NVIDIA AT MICCAI

September 27 – October 1, 2021 – Welcome to the NVIDIA Virtual Booth

Nadim Daher

Healthcare Ecosystem Development Lead at NVIDIA

Moderator

Prerna Dogra

Sr. Product Manager at NVIDIA & Community Adoption & Outreach Lead for MONAI

Healthcare Product Management

Nicola Rieke

Head of Healthcare & Life Sciences, Solution Architecture EMEA at NVIDIA

NVFlare

Marc Edgar

Sr. Alliance Manager for Medical Devices & Developer Relations at NVIDIA

Clara AGX

Prerna Dogra

Sr. Product Manager at NVIDIA &
Community Adoption & Outreach Lead for MONAI

Healthcare Product Management

September 27 – October 1, 2021

MONAI

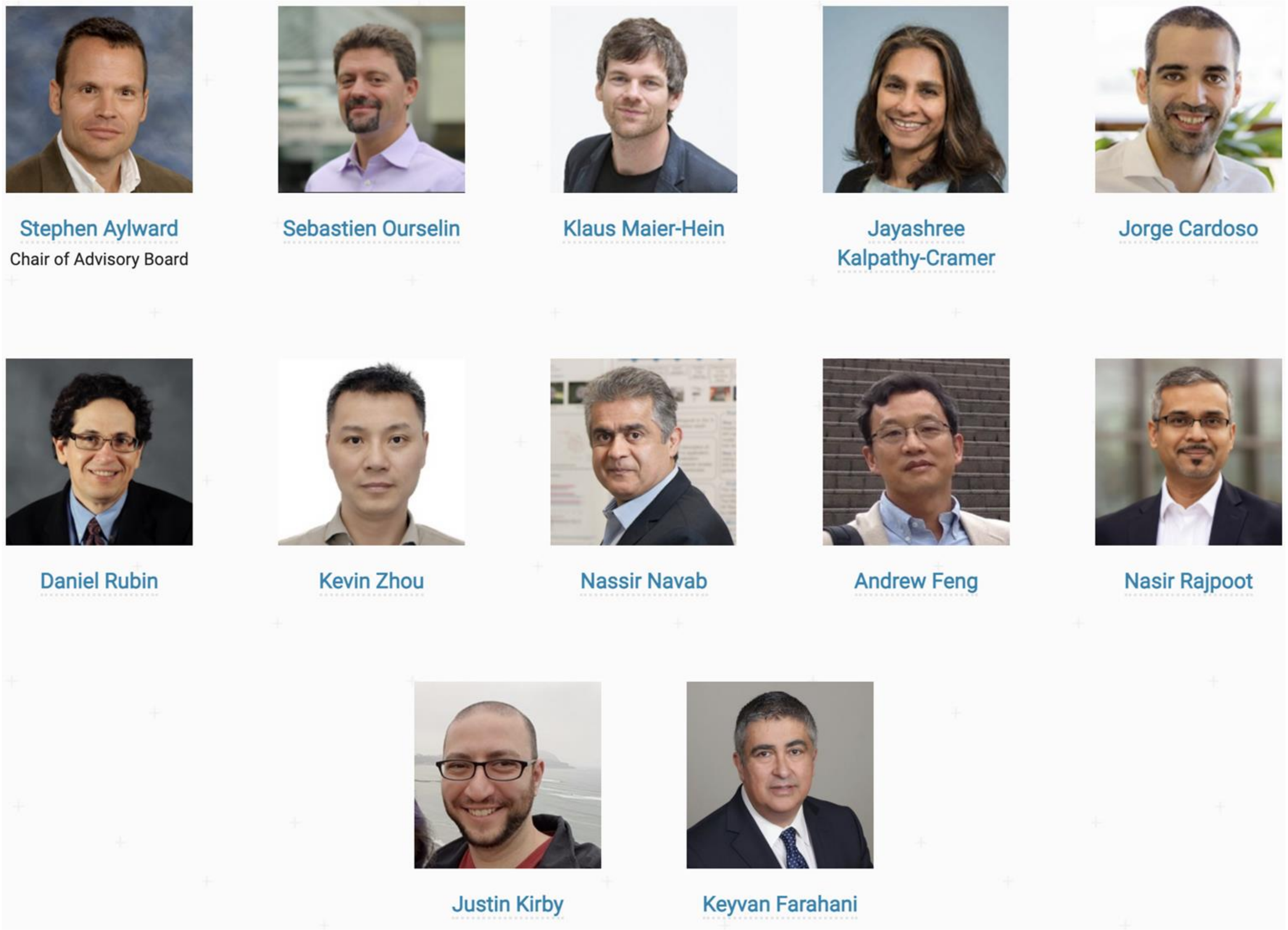
Medical Open Network for AI

Prerna Dogra: Sr. Product Manager, Community Adoption & Outreach Lead for MONAI

WHAT IS MONAI?

Medical Open Network for AI

Project MONAI is a collaborative open-source initiative built by academic & industry leaders to establish and standardize the best practices for deep learning in healthcare imaging to accelerate the pace of innovation"



Project MONAI is guided by Advisory Board chaired by Dr Stephen Aylward

MONAI

WHAT IS MONAI?

Accelerate Pace of Research Innovation With a Common Foundation

Datasets → **Labeling** → **Training** → **App Development** → **Deployment**

Labeling

MONAI Label, an intelligent open-source ***image labeling and learning tool***

That helps researchers and clinicians collaborate, create annotated datasets, and build AI models in a standardized MONAI paradigm.

MONAI Label v0.1

Training

MONAI, the core Pytorch-based library for deep learning in healthcare imaging.

Provides domain-optimized foundational capabilities for developing healthcare imaging ***training workflows***

MONAI Label v0.7

App Development

The very first release of MONAI Deploy App SDK that allows users to create applications from AI models in minutes

MONAI Deploy App SDK v0.1

Deployment

Coming Soon !

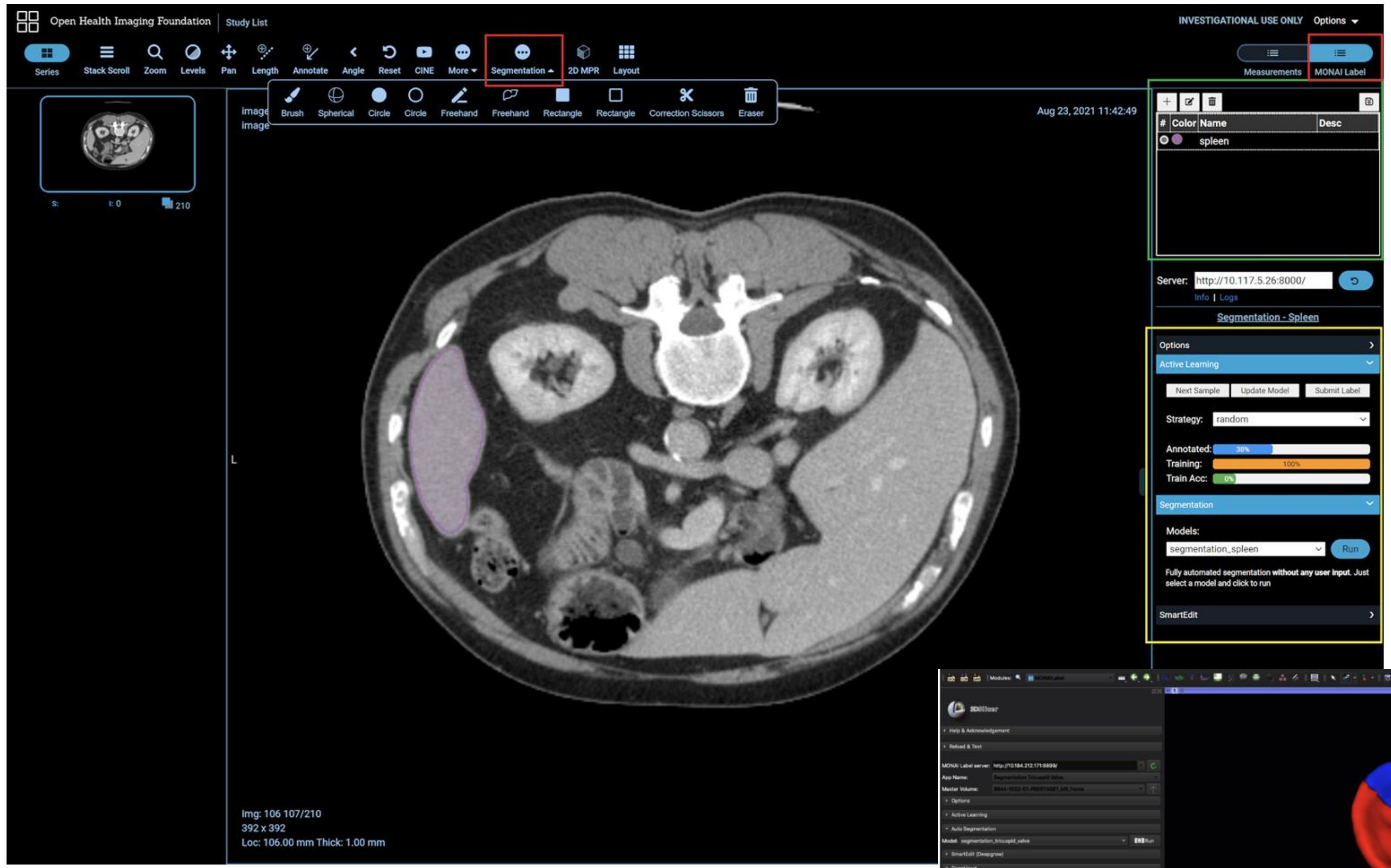
King's College London · NVIDIA · MGH & BWH Center for Clinical Data Science · dkfz. German Cancer Research Center in the Helmholtz Association · Stanford University · TUM Technische Universität München · Kitware · Frederick National Laboratory for Cancer Research · Warwick The University of Warwick · Vanderbilt University

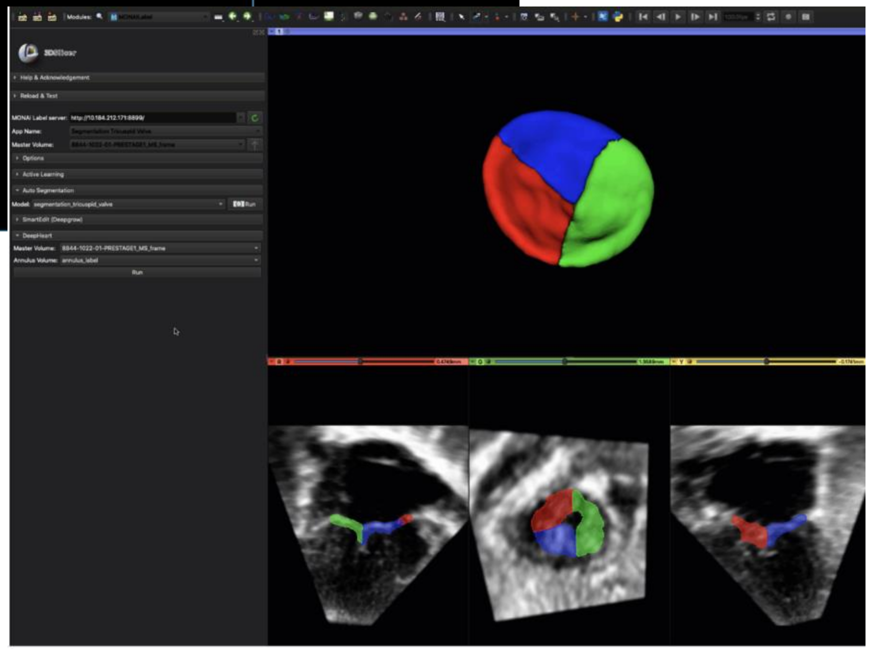
MONAI LABEL V0.2

An intelligent open-source image labeling and learning tool

MONAI Label helps researchers and clinicians collaborate, create annotated datasets and build AI models in a standardized MONAI paradigm.

- MONAI Label v0.2 now includes:
    - Support for OHIF, a zero-footprint web viewer, now get started with MONAI Label with no local installations
    - Support for DICOM web & new MONAI Label application Scribbles
    - New DL based Active Learning strategies





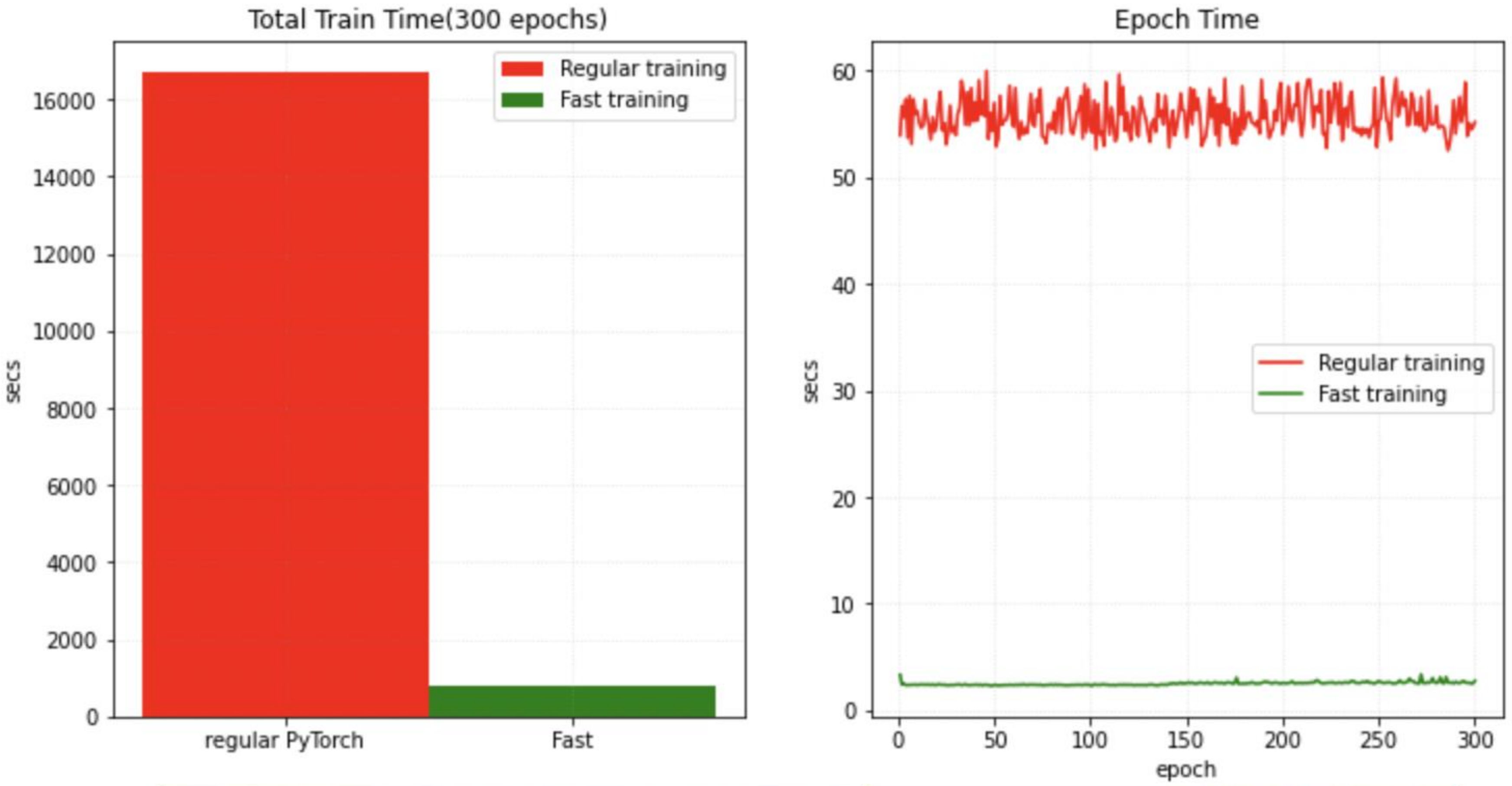
Open-source frameworks like Project MONAI provide a standardized, transparent, and reproducible template for the creation of, and deployment of medical imaged-focused machine learning models, potentiating efforts such as ours. They allow us to focus on investigating novel algorithms and their application, rather than developing and maintaining software infrastructure. This in turn has accelerated research progress which we are actively translating into tools of practical relevance to the pediatric community we serve" – Dr. Matthew Jolley, MD, CHOP

MONAI V0.7

Flagship domain specialized training library

MONAI, the flagship library of Project Monai providing domain specialized best practices for building AI models in healthcare imaging

- MONAI v0.7 now includes:
  - Perf features, enabling up to 20x faster training with developers guides on building state of the art high performing training pipelines using MONAI
  - New tutorials showcasing reference Kaggle top performing methods implemented as MONAI pipelines.
  - MICCAI Research powered by MONAI, Attention driven visual grounding for disease localization



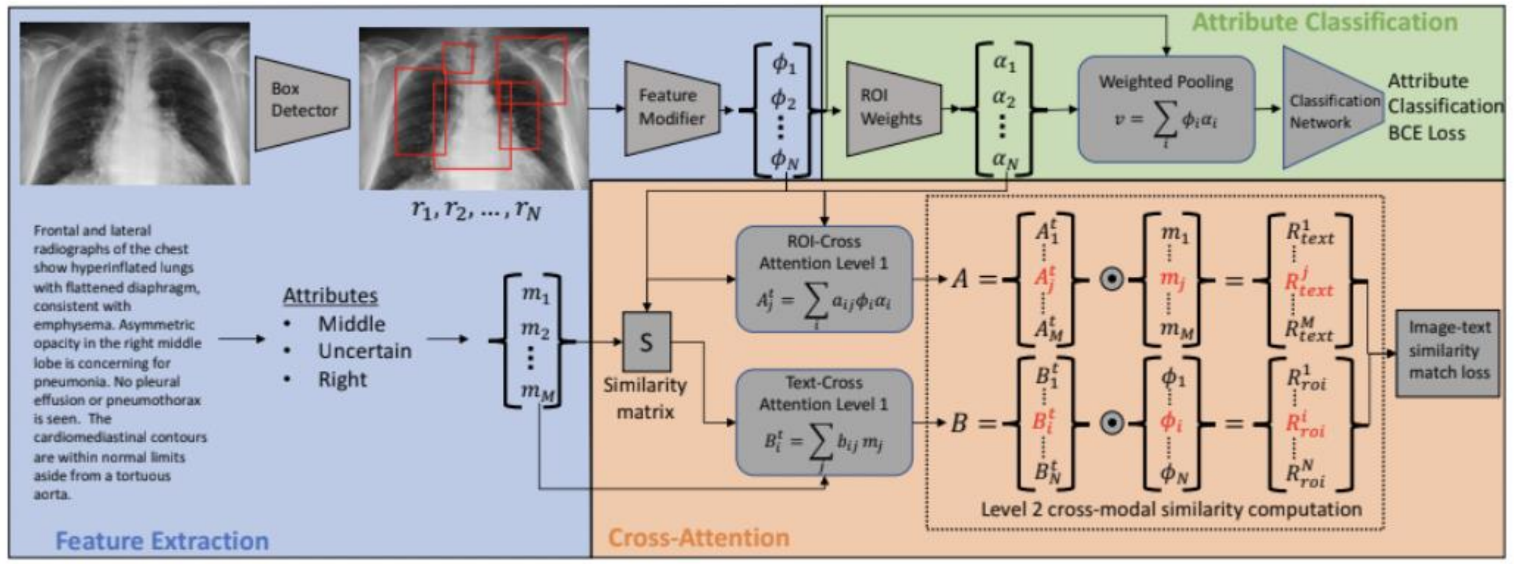


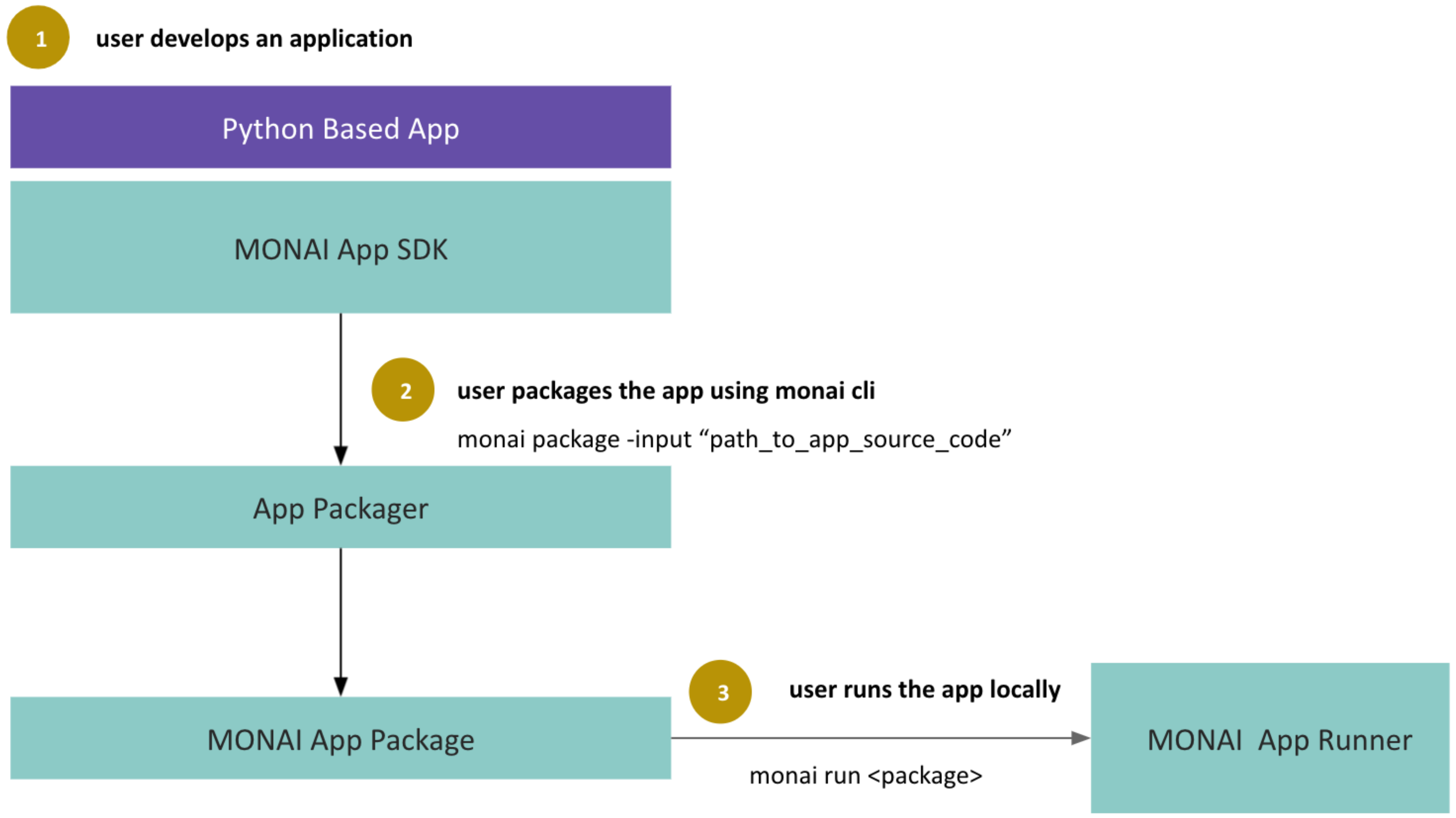
Fig. 1. Network architecture for training the attention based image-text matching for localization.

MONAI DEPLOY V0.1

Develop and test medical applications from AI trained models, in minutes!

MONAI Deploy App SDK offers a framework and associated tools to design, develop and verify AI-driven applications in the healthcare imaging domain.

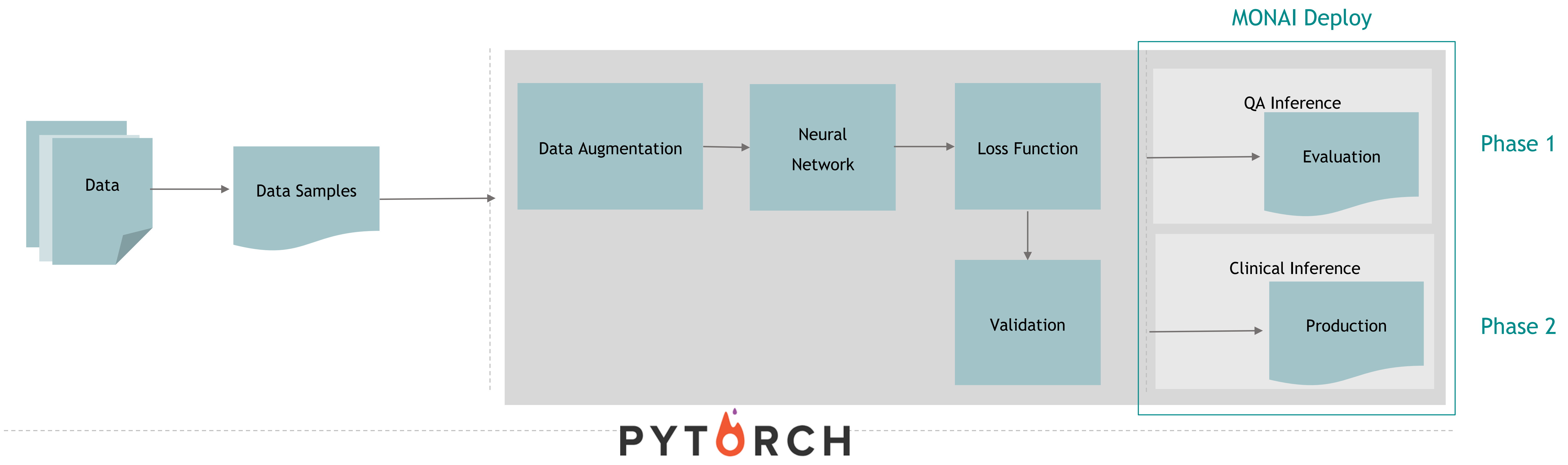
- V0.1.0 includes
  - Pythonic framework for app development
  - API documentation and user's guide
  - A mechanism to locally run a MONAI Deploy App via App Runner
  - Sample applications for a simple Image processing app, MedNist Classifier app and an organ segmentation app



MONAI DEPLOY

Bridging the gap from research innovation to clinical production

- MONAI Deploy aims to become the de-facto standard for developing, testing, deploying and running medical AI applications in clinical production.
- *For Researchers & 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.

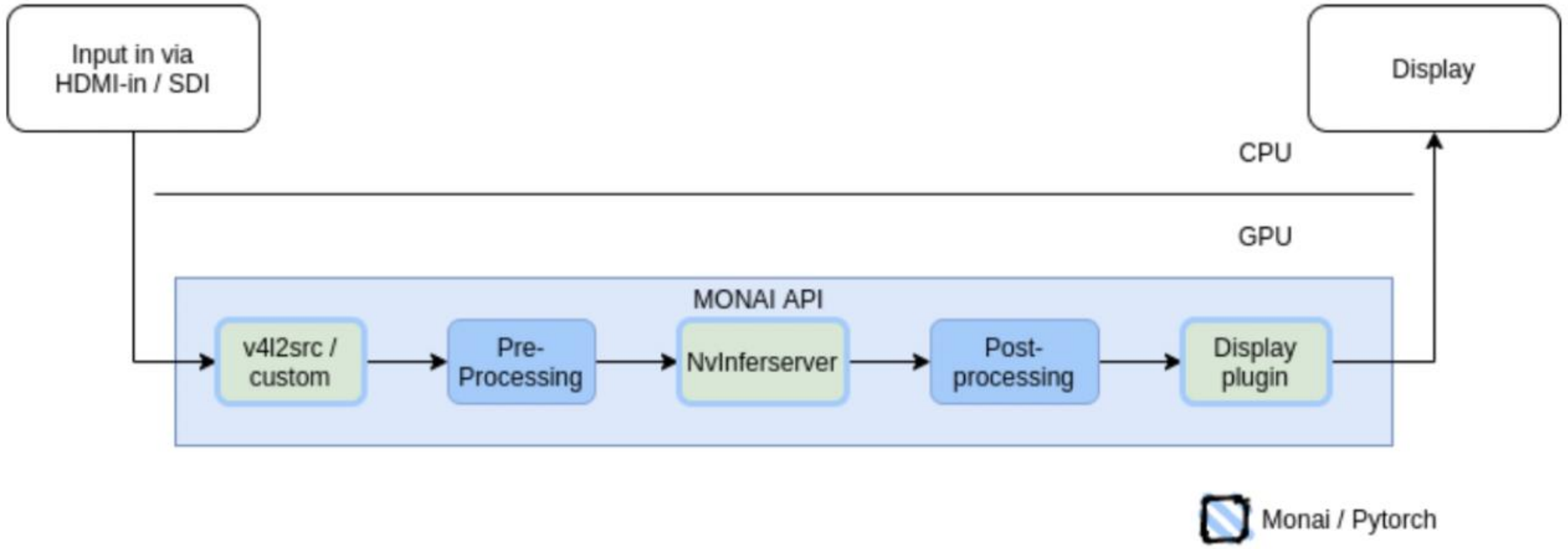


MONAI STREAM

Accelerating Research Prototyping for Streaming Applications

- Announcing MONAI Stream, enables faster prototyping for data streaming research into real-time imaging and computer-assisted interventions.
- Dr. Tom Vercauteren, Professor at King's College London would be leading the MONAI Stream working group.
- Please stay tuned to learn more !

Dr. Tom Vercauteren
MONAI Stream Lead



MONAI MOMENTUM IS EXPLODING

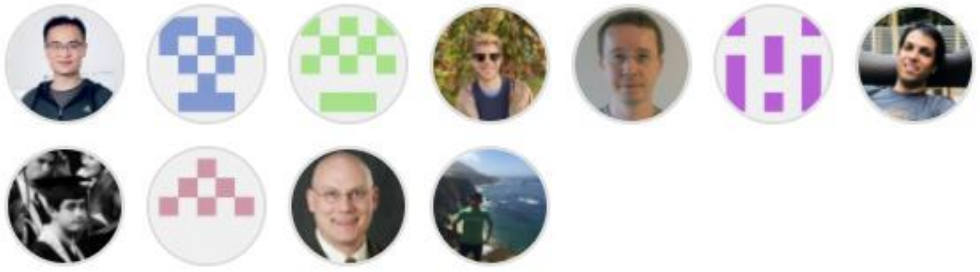
Let’s build MONAI together

Summary

PyPI link	https://pypi.org/project/monai
Total downloads	111,846
Total downloads - 30 days	14,061
Total downloads - 7 days	3,394

MONAI
MEDICAL OPEN NETWORK FOR AI

Contributors 76



+ 65 contributors

Project MONAI
AI Toolkit for Healthcare Imaging
https://monai.io/ @ProjectMONAI

King's College London · NVIDIA · Stanford University · MGH & BWH Center for Clinical Data Science · dkfz. German Cancer Research Center in the Helmholtz Association · TUM Technische Universität München · Warwick The University of Warwick · Kitware · Vanderbilt University · Frederick National Laboratory for Cancer Research

112k Downloads
105 external projects

10 Working groups
80 external contributors

Join the open-source force
of multiple organizations

ENGAGE WITH MONAI TODAY

Get Started: https://github.com/Project-MONAI

Create AI Model for Healthcare Imaging with MONAI: https://github.com/Project-MONAI/MONAI

Create AI models for annotation and integrate with your viewer of choice: https://github.com/Project-MONAI/MONAILabel

Create an application from an AI model with MONAI Deploy: https://github.com/Project-MONAI/monai-deploy-app-sdk

We want to hear from you

- MONAI Core GitHub Discussion: https://github.com/Project-MONAI/MONAI/discussions
- MONAI Label GitHub Discussion: https://github.com/Project-MONAI/MONAILabel/discussions
- MONAI Deploy Discussion: https://github.com/Project-MONAI/monai-deploy-app-sdk/discussions

Contribute

- GitHub
    - Community Guide: https://github.com/Project-MONAI/MONAI#community
    - Contributing Guide: https://github.com/Project-MONAI/MONAI#contributing
- Join our Slack Channel. Fill out the Google Form here: https://forms.gle/QTxJq3hFictp31UM9

Nicola Rieke

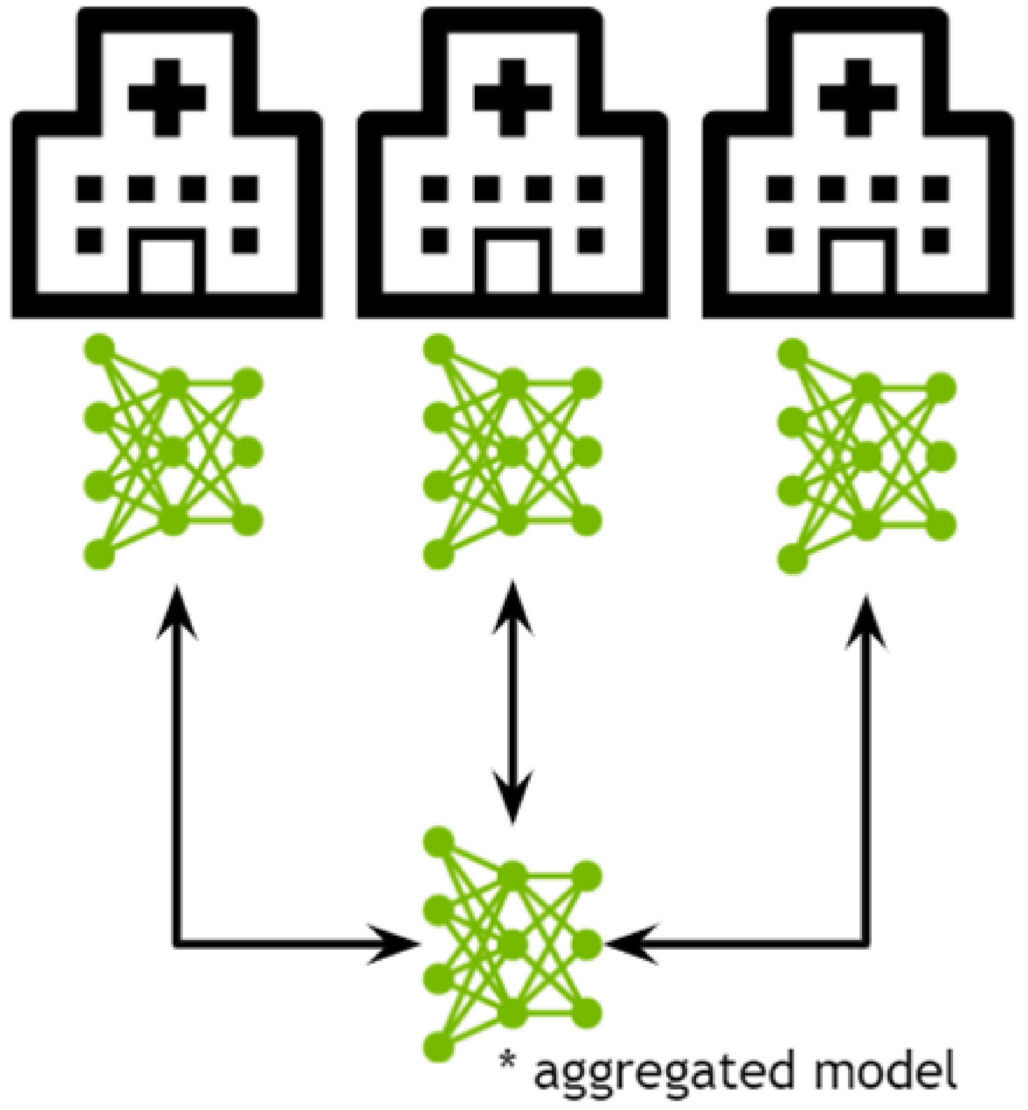
Head of Healthcare & Life Sciences, Solution Architecture EMEA at NVIDIA

Federated Learning with NVFlare
NVIDIA Federated Learning Application Runtime Environment

September 27 – October 1, 2021

FEDERATED EFFORT

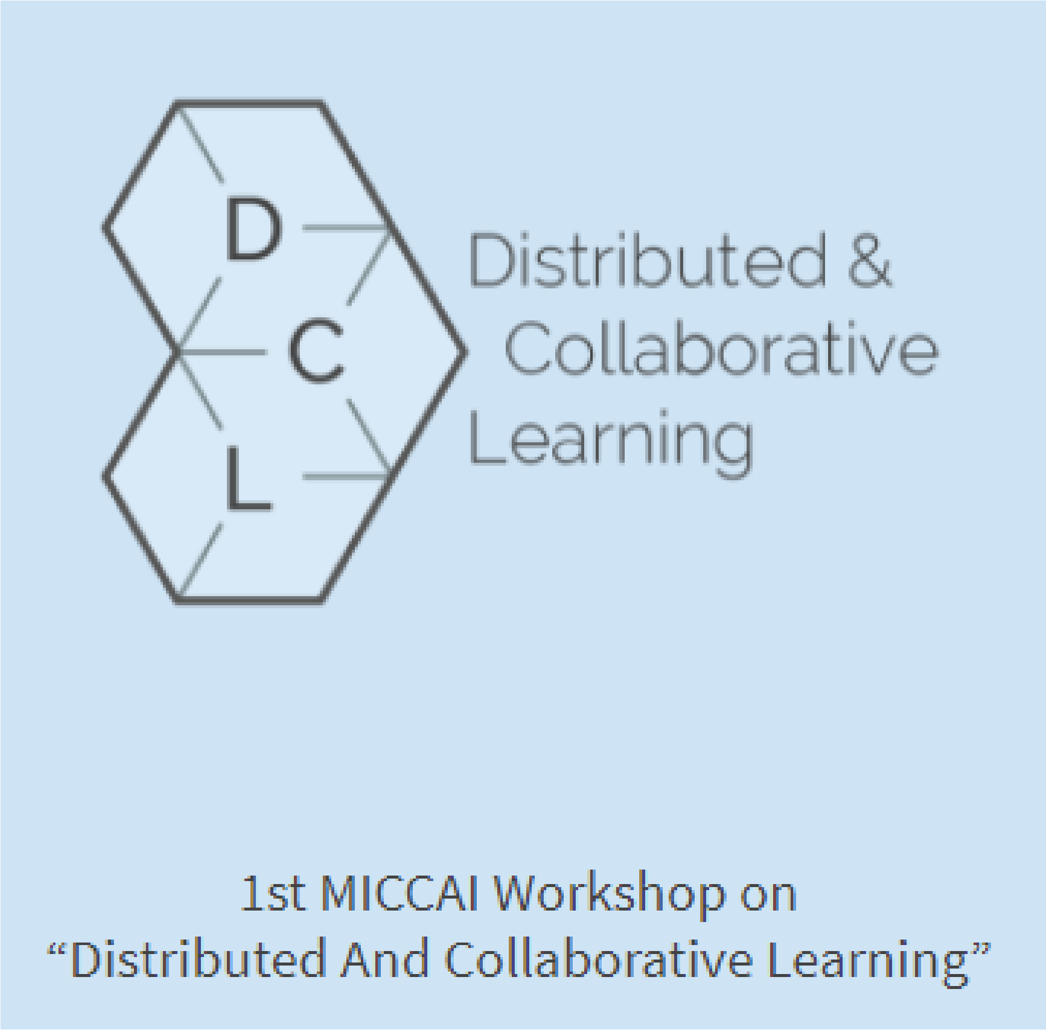
ROBUST MODELS, LARGE SCALE TRAINING



- Training of AI models requires sufficiently large, diverse and curated data sets
- Share model updates, not data
- Collaborative Learning without centralizing data
- AI training occurs locally at each participant
- Participant controls data access and the ability to revoke it

FEDERATED LEARNING

NVIDIA has strong footprints for FL in healthcare




npj | Digital Medicine www.nature.com/npjdigitalmed

PERSPECTIVE OPEN

The future of digital health with federated learning

Nicola Rieke, Jonny Hancox, Wenqi Li, Fausto Milletarì, Holger R. Roth, Shadi Albarqouni, Spyridon Bakas, Mathieu N. Galtier, Bennett A. Landman, Klaus Maier-Hein, Sébastien Ourselin, Micah Sheller, Ronald M. Summers, Andrew Trask, Daguang Xu, Maximilian Baust and M. Jorge Cardoso

Data-driven machine learning (ML) has emerged as a promising approach for building accurate and robust statistical models from medical data, which is collected in huge volumes by modern healthcare systems. Existing medical data is not fully exploited by ML primarily because it sits in data silos and privacy concerns restrict access to this data. However, without access to sufficient data, ML will be prevented from reaching its full potential and, ultimately, from making the transition from research to clinical practice. This paper considers key factors contributing to this issue, explores how federated learning (FL) may provide a solution for the future of digital health and highlights the challenges and considerations that need to be addressed.

npj Digital Medicine (2020)3:119 ; https://doi.org/10.1038/s41746-020-00323-1

INTRODUCTION

DATA-DRIVEN MEDICINE REQUIRES FEDERATED EFFORTS


arXiv:2009.13148v1 [eess.IV] 28 Sep 2020

arXiv:2009.01871v2 [eess.IV] 17 Sep 2020

arXiv:1910.00962v1 [cs.CV] 2 Oct 2019

Privacy-preserving Federated Brain Tumour Segmentation

Wenqi Li, Fausto Milletarì, Daguang Xu, Nicola Rieke, Jonny Hancox, Wentao Zhu, Maximilian Baust, Yan Cheng, Sébastien Ourselin, M. Jorge Cardoso, and Andrew Feng

NVIDIA
Biomedical Engineering and Imaging Sciences, King's College London, UK

Abstract. Due to medical data privacy regulations, it is often infeasible to collect and share patient data in a centralised data lake. This poses challenges for training machine learning algorithms, such as deep convolutional networks, which often require large numbers of diverse training examples. Federated learning sidesteps this difficulty by bringing code to the patient data owners and only sharing intermediate model training updates among them. Although a high-accuracy model could be achieved by appropriately aggregating these model updates, the model shared could indirectly leak the local training examples. In this paper, we investigate the feasibility of applying differential-privacy techniques to protect the patient data in a federated learning setup. We implement and evaluate practical federated learning systems for brain tumour segmentation on the BraTS dataset. The experimental results show that there is a trade-off between model performance and privacy protection costs.

1 Introduction

FEDERATED LEARNING FOR HEALTHCARE

2nd MICCAI DCL Workshop on Oct 1!

http://dcl-workshop.net/

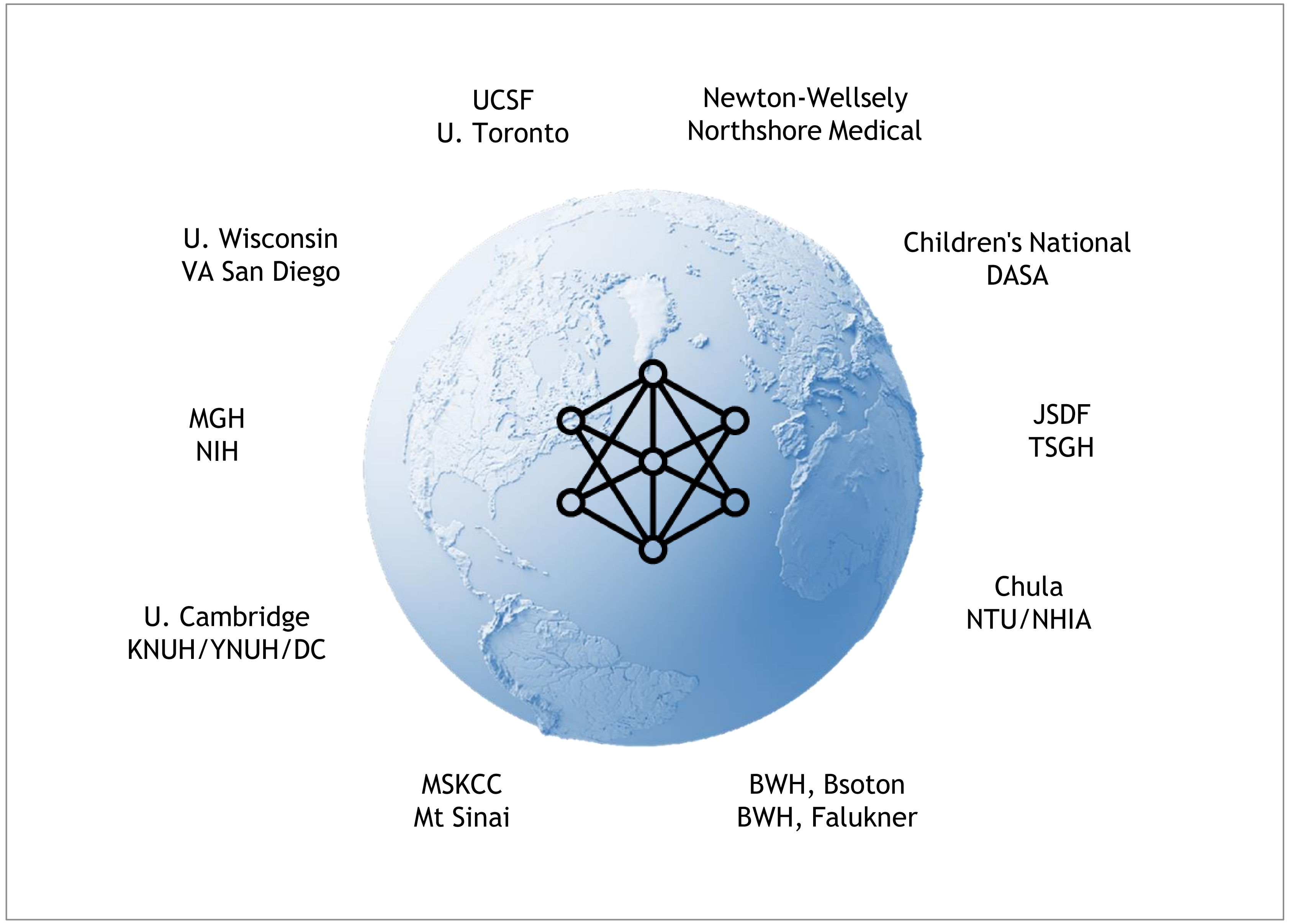
NATURE PARTNER JOURNAL - POSITIONING FL FOR HEALTHCARE

https://www.nature.com/articles/s41746-020-00323-1

ADDRESSING OPEN FL RESEARCH QUESTIONS

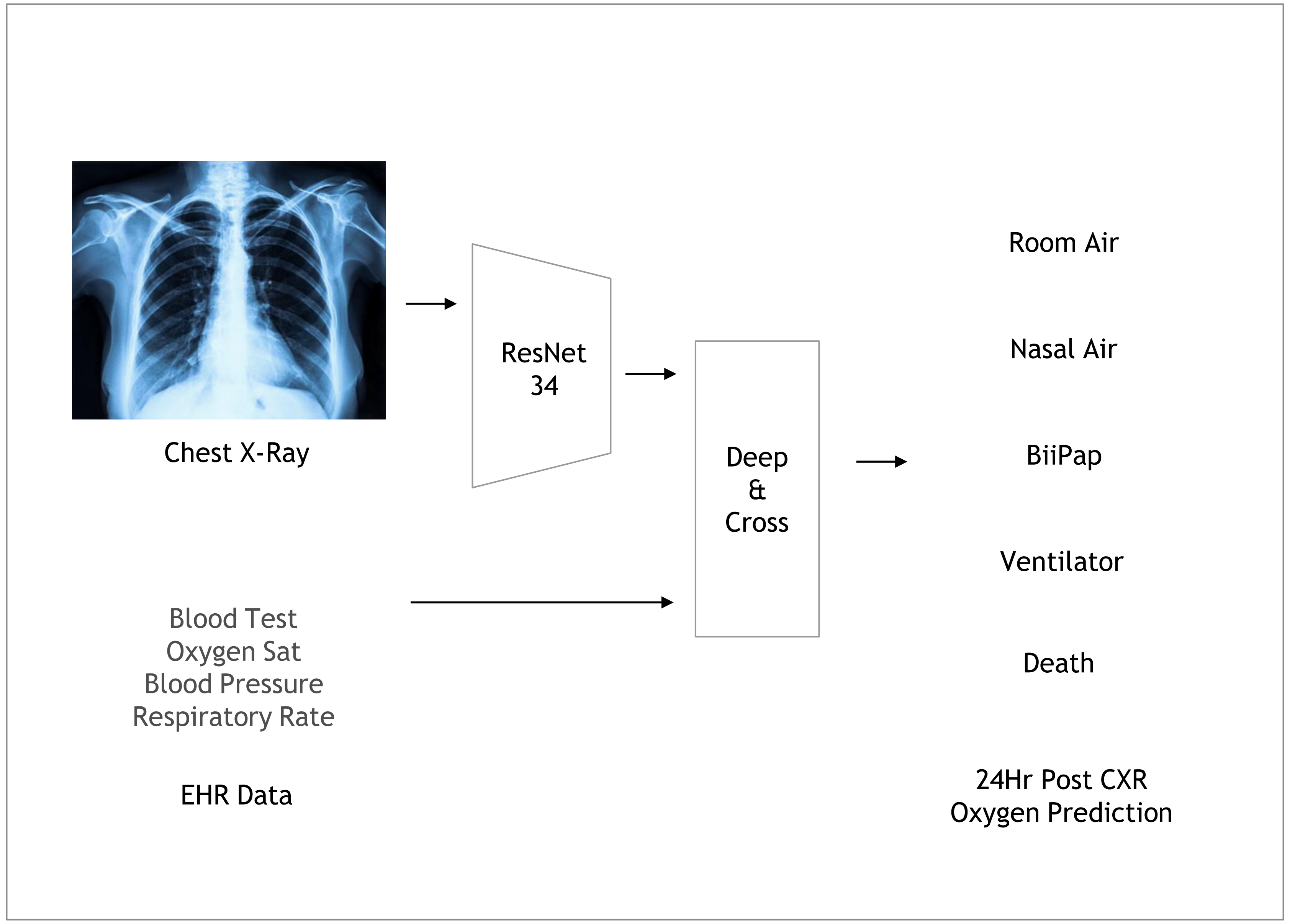
Connect with the NVIDIA Researchers at the NVIDIA booth!

CLARA FEDERATED LEARNING FOR COVID-19 PATIENT CARE
“EXAM” AI MODEL



Clara Federated Learning

20 Sites | 8 Countries
COVID-19 Oxygen Prediction



Global Model Achieved .93AUC

>25% Relative Improvement
Every Site Benefited Regardless of Dataset Size

'Federated learning for predicting clinical outcomes in patients with COVID-19', Nature Medicine
https://www.nature.com/articles/s41591-021-01506-3

CLARA FEDERATED LEARNING

Privacy Preserving | Extensible | Ease of provisioning

Privacy-Preserving

Homomorphic Encryption

Model Truncation

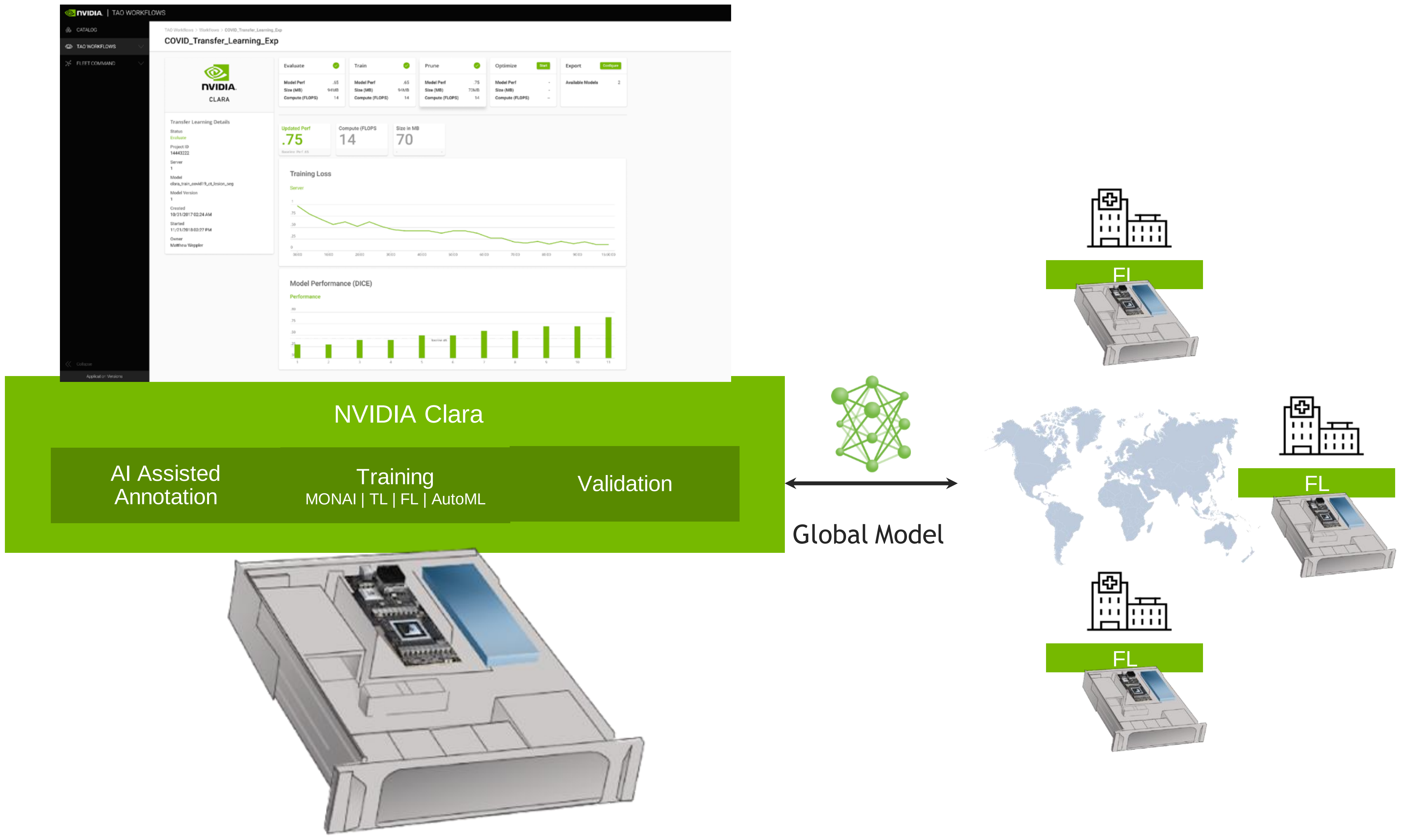
Model Noise

Easy Provisioning & Extensibility

Secure & seamless provisioning

Extensible with ability to bring your own component

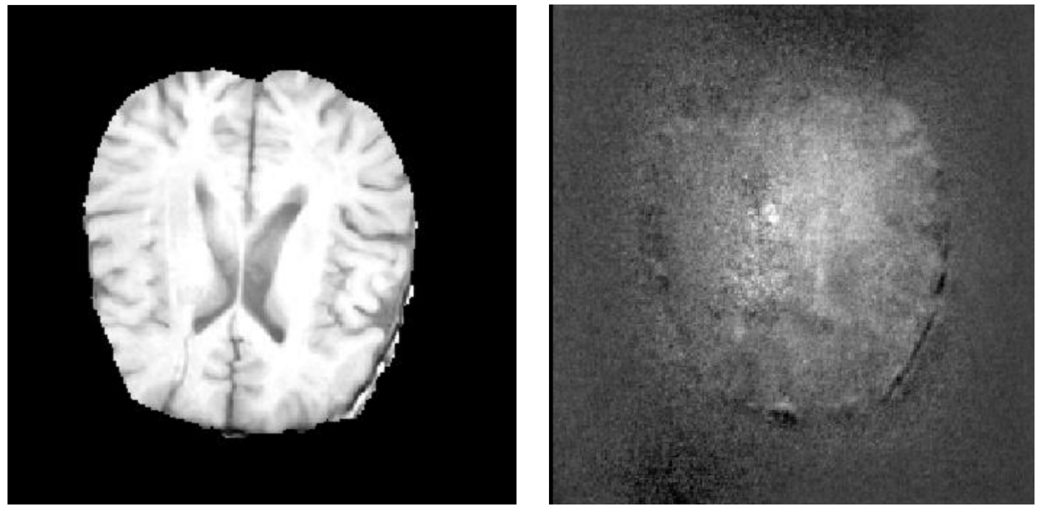
Certified Deployment with NVIDIA certified servers



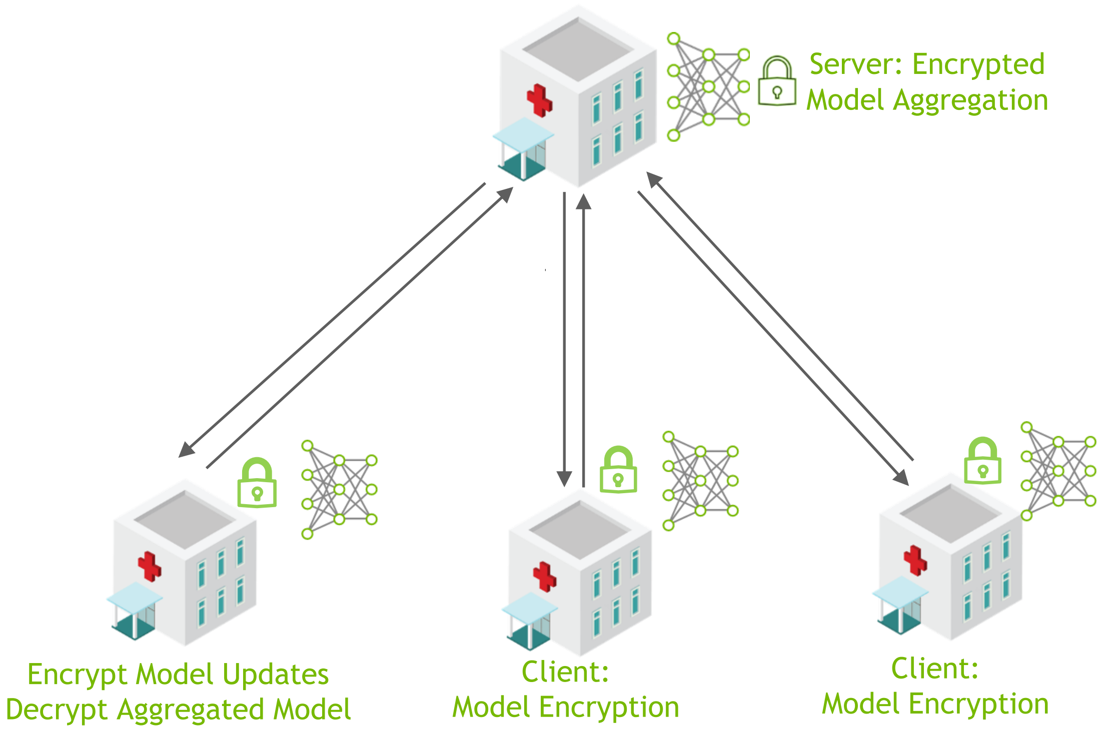
NVIDIA Clara Federated Learning Documentation

CLARA FEDERATED LEARNING

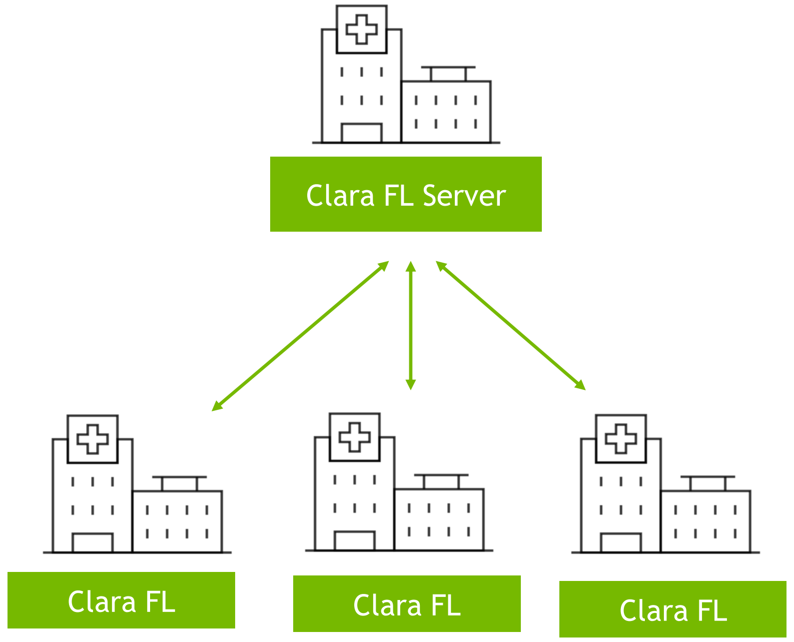
Privacy Preserving & Extensible Collaborative Learning



DIFFERENTIAL PRIVACY
Prevent data leakage



HOMOMORPHIC ENCRYPTION
Aggregation on Encrypted Models



EXTENSIBLE
Use Cases Beyond Imaging
Use Preferred Training Framework
Standalone Python Package for Easy Integration

PRIVACY PRESERVING
Collaborate without compromising privacy

NVIDIA FEDERATED LEARNING

Secure, Manageable & Scalable Framework

Clara | Drive | Metropolis | TAO | 3rd party

NVFlare

FL Simulator

(Accelerate pace of research & development)

Federated Learning API:
Workflow, Trainer, Aggregator, Validator, Provision

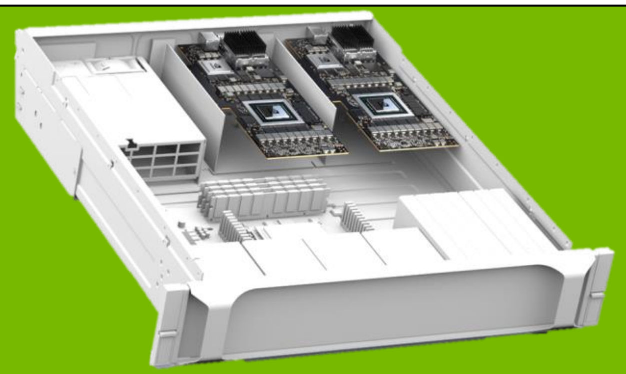
Learning Components
Trainers: IDD and non-IDD trainer
Aggregation: Accumulate & in-Time FedAvg, FedAsync
Evaluation: Model Selector, Cross-site Validator
Data: Analytics, *Tracking*

Federation Workflows
Fed Avg, *P2P*, Cyclic, etc.

Orchestration
Provision,
Data Prep,
Study Mgmt,
System Monitoring,
Post-study Analysis

Confidential, Secure, Manageable Compute
Data: Differential Privacy, Gradient Inversion Protection, Homomorphic Encryption
Manage: Messaging, Identity, Authentication, Authorization





NVFlare: NVIDIA FEDERATED LEARNING APPLICATION RUNTIME ENVIRONMENT

Enabler of FL application development

- NVFlare is an enabler for Federated Learning across industries
    - NVFlare is application agnostic, not framework specific
    - NVFlare is for all kinds of Federated study, not limited to model weights
    - Users are in control, NVFlare helps
- NVFlare is SDK, not end-to-end solution
    - We provide reference application in native PT, TF, numpy, Clara Train and MONAI
- How NVFlare helps
    - Solve hard real-world problems: comm security, identity, session management, reconnect …
    - Provide programming framework for FL research/innovation
    - Provide a runtime environment for FL study
    - Provide a set of general-purpose FL components

NVFlare Examples

Getting Started

Github: https://github.com/NVIDIA/NVFlare

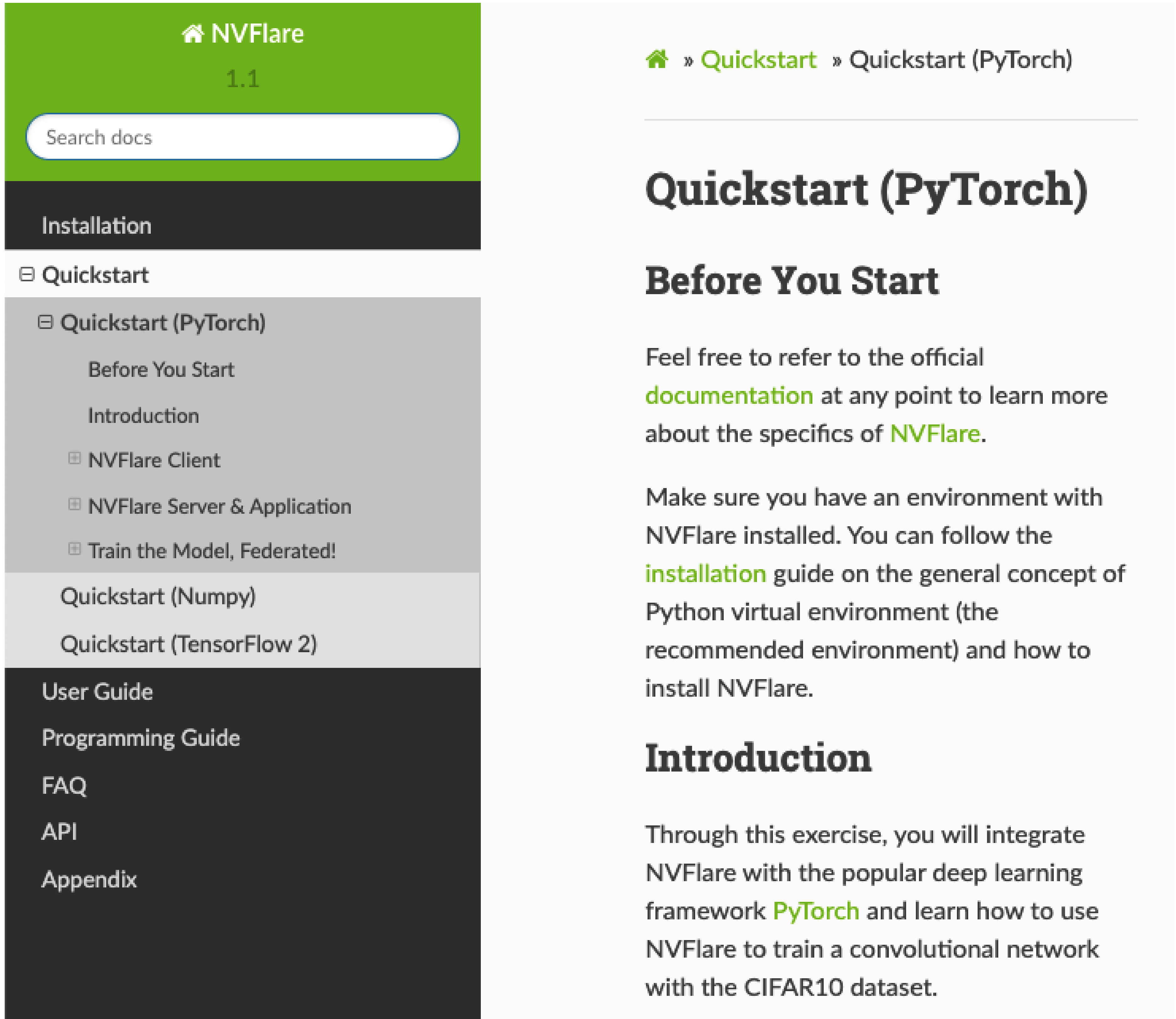
Docs: https://nvidia.github.io/NVFlare/

Installation - pip install in a python virtualenv

Quickstart – simple examples illustrating the basic structure of an NVFlare application and flow between server and clients

- Pytorch – hello-pt – simple CNN on CIFAR10
- Numpy – hello-numpy – Fibonacci sequence
- Tensorflow – hellow-tf2 – MNIST
- Coming soon – hello-cross-site-validation, hello-events, mnist-pt

Contact: FederatedLearning@nvidia.com



NVFLARE AND MONAI

Project-MONAI / **tutorials**

<> Code | Issues 22 | Pull requests 8 | Discussions | Actions | Security | Insights

master ▾ tutorials / federated_learning / nvflare /

Go to file | Add file ▾ | ···

Borda and wyli rename n_classes (#322) ... ✓ 3249a74 5 days ago History

..		
nvflare_example	rename n_classes (#322)	5 days ago
nvflare_example_docker	rename n_classes (#322)	5 days ago
README.md	299 add inference script (#338)	10 days ago

README.md

Federated learning with NVFlare

The examples here show how to train federated learning models with NVFlare and MONAI-based trainers.

1. nvflare_example shows how to run NVFlare with MONAI on a local machine to simulate an FL setting (server and client communicate over localhost). It also shows how to run a simulated FL experiment completely automated using the admin API. To streamline the experimentation, we have already prepared startup kits for up to 8 clients in this tutorial.

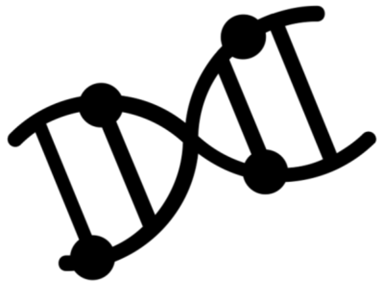
2. nvflare_example_docker provides further details on running FL with MONAI and NVFlare using docker containers for the server and each client for easier real-world deployment.

Example: NVFlare with MONAI

FEDERATED LEARNING

Some application areas… there are many more!

Medical
Imaging



Genomics

Digital
Pathology

Drug
Discovery

Contact: FederatedLearning@nvidia.com

Marc Edgar

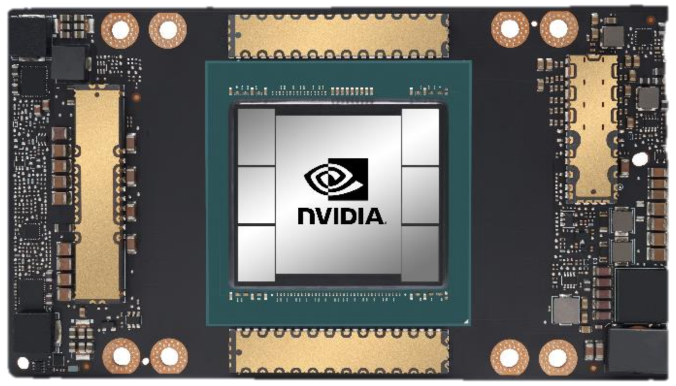
Sr. Alliance Manager for Medical Devices at NVIDIA

NVIDIA Clara AGX Dev Kit
The Era of Software Defined Medical Devices

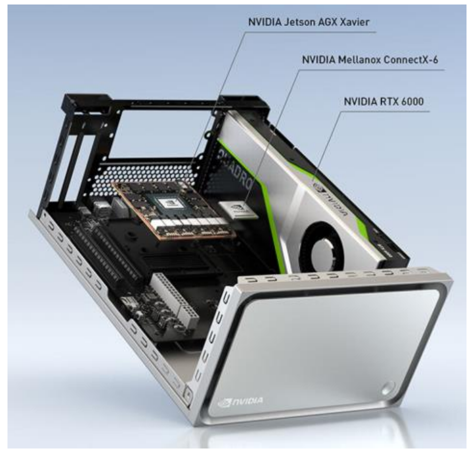
September 27 – October 1, 2021

NVIDIA Full-Stack Accelerated Computing for Healthcare

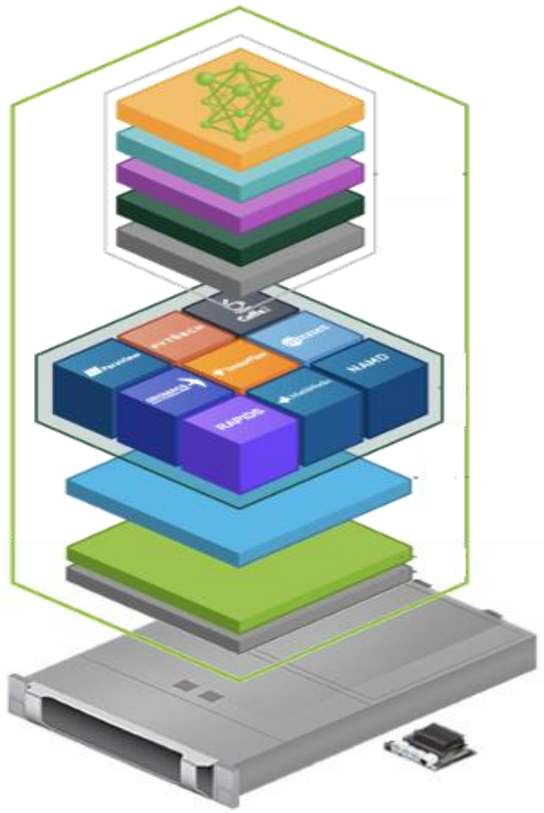
Accelerated | Optimized | Cloud Native | Software Defined | Domain Specific



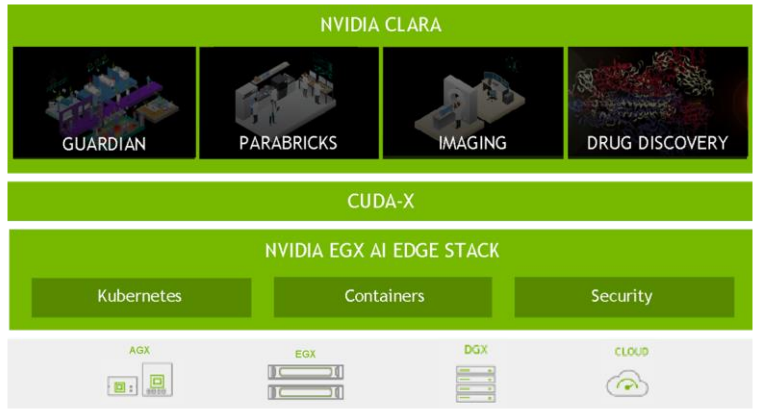
GPUs
A100 Ampere
Largest 7nm Chip
25B Transistors



Systems
AGX for Autonomous/Embedded
EGX for Edge Computing
DGX for Datacenter



Platforms
AI Accelerated Hybrid Edge-Cloud
Remote Management & Security
Software Defined Infrastructure



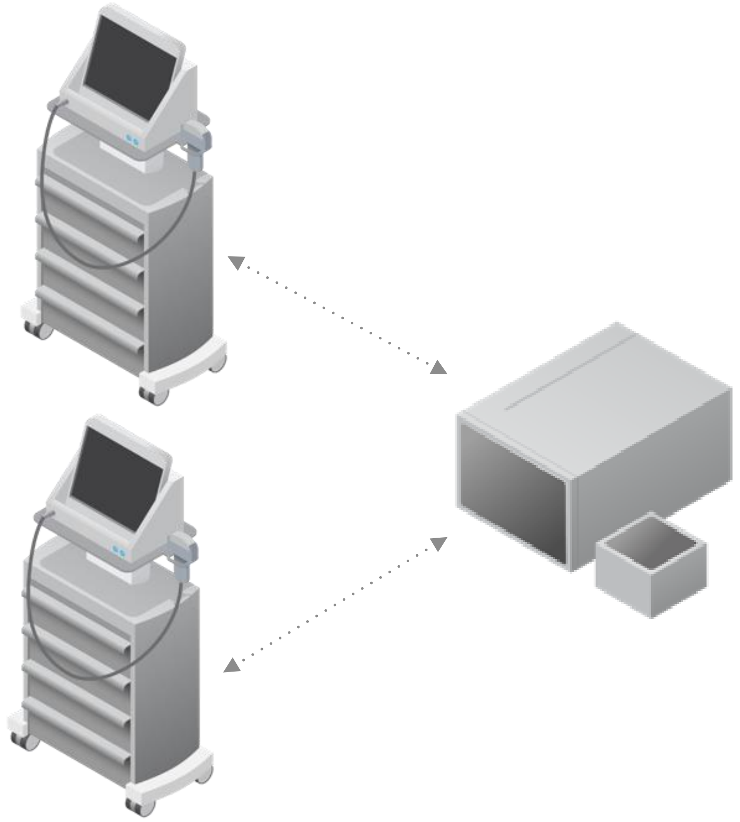
Application Frameworks and Algorithms
Domain Specific / Healthcare Specific
Optimized Performance
Accelerate Dev to Deploy

SOFTWARE DEFINED MEDICAL DEVICES

A NEW ERA OF ACCELERATED INNOVATION

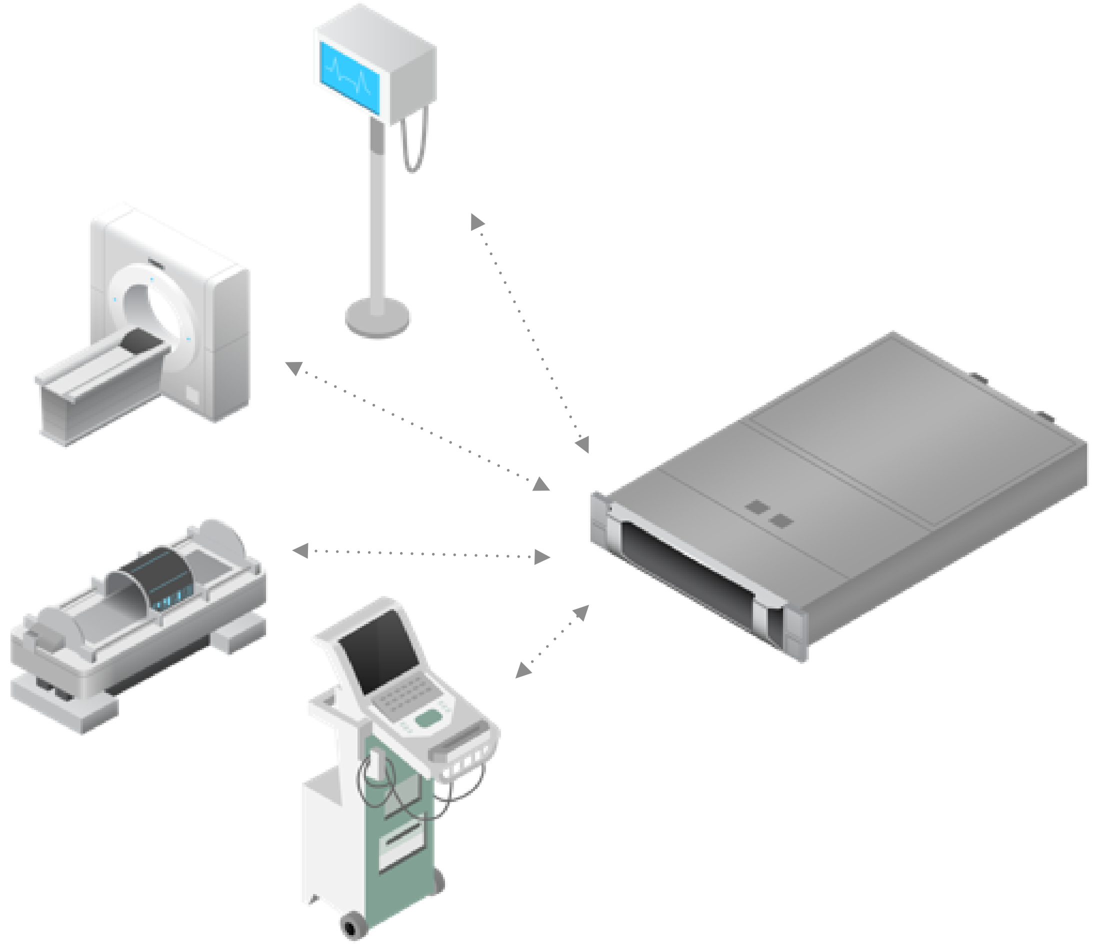
Embedded AI

Accelerated, Compact, Low Power



Sidecar AI

Add AI to unmodified medical devices



Streaming AI

Multiple Connected Devices

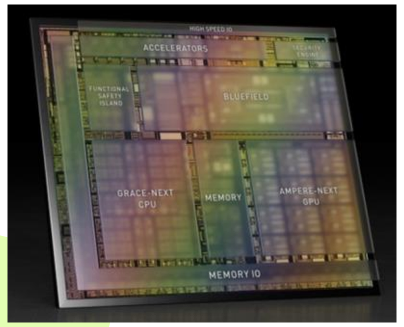
Clara AGX for Development to Translational Study to Commercialization

CLARA AGX DEV KIT

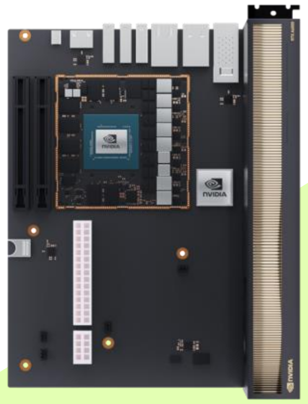
1. NVIDIA® JETSON AGX XAVIER™
2. NVIDIA RTX™ 6000
3. NVIDIA CONNECTX®-6 SmartNIC
   -QSFP28 FOR 100GbE and RJ45 for 10GbE
4. HDMI 2.0 INPUT
5. 2X PCIE GEN4x8 SLOTS
6. 250GB M.2 SATA STORAGE

NVIDIA CLARA AGX ROADMAP

Develop Today for Tomorrow's Embedded Solution

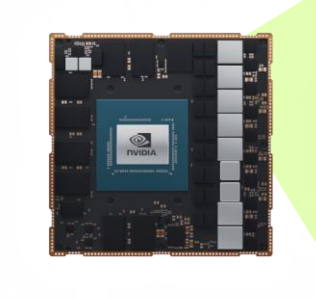


Atlan
1000 TOPS



Developer Kit
Clara AGX Orin
12 Cortex-A78 ARM Cores
400+ TOPS
200 GbE

Developer Kit
Clara AGX Xavier
8 Carmel ARM Cores
200+ TOPS
100 GbE



Commercialization Platform
AGX Orin
12 Cortex-A78 ARM Cores
250+ TOPS
4x 10 GbE

2021 2022 2023 2024

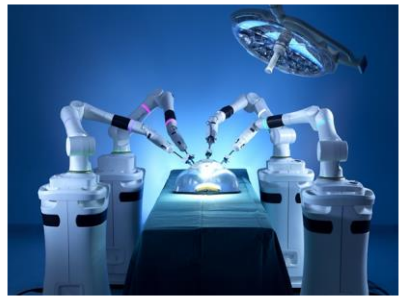
APPLICATIONS OF CLARA AGX

Real-time Embedded AI + Connectivity

Modalities : Vertical Applications

Endoscopy Laparoscopy

Ultrasound



Surgical Robotics

Connected OR / ICU

Interventional Radiology

Digital Pathology

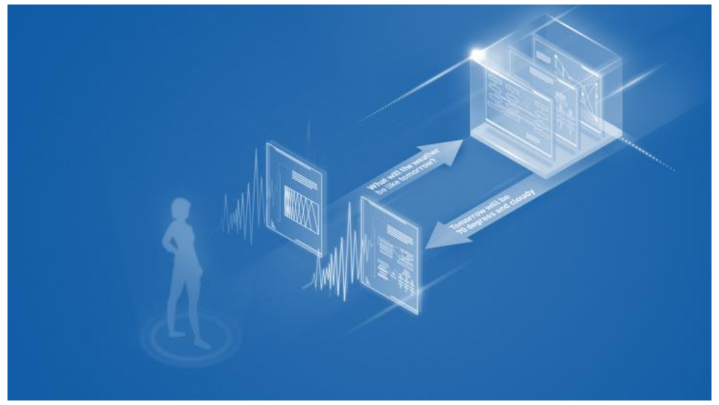
Desktop Genomics

Horizontal Applications

Low-latency AI Inferencing

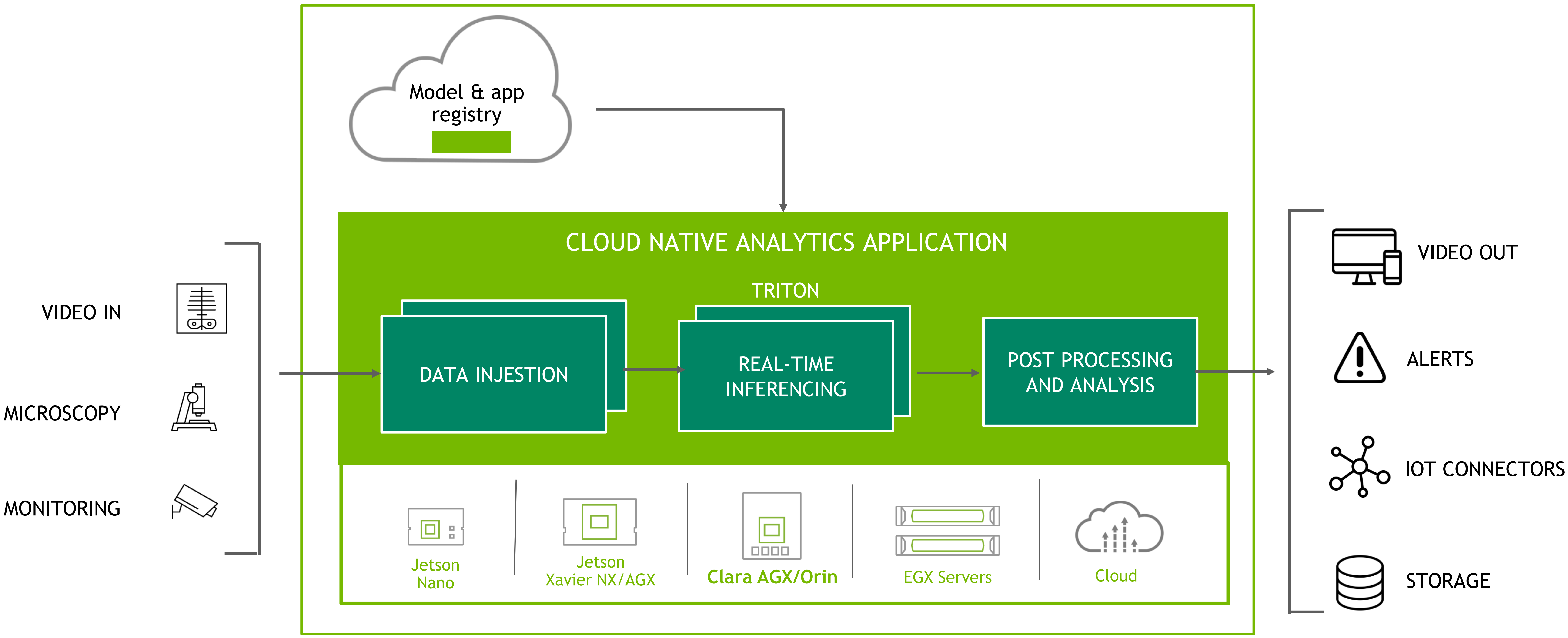
Streaming Video AI and Rendering

Data Collection



Conversational AI NLU

DEEPSTREAM PIPELINE AI-POWERED VIDEO APPLICATIONS



Easy to use, low-latency acquisition, transfer and processing

TRITON INFERENCING SERVER

Simplifying the execution and deployment of AI models

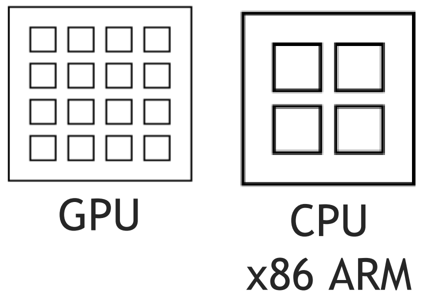
Multiple Frameworks

TensorFlow | TensorRT | PYTORCH | ONNX RUNTIME

Supports All Major Frameworks

Consistent API

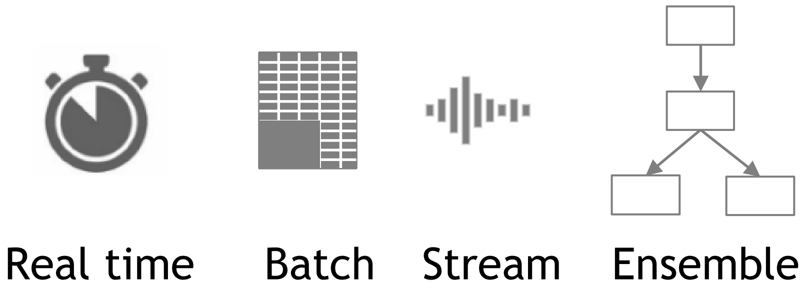
Inferencing on GPU and CPU



Cloud | Data Center | Edge

Bare metal | Virtualized

Queue Strategies



Support for Use Cases

Maximize Throughput

Dynamic Batching Optimizes Latency Constraints

Concurrent Model Execution

Zero Down Time Updates

Open Source: https://github.com/triton-inference-server

NVIDIA

CLARA AGX ECOSYSTEM OF SENSORS

Software defined ultrasound development platform

High res video capture

Highspeed frame grabber

High speed networking ConnectX-6

GETTING STARTED WITH CLARA AGX

NVIDIA Clara AGX

HOME | PRODUCTS | DOCUMENTATION | RESEARCH

NVIDIA Clara AGX Development Kit

The NVIDIA Clara AGX Development Kit delivers real-time AI and imaging for medical devices. By combining low-powered, NVIDIA Jetson AGX Xavier and RTX GPU with the NVIDIA Clara AGX SDK and the NVIDIA EGX stack, it's easy to securely provision and remotely manage fleets of distributed medical instruments.

Request Clara AGX Developer Kit

NVIDIA Clara AGX Software

NVIDIA Clara AGX SDK runs on the NVIDIA Clara AGX and Jetson platform and provides developers with capabilities to build end-to-end streaming workflows for medical imaging. It includes advanced samples for ultrasound video and endoscopy. Access to the NVIDIA Clara AGX SDK requires an NVIDIA Developer Account.

Download Clara AGX SDK

https://developer.nvidia.com/clara-agx-devkit

Over 150 customers the Development Partner Program

Including ....

Medtronic

SIEMENS Healthineers

kaliber.ai™

Carestream

ACTIV SURGICAL

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us4us

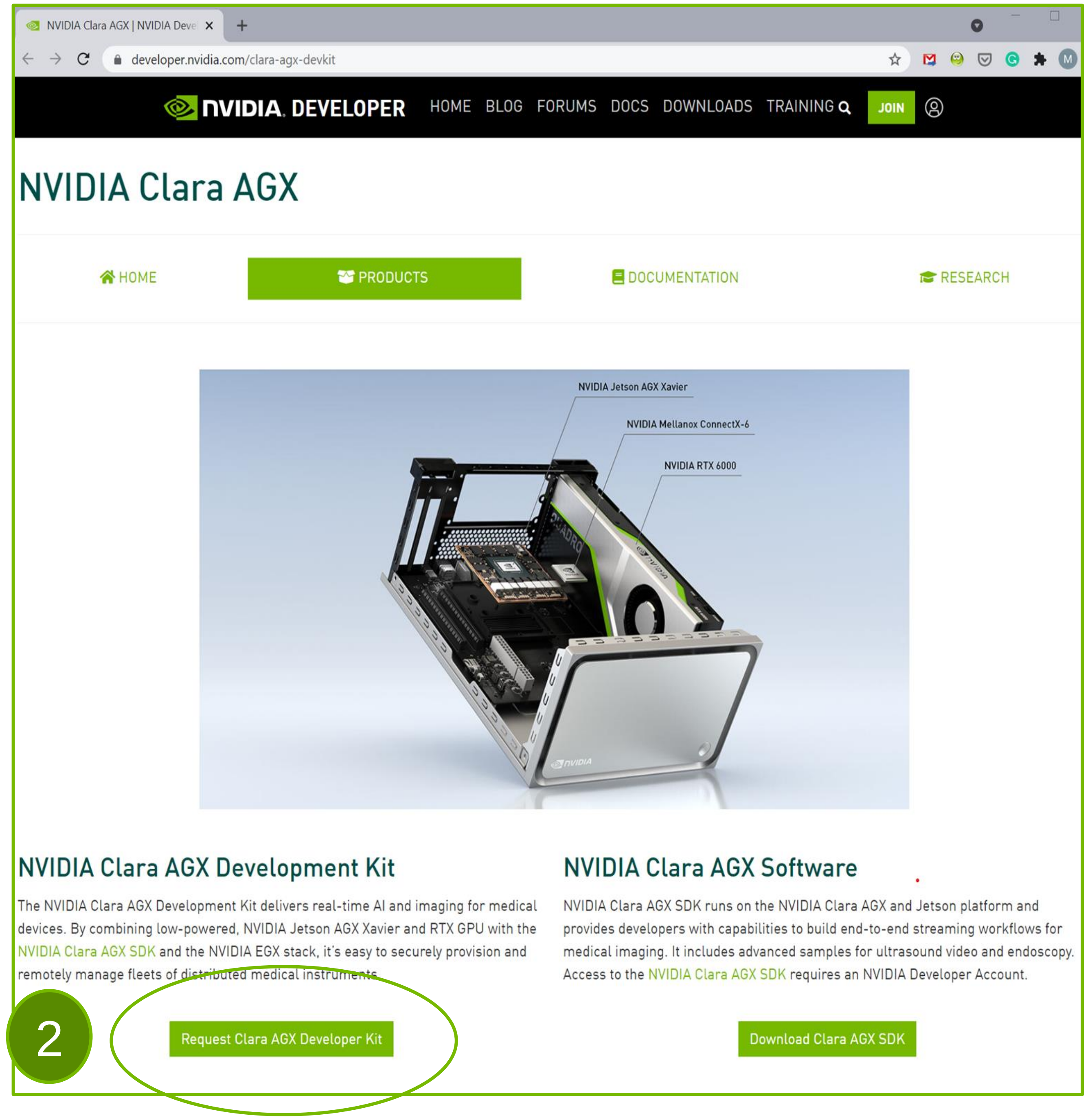
AJA VIDEO SYSTEMS

KAYA INSTRUMENTS

CLARA AGX DEV KIT
SOFTWARE DEFINED MEDICAL DEVICE CHALLENGE

NVIDIA will donate a Clara AGX to an educational institution to develop an innovative application

1. Go to: https://developer.nvidia.com/clara-agx-devkit
2. Click on "Request Clara AGX Developer Kit"
3. Answer the question: "What use case are you going to use Clara AGX Dev Kit for?"
   - Describe how you would use a Clara AGX Developer Kit to create an innovative and impactful software defined medical device.
   - No more than 500 words
   - Include the words "MICCAI 2021 CHALLENGE"
4. Submissions must be received before October 14, 2021



RESOURCES

RESOURCES - FEDERATED LEARNING

NVIDIA Clara Imaging & NVFlare

NVIDIA Clara Imaging:

- Clara v4.0 : https://ngc.nvidia.com/catalog/containers/nvidia:clara-train-sdk
- Clara Notebooks/Tutorial: https://github.com/NVIDIA/clara-train-examples
- Clara Documentation: https://docs.nvidia.com/clara/clara-train-sdk/index.html , in particular https://docs.nvidia.com/clara/clara-train-sdk/federated-learning/federated_learning.html
- Clara Dev Forum: https://forums.developer.nvidia.com/c/healthcare/clara-train-transfer-learning-toolkit-for-medi/154

NVFlare:

- Github: https://github.com/NVIDIA/NVFlare
- Docs: https://nvidia.github.io/NVFlare/
- 101 examples: https://github.com/NVIDIA/NVFlare/tree/main/examples
- MONAI Example: https://github.com/Project-MONAI/tutorials/tree/master/federated_learning/nvflare

RESOURCES - FEDERATED LEARNING

GTC talks on NVIDIA on demand

- General:
  - Overview of NVIDIA and Federated Learning: Federated Learning for Medical AI [S32530], Mona Flores: https://www.nvidia.com/en-us/on-demand/session/gtcspring21-s32530/
  - Example of Clara FL in Industry: Accelerating Health Care at Bayer with Science@Scale and Federated Learning [E32541], David Ruau: https://www.nvidia.com/en-us/on-demand/session/gtcspring21-e32541/
  - Federated Learning – Scientific Perspective: Developing Robust Medical Imaging AI Applications: Federated Learning and Other Approaches [S32014], Daniel Rubin: https://www.nvidia.com/en-us/on-demand/session/gtcspring21-s32014/
  - Collaborative Learning in Medical Imaging: Opportunities and Challenges [S32449], Jayashree Kalpathy-Cramer: https://www.nvidia.com/en-us/on-demand/session/gtcspring21-s32449/
- Clara 4.0:
  - Clara Train 4.0 - 201 Federated Learning [SE3208]: https://www.nvidia.com/en-us/on-demand/session/gtcspring21-se3208/
  - Clara 4.0 (Overview): https://www.nvidia.com/en-us/on-demand/session/gtcspring21-s32482/

RESOURCES - FEDERATED LEARNING

NVIDIA Publications (a selection)

- Federated learning for predicting clinical outcomes in patients with COVID-19 (Nature Medicine, https://www.nature.com/articles/s41591-021-01506-3)

- The future of digital health with federated learning (npj Digital medicine, https://www.nature.com/articles/s41746-020-00323-1)

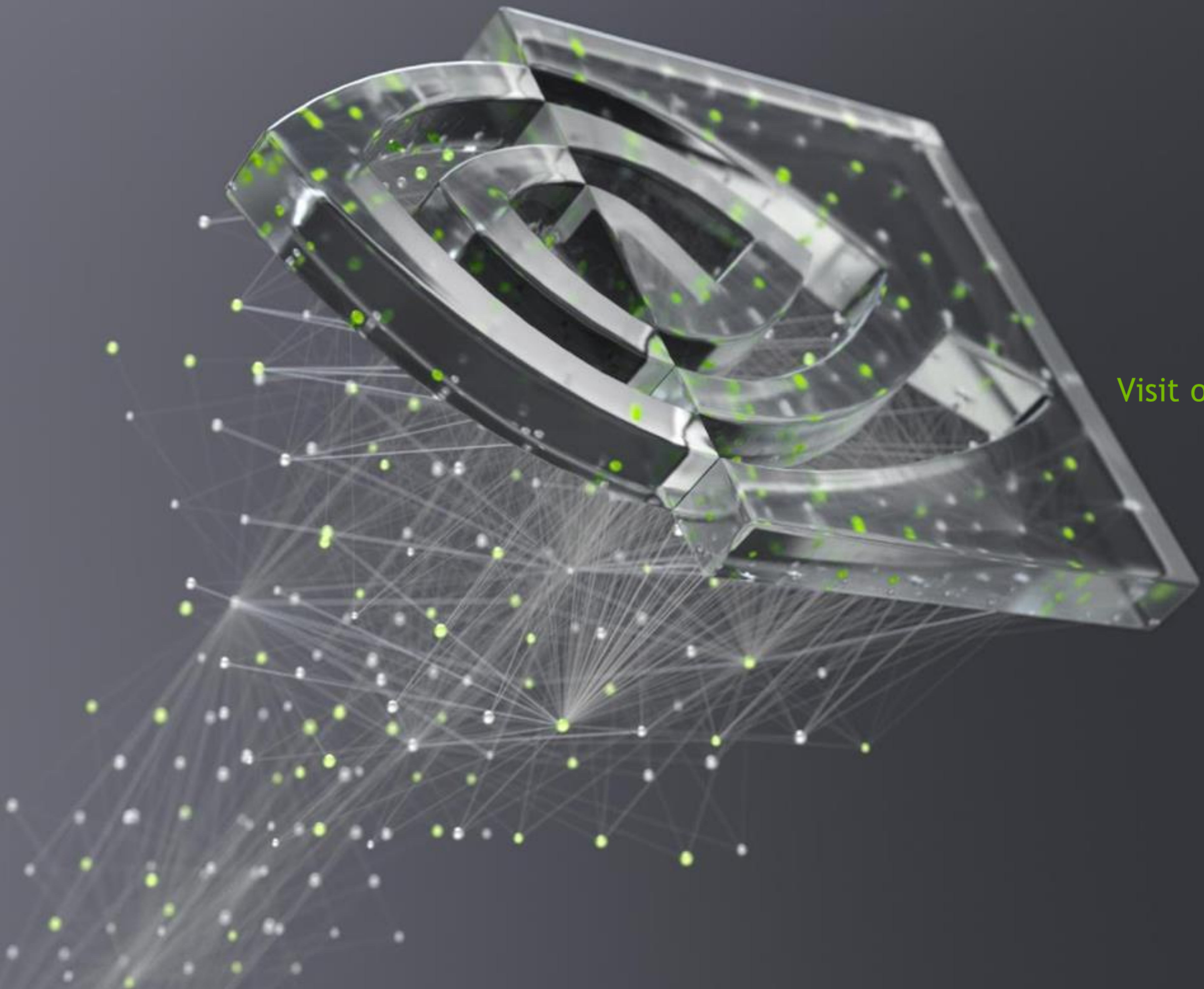
- Federated semi-supervised learning for COVID region segmentation in chest CT using multi-national data from China, Italy, Japan (Medical Image Analysis (2021): 101992 , https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7864789/)

- Federated learning improves site performance in multicenter deep learning without data sharing (Journal of the American Medical Informatics Association (2021), https://academic.oup.com/jamia/advance-article/doi/10.1093/jamia/ocaa341/6127556)

- Federated Learning for Breast Density Classification: A Real-World Implementation (MICCAI DCL 2020 workshop, https://arxiv.org/pdf/2009.01871.pdf)

- Privacy-preserving Federated Brain Tumour Segmentation (MICCAI MLMI 2019 workshop, https://arxiv.org/pdf/1910.00962.pdf)

MICCAI 2021 Workshop focusing on medical Federated Learning: http://dcl-workshop.net/



THANK YOU

Visit our Virtual Booth for more information (# 209)

MICCAI2021 NVIDIA