# Intro to This Course; Getting Started with R Enrico Toffalini

# Why becoming an R user?

- Mainstream in academia for data science, increasingly used in business. *Job market advantage!*
- Free & open-source: wherever you go, R will be with you at no costs (unlike *MPLUS*, *MATLAB*, *SPSS*, etc.)
- **Real programming language**: difficult at the beginning, but: 1) gives you lots of flexibility; 2) has transfer on other programming languages (e.g., *Python*).
- Vast community support thanks to a large and active community (also, *chatGPT*, *Lucrez-IA*, etc., know it pretty well!).
- Huge ecosystem, >20,000 packages on CRAN, more from other sources (e.g., GitHub), to do amazing stuff with statistical data analysis, machine learning, data visualization, developing webapps [*shiny*], writing reports and even entire books [*bookdown*, *rmarkdown*]), can integrate with *quarto*, *github*.
- Facilitates **reproducible research** by sharing code and workflows.

# What you may expect to learn in this course:

- Executing fundamental operations and using basic functions;
- Working with essential data types and structures;
- Gaining some proficiency in managing and manipulating data with vectors and dataframes;
- Understanding some fundamental concepts of programming.

### Over the next *couple of years*, following this PhD program, you may have the opportunity to learn to use R to perform at least some fundamentals about:

- Core statistical inference methods;
- (Generalized) linear (mixed-effects) modeling;
- Data visualization using ggplot2;
- Power analysis via data simulation;
- Structural Equation Modeling (SEM);
- Conducting Meta-Analysis.

### you may even create greeting cards



### you may even create greeting cards



### or like fancy infographics



# or like fancy infographics







### perform classical data analysis



### you may create interactive webapps with Shiny

#### see Shiny gallery

here's a couple of recent real examples from **Psicostat** members:

- this game-like shiny app developed for the science4all event in Padova; see here some explanation in Italian
- practical ad-hoc shiny app for scoring experimental data collected by students

### you may create interactive webapps with Shiny



### or entire websites and books

- this entire course is a website in its own right
- the course textbook is a book/website
- also see this wonderful book by Daniël Lakens explaining Statistical Inference

of course, these resources integrate other tools such as GitHub and Quarto, but they can be created within the R ecosystem

### install R and Rstudio

first of all, for getting started, follow the instructions in *Chapter 1* of *Introduction2R* to ensure that both R and RStudio are installed

### R Console (just base R)

<pre>Number Variation Variatio Variation Variation Variation Variation Variation Varia</pre>	<pre>The Modifica Vusaliza Varia Pachetic Finetic Auto  Presulta Spratue=NA)  % = 50 % 0 = 0 bl = 0.5 sigma = 1 for(i in 1:niter){ x = norm(N,0,1) y = b0 + x*b1 + norm(N,0, sigma) df = data.frame(x,y) fit = lm(y-x, data=df) resultsSpratue[1] = summary(fit)Scoefficients["x", "Pr(&gt; t )"] } (power = mean(resultsSpratue&lt;0.05))  CONSOLEE  CONSOLE  CONSOL  CONSO</pre>	RGui (64-bit)	- 🗆 X
<pre>Cluerstud fain Destrop RetuideShow R - Editor di R  Cluerstud fain Destrop RetuideShow R - Editor di R  Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Destrop RetuideShow R - Editor di R  F Cluerstud fain Person Retuites Person Retuites</pre>	<pre>     Set b b c 0      ContentiationDestrophysicalCode R+ idea dR</pre>	File Modifica Visualizza Varie Pacchetti Finestre Aiuto	
<pre>     CONsectorfaim/Destacy/Estudidshow.R-Editor diR     f Simulation example     niter = 10000     results = data.frame(iter=1:niter,</pre>	<pre>     CluentueHaindDestrepRitudedShow.R-tider diR     f Simulation example     niter = 10000     results = data.frame(iter=1:niter,</pre>		
		<pre>CluserAtoffalinADecktop/RetudioShow.R - Editor diR  # Simulation example niter = 10000 results = data.frame(iter=1:niter,</pre>	<pre>Presults = data.frame(iter=1:niter,</pre>
			> > < <

# R Studio (full IDE)

RStudio			- 0 ×
		Constant Transfer Law Parlamental Library	
na Vinaex.Rma		Console lerminal Background Jobs	ata Caian ao Kilidae (Egurae) ( 🛋
<pre>Source i Source Sour</pre>	<pre>example ota.frame(iter=1:niter, pvalue=NA) sccript bl + rnorm(N,0,sigma) frame(x,y) -x, data=df) alue[i] = summary(fit)\$coefficients["x","Pr(&gt; t )"] n(results\$pvalue&lt;0.05)) R Script = onnections Tutorial t = 176 MiR + 100 = Lit + 100</pre>	<pre>     R 4.3.3 - ~/Dottorato lezioni didattica/R for Data Science/_GITHUB Basics R D     + }         (power = mean(results\$pvalue&lt;0.05)) [1] 0.918         # Simulation example         niter = 10000         results = data.frame(iter=1:niter,</pre>	ataScience/Slides/figures/ ↔
R 👻 💼 Global Environmer	nt • Q	Files Plots Packages Help Viewer Presentation	
Data		🖆 New Folder 📩 New Blank File 👻 🎙 Delete 📑 Rename 🔅 More	C
💽 df	50 obs. of 2 variables	□	s R DataScience > Slides > figures
🔍 fit	List of 12 Q	A Name	Size Modified
results	10000 obs. of 2 variables	<b>t</b>	
Values		🔲 🔤 faviconpsicostat2.png	79.8 KB Oct 31, 2024, 10:25 AM
b0	0		264 KP Mar 4 2024 2:05 DM
b1	0.5		
i	10000L	RstudioShow.R	378 B Oct 31, 2024, 5:08 PM
N niter power	50 10000 0.9105	FILE EXPLO	DRER, ETC.
	Q Search	0 0 🗐 📮 🛃 🧳	17:08 31/10/2024

#### Some R packages that you will or may need in the future (1/3)

Package	Used for what	Example(s) of functions
<mark>base</mark> (base R)	Basic functions	<pre>sum, mean, sqrt, abs, c, data.frame, summary, scale, plot, +, -</pre>
<mark>stats</mark> (base R)	Basic statistical calculations and functions	<pre>sd, cor, cor.test, t.test, lm, glm, AIC, rnorm, rbinom</pre>
<b>graphics</b> (base R)	Basic statistical calculations and functions	boxplot,hist,barplot
effectsize	Compute different effect sizes	cohens_d,hedges_g, cohens_f,d_to_r

Some R packages that you will or may need in the future (2/3)

Package	Used for what	Example(s) of functions
lme4	Fitting (generalized) (non-)linear mixed-effects models	lmer,glmer,ranef
performance	Useful tools for models	<pre>check_collinearity, r2_nagelkerke,icc</pre>
effects	Display effects for various statistical models	allEffects
emmeans	Estimate marginal means for various models	emmeans
ggplot2	Create beautiful plots using The Grammar of Graphics	ggplot,geom_*

Some R packages that you will or may need in the future (3/3)

Package	Used for what	Example(s) of functions
lavaan	Structural equation modeling (SEM)	cfa,sem
semTools	Useful tools for SEMs	reliability
metafor	Perform meta-analysis	rma,rma.mv,forest, funnel,regtest
brms	Fitting practically any Bayesian model via MCMC with STAN	brm, prior
blavaan	Fitting Bayesian SEMs	bcfa,bsem

# Let's Test the Environment!

#### Let's run a few commands in RStudio to familiarize with its console and see if the installation works properly

rnorm(10) # draw 10 random values from a Standard Normal distribution

[1] -0.6413310 0.8836073 1.8365631 -0.1827433 -0.5840397 0.3447416 [7] -0.1011572 -0.4105428 0.7944173 1.4587431

?rnorm # open the help tab for the "rnorm" function

round ( rnorm (10, mean=100, sd=15) ) # draw 10 values from IQ distribut.

[1] 116 103 112 108 116 124 121 87 85 87

install.packages("psych") # install a package from CRAN

library(psych) # load the newly installed package

fisherz(rho=0.9) # use it to transform a correlation into a Fisher's z

[1] 1.472219