Ra'ad Costello-Mahmoud
PhD MPhys

Career Summary

Machine learning engineer with 4 years of industry experience and a doctorate in computational astrophysics. Experienced Python developer with over a decade of software contributions. I've worked on time-series models of black holes, novel computer vision techniques for automotive manufacturing, and explosive detection in X-ray images. Currently leading neural network development for pathogenic genomic material characterization to combat bio-terrorism, funded by a key UK Governmental body, and serving on a NATO Sensors & Electronics Technology Panel.

Software Development Skills

Programming Languages.

Python — Native language. 11 years experience on projects including physical modelling of magnetic dipoles, cosmic expansion, black hole accretion dynamics, and extensive ML. Proficient with many Python libraries, including: `SciPy`; `NumPy`; `matplotlib`; `scikit-learn`; `OpenCV`; `PIL`; `pandas`; `SQLite`; `fastAPI`; `wandb`; `boto3`; `PyTorch` and `TensorFlow`.

Bash — Working proficiency. 10 years of working with Linux - primarily in Ubuntu - has led to good knowledge of shell scripting. I am comfortable with environment management tools such as `conda`, `pip` and `venv`.

SQL — Working proficiency. 4 years experience. Familiar with a range of integrations including Python `SQLite`, `postgres`, `PGAdmin`, with experience integrating into live service systems.

C++ — Moderate proficiency. 1 year experience, producing subroutines to model the behaviour of accreting matter. This fast code allowed direct model fitting of observational high-energy data for the first time, overcoming decades-long standing challenges.

Deep Learning & MLOps.

Tensorflow Keras PyTorch — Over 6 years of experience in academia and industry developing deep learning algorithms for applications in astronomy, automotive manufacturing, aviation security, and bioinformatics. Proficient in the mathematical foundations of various neural networks, particularly convolutional networks and object detection. Skilled in constructing customized networks, loss functions, and robust datasets using object-oriented programming.

Cloud Computing & Restful APIs — Extensive experience with AWS (mainly EC2) for data generation, model development and deployment, building micro-service based architectures for a growing professional user-base. These micro-services have mainly employed `fastAPI` as their web framework.

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CI/CD Fluent in in app containerisation with Docker and deployment via `uvicorn`, DockerHub, GitHub actions to AWS.

VCS Git & GitHub: 7 years of programming collaboratively has necessitated good Git habits. See contribution history at GitHub.

Data Generation Pipelines Responsible for designing and implementing data generation pipelines for object detection (explosive ID) and genomic sequence characterization at Kromek. Developed systems to generate simulated data, enable custom augmentations, and ensure reproducibility of large datasets (~ 100s of GBs). Experienced in automated data annotation, including building tools for web-scraping virology literature and curating clean labels.

Local LLMs 1 year of experience leveraging LLMs with tools like `Langchain`, `CrewAI`, and `Ollama` to develop, deploy, and maintain systems for web scraping, data annotation, and internal corporate assistance.

HPC 3 years experience writing Python/C++ code for usage on high performance computing on COSMA5, a 6700-core Sandy Bridge system.

Interpersonal & Communication.

Extensive experience of interacting with technical and non-technical stakeholders, having spoken at international conferences in astrophysics and bioinformatics, as well as leading regular delivery meetings with key funding bodies and internal/external C-suites.

Good experience of mentoring in an industrial context at Kromek, where I have directed the technical work of postgraduate interns and several junior colleagues.

Proven ability in output-oriented teamwork and collaboration, evidenced by past internships, prolific collaborations during PhD, and multiple continuation projects.

Employment + Experience

Apr 2020 – Present **Kromek Group Ltd.**, *Sedgefield, UK*.

- **Deep Learning Engineer** *3 years 6 months*
  - Led a team in developing neural networks for genomic read characterization, overseeing deployment for bioinformatics users.
  - Spearheaded a UK Government-funded project, building on a successful 24-month initiative I previously led.
  - Engineered proprietary neural networks combining computer vision and materials analysis for explosive detection in aviation security.
  - Enhanced object-detection systems with 3D and materials data, significantly improving threat detection rates in X-ray imaging.
- **Image Processing Engineer** *7 months*
  - Developed and optimized image processing algorithms.
  - Implemented real-time image analysis systems.
  - Worked closely with software engineers to deploy solutions.

May 2019 – Aug 2019 **Nissan Motor Manufacturing UK Ltd**, *Sunderland, UK*.

- **AI Intern** *3 months*
  - Completed industrial placement in the Deep Learning team during my PhD.
  - Developed advanced computer vision techniques, focusing on CNN optimization.
  - Designed an image optimization method now integral to their automated defect detection system, deployed across multiple global manufacturing sites.

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Jan 2017 – Apr 2017 **Japan Aerospace Exploration Agency (JAXA)**, *Tokyo, Japan.*

- **Astrophysics Researcher** *3 months*
  - Collaborated with international team on black hole accretion physics research.
  - Provided Python-based detector calibration code now employed for interpretation of space-based detector data.

Jun 2015 – Aug 2015 **Durham University Superconductivity Group**, *Durham, UK.*

- **Intern** *3 months*
  - Conducted research into the mechanical properties of superconducting solder alloys for use in the next generation of fusion tokamaks to follow the $14 billion ITER (International Thermonuclear Experimental Reactor) in Cadarache, France.

Education

Oct 2016 – Apr 2020 **PhD in Computational Astrophysics**, *Centre for Extragalactic Astronomy, Durham University, Durham, UK.*

- Thesis title: ***Spectral-Timing Models of the Central Engine in Accreting Black Holes***
  - Fully funded by STFC over 3.5 years.
- Awards:
  - Elsevier book prize for outstanding 1st year postgraduate student [pool of 30; £100].

Oct 2012 – Jul 2016 **MPhys in Physics and Astronomy**, *Department of Physics, Durham University, Durham, UK.*

- 1st Class, highest degree mark in year
- Dissertation title: ***A Monte Carlo Approach to Modeling Habitability in the Milky Way***
- Awards:
  - 2014 Vice-Chancellor's academic excellence award [£2000].
  - 2015 Computational physics prize [pool of 200; £100].
  - 2016 JA Chalmers prize for highest overall degree mark (83%) [pool of 200; £100].

Sep 2010 – Jul 2012 **A-Levels**, *Monks Walk Comprehensive School*, Welwyn Garden City, UK.

- 'A2': Mathematics (A*)
- 'A2': Physics (A)
- 'A2': Chemistry (A)
- 'AS': Further Mathematics (A)

Publications

"Origins of the UV/X-ray Relation in Arakelian 120", *R. Mahmoud, C. Done, D. Porquet, A. Lobban, 2023, MNRAS, 521(3), 3586.*

"Discarding the disc in a changing state AGN: the UV/X-ray relation in NGC 4151", *R. Mahmoud, C. Done, 2020, MNRAS, 491(4), 5126.*

"Reverberation Reveals the Truncated Disc in the Hard State of GX 339-4", *R. Mahmoud, C. Done, B. De Marco, 2019, MNRAS, 486(2), 2137.*

"A Physical Model for the Spectral-Timing Properties of Black Holes", *R. Mahmoud, C. Done, 2018, MNRAS, 480(3), 4040.*

"Modelling the Energy Dependence of Black Hole Binaries", *R. Mahmoud, C. Done, 2018, MNRAS, 473(2), 11.*

"Superconducting and Mechanical Properties of Low-Temperature Solders for Joints", *Y. Tsui, R. Mahmoud, E. Surrey and D. Hampshire, 2016, IEEE Trans. Appl. Supercond., 23 (3).*

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