

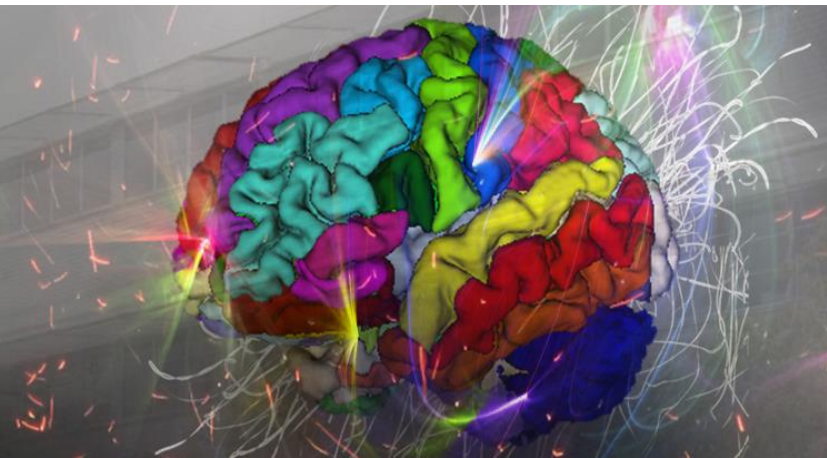


# Insight Segmentation and Registration Toolkit (ITK) Simple ITK



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# Aim of the course

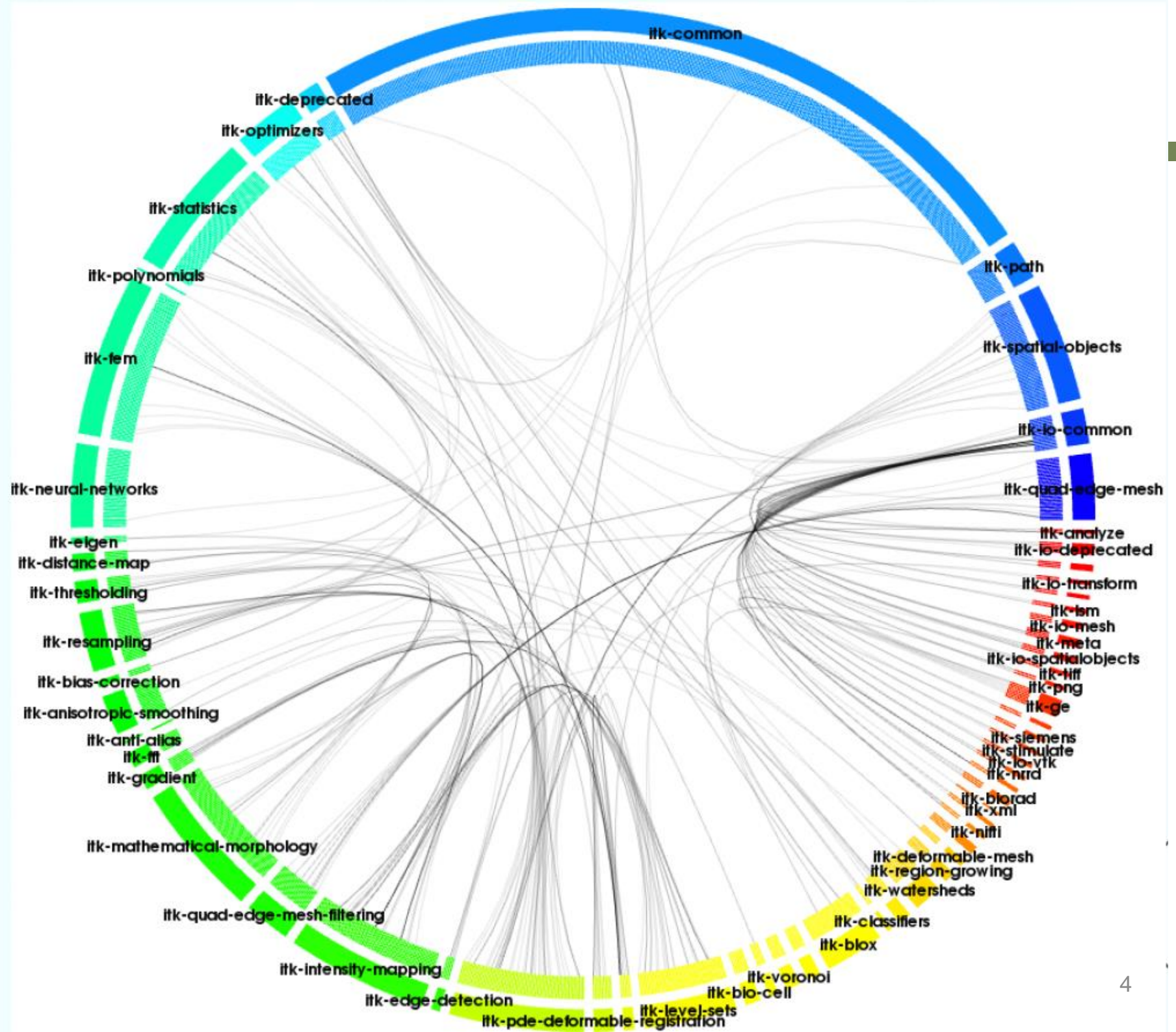
- Introduction to ITK and its modules
- To know how to develop open source cross-platform code
- Install & use ITK for different image analysis tasks
- Follow ITK slides & tutorials.
- Simple ITK (hands-on)
- Examples
  - Hello World
  - Image IO
  - Basic filtering (Insight Journal)
  - Image segmentation
  - Image Registration
  - Image segmentation and evaluation...

# What is ITK?

- Open source & cross platform library for (medical) image analysis.
- ITK is not for deep learning, but helps A LOT!
- Incorporates common pre-processing, IO, segmentation and registration algorithms.
- Organised in modules

Bridge	External	IO	Registration
Compatibility	Filtering	Nonunit	Segmentation
Core	GPU	Numerics	ThirdParty

- Highly template based.
- Insight journal.
  - <http://www.insight-journal.org/>

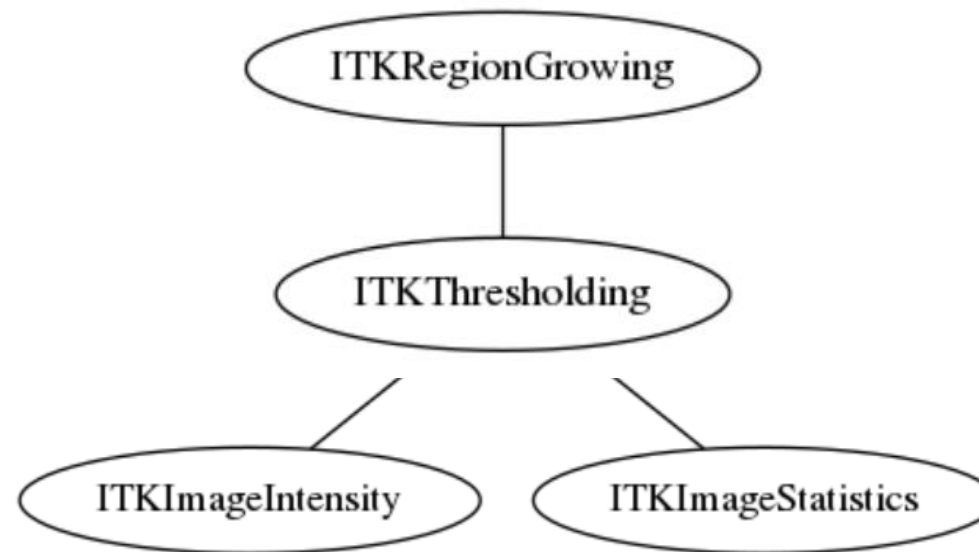


# Software Tools

- ITK libraries (now version 5.2.1)
  - <https://itk.org/ITK/resources/software.html>
- Cross-platform compilation files generation (cmake)
  - <https://cmake.org/>
- C++ compiler (i.e. visual studio, or gcc in linux/osx)
  - <https://github.com/InsightSoftwareConsortium/ITKSoftwareGuide/pull/129>
  - ITK 5.0 and later requires Visual Studio 2015 (but not >2019)
- Software guide <https://itk.org/ItkSoftwareGuide.pdf>
- ITK Snap
  - <http://www.itksnap.org>
- Patience & cup of coffee (tea also valid).
- For Simple ITK: python (anaconda)
  - <https://www.anaconda.com/distribution/>

# Software Tools

- What can I do with ITK?
- Extensive documentation
  - Examples for each algorithm
  - <https://itk.org/Doxygen/html/index.html>
  - See for instance **ITKRegionGrowing** example.
  - No DL!





# Should we start?

- Download all files. Try:
  - <https://goo.gl/uEFEmc>
- Set up install folder
  - C:\itk
- Separate source & binaries!
- Compile ITK libraries first (assuming Windows)
  - Cmake
  - Have space (some Gb!)
  - Don't compile unneeded parts (examples, tests....).
  - Compile for debug and release? More space but interesting.
- Mac OS
  - <http://itkdebug.blogspot.com.es/2013/02/install-itk-on-mac-os.html>
- Ubuntu Linux
  - [https://itk.org/Wiki/ITK\\_Configuring\\_and\\_Building\\_for\\_Ubuntu\\_Linux](https://itk.org/Wiki/ITK_Configuring_and_Building_for_Ubuntu_Linux)
- Set up ITK\_DIR environment variable

# Hello World

- CMakeLists.txt

```
project(HelloWorld)

cmake_minimum_required(VERSION 3.11)

find_package(ITK REQUIRED)
include(${ITK_USE_FILE})

add_executable(helloworld helloworld.cxx )
target_link_libraries(helloworld ${ITK_LIBRARIES})
```

- helloworld.cxx

```
#include "itkImage.h"
#include <iostream>
int main()
{
    typedef itk::Image< unsigned short, 3 > ImageType;
    ImageType::Pointer image = ImageType::New();
    std::cout << "ITK Hello World !" << std::endl;
    return EXIT_SUCCESS;
}
```



# Bibliography

- *Itk.org*
  - *Software guide*
  - *Tutorials*
- Cmake
  - Cmake.org
- Insight journal
  - <http://www.insight-journal.org/>
- ITK Snap
  - <http://www.itksnap.org>

# Simple ITK

- Install Simple ITK  
pip install simpleitk
- <http://www.simpleitk.org/>
- Documentation
  - <https://github.com/InsightSoftwareConsortium/SimpleITK-Notebooks>

# Notebook examples

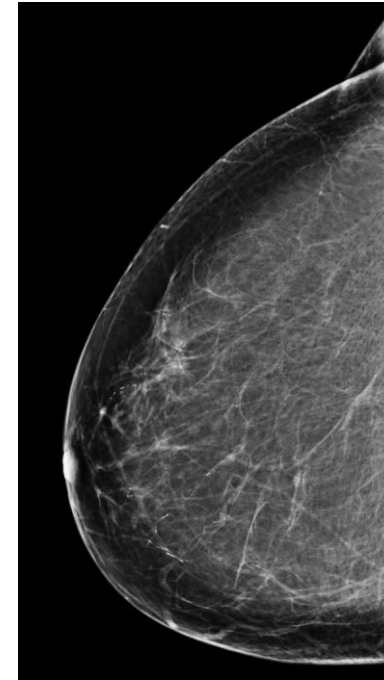
## Python

---

- 00 Setup
- 01 Image Basics
- 02 Pythonic Image
- 03 Image Details
- 10 matplotlib's imshow
- 20 Expand With Interpolators
- 21 Transforms and Resampling
- 22 Transforms
- 300 Segmentation Overview
- 30 Segmentation Region Growing
- 31 Levelset Segmentation
- 32 Watersheds Segmentation
- 34 Segmentation Evaluation
- 35 Segmentation Shape Analysis
- 41 Progress
- 51 VH Segmentation1
- 55 VH Resample
- 56 VH Registration1
- 60 Registration Introduction
- 61 Registration Introduction Continued
- 62 Registration Tuning
- 63 Registration Initialization
- 64 Registration Memory Time Tradeoff
- 65 Registration FFD
- 66 Registration Demons
- 67 Registration Semiautomatic Homework
- 70 Data Augmentation

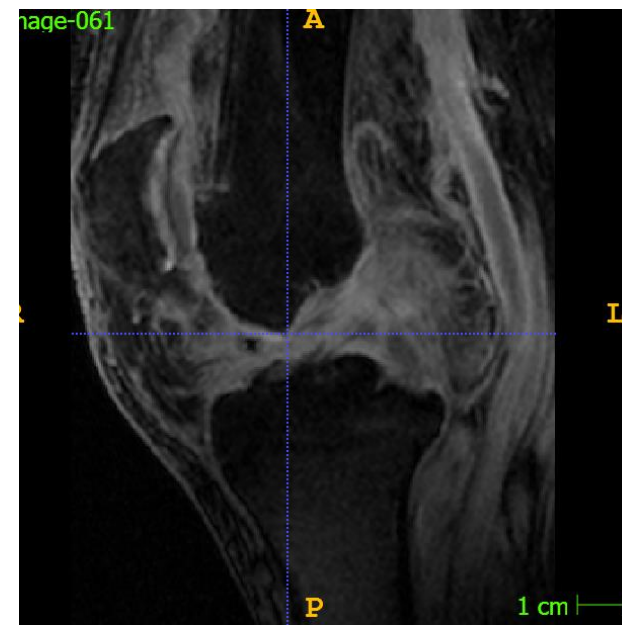
- DICOM mammography file

- <https://goo.gl/TmQzsR>



- Knee MRI data (mhd)

- <https://goo.gl/x8k2Gf>



# Simple ITK. Hands on

- Github of the winter school based on the ITK notebooks  
[https://github.com/rmartimarly/MAIA\\_WinterSchool](https://github.com/rmartimarly/MAIA_WinterSchool)  
<https://github.com/InsightSoftwareConsortium/SimpleITK-Notebooks>
- Tutorials
  - Image information
  - DICOM tags
  - Image segmentation
- Exercises
  1. Open DICOM images, understand DICOM tags
  2. Obtain ground truth and segment an image.

# Exercise 1

## Aim: Read DICOM Mammography and print Image tags (2h)

- Print pixel spacing tag (0028,0030) and the bits allocated tag (0028,0100).
- Find out what is the distance between source and detector.
- Modify the code to load a 3D image. Check the spacing in z direction: Slice thickness tag (0018|0050), spacing between slices (0018|0088).
- BONUS: Convert image to 8 bits and save it as png and DICOM.
- Notebooks:
  - [https://github.com/rmartimarly/MAIA\\_WinterSchool/blob/main/DICOMread.ipynb](https://github.com/rmartimarly/MAIA_WinterSchool/blob/main/DICOMread.ipynb)
  - [https://github.com/rmartimarly/MAIA\\_WinterSchool/blob/main/image\\_information.ipynb](https://github.com/rmartimarly/MAIA_WinterSchool/blob/main/image_information.ipynb)
  - [https://github.com/InsightSoftwareConsortium/SimpleITK-Notebooks/blob/master/Python/03\\_Image\\_Details.ipynb](https://github.com/InsightSoftwareConsortium/SimpleITK-Notebooks/blob/master/Python/03_Image_Details.ipynb)
  - [https://simpleitk.org/SPIE2019\\_COURSE/02\\_images\\_and\\_resampling.html](https://simpleitk.org/SPIE2019_COURSE/02_images_and_resampling.html)

# Exercise 2

## Aim: Segment Knee MRI

- Install ITK Snap
- Open the knee MRI image, try to segment manually/semi-automatically the femur.
- With a notebook, perform an automatic segmentation
- BONUS: Evaluate your segmentation
- Notebooks

[https://github.com/InsightSoftwareConsortium/SimpleITK-Notebooks/blob/master/Python/300\\_Segmentation\\_Overview.ipynb](https://github.com/InsightSoftwareConsortium/SimpleITK-Notebooks/blob/master/Python/300_Segmentation_Overview.ipynb)

[https://github.com/InsightSoftwareConsortium/SimpleITK-Notebooks/blob/master/Python/34\\_Segmentation\\_Evaluation.ipynb](https://github.com/InsightSoftwareConsortium/SimpleITK-Notebooks/blob/master/Python/34_Segmentation_Evaluation.ipynb)