AFRICAI Summer School

MODEL DEVELOPMENT 2: MODEL-CENTRIC BEST PRACTICES, PITFALLS, AND OPEN ACCESS INFRASTRUCTURES

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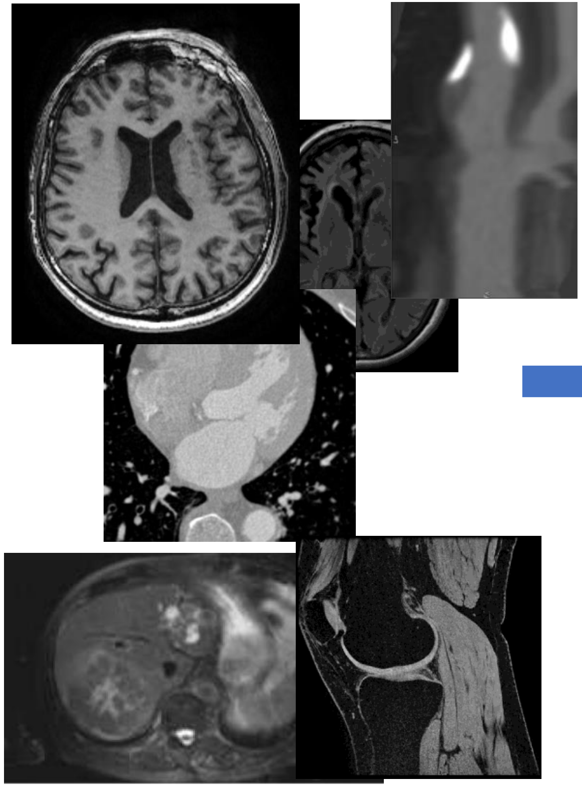
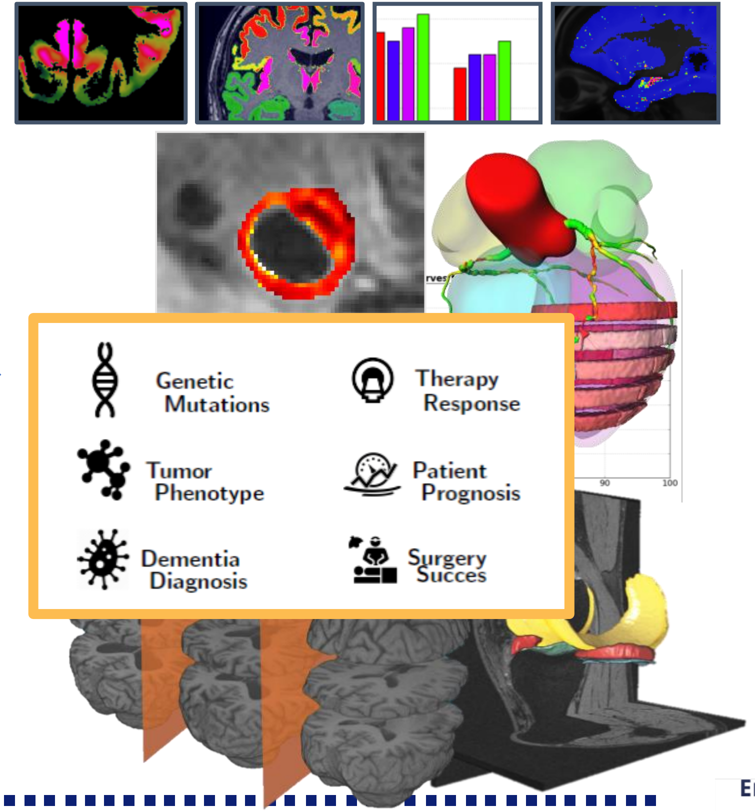
Erasmus University Medical Center

Erasmus MC

Biomedical Imaging Group Rotterdam (bigr.nl)

BIGR
Biomedical Imaging Group Rotterdam





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Programme

Model Development 2: Model-centric best practices, pitfalls, and open-access infrastructures

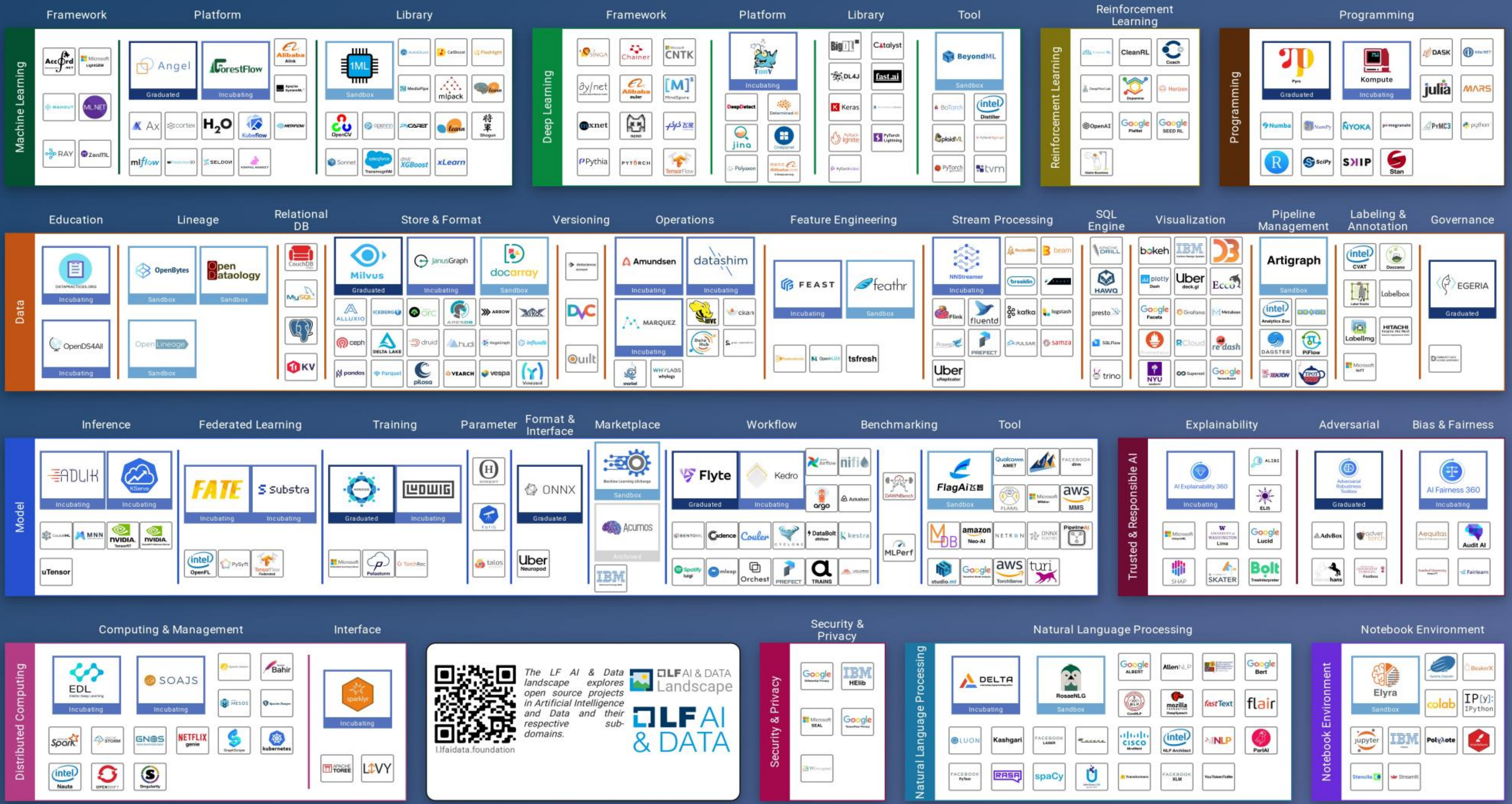
Agenda

Time	Mon. 11 Sept	Tue. 12 Sept	Wed. 13 Sept	Thu. 14 Sept	Fri. 15 Sept	Sat, 16 Sept
8.30-10:00	Welcome (Karim, Jihad) Presentation MICCAI & AFRICAI (Nassir, Karim)	From an idea to a MICCAI paper Paper 1 (Mohammad)	From an idea to a MICCAI paper Paper 2 (Anees)	New trends in AI (Victor)	MICCAI writing Part 2 Methods (Sandrine)	Final presentations by the participants
10h00-10h30	Break	Break	Break	Break	Break	Break
10h30-12h00	What is a MICCAI Paper? (Scope, structure, review process)	Developing medical AI in Africa (Florent)	Design Thinking in AI (Islem)	MICCAI writing Part 1 Introduction (Karim)	MICCAI writing Part 3 Results (Martijn)	Feedback by mentors + Awards
12h00-13h30	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
13h30-15h00	Pitch presentations by the Participants	Model development Part 1: Data (Apostolia)	Model development Part 2: Models (Martijn)	Model development Part 3: Evaluation (Martin)	Discussion of next steps until 2024 (All)	Free
15h00-15h30	Break	Break	Break	Break	Break	
15h30-17h30	Practical session with mentors	Practical session with mentors	Practical session with mentors	Practical session with mentors	Practical session with mentors	

Linux Foundation AI & Data Landscape
1.0

See the interactive landscape at l.lfaidata.foundation

Greyed logos are not open source



Goals

You will know:

- Which AI toolboxes are available
- How to use the MONAI AI toolbox: (**main aim of practice today**)
    - To make a data loader for your data
    - To design and train a deep learning model
- Which monitoring tools you can use to track the progress of your models
- Which processing environments you can use
- How you can benefit from pre-trained models
- Which open-access infrastructures you can use

AI toolboxes

Focus: Python

Arguably, three main AI toolboxes:

- Tensorflow
- PyTorch
- Keras (Tensorflow or PyTorch backend)

All AI in general: what is most suitable for medical imaging?

MONAI+

Medical Open Network for Artificial Intelligence

Core v1.1 | Label v0.6 | Deploy App SDK v0.5.1

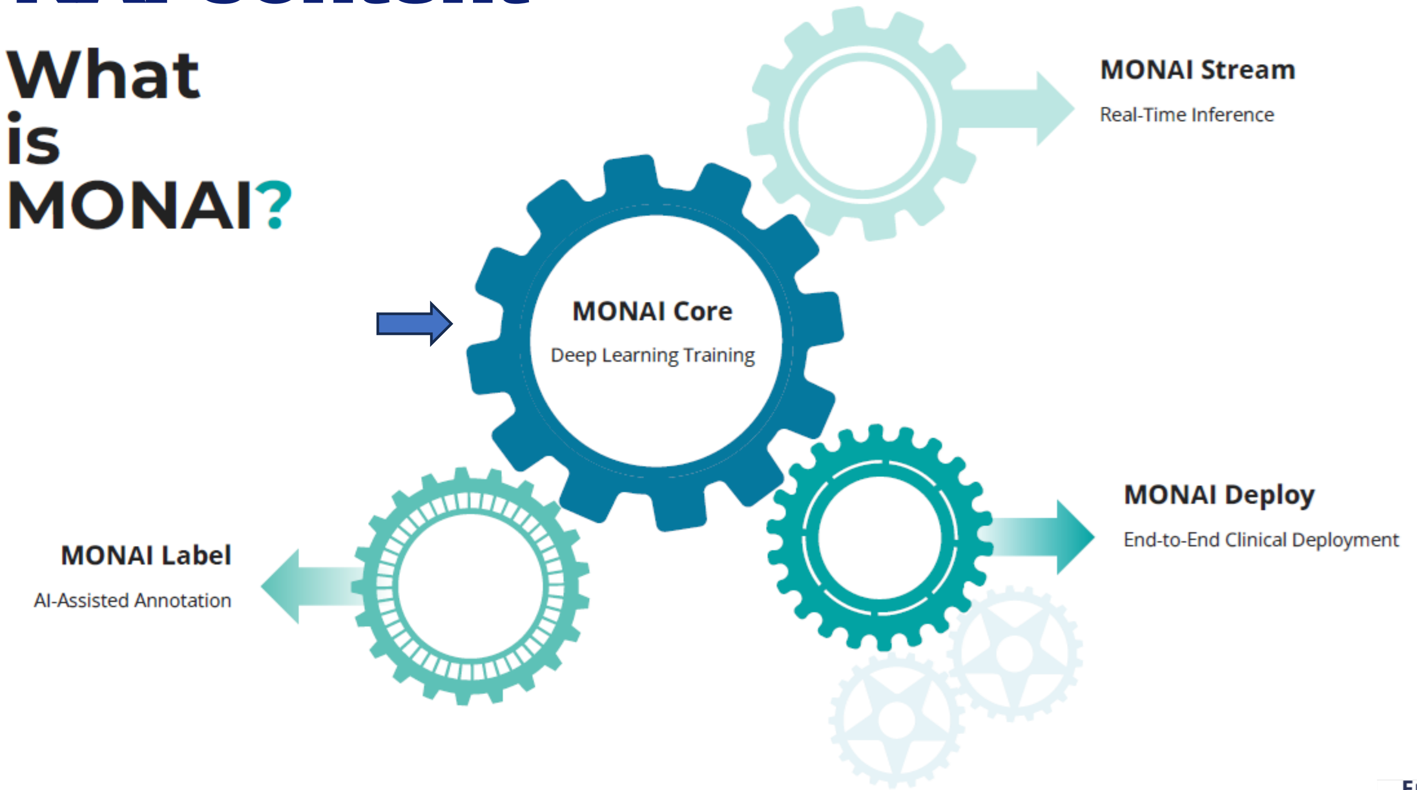
1,000,000+ downloads and counting

Contributors

Answer · Chinese Academy of Sciences · dkfz. · Frederick National Laboratory for Cancer Research · Guy's and St Thomas' NHS Foundation Trust · King's College London · kitware · Mayo Clinic · MGH & BWH Center for Clinical Data Science · Memorial Sloan Kettering Cancer Center · NIH National Cancer Institute · nVIDIA · Stanford University · TUM · UCL · Vanderbilt University · Warwick The University of Warwick

2021, 2023: MICCAI/MIDL – MONAI bootcamp

MONAI content



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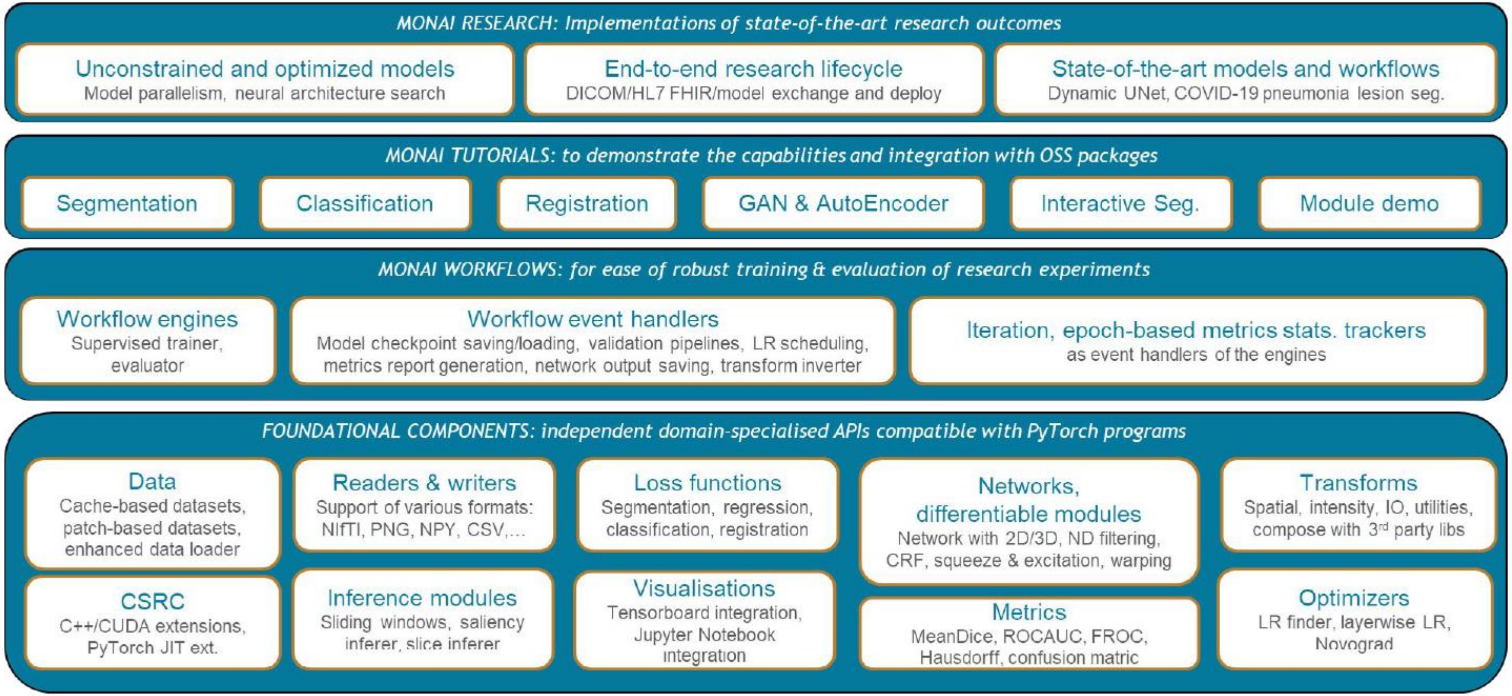
See slides of MONAI 2023 bootcamp: https://github.com/Project-MONAI/monai-bootcamp/blob/main/MONAI%20Bootcamp%20Slides.pdf

MONAI Core

MONAI is based on PyTorch, expands upon that by adding medical imaging-specific solutions:



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MONAI Core

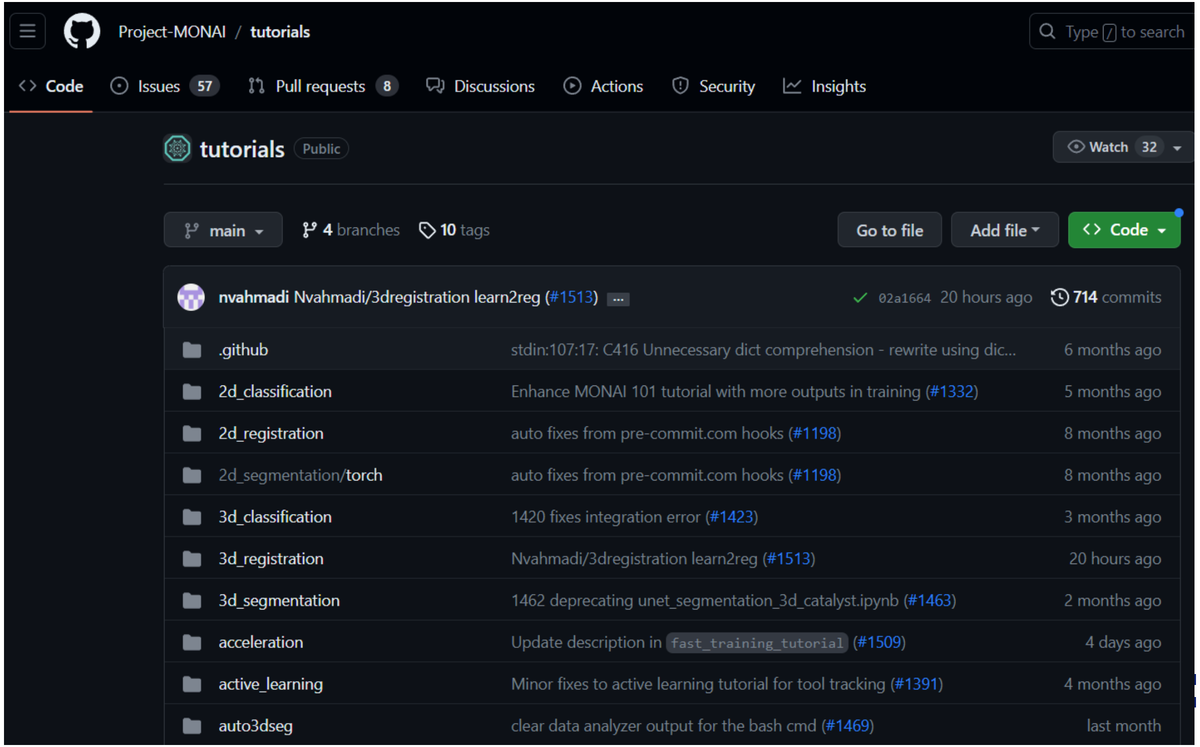
MONAI is based on PyTorch, expands upon that by adding medical imaging-specific solutions:

- ✓ Easy to use (lot of functionality implemented already for you)
- ✓ Easy to learn (lot of tutorials)
- ✓ Efficient (training about 12x speedup compared with native PyTorch implementation)
- ✓ Scalable (lot of newly proposed (MICCAI) solutions developed in MONAI)
- ✓ Sustainable (live community)

See slides of MONAI 2023 bootcamp: https://github.com/Project-MONAI/monai-bootcamp/blob/main/MONAI%20Bootcamp%20Slides.pdf

MONAI Core tutorials

https://github.com/Project-MONAI/tutorials https://docs.monai.io/en/stable/index.html



MONAI 2023 Bootcamp

https://github.com/Project-MONAI/monai-bootcamp
https://www.youtube.com/playlist?list=PLtoSVSQ2XzyAJAGzaHF0nUIkav0BnxhrJ

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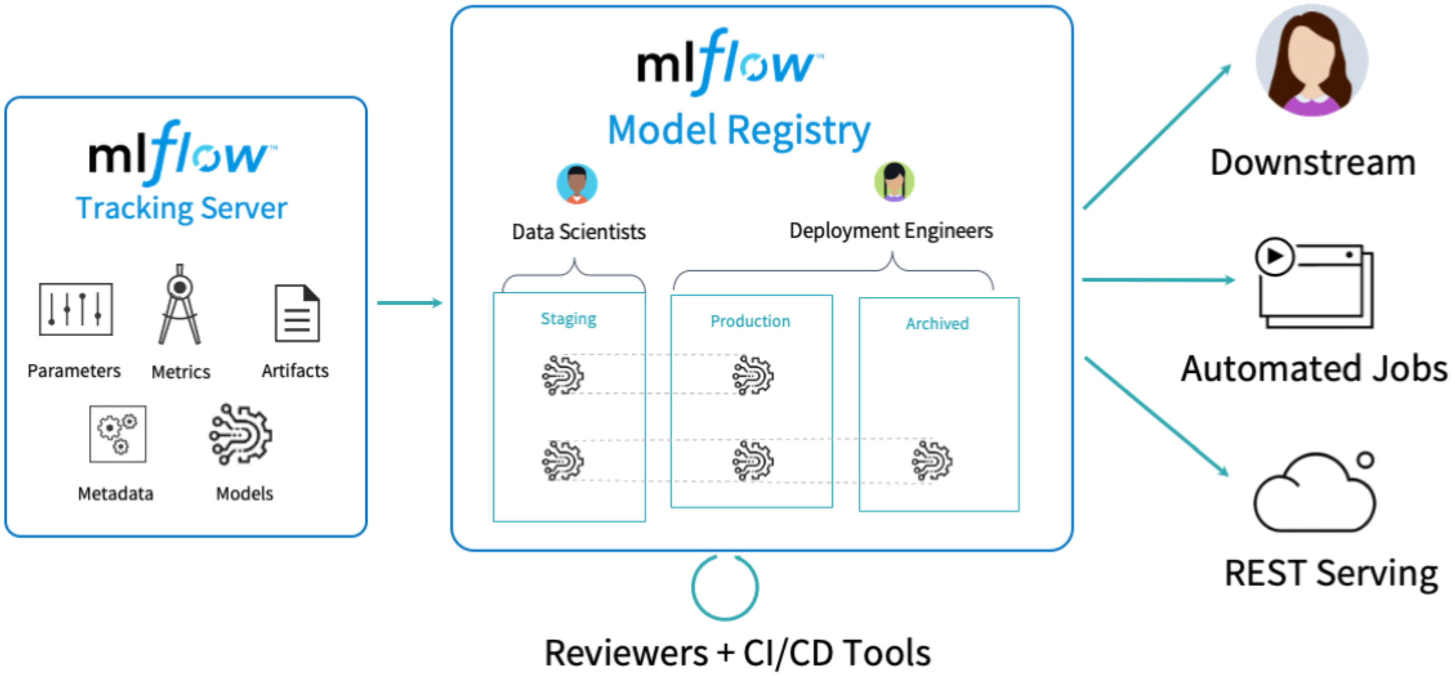
Monitoring

When training many models, how to keep an overview -> Monitoring!



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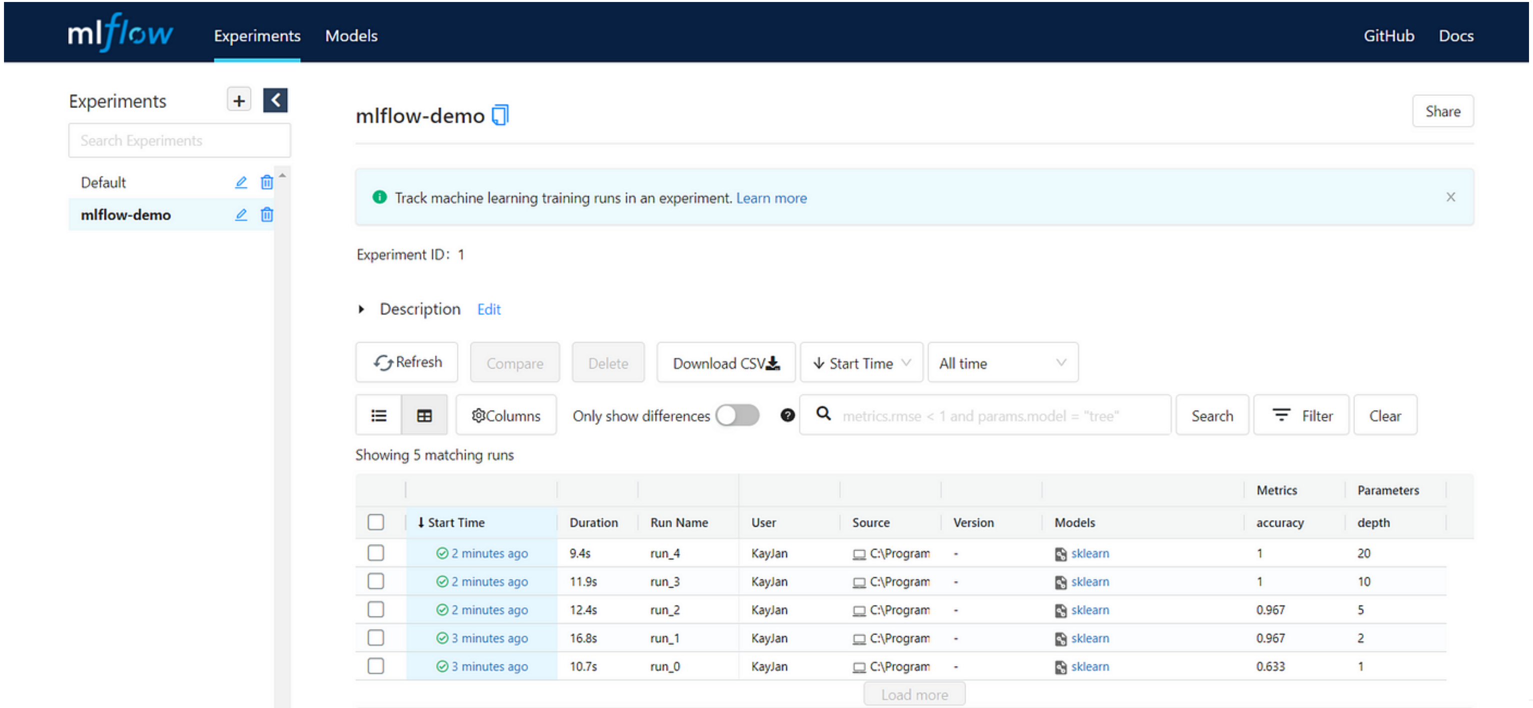

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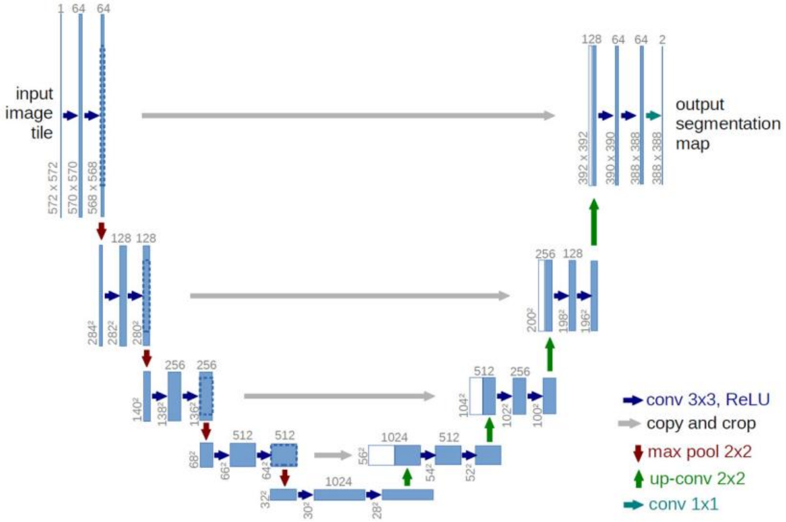
Hyperparameter Optimization

Which configurations of network give the best performance?



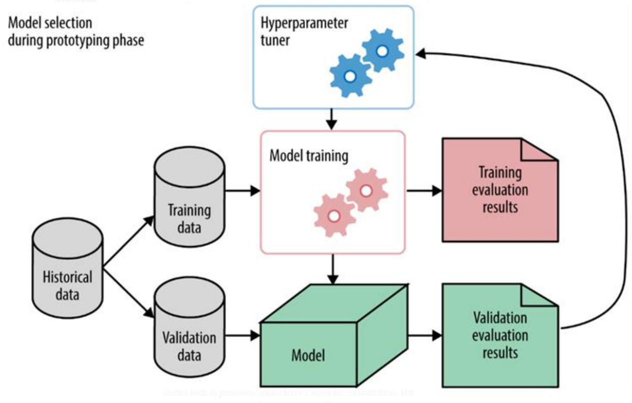
U-net (Ronneberger et al. 2015)

Parameter	Values
Min. Kernels	16, 32, 64, 128
Kernel Size	1, 3, 5, 7, 9
Activations	sigmoid, tanh, relu, elu, PReLU, LeakyReLU, ThresholdedReLU
Initializers	zeros, ones, glorot_normal, he_normal
Regularizers	l1, l2, l1_l2
Dropout Rate	uniform distribution over $[0, 1]$
Learning Rate	uniform distribution over $[10^{-4}, 1]$

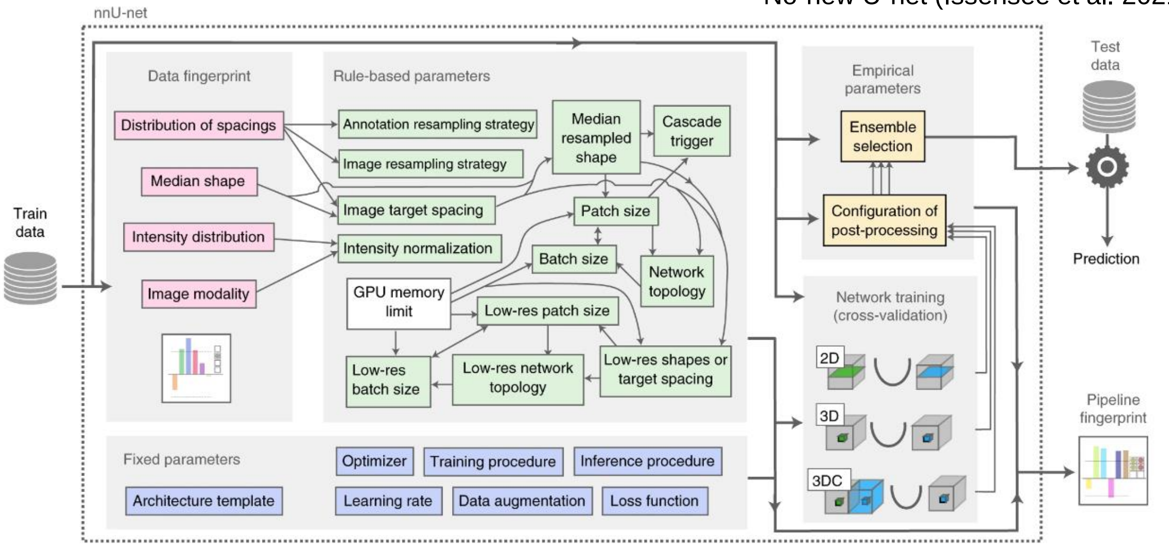
Hyperparameter Optimization

Optimization versus logical motivation (versus experimental observation)

No-new U-net (Issensee et al. 2021)



vs



Never use test dataset for anything except testing, also not hyperparameter tuning!

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Processing Environments

How to get access to (GPU) resources for processing -> cloud processing environments?

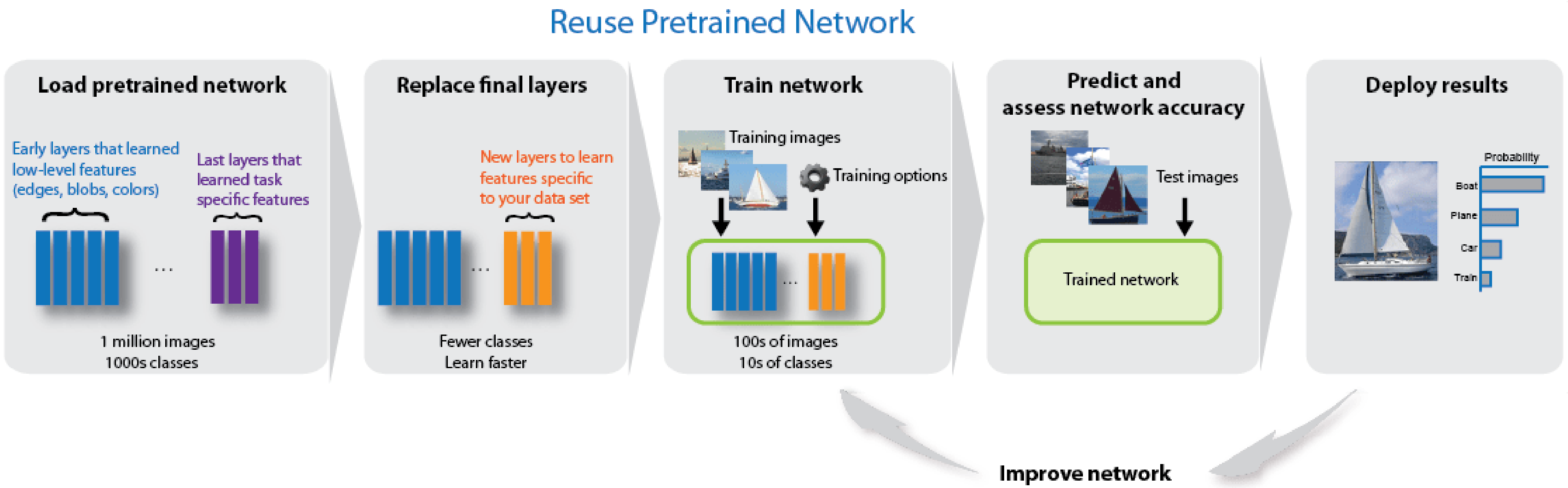
- Google Colab: Free, but limited resources

Three “big” players, but:

- Pricing per / hour minute
- Hospital may not allow data on a cloud platform

Pre-trained models

Initialize model with weights learned from another dataset:



Potential improvement in efficiency and performance, but no guarantees

- Pretrain on large public datasets, finetune on African datasets?

Open Access Infrastructures

How to combine all these separate tools in an infrastructure?

- No need to re-invent the wheel, use and learn from open access infrastructures!

EURO BIOIMAGING

https://www.eurobioimaging.eu/

EUCAIM

eosc | cancer

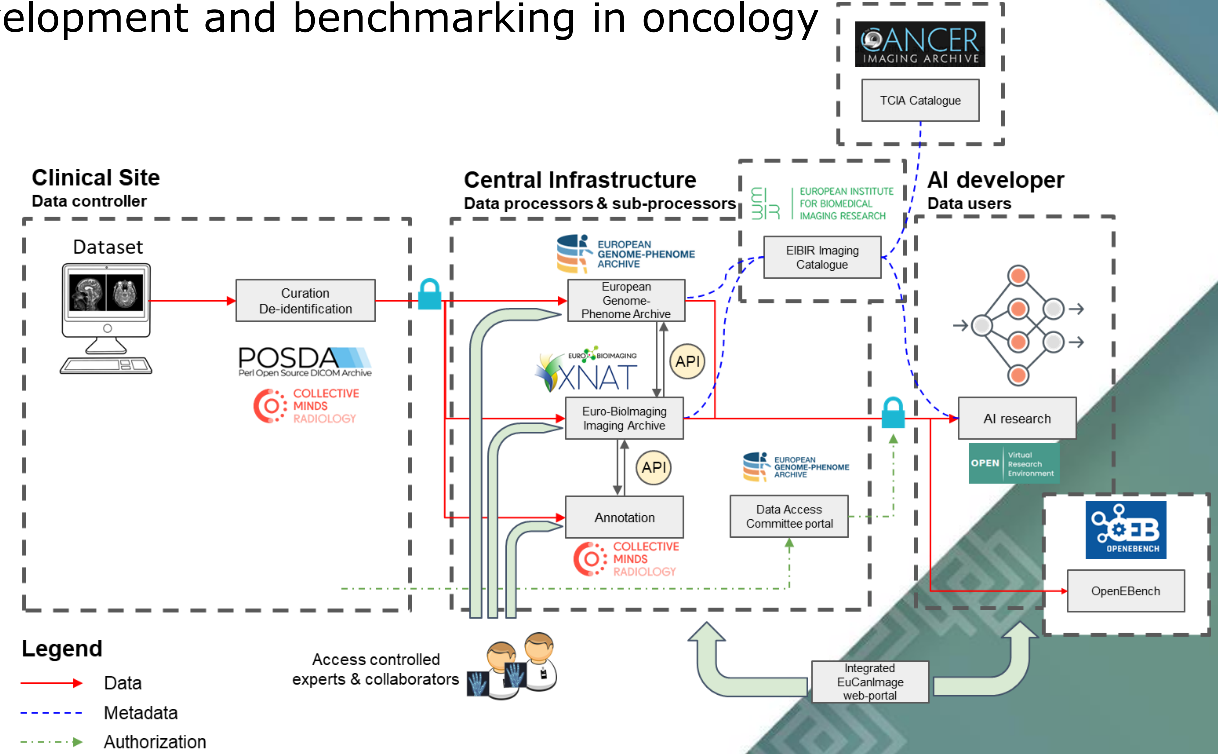
https://eosc-portal.eu/

EUCAN IMAGE

https://eucanimage.eu/

The EuCanImage Platform

- Build a **<u>federated</u>**, **<u>GDPR-compliant</u>**, **<u>scalable</u>** and **<u>FAIR</u>** cancer imaging platform linked to biological and health repositories for integrated multi-scale AI development and benchmarking in oncology



Programming Time!

Goal: get familiar with MONAI, and optionally start applying it to your own data.

Notebooks:

- 2- custom-DL-PyTorch-TorchIO-[optional].ipynb
- 2- TorchIO_MONAI_PyTorch_Lightning-[optional].ipynb
- **3- MONAI.ipynb (main notebook)**
- 4-MONAI_MLFlow-[optional].ipynb
- 7- Pretrained-Models-MONAI_Model_Zoo-[optional].ipynb

No installation required, Free GPU

Suggestion: check the Readme, start with the main notebook. Afterwards, start running MONAI on your own data (see main notebook), follow other notebooks, or other MONAI tutorials (see Readme).

Programming Time!

Goal: get familiar with MONAI, and optionally start applying it to your own data

Timeline

- 08.30 – 08.45: Introduction in central Zoom call
- 08.45 – 09.50: Practice session in Zoom breakout rooms
- 09.50 – 10.00: Wrap-up and discussion in central Zoom call

Note: you can pick your own breakout room this time!

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