ABSTRACT

These days, software is an integral part of most systems with responsibility of carrying out critical tasks. Functionally attractive software also needs to be safe, reliable and cost effective to sustain in the market. This thesis proposes artificial neural network (ANN) based models to predict: a) cumulative number of software failures observed in a certain testing time, b) time between software failures in testing phase, c) fault-prone software modules before testing phase, and d) software development efforts before testing phase. For all the above objectives, effect of non-linear scaling of ANN inputs on predictive capability is studied. It is found that a non-linear logarithmic scaling function improves prediction accuracy for all the problems. This learning is utilized in form of a new proposed ANN architecture with an additional input layer trained using Particle Swarm Optimization (PSO) method named as ANN-PSO model. The additional input layer contains neurons equal in number of inputs. Each additional input layer neuron receives only one input from corresponding input layer neuron and logarithmic scaling function is used its activation function. The study shows that the proposed additional input layer architecture further improves accuracy.

The ANN-PSO model is used as single input (testing time) and single output (failure count) ANN architecture which is experimented with multiple datasets to predict cumulative number of software failures. The results show better prediction accuracy. The same architecture is configured in time series fashion to predict time between failures and its application on multiple datasets also showed better prediction accuracy. The ANN-PSO model is configured as multiple inputs (software quality metrics) and single output to classify software modules as fault-prone or not fault-prone. Sensitivity analysis and principal component analysis (PCA) are studied for the purpose of input dimension reduction. PCA is found to be providing better accuracy. Similar multiple input and single output ANN-PSO model is used for predicting software development efforts from effort multipliers. It gives better prediction accuracy for multiple datasets experimented. Besides, effect of optimizing ANN architecture using Genetics algorithm (GA) for effort prediction is studied. The GA application improves the prediction accuracy but not significantly.

Keywords: Software reliability, artificial neural network, logarithmic scaling, time series, sensitivity analysis, principal component analysis, particle swarm optimization, genetics algorithm.