# CONSTRUCTING MULTILAYER FEEDFORWARD NEURAL NETWORKS TO MODEL NONLINEAR FUNCTIONS IN ENGINEERING MECHANICS APPLICATIONS

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This paper presents an ongoing development and a validation of a heuristic methodology proposed by the first author and her co-authors for designing multilayer feedforward neural networks in modeling nonlinear restoring forces [1-4]. The applications of this work are extensive and include identification of nonlinear dynamic systems and neural network-based damage detection.

It is well known that a foolproof way to determine a neural network architecture for training has not yet been established. However, in function approximation, a good design may be achieved by examining the dominant features of the target function. In this and previous studies, the authors do not presume to provide a universal method to approximate any arbitrary function, rather the focus is given to modeling nonlinear hysteretic restoring forces, a significant domain function approximation problem. The governing physics of the target and the strength of the sigmoidal basis function are exploited to determine both a neural network architecture (e.g., the number of hidden nodes) as well as the initial weights and biases for those nodes. These efforts lead to a methodology of constructing neural network "prototypes" for the training initialization [1-4].

With the use of illuminating mathematical insights as well as a large number of training examples, this study demonstrates the usefulness and versatility of the proposed prototype-based initialization methodology. Prototypes (with compact numerical nomenclature) which can be used to model various nonlinear functions commonly seen in engineering mechanics are provided. Comparisons are made between the proposed methodology and the widely used Nguyen-Widrow initialization to demonstrate the robustness and efficiency of the proposed scheme for the specified applications. Future work is also identified.

**References**

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