



— AI/ML SECTOR OF THE EICUG SOFTWARE WORKING GROUP —

<https://eic.ai/>
<https://indico.bnl.gov/e/AI4EIC>

C. Fanelli, T. Horn



WILLIAM & MARY
CHARTERED 1693



What is AI4EIC?

<http://www.eicug.org/content/wg.html>

EIC has the unique opportunity to start incorporating AI from the very beginning and to systematically leverage on it during all phases of the project.

AI will be an integral part of the EIC software and we will take advantage of intelligent decisions in all aspects of data processing from detector readout and control to analysis.

To work in this direction, the AI4EIC working group (a sector of the SWG within the EICUG) has been established in Dec 2021. The AI WG (aka AI4EIC) serves as an entry point to AI applications and will organize workshops, tutorials, and Kaggle-like challenges.

Educational activities are aimed at disseminating AI in the EIC community.

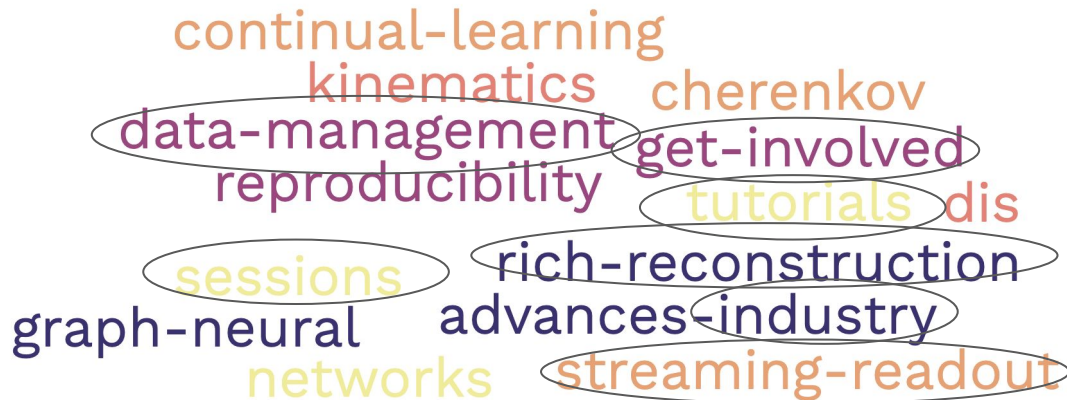
<https://eic.ai>

Survey (early 2022)

Hackathon: <https://indico.bnl.gov/event/16586/page/435-hackathon>

Tutorials: <https://indico.bnl.gov/event/16586/page/426-tutorials>

- A detailed survey was sent few months ago now <https://forms.gle/6LADKTGaX7DeTVE46>
- We want to learn more about our community, and we asked for feedback on what the needs and interests are, and what potential opportunities
- Feedback and key-words:



A word cloud of survey feedback keywords. The words are arranged in a roughly circular pattern. Some words are circled in black. The circled words are: data-management, get-involved, tutorials, sessions, rich-reconstruction, industry, streaming-readout, and graph-neural networks. Other words include: continual-learning, kinematics, cherenkov, reproducibility, dis, advances, and networks.

We organized our monthly **meetings** and this event (**workshop** and **hackathon**) taking into account this feedback

We have **tutorial** sessions every day of the workshop

For more details on the survey, see <https://indico.bnl.gov/event/15636/>

AI4EIC Events

The AIWG serves as an entry point to AI applications and will organize workshops, tutorials, and Kaggle-like challenges.

10/14/2022 **AI4EIC Hackathon** In presence + virtual
First AI4EIC hackathon, hosted by College of William and Mary, Williamsburg, VA October 14, 2022
<https://doi.org/10.5281/zenodo.7197023>
[Le...](#)
[+ Event Details](#)
<https://indico.bnl.gov/e/AI4EIC>

10/10-13/2022 **AI4EIC Workshop** In presence + virtual
[2nd workshop](#), hosted by College of William and Mary, Williamsburg, VA October 10-13, 2022
For registration:
<https://indico.bnl.gov/e/AI4EIC>
<https://indico.bnl.gov/e/AI4EIC>

8/24/2022 **AI WG 5th meeting** 9am - 11am ET
[5th meeting of the EICUG AI WG](#) Virtual
topic-oriented: streaming readout + continual learning
<https://indico.bnl.gov/event/16605/>

7/20/2022 **AI WG 4th meeting** 9am - 11am ET
[4th meeting of the EICUG AI WG](#) Virtual
topic-oriented: detector design (re-scheduled; slides uploaded)
<https://indico.bnl.gov/event/16328/>

6/22/2022 **AI WG 3rd meeting** 9am - 11am ET
[3rd meeting of the EICUG AI WG](#) Virtual
topic-oriented: uncertainty quantification
<https://indico.bnl.gov/event/16073>

- Topic-oriented meetings: streaming readout, continual learning, detector design, uncertainty quantification
- Two well attended workshops (200++), that resulted in [publications](#)
- Hackathon

5/4/2022 **AI WG 2nd meeting** 11am - 12pm ET
[2nd meeting of the EICUG AI WG](#) Virtual
Survey: <https://forms.gle/6lADKtGaX7DeTVE46>
<https://indico.bnl.gov/event/15636/>

3/30/2022 **AI WG kickoff meeting** 11am - 12pm ET
[Kickoff meeting of the EICUG AI WG](#) Virtual
<https://indico.bnl.gov/event/14923/>

9/7-10/2021 **AI4EIC Workshop** Virtual
1st workshop, hosted by CFNS/BNL
September 7-10, 2021

<https://eic.ai/events>

AI4EIC 2nd Workshop: Oct 10-14 2022, William & Mary

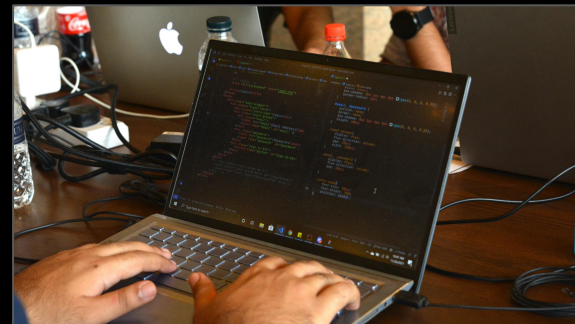


- We had a total of 220 registered participants (also last year, >200!)
 - Very good attendance in person!
- Workshop: 6 sessions (15 [conveners](#), 40+ [speakers](#))
 - Design
 - Theory/Exp connections (morning + afternoon sessions)
 - Recon & PID
 - Infrastructure (+ Panel Discussion)
 - Streaming

- Educational: 4 Tutorials

- MOBO, OmniFold, MLFlow, GNN

- Community: Hackathon (>90 interested people, 30+ participants from North, South America, Asia, Europe)



~300 users in ai4eic slack
sign-up [here](#)

AI4EIC Workshop (2022) Goals

- Goal of this second workshop was to cover all active and potential areas of applications of AI/ML for the EIC.
- Extend the scope of first workshop (focused on experimental applications only) to identify **cross-cutting aspects** and bring together **different communities** (accelerator, detector, theory, CS/DS)
- Identify impact and opportunities of AI in EIC
 - Write workshop report paper — comments from participants will be integrated (paper draft in progress; aim to complete by mid December)
 - The discussion from this workshop contributed to the LRP WP

AI4EIC Detailed Agenda

Convener list

Mon, October 10, morning: introduction and overview

10:00	Welcome & Intro to AI4EIC room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	10:00 - 10:25
	EIC schedule and overview Elie-Caroline Auchincloss et al.	
11:00	Discussion room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	10:25 - 11:05
	Coffee break room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	11:05 - 11:20
	DOE perspective on opportunities for AI in nuclear physics Manohar Parthasarathy	11:20 - 11:40
12:00	NSF perspective on opportunities for AI in nuclear physics room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	11:40 - 12:15
13:00	Discussion room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	12:10 - 12:30
	Lunch (on your own) room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	12:30 - 13:30
	Discussion room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	13:30 - 14:00

DOE and NSF Perspectives



Wed, October 12, morning: Reconstruction & PID

10:00	Interpretable Networks for Identifying Leptons room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	David Johnson	10:00 - 10:25
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		
	Derivative Deep learning for jet tagging room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Rajhar Khanolkar et al.	10:25 - 10:50
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		
11:00	Machine Learning in ACTS room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Carsten-Alex	10:50 - 10:57
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		
	Coffee break room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		11:10 - 11:20
	Identifying Neutron Interactions with Deep Learning at EIC room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	William Probst	11:20 - 11:30
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		
	ML particle identification with measured shower profiles from calorimetry room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Chao Peng	11:30 - 12:15
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		
	Landscape event tagging at CLAS12 room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Matthew McInerney	12:10 - 12:30
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		
	ML for calorimetry room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Nehal Bhavsar	12:30 - 12:45
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		
	Deep driven learning: Flow-Multiscale room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	James Gao	12:45 - 12:57
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		

Mon, October 10, afternoon: Design

14:00	Tutorial on AutoBots: Multi-Objective Optimization room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Alar Seidman	14:00 - 14:45
	Discussion room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		14:45 - 14:55
	Accelerated detector design: Updates from EIC to ERF room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Harish Sethi	14:55 - 15:15
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		15:15 - 15:20
	AI-driven detector design for the EIC room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Rajagopal Natharaj	15:20 - 15:45
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		15:40 - 15:45
	Coffee break room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		15:45 - 16:00
	ML application for beam optics control at the LHC room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Elmer Fil	16:00 - 16:20
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		16:20 - 16:25
	AIML overview for accelerator design activities room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Toad Sengupta	16:25 - 16:45
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		16:40 - 16:50
	Discussion room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		16:50 - 17:00

Tutorial on MLFlow (JLab)

Wed, October 12, afternoon: Infrastructure and Frontiers

14:00	Tutorial on MLFlow room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	David Richardson	14:00 - 14:45
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		14:45 - 14:50
	Coffee break room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		14:50 - 15:00
	AIML: hardware co-design room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Frank Liu	15:00 - 15:15
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		15:15 - 15:20
	Machine Learning with FPGA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Mani Thi	15:20 - 15:45
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		15:40 - 15:45
	AI for data reduction for increasing DAQ room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Yu-Huang	15:45 - 16:00
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		16:00 - 16:10
	Machine Learning with FPGA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Mani Thi	16:10 - 16:30
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		16:30 - 16:40
	Panel Discussion room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Jay Hwang et al.	16:40 - 17:00

Panel Discussion

Tue, October 11, morning: theory/experiment connections

10:00	ML for QCD Analysis - 3D Imaging room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Arvind Nair	10:00 - 10:20
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		10:20 - 10:25
	Building Machine Learning ML and the Land String Model room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Tony Harrod	10:25 - 10:45
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		10:45 - 10:50
	Building Machine Learning ML and the Land String Model room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Arvind Nair	10:50 - 11:10
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		11:10 - 11:15
	ADAPT room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Arvind Nair	11:15 - 11:30
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		11:30 - 11:35
	Reinforce learning of Nuclei using ML and Exotic Phenomena room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Andreas	11:35 - 12:00
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		12:00 - 12:05
	Differentiable Simulations room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Benjamin Natharaj	12:05 - 12:40
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		12:40 - 12:45
	Discussion room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		12:45 - 12:50

Thu, October 13, morning: Streaming Readout

10:00	Streaming in a Data or HEP/HEP/HEP room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Harish Sethi	10:00 - 10:20
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		10:20 - 10:25
	Flow ML for PFCs room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Mani Thi	10:25 - 10:45
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		10:45 - 10:50
	AI for real-time applications in flow generation HEP detectors room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Mani Thi	10:50 - 11:10
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		11:10 - 11:15
	Streaming Readout for Next Generation Electron Telescoping Experiments room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Mani Thi	11:15 - 11:30
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		11:30 - 11:35
	ML for Heavy Flavor Identification room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Carroll Dean	11:35 - 12:00
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		12:00 - 12:05
	AI for Experimental Controls room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Thomas Britten	12:05 - 12:40
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		12:40 - 12:45
	Discussion room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		12:45 - 12:50

Tue, October 11, afternoon: theory/experiment connections

14:00	Reconstructing DPs and SDPs preproton room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Carroll Dean	14:00 - 14:20
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		14:20 - 14:25
	Machine Learning in Spectroscopy and Partial Wave Analysis room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	William Probst	14:25 - 14:45
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		14:45 - 14:50
	Fast Detector Simulations with Machine Learning room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	David Smit	14:50 - 15:10
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		15:10 - 15:15
	Coffee break room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		15:15 - 15:30
	overview talk on ML-based unfolding room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Anga Butler	15:30 - 15:55
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		15:55 - 16:00
	Tutorial on Unfolding room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Fernando Torres - Access et al.	16:00 - 16:45
	Discussion room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		16:45 - 17:00

Tutorial on GNN (BNL)

Thu, October 13, afternoon: Summary and Future

14:00	Tutorial on Graph Neural Networks room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Yihou Chen	14:00 - 14:45
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		14:45 - 14:50
	Hackathon on October 14 room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		14:50 - 15:15
	Coffee break room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		15:10 - 15:30
	Summaries room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		15:30 - 16:12
	QA room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		16:12 - 16:15
	Future room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall	Christoph Pasca	16:15 - 16:30
	Closing room 2023, William & Mary, Raymond, A. Mason School of Business, Alan B. Miller Hall		16:30 - 16:40



Design

- M. Balandat (Meta) Multi-objective Optimization Tutorial
- K. Suresh (Regina) Adaptive Experimentation in EIC
- B. Nachman (LBNL) AI-driven detector design
- E. Fol (CERN) ML Application for beam optics control in the LHC
- T. Satogata AI/ML overview for accelerator design activities

The/Exp (morn.)

- S. Liuti (UVA) ML for QCD analysis - 3D imaging
- T. Menzo (U. Cincinnati) Modeling Hadronization Using ML and the Lund String Model
- S. Andzrej (Jagiellonian U.) Modeling Hadronization Using ML and the Cluster Model
- A. Hiller Blin (U. Regensburg) A(I)DAPT
- N. Sato (JLab) Femtoscale Imaging of Nuclei using ML and Exascale Platforms
- B. Nachman (LBNL) Differentiable Simulations

Data centric analysis, UQ, modeling, analysis/preservation, event level inference

The/Exp (aftern.)

- D. Shih (Rutgers) Fast Detector Simulations with ML
- W. Phelps (CNU/JLab) ML in Spectroscopy and Partial Wave Analysis
- C. Pecar (Duke) Reconstructing DIS and SIDIS properties
- A. Butter (LPNHE CNRS) Ideas for ML based unfolding
- F. Torresales Acosta (LBNL) and V. Mikuni (NERSC) Unfolding Tutorial

Fast sim, spectroscopy, event-level reco, unfolding

Reco/PID Particle-level, event tagging, data-driven

- D. Whiteson (UC Irvine) Interpretable Networks for Identifying Leptons
- R. Kunnawalkam Elayavalli (Vanderbilt U.) Tagging heavy flavor jets @ RHIC
- W. Phelps (CNU/JLab) Muon identification with Deep Learning at EIC
- C. Allaire (IJC-Lab) Machine Learning in ACTS
- C. Peng (ANL) ML PID with measured shower profiles from calorimetry
- M. McEaney (Duke) Λ event tagging at CLAS12
- N. Branson (Messiah U.), ML for calorimetry
- J. Groux (Regina), Data-driven learning : Flux + Mutability

Infrastructure

- D. McSpadden (JLab/DS) MLFlow tutorial
- S. Volkova (PNNL) Foundation Model Infrastructure
- F. Liu (ORNL) AI/ML hardware co-design
- N. Tran (FNAL) Machine Learning with FPGA
- B. Joo (ORNL) AI/ML with HPC
- J. Huang (BNL), T. Miceli (FNAL), M. Williams (MIT), Panel Discussion

SRO

- M. Diefenthaler (JLab) INDRA-ASTRA
- S. Furlotov (JLab) FastML for FPGA
- R. Ammendola (Tor Vergata, Rome) AI for streaming readout: an architectural perspective
- J. Huang (BNL) AI-based data reduction for streaming DAQ
- M. Bondi' (INFN/Catania) SRO for next generation electron scattering experiments
- C. Dean (MIT) ML for Heavy Flavor Identification
- T. Britton (JLab) AI for Experimental Controls

Live Document

https://docs.google.com/document/d/13BWnq_ywTYs__2zA0beeDob8pcuiiBiVqXNk33Kk8LY/edit



Live Document:

Artificial Intelligence for the Electron Ion Collider

[Timetable](#)

This is the live meeting notes (Q&A) document for the second workshop dedicated to Artificial Intelligence for the Electron Ion Collider, which will take place at William & Mary from **October 10 to October 14, 2022**.

This has been used during the workshop to collect questions and replies

Conveners monitored discussion/questions in the live document

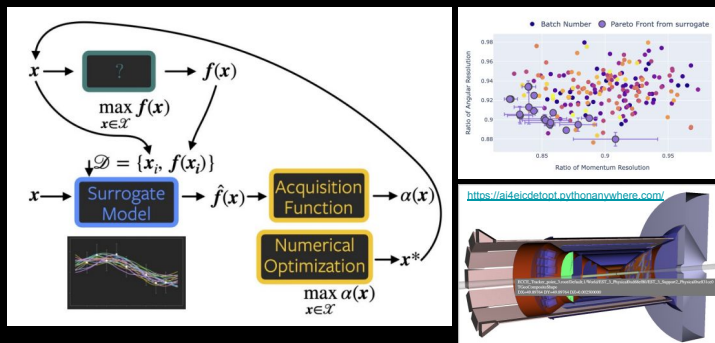
Total of 26 pages

AI4EIC Tutorials

<https://eic.ai/community>



M. Balandat, Meta AI



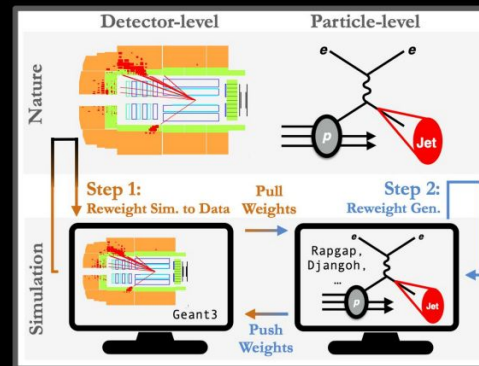
Multi-objective Optimization



F. Torales Acosta (LBNL)



V. Mikuni (NERSC)



OmniFold

Unfolding



K. Rajput JLab/DS

flow

Tracking

Record and query experiments: code, data, config, results

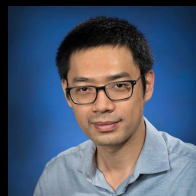
Projects

Packaging format for reproducible runs on any platform

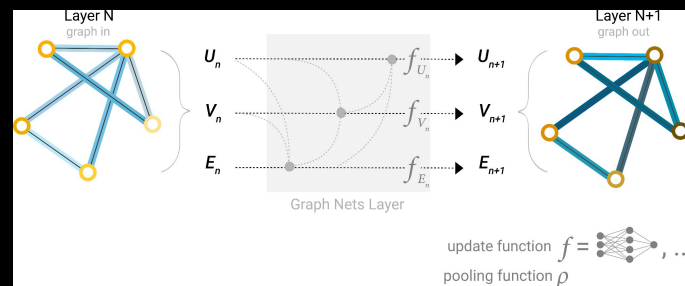
Models

General format for sending models to diverse deploy tools

MLflow — ML lifecycle



Y. (Ray) Ren (BNL)



Graph Neural Network 10

AI4EIC Hackathon (Oct 14)

hackathon supported by AWS —
4 GPUs / instance on cloud computing;
1 instance / team;
10 teams total —
prize supported by W&M



10 teams, 30+ people, both in person and virtual; participation from America, Europe, Asia

- Documentation ([problem description](#) and dataset):
<https://doi.org/10.5281/zenodo.7197023>
- Solutions accepted only above a certain threshold for the score
 - Hackathon winning team declared by 5pm ET of 10/14
 - Team JINR! (Alexey Aparin, Artem Korobitsin, Grigorii Tolkachev, Vladimir Papoyan)
 - Solutions accepted for an additional week:
 - Best solution overall by Team Jets (Pierre Chatagnon, Ibrahim Chahrour, Dmitry Kalinkin, Dulitha Jayakodige)



<https://ai4eichackathon.pythonanywhere.com/leaderboard>



AI4EIC Hackathon

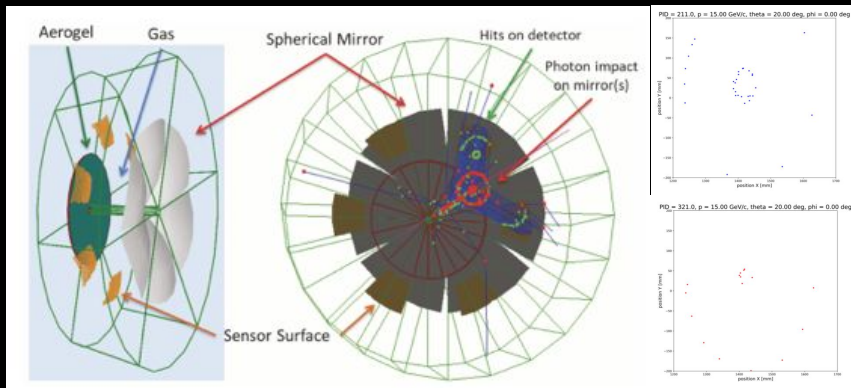
Congrats Team JINR!!!!!!! (submission on 10-14-2022)

Hackathon Leaderboard

RANK	TEAM	SCORE	QUESTIONS ATTEMPTED
1	Jets	295.502	Q 1, Q 3, Q 2
2	JINR	294.508	Q 1, Q 3, Q 2
3	JB and EC	262.313	Q 1, Q 3, Q 2

<https://aic.ai/hackathons>

Hackathon: Problems



π , K datasets

Training Events	1.5 Million Events	With Magnetic Field ($\sim 1.5T$)
Momentum	15 GeV/c	at Interaction Point (0, 0, 0)
Theta θ	20°	at Interaction Point (0, 0, 0)
Phi ϕ	0°	at Interaction Point (0, 0, 0)

Training Events	3 Million Events	With Magnetic Field ($\sim 1.5T$)
Momentum	15 – 20 GeV/c	at Interaction Point (0, 0, 0)
Theta θ	15 – 16°	at Interaction Point (0, 0, 0)
Phi ϕ	0 – 5°	at Interaction Point (0, 0, 0)

*Problem 3: addition of noisy hits

Organizers: Cris Fanelli (William & Mary/JLab), Diana McSpadden (JLab/Data Science), Kishan Rajput (JLab/Data Science)

Advisory and problem definition: Evaristo Cisbani (INFN), Wouter Deconinck (U. Manitoba)

Computing resources: Eric Walter (William & Mary, IT)

Data generation, Documentation, Validation: James Giroux (U. Regina), Karthik Suresh (U. Regina)

Technical Assistance: Eric Walter (William & Mary, IT), James Giroux (U. Regina), Karthik Suresh (U. Regina)



CF, DMcS, KR, EC, WD, EW, KS, JG

Problem Number	Threshold Accuracy
Problem 1	94%
Problem 2	86%
Problem 3	80%

Solutions:

- JINR: CatBoost, <https://catboost.ai/>
- Jets: 2D CNN

Problem 1

Problem 2,3*

The best solutions were all Machine Learning/Deep Learning-based, they were quite original, and they outperformed solutions based on classical approaches (followed by some teams). While this is only a first step towards deeply learning the identification of particles reconstructed with the dual-RICH, these exploratory studies clearly indicates the potential of ML/DL approaches for reconstruction and PID.

<https://eic.ai/hackathons>

AI4EIC Community

Based on the discussions during the workshop it is clear that AI4EIC fills an important need in the community by providing a forum for the community to come together and to learn from each other.

A few comments from workshop participants and the Panel session:

“AI4EIC very important to have in this growing community and to bring together people from different areas in the community”

“Need to keep moving things forward and AI4EIC provides a way to learn from each other and to broaden the community”

“Very fruitful to work with an interdisciplinary team...”

“Cannot be successful in the scientific communities alone. Used to go to many small workshops, which helps build connections.”

A few overarching points that were discussed in more than one session

- Need to include expert/domain knowledge in the AI/ML approach and perhaps more importantly make clear that it is being included
- Need for encouraging participation of underrepresented groups in AI4EIC
- Need for the community work together in a coordinated way to be most efficient in reaching the overarching goals

AI4EIC Near Term

- Tools that have been important for AI4EIC and have received much community support
 - **AI4EIC Topical Meetings via zoom approximately every month** — they will be announced via multiple communication platforms such as webpage (<https://aic.ai/events>), mailing list (eicug-software-ai@eicug.org), and slack (<https://ai4eic.slack.com/>). Please join the mailing list to receive the announcements and forward to those you think should be on it, e.g., colleagues in theory or experiment
 - **AI4EIC annual workshops** — really brings together the community
 - Please send us an email if you are interested in hosting the AI4EIC workshop in 2023
 - Only requirement is that your institution can support a hybrid format
 - **AI4EIC hackathons, kaggle-like challenges, etc**

AI4EIC Longer Term

- Discussion of the possible realization of a venue for people to come together and share ideas, knowledge and resources

“Several institutions could team up to provide alternative disciplines.”

- In addition to that, AI/ML activities are often fragmented, and despite this sparsity, similar efforts are often duplicated! Furthermore, AI/ML at scale and in the production environment, as well as dedicated heterogeneous resources, are limited. Need coordination and resources.
- Funding mechanism for AI/ML-related activities often complicated... Funding agencies presented several opportunities — need to discuss readiness with EIC PM, program managers, etc...
- AI4EIC looks timely given the data science expansion and emphasis. E.g., during the workshop, discussion on how this can increase involvement of universities, potential large educational component, etc.

Outlook

We plan to have the third annual workshop on Fall 2023

As discussed in the first AI4EIC workshop and hackathon locations will keep being rotated

Interested people can send an email with a proposal to support@aic.ai

More info on <https://aic.ai/how-to-join>