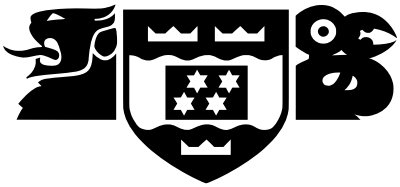
VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wananga o te Upoko o te Ika a Maui



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Project Title - Todo

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Supervisor: William Neil L Browne

Submitted in partial fulfilment of the requirements for
Bachelor of Engineering.

1. Introduction

Determining the chance of liquefaction within a specific geographic area is an important task especially in light of the recent Christchurch earthquakes. The current processes are labour intensive and subject to human error and bias. Developing a processes that would provide accurate reliable data with a reduction in human processing time would be benefifical tool to the geotech industry. The benfits include:

- A reduction in the cost of site evaluations by lessening a geotech's billable hours.
- A reduction in the time to anaylse the data, resulting in faster evluations.
- A more transparent result that is devoid of human bias, allowing greater client confidence.

There are also several academic outcomes that an AI solution would acheive, these include:

- ?
- An AI solution to an industry problem reinforcing the benefit of further AI research.

GNS and Victoria University have already developed a proof of concept prototype as a solution to this problem. This work is still in its infancy with a lot of further work required before it is a fully realized solution. The objective of this project is to help ensure that the direction of current research is the best course for further investment, both in time and financial support[1].

The current research investigates the use of a single AI technique, parallel linear genetic programming. This technique while powerful is not the best fit for every situation[2]. Being a relativly new technique there was also an element of novelty in its use. This projects aims to ratify its selction for this particular problem through a formal analysis of alternatives. This will be acheived by exploring the viability of additional AI techniques contrasting them against the inital study.

2. The Problem

Standard regression techniques for soil analysis are time consuming and subject to human bias. One of the most important peices of data that needs extracting is the shear wave velocity of specic soil layers. This information is used to determine the chance a specific area has of liqufying during an earthquake event[3]. The development of an artifical inteligence (AI) system for increasing the performance for estimating this shear wave velocity has already begun.

Currently a joint Victoria University and GNS effort has produced a proof of concept model to tackle this problem. The system uses parallel linear genetic programming and is in need of several major performance enhancements before it can become industry viable. To get this solution to an industry ready stage a substantial amount of both financial and time investment would be required. Up until this point no alternative solutions have been investigated and it is possible that an alternative solution will perform the task more effectivly. This needs to be explored so that future resources can be allocated appropiratly.

3. Proposed Solution

This project plans to develop and evaluate five alternative AI techniques against the existing parallel linear genetic programming solution. These techniques are:

- **GP** Genetic programming
- **LGP** Linear genetic programming
- **CGA** Compact genetic algorithm
- **CMA-ES** Covariance matrix adaptation evolution strategy
- **LCS** Learning classifier system

The project will be broken down into the following stages:

Stage 1 - This will primarily be research into the problem itself.This includes the physical science behind it and the algorithms mentioned above. While a portion of this will be continuious throughout the project the bulk should be completed by 22 April.

Stage 2 - Each of the above techniques will then be further investigated to determine their fit for the proposed problem. This is to remove any redundancy and avoid complication during stage 3. This should be completed by 10 May.

Stage 3 - The third task will be determining the evaluation methods used to benchmark the success of each technique. A fitness function for the given problem will be determined using the pre-existing work and communication with a GeoTech at GNS. This should be completed by 19 July.

Stage 4 - The techniques that meet the problems criteria will then be developed in java and tested against existing benchmarks/standards to ensure accuracy. 8 September

Stage 5 - The evaluation techniqes that were developed during stage 3 will then be tested against the remaining algorithms and the existing parallel linear genetic programming solution. 27 September

Stage 6 - The final stage will be to ensure all the resources used and developed during the project are in a presentable format. This includes a written report, oral presentation and a tidy code repository for any future work.

Written Report - 18 October(estimation only)

Oral Presentation - 16 November(estimation only)

Tidy Code Repository - 16 November(estimation only)

4. Evaluating your Solution

The success of the project will be determined by the successful implementation of the above techniques and their evaluation against the existing system. The exact evaluation methods will be determined during stage 3. Below is an example of the things that may be measured:

- Fitness data measured against the parallel linear genetic programming technique.
- Time taken to compute against the parallel linear genetic programming technique.

Should one of the methods outperform the existing system a further set of evaluation methods will be employed to determine the following (These are likely to be out of scope):

- Time taken to compute against a human operator.
- Fitness function against a human operator.
- Confidence in data as determined by GNS.

The project should upon its completion lead strength to the argument that parallel linear genetic programming is the correct solution to the problem, or find that an alternative method would be more viable.

5. Ethics and Resourcing

Ethics

Ethics approval for this project will not be required.

Safety

There are no saftey concerns for this project successfully

Budget

A transportation expenditure for George Davie will be incurred to facilitate meetings with GNS in Avalon.

Access to a vehicle is available. The default mileage rate for a motor vehicle is 77 cents per kilometer(Inland Revenue)[4].
Kelburn to Avalon return trip is 42 kilometers.
Estimation of 8 meetings during the course of the project.
8 X 42 X 77 = $258.72
Which is preferable to -
Wellington Combined taxi estimation-
Victoria University Kelburn - Avalon - $80 one way
5 return trips = $800

Total $258.72

Space and Access

This project will need access to a personal computer, software packages and a computing grid that can all be found within the Engineering and Computer Science school at Victoria University.

Access to Will Brown as a project supervisor will be needed at a minimum of once per week with the provision that he can dedicate some additional time to the review of work.

GNS involvement will be required as the industry partners for this project. A set of contact people including a GeoTech and a seismologist should be available via email and available for monthly progress meetings.

Intellectual Property

(Talk to Will)

Bibliography

[1] B. W. Scoble, Aaron and M. Zhang, "Evolutionary Spatial Auto-Correlation for Assessing Earthquake Liquefaction Potential using Parallel Linear Genetic Programming," 2013. Victoria University Wellington.

[2] C. Downey and M. Zhang, "Parallel Linear Genetic Programming," 2011. Victoria University Wellington.

[3] R. D. Andrus and K. H. I. Stockoe, "Liquefaction resistance of soils from shear-wave velocity," 2000. Geotechnical and Geoenvironmental Engineering.

[4] Inland Revenue, "Claiming business expenses - Mileage rate," http://www.ird.govt.nz/business-income-tax/expenses/mileage-rates/. Accessed on 26 March 2013.