AFRICAI Summer School MODEL DEVELOPMENT 2: MODELCENTRIC BEST PRACTICES, PITFALLS, AND OPEN ACCESS INFRASTRUCTURES



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Erasmus University Medical Center

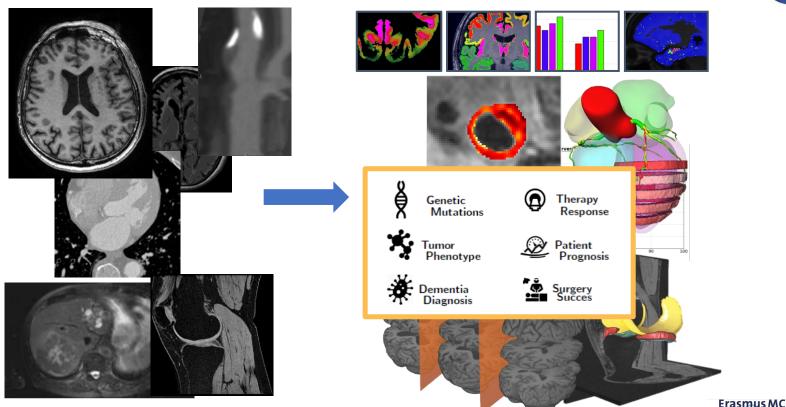






Biomedical Imaging Group Rotterdam (bigr.nl) BIGR





Programme

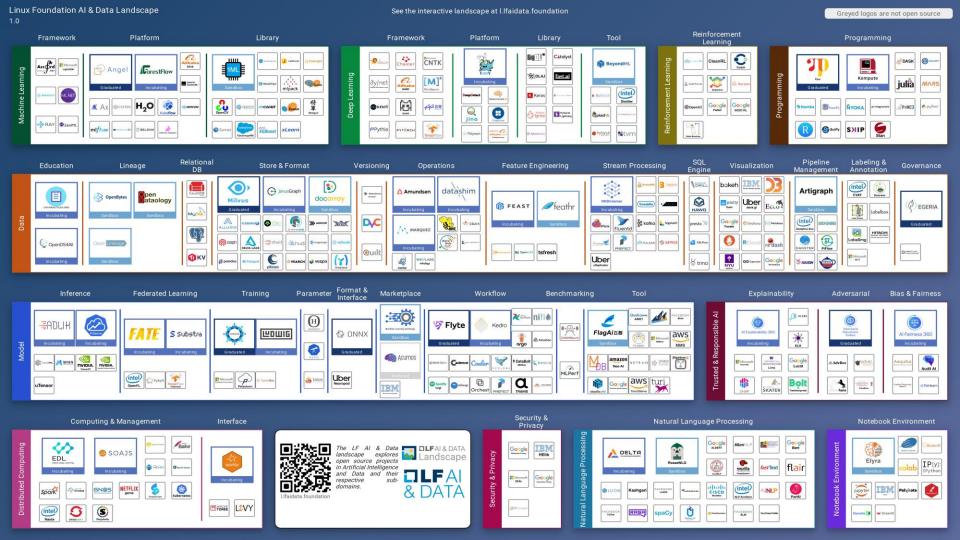
Model Development 2: Model-centric best practices, pitfalls, and open-access infrastructures

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 Al (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 Al (Islem)	MICCAl 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	

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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



Al toolboxes

Focus: Python

Arguably, three main AI toolboxes:

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

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

Top 10 Python Libraries





Pandas

Data analysis and manipulation



NumPy

Mathematical functions



Matplotlib

Data visualisations



SeaBorn

Data visualisations



Tensorflow

Machine Learning



Keras

Deep Learning



SciPy

Scientific computing



PyTorch

Machine Learning



Scrapy

Web crawling



SQLModel

Interact with SQL databases



DATA RUNDOWN

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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































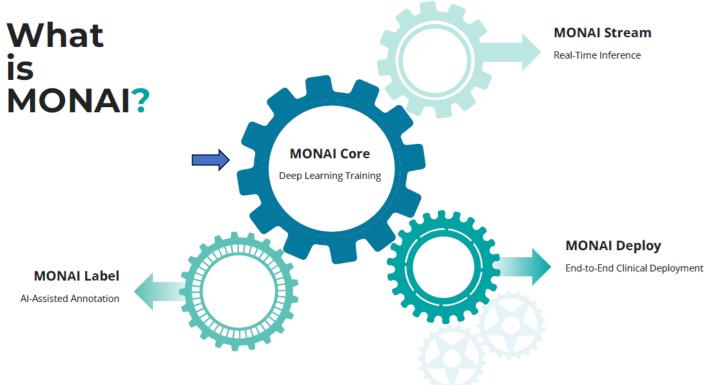




2021, 2023: MICCAI/MIDL – MONAI bootcamp

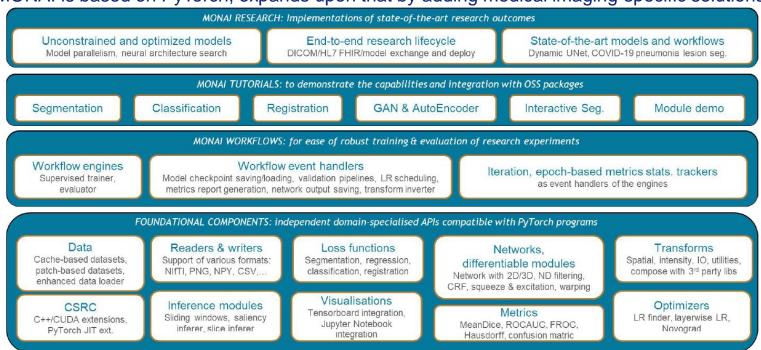


MONAI content



MONAI Core

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



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MONAI Core

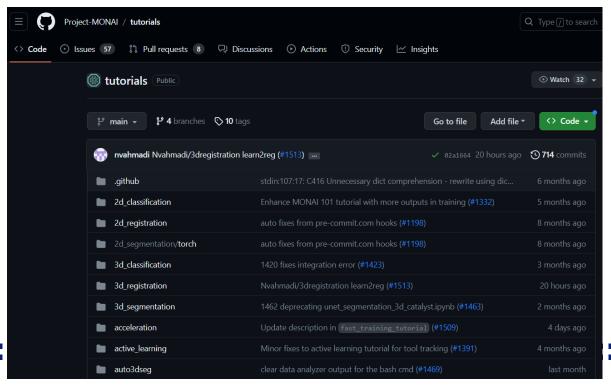
MONAI is based on PyTorch, expands upon that by adding medical imaging-specific solutions:

- ✓ 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)



MONAl Core tutorials

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



MONAI 2023

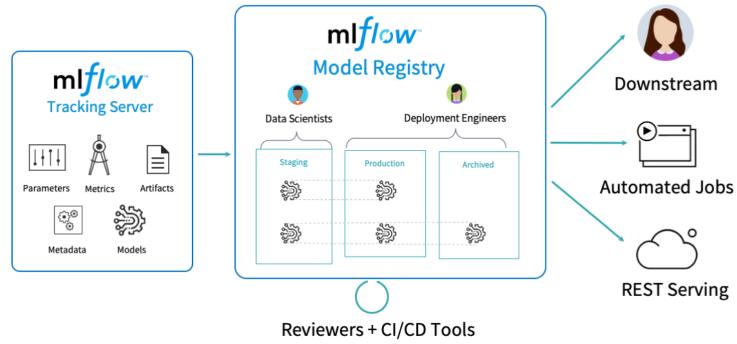
Bootcamp

https://github.com/Project-MONAI/monai-bootcamp https://www.youtube.com/playlist?list =PLtoSVSQ2XzyAJAGzaHF0nUlkav 0BnxhrJ



Monitoring

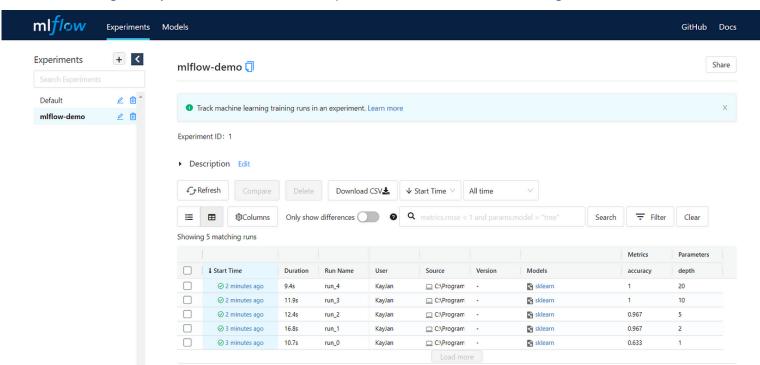
When training many models, how to keep an overview -> Monitoring!



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Monitoring

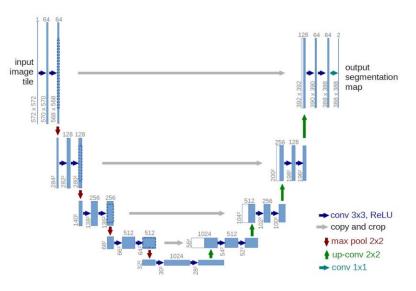
When training many models, how to keep an overview -> Monitoring!





Hyperparameter Optimization

Which configurations of network give the best performance?



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	11, 12, 11_12
Dropout Rate	uniform distribution over $[0,1]$
Learning Rate	uniform distribution over $[10^{-4}, 1]$

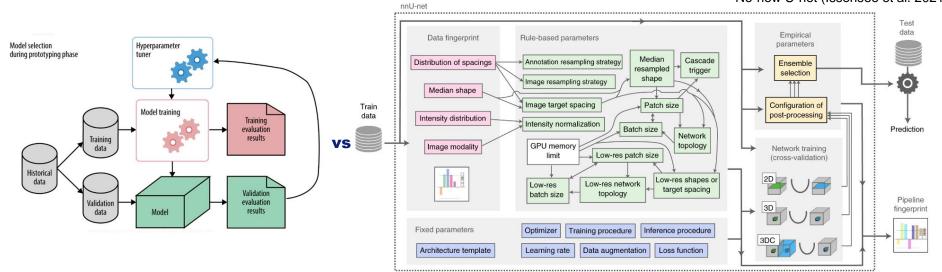
U-net (Ronneberger et al. 2015)



Hyperparameter Optimization

Optimization versus logical motivation (versus experimental observation)

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



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



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

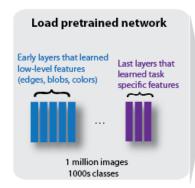


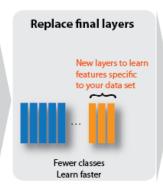


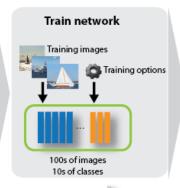
Pre-trained models

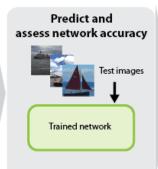
Initialize model with weights learned from another dataset:

Reuse Pretrained Network











Improve network

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!







https://eosc-portal.eu/

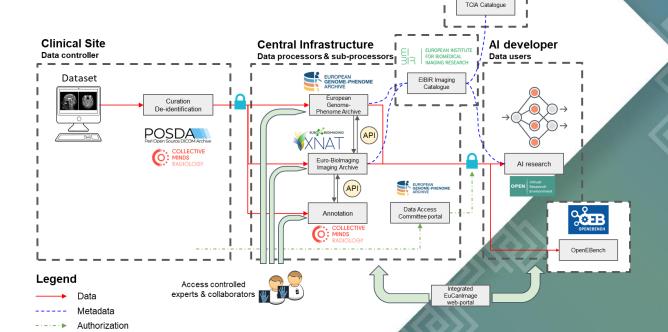






Build a <u>federated</u>, <u>GDPR-compliant</u>, <u>scalable</u> and <u>FAIR</u> cancer imaging platform linked to biological and health repositories for integrated multi-scale AI development and benchmarking in oncology

IMAGING ARCHIVE



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- MONAl.ipynb (main notebook)
- 4-MONAI_MLFlow-[optional].ipynb
- 7- Pretrained-Models-MONAI_Model_Zoo-[optional].ipynb



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 10.20: Practice session in Zoom breakout rooms
- 10.20 10.30: Wrap-up and discussion in central Zoom call

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



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