Rabah Abdul Khalek

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Theoretical Particle Physics • Machine Learning • Statistics
Data Science • Bayesian Inference • Coding • Python • C++
Deep Learning • TensorFlow • PyTorch • TMVA • ceres-solver

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Experience

2021 – PRESENT
Virginia, USA
[Slides]

Postdoc – Artificial Intelligence for Quantum Chromodynamics
Jefferson Lab – Theory division
Topic: Three-dimensional imaging of the proton using Machine Learning
- Developed a TensorFlow framework to constrain ANNs' derivatives with differential equations.
- Interfaced a Python framework to a C++ library that efficiently compute complicated integrals.

2017 – 2021
Amsterdam, NL
[Thesis]
[releases]
[reference]

PhD (with Cum Laude) – Theoretical Physics and Machine Learning
Nikhef Theory group & Vrije Universiteit Amsterdam
Topic: Exploring the substructure of nucleons and nuclei with machine learning
- Lead the development of an ML pipeline based on TensorFlow and Bayesian inference.
- Results reported in the world-renowned review of particle physics (Particle Data Group).
- Published more than 14 papers, 3 on the thesis topic were cited more than 150 times.

Public projects

[code] [doc] [refs]	co-developer	**MontBlanc** – Neural Network Fragmentation Functions
[code] [doc] [refs]	co-creator	**NNAD** – Neural Network Analytic Derivatives
[code] [doc] [site]	ex-collaborator	**NNPDF** – Neural Network Parton Distribution Functions
[Python] [C++]	co-creator	**TensorFlow and TMVA Tutorials in Machine Learning**

Internships

MAR – JUN 2017
Saclay, France
[Outline] [Slides]

JLab: Improving the extraction of Generalized Parton Distributions with ML
CEA (Commissariat à l'énergie atomique et aux énergies alternatives)
- Improved the identification of a rare process in electron-proton collisions with **Deep Learning**.

MAY – JUL 2016
Orsay, France
[Slides]
[Slides]
[Report]

LHCb Upgrade: Optimization of a track reconstruction algorithm
LAL (Laboratoire de l'Accélérateur Linéaire) - LHCb Group
- Achieved a 40% reduction of fake tracks by applying **Machine Learning techniques**.
- Achieved a 15% reduction of execution time by optimizing the C++ code structure.
- **Merged results** in the official version of the algorithm.

JUN – AUG 2015
France
Switzerland
[Report]

ATLAS: AFP and ALFA Detectors as a momentum spectrometer system
CERN (European Organization for Nuclear Research)
- Created a simple model of the AFP detector using Geant4 software for simulation.
- Estimated analytically the resolution of the tracking using this system using MATLAB.

Skills

PROGRAMMING					MACHINE LEARNING		
	C++	8 years	**LaTeX**	6 years		**TensorFlow**	5 years
	Linux	7 years	**Git**	6 years		**PyTorch**	2 years
	Python	6 years	**MATLAB**	1 year		**ceres-solver**	3 years
	ROOT	4 years	**Geant4**	3 months		**TMVA**	3 years

LANGUAGES		
	Arabic	Native
	English	Fluent
	French	Fluent
	Dutch	Beginner

HIGH ENERGY PHYSICS		
	APFEL	3 years
	MCFM6.8	3 years
	NLOJET++	1 year

Education

2016 – 2017 | Paris, France
Master 2 – NPAC (Nuclei Particles Astroparticles Cosmology)
Paris-Sud University
[Report] **C++/ROOT project**: Calorimeter simulation and reconstruction
[Report] **Hands-on experiment (LAL)**: Compton effect and QED measurements

2015 – 2016 | Orsay, France
Master 1 – Fundamental physics
Paris-Sud University
Optional courses: Classical and Quantum Electrodynamics ◦ Fields-Particle Interactions
[Report] **C++/Python project**: Simulation of the Pierre Auger observatory

Conferences

March 2022 | Machine Learning for Nuclear Theory at the INT [Contribution]
May 2020 | Multi-dimensional Analyses of Partonic distributions Workshop [Contribution]
May 2020 | Electron-Ion Collider Yellow Report Workshop [Contribution]
Jan 2020 | Quarkonia as tools [Contribution]
Jan 2018, 19, 20 | Physics@Veldhoven [Poster]
Jul 2019 | Electron-Ion Collider User Group Meeting [Contribution]
Apr 2019 | 27th Workshop on Deep-Inelastic Scattering [Contribution]
Sep 2018 | HardProbes [Contribution]
Aug 2018 | Low-x and Diffraction [Contribution]
Nov 2017 | NNV meeting [Contribution]

Schools

Mar 2020 | DESY PREFIT20: PRecision Effective Field Theory (Hamburg, Germany)
Jan 2020 | Dutch Research School of Theoretical Physics (Dalfsen, The Netherlands)
Jul 2018 | Mass: From the Higgs to Cosmology (Corsica, France)
Jan 2018 | Dutch Research School of Theoretical Physics (Dalfsen, The Netherlands)
Aug 2015 | CERN summer school (Geneva, Switzerland)

Teaching

Sep – Oct 2020 | Amsterdam
'Machine Learning for Physics and Astronomy' course
TA for Natuuren Sterrenkunde Joint UvA/VU BSc degree.

Jan – Jul 2020 | Amsterdam
Daily co-supervision of MSc. student G. van Weelden
Impact of new processes on nNNPDF2.0 nuclear PDFs

Aug 2019 | Amsterdam
'Machine Learning: a New Toolbox for Theoretical Physics' course
TA for High Energy Physics MSc. at Nikhef

2018 & 2019 | Amsterdam
'From quantum to molecule' course
TA for Medical Natural Sciences BSc. at Vrije Universiteit Amsterdam

2018 & 2019 | Amsterdam
'Electricity and Magnetism' course
TA for Medical Natural Sciences BSc. at Vrije Universiteit Amsterdam

Apr 2018 | Amsterdam
Machine learning tutorial: High energy gamma particles discrimination
Topical lectures for PhD students at Nikhef

Mar-Jul 2018 | Amsterdam
Daily co-supervision of BSc. student M. Bout
Writing from scratch a Neural Network algorithm and fitting HEP data.

Publications

21 April 2022	**Pion and kaon fragmentation functions at next-to-next-to-leading order.** arXiv:2204.10331
28 January 2022 [17 cit.]	**nNNPDF3.0: Evidence for a modified partonic structure in heavy nuclei.** arXiv:2201.12363
28 July 2020 [10 cit.]	**Self-consistent determination of proton and nuclear PDFs at the EIC.** Phys.Rev.D 103 (2021) 9, 096005 – arXiv:2102.00018
28 July 2020 [15 cit.]	**The Large Hadron-Electron Collider at the HL-LHC.** CERN-ACC-Note-2020-0002 – arXiv:2007.14491
25 Jun 2020 [70 cit.]	**nNNPDF2.0: Quark Flavor Separation in Nuclei from LHC Data** J. High Energ. Phys. 2020, 183 (2020) – arXiv:2006.14629
22 May 2020 [30 cit.]	**Phenomenology of NNLO jet production at the LHC and its impact on PDFs** Eur.Phys.J.C 80 (2020) 8, 797 – arXiv:2005.11327
12 May 2020 [3 cit.]	**On the derivatives of feed-forward neural networks** arXiv:2005.07039
25 Jun 2019 [64 cit.]	**Parton Distributions with Theory Uncertainties** Eur.Phys.J.C 79 (2019) 11, 931 – arXiv:1906.10698
24 Jun 2019 [25 cit.]	**Probing Proton Structure at the Large Hadron electron Collider** SciPost Phys. 7 (2019) 4, 051 – arXiv:1906.10127
10 May 2019 [59 cit.]	**A first determination of parton distributions with theoretical uncertainties** Eur.Phys.J. C (2019) 79:838 – arXiv:1905.04311
29 Mar 2019 [81 cit.]	**nNNPDF1.0: Nuclear parton distributions from lepton-nucleus scattering and the impact of an electron-ion collider** Eur.Phys.J.C 79 (2019) 6, 471 – arXiv:1904.00018
11 Feb 2019 [171 cit.]	**Standard Model Physics at the HL-LHC and HE-LHC** CERN Yellow Rep.Monogr. 7 (2019) 1-220 – arXiv:1902.04070
31 Jan 2019 [485 cit.]	**Higgs Physics at the HL-LHC and HE-LHC** CERN Yellow Rep.Monogr. 7 (2019) 221-584 – arXiv:1902.00134
14 Nov 2018 [3 cit.]	**Nuclear Parton Distributions from Neural Networks** Acta Phys.Polon.Supp. 12 (2019) 4, 927 – arXiv:1811.05858
8 Oct 2018 [54 cit.]	**Towards Ultimate Parton Distributions at the High-Luminosity LHC** Eur.Phys.J.C 78 (2018) 11, 962 – arXiv:1810.03639

Other skills

2019 – 2021	**Member of the PhD council in the Dutch Research School of Theoretical Physics**
2016	**Participated in the 10th edition of the Jean Monnet "short story contest"** - Paris
2012-2015	**Oud student - 4th year** - Lebanese National Higher Conservatory of Music
Spring 2014	**Designed a mechanical device for an art installation** - Beirut
Summer 2013	**Taught 16 students the basics Guitar, Oud, Solfeggio and Rhythm** - Lebanon
2010-2013	**Choir Leader of a Scout association** - Lebanon
2007-2009	**Co-Founder of an IT service startup company** - Lebanon