Principal Component Analysis (PCA) Coding Assignment

```
library(ggplot2)
## Warning: package 'ggplot2' was built under R version 4.3.2
library(dplyr)
##
## Attaching package: 'dplyr'
## The following objects are masked from 'package:stats':
##
##
      filter, lag
## The following objects are masked from 'package:base':
##
##
      intersect, setdiff, setequal, union
library(mice)
## Warning: package 'mice' was built under R version 4.3.3
## Warning in check_dep_version(): ABI version mismatch:
## lme4 was built with Matrix ABI version 1
## Current Matrix ABI version is 0
## Please re-install lme4 from source or restore original 'Matrix' package
## Attaching package: 'mice'
## The following object is masked from 'package:stats':
##
##
      filter
## The following objects are masked from 'package:base':
##
##
      cbind, rbind
## Load ICU dataset
file = 'Data/ICU_filtered.csv'
dfICU = read.csv(file, header = TRUE, stringsAsFactors = TRUE)
str(dfICU)
## 'data.frame':
                   7886 obs. of 36 variables:
## $ recordid
                      : int 132539 132540 132541 132543 132545 132547 132548 132551 132554 132555 ...
## $ Length_of_stay : int 5 8 19 9 4 6 9 6 17 8 ...
## $ In.hospital_death: int 000000100...
## $ Age
                     : int 54 76 44 68 88 64 68 78 64 74 ...
## $ Gender
                      : int 0 1 0 1 0 1 0 0 0 1 ...
## $ Height
                      : num NA 175 NA 180 NA ...
                      : int 0000010000...
## $ CCU
## $ CSRU
                     : int 0 1 0 0 0 0 0 0 0 1 ...
## $ SICU
                      : int 1000000000...
```

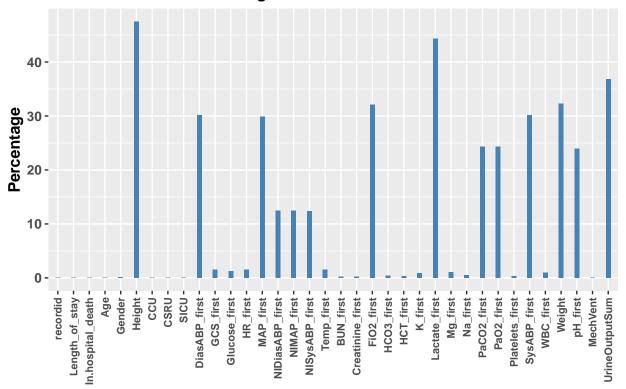
```
## $ DiasABP first
                      : int NA 67 81 NA NA 79 98 50 NA 51 ...
## $ GCS first
                      : int 15 3 7 15 15 7 15 15 15 10 ...
## $ Glucose first
                    : int 205 105 141 129 113 264 94 132 113 106 ...
                      : num 73 88 100 79 93 78 73 111 127 67 ...
## $ HR_first
                      : num NA 79 107 NA NA 101 136 83 NA 67 ...
## $ MAP first
## $ NIDiasABP first : int 65 38 84 63 41 89 88 51 71 57 ...
## $ NIMAP first
                      : num 92.3 49.3 100.3 86.7 75.3 ...
## $ NISysABP first
                      : int 147 72 133 134 144 129 187 100 138 134 ...
                      : num 35.1 35.2 37.8 36.3 37.8 35.8 36.3 38 37.3 34.8 ...
## $ Temp_first
## $ BUN_first
                      : int
                             13 16 8 23 45 15 32 81 21 19 ...
## $ Creatinine_first : num    0.8    0.8    0.4    0.9    1    1.4    3.4    0.9    0.7    1.1    ...
## $ FiO2_first
                             NA 1 1 NA NA 0.5 NA 1 NA 1 ...
                      : num
## $ HCO3_first
                      : int
                             26 21 24 28 18 19 25 18 21 23 ...
## $ HCT_first
                             33.7 24.7 28.5 41.3 22.6 41.6 31.9 32.6 28.3 31.5 ...
                      : num
## $ K_first
                             4.4 4.3 3.3 4 6 5.1 3.7 4.2 3.9 4.6 ...
                      : num
## $ Lactate_first
                      : num
                             NA NA 1.3 NA NA NA NA 1.4 NA NA ...
## $ Mg_first
                             1.5 3.1 1.9 2.1 1.5 1.7 1.9 2.2 1.6 1.8 ...
                      : num
## $ Na first
                      : int
                             137 139 137 140 140 141 140 141 139 141 ...
## $ PaCO2_first
                      : int NA 34 37 NA NA 45 NA 30 NA 42 ...
## $ PaO2 first
                      : int NA 344 65 NA NA 78 NA 128 NA 486 ...
## $ Platelets_first : int 221 164 72 391 109 276 325 91 696 141 ...
## $ SysABP_first
                      : int NA 105 148 NA NA 150 205 103 NA 98 ...
## $ WBC_first
                      : num 11.2 7.4 4.2 11.5 3.8 24 6.2 16.1 15.2 9 ...
## $ Weight
                      : num NA 80.6 56.7 84.6 NA NA 87 48.4 60.7 66.1 ...
## $ pH first
                      : num NA 7.45 7.51 NA NA 7.29 NA 7.4 NA 7.39 ...
## $ MechVent
                      : int 0 1 1 0 0 1 0 1 0 1 ...
## $ UrineOutputSum : int NA 5 14 NA NA 12 NA 12 NA 4 ...
head(dfICU, n = 5)
```

Print first 5 samples of data frame

##		recordid	Lengt	th_of_	stay	In.h	ospi	tal_d	eath	Age	Gende	er H	Height	CCU	CSRU	SICU	Г
##	1	132539			5				0	54		0	NA	0	0	1	
##	2	132540			8				0	76		1	175.3	0	1	0)
##	3	132541			19				0	44		0	NA	0	0	0)
##	4	132543			9				0	68		1	180.3	0	0	0)
##	5	132545			4				0	88		0	NA	0	0	0)
##		DiasABP_f	irst	GCS_f	irst	Gluc	ose_	first	HR_f	irst	MAP_	fir	st NII)ias/	ABP_f:	irst	
##	1		NA		15			205		73	}		NA			65	
##	2		67		3			105		88	}		79			38	
##	3		81		7			141		100)	1	L07			84	
##	4		NA		15			129		79)		NA			63	
##	5		NA		15			113		93	}		NA			41	
##		NIMAP_fir	st N	ISysAB	P_fi	rst Te	emp_	first	BUN_	firs	t Cre	eati	inine_i	first	t FiO	2_fir	st
## ##	1	NIMAP_fir 92.		ISysAB	_	rst Te 147	emp_	first 35.1	BUN_		t Cre	eati	inine_t	first 0.8		_	st NA
		_	33	ISysAB	_		emp_		BUN_	1		eati	inine_t		3	_	
##	2	92.	33 33	ISysAB	:	147	emp_	35.1	BUN_	1 1	.3	eati	inine_t	0.8	3 3	_	NA
## ##	2 3	92. 49.	33 33 30	ISysAB	:	147 72	emp_	35.1 35.2	BUN_	1 1	.3 .6	eati	inine_t	0.8	3 3 4		NA 1
## ## ##	2 3 4	92. 49. 100.	33 33 30 67	ISysAB	:	147 72 133	emp_	35.1 35.2 37.8	BUN_	1 1 2	.3 .6 8	eati	inine_t	0.8 0.8	3 3 4 9		NA 1 1
## ## ## ##	2 3 4	92. 49. 100. 86.	33 33 30 67 33	·		147 72 133 134 144	•	35.1 35.2 37.8 36.3 37.8		1 1 2 4	3 6 8 3 5			0.8 0.8 0.2 0.9	3 3 4 9		NA 1 1 NA
## ## ## ##	2 3 4 5	92. 49. 100. 86. 75. HCO3_firs	33 33 30 67 33	·	t K_	147 72 133 134 144	•	35.1 35.2 37.8 36.3 37.8		1 1 2 4 Mg_	3 6 8 3 5	. Na		0.8 0.4 0.9 1.0	3 3 4 9		NA 1 1 NA
## ## ## ## ##	2 3 4 5	92. 49. 100. 86. 75. HCO3_firs	33 33 30 67 33 t HC	Γ_firs	t K_1	147 72 133 134 144 first	•	35.1 35.2 37.8 36.3 37.8	first	1 1 2 4 Mg_	3 6 8 3 5 first	s Na	a_first	0.8 0.4 0.9 1.0 t Pac	3 3 4 9	irst	NA 1 1 NA
## ## ## ## ## ##	2 3 4 5	92. 49. 100. 86. 75. HCO3_firs 2	33 33 30 67 33 t HC	Γ_firs 33.	t K_: 7	147 72 133 134 144 first 4.4	•	35.1 35.2 37.8 36.3 37.8	first NA	1 1 2 4 Mg_	3 6 8 3 5 first 1.5	z Na	a_first 137	0.8 0.2 0.9 1.0 t Pac	3 3 4 9	irst NA	NA 1 1 NA
## ## ## ## ## ##	2 3 4 5 1 2 3	92. 49. 100. 86. 75. HCO3_firs 2	33 33 30 67 33 t HC 6 1	Γ_firs 33. 24.	t K_====================================	147 72 133 134 144 first 4.4 4.3	•	35.1 35.2 37.8 36.3 37.8	first NA NA	1 1 2 4 Mg_	3 6 8 3 5 first 1.5 3.1	s Na 5	a_first 137 138	0.8 0.2 0.2 1.0 t Pa0	3 3 4 9	irst NA 34	NA 1 1 NA

```
PaO2_first Platelets_first SysABP_first WBC_first Weight pH_first MechVent
## 1
                            221
                                                   11.2
                                                            NA
             NA
                                          NA
                                                                     NA
            344
                                                    7.4
## 2
                            164
                                          105
                                                          80.6
                                                                   7.45
                                                                                1
## 3
             65
                             72
                                          148
                                                    4.2
                                                          56.7
                                                                   7.51
                                                                               1
## 4
             NA
                            391
                                           NA
                                                   11.5
                                                          84.6
                                                                     NA
                                                                               0
## 5
             NA
                            109
                                          NA
                                                    3.8
                                                                     NA
                                                                               0
                                                            NA
    UrineOutputSum
##
## 1
## 2
                  5
## 3
                 14
## 4
                 NA
## 5
                 NA
## Plot fraction of missing values (NAs) in each column of the data frame
pMissDF = setNames(stack(sapply(dfICU, function(x){(sum(is.na(x))/length(x))*100}))[2:1], c('Feature','
p = ggplot(data = pMissDF, aes(x = Feature, y = Value)) +
  geom_bar(stat = 'identity', fill = 'steelblue', width = 0.3) +
  theme(text = element_text(size = 14, face = 'bold'),
  axis.text.x = element_text(angle = 90, hjust = 1, vjust = 0.5)) +
  xlab('') + ylab('Percentage') +
  ggtitle('Percentage of NAs across all features') +
  theme(plot.title = element_text(size = 12, hjust = 0.5),
        axis.text = element_text(size = 8),
        axis.text.x = element_text(size = 8),
        axis.text.y = element_text(size = 10),
        axis.title = element_text(size = 12, face = "bold"))
р
```

Percentage of NAs across all features



```
## Drop columns with more than 20% missing values
dfICU = dfICU %>% select(-c(pMissDF[pMissDF['Value'] > 20, 'Feature']))
## Collate 4 different ICU types (CCU, CSRU, SICU, CCU) into one column
## called 'ICU', remove separate ICU columns and the following columns:
## (1) 'recordid' (2) In.hospital_death (3) Length_of_stay
dfICU[dfICU['CCU'] == 1, 'ICU'] = 1
dfICU[dfICU['CSRU'] == 1, 'ICU'] = 2
dfICU[dfICU['SICU'] == 1, 'ICU'] = 3
dfICU[(dfICU['CCU'] == 0) & (dfICU['CSRU'] == 0) & (dfICU['SICU'] == 0), 'ICU'] = 4
dfICU = dfICU %>% select(-c(CCU, CSRU, SICU, recordid, In.hospital_death, Length_of_stay))
## Create list of continuous and categorical features
features = colnames(dfICU)
categorical_features = c('Gender', 'GCS_first', 'MechVent', 'ICU')
continuous_features = features[c(!(colnames(dfICU) %in% categorical_features))]
# Impute missing values using the MICE package
dfICU = complete(mice(dfICU, m = 40, maxit = 10, pred = quickpred(dfICU, minpuc = 0.25), seed = 500))
##
##
    iter imp variable
##
     1
         1 Gender
                    GCS_first Glucose_first HR_first NIDiasABP_first NIMAP_first
                                                                                      NISysABP_first
                                              HR_first NIDiasABP_first
##
     1
         2 Gender
                    GCS_first
                               Glucose_first
                                                                         NIMAP_first
                                                                                      NISysABP_first
                               {\tt Glucose\_first}
##
         3 Gender
                    GCS_first
                                              HR_first NIDiasABP_first
                                                                         NIMAP_first
                                                                                      NISysABP_first
     1
##
     1
           Gender
                    GCS_first
                               Glucose_first
                                              HR_first NIDiasABP_first
                                                                         NIMAP_first
                                                                                      NISysABP_first
```

Glucose_first HR_first NIDiasABP_first NIMAP_first

NISysABP_first

##

1

Gender

GCS_first

```
##
                     GCS first
                                Glucose_first
                                                HR first
                                                           NIDiasABP_first
                                                                             NIMAP_first
                                                                                           NISvsABP first
                                                                                                            T
     1
         6
            Gender
##
                                                           {\tt NIDiasABP\_first}
         7
     1
            Gender
                     GCS first
                                Glucose_first
                                                HR first
                                                                             NIMAP_first
                                                                                           NISysABP first
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                                                 HR first
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##
     1
            Gender
                     GCS first
                                 Glucose first
                                                           NIDiasABP first
                                                HR_first
                                                           NIDiasABP_first
                                                                             NIMAP_first
                                                                                           NISysABP_first
##
     1
         9
            Gender
                     GCS_first
                                 Glucose_first
##
     1
         10
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                           NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
                                                            NIDiasABP first
                                                                              NIMAP first
##
     1
             Gender
                      GCS first
                                 Glucose first
                                                 HR first
                                                                                            NISysABP first
         11
                                                            NIDiasABP first
                                                                              NIMAP first
##
     1
             Gender
                      GCS first
                                 Glucose first
                                                 HR first
                                                                                            NISysABP first
         12
                                                            NIDiasABP first
                                                                              NIMAP first
##
     1
         13
             Gender
                      GCS first
                                 Glucose first
                                                 HR first
                                                                                            NISysABP_first
##
     1
         14
             Gender
                      GCS first
                                  Glucose first
                                                 HR first
                                                            NIDiasABP first
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                                                                                            NISysABP_first
##
     1
         15
             Gender
                      GCS_first
                                  Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
##
     1
         16
             Gender
                      GCS_first
                                  Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
##
     1
         17
             Gender
                      GCS_first
                                  Glucose_first
                                                 HR_first
                                                                                            NISysABP_first
##
     1
         18
             Gender
                      GCS_first
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                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
                                                 HR_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
##
     1
         19
             Gender
                      GCS_first
                                  Glucose_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
##
     1
         20
             Gender
                      GCS_first
                                  Glucose_first
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                                                            NIDiasABP_first
                                                                                            NISysABP_first
##
     1
         21
             Gender
                      GCS_first
                                  Glucose_first
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                                                            NIDiasABP_first
                                                                              NIMAP_first
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##
         22
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
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     1
##
         23
             Gender
                      GCS first
                                  Glucose first
                                                  HR first
                                                            NIDiasABP first
                                                                              NIMAP first
                                                                                            NISvsABP first
     1
##
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
     1
         24
##
     1
         25
             Gender
                      GCS first
                                  Glucose first
                                                 HR first
                                                            NIDiasABP first
                                                                              NIMAP first
                                                                                            NISysABP first
##
     1
         26
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
             Gender
                      GCS first
                                                 HR_first
                                                            NIDiasABP first
                                                                              NIMAP first
                                                                                            NISysABP_first
##
     1
         27
                                  Glucose first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
##
         28
             Gender
                      GCS_first
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     1
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                                                            NIDiasABP first
                                                                              NIMAP first
                                                                                            NISysABP first
##
     1
         29
             Gender
                      GCS first
                                  Glucose first
##
     1
         30
             Gender
                      GCS first
                                  Glucose first
                                                 HR first
                                                            NIDiasABP first
                                                                              NIMAP first
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         31
             Gender
                      GCS_first
                                  Glucose_first
                                                 HR_first
                                                            NIDiasABP first
                                                                              NIMAP first
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                      GCS_first
                                                            NIDiasABP_first
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         32
             Gender
                                  Glucose_first
                                                 HR_first
##
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         33
             Gender
                      GCS_first
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                      GCS_first
                                                 {\tt HR\_first}
                                                            NIDiasABP_first
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     1
         34
             Gender
                                  Glucose_first
                                                                                            NISysABP_first
##
     1
         35
             Gender
                      GCS_first
                                  Glucose_first
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                                                            NIDiasABP_first
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         36
             Gender
                      GCS_first
                                  Glucose_first
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                                                            NIDiasABP_first
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##
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         37
             Gender
                      GCS_first
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         39
             Gender
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                     {\tt GCS\_first}
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            Gender
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                                Glucose_first
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                                                                             NIMAP_first
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         6
            Gender
                     GCS first
                                 Glucose first
                                                 HR first
                                                                                           NISysABP first
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         7
            Gender
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                                 Glucose first
                                                HR first
                                                           NIDiasABP first
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            Gender
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                                                                             NIMAP_first
                                                                                           NISysABP_first
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##
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             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first NIDiasABP_first
                                                                              NIMAP_first
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                                                            NIDiasABP_first
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##
         11
             Gender
                      GCS_first
                                  Glucose_first
                                                 \mathtt{HR}_{\mathtt{first}}
                                                                                            NISysABP_first
     2
##
         12
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
     2
##
         13
             Gender
                      GCS_first
                                  Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
##
     2
         14
             Gender
                      GCS_first
                                  Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
     2
##
         15
             Gender
                      GCS_first
                                  Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
##
     2
         16
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
     2
##
         17
             Gender
                      GCS first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP first
                                                                                            NISysABP_first
##
     2
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP first
         18
     2
##
             Gender
                      GCS first
                                 Glucose first
                                                 HR first NIDiasABP first
                                                                              NIMAP first NISysABP first
```

```
##
     2
         20
                      GCS first
                                  Glucose first
                                                  HR first
                                                            NIDiasABP first
                                                                               NIMAP first
                                                                                             NISvsABP first
             Gender
##
     2
                                                                               NIMAP first
         21
             Gender
                      GCS first
                                  Glucose first
                                                  HR first
                                                            NIDiasABP first
                                                                                             NISysABP first
     2
##
         22
             Gender
                      GCS first
                                  Glucose first
                                                  HR first
                                                            NIDiasABP first
                                                                               NIMAP first
                                                                                             NISysABP first
##
     2
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##
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##
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             Gender
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##
         19
             Gender
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##
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##
         22
             Gender
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                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
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##
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         23
             Gender
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                                                            NIDiasABP_first
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     5
##
         24
             Gender
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##
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##
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         27
             Gender
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##
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         28
             Gender
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##
         29
             Gender
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##
         31
             Gender
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##
         32
             Gender
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                                                            NIDiasABP first
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             Gender
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                      GCS_first
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         36
             Gender
                                 Glucose_first
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##
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         37
             Gender
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                                                            NIDiasABP_first
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##
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         38
             Gender
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                                                            NIDiasABP_first
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##
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         39
             Gender
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##
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##
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            Gender
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         9
            Gender
##
     6
         10
             Gender
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                                                                                            NISysABP_first
##
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##
     6
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##
         13
             Gender
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                                 Glucose_first
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##
     6
         14
             Gender
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                                                            NIDiasABP_first
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##
     6
         15
             Gender
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##
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         16
             Gender
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                                                            NIDiasABP_first
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##
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         17
             Gender
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                                                            NIDiasABP_first
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##
     6
         18
             Gender
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##
     6
         19
             Gender
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                                                            NIDiasABP_first
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##
     6
         20
             Gender
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                                                                                            NISvsABP first
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##
         23
             Gender
                      GCS first
                                  Glucose first
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                                                            NIDiasABP first
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                      GCS first
##
     6
         24
             Gender
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                                                            NIDiasABP first
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                      GCS_first
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##
         25
             Gender
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##
     6
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             Gender
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##
         27
             Gender
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##
     6
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             Gender
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##
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         29
             Gender
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##
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         30
             Gender
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             Gender
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##
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             Gender
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##
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             Gender
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##
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             Gender
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##
     6
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             Gender
                      GCS_first
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                                                            NIDiasABP_first
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##
     6
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             Gender
                      GCS_first
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                                                            NIDiasABP_first
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##
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         37
             Gender
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                                  Glucose_first
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##
     6
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             Gender
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                                                            NIDiasABP_first
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##
     6
             Gender
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##
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             Gender
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                                                           NIDiasABP_first
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##
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##
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##
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##
         9
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##
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             Gender
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##
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             Gender
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             Gender
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##
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##
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##
         28
             Gender
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         36
             Gender
##
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             Gender
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         4
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##
     8
            Gender
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                                 Glucose_first
                                                {\tt HR\_first}
                                                           NIDiasABP_first
     8
                                                 HR_first NIDiasABP_first
                                                                              NIMAP_first
##
         10
             Gender
                      GCS_first
                                 Glucose_first
                                                                                            NISysABP_first
##
     8
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
         11
##
     8
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
         12
             Gender
##
     8
                      GCS first
                                 Glucose first
                                                 HR first
                                                            NIDiasABP first
                                                                              NIMAP first
                                                                                            NISvsABP first
         13
             Gender
##
     8
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
         14
##
     8
         15
             Gender
                      GCS first
                                 Glucose first
                                                 HR first
                                                            NIDiasABP first
                                                                              NIMAP first
                                                                                            NISysABP first
##
     8
         16
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
     8
                                                 HR first
                                                            NIDiasABP first
                                                                              NIMAP first
                                                                                            NISysABP_first
##
         17
             Gender
                      GCS first
                                 Glucose first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
##
     8
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
         18
                                                 HR first
                                                            NIDiasABP first
                                                                              NIMAP first
                                                                                            NISysABP first
##
     8
         19
             Gender
                      GCS first
                                 Glucose first
##
     8
         20
             Gender
                      GCS first
                                 Glucose first
                                                 HR first
                                                            NIDiasABP first
                                                                              NIMAP first
                                                                                            NISysABP first
##
     8
         21
             Gender
                      GCS_first
                                 Glucose first
                                                 HR_first
                                                            NIDiasABP first
                                                                              NIMAP first
                                                                                            NISysABP_first
##
                      GCS_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
     8
         22
             Gender
                                 Glucose_first
                                                 HR_first
##
     8
         23
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
##
     8
                                                 HR_first
                                                                              NIMAP_first
         24
             Gender
                      GCS_first
                                 Glucose_first
                                                            NIDiasABP_first
                                                                                            NISysABP_first
##
     8
         25
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
##
     8
         26
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
##
     8
         27
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
##
     8
         28
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
##
     8
         29
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
             Gender
##
     8
                      GCS first
                                 Glucose first
                                                 HR first
                                                            NIDiasABP_first
                                                                              NIMAP first
                                                                                            NISvsABP first
         30
             Gender
     8
##
         31
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
##
     8
             Gender
                      GCS first
                                 Glucose first
                                                 HR first
                                                            NIDiasABP first
                                                                              NIMAP first
                                                                                            NISysABP first
##
     8
                      GCS_first
                                 Glucose_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
         33
             Gender
                                                 HR_first
                      GCS_first
     8
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP first
                                                                              NIMAP_first
                                                                                            NISysABP_first
##
         34
             Gender
     8
                                                            NIDiasABP_first
                                                                              NIMAP_first
##
         35
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                                                            NISysABP_first
                                                            NIDiasABP first
                                                                              NIMAP first
##
     8
         36
             Gender
                      GCS first
                                 Glucose first
                                                 HR first
                                                                                            NISysABP first
     8
                      GCS first
                                 Glucose first
                                                 HR first
                                                            NIDiasABP first
                                                                              NIMAP first
                                                                                            NISysABP first
##
         37
             Gender
##
     8
         38
             Gender
                      GCS first
                                 Glucose first
                                                 HR first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
##
     8
         39
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
##
     8
         40
             Gender
                      GCS_first
                                 Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                              NIMAP_first
                                                                                            NISysABP_first
                                                           NIDiasABP_first
                                                                             NIMAP_first
     9
                     GCS_first
                                                                                           NISysABP_first
##
         1
            Gender
                                 Glucose_first
                                                \mathtt{HR}_first
##
     9
         2
            Gender
                     GCS_first
                                 Glucose_first
                                                HR_first
                                                           NIDiasABP_first
                                                                             NIMAP_first
                                                                                           NISysABP_first
                                                                                                            Т
     9
##
         3
            Gender
                     GCS_first
                                 Glucose_first
                                                HR_first
                                                           NIDiasABP_first
                                                                             NIMAP_first
                                                                                           NISysABP_first
##
     9
         4
            Gender
                     GCS_first
                                 Glucose_first
                                                HR_first
                                                           NIDiasABP_first
                                                                             NIMAP_first
                                                                                           NISysABP_first
                                                                                                            Т
##
     9
         5
            Gender
                     GCS_first
                                Glucose_first
                                                HR_first
                                                           NIDiasABP_first
                                                                             NIMAP_first
                                                                                           NISysABP_first
                                                                                                            Т
##
     9
         6
            Gender
                     GCS_first
                                Glucose_first
                                                HR_first
                                                           NIDiasABP_first
                                                                             NIMAP_first
                                                                                           NISysABP_first
                                                                                                            Т
     9
##
         7
            Gender
                     GCS_first
                                Glucose_first
                                                HR first
                                                           NIDiasABP_first
                                                                             NIMAP_first
                                                                                           NISysABP first
##
     9
            Gender
                     {\tt GCS\_first}
                                Glucose_first
                                                HR_first
                                                           NIDiasABP_first
                                                                             NIMAP_first
                                                                                           NISysABP_first
##
     9
            Gender
                     GCS first
                                Glucose first HR first NIDiasABP first NIMAP first
                                                                                           NISysABP first
```

```
##
     9
             Gender
                      GCS first
                                  Glucose first
                                                  HR first
                                                            NIDiasABP first
                                                                               NIMAP first
                                                                                             NISvsABP first
         10
##
     9
         11
                                                                               NIMAP first
             Gender
                      GCS first
                                  Glucose first
                                                  HR first
                                                            NIDiasABP first
                                                                                             NISysABP first
                                                                                             NISysABP first
##
     9
         12
             Gender
                      GCS first
                                  Glucose first
                                                  HR first
                                                            NIDiasABP first
                                                                               NIMAP first
##
     9
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
         13
             Gender
##
     9
         14
             Gender
                      GCS first
                                  Glucose first
                                                  HR first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
     9
             Gender
                      GCS first
                                                  HR first
                                                            NIDiasABP first
                                                                               NIMAP first
                                                                                             NISysABP first
##
         15
                                  Glucose first
     9
                                                  HR first
                                                            NIDiasABP first
                                                                               NIMAP first
##
         16
             Gender
                      GCS first
                                  Glucose first
                                                                                             NISysABP first
                                                            NIDiasABP first
                                                                               NIMAP first
##
     9
         17
             Gender
                      GCS first
                                  Glucose first
                                                  HR first
                                                                                             NISysABP first
##
     9
         18
             Gender
                      GCS first
                                  Glucose first
                                                  HR first
                                                            NIDiasABP first
                                                                               NIMAP_first
                                                                                             NISysABP first
     9
##
         19
             Gender
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
##
     9
         20
             Gender
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
     9
                                  Glucose_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
##
         21
             Gender
                      GCS_first
                                                  HR_first
##
     9
         22
             Gender
                      GCS_first
                                  Glucose first
                                                  HR_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
     9
                                                                                             NISysABP_first
##
         23
             Gender
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
##
     9
         24
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
             Gender
##
     9
         25
             Gender
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
     9
                                                                               NIMAP_first
##
         26
             Gender
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                                             NISysABP_first
##
         27
             Gender
                      GCS first
                                  Glucose first
                                                  HR first
                                                            NIDiasABP first
                                                                               NIMAP first
                                                                                             NISvsABP first
                                                                               NIMAP_first
##
     9
         28
             Gender
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                                             NISysABP_first
##
     9
         29
             Gender
                      GCS first
                                  Glucose first
                                                  HR first
                                                            NIDiasABP first
                                                                               NIMAP first
                                                                                             NISysABP first
##
     9
         30
             Gender
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
##
     9
             Gender
                      GCS first
                                  Glucose first
                                                  HR first
                                                            NIDiasABP first
                                                                               NIMAP first
                                                                                             NISysABP_first
         31
                      GCS_first
                                  Glucose_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
##
     9
         32
             Gender
                                                  HR_first
     9
             Gender
                                  Glucose first
                                                  HR first
                                                            NIDiasABP first
                                                                               NIMAP first
                                                                                             NISysABP first
##
         33
                      GCS first
     9
                                                                               NIMAP first
##
         34
             Gender
                      GCS first
                                  Glucose first
                                                  HR first
                                                            NIDiasABP first
                                                                                             NISysABP first
##
     9
         35
             Gender
                      GCS first
                                  Glucose first
                                                  HR_first
                                                            NIDiasABP first
                                                                               NIMAP first
                                                                                             NISysABP first
##
     9
             Gender
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
         36
     9
##
         37
             Gender
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
     9
##
         38
             Gender
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
##
     9
         39
             Gender
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
##
     9
         40
             Gender
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
##
     10
          1
             Gender
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
##
     10
              Gender
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
                                                                               NIMAP_first
##
     10
             Gender
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                                             NISysABP_first
          3
##
     10
             Gender
                      GCS first
                                  Glucose first
                                                  HR first
                                                            NIDiasABP first
                                                                               NIMAP first
                                                                                             NISvsABP first
          4
##
     10
                                                  HR first
                                                                               NIMAP_first
          5
             Gender
                      GCS first
                                  Glucose_first
                                                            NIDiasABP first
                                                                                             NISysABP_first
##
     10
          6
             Gender
                      GCS first
                                  Glucose first
                                                  HR first
                                                            NIDiasABP first
                                                                               NIMAP first
                                                                                             NISysABP first
##
     10
          7
             Gender
                      GCS_first
                                  Glucose_first
                                                  HR_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
                                                                                             NISysABP_first
##
             Gender
                      GCS first
                                  Glucose first
                                                  HR_first
                                                            NIDiasABP first
                                                                               NIMAP_first
                                                                                             NISysABP first
     10
          8
##
                                  Glucose_first
                                                            NIDiasABP_first
                                                                               NIMAP_first
     10
          9
             Gender
                      GCS_first
                                                  HR_first
                                                                                             NISysABP_first
                                                             NIDiasABP first
                       GCS first
                                                   HR first
                                                                                NIMAP first
##
     10
          10
               Gender
                                   Glucose first
                                                                                              NISysABP first
##
     10
              Gender
                       GCS first
                                   Glucose first
                                                   HR first
                                                             NIDiasABP first
                                                                                NIMAP first
                                                                                              NISysABP first
          11
                                                   HR first
                                                                                NIMAP first
##
     10
          12
               Gender
                       GCS first
                                   Glucose first
                                                             NIDiasABP_first
                                                                                              NISysABP first
                                                                                NIMAP_first
##
     10
          13
               Gender
                       GCS_first
                                   Glucose_first
                                                   HR_first
                                                              NIDiasABP_first
                                                                                              NISysABP_first
                                                                                NIMAP_first
##
     10
          14
               Gender
                       GCS_first
                                   Glucose_first
                                                   HR_first
                                                              NIDiasABP_first
                                                                                              NISysABP_first
                                                                                NIMAP_first
                                                                                              NISysABP_first
##
     10
          15
                       GCS_first
                                   Glucose_first
                                                   HR_first
                                                              NIDiasABP_first
               Gender
##
     10
          16
               Gender
                       GCS_first
                                   Glucose_first
                                                   HR_first
                                                              NIDiasABP_first
                                                                                NIMAP_first
                                                                                              NISysABP_first
##
     10
          17
               Gender
                       GCS_first
                                   Glucose_first
                                                   HR_first
                                                              NIDiasABP_first
                                                                                NIMAP_first
                                                                                              NISysABP_first
                                                   HR_first
##
     10
          18
               Gender
                       GCS_first
                                   Glucose_first
                                                              NIDiasABP_first
                                                                                NIMAP_first
                                                                                              NISysABP_first
##
     10
          19
               Gender
                       GCS_first
                                   Glucose_first
                                                   HR_first
                                                              NIDiasABP_first
                                                                                NIMAP_first
                                                                                              NISysABP_first
##
     10
          20
               Gender
                       GCS_first
                                   Glucose_first
                                                   HR_first
                                                              NIDiasABP_first
                                                                                NIMAP_first
                                                                                              NISysABP_first
##
     10
          21
               Gender
                       GCS_first
                                   Glucose_first
                                                   HR_first
                                                              NIDiasABP_first
                                                                                NIMAP first
                                                                                              NISysABP_first
                                                             {\tt NIDiasABP\_first}
##
     10
          22
               Gender
                       GCS_first
                                   Glucose_first
                                                   HR_first
                                                                                NIMAP_first
                                                                                              NISysABP first
                                                                                NIMAP first
##
     10
               Gender
                       GCS first
                                   Glucose first HR first NIDiasABP first
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##
     10
              Gender
                      GCS first
                                 Glucose first HR first NIDiasABP first
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                                                                                           NISvsABP first
##
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          25
              Gender
                                  Glucose_first HR_first NIDiasABP_first
                                                                             NIMAP first
                      GCS first
                                                                                           NISysABP first
                                                 HR first
                                                                                           NISysABP first
##
     10
          26
              Gender
                      GCS first
                                  Glucose first
                                                           NIDiasABP first
                                                                             NIMAP first
                                                           NIDiasABP_first
                                                                             NIMAP_first
##
     10
              Gender
                      GCS_first
                                  Glucose_first HR_first
                                                                                           NISysABP_first
##
     10
              Gender
                      GCS first
                                  Glucose first HR first
                                                            NIDiasABP_first
                                                                             NIMAP first
                                                                                           NISysABP first
##
     10
          29
              Gender
                      GCS first
                                  Glucose first HR first
                                                           NIDiasABP first
                                                                             NIMAP first
                                                                                           NISysABP first
              Gender
                                  Glucose first HR first
                                                           NIDiasABP first
                                                                             NIMAP first
                                                                                           NISysABP first
##
     10
                      GCS first
                                                                             NIMAP first
          31
              Gender
                                  Glucose first HR first
                                                           NIDiasABP first
                                                                                           NISysABP first
##
     10
                      GCS first
##
     10
          32
              Gender
                      GCS first
                                  Glucose first HR first
                                                            NIDiasABP_first
                                                                             NIMAP first
                                                                                           NISysABP first
##
     10
              Gender
                                                                             NIMAP_first
          33
                      GCS_first
                                  Glucose_first HR_first
                                                            NIDiasABP_first
                                                                                           NISysABP_first
##
     10
              Gender
                      GCS_first
                                  Glucose_first HR_first
                                                            NIDiasABP_first
                                                                             NIMAP_first
                                                                                           NISysABP_first
                                                                             NIMAP_first
                                                                                           NISysABP_first
##
     10
              Gender
                      GCS_first
                                  Glucose_first
                                                 \mathtt{HR}_{\mathtt{first}}
                                                            NIDiasABP_first
          35
##
     10
          36
              Gender
                      GCS_first
                                  Glucose_first HR_first
                                                            NIDiasABP_first
                                                                             NIMAP_first
                                                                                           NISysABP_first
##
              Gender
                      GCS_first
                                  Glucose_first
                                                 HR_first
                                                                             NIMAP_first
     10
          37
                                                            NIDiasABP_first
                                                                                           NISysABP_first
##
     10
              Gender
                      GCS_first
                                  Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                             NIMAP_first
                                                                                           NISysABP_first
          38
##
     10
          39
              Gender
                      GCS_first
                                  Glucose_first
                                                 HR_first
                                                            NIDiasABP_first
                                                                             NIMAP_first
                                                                                           NISysABP_first
##
                                Glucose_first HR_first
                                                           NIDiasABP_first
                                                                             NIMAP_first
     10
          40
              Gender
                      GCS_first
                                                                                           NISysABP_first
## Select only continuous features
dfICU_continuous = dfICU %>% select(continuous_features)
## Warning: Using an external vector in selections was deprecated in tidyselect 1.1.0.
## i Please use `all of()` or `any of()` instead.
     # Was:
##
##
     data %>% select(continuous_features)
##
##
     # Now:
     data %>% select(all_of(continuous_features))
##
##
## See <https://tidyselect.r-lib.org/reference/faq-external-vector.html>.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
head(dfICU_continuous)
     Age Glucose_first HR_first NIDiasABP_first NIMAP_first NISysABP_first
##
## 1
     54
                   205
                              73
                                              65
                                                        92.33
                                                                         147
## 2 76
                   105
                              88
                                              38
                                                        49.33
                                                                          72
## 3
                             100
                                              84
                                                                         133
      44
                   141
                                                       100.30
## 4
      68
                   129
                              79
                                              63
                                                        86.67
                                                                         134
## 5
                              93
                                                        75.33
                                                                         144
      88
                   113
                                              41
## 6
                              78
      64
                   264
                                              89
                                                       102.30
                                                                         129
     Temp_first BUN_first Creatinine_first HCO3_first HCT_first K_first Mg_first
## 1
                        13
                                                                      4.4
           35.1
                                        0.8
                                                     26
                                                             33.7
                                                                                1.5
## 2
           35.2
                        16
                                        0.8
                                                     21
                                                             24.7
                                                                      4.3
                                                                                3.1
## 3
                        8
                                                     24
                                                                      3.3
           37.8
                                        0.4
                                                             28.5
                                                                                1.9
## 4
           36.3
                        23
                                        0.9
                                                     28
                                                                      4.0
                                                                                2.1
                                                             41.3
## 5
           37.8
                        45
                                        1.0
                                                     18
                                                             22.6
                                                                      6.0
                                                                                1.5
## 6
           35.8
                                        1.4
                                                     19
                                                             41.6
                                                                      5.1
                                                                                1.7
                        15
     Na first Platelets first WBC first
## 1
          137
                           221
                                    11.2
## 2
          139
                           164
                                     7.4
## 3
          137
                           72
                                     4.2
## 4
          140
                           391
                                    11.5
```

3.8

109

5

140

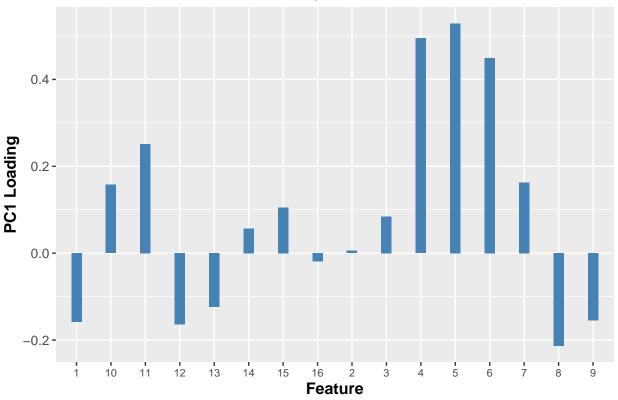
```
## 6
         141
                        276
                                24.0
## Scale the data containing the continuous features and perform PCA
# Scale the data containing the continuous features
X = scale(dfICU_continuous) # note that the output of the scale function is a matrix
# Covariance of scaled data matrix
S = cov(X)
# Calculate eigenvectors and eigenvalues of covariance matrix
e = eigen(S)
V = e$vectors
lambda = e$values
colnames(dfICU_continuous)
   [1] "Age"
                                           "HR first"
                         "Glucose_first"
                                                             "NIDiasABP_first"
   [5] "NIMAP_first"
                         "NISysABP_first"
##
                                           "Temp_first"
                                                             "BUN_first"
   [9] "Creatinine_first" "HCO3_first"
                                           "HCT_first"
                                                             "K first"
## [13] "Mg_first"
                                           "Platelets_first"
                         "Na_first"
                                                             "WBC_first"
print(V)
                [,1]
                                        [,3]
##
                            [,2]
                                                   [,4]
                                                                [,5]
   [1,] -0.157731074 -0.114530569 -0.388013220 -0.20059326
                                                         0.005915649
   [2,] 0.005635612 -0.172437854 0.159764114 0.00723908
                                                         0.473930391
  [3,] 0.084657475 -0.001300709 0.540994038 0.22311398 -0.233916420
  [4,] 0.494945453 -0.202688811 -0.025706623
                                             0.10622443 0.033839267
   [5,] 0.528992203 -0.230211214 -0.118111402 0.08685209
                                                         0.042332360
##
  [6,] 0.449431830 -0.234527148 -0.201498710 0.02985685 0.029476245
  [7,] 0.162897380 0.047851054 0.317785388 0.02704535 -0.486713293
   [8,] -0.213571929 -0.542042198 -0.007167586 0.06753904 -0.229836010
## [9,] -0.154799799 -0.548047159 0.061673637 0.12320867 -0.191547259
## [10,] 0.157524382 0.203367765 -0.296760302 -0.33991378 -0.361045821
## [11,] 0.251551548 -0.031364913 0.080536744 -0.35760611 0.125964901
## [13,] -0.123474974 -0.215189739 -0.223004906 -0.29063844 -0.251198610
## [14,] 0.056542301 0.107109994 -0.096687245 0.06388189 -0.413015376
## [15,] 0.105424742 -0.077101745 0.283895858 -0.57406133 0.001832752
  [16,] -0.018719481 -0.068626251
                                 0.369074279 -0.43437064
                                                         0.036279605
##
                            [,7]
                                                               [,10]
                [,6]
                                       [,8]
                                                   [,9]
##
   [1,] 0.377402392 0.410246656
                                0.01761530 -0.188522420 0.248295572
  [2,] 0.289316085 0.323140750 0.60151015 0.174142588 -0.055318183
   [3,] -0.007860540 0.009145545 0.34862544 -0.251823707 -0.025167970
  [4,] -0.062992708 -0.131462094 0.03098183 -0.114210745 0.002672089
  [5,] -0.009254811 -0.017287385 -0.03180196 -0.144260166 0.009327204
  [6,] 0.069242177 0.118243963 -0.07179352 -0.161765928 -0.007308783
   [7,] -0.105951164  0.484795171  0.03350668  0.196329234  0.286278586
## [8,] 0.172658613 0.071582144 -0.08756448 0.110829640 -0.029966589
## [9,] 0.009113297 -0.010802378 -0.23540846 0.242792450 -0.043261167
## [11,] 0.038804711 -0.264961922 0.06683977
                                            0.654623272  0.332417113
## [12,] -0.474222443 -0.181943298 0.14587459 0.005404975 0.089831214
## [13,] -0.216371178 -0.205871146 0.53924956 -0.255184263 -0.017027829
```

```
## [14,] 0.586538151 -0.448106907 0.20327227 0.125846863 -0.170267220
## [15,] 0.057492755 0.148928124 -0.17397606 -0.013245146 -0.690507459
  [16,] 0.260188397 -0.191742703 -0.20254861 -0.424629958 0.474456040
##
              [,11]
                         [,12]
                                    [,13]
                                               [,14]
                                                           [,15]
   [1,] -0.429396734 -0.350138409 0.07256257 -0.12806968 -0.1851863129
   [2,] 0.150603663 0.326802497 -0.02950747 -0.06201052 -0.0501574721
   [3,] -0.288790517 -0.236242768 0.46445381 0.22784212 -0.0532992625
   [4,] -0.001714367 -0.073589575 0.10643445 -0.63155485 -0.0295162938
   [5,] -0.026229643   0.016036703 -0.02326936 -0.08592667   0.0233507660
   [6,] -0.023176398  0.097127449 -0.16892331  0.68809292  0.0337060161
   [7,] 0.031332168 -0.012602522 -0.49865482 -0.12160924 0.0061066931
   [8,] 0.076861992 0.007557207 0.18018624 -0.04749545 0.7117487624
   [9,] 0.159458216 0.104443485 0.16145709 0.04022027 -0.6627619853
## [10,] 0.018898119 0.473560911 0.51258509 -0.01363686 -0.0006351825
## [11,] -0.054529513 -0.349439687 0.14522622 0.14786735 0.0472908981
## [13,] 0.405733293 -0.301567663 -0.18107450 0.04554407 -0.0696160600
## [14,] -0.242469445 0.227870385 -0.23305189 -0.04026719 -0.0607377346
## [15,] -0.101306038 -0.132837121 -0.09645321 -0.05139781 -0.0130771782
  [16,] 0.167487388 0.297383642 0.02258348 -0.02575046 -0.0125806713
##
               [,16]
   [1,] 0.0007563845
   [2,] -0.0030633727
   [3,] -0.0156716613
  [4,] 0.4991150399
   [5,] -0.7824163101
   [6,] 0.3706481369
   [7,] 0.0082054614
  [8,] 0.0090541665
## [9,] -0.0171902008
## [10,] 0.0023612386
## [11,] -0.0042733809
## [12,] 0.0090888615
## [13,] -0.0217949905
## [14,] -0.0021386655
## [15,] -0.0064094167
## [16,] 0.0011681853
print(lambda)
   [1] 2.7106781 1.9763327 1.4941549 1.2145392 1.1661721 1.0726946 0.9719390
   [8] 0.9047355 0.8791409 0.7515047 0.7241747 0.6945458 0.6101434 0.4049811
## [15] 0.2922539 0.1320093
## Note that PCA can also be performed using R in-built function prcomp()
prcomp(X)$rotation # extracting the eigenvectors matrix
                                     PC2
                                                PC3
                  ## Age
                 ## Glucose_first
                 ## HR_first
## NIDiasABP_first -0.494945453 0.202688811 0.025706623 -0.10622443
                 ## NIMAP_first
## NISysABP_first
                 -0.449431830 0.234527148 0.201498710 -0.02985685
## Temp_first
                 -0.162897380 -0.047851054 -0.317785388 -0.02704535
```

```
## BUN first
                ## Creatinine_first 0.154799799 0.548047159 -0.061673637 -0.12320867
## HCO3 first
               -0.157524382 -0.203367765 0.296760302 0.33991378
## HCT_first
                0.35760611
## K_first
                0.164371612  0.317541376  -0.027314011
                                                0.13978209
                ## Mg first
## Na first
                -0.056542301 -0.107109994 0.096687245 -0.06388189
## Platelets_first -0.105424742 0.077101745 -0.283895858
                                                0.57406133
## WBC first
                0.018719481 0.068626251 -0.369074279
                                                0.43437064
##
                       PC5
                                 PC6
                                            PC7
                                                     PC8
## Age
                0.005915649 -0.377402392 -0.410246656
                                               0.01761530
                0.473930391 -0.289316085 -0.323140750
## Glucose_first
                                                0.60151015
                                                0.34862544
## HR_first
                -0.233916420 0.007860540 -0.009145545
                                                0.03098183
## NIDiasABP_first
                0.033839267 0.062992708 0.131462094
                ## NIMAP_first
## NISysABP_first
                0.029476245 \ -0.069242177 \ -0.118243963 \ -0.07179352
## Temp_first
                ## BUN first
                -0.229836010 -0.172658613 -0.071582144 -0.08756448
## Creatinine_first -0.191547259 -0.009113297 0.010802378 -0.23540846
## HCO3 first
               ## HCT_first
                0.125964901 -0.038804711 0.264961922 0.06683977
## K first
                0.095937990 0.474222443 0.181943298 0.14587459
## Mg_first
               -0.251198610 0.216371178 0.205871146 0.53924956
## Na first
                -0.413015376 -0.586538151 0.448106907 0.20327227
## Platelets first
                0.001832752 -0.057492755 -0.148928124 -0.17397606
## WBC_first
                ##
                       PC9
                                PC10
                                           PC11
                                                     PC12
## Age
                0.350138409
## Glucose_first
                0.174142588 -0.055318183 -0.150603663 -0.326802497
                                                0.236242768
## HR_first
                -0.251823707 -0.025167970 0.288790517
## NIDiasABP_first
               -0.114210745 0.002672089
                                     0.001714367
                                                0.073589575
## NIMAP_first
                -0.144260166 0.009327204
                                     0.026229643 -0.016036703
## NISysABP_first
                -0.161765928 -0.007308783 0.023176398 -0.097127449
## Temp_first
                ## BUN first
                0.110829640 -0.029966589 -0.076861992 -0.007557207
## Creatinine_first 0.242792450 -0.043261167 -0.159458216 -0.104443485
## HCO3 first
                0.104476321 -0.004746577 -0.018898119 -0.473560911
## HCT_first
                ## K first
                ## Mg_first
               -0.255184263 -0.017027829 -0.405733293 0.301567663
## Na first
                0.125846863 -0.170267220 0.242469445 -0.227870385
## Platelets first -0.013245146 -0.690507459 0.101306038 0.132837121
## WBC first
               ##
                     PC13
                               PC14
                                          PC15
                                                     PC16
## Age
                0.07256257 -0.12806968 -0.1851863129 -0.0007563845
                -0.02950747 -0.06201052 -0.0501574721
## Glucose_first
                                              0.0030633727
## HR_first
                ## NIDiasABP_first
                0.10643445 -0.63155485 -0.0295162938 -0.4991150399
## NIMAP_first
                -0.02326936 -0.08592667 0.0233507660 0.7824163101
## NISysABP_first
                -0.16892331 0.68809292
                                   0.0337060161 -0.3706481369
                ## Temp_first
## BUN_first
                0.18018624 -0.04749545 0.7117487624 -0.0090541665
## Creatinine_first 0.16145709 0.04022027 -0.6627619853 0.0171902008
## HCO3 first
                0.51258509 -0.01363686 -0.0006351825 -0.0023612386
```

```
## HCT first
                   ## K_first
                  -0.22316178 -0.02026051 0.0286051143 -0.0090888615
## Mg first
                  -0.18107450 0.04554407 -0.0696160600 0.0217949905
## Na_first
                  -0.23305189 -0.04026719 -0.0607377346 0.0021386655
## Platelets first -0.09645321 -0.05139781 -0.0130771782 0.0064094167
## WBC first
                   0.02258348 -0.02575046 -0.0125806713 -0.0011681853
## Plot PC1 loadings
dfPCA = data.frame(V)
colnames(dfPCA) = paste0('PC', c(1:ncol(V)), 'L')
ggplot(data = dfPCA) +
 geom_bar(aes(x = rownames(dfPCA), y = PC1L), stat = 'identity', width = 0.3, fill = 'steelblue') +
  labs(x = 'Feature', y = 'PC1 Loading') +
  ggtitle("PC1 Loading for All Features") +
  theme(plot.title = element_text(size = 16, hjust = 0.5),
  axis.text = element_text(size = 12),
  axis.text.x = element_text(size = 8),
  axis.text.y = element_text(size = 10),
  axis.title = element_text(size = 12, face = "bold"))
```

PC1 Loading for All Features



```
## Calculate PC scores of all samples
PC_scores = lambda
print(lambda)
```

```
## [1] 2.7106781 1.9763327 1.4941549 1.2145392 1.1661721 1.0726946 0.9719390 
## [8] 0.9047355 0.8791409 0.7515047 0.7241747 0.6945458 0.6101434 0.4049811 
## [15] 0.2922539 0.1320093
```

```
## How much variance is explained by each principal direction
## or each principal component?
print(cumsum(lambda))
## [1] 2.710678 4.687011 6.181166 7.395705 8.561877 9.634572 10.606511
## [8] 11.511246 12.390387 13.141892 13.866066 14.560612 15.170756 15.575737
## [15] 15.867991 16.000000
## Percentage of total variance explained by each principal component
percentage_explained_var = (cumsum(lambda) / sum(lambda)) * 100
print(percentage_explained_var)
  [1] 16.94174 29.29382 38.63229 46.22316 53.51173 60.21607 66.29069
## [8] 71.94529 77.43992 82.13682 86.66292 91.00383 94.81722 97.34836
## [15] 99.17494 100.00000
## How many minimum principal components are needed to explain more than
## 80% of the variance in the data?
n_PC = which(cumsum(percentage_explained_var) >= 80)[1]
print(n_PC)
## [1] 3
```