

MULTIVARIJANTNA I DUBINSKA ANALIZA PODATAKA

ZDRAVSTVENI POKAZATELJI DIJABETESA

CDC DIABETES HEALTH INDICATORS

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SADRŽAJ



Opis skupa podataka



Popis i opis varijabli (vrijednosti i klasifikacija)



Popis obrada koji će se napraviti



Rezultati obrada



Zaključak

PODACI O DATASETU

- Behavioral risk factor surveillance system (BRFSS) – godišnja anketa CDC-a preko telefona
- 70,692 pojedinaca odgovorilo (opservacija)
 - 21 varijabli (podaci su odgovori ili izračunati s obzirom na odgovore)
 - 50% nema dijabetes
- **Diabetes_binary**
 - 0 – nema dijabetes, 1 - ima preddijabetes ili dijabetes

Varijable koje ćemo analizirati

Prikupljeni podaci za različite rizične i druge faktore za dijabetes – kolesterol, fizičko i mentalno zdravlje, pokriće zdravstvenim osiguranjem, ekonomski i socijalni status...

Varijabla	Značenje	Vrsta varijable	Vrijednosti koje poprima
HighChol	Razina kolesterola	Kvalitativna, nominalna	0 (nizak), 1 (visok)
CholCheck	Pregledan kolesterol u zadnjih 5 godina?	Kvalitativna, nominalna	0 (jest), 1 (nije)
BMI	Indeks tjelesne mase	Numerička, diskretna	12-98
HvyAlcoholConsump	Žene >= 7 pića tjedno Muškarci >= 14 pića tjedno	Kvalitativna, nominalna	0 (ne), 1 (da)
AnyHealthcare	Ima li zdravstveno osiguranje?	Kvalitativna, nominalna	0 (ne), 1 (da)
NoDocbcCost	U zadnjih godinu dana, nemogućnost odlaska doktoru zbog cijene?	Kvalitativna, nominalna	0 (ne), 1 (da)
Sex	Spol	Kvalitativna, nominalna	0 (žena), 1 (muškarac)

Tablica 1. Varijable koje ćemo analizirati

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Varijabla	Značenje	Vrsta varijable	Vrijednosti koje poprima
Age_Group	AGE5GYR skala dobi: 1 = 18-24, 2 = 25-29, 3 = 30-34, 4 = 35-39, 5 = 40-44, 6 = 45-49, 7 = 50-54, 8 = 55-59, 9 = 60-64, 10 = 65-69, 11 = 70-74, 12 = 75-79, 13 = 80+ godina	Kvalitativna, redoslijedna	1-13
Education_Group	EDUCA skala obrazovanja: 1 = samo vrtić, 2 = osnovna, 3 = nešto srednje škole, 4 = srednja škola, 5 = fakultet 1-3 godine, 6 = fakultet 4 godine ili više	Kvalitativna, redoslijedna	1-6
Income	INCOME2 skala zarade: 1 = manje od 10.000 dolara, 2 = 10.000-15.000 dolara, 3 = 15.000-20.000 dolara, 4 = 20.000-25.000, 5 = 25.000-35.000, 6 = 35.000-50.000, 7 = 50.000-75.000, 8 = 75.000 ili više dolara	Kvalitativna, redoslijedna	1-8

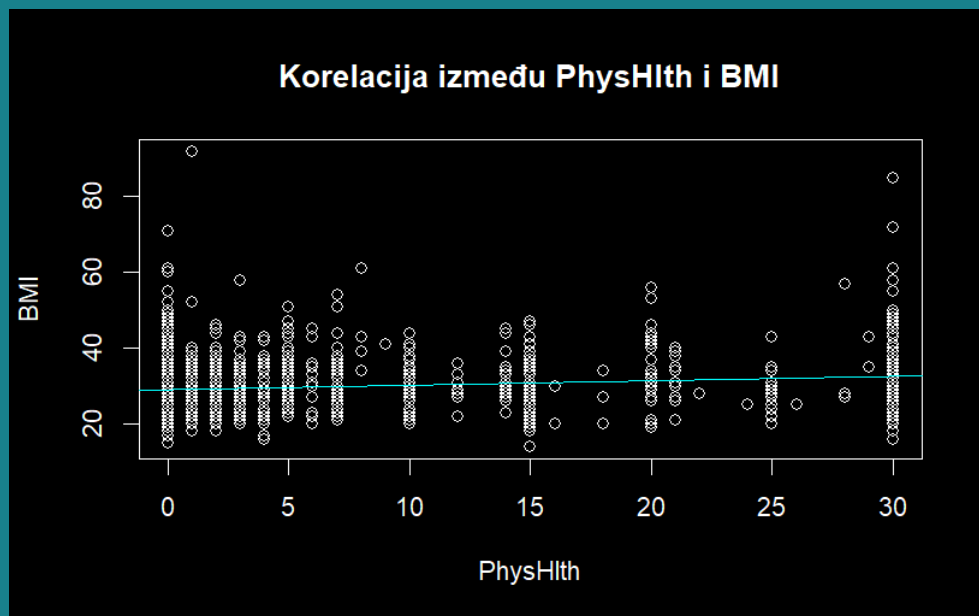
Tablica 1. Varijable koje ćemo analizirati

Varijable koje ćemo analizirati

Varijabla	Značenje	Vrsta varijable	Vrijednosti koje poprima
HighBP	Ima li povišen tlak krvi?	Kvalitativna, nominalna	0 (ne), 1 (da)
GenHlth	Osobna procjena općenitog zdravstvenog stanja na skali 1-5: 1 = odlično, 2 = vrlo dobro, 3 = dobro, 4 = u redu, 5 = loše	Kvalitativna, redoslijedna	1-5

Tablica 1. Varijable koje ćemo analizirati

DESKRIPTIVNA STATISTIKA



Slika 1. Korelacija PhysHlth i BMI

```
> # Deskriptivna statistika - numericka varijabla (BMI)
> median_bmi <- median(data$BMI)
> print(median_bmi)
[1] 29

> mean_bmi <- mean(data$BMI)
> print(mean_bmi)
[1] 29.77

> standard_deviation <- sd(data$BMI)
> print(standard_deviation)
[1] 6.806707

> variance <- var(data$BMI)
> print(variance)
[1] 46.33127

> quantiles <- quantile(data$BMI, probs = c(0.25, 0.5, 0.75))
> print(quantiles)
25% 50% 75%
 25  29  33

> correlation <- cor(data$PhysHlth, data$BMI)
> print(correlation)
[1] 0.1499764
```

summary(data) # za sve varijable

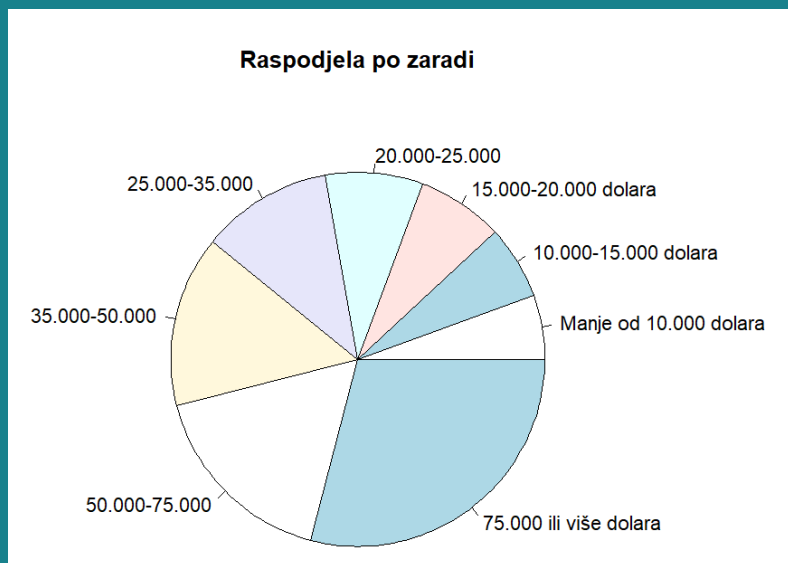
```
> summary(data)
Diabetes_binary      HighBP      HighChol      CholCheck      BMI      Smoker      Stroke      HeartDiseaseorAttack
1:1000      Min.   :0.0000      Min.   :0.000      Min.   :0.000      Min.   :14.00      Min.   :0.000      Min.   :0.000      Min.   :0.000
2:1000      1st Qu.:0.0000      1st Qu.:0.000      1st Qu.:1.000      1st Qu.:25.00      1st Qu.:0.000      1st Qu.:0.000      1st Qu.:0.000
      Median :1.0000      Median :1.000      Median :1.000      Median :28.00      Median :0.000      Median :0.000      Median :0.000
      Mean   :0.5775      Mean   :0.528      Mean   :0.972      Mean   :29.69      Mean   :0.475      Mean   :0.072      Mean   :0.156
      3rd Qu.:1.0000      3rd Qu.:1.000      3rd Qu.:1.000      3rd Qu.:33.00      3rd Qu.:1.000      3rd Qu.:0.000      3rd Qu.:0.000
      Max.   :1.0000      Max.   :1.000      Max.   :1.000      Max.   :92.00      Max.   :1.000      Max.   :1.000      Max.   :1.000

PhysActivity      Fruits      Veggies      HvyAlcoholConsump      AnyHealthcare      NoDocbcCost      GenHlth      Menthlth
Min.   :0.000      Min.   :0.000      Min.   :0.0000      Min.   :0.000      Min.   :0.0000      Min.   :0.0000      Min.   :1.000      Min.   : 0.000
1st Qu.:0.000      1st Qu.:0.000      1st Qu.:1.0000      1st Qu.:0.000      1st Qu.:1.0000      1st Qu.:0.0000      1st Qu.:2.000      1st Qu.: 0.000
Median :1.000      Median :1.000      Median :1.0000      Median :0.000      Median :1.0000      Median :0.0000      Median :3.000      Median : 0.000
Mean   :0.704      Mean   :0.605      Mean   :0.7875      Mean   :0.046      Mean   :0.9585      Mean   :0.0975      Mean   :2.824      Mean   : 3.865
3rd Qu.:1.000      3rd Qu.:1.000      3rd Qu.:1.0000      3rd Qu.:0.000      3rd Qu.:1.0000      3rd Qu.:0.0000      3rd Qu.:4.000      3rd Qu.: 3.000
Max.   :1.000      Max.   :1.000      Max.   :1.0000      Max.   :1.000      Max.   :1.0000      Max.   :1.0000      Max.   :5.000      Max.   :30.000

PhysHlth      Diffwalk      Sex      Age      Education      Income      BMI_Group      Age_Group
Min.   : 0.000      Min.   :0.0000      Min.   :0.0000      Min.   : 1.000      Min.   :1.000      Min.   :1.000      Underweight   : 17      18-34 :125
1st Qu.: 0.000      1st Qu.:0.0000      1st Qu.:0.0000      1st Qu.: 7.000      1st Qu.:4.000      1st Qu.:4.000      Healthy weight:439      35-54 :280
Median : 0.000      Median :0.0000      Median :0.0000      Median : 9.000      Median :5.000      Median :6.000      Overweight   :672      55-69 :750
Mean   : 5.923      Mean   :0.2495      Mean   :0.4685      Mean   : 8.635      Mean   :4.932      Mean   :5.713      Obesity       :706      70-80+ :701
3rd Qu.: 5.250      3rd Qu.:0.0000      3rd Qu.:1.0000      3rd Qu.:11.000      3rd Qu.:6.000      3rd Qu.:8.000      Severe obesity:166      NA's   :144
Max.   :30.000      Max.   :1.0000      Max.   :1.0000      Max.   :13.000      Max.   :6.000      Max.   :8.000

Education_Group
Min.   :1.000
1st Qu.:2.000
Median :3.000
Mean   :2.634
3rd Qu.:3.000
Max.   :3.000
```


DESKRIPTIVNA STATISTIKA



Slika 2. Raspodjela kvalitativnih varijabli

```
# Deskriptivna statistika - kvalitativne varijable
promatranja <- table(data$Diabetes_binary)
pie(promatranja, labels = c("Nema dijabetes", "Ima dijabetes"), main =
  "Raspodjela po dijabetesu")

promatranja <- table(data$Sex)
pie(promatranja, labels = c("Žene", "Muškarci"), main = "Raspodjela spola")

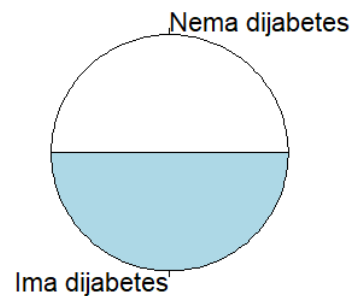
promatranja <- table(data$HighChol)
pie(promatranja, labels = c("Visok kolesterol", "Nizak kolesterol"),
  main = "Raspodjela po kolesterolu")

promatranja <- table(data$Age)
pie(promatranja, labels = c("18-24", "25-29", "30-34", "35-39", "40-44",
  "45-49", "50-54", "55-59", "60-64", "65-69",
  "70-74", "75-79", "80+ godina"),
  main = "Raspodjela po dobi")

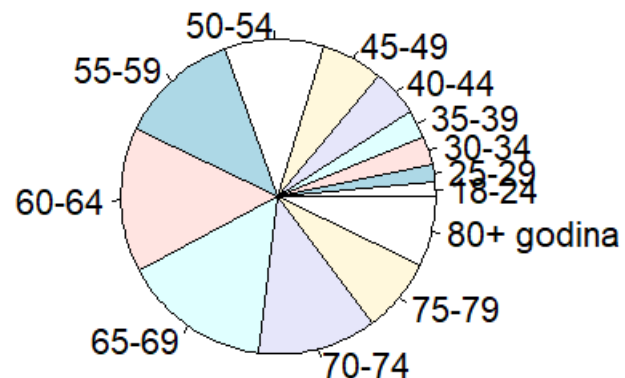
promatranja <- table(data$Education)
pie(promatranja, labels = c("Samo vrtić", "Osnovna", "Nešto srednje škole",
  "Srednja škola", "Fakultet 1-3 godine",
  "Fakultet 4 godine ili više"),
  main = "Raspodjela po edukaciji")

promatranja <- table(data$Income)
pie(promatranja, labels = c("Manje od 10.000 dolara", "10.000-15.000 dolara",
  "15.000-20.000 dolara", "20.000-25.000",
  "25.000-35.000", "35.000-50.000", "50.000-75.000",
  "75.000 ili više dolara"),
  main = "Raspodjela po zaradi")
```

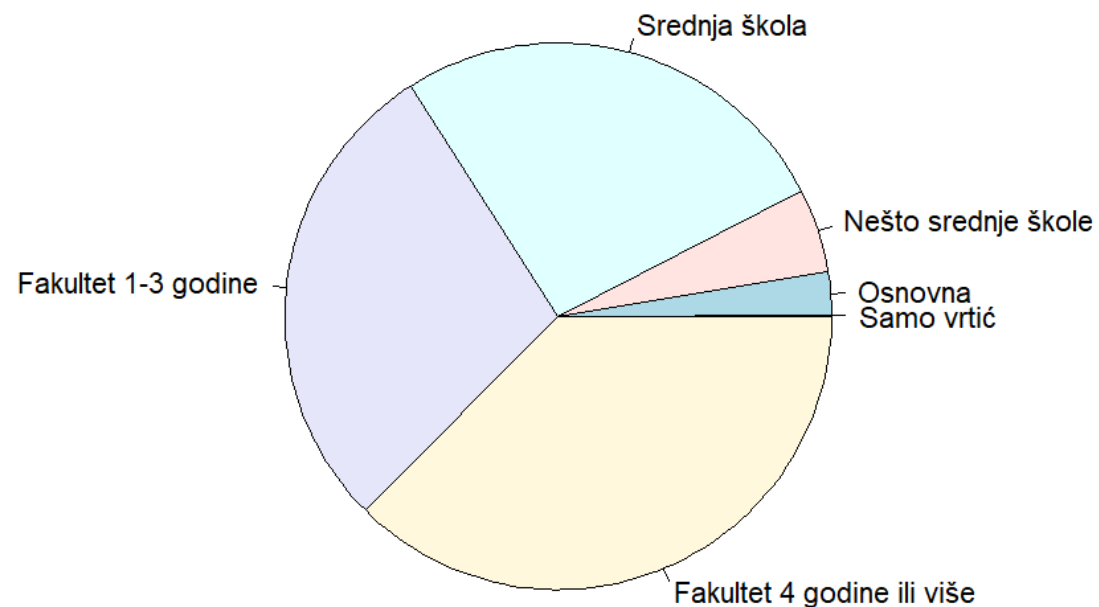
Raspodjela po dijabetesu



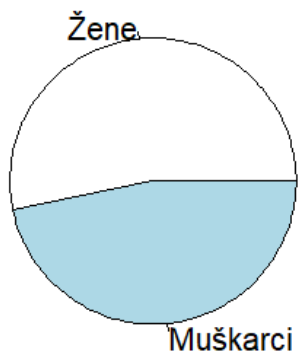
Raspodjela po dobi



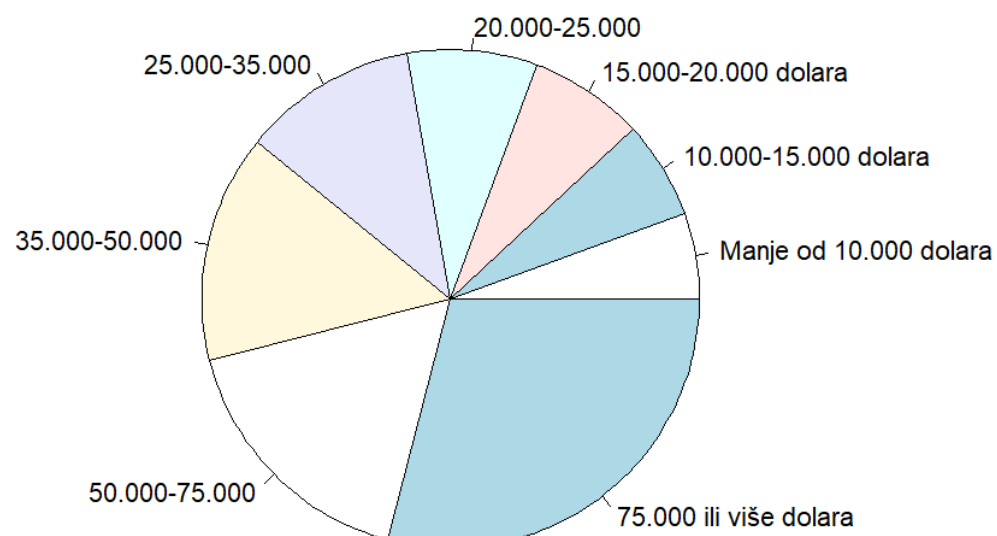
Raspodjela po edukaciji



Raspodjela spola



Raspodjela po zaradi



Raspodjela po kolesterolu



Slika 2. Raspodjela kvalitativnih varijabli

PROVEDENE OBRADE

- 2 nezavisna uzorka
 - dijabetičari vs ne-dijabetičari
- Odabrane varijable (kontinuirane, kvalitativne)
 - BMI: $x \in [14, 92]$
 - Income: 1, 2, 3, 4, 5, 6, 7, 8
 - HighBP: 0, 1
 - GenHlth: 1, 2, 3, 4, 5

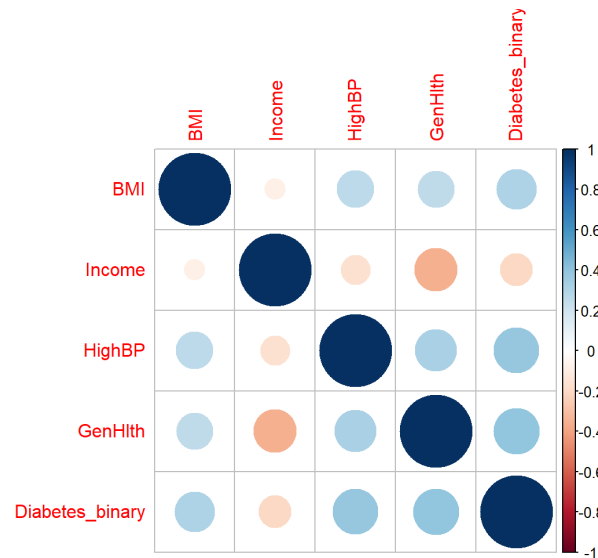
Matrica korelacije
Dijagrami rasipanja

Logistička regresija

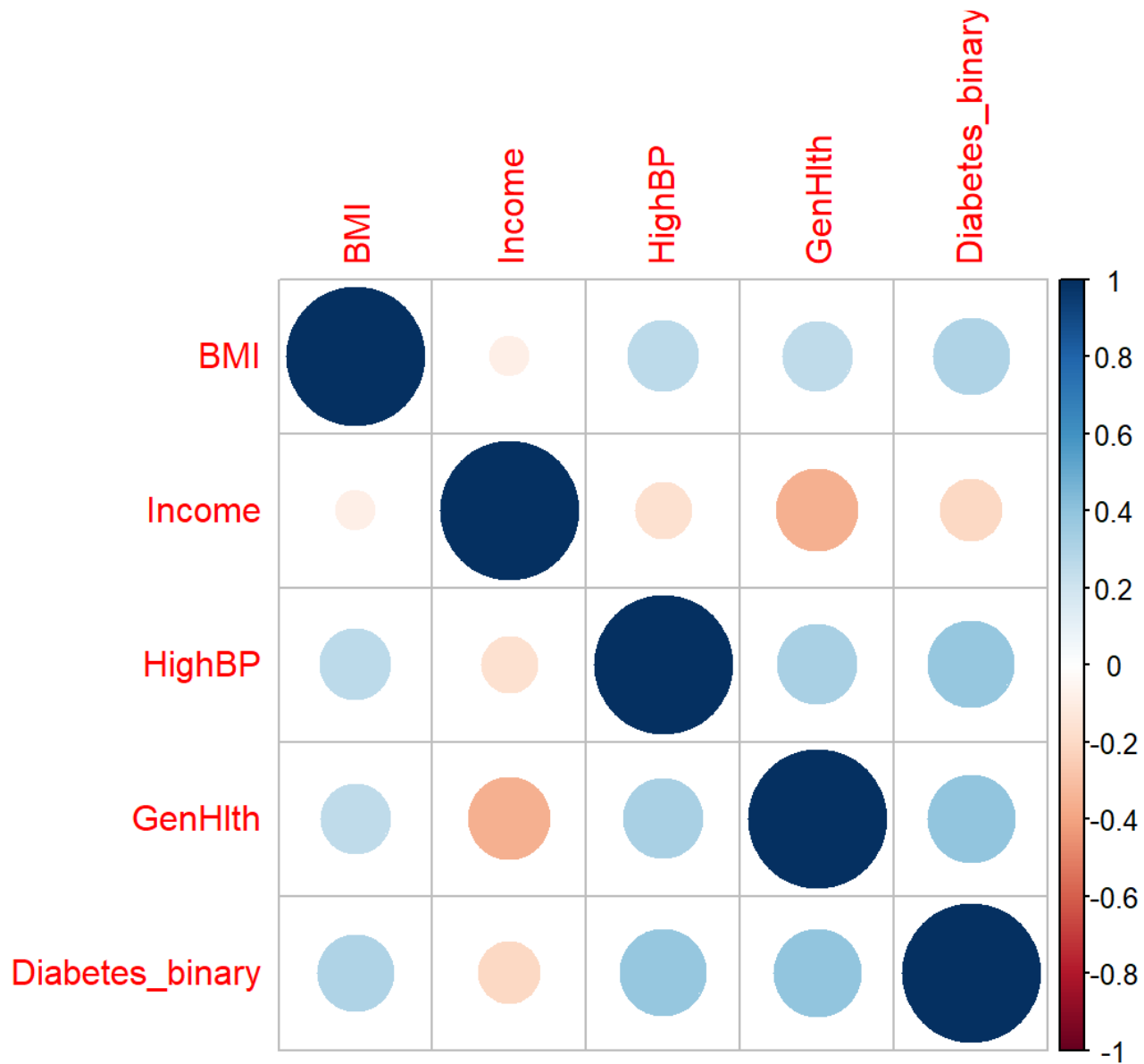
Hi-kvadrat

MATRICA KORELACIJE

##	BMI	Income	HighBP	GenHlth	Diabetes_binary
## BMI	1.00000000	-0.08070523	0.2653145	0.2565445	0.3015427
## Income	-0.08070523	1.00000000	-0.1666267	-0.3541305	-0.2034299
## HighBP	0.26531455	-0.16662669	1.0000000	0.3273458	0.3857488
## GenHlth	0.25654447	-0.35413051	0.3273458	1.0000000	0.3982426
## Diabetes_binary	0.30154274	-0.20342990	0.3857488	0.3982426	1.0000000



Slika 3. Matrica korelacije

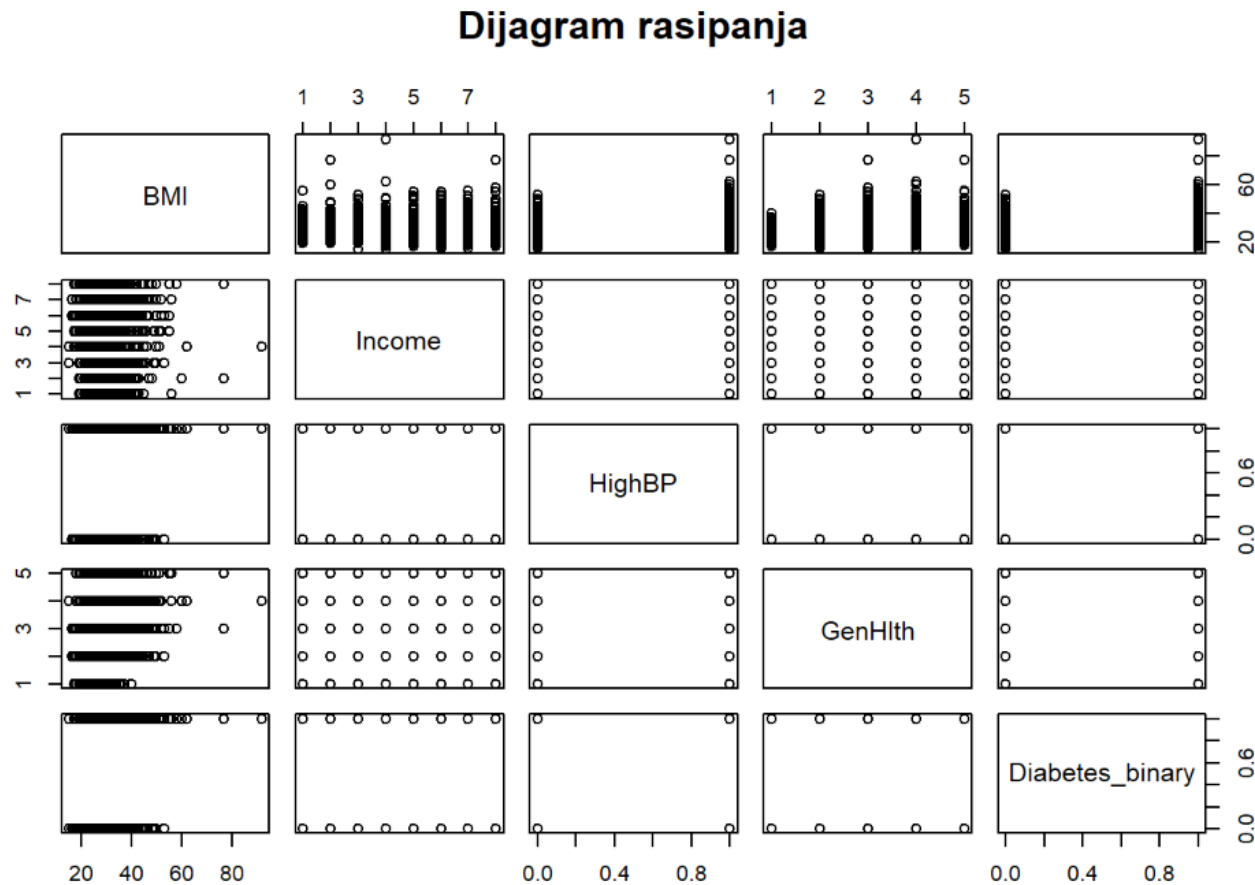


```
# matrica korelacije
correlation_matrix <-
  cor(numeric_vars, use = "complete.obs")

print(correlation_matrix)
corrplot(correlation_matrix,
  method = "circle")
```

Slika 3. Matrica korelacije

DIJAGRAM RASIPANJA



```
# dijagrami rasipanja  
pairs(~ BMI + Income + HighBP +  
      GenHlth + Diabetes_binary,  
      main = "Dijagram rasipanja",  
      data = data)
```

Slika 4. Dijagram rasipanja

LOGISTIČKA REGRESIJA FORMULA

$$\text{logit}(\text{DiabetesBinary}) = \beta_0 + \beta_1 \text{BMI} + \beta_2 \text{HighBP} + \beta_3 \text{GenHlth} + \beta_4 \text{Income} + \epsilon$$
$$\ln(P(\text{imati_diabetes})/P(\text{nemati_diabetes}))$$

PROVEDBA

```
data$Diabetes_binary <- as.factor(data$Diabetes_binary)
data$Income <- as.factor(data$Income)
data$HighBP <- as.factor(data$HighBP)
data$GenHlth <- as.factor(data$GenHlth)

skup <- data %>%
  select(Diabetes_binary, HighBP, GenHlth, Income, BMI)

set.seed(1)
split = initial_split(skup, prop = 0.7, strata = Diabetes_binary)

train = split %>%
  training()
test = split %>%
  testing()
```

OBRADA LOGISTIČKA REGRESIJA

```
attach(train)
summary(train)
```

```
## Diabetes_binary HighBP GenHlth Income BMI
## 0:700           0:598 1:142 8      :385 Min.    :15.00
## 1:700           1:802 2:432 7      :224 1st Qu.:25.00
##                3:449 6      :216 Median :29.00
##                4:263 5      :169 Mean   :29.65
##                5:114 4      :157 3rd Qu.:33.00
##                3      :114 Max.    :92.00
##                (Other):135
```


OBRADA LOGISTIČKA REGRESIJA

```
describe(train)
```

##	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
## Diabetes_binary*	1	1400	1.50	0.50	1.5	1.50	0.74	1	2	1	0.00	-2.00	0.01
## HighBP*	2	1400	1.57	0.49	2.0	1.59	0.00	1	2	1	-0.29	-1.91	0.01
## GenHlth*	3	1400	2.84	1.10	3.0	2.82	1.48	1	5	4	0.23	-0.63	0.03
## Income*	4	1400	5.69	2.10	6.0	5.91	2.97	1	8	7	-0.60	-0.71	0.06
## BMI	5	1400	29.65	6.72	29.0	29.04	5.93	15	92	77	1.62	7.76	0.18

REZULTATI LOGISTIČKA REGRESIJA

```
model <- glm(Diabetes_binary ~ BMI + Income + HighBP + GenHlth,  
  data = train, family = binomial)  
summary(model)
```

```
## Coefficients:  
##              Estimate Std. Error z value Pr(>|z|)      ## (Dispersion parameter for binomial family taken to be 1)  
## (Intercept) -5.36003    0.54125  -9.903  < 2e-16 ***  
> ## BMI         0.06975    0.01115   6.254 3.99e-10 ***  
## Income2      0.78698    0.40396   1.948 0.051398 .  
> ## Income3     1.02183    0.37235   2.744 0.006065 **  
> ## Income4     0.76518    0.34767   2.201 0.027743 *  
> ## Income5     1.18561    0.35285   3.360 0.000779 ***  
## Income6      0.61090    0.33848   1.805 0.071098 .  
> ## Income7     0.70241    0.33737   2.082 0.037341 *  
## Income8      0.38522    0.32775   1.175 0.239850  
> ## HighBP1     1.20292    0.13132   9.160  < 2e-16 ***  
> ## GenHlth2    1.34604    0.33071   4.070 4.70e-05 ***  
> ## GenHlth3    2.37584    0.32999   7.200 6.03e-13 ***  
> ## GenHlth4    2.51745    0.34872   7.219 5.23e-13 ***  
> ## GenHlth5    2.80037    0.39705   7.053 1.75e-12 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
## Null deviance: 1940.8  on 1399  degrees of freedom  
## Residual deviance: 1488.9  on 1386  degrees of freedom  
## AIC: 1516.9  
## Number of Fisher Scoring iterations: 5
```

REZULTATI LOGISTIČKA REGRESIJA

$$\begin{aligned} \text{logit}(\text{DiabetesBinary}) = & -5.36003 + 0.06975 * BMI + 1.20292 * HighBP1 + 1.34604GenHlth2 \\ & + 2.37584GenHlth3 + 2.51745GenHlth4 + 2.80037GenHlth5 + 0.78698Income2 + 1.02183Income3 \\ & + 0.76518Income4 + 1.18561Income5 + 0.61090Income6 + 0.70241Income7 + 0.38522Income8 \end{aligned}$$

KOEFICIJENTI LOGISTIČKE REGRESIJE & OMJERA IZGLEDA

`exp(model$coefficients)`

```
## (Intercept)      BMI      Income2      Income3      Income4      Income5      Income6      Income7      Income8
## 0.004700749  1.072236345  2.196753842  2.778278951  2.149387700  3.272666611  1.842095207  2.018606202  1.469943960
##      HighBP1      GenHlth2      GenHlth3      GenHlth4      GenHlth5
## 3.329819837  3.842188376 10.760003655 12.396899569 16.450794905
```

Intercept (Intercept)

Vjerojatnost dijabetesa za referentnu kategoriju ostalih varijabli (kada su sve ostale nula) je 0.47% (vrlo niska).

BMI

Koeficijent 1.072236345 – vjerojatnost dijabetesa povećava se za 7.2% za svako jedinično povećanje u BMI-u.

Income2-Income8

Koeficijenti (2.197-1.470) – pokazuju kako se vjerojatnost dijabetesa mijenja u odnosu na različite razine dohotka (Income).

KOEFICIJENTI LOGISTIČKE REGRESIJE & OMJERA IZGLEDA

`exp(model$coefficients)`

```
## (Intercept)      BMI      Income2      Income3      Income4      Income5      Income6      Income7      Income8
## 0.004700749  1.072236345  2.196753842  2.778278951  2.149387700  3.272666611  1.842095207  2.018606202  1.469943960
##      HighBP1      GenHlth2      GenHlth3      GenHlth4      GenHlth5
## 3.329819837  3.842188376 10.760003655 12.396899569 16.450794905
```

HighBP1

Koeficijent 3.330, što znači da osobe s visokim krvnim tlakom imaju približno 233% veću vjerojatnost dijabetesa u odnosu na osobe bez visokog krvnog tlaka.

GenHlth2-GenHlth5

Koeficijenti 3.842-16.451 – pokazuju povećanje vjerojatnosti dijabetesa za različite razine općeg zdravstvenog stanja (GenHlth).

Npr., za najgoru kategoriju GenHlth5 (koeficijent 16.451), vjerojatnost dijabetesa je povećana za ~1545.1% u odnosu na referentnu kategoriju (GenHlth1 – najbolje zdravlje).

KOEFICIJENTI LOGISTIČKE REGRESIJE & OMJERA IZGLEDA

##	2.5 %	97.5 %
## (Intercept)	0.001581672	0.01325646
> ## BMI	1.049385430	1.09629860
## Income2	0.999029915	4.88480843
> ## Income3	1.341095643	5.79091611
> ## Income4	1.086509315	4.25935115
> ## Income5	1.640188370	6.56144053
## Income6	0.947701662	3.58412113
> ## Income7	1.040968740	3.91996879
## Income8	0.772324534	2.80130492
> ## HighBP1	2.577079346	4.31311992
> ## GenHlth2	2.081990516	7.69080889
> ## GenHlth3	5.842622516	21.51772115
> ## GenHlth4	6.465416517	25.60844677
> ## GenHlth5	7.781523726	37.16838503

`exp(confint(model))`

SIGNIFIKANTNOST MODELA

- logistički regresijski model je statistički značajan na razini od 5%
- model je bolji od nultog modela

```
# testna statistika
ModelChi = model$null.deviance
          - model$deviance
ModelChi
```

```
[1] 451.9521
```

```
# broj stupnjeva slobode
ChiDf = model$df.null - model$df.residual
ChiDf
```

```
[1] 13
```

```
# p-vrijednost
ChisqProb = 1 - pchisq(ModelChi, ChiDf)
ChisqProb
```

```
[1] 0
```

ZAKLJUČAK

- ❖ Gore kategorije općenitog zdravlja (GenHlth) – veća varijabilnost
- ❖ Povišeni krvni tlak (HighBP) – značajniji faktor od BMI-a
- ❖ **Variable** BMI + Income + HighBP + GenHlth u logističkoj regresiji modeliraju statistički značajnu korelaciju

regresija.Rmd

```
---
title: "Regresija"
output: html_document
---

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# 2. faza projekta - Logistička regresija

```{r}
if (!require("dplyr")) install.packages("dplyr")

library(ggplot2)
library(corrplot)

data <- read.csv(file.choose())

matrica korelacije
correlation_matrix <- cor(numeric_vars, use = "complete.obs")
print(correlation_matrix)
corrplot(correlation_matrix, method = "circle")

dijagrami rasipanja
pairs(~ BMI + Income + HighBP + GenHlth + Diabetes_binary,
 main = "Dijagram rasipanja", data = data)
```

Jednadžba:


$$\text{\$}\logit(\text{DiabetesBinary}) = \text{\backslash}\beta_0 + \text{\backslash}\beta_1\text{BMI} + \text{\backslash}\beta_2\text{HighBP} + \text{\backslash}\beta_3\text{GenHlth} + \text{\backslash}\beta_4\text{Income} + \text{\backslash}\epsilon$$



$$\text{\$}\logit(\text{admit})\$ \text{ je } \ln(P(\text{imati\_dijabetes})/P(\text{nemati\_dijabetes}))\$$$


```{r}
data$Diabetes_binary <- as.factor(data$Diabetes_binary)
data$Income <- as.factor(data$Income)
data$HighBP <- as.factor(data$HighBP)
data$GenHlth <- as.factor(data$GenHlth)

if (!require("rsample")) install.packages("rsample")
library(rsample)

skup <- data %>%
 select(Diabetes_binary, HighBP, GenHlth, Income, BMI)
```

GitHub poveznica na ovu datoteku u trenutku izrade dokumentacije.

```
set.seed(1)
split = initial_split(skup, prop = 0.7, strata = Diabetes_binary)
train = split %>%
 training()
test = split %>%
 testing()

attach(train)
summary(train)

library(psych)
describe(train)

model <- glm(Diabetes_binary ~ BMI + Income + HighBP + GenHlth, data = train, family = binomial)
summary(model)
```


$$\text{\$}\logit(\text{DiabetesBinary}) = -5.36003 + 0.06975*\text{BMI} + 1.20292*\text{HighBP1} + 1.34604\text{GenHlth2} + 2.37584\text{GenHlth3} + 2.51745\text{GenHlth4} + 2.80037\text{GenHlth5} + 0.78698\text{Income2} + 1.02183\text{Income3} + 0.76518\text{Income4} + 1.18561\text{Income5} + 0.61090\text{Income6} + 0.70241\text{Income7} + 0.38522\text{Income8}$$


## Koeficijenti logističke regresije i omjera izgleda

```{r}
exp(model$coefficients)
exp(confint(model))
```

## Signifikantnost modela

```{r}
testna statistika
ModelChi = model$null.deviance - model$deviance
ModelChi

broj stupnjeva slobode
ChiDf = model$df.null - model$df.residual
ChiDf

p-vrijednost
ChisqProb = 1 - pchisq(ModelChi, ChiDf)
ChisqProb
```
```

LITERATURA

Sav programski kod se može pronaći na javnom GitHub repozitoriju ovog rada:
<https://github.com/jfletcher20/diabetes-health-indicators-analysis>

- ❖ *AGE5GYR - Variable Home Page* (bez dat.). Preuzeto na:
<https://www.icpsr.umich.edu/web/NAHDAP/studies/34085/datasets/0001/variables/AGE5GYR?archive=NAHDAP> (pristupano: 5.5.2024.).
- ❖ *Body mass index (BMI) I NHS inform* (bez dat.). Preuzeto na:
<https://www.nhsinform.scot/healthy-living/food-and-nutrition/healthy-eating-and-weight-loss/body-mass-index-bmi/> (pristupano: 5.5.2024.).
- ❖ *Diabetes Health Indicators Dataset* (bez dat.). Preuzeto na:
https://www.kaggle.com/datasets/alexteboul/diabetes-health-indicators-dataset/data?select=diabetes_binary_5050split_health_indicators_BRFSS2015.csv (pristupano: 5.5.2024.).
- ❖ *EDUCA - Variable Home Page* (bez dat.). Preuzeto na:
<https://www.icpsr.umich.edu/web/NAHDAP/studies/34085/datasets/0001/variables/EDUCA?archive=nahdap> (pristupano: 5.6.2024.).
- ❖ *INCOME2 - Variable Home Page* (bez dat.). Preuzeto na:
<https://www.icpsr.umich.edu/web/NAHDAP/studies/34085/datasets/0001/variables/INCOME2?archive=NAHDAP> (pristupano: 5.6.2024.).

HVALA VAM NA PAŽNJI

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