Review of the Ph.D. thesis
"Neural Network Synthesis"
by Ing. Bc. Pavel Vařacha

This thesis describes a feed forward artificial neural network synthesis via an Analytic Programming by means of the neural network creation, learning and optimization. This process encompasses four different fields: evolutionary algorithms, symbolic regression, neural networks and parallel computing to successfully synthetize a suitable neural network within a reasonable time.

In accordance with the thesis aims neural network synthesis is applied on various tasks of approximation, prediction, classification, on several benchmarks problems as well as to the real life problems of heat load prediction optimization of the heating plant in Komořany and cancer classification problem.

Remarks to the thesis:

The Ph.D. thesis has a very good graphical form, text is logically structured into chapters and subchapters, all necessary notions are clearly explained and then demonstrated by examples. Results are compared with results of the competitive methods published in the recent literature.

With respect to the size of the Ph.D. thesis it contains few typographic errors. For example ',' is typed within several tables where correctly '.' should be placed. The author also used an abbreviation RMSD where RMSE is more commonly used. Some pages of a printed version of the thesis lack printing quality so several lines are lighter than others. However these comments on the Ph.D. thesis are not substantial and do not cast doubt on its scientific level.

We can conclude that the author fulfilled given aims and evidence abilities of creative invention based on a wide scope of knowledge in the theoretical literature and high level in work with artificial neural networks, distributed computation, evolutionary algorithms and software development.

The author's main contribution is an extension of the class of method that can be used for neural networks optimization, because it increase a chance find optimal neural network topology and weights settings in order to successfully solve given task.

I would like specifically highlight the fact that the author successfully used developed method not only on theoretical benchmarks but also for solving real life and industrial problems.

Questions:

1. In chapter 5.3 hyperbolic tangent was proposed as an artificial neuron's transfer function. This function was then used in almost all following experiments. Is it possible to use different transfer function and was this possibility experimentally evaluated?

2. In chapter 12 the author describes software development based on .NET Framework technology. Why such approach was used - in comparison with Java or C++ language?

Conclusion:

In my opinion, Ing. Pavel Vařacha has proved to be capable of soling difficult research problems. His Ph.D thesis satisfies conditions of the Czech Act 111/1998 and its Section 47, parts of the thesis have been published in 19 international conference papers and are included in technical reports of research project. Neural network synthesis method was also accepted for publication as a chapter of Handbook of Optimization 2011, Springer, therefore

I recommended

Ph.D. thesis submitted by Pavel Vařacha for acceptance by the Committee to be presented and defended in the Information Technology study branch.

In Zlín 11. 3. 2011

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Review of Dissertation Thesis

Thesi name:	Neural Network Synthesis
Ph.D. candidate:	Ing. Bc. Pavel Vařacha
Supervisor:	Prof. Ing. Ivan Zelinka, Ph.D.
Study branch:	Information technology
Place of work, where defence takes place:	Tomas Bata Univerzity in Zlín, Faculty of Applied Informatics
	Nad Stráněmi 4511, 760 05 Zlín

Dear colleagues,

I would like to share with you my observations concerning Ing. Pavel Vařacha's Ph.D. thesis *Neural Network Synthesis*, which deals with Artificial Neural Network (ANN) synthesis using Self-Organizing Migration Algorithm.

First of all, I am pleased say that according to my opinion, topic of the thesis undoubtedly contributes to the development in the field of ANN optimization and that Ph.D. candidate has demonstrated strong ability to produce fresh approach.

It is vital to notice that author has been already actively publishing approaches leading in the end to the development of methodology presented now in the thesis as can be demonstrated by examining references. Literature review is quite sufficient, up-to-date and quoting numerous articles in respected journals.

The professional level of the thesis is of high academic standard and, in my opinion, definitely represents Ph.D. level research.

Dissertation work is formally processed at a decent level. Text is written neatly and is understandable. Grammatical errors that occur in it do not affect its level in a significant way. The thesis is also well structured. I was able to find several omissions, e.g. fig. 55 misses unit description on x-axis.

I was intrigued by the fact that the discussed methodology has already been applied on the real-life problem situation dealing with heat load prediction of the actual heating plant located in Komořany, Czech Republic.

In chapter 11, the author describes application of his method on cancer classification problem published in Proben 1 benchmark set. I would like to ask the author if the method was tested also on other problems contained in the set and why specifically *cancer1* set was chosen for the experiment conducted within the chapter.

To conclude, I would like to say that the Ph.D. candidate has exercised independent critical thinking with overlap into real-life problems while keeping high academic standard. The thesis by all means represents Ph.D. level research and therefore I would recommend that the candidate is awarded **Ph.D. degree** in accordance with Czech act No. 111/98 Sb. § 47.

In case I could be of any assistance, please, do not hesitate to contact me.

Your Sincerely,

In Bratislava, 11. 11. 2011

....
doc. Ing. Eva Kureková, Ph.D.

prof. Ing. Jiří Dvořák, DrSc.
Brno University of Technology

Evaluation of Doctoral Thesis
Ing. Bc. Pavel Vařacha
Neural Network Synthesis

The topicality of the subject proposed in the thesis

This thesis describes a method called "Artificial Neural Network synthesis" via an Analytic Programming by means of the neural network creation, learning and optimization.

An important part of this process is the application of the method to the specifically chosen tasks of the function approximation, prediction and classification of problems considering real life data as well as standardized benchmarks.

Fulfillment of the goals formulated in the thesis

The neural network synthesis proves to be useful and efficient tools for nonlinear modeling in comparison with competing methods while the optimal strategy of its control parameter settings was explored.

The neural network optimized by the "neural network synthesis" was practically deployed within "The intelligent system controlling an energetic framework of an urban agglomeration", the final technical report of the National Research Program II. These results together with the theoretical background of the method were also accepted for publication by Springer and published by the author within almost twenty international papers.

Selected working method used in the thesis

The methods of processing the thesis meet the criteria of doctoral thesis. It contains description of the problem statement with quotation of the literature used. The biggest part of the thesis is author's input to the problematic described. It contains evolutionary algorithms, symbolic regression, neural networks and parallel computing.

Practical part contains verification of proposed method based on respected benchmarks as well as on real life problems. To verify thesis goals proposed, author applied also evolutionary algorithm named SOMA (Self Organising Migrating Algorithm), which was developed by his supervisor,

The working methods in the thesis documented, that the candidate possesses abilities to work all by himself and in a scientific way.

Remarks

The thesis is well structured and sufficiently covers all important issues. English language used as the thesis publication tongue is on very good level with only minor typing errors.

An algorithm's code published in Appendix V should be commented for better understandability

Questions

1) In table 12, the author proposed an interval <-10; 10> for neural network's weight learning. Explain why exactly this interval was chosen.

2) Is it possible to use "neural network synthesis" optimization method on economical time lines prediction, for example for exchange rates forecasting?

Conclusion

Ing. Bc. Pavel Vařacha as Ph.D. candidate proved in his thesis that Analytic Programming is able to successfully learn and optimize artificial neural networks usable within variety of tasks.

The author developed new scientific knowledge which was introduced into area of artificial neural networks optimization. I confirm that Ing. Bc. Pavel Vařacha is talented and perspective scientific worker.

On base of mentioned facility and comfortable with § 47, section 4 of decree No. 111/98 Sb. and the article No. 52 of the Study and examination rules of Tomas Bata University in Zlín,

I recommended the thesis on defense.

In Brno, November 12. 2011

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