College of Engineering, Mathematics and Physical Sciences

APPLICATION OF AN EVOLUTIONARY DATA MINING TECHNIQUE FOR CONSTITUTIVE MODELLING OF GEOMATERIALS

Submitted by

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I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

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ABSTRACT

Modelling behaviour of materials involves approximating the actual behaviour with that of an idealised material that deforms in accordance with some constitutive relationships. Several constitutive models have been developed for various materials many of which involve determination of material parameters with no physical meaning. ANN is a computer-based modelling technique for computation and knowledge representation inspired by the neural architecture and operation of the human brain. It has been shown by various researchers that ANNs offer outstanding advantages in constitutive modelling of material; however, these networks have some shortcoming. In this thesis, the Evolutionary Polynomial Regression (EPR) was introduced as an alternative approach to constitutive modelling of the complex behaviour of saturated and unsaturated soils and also modelling of a number of other civil and geotechnical engineering materials and systems. EPR overcomes the shortcomings of ANN by providing a structured and transparent model representing the behaviour of the system. In this research EPR is applied to modelling of stress-strain and volume change behaviour of unsaturated soils, modelling of SWCC in unsaturated soils, hydro-thermo-mechanical modelling of unsaturated soils, identification of coupling parameters between shear strength behaviour and chemical's effects in compacted soils, modelling of permeability and compaction characteristics of soils, prediction of the stability status of soil and rock slopes and modelling the mechanical behaviour of rubber concrete. Comparisons between EPR-based material model predictions, the experimental data and the predictions from other data mining and regression modelling techniques and also the results of the parametric studies revealed the exceptional capabilities of the proposed methodology in modelling the very complicated behaviour of geotechnical and civil engineering materials.

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