SAINTS Short Course: AI and ML applications in Nuclear and Particle Physics

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iThemba LABS [1], Wits University [2]

5 - 7 June 2024

Firstly……

Welcome and thank you to all participants for registering for the short course.

NRF/iThemba LABS hosting AI/ML short course

Cape Town

Johannesburg

- Multidisciplinary Research Facility of the NRF

  - Fundamental Nuclear and Particle Physics

  - Materials Research

  - Production of Radiopharmaceuticals (local & international markets)

  - Training & Development of students

- \> 5 Accelerators

Artificial Intelligence and Machine learning curriculum
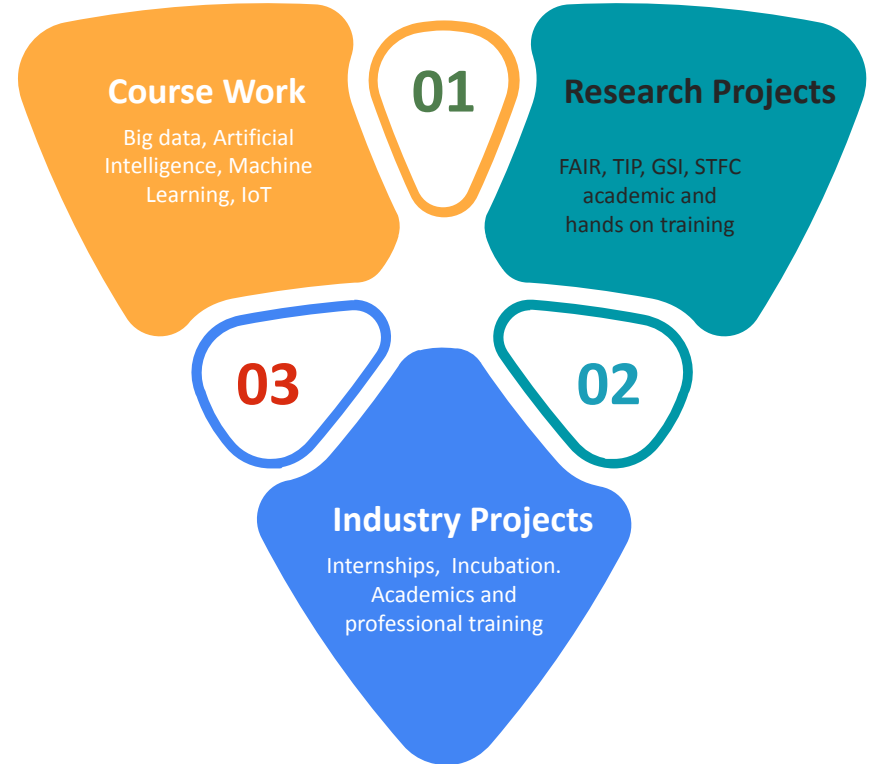
01. SAINTS programme: Course Work

is a specialized course designed to provide students with advanced training and support. This program aims to enhance students' skills and knowledge in specific areas, preparing them for future academic and professional challenges.

02. Research Projects - CERN, JINR , STFC, FAIR

Research projects involve in-depth exploration and analysis of a specific topic or problem. These projects are designed to foster critical thinking, data analysis, and problem-solving skills while contributing to the advancement of knowledge in the chosen field.

03. Projects with Industry - TIP

Industry projects involve working closely with Technology Innovation Platform at NRF-iThemba LABS to solve specific problems or develop new products and services. These projects provide students with valuable experience in a professional setting and help them understand the challenges and opportunities in their chosen industry.

Course Work

Big data, Artificial Intelligence, Machine Learning, IoT

01

Research Projects

FAIR, TIP, GSI, STFC academic and hands on training

03

02

Industry Projects

Internships, Incubation. Academics and professional training

Facilitators

Thokozile Manaka

Thokozile is an innovative and accomplished data scientist and PhD candidate in Computer Science at the University of the Witwatersrand, South Africa. She obtained her BSc in Mathematics and Physics from the National University of Lesotho and later earned her honors and master's degrees in physics at the University of the Witwatersrand.

Her research and areas of interest are at the intersection of artificial intelligence applications and the healthcare domain. She is committed to driving innovation and improving patient outcomes through cutting-edge research in machine learning and natural language processing and has published works towards this theme in local and international journals.

She is the recipient of UNESCO's Organization of Women in Science for the Developing World fellowship (OWSD) PhD fellowship and serves as president of the organisation's Lesotho chapter. An ardent lifelong learner, she is currently in the second cohort of the African Women in Tech and AI program by AI Movement-UM6P – Mohammed VI Polytechnic University and UNESCO.

Outside of her academic pursuits, Thokozile enjoys traveling and reading psychology literature. She is also a runner and is in recovery from a fitness addiction.

Facilitators

Chuene Mosomane

Chuene is a researcher at iThemba Labs, currently involved in the Phase-II Upgrade of the Low Voltage Power Supply using machine learning techniques for CERN. He completed his PhD in Statistical Physics and Machine Learning at the University of the Witwatersrand. His research is focused on the application of deep neural networks to identify critical behavior in complex systems, specifically the 2D Ising model with next-to-nearest neighbor interactions. During his MSc degree, he studied beyond the standard model theory, with a focus on the general two Higgs doublet model and its particle spectrum. He explored the type-II two Higgs doublet model and studying its behavior in the LHeC collider.

Facilitators

Thuso Mathaha

Thuso is a researcher at the University of the Witwatersrand in the School of Physics, focusing on Quantum Machine Learning for anomaly detection in multilepton final states. He completed his MSc in Particle Physics and Machine Learning at the University of the Witwatersrand in 2023, where his research concentrated on applying deep neural networks to identify the production of four top quarks using a Type-2 Two-Higgs-Doublet Model. During the COVID-19 pandemic, he was part of a team that made recommendations to Gauteng Health on how to effectively manage the crisis. By applying his knowledge of algorithms and machine learning, Thuso contributed to the development of data-driven strategies to mitigate the impact of the pandemic on the healthcare system and the general population.

Facilitators

Edward Nkadimeng

Edward Nkadimeng is an experimental high-energy physicist and machine-learning researcher. He obtained is Ph.D. in Physics at the University of the Witwatersrand. As a member of the CALICE (Calorimeter for Linear Collider Experiment) collaboration, an international R&D group working on developing high-performance detectors for future positron-electron experiments.

He focuses on the development and implementation of multivariate analysis methods and their application to the study of hadronic and semileptonic tagging algorithms. He is also spearheaded the establishment of an AI hub at iThemba LABS. This hub focuses on the convergence of artificial intelligence and machine learning with nuclear and particle sciences between AI experts and physicists.

As the elected co-chair of the South African Institute of Physics (SAIP) Nuclear, Particle, and Radiation Physics division. Edward's work has been widely recognized, with numerous publications in prestigious journals and features in various media outlets.

Hands on practical session

Participants must have access to a computer with a either <u>Mac, Linux, or Windows operating system</u> (not a tablet, Chromebook, etc.) that you have administrative privileges on.

LINK FOR HAND'S ON TRAINING SESSION AT 2PM:

https://cern.zoom.us/j/69702184021?pwd=7Cqsl3vk5WbRY2rN0JPXhV1xUi8Hny.1

Short assessment will be open from 11am till 2 pm on Friday, 7th June 2024

Programe

5 June 2024	09:00 - 10:00	Introduction to AI and ML: Definitions and Distinctions	T. Manaka
	10:05 - 10:30	Coffee/Tea Break	
	10:30 - 11:30	Overview of AI/ML Applications in Nuclear and Particle Physics	C Mosomane
	11:30 - 13:00	Ethical Implications of AI in Scientific Research	E Nkadimeng
	13:05 - 14:00	Lunch Break	
	14:00 - 16:30	Hands-on Training Session	T Mathaha
6 June 2024	09:00 - 10:00	Predictive Modelling and Data Analysis in Nuclear and Particle Physics	C Mosomane
	10:05 - 10:30	Coffee/Tea Break	
	10:30 - 11:30	Integrating AI/ML into Particle Physics Research Workflows	T Manaka
	11:30 - 13:00	AI/ML Optimizing techniques	E Nkadimeng
	13:05 - 14:00	Lunch Break	
	14:00 - 16:30	Hands on Training Session	T Mathaha

Group 1

Mr	Shahzaib	Abbas
Ms	Basma	Afzal Ellahi
Dr	Abdulraoof	Ali
Mr	Waqar	Ali
Dr	Cebo	Ngwethseni
Mr	Busani	Bhengu
Ms	Tshegofatso	Bokhutlo
Mr	Ntokozo G Cebekhulu	cebekhulu
Mr	Vongani	Chabalala
Dr	Ernest	Ejeh
Ms	Nametso	Gontlafetse
Dr	Muneer	Sakildien

Thokozile Manaka

Group 2

Mr	Muhammad Zuhaib	Khan
Mr	Falatsi Andrew	Khomo
Dr	Boniface Dimitri Christel	Kimene Kaya
Mr	Katlego	Machethe
Mr	Motlatsi Vincent	Mahanyapane
Mr	Mahabe Benedict	Mahatikele
Mr	Arslan	malik
Mr	Vuako	Maluleke

Chuene Mosomane

Group 3

Mr	Neo	Namane
Dr	Zina	Ndabeni
Mr	Pfano	Nemakonde
Ms	Farisha	Panday
Ms	Ashley	Phala
Mr	Thabo	Pilusa
Mr	Bryan	Thebeemang
Mr	Mooketsi	Hlongwani
Ms	Natasha Goaba	Kalanke

Thuso Mathaha

Group 4

Mr	Phumlani	Thethwayo
Mr	Otsile	Tikologo
Mr	Lekgotla Jimmy	Tjiane
Ms	Anakha	T X
Mr	Happy	Vilakazi
Mr	Nkonzo	Xulu
Dr	Wasiu	Yahya
Ms	Khanyisile	Masemola
Dr	Craig	Mehl
Mr	Tumisang	Mello
Mr	Muzomuhle	Mlotshwa
Ms	Avheyani	Molaudzi

Edward Nkadimeng

Thank you

Any questions, queries directed to eknkadimeng@tlabs.ac.za and saintsadmin@tlabs.ac.za