VICTORIA UNIVERSITY OF WELLINGTON
TE HERENGA WAKA

**School of Engineering and Computer Science**
Te Kura Mātai Pūkaha, Pūrorohiko

PO Box 600
Wellington
New Zealand

Tel: +64 4 463 5341
Internet: office@ecs.vuw.ac.nz

# Genetic Programming for Antarctic Ice Sheet Modelling

Samuel Mata

Supervisors: Dr. Bach Nguyen, Dr. Bing Xue

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**Abstract**

This project aims to investigate and evaluate the use of Genetic Programming *(GP)* and Evolutionary Learning techniques for the long-term modelling of Antarctic Ice Sheet measurements.

## 1. Problem Statement

The changing conditions of Antarctica's Ice Sheets are a significant factor in the changing global climate, particularly with respect to rising sea levels [REFERENCE]. In this context, the ability to accurately model the long-term behaviour of these ice sheets is of great importance.

## 2. Motivations

Current modelling of Antarctic Ice Sheet measurements - such as that being undertaked at Victoria University's Antarctic Research Center *(ARC)* - is commonly based on the use of traditional statistical models. These models are complex and time-consuming to use, limiting the practical scope of the predictive capabilities. The use of machine learning models shows promise as an approach due to the improved computational efficiency of these predictive systems. Specifically, the use of Genetic Programming *(GP)* and Evolutionary Learning techniques provide the greatest potential due to the increased explainability these methods provide.

## 3. Goals

The primary goal of this project is to investigate the application of Genetic Programming and Evolutionary Learning techniques on the problem of Antarctic Ice Sheet modelling. This will involve several stages:

1. **An initial Exploratory Data Analysis *(EDA)*** of the data provided by the ARC, to greater understand the the nature of the problem and the data. *( 2 weeks)*

   This will involve the use of univariate, bivariate, and multi-variate analysis to identify the distribution, shape, and relationships of the features.

   Variables should also be analysed in terms of their spatial and temporal distributions.

   Finally, potential feature engineering opportunities should be explored to identify potential improvements.

2. **Development of target-independant models** to predict target variables using advanced machine learning principles. At this stage each target should be predicted independently, without usage of other predicted values. *( 6 weeks)*

   Each model should explore implementing a different approach, before analysing and evaluating the results against previous iterations.

3. **Development of target-dependant models** for similar predictions, but taking into account the possible relationships between target variables. *( 6 weeks)*

   Each model should explore implementing a different approach, before analysing and evaluating the results against previous iterations.

4. **Evaluation of model interpretability and explainability**, targetting the explainability and interpretability of the predicted outputs. *( 4 weeks)*

   This will involve analysing and visualising the underlying mathematical expressions evolved by the model, and checking these against current scientific understanding of the problem.

5. **Further evaluation and improvement of the most effective model**, to determine the potential for improvement over traditional methods. *( 4 weeks)*

   Evaluation should consider many measures, particularly the computational efficiency of the model, the accuracy of the predictions, and the interpretability of the results.

Project milestones should be set for each of these stages to ensure that the project remains on track. It is important to note the potential for these goals to change as the direction of the project becomes clearer.

## 4. Evaluation

## 5. Resource Requirements

No external or additional resources are required for the project as all tooling is publicly and freely accessible.

# Bibliography