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Program

Session 1. Chair: Susanne Saminger-Platz

9:30 F. Sobieczky:
Adaptive Model Predictive Control for the Domestic Energy Management Problem

10:00 W. Zellinger:
Deep Learning Trends and ICLR2017 - With a Bias Towards Transfer Learning

10:30 A.-C. Zavoianu:
Multi-Objective Topology Optimization of Electrical Machine Designs using Evolutionary Algorithms with Discrete and Real Encodings

Adaptive Model Predictive Control for the Domestic Energy Management Problem

Sobieczky Florian

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Abstract - We present an adaptive variation of a well established method (MPC = Model Predictive Control) for the problem of optimal energy flow management in a domestic environment (i.e. PV, battery, heat pump and solar global radiation are used to feed the demand for energy in a household). For the numerical experiment real world data is used. It is shown how cost reduction can be achieved by selecting the time-frame for the system identification (parameter estimation), adaptively. Both, the system dynamics, as well as the optimization is linear, allowing for applicability in a large-scale context. Statistical aspects about the calibration of the method are discussed with respect to optimal use of the available weather data.

Deep Learning Trends @ ICLR2017 - With a Bias Towards Transfer Learning

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Abstract - An overview of the recent state-of-the-art in the field of Deep Learning is given by means of content analysis of articles accepted at the International Conference of Learning Representations.
In addition, the learning of domain-invariant representations in the context of domain adaptation with neural networks is considered. We propose a new regularization method that minimizes the domain-specific latent feature representations directly in the hidden activation space. Although some standard distribution matching approaches exist that can be interpreted as the matching of weighted sums of moments, e.g. Maximum Mean Discrepancy (MMD), an explicit order-wise matching of higher order moments has not been considered before. We propose to match the higher order central moments of probability distributions by means of order-wise moment differences. Our model does not require computationally expensive distance and kernel matrix computations. We utilize the equivalent representation of probability distributions by moment sequences to define a new distance function, called Central Moment Discrepancy (CMD). We prove that CMD is a metric on the set of probability distributions on a compact interval. We further prove that convergence of probability distributions on compact intervals w.r.t. the new metric implies convergence in distribution of the respective random variables. We test our approach on two different benchmark data sets for object recognition (Office) and sentiment analysis of product reviews (Amazon reviews). CMD achieves a new state-of-the-art performance on most domain adaptation tasks of Office and outperforms networks trained with MMD, Variational Fair Autoencoders and Domain Adversarial Neural Networks on Amazon reviews. In addition, a post-hoc parameter sensitivity analysis shows that the new approach is stable w.r.t. parameter changes in a certain interval. The source code of the experiments is publicly available.

Multi-Objective Topology Optimization of Electrical Machine Designs using Evolutionary Algorithms with Discrete and Real Encodings

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Extended abstract

Classically, designing electrical drives that are (simultaneously) optimal with regard to given criteria – e.g., energy efficiency, costs, fault tolerance, etc. – is a two step procedure. In the first step, a domain expert defines the complete geometric specifications of future designs. This means that the human expert actually creates / chooses a parametric model that will act as a generic template for any subsequent electrical drive that aims to solve the given task. In the second step, a (usually multi-objective) optimization method is employed to find those sets of parameter combinations that, when applied on the chosen generic template, produce (Pareto-)optimal design instances.

Even when carrying out the optimization part via state-of-the-art solvers, like hybrid multi-objective evolutionary algorithms (MOEAs) [6] and particle swarm optimization [1], one can easily argue that the truly creative part of the design process remains with the domain expert. When the wrong parametric model for the task at hand is chosen, no amount of optimization will be able to deliver good results. Thus, by imposing hard constraints in variable space, a choice for a parametric model actually entails restrictions on the shape of possible designs.

Direct *topology optimization* [3] is an alternative approach that, when applicable, seems better suited to fully benefit from the explorative strength of modern MOEAs and recent advances in simulation software and computation power [4]. In this case, the domain expert only needs to define the boundaries of the design region and to choose a discretization factor. This results in a grid in which each cell can be parameterized from a limited set of values. The simplest of such sets contains only two elements: iron and air. The task of the MOEA is to find those grid configurations (i.e., discrete matrices) that encode Pareto-optimal solutions. All in all, since the optimization problem is formulated in a far less restrictive manner, the optimization algorithm also "becomes responsible" for the more advanced / creative part of the design automation process.

In order to gain insight regarding the performance of MOEAs on direct topology optimization problems, we performed several experiments. Firstly, we applied classical MOEAs like NSGA-II [2] and SPEA2 [5] with basic genetic operators suitable for a discrete encoding: binary crossover and bit flip mutation. Interestingly, very good Pareto fronts and convergence behaviors were obtained in a second series of tests when adopting a rather counter-intuitive real encoding of the topology matrices that facilitates the use of more advanced optimization methods that also integrate differential evolution operators and decomposition-based search space exploration strategies.

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