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Phase estimation for oscillatory processes

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We introduce a new class of stationary time series models. The aim is to model time series with a specific oscillatory pattern but an unobserved phase process in the background. The goals are to estimate the unknown phase process and the oscillatory pattern. An example is the curve of an electrocardiogram recording.

The model can be written as a general state-space model treating the phase, amplitude, and baseline as latent Markov processes. For the estimation we suggest a Rao-Blackwellized particle smoother that combines the Kalman smoother and an efficient sequential Monte Carlo smoother. Sequential Monte Carlo smoothers can be applied to nonlinear, non-Gaussian state space models and are based on the idea to approximate the smoothing distribution of the latent states by weighted samples.

For the estimation of the oscillatory pattern we develop a nonparametric estimation procedure.

We also discuss how different oscillatory processes synchronize.