House Rent Analysis

Data Preparation

I have introduced the dataset `munichrent03` which is integrated in the R package `LinRegInteractive`, available at README.md file. Therefore, I can simply load this dataset to begin the subsequent steps of the analysis.

```
library(LinRegInteractive)
data(munichrent03)
data <- munichrent03
```

I began by examining the variable types to understand the structure of the dataset.

```
> str(data)
'data.frame':   2053 obs. of  12 variables:
$ rent     : num  741 716 528 554 698 ...
$ rentsqm  : num  10.9 11.01 8.38 8.52 6.98 ...
$ area     : int  68 65 63 65 100 81 55 79 52 77 ...
$ rooms    : int  2 2 3 3 4 4 2 3 1 3 ...
$ yearc    : num  1918 1995 1918 1983 1995 ...
$ bathextra: Factor w/ 2 levels "no","yes": 1 1 1 2 2 1 2 1 1 1 ...
$ bathtile : Factor w/ 2 levels "yes","no": 1 1 1 1 1 1 1 1 1 1 ...
$ cheating : Factor w/ 2 levels "yes","no": 1 1 1 1 1 1 1 1 1 1 ...
$ district : Factor w/ 25 levels "All-Umenz","Alt-Le",..: 10 10 10 17 17 17 21 21 21 21 ...
$ location : Ord.factor w/ 3 levels "normal"<"good"<..: 2 2 2 1 2 1 1 1 1 1 ...
$ upkitchen: Factor w/ 2 levels "no","yes": 1 1 1 1 2 1 1 1 1 1 ...
$ wwater   : Factor w/ 2 levels "yes","no": 1 1 1 1 1 1 1 1 1 1 ...
> names(data)
'rent''rentsqm''area''rooms''yearc''bathextra''bathtile''cheating''district''location''upkitchen''wwater'
```

After that, I reviewed the distributions, value ranges, and identified any potential missing values.

```
> summary(data)
      rent            rentsqm            area           rooms
Min.   :  77.31   Min.   : 1.470   Min.   : 17.0   Min.   :1.000
1st Qu.: 389.95   1st Qu.: 6.800   1st Qu.: 53.0   1st Qu.:2.000
Median : 534.30   Median : 8.470   Median : 67.0   Median :3.000
Mean   : 570.09   Mean   : 8.394   Mean   : 69.6   Mean   :2.598
3rd Qu.: 700.48   3rd Qu.:10.090   3rd Qu.: 83.0   3rd Qu.:3.000
Max.   :1789.55   Max.   :20.090   Max.   :185.0   Max.   :6.000

yearc      bathextra  bathtile   cheating        district      location
Min.   :1918   no :1862   yes:1673   yes:1878   Neuh-Nymp: 177   normal:1205
1st Qu.:1948   yes: 191   no : 380   no : 175   Lud-Isar : 161   good  : 803
Median :1960                                    Au-Haid  : 139   top   :  45
Mean   :1958                                    SchwWest : 137
3rd Qu.:1973                                    Maxvor   : 132
Max.   :2001                                    Laim     : 117
(Other)  :1190
upkitchen  wwater
no :1903   yes:1981
yes: 150   no :  72
```

Note that the variables `rentsqm, rent` and `area` are related by the equation: `rent` = `rentsqm` × `area`. For example, at row 100, we have:

```
> round(data$rent[100]/data$area[100],2)  #compute rentsqm
11.3
> data$rentsqm[100]
11.3
```

Since `rentsqm` is a derived variable, I chose to exclude it and instead focus on total `rent`, which may better capture the underlying relationships with other features.

```
> data$rentsqm <- NULL
```

Exploratory Data Analysis

Subsequently, I conducted an Exploratory Data Analysis (EDA) to gain initial insights into the dataset. A few key findings from this phase include:

- The 7 districts with the largest number of houses

```
Neuh-Nymp  Lud-Isar   Au-Haid  SchwWest    Maxvor      Laim   Ram-Per
177        161        139       137        132         117       115
```

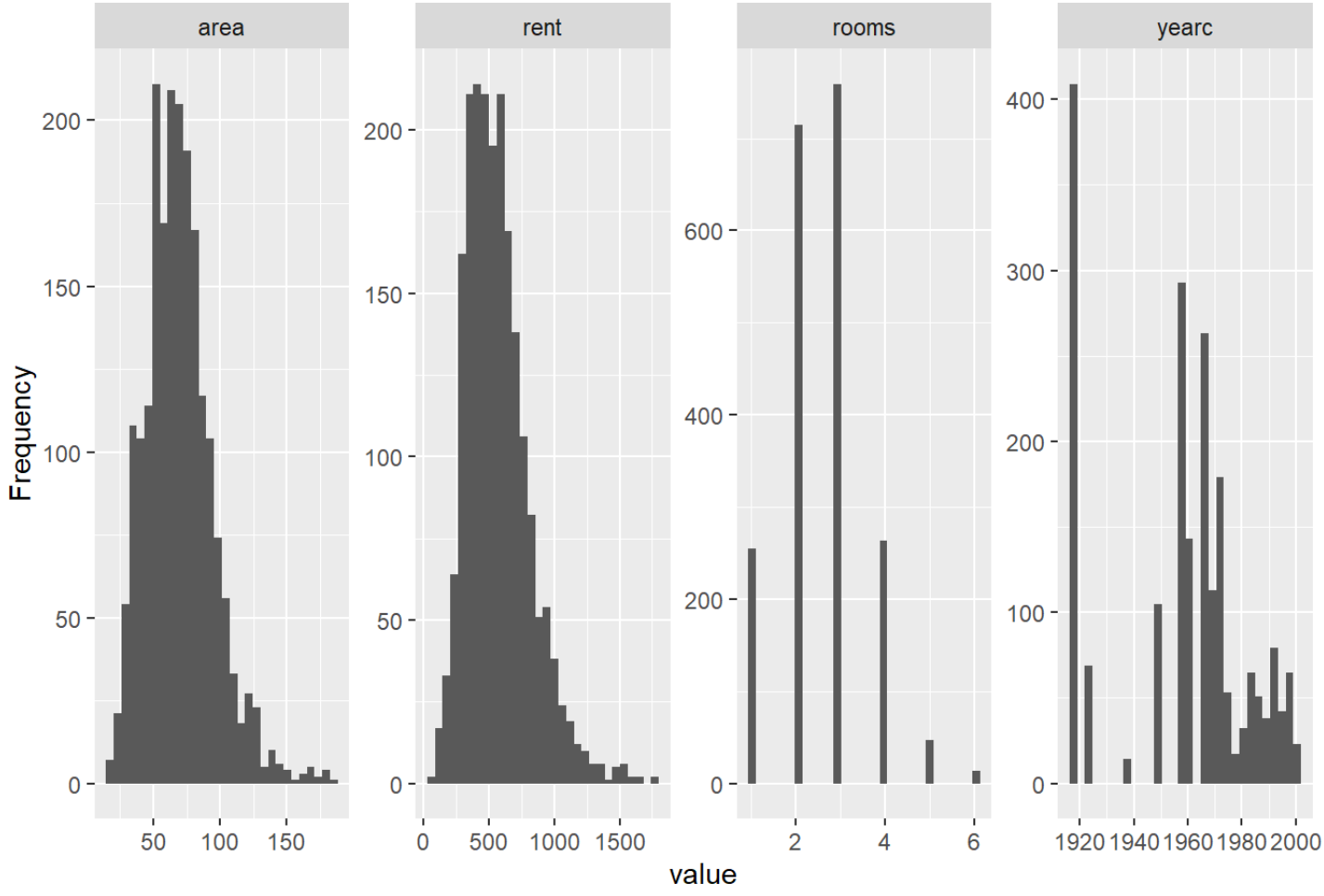
- The 7 districts with the highest number of houses where the location is classified as either "top" or "good":

```
Maxvor   Neuh-Nymp    Lud-Isar    SchwWest     Au-Haid Schwab-Frei    Trud-Rie
118         116          97          96          81          50          37
```

- The proportion of houses equipped with each feature:

```
    Feature Count Percent
1 bathextra   191     9.3
2  bathtile  1673    81.5
3  cheating  1878    91.5
4 upkitchen   150     7.3
5    wwater  1981    96.5
```

- The distribution of the numerical variables in the dataset



- The variable`yearc` represents discrete individual years, and the number of rooms(`room`)ranges only from 1 to 6.

```
> table(data$room) #Count for each number of room

1   2   3   4   5   6
255 715 759 263  47  14
> table(data$yearc) #Count for each year

1918   1924   1939   1948   1957 1957.5   1960   1966   1967   1968
409     69     14    105    225     68    143    228     35     23
1969   1970   1971   1972   1973   1974   1975   1976   1977   1978
44     46     35     89     55     30     16      7      6      5
1979   1980   1981   1982   1983   1984   1985   1986   1987   1988
6     17     15      8     40     17     20     11     20     13
1989   1990   1991   1992   1993   1994   1995   1996   1997   1998
15     10     14     24     41     13      9     20     12     14
1998.5   1999   2000   2001
32      7     18      5
```

Graphical Model Learning

Inference and Querying

$$\mathbb{P}(X < 1, Y > 1) = \int_{-\infty}^{1} \int_{1}^{+\infty} f(x, y) dx dy$$