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

With the growing need for accurate long-term modelling of the Antarctic Ice Sheets, the currently used statistical models do not provide the necessary computational efficiency for sufficiently long term predictions. This project aims to investigate and evaluate the application of Genetic Programming *(GP)* and Evolutionary Learning techniques as a potential alternative to traditional methods.

1. Problem Statement

The changing conditions of Antarctica's Ice Sheets are a significant factor in global climate change, particularly with respect to rising sea levels. In this context, the ability to accurately model the long-term behaviour of these ice sheets is of great importance. Current approaches are not computationally efficient enough to provide meaningfully long-term predictions, and so this project aims to investigate the application of Genetic Programming *(GP)* and Evolutionary Learning techniques as a potential alternative. There is some challenge in the application of these techniques, as the models produced must be accurate and efficient enough to meaningfully improve the practicality of long-term predictions. Furthermore, for the results to be trusted the models must be explainable and interpretable.

2. Motivations

Current methods of modelling Antarctic Ice Sheet measurements - such as those being undertaken at Victoria University's Antarctic Research Center *(ARC)* - are typically based on traditional statistical methods, which are computationally intensive and time consuming. This inefficiency limits the practical scope of predictions, excluding the potential of longer-term forecasts. The use of machine learning models shows promise as an approach due to the relatively 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 allowing for greater understanding in the results provided. This is a novel application for these techniques, and so the potential for improvement compared to traditional methods is worth investigation.

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. *(3 weeks)*
2. Several iterations of model development and evaluation using Genetic Programming and Evolutionary Learning techniques, to identify the most effective approach. *(9 weeks)*
3. Further development of the most effective approach, targetting the explainability and interpretability of the predicted outputs. *(3 weeks)*
4. A final evaluation of the most effective model, to determine the potential for improvement over traditional methods. *(4 weeks)*

4. Evaluation

5. Resource Requirements

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

Bibliography