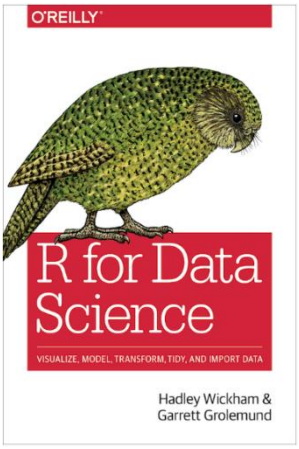
11. Týždeň

Data science a získavanie znalostí pomocou R



1) Jemný úvod do R

a) Čo je R?
b) Vektory a data frame-y
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2) Databázové operácie a *tidyverse*

3) Pivot tabuľka polikliniky – 2

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- group_by spolu s group_map

4) Balík rpivotTable

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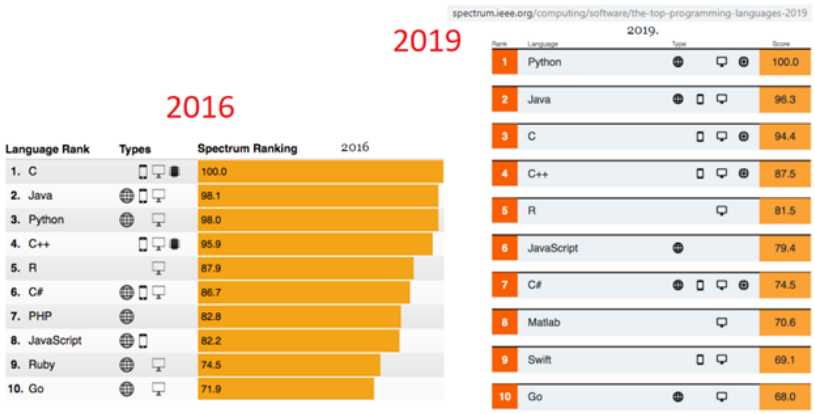
1) Jemný úvod do R

a) Čo je R?

```
* R: A Computer Language for Statistical Data Analysis
* Copyright (C) 1995, 1996 Robert Gentleman and Ross Ihaka
* Copyright (C) 1997--2019 The R Core Team
  https://svn.r-project.org/R/trunk/src/main/util.c
```



Populárnosť programovacích jazykov

R je interaktívny, vektorový jazyk s podporou funkcionálneho programovania. Jeho predchodcom bol jazyk S. Najprv sa inštaluje R a potom RStudio.

b) Vektory a data frame-y

Hodnoty do vektora k(c)ombinujeme pomocou funkcie c(...) [či lgl(...)]

```
z <- c(1, 2, NA, 4.1, 1/3); z;
```

```
## [1] 1.0000000 2.0000000        NA 4.1000000 0.3333333
```

```
length(z);  # 5
```

```
sort(z, decreasing = FALSE);
## [1] 0.3333333 1.0000000 2.0000000 4.1000000
```
Vektory môžeme vytvárať pomocou metódy sekvencie *sec*, *rep* alebo : operátora.
```
# from, to, by
seq(-2, 2, 0.4);   # <=> by=0.4
## [1] -2.0 -1.6 -1.2 -0.8 -0.4  0.0  0.4  0.8  1.2  1.6  2.0
# <=>
seq(-2, 2, len = 11);
- 2: 2/ 5           # -0.4 -0.2  0.0  0.2  0.4
-20:20/50          # -0.40 -0.38 -0.36 ... 0.38  0.40
1.1:5.6/5          # 0.22 0.42 0.62 0.82 1.02

rep(1:2, each=5);
## [1] 1 1 1 1 1 2 2 2 2 2

rep(1:5, each=2);
## [1] 1 1 2 2 3 3 4 4 5 5

rep(1:5, times=2);
## [1] 1 2 3 4 5 1 2 3 4 5
rep(1:5,each=2, len=5);
## [1] 1 1 2 2 3
```
Vektory z písmen dostaneme pomocou
```
letters;
## [1] "a" "b" "c" "d" "e" "f" "g" "h" "i" "j" "k" "l" "m" "n" "o" "p" "q"
## [18] "r" "s" "t" "u" "v" "w" "x" "y" "z"

LETTERS[1:3];
## [1] "A" "B" "C"
```
Vektory s pseudonáhodnými veličinami obdržíme vďaka *runif* či *rnorm*
```
# 2000 hodnot medzi 2 a 10.5:
set.seed(345);
x = runif(2000, 2, 10.5); x;
##   [1]  3.838157  4.335494  5.314363  7.573788  5.704864
##        ...
## [996]  8.606280  7.030828  7.435523  3.318158  4.356125

# 2000 hodnot s m=2 a s=10:
set.seed(347); x = rnorm(2000, 2, 10);
mean(x); var(x);
## [1] 1.966481
## [1] 99.97764
```
Z vektorov ľahko vytvárame matice pomocou *dim* alebo *cbind*, *rbind*.
```
A = 1:12;
dim(A) = c(3,4); A;
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    1    4    7   10
## [2,]    2    5    8   11
## [3,]    3    6    9   12
```

```
rbind(A[1:3], 4*A[1:3]);
```
```
##      [,1] [,2] [,3]
## [1,]    1    2    3
## [2,]    4    8   12
```

```
is.matrix(A);
```
```
## [1] TRUE
```

```
is.vector(A);
```
```
## [1] FALSE
```

Data frame – DB tabuľka

```
df1 <- data.frame(x = c(1, 2, 3), y = 7:5, z = letters[3:5]);  df1;
```
```
##   x y z
## 1 1 7 c
## 2 2 6 d
## 3 3 5 e
```
```
class(df1);  # data.frame
```

c) IO operácie

```
write.csv(A, file = "maz.csv", row.names = FALSE);
AA = read.csv("maz.csv"); AA;
```
```
##   V1 V2 V3 V4
## 1  1  4  7 10
## 2  2  5  8 11
## 3  3  6  9 12
```

Kde sa nachádza súbor *maz.csv* zistíme pomocou

```
getwd();
```
```
## [1] "C:/Users/Csaba/…/DBS1/___Cvic_R"
```

Pre data môžeme vytvoriť konkrétny adresár príkazom *setwd*("C:/Users/Data"). Ďalšie príkazy

```
dir(getwd());
R.home();                # domovsky adresar R
list.files(R.home());
```

Funkcia *read.table* slúži nielen na načítanie štrukturovaných údajov zo súboru, podobne ako aj *read.csv*, ale aj na vytvorenie *data.frame* z reťazca so štrukturou:

```
df1 <- read.table(text = "
a b x y
0 0 0 7
0 0 1 1
0 1 0 3
", header = TRUE);
df1;
```
```
##   a b x y
## 1 0 0 0 7
## 2 0 0 1 1
## 3 0 1 0 3
```

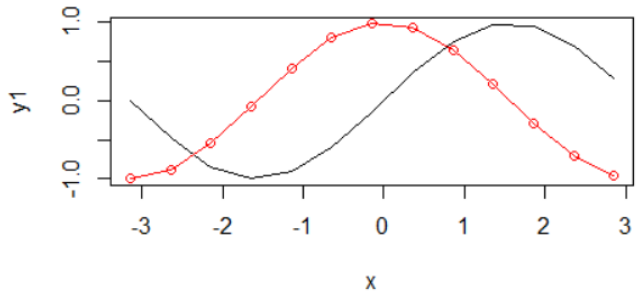
d) Balíky a knižnice

Systém R má viactisíc balíkov, knižníc (package, library). Každý balík treba raz nainštalovať a potom hocikedy načítať do pamäte. Napr.

```
if (!require(ggplot2, quietly = TRUE)) install.packages("ggplot2");
library(ggplot2);
```

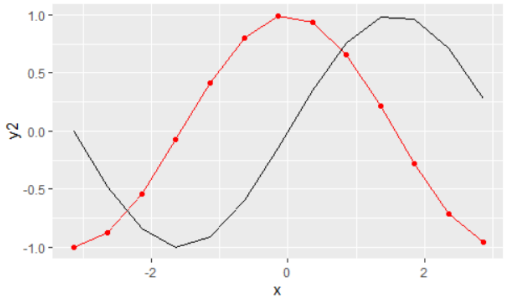
e) Grafika

```
x = seq(-pi,pi,.5);
y1=sin(x);
y2=cos(x);
plot(x,y1, type='l');
lines(x,y2, col='red');
points(x,y2, col='red');
```




```
# <=> Pomocou matplot s pouzitim                                    add=TRUE
matplot(x, y1, type='l');
matplot(x, y2, type='l', col='red', add=T);
points (x, y2, col='blue');
matplot(x, y2, type='p', pch = 1, col='red', add=T);
```

```
# <=> az na nadpis y-ej osi
A = cbind(y1, y2, y2);
matplot(x, A, type = c('l', 'l', 'p'), lty=1, pch = 1, col = c('black', 'red', 'red'));
```



Pomocou balíka *ggplot2* môžeme vytvárať krajšie grafy.

```
library(ggplot2);
xy12 = as.data.frame(cbind(x, y1,y2));
g = ggplot(data = xy12, aes(x = x, y = y2)); g;
g = g + geom_line(col = 'red'); g;
g = g + geom_point(col = 'red'); g;     # scatterplot
g = g + geom_line(aes(x = x, y = y1)); g;
```

Daný kód nie je efektívny, veď sa trikrát prekresluje obrázok. Jeho jedinou výhodou je, že môžeme postupne sledovať, čo sa urobí jednotlivými krokmi. Správny postup kódovania je zreťazenie/piping:

```
# <=> lepsie piping pomocou +
ggplot(xy12, aes(x = x, y = y2)) +
 geom_line(col = 'red') +
  geom_point(col = 'red') +
   geom_line(aes(x = x, y = y1));
```

2) Databázové operácie a *tidyverse*

Teraz ukážeme ako sa robí data science v R. Už vieme ako dostať dáta do R, resp. ako ich vytvárať a oboznámili sme sa aj s najužitočnejšími dátovými štruktúrami R. Tu uvidíme ako sa transformujú dáta v podobe data frame resp. tibble pomocou DB-ých operácií knižnice dplyr https://r4ds.had.co.nz/transform.html

SQL	-	**R, dplyr**
SELECT	-	*select()*
Vytvorenie nových premenných	-	*mutate()*
WHERE	-	*filter()*
GROUP BY a agregácia	-	*group_by a summarise()*
ORDER BY	-	*arrange()*
Pivot tabuľky	-	*pivot_wider a pivot_longer*

V súčastnosti sa vykonaním kódových riadkov pre *tidyverse* https://www.tidyverse.org/blog/2019/09/tidyr-1-0-0/

```
if (!require(tidyverse, quietly = TRUE)) install.packages("tidyverse");
library(tidyverse);
```

nainštalujú sa a pripoja nasledujúce balíky

tidyverse, ggplot2, tibble, tidyr, readr, purrr, dplyr, stringr, forcats, lubridate.

Medzi data frame a tibble sú tri rozdiely, pozri https://cran.r-project.org/web/packages/tibble/vignettes/tibble.html

Atomické typy sú integer, double, character, logical, complex, raw.

Ak máme veľa stĺpcov s podobným názvom, pre vertikálnu filtráciu *select* sú užitočné nasl. funkcie
- *starts_with*(), *ends_with*(), *contains*()
- *matches*()
- *num_range*()
- *one_of*()
- *everything*()
- *group_cols*()

Editovať: kvôli obrázku napravo nesmie byť prázdny znak vnútri " " na konci riadku!

```
dfW_ <- read.table(text ="
aa bb age vv
Pepsi likes 10 6
Pepsi likes 15 8
Pepsi gets 5 2
Pepsi non 10 4
Coca likes 5 10
Coca non 10 8
Coca likes 15 6
Coca gets 5 8
Coca gets 10 6
" , header = TRUE);
dfW <- as_tibble(dfW_); dfW;
m1 = mutate     ( dfW,  ha   = 2*vv,  haha = 4*vv );  m1;
m2 = transmute( dfW,  ha   = 2*vv,  haha = 4*vv );  m2;
```

dfW

	aa	bb	age	vv
1	Pepsi	likes	10	6
2	Pepsi	likes	15	8
3	Pepsi	gets	5	2
4	Pepsi	non	10	4
5	Coca	likes	5	10
6	Coca	non	10	8
7	Coca	likes	15	6
8	Coca	gets	5	8
9	Coca	gets	10	6

m1

	aa	bb	age	vv	ha	haha
1	Pepsi	likes	10	6	12	24
2	Pepsi	likes	15	8	16	32
3	Pepsi	gets	5	2	4	8
4	Pepsi	non	10	4	8	16
5	Coca	likes	5	10	20	40
6	Coca	non	10	8	16	32
7	Coca	likes	15	6	12	24
8	Coca	gets	5	8	16	32
9	Coca	gets	10	6	12	24

m2

	ha	haha
1	12	24
2	16	32
3	4	8
4	8	16
5	20	40
6	16	32
7	12	24
8	16	32
9	12	24

```
# <=>
select(m1, contains("ha"));
# <=>
select(m1, starts_with("ha"));
s1 = select( arrange(dfW, age, bb, aa), age, bb, aa); s1;
s2 = select(dfW, -c(age:vv));   s2;
s3 = select(dfW, age, everything());   s3;
```

s1

	age	bb	aa
1	5	gets	Coca
2	5	gets	Pepsi
3	5	likes	Coca
4	10	gets	Coca
5	10	likes	Pepsi
6	10	non	Coca
7	10	non	Pepsi
8	15	likes	Coca
9	15	likes	Pepsi

s2

	aa	bb
1	Pepsi	likes
2	Pepsi	likes
3	Pepsi	gets
4	Pepsi	non
5	Coca	likes
6	Coca	non
7	Coca	likes
8	Coca	gets
9	Coca	gets

s3

	age	aa	bb	vv
1	10	Pepsi	likes	6
2	15	Pepsi	likes	8
3	5	Pepsi	gets	2
4	10	Pepsi	non	4
5	5	Coca	likes	10
6	10	Coca	non	8
7	15	Coca	likes	6
8	5	Coca	gets	8
9	10	Coca	gets	6

```
if (!require(gridExtra, quietly = TRUE)) install.packages("gridExtra");
library(gridExtra);

grid.arrange(tableGrob(dfW), tableGrob(m1), tableGrob(m2), newpage = TRUE,
        tableGrob(s1), tableGrob(s2), tableGrob(s3), nrow = 2, ncol = 3);
```

Výpočtovo náročnú metódu *grid.arrange* z balíka *gridExtra* používame tu iba kvôli úspornému , prehľadnému zobrazeniu viac dát. štruktúr.

```
a1 = arrange(dfW, age, bb, aa);  a1;
a2 = select( a1, age, bb, aa);  a2;

f1 = filter(dfW, vv<7);  f1;
f2 = filter(dfW, vv<7 & age>=10);  f2;
```

a1

	aa	bb	age	vv
1	Cocao	gets	5	8
2	Pepsi	gets	5	2
3	Cocao	likes	5	10
4	Cocao	gets	10	6
5	Pepsi	likes	10	6
6	Cocao	non	10	8
7	Pepsi	non	10	4
8	Cocao	likes	15	6
9	Pepsi	likes	15	8

a2

	age	bb	aa
1	5	gets	Cocao
2	5	gets	Pepsi
3	5	likes	Cocao
4	10	gets	Cocao
5	10	likes	Pepsi
6	10	non	Cocao
7	10	non	Pepsi
8	15	likes	Cocao
9	15	likes	Pepsi

f1

	aa	bb	age	vv
1	Pepsi	likes	10	6
2	Pepsi	gets	5	2
3	Pepsi	non	10	4
4	Cocao	likes	15	6
5	Cocao	gets	10	6

f2

	aa	bb	age	vv
1	Pepsi	likes	10	6
2	Pepsi	gets	5	2
3	Pepsi	non	10	4
4	Cocao	likes	15	6
5	Cocao	gets	10	6

```
grid.arrange(tableGrob(a1), tableGrob(a2),newpage = TRUE,
        tableGrob(f1), tableGrob(f1), nrow = 2, ncol = 2);
```

group_by a summarise

Zoskupenie nemení vzhľad údajov!

```
# zoskupenie nemení vzhľad údajov
 gg1 <- group_by(dfW, age, aa);  gg1;
 gg2 <- group_by(dfW, age, bb);  gg2;
writeLines("Groups: age, bb, vv [6]\n !!! vs \nGroups: bb, vv [6]")
grid.arrange(tableGrob(gg1), tableGrob(gg2), ncol = 2);
```

gg1

	aa	bb	age	vv
1	Pepsi	likes	10	6
2	Pepsi	likes	15	8
3	Pepsi	gets	5	2
4	Pepsi	non	10	4
5	Cocao	likes	5	10
6	Cocao	non	10	8
7	Cocao	likes	15	6
8	Cocao	gets	5	8
9	Cocao	gets	10	6

gg2

	aa	bb	age	vv
1	Pepsi	likes	10	6
2	Pepsi	likes	15	8
3	Pepsi	gets	5	2
4	Pepsi	non	10	4
5	Cocao	likes	5	10
6	Cocao	non	10	8
7	Cocao	likes	15	6
8	Cocao	gets	5	8
9	Cocao	gets	10	6

```
 s1 = summarise(gg1); s1;  # kombinacie
 s2 = summarise(gg2); s2;
### !!!!! V summarise 1. arg. je group_by a dalsie su agr.funkcie!
 s3 = summarise(gg1, sum = sum(vv, na.rm = TRUE)); s3;
 s4 = summarise(gg2, pct = sum(!is.na(vv) )); s4;
 s5 = summarise(gg2, sum = sum(vv, na.rm = TRUE)); s5;
grid.arrange(tableGrob(gg2), tableGrob(s1), tableGrob(s2), newpage = TRUE,
        tableGrob(s3), tableGrob(s4), tableGrob(s5), nrow = 2, ncol = 3);
```

s1

	aa	bb	age	vv
1	Pepsi	likes	10	6
2	Pepsi	likes	15	8
3	Pepsi	gets	5	2
4	Pepsi	non	10	4
5	Cocao	likes	5	10
6	Cocao	non	10	8
7	Cocao	likes	15	6
8	Cocao	gets	5	8
9	Cocao	gets	10	6

s2

	age	aa
1	5	Cocao
2	5	Pepsi
3	10	Cocao
4	10	Pepsi
5	15	Cocao
6	15	Pepsi

s3

	age	bb
1	5	gets
2	5	likes
3	10	gets
4	10	likes
5	10	non
6	15	likes

s4

	age	aa	sum
1	5	Cocao	18
2	5	Pepsi	2
3	10	Cocao	14
4	10	Pepsi	10
5	15	Cocao	6
6	15	Pepsi	8

s5

	age	bb	pct
1	5	gets	2
2	5	likes	1
3	10	gets	1
4	10	likes	1
5	10	non	2
6	15	likes	2

s6

	age	bb	sum
1	5	gets	10
2	5	likes	10
3	10	gets	6
4	10	likes	6
5	10	non	12
6	15	likes	14

Inverzné operácie pivot_wider a pivot_longer

V pivot_wider **chýbajúce** stĺpce tvoria **prvé stĺpce** vo výsledku.

Kým

- *names_from* určuje stĺpce pomocou c( ), z diskrétnych hodnôt ktorých sa vytvárajú výstupné stĺpce,
- *values_from* určuje stĺpce, z ktorých sa výpočítavajú (agregačné) hodnoty pre bunky,
- *values_fn* () – agregačná funkcia:

```
* Use `values_fn = list(Obrat = list)`         to suppress this warning.
* Use `values_fn = list(Obrat = length)`       to identify where the duplicates arise
* Use `values_fn = list(Obrat = summary_fun)` to summarise duplicates
```

V pivot_longer

- cols - columns to pivot into longer format.
- names_to - the column to create from the data stored in the columns.
- values_to - the column to create from the data stored in cell values.

Data frame dfW obsahuje stĺpce aa, bb, age, vv, preto:

```
names(dfW);  ## "aa"  "bb"  "age" "vv"
```

```
pt1 = dfW %>%
        tidyr::pivot_wider(names_from = bb,          # aa je 1. stlpec
                           values_from = vv);
pt2 = dfW %>% pivot_wider(names_from = aa,           # bb je 1. stlpec
                           values_from = vv);
pt3 = dfW %>% pivot_wider(names_from = c(bb,aa),     # age je 1. stlpec
                           values_from = vv);
### <=>
pt4 = dfW %>% pivot_wider(names_from = c(aa,bb),
                           values_from = vv);
pt5 = dfW %>% pivot_wider(names_from = c(bb,age),    # aa je 1. stlpec
                           values_from = vv);
pt6 = dfW %>% pivot_wider(names_from = c(aa,age),    # bb je 1. stlpec
                           values_from = vv);
grid.arrange(arrangeGrob(tableGrob(pt1), tableGrob(pt2),ncol = 2),
    tableGrob(pt3), tableGrob(pt5), tableGrob(pt6), nrow = 4);
```

	aa	age	likes	gets	non
1	Pepsi	10	6	NA	4
2	Pepsi	15	8	NA	NA
3	Pepsi	5	NA	2	NA
4	Cocao	5	10	8	NA
5	Cocao	10	NA	6	8
6	Cocao	15	6	NA	NA

	bb	age	Pepsi	Cocao
1	likes	10	6	NA
2	likes	15	8	6
3	gets	5	2	8
4	non	10	4	8
5	likes	5	NA	10
6	gets	10	NA	6

	age	likes_Pepsi	gets_Pepsi	non_Pepsi	likes_Cocao	non_Cocao	gets_Cocao
1	10	6	NA	4	NA	8	6
2	15	8	NA	NA	6	NA	NA
3	5	NA	2	NA	10	NA	8

	aa	likes_10	likes_15	gets_5	non_10	likes_5	gets_10
1	Pepsi	6	8	2	4	NA	NA
2	Cocao	NA	6	8	8	10	6

	bb	Pepsi_10	Pepsi_15	Pepsi_5	Cocao_5	Cocao_10	Cocao_15
1	likes	6	8	NA	10	NA	6
2	gets	NA	NA	2	8	6	NA
3	non	4	NA	NA	NA	8	NA

```
L0 <- read.table(text = "
mesto kvart xx
A    Q2    4
C    Q1    3
D    Q3    2
A    Q1    5
B    Q2    7
", header = TRUE); print(L0);
L0 = as_tibble(L0); print(L0);
### Wider
LG = group_by(L0, mesto, kvart); #print(dLG);
LGW = pivot_wider(LG, names_from = kvart, values_from = xx); #print(dLGI)
### Longer
LGWI1 = pivot_longer(LGW, cols = starts_with("Q")); print(LGWI1);
LGWI2 = pivot_longer(LGW, cols = starts_with("Q"),values_drop_na = TRUE
                                , names_to = "KVART",values_to = "XX"  ); print(LGWI2);
###
### TEST setdiff – prázdna tabuľka
###
names(LGWI2) = names(L0);
jaj = setdiff(L0, LGWI2); print(jaj);

L0; LG; LGW; LGWI1; LGWI2;
grid.arrange(tableGrob(arrange(L0, mesto)),
        tableGrob(arrange(LGWI1, mesto)),
        tableGrob(arrange(LGWI2, mesto)), ncol = 3);
```

	mesto	kvart	xx
1	A	Q2	4
2	A	Q1	5
3	B	Q2	7
4	C	Q1	3
5	D	Q3	2

L0

	mesto	name	value
1	A	Q2	4
2	A	Q1	5
3	A	Q3	NA
4	B	Q2	7
5	B	Q1	NA
6	B	Q3	NA
7	C	Q2	NA
8	C	Q1	3
9	C	Q3	NA
10	D	Q2	NA
11	D	Q1	NA
12	D	Q3	2

LGVI1

	mesto	kvart	xx
1	A	Q2	4
2	A	Q1	5
3	B	Q2	7
4	C	Q1	3
5	D	Q3	2

LGWI1 = L0

3) Pivot tabuľka polikliniky – 2

Zistite počet pacientov u jednotlivých lekárov v jednotlivých mesiacoch!

Po ozrejmení práce s metódami *pivot_wider* a *pivot_longer* vrátime sa k pivotovaniu DB polikliniky a uvedieme dve ekvivalentné riešenia DF2 a DF3 (ekv. riešenie DF1 pomocou "Select … CASE …" sme vytvorili na predch. prednáške).

```
library(RODBC);
library(tidyverse);
# conn <- odbcDriverConnect(conSS);              # SQL Server  conSS - pozri predchád. prednášku
conn <- odbcConnect('mysql_poliklinika');        # MySQL
qq = "select krstne, spec, month(den) mes, poplatok
       from lekari L join navstevy N ON L.idL=N.idL;";
df2 <- sqlQuery(conn, qq); df2;
close(conn);

if (!require(data.table, quietly = TRUE)) install.packages("data.table");
library(data.table);
DF2 = reshape2::dcast(df2, mes ~ krstne,
        value.var = c("poplatok"), fun=length); DF2;
#        value.var = c("poplatok"), fun=sum)
```

```
df3 = df2 %>%
  #dplyr::filter(!is.na(result)) %>%
  dplyr::count(mes, krstne) %>%
    tidyr::pivot_wider(
      names_from = krstne
      ,values_from = n
      ,values_fill = list(n = 0) # un/comment
    # ,values_fn = list(y = sum)
    );
#df3[,order(colnames(df3),decreasing = FALSE)];
juj = c(1,1+order(colnames(df3)[2:length(colnames(df3))], decreasing = FALSE));
DF3 <- df3[,juj];
DF2; DF3; # DF1 - pozri poslednu prednasku;
grid.arrange(arrangeGrob(tableGrob(DF1), tableGrob(DF2),
             tableGrob(DF3),ncol = 3), nrow = 1)
```

```
# Sumarny poplatok:
df2 %>% select(mes,krstne,poplatok) %>%
        tidyr::pivot_wider(
          names_from = krstne
          ,values_from = poplatok
          ,values_fn = sum    # length
        ) %>% arrange(.,mes)
```

	mes	Imro	Klara	Oto	Zoli	Zuzka
1	5	0	2	0	1	0
2	6	0	0	3	0	1
3	7	0	2	1	0	0
4	8	0	0	0	2	1
5	9	1	0	3	0	0
6	10	1	0	1	0	1
7	11	1	0	1	0	0

	mes	Imro	Klara	Oto	Zoli	Zuzka
1	5	0	2	0	1	0
2	6	0	0	3	0	1
3	7	0	2	1	0	0
4	8	0	0	0	2	1
5	9	1	0	3	0	0
6	10	1	0	1	0	1
7	11	1	0	1	0	0

	mes	Imro	Klara	Oto	Zoli	Zuzka
1	5	0	2	0	1	0
2	6	0	0	3	0	1
3	7	0	2	1	0	0
4	8	0	0	0	2	1
5	9	1	0	3	0	0
6	10	1	0	1	0	1
7	11	1	0	1	0	0

Pred záverom o možnostiach R v oblasti pivotovania ilustrujeme ešte **množinové** a **join** operácie v jazyku R, a **group_by** spolu s **group_map**.

- **Množinové operácie, join**

union, intersect, setdiff

```
tb3 <- tibble(x = 1:2, y = c(1L, 1L)); tb3;
tb4 <- tibble(x = 1:2, y = 1:2);         tb4;
se2 = union(tb3, tb4);
se1 = intersect(tb3, tb4);
se3 = setdiff(tb3, tb4);
grid.arrange(arrangeGrob(tableGrob(tb3),
             tableGrob(tb4),ncol = 2),
        arrangeGrob(tableGrob(se1), tableGrob(se2),
             tableGrob(se3),ncol=3), nrow = 2);
```

	x	y
1	1	1
2	2	1

	x	y
1	1	1
2	2	2

	x	y
1	1	1

	x	y
1	1	1
2	2	1
3	2	2

	x	y
1	2	1

JOIN

inner_join vs left_join [semi_join, nest_join, anti_join]

```
tb1 <- tibble(x = c(1, 2, 3), y = 2:0);          tb1;
tb2 <- tibble(x = c(1, 3), a = 10, b = "a");  tb2;
```

```
# Vsetko z tb1:
j1 = tb1 %>% left_join(tb2); j1;

# Iba zhodne x, y:
j2 = tb1 %>% inner_join(tb2); j2;
j2 %>% knitr::kable();

j3 = setdiff(j1, j2);
dim(j3);
grid.arrange(arrangeGrob(tableGrob(tb1),
                         tableGrob(tb2),ncol = 2),
             arrangeGrob(tableGrob(j1), tableGrob(j2),
                         tableGrob(j3),ncol=3), nrow = 2);
```

	x	y
1	1	2
2	2	1
3	3	0

	x	a	b
1	1	10	a
2	3	10	a

	x	y	a	b
1	1	2	10	a
2	2	1	NA	NA
3	3	0	10	a

	x	y	a	b
1	1	2	10	a
2	3	0	10	a

	x	y	a	b
1	1	2	10	a
2	3	0	10	a

- **group_by spolu s group_map**

Uvažujme data frame dat

```
library(tidyverse)
folder="C://Csaba//...//__Pdf//";
meno="T_11_mtcars.csv";
mtcarsT = read.table(paste(folder, meno, sep=""), header = TRUE, sep = ","); mtcarsT;
dim(mtcarsT);
dat = mtcarsT[3:9,1:3]; dat;
```

```
                   mpg cyl  disp
Datsun 710        22.8   4 108.0
Hornet 4 Drive    21.4   6 258.0
Hornet Sportabout 18.7   8 360.0
Valiant           18.1   6 225.0
Duster 360        14.3   8 360.0
Merc 240D         24.4   4 146.7
Merc 230          22.8   4 140.8
```

=>

```
                   mpg cyl  disp
4.Datsun 710      22.8   4 108.0
4.Merc 230        22.8   4 140.8
4.Merc 240D       24.4   4 146.7
6.Valiant         18.1   6 225.0
6.Hornet 4 Drive  21.4   6 258.0
8.Duster 360      14.3   8 360.0
8.Hornet Sportabout 18.7 8 360.0
```

Vytvorme **skupiny** podľa cyl (4, 6, 8) a **usporiadajme** riadky vnutri skupín podľa mpg.
Ukážeme **štyri** riešenia, posledné dve pomocou knižníc plyr a dplyr.

```
do.call(rbind, lapply(split(dat, dat$cyl), function(x) tail(x[order(x$mpg),], 3)));
do.call(rbind, by(dat, dat$cyl, function(x) tail(x[order(x$mpg),], 3)));
library(plyr);
tt=ddply(plyr::name_rows(dat), .(cyl),   function(df,k) {tail(df[order(df$mpg),], k)},   3); tt;
row.names(tt)=paste0(tt$cyl,".",tt$.rownames); tt[,1:4];
```

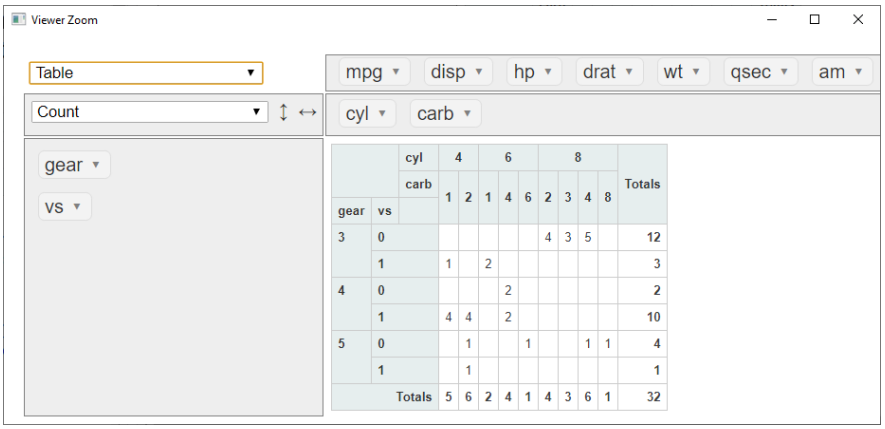
Poznamenáme, že v tibble riadky nemôžu byť pomenované.

```
library(dplyr);
dat2 = plyr::name_rows(dat) %>%
group_by(cyl) %>%
    group_map(function(df,k) {tail(df[order(df$mpg),], 3)},
                  .keep=T); #dat2
t2=do.call(rbind,dat2); t2;
t3=t2 %>%
   dplyr::mutate(rname=paste0(tt$cyl,".",tt$.rownames)); t3;
t4=cbind(t3[,6], t3[,1:4]);
row.names(t4)=t4$rname;   t4[,2:5];
```

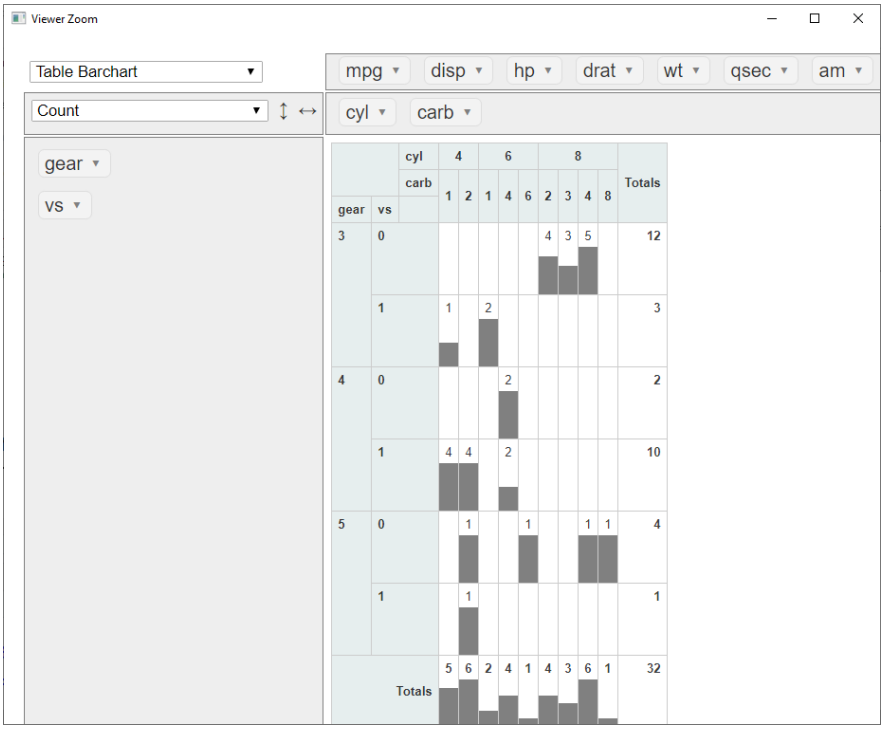
```
  rname              model  mpg cyl  disp
1   4.3        Datsun 710 22.8   4 108.0
2   4.9          Merc 230 22.8   4 140.8
3   4.8          Merc 240D 24.4   4 146.7
4   6.6            Valiant 18.1   6 225.0
5   6.4    Hornet 4 Drive 21.4   6 258.0
6   8.7        Duster 360 14.3   8 360.0
7   8.5 Hornet Sportabout 18.7   8 360.0
```

4) Balík rpivotTable https://cran.r-project.org/web/packages/rpivotTable/vignettes/rpivotTableIntroduction.html

```
if (!require(htmlwidgets, quietly = TRUE)) install.packages("htmlwidgets");
library(htmlwidgets);
if (!require(rpivotTable, quietly = TRUE)) install.packages("rpivotTable");
library(rpivotTable);

data(mtcars);
rpivotTable(mtcars, rows=c("gear","vs"),
                    cols=c("cyl","carb"),
                    width="100%", height="400px");
```



Select: Table Barchart =>



Poznamenáme, že v MS Excel okrem rovnakého interaktívneho pivotovania môžeme dosiahnuť nielen rôzne 2D, ale aj 3D zobrazenia, pozri aj MS Power BI Desktop.

5) Exoplanety – NASA

Dáta o exoplanetách, ktoré obiehajú nie okolo Slnka ale iných hviezd, načítame zo **súboru** a vybrané pôvodné dlhé stĺpce premenujeme. Zúžením dát hľadáme v nich **závislosť** (lineárnu).

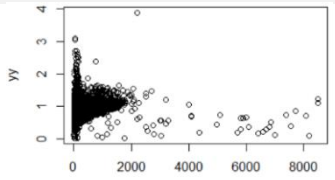
```
# Načítanie zo servera MySQL alebo SQL Server pozri poslednú prednášku.
# conn <- odbcConnect('mysql_NASA');              # MySQL
# qq = "select * from Exoplanets;"
# df2_ <- sqlQuery(conn, qq); df2_;      #close(conn)
library(tidyverse);
folder = "C://Csaba// . . . //_____Data//";
meno = "T_11_NASA_Exoplanets_OK.csv";
df2_= read.table(paste(folder, meno, sep=""), header = TRUE, sep = ","); df2_;

is.data.frame(df2_);
names(df2_);
head(df2_[1,13:14]);
```

Vyberieme šesť stĺpcov:

```
library(tidyverse);
df2 = transmute(df2_, dist = st_distance, mass = st_mass,
                      type = st_spectral_type, temp = st_effective_temp,
                      radi = st_solar_radii, disc = pl_discovery_method );
names(df2);
```

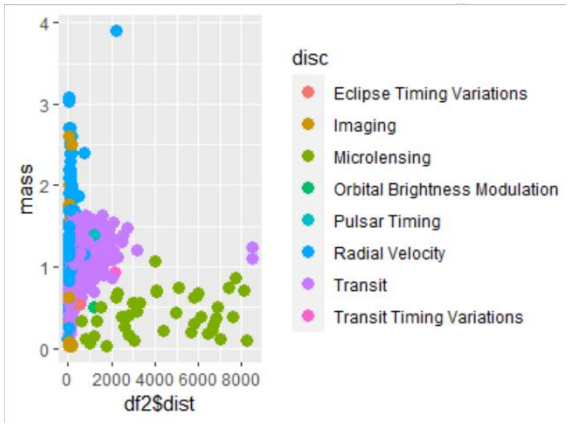
Nakreslíme bodový graf dvojice hodnôt zo stĺpcov dist, mass.

```
plot(df2$dist, df2$mass);
#plot(df2$dist, df2$mass, col=df2$dist);
```



Nakreslíme bodový graf pre dist, mass farebne v závislosti od spôsobu objavenia disc.

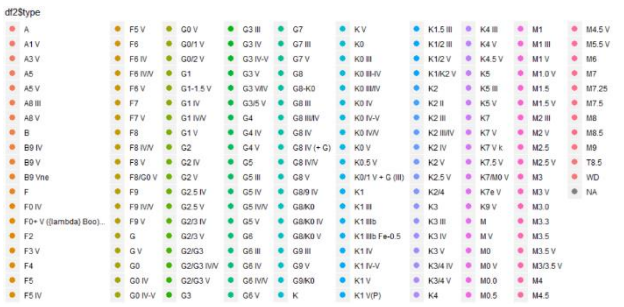
```
library(ggplot2);
# resp. dist namiesto df2$dist:
ggplot(df2, aes(x=df2$dist, y=mass, color=disc)) +
 geom_point(size=3);
```



Nakreslíme bodový graf pre dist, mass a temp, radi farebne v závislosti od deviatich (pozri 2:10) najpočetnejších type hodnôt. Ukážeme aj medzikroky, ktoré viedli k výberu 2:10.

```
### Naslepo - prilis vela typov
ggplot(df2, aes(x=df2$dist, y=df2$mass, color=df2$type)) +
 geom_point(size=3);
```

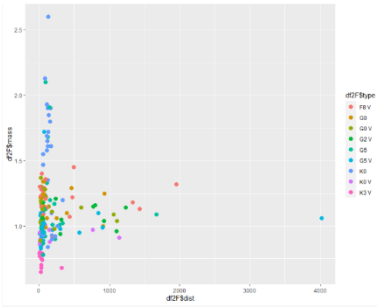
```
gg <- group_by(df2, type);   #gg
s3 = dplyr::summarise( gg ); s3;
s3p= dplyr::summarise( gg, pct = sum(!is.na(type)) );
s3p[1:15,];
### typ10  = c("A", "B", "F", "G", "K", "M");  # - cvic.
```

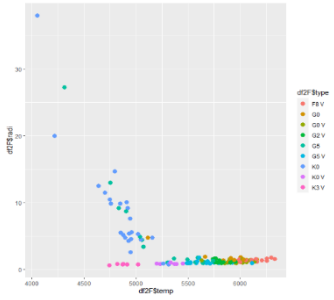


```
#typ10 = c("G5 V","K0","G0 V","G5","F8 V","K3 V","G2 V","G0","K0 V");
### - takto automatizovat: !!!!!
typ10  = as.vector( t(arrange(s3p,desc(pct))[2:10,1]) );
typ10;

df2F = filter(df2, type %in% typ10);
ggF <- group_by(df2F, type);   #ggF
s3pF= dplyr::summarise(ggF, pct = sum(!is.na(type) ));
s3pF;
ggplot(df2F, aes(x=df2F$dist, y= mass, color= type))  +  geom_point(size=3);
```

```
ggplot(df2F, aes(x=df2F$temp, y=radi, color= type))  +   geom_point(size=3);
```

```
> s3pF
# A tibble: 9 x 2
  type    pct
  <chr> <int>
1 F8 V     29
2 G0       23
3 G0 V     34
4 G2 V     26
5 G5       32
6 G5 V     52
7 K0       40
8 K0 V     23
9 K3 V     28
```





Na druhom obrázku sa rysujú **dve lineárne závislosti**, ktoré by bolo možné ďalej skúmať!

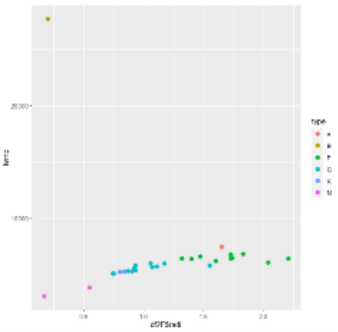
```
{
 df2F %>% drop_na(radi);
 # <=>
 df3=df2F %>% filter(!is.na(radi)) %>%
  filter(radi<2.5); df3;
 ggplot(df3, aes(x=temp, y=radi, color= type))  +   geom_point(size=3);

 df4=df2F %>% filter(!is.na(radi)) %>%
  filter(temp<5300) %>% filter(radi>0.9); df4;
 ggplot(df4, aes(x=temp, y=radi, color= type))  +   geom_point(size=3);
}
```

Cvičenie. Zistite v R pomocou *pivot_wider* sumárne poplatky pre každý poplatok z daných troch poplatkov {200, 500, 800} a pre každého špecialistu na základe importovaných tabuliek Lekari a Navstevy (pozri pr. 5b v T_08b_VnoreneDopyty_Rollup.pdf).

	Spec	poplatok	suma
1	Ocny	200	1000
2	Ocny	500	500
3	Zubny	500	1000
4	Zubny	800	1600

Výsledok

```
# A tibble: 2 x 4
  spec   `200` `500` `800`
  <fct> <int> <int> <int>
1 Ocny   1000   500    NA
2 Zubny    NA  1000  1600
```



Cvičenie:

Nakreslite bodový graf pre dvojicu stĺpcov temp, radi farebne v závislosti od šiestich hodnôt A,B,F,G,K,M stĺpca type.

DF1 z T10

```
qq = "SELECT  month(den) mes
 , COUNT(CASE WHEN idL = 5 THEN 1 ELSE null END) Imro
 , COUNT(CASE WHEN idL = 3 THEN 1 ELSE null END) Klara
 , COUNT(CASE WHEN idL = 1 THEN 1 ELSE null END) Oto
 , COUNT(CASE WHEN idL = 2 THEN 1 ELSE null END) Zoli
 , COUNT(CASE WHEN idL = 4 THEN 1 ELSE null END) Zuzka
--  , SUM(1) AS Vcelku
 FROM Navstevy
 GROUP BY month(den);";
# SQL Server, MySQL
#conn <- odbcDriverConnect(cons)
conn <- odbcConnect('mysql_poliklinika');
DF1 <- sqlQuery(conn, qq);
close(conn);
```

```
### Pivot tabulka DF3
library(RODBC)
library(tidyverse)
conn <- odbcConnect('mysql_poliklinika');    # MySQL
qq = "select krstne, spec, month(den) mes, poplatok
   from lekari L join navstevy N ON L.idL=N.idL;"
df2 <- sqlQuery(conn, qq); df2
close(conn)

if (!require(data.table, quietly = TRUE))install.packages("data.table")
library(data.table)
df3 = df2 %>%
 #dplyr::filter(!is.na(result)) %>%
 dplyr::count(mes, krstne) %>%
 tidyr::pivot_wider(
   names_from = krstne
   ,values_from = n
   ,values_fill = list(n = 0) # un/comment
   # ,values_fn = list(y = sum)
 )
#df3[,order(colnames(df3),decreasing = FALSE)]
juj = c(1,1+order(colnames(df3)[2:length(colnames(df3))], decreasing = FALSE))
DF3 <- df3[,juj];
DF3; # DF1;

### Kodove riadky pre Exoplanety – NASA
library(tidyverse)
#conn <- odbcConnect('mysql_NASA');         # MySQL
#qq = "select * from Exoplanets;"
#df2_ <- sqlQuery(conn, qq); df2_;       #close(conn)
folder="C://Csaba// . . . //_____NASA_Exoplanets_Uj//_____Data//"
meno="NASA_Exoplanets_OK.csv"
df2_= read.table(paste(folder, meno, sep=""), header = TRUE, sep = ","); df2_
```

```
is.data.frame(df2_)
names(df2_);
head(df2_[1,13:14])

library(tidyverse)
df2 = transmute(df2_, dist = st_distance, mass = st_mass,
            type = st_spectral_type, temp = st_effective_temp,
            radi = st_solar_radii, disc = pl_discovery_method );
names(df2)

plot(df2$dist, df2$mass)
#plot(df2$dist, df2$mass, col=df2$dist)

library(ggplot2)
# resp. dist namiesto df2$dist
ggplot(df2, aes(x=df2$dist, y=mass, color=disc)) +
  geom_point(size=3)

### Naslepo - prilis vela typov
#ggplot(df2, aes(x=df2$dist, y=df2$mass, color=df2$type)) + geom_point(size=3)

gg <- group_by(df2, type);   #gg
s3 = dplyr::summarise( gg ); s3
s3p= dplyr::summarise( gg, pct = sum(!is.na(type)) );
s3p[1:15,]
#typ10  = c("A", "B", "F", "G", "K", "M");
#typ10 = c("G5 V","K0","G0 V","G5","F8 V","K3 V","G2 V","G0","K0 V");
### - takto automatizovat: !!!!!
typ10  = as.vector( t(arrange(s3p,desc(pct))[2:10,1]) );
typ10

df2F = filter(df2, type %in% typ10)
ggF <- group_by(df2F, type);   #ggF
s3pF= dplyr::summarise(ggF, pct = sum(!is.na(type) ));
s3pF

ggplot(df2F, aes(x=df2F$dist, y=mass, color=type)) +
  geom_point(size=3)

ggplot(df2F, aes(x=df2F$temp, y=radi, color=type)) +
  geom_point(size=3)
```