Uncertainty in Wind Power production

Reliable wind power generation forecasting is crucial to:

- Meet energy demand through renewable power sources.
- Energy trading of future excess power.
- Design of Investment strategies.

We would like to:

- Simulate forecast error and quantify its uncertainty.
- Calibrate a forecast model for optimal dispatch of electric power.

Our model is based on:

- Parametric Stochastic Differential Equations.
- Continuous optimization of approximate Maximum Likelihood.

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Prediction error of Wind Power production can be modeled by a parametric SDE,

$$dV_t = -\theta_t V_t \; dt + \sqrt{2\theta_t \alpha (V_t + p_t)(1 - V_t - p_t)}\, dW_t$$
$$V_0 = v_0$$

where V_t is an error stochastic process, p_t is a given wind power forecast and (α, θ) are parameters to the model

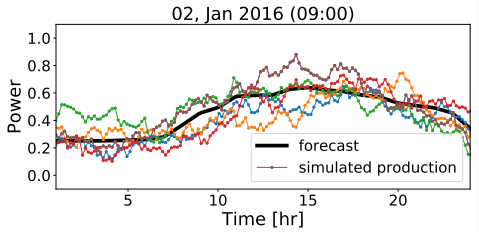

Figure 1: Example of Wind power production simulation and confidence intervals.

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Parameters of the model are inferred using optimization techniques of approximate transition likelihood functions.

$$\mathcal{L}(\boldsymbol{\theta}; V) = \prod_{j=1}^{M} \prod_{i=1}^{N} \rho(V_{j,i+1} | V_{j,i}, \boldsymbol{\theta}) \rho(V_{j,0})$$

Where $V^{M,N} = \{V_{t_1^{M,N}}, V_{t_2^{M,N}}, \ldots, V_{t_N^{M,N}}\}$ is a set of M paths with N observations observed in intervals of time Δ_N.

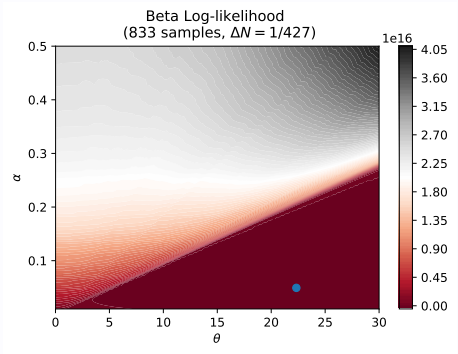

Figure 2: Likelihood of sample paths. Point of optimality shown in blue.