StochasticSTF

Shiro Hirano

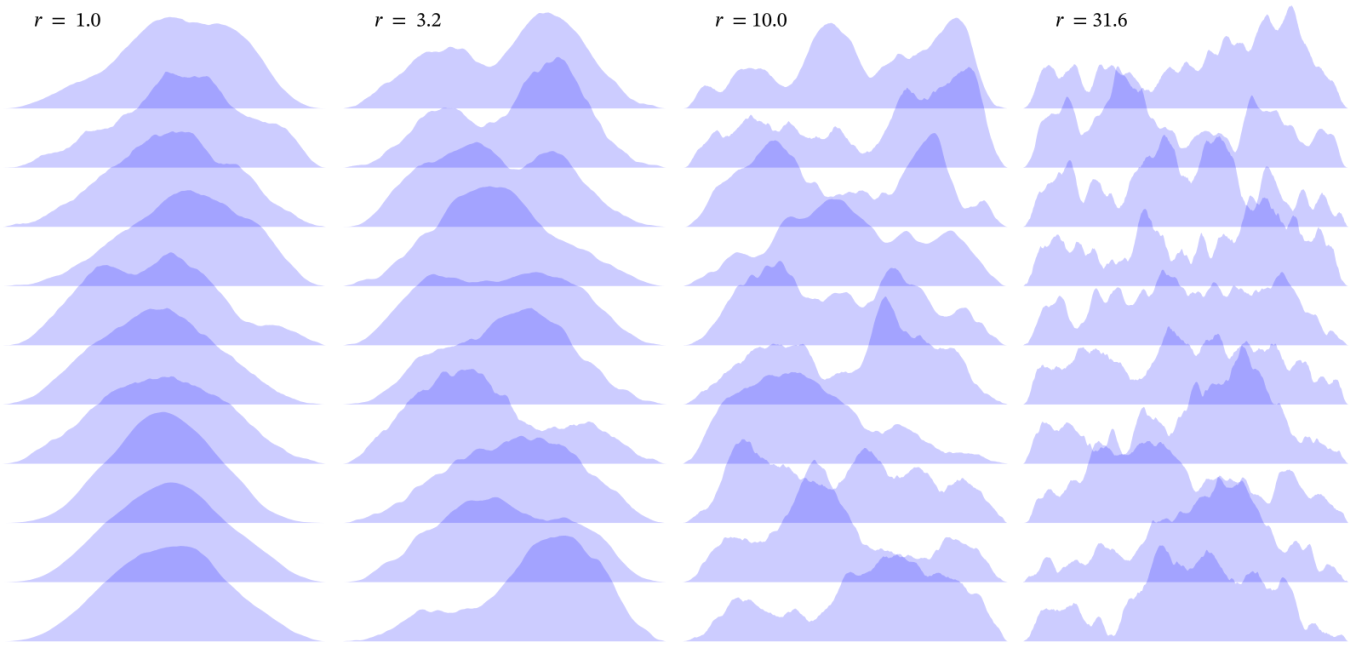
Summary

In fortran90+, julia, and matlab code,

```
x = StochasticSTF(n, 1.0)
```

returns a stochastic Source Time Function (STF) of length `n` that satisfies the following properties:

- The STF starts from and terminates at zero (i.e., `x(1) = x(n) = 0`).
- The STF amplitude is non-negative.
- The Fourier amplitude spectrum follows ω^{-2}-model.
- The moment function $M_0(t) = \displaystyle\int_0^t \textrm{StochasticSTF}(s) \ ds$ is propotional to t^3.



Running

```
x = StochasticSTF(n, r)
```

with a floating-point number `r` (> 1.0) results in more complicated STFs as in the above figure.

Arguments and behavior

The function `StochasticSTF(n,r)` or `StochasticSTF(n,r,d)` returns a stochastic Source Time Function (STF) of length `n`. The floating-point number `r` (≥ 1.0) is the ratio of two corner frequencies and determines roughness of the STF, where `r=1.0` results in STF with the ω^{-2}-type spectrum, and STFs get rougher as `r` increases. Integer `d` (≥ 2), dimension of the Bessel bridge, is optional; the default value is `d=2`, and STFs get smoother as `d` increases. The result is normalized so that `sum(STF) = 1.0` holds. The algorithm has been modified after Hirano(2022; 2023). This code generates STFs with arbitrary lengths by using Bessel bridges, while the original model has probabilistic lengths following the Gutenberg-Richter law.

References

- Hirano, S. (2022), "Source time functions of earthquakes based on a stochastic differential equation", Scientific Reports, 12:3936, https://doi.org/10.1038/s41598-022-07873-2
- Hirano, S. (2023), "Stochastic source time functions with double corner frequencies", AGU23 Fall Meeting, S13F-0407, https://agu.confex.com/agu/fm23/meetingapp.cgi/Paper/1299761

Fortran90+: Usage and Compilation

Simply after compiling `m_stochasticSTF.f90`, the function `StochasticSTF(n,r)` will be callable.

For example,

```
gfortran m_stochasticSTF.f90 main.f90
./a.out
```

results in an ascii file `STF.txt`, and the column therein is the amplitude of a stochastic source time function. See lines 2-7 in `main.f90` for usage.

To specity precision, see the comments in `m_stochasticSTF.f90`.

Julia and Matlab: Usage

Running `main.jl` or `main.m` calculates and plots a stochastic STF.

LinearAlgebra, DSP, and Plots are required for julia.