In [1]:

```
options(repr.plot.width = 8, repr.plot.height = 6)
```

Работа с данными в R

Табличные данные

Создание таблиц

In [2]:

```
t <- data.frame(matrix(nrow = 3, ncol = 4, data = 1:12))
colnames(t) <- c('x', 'x2', 'y')
nrow(t)
ncol(t)
t
```

3

4

A data.frame: 3 × 4

x	x2	y	NA
<int>	<int>	<int>	<int>
1	4	7	10
2	5	8	11
3	6	9	12

Столбцы

In [3]:

```
t[[1]]  # первый столбец
t[1]
t[,1]
```

1 2 3

A data.frame: 3 × 1

x
<int>
1
2
3

1 2 3

Строки, элементы и подматрицы

In [4]:

```
t[1,]  # первая строка
t[2, 3]
t[c(1, 3), c(2, 4)]
```

A data.frame: 1 × 4

x	x2	y	NA
<int>	<int>	<int>	<int>
1	4	7	10

8

A data.frame: 2 × 2

	x2	NA
	<int>	<int>
1	4	10
3	6	12

Изменение значений

In [5]:

```r
t$x
t$x[2] <- 100
t
```

1 2 3

A data.frame: 3 × 4

x	x2	y	NA
<dbl>	<int>	<int>	<int>
1	4	7	10
100	5	8	11
3	6	9	12

Данные, удовлетвоящие условию

In [6]:

```r
t[(t$x2 > 4) & (t$y < 9), ]
```

A data.frame: 1 × 4

	x	x2	y	NA
	<dbl>	<int>	<int>	<int>
2	100	5	8	11

Упражнение. Создайте датасет из 1000 строк и 5 столбцов с помощью генерации случайных чисел от 0 до 100. Присвойте столбцам некоторые имена. Посчитайте количество строк, для которых сумма квадратов значений в первых двух строках не превосходит квадрата значения в четвертой строке, а значение в пятой строке меньше значения в третьей.

In [7]:

```r
t <- data.frame(matrix(runif(n = 1000 * 5, min = 0, max = 100), ncol = 5))
colnames(t) <- c('cat', 'dog', 'snake', 'wolf', 'tiger')
t[1:5,]
```

A data.frame: 5 × 5

cat	dog	snake	wolf	tiger
<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
52.675643	15.58754	89.14285	99.80145	37.232733
14.328834	17.75583	84.79620	38.19774	6.013008
1.232147	51.22265	98.96202	49.52443	66.994241
22.613924	19.12695	60.32961	83.87787	6.930470
82.703759	61.50999	25.23991	31.01396	76.672180

In [8]:

```
first_condition <- t$cat^2 + t$dog^2 <= t$wolf^2
second_condition <- t$tiger < t$snake
sum(first_condition & second_condition)
```

135

Статистические методы

- `summary` -- основные описательные статистики;
- `hist` -- гистограмма;
- `qqnorm` -- строит Q-Q plot, `qqline` -- проводит прямую по точкам на Q-Q plot;
- `ks.test` -- критерий Колмогорова;
- `shapiro.test` -- критерий Шапиро-Уилка;
- `density` -- ядерная оценка плотности;
- `ecdf` -- эмпирическая функция распределения;
- `lillie.test` -- критерий Лиллиефорса (критерий Колмогорова для проверки нормальности), пакет `nortest`;
- `ad.test` -- критерий Андерсона-Дарлинга;
- `cvm.test` -- критерий Крамера-фон Мизеса;
- `jb.norm.test` -- критерий Жарка-Бера для проверки нормальности, пакет `normtest`;
- `p.adjust` -- множественная проверка гипотез

In [9]:

```
?shapiro.test
```

In [10]:

```
?density
```

In [11]:

```
?p.adjust
```

[Полное описание пакета `stats` . (https://stat.ethz.ch/R-manual/R-devel/library/stats/html/00Index.html)](https://stat.ethz.ch/R-manual/R-devel/library/stats/html/00Index.html)

[Пакет `datasets` (https://stat.ethz.ch/R-manual/R-devel/library/datasets/html/00Index.html)](https://stat.ethz.ch/R-manual/R-devel/library/datasets/html/00Index.html) --- встроенные в R датасеты.

Wine Data Set

[http://archive.ics.uci.edu/ml/datasets/Wine (http://archive.ics.uci.edu/ml/datasets/Wine)](http://archive.ics.uci.edu/ml/datasets/Wine)

Читаем данные

In [12]:

```r
t <- read.table('wine.data', sep=',')
t[1:5,]
```

A data.frame: 5 × 14

V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V
<int>	<dbl>	<dbl>	<dbl>	<dbl>	<int>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<i
1	14.23	1.71	2.43	15.6	127	2.80	3.06	0.28	2.29	5.64	1.04	3.92	10
1	13.20	1.78	2.14	11.2	100	2.65	2.76	0.26	1.28	4.38	1.05	3.40	10
1	13.16	2.36	2.67	18.6	101	2.80	3.24	0.30	2.81	5.68	1.03	3.17	11
1	14.37	1.95	2.50	16.8	113	3.85	3.49	0.24	2.18	7.80	0.86	3.45	14
1	13.24	2.59	2.87	21.0	118	2.80	2.69	0.39	1.82	4.32	1.04	2.93	7

Присвоение названий столбцам

In [13]:

```r
colnames(t) <- c('Class', 'Alcohol', 'Malic_acid', 'Ash', 'Alcalinity_of_ash',
                 'Total_phenols', 'Flavanoids', 'Nonflavanoid_phenols', 'Proant
                 'Color_intensity', 'Hue', 'OD_OD_of_diluted_wines', 'Proline')
t[1:5,]
```

A data.frame: 5 × 14

Class	Alcohol	Malic_acid	Ash	Alcalinity_of_ash	Magnesium	Total_phenols	Flavanoids	No
<int>	<dbl>	<dbl>	<dbl>	<dbl>	<int>	<dbl>	<dbl>	
1	14.23	1.71	2.43	15.6	127	2.80	3.06	
1	13.20	1.78	2.14	11.2	100	2.65	2.76	
1	13.16	2.36	2.67	18.6	101	2.80	3.24	
1	14.37	1.95	2.50	16.8	113	3.85	3.49	
1	13.24	2.59	2.87	21.0	118	2.80	2.69	

Значения признака

In [14]:

```
t$Alcalinity_of_ash
```

15.6 11.2 18.6 16.8 21 15.2 14.6 17.6 14 16 18 16.8 16 11.4 12 17.2
20 20 16.5 15.2 16 18.6 16.6 17.8 20 25 16.1 17 19.4 16 22.5 19.1
17.2 19.5 19 20.5 15.5 18 15.5 13.2 16.2 18.8 15 17.5 17 18.9 16 16
18.8 17.4 12.4 17.2 14 17.1 16.4 20.5 16.3 16.8 16.7 10.6 16 16.8 18
19 19 18.1 15 19.6 17 16.8 20.4 25 24 30 21 16 16 18 14.8 23 19
18.8 24 22.5 18 18 22.8 26 21.6 23.6 18.5 22 20.7 18 18 19 21.5 16
18.5 18 17.5 18.5 21 19.5 20.5 22 19 22.5 19 20 19.5 21 20 21 22.5
21.5 20.8 22.5 16 19 20 28.5 26.5 21.5 21 21 21.5 28.5 24.5 22 18
20 24 21.5 17.5 18.5 21 25 19.5 24 21 20 23.5 20 18.5 21 20 21.5
21.5 21.5 24 22 25.5 18.5 20 22 19.5 27 25 22.5 21 20 22 18.5 22
22.5 23 19.5 24.5 25 19 19.5 20 20.5 23 20 20 24.5

Значения некоторых статистик для каждого признака

In [15]:

```
summary(t)
```

```
     Class          Alcohol        Malic_acid         Ash       
 Min.   :1.000   Min.   :11.03   Min.   :0.740   Min.   :1.360  
 1st Qu.:1.000   1st Qu.:12.36   1st Qu.:1.603   1st Qu.:2.210  
 Median :2.000   Median :13.05   Median :1.865   Median :2.360  
 Mean   :1.938   Mean   :13.00   Mean   :2.336   Mean   :2.367  
 3rd Qu.:3.000   3rd Qu.:13.68   3rd Qu.:3.083   3rd Qu.:2.558  
 Max.   :3.000   Max.   :14.83   Max.   :5.800   Max.   :3.230  
 Alcalinity_of_ash   Magnesium      Total_phenols     Flavanoids   
 Min.   :10.60     Min.   : 70.00   Min.   :0.980   Min.   :0.340  
 1st Qu.:17.20     1st Qu.: 88.00   1st Qu.:1.742   1st Qu.:1.205  
 Median :19.50     Median : 98.00   Median :2.355   Median :2.135  
 Mean   :19.49     Mean   : 99.74   Mean   :2.295   Mean   :2.029  
 3rd Qu.:21.50     3rd Qu.:107.00   3rd Qu.:2.800   3rd Qu.:2.875  
 Max.   :30.00     Max.   :162.00   Max.   :3.880   Max.   :5.080  
 Nonflavanoid_phenols Proanthocyanins Color_intensity       Hue        
 Min.   :0.1300       Min.   :0.410   Min.   : 1.280   Min.   :0.4800  
 1st Qu.:0.2700       1st Qu.:1.250   1st Qu.: 3.220   1st Qu.:0.7825  
 Median :0.3400       Median :1.555   Median : 4.690   Median :0.9650  
 Mean   :0.3619       Mean   :1.591   Mean   : 5.058   Mean   :0.9574  
 3rd Qu.:0.4375       3rd Qu.:1.950   3rd Qu.: 6.200   3rd Qu.:1.1200  
 Max.   :0.6600       Max.   :3.580   Max.   :13.000   Max.   :1.7100  
 OD_OD_of_diluted_wines    Proline      
 Min.   :1.270          Min.   : 278.0  
 1st Qu.:1.938          1st Qu.: 500.5  
 Median :2.780          Median : 673.5  
 Mean   :2.612          Mean   : 746.9  
 3rd Qu.:3.170          3rd Qu.: 985.0  
 Max.   :4.000          Max.   :1680.0  
```

Структура датасета

In [16]:

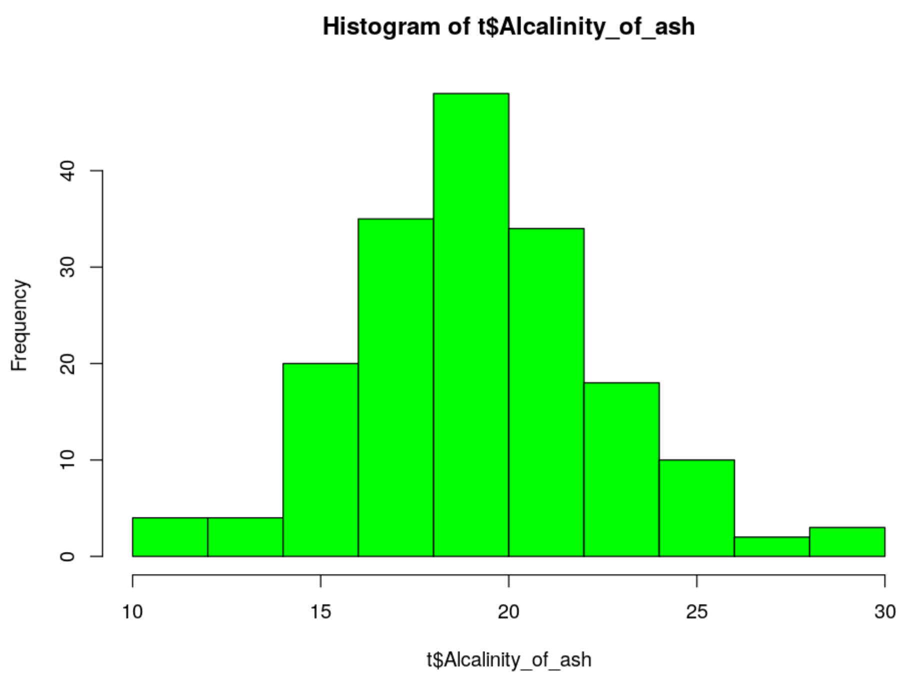
```
str(t)
```

```
'data.frame':	178 obs. of  14 variables:
 $ Class                 : int  1 1 1 1 1 1 1 1 1 1 ...
 $ Alcohol               : num  14.2 13.2 13.2 14.4 13.2 ...
 $ Malic_acid            : num  1.71 1.78 2.36 1.95 2.59 1.76 1.87 2.1
5 1.64 1.35 ...
 $ Ash                   : num  2.43 2.14 2.67 2.5 2.87 2.45 2.45 2.61
2.17 2.27 ...
 $ Alcalinity_of_ash     : num  15.6 11.2 18.6 16.8 21 15.2 14.6 17.6
14 16 ...
 $ Magnesium             : int  127 100 101 113 118 112 96 121 97 98
...
 $ Total_phenols         : num  2.8 2.65 2.8 3.85 2.8 3.27 2.5 2.6 2.8
2.98 ...
 $ Flavanoids            : num  3.06 2.76 3.24 3.49 2.69 3.39 2.52 2.5
1 2.98 3.15 ...
 $ Nonflavanoid_phenols  : num  0.28 0.26 0.3 0.24 0.39 0.34 0.3 0.31
0.29 0.22 ...
 $ Proanthocyanins       : num  2.29 1.28 2.81 2.18 1.82 1.97 1.98 1.2
5 1.98 1.85 ...
 $ Color_intensity       : num  5.64 4.38 5.68 7.8 4.32 6.75 5.25 5.05
5.2 7.22 ...
 $ Hue                   : num  1.04 1.05 1.03 0.86 1.04 1.05 1.02 1.0
6 1.08 1.01 ...
 $ OD_OD_of_diluted_wines: num  3.92 3.4 3.17 3.45 2.93 2.85 3.58 3.58
2.85 3.55 ...
 $ Proline               : int  1065 1050 1185 1480 735 1450 1290 1295
1045 1045 ...
```

Гистограмма

In [17]:

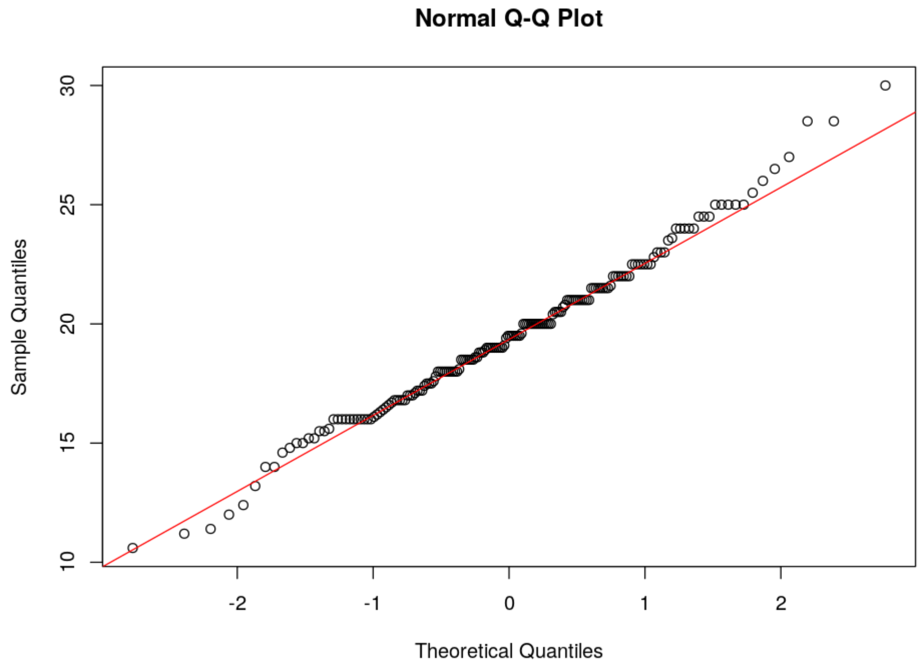
```
hist(t$Alcalinity_of_ash, col = 'green')
```



QQ plot

In [18]:

```
qqnorm(t$Alcalinity_of_ash)
qqline(t$Alcalinity_of_ash, col = 2)
```



Тест Колмогорова и тест Шапиро-Уилка

In [19]:

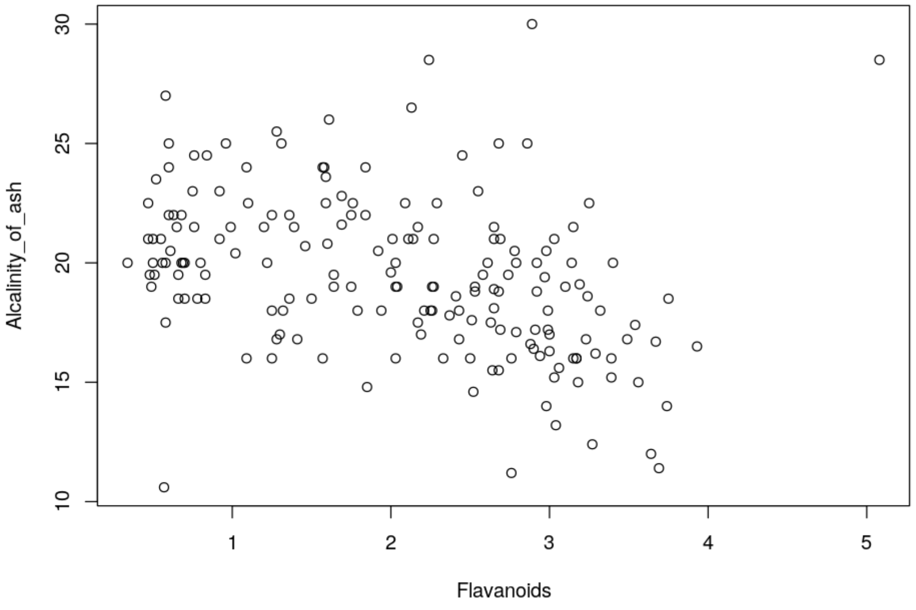
```
ks.test(t$Alcalinity_of_ash, pnorm, mean(t$Alcalinity_of_ash), sd(t$Alcalinity_
shapiro.test(t$Alcalinity_of_ash)
```

```
Warning message in ks.test(t$Alcalinity_of_ash, pnorm, mean(t$Alcalini
ty_of_ash), :
“ties should not be present for the Kolmogorov-Smirnov test”


        One-sample Kolmogorov-Smirnov test

data:  t$Alcalinity_of_ash
D = 0.063491, p-value = 0.4698
alternative hypothesis: two-sided


        Shapiro-Wilk normality test

data:  t$Alcalinity_of_ash
W = 0.99023, p-value = 0.2639
```

График зависимости Alcalinity_of_ash от Flavanoids

In [20]:

```
plot(Alcalinity_of_ash ~ Flavanoids, t)
```



Прикладная статистика и анализ данных, 2019

Никита Волков

[https://mipt-stats.gitlab.io/ (https://mipt-stats.gitlab.io/)](https://mipt-stats.gitlab.io/)