Лабораторная работа 7

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Цель работы

Цель работы

Основной целью работы является изучение специализированных пакетов Julia для обработки данных.

Выполнение лабораторной работы

Считывание данных

```
[2]: # Считывание данных и их запись в структуру:
P = CSV.File("programminglanguages.csv") |> DataFrame
```

[2]: 73×2 DataFrame *48 rows omitted*

Row	year	language
	Int64	String31
1	1951	Regional Assembly Language
2	1952	Autocode
3	1954	IPL
4	1955	FLOW-MATIC
5	1957	FORTRAN
6	1957	COMTRAN
7	1958	LISP
8	1958	ALGOL 58
9	1959	FACT

Рис. 1: Считывание данных и запись в структуру

Пример

```
# Функция определения по названию языка программирования года его создания:
function language_created_year(P,language::String)
loc = findfirst(P[:,2].==language)
return P[loc,1]
end
```

```
language_created_year (generic function with 1 method)
```

```
# Пример вызова функции и определение даты создания языка Python:
print(language_created_year(P,"Python"))
# Пример вызова функции и определение даты создания языка Julia:
language_created_year(P,"Julia")
```

```
1991
2012
```

Рис. 2: Пример

Поиск “julia” со строчной буквы

```
# Функция определения по названию языка программирования
# года его создания (без учёта регистра):
function language_created_year_v2(P,language::String)
loc = findfirst(lowercase.(P[:,2]).==lowercase.(language))
return P[loc,1]
end
```

```
language_created_year_v2 (generic function with 1 method)
```

```
# Пример вызова функции и определение даты создания языка julia:
language_created_year_v2(P,"julia")
```

```
2012
```

Рис. 3: Изменение исходной функции

Построчное считывание данных

```
# Построчное считывание данных с указанием разделителя:
Tx = readdlm("programminglanguages.csv", ',')
```

```
74×2 Matrix{Any}:
     "year"  "language"
 1951        "Regional Assembly Language"
 1952        "Autocode"
 1954        "IPL"
 1955        "FLOW-MATIC"
 1957        "FORTRAN"
 1957        "COMTRAN"
 1958        "LISP"
 1958        "ALGOL 58"
 1959        "FACT"
 1959        "COBOL"
 1959        "RPG"
 1962        "APL"
    ⋮
```

```
# Запись данных в CSV-файл:
CSV.write("programming_languages_data2.csv", P)
```

```
"programming_languages_data2.csv"
```

Рис. 5: Запись данных в файл

```
# Инициализация словаря:
dict = Dict{Integer,Vector{String}}()
```

```
Dict{Integer, Vector{String}}()
```

Рис. 6: Инициализация словаря

```
dict[2003]
```

```
2-element Vector{String}:
 "Groovy"
 "Scala"
```

Рис. 7: Пример работы словаря

DataFrames

```
using DataFrames
# Задаём переменную со структурой DataFrame:
df = DataFrame(year = P[:,1], language = P[:,2])
```

73×2 DataFrame

Row	year	language
	Int64	String31
1	1951	Regional Assembly Language
2	1952	Autocode
3	1954	IPL
4	1955	FLOW-MATIC
5	1957	FORTRAN
6	1957	COMTRAN
7	1958	LISP
8	1958	ALGOL 58
9	1959	FACT
10	1959	COBOL
11	1959	RPG
12	1962	APL
13	1962	Simula
⋮	⋮	⋮

RDatasets

```
# Подгружаем пакет RDatasets:
using RDatasets
# Задаём структуру данных в виде набора данных:
iris = dataset("datasets", "iris")
```

150×5 DataFrame

Row	SepalLength	SepalWidth	PetalLength	PetalWidth	Species
	Float64	Float64	Float64	Float64	Cat…
1	5.1	3.5	1.4	0.2	setosa
2	4.9	3.0	1.4	0.2	setosa
3	4.7	3.2	1.3	0.2	setosa
4	4.6	3.1	1.5	0.2	setosa
5	5.0	3.6	1.4	0.2	setosa
6	5.4	3.9	1.7	0.4	setosa
7	4.6	3.4	1.4	0.3	setosa
8	5.0	3.4	1.5	0.2	setosa
9	4.4	2.9	1.4	0.2	setosa
10	4.9	3.1	1.5	0.1	setosa
11	5.4	3.7	1.5	0.2	setosa
12	4.8	3.4	1.6	0.2	setosa
13	4.8	3.0	1.4	0.1	setosa

Получение основных статических сведений о каждом столбце в наборе данных

```
# Определения типа переменной:
typeof(iris)
```

```
DataFrame
```

```
describe(iris)
```

5×7 DataFrame

Row	variable	mean	min	median	max	nmissing	eltype
	Symbol	Union…	Any	Union…	Any	Int64	DataType
1	SepalLength	5.84333	4.3	5.8	7.9	0	Float64
2	SepalWidth	3.05733	2.0	3.0	4.4	0	Float64
3	PetalLength	3.758	1.0	4.35	6.9	0	Float64
4	PetalWidth	1.19933	0.1	1.3	2.5	0	Float64
5	Species		setosa		virginica	0	CategoricalValue{String, UInt8}

```
# Отсутствующий тип:
a = missing
typeof(a)
```

```
Missing
```

Рис. 11: Использование “отсутствующего” типа

```
# Определение перечня продуктов:
foods = ["apple", "cucumber", "tomato", "banana"]
# Определение калорий:
calories = [missing,47,22,105]
```

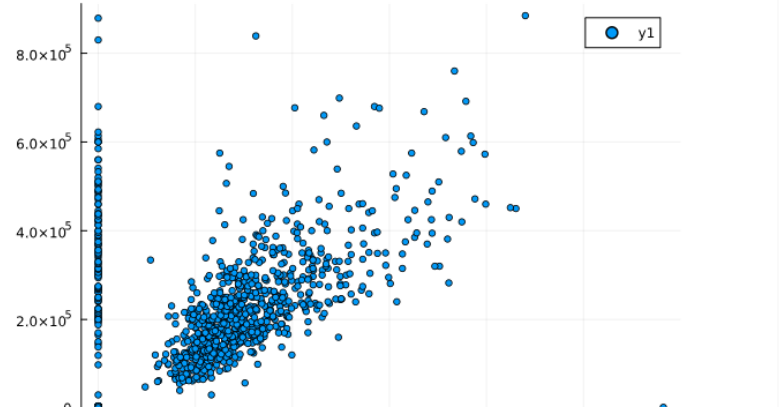
```
4-element Vector{Union{Missing, Int64}}:
     missing
  47
  22
 105
```

Рис. 12: Пример работы с данными, среди которых есть данные с отсутствующим типом

```
# Загрузка изображения:
X1 = load("julialogo.png")
```

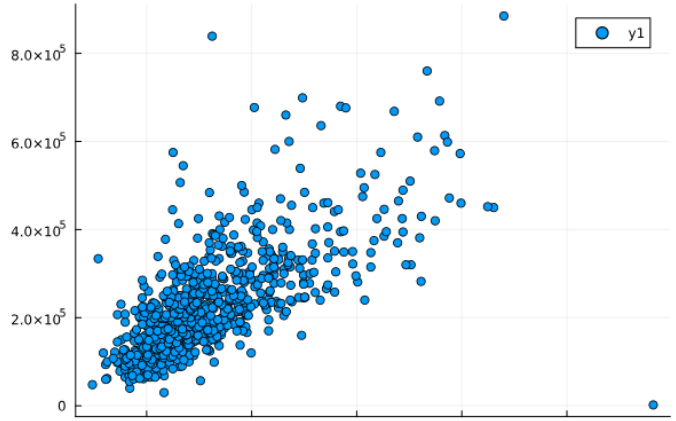
```
460×460 Array{RGBA{N0f8},2} with eltype ColorTypes.RGBA{FixedPointNumbers.N0f8}
 RGBA{N0f8}(0.0,0.0,0.0,0.0)  …  RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)  …  RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)  …  RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 ⋮                            ⋱
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)  …  RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)  …  RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
 RGBA{N0f8}(0.0,0.0,0.0,0.0)     RGBA{N0f8}(0.0,0.0,0.0,0.0)
```

```
# Построение графика:
using Plots
plot(size=(500,500),leg=false)
x = houses[!,:sqft]
y = houses[!,:price]
scatter(x,y,markersize=3)
```



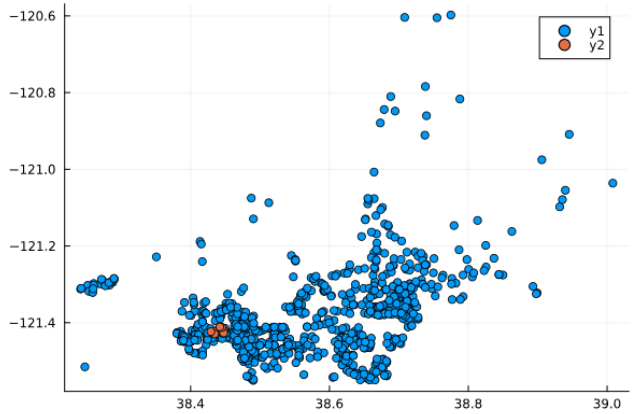
Построение графика без “артефактов”

```
# Фильтрация данных по заданному условию:
filter_houses = houses[houses[!,:sqft].>0,:]
# Построение графика:
x = filter_houses[!,:sqft]
y = filter_houses[!,:price]
scatter(x,y)
```



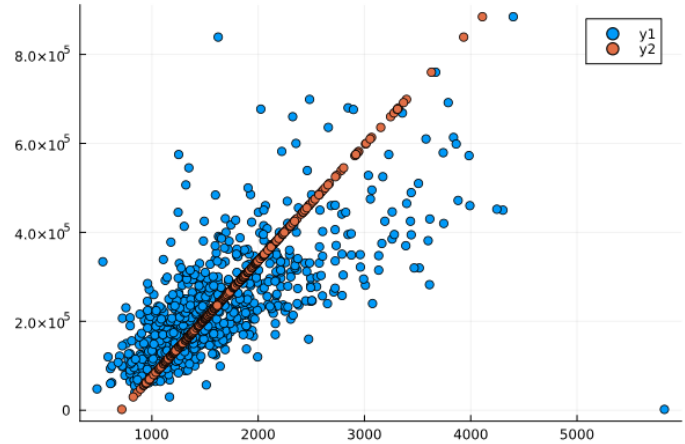
Кластеризация данных. Метод k ближайших соседей

```
# Все объекты недвижимости:
x = filter_houses[!,:latitude];
y = filter_houses[!,:longitude];
scatter(x,y)
# Соседи:
x = filter_houses[idxs,:latitude];
y = filter_houses[idxs,:longitude];
scatter!(x,y)
```

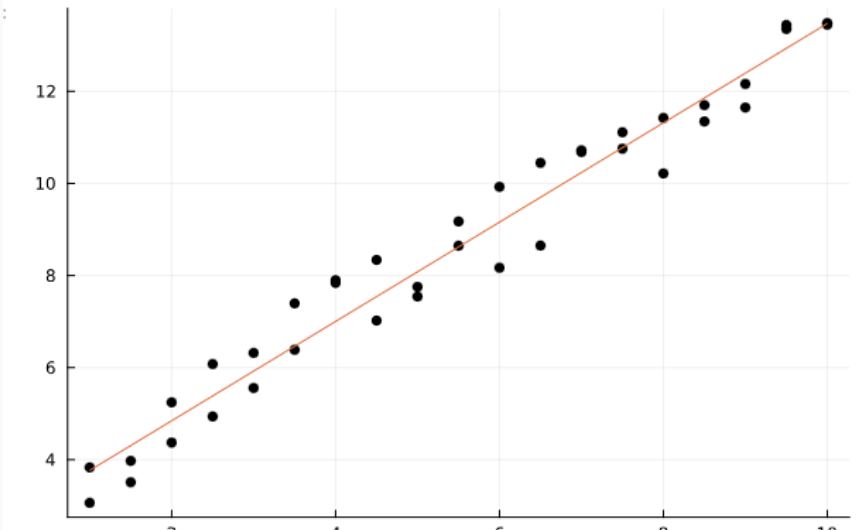


Обработка данных. Метод главных компонент

```
y= MultivariateStats.transform(M,F)
# Выделение значений главных компонент в отдельную переменную:
Xr = reconstruct(M, y)
# Построение графика с выделением главных компонент:
scatter(F[1,:],F[2,:])
scatter!(Xr[1,:],Xr[2,:])
```



```
plot!(xvals, ynew)
```



Сравнение

```
py"""
import numpy
def find_best_fit_python(xvals,yvals):
    meanx = numpy.mean(xvals)
    meany = numpy.mean(yvals)
    stdx = numpy.std(xvals)
    stdy = numpy.std(yvals)
    r = numpy.corrcoef(xvals,yvals)[0][1]
    a = r*stdy/stdx
    b = meany - a*meanx
    return a,b
"""
```

```
find_best_fit_python = py"find_best_fit_python"
xpy = PyObject(xvals)
ypy = PyObject(yvals)
@time a,b = find_best_fit_python(xpy,ypy)
```

```
  0.064046 seconds (74.75 k allocations: 5.179 MiB, 91.19% compilation time)
```

```
(0.9999999961460347, 3.000038831247366)
```

```
import Pkg
Pkg.add("BenchmarkTools")
using BenchmarkTools
@btime a,b = find_best_fit_python(xvals,yvals)
@btime a,b = find_best_fit(xvals,yvals)
```

```
  2.810 ms (25 allocations: 832 bytes)
  429.597 μs (1 allocation: 32 bytes)
   Resolving package versions...
  No Changes to `~/.julia/environments/v1.10/Project.toml`
  No Changes to `~/.julia/environments/v1.10/Manifest.toml`
```

```
(0.9999999961460344, 3.000038831269194)
```

Самостоятельное выполнение

```
using RDatasets
iris = dataset("datasets", "iris")
```

150 rows × 5 columns

	SepalLength	SepalWidth	PetalLength	PetalWidth	Species
	Float64	Float64	Float64	Float64	Cat...
1	5.1	3.5	1.4	0.2	setosa
2	4.9	3.0	1.4	0.2	setosa
3	4.7	3.2	1.3	0.2	setosa
4	4.6	3.1	1.5	0.2	setosa

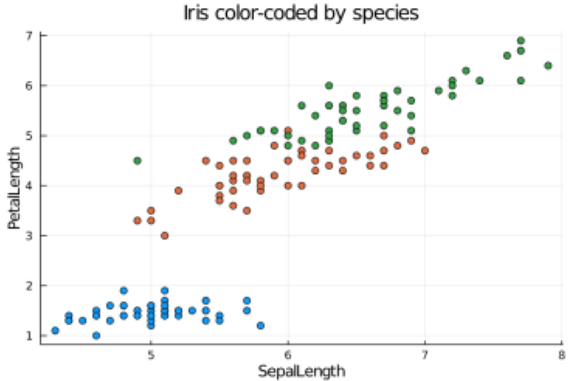
Решение задания №1

```
# Построение графика:
plot(size=(500,500),leg=false)

x = iris[!,:SepalLength]
y = iris[!,:PetalLength]
scatter(x, y, markersize=3, title="Распределение признаков SepalLength и PetalLength",
    xlabel="SepalLength", ylabel="PetalLength", leg=false)
```

Решение задания №1

```
unique_species = unique(iris[!,:Species])
species_figure = plot(legend = false)
for uspecies in unique_species
    iris_sp = iris[iris[!,:Species].==uspecies,:]
    x = iris_sp[!,:SepalLength]
    y = iris_sp[!,:PetalLength]
    scatter!(species_figure, x, y)
end
xlabel!("SepalLength")
ylabel!("PetalLength")
title!("Iris color-coded by species")
display(species_figure)
```



```
function linear_regression_model(X, y)
    X2 = ones(1000)
    X = hcat(X, X2)
    return  X \ y
end
```

```
linear_regression_model (generic function with 1 method)
```

```
a = linear_regression_model(X, y)
print(a)
```

```
[0.6468629061323115, 0.04253975444213305, 0.5580332821634576, -0.0014055938037774972]
```

Рис. 23: Решение задания №1

```
X1 = X[:,1]
X2 = X[:,2]
X3 = X[:,3]

data = DataFrame(y = y, x1 = X1, x2 = X2, x3 = X3);

lm(@formula(y ~ x1 + x2 + x3), data)
```

```
y ~ 1 + x1 + x2 + x3

Coefficients:
```

	Coef.	Std. Error	t	Pr(>|t|)	Lower 95%	Upper 95%
(Intercept)	-0.00140559	0.00310024	-0.45	0.6504	-0.00748934	0.00467815
x1	0.646863	0.00306265	211.21	<1e-99	0.640853	0.652873
x2	0.0425398	0.00328213	12.96	<1e-34	0.0360991	0.0489804
x3	0.558033	0.00308713	180.76	<1e-99	0.551975	0.564091

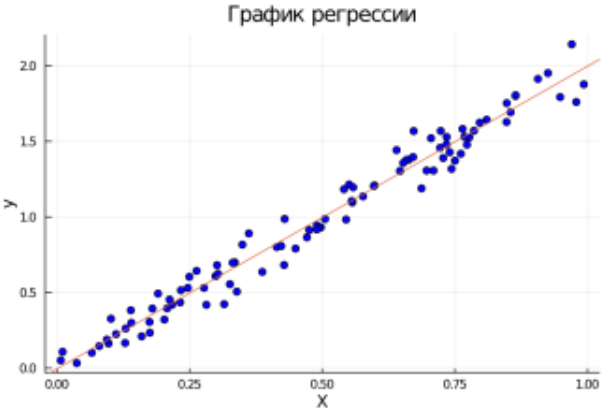
Рис. 24: Решение задания №1

Решение задания №2-2

```
X = rand(100);
y = 2*X + 0.1 * randn(100);
```

```
a, b = find_best_fit(X, y)
ynew = a * X .+ b

scatter(X, y, title="График регрессии", xlabel="X", ylabel="y", color=:blue, leg=false, line=:scatter)
Plots.abline!(a, b, line=:solid)
```



```
using Plots
plot(stockTree, title="Траектория курса акций", xlabel="Длина биномиального дерева в годах", ylabel="Курс акций", leg=false)
```

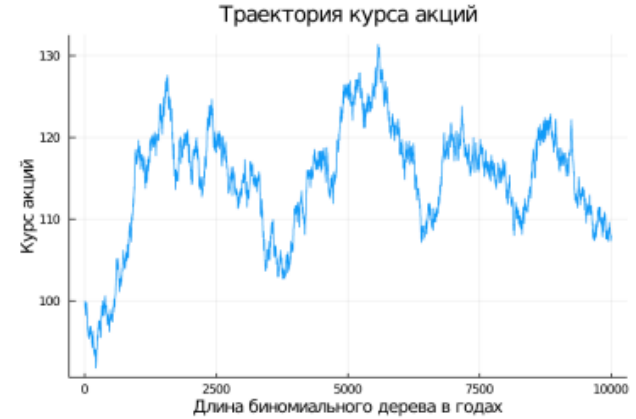
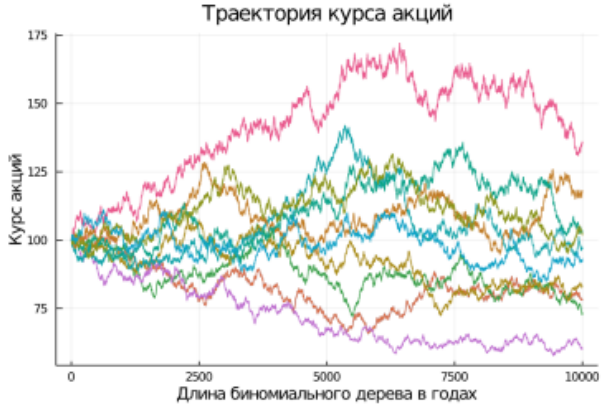


Рис. 26: Решение задания №1

Решение задания №2-2b

```
for i in 1:10
    IJulia.clear_output(true)
    traj = createPath(100, 1, 10000, 0.3, 0.08)
    if i == 1
        p = plot(traj, title="Траектория курса акций", xlabel="Длина биномиального дерева в годах",
            ylabel="Курс акций", leg=false)
    end
    p = plot!(traj)
    display(p)
end
```



Решение задания №2-2c

```
using Base.Threads

Threads.@threads for i in 1:10
    IJulia.clear_output(true)
    traj = createPath(100, 1, 10000, 0.3, 0.08)
    if i == 1
        g = plot(traj, title="Траектория курса акций", xlabel="Длина биномиального дерева в годах",
            ylabel="Курс акций", leg=false)
    end
    g = plot!(traj)
    display(g)
end
```

Выводы

Выводы

В ходе выполнения лабораторной работы были изучены специализированные пакеты Julia для обработки данных.