Molding the knowledge in modular neural networks

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Abstract:

Problem description. The learning of monolithic neural networks becomes harder with growing network size. Likewise the knowledge obtained while learning becomes harder to extract. Such disadvantages are caused by a lack of internal structure, that by its presence would reduce the degrees of freedom in evolving to a training target. A suitable internal structure with respect to modular network construction as well as to nodal discrimination is required. Details on the grouping and selection of nodes can sometimes be concluded from the characteristics of the application area; otherwise a comprehensive search within the solution space is necessary.

Generally the local discrimination (or kernel) function typifies the nature of the modeling problem. It expresses a functional hierarchy that is mandatory to support the solving method. Over time, optimal kernels have been suggested for several methods. In contrast, the modular structure is dominated by the application area [1]. It reflects the deep insight and experience that has been gathered over decennia by scientists and operators. Such fundamental and applicative knowledge can sometimes be cast into mathematical expressions, but are at least expressed in base functions, that can be adapted in nature and composition.

Relevance. Production processes are often not understood to a level, where complete mathematical models can be constructed. The desire for fabrication efficiency and societal demands to bring down environmental side-effects limit the time to get the process under control. Here, it is proposed to accelerate industrial knowledge creation by applying modular neural networks. A domain oriented assembly of hierarchical and modular structures will be personalized over measurement data. By making changes in the hierarchy and modularity, the balance between modeling quality and transparency of the internal knowledge can be optimized and existing knowledge can be enhanced to reach a goal directed method to improve the process.

Originality. The methodology builds on extensive research in the area of neural training quality control. It has been found, that robust learning can be achieved by judiciously enhancing the structural and functional redundancy of the network. Modular neural networks achieve robustness while avoiding classical pitfalls as “catastrophic forgetting” and “compromising averages” [2]. The poster is especially focused on the use of neural networks as a means to merge existing knowledge and measured data, while leaving room for efficient extraction of knowledge in a format that is presentable to the operator [3]. It opens the floor for mechanical problem solving using functional programming languages to formally unify both explicit and implicit knowledge domains.

References: