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Data processing based on deterministic neural network in applied gravimetry

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Under the processing of gravimetric observations we often understand a complex task that covers the data acquisition, adjustment and estimation of precision characteristics. The conventional methods of data processing and modelling rest on the realization of a functional tie (so-called error equation) between observations and model parameters. Subsequently, unknown parameters in the error equations are identified and determined within the least-squares adjustment. Such a realization of the error equation is limited by the ability to express known and hidden systematic/instrumental effects. Within this article, a generalization of the approach by means of a construction of a finite automaton that implements flexible ties between elementary processing elements called 'deterministic neurons' is proposed. Input states of such neuron are transformed to the output by employing a certain set of elementary functions. Interactions within the network are provided by a standard feed-forward mechanism. This concept enables us to create functional approximation of more complex functional relations by compositions of processing elements. Moreover, non-functional relations as hysterons, or stochastic relations, can be included in the model. Nevertheless, the parameters of the model are restricted to the weights of neuron inputs. This makes possible to evaluate a derivative of any model parameter, which can be used for linearization of the functional relations or for error estimates. Therefore, the data adjustment means just a reweighing of the neural network, for which one can use the least-squares method, maximum-likelihood method or any other approach known as 'training' of the neural network.