Complementary materials and R code for the study “Spatio-temporal modeling of chikungunya in Brazil: The Interplay of Climate, Mobility, and Socioeconomic Factors.” Includes SPDE-based INLA modeling, visualization scripts, and mapping outputs.

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This repository contains the complementary materials associated with the article:

"Spatio-temporal Modeling of chikungunya in Brazil: Interplay of Climate, Mobility, and Socioeconomic Factors"
Authors: Raquel Gardini Sanches Palasio, Patricia Marques Moralejo Bermudi, Gerson Laurindo Barbosa, Pedro Silva Peixoto, Sergio Muniz Oliva, Camila Lorenz, Marta Blangiardo, Monica Pirani, and Francisco Chiaravalloti-Neto.

Includes SPDE-based INLA modeling, visualization scripts, and mapping outputs.

Repository Structure

1. Folders

- `data/`
  Contains the datasets and auxiliary files used in the study:
  - `*.RData` : model outputs.

- `borda_102033.*` : Shapefile defining Brazilian administrative borders for spatial modeling.

2. Scripts

- **`Chik_SPDE_nbi_model.R`**
  Implements the full spatio-temporal model using R. The model employs the **Stochastic Partial Differential Equations (SPDE)** approach with a **Negative Binomial likelihood** to capture the spatial and temporal dynamics of chikungunya incidence in Brazil, within the Diffusion-based Extension of the Matérn Field (DEMF) (1,2,1) family, as proposed by Lindgren et al. 2024.

  Key features of the script:

  i. Load and preprocess chikungunya incidence data and covariates (climate, mobility, socioeconomic, and environmental factors).
  ii. Load and transform shapefiles for municipalities and regions of Brazil.
  iii. Construct a spatial mesh using the SPDE approach.
  iv. Specify a spatio-temporal model with:
  v. Fit the model using the **INLA** framework and `inlabru` interface.
  vi. Extract posterior summaries (fixed effects, hyperparameters, random effects, fitted values).
  vii. Generate figures:
    - Plots of incidence rate ratios (IRR) with 95% credible intervals
    - Non-linear climate effect plots
    - Maps of predicted chikungunya incidence, including posterior mean and 95% CI

Data Availability

The datasets and variable dictionary are publicly available at:
[**Figshare (link to be inserted)**]

The dataset includes:

- Chikungunya incidence per municipality and time point (seasonal aggregation)
- Covariates: climate (temperature, precipitation), mobility, socioeconomic indicators (Katz index, piped water, sewerage), environmental (forest cover, altitude, biome), ENSO classification
- Spatial units: municipalities (`COD_MUN6`) and Brazilian regions
- Temporal coverage: 2015–2024 (seasonal)

Requirements

This project was developed in **R (version 4.3.3 — "Angel Food Cake")** with the following key packages:

```
library(INLA)          # Bayesian inference via Integrated Nested Laplace Approximation
library(INLAspacetime) # Spatio-temporal extensions for INLA
library(inlabru)       # Bayesian spatial modeling using INLA
library(INLAOutputs)   # Utilities for INLA posterior summaries
library(geobr)         # Brazilian shapefiles (municipality and region)
library(ggspatial)     # Scale bars and north symbols in ggplot2
library(ggsn)          # North symbols and scale bars
```

```
library(fmesher)       # Mesh construction for SPDE

Package versions used:

INLA: 24.3.29
INLAspacetime: 0.1.8
inlabru: 2.10.1
fmesher: 0.1.7
```

Citation

If you use or adapt this code, please cite the original article: Palasio, R.G.S., Bermudi, P.M.M., Barbosa, G.L., Peixoto, P.S., Oliva, S.M., Lorenz, C., Blangiardo, M., Pirani, M., & Chiaravalloti-Neto, F. Spatio-temporal Modeling of chikungunya in Brazil: Interplay of Climate, Mobility, and Socioeconomic Factors. [Journal name, Year, DOI – to be added upon publication]

Contact: Raquel Gardini Sanches Palasio Thank you for your interest in this project!

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Languages

- **R** 100.0%