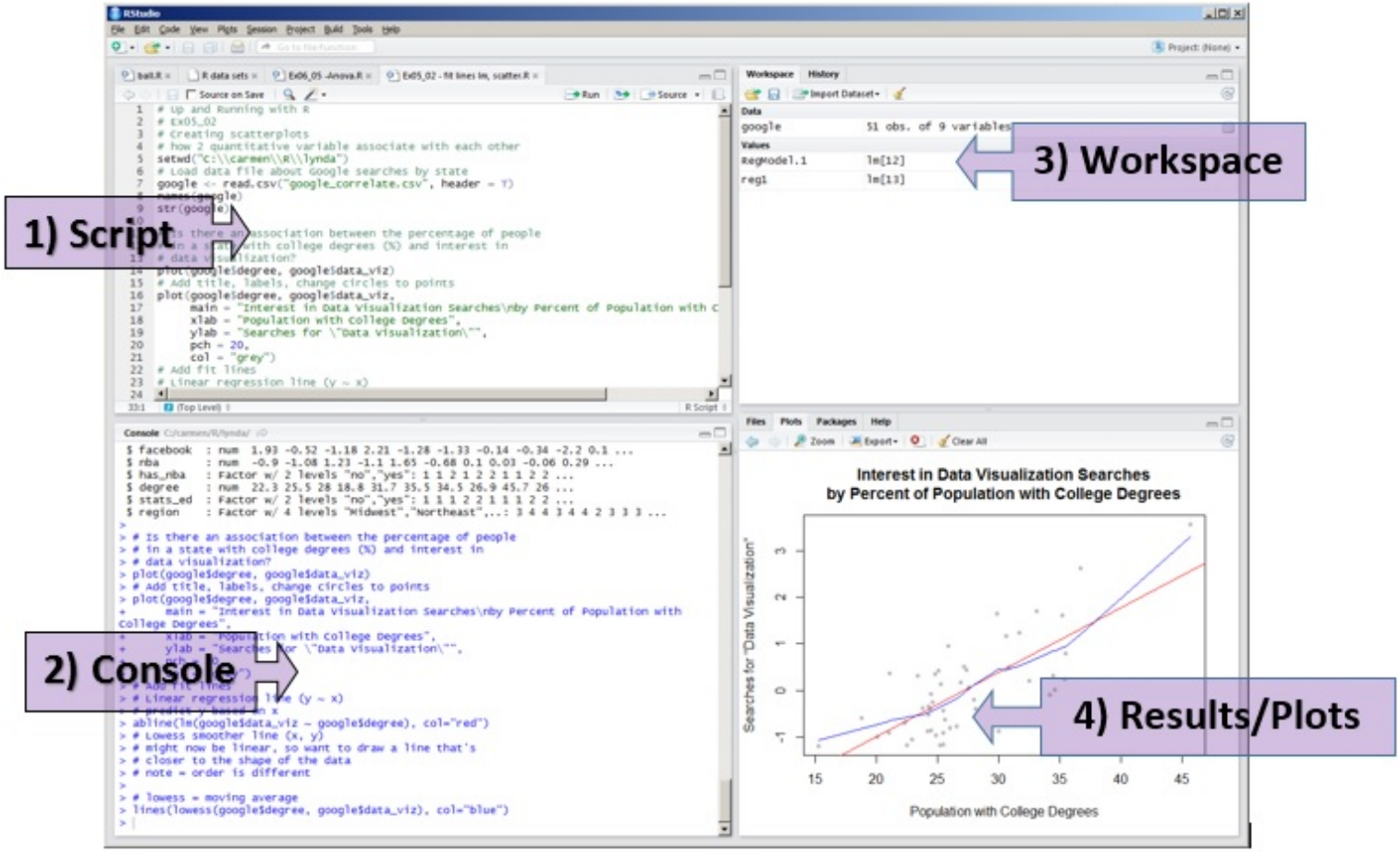
Introduction to R

November 22, 2018

R and RStudio



What R can do

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Everything.[1,2]

1 Except think about your science

2 Occasionally in a non efficient way

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What about RStudio?

- Makes your life easier
- Many handy tricks
  - Autocomplete suggestion
  - Ctrl-Enter to send command to R
  - str() and View() objects in Environment
  - Files, packages, help selectors
  - Version control...

About R-studio projects

Use them

Calculating a mean: Arithmetic and assignment

```
  (2 + 3 + 5 + 1) / 4
```

```
[1] 2.75
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  d <- 1

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Calculating a mean: Arithmetic and assignment

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  a <- 2
  b <- 3
  c <- 5
  d <- 1

  (a + b + c + d) / 4
```

```
[1] 2.75
```

```
  a <- 45
  (a + b + c + d) / 4
```

```
[1] 13.5
```

Calculating a mean: using vectors

```
  c(2,3,5,1) # c is for concatenate
```

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mydata <- c(2,3,5,1) # save the vector
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```
[1] 2 3 5 1
```

```
 mydata <- c(2,3,5,1) # save the vector
```

```
  mydata <- (2,3,5,1) # c is missing => error!
```

```
Error:  <text>:1:15:  unexpected ','
1:  mydata <- (2,
                  ^
```

Why bother with vectors?

Substitution:

```
  mydata[2] <- 4
  mydata

[1] 2 4 5 1
```

Vectorized operations:

```
  mydata*5 + 2

[1] 12 22 27  7
```

Exercise

```
  -5:20

 [1] -5 -4 -3 -2 -1  0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15
[24] 18 19 20
```

Calculating a mean: using functions

How to use a function?

```
?mean
```

Or use **tab**

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```

Or use **tab**

```
mean(c(2,4,5,1))

[1] 3

mean(mydata)

[1] 3

mean(x = mydata)

[1] 3
```

Loading data

```
trees <- read.csv("trees.csv")
```

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```

```
str(trees)

'data.frame': 31 obs. of  3 variables:
 $ Girth : num  8.3 8.6 8.8 10.5 10.7 10.8 11 11 11.1 11.2 ...
 $ Height: int  70 65 63 72 81 83 66 75 80 75 ...
 $ Volume: num  10.3 10.3 10.2 16.4 18.8 19.7 15.6 18.2 22.6 19.9 ...
```

Try also `summary`, `class`, `head`, `tail`

Access

Bracket-syntax

- Row: dataframe[row,]
- Column: dataframe[, column]
- Element: dataframe[row, column]

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```
trees[,1]
trees[1:8,]
trees[c(2,1,2), 3]
trees[, "Height"]
```

Dollar-syntax

- Column `dataframe$column_name`
- Element `dataframe$column_name[row]`

```
trees$Height
```

Time to think a tiny bit!

Calculate the mean for all three variables in trees, excluding the last (31st) record.

Solution for one column

Calculate the mean for all three variables in trees, excluding the last (31st) record.

```
mean(trees$Girth[1:30])
mean(trees[1:30, "Girth"])
mean(trees$Girth[-31])
mean(trees[-31, "Girth"])
```

How to get the row means?

```
mean(trees[1,])
mean(trees[2,])
mean(trees[...,])
```

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:

How to get the row means? For-loops

```
for (i in 1:N)
{
  something as a function of i
}#end of the loop
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```

```
for (i in 1:31)
{
  print(i)
}
```

How to get the row means? For-loops

Start by buiding the code for 1 iteration (1 "i" value, e.g., 22):

```
mean(as.numeric(trees[22,]))
```

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We will want to store the result somewhere:

```
  ResultMean <- vector() # we will store the results there
  ResultMean[22] <- mean(as.numeric(trees[22,]))
```

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```
mean(as.numeric(trees[22,]))
```

We will want to store the result somewhere:

```
  ResultMean <- vector() # we will store the results there
  ResultMean[22] <- mean(as.numeric(trees[22,]))
```

Now change 22 to "i" and write a loop around:

```
ResultMean <- vector() # we will store the results there
for (i in 1:31)
{
  ResultMean[i] <- mean(as.numeric(trees[i,]))
}
```

For-loops: your turn!

Load rock data

```
rock <- read.csv("rock.csv")
```

Use a for loop to obtain column averages

Solution

Load rock data.

```
rock <- read.csv("rock.csv")
```

Use a for loop to obtain column averages

```
storage <- vector(length = ncol(rock))
for (i in 1:ncol(rock))
{
  storage[i] <- mean(rock[,i])
}
```

More concise alternative: apply functions

```
apply(X = dataframe, MARGIN = 1 (row) or 2 (col), FUN = function)
```

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```
apply(X = dataframe, MARGIN = 1 (row) or 2 (col), FUN = function)
```

```
apply(X = rock, MARGIN = 1, FUN = mean)#by row (not meaningful)
apply(X = rock, MARGIN = 2, FUN = mean)#by column
```

Even better (worse)...

```
colMeans(rock)
rowMeans(rock)
```

Even better (worse)...

```
colMeans(rock)
rowMeans(rock)
```

Trade-off concision / flexibility

- colMeans shortest, but does only means
- apply very flexible, but does only array/matrix/data-frame
- for-loop looks complex, but infinitely flexible
- (NB: your computer does a for-loop whether you see it or not)

The last value

Sometimes a function takes very long to run

```
rowMeans(rock[rep(1:nrow(rock),100000),])
```

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What if you forgot to save the output to an object??

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```
    rowMeans(rock[rep(1:nrow(rock),100000),])
```

What if you forgot to save the output to an object??

```
ourlasthope <- .Last.value
```

While-loop: idea

Less common than for-loops
Stop the loop after a condition is met

```
while(condition TRUE)
{
  something
}
```

What is the smallest reproductive rate necessary to obtain a growing population?

```
library(popbio)
mat <- matrix(c(0,0.8,1,0), nrow = 2)
lambda(mat)

[1] 0.8944272

cond <- 1
while(lambda(mat) < 1 )
{
  mat[1,2] <- mat[1,2]+0.001
}
mat[1,2]

[1] 1.251
```

But think twice before running a while loop...

What happens if you run:

```
x <- 1
while(x>0)
{
  x <- x + 1
}
```

Looking for a rare event

The function sample() takes 5 number between 1 and 6 (like 5 dice!):

```
x <- sample(x = 1:6, size = 5, replace = TRUE)
```

Are all die equal?

```
all(x == x[1])

[1] FALSE
```

Are they ever going to be equal? Write a while loop to find a case

If-else statements

```
if(condition)
{
  do something
}
```

```
if(condition)
{
  do something
}else{
  do something else
}
```

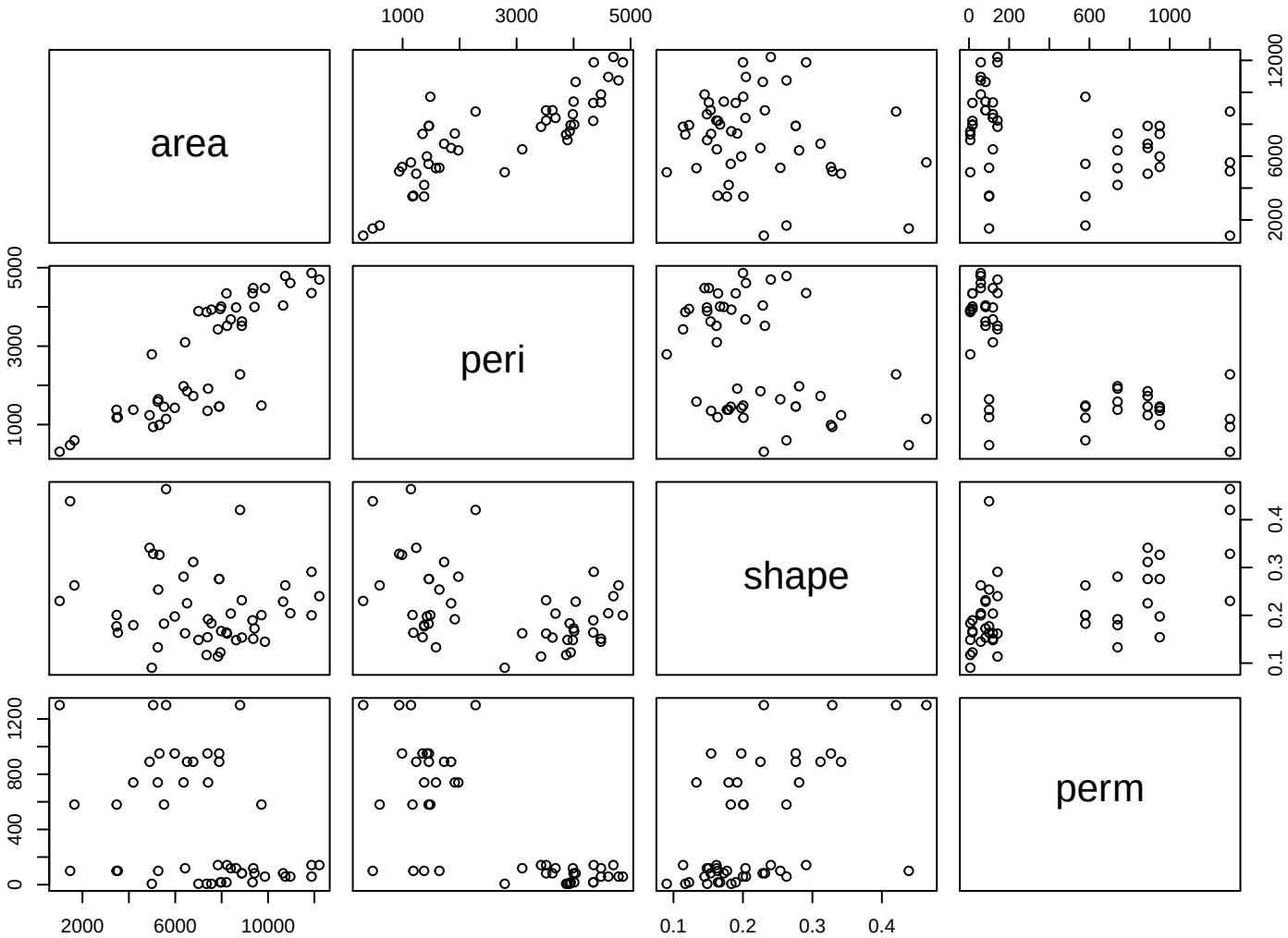
If-else statements

For instance:

```
for (i in 1:10)
{
  if(i < 6)
  {
    print("tofu")
  }else{
    print("bacon")
  }
}
```

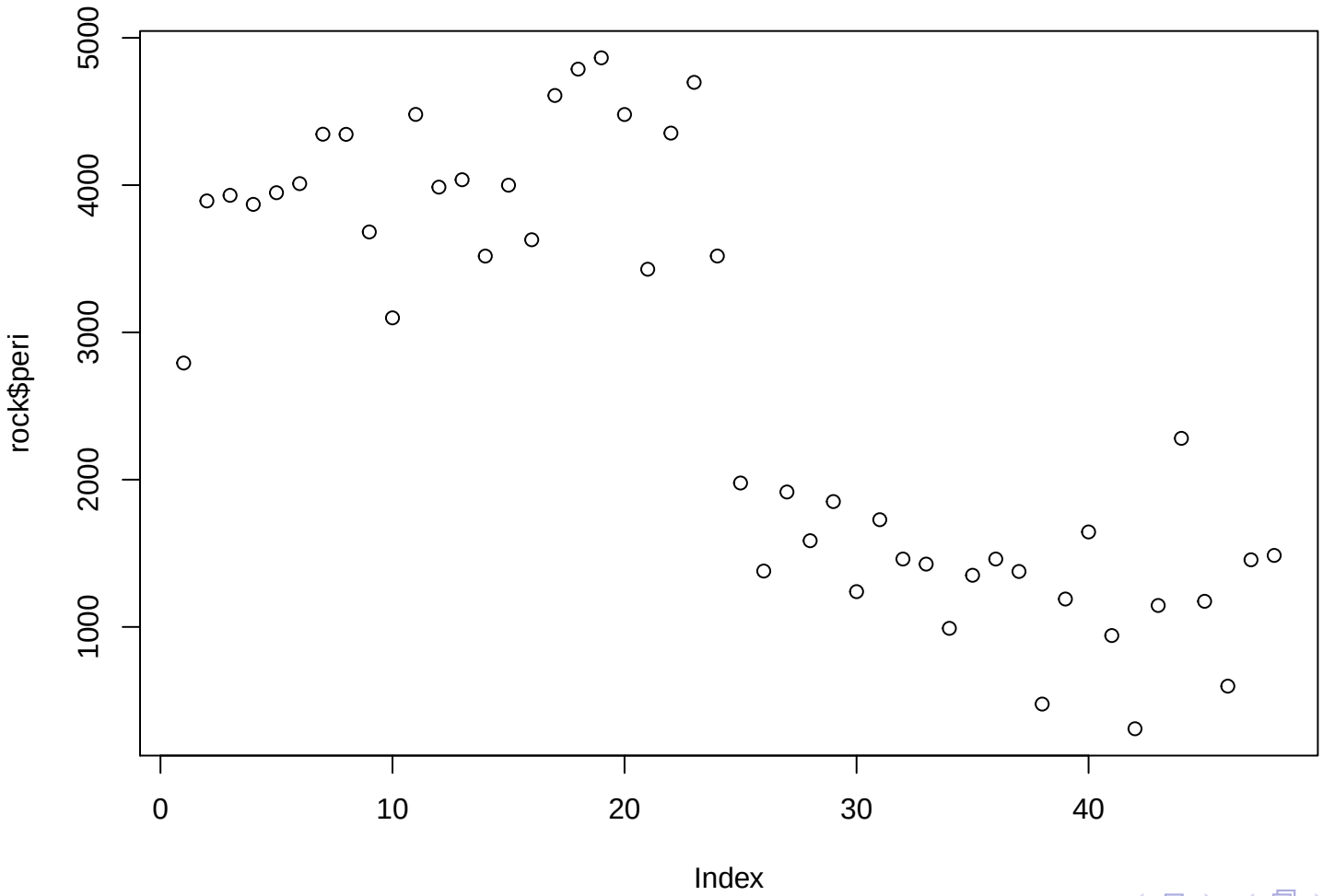
plot function

```
plot(rock)
```



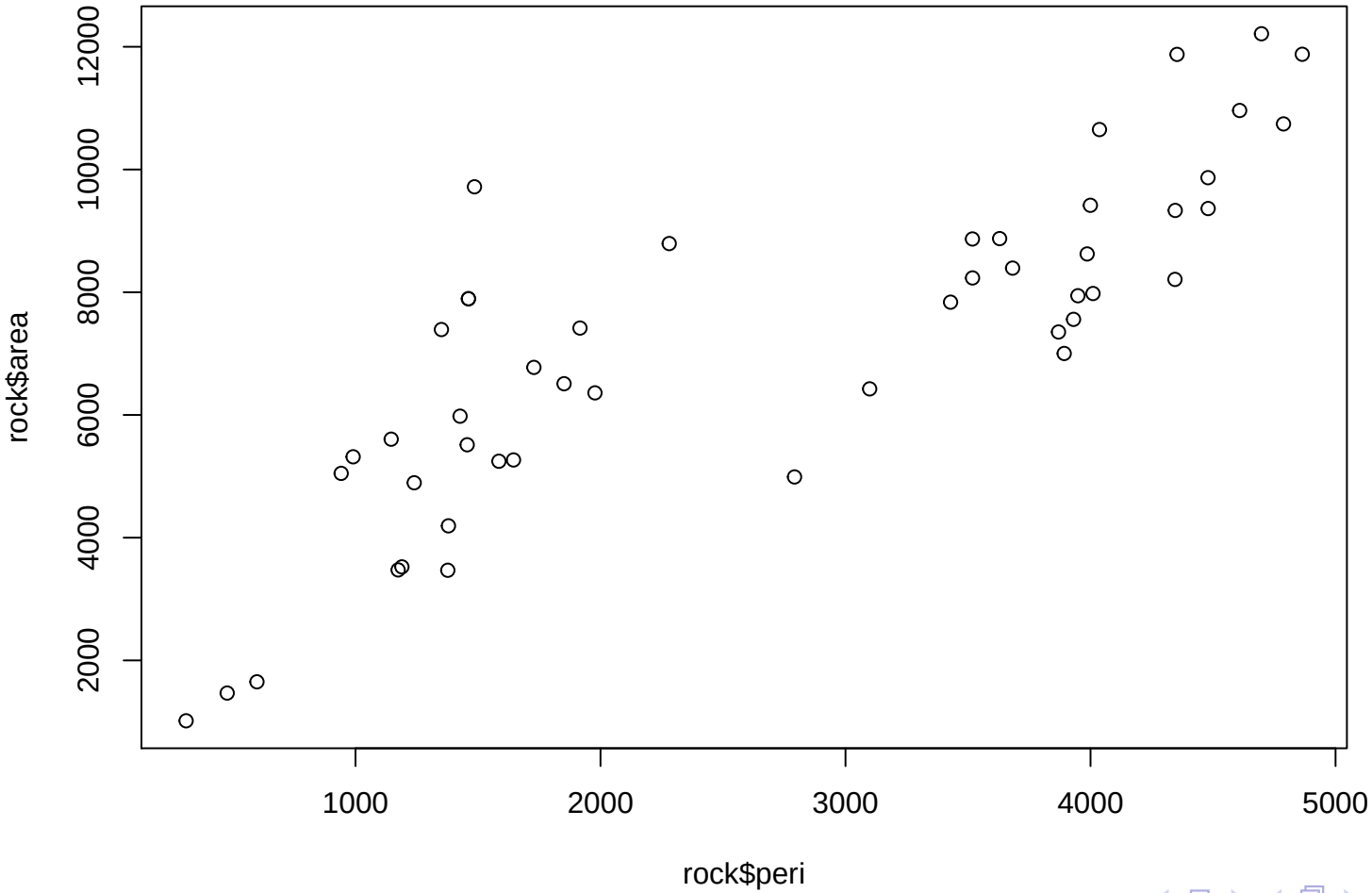
plot function

```
plot(rock$peri)
```



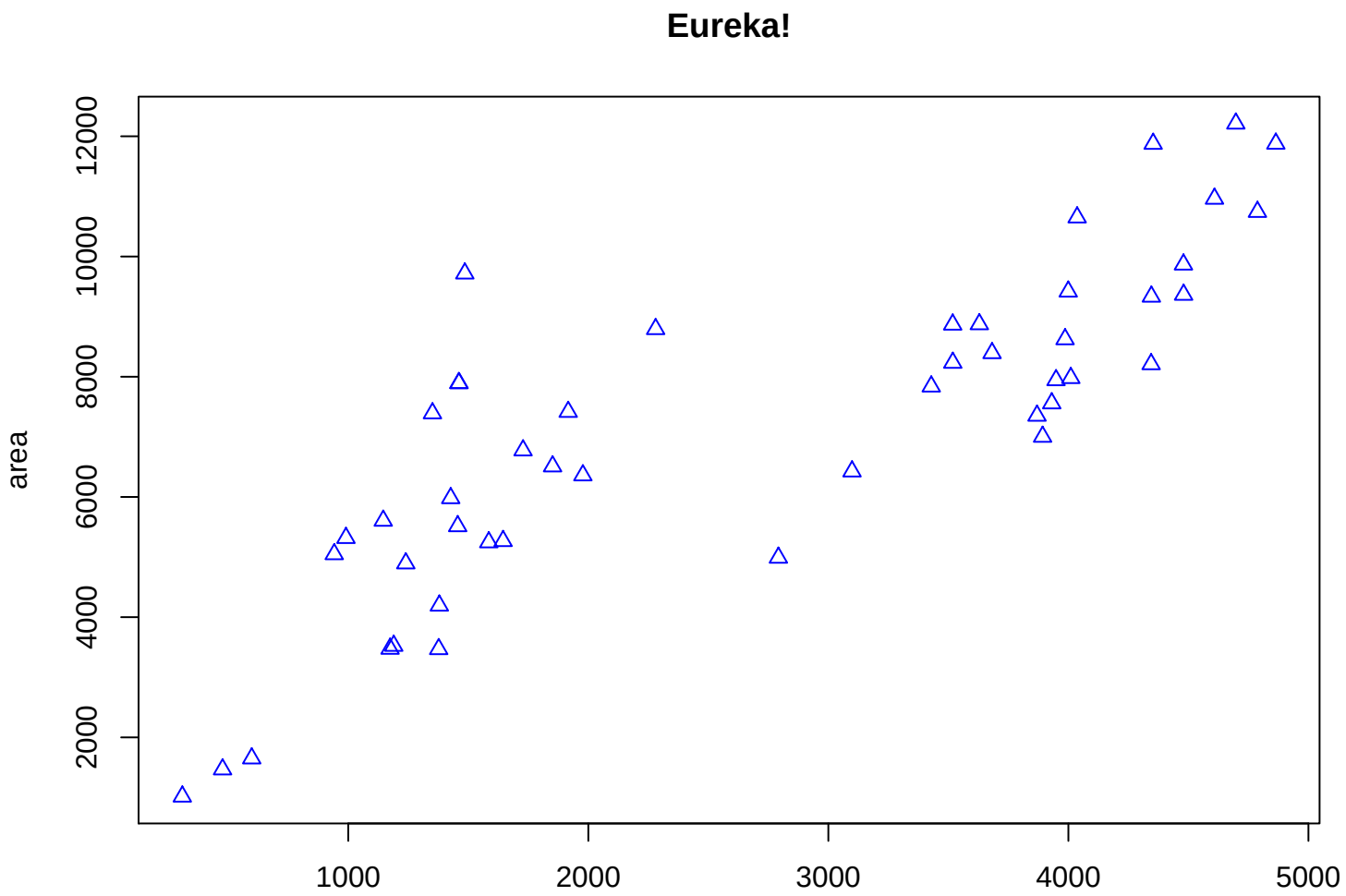
plot function

```
plot(x = rock$peri, y = rock$area)
```



plot function

```
plot(x = rock$peri, y = rock$area, main = "Eureka!",
     xlab = "Perimeter", ylab = "area", col="blue", pch=2)
```

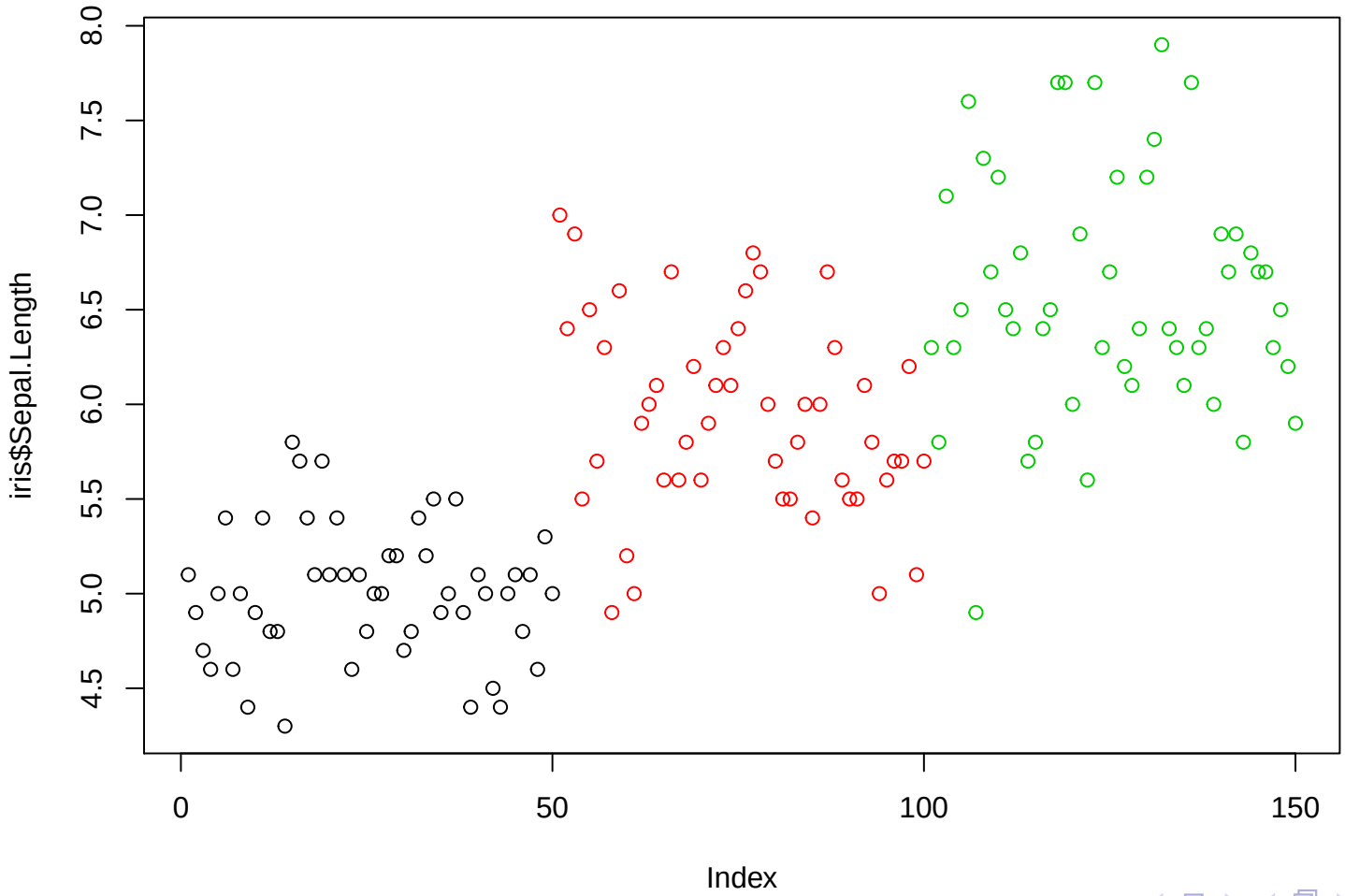


plot function: back to the mean

```
data("iris")
```

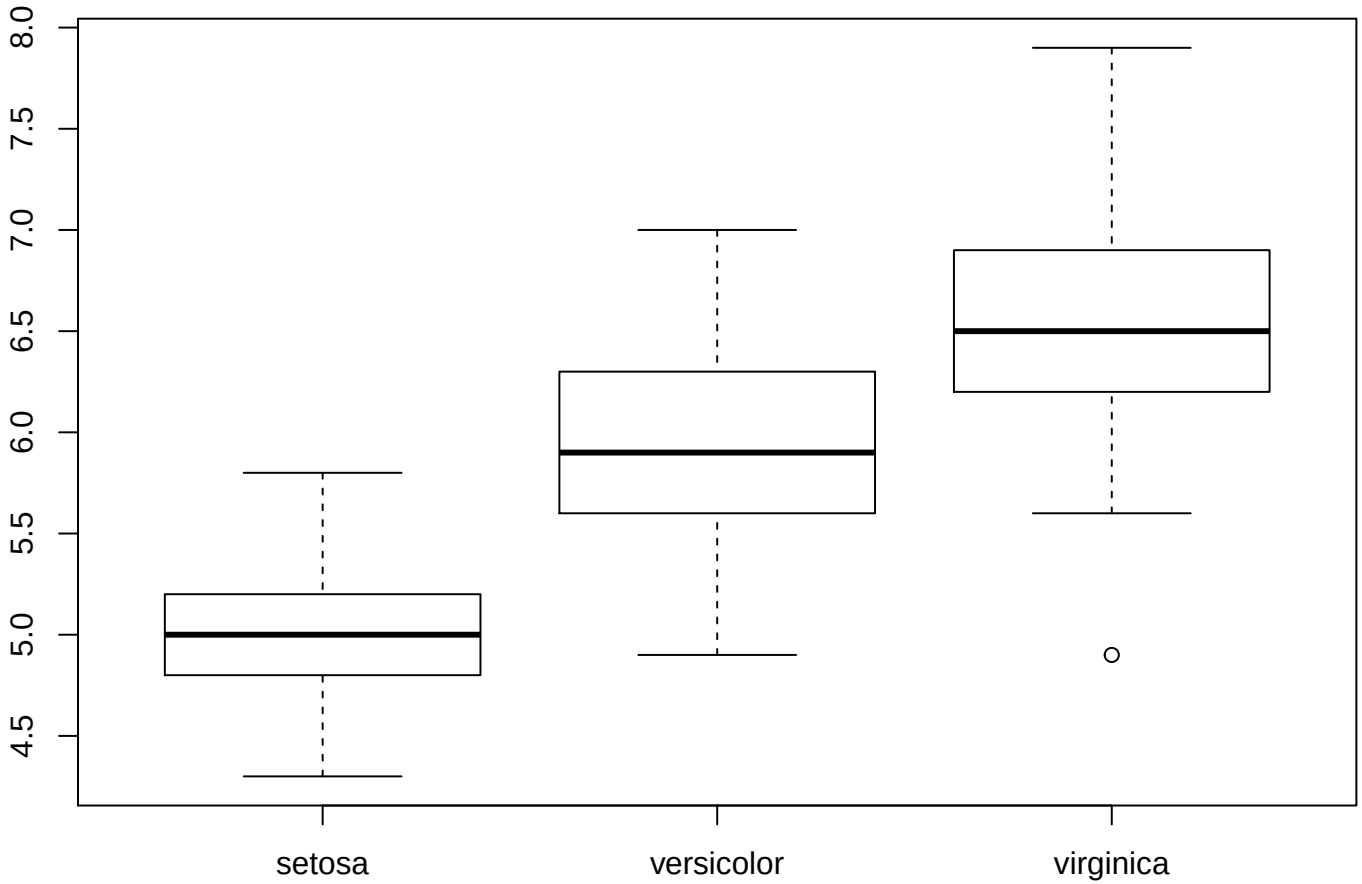
plot function: back to the mean

```
plot(iris$Sepal.Length, col=iris$Species)
```



boxplots

```
boxplot(iris$Sepal.Length ~ iris$Species)
```



Student's T.test introduction

```
?t.test
```

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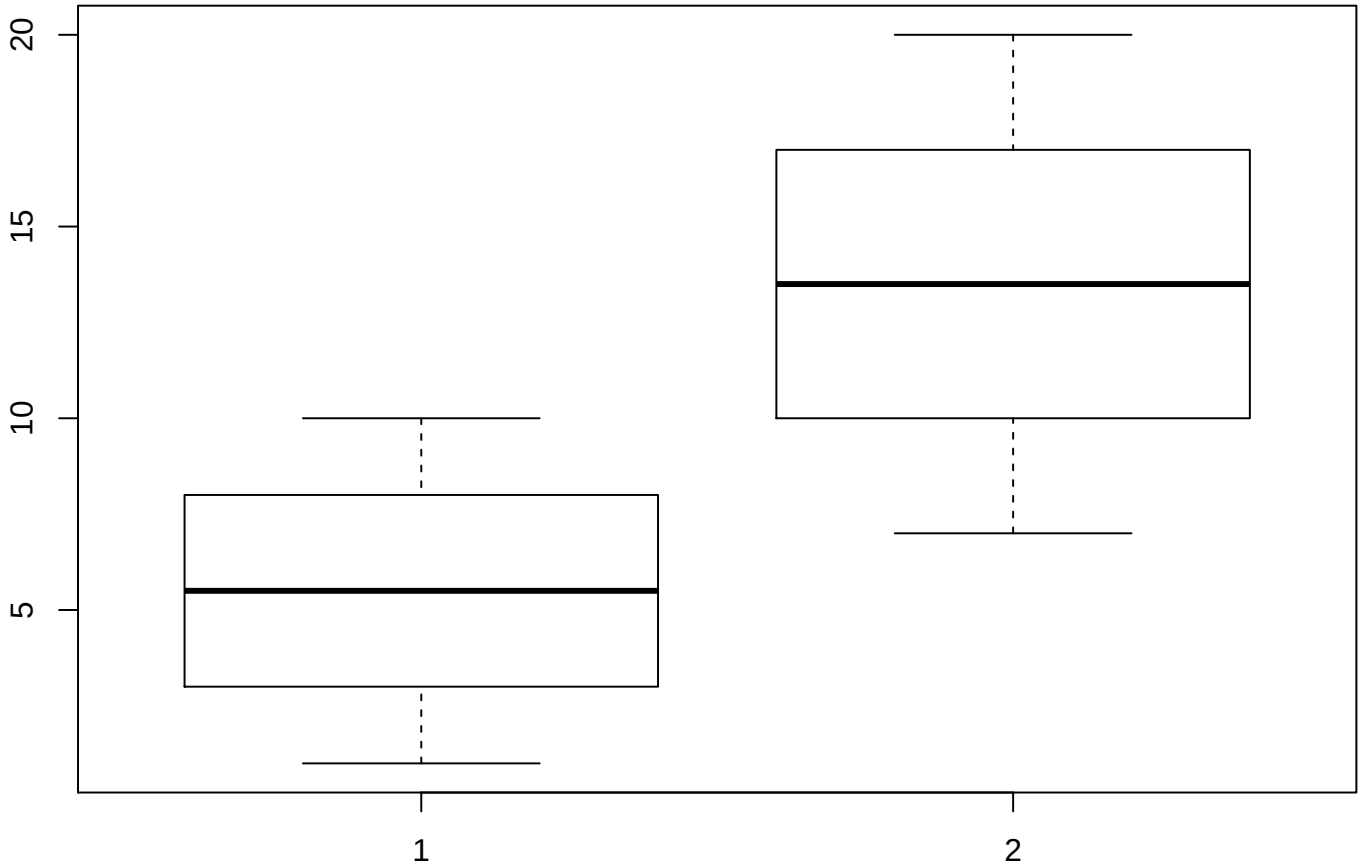
```
t.test(1:10, y = c(7:20))
```

```
Welch Two Sample t-test

data:  1:10 and c(7:20)
t = -5.4349, df = 21.982, p-value = 1.855e-05
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -11.052802  -4.947198
sample estimates:
mean of x mean of y
      5.5      13.5
```

T.test introduction

```
boxplot(c(1:10, 7:20) ~ c(rep(1,10), rep(2, 14)))
```



Are irises different?

Use t-tests to compare species in the iris dataset

Are irises different? Solution

Use t-tests to compare species in the iris dataset
Sorry, I was mean and forgot to tell about subsetting, which you needed here.
Subset to the species *setosa*:

```
iris[iris$Species == "setosa", ]
```

One t-test for sepal length between *setosa* and *versicolor*:

```
t.test(x = iris$Sepal.Length[iris$Species == "setosa"],
       y = iris$Sepal.Length[iris$Species == "versicolor"])
```