ACCELERATED, REPRODUCIBLE AND SCALABLE AI-DRIVEN GRAVITATIONAL WAVE DISCOVERY

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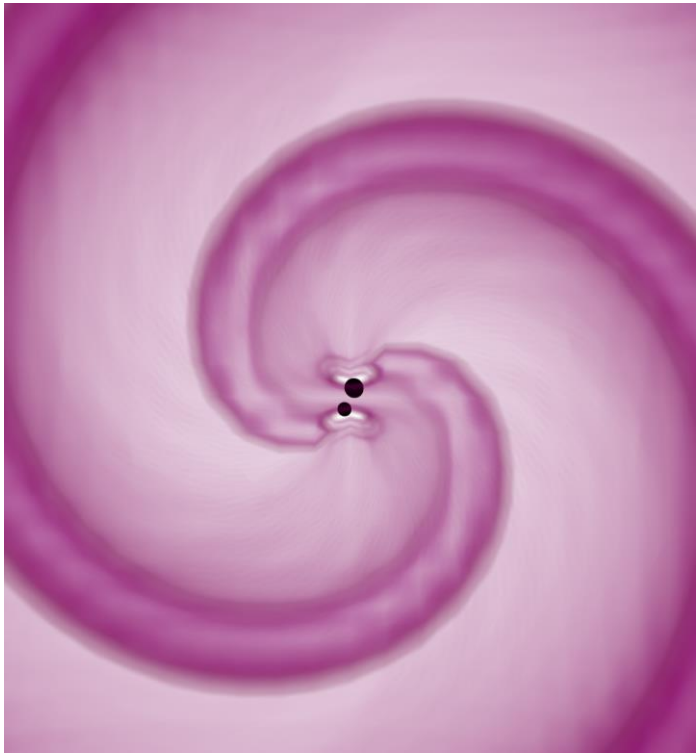
Parsl & *funcX* Fest
October 27-28, 2021

GRAVITATIONAL WAVE ASTRONOMY

WHAT

Gravitational wave observation of binary black hole mergers



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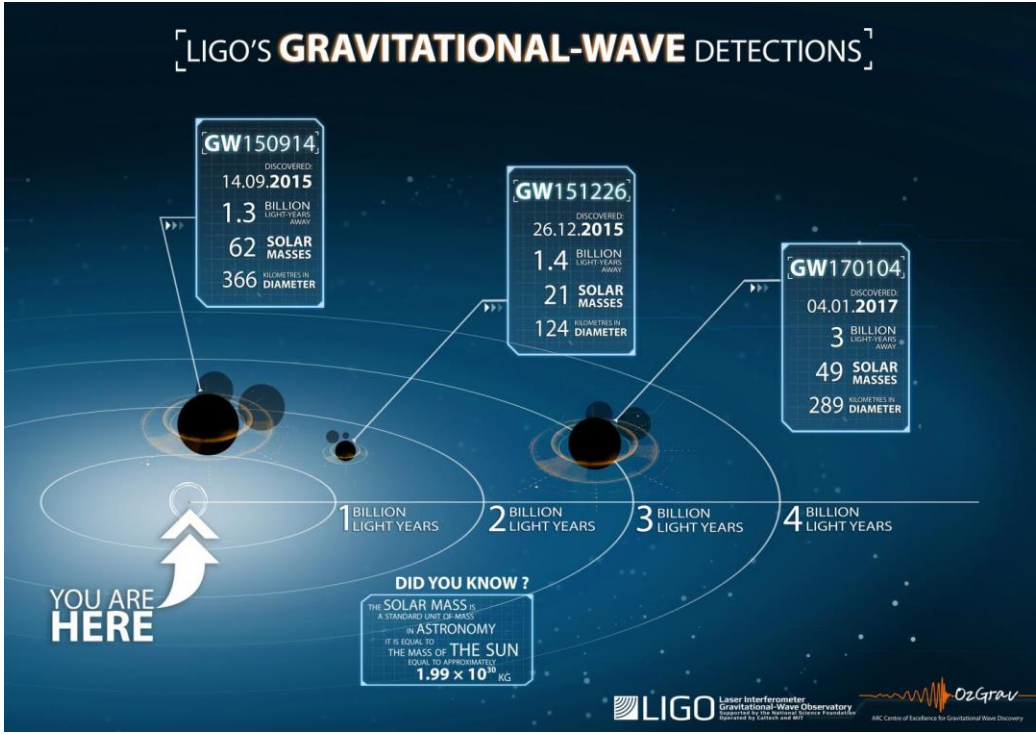
GRAVITATIONAL WAVE ASTRONOMY

WHAT

Ground-based detectors continue to improve their sensitivity to gravitational wave sources



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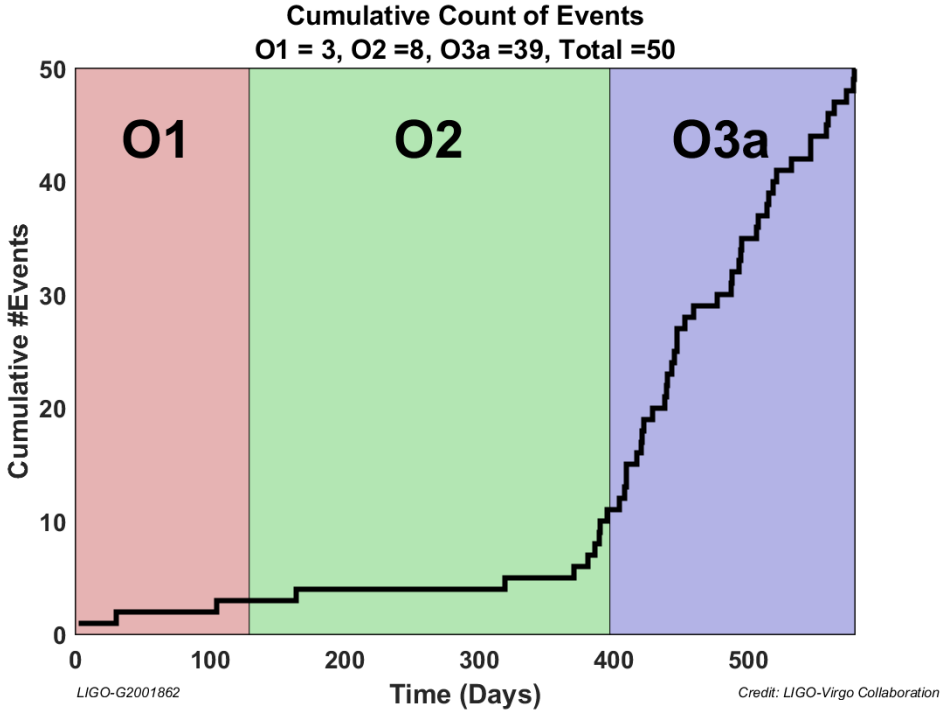
WHY

Advanced LIGO's enhanced sensitivity boosts detection rate of gravitational wave sources



GRAVITATIONAL WAVE ASTRONOMY

WHY

Number of detections continues to grow

Available computational resources remain finite and oversubscribed

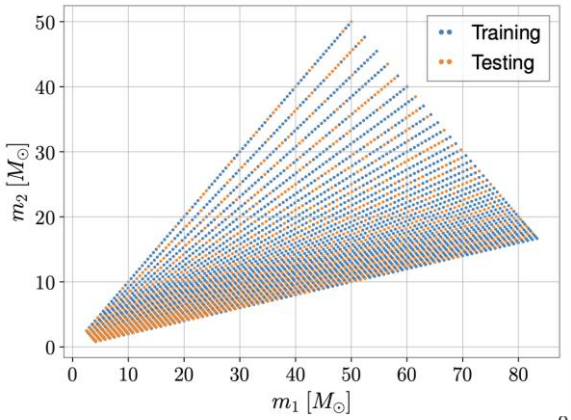
Radical re-thinking of computational methods for gravitational wave discovery

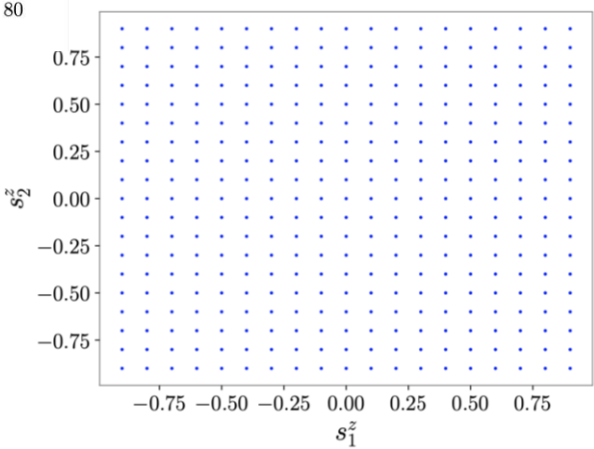
GRAVITATIONAL WAVE ASTRONOMY

WHAT

Demonstrate that AI + HPC provide a novel solution for production scale AI-driven gravitational wave detection

Consider 4-D signal manifold of real-time gravitational wave detection algorithms





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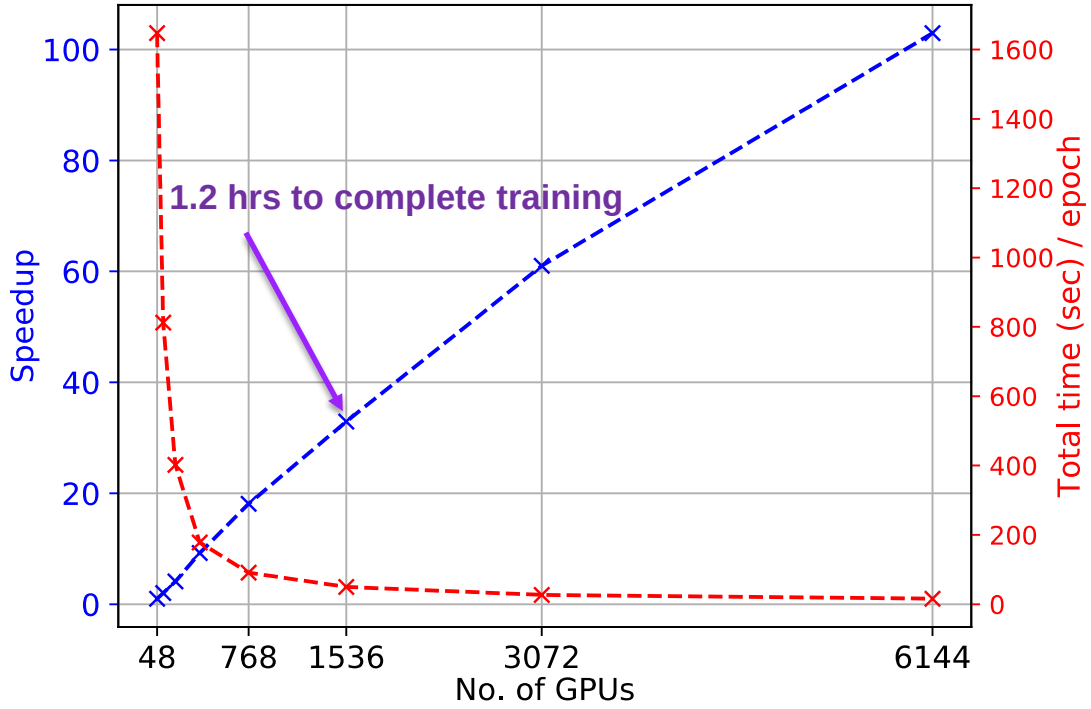
WHAT

Densely sampling this 4-D signal manifold requires millions of modeled waveforms

Training stage: 1 month with a single NVIDIA V100 GPU



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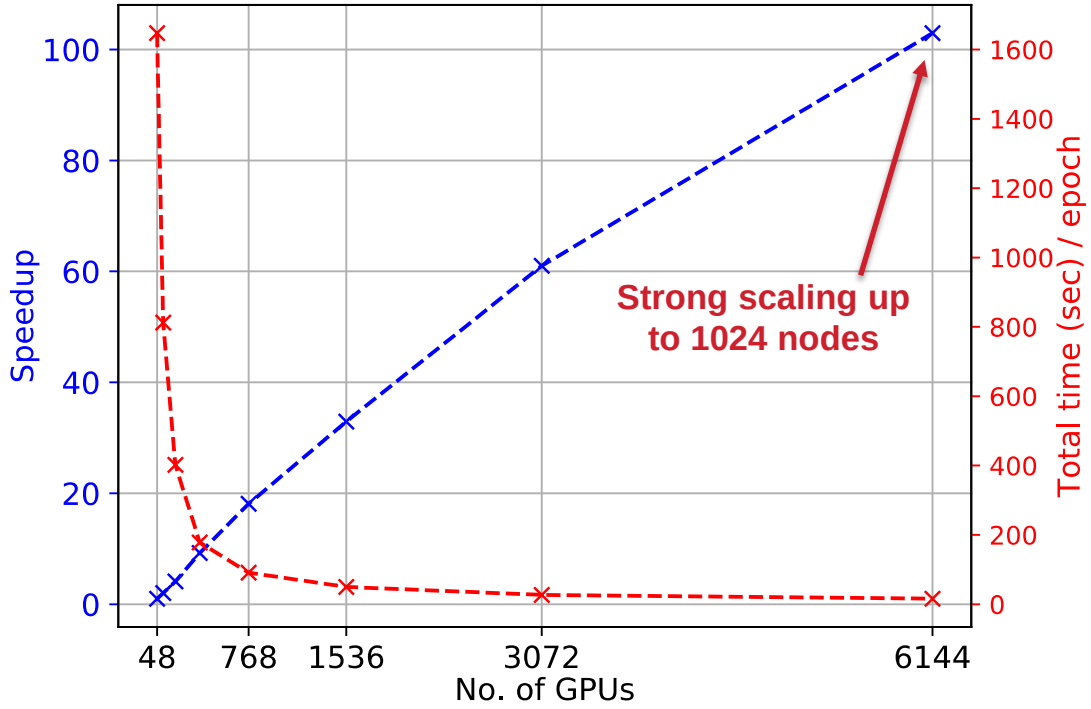
HOW

Deployed and used new optimizers in Summit to reach optimal classification performance

600-fold speed up in training

Developed AI ensemble for real-time gravitational wave detection



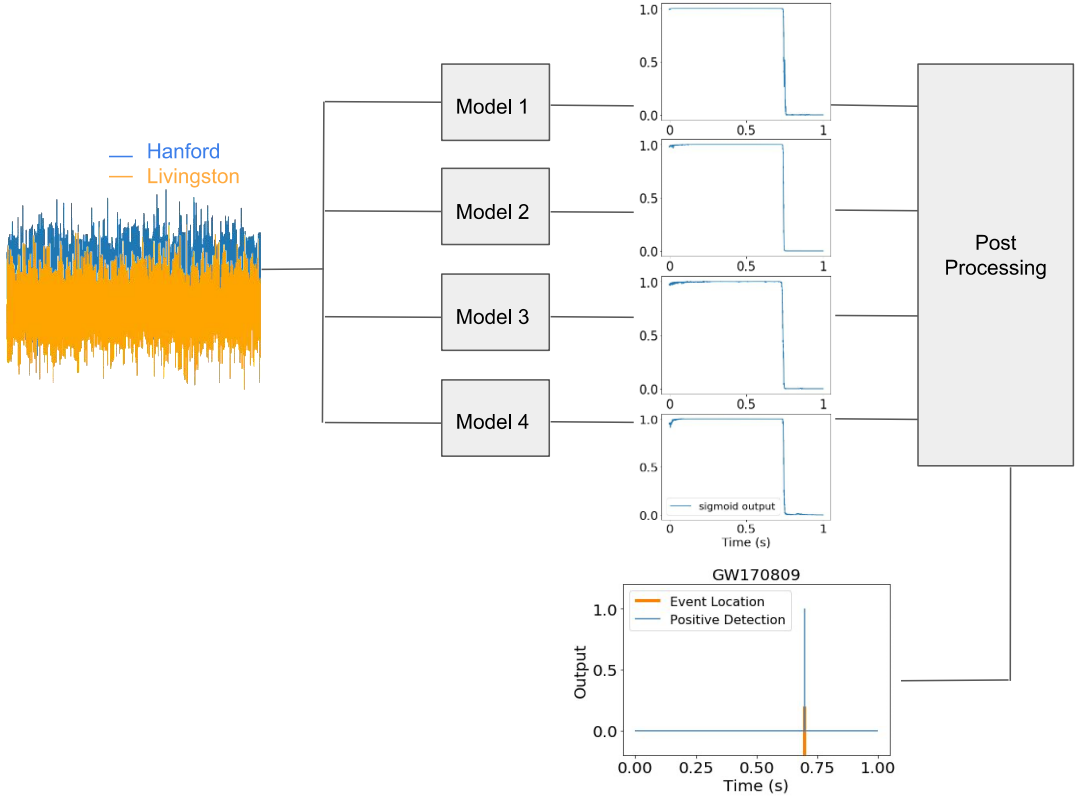
GRAVITATIONAL WAVE ASTRONOMY

HOW

4 AI models processing advanced LIGO data in tandem

Each model processes data faster than real time

Combine output of all models to increase confidence of detection



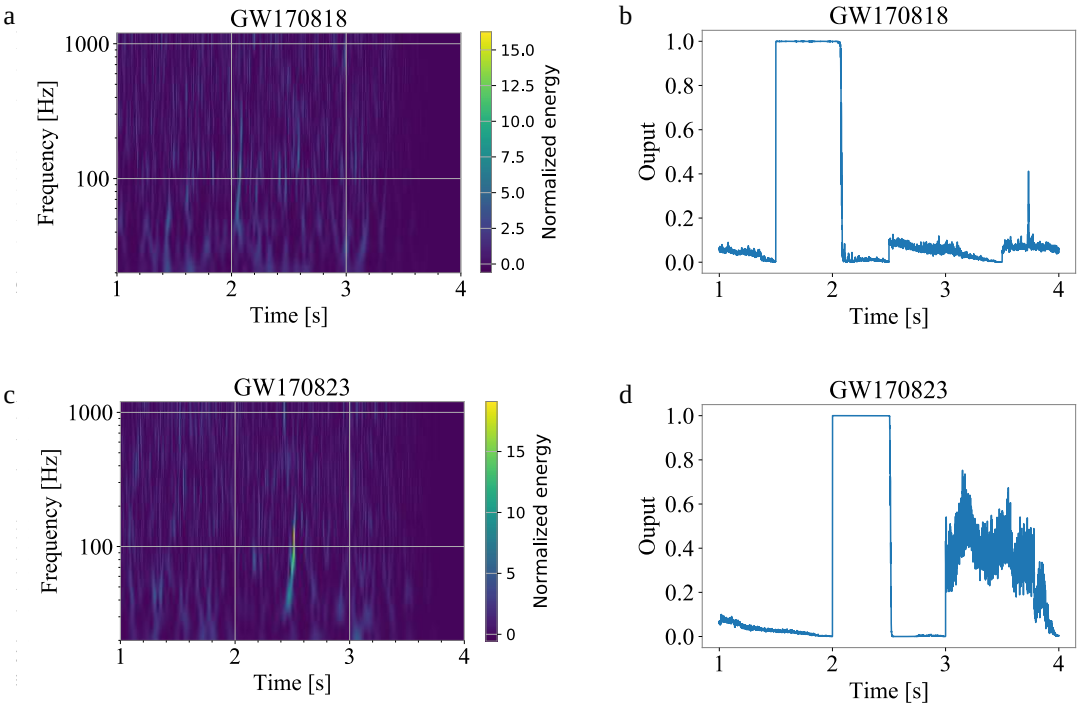
GRAVITATIONAL WAVE ASTRONOMY

HOW

4 AI models processing advanced LIGO data in tandem

Each model processes data faster than real time

Target: identify real events while reducing # of misclassifications



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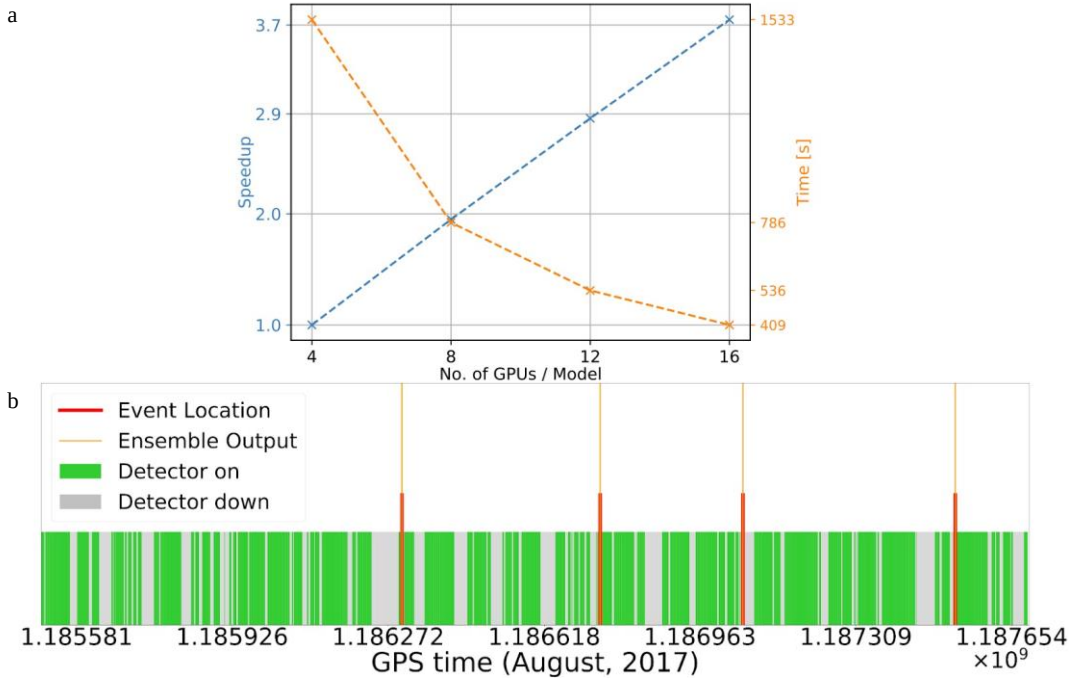
HOW

Use AI ensemble to process one month of advanced LIGO data

Quantify sensitivity, inference speed and scalability

Distribute inference on Hardware-Accelerated Learning (HAL) GPU cluster at NCSA
[64 NVIDIA V100 GPUs]



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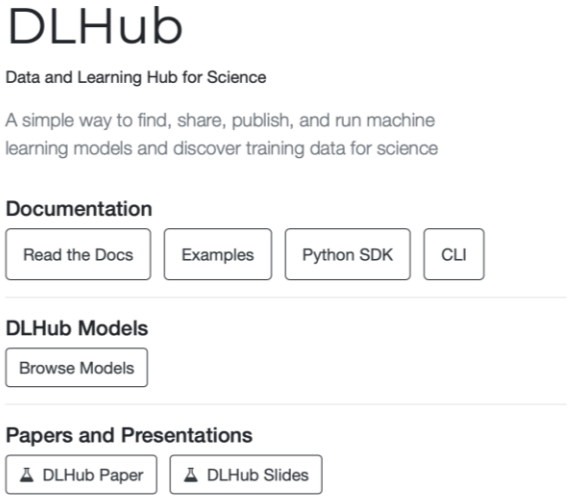
REALLY?

Establish reproducibility, scalability and performance of results

Make AI ensemble and post-processing pipeline open source and containerized at the Data and Learning Hub for Science (DLHub)



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REALLY?

Open source + containerized is great

Can we do better than that?

DLHub

Data and Learning Hub for Science

A simple way to find, share, publish, and run machine learning models and discover training data for science

Documentation

Read the Docs | Examples | Python SDK | CLI

DLHub Models

Browse Models

Papers and Presentations

DLHub Paper | DLHub Slides

PRESENT – STATIC APPROACH

DLHub & funcX:
reproducible, scalable and accelerated AI-discovery

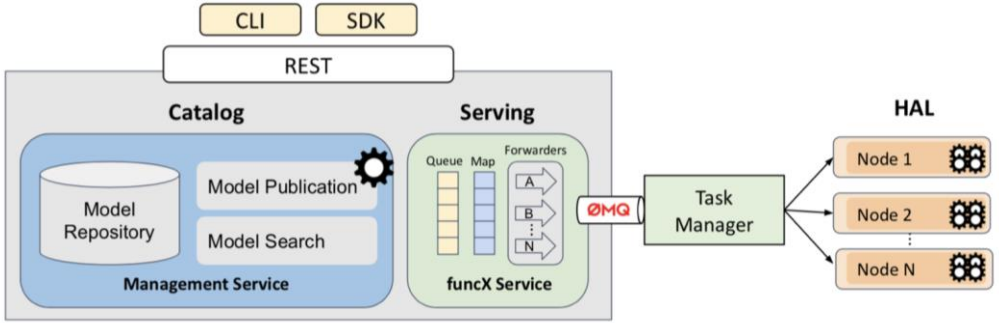
Reduce time-to-insight with HPC platforms
Optimal distributed training

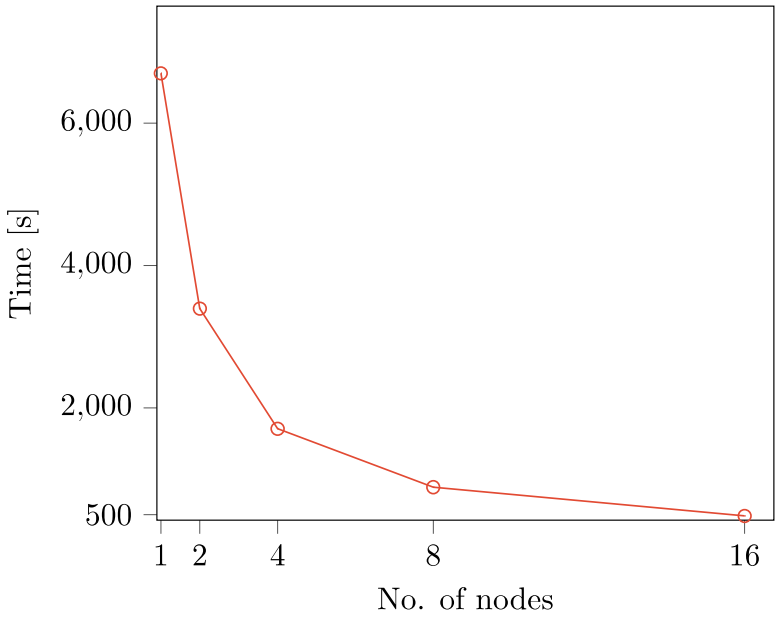
Deploy AI models in DLHub

Already used at scale!

GRAVITATIONAL WAVE ASTRONOMY

DLHub & funcX





Deploy funcX end-point at HAL

Call AI models hosted at DLHub

Optimal scalability, reproducibility established

PRESENT – STATIC APPROACH

DLHub & funcX: reproducible, scalable and accelerated AI-discovery at the edge

Reduce time-to-insight with HPC platforms
Optimal distributed training

Deploy AI models in DLHub

TensorRT

Already used at scale!

TensorRT further reduced the analysis to just 2 minutes!

nature > nature astronomy > articles > article

Article | Published: 05 July 2021

Accelerated, scalable and reproducible AI-driven gravitational wave detection

E. A. Huerta, Asad Khan, Xiaobo Huang, Minyang Tian, Maksim Levental, Ryan Chard, Wei Wei, Maeve Heflin, Daniel S. Katz, Volodymyr Kindratenko, Dawei Mu, Ben Blaiszik & Ian Foster

Nature Astronomy **5**, 1062–1068 (2021) | Cite this article

Contributor Nature Astronomy

BEHIND THE PAPER

From Disruption to Sustained Innovation: Artificial Intelligence for Gravitational Wave Astrophysics

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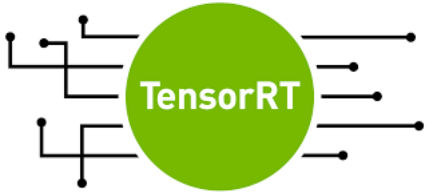
DYNAMIC AI

DLHub & funcX: reproducible, scalable and accelerated AI-discovery at the edge

Summit
Theta-G AURORA …

Reduce time-to-insight with HPC platforms



Deploy dynamic AI models in DLHub

Edge Distributed Computing TensorRT …

Major upgrade of AI models

Active/Transfer/Reinforcement

Burst training

ACKNOWLEDGEMENTS

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