HEALTH METRICS IN PREDICTING DIABETES

TABLE OF CONTENTS

01

PRACTICAL MOTIVATION

422 MILLION

Individuals has diabetes worldwide according to the World Health Organisation (2022).

The prevalence of diabetes in Singapore is costing our country over $1 billion a year to manage. Learn more about how we intend to win the war against this lifestyle condition.

The Singapore government has issued a clarion call — it officially declared war on diabetes, calling the disease one of the biggest drains on the healthcare system, and one which costs the country over $1 billion a year to manage.

Prevalence of Diabetes

During the 2016 Committee of Supply debates in Parliament, Health Minister Gan Kim Yong revealed that over 400,000 people have diabetes in Singapore. Of these, one in three is not aware he/she has the disease, and of the rest who do know, one in three has poor control of it. If left unchecked, nearly one million people in Singapore will have diabetes by 2050.

Fig. 1: *Prevalence of Diabetes in Singapore.*
(*Singapore's War on Diabetes*, 2021)

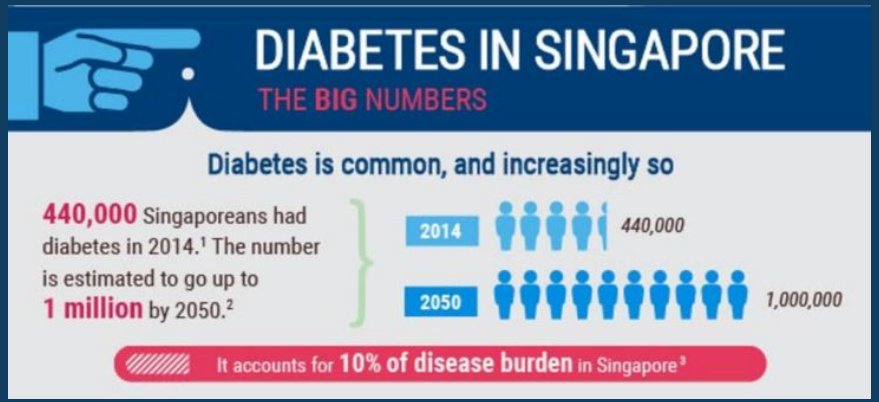


Fig. 2: *Diabetes in Singapore.*
(James, T., n.d.)

WHAT ARE SOME OF THE IMPORTANT HEALTH METRICS IN DETERMINING RISK OF DIABETES?

THE DATASET

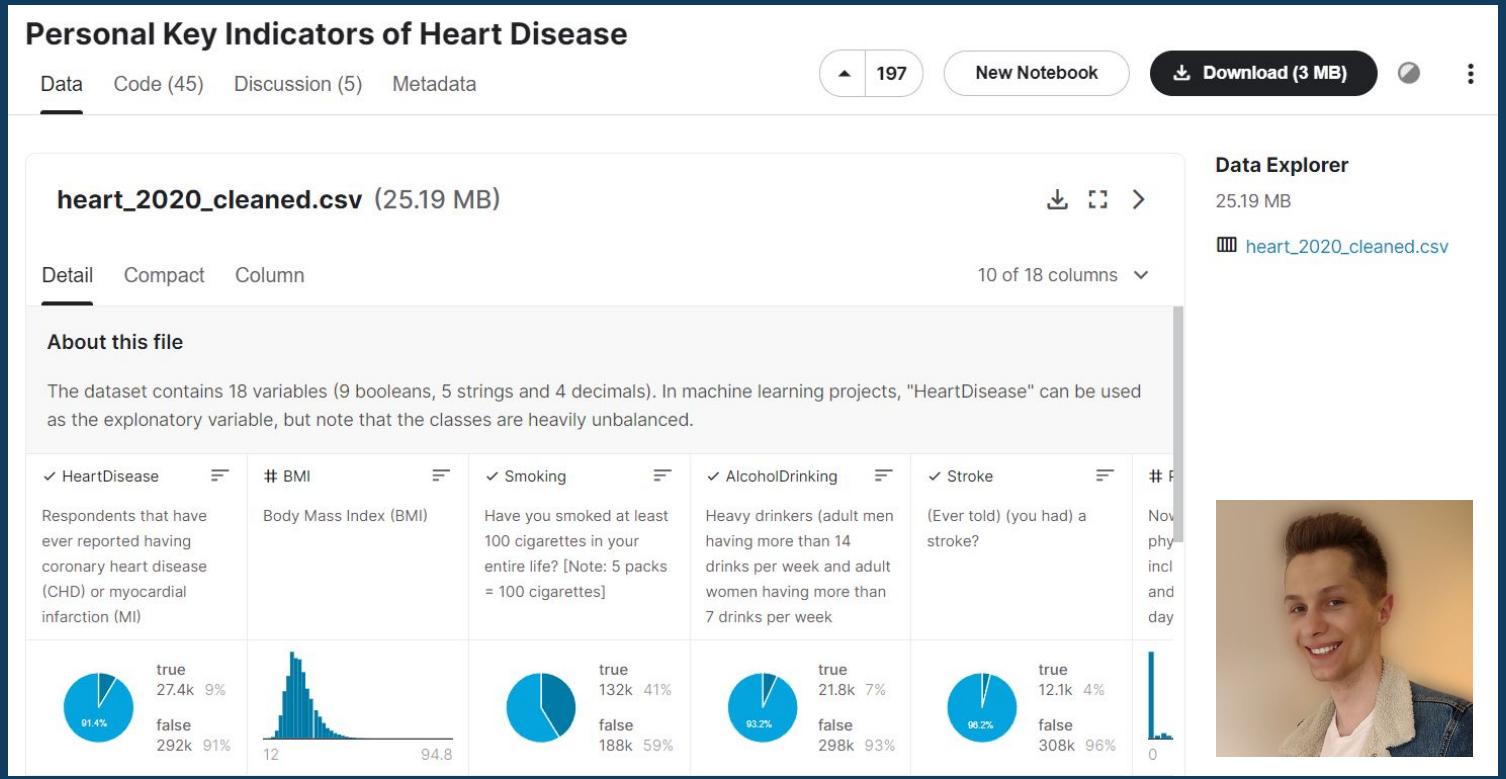
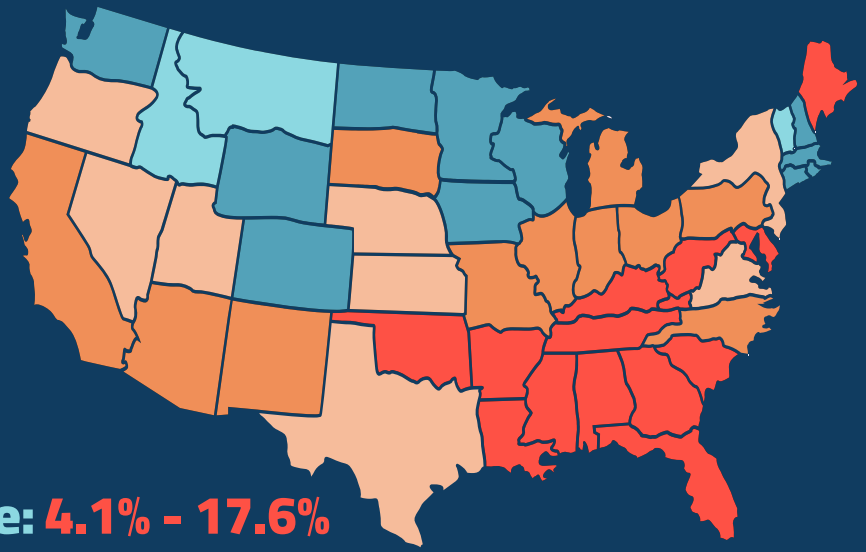


Fig. 3: *Personal key indicators of heart disease dataset on Kaggle* (Pytlak, K., 2022)

PREVALENCE IN THE U.S. (2019)

Estimates of diagnosed diabetes across US counties



- > 10.1%
- 8.5 - 10.0 %
- 7.4 - 8.4 %
- 6.6 - 7.3 %
- < 6.6 %

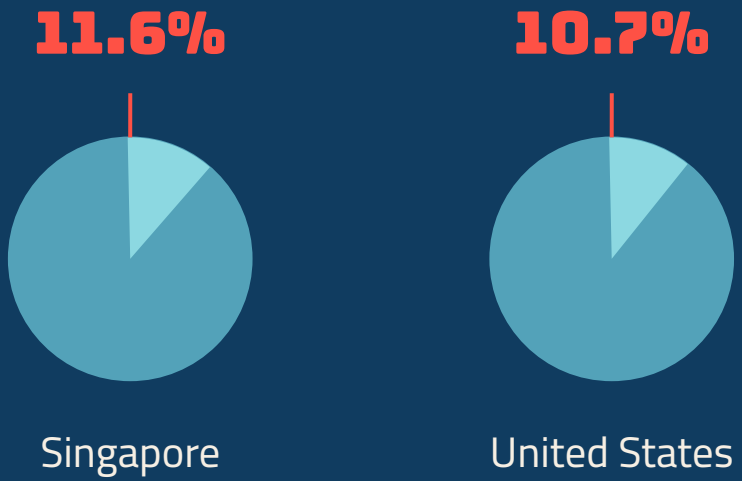
Range: 4.1% - 17.6%

Average: 8.7%

Source: National Diabetes Statistics Report (CDC, 2020)

SINGAPORE VS U.S.

Percentage Estimates of Individuals with Diabetes (2021)



Source: International Diabetes Federation, 2021

02

EXPLORATORY DATA ANALYSIS

INITIAL CLEANING OF DATA

- Dropping duplicate entries
- Dropping subjective variables: Mental health and physical health
- No missing values
- Dropping diabetic variable categories: No (with borderline diabetes) and Yes (during pregnancy) rows

VARIABLES AT A GLANCE

BMI	Sleep Time	Sex
Age Category	General Health	Race
Physical Activity	Alcohol Drinking	Smoking
Difficulty Walking	Asthma	Kidney Disease
Skin Cancer	Heart Disease	Stroke

Legend:

Numeric Categorical

BMI & DIABETES

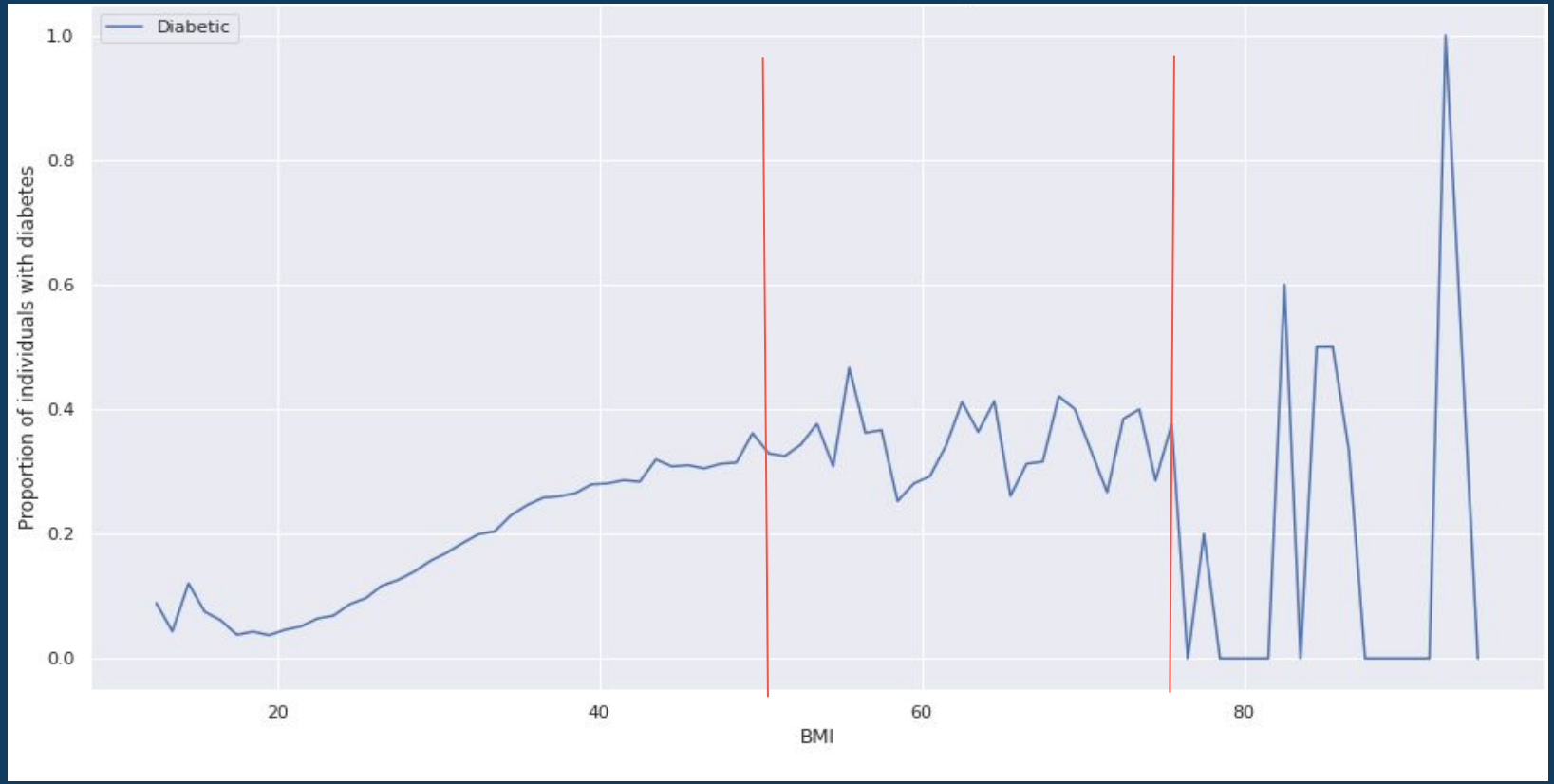


Fig. 4: *Proportion of diabetic individuals against BMI*

SLEEP TIME & DIABETES

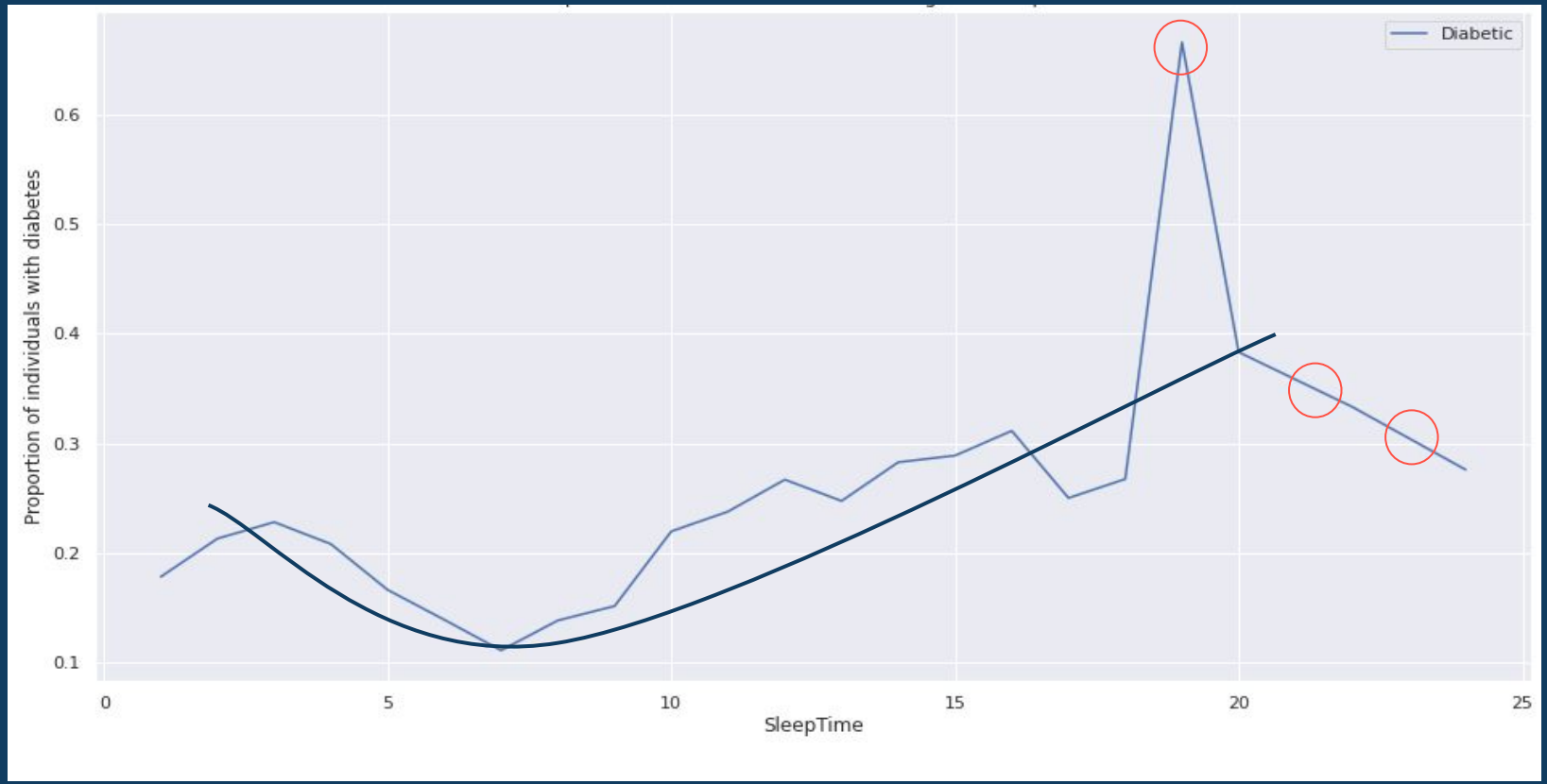


Fig. 5: *Proportion of diabetic individuals against sleep time*

MODIFICATIONS TO DATASET

- Polynomial Feature was used to model sleep time.
- Dropping outliers based on box plots.
- The data was transformed into a Gaussian distribution of mean = 0 and s.d. = 1.

AGE CATEGORY & DIABETES

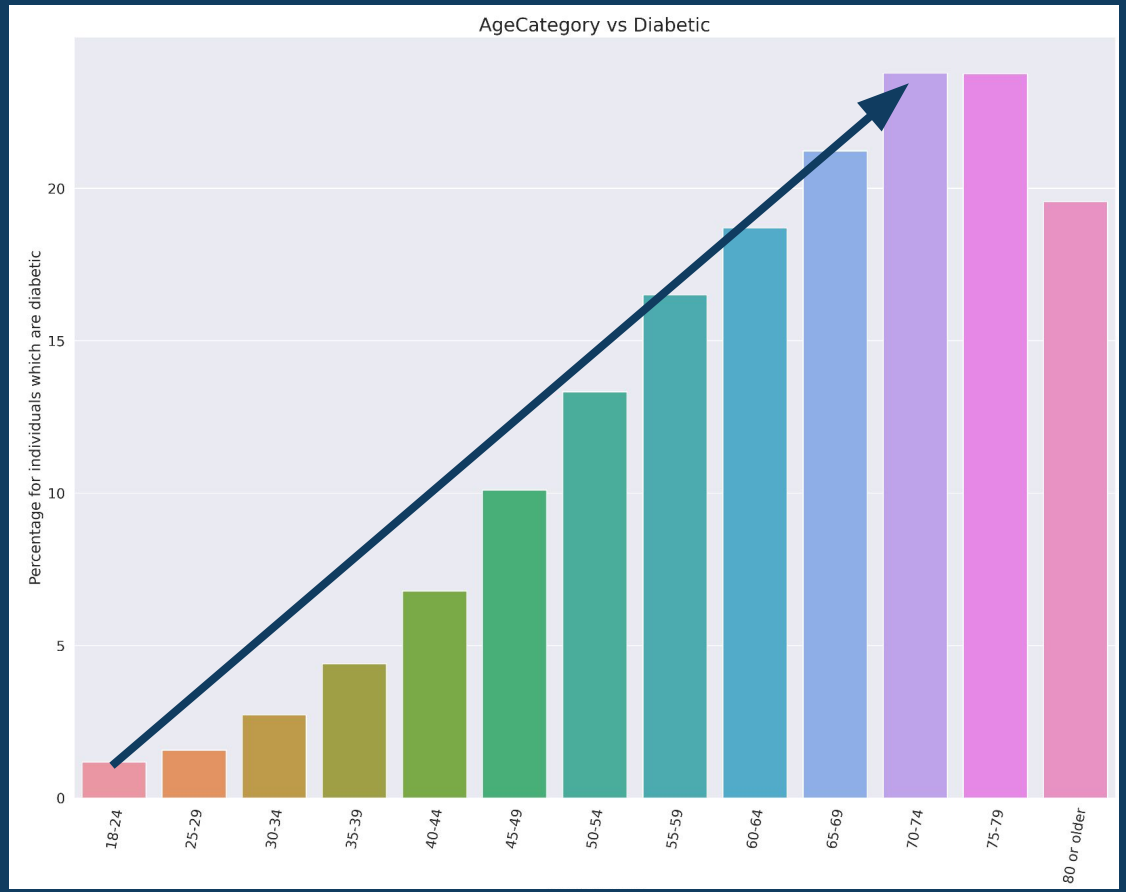


Fig. 6: *Percentage of diabetic individuals with age category*

INITIAL INSIGHTS

Categorical variable	Relationship with Diabetes (response variable)
Age Category	Proportion increases with age
Others	Proportion changes significantly
Sex, Asthma, Skin Cancer	Proportion remains relatively similar

Most categorical variables show a relationship with diabetes.

CHI-SQUARED TEST OF INDEPENDENCE

Null hypothesis

Independence

Alternative hypothesis

Association

Chi-Square (χ^2) Distribution

Area to the Right of Critical Value

Degrees of Freedom	0.995	0.99	0.975	0.95	0.90	0.10	0.05	0.025	0.01	0.005
1	—	—	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.597
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.860
5	0.412	0.554	0.831	1.145	1.610	9.236	11.071	12.833	15.086	16.750

Fig. 7: *Chi-square distribution table* (Seb, 2021)

Existence of Relationship

Chi-squared value (χ2) ≥ critical value

Strength

χ2 → Cramer's V

CHI-SQUARED TEST RESULTS

Categorical variable	General Health	Age Category
Chi-squared value	23453.4700	15657.2020
Critical value	9.488	21.026
Critical value ≥ chi-squared value?	Yes → Relationship exists	Yes → Relationship exists
Cramer's V	0.2832	0.2314

General Health and Age Category show the strongest relationship with diabetes.

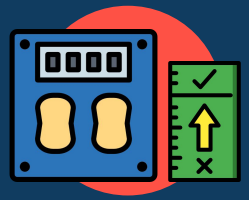
03

CORE ANALYSES USED

VARIABLES USED

SLEEP TIME

The approximate amount of sleep the respondents had.



BMI

Body mass index. A typical measurement for an individual's physical metrics.

GENERAL HEALTH

Respondents were asked to rate their own personal health over the past 30 days.

AGE CATEGORY

Respondents' ages in discrete categories.

HANDLING DATA IMBALANCE

- Our data was moderately unbalanced.
- Downsampling & Upweighting
  - Downsampling - Undersampling
  - Upweighting - Relative class weight
- We decided to downsample and upweight it by a factor of 6.6.

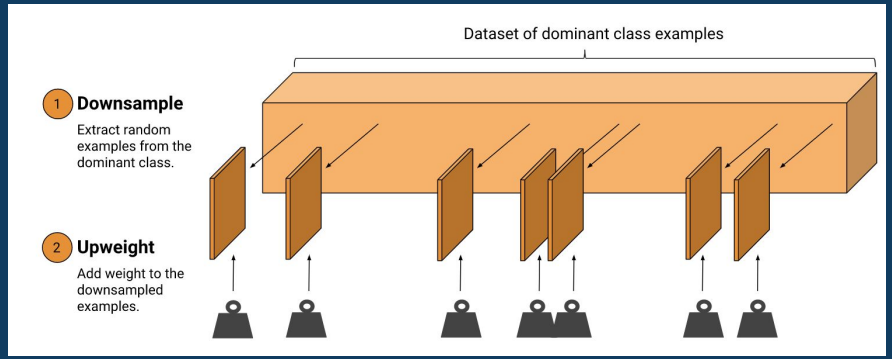


Fig. 8: Downsample and upweight (*Imbalanced Data*, 2021)

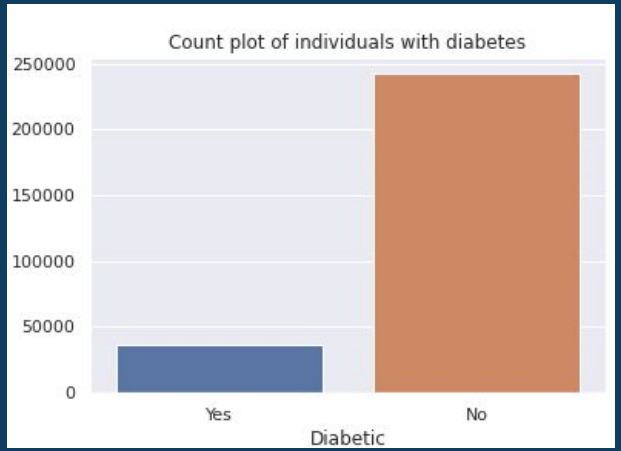


Fig. 9: *Count plot of diabetic individuals*

MACHINE LEARNING TOOLS

Logistic Regression

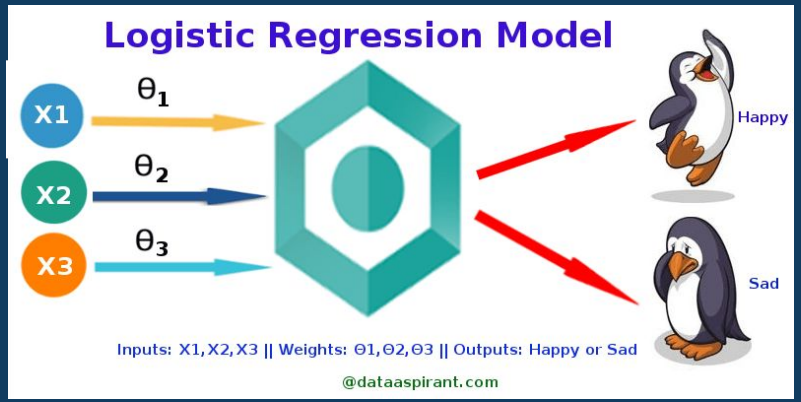


Fig. 10: *Logistic Regression Model*
(Polamuri, S., 2017)

Random Forest Classifier

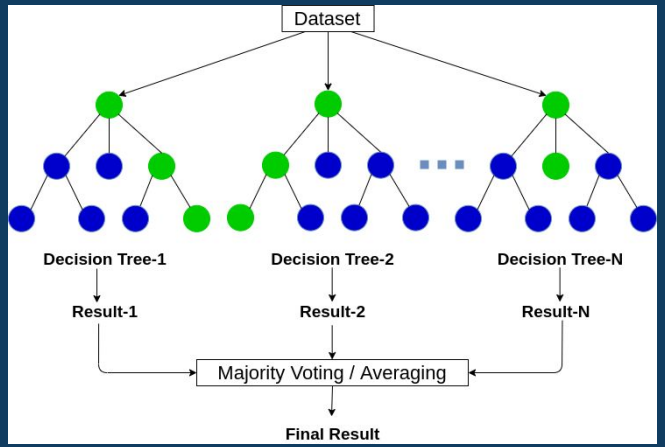


Fig. 11: *Random Forest Classifier*
(Sharma, A., 2020)

04

OUR INSIGHTS

PERFORMANCE OF EACH MODEL

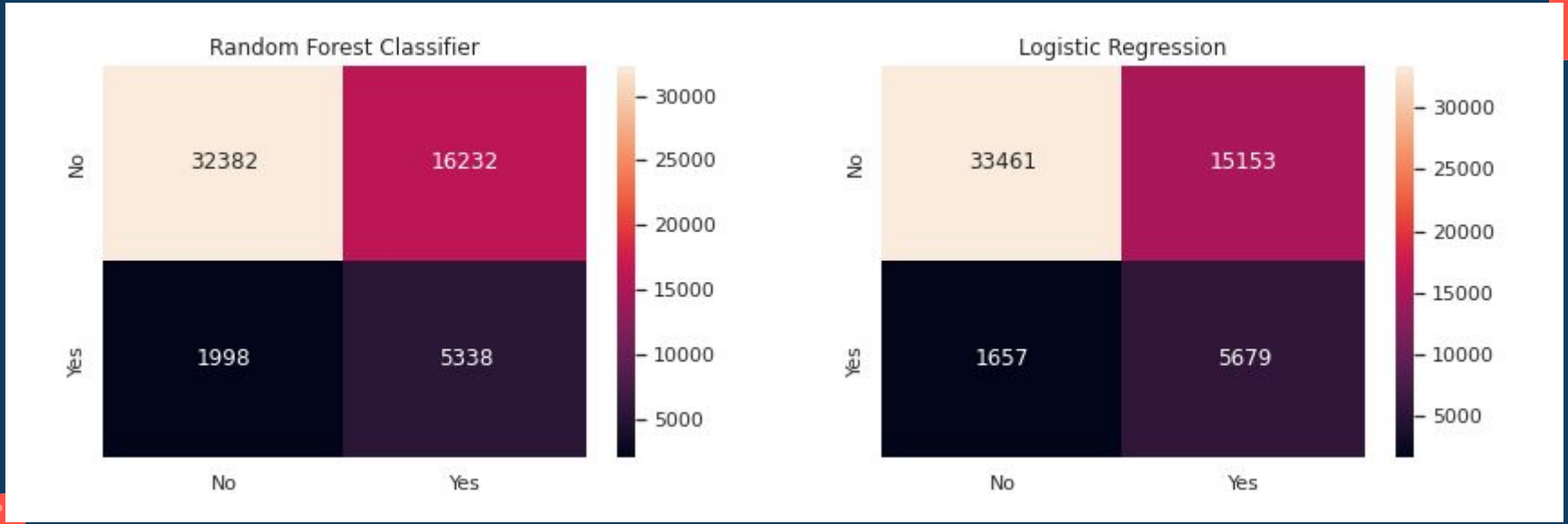
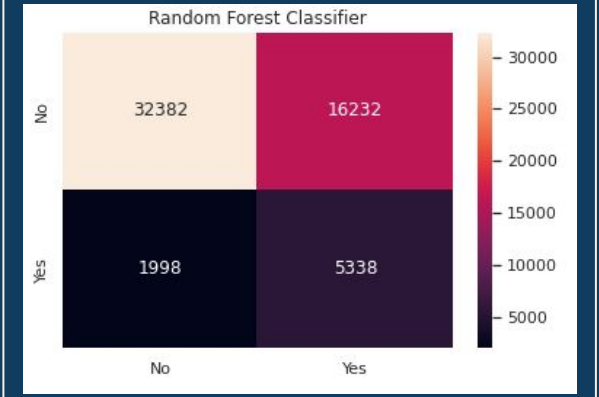


Fig. 12: *Confusion metrics for random forest classifier and logistic regression models*

PERFORMANCE OF EACH MODEL

Metrics \ Model		
Accuracy	0.699553	0.674173
FPR	0.3117	0.333896
FNR	0.225872	0.272356
AUC	0.802888	0.761871

RELATIVE FEATURE IMPORTANCES FOR *LOGISTIC REGRESSION*

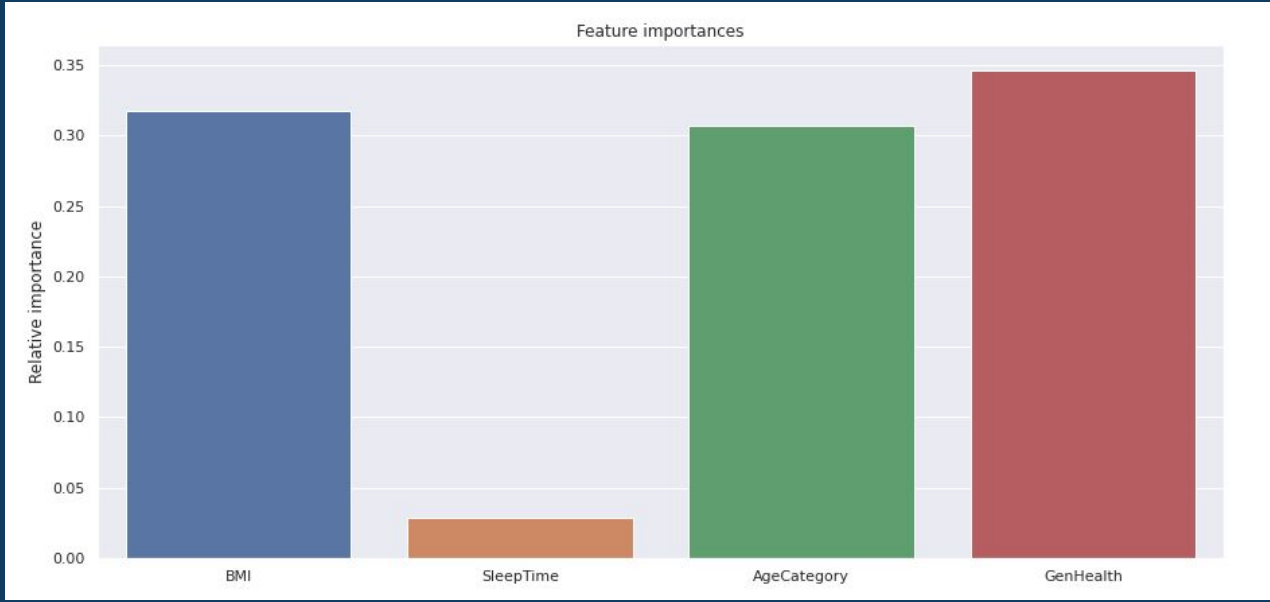


Fig. 13: *Feature importances proportion in logistic regression model*

RELATIVE FEATURE IMPORTANCES FOR *RANDOM FOREST CLASSIFIER*

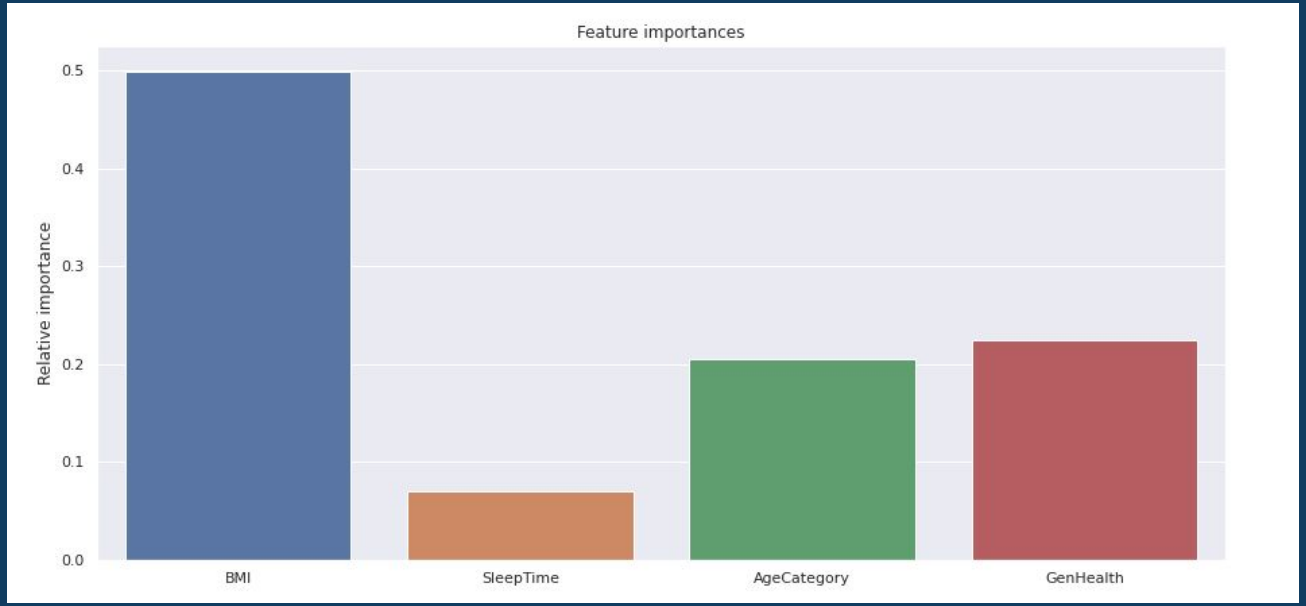


Fig. 14: *Feature importances proportion in random forest classifier model*

CONCLUSIONS

LOGISTIC REGRESSION > RANDOM FOREST CLASSIFIER

Logistic Regression was more accurate (70%) as compared to Random Forest Classifier (67%).

IMPORTANCE OF VARIABLES: SIMILARITIES

Both models considered sleep time an unimportant factor.

CONCLUSIONS

IMPORTANCE OF VARIABLES: DIFFERENCES

The two models also placed a different level of importance on each of the variables.

NUMERIC VARIABLES > CATEGORICAL VARIABLES

PREVENTION BETTER THAN CURE

PHYSICAL ACTIVITY

Regular aerobic and resistance exercises.

HEALTHY DIET

Less sweet fruits and starchy foods. More grains and legumes.

PORTION SIZES

Smaller portions reduce calorie intake and regulate insulin fluctuations.

THANKS!

CREDITS: This presentation template was created by **Slidesgo**, including icons by **Flaticon** and infographics & images by **Freepik**

REFERENCES

Slide 4:

Diabetes. (2022). World Health Organization. https://www.who.int/health-topics/diabetes#tab=tab_1

Slide 5:

James, T. (n.d.). *Diabetes in Singapore*. https://acetutors.com.sg/diabetes-in-singapore

Ministry of Health, Singapore (2011, Oct). *National Health Survey 2010*. https://www.moh.gov.sg/docs/librariesprovider5/resources-statistics/reports/nhs2010---low-res.pdf

Singapore's War on Diabetes. (2021, May 26). HealthHub. https://www.healthhub.sg/live-healthy/1273/d-day-for-diabetes

Slide 7:

Pytlak, K. (2022). *Personal Key Indicators of Heart Disease*. https://www.kaggle.com/datasets/kamilpytlak/personal-key-indicators-of-heart-disease

REFERENCES

Slide 19:

Seb. (2021, April 8). *Chi-Square Distribution Table*. Programmathically. https://programmathically.com/chi-square-distribution-table/

Slide 22

Freepik. (n.d.). *Pulse on heart* [Icon]. Flaticon. https://www.flaticon.com/free-icon/pulse_1240841

Freepik. (n.d.). *Hourglass* [Icon]. Flaticon. https://www.flaticon.com/free-icon/hourglass_1255391

Photo3idea_studio. (n.d.). *Bed time* [Icon]. Flaticon. https://www.flaticon.com/free-icon/bed_1257318

Smalllikeart. (n.d.). *Weighing scale* [Icon]. Flaticon. https://www.flaticon.com/free-icon/weight-scale_1256551

Smashicons. (n.d.). *Height scale* [Icon]. Flaticon. https://www.flaticon.com/free-icon/height_950746

REFERENCES

Slide 23:

Imbalanced Data. (2021, Nov 11). Google Developers. https://developers.google.com/machine-learning/data-prep/construct/sampling-splitting/imbalanced-data

Slide 24:

Polamuri, S. (2017, Mar 2). *How The Logistic Regression Works*. Dataaspirant. https://dataaspirant.com/how-logistic-regression-model-works/

Sharma, A. (2020, May 12). *Decision Tree vs. Random Forest – Which Algorithm Should you Use?*. Analytics Vidhya. https://www.analyticsvidhya.com/blog/2020/05/decision-tree-vs-random-forest-algorithm/

REFERENCES

Slide 33:
Becris. (n.d.). *Food pyramid* [Icon]. Flaticon. https://www.flaticon.com/free-icon/diet_1240823

Mayo Clinic Staff. (2021, June 25). *Diabetes prevention: 5 tips for taking control*. Mayo Clinic. https://www.mayoclinic.org/diseases-conditions/type-2-diabetes/in-depth/diabetes-prevention/art-20047639

Nawicon. (n.d.). *Plate with fork and spoon* [Icon]. Flaticon. https://www.flaticon.com/free-icon/portion_7126726?term=portion&page=1&position=38&page=1&position=38&related_id=7126726&origin=search

Streit, L. (2022, Jan 28). *11 Ways to Prevent Type 2 Diabetes.* https://www.healthline.com/nutrition/prevent-diabetes

Turkkub. (n.d.). *A person stretching* [Icon]. Flaticon. https://www.flaticon.com/free-icon/running_815082?related_id=815119&origin=search

REFERENCES

Music:
Tissot, B. (n.d.). *Cute* [Song]. https://www.bensound.com/royalty-free-music/track/cute.