KING'S College LONDON

Platforms for medical AI, from prototype to clinical deployment

JADE Day - Friday 29th September 2023

JADE Tier 2 HPC

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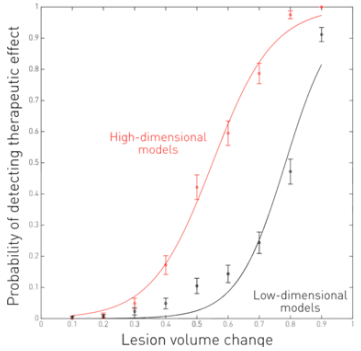
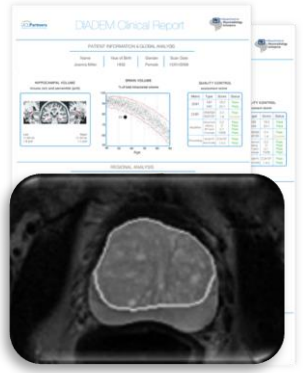
Faculty of Life Sciences and Medicine, King's College London

Medical AI: many opportunities for clinical impact

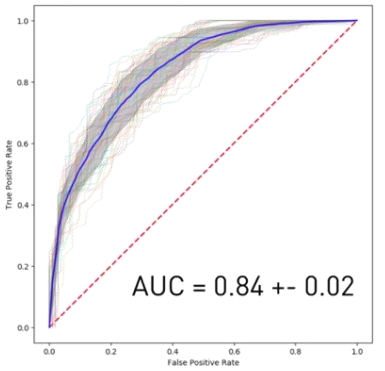
How can AI improve healthcare?



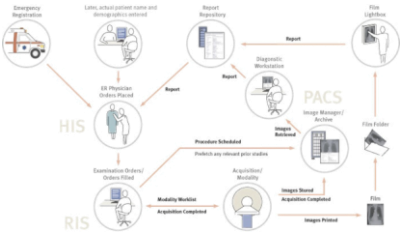
Patient Care



Clinical Efficiency



Live Auditing



Operational Efficiency

Value Based Heathcare

Improved diagnostic, …

Faster radiological reads, …

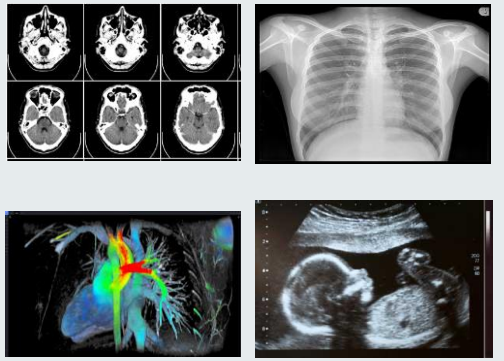
Abnormality detection, …

Bed allocation predictions, …

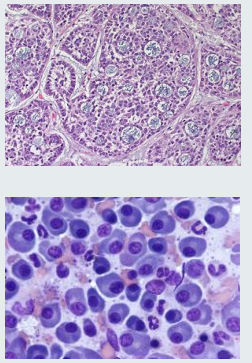
More cost-effective care, …

Translation to clinical environments

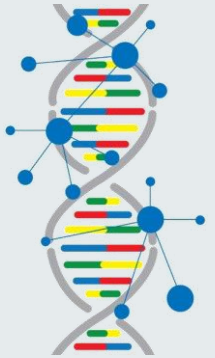
Many potential applications, however …



Radiology
CT, MR, US, X-RAY

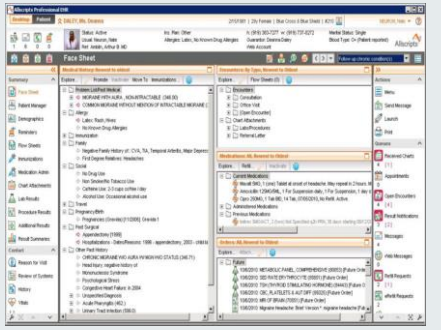


Digital
pathology



Genetic

Dermatology
Ophthalmology



Electronic
Health
Record

27k Medical AI papers
~30 FDA Approved products
~7 Billion USD investment by 2021

Healthcare machine learning challenge

What about impact on patients?

https://www.technologyreview.com

Analysis | Open Access | Published: 15 March 2021

Common pitfalls and recommendations for using machine learning to detect and prognosticate for COVID-19 using chest radiographs and CT scans

Michael Roberts, Derek Driggs, Matthew Thorpe, Julian Gilbey, Michael Yeung, Stephan Ursprung, Angelica I. Aviles-Rivero, Christian Etmann, Cathal McCague, Lucian Beer, Jonathan R. Weir-McCall, Zhongzhao Teng, Effrossyni Gkrania-Klotsas, AIX-COVNET, James H. F. Rudd, Evis Sala & Carola-Bibiane Schönlieb

Nature Machine Intelligence **3**, 199–217 (2021) | Cite this article

Challenges associated with medical AI

Does the image have an artefact? In FOV?
Need for QC tools and robust algorithms

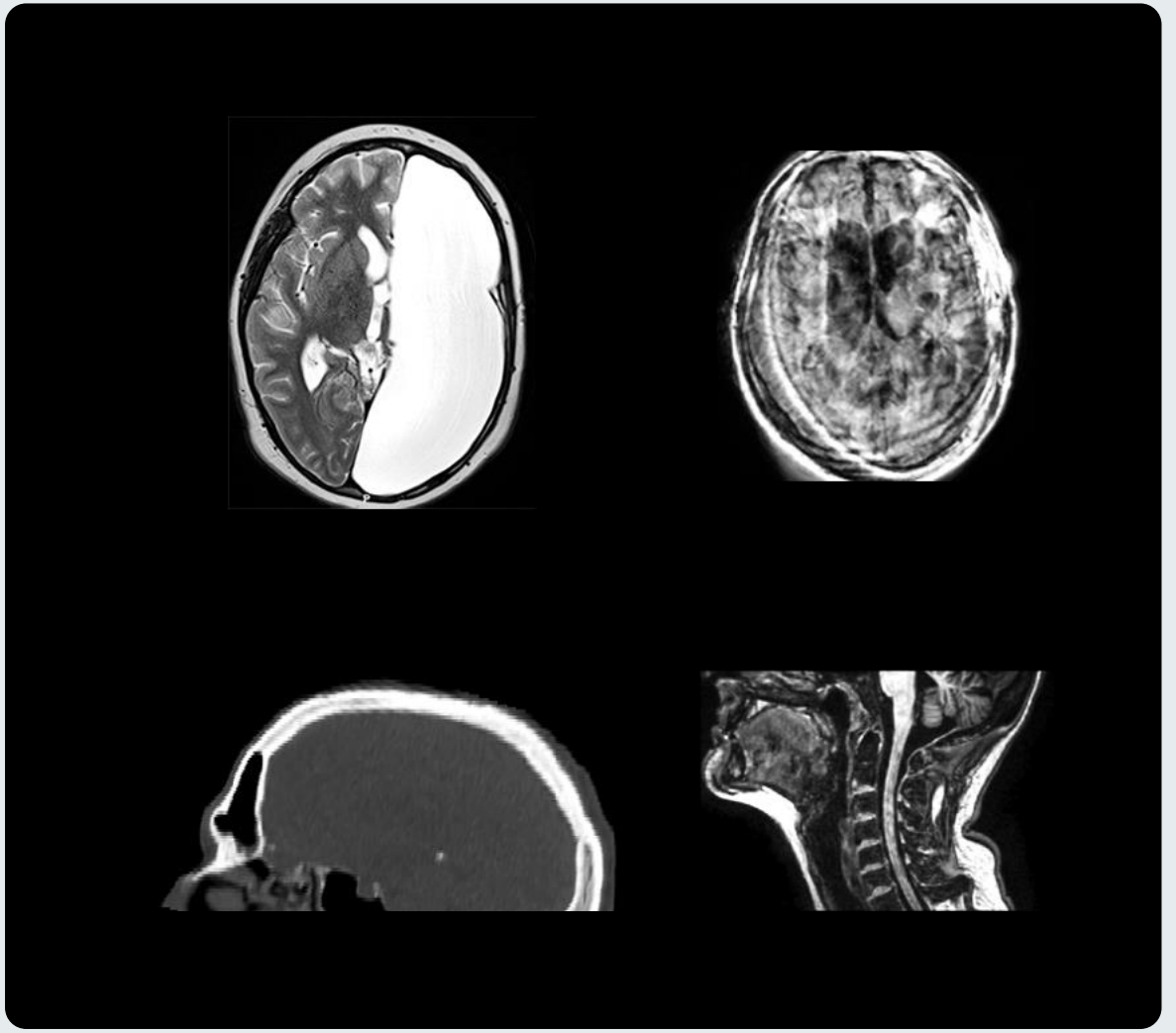
What are the acquisition differences?
Knowledge of acquisition physics

Is all necessary data available?
Deal with missing data

Is the image of the right kind?
Modality and body part classifier

Does my model generalise?
Validation is key and often lacking

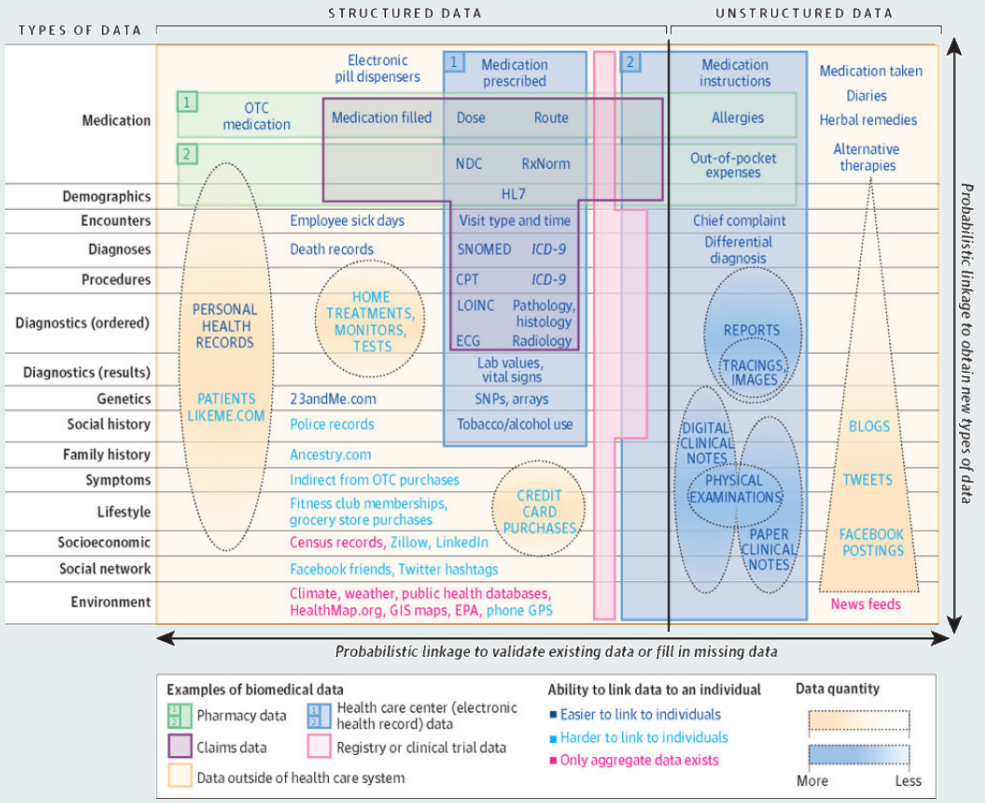
Can my code be used in the clinic?
Research implementation are often crude

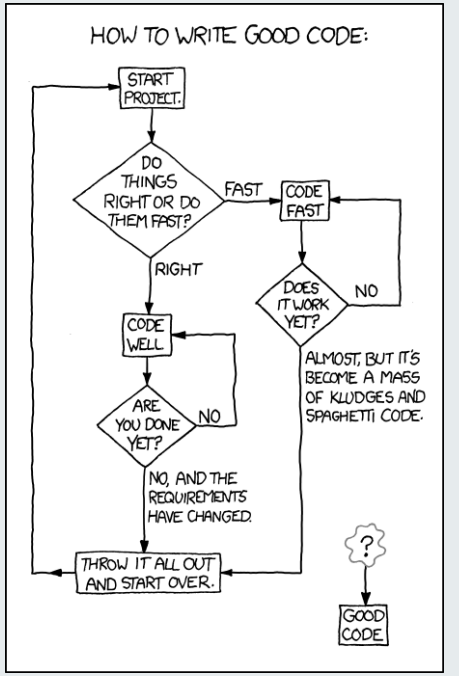


Blueprint requirements for "good" medical AI?

The development of medical AI tool should include (amongst other things):

- Implementation following industry coding standards & best practices.
- Model trained on large dataset(s) of "real" clinical data.
- Application deployed in clinical environments for prospective validation.



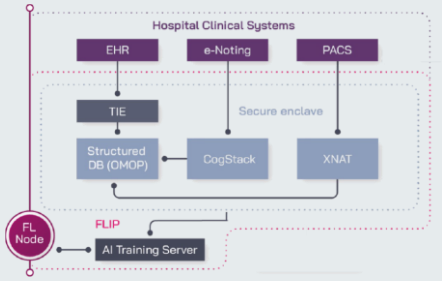


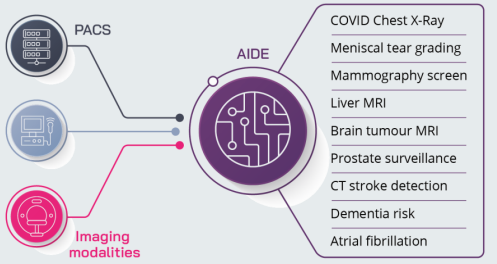
Outline

Interoperative platforms

Development Training Deployment

Idea → MONAI → FLIP → AIDE → Product





https://monai.io, https://github.com/Project-MONAI
https://www.aicentre.co.uk/our-platforms

MONAI: Medical Open Network for Artificial Intelligence

Project MONAI is a collaborative open-source initiative built by academic and industry leaders for deep learning in healthcare imaging.

Part of the PyTorch ecosystem and builds on other popular libraries, such as Pytorch Ignite, to leverage the technical expertise of the biomedical research community.

Community-based including academia and enterprise researchers.

Platform governance now includes an advisory board of members and many working groups.

Accelerating the pace of innovation, through code sharing and reproducible research.

Project MONAI

MONAI

King's College London

NVIDIA

UCSF ci² center for intelligent imaging Department of Radiology & Biomedical Imaging

Mass General Brigham

NIH National Cancer Institute

SIMBIOSYS

Amazon SageMaker

Frederick National Laboratory for Cancer Research

Answer

quantiphi

ACR AI-LAB™

ENTUITT

Mayo Clinic

PHILIPS

NHS Guy's and St Thomas' NHS Foundation Trust

AI CENTRE for Value Based Healthcare

Children's Hospital of Philadelphia

中国科学院 Chinese Academy of Sciences

Kyung Hee University

Consortium Members.

ENTUITT

Methinks

contextflow

Vanderbilt University

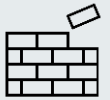
Stanford University

Project MONAI

MONAI Design Goals

Customizable

Abstracted for customizable design for varying user expertise



Composable

Portable with ease of Integration into existing workflows

Domain Specialized

3D Transformations, Network Architectures, and workflows for Medical Imaging

GPU Optimized

Multi-GPU CUDA accelerated data and model parallel processing

Reproducible

Built for reproducibility and comparison with state of the art

High Quality

Tutorials for getting started, robust validation, and documentation

Project MONAI

MONAI Workflow

Labelling

AI assisted segmentation with active learning framework

MONAI Label

App Deployment

Turn model into AI application

MONAI Deploy App SDK

Data

Easy access to standard datasets, caching mechanisms, ...

Training

Domain-optimized foundational capabilities to train model

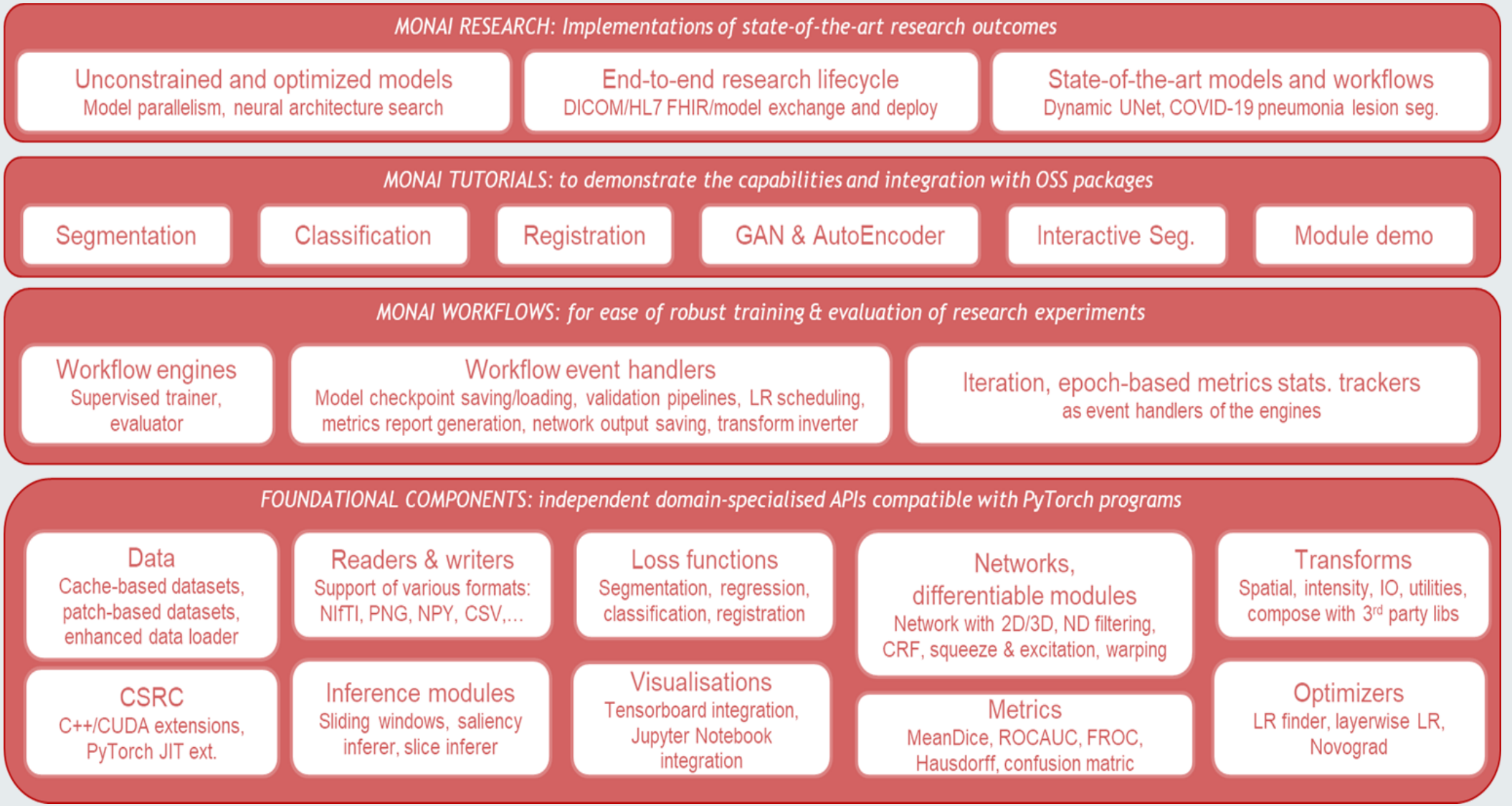
MONAI Core

Deployment

MONAI Inference Service
MONAI Workflow Manager
MONAI Informatics Gateway

Project MONAI

MONAI core components

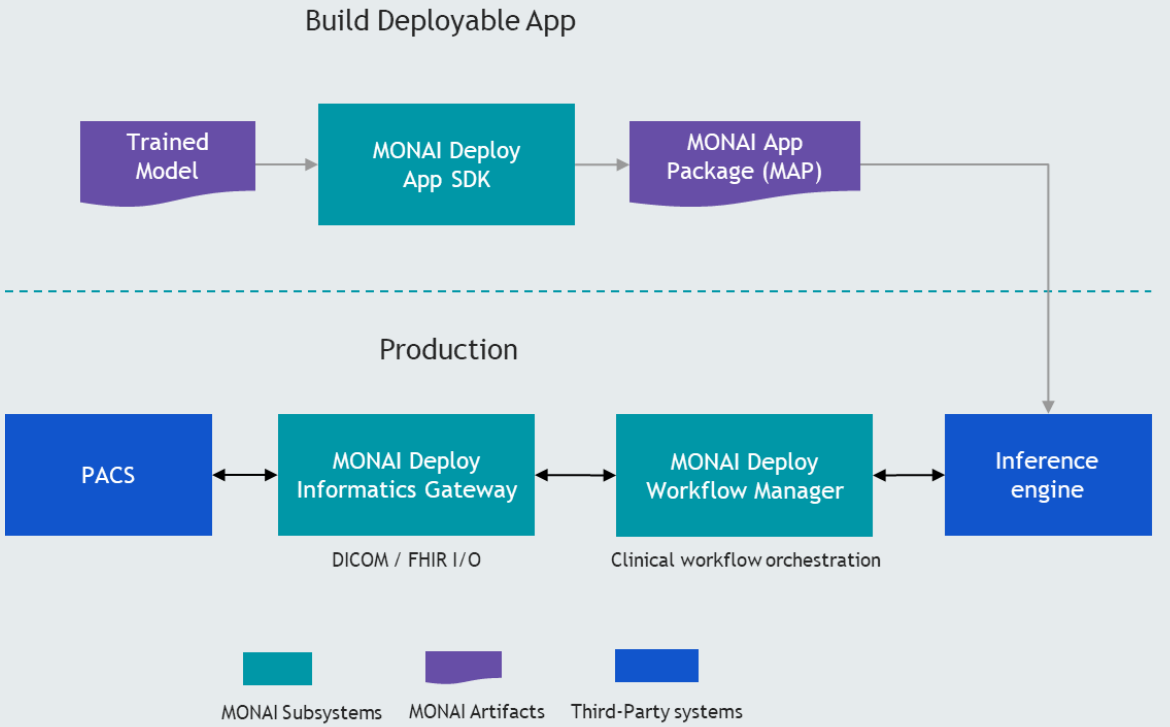


Project MONAI

MONAI deploy

For Researchers and Developers
MONAI Deploy provides an easy way to develop MONAI Deploy Application Packages (MAPs).

For Hospital Operations
MONAI Deploy will define what a clinical infrastructure to run AI should look like, and how to interoperate with medical imaging systems over standards like DICOM and FHIR.

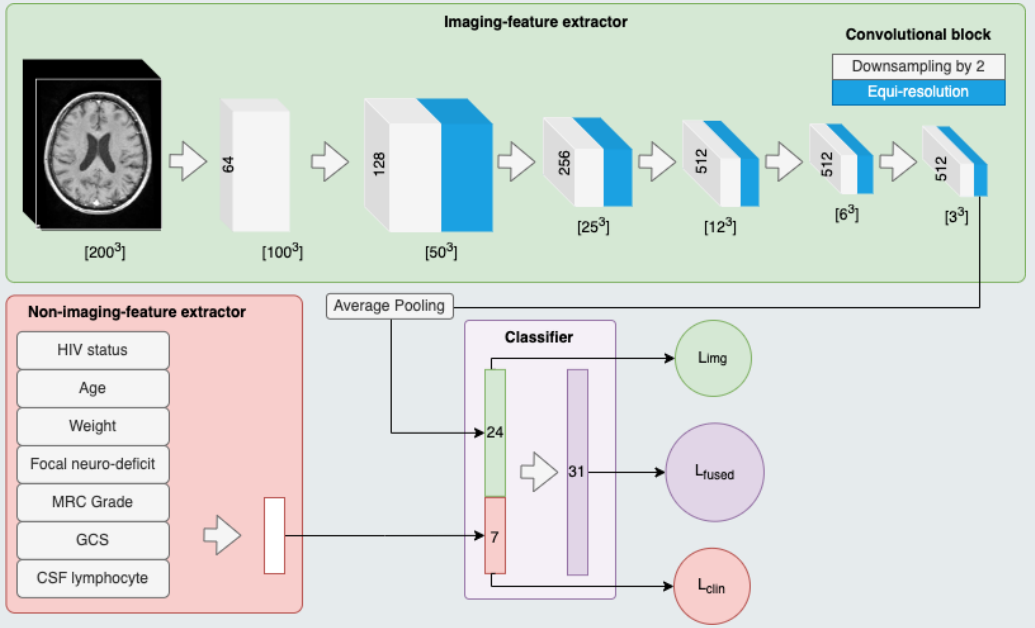


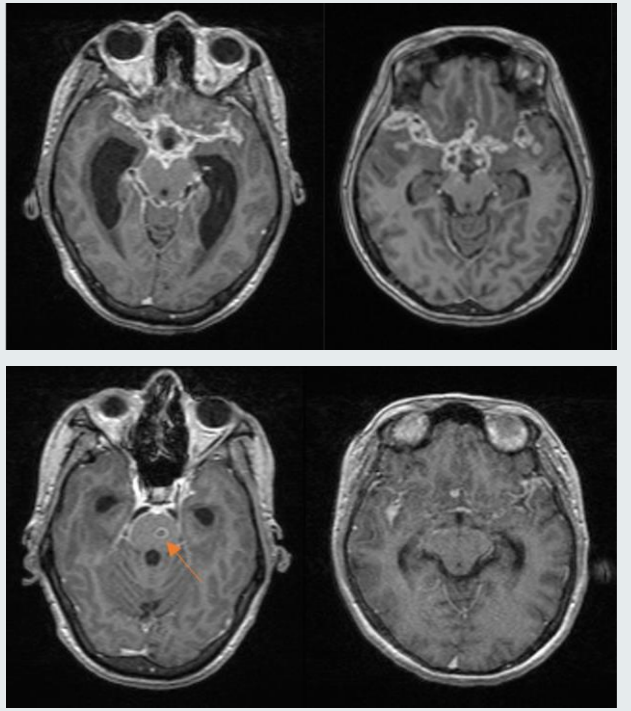
Project MONAI

Example research project using MONAI

Convolutional neural network using magnetic resonance brain imaging to predict outcome from tuberculosis meningitis

- Exploration study to assess imaging complementary nature for prognosis
- Two-branch network with auxiliary losses





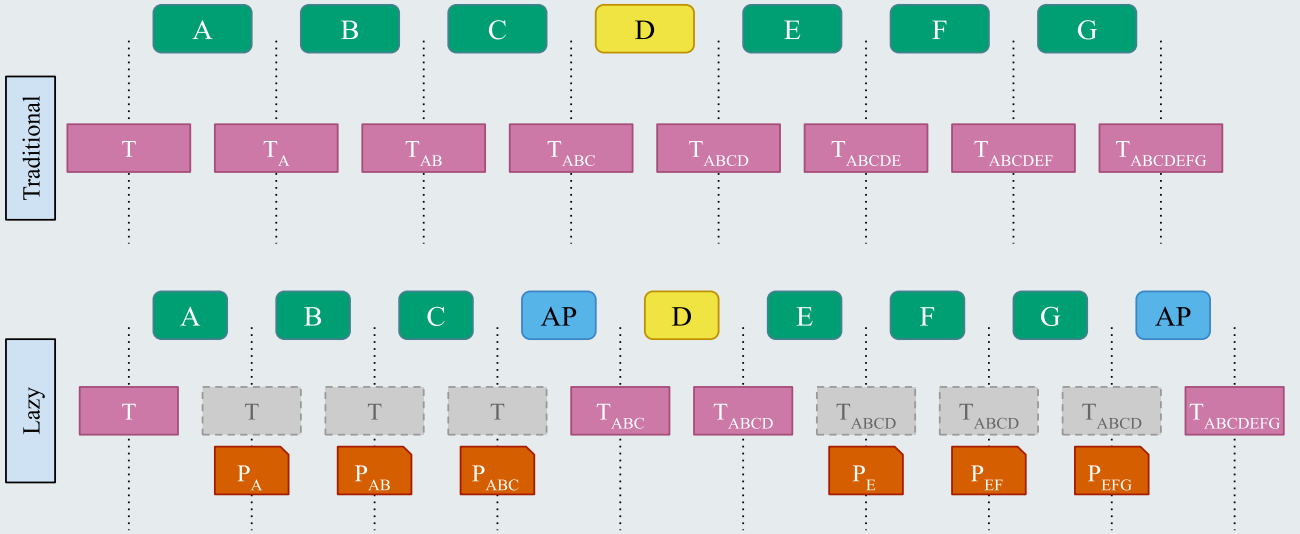
Trinh Dong *et al.*

Project MONAI

Example core development to benefit the broader community

Lazy resampling, Fast and information preserving preprocessing for deep learning

- Suitable for all imaging preprocessing pipeline
- Abstract implementation
- Reduce image degradation



Benjamin Murray *et al.*

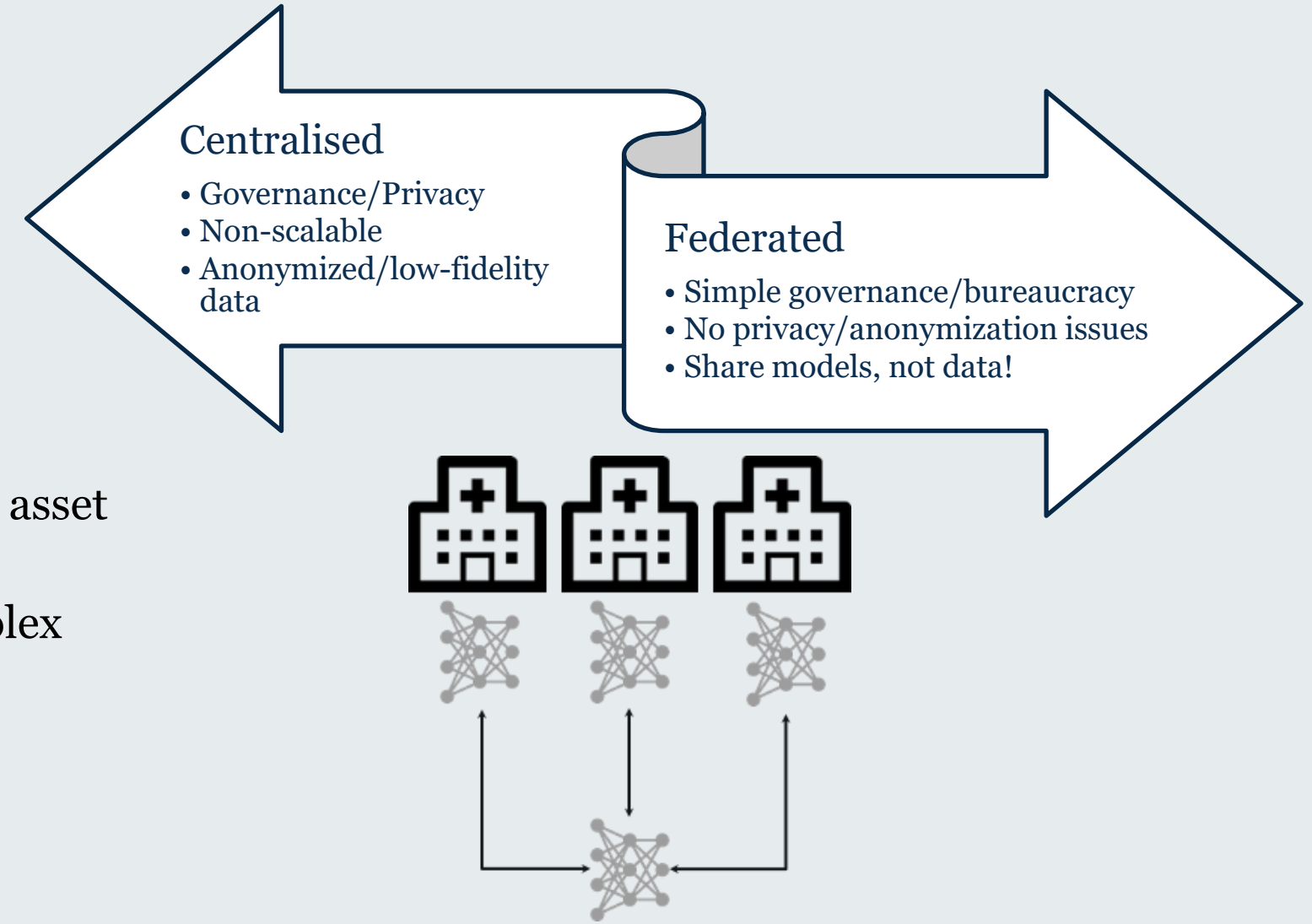
Model training at scale

AI CENTRE for Value Based Healthcare

Large training dataset tend to produce more robust network

Collaborative learning solves crucial issues in healthcare

- Private data can't be shared
- Anonymization is not truly effective
- Data annotation is costly. Data is an asset
- Bureaucracy of data sharing is complex
- Share models, not data!



FLIP: Federated Learning Interoperability Platform

AI CENTRE for Value Based Healthcare

Developed by the AI Centre for Value Based Healthcare

Safe

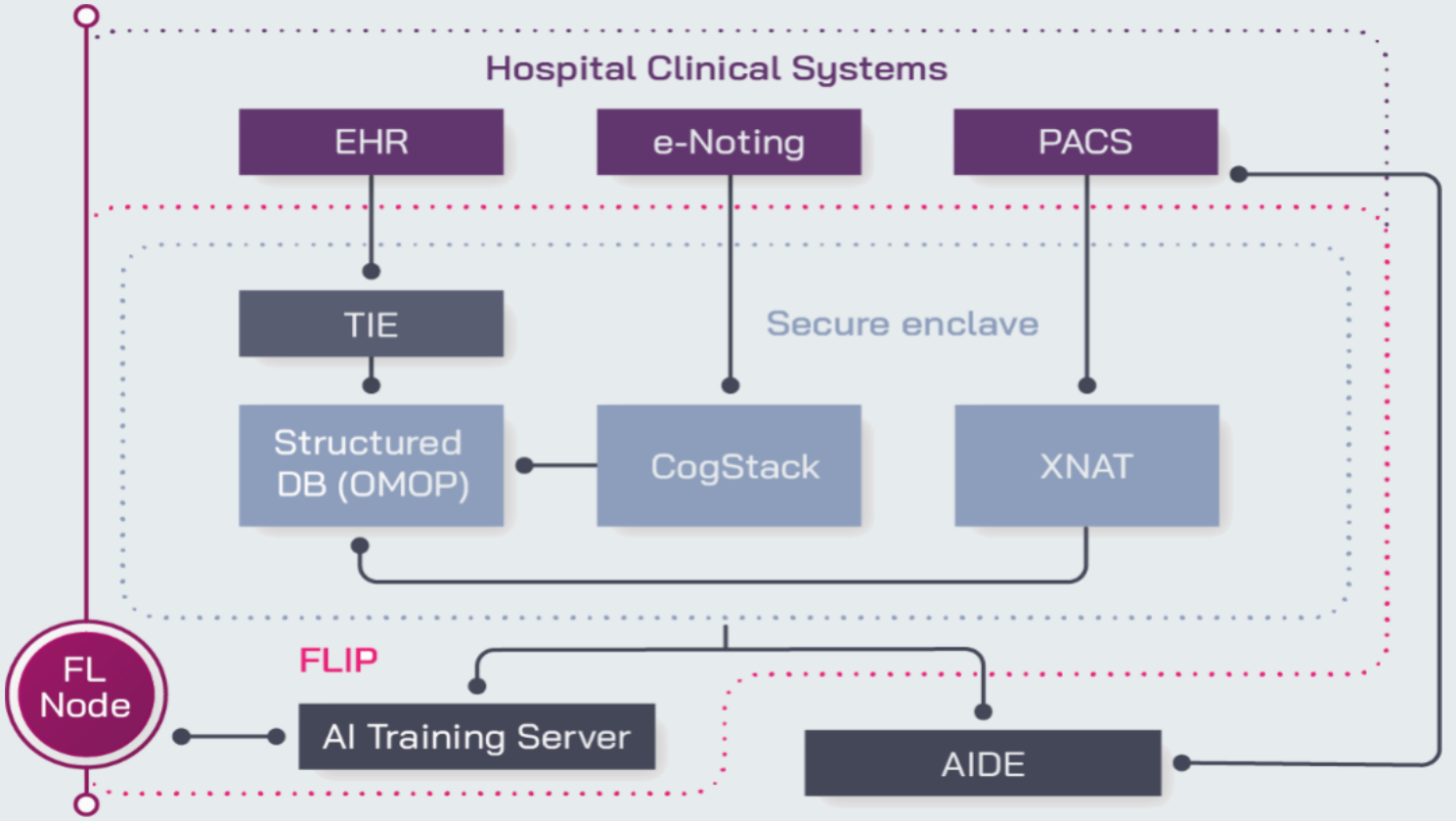
Open Source

Privacy-preserving

Traceability

Scalable

Governance compliance



https://www.aicentre.co.uk

AIDE: AI Deployment Engine

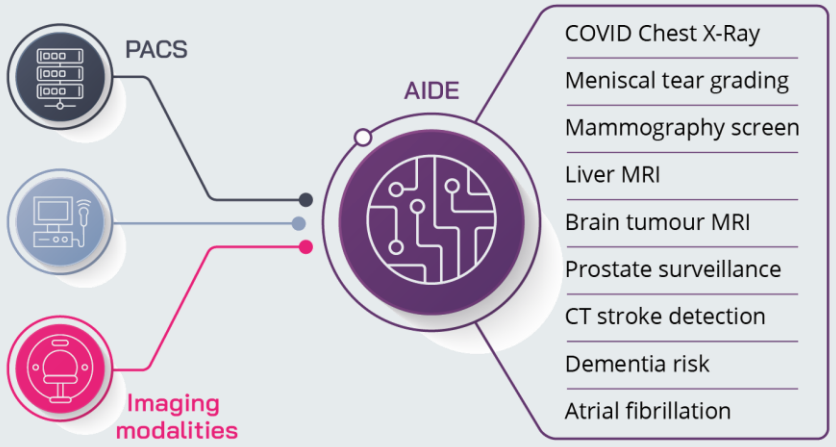
Needed to close the translational gap

It is critical to evaluate developed tools in the target environment

Integrating research software in clinical system is complicated and time consuming

AIDE: AI Deployment Engine

AIDE was first deployed in 2021 in KCH
Deployment in 10 NHS Trust by Sept. 2023

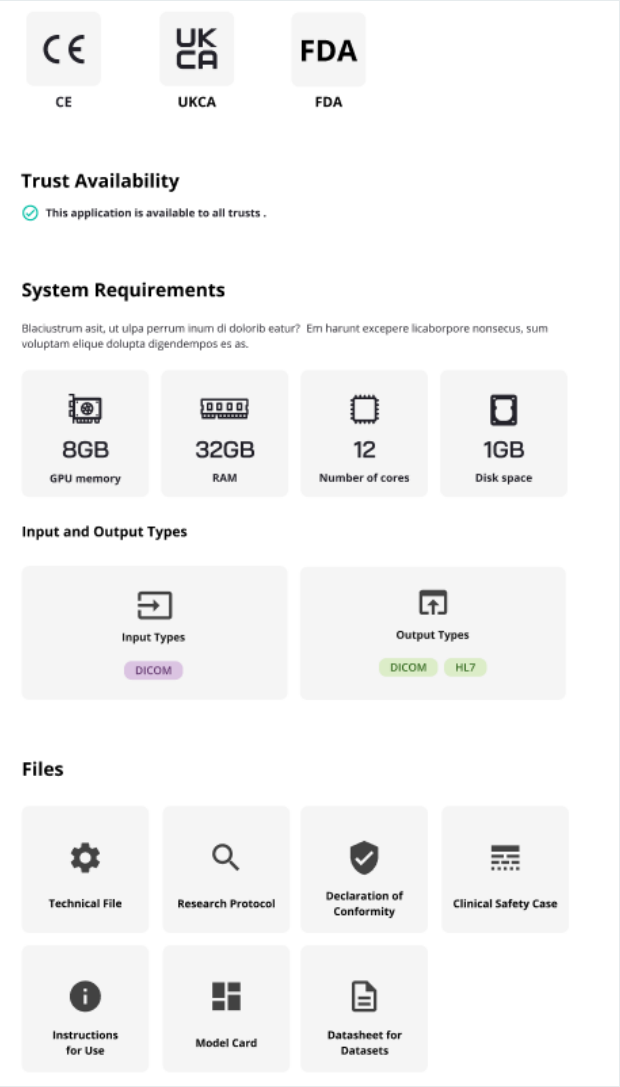


Vendor-agnostic AI model deployment platform	DICOM support for imaging data	FHIR integration supporting non-imaging data
QA mode validate AI applications in safe environment	Approval workflow for integrated deployment process	Central repository of clinical/research applications

AIDE: AI Deployment Engine

AI CENTRE for Value Based Healthcare

AIDE regulated market place



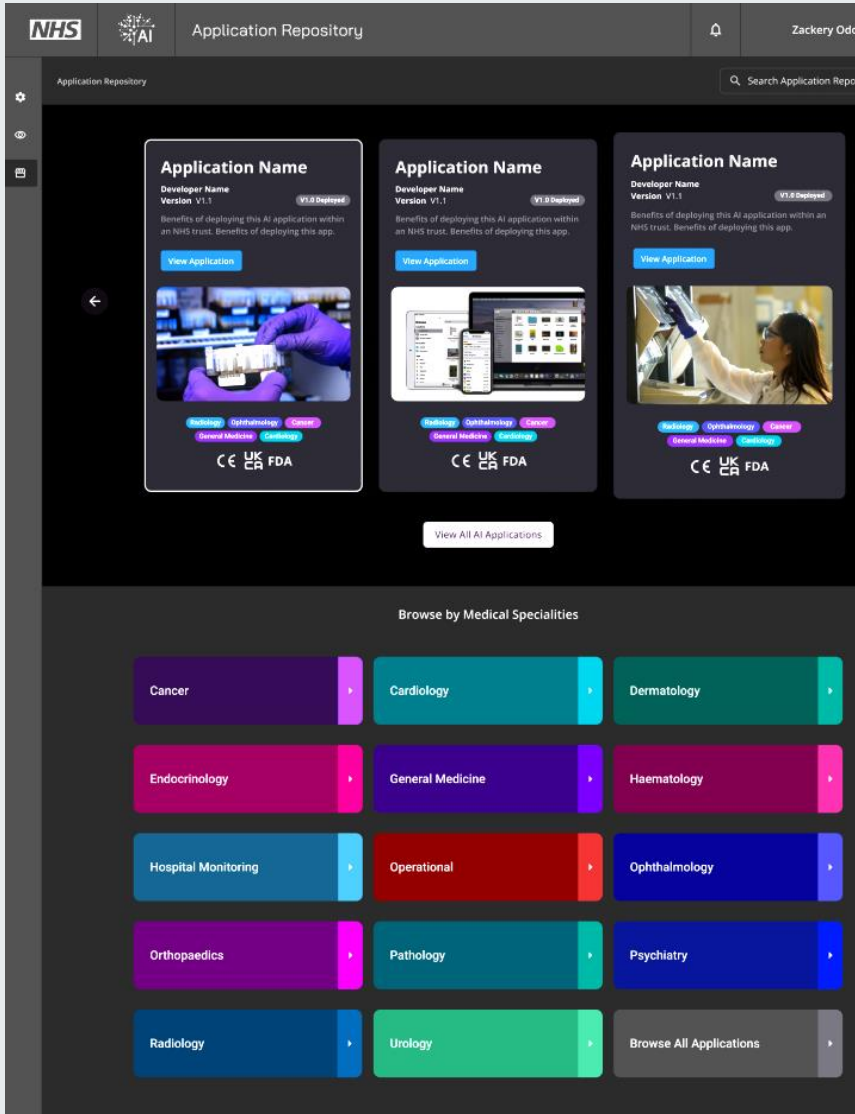
QA, shadow and research modes

Centralised reporting

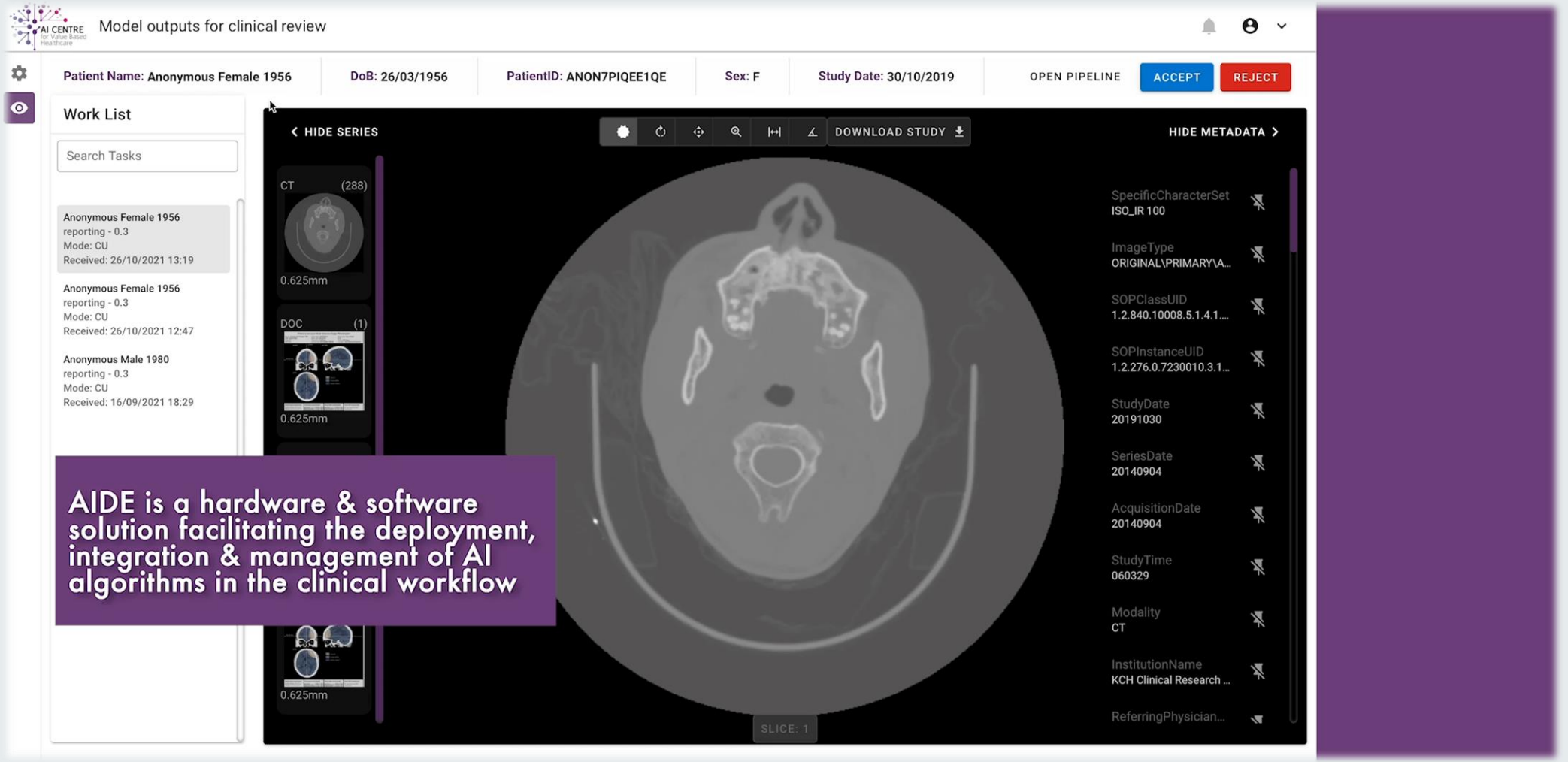
Audit activity

App store with regulators

Distribution for commercial 3rd party AI



Deployment ecosystem – A stroke exemplar



Academic leads for this project: Dr Jorge Cardoso (KCL), Prof Parashkev Nachev (UCL) and Prof Sebastien Ourselin (KCL)

Conclusion

Research related to medical AI is a very active field,
Medical AI impact could be transformative.

Very few tools are reaching patient care.

Project MONAI, FLIP and AIDE are open-source platforms aiming to accelerate development and deployment.

A lot more to do! Let's get coding!

Community-based

Consortium of universities,
hospitals and companies

Thank you for your attention

Acknowledgments:
School of Biomedical Engineering & Imaging Sciences
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