Karlsruhe Institute of Technology

Optimization and Control Group | Institute for Automation and Applied Informatics (IAI)

Reliable Numerical Optimization for Stochastic Optimal Power Flow

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Duration:	3–6 months
Start:	immediate start possible

The so-called optimal power flow (OPF) problem is a cornerstone problem for the operational planning of electric power systems. The solution of this nonlinear program provides an ensemble of generator set points such that the network flow constraints and the power demand are satisfied whilst respecting engineering constraints, e.g. line limits and generator limits. The formulation and reliable solution of OPF problems is becoming increasingly challenging due to the influx of renewables—it is non longer certain how much electricity is being produced where and by whom. Modeling uncertainties via random variables, this leads to the so-called stochastic OPF problem. Its solution provides an ensemble of generator set points such that the network flow constraints and the power demand are satisfied despite uncertain generation/production. The stochastic OPF problem can be formulated as a nonlinear optimization problem with random variables as decision variables. The solution of this problem can be obtained using Polynomial Chaos Expansion—a Hilbert space method for random variables that is mathematically equivalent to Fourier expansion of periodic signals.

The objective of the project is to design and implement fast and reliable algorithms to solve stochastic OPF via polynomial chaos expansion. This may involve automatic re-scaling of the problem or sparse grid techniques, to name a few. The problem may be solved either via intrusive or non-intrusive techniques. Other methods from the field of uncertainty quantification may be equally applicable.

We wish to emphasize that it is not required to have a strong background in electrical engineering. On the contrary, a solid understanding of numerical optimization and/or uncertainty quantification is much more favorable.

Preferable background:	mathematics	
	physics	
	computer science	
Required skills:	numerical/scientific computing	
	Julia, Matlab, and/or Python	
	numerical optimization	
	uncertainty quantification	
Estimated work load:	study of literature	20 %
	theory	30 %
	implementation	50 %

References

T. Mühlpfordt, T. Faulwasser, L. Roald and V. Hagenmeyer, "Solving optimal power flow with non-Gaussian uncertainties via polynomial chaos expansion," 2017 IEEE 56th Annual Conference on Decision and Control (CDC), Melbourne, Australia, 2017, pp. 4490-4496. doi: 10.1109/CDC.2017.8264321

T. Mühlpfordt, R. Findeisen, V. Hagenmeyer and T. Faulwasser, "Comments on Truncation Errors for Polynomial Chaos Expansions," in IEEE Control Systems Letters, vol. 2, no. 1, pp. 169-174, Jan. 2018. doi: 10.1109/LCSYS.2017.2778138