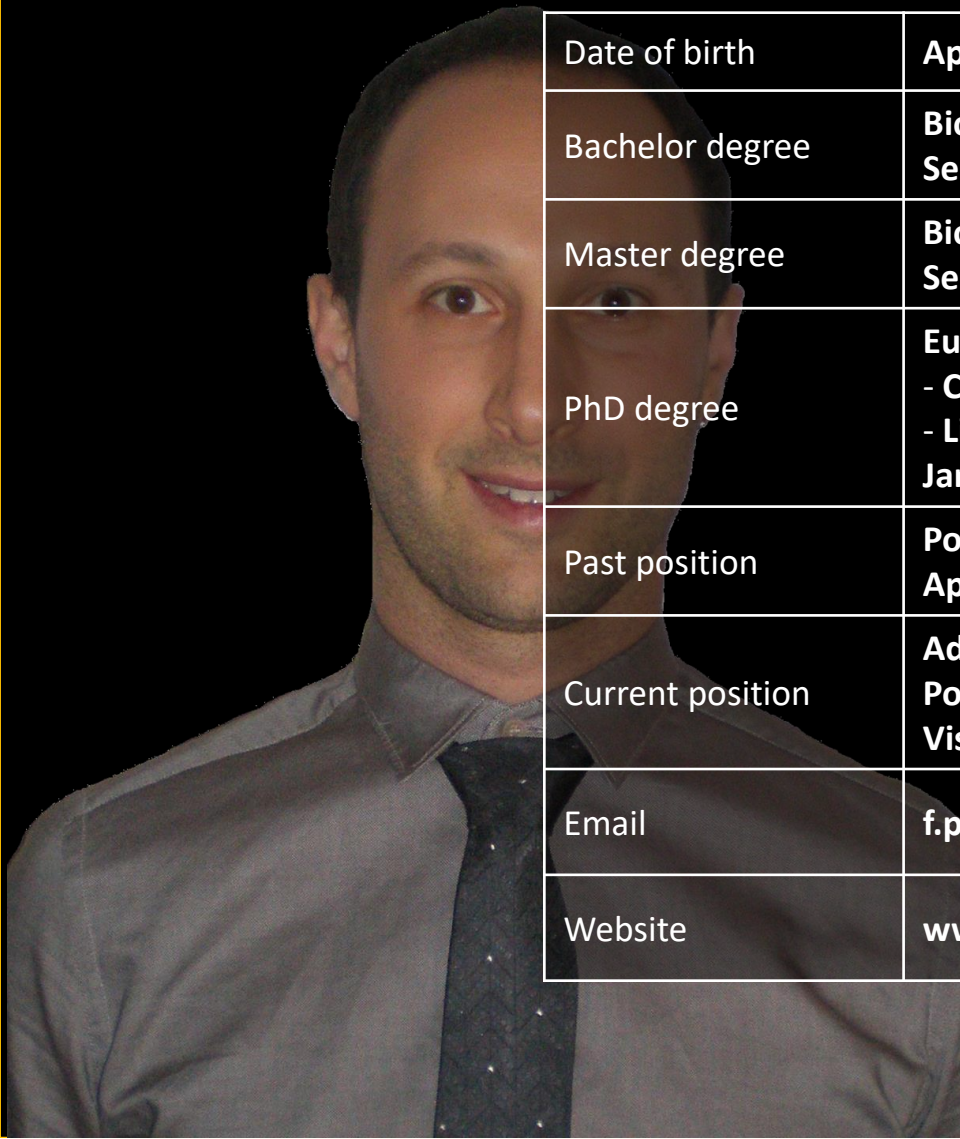# 76528 - LABORATORY OF COMPUTER PROGRAMMING

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

Laurea in Economics and Finance (CLEF)
Alma Mater Studiorum, University of Bologna
2019/2020

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?
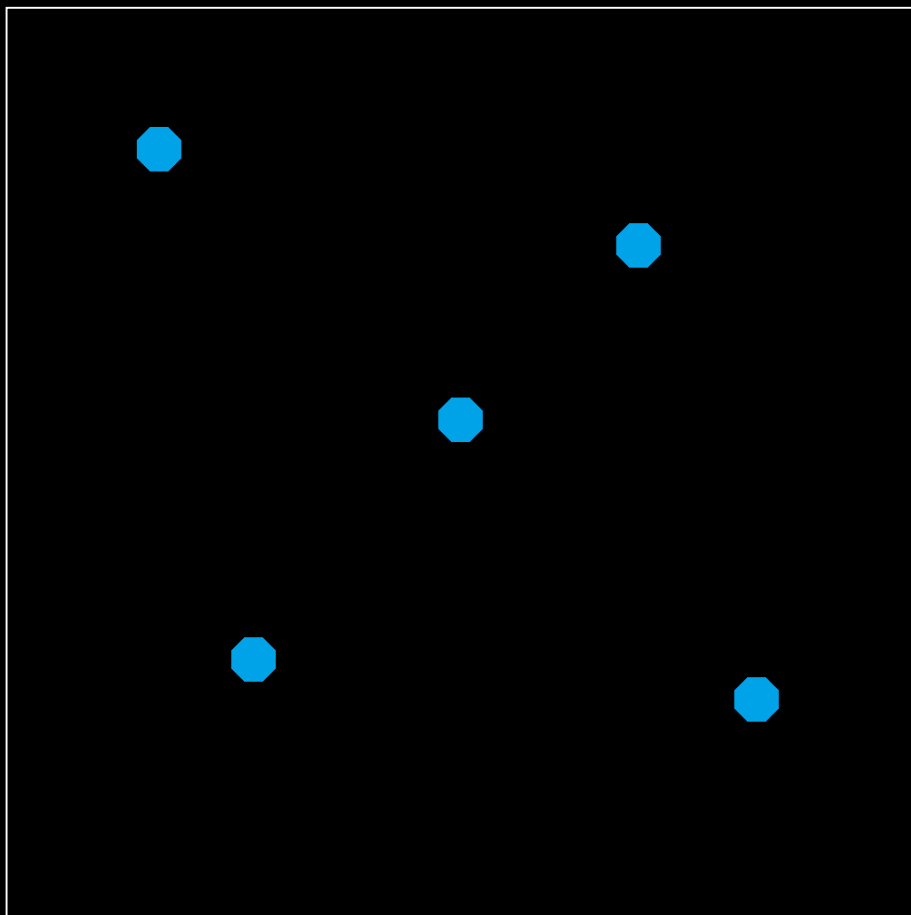
Let's play!

How many dots are there?
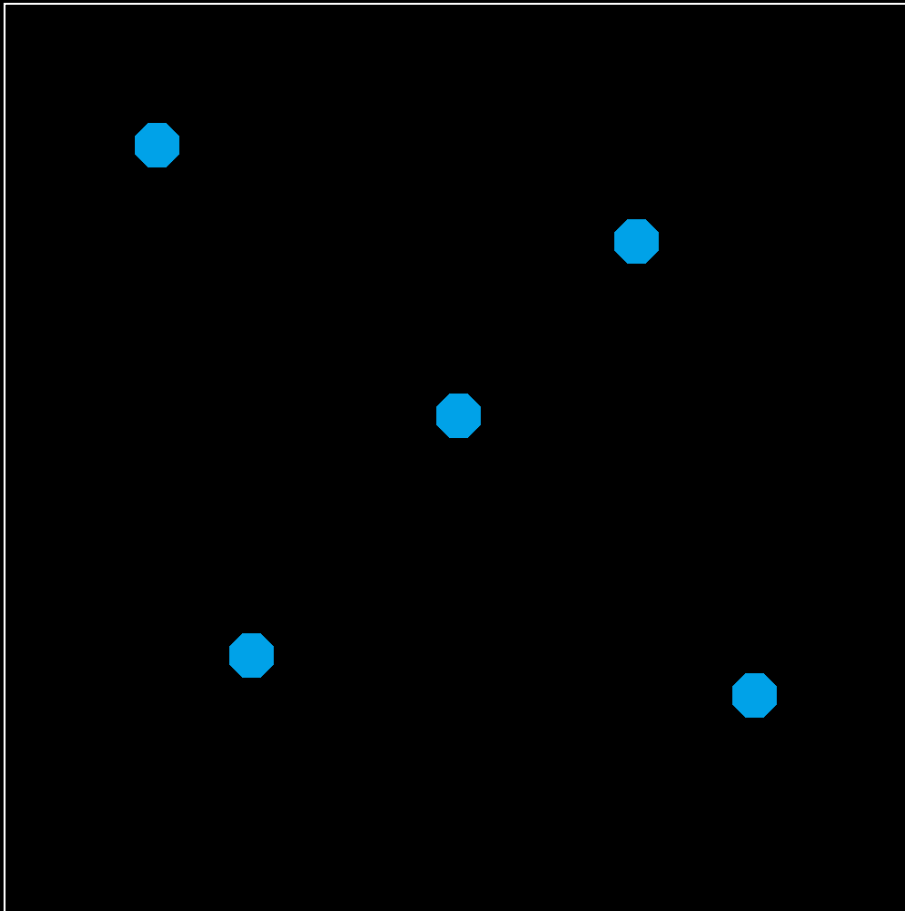
5 DOTS

PERFORMANCE:

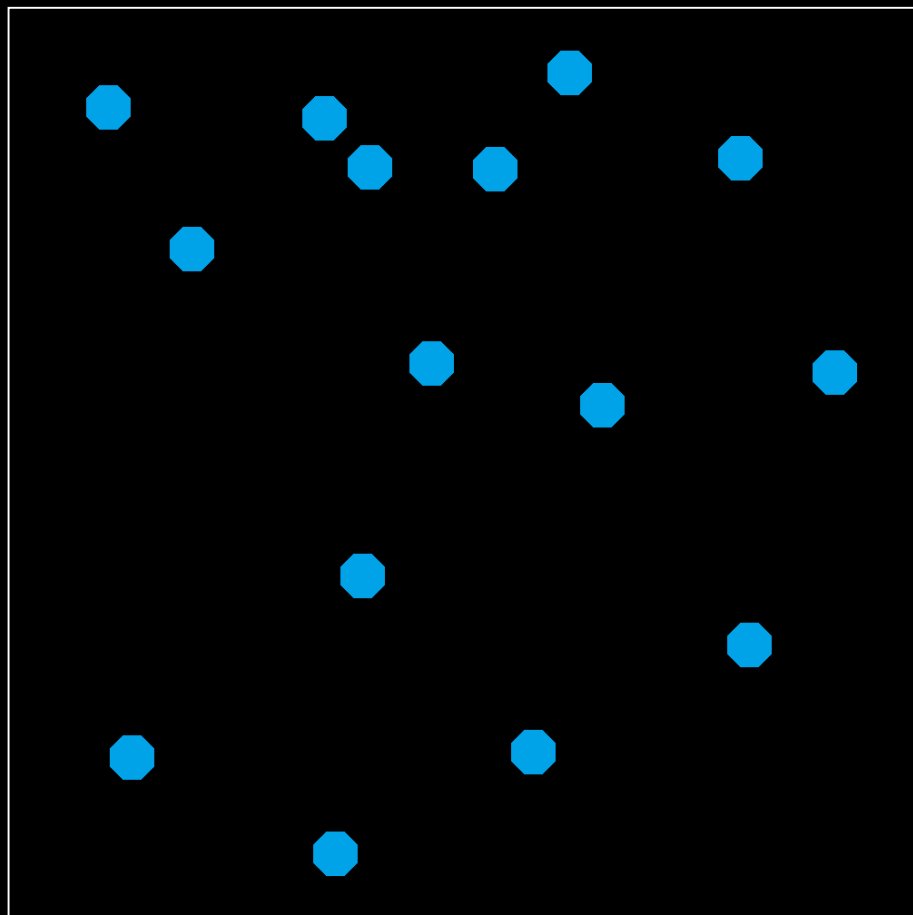**Humans ~3 sec**

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)
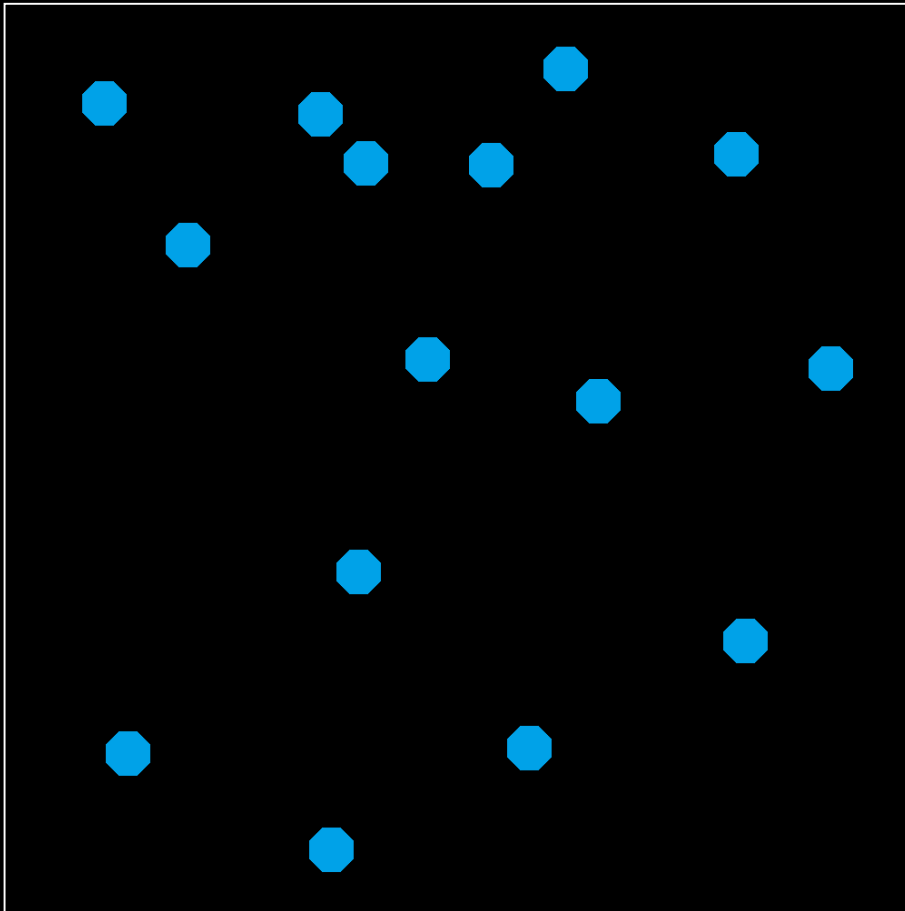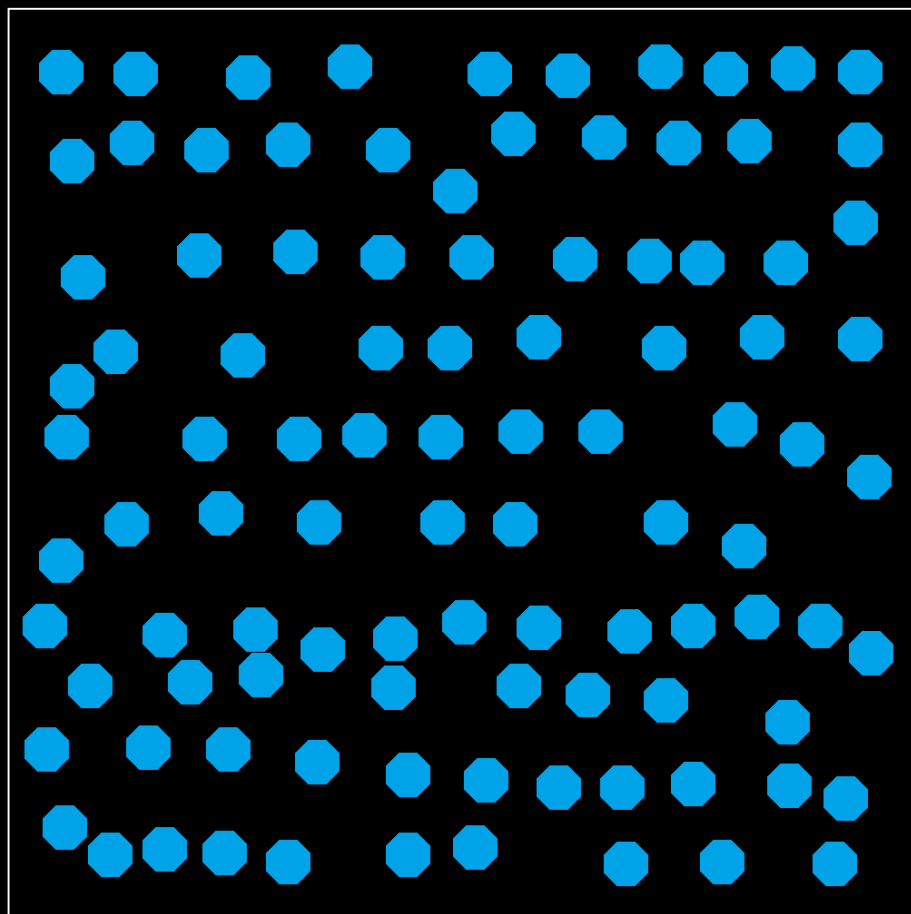
Let's play!

How many dots are there?

Let's play!

How many dots are there?

Let's play!

How many dots are there?
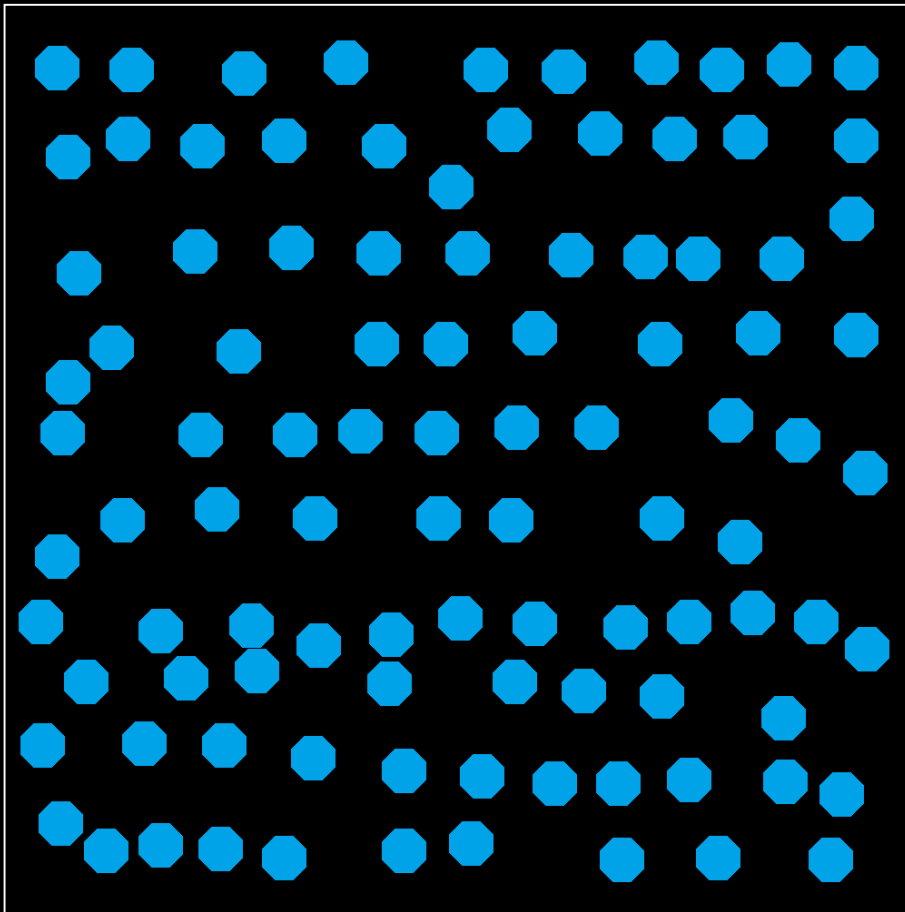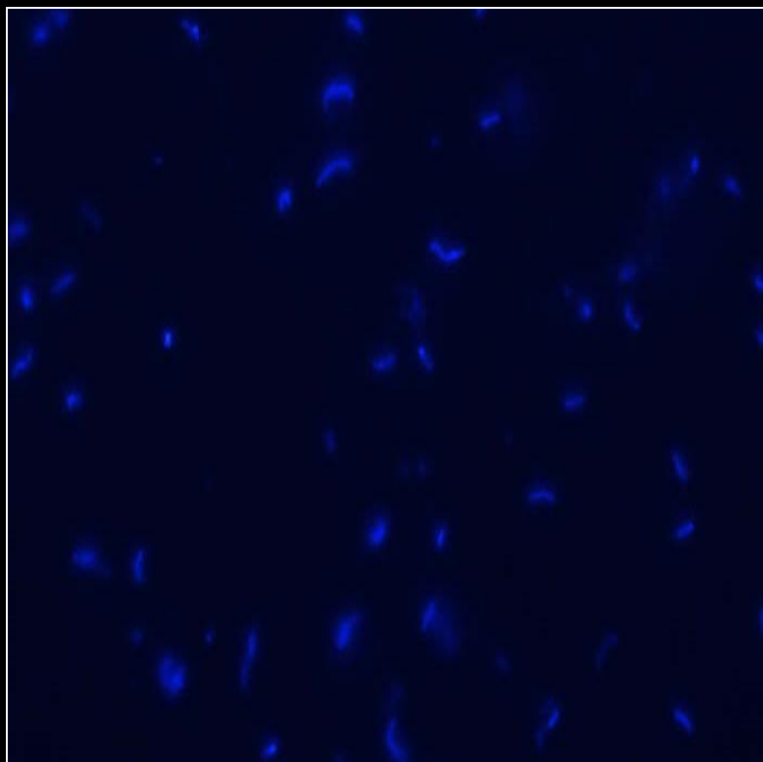
99 DOTS

PERFORMANCE:
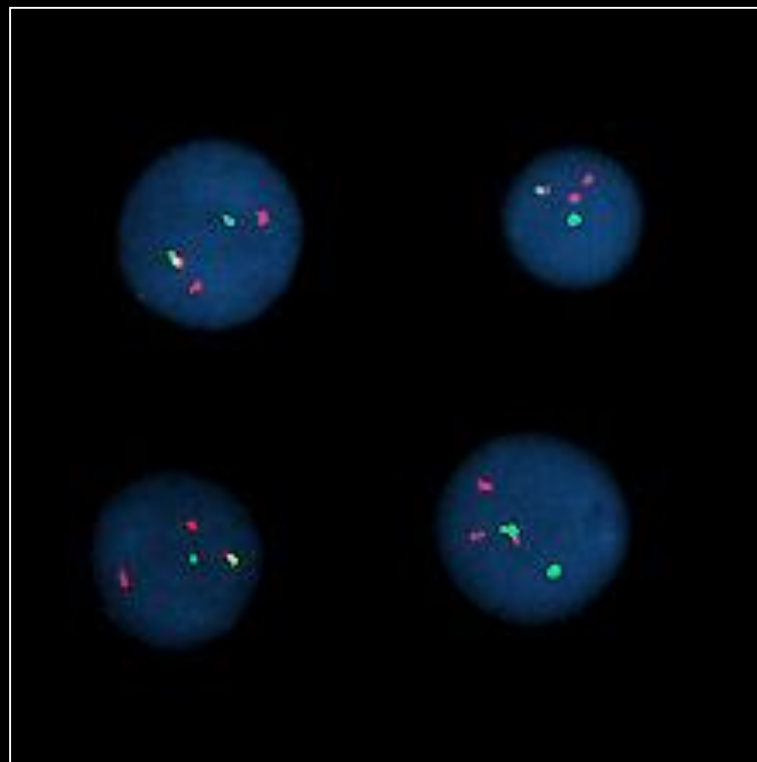
Humans   :-(

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**

Outline

- **Aim of the course**

- **References**

- **Lessons**

- **Final test**

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!

Why learn *R*?

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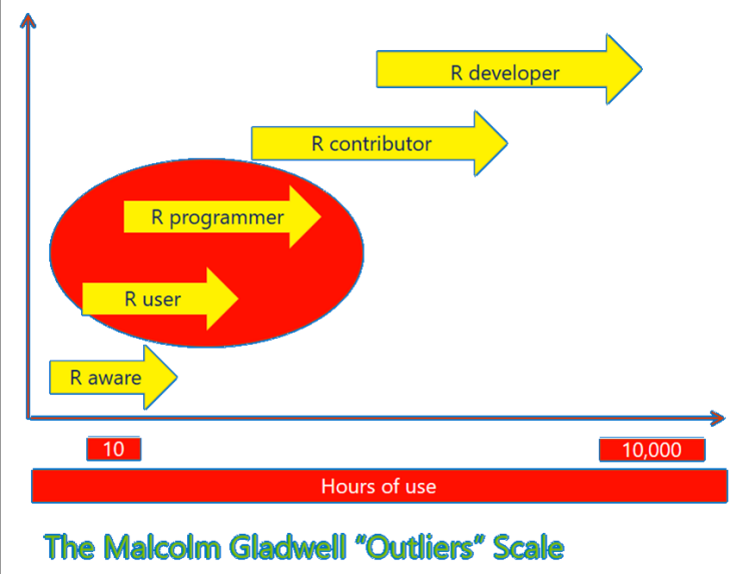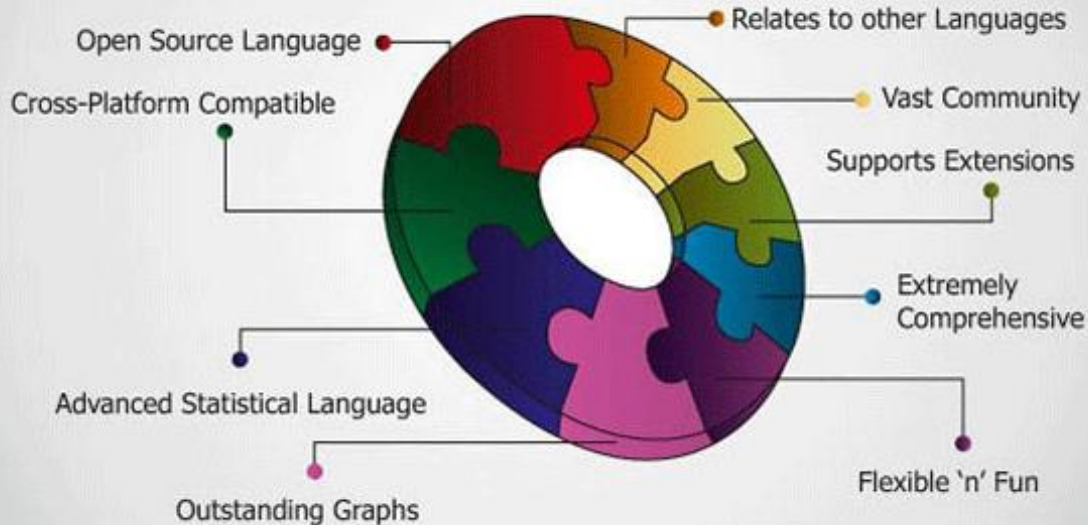
Outline

- **Aim of the course**

- **References**

- **Lessons**

- **Final test**

References

○ **Official course's website:**
https://www.unibo.it/en/teaching/course-unit-catalogue/course-unit/2019/422027

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

○ **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

○ **Information (also for quick info like lesson-changing, problems, etc.)**:
www.filippopiccinini.it → "Teaching" section → Link to the Homepage of your course

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

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

References – other links

- **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

References – exercises

○ **Datacamp "Introduction to *R*" (look at the first part only, which is freely available)**:
https://www.datacamp.com/onboarding/learn?from=home&technology=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, 11, 16, 18, 19, 20, 21)
- 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**

Course timetable

Remember: during the lessons bring your laptop!

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

● 1st lesson – Tuesday 17/09/2019, 08:00-11:00 (3 hours)

● 2nd lesson - Tuesday 24/09/2019, 08:00-11:00 (3 hours)

● 3rd lesson - Tuesday 01/10/2019, 08:00-11:00 (3 hours)

● 4th lesson - Tuesday 08/10/2019, 08:00-11:00 (3 hours)

● 5th lesson - Tuesday 15/10/2019, 08:00-11:00 (3 hours)

OFFICIAL LINK:
https://www.unibo.it/it/didattica/insegnamenti/insegnamento/2019/422027/orariolezioni

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

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

Outline

- **Aim of the course**

- **References**

- **Lessons**

- **Exam**

Exam

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 positive result obtained by the students resulting eligible, is recorded in the days following the communication of the exam's result (if it is not request to attend to the oral part). Students who in case of a positive result do not want to verbalize their eligibility, must send the request by email to the professor immediately after the exam.

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 pens and paper!

(Optional) oral part

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

Exam

EXAM: WRITTEN PART

Every Academic Year (A.Y.) there will be 3 exam-calls:
-One exam-call in October/November;
-One exam-call in December/January/February;
-One exam-call in August/September.

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

EXAM: ORAL PART (OPTIONAL)

The Professor (not the student), depending on the result of the written part of the exam, can require the student to attend an oral examination, this to better evaluate the level of preparation of the student. These days are also used as "Reception Days" for who want to privately see the result of the written part.

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