Lab: Learning R

Genomic Technologies Workshop 2024 (PLPTH885)

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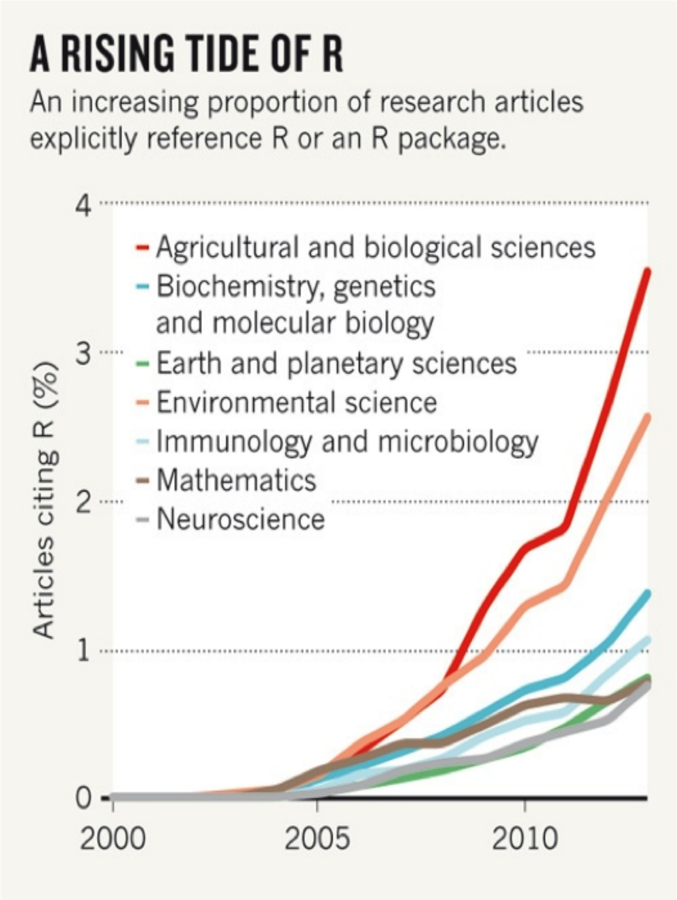
Outlines

- Introduction of R programming
- Introduction of RStudio's IDE
- Running basic R
    - Data structure (vector and data frame)
    - Data importing and exporting
    - Plotting
    - String operations

Why R?

- R is a free software
- R is great at statistical computing and graphics
- R has great community supports (CRAN repository, Bioconductor, GitHub)

r-project.org



R example 1 (R for statistics)

Chi-square test

```
d <- c(12, 36, 24, 70)
dm <- matrix(d, nrow=2, byrow=T)
dm
```

```
     [,1] [,2]
[1,]   12   36
[2,]   24   70
```

```
chisq.test(dm)
```

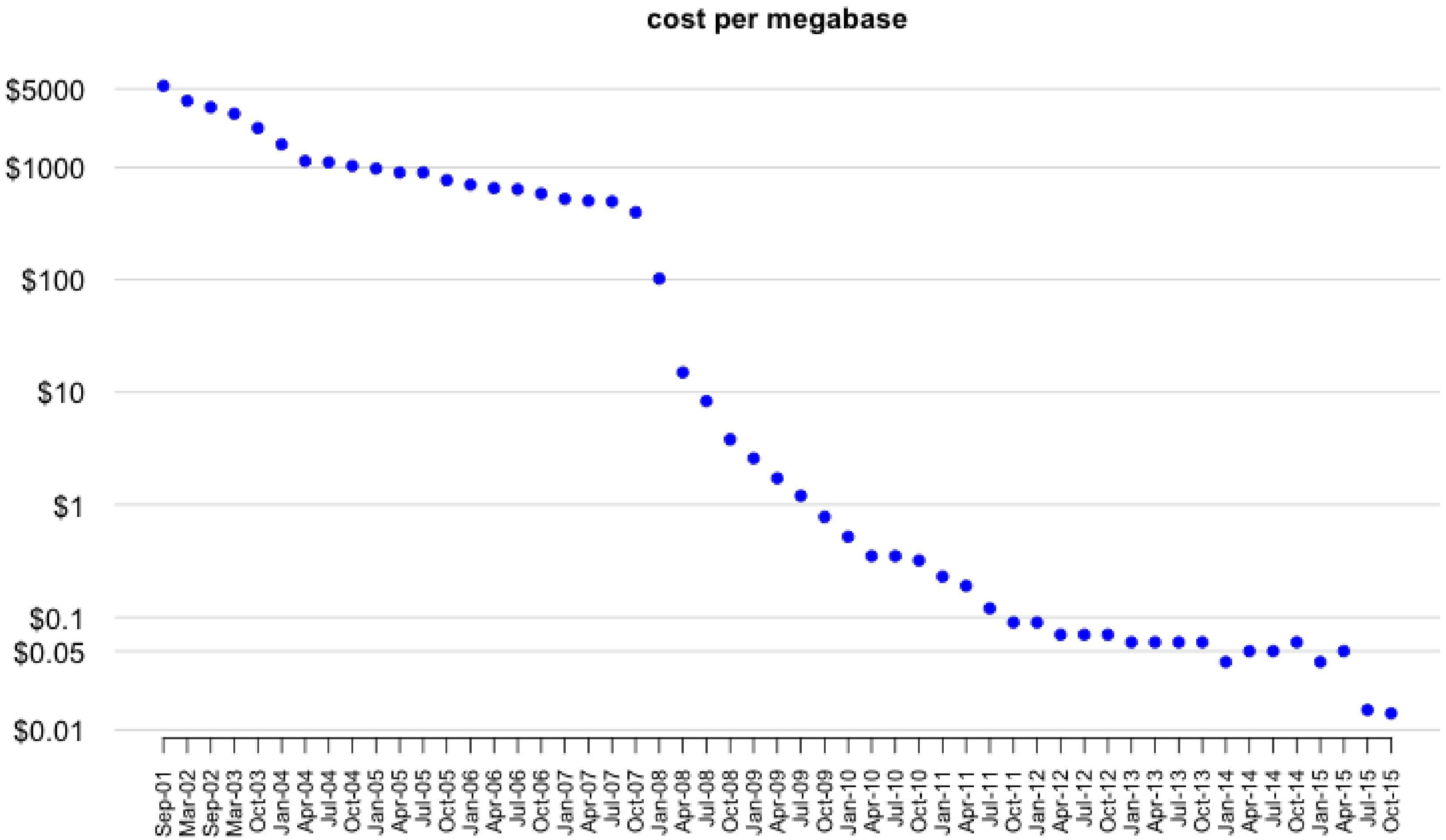
```

    Pearson's Chi-squared test with Yates' continuity correction

data:  dm
X-squared = 7.8894e-31, df = 1, p-value = 1
```

R example 2 (R for graphs)

```
ts="https://raw.githubusercontent.com/liu3zhenlab/teaching/master/RNA
source(ts)
```

R example 3 (R for graphs)

```
cs="https://raw.githubusercontent.com/liu3zhenlab/teaching/master/RN
source(cs)
```



How to run R?

Rstudio is an open source integrated development environment (IDE) for R.

https://www.rstudio.com/products/rstudio/

There are two versions of RStudio:

RStudio Desktop

Run RStudio on your desktop

RStudio Server

Centralize access and computation

beocat server

Install RStudio

- On your own machine (Rstudio Desktop)
    - Download and install R
    - Download and install Rstudio

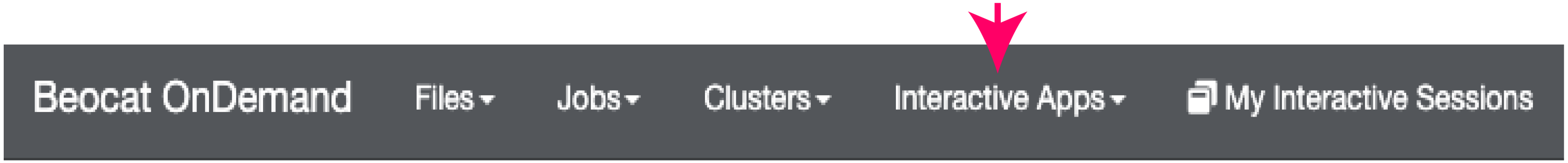
Slides and codes

https://github.com/liu3zhenlab/teaching/tree/master/RNA-Seq-Workshop/2024/forYOU

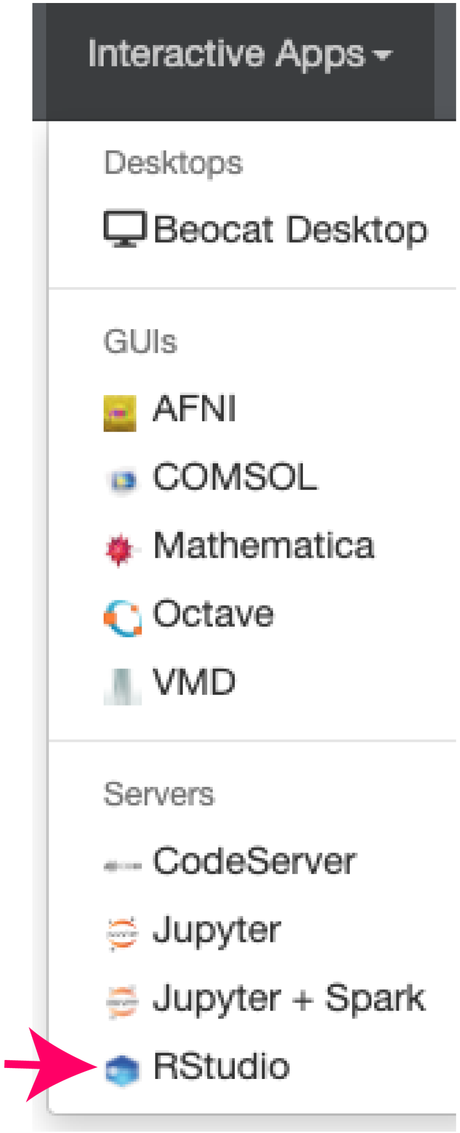
OnDemand at Beocat

ondemand https://ondemand.beocat.ksu.edu

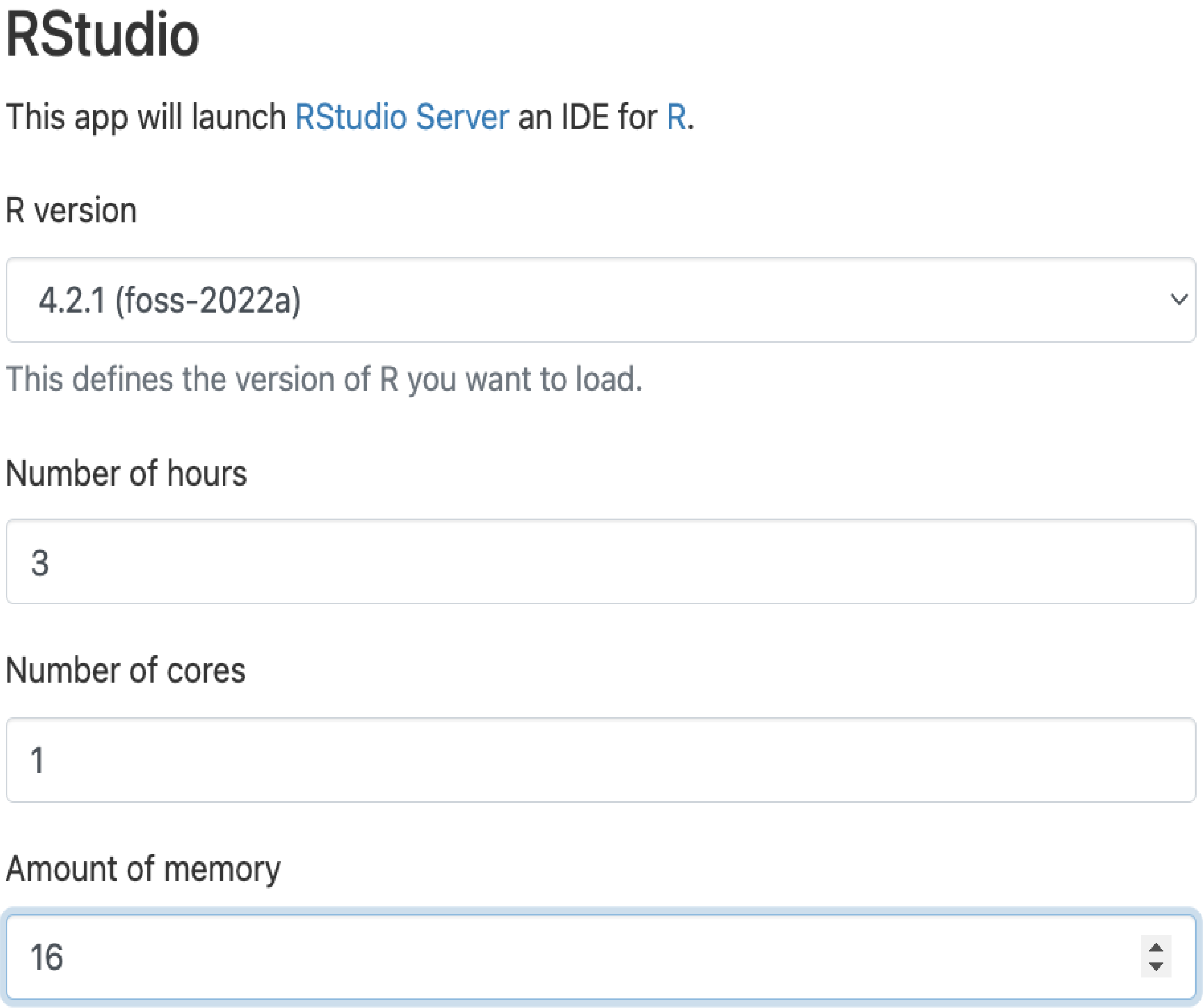
login with eID



Select RStudio



Request resources



RStudio

This app will launch RStudio Server an IDE for R.

R version

4.2.1 (foss-2022a)

This defines the version of R you want to load.

Number of hours

3

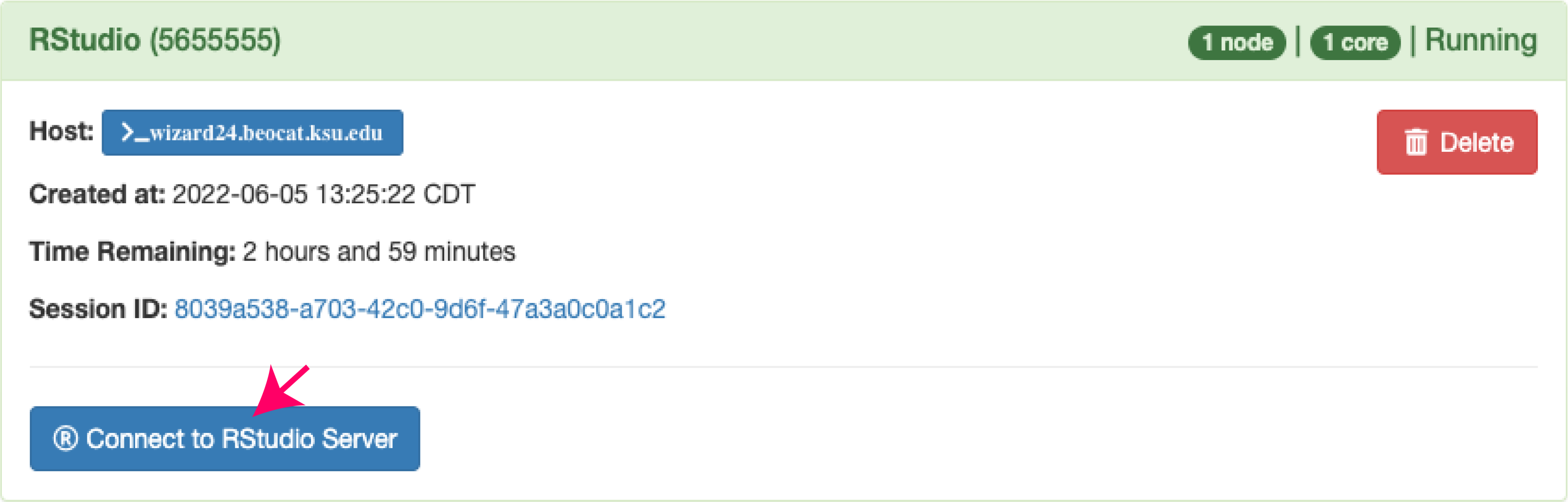
Number of cores

1

Amount of memory

16

Connect to RStudio



RStudio (5655555)

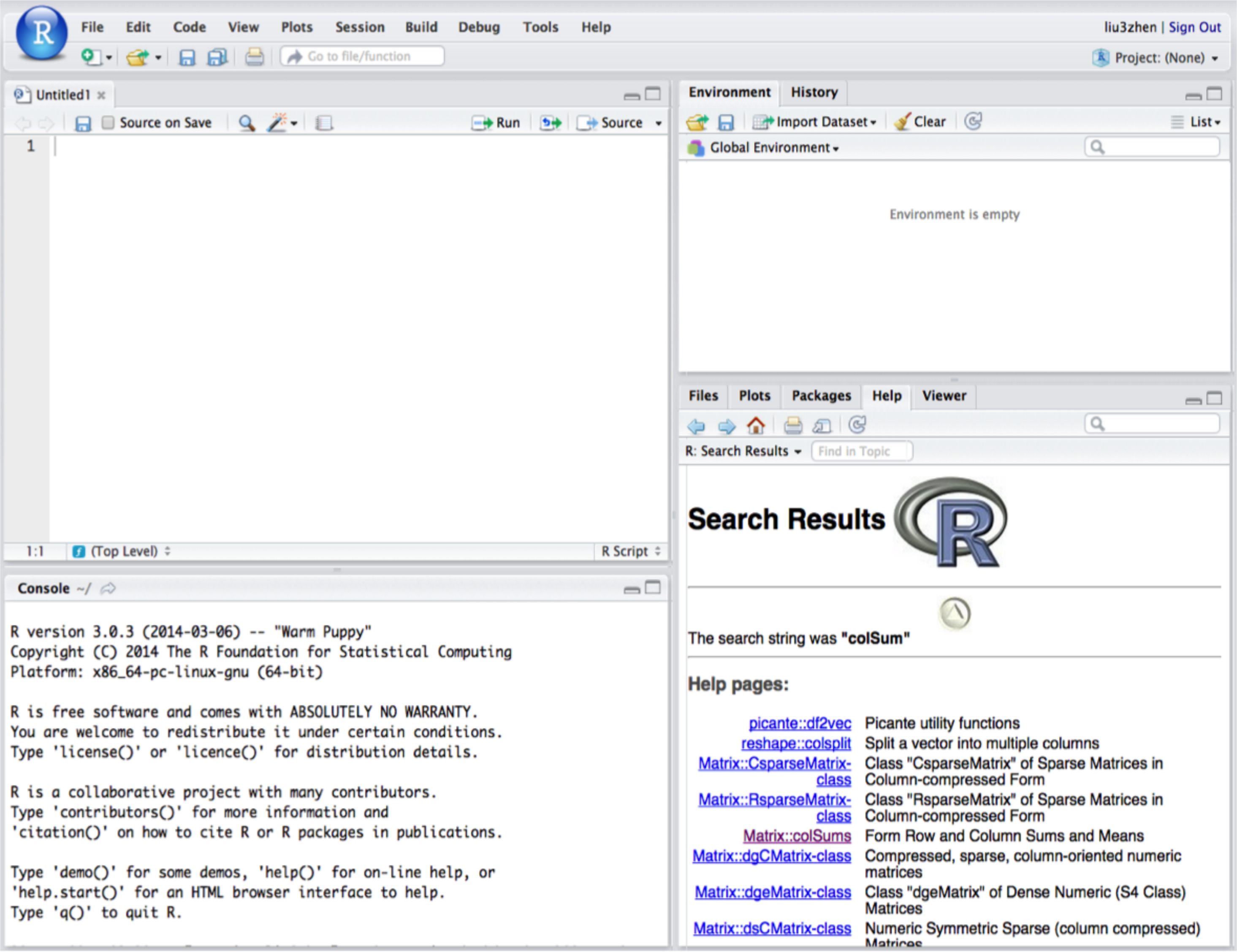
Host: >_wizard24.beocat.ksu.edu

Created at: 2022-06-05 13:25:22 CDT

Time Remaining: 2 hours and 59 minutes

Session ID: 8039a538-a703-42c0-9d6f-47a3a0c0a1c2

Rstudio interface



Environment is empty

```
R version 3.0.3 (2014-03-06) -- "Warm Puppy"
Copyright (C) 2014 The R Foundation for Statistical Computing
Platform: x86_64-pc-linux-gnu (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
```

Search Results

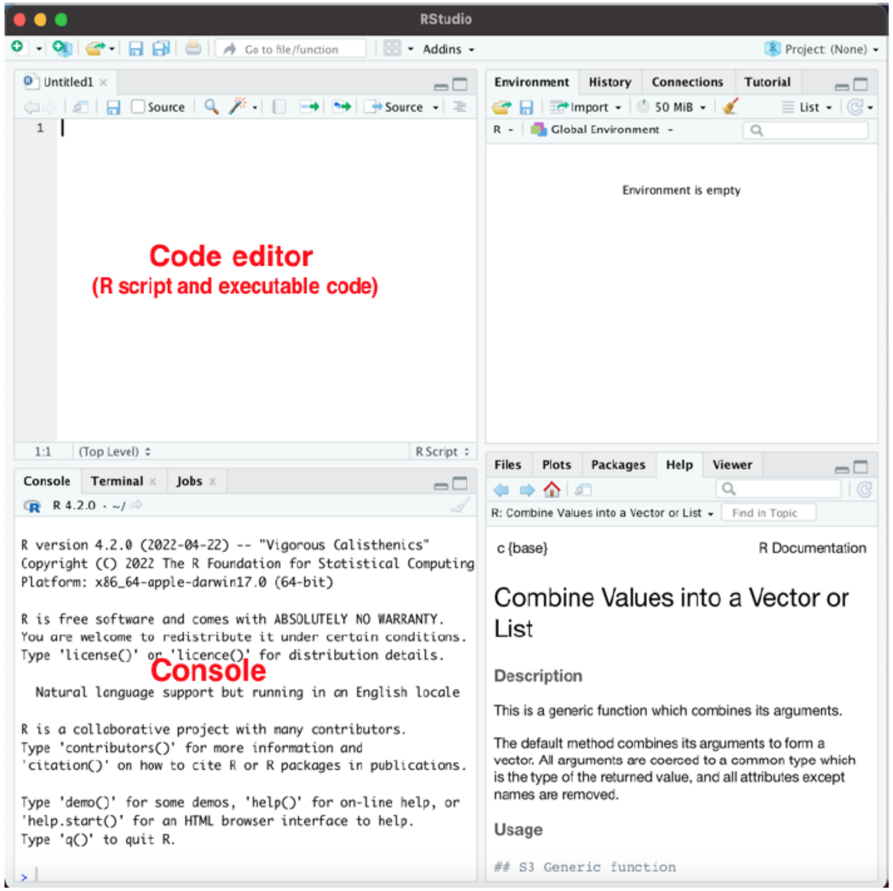
The search string was **"colSum"**

Help pages:

picante::df2vec	Picante utility functions
reshape::colsplit	Split a vector into multiple columns
Matrix::CsparseMatrix-class	Class "CsparseMatrix" of Sparse Matrices in Column-compressed Form
Matrix::RsparseMatrix-class	Class "RsparseMatrix" of Sparse Matrices in Column-compressed Form
Matrix::colSums	Form Row and Column Sums and Means
Matrix::dgCMatrix-class	Compressed, sparse, column-oriented numeric matrices
Matrix::dgeMatrix-class	Class "dgeMatrix" of Dense Numeric (S4 Class) Matrices
Matrix::dsCMatrix-class	Numeric Symmetric Sparse (column compressed) Matrices

RStudio Interface

RStudio IDE cheatsheet



```
R version 4.2.0 (2022-04-22) -- "Vigorous Calisthenics"
Copyright (C) 2022 The R Foundation for Statistical Computing
Platform: x86_64-apple-darwin17.0 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
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  Natural language support but running in an English locale

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'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

>
```

c {base} R Documentation

Combine Values into a Vector or List

Description

This is a generic function which combines its arguments.

The default method combines its arguments to form a vector. All arguments are coerced to a common type which is the type of the returned value, and all attributes except names are removed.

Usage

```
## S3 Generic function
```

- Executing commands for the code editor
    - PC window: control + return (enter)
    - Apple MAC: command + return (enter)

Setup working directory

Working directory is the default folder for input and output data.

```
setwd("/Users/liu3zhen/Downloads")
```

Getting started, R commands

Expression: evaluated, printed, and the value lost

```r
2 + 4
```

```
[1] 6
```

```r
68 * 0.15
```

```
[1] 10.2
```

Assignment

assign values to a variable
the value passed to a variable but NOT printed

assignment operator: <- or =

```
y <- 2
y = 2
y
```

```
[1] 2
```

```
info <- "hello world"
cat(info)
```

```
hello world
```

Notes

- Comments (#): Notes to scripts, starting with a hashtag (‘#’), everything to the end of the line is a comment.

```
y <- 2 + 4  # an example of the assignment
```

- Variable names are case senstive

```
y <- 2
Y <- 3
y
```

```
[1] 2
```

```
Y
```

```
[1] 3
```

vector: multiple elements

A vector is a single entity consisting of an ordered collection of numbers, characters, logical quantities, etc.

concatenate command: **c()**

- Numeric vector
  c(10.4, 5.6, 3.1, 6.4, 21.7)

vector manipulation (I)

```
# Numeric vector
x <- c(10.4, 5.6, 3.1, 6.4, 21.7)
sum(x)
```

```
[1] 47.2
```

```
2*x
```

```
[1] 20.8 11.2  6.2 12.8 43.4
```

```
### extract 2nd elements
x[2]
```

```
[1] 5.6
```

vector manipulation (II)

Logical vector

```r
lv <- c(TRUE, FALSE, TRUE, TRUE)
!lv
```

```
## [1] FALSE  TRUE FALSE FALSE
```

```r
lv == FALSE
```

```
## [1] FALSE  TRUE FALSE FALSE
```

vector manipulation (III)

```r
# Character vector
cv <- c("a", "b", "c")
cv2 <- paste(cv, 1:3, sep="")
cv2
```

```
[1] "a1" "b2" "c3"
```

```r
# Missing value  (NA, not available)
mvv <- c("a", "b", "c", NA)
is.na(mvv)
```

```
[1] FALSE FALSE FALSE  TRUE
```

vector manipulation (IV)

Vectors must have their values with the same mode, either numeric, character, logical, or other types. **conversion to other modes**

```
z <- 0:9
is.numeric(z)
```

```
[1] TRUE
```

```
z
```

```
 [1] 0 1 2 3 4 5 6 7 8 9
```

```
digits <- as.character(z) # convert to character
digits
```

```
 [1] "0" "1" "2" "3" "4" "5" "6" "7" "8" "9"
```

```
d <- as.numeric(digits) # convert to numeric
d
```

```
 [1] 0 1 2 3 4 5 6 7 8 9
```

vector manipulation (V)

- Select a subset of a vector

```
x <- c(4, 5, 7, 3, 9)
x[c(2, 3)]
```

```
[1] 5 7
```

```
x[x>6]
```

```
[1] 7 9
```

```
x[-c(1, 5)]
```

```
[1] 5 7 3
```

- Modify a vector

```
x[3] <- 23.1
c(x, 10.9)
```

```
[1]  4.0  5.0 23.1  3.0  9.0 10.9
```

Question

Can a vector contain different types of elements?

```
c(1, "a")
c(1, TRUE)
c(TRUE, "a")
c(1, "a", TRUE)
```

Data frame

A data frame may be regarded as a matrix (table) with columns possibly of differing modes

- Making data frames

```
df <- data.frame(name=c("Josh", "rose"), age=c(23, 35))
df
```

```
  name age
1 Josh  23
2 rose  35
```

Working with a data frame

```
df
```

```
  name age
1 Josh  23
2 rose  35
```

Trying these commands:

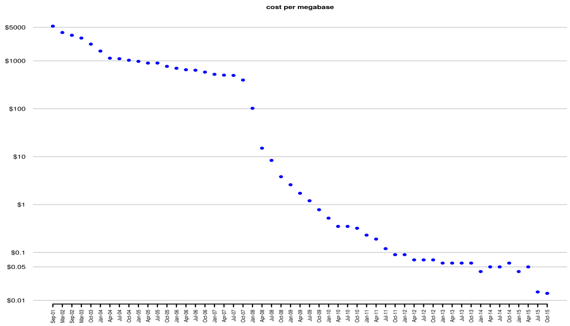
```
head(df, 1)
tail(df, 1)
str(df)
df[2, 1]
df[2, 2]
df[2]
df[, 2]
```

Importing data

read.table(): to read a data frame (table)
read.delim, **read.csv**

```
cpm="https://raw.githubusercontent.com/liu3zhenlab/teaching/master/RN
d <- read.delim(cpm)
head(d, 3)
```

```
    Date Cost.per.Mb Cost.per.Genome
1 Sep-01     5292.39        95263072
2 Mar-02     3898.64        70175437
3 Sep-02     3413.80        61448422
```



cpm="https://raw.githubusercontent.com/liu3zhenlab/teaching/master/RNA-Seq-Workshop/2024/lab_DE/data/cs.txt"

Exporting data

write.table() or **write.csv()**

To write a tab-delimited file

```
x <- data.frame(a = "pi", b = pi)
write.table(x, file="foo.txt", sep="\t", row.names=FALSE)
```

- file="foo.txt": foo.txt is the ouput file name
- sep="\t": separated by a tab (\t)
- row.names=FALSE: row names are not included in the output

Practice by your own

- Create a data frame

  three columns: 1. Name 2. Major 3. Gender
  three rows (entries): your neighbors and you

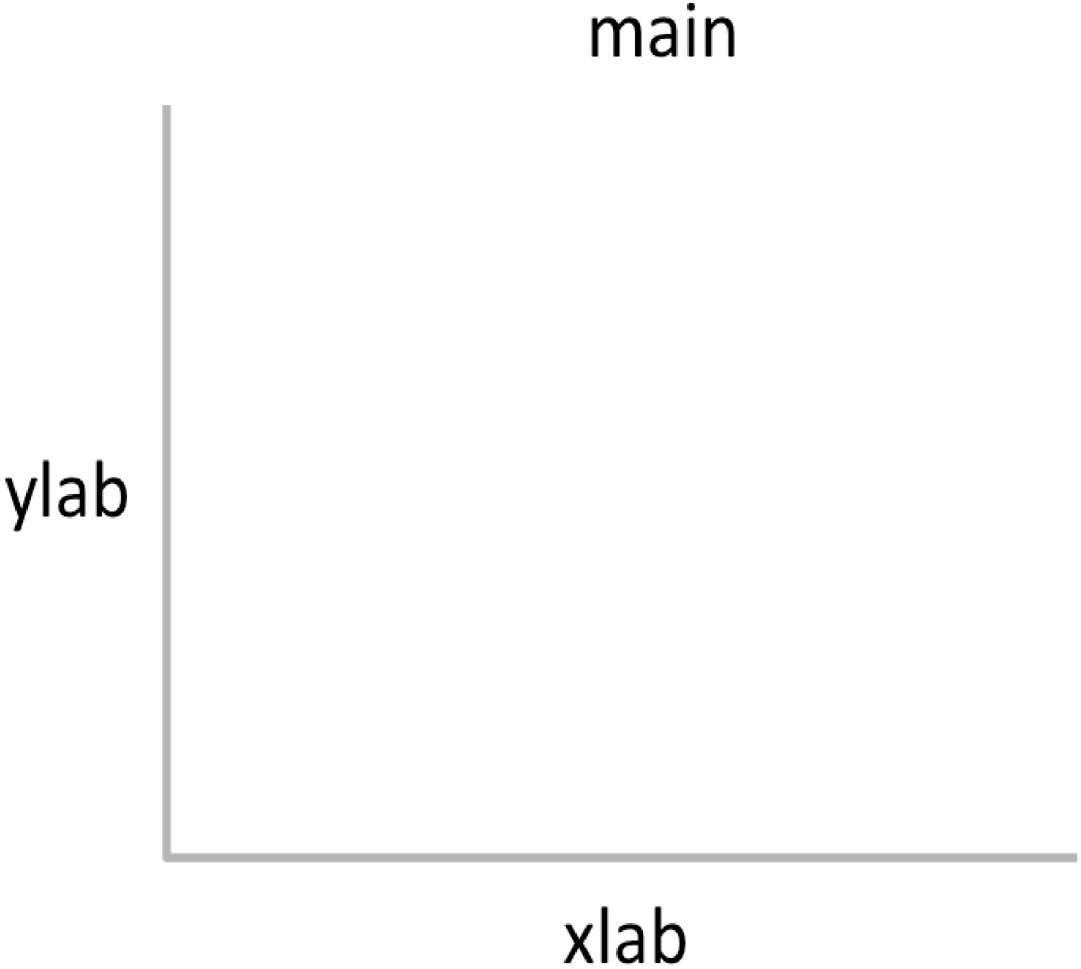
- Write the data frame to an output file

- Read the file to R and add one more column (e.g., favorite color)

Plotting: plot()

High-level plot: create a new plot

plot(x, y, xlab, ylab, main, …)



Adding contents to a plot

Low-level plot: add to an existing plot

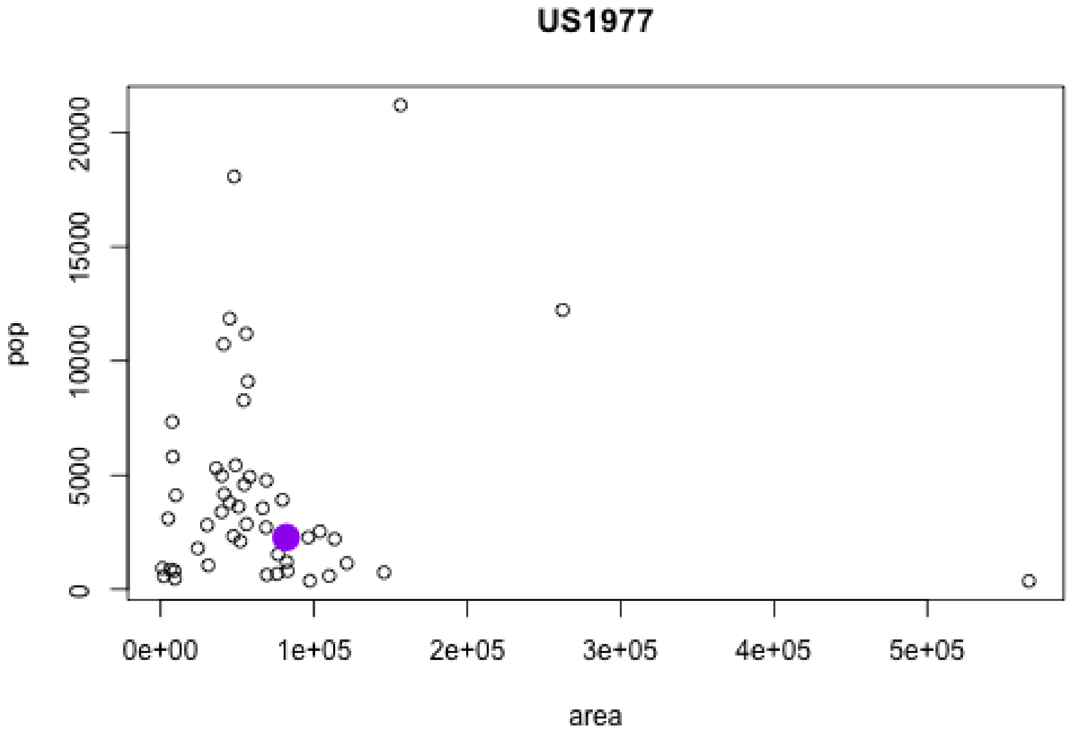
- add points
  points()

- add lines
  lines()

- add text or legend
  text()
  legend()

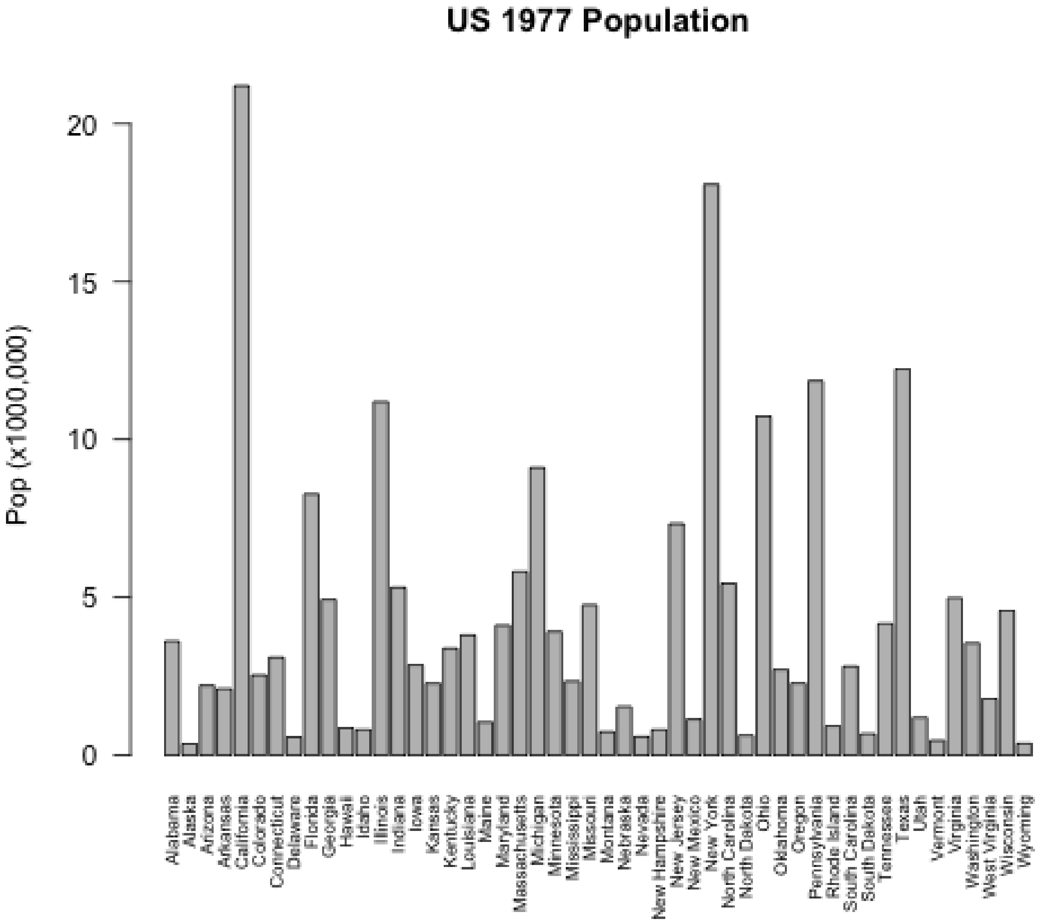
Scatter plot

```
area <- state.x77[, "Area"]
pop <- state.x77[, "Population"]
# scatter plot
plot(area, pop, main="US1977")
# label points
points(area["Kansas"], pop["Kansas"], col="purple",
       lwd=2, pch=19, cex=2)
```



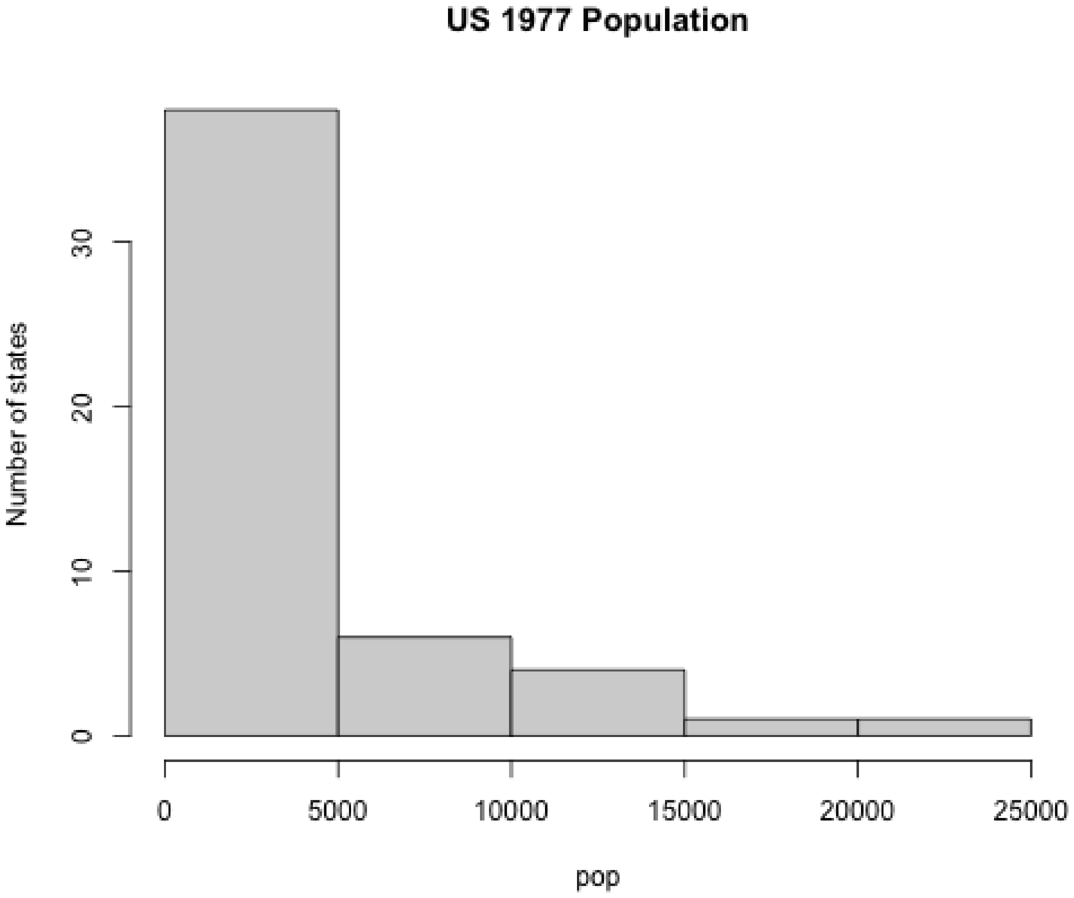
Boxplot

```r
barplot(pop/1000, las=2, cex.names=0.65, ylab="Pop (x1000,000)",
        main="US 1977 Population")
```



Histogram

```
hist(pop, ylab="Number of states", main="US 1977 Population")
```



String operations - nchar

nchar() nchar the sizes of the corresponding elements of a vector.

```
cvec <- c("google", "hello", "the", "world")
nchar(cvec)
```

```
[1] 6 5 3 5
```

String operations - grep

grep() grep searches for matches to argument pattern within each element of a character vector

```r
cvec
```

```
[1] "google" "hello"  "the"    "world"
```

```r
grep("o", cvec)
```

```
[1] 1 2 4
```

String operations – sub and gsub

sub() and **gsub()** sub and gsub perform replacement of the first and all matches respectively.

```
cvec
```

```
[1] "google" "hello"  "the"    "world"
```

```
sub("o", "O", cvec)
```

```
[1] "gOogle" "hellO"  "the"    "wOrld"
```

```
gsub("o", "O", cvec)
```

```
[1] "gOOgle" "hellO"  "the"    "wOrld"
```

Getting help

Usage of commands

- help(nchar)
- ?nchar
- ??colsum

R Reference Card

- stack overflow
- google

Learning R at swirlstats

education.rstudio.com