This form documents the artifacts associated with the article (i.e., the data and code supporting the computational findings) and describes how to reproduce the findings.

Part 1: Data

☐ This paper does not involve analysis of external data (i.e., no data are used or the only data are generated by the authors via simulation in their code).

☒ I certify that the author(s) of the manuscript have legitimate access to and permission to use the data used in this manuscript.

Abstract

There are three publicly available data sets associated with this paper. The data feature geo-statistical coordinate systems in the form latitude and longitude.

(a) Boston Housing Data: Consists of median house values along with other demographic variables at the county level for Boston, Massachusetts. We model the median household value using a Bayesian hierarchical spatial model.

(b) Meuse River Data: Comprised of data on various heavy metal concentrations and soil properties. The shape file outlining the Meuse river is also part of the data object.

(c) Temperatures in the Northeastern US: Consists monthly temperature data (in Celsius) recorded across the Northeastern US starting in January 2000. Station UTM coordinates and elevation are also included. We use only the temperature and UTM coordinates when modeling.

Availability

☒ Data **are** publicly available.
☐ Data **cannot be made** publicly available.

If the data are publicly available, see the *Publicly available data* section. Otherwise, see the *Non-publicly available data* section, below.

Publicly available data

☒ Data are available online at: Within open-source `R`-packages. Boston Housing Data and Meuse River Data are available within `spData`. Temperatures in the Northeastern US is available in `spBayes`

☒ Data are available as part of the paper's supplementary material: Copies of the data are provided with the open-source implementation in GitHub https://github.com/arh926/spWombling/data

☐ Data are publicly available by request, following the process described here:

☐ Data are or will be made available through some other mechanism, described here:

Non-publicly available data

Description

The data sets used are part of avidly used packages in the `R` statistical environment as mentioned in the data sources above. To make the package more self contained we have included the data objects within the Git implementation.

File format(s)

All data included in the implementation are in .Rda format.

☐ CSV or other plain text.
☒ Software-specific binary format (.Rda, Python pickle, etc.): pkcle
☐ Standardized binary format (e.g., netCDF, HDF5, etc.):
☐ Other (please specify):

Data dictionary

☐ Provided by authors in the following file(s):
☐ Data file(s) is(are) self-describing (e.g., netCDF files)
☒ Available at the following URL:

Boston Housing Data: https://www.cs.toronto.edu/~delve/data/boston/bostonDetail.html Meuse River Data: https://www.rdocumentation.org/packages/sp/versions/1.5-0/topics/meuse Temperatures in northeastern US: https://rdrr.io/cran/spBayes/man/NETemp.dat.html

Additional Information (optional)

Part 2: Code

Abstract

The codes/scripts included are in the form of (a) reference to a package containing necessary tools for performing wombling over a spatial domain of reference (b) reproducible code to produce tables and figures included in the manuscript. There are three main components in the package provided (i) a hierarchical spatial model (one could also use well-known routines available in `spBayes`) with choices for specification of different covariance structures that govern spatial variation (ii) sub-routine that estimates gradient based on posterior estimates (iii) sub routine that performs wombling given specified curves within the spatial domain of reference.

Description

Code format(s)

☒ Script files
  ☒ R
  ☐ Python
  ☐ Matlab
  ☐ Other:
☒ Package
  ☒ R
  ☐ Python
  ☐ MATLAB toolbox
  ☐ Other:
☒ Reproducible report
  ☒ R Markdown
  ☐ Jupyter notebook
  ☐ Other:
☐ Shell script
☐ Other (please specify): The R package provided is only available through GitHub.

Supporting software requirements

Requires `R` version (>= 4.0)

Version of primary software used Originally compiled on `R` version (4.1.1)

Libraries and dependencies used by the code `stats`, `MASS`, `coda`, `Matrix`, `parallel`, `MBA`, `raster`, `maps`.

Supporting system/hardware requirements (optional)

Standard personal computer.

Parallelization used

- ☐ No parallel code used
- ☒ Multi-core parallelization on a single machine/node
  - Number of cores used: 4
- ☐ Multi-machine/multi-node parallelization
  - Number of nodes and cores used:

License

- ☒ MIT License (default)
- ☐ BSD
- ☐ GPL v3.0
- ☐ Creative Commons
- ☐ Other: (please specify)

Additional information (optional)

Part 3: Reproducibility workflow

Scope

The provided workflow reproduces:

- ☒ Any numbers provided in text in the paper
- ☒ The computational method(s) presented in the paper (i.e., code is provided that implements the method(s))
- [] All tables and figures in the paper
- ☒ Selected tables and figures in the paper, as explained and justified below:

Partial scripts are provided for some of the applications (Boston Housing and Temperatures), until selection of curves. The remaining analysis is straightforward repetitive use of script.

Workflow

Location

The workflow is available:

- ☐ As part of the paper's supplementary material.
- ☒ In this Git repository: https://github.com/arh926/spWombling/data
- ☐ Other (please specify):

Format(s)

- ☒ Single master code file
- ☐ Wrapper (shell) script(s)
- ☐ Self-contained R Markdown file, Jupyter notebook, or other literate programming approach
- ☐ Text file (e.g., a readme-style file) that documents workflow
- ☐ Makefile
- ☒ Other (more detail in *Instructions* below)

Instructions

The R-package is provided in the GitHub repository consisting of all sub-routines required for successfully performing wombling. The master file containg the subroutines is provided as a part of the supplement. Reproducibility materials comprised of required scripts to reproduce tables and figures in the manuscript are provided in a separate repository: https://github.com/arh926/Bayesian-Modeling-with-Spatial-Curvature-Processes/ fashioned after the template provided in https://github.com/jasa-acs/repro-template.

Expected run-time

Approximate time needed to reproduce the analyses on a standard desktop machine:

- ☐ < 1 minute
- ☐ 1-10 minutes
- ☐ 10-60 minutes
- ☒ 1-8 hours
- ☐ > 8 hours
- ☐ Not feasible to run on a desktop machine, as described here:

Additional information (optional)

The R package can be installed simply by running the following chunk:

```
if(!require(devtools)) install.packages("devtools")
```

```
## Loading required package: devtools
```

```
## Loading required package: usethis
```

```
devtools::install_github('arh926/spWombling', force = TRUE)
```

```
## Downloading GitHub repo arh926/spWombling@HEAD
```

```
##
## -- R CMD build -------------------------------------------------------------
##      checking for file ‘/private/var/folders/dd/yrhhqlyj0j588v9wnd6lfhrr0000gn/T/Rtmpc2XUd5/remotes1
##   -  preparing ‘spWombling’:
##        checking DESCRIPTION meta-information ...  v  checking DESCRIPTION meta-information
##   -  checking for LF line-endings in source and make files and shell scripts
##   -  checking for empty or unneeded directories
##   -  building ‘spWombling_0.0.0.9000.tar.gz’
##
##
```

```
require(spWombling)
```

```
## Loading required package: spWombling
```

The package consists of a vignette for Boston Housing data and some use-cases pertaining to simulated data in its README.md file.

Notes (optional)