Mahyar OSANLOUY

Senior Machine Learning Engineer & Scientist

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I am passionate about intelligence, both in brains and machines.

Currently a senior ML/AI scientist with a wide range of expertise in engineering, computer science, and biology. Technical insights and domain knowledge in mathematical and statistical modelling, machine learning, computer vision, and neuroscience. Passionate and experienced in the design and development of intelligent machines, machine learning, bioengineering simulations, and computer vision applications. Eager to solve challenging questions to create new knowledge, help to make decisions, develop products, and ultimately contribute to the discoveries that could lead to a better world.

💼 WORK AND RESEARCH EXPERIENCE

Jan 2023 -

Sr. ML Engineer, TRANSPORT FOR NSW, Sydney
- › Joined the InfraTech R&D team to lead the TfNSW's AI initiatives for Smart City & Digital Twin.
- › Leading the government's AI in Project Management & Delivery Program to develop a smart integrative platform for document generation and analysis using language models. This requires building large vector databases from existing databses for a wide range of data formats (e.g., digital PDFs, scanned PDFs, spreadsheets, DOCXs, images, ect.).
- › Leading the government's Road Condition Monitoring Program to develop AI- and Computer Vision-based systems for monitoring infrastructural assets and defects.
- › Leading some of the GeoSpatial data analytics projects to develop AI-based approaches for analysing satellite imagery datasets for natural disaster monitoring in NSW.

PyTorch | Numpy and Scipy | Scikit-Learn | OpenCV | Azure | Computer vision | LLMs | Database | PostgreSQL | OCR | Edge devices | IoT | Robotics | Leadership | Mentoring

Mar 2022 Jan 2023

Sr. ML Scientist, PROVECTUS ALGAE PTY LTD, Noosaville
- › Joined this company to lead the AI/ML team.
- › Designed the complete AI/ML architecture and pipeline from scratch to integrate cloud-based (AWS) and edge-based (Raspberry Pi) inference and training (MLOps & DataOps).
- › Lead two teams, one based in Australia and the other in Poland.
- › Within the first week of my role, improved the existing object detection algorithm for microscopic images by over 40%
- › Within the second week of my role, developed and implemented an optimisation algorithm for validating the existing models in the production, which increased the speed of the model validation process significantly. Additionally, the algorithm discovered errors that were undetected previously.
- › Improved the speed and memory footprint of existing models in the production by over 300% and 80%, respectively.

PyTorch | TensorFlow | Numpy and Scipy | Scikit-Learn | OpenCV | AWS CDK | Database | PostgreSQL | Edge devices | Leadership | Mentoring

Mar 2022 -

Scientific Consultant [part-time], AUCKLAND BIOENGINEERING INSTITUTE, Auckland
- › Continuing my role as a consultant in two different large, international collaborative projects funded by the National Institute of Health (US) and Ministry of Business, Innovation and Employment (NZ) to research and develop new tools and methods for neuromodulation, digital twins, and bioengineering.

PyTorch | TensorFlow | Theano | Numpy and Scipy | Scikit-Learn | OpenCV | Networkx | PyOpenGL | PyQt

June 2018
Mar 2022

ML R&D Software Engineer, AUCKLAND BIOENGINEERING INSTITUTE, Auckland
> Designed and developed a new Bayesian-based machine learning algorithm for bio-plausible model of neural activity based on the Free Energy Principle approach.
> Designed and developed a full product-level pipeline for big image data processing, segmentation, registration, analysis, and visualization.
> Designed and developed a smart algorithm to generate parametric models of neural trees based on image data. This is now incorporated into a well-known commercial software as a plugin.
> Developed methods and pipelines for multi-modal neuroimage data (EEG, fMRI, fNIRS, DWI) processing and integration.
> Designed and developed a novel algorithm to automatically find and draw neural pathways based on semantics and a knowledgebase. This work is verified and publicly available online on a NIH-based website (https://sparc.science/maps).
> Designed and developed methods for accurate and efficient object detection and tracking from video data of an in-vivo heart experiment using a combination of optical flow and neural network approach.
> Designed and developed a full pipeline for an accurate 3D segmentation of embryonic myocardial cells using a modified U-Net convolutional neural network model.
> Designed and developed workflows for mapping neural trees from various image modalities onto computationally-derived models of organ systems (scaffolds).
> Implemented an automatic optimization pipeline for fitting data cloud to computational finite element models.
> Proposed, designed, and developed a novel algorithm to re-sample volumetric images for fast and efficient visualization and processing of big image data.
> Implemented accurate, mechanics-based image registration methods for non-rigid data alignment.
> Designed and developed a machine learning approach for describing geometrical changes of human corpus callosum from brain MRI data.
> Contributed significantly to many different open-source projects as part of my various research collaborations (see my *GitHub account*).
> Published peer-reviewed articles in high-impact and prestigious journals and conferences.

PyTorch   TensorFlow   Theano   Numpy and Scipy   Scikit-Learn   OpenCV   Networkx   PyOpenGL   PyQt

Mar 2018
Aug 2018

ML R&D Software Engineer, SOUL MACHINES, Auckland
> Proposed, designed, and implemented a psychometric-based research for the development of a realistic, human-like motion generation in digital avatars. This research involved developing 2D/3D/4D capture of actors performing in single-person and dyadic interaction scenes, processing and analyzing performance capture data to identify behaviour patterns, and building neural network models (including FCNN, RNN, and GAN) for human motion generation and prediction.
> Contributed to a project to build a biomechanic and neural network coupled model for realistic facial and body motion.

Theano   TensorFlow   Numpy and Scipy   Blender   Unity   Motion Capture

Dec 2017
Mar 2018

Data Science Intern, AIDER, Auckland
> Proposed, designed, learned, and developed a number of prototypes for smart digital assistants using natural language processing methods. In this internship, I learned a lot about state-of-the-art algorithms including Google's Smart Reply and Stanford's NLP methods.

TensorFlow   NLTK   Keras

July 2017
Mar 2018

Postdoctoral Research Scientist, UNIVERSITY OF AUCKLAND, Auckland
> Developed SFEAL V0.1, an advanced version of the original library.
> Developed classification models to distinguish healthy lungs from diseased lungs (interstitial pulmonary fibrosis and cystic fibrosis) using a combination of different machine learning methods.

Scikit-Learn   Numpy and Scipy   Statsmodels   FEM   OOP

Mar 2013 Dec 2017	**Ph.D. Research Scientist, UNIVERSITY OF AUCKLAND, Auckland** > Proposed, designed, developed, and validated SFEAL (V0.0), an open-source Python library for statistical modeling of lung CT images. The module contains novel algorithms for building high-order mathematical models of lung shape, decomposing a population of models into main components of shape variation using a principal component approach. > Created multivariate statistical models to develop a structure-function mapping. > Proposed, designed, and developed an automatic, highly accurate machine learning method to predict and reconstruct the 3D CT image of a person's lung from their demographic and basic measurements. > Proposed, co-designed, and co-developed a novel machine learning method to accurately detect pulmonary fissures to segment lobar structures from different lung image modalities. > Contributed and collaborated significantly to many different projects in the lab. > My Ph.D. work was published in Nature Scientific Reports Journal. `Scikit-Learn` `Numpy and Scipy` `OpenCV` `Scikit-Image` `Statsmodels` `FEM` `OOP`
Nov 2012 Mar 2013	**Research Intern, MILLAR INC., Auckland** > Developed a method to analyze large physiological signal data recorded from telemetry devices over multiple days. > Accurately identified signal anomalies across the data and proposed a technique to automatically identify and remove them. > Quantified the drift in data to estimate the long-term error of the device in order to design better prototypes. `Telemetry` `Sensor Analysis` `Signal Processing` `Data Analysis`

💼 EDUCATION

Mar 2013 Dec 2017	**Ph.D. Mathematical Modelling, UNIVERSITY OF AUCKLAND, Auckland** *Professor Merryn Tawhai, Dr. Alys Clark, Dr. Haribalan Kumar* > Auckland Bioengineering Institute (ABI) > Faculty of Medical and Health Science (FMHS) > Auckland Hospital and Auckland District Health Board
Mar 2014 Dec 2015	**GradDipSci. Computer Science and Mathematics , UNIVERSITY OF AUCKLAND, Auckland** *Admitted into the program and studied part-time during my Ph.D.*
Mar 2012 Jan 2013	**B.Sc. (Honors) Biomedical Science , UNIVERSITY OF AUCKLAND, Auckland** *Dr. Carolyn Barrett, Professor Simon Malpas* > Faculty of Medical and Health Science (FMHS) > School of Biological Science (SBS)
Mar 2008 Dec 2011	**B.Sc. Physiology, UNIVERSITY OF AUCKLAND, Auckland** > Faculty of Medical and Health Science (FMHS) > School of Biological Science (SBS)

🎓 Honors and Awards

2022	Winner of Velocity $100K Challenge - First Place
2022	Winner of Velocity Innovation Challenge - Academic Prize
2021	Best Publication Award (Runner-up) at the ABI Research Forum
2021	Selected by NZ Gov. to attend the Global Young Scientists Summit, Singapore
2020	Second place for the best scientific image in the Art of Bio Eng
2020	People's choice third place for the best scientific image in the Art of Bio Eng
2017	Winner of BIRU Image Competition's Visualization and Analysis Award
2017	EM Steer and IM Booth Fund Fellowship
2015	Spark Ideas Challenge Commercial Prize (SPARK - The University of Auckland Entrepreneurship Program)
2015	Distinguished Student Award - Computer Science, University of Auckland
2013	The Evelyn May Steer Estate Doctoral Scholarship

≡ Skills

Programming	Python, Julia, C/C++, Java, Cuda, Matlab, Perl, Javascript, Typescript.
Frameworks	TensorFlow, PyTorch, Theano, OpenCV, OpenAI, Scikit-Learn and Scikit-Image, Numpy and Scipy, FSL, MNE, Nipype, fMRIPrep, PsychoPy, OpenCMISS, CellML.
Cloud	AWS, Azure
Development Tools	IntelliJ IDEA, Eclipse, Visual Studio, SVN, Git, Qt Creator, iPython
OS	Linux Debian, Linux Ubuntu, Linux Fedora, macOS, Windows
Other software	Blender, Mayavi, Unity, Ansys, ImageJ

- All with theoretical knowledge and practical experiences.

🖥 Projects

12 Labours June 2021 -

🔗 NZ-MBIE 12 Labours

I act as a research consultant and algorithm developer in this project. The main aim of the "12-Labours" project is to build digital models of various internal systems of the human body by using clinical research results. This research project will have a strong influence on diagnosis and patient care. Furthermore, the bioengineering understanding of human physiology is essential for the future development of medical devices and clinical examinations.

`Mathematical Modelling` `3D Data Machine Learning` `3D Geometrical Modelling` `Non-linear Optimisation`

The Human BioMolecular Atlas Program Feb 2021 -

🔗 HuBMAP   🔗 3D Portal

This is and NIH-funded program and I was invited to this project to develop the link between SPARC and HuBMAP data mapping and modelling. The outcome will ensure a consistent pipeline between organs, neurons, and molecular entities.

`3D Geometrical Modelling` `3D Data Mapping`

Graph Neural Networks for Understanding the Brain July 2021 -

(Codes and data are available upon request.)
This is a collaborative project with neuroscientists and electrophysiologists to use live, high-resolution image data to build models of biological neurons using a graph based neural network architecture combined with Bayesian learning.

`Neural Network` `Bayesian learning` `Graph Theory` `Live Imaging`

Predictive Coding in the Brain November 2020 -

(Codes and data are available upon request.)
I began this project in collaboration with Professor Rafal Bogacz from the University of Oxford, to design and implement a new machine learning algorithm to understand biological neurons functions and properties.

`Neural Network` `Machine Learning` `Bayesian learning` `Mathematical Modelling` `Predictive Coding`

NIH SPARC June 2018 -

🔗 github.com/nih-sparc/data-portal   🔗 https://commonfund.nih.gov/sparc   🔗 MAPCore Portal

Initially began as a research software engineer to develop an integrative, web-based interface to connect and map anatomical, physiological, molecular, and cellular data from different organ systems in collaboration with a large number of university laboratories and research institutes.
In September 2019, I was promoted to **Lead Scientist** to design and develop the algorithms for neural mapping.

`Mathematical Modelling` `Machine Learning` `Data Science` `Data Management` `Computer Vision` `Software Development`

Virtual Brain Project April 2019 -

🔗 github.com/ABI-Virtual-Brain-Project   (All repos are currently private) 🔗 virtual-brain-project-group

Co-established the first brain group at the Auckland Bioengineering Institute. This project was initiated in an attempt to develop biologically-driven computational models of the mammalian brain using deep learning and bioengineering simulation techniques.

`Deep Learning` `Machine Learning` `Computer Vision` `Mathematical Modeling` `Simulation`

CellNet May 2018 -

(All data and codes are currently being finalized for publication)
As part of a large research project, I contributed significantly to the development of a neural network coupled with a kinematic model of a C-looping phase of a developing heart.

`Convolutional Neural Network` `Machine Learning` `Mathematical Modeling` `Kinematics`

MAP Client - Plugins July 2018 -

🔗 github.com/mapclient-plugins   🔗 MAPClient

Developed and co-developed a large number of plugins for the MAPClient software for various projects and tasks in bioengineering and computer vision areas. Additionally, created robust and efficient workflows using those plugins for different applications.

`Workflow Management` `Computer Vision Applications` `Modeling Environment` `Pipeline Development`

LungNoodle

 github.com/LungNoodle

Developed and contributed significantly to the development of a large number of packages for lung image analysis, pulmonary simulation, web-based visualizations, and modeling environment.

Computer Vision Computational Physiology Mathematical Modeling Simulation

2024   Millidge, B., **Osanlouy M.**, Bogacz, R. 2024. "Predictive Coding Networks for Temporal Prediction." *PLOS Computational Biology*.

2023   Low, V. F, Lin, C., Su, S.,**Osanlouy M.**, Safaei, S., Talou, G., M., Curtis, M., A., Mombaerts, P. 2022. "Visualizing the human primary olfactory pathway and ancillary structures in a 3D reconstruction by high-performance computing and deep learning." *Cell. Submitted*.

2022   Ebrahimi, N., **Osanlouy, M.**, Bradley, C., Kubke, F., Hunter, P., 2021 "How the Heart Grows : From Multi-scale Data to Multi-scale Model." *iScience*. 25(7), 104600

2022   **Osanlouy M**, Lin, M., Soltani, E., Hunter, P.J., 2022. "Mapping the Autonomic Nervous System : The SPARC project". In Low PA, Editor (Eds.), *Primer on the autonomic nervous system*. Academic Press.

2022   Smyth, L. C., Murray, H. C., Hill, M., van Leeuwen, E., Highet, B., Magon, N. J., **Osanlouy, M.**, ... & Hampton, 2022. "Neutrophil-vascular interactions drive myeloperoxidase accumulation in the brain in Alzheimer's disease" *Acta Neuropathologica Communications*. 10(1), 1-17.

2021   **Osanlouy M**, Bandrowski A, De Bono B, Brooks D, Cassara AM, Christie R, Ebrahimi N, Gillespie T, Grethe JS, Guercio LA, Heal M., ... & Hunter, P. J. 2021. "The SPARC DRC : Building a resource for the autonomic nervous system community." *Frontiers in Physiology*. 12, 929.

2021   **Osanlouy M**, Christie R., Leung, C., Robbins, S., Moss, A., Heal, M., Tappan, S., Vadigepalli, R., Chen, J., Cheng Z., Schwaber, J., Nickerson, D., Hunter, P. J. "SPARC : a common spatial representation for the intrinsic cardiac nervous system." *In Society for Neuroscience* 2021.

2021   Leung, C., Robbins, S., Moss, A., Heal, M., **Osanlouy, M.**, Christie, R., Farahani, N., Monteith, C., Chen, J., Hunter, P. and Tappan, S., 2021. "3D single cell scale anatomical map of sex-dependent variability of the rat intrinsic cardiac nervous system." *iScience*, p.102795.

2020   **Osanlouy, M.**, Clark, A.R., Kumar, H., King, C., Wilsher, M.L., Milne, D.G., Whyte, K., Hoffman, E.A. and Tawhai, M.H., 2020. "Lung and fissure shape is associated with age in healthy never-smoking adults aged 20–90 years." *Nature Scientific Reports*, 10(1), pp.1-13

2020   Ebrahimi, N., **Osanlouy, M.**, Bradley, C.P., Kubke, M.F., Gerneke, D.A. and Hunter, P., 2020. "Spatio-Temporal Growth Patterns at Cell and Tissue Levels in the C-Looping Heart." *Preprint - Cell Press*.

2019   Zhang, Y., **Osanlouy, M.**, Clark, A.R., Kumar, H., King, C., Wilsher, M.L., Milne, D.G., Hoffman, E.A. and Tawhai, M.H., 2019, March. "Pulmonary lobar segmentation from computed tomography scans based on a statistical finite element analysis of lobe shape". *Medical Imaging : Image Processing*. 10949, 1094932.

2018   **Osanlouy, Mahyar**. "Statistical Shape Analysis to Quantify Lung Structure-Function Relationships over the Adult Lifespan." PhD diss., ResearchSpace@ Auckland.

2017   **Osanlouy, Mahyar**, Yuwen Zhang, Haribalan Kumar, Alys Clark, Duane Malcolm, Eric A. Hoffman, and Merryn Tawhai. "Age-Associated Changes In Thoracic Structure And The Impact On Lung Function : A Quantitative Study." ADVANCES IN PULMONARY MEASUREMENTS, MODELING, AND METHODOLOGY, pp. A4883-A4883. American Thoracic Society.

2016   Tawhai, M, **Mahyar Osanlouy**, Yuwen Zhang, Eric A. Hoffman, Margaret L. Wilsher, David G. Milne, Clair King, and Alys R. Clark. "A statistical and biophysical model of the young-to-old adult human lung for predicting function from structure. Biomedical Engineering Society

2016   Clark, Alys, **Mahyar Osanlouy**, Yuwen Zhang, and Merryn Tawhai. "A statistically averaged model of the lungs to predict physiology from imaging. publication descriptionAmerican Physiological Society

2017   **Osanlouy, Mahyar**, Yuwen Zhang, Haribalan Kumar, Alys Clark, Duane Malcolm, Eric A. Hoffman, and Merryn Tawhai. "A statistical shape model of the lung to predict pulmonary fissures : Towards a fully automated lung lobe segmentation method." New Zealand Medical Science Congress.

2016   Tawhai, M.H., **Osanlouy, M.**, Zhang, Y., Clark, A., Wilsher, M.L., Milne, Lin, CL., Hoffman, E.A. and Clark, A.R. "A statistical and biophysical model of the young-to-old adult human lung for predicting function from structure." *In Biomedical Engineering Society* 2016.

2015   **Osanlouy, M.**, Tawhai, M.H., Kumar, H., Clark, A. and Hoffman, E. "Quantifying age-related changes in pulmonary lobar geometry." *In Respirology 2015*.

2014   Osanlouy, M., Kumar, H., Clark, A.R., Malcolm, D.T., Hoffman, E.A. and Tawhai, M.H. "Quantifying The Difference In Lung Shape At FRC Between Normal Old And Young Subjects." CHRONIC LUNG DISEASE THROUGHOUT LIFE : FROM PRIMING IN UTERO TO THE AGING LUNG. *American Journal of Respiratory and Critical Care Medicine*

Mar 2021
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Undergraduate Supervision, Software tools for preprocessing of brain data, Auckland Bioengineering Institute
> I supervise two Bachelor students for their final year project dissertation to develop software pipelines for integrative preprocessing of brain data such as EEG and fMRI.

Neuroimaging | Software | Workflow Management

Oct 2020
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PhD Supervision, Integration of multi-modal brain image data, Auckland Bioengineering Institute
> I supervise a PhD student as a primary supervisor to develop mathematical models to integrate simultaneous neuroimage data from fMRI and EEG.

Neuroimaging | Mathematical Modeling | Machine Learning

Dec 2019
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Supervision, Machine learning for big image data, Auckland Bioengineering Institute
> I supervise a Research Assistant to design, develop, and prototype an open-source machine learning tool for big image data processing and visualization.

Big Data | Machine Learning | Computer Vision | Biomedical Imaging | Software Development

July 2019
Nov 2019

Supervision, A novel framework for big image data visualization, University of Auckland
> I supervised and mentored an M.Sc. student from the Computer Science department as part of an internship program to develop visualization tools for big image data.
> Reviewed codes, provided feedback, and guided the intern throughout the project.

Big Data | Machine Learning | Visualization | Software Development

Mar 2019

Nov 2019

Supervision, Regional segmentation of brain structure using deep convolutional neural networks, University of Auckland
> I co-Supervised a B.Sc. Hons. student from Engineering Science as part of the Research Year Part IV to develop a neural network model for the regional segmentation of brain structures from MRI using state-of-the-art deep learning techniques.
> Provided feedback and guidance throughout the project.

Deep Learning | Image Processing | Biomedical Imaging

Mar 2015
Nov 2017

Teaching, B.E. Biomedical Engineering | B.E. Engineering Science, University of Auckland
> I tutored in mathematical modeling courses.
> I demonstrated in computer labs for C and Matlab languages.

Mathematical Modeling | Computational Software

Nov 2014
May 2018

Supervision, B.E. Biomedical Engineering | MB.Ch.B, University of Auckland
> I supervised and mentored several different students for internship programs in the areas of mathematical modeling, optimization, computational physiology.
> Reviewed codes, reviewed reports, and provided guidance throughout the internships.

Mathematical Modeling | Optimization | Image Processing | Computational Software

Mar 2009
Nov 2015

Teaching, B.Sc. Biomedical Science | B.Sc. Pharmacy | MB.Ch.B, University of Auckland
> I tutored in several courses and labs including physiology, anatomy, pharmacology, and biological science.

Biomedical Science | Medical Science | Anatomy and Physiology | Pharmacy and Pharmacology

☞ Outreach and Volunteering

2019	Volunteered to organize workshops for postgraduate students on machine learning methods for medical image analysis on a regular basis.
2018	Volunteered to co-establish and co-host a weekly meeting at the Auckland Bioengineering Institute to review and discuss state-of-the-art machine learning and deep learning algorithms.
2017	Volunteered to talk at the University of Auckland Biomedical Engineering Careers Evening about career choices for students from STEM subjects.
2017	Volunteered to present and showcase some of my research to high school and college students as part of the National Biomechanics Day.
2016	Volunteered to present and educate the public about medical technologies at the MedTech CoRE Silio Park event for one week.

❝ References

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