User's guide for the R codes implementing "Filtered Likelihood for Point Processes" by Kay Giesecke and Gustavo Schwenkler

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Abstract

1 References

The codes in this zip file implement in R the algorithms of the paper "Filtered Likelihood for Point Processes" by Kay Giesecke and Gustavo Schwenkler. These algorithms are used to compute the filters of the paper. The algorithms also compute parameter estimators based on the log-likelihood approximation of the paper as well as the corresponding standard errors.

2 How to use the code

2.1 What is inside the zip file

The zip file contains the following R files:

Name	Usage
algorithms.R	Implementation of all algorithms of the paper.
input_probabilities.R	Input of the probability laws of the partially observed factor Y and the frailty Z. This is to be specified by the user.
output_filtered_error.R	Example file which computes log-likelihood approximations as well their errors as in Section 6.2 of the paper.
output_filtered_factors.R	Example file which outputs approximations of the filtered paths of the intensity and the factor Y.
output_parameter_estimation.R	Example file which computes parameter estimates as in Section 6.3 of the paper.
output_standard_errors.R	Example file which outputs standard errors computed in accordance with Appendix B of the paper.
simulated_events_1.txt simulated_events_2.txt	Samples of the event data $(\mathsf{N}_\tau, \mathsf{U}_\tau)$ for $\tau = 40$ as used in Section 6 of the paper.
simulated_factors_1.txt simulated_factors_2.txt	Samples of the factor data Y_τ for $\tau = 40$ as used in Section 6 of the paper.

2.2 An example

The file "output_parameter_estimation.R" provides an example of how to compute parameter estimators by maximizing the approximate log-likelihood

$$L_\tau(\theta) = \log \mathcal{L}_E^*(\theta;\tau) + \log \mathcal{L}_F^*(\theta;\tau)$$

using Algorithm 5.2 of the paper.

The original file implements the computation of the approximate log-likelihood for the example in Section 6 of the paper. If you wish to compute the approximate log-likelihood for an alternative model, you will first need to update the file "input_probabilities.R" and enter the transition density of the frailty Z as well as the conditional transition density of the partially observed factor Y given the data Y_τ under the measure $\mathbb{P}_\theta^*$. In the example of Section 6, these densities are log-normal.

In the file "output_parameter_estimation.R", you can change the model parameter θ in lines 6-16 and the time horizon τ in line 22.

Lines 25-26 call all algorithms and probability implementations necessary to compute the log-likelihood. Lines 29-36 contain all time parameters used to scale time in "algorithms.R:" "day_freq" indicates the amount of time that corresponds to one day in calendar time, "freq_zeta" gives the number of days per month, "dpy" indicates the number of days per year, "dpw" the number of days per week, "hpd" gives the number of hours per day, "mpd" the number of minutes per day, "tau2" expresses the time horizon τ in days, and "precision" gives the smallest measured calendar time.

Lines 39-40 load the data at which to evaluate the likelihood. Line 43 extracts the observation times of the partially observed factor Y, and line 44 extracts the observations of the factor Y. Lines 47 and 48 construct the factor data $(\mathsf{N}_\tau, \mathsf{U}_\tau)$ given the sample data.

Lines 53-97 construct the state space and time discretizations as in Section 6.1 of the paper. Line 53 fixed the value of n. The number of time steps m_T^n for the time discretization is fixed as freq_zeta $\times \sqrt{n}$ in line 56. Lines 57-85 complement the time discretization with the dates at which the factor Y is observed. Lines 88-93 fix the state space discretization. Lines 88-92 construct the quantiles q_Y^n, q_Z^n, Q_Y^n, and Q_Z^n of Section 6.1 of the paper. Line 93 fixes m_S^n as in Section 6.1 of the paper. The grid for the factor Y is constructed in line 96, the grid for the frailty Z is fixed in line 97.

Lines 100-107 define vectors and matrices that are used by the algorithms in the file "algorithms.R" in order to vectorize all operations. This significantly increases the speed of the computations.

Finally, line 114 calls the optimization of the approximate log-likelihood to compute parameter estimates. The parameter at which the optimization routine is initialized is fixed in line 111. Line 117 calls for a print out of the results of the optimization routine, which includes the parameter estimates, the maximum approximate log-likelihood, as well as the time it takes to run the optimization.