Mahyar **Osanlouy**

Research Software Engineer

linkedin.com/in/mahyar-osanlouy github.com/mahyar-osn
+61 452 101 629 m.osanlouy@auckland.ac.nz
Melbourne, Vic, Australia

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

Currently a Research Software Engineer and an Algorithm Developer 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

**June 2018 - **

Research 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, automated 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 (ongoing) 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

Research Development 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 2017 | **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 2009 – Dec 2011 | B.Sc. Physiology, University of Auckland, Auckland
- Faculty of Medical and Health Science (FMHS)
- School of Biological Science (SBS)

Honors and Awards

2021 Best Publication Award (Runner-up) at the ABI Research Forum
2021 Nominated and selected 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 for highest grade in Principles of Computer Science, University of Auckland
2013 The Evelyn May Steer Estate Doctoral Scholarship

Skills

Programming	Python, Julia, C/C++, Java, Cuda, Matlab, Perl, Javascript.
Frameworks	PyTorch, TensorFlow, Theano, OpenCV, Scikit-Learn and Scikit-Image, Numpy and Scipy, FSL, MNE, Nipype, fMRIPrep, PsychoPy, OpenCMISS, CellML.
Development Tools	IntelliJ IDEA, Eclipse, Visual Studio, SVN, Git, Qt Creator, iPython
Deployments	MLOps : Hydra, ONNX, MLflow, GitHub Actions, FastAPI Wrapper, Docker & Docker Compose, AWS Lambda, Amazon Cloudwatch Logs, Kibana
OS	Linux Debian, Linux Ubuntu, Linux Fedora, macOS, Windows
Other software	Blender, Mayavi, Unity, Ansys, ImageJ

- All with theoretical knowledge and practical experiences.

Projects

Graph Neural Networks for Understanding the Brain

July 2021 -

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 new machine learning algorithms to understand biological neurons functions and properties.

Neural Network | Machine Learning | Bayesian learning | Mathematical Modeling | 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 Modeling | 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

Mar 2013 -

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

Selected Publications & Presentations

2022 Millidge, B., **Osanlouy M.**, Bogacz, R. 2022. "Extending Predictive Coding to Temporal Prediction." *Neural Computation*. *In Prep for submission*.

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*. *In Review* - Academic Press.

2022 Ebrahimi, N., **Osanlouy, M.**, Bradley, C., Kubke, F., Hunter, P., 2021 "How the Heart Grows : From Multi-scale Data to Multi-scale Model." *In Review - Cell Reports*.

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*

Supervision, teaching, and Mentoring

Mar 2021 - **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 - 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 - 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

Dist. Professor Peter Hunter
Director, ABI
@ p.hunter@auckland.ac.nz
+64 9 923 8395

Professor Rafal Bogacz
Lab Director, University of Oxford
@ rafal.bogacz@ndcn.ox.ac.uk

Associate Professor Mark Sagar
CEO, Soul Machines
@ mark@soulmachines.com
+64 27 2053302