

# Sindiso Mkhathshwa

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Konstanz, Baden-Württemberg, Germany

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## EXPERIENCE

### PhD Researcher

Jun 2024 – Present

Konstanz, Germany

- Duties: research planning and implementation, teaching, and cross-functional responsibilities.

### Lead Experimental Engineer

Dec 2023 – May 2024

Sensorit, Cape Town, South Africa

- Duties: hardware design and development, software design and development, and cross-functional responsibilities.

### Computer Science Teaching Assistant

#### Functional Programming - Honors level

Feb 2024 – Apr 2024

UCT, Cape Town, South Africa

- Duties: general course administration, grading class tests, assignments, and exams.

### Research Assistant

#### Nitschke Lab, UCT

April 2022 – Dec 2023

Cape Town, South Africa

- Duties: develop new methods for evolving and adapting artificial brains on various experimental platforms such as evolutionary-robotic, artificial life, and agent-based systems, using techniques from a wide range of biologically inspired machine learning sub-fields such as evolutionary computation and artificial neural networks (neuro-evolution) as well as statistical machine learning.

### Application Development Consultant

#### Modelling and Simulation Hub, Africa

April 2022 – April 2023

Cape Town, South Africa

- Duties: Design and development of wireframes, Live-running model implementation, and optimization, Interface design, Data wrangling, Model visualization development.

### Computer Science Teaching Assistant

#### Functional Programming - Honors level

Feb 2022 – April 2022

UCT, Cape Town, South Africa

- Duties: general course administration, grading class tests, assignments, and exams.

### Summer Intern

#### Project: WebAssembly Module for Spectrum Analysis

Jan 2022 – Feb 2022

VASTech, Cape Town, South Africa

- Design and development of a proof-of-concept web application that incorporates WebAssembly technology to speed up signal processing.

## EDUCATION

### PhD in Computer Science

#### University of Konstanz

Jun 2024 – Present

**Thesis topic:** The Benefits of Heterogeneity in Collective Robotics.

### MSc by dissertation, specialising in Computer Science (with Distinction)

#### University of Cape Town

Jan 2021 – Jun 2023

**Thesis topic:** Body and Brain Quality-Diversity in Robot Swarms.

### BSc(Eng) in Electrical & Computer Engineering (with Hons)

#### University of Cape Town

Mar 2017 – Dec 2020

**Culminating project:** Simulating Swarm Behavior for Surrounding a Target.

## PUBLICATIONS

Mkhatshwa, S., and Nitschke, G. (2023). The Impact of Morphological Diversity in Robot Swarms. Proceedings of the Genetic and Evolutionary Computation Conference (**GECCO 2023 Best Paper Award Recipient**)

*Reports on findings from ensembles of neural networks controllers that automate object classification and retrieval in a simulation environment.*

Mkhatshwa, S., and Nitschke, G. (2024). Body and Brain Quality-Diversity in Robot Swarms. ACM Transactions on Evolutionary Learning.

*Journal article that reports on findings from ensembles of neural networks controllers that automate object classification and retrieval in a simulation environment.*

## MOST PROUD OF

### GECCO 2023 Best Paper Award



Our publication won the Best Paper Award at the Genetic and Evolutionary Computation Conference

### UCT Computer Science Best Paper Award 2023



Our publication won the Best Paper Award at the School of IT showcase.

## EXPERIENCE (CONT'D)

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### Research Assistant

#### Task: Development of ToCTeditor tool

📅 Oct 2021 – Dec 2021      📍 UCT, Cape Town, South Africa

- Design and development of a tool that makes it easy to specify templates, given the model for template specification - called ToCT.

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### Computer Science Capstone Project Supervisor

#### Computer Science Dept.

📅 Aug 2021 – Nov 2021      📍 UCT, Cape Town, South Africa

- CSC3003S - Supervised 15 final-year Computer Science students undertaking a capstone project on Robotics.
- Duties: Writing up a project description, consulting with students as needed, grading final demos and reports.

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### Machine Learning Tutor

#### Computer Science Dept.

📅 Jan 2021 – Jun 2021      📍 UCT, Cape Town, South Africa

- CSC3022F - Machine Learning: The goals of this course are to provide final-year Computer Science students with a solid introduction to Python frameworks, along with concepts such as supervised/unsupervised learning, and implementation strategies such as neural networks, genetic algorithms, and decision trees.

The end goal is to provide practical experience in the design and development of Machine Learning algorithms.

- Duties: Grading tutorials, assignments, and class tests.

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### Research Assistant

#### Task: Signal Base-banding on FPGA

📅 Jan 2020 – Nov 2020      📍 UCT, Cape Town, South Africa

- Research and development of a Signal Base-banding system on a Field Programmable Gate Array (FPGA).

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## REFEREES

### A/Prof Geoff Nitschke

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### Dr Zola Mahlaza

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## SKILLS

### Written Communication

- Report writing and code documentation, with extensive knowledge of tools such as LaTeX, Doxygen, Sphinx, and Pandoc.

### Verbal Communication

- Presenting research findings in research seminars and conferences.
- Teaching and demonstrating at undergraduate practical and tutorial sessions.

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## TECHNICAL SKILLS

### Machine Learning

- Data-driven supervised learning and data-augmentation methods for classification and recognition applications.
- Deep Learning/Convolutional Neural Networks.
- SVMs, K-Nearest Neighbors, and Artificial Neural Networks.
- Unsupervised learning methods for controller design, object recognition, and classification tasks.
- Evolutionary algorithms, Adversarial learning, and Reinforcement learning.

### Technologies/Computational Toolkits:

- Torch & PyTorch, scikit-learn, TensorFlow, OpenCV
- Raspberry Pi, Micro-controllers, FPGAs, MATLAB

### Programming languages:

C/C++, Java, Python, R, Javascript, Verilog, ARM & MIPS Assembly

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## PROJECTS

### Self-Adaptation in Swarm Robotics

The purpose of this project is to research novel artificial life implementation techniques for self-adapting neural networks that must collaborate with one another in order to solve group (swarm) challenges.

### Marine Oil-spill Containment using Swarm Robotics

The objectives of the project were to implement a swarm of robots exhibiting surrounding behavior and to investigate how this behavior could be used to provide a robust and scalable response action for oil spill containment in marine ecosystems.

### Unsupervised Image Classification

The objectives of this project were to implement a simple unsupervised classification scheme—K-means clustering—to classify images into different categories or types. This necessitated the creation of a compact image descriptor, often known as a feature, to represent each image.

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*All projects are available on GitHub.*