoking habit**. Analysis shows that people who smoke will get insurance charges higher than people who don't smoke, the **charges for smokers are around $18750** for smokers with **relatively a good value of BMI,** and around **$40000** for smokers with a **bad value of BMI**. Whereas insurance charges for **non-smokers** are just around **$4000**. **BMI** also becomes the **second most contributing factor for insurance charge determination**, but the BMI contribution to charges determination is **larger in smoker people.** The analysis also shows that **as people get older**, the insurance **charge is getting expensive**, this age factor is also different in smokers and non-smokers people. The rest of the factor such as **gender, region, and the number of children** in a family does contribute to the determination of insurance charge but the value is **very small** compared to smoking, BMI, and age factor.

Reference

- Probability and Statistics for Engineers and Scientist, Ronal E. Walpole et. All
- Pacmann : Intro to Probability Learning Module
- Exploratory and Data Analysis Document

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Thank You

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Sertifikat
Kompetensi
Kelulusan

CERTIFICATE

OF COMPLETION

Has Been Awarded To

Stefanus Yudi Irwan

for successfully completing in class

Introduction to Data & Introduction to Visualization

August 06, 2022 – October 09, 2022

Adityo Sanjaya
CEO Pacmann

SIGNATURE: 10/10/2022

Verifikasi Sertifikat
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Project Notebook,
Repository, & Presentation

Project-Notebook

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Kaggle-Repository

YouTube Presentation