

Revarie

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What is Revarie?

Revarie is a spatial statistical analysis toolset which is targeted for computational physics applications. Its primary focus is on variography of random fields described by Cartesian coordinate systems. Currently, it supports computation and fitting of isotropic variograms. Another major aspect of the library is random field generation given a variogram.

What is a Variogram?

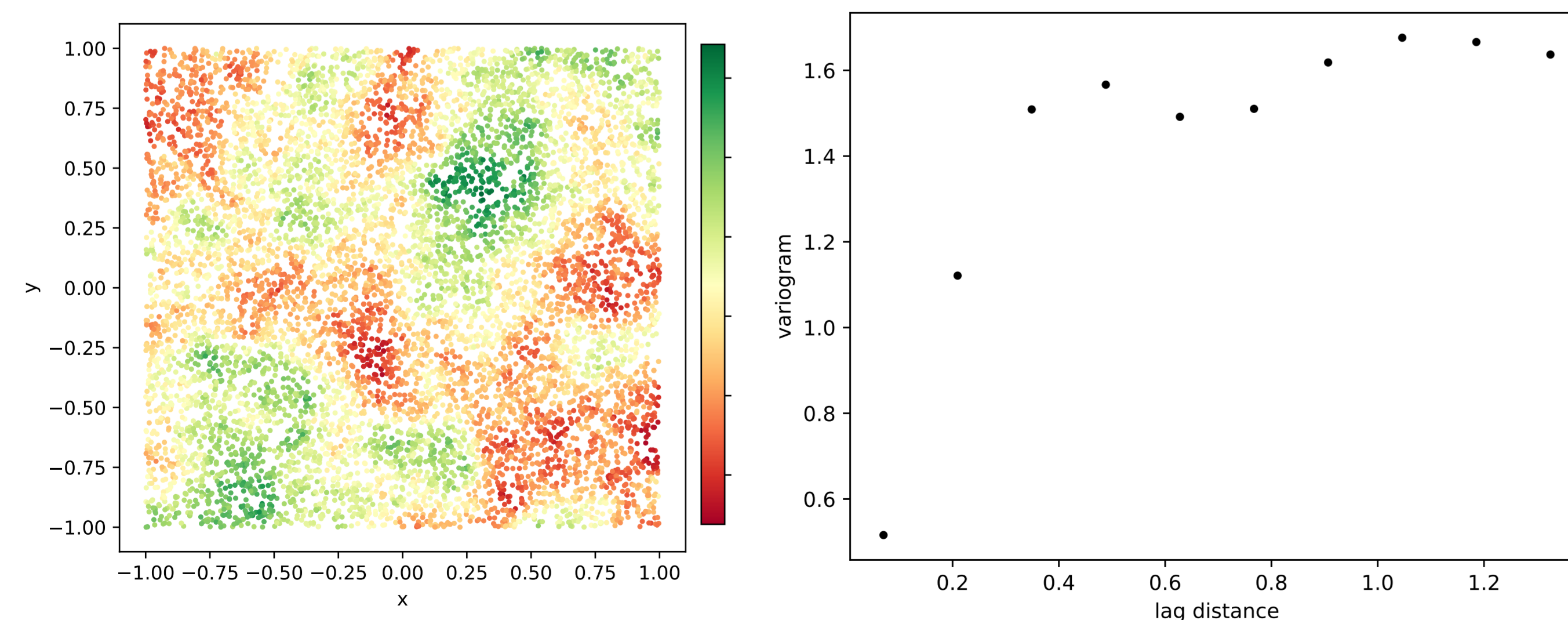
Put simply, a variogram (sometimes referred to as a semi-variogram) is a plot of spatial dissimilarity as a function of scale. Mathematically, an isotropic variogram is described as [1]:

$$\gamma(h) = \frac{1}{2|H(h)|} \sum_{(i,j) \in H(h)} (f_i - f_j)^2$$

where $H(h) \equiv \{(i, j) : D(i, j) - h < \Delta\}$

- $\gamma(h)$: variogram
- h : lag distance, dependent variable
- (i, j) : any two points in field
- f_i, f_j : field values at points i and j
- $D(i, j)$: distance between point i and j
- Δ : "bin width" for variogram calculation

In practice, only a few linearly-spaced values of h are actually chosen. Typically, Δ will be chosen to be equal to half the separation between h values. Below is an example of a random field with its associated variogram:



Variograms of physical fields typically start small—suggesting small variation in field values for points close together—and grow to meet the spatially-independent variance of the field, or the sill.

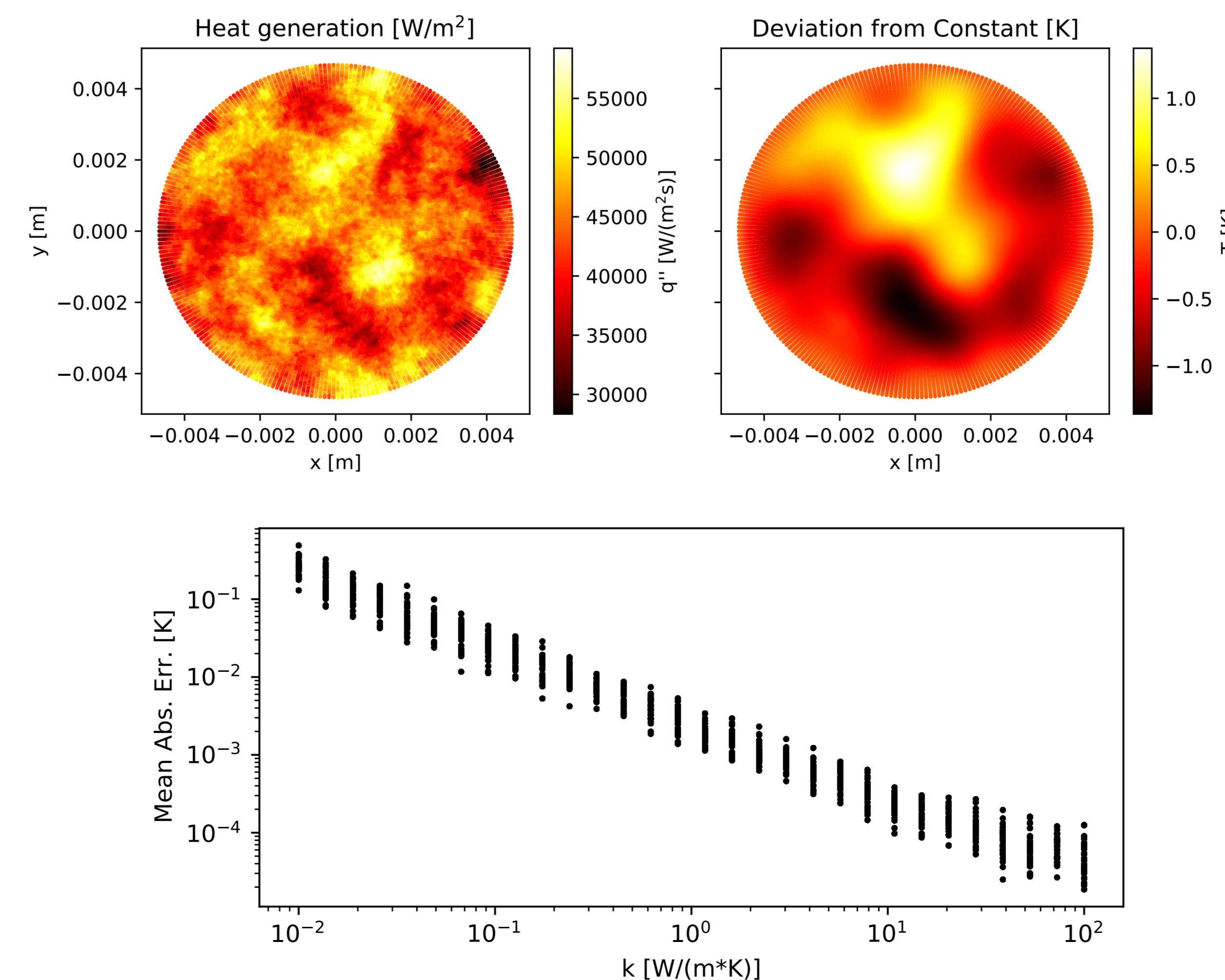
Core Functionality

Revarie can be broken up into 3 main capabilities:

- Variogram Calculation:**
Revarie can efficiently compute anisotropic variograms for input fields. An example field and calculated variogram are shown in "What is a Variogram?" Section.
- Variogram Fitting:**
Revarie has a suite of tools for interfacing with pre-built fitting routines in the numpy and scipy libraries. These tools are conveniently built into a function that is intentionally built to interface with field generation routines in Revarie.
- Field Generation:**
Revarie also has a tool for generating random fields given functional forms of variograms. This tool can be useful for

Example Application in Nuclear Engineering

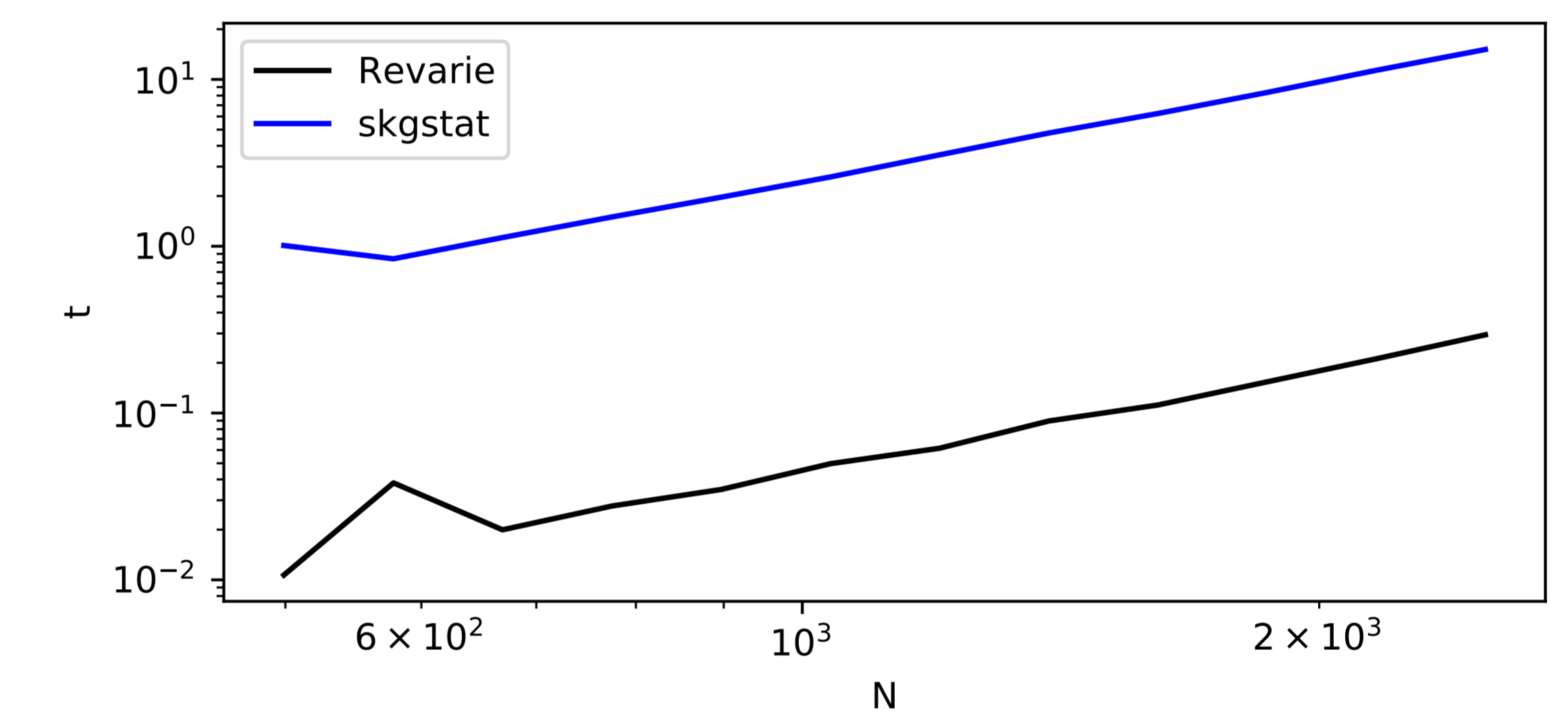
Consider an infinite cylinder with a volumetric heat source: **How do heterogeneities in the heat generation distribution affect the temperature distribution?** Below, we show an example random heat generation distribution (generated with Revarie) and the corresponding difference in temperature if the heat generation distribution was uniform.



Built for Scalability

Revarie was built for large-scale problems. Therefore, careful use of existing libraries for linear algebra such as numpy and scipy ensure efficient, scalable calculations. This also makes Revarie fit nicely into existing workflows using these libraries.

Scikit-gstat is a popular Python library for variogram calculation and spatial statistics analysis. Below is a variogram calculation time comparison for fields of differing sizes.



There are even built-in benchmarking routines to help the user evaluate the feasibility of larger calculations.

More Information

Check us out on [github](#) and download the [user manual!](#)

or install via command line:

```
pip install revarie
```

If you want to get involved, contact me at [deanrp@umich.edu!](mailto:deanrp@umich.edu)

Acknowledgements

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References

- [1] R. Kerry and M.A. Oliver. Determining the effect of asymmetric data on the variogram. ii. outliers. *Computers Geosciences*, 33(10):1233 -- 1260, 2007. Spatial Analysis.