TutorialImputingMissingData

Tutorial on Missing Data Imputation

We follow the tutorial on R packages for missing data imputation by MANISH SARASWAT which can be found here, but discuss the mi package first:

mi

mi is the package by Dr. Gelman, maintained bt Dr. Goodrich and uses predictive mean matching (pmm). predictive mean matching is explained well here, by Paul Allsion on Statistical Horizon with statistical background and pitfalls, referencing also (Morris 2014).

```
library(mi)
library(missForest)
```

```
data("iris")

# seed missing values ( 10% )
iris.mis <- prodNA(iris, noNA = 0.1)
summary(iris.mis)
```

```
##   Sepal.Length    Sepal.Width     Petal.Length    Petal.Width
##  Min.   :4.400   Min.   :2.000   Min.   :1.000   Min.   :0.100
##  1st Qu.:5.100   1st Qu.:2.800   1st Qu.:1.600   1st Qu.:0.300
##  Median :5.700   Median :3.000   Median :4.400   Median :1.300
##  Mean   :5.799   Mean   :3.062   Mean   :3.838   Mean   :1.196
##  3rd Qu.:6.400   3rd Qu.:3.350   3rd Qu.:5.100   3rd Qu.:1.800
##  Max.   :7.900   Max.   :4.400   Max.   :6.900   Max.   :2.500
##  NA's   :19      NA's   :11      NA's   :14      NA's   :15
##        Species
##  setosa    :44
##  versicolor:42
##  virginica :48
##  NA's      :16
##
##
##
```

```
# imputing missing value with mi
mi_data <- mi(iris.mis, seed = 335)
summary(mi_data)
```

```
## $Sepal.Length
## $Sepal.Length$is_missing
## missing
## FALSE  TRUE
##   131    19
##
## $Sepal.Length$imputed
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -1.6110 -0.2304  0.2033  0.1184  0.4818  1.2290
```

```
##
## $Sepal.Length$observed
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## -0.87930 -0.43940 -0.06236  0.00000  0.37750  1.32000
##
##
## $Sepal.Width
## $Sepal.Width$is_missing
## missing
## FALSE  TRUE
##   139    11
##
## $Sepal.Width$imputed
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## -1.50400 -0.37170 -0.01112 -0.01717  0.33670  0.93960
##
## $Sepal.Width$observed
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## -1.23600 -0.30490 -0.07204  0.00000  0.39370  1.55800
##
##
## $Petal.Length
## $Petal.Length$is_missing
## missing
## FALSE  TRUE
##   136    14
##
## $Petal.Length$imputed
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -0.9199 -0.7391 -0.5747 -0.2510  0.3358  0.8095
##
## $Petal.Length$observed
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -0.8118 -0.6402  0.1607  0.0000  0.3609  0.8757
##
##
## $Petal.Width
## $Petal.Width$is_missing
## missing
## FALSE  TRUE
##   135    15
##
## $Petal.Width$imputed
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -0.8620 -0.5160  0.1088  0.0147  0.5229  0.8280
##
## $Petal.Width$observed
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## -0.73390 -0.60000  0.06943  0.00000  0.40420  0.87280
##
##
## $Species
## $Species$crosstab
##
```

```
##              observed imputed
##   setosa          176      37
##   versicolor      168      20
##   virginica       192       7
```

MICE Package

```r
library(missForest)
library(mice)
library(VIM)
```

```r
data <- iris
```

Generate Missing Data with missForest

Generate 10% missing values at Random using the missForest package

```r
iris.mis <- prodNA(iris, noNA = 0.1)
summary(iris.mis)
```

```
##   Sepal.Length    Sepal.Width     Petal.Length    Petal.Width   
##  Min.   :4.300   Min.   :2.000   Min.   :1.000   Min.   :0.100  
##  1st Qu.:5.100   1st Qu.:2.800   1st Qu.:1.600   1st Qu.:0.300  
##  Median :5.800   Median :3.000   Median :4.400   Median :1.300  
##  Mean   :5.859   Mean   :3.057   Mean   :3.794   Mean   :1.197  
##  3rd Qu.:6.400   3rd Qu.:3.300   3rd Qu.:5.100   3rd Qu.:1.800  
##  Max.   :7.700   Max.   :4.400   Max.   :6.900   Max.   :2.500  
##  NA's   :27      NA's   :14      NA's   :12      NA's   :8      
##        Species  
##  setosa    :44  
##  versicolor:49  
##  virginica :43  
##  NA's      :14  
##                 
##                 
## 
```

Remove categorical variables and focus on continuous variables

```r
iris.mis <- subset(iris.mis, select = -c(Species))
summary(iris.mis)
```

```
##   Sepal.Length    Sepal.Width     Petal.Length    Petal.Width   
##  Min.   :4.300   Min.   :2.000   Min.   :1.000   Min.   :0.100  
##  1st Qu.:5.100   1st Qu.:2.800   1st Qu.:1.600   1st Qu.:0.300  
##  Median :5.800   Median :3.000   Median :4.400   Median :1.300  
##  Mean   :5.859   Mean   :3.057   Mean   :3.794   Mean   :1.197  
##  3rd Qu.:6.400   3rd Qu.:3.300   3rd Qu.:5.100   3rd Qu.:1.800  
##  Max.   :7.700   Max.   :4.400   Max.   :6.900   Max.   :2.500  
##  NA's   :27      NA's   :14      NA's   :12      NA's   :8
```

Inspect Missing Pattern with MICE

```
md.pattern(iris.mis)
```

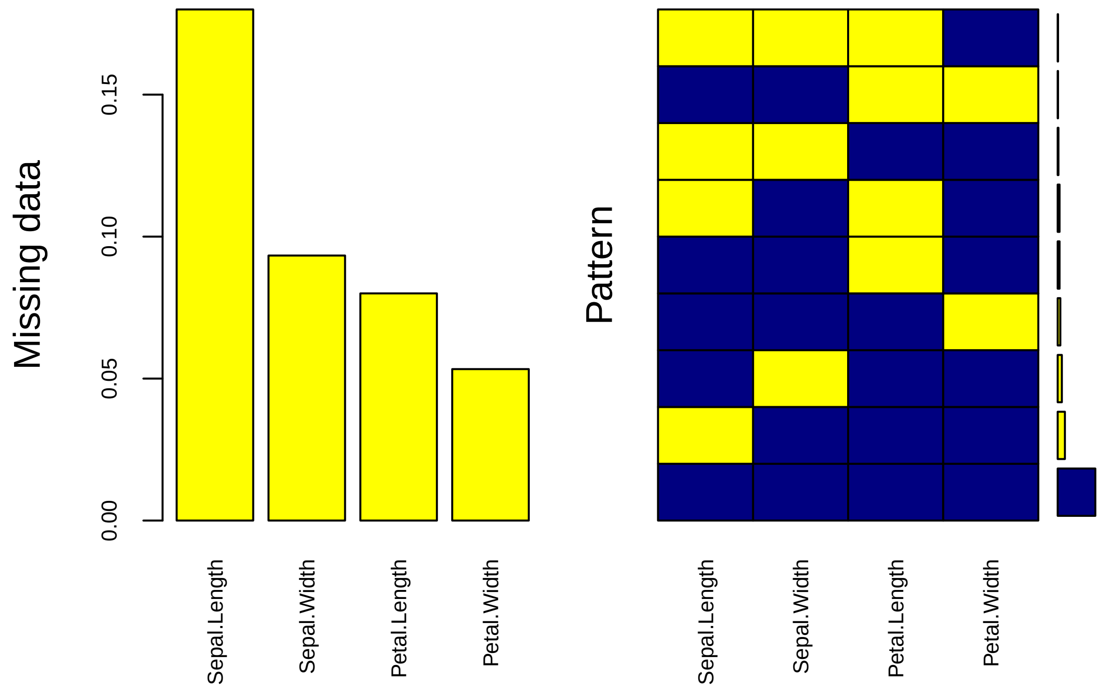
```
##    Petal.Width Petal.Length Sepal.Width Sepal.Length
## 99           1            1           1            1  0
## 19           1            1           1            0  1
## 11           1            1           0            1  1
##  5           1            0           1            1  1
##  7           0            1           1            1  1
##  2           1            1           0            0  2
##  5           1            0           1            0  2
##  1           0            0           1            1  2
##  1           1            0           0            0  3
##              8           12          14           27 61
```

```
md.pattern(iris.mis)
```


```
##    Petal.Width Petal.Length Sepal.Width Sepal.Length
## 99           1            1           1            1  0
## 19           1            1           1            0  1
## 11           1            1           0            1  1
##  5           1            0           1            1  1
##  7           0            1           1            1  1
##  2           1            1           0            0  2
##  5           1            0           1            0  2
##  1           0            0           1            1  2
##  1           1            0           0            0  3
##              8           12          14           27 61
```


Visual Inspection of Missing Patern with VIM

```
mice_plot <- aggr(iris.mis, col=c('navyblue','yellow'),
                    numbers=TRUE, sortVars=TRUE,
                    labels=names(iris.mis), cex.axis=.7,
                    gap=3, ylab=c("Missing data","Pattern"))
```




```
##
##  Variables sorted by number of missings:
##      Variable      Count
##  Sepal.Length 0.18000000
##   Sepal.Width 0.09333333
##  Petal.Length 0.08000000
##   Petal.Width 0.05333333
```

Imputing the missing data with MICE

```
imputed_Data <- mice(iris.mis, m=5, maxit = 50, method = 'pmm', seed = 500)
```

```
summary(imputed_Data)
```

```
## Multiply imputed data set
## Call:
## mice(data = iris.mis, m = 5, method = "pmm", maxit = 50, seed = 500)
## Number of multiple imputations:  5
## Missing cells per column:
## Sepal.Length  Sepal.Width Petal.Length  Petal.Width
##           27           14           12            8
## Imputation methods:
## Sepal.Length  Sepal.Width Petal.Length  Petal.Width
##        "pmm"        "pmm"        "pmm"        "pmm"
## VisitSequence:
## Sepal.Length  Sepal.Width Petal.Length  Petal.Width
##            1            2            3            4
## PredictorMatrix:
```

```
##              Sepal.Length Sepal.Width Petal.Length Petal.Width
## Sepal.Length            0           1            1           1
## Sepal.Width             1           0            1           1
## Petal.Length            1           1            0           1
## Petal.Width             1           1            1           0
## Random generator seed value:  500
```

```
#check imputed values
imputed_Data$imp$Sepal.Width
```

```
##       1   2   3   4   5
## 7   3.0 3.0 2.9 3.1 3.2
## 8   3.3 3.8 3.8 3.2 3.1
## 31  3.1 3.0 3.6 2.8 3.9
## 34  3.7 3.4 3.4 3.4 4.4
## 43  3.4 3.0 3.0 3.2 3.0
## 46  3.0 3.2 3.7 3.1 3.6
## 81  2.7 2.4 3.0 2.5 3.0
## 83  3.0 3.4 2.5 2.9 2.8
## 84  2.7 3.3 2.9 2.8 2.0
## 86  2.6 3.3 3.1 3.0 3.2
## 109 2.3 2.8 2.8 3.0 2.5
## 116 2.8 3.1 3.0 3.3 3.8
## 121 2.8 3.4 3.0 2.8 2.7
## 147 2.6 2.8 2.6 2.9 2.6
```

```
#get complete data ( 2nd out of 5)
completeData <- complete(imputed_Data,2)
```

Build a model using the imputed data

```
#build predictive model
#Caveat I deviate from the Tutorial by using imputed_Data instead of iris.mis, because it otherwise thr
fit <- with(data = imputed_Data, exp = lm(Sepal.Width ~ Sepal.Length + Petal.Width))

#combine results of all 5 models
combine <- pool(fit)
summary(combine)
```

```
##                     est         se         t        df     Pr(>|t|)
## (Intercept)   2.0545050 0.34950151  5.878387  80.46665 9.007068e-08
## Sepal.Length  0.2613735 0.07049808  3.707526  97.07369 3.484152e-04
## Petal.Width  -0.4377542 0.07219741 -6.063295 142.33757 1.138309e-08
##                   lo 95      hi 95 nmis        fmi     lambda
## (Intercept)   1.3590367  2.7499732   NA 0.15445611 0.13369807
## Sepal.Length  0.1214556  0.4012913   27 0.12031921 0.10238003
## Petal.Width  -0.5804720 -0.2950365    8 0.02642488 0.01284051
```

Build a model without imputation to compare

```
raw.data <- iris
poor_fit <- fit <- with(data = raw.data, exp = lm(Sepal.Width ~ Sepal.Length + Petal.Width))
summary(poor_fit)
```

```
##
## Call:
## lm(formula = Sepal.Width ~ Sepal.Length + Petal.Width)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.99563 -0.24690 -0.00503  0.23354  1.01131
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   1.92632    0.32094   6.002 1.45e-08 ***
## Sepal.Length  0.28929    0.06605   4.380 2.24e-05 ***
## Petal.Width  -0.46641    0.07175  -6.501 1.17e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3841 on 147 degrees of freedom
## Multiple R-squared:  0.234,  Adjusted R-squared:  0.2236
## F-statistic: 22.46 on 2 and 147 DF,  p-value: 3.091e-09
```

The point estimates of the poor_fit regression summary (without imputation) differ from the regression coefficients based on the imputed data; the latter also have wider confidence bands expressing the increased uncertainty due to imputation.

AMELIA package

```r
rm(list = setdiff(ls(), lsf.str())) # uses setdiff to identify all  objects that are NOT functions.
# and remoes them
# lsf.str() finds all functions

library(Amelia)
library(missForest)
```

Seed 10% missing values

```r
data("iris")
iris.mis <- prodNA(iris, noNA = 0.1)
summary(iris.mis)
```

```
##   Sepal.Length    Sepal.Width     Petal.Length    Petal.Width
##  Min.   :4.300   Min.   :2.200   Min.   :1.000   Min.   :0.100
##  1st Qu.:5.100   1st Qu.:2.800   1st Qu.:1.525   1st Qu.:0.300
##  Median :5.800   Median :3.000   Median :4.400   Median :1.300
##  Mean   :5.836   Mean   :3.078   Mean   :3.808   Mean   :1.216
##  3rd Qu.:6.400   3rd Qu.:3.400   3rd Qu.:5.100   3rd Qu.:1.800
##  Max.   :7.900   Max.   :4.400   Max.   :6.900   Max.   :2.500
##  NA's   :12      NA's   :15      NA's   :16      NA's   :16
##        Species
##  setosa    :45
##  versicolor:45
##  virginica :44
##  NA's      :16
```

```
##
##
##
```

Specify columns and run amelia

```r
amelia_fit <- amelia(iris.mis, m=5, parallel = "multicore", noms = "Species")
```

```
## -- Imputation 1 --
##
##   1  2  3  4  5  6
##
## -- Imputation 2 --
##
##   1  2  3  4  5  6
##
## -- Imputation 3 --
##
##   1  2  3  4  5  6
##
## -- Imputation 4 --
##
##   1  2  3  4  5  6
##
## -- Imputation 5 --
##
##   1  2  3  4  5  6  7  8
```

```r
# access imputed outputs
amelia_fit$imputations[[1]]
```

```
##     Sepal.Length Sepal.Width Petal.Length Petal.Width    Species
## 1       5.100000    3.330577     1.400000  0.39988457     setosa
## 2       4.900000    3.000000     1.400000  0.20000000     setosa
## 3       4.700000    3.200000     1.300000  0.20000000     setosa
## 4       4.600000    3.100000     1.500000  0.20000000     setosa
## 5       5.000000    3.600000     1.400000  0.20000000     setosa
## 6       5.400000    3.900000     1.700000  0.40000000     setosa
## 7       4.600000    3.400000     1.400000  0.30000000     setosa
## 8       5.000000    3.400000     1.500000  0.20000000     setosa
## 9       4.400000    2.900000     1.400000  0.23935405     setosa
## 10      4.900000    3.100000     1.500000  0.10000000     setosa
## 11      5.400000    3.700000     1.500000  0.20000000     setosa
## 12      4.800000    3.400000     1.177967  0.20000000     setosa
## 13      4.800000    3.000000     1.400000  0.10000000     setosa
## 14      4.300000    3.000000     1.292697  0.10000000     setosa
## 15      5.800000    4.000000     1.200000  0.20000000     setosa
## 16      5.700000    4.400000     1.500000  0.40000000     setosa
## 17      5.400000    3.900000     1.964659  0.42279760     setosa
## 18      5.100000    4.072374     1.400000  0.30000000     setosa
## 19      5.700000    3.800000     1.700000  0.30000000     setosa
## 20      5.100000    3.800000     1.264734  0.30000000     setosa
## 21      5.400000    3.400000     1.989505  0.20000000     setosa
## 22      5.100000    3.700000     1.500000  0.40000000     setosa
```

```
## 23        4.600000     3.600000     1.000000  0.20000000      setosa
## 24        5.100000     3.300000     1.700000  0.50000000      setosa
## 25        4.800000     3.400000     1.900000  0.20000000      setosa
## 26        5.000000     3.000000     1.600000  0.20000000      setosa
## 27        5.000000     3.400000     1.600000  0.40000000      setosa
## 28        5.200000     3.500000     1.500000  0.44604599      setosa
## 29        5.200000     3.400000     1.400000  0.20000000      setosa
## 30        4.700000     3.507064     1.086849 -0.03636943      setosa
## 31        4.980361     3.100000     1.600000  0.20000000  versicolor
## 32        5.400000     3.400000     1.500000  0.40000000      setosa
## 33        5.200000     4.100000     1.500000  0.10000000      setosa
## 34        5.500000     4.200000     1.400000  0.20000000      setosa
## 35        4.900000     3.219927     1.500000  0.20000000      setosa
## 36        5.007234     3.202944     1.200000  0.20000000      setosa
## 37        5.500000     3.500000     1.300000  0.20000000      setosa
## 38        4.900000     3.600000     1.400000  0.10000000      setosa
## 39        4.400000     3.000000     1.300000  0.20000000      setosa
## 40        5.100000     3.400000     1.500000  0.20000000      setosa
## 41        5.000000     3.500000     1.300000  0.30000000      setosa
## 42        4.500000     2.300000     1.300000  0.30000000      setosa
## 43        4.400000     3.200000     1.300000  0.60060704      setosa
## 44        5.000000     3.500000     1.600000  0.05965278      setosa
## 45        5.100000     3.800000     1.615997  0.40000000   virginica
## 46        4.800000     3.000000     1.400000  0.30000000      setosa
## 47        5.004813     3.800000     1.600000  0.25853418      setosa
## 48        4.600000     3.200000     1.400000  0.20000000      setosa
## 49        5.300000     3.700000     1.500000  0.20000000      setosa
## 50        5.000000     3.300000     1.400000  0.20000000      setosa
## 51        7.000000     3.200000     4.700000  1.40000000  versicolor
## 52        6.400000     3.200000     4.500000  1.50000000  versicolor
## 53        6.900000     3.100000     4.900000  1.50000000  versicolor
## 54        5.500000     2.300000     4.000000  1.30000000  versicolor
## 55        6.500000     2.800000     4.600000  1.50000000  versicolor
## 56        5.700000     2.800000     4.081530  1.22805684  versicolor
## 57        6.300000     3.300000     4.700000  1.60000000  versicolor
## 58        4.900000     2.400000     3.300000  1.00000000  versicolor
## 59        6.600000     2.900000     4.728998  1.30000000  versicolor
## 60        5.200000     2.599399     3.900000  1.40000000  versicolor
## 61        5.000000     2.228232     3.500000  1.00000000  versicolor
## 62        5.900000     3.000000     4.200000  1.50000000  versicolor
## 63        6.000000     2.200000     3.993515  1.00000000  versicolor
## 64        6.100000     2.900000     4.700000  1.40000000  versicolor
## 65        5.373604     2.900000     3.600000  1.30000000  versicolor
## 66        6.700000     3.100000     4.400000  1.40000000  versicolor
## 67        6.108290     3.000000     4.500000  1.50000000  versicolor
## 68        5.800000     2.700000     4.100000  1.00000000  versicolor
## 69        6.200000     2.200000     4.500000  1.50000000  versicolor
## 70        5.600000     2.500000     3.900000  1.10000000   virginica
## 71        5.900000     3.200000     4.800000  1.80000000  versicolor
## 72        6.100000     2.800000     4.000000  1.30000000  versicolor
## 73        6.300000     3.154109     4.900000  1.50000000  versicolor
## 74        6.100000     2.800000     4.700000  1.20000000  versicolor
## 75        6.400000     2.900000     4.300000  1.30000000  versicolor
## 76        6.600000     3.000000     4.400000  1.40000000  versicolor
```

```
## 77      6.800000   2.800000    4.800000  1.40000000 versicolor
## 78      6.700000   3.000000    5.000000  1.70000000 versicolor
## 79      6.000000   2.900000    4.500000  1.50000000 versicolor
## 80      5.113774   2.600000    3.500000  1.32383482 versicolor
## 81      5.500000   2.400000    3.800000  1.10000000 versicolor
## 82      4.847074   2.698750    3.700000  1.00000000 versicolor
## 83      5.800000   2.700000    3.900000  1.20000000 versicolor
## 84      6.000000   2.584889    5.100000  1.60000000 versicolor
## 85      5.400000   3.000000    4.500000  1.50000000 versicolor
## 86      6.000000   3.400000    4.500000  1.60000000 versicolor
## 87      6.700000   3.100000    4.700000  1.50000000 versicolor
## 88      6.300000   2.300000    4.400000  1.30000000 versicolor
## 89      5.600000   3.000000    4.100000  1.30000000 versicolor
## 90      5.500000   2.500000    4.044402  1.30000000 versicolor
## 91      5.500000   2.566176    4.400000  1.20000000 versicolor
## 92      6.100000   3.000000    4.600000  1.40000000 versicolor
## 93      5.800000   2.600000    3.939241  1.20000000 versicolor
## 94      5.000000   2.300000    3.300000  1.00000000 versicolor
## 95      5.600000   2.700000    4.200000  1.30000000 versicolor
## 96      5.700000   3.000000    4.200000  1.20000000 versicolor
## 97      5.700000   2.900000    4.238714  1.30000000 versicolor
## 98      6.200000   2.900000    4.300000  1.30000000 versicolor
## 99      5.100000   2.500000    3.000000  1.10000000 versicolor
## 100     5.700000   2.800000    4.100000  1.30000000 versicolor
## 101     6.300000   3.300000    6.000000  2.50000000  virginica
## 102     5.800000   2.700000    5.100000  1.90000000  virginica
## 103     7.100000   3.000000    5.900000  2.10000000  virginica
## 104     6.300000   2.900000    5.600000  1.80000000  virginica
## 105     6.500000   3.000000    5.800000  2.20000000  virginica
## 106     7.600000   3.000000    6.600000  2.10000000  virginica
## 107     4.900000   2.500000    4.500000  1.70000000  virginica
## 108     7.300000   2.750850    6.300000  1.80000000  virginica
## 109     6.700000   2.500000    5.800000  1.80000000  virginica
## 110     7.200000   3.600000    6.100000  2.50000000  virginica
## 111     6.500000   3.200000    5.100000  2.00000000  virginica
## 112     6.022868   2.700000    5.300000  1.76363897  virginica
## 113     6.800000   3.000000    5.500000  2.10000000  virginica
## 114     5.700000   2.500000    5.000000  2.00000000  virginica
## 115     5.800000   2.800000    5.100000  2.40000000  virginica
## 116     6.400000   3.200000    5.300000  2.30000000  virginica
## 117     6.500000   3.000000    5.500000  1.80000000  virginica
## 118     7.700000   3.800000    6.700000  2.20000000  virginica
## 119     7.700000   2.600000    6.900000  2.30000000  virginica
## 120     6.000000   2.200000    5.000000  1.50000000  virginica
## 121     6.900000   3.200000    5.700000  2.30000000  virginica
## 122     5.600000   2.800000    4.900000  2.00000000  virginica
## 123     7.700000   3.125382    6.700000  2.00000000  virginica
## 124     6.300000   2.700000    4.900000  1.80000000  virginica
## 125     6.700000   3.300000    5.700000  2.08762104  virginica
## 126     7.396717   2.859290    6.000000  1.80000000  virginica
## 127     6.200000   2.800000    4.800000  1.80000000  virginica
## 128     6.100000   3.000000    4.900000  1.80000000  virginica
## 129     6.880215   3.041143    5.814224  2.10000000  virginica
## 130     7.070717   3.000000    5.800000  1.60000000  virginica
```

```
## 131     7.400000    2.800000     6.346632  1.90000000  virginica
## 132     7.900000    3.800000     6.400000  2.00000000  virginica
## 133     6.400000    2.800000     5.600000  2.20000000  virginica
## 134     6.300000    2.800000     5.100000  1.50000000  virginica
## 135     6.100000    2.600000     5.600000  1.40000000  virginica
## 136     7.700000    3.000000     6.100000  1.93107089  virginica
## 137     6.300000    3.400000     5.600000  2.40000000  virginica
## 138     6.400000    3.100000     5.500000  1.99954423  virginica
## 139     6.000000    3.000000     4.800000  1.80000000  virginica
## 140     6.900000    3.100000     5.400000  2.08780234  virginica
## 141     6.700000    3.100000     5.600000  2.40000000 versicolor
## 142     6.900000    3.100000     5.100000  2.30000000  virginica
## 143     5.800000    2.700000     5.100000  1.90000000  virginica
## 144     6.800000    3.200000     5.900000  2.30000000  virginica
## 145     6.700000    3.300000     5.898961  2.50000000  virginica
## 146     6.218693    3.000000     5.200000  2.04898523  virginica
## 147     6.300000    2.500000     5.000000  1.90000000  virginica
## 148     6.500000    3.000000     5.200000  2.00000000  virginica
## 149     6.200000    3.400000     5.400000  2.30000000  virginica
## 150     5.900000    3.000000     5.100000  1.80000000  virginica
```

```
# ...
```

missForest package

```
#missForest
library(missForest)

#load data
data("iris")

#seed 10% missing values
iris.mis <- prodNA(iris, noNA = 0.1)
summary(iris.mis)
```

```
##   Sepal.Length    Sepal.Width    Petal.Length    Petal.Width
##  Min.   :4.300   Min.   :2.00   Min.   :1.000   Min.   :0.100
##  1st Qu.:5.100   1st Qu.:2.80   1st Qu.:1.600   1st Qu.:0.300
##  Median :5.800   Median :3.00   Median :4.400   Median :1.300
##  Mean   :5.832   Mean   :3.07   Mean   :3.847   Mean   :1.179
##  3rd Qu.:6.400   3rd Qu.:3.40   3rd Qu.:5.100   3rd Qu.:1.800
##  Max.   :7.900   Max.   :4.40   Max.   :6.900   Max.   :2.500
##  NA's   :11      NA's   :18     NA's   :15      NA's   :16
##        Species
##  setosa    :44
##  versicolor:46
##  virginica :45
##  NA's      :15
##
##
##
```

Hmisc

another package discussed but which I did not explore so far.