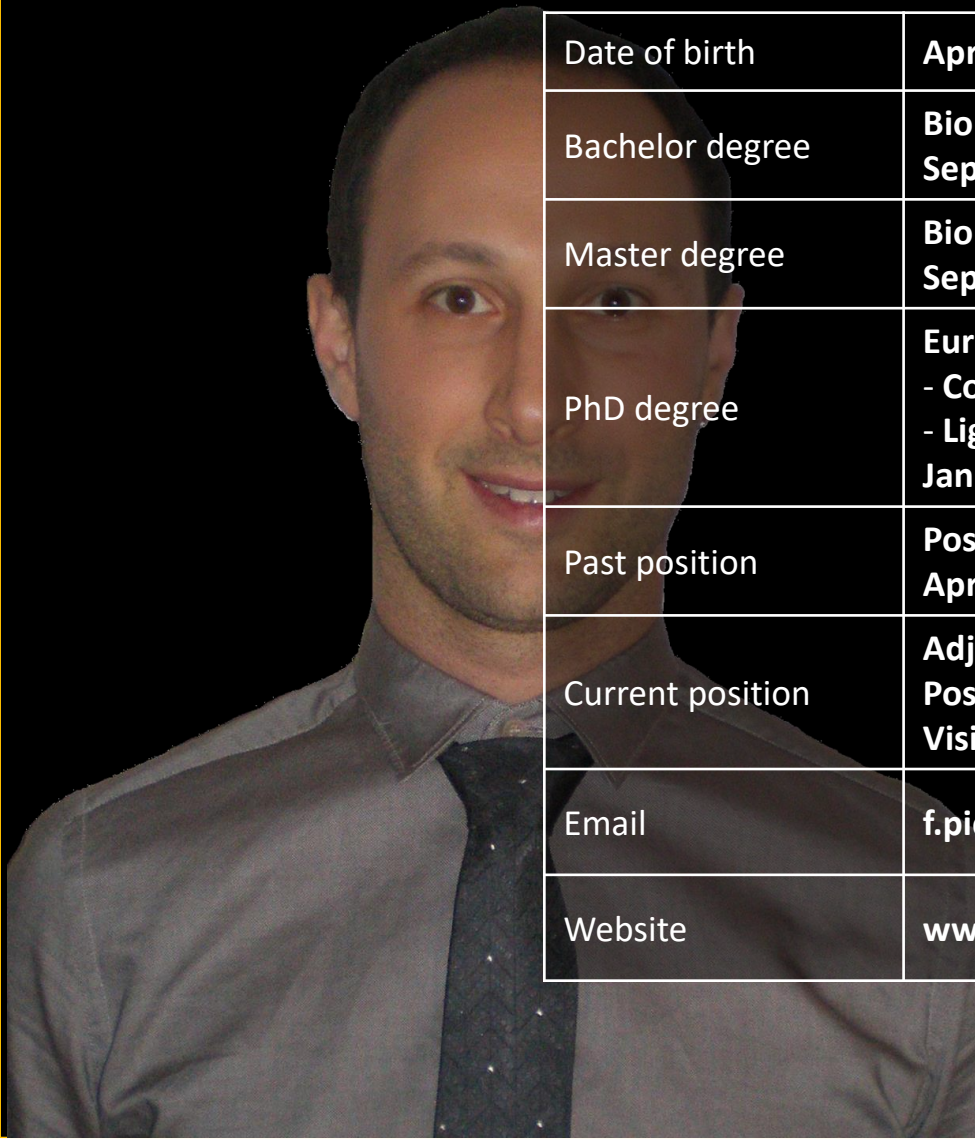# 93064 - STATISTICS (Modulo 2)

Eng. Filippo Piccinini, PhD
f.piccinini@unibo.it

Laurea in Economics and Finance (CLEF)
Alma Mater Studiorum, University of Bologna
2020/2021

Filippo Piccinini

Date of birth	**April 20, 1985**
Bachelor degree	**Biomedical Engineer, University of Bologna, September 2004 - July 2007, score: 110/110 cum LAUDE**
Master degree	**Biomedical Engineer, University of Bologna September 2007 - October 2009, score: 110/110 cum LAUDE**
PhD degree	**European Doctorate in Information Technology** **- Computer Vision Group, University of Bologna** **- Light Microscopy and Screening Center, ETH Zurich** **January 2010 – April 2013 (3 years)**
Past position	**Postdoc Research Fellow, University of Bologna April 2013 – February 2017 (4 years)**
Current position	**Adjunct Professor, University of Bologna, Italy** **Postdoc Research Fellow, IRCCS-IRST, Meldola, Italy** **Visiting Scientist, BIOMAG, HAS-BRC, Szeged, Hungary**
Email	**f.piccinini@unibo.it**
Website	**www.filippopiccinini.it**

Software tools

- **ReViSP**, for cancer spheroids Reconstruction and Visualization using a Single Projection
  http://sourceforge.net/projects/revisp

- **ReViMP**, for cancer spheroids Reconstruction and Visualization using Multiple Sections
  http://sourceforge.net/projects/revimp

- **AnaSP**, software suite to segment brightfield images of multicellular spheroids
  http://sourceforge.net/projects/anasp

- **F-Tracker3D,** for tracking in 3D fluorescent particles imaged with a light-sheet microscope.
  http://sourceforge.net/p/f-tracker3d

- **CellTracker,** for tracking cells cultured in vitro
  http://celltracker.website

- **Advanced Cell Classifier**, for classifying cells in high-content screening images
  http://www.cellclassifier.org

- **MicroMos**, for building a panorama, starting from a set of overlapping images
  http://www.filippopiccinini.it/Mosaicing/index.html

- **CIDRE**, for correcting the illumination field of microscopy images
  http://www.nature.com/nmeth/journal/v12/n5/full/nmeth.3323.html

- ....

Let's play!

How many dots are there?
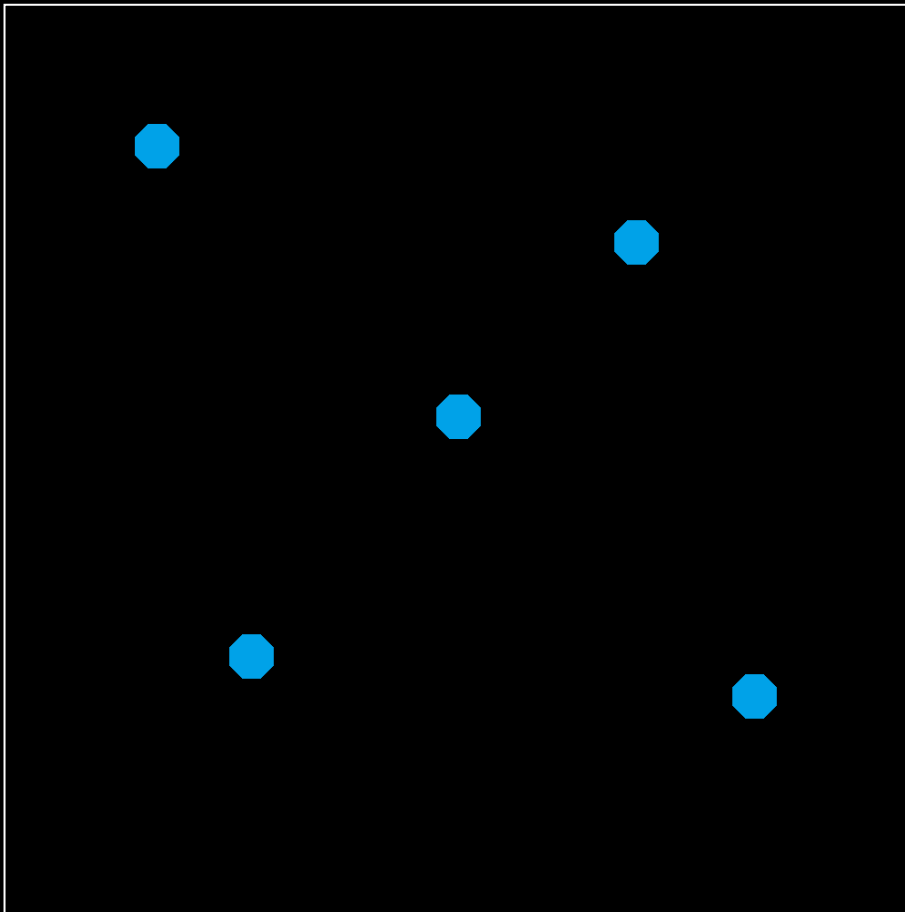
Let's play!

How many dots are there?
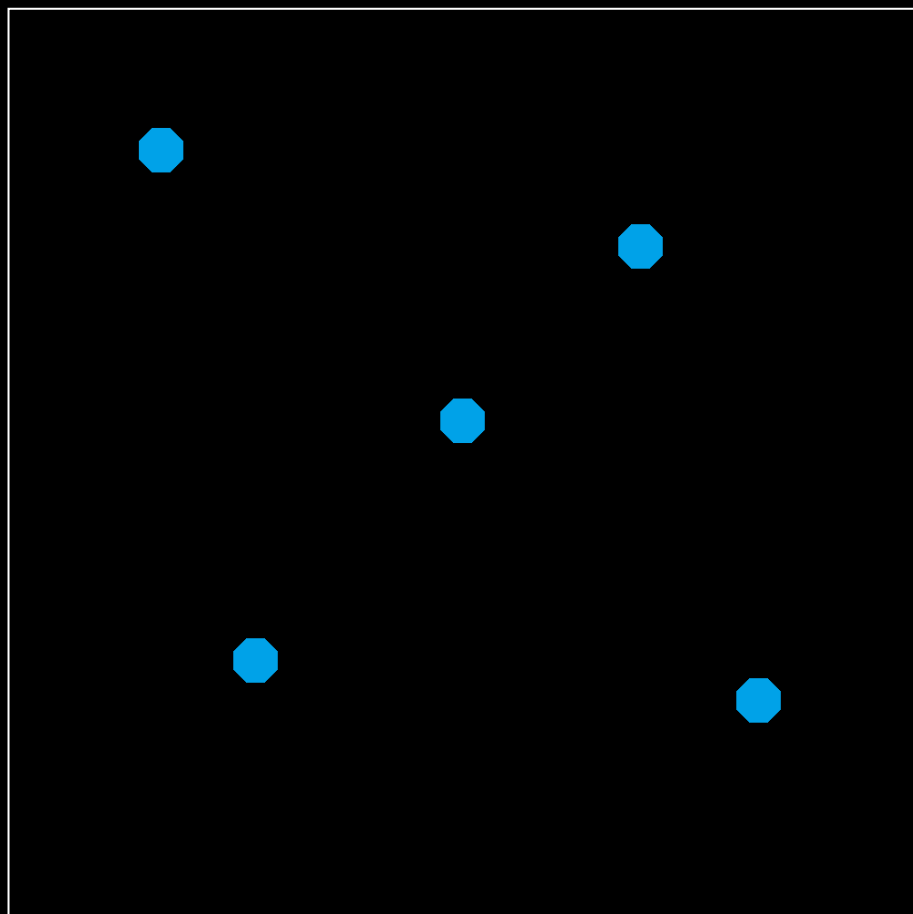
Let's play!

How many dots are there?

5 DOTS

PERFORMANCE:

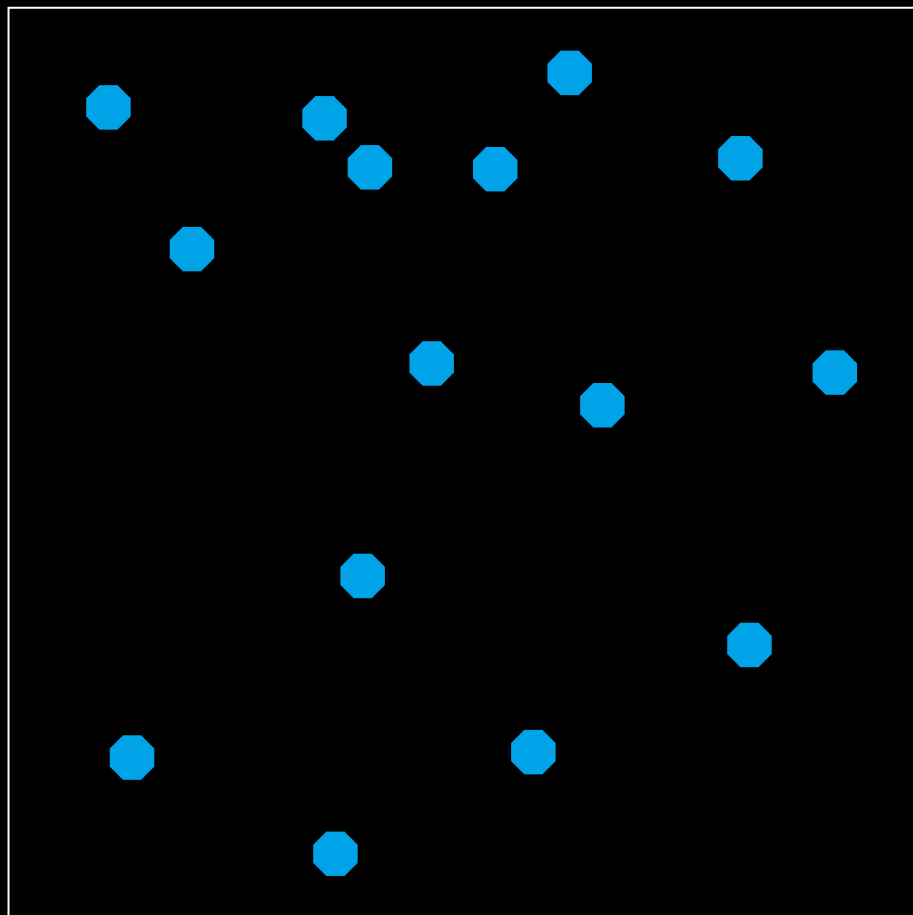**Humans ~3 sec**

Computers ~1 sec

(using the standard Watershed segmentation algorithm)

Let's play!

How many dots are there?

Let's play!

How many dots are there?

Let's play!

How many dots are there?

15 DOTS

PERFORMANCE:

Humans ~6 sec

Computers ~1 sec

(using the standard Watershed segmentation algorithm)
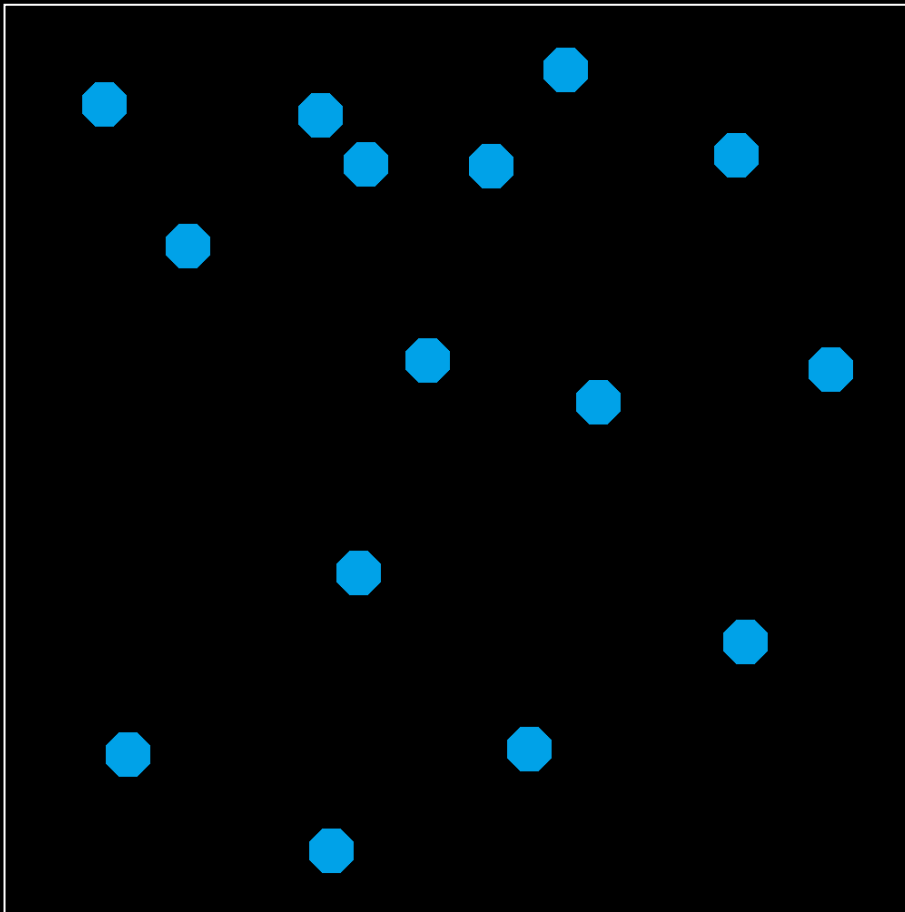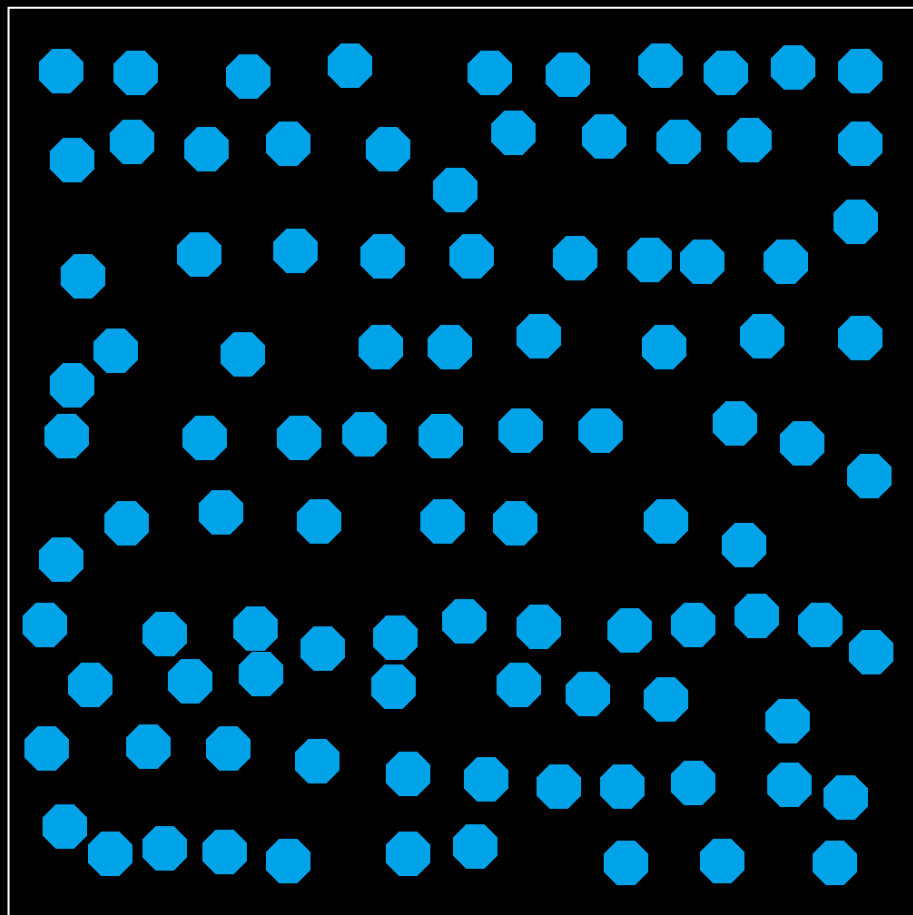
Let's play!

How many dots are there?

Let's play!

How many dots are there?

Let's play!

How many dots are there?
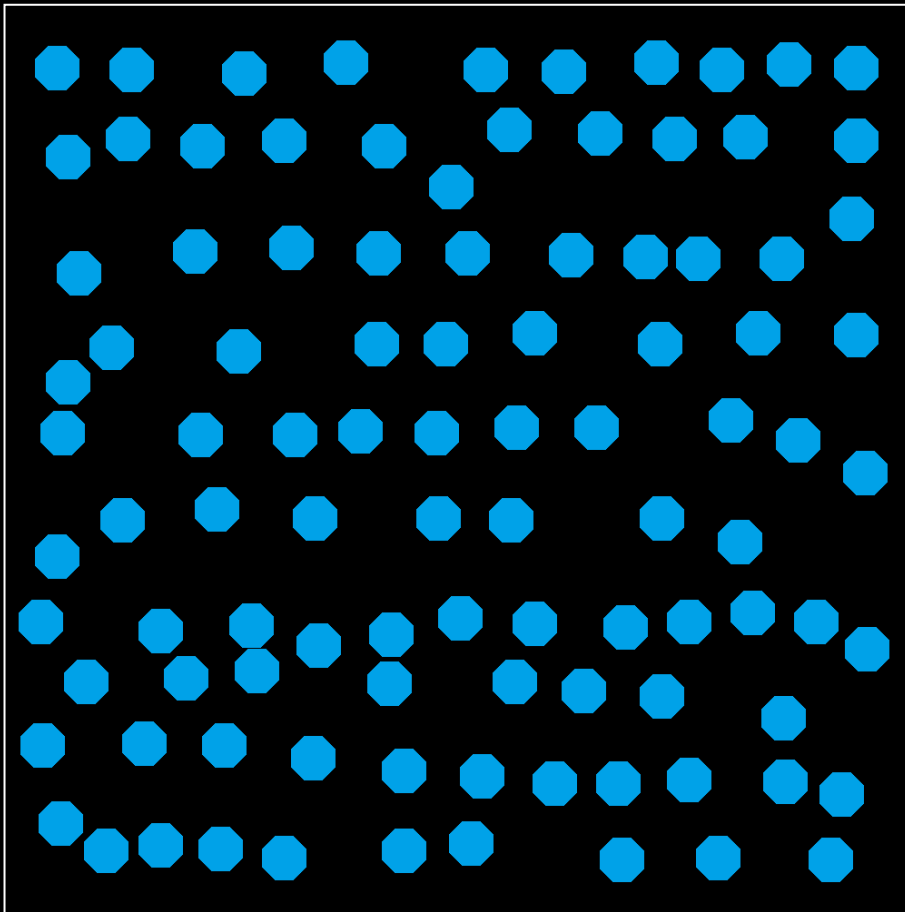
99 DOTS

PERFORMANCE:

Humans   :-(

Computers ~1 sec
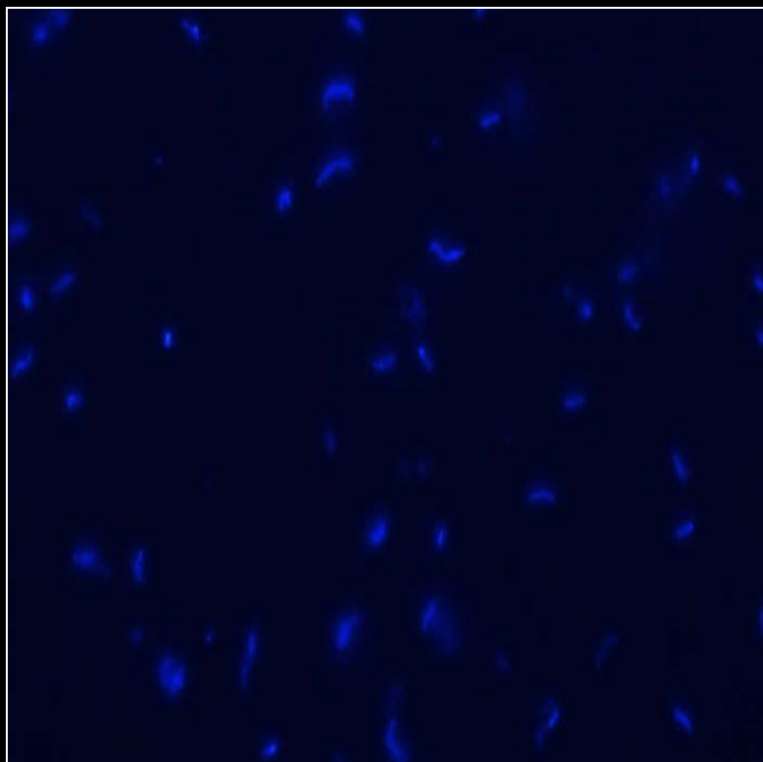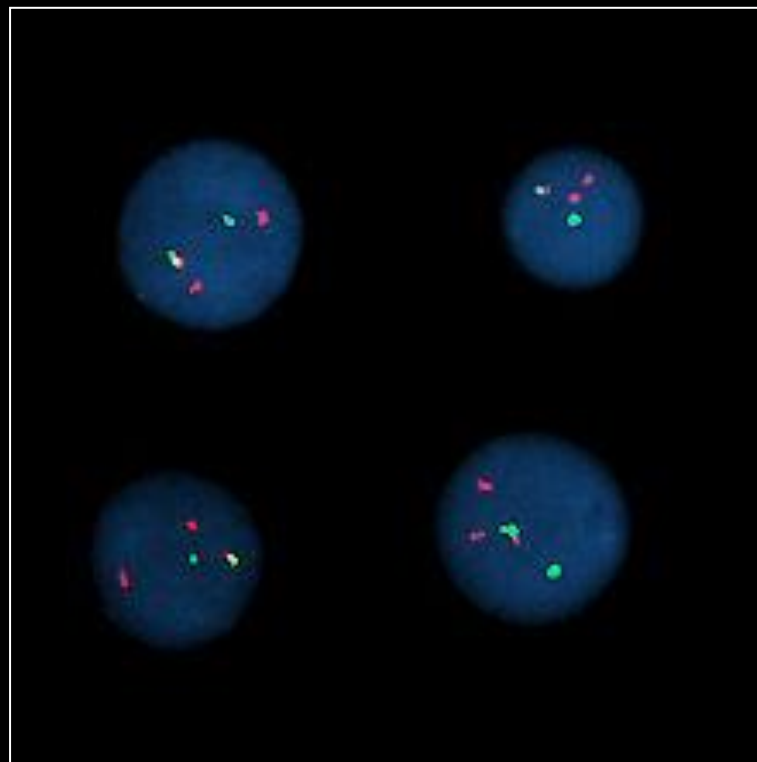(using the standard Watershed segmentation algorithm)

To be competitive we need customized algorithms!

Cell counting applications

FISH analysis

Outline

- **Aim of the course**

- **References**

- **Lessons**

- **Final test: "Rexam – Statistics – Module 2"**

Outline

○ **Aim of the course**

○ **References**

○ **Lessons**

○ **Final test: "Rexam – Statistics – Module 2"**

Aim of the course

IN THIS SHORT COURSE WILL WE LEARN THE BASICS OF PROGRAMMING

We will use:

R (*https://cran.r-project.org/*): *R* is a programming language and free software environment for statistical computing and graphics

&

RStudio (*https://www.rstudio.com/products/rstudio/download/*): *RStudio* is a set of integrated tools designed to help you be more productive with *R*. It includes a console, syntax-highlighting editor that supports direct code execution, and a variety of robust tools for plotting, viewing history, debugging and managing your workspace

R and *Rstudio* are open-source!
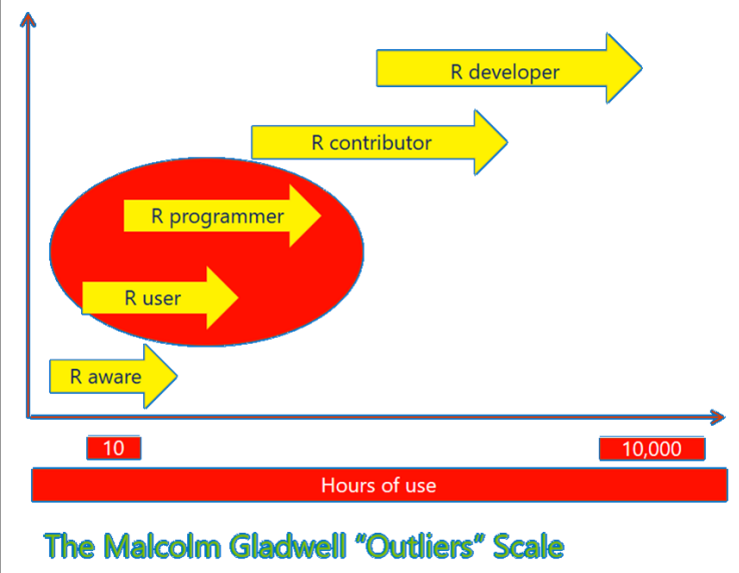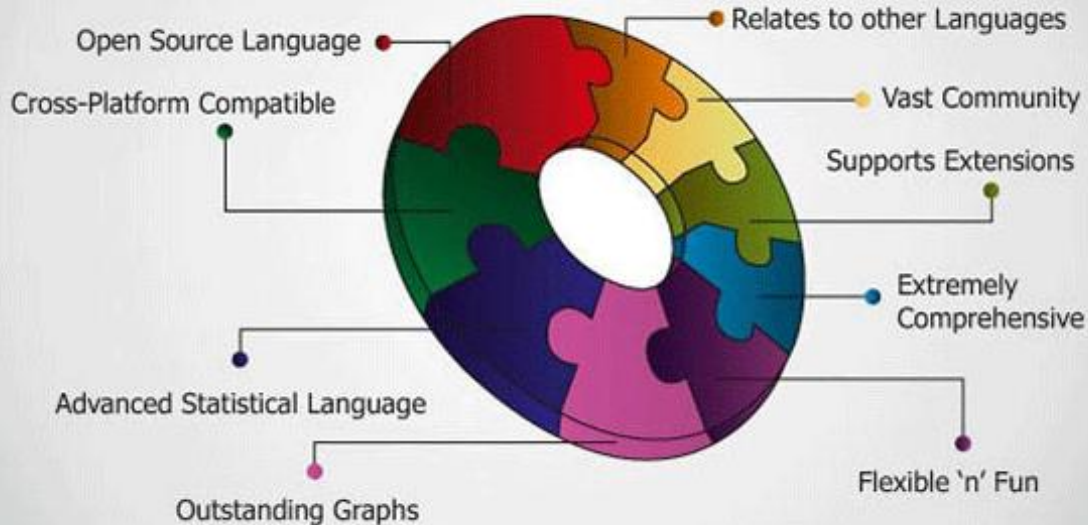**You need just a computer and nothing more!**

NOTE: first you must install R
and just after that you should install *Rstudio, not vice-versa*

Why learn *R*?

"R is the most popular language used in the field of statistics" [Roger Peng]

Outline

- **Aim of the course**

- **References**

- **Lessons**

- **Final test: "Rexam – Statistics – Module 2"**

References

- **Official course's website:**
  https://www.unibo.it/en/teaching/course-unit-catalogue/course-unit/2020/454553

- **Piccinini's website**:
  www.filippopiccinini.it → Teaching section → Link to the Homepage of your course

- **Quick info (train in late, lesson-changing, problems, etc.)**:
  http://filippopiccinini.altervista.org/joomla/men-teachings/24-cat-teachingpages/22-20202021bolognastatisticsm2clef

- **Book1 (the book really used in this course)**:
  "R Programming", tutorialspoint.
  Website: https://www.tutorialspoint.com/r/index.htm
  Book PDF: https://www.tutorialspoint.com/r/r_pdf_version.htm

- **Book2 (it can be a good alternative)**:
  "An introduction to R", W. N. Venables and D. M. Smith
  Website: https://cran.r-project.org/doc/manuals/R-intro.pdf

- *R* **website (see the Download section)**:
  https://cran.r-project.org/

- *RStudio* **(see the Download section)**:
  https://rstudio.com/products/rstudio/download/#download

References

- **How to install *R* and *Rstudio* (in a MAC):**
  https://www.youtube.com/watch?v=d-u_7vdag-0

- **Introduction to *RStudio*:**
  https://www.youtube.com/watch?v=5YmcEYTSN7k

- **Data Frame: how to select data using conditions**
  https://www.youtube.com/watch?v=ahTLpzTIJNE

- **How to use functions saved in different files:**
  - https://www.youtube.com/watch?v=QlQZWfNGgSg
  - https://stackoverflow.com/questions/13548266/define-all-functions-in-one-r-file-call-them-from-another-r-file-how-if-pos

- **Scatter-plot: how to set different parameters**
  https://www.youtube.com/watch?v=5AeqvuiUqCU

- **Packages: install, load, use, unload**
  https://www.dummies.com/programming/r/how-to-install-load-and-unload-packages-in-r/

- **Package: example "*pastecs*", function first and last**
  https://cran.r-project.org/web/packages/pastecs/index.html

- **Function "apply":**
  - https://www.rdocumentation.org/packages/base/versions/3.6.2/topics/apply
  - https://www.datacamp.com/community/tutorials/r-tutorial-apply-family

References – exercises

○ **Datacamp "Introduction to *R*" (look at the first part only, which is freely available)**:
https://learn.datacamp.com/courses/free-introduction-to-r

○ **Datacamp "Intermediate *R*" (look at the first part only, which is freely available)**:
https://www.datacamp.com/courses/intermediate-r

○ **Some exercises with *R*:**
- https://www.w3resource.com/r-programming-exercises/vector/index.php
  (in particular exercises: 2, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 20, 22, 25, 26, 28)
- https://www.w3resource.com/r-programming-exercises/matrix/index.php
  (in particular exercises: 1, 2, 3, 4, 5, 13)
- https://www.w3resource.com/r-programming-exercises/list/index.php
  (in particular exercises: 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 16, 18, 19, 20, 21)
- https://www.w3resource.com/r-programming-exercises/factors/index.php
  (in particular exercises: 1, 2, 5)
- https://www.w3resource.com/r-programming-exercises/dataframe/index.php
  (in particular exercises: 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 14, 19, 20, 21, 23)
- https://www.r-bloggers.com/data-frame-exercises/
- https://www.r-exercises.com/2016/06/01/scripting-loops-in-r/
- https://www.r-exercises.com/2016/02/07/functions-exercises/
- https://www.r-exercises.com/2016/01/07/reading-delimited-data/
- https://www.r-exercises.com/2016/03/11/start-plotting-data-3/

Outline

- **Aim of the course**

- **References**

- **Lessons**

- **Final test: "Rexam – Statistics – Module 2"**

Course timetable

Remember: during the lessons bring your laptop!

5 lessons of 3 hours each (in total 15 hours):

● 1st lesson – Monday 15/02/2021, 17:00-20:00 (3 hours), online + ROOM3

● 2nd lesson – Friday 19/02/2021, 08:00-11:00 (3 hours), online + ROOM11

● 3rd lesson – Monday 22/02/2021, 17:00-20:00 (3 hours), online + ROOM31

● 4th lesson – Saturday 27/02/2021, 09:00-12:00 (3 hours), ONLINE only.

● 5th lesson – Monday 01/03/2021, 17:00-20:00 (3 hours), ONLINE only.

OFFICIAL LINK:
https://www.unibo.it/en/teaching/course-unit-catalogue/course-unit/2020/454553/orariolezioni#461166

Tentative lesson plan

1ST LESSON:

- Course organization
- Presentation of the course's book
- Presentation of the online material
- Introduction to other online courses
- How to install *R* and *RStudio*
- How *RStudio* works
- *R* – data types
- *R* – variables
- *R* – operators
- *R* – basic syntax

2ND LESSON:

- *R* – vectors
- *R* – lists
- *R* – matrices
- *R* – factors
- *R* – data frames

Tentative lesson plan

3RD LESSON:

- *R* – decision making
- *R* – loops
- *R* – function
- *Apply* function

4TH LESSON:

- Reading data from files
- *R* – CSV files
- *R* – histograms
- *R* – line graphs
- *R* – scatterplots

5TH LESSON:

- *R* – mean, median & mode
- *R* – linear regression
- *R* – packages
- Course evaluation

Outline

- **Aim of the course**

- **References**

- **Lessons**

- **Final test: "Rexam – Statistics – Module 2"**

Final test: "Rexam – Statistics – Module 2"

Assessment method

The exam consists of a written part and an optional oral part based on the outcome of the written part. For this course there is no final numeric score, but simply a final evaluation in the form "pass/fail". The names of the students passing the <final test for "Statistics – Module 2"> are communicated to Prof. Paola Bortot. The full exam Statistics will be recorded by Prof. Paola Bortot just once also the <final test for "Statistics – Module 2"> will be positively passed.

Written part

The written part of the exam is composed by a few exercises, to be solved using the *R* language. The students cannot use computers, devices and any other type of material, just a white file!

(Optional) oral part

The Professor (not the students), depending on the result of the written part of the exam, may ask the student to attend an oral examination, this to better evaluate the level of preparation of the student.

Final test for "Statistics – Module 2": WRITTEN PART

Every Academic Year (A.Y.) there will be 3 calls:

The dates will be reported directly in the website www.filippopiccinini.it

EXAM: ORAL PART (OPTIONAL)

The Professor (not the students), depending on the result of the written part of the exam, may ask the student to attend an oral examination, this to better evaluate the level of preparation of the student.

In case, the Professor will write directly to the student interested.

THANK YOU

Eng. Filippo Piccinini, PhD
f.piccinini@unibo.it