MAR 30% missing - DPMPM

```
# sample MCAR dataset from PUMS
source("../../utils/sampleMAR30.R")
n = 10000
missing_col = c(1,3,7,9,10,11)
set.seed(2)

output_list <- sampleMAR30(n)
df <- output_list[['df']]
df_observed <- output_list[['df_observed']]

apply(is.na(df_observed), MARGIN = 2, mean)
```

```
##    VEH     MV     NP   RMSP    ENG  MARHT   SCHL RACNUM   AGEP    WKL  PINCP
## 0.3074 0.0000 0.2605 0.0000 0.0000 0.0000 0.3424 0.0000 0.3227 0.3078 0.3049
```

DPMPM

Multiple imputation using NPBayesImputeCat package

Ref: https://cran.r-project.org/web/packages/NPBayesImputeCat/NPBayesImputeCat.pdf

1. Create and initialize the Rcpp_Lcm model object using CreateModel with the following arguments:

- X: dataframe to be imptuted = df
- MCZ: dataframe with the definition of structural zero = NULL
- K: the maximum number of mixture components = 40
- Nmax: An upper truncation limit for the augmented sample size = 0
- aalpha: the hyper parameter alpha in stick-breaking prior = 0.25
- balpha: the hyper parameter beta in stick-breaking prior = 0.25
- seed = 0

2. Set the tracer for the sampling process

- k_star: the effective cluster number
- psi: conditional multinomial probabilties
- ImputedX: imputation result

3. Run the model using the method Run of Rcpp_Lcm class with the following arguments:

- burnin = 10000
- iter = 10000
- thinning = 5

4. Obtain result

```
N = 40
Mon = 10000
B = 10000
thin.int = 5

# 1. Create and initialize the Rcpp_Lcm model object
model = CreateModel(X = df_observed, MCZ = NULL, K = N, Nmax = 0,
                    aalpha = 0.25, balpha = 0.25, seed = 0)
# 2. Set tracer
```

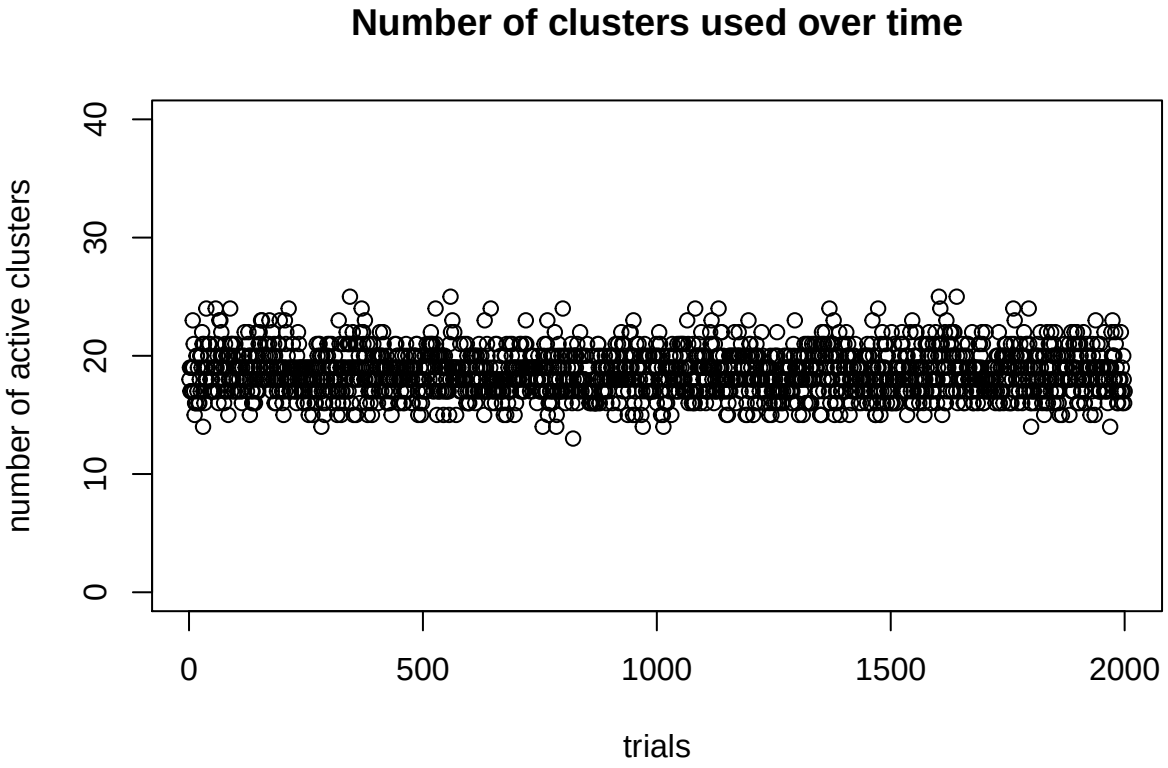
```
model$SetTrace(c('k_star', 'psi', 'ImputedX', 'alpha'),Mon)

# 3. Run model using Run(burnin, iter, thinning)
model$Run(B,Mon,thin.int)
```

```
# Extract results and format output
output <- model$GetTrace()
k_star <- output$k_star
psi <- output$psi
imputed_df <- output$ImputedX
alpha <- output$alpha

#retrieve parameters from the final iteration
result <- model$snapshot

#convert ImputedX matrix to dataframe, using proper factors/names etc.
ImputedX <- GetDataFrame(result$ImputedX,df)

# extract 5 imputed dataset from DP model
imputation_index = as.integer(seq(1,dim(imputed_df)[1], length.out = 5))
imputation_list = list()
levels = c(7,7,7,19,5,4,7,2,17,3,13)
for (i in 1:length(imputation_index)) {
  index = imputation_index[i]
  # need to plus 1 here because the class index of DP function starts at 0
  d = imputed_df[index,] + 1
  dim(d) = dim(t(df_observed))
  d = data.frame(t(d))
  colnames(d) = colnames(df_observed)
  # format columns of d
  for (col_index in 1:ncol(df_observed)) {
    d[,col_index] = factor(d[,col_index], levels = 1:levels[col_index], ordered = TRUE)
  }
  imputation_list[[i]] = d
}
```

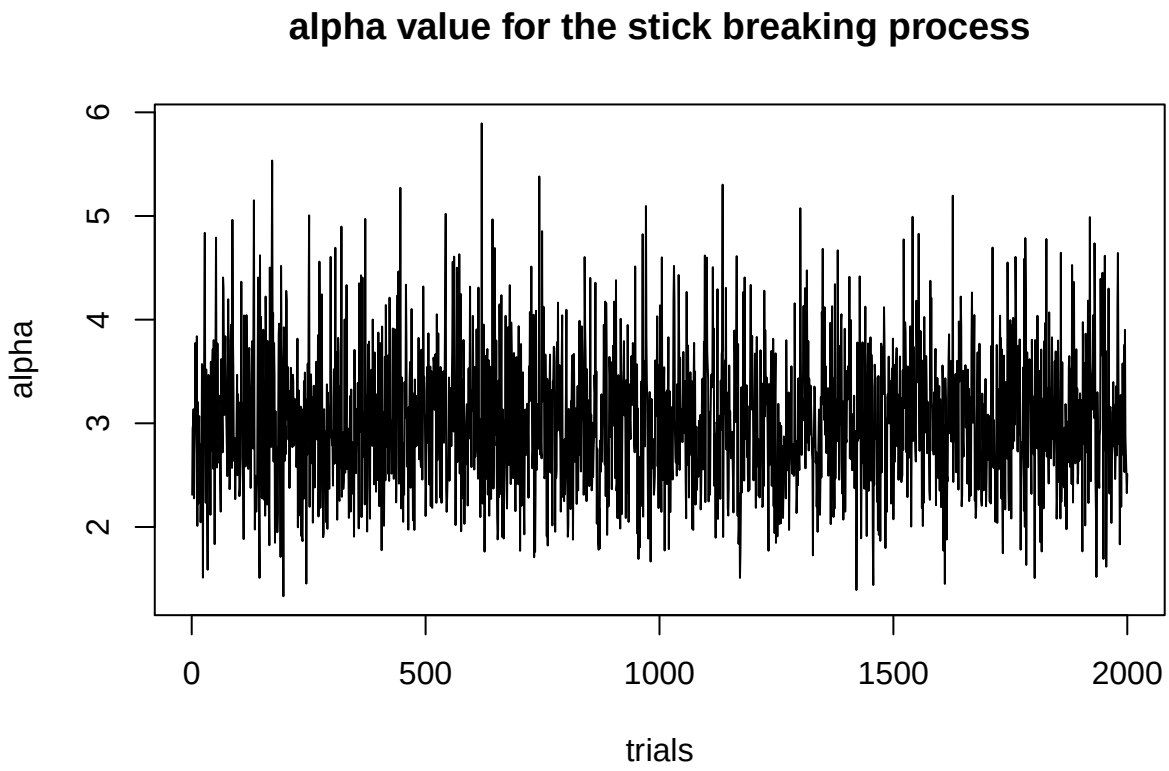
Diagnostics

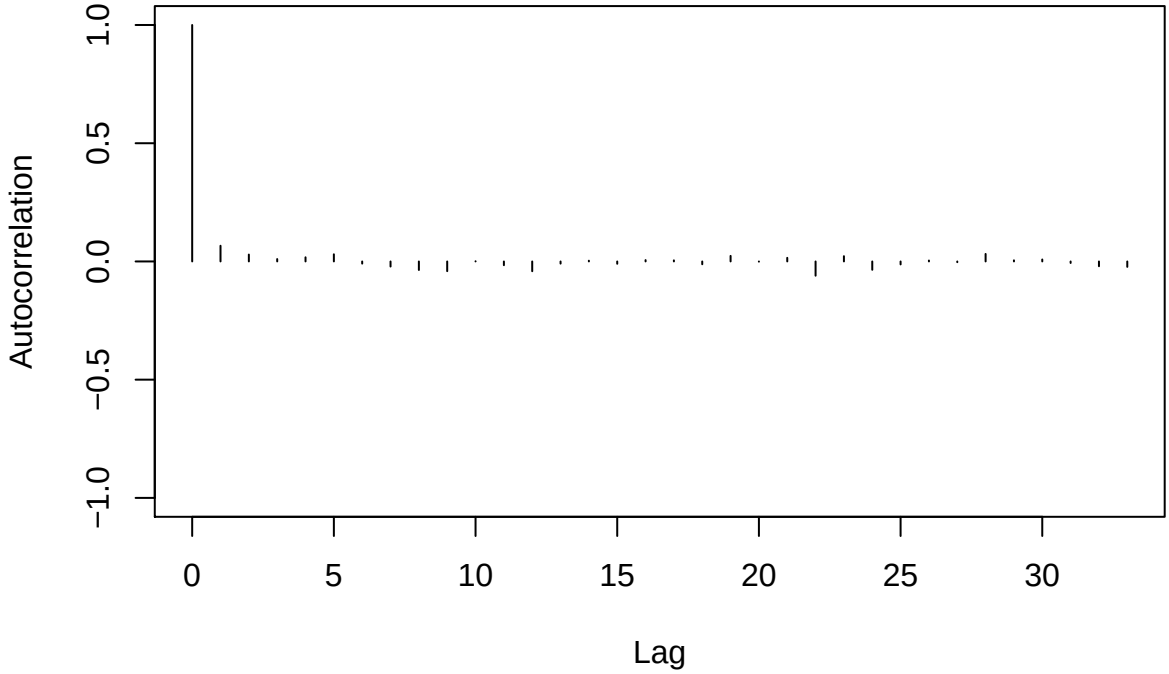
```
source("../../utils/create_report.R")
create_report(imputation_list, max_nway=4, missing_col, df_observed)
```

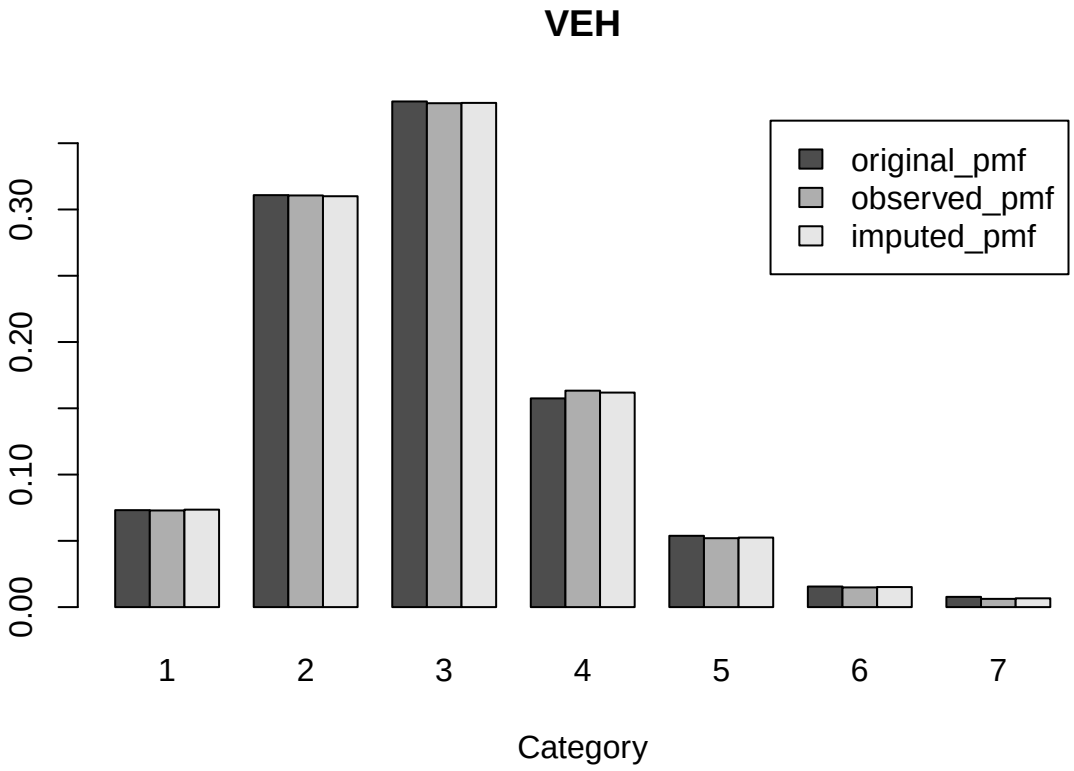
```
## ##### Coverage #####
## Coverage 1 way: 79.63 percent
## Coverage 2 way: 94.43 percent
## Coverage 3 way: 97.32 percent
## Coverage 4 way: 98.57 percent
##
## ##### RMSE #####
## RMSE 1 way: 0.004811
## RMSE 2 way: 0.00165
## RMSE 3 way: 0.000563
## RMSE 4 way: 0.00019
##
## ##### MAE #####
## MAE 1 way: 0.003565
```

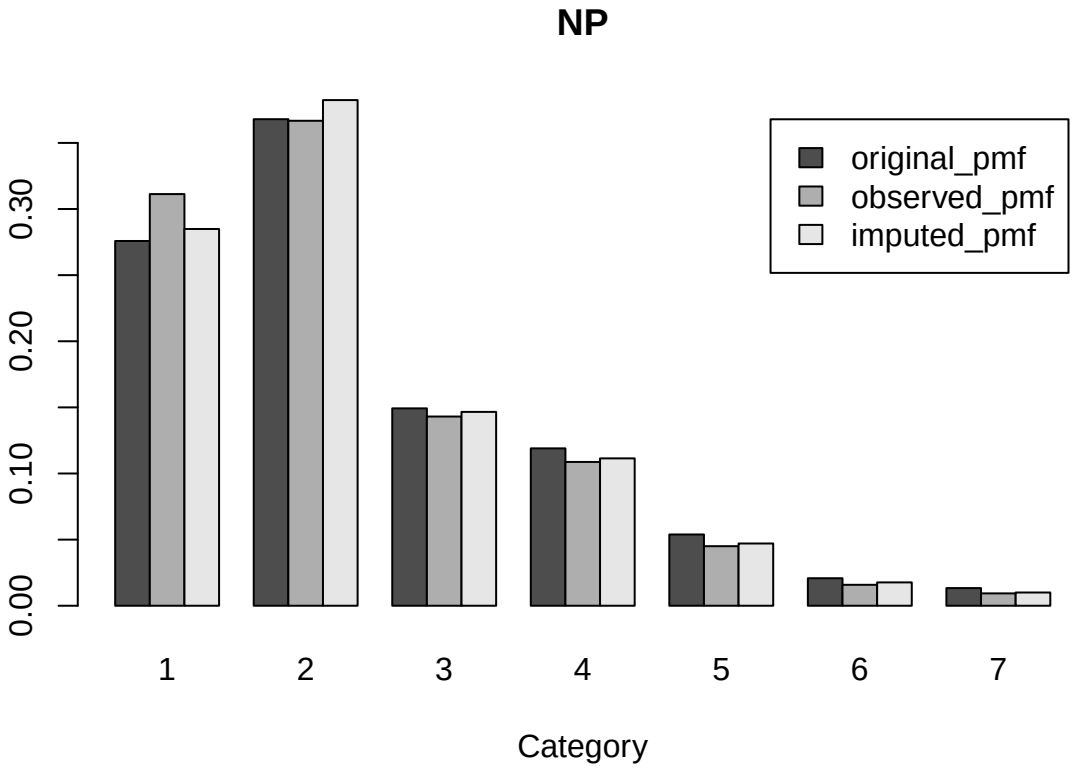


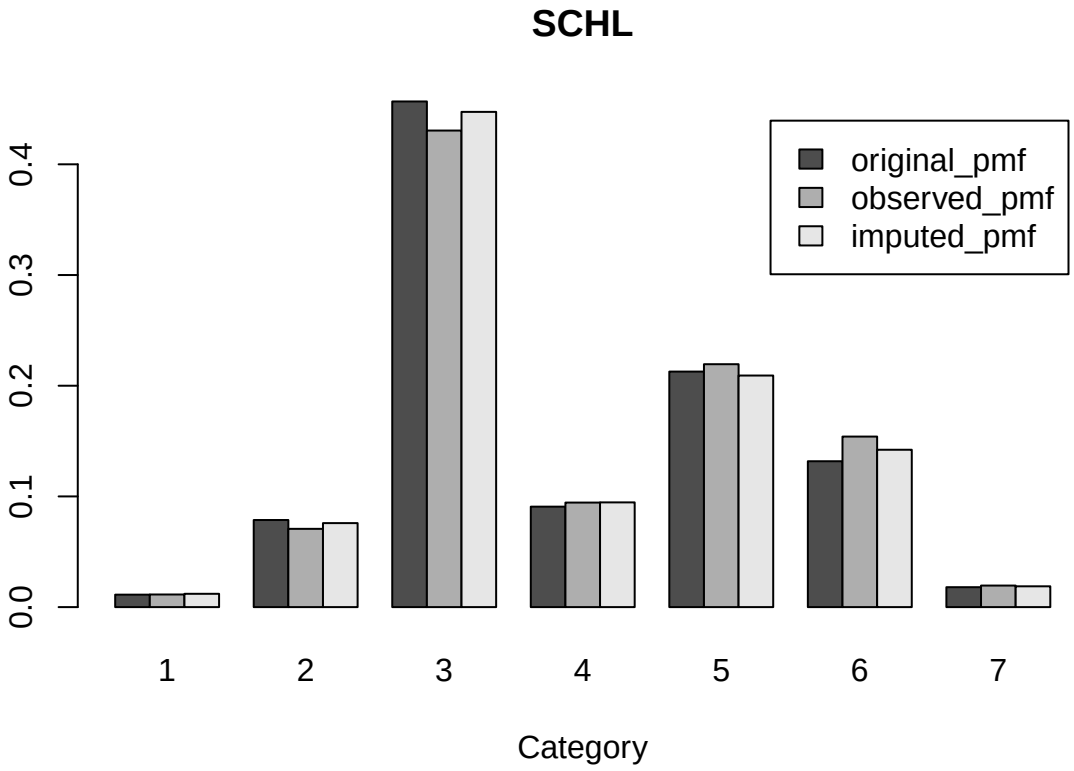

```
## MAE 2 way: 0.000869
## MAE 3 way: 0.000218
## MAE 4 way: 5.5e-05
```

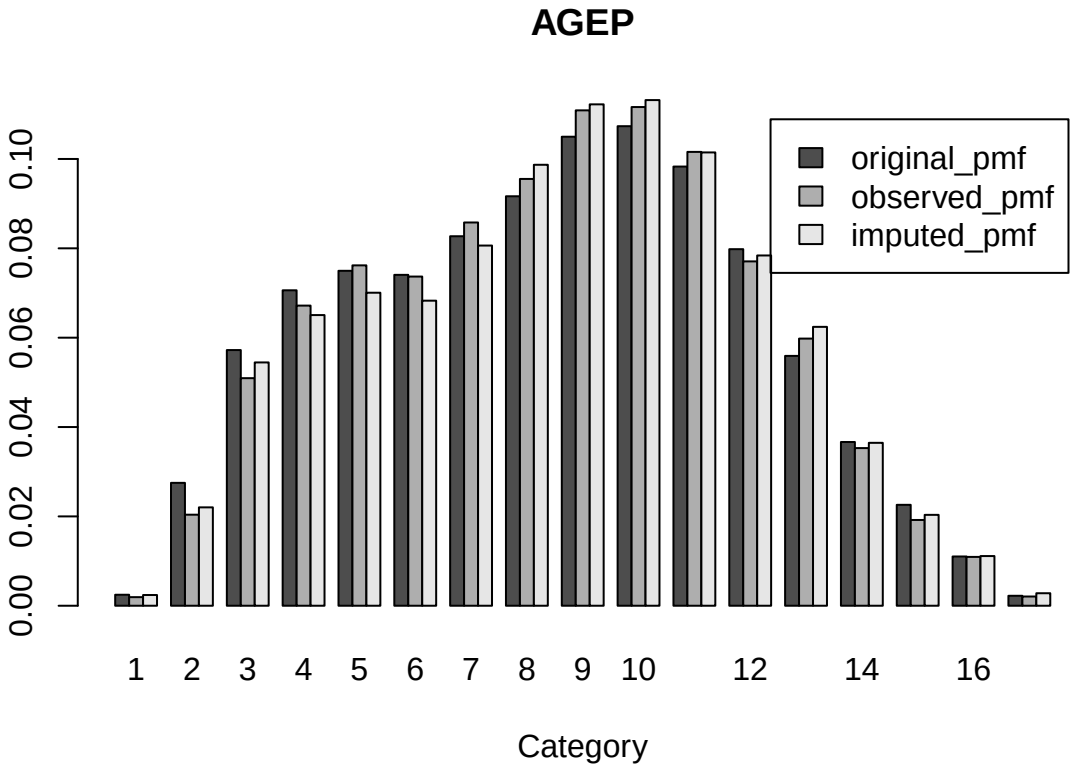

alpha value for the stick breaking process
alpha
2
3
4
5
6
0
500
1000
1500
2000
trials

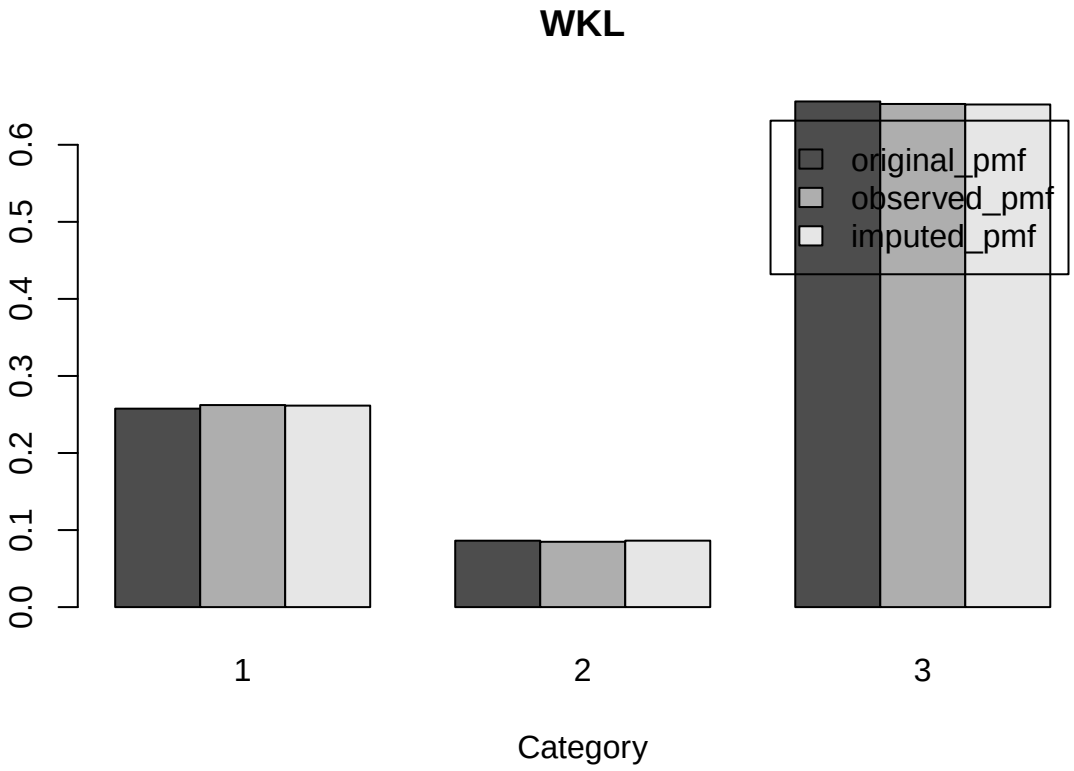

Autocorrelation
−1.0
−0.5
0.0
0.5
1.0
0
5
10
15
20
25
30
Lag

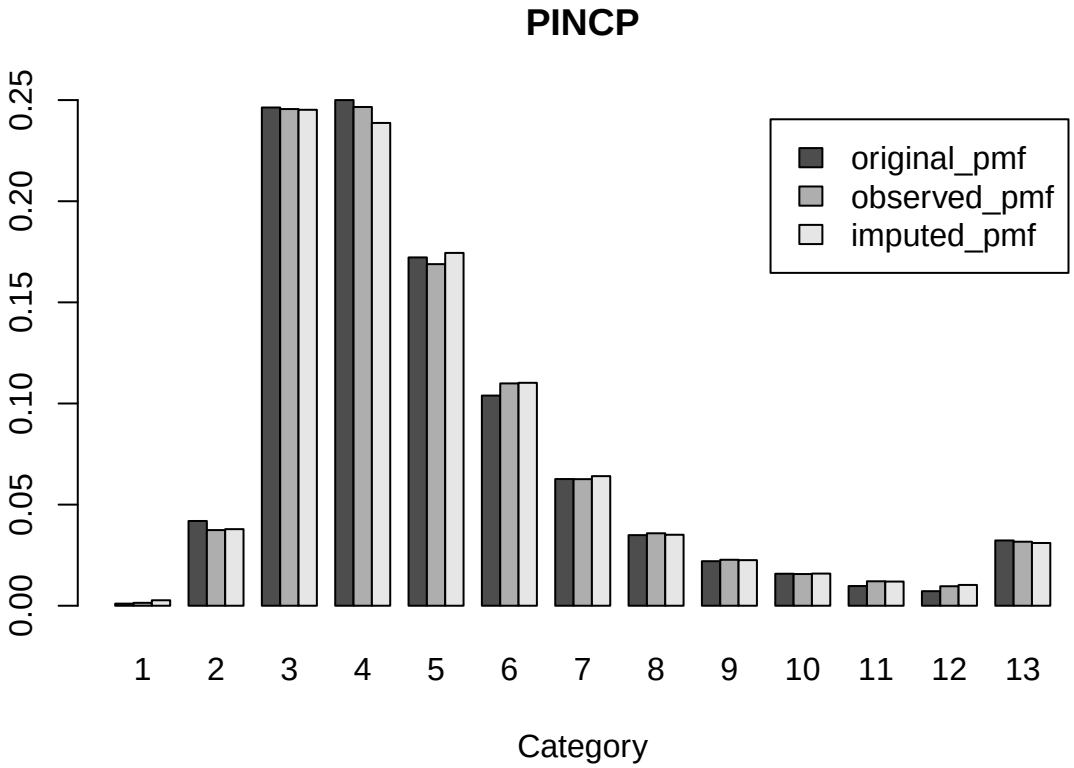

VEH
original_pmf
observed_pmf
imputed_pmf
0.00
0.10
0.20
0.30
1
2
3
4
5
6
7
Category

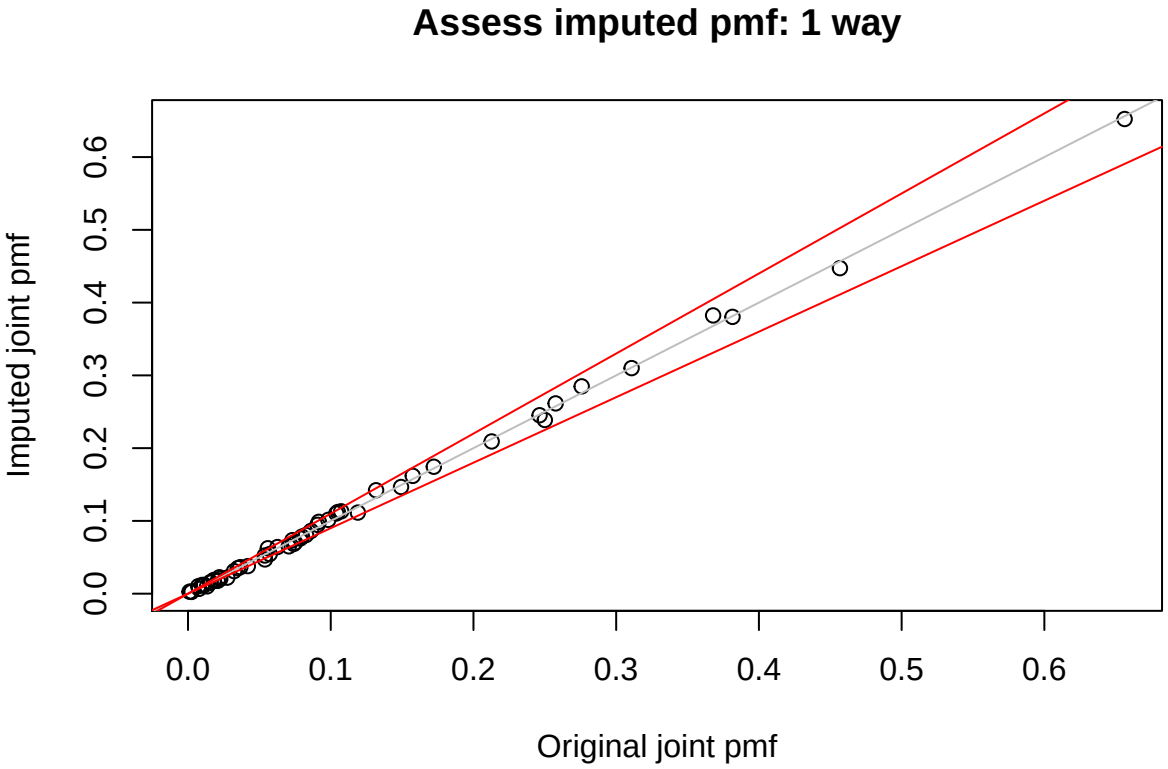

NP
original_pmf
observed_pmf
imputed_pmf
0.00
0.10
0.20
0.30
1
2
3
4
5
6
7
Category

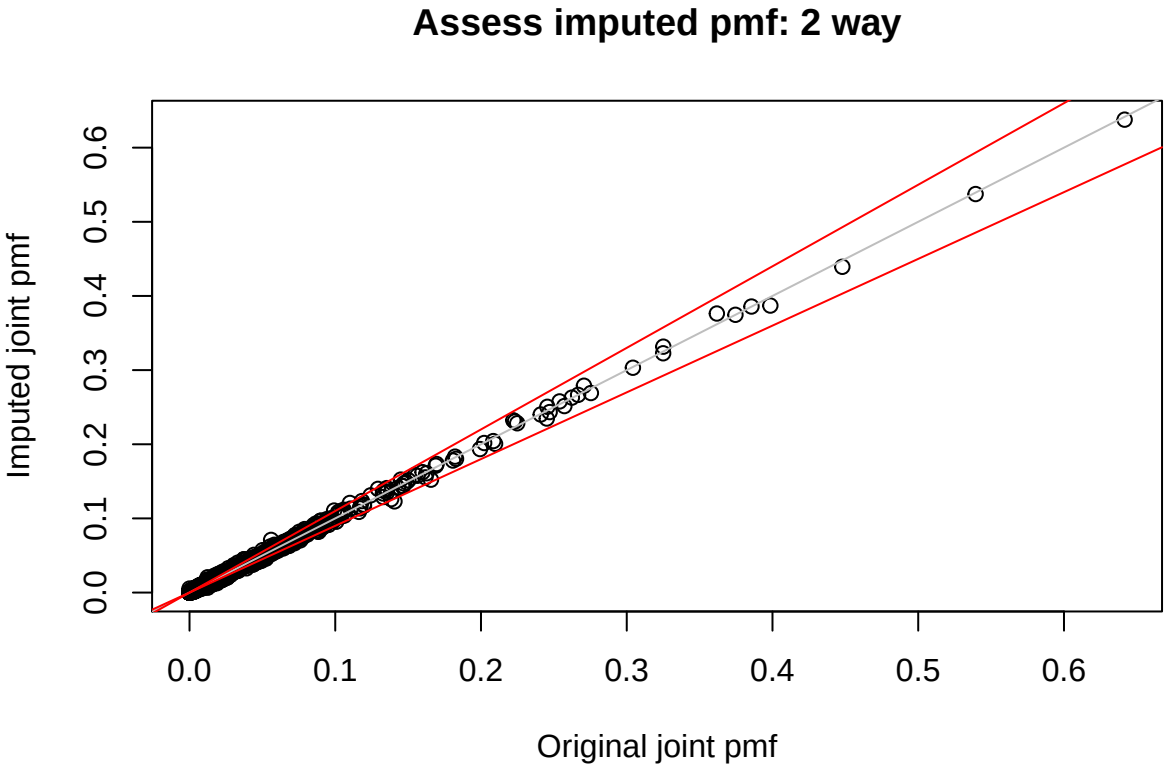

SCHL
original_pmf
observed_pmf
imputed_pmf
0.0
0.1
0.2
0.3
0.4
1
2
3
4
5
6
7
Category

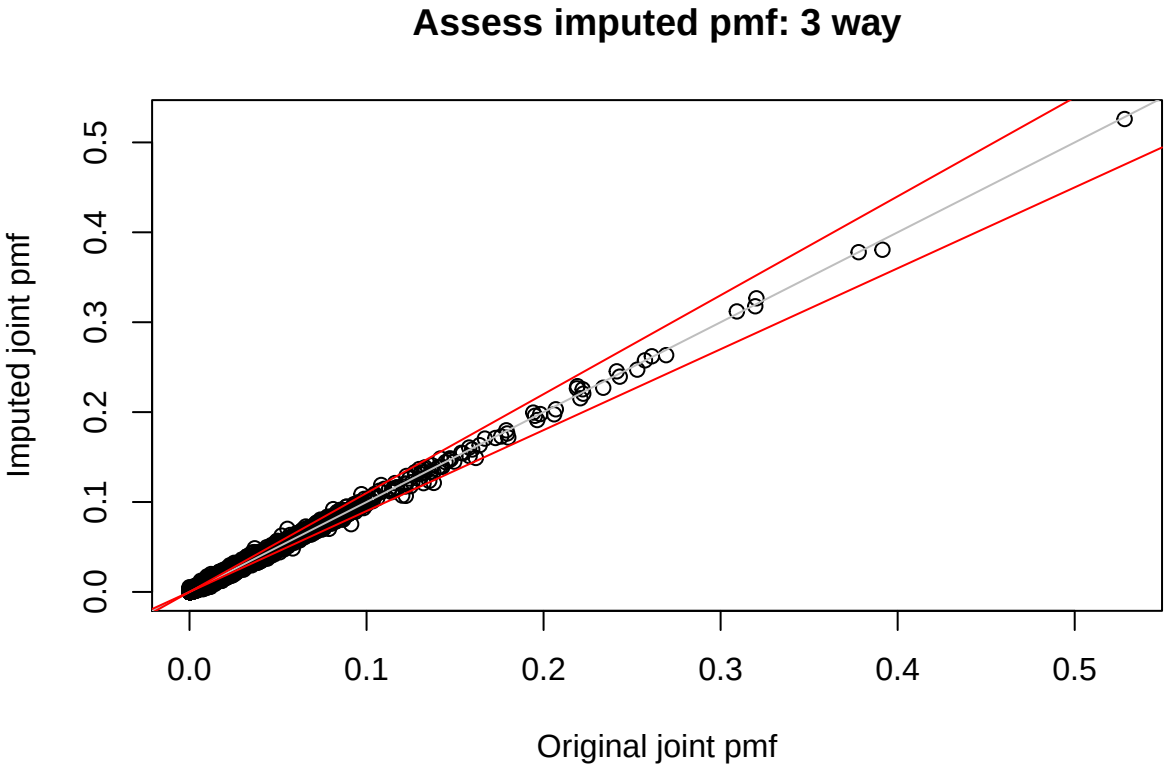

AGEP
original_pmf
observed_pmf
imputed_pmf
0.00
0.02
0.04
0.06
0.08
0.10
1
2
3
4
5
6
7
8
9
10
12
14
16
Category

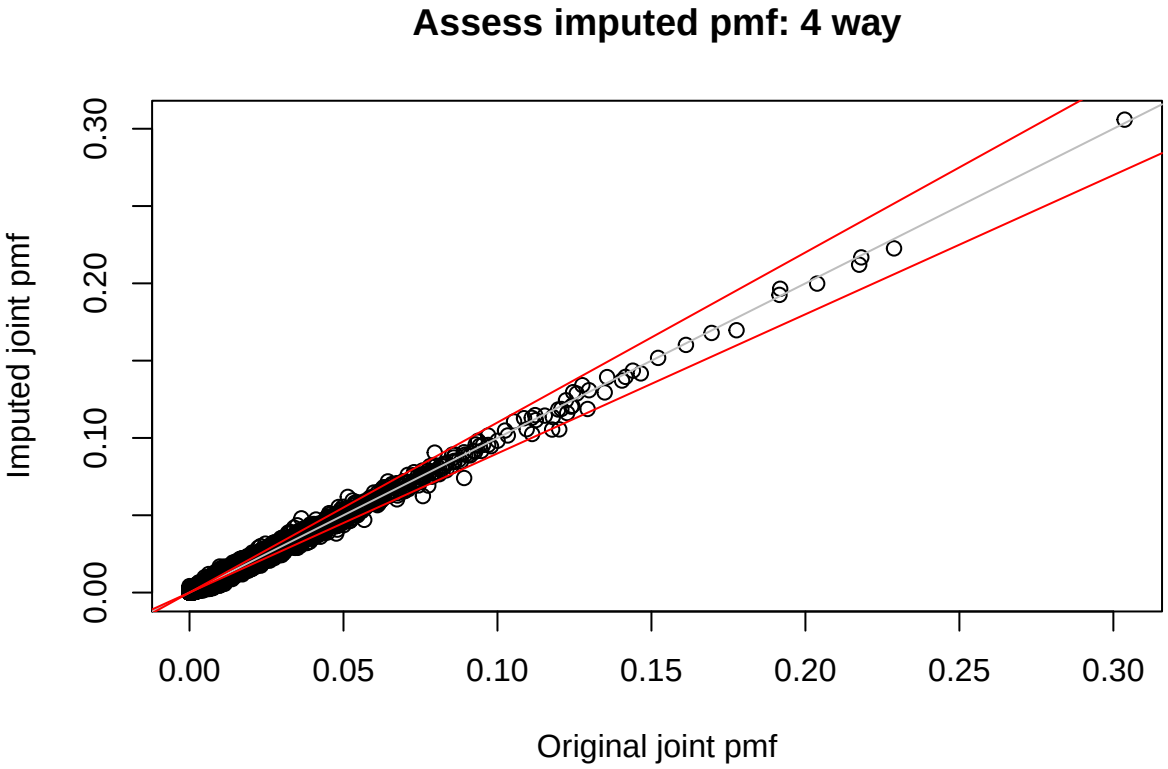

WKL
0.0
0.1
0.2
0.3
0.4
0.5
0.6
original_pmf
observed_pmf
imputed_pmf
1
2
3
Category


PINCP
0.00
0.05
0.10
0.15
0.20
0.25
original_pmf
observed_pmf
imputed_pmf
1
2
3
4
5
6
7
8
9
10
11
12
13
Category


Assess imputed pmf: 1 way
Imputed joint pmf
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Original joint pmf


Assess imputed pmf: 2 way
Imputed joint pmf
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Original joint pmf


Assess imputed pmf: 3 way
Imputed joint pmf
0.0
0.1
0.2
0.3
0.4
0.5
Original joint pmf


Assess imputed pmf: 4 way
Imputed joint pmf
0.00
0.10
0.20
0.30
0.05
0.15
0.25
Original joint pmf