



VISUALIZAÇÃO DE MAPAS E INFORMAÇÕES C31 ESPACIAIS EM SAÚDE UTILIZANDO R PARA VIGILÂNCIA EPIDEMIOLÓGICA

Estatística espacial e Programa R: fundamentos

Elisangela Ap. da Silva Lizzi

Edson Zangiacomi Martinez



24 A 27/11/24 • RIO DE JANEIRO

12ºEPI

A Epidemiologia e
a complexidade dos
desafios sanitários

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- Editora associada da Revista do SUS
- Professora/ pesquisadora no PPGBioInfo



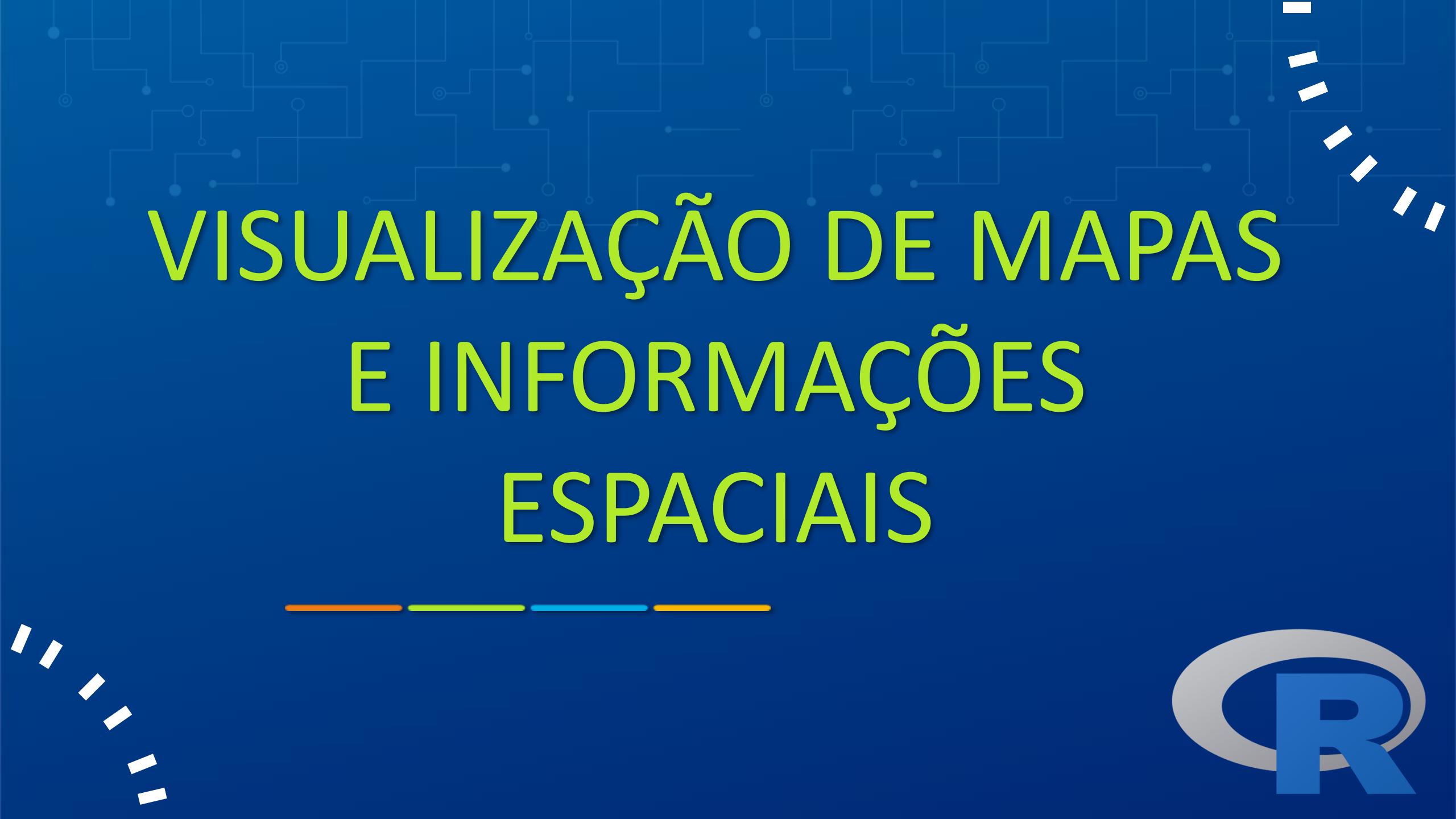


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VISUALIZAÇÃO DE MAPAS E INFORMAÇÕES ESPACIAIS





ArcGIS



MapInfo

eSoftner

Terraview

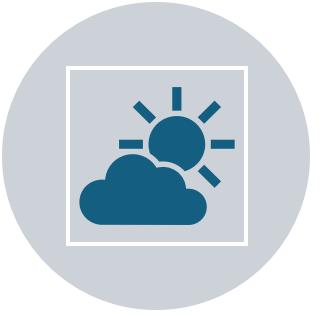
QGIS



**CONSTRUÇÃO DE
MAPAS**



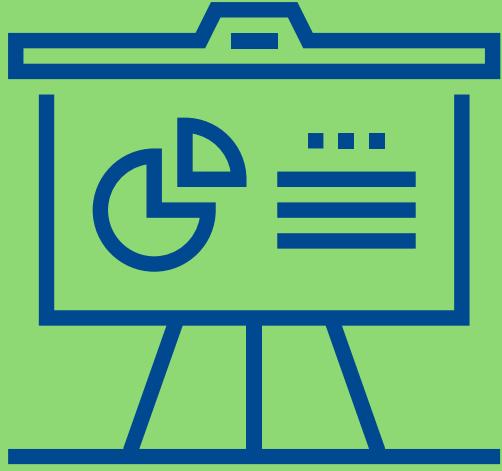
**UM MAPA BEM
CONSTRUÍDO
DISPENSA,
QUALQUER TIPO DE
EXPLICAÇÃO OU
LEGENDA
ELABORADAS.**



**POUPA TEMPO NO
ENTENDIMENTO DA
INFORMAÇÃO**



**MAPA DIFÍCIL DE
ENTENDER É UMA
FERRAMENTA
INÚTIL.**



QUAL A IMPORTÂNCIA DOS MAPAS?

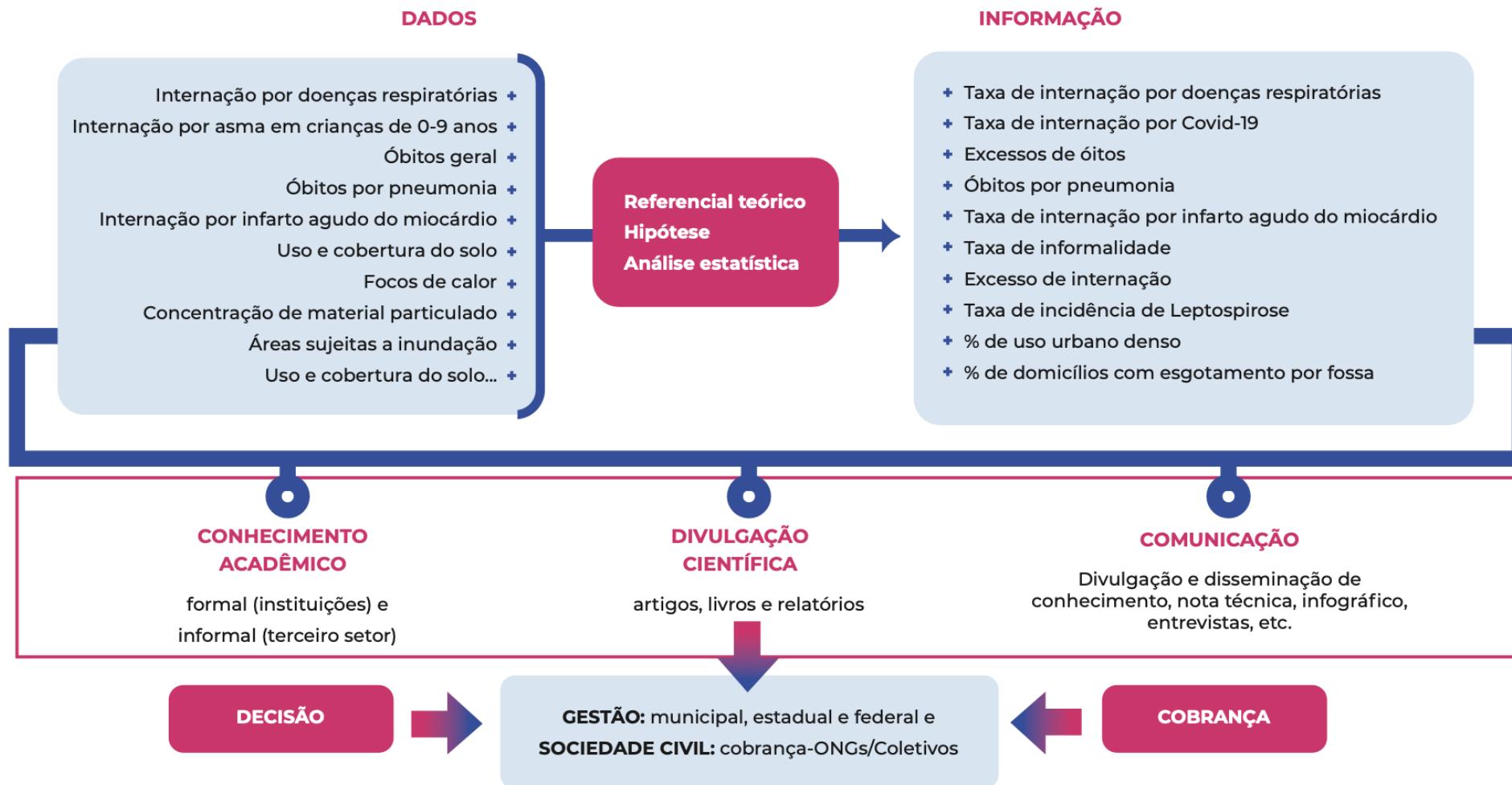
Os mapas devem ser relevantes para o conteúdo. Gráficos e/ou mapas [informações visuais] irrelevantes, mesmo que sejam interessantes, podem distrair o interesse e dificultar a compreensão da mensagem.



QUAL A IMPORTÂNCIA DA VISUALIZAÇÃO?

Usar mapas para a visualização de um tema de forma estratégica para comunicar uma informação ao público/ comunidade em geral.

Análise da Situação de Saúde (ASIS): Diagnóstico



RESUMIR A INFORMAÇÃO COM USO DE MAPAS NA VIGILÂNCIA EM SAÚDE?



Dicionário

Definições de [Oxford Languages](#) · [Saiba mais](#)



epidemiologia

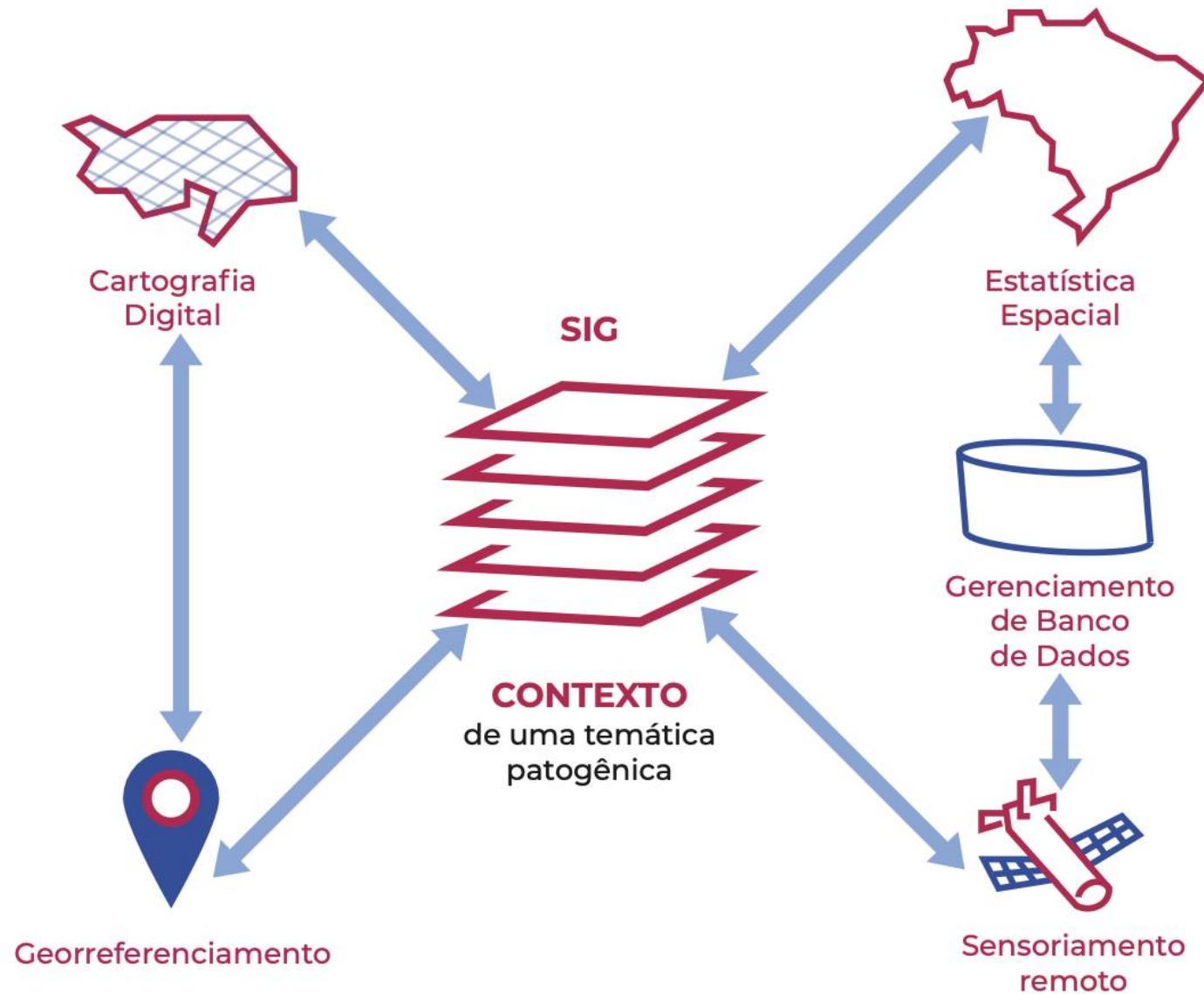
substantivo feminino

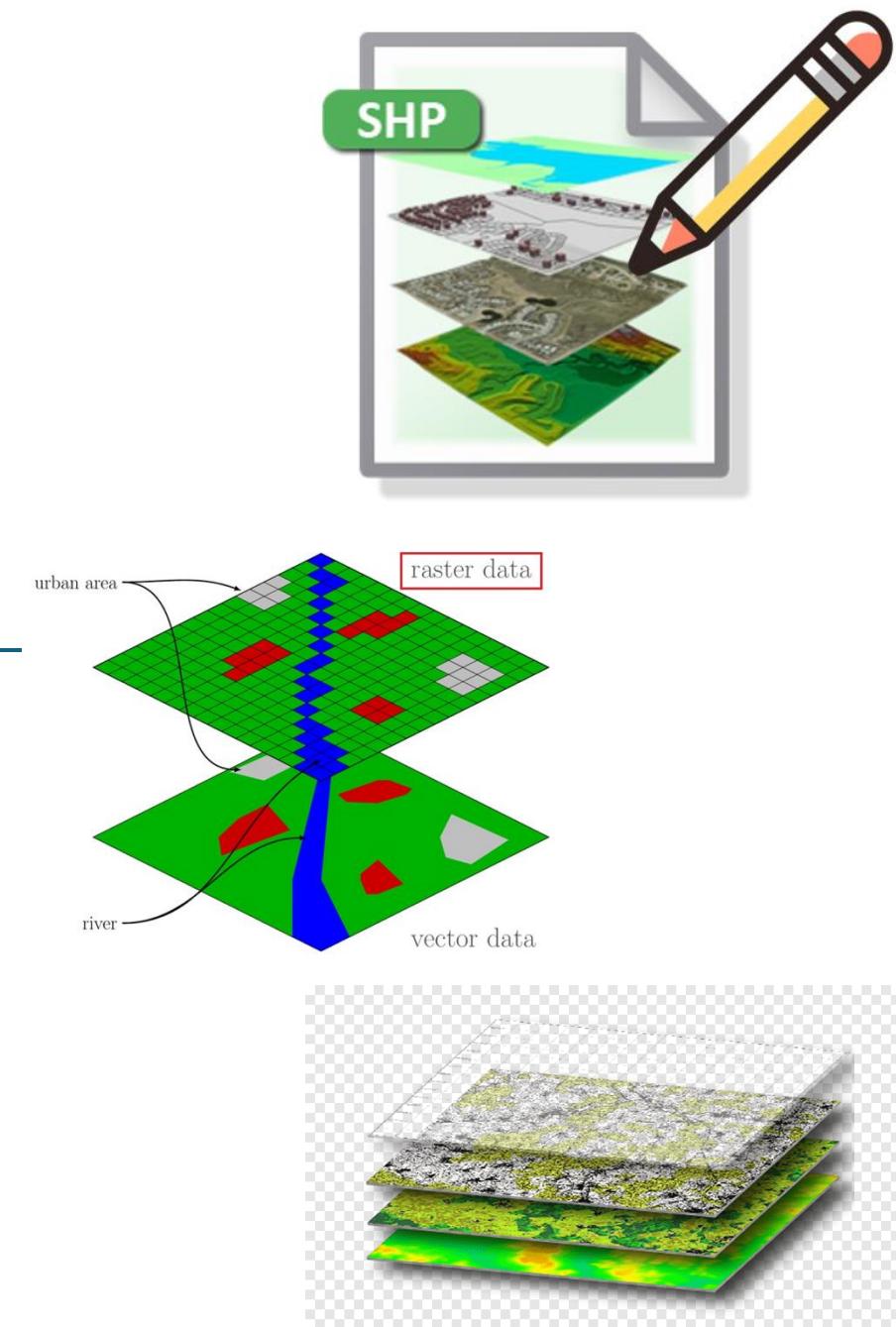
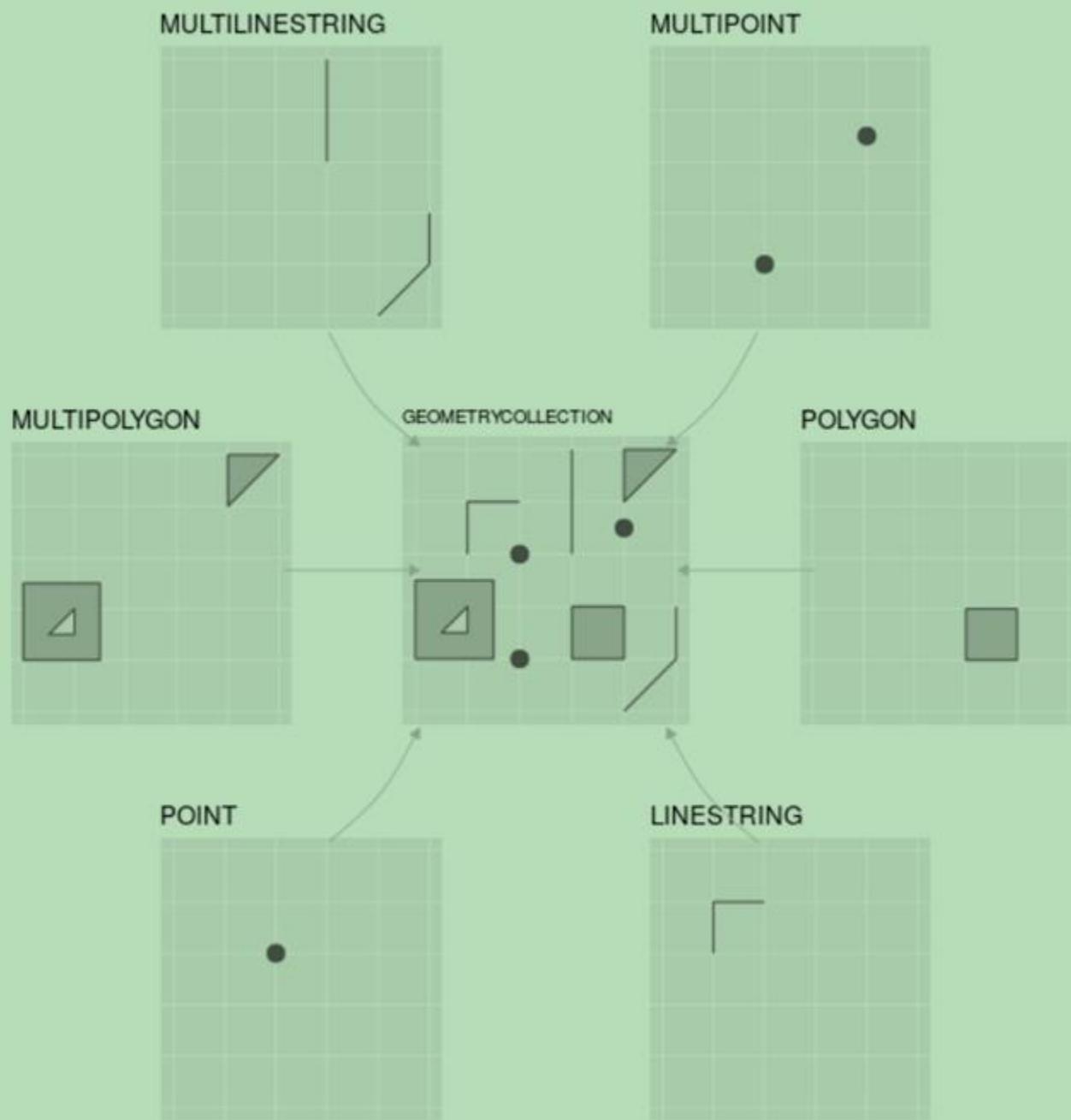
MEDICINA

ramo da medicina que estuda os diferentes fatores que intervêm na difusão e propagação de doenças, sua frequência, seu modo de distribuição, sua evolução e a colocação dos meios necessários a sua prevenção.

A epidemiologia estuda quantitativamente a distribuição dos fenômenos de saúde e doença e seus fatores condicionantes e determinantes, nas populações humanas e ambiente.

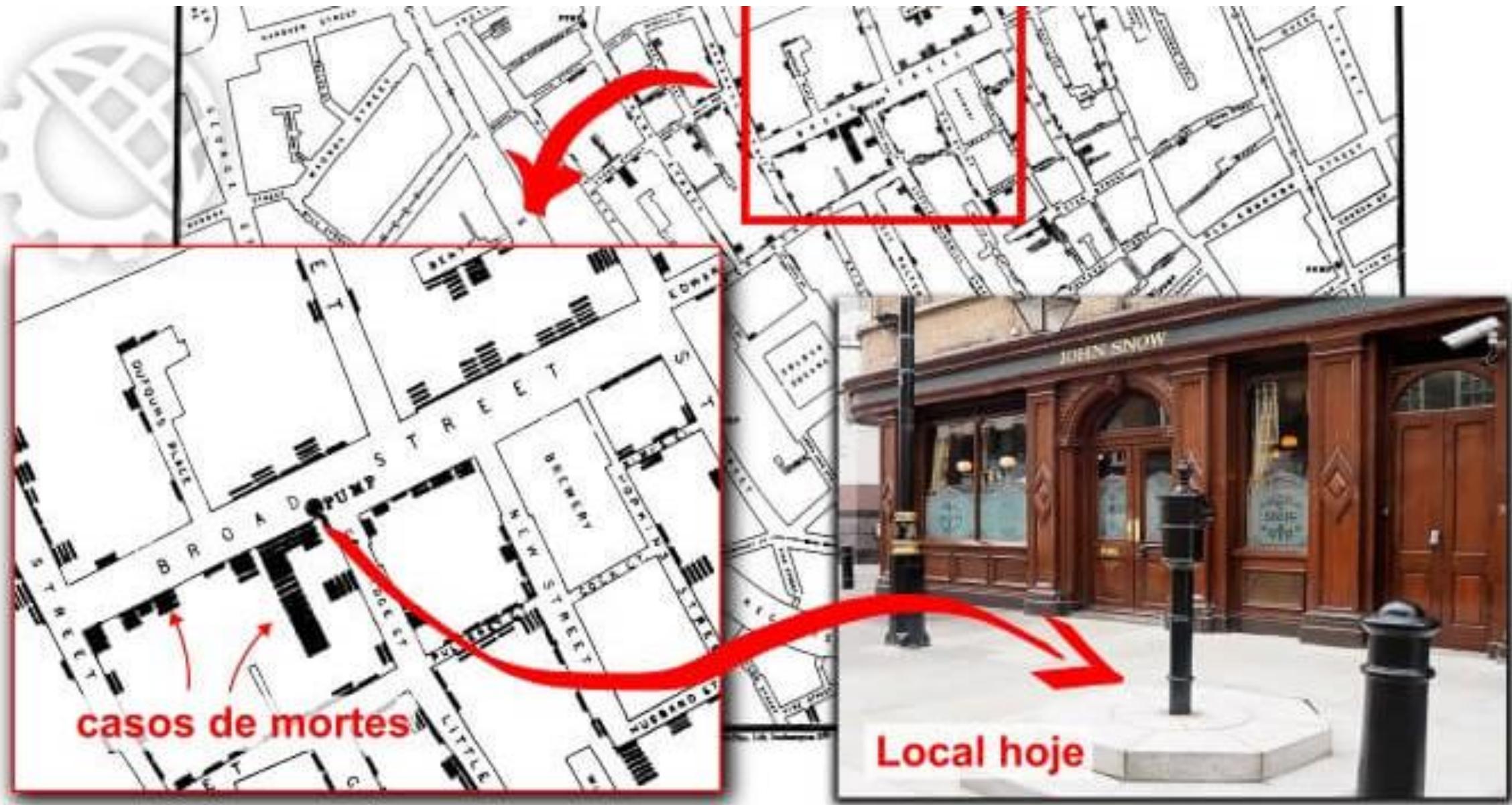
Vigilância deve ser integrada no espaço, destacando notadamente a vigilância epidemiológica.





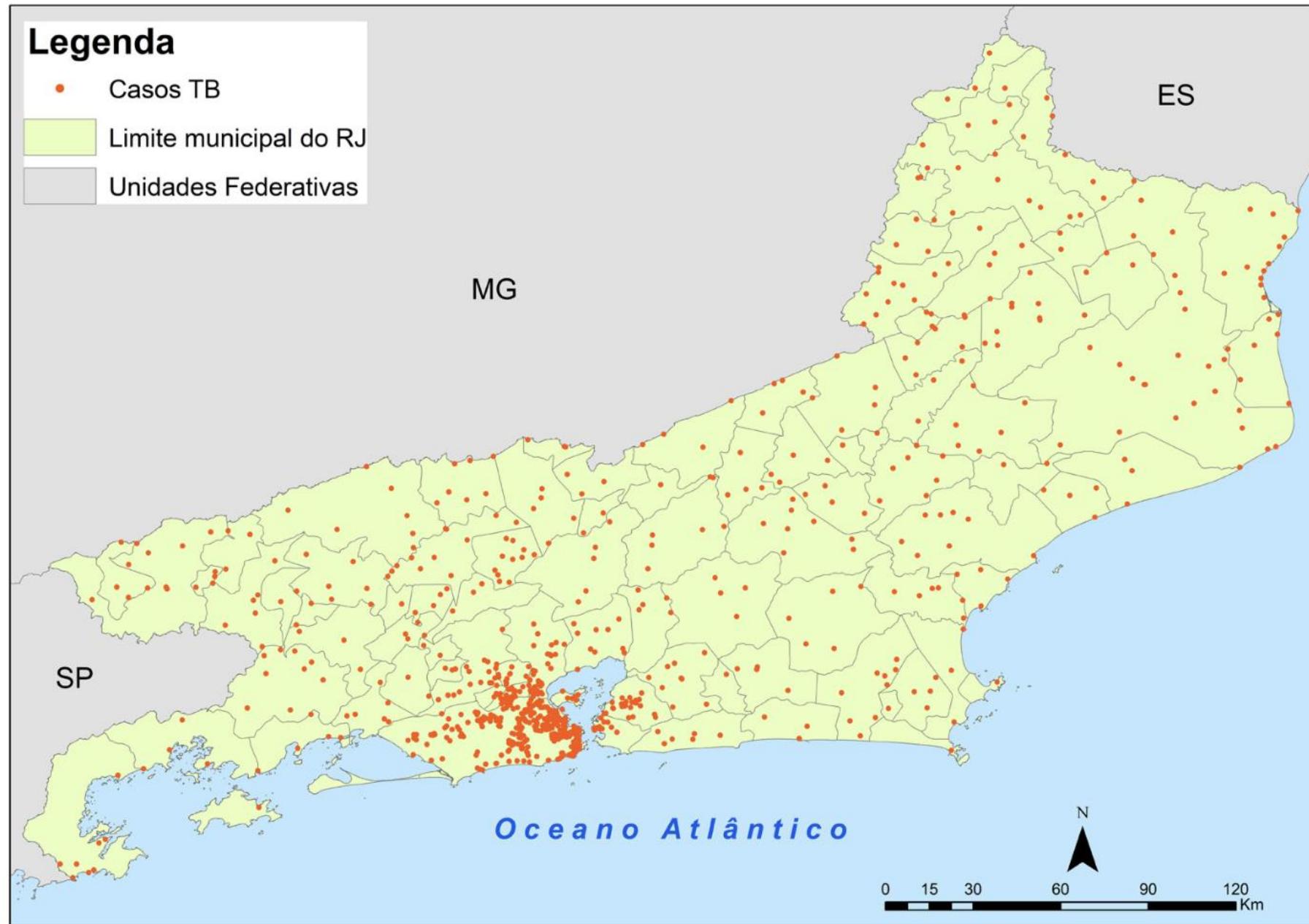


Surto de cólera de 1854,
devido a bombas de água
contaminadas



Legenda

- Casos TB
- Limite municipal do RJ
- Unidades Federativas



Fonte: SINAN-DATA SUS.

Magalhães e Carrijo, 2024- Análise Espacial e Geoprocessamento na Vigilância em Saúde



COVID-19 Dashboard

 by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU)

JHU Ceased Updates at:
10/03/2023, 10:21
See Terms of Use for more info

Cases | Deaths by Country/Region/Sovereignty

US

28-Day: **959.794** | 9.451
Totals: **103.804.263** | 1.123.8
36

Japan

28-Day: **418.671** | 2.804
Totals: **33.329.551** | 73.046

Germany

28-Day: **355.168** | 2.275
Totals: **38.249.060** | 168.935

Russia

28-Day: **350.549** | 989
Totals: **22.086.064** | 388.521

Korea, South

28-Day: **290.039** | 396
Totals: **30.615.522** | 34.093

Taiwan*

Total Cases

676.609.955

28-Day Cases

4.035.254

Total Deaths

6.881.955

28-Day Deaths

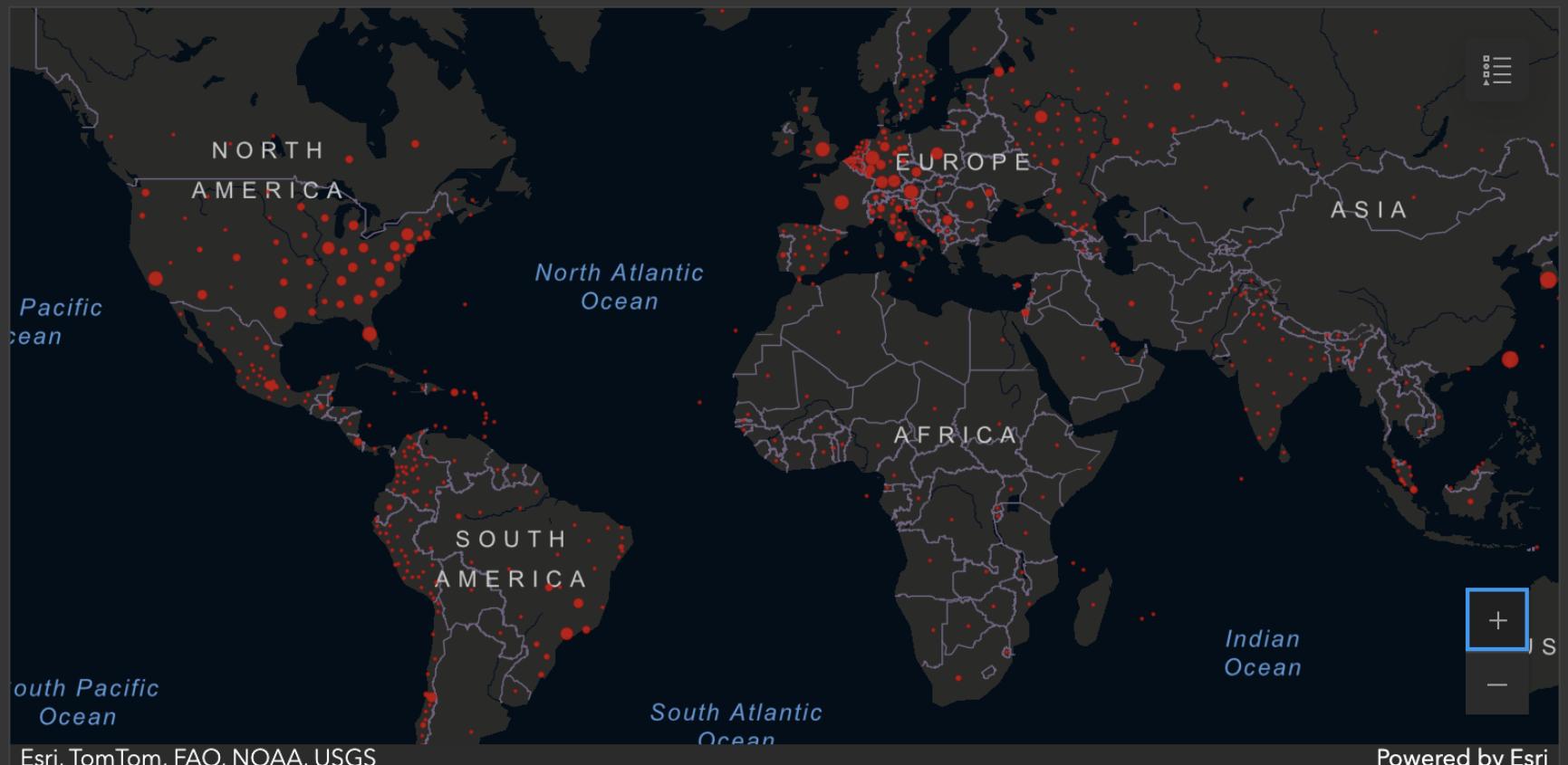
28.018

Total Vaccine Doses Administered

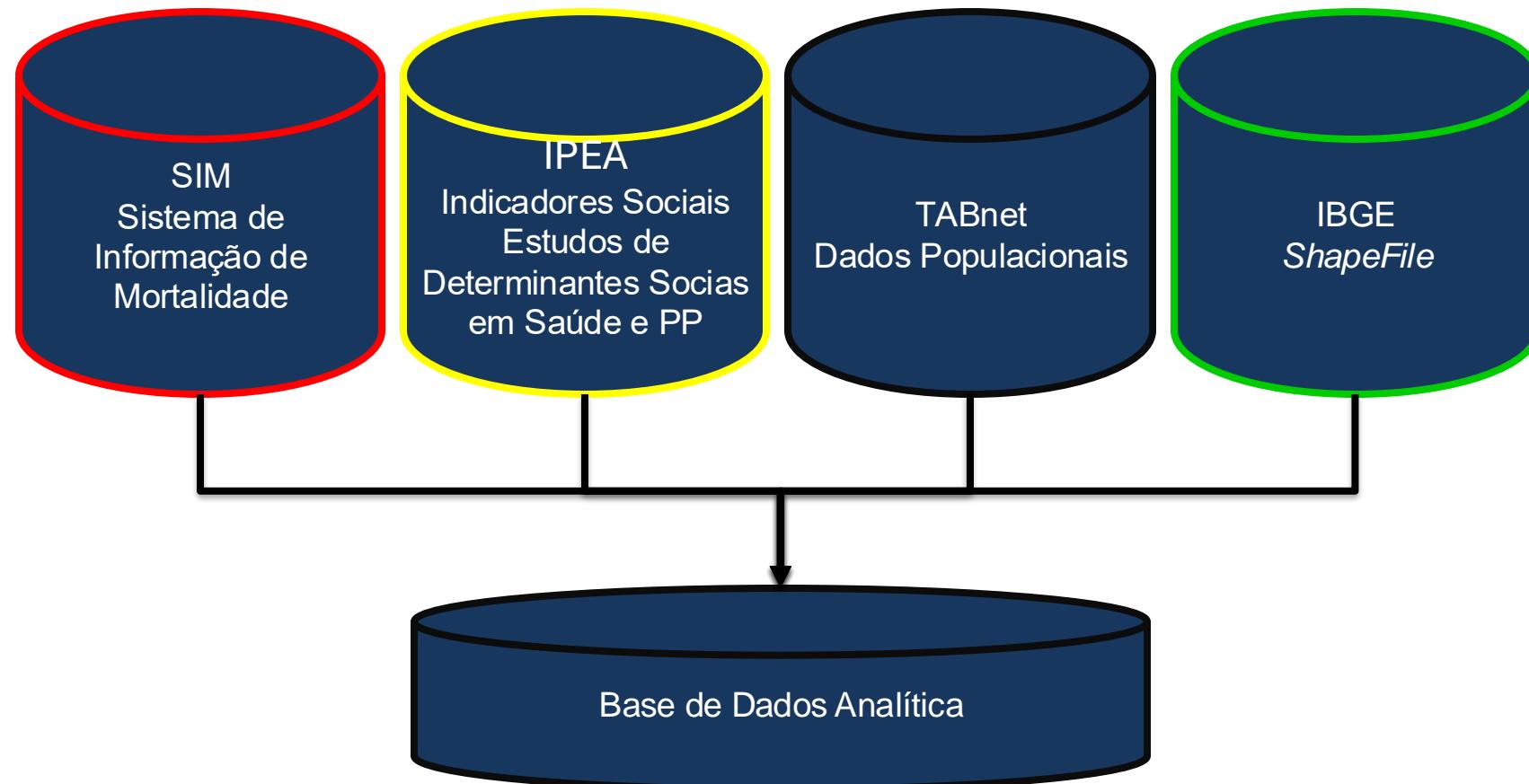
13.338.833.198

28-Day Vaccine Doses Administered

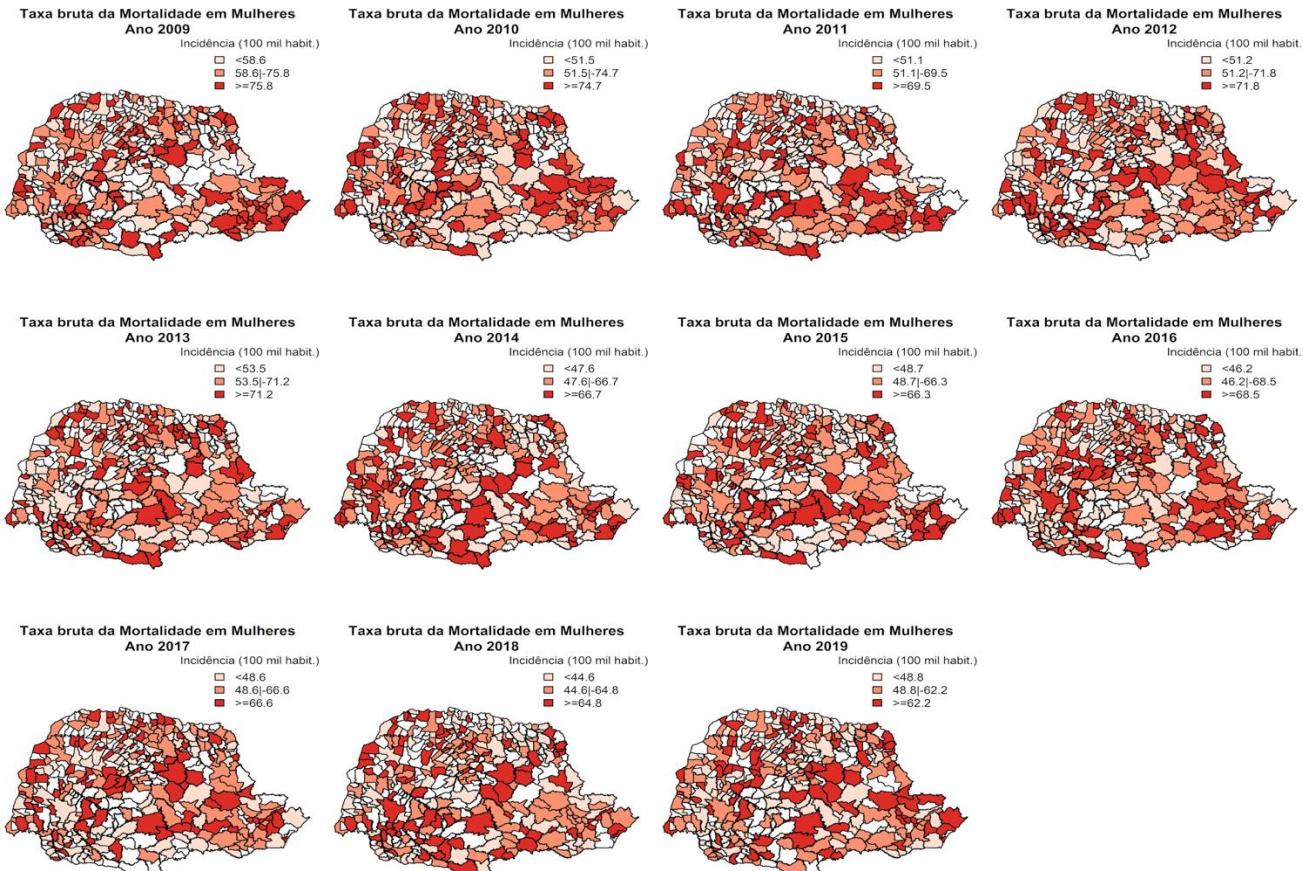
28.156.730



Integração e *linkage* das bases de diferentes Sistemas de informação



Mapas da mortalidade feminina- Paraná-BR



Descrição Espacial Indicadores Sociais

PIB

Em Reais
■ <10266
■ 10266|12868
■ >=12868

Analfabetismo

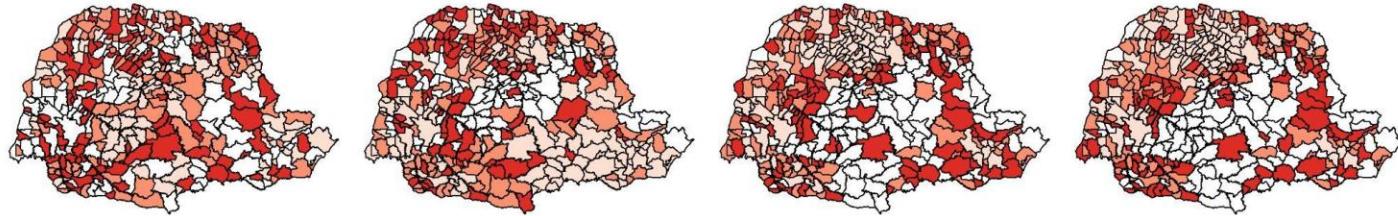
Percentual
■ <7.3
■ 7.3|10.1
■ >=10.1

Baixa Renda (até 1/5SM)

Percentual
■ <21.17
■ 21.17|28.41
■ >=28.41

Baixa Renda (até 1/4SM)

Percentual
■ <5.19
■ 5.19|8.6
■ >=8.6



Desemprego

Percentual
■ <3.08
■ 3.08|4.22
■ >=4.22

Trabalho Infantil

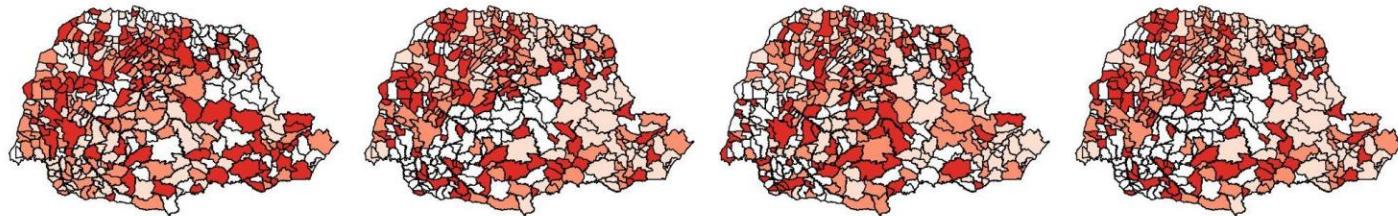
Percentual
■ <9.335
■ 9.335|13.47
■ >=13.47

Idosos Residentes com Outros Parentes

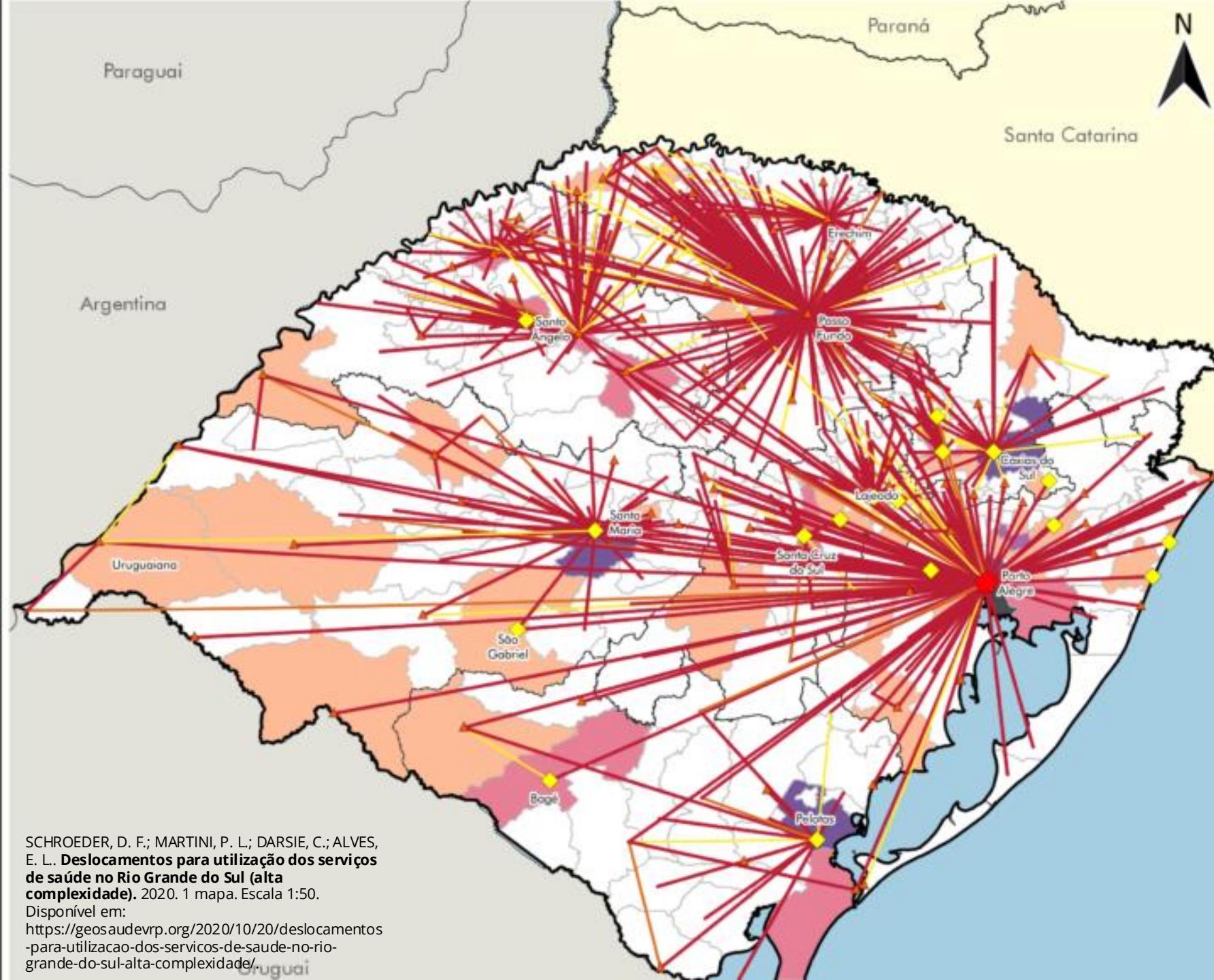
Percentual
■ <0.435
■ 0.435|0.52
■ >=0.52

Índice de Vulnerabilidade Social

Pontuação
■ <9.335
■ 9.335|13.47
■ >=13.47



Deslocamentos para utilização dos serviços de saúde no Rio Grande do Sul



Deslocamento para saúde de alta complexidade

- Macrorregiões de saúde do RS
- Território brasileiro
- Território internacional

Polos de saúde e fluxos de deslocamento

Classe de complexidade dos serviços de saúde
Centralidade

- Primária
- Secundária
- Terciária

Ordem de frequência

- Primeira
- Segunda
- Terceira

Leitos de UTI por município

- | | |
|---------------|------------------|
| Nenhum leito | Até 100 leitos |
| Até 20 leitos | Até 160 leitos |
| Até 50 leitos | 903 leitos (POA) |

Fonte: Secretaria Estadual de Saúde do Rio Grande do Sul
Regiões de Influência das Cidades - REGIC 2018



SCHROEDER, D. F.; MARTINI, P. L.; DARSIE, C.; ALVES, E. L. **Deslocamentos para utilização dos serviços de saúde no Rio Grande do Sul (alta complexidade).** 2020. 1 mapa. Escala 1:50.
Disponível em:
<https://geosaudevrp.org/2020/10/20/deslocamentos-para-utilizacao-dos-servicos-de-saude-no-rio-grande-do-sul-alta-complexidade/>

USO DO R

No R os mapas são altamente extensíveis e podem ser completamente personalizados, usando tanto o Rbase com linguagem de implementação dos comandos em plot () ou usando a bibliotecas específicas.



<https://www.r-project.org/>



-
- **What is R?**
 - R is an open source language and environment for statistical computing and graphics.



-
- Many users think of R as a statistics system. We prefer to think of it of an environment within which statistical techniques are implemented. R can be extended (easily) via *packages*.



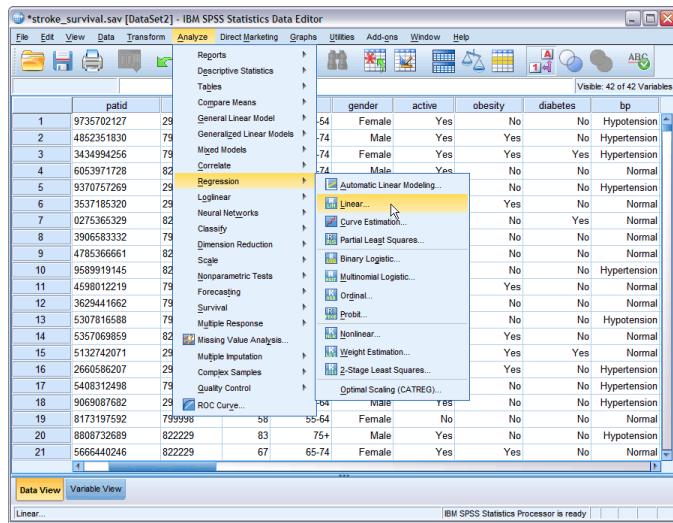


Learning curve → Difficult at the beginning

Formas em que os usuários podem interagir com dispositivos eletrônicos

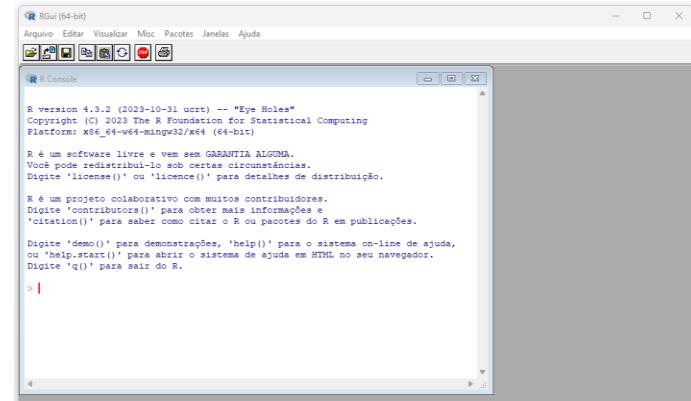
GUI: graphical user interface

- Os usuários clicam em ícones e botões para controlar o software ou os dispositivos
- Os usuários executam tarefas clicando em ícones, selecionando itens de menu e arrastando e soltando arquivos



CLI: command line interface

- Os usuários digitam comandos em um terminal para operar e navegar
- Pode ser intimidadora para iniciantes
- Os comandos devem ser lembrados ou consultados em um manual
- Permitem que o ser humano use habilidades de linguagem em vez de limitar a interação a apontar
- Aumentam a produtividade pois todas as ações têm um nome e uma série de ações pode ser escrita em um *script*
- Tarefas repetitivas podem ser facilmente realizadas com *loops*



Formas em que os usuários podem interagir com dispositivos eletrônicos

GUI: graphical user interface

**Fácil de
aprender**

CLI: command line interface

**Poderoso
quando
aprendemos**



<http://www-03.ibm.com/software/products/pt/spss-statistics>

*stroke_survival.sav [DataSet2] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Direct Marketing Graphs Utilities Add-ons Window Help

Visible: 42 of 42 Variables

	patid		gender	active	obesity	diabetes	bp
1	9735702127	29	-54	Female	Yes	No	Hypotension
2	4852351830	79	-74	Male	Yes	Yes	Hypertension
3	3434994256	79	-74	Female	Yes	Yes	Hypertension
4	6053971728	82	-74	Male	Yes	No	Normal
5	9370757269	29				No	No
6	3537185320	29				No	Hypertension
7	0275365329	82				Yes	No
8	3906583332	79				No	Normal
9	4785366661	82				No	No
10	9589919145	82				No	Normal
11	4598012219	79				No	Hypertension
12	3629441662	79				Yes	No
13	5307816588	79				No	No
14	5357069859	82				No	Normal
15	5132742071	29				No	No
16	2660586207	29				Yes	Yes
17	5408312498	79				Yes	No
18	9069087682	29				No	Hypertension
19	8173197592	799998	58	55-64	Female	No	No
20	8808732689	822229	83	75+	Male	Yes	No
21	5666440246	822229	67	65-74	Female	Yes	Yes

Data View Variable View

Linear... IBM SPSS Statistics Processor is ready

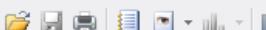
The screenshot shows the IBM SPSS Statistics Data Editor window. The menu bar includes File, Edit, View, Data, Transform, Analyze, Direct Marketing, Graphs, Utilities, Add-ons, Window, and Help. The Analyze menu is open, showing various statistical analysis options like Reports, Descriptive Statistics, Tables, Compare Means, General Linear Model, Generalized Linear Models, Mixed Models, Correlate, Regression, Loglinear, Neural Networks, Classify, Dimension Reduction, Scale, Nonparametric Tests, Forecasting, Survival, Multiple Response, Missing Value Analysis..., Multiple Imputation, Complex Samples, Quality Control, ROC Curve..., and Optimal Scaling (CATREG)... . A sub-menu for Regression is open, with Linear... highlighted. The main workspace displays a data table with 21 rows and 8 columns. The columns are labeled patid, gender, active, obesity, diabetes, and bp. The data includes various patient IDs, gender (Female/Male), activity status (Yes), obesity status (Yes/No), diabetes status (Yes/No), and blood pressure (bp) levels (Hypotension, Normal, Hypertension). The bottom status bar indicates "IBM SPSS Statistics Processor is ready".



Stata/MP 14.0

File Edit Data Graphics

Statistics User Window Help



Review

Filter commands here

Command

There are no items to show.

Summaries, tables, and tests

Linear models and related

Binary outcomes

Ordinal outcomes

Categorical outcomes

Count outcomes

Fractional outcomes

Generalized linear models

Treatment effects

Endogenous covariates

Sample-selection models

Exact statistics

Nonparametric analysis

Time series

Multivariate time series

Longitudinal/panel data

Multilevel mixed-effects models

Survival analysis

Epidemiology and related

SEM (structural equation modeling)

IRT (item response theory)

Survey data analysis

Multiple imputation

Multivariate analysis

Power and sample size

Bayesian analysis

Resampling

Postestimation

Other

(R)
14.0 Copyright 1985-2015 StataCorp LP
StataCorp
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College Station, Texas 77845 USA
800-STATA-PC <http://www.stata.com>
979-696-4600 stata@stata.com
979-696-4601 (fax)

Work perpetual license:

Stata Developer

StataCorp LP

Setup and utilities

ARIMA and ARMAX models

ARCH/GARCH

ARFIMA models

Unobserved-components model

Markov-switching model

Prais-Winsten regression

Regression with Newey-West std. errors

State-space models

Forecasting

Postestimation

Rolling-window and recursive estimation

Smothers/univariate forecasters

Filters for cyclical components

Tests

Graphs

Variables

Filter variables here

Name Label

There are no items to show.

Properties

Variables

Name

Label

Type

Format

Value label

Notes

Data

Filename

Label

Notes

Variables 0

Observations 0

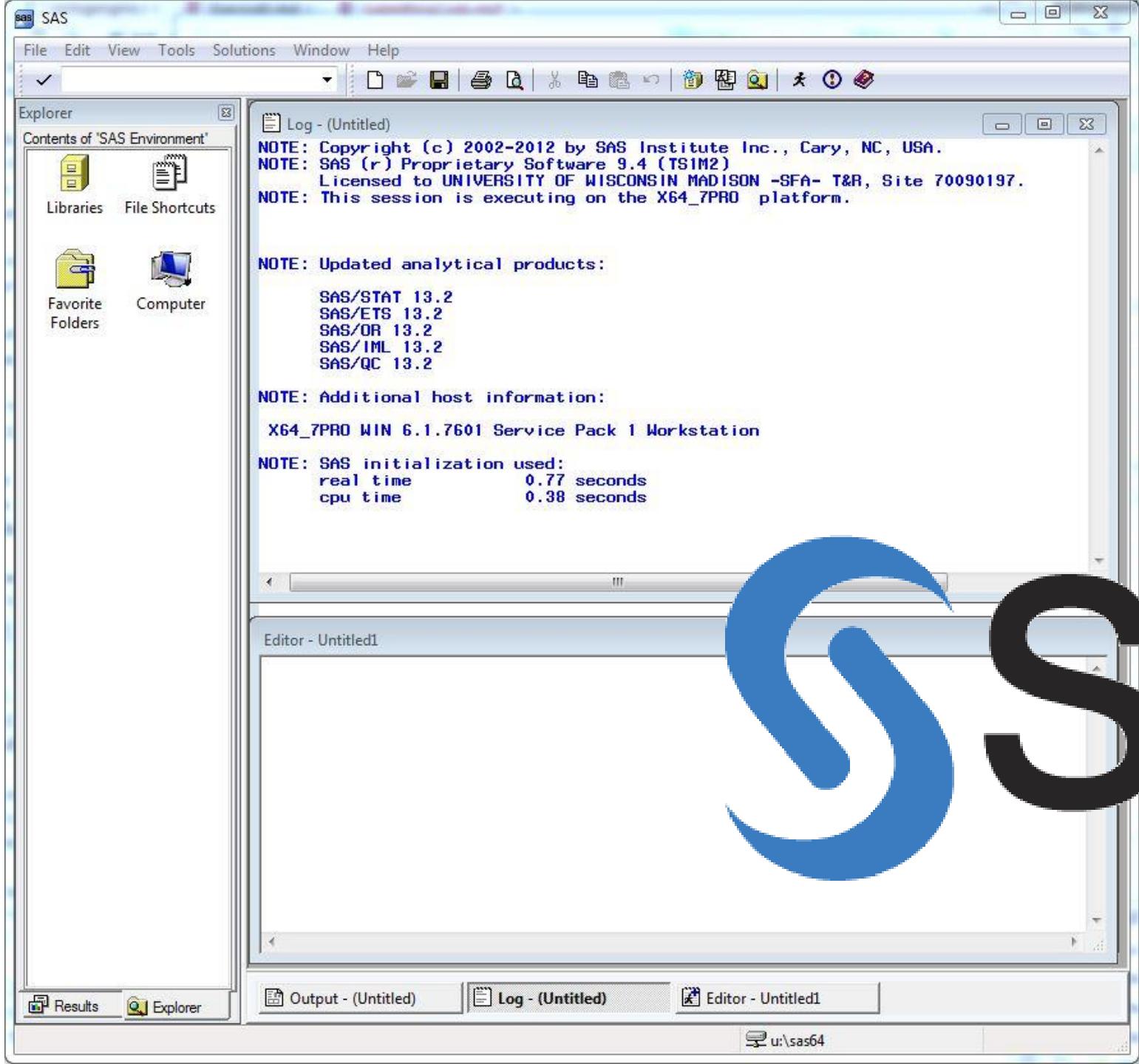
Size 0

Memory 64M

Sorted hv

C:\Users

CAP NUM OVR



sas

IDE (Integrated Development Environment)

Um ambiente de desenvolvimento integrado (IDE) é um software para criar aplicações que combina ferramentas comuns de desenvolvedor em uma única interface de usuário gráfica (GUI). Um IDE geralmente consiste em:

- **Editor de código-fonte:** é um editor de texto que auxilia na criação de código de software por meio de funcionalidades como destaque da sintaxe com indicadores visuais, recurso de preenchimento automático específico da linguagem e verificação de bugs durante o desenvolvimento.
- **Automação de compilação local:** são utilitários que automatizam tarefas simples e repetíveis durante a criação de uma compilação local do software usada pelo desenvolvedor. São tarefas como compilação de código-fonte em código binário, criação de pacotes de código binário e execução de testes automatizados.
- **Debugger:** é um programa usado para testar outros programas e mostrar graficamente a localização do bug no código original.

<https://www.redhat.com/pt-br/topics/middleware/what-is-ide>

R Outputs - RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

Console Terminal x Background Jobs x

R 4.3.2 · ~/cursoR2024/ROutputs/ ↵

R version 4.3.2 (2023-10-31 ucrt) -- "Eye Holes"
Copyright (C) 2023 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

R é um software livre e vem sem GARANTIA ALGUMA.
Você pode redistribuí-lo sob certas circunstâncias.
Digite 'license()' ou 'licence()' para detalhes de distribuição.

R é um projeto colaborativo com muitos contribuidores.
Digite 'contributors()' para obter mais informações e
'citation()' para saber como citar o R ou pacotes do R em publicações.

Digite 'demo()' para demonstrações, 'help()' para o sistema on-line de ajuda,
ou 'help.start()' para abrir o sistema de ajuda em HTML no seu navegador.
Digite 'q()' para sair do R.

[Workspace loaded from ~/cursoR2024/ROutputs/.RData]

> |

Environment History Connections Build Git Tutorial

Install Test Check More

Files Plots Packages Help Viewer Presentation

Install Update

Name	Description	Version
abind	Combine Multidimensional Arrays	1.4-8
anytime	Anything to 'POSIXct' or 'Date' Converter	0.3.9
ape	Analyses of Phylogenetics and Evolution	5.8
arrangements	Fast Generators and Iterators for Permutations, Combinations, Integer Partitions and Compositions	1.1.9
askpass	Password Entry Utilities for R, Git, and SSH	1.2.0
backports	Reimplementations of Functions Introduced Since R-3.0.0	1.5.0
base64enc	Tools for base64 encoding	0.1-3
bayesianova	Bayesian Inference in the Analysis of Variance via Markov Chain Monte Carlo in Gaussian Mixture Models	1.6
BH	Boost C++ Header Files	1.84.0-0
bit	Classes and Methods for Fast Memory-Efficient Boolean Selections	4.0.5
bit64	A S3 Class for Vectors of 64bit Integers	4.0.5
boot	Bootstrap Functions (Originally by Angelo Canty for S)	1.3-31
brew	Templating Framework for Report Generation	1.0-10
brio	Basic R Input Output	1.1.5
broom	Convert Statistical Objects into Tidy Tibbles	1.0.6
bslib	Custom 'Bootstrap' 'Sass' Themes for 'shiny' and 'rmarkdown'	0.8.0

O RStudio é uma IDE



RGui

Arquivo Editar Visualizar Misc Pacotes Janelas Ajuda



R Console

```
R version 4.4.1 (2024-06-14 ucrt) -- "Race for Your Life"
Copyright (C) 2024 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64
```

```
R é um software livre e vem sem GARANTIA ALGUMA.
Você pode redistribuí-lo sob certas circunstâncias.
Digite 'license()' ou 'licence()' para detalhes de distribuição.
```

```
R é um projeto colaborativo com muitos contribuidores.
Digite 'contributors()' para obter mais informações e
'citation()' para saber como citar o R ou pacotes do R em publicações.
```

```
Digite 'demo()' para demonstrações, 'help()' para o sistema on-line de ajuda,
ou 'help.start()' para abrir o sistema de ajuda em HTML no seu navegador.
Digite 'q()' para sair do R.
```

> |

Integrated development environment



Visual Studio Code remains the preferred IDE across all developers, increasing its use among those learning to code compared to professional developers (78% vs. 74%).

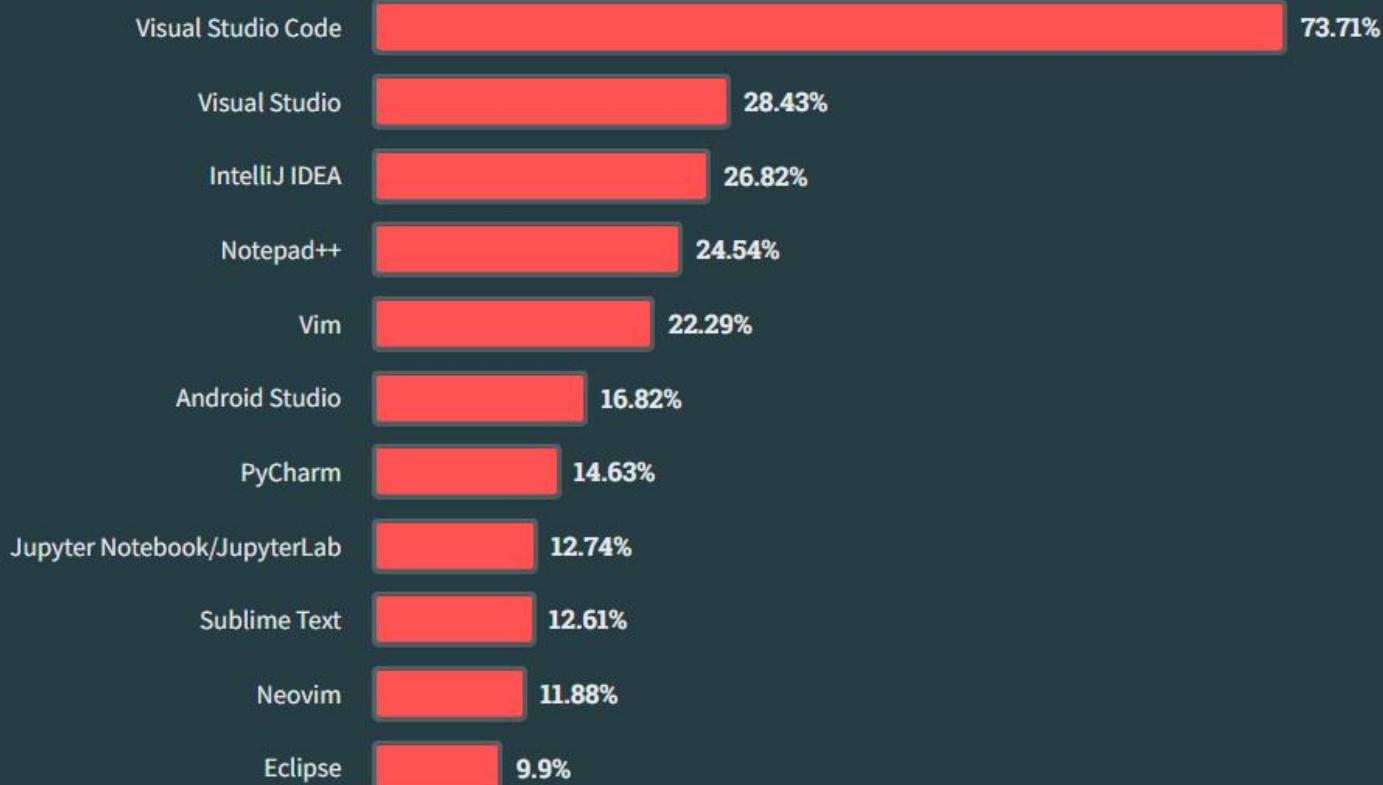
All Respondents

Professional Developers

Learning to Code

Other Coders

86,544 responses



[Version 1.94](#) is now available! Read about the new features and fixes from September.

[Overview](#)[SETUP](#)[GET STARTED](#)[USER GUIDE](#)[SOURCE CONTROL](#)[TERMINAL](#)[GITHUB COPILOT](#)

Languages

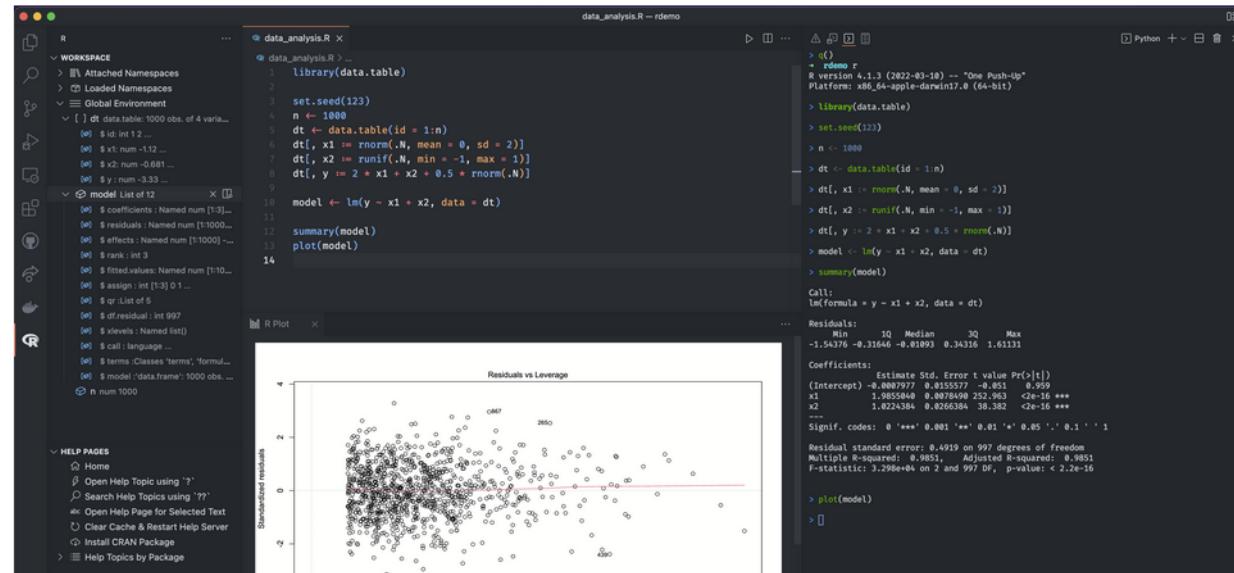
[Overview](#)[JavaScript](#)[JSON](#)[HTML](#)[CSS, SCSS and Less](#)[TypeScript](#)[Markdown](#)[PowerShell](#)[C++](#)[Java](#)[Python](#)

R in Visual Studio Code

[Edit](#)

The [R programming language](#) is a dynamic language built for statistical computing and graphics. R is commonly used in statistical analysis, scientific computing, machine learning, and data visualization.

The [R extension](#) for Visual Studio Code supports extended syntax highlighting, code completion, linting, formatting, interacting with R terminals, viewing data, plots, workspace variables, help pages, managing packages and working with [R Markdown](#) documents.



A screenshot of the Visual Studio Code interface showing the R extension. On the left, the Explorer sidebar shows a file named 'data_analysis.R'. In the center, the R terminal window displays R code and its output. The output includes library imports like 'library(data.table)', random number generation ('set.seed(123)', 'n <- 1000', 'dt <- data.table(id = 1:n)', 'dt[, x1 := rnorm(N, mean = 0, sd = 2)]', 'dt[, x2 := runif(N, min = -1, max = 1)]', 'dt[, y := 2 * x1 + x2 + 0.5 * rnorm(N)]'), model fitting ('model <- lm(y ~ x1 + x2, data = dt)'), and summary statistics ('summary(model)'). A plot window titled 'R Plot' shows a scatter plot of 'Standardized residuals' versus 'Leverage' with points labeled 'o67', '250', '490', and '250'.

IN THIS ARTICLE

[Getting started](#)[Running R code](#)[Code completion \(IntelliSense\)](#)[Linting](#)[Workspace viewer](#)[Debugging](#)[Next steps](#)[Subscribe](#)[Ask questions](#)[Follow @code](#)[Request features](#)[Report issues](#)[Watch videos](#)

<https://code.visualstudio.com/docs/languages/r>

Começando...

John M. Chambers diz que há três princípios fundamentais para entender o programa R:

1. Tudo que existe no R é um **OBJETO**
2. Tudo que acontece no R é uma **CHAMADA DE FUNÇÃO**
3. Interfaces para outros programas são parte do R

```
a <- sqrt(12)
```



Aplicações
computacionais



Conjuntos de funções do R



- 1. R-base:** são as funções principais do R, acessíveis quando instalamos o programa.
- 2. Recommended packages:** são pacotes de funções que são instalados junto com o programa R, mas não são carregados quando iniciamos o programa. São exemplos os pacotes survival (usado para análise de sobrevivência), MASS e lattice. Para usarmos as funções do pacote survival, por exemplo, precisamos antes usar a função library (survival).
- 3. Contributed packages:** são pacotes oficiais, que não são instalados junto com o programa R.

Available CRAN Packages By Name

[A](#) [B](#) [C](#) [D](#) [E](#) [F](#) [G](#) [H](#) [I](#) [J](#) [K](#) [L](#) [M](#) [N](#) [O](#) [P](#) [Q](#) [R](#) [S](#) [T](#) [U](#) [V](#) [W](#) [X](#) [Y](#) [Z](#)

[A3](#)

[AalenJohansen](#)

[AATtools](#)

[ABACUS](#)

[abasequence](#)

[abbreviate](#)

[abc](#)

[abc.data](#)

[ABC.RAP](#)

[ABCanalysis](#)

[abclass](#)

[ABCoptim](#)

[ABCp2](#)

[abcrf](#)

[abcrlda](#)

[abctools](#)

[abd](#)

[abdiv](#)

[abe](#)

[aberrance](#)

[abess](#)

[abglasso](#)

[ABHgenotypeR](#)

Accurate, Adaptable, and Accessible Error Metrics for Predictive Models

Conditional Aalen-Johansen Estimation

Reliability and Scoring Routines for the Approach-Avoidance Task

Apps Based Activities for Communicating and Understanding Statistics

Coding 'ABA' Patterns for Sequence Data

Readable String Abbreviation

Tools for Approximate Bayesian Computation (ABC)

Data Only: Tools for Approximate Bayesian Computation (ABC)

Array Based CpG Region Analysis Pipeline

Computed ABC Analysis

Angle-Based Large-Margin Classifiers

Implementation of Artificial Bee Colony (ABC) Optimization

Approximate Bayesian Computational Model for Estimating P2

Approximate Bayesian Computation via Random Forests

Asymptotically Bias-Corrected Regularized Linear Discriminant Analysis

Tools for ABC Analyses

The Analysis of Biological Data

Alpha and Beta Diversity Measures

Augmented Backward Elimination

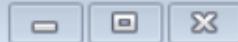
Detect Aberrant Behavior in Test Data

Fast Best Subset Selection

Adaptive Bayesian Graphical Lasso

Easy Visualization of ABH Genotypes

Currently, the CRAN package repository features 21694 available packages.



```
> install.packages("CARBayesdata")
Instalando pacote em 'C:/Users/zenit/AppData/Local/R/win-library/4.4'
(como 'lib' não foi especificado)
instalando as dependências 'wk', 's2', 'units', 'sf' também

tentando a URL 'https://briege.r.esalq.usp.br/CRAN/bin/windows/contrib/4.4/wk_0.9.4.zip'
Content type 'application/zip' length 2046426 bytes (2.0 MB)
downloaded 2.0 MB

tentando a URL 'https://briege.r.esalq.usp.br/CRAN/bin/windows/contrib/4.4/s2_1.1.7.zip'
Content type 'application/zip' length 4099553 bytes (3.9 MB)
downloaded 3.9 MB

tentando a URL 'https://briege.r.esalq.usp.br/CRAN/bin/windows/contrib/4.4/units_0.8-5.zip'
Content type 'application/zip' length 787591 bytes (769 KB)
downloaded 769 KB

tentando a URL 'https://briege.r.esalq.usp.br/CRAN/bin/windows/contrib/4.4/sf_1.0-19.zip'
Content type 'application/zip' length 40986608 bytes (39.1 MB)
downloaded 39.1 MB

tentando a URL 'https://briege.r.esalq.usp.br/CRAN/bin/windows/contrib/4.4/CARBayesdata_3.0.zip'
Content type 'application/zip' length 358560 bytes (350 KB)
downloaded 350 KB

pacote 'wk' desempacotado com sucesso e somas MD5 verificadas
pacote 's2' desempacotado com sucesso e somas MD5 verificadas
pacote 'units' desempacotado com sucesso e somas MD5 verificadas
pacote 'sf' desempacotado com sucesso e somas MD5 verificadas
pacote 'CARBayesdata' desempacotado com sucesso e somas MD5 verificadas

Os pacotes binários baixados estão em
      C:\Users\zenit\AppData\Local\Temp\Rtmp6vHN8n\downloaded_packages
> |
```

Simple Features for R

A package that provides [simple features access](#) for R.

[Blogs, links](#) • [Cheatsheet](#) • [Installing](#) • [Contributing](#) •
[Acknowledgment](#) • [How to cite](#)

Package sf:

- represents simple features as records in a `data.frame` or `tibble` with a geometry list-column
- represents natively in R all 17 simple feature types for all dimensions (XY, XYZ, XYM, XYZM)
- interfaces to [GEOS](#) for geometrical operations on projected coordinates, and (through R package [s2](#)) to [s2geometry](#) for geometrical operations on ellipsoidal coordinates
- interfaces to [GDAL](#), supporting all driver options, `Date` and `POSIXct` and list-columns
- interfaces to [PROJ](#) for coordinate reference system conversion and transformation
- uses [well-known-binary](#) serialisations written in C++/Rcpp for fast I/O with GDAL and GEOS
- reads from and writes to spatial databases such as [PostGIS](#) using [DBI](#)
- is extended by
 - [lwgeom](#) for selected liblwgeom/PostGIS functions
 - [stars](#) for raster data, and raster or vector data cubes (spatial time series)



Links

[View on CRAN](#)

[Browse source code](#)

[Report a bug](#)

License

[GPL-2 | MIT](#) + file [LICENSE](#)

Citation

[Citing sf](#)

Developers

Edzer Pebesma

Author, maintainer

[More about authors...](#)

Dev status

R-CMD-check passing

tic-db passing

coverage 78%

license GPL (>= 2)

CRAN 1.0-19

mapview

Interactive viewing of spatial data in R

mapview provides functions to very quickly and conveniently create interactive visualisations of spatial data. Its main goal is to fill the gap of quick (not presentation grade) interactive plotting to examine and visually investigate both aspects of spatial data, the geometries and their attributes. It can also be considered a data-driven API for the [leaflet](#) package as it will automatically render correct map types, depending on the type of the data (points, lines, polygons, raster). In addition, it makes use of some advanced rendering functionality that will enable viewing of much larger data than is possible with [leaflet](#). Furthermore, if you're a fan of [mapdeck](#) (which you should!), you can choose to use it as the rendering platform instead of [leaflet](#) by setting `mapviewOptions(platform = "mapdeck")`.

The main user relevant functions are:

- `mapview` - view (multiple) spatial objects on a set of background maps
- `viewExtent` - view extent / bounding box of spatial objects
- `viewRGB` - view RGB true- or false-color images of raster objects
- `mapshot` - easily save maps (including leaflet maps) as `html` and/or `png` (or other image formats)

Functions that have been deprecated/deleted recently:

- `addHomeButton` - deprecated, use package [leafem](#) instead.
- `addLogo` - deprecated, use package [leafem](#) instead.
- `addFeatures` - deprecated, use package [leafem](#) instead.
- `addMouseCoordinates` - deprecated, use package [leafem](#) instead.



Links

[View on CRAN](#)

[Browse source code](#)

[Report a bug](#)

License

GPL (>= 3) | file [LICENSE](#)

Citation

[Citing mapview](#)

Developers

Tim Appelhans

Maintainer, author

Florian Detsch

Author

Christoph Reudenbach

Author

Stefan Woellauer

Author

[More about authors...](#)

Dev status

tic passing

CRAN NOTE

CRAN 2.11.2

spdep

 R-CMD-check passing [CRAN](#)

Spatial Dependence: Weighting Schemes and Statistics

A collection of functions to create spatial weights matrix objects from polygon contiguities, from point patterns by distance and tessellations, for summarizing these objects, and for permitting their use in spatial data analysis, including regional aggregation by minimum spanning tree; a collection of tests for spatial autocorrelation, including global Morans I and Gearys C proposed by Cliff and Ord (1973, ISBN: 0850860369) and (1981, ISBN: 0850860814), Hubert/Mantel general cross product statistic, Empirical Bayes estimates and Assunção/Reis (1999) ([https://doi.org/10.1002/\(SICI\)1097-0258\(19990830\)18:16%3C2147%3A%3AAID-SIM179%3E3.0.CO%3B2-I](https://doi.org/10.1002/(SICI)1097-0258(19990830)18:16%3C2147%3A%3AAID-SIM179%3E3.0.CO%3B2-I)) Index, Getis/Ord G (Getis and Ord 1992) (<https://doi.org/10.1111/j.1538-4632.1992.tb00261.x>) and multicoloured join count statistics, APLE (Li et al.) (<https://doi.org/10.1111/j.1538-4632.2007.00708.x>), local Morans I (Anselin 1995) (<https://doi.org/10.1111/j.1538-4632.1995.tb00338.x>) and Getis/Ord G (Ord and Getis 1995) (<https://doi.org/10.1111/j.1538-4632.1995.tb00912.x>), saddlepoint approximations (Tiefelsdorf 2002) (<https://doi.org/10.1111/j.1538-4632.2002.tb01084.x>) and exact tests for global and local Morans I (Bivand et al. 2009) (<https://doi.org/10.1016/j.csda.2008.07.021>) and LOSH local indicators of spatial heteroscedasticity (Ord and Getis) (<https://doi.org/10.1007/s00168-011-0492-y>), with further extensions in 'Bivand' (2022) [doi:10.1111/gean.12319](https://doi.org/10.1111/gean.12319). The implementation of most of the measures is

Links

[View on CRAN](#)

[Browse source code](#)

[Report a bug](#)

License

GPL (>= 2)

Citation

[Citing spdep](#)

Developers

Roger Bivand

Maintainer, author 

[More about authors...](#)

Introduction

1. Application

1.1. editR

1.2. flexdashboard

1.3. htmlwidgets

1.4. listviewer

1.5. miniUI

1.6. shiny

1.7. shinygadgets

1.8. shinyLP

1.9. shinystan

1.10. tooltipsterR

1.11. V8

1.12. xmlview

2. Data Handling

2.1. dplyr

2.2. fuzzyjoin

2.3. janitor

2.4. multidplyr

^ A

CARBayes: Spatial Generalised Linear Mixed Models for Areal Unit Data

- CRAN: <http://cran.r-project.org/web/packages/CARBayes/index.html>
- Vignettes:
 - [Vignette for CARBayes package. \(PDF\)](#)

```
> library(CARBayes)
```

```
Loading required package: MASS
```

```
Attaching package: 'MASS'
```

```
The following object is masked from 'package:dplyr':
```

```
select
```

efg's R Notes: RColorBrewer Package

RNotes

ColorBrewer Palettes

```
library(RColorBrewer)
```

Sequential palettes

Sequential palettes are suited to ordered data that progress from low to high. Lightness steps dominate the look of these schemes, with light colors for low data values to dark colors for high data values.

All the sequential palettes are available in variations from 3 different values up to 9 different values.

```
par(mar=c(1,5,1,1))
display.brewer.all(type="seq")
```



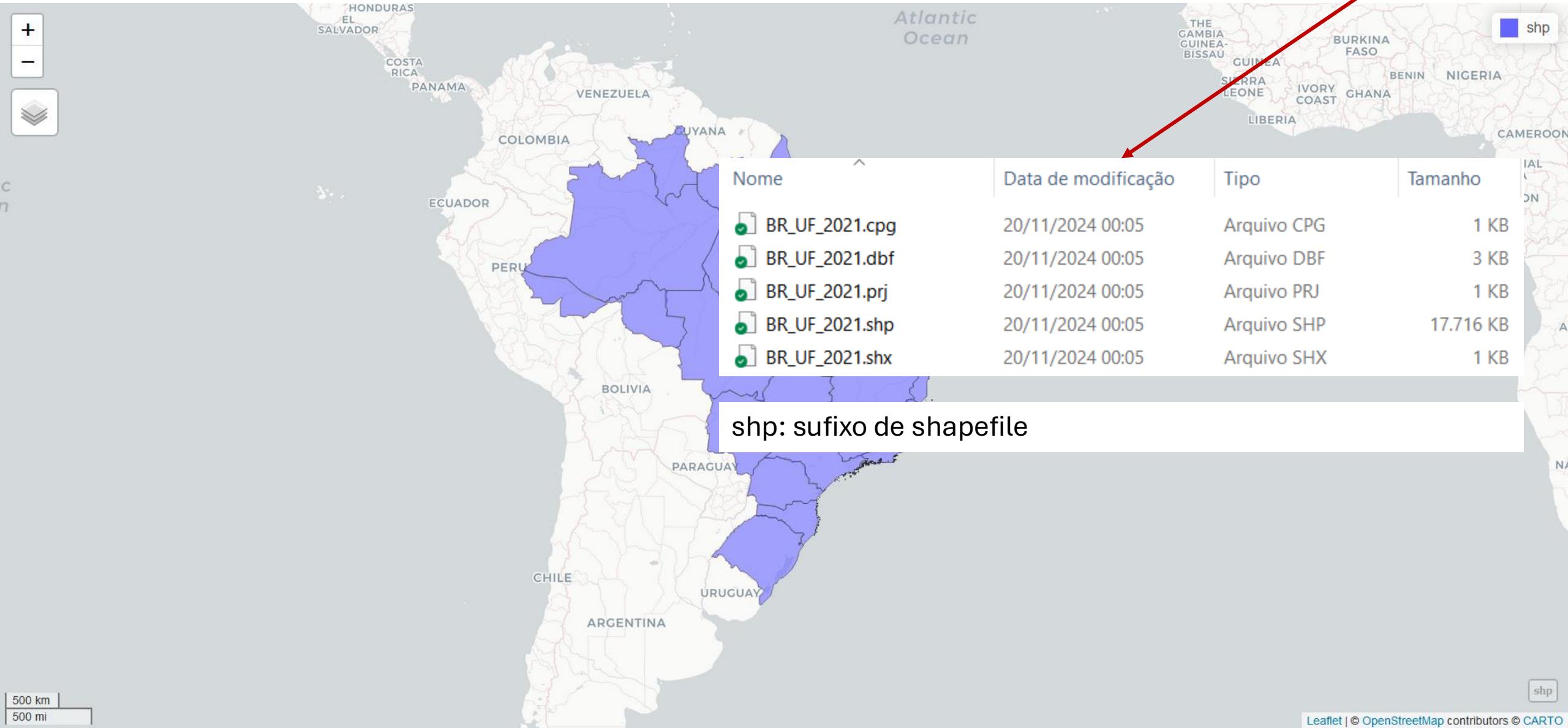
```
> library(sf)
> library(spdep)
> library(mapview)
> library(CARBayes)
>
> shp <- sf::st_read("/vsizip//vsicurl/https://raw.githubusercontent.com/edsonzmartinez/spatial/main/BR_UF_2021.zip")
Reading layer 'BR_UF_2021' from data source
  '/vsizip//vsicurl/https://raw.githubusercontent.com/edsonzmartinez/spatial/main/BR_UF_2021.zip'
    using driver 'ESRI Shapefile'
Simple feature collection with 27 features and 4 fields
Geometry type: MULTIPOLYGON
Dimension:     XY
Bounding box:  xmin: -73.99045 ymin: -33.75118 xmax: -28.84764 ymax: 5.271841
Geodetic CRS:  SIRGAS 2000
>
> mapview::mapview(shp)
> class(shp)
[1] "sf"          "data.frame"
> mode(shp)
[1] "list"
> names(shp)
[1] "CD_UF"       "NM_UF"        "SIGLA"        "NM_REGIAO"   "geometry"
> |
```

O /vsizip/ é um manipulador de arquivos que permite a leitura de arquivos ZIP em tempo real, sem descompactá-los previamente

```
library(sf)
library(mapview)
shp <- sf::st_read("/vsizip//vsicurl/https://raw.githubusercontent.com/edsonzmartinez/spatial/main/BR_UF_2021.zip")
mapview::mapview(shp)
```

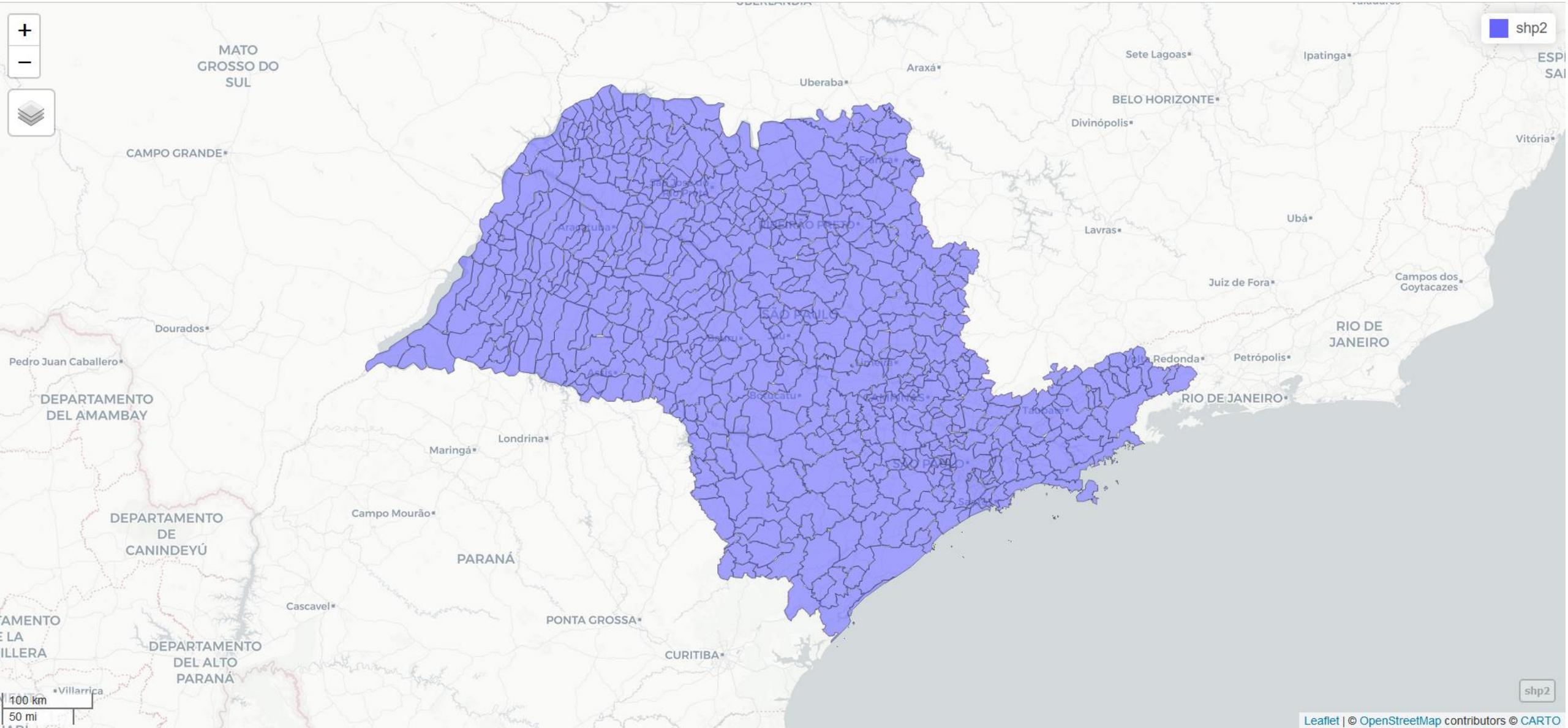


```
library(sf)
library(mapview)
shp <- sf::st_read("/vsizip//vsicurl/https://raw.githubusercontent.com/edsonzmartinez/spatial/main/BR_UF_2021.zip")
mapview::mapview(shp)
```



Podemos abrir mapas shapefile diretamente do site do IBGE sem a necessidade de download

```
shp2 <- st_read("/vsizip//vsicurl/https://geoftp.ibge.gov.br/organizacao_do_territorio/malhas_territoriais/  
malhas_municipais/municipio_2022/UFs/SP/SP_UF_2022.zip")  
mapview::mapview(shp2)
```




```
> shp
Simple feature collection with 27 features and 4 fields
Geometry type: MULTIPOLYGON
Dimension: XY
Bounding box: xmin: -73.99045 ymin: -33.75118 xmax: -28.84764 ymax: 5.271841
Geodetic CRS: SIRGAS 2000
First 10 features:
```

	CD_UF	NM_UF	SIGLA	NM_REGIAO	geometry
1	11	Rondônia	RO	Norte	MULTIPOLYGON ((((-62.86662 -...
2	12	Acre	AC	Norte	MULTIPOLYGON ((((-73.1655 -7...
3	13	Amazonas	AM	Norte	MULTIPOLYGON ((((-67.32609 2...
4	14	Roraima	RR	Norte	MULTIPOLYGON ((((-60.20051 5...
5	15	Pará	PA	Norte	MULTIPOLYGON ((((-46.43676 -...
6	16	Amapá	AP	Norte	MULTIPOLYGON ((((-50.45011 2...
7	17	Tocantins	TO	Norte	MULTIPOLYGON ((((-48.35878 -...
8	21	Maranhão	MA	Nordeste	MULTIPOLYGON ((((-44.66115 -...
9	22	Piauí	PI	Nordeste	MULTIPOLYGON ((((-41.78076 -...
10	23	Ceará	CE	Nordeste	MULTIPOLYGON ((((-40.49582 -...

```
> class(shp)
```

```
[1] "sf" ← "data.frame"
```

```
> mode(shp)
```

```
[1] "list"
```

Em sua forma mais básica, um **objeto sf** é uma coleção de características (features) simples que inclui atributos e geometrias na forma de uma base de dados (data frame). Em outras palavras, é uma base de dados com linhas de características, colunas de atributos e uma **coluna de geometria especial que contém os aspectos espaciais das características**.

```
> shp
Simple feature collection with 27 features and 4 fields
Geometry type: MULTIPOLYGON
Dimension: XY
Bounding box: xmin: -73.99045 ymin: -33.75118 xmax: -28.84764 ymax: 5.271841
Geodetic CRS: SIRGAS 2000
First 10 features:
```

	CD_UF	NM_UF	SIGLA	NM_REGIAO		geometry
1	11	Rondônia	RO	Norte	MULTIPOLYGON	(((-62.86662 -...
2	12	Acre	AC	Norte	MULTIPOLYGON	(((-73.1655 -7...
3	13	Amazonas	AM	Norte	MULTIPOLYGON	(((-67.32609 2...
4	14	Roraima	RR	Norte	MULTIPOLYGON	(((-60.20051 5...
5	15	Pará	PA	Norte	MULTIPOLYGON	(((-46.43676 -...
6	16	Amapá	AP	Norte	MULTIPOLYGON	(((-50.45011 2...
7	17	Tocantins	TO	Norte	MULTIPOLYGON	(((-48.35878 -...
8	21	Maranhão	MA	Nordeste	MULTIPOLYGON	(((-44.66115 -...
9	22	Piauí	PI	Nordeste	MULTIPOLYGON	(((-41.78076 -...
10	23	Ceará	CE	Nordeste	MULTIPOLYGON	(((-40.49582 -...

```
> class(shp)
[1] "sf"
> mode(shp)
[1] "list"
```

Geodetic CRS: Trata-se do Sistema Geodésico de Referência, que permite que se faça a localização espacial de qualquer objeto sobre a superfície terrestre.

SIRGAS2000: sistema geodésico de referência adotado oficialmente no Brasil em 25 de fevereiro de 2005

```
> shp
```

Simple feature collection with 27 features and 4 fields

Geometry type: MULTIPOLYGON

Dimension: XY

Bounding box: xmin: -73.99045 ymin: -33.75118 xmax: -28.84764 ymax: 15.75118

Geodetic CRS: SIRGAS 2000

First 10 features:

	CD_UF	NM_UF	SIGLA	NM_REGIAO	geometry
1	11	Rondônia	RO	Norte	MULTIPOLYGON ((((-62.866
2	12	Acre	AC	Norte	MULTIPOLYGON ((((-73.165
3	13	Amazonas	AM	Norte	MULTIPOLYGON ((((-67.326
4	14	Roraima	RR	Norte	MULTIPOLYGON ((((-60.200
5	15	Pará	PA	Norte	MULTIPOLYGON ((((-46.4367
6	16	Amapá	AP	Norte	MULTIPOLYGON ((((-50.45011
7	17	Tocantins	TO	Norte	MULTIPOLYGON ((((-48.35878
8	21	Maranhão	MA	Nordeste	MULTIPOLYGON ((((-44.66115
9	22	Piauí	PI	Nordeste	MULTIPOLYGON ((((-41.78076
10	23	Ceará	CE	Nordeste	MULTIPOLYGON ((((-40.49582 -...)))))

```
> class(shp)
```

```
[1] "sf"
```

```
> mode(shp)
```

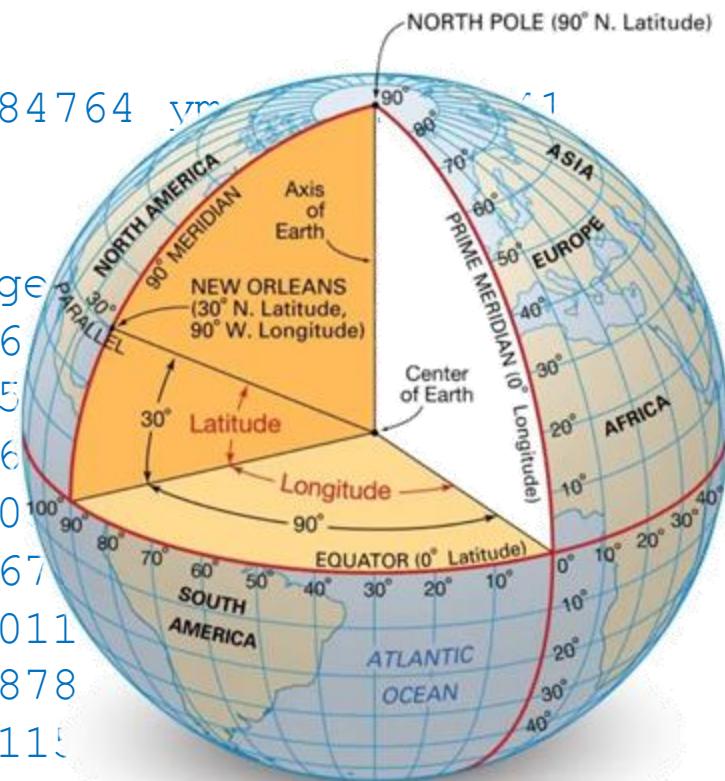
```
[1] "list"
```

"data.frame"

Orientação:

Geocêntrica: Eixo de rotação paralelo ao eixo de rotação da Terra, onde a origem está localizada no centro de massa da Terra.

Topocêntrica: O centro do elipsóide (ou origem dos eixos) não está localizado no centro de massa da Terra, mas sim no ponto de origem (vértice) escolhido.



© Encyclopædia Britannica, Inc.

```
> shp
```

```
Simple feature collection with 27 feature
```

```
Geometry type: MULTIPOLYGON
```

```
Dimension: XY
```

```
Bounding box: xmin: -73.99045 ymin: -33.
```

```
Geodetic CRS: SIRGAS 2000
```

```
First 10 features:
```

	CD_UF	NM_UF	SIGLA	NM_REGIAO		
1	11	Rondônia	RO	Norte	MULTIP	
2	12	Acre	AC	Norte	MULTIP	
3	13	Amazonas	AM	Norte	MULTIP	
4	14	Roraima	RR	Norte	MULTIP	
5	15	Pará	PA	Norte	MULTIP	
6	16	Amapá	AP	Norte	MULTIP	
7	17	Tocantins	TO	Norte	MULTIP	
8	21	Maranhão	MA	Nordeste	MULTIP	
9	22	Piauí	PI	Nordeste	MULTIP	
10	23	Ceará	CE	Nordeste	MULTIPOLYGON (((-40.49502 -11	

```
> class(shp)
```

```
[1] "sf"
```

```
> mode(shp)
```

```
[1] "list"
```

```
"data.frame"
```

Orientação:

Geocêntrica: Eixo de rotação paralelo ao eixo de rotação da Terra, onde a origem está localizada no centro de massa da Terra.

Topocêntrica: O centro do elipsóide (ou origem dos eixos) não está localizado no centro de massa da Terra, mas sim no ponto de origem (vértice) escolhido.

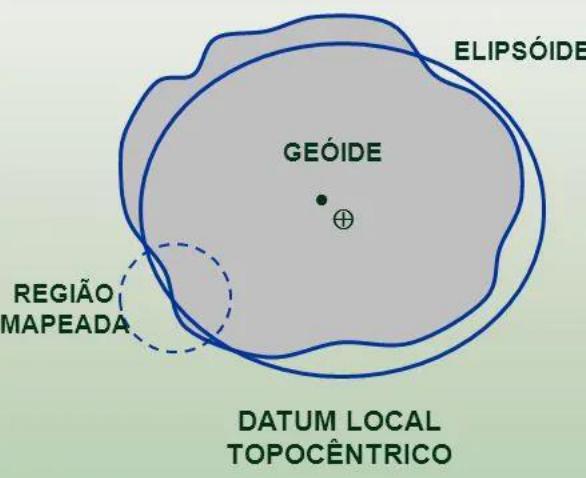
Sistemas Geodésicos no Brasil

SAD-69

Sistema Geodésico Sul-Americano

1969

Datum Local, Topocêntrico



SIRGAS 2000

Sistema de Referência Geocêntrico para as

Américas

Datum Global, Geocêntrico

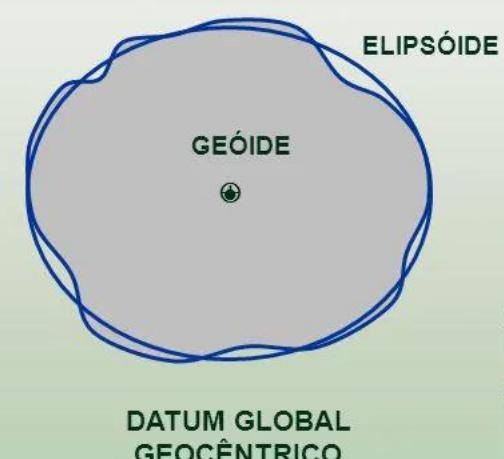
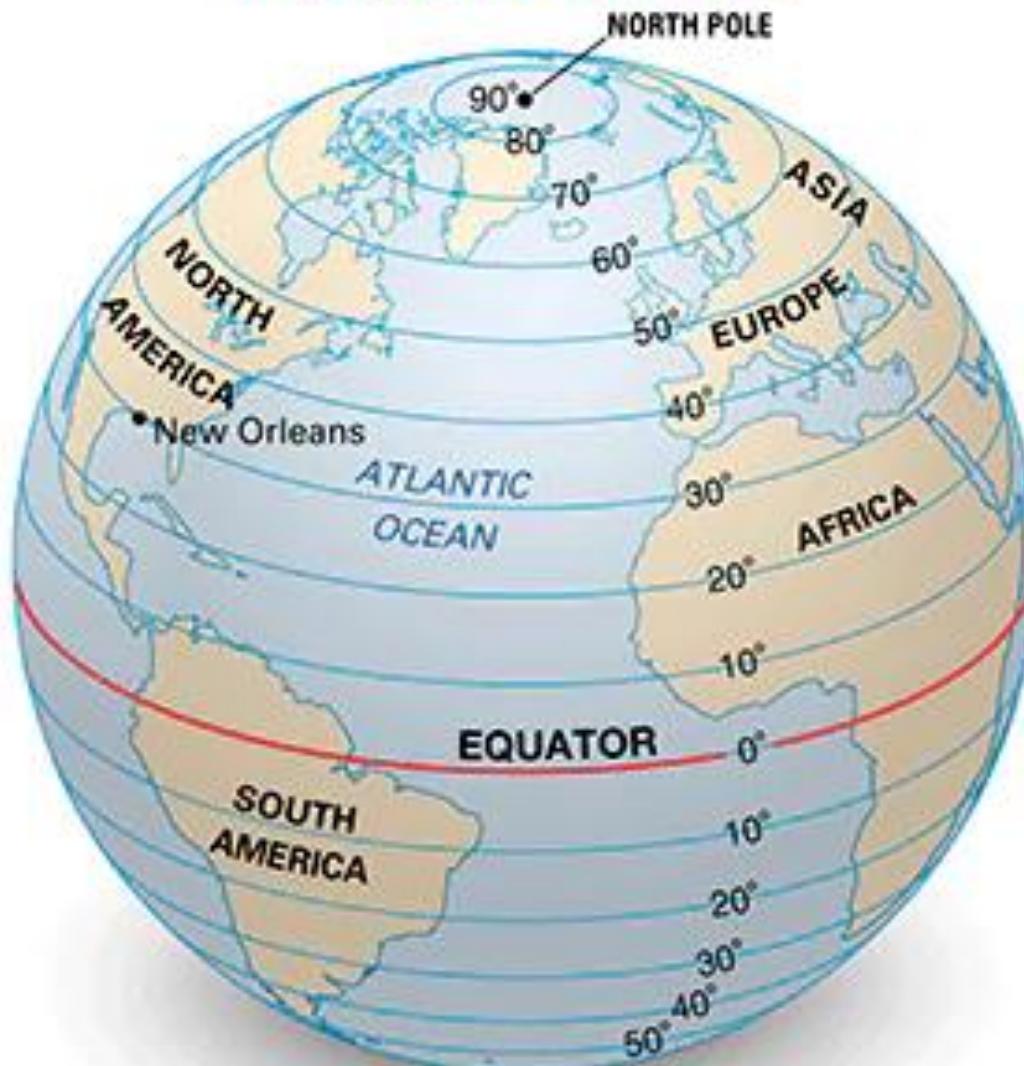
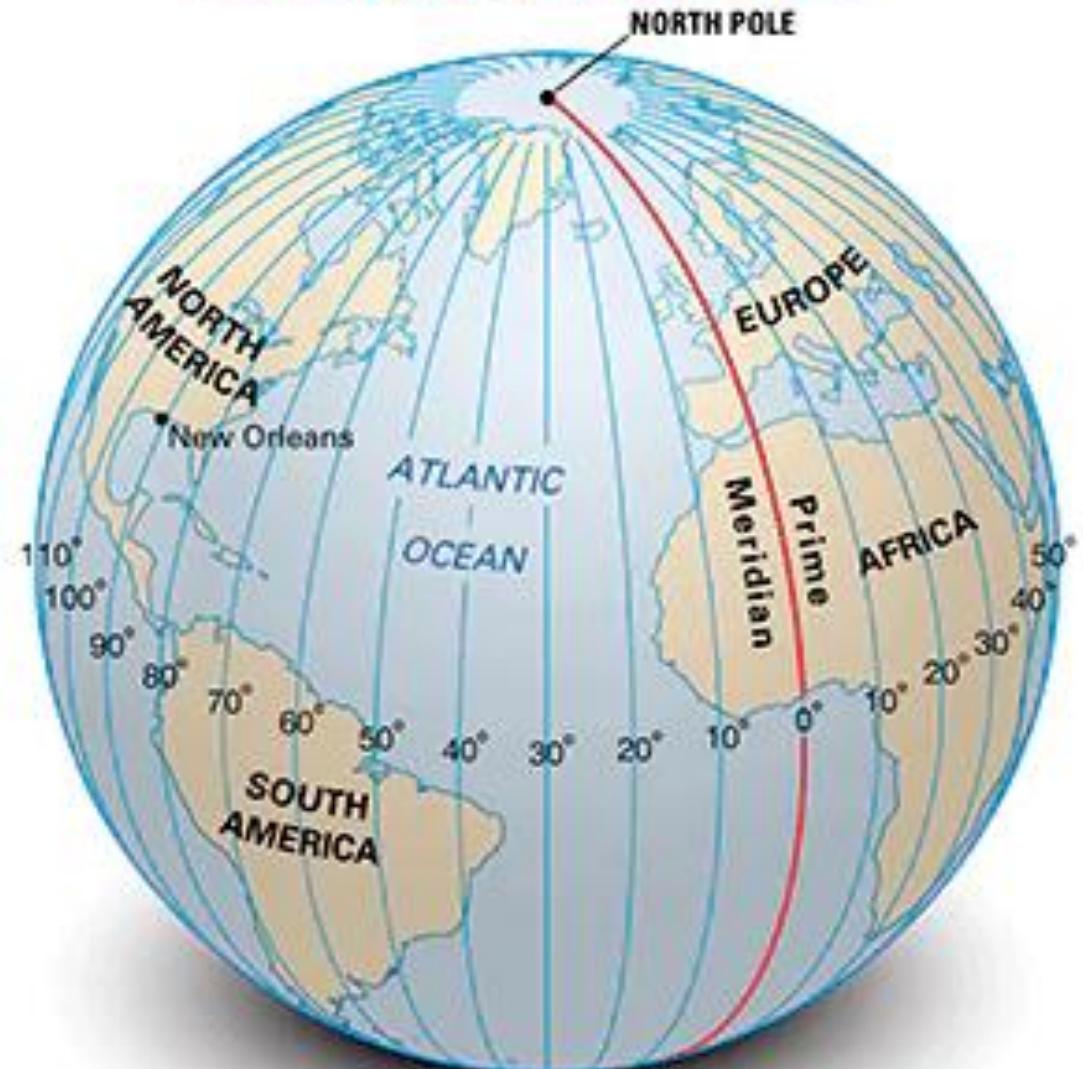


Figura: Júlio D'Alge

LATITUDE



LONGITUDE



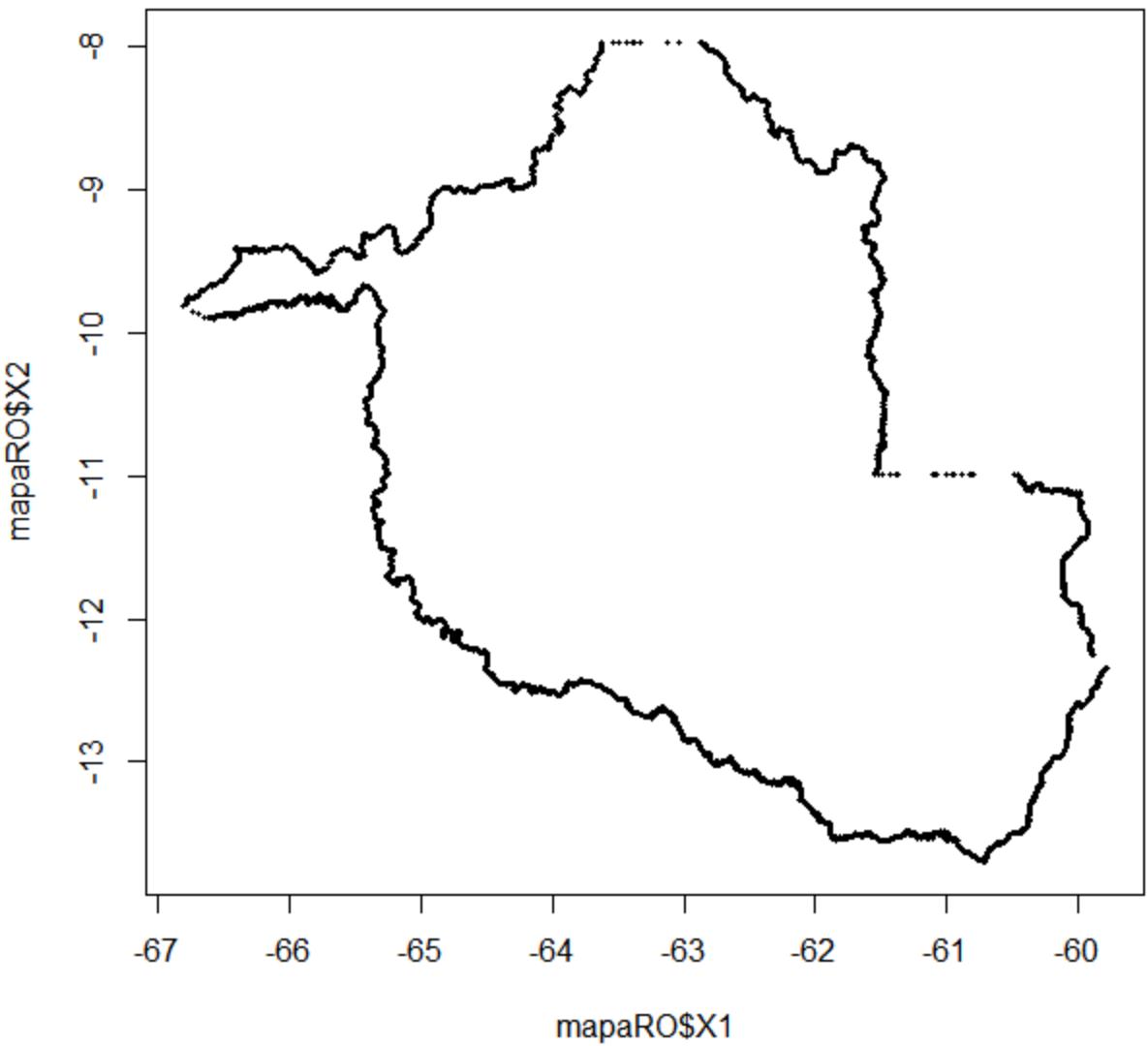
```
> shp
Simple feature collection with 27 features and 4 fields
Geometry type: MULTIPOLYGON
Dimension: XY
Bounding box: xmin: -73.99045 ymin: -33.75118 xmax: -28.84764 ymax: 5.271841
Geodetic CRS: SIRGAS 2000
First 10 features:
  CD_UF NM_UF SIGLA NM_REGIAO geometry
1    11 Rondônia RO      Norte MULTIPOLYGON ((((-62.86662 -...
2    12 Acre       AC      Norte MULTIPOLYGON ((((-73.1655 -7...
3    13 Amazonas AM      Norte MULTIPOLYGON ((((-67.32609 2...
4    14 Roraima  RR      Norte MULTIPOLYGON ((((-60.20051 5...
5    15 Pará        PA      Norte MULTIPOLYGON ((((-46.43676 -...
6    16 Amapá       AP      Norte MULTIPOLYGON ((((-50.45011 2...
7    17 Tocantins TO      Norte MULTIPOLYGON ((((-48.35878 -...
8    21 Maranhão MA      Nordeste MULTIPOLYGON ((((-44.66115 -...
9    22 Piauí       PI      Nordeste MULTIPOLYGON ((((-41.78076 -...
10   23 Ceará       CE      Nordeste MULTIPOLYGON ((((-40.49582 -...
```

```
> class(shp)
[1] "sf"           "data.frame"
> mode(shp)
[1] "list"
```

Vamos considerar a primeira
“feature” como exemplo

```
> shp$geometry[[1]]  
MULTIPOLYGON ((((-62.86662 -7.975868, -62.86017 -7.982323, -62.85336 -7.987563, -62.84506 -  
7.986531, -62.84161 -7.994973, -62.83283 -7.994372, -62.82572 -8.007521, -62.821 -8.014496, -  
62.81434 -8.018363, -62.81 -8.02534, -62.80176 -8.025656, -62.7943 -8.027548, -62.78857 -8.026695,  
-62.7862 -8.026343, -62.78218 -8.029451, -62.77984 -8.031259, -62.77219 -8.031494, -62.76528 -  
8.036046, -62.75789 -8.038437, -62.7518 -8.043556, -62.74397 -8.045286, -62.73803 -8.050069, -  
62.73311 -8.056566, -62.72764 -8.062485, -62.72462 -8.069198, -62.71811 -8.074114, -62.71283 -  
8.080583, -62.70642 -8.085313, -62.6995 -8.088366, -62.69228 -8.092908, -62.69056 -8.100904, -  
62.68403 -8.104888, -62.67884 -8.111445, -62.67914 -8.111673, -62.6855 -8.116438, -62.6833 -  
8.12397, -62.67825 -8.130067, -62.67411 -8.136953, -62.67303 -8.145311, -62.67673 -8.152449, -  
62.67917 -8.160776, -62.68525 -8.165718, -62.68666 -8.173774, -62.683 -8.180565, -62.67667 -  
8.185398, -62.67352 -8.192735, -62.66694 -8.196721, -62.65989 -8.199634, -62.65103 -8.22203, -  
62.655 -8.229056, -62.64995 -8.237026, -62.64195 -8.239343, -62.63628 -8.244598, -62.62897 -  
8.248555, -62.6182 -8.25721, -62.61036 -8.2598, -62.60402 -8.265124, -62.60006 -8.272239, -  
62.59277 -8.27497, -62.58539 -8.271881, -62.5815 -8.278625, -62.57419 -8.280653, -62.56923 -  
8.287279, -62.56192 -8.284007, -62.55731 -8.296261, -62.55626 -8.304282, -62.55594 -8.306759, -  
62.56116 -8.313832, -62.55527 -8.319387, -62.55578 -8.327436, -62.54911 -8.342143, -62.54892 -  
8.350315, -62.55153 -8.358195, -62.53956 -8.35811, -62.532 -8.371029, -62.52547 -8.375347, -  
62.52614 -8.383054, -62.51847 -8.384738, -62.50825 -8.372602, -62.50083 -8.366128, -62.49269 -  
8.36436, -62.48695 -8.359212, -62.48275 -8.352751, -62.47892 -8.345673, -62.47297 -8.340753, -  
62.46547 -8.33974, -62.45895 -8.343581, -62.45377 -8.349173, -62.44533 -8.362483, -62.43972 -  
8.367898, -62.43225 -8.372028, -62.42456 -8.374985, -62.41622 -8.376628, -62.40825 -8.377448, -  
62.40002 -8.374803, -62.39236 -8.375321, -62.38403 -8.377556, -62.37055 -8.384659, -62.36508 -  
8.391022, -62.3608 -8.398549, -62.35997 -8.406998, -62.36122 -8.42369, -62.36713 -8.43845, -  
62.36928 -8.446119, -62.36956 -8.454197, -62.36767 -8.462729, -62.36511 -8.470626, -62.36372 -  
8.478227, -62.36402 -8.4859, -62.36605 -8.493562, -62.36008 -8.506364, -62.35398 -8.511701, -  
62.34489 -8.513193, -62.33736 -8.516639, -62.33322 -8.527763, -62.33514 -8.537184, -62.33433 -  
8.546194, -62.32941 -8.555074, -62.3258 -8.563707, -62.32772 -8.572537, -62.33414 -8.579543
```

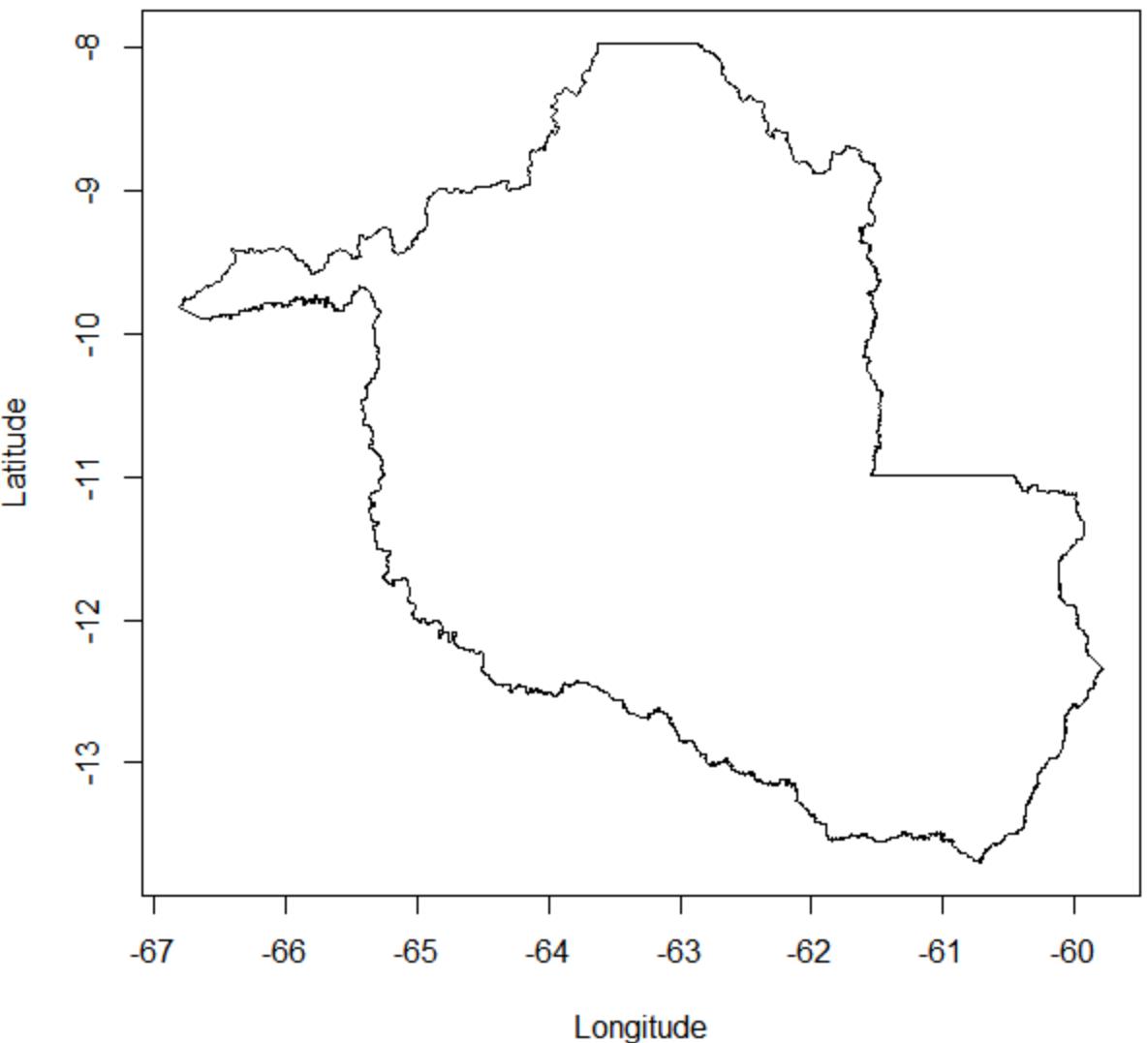
```
> # Rondônia  
> mapaRO <- data.frame(shp$geometry[[1]][1])  
> head(mapaRO, 25)  
      X1      X2  
1 -62.86662 -7.975868  
2 -62.86017 -7.982323  
3 -62.85336 -7.987563  
4 -62.84506 -7.986531  
5 -62.84161 -7.994973  
6 -62.83283 -7.994372  
7 -62.82572 -8.007521  
8 -62.82100 -8.014496  
9 -62.81434 -8.018363  
10 -62.81000 -8.025340  
11 -62.80176 -8.025656  
12 -62.79430 -8.027548  
13 -62.78857 -8.026695  
14 -62.78620 -8.026343  
15 -62.78218 -8.029451  
16 -62.77984 -8.031259  
17 -62.77219 -8.031494  
18 -62.76528 -8.036046  
19 -62.75789 -8.038437  
20 -62.75180 -8.043556  
21 -62.74397 -8.045286  
22 -62.73803 -8.050069  
23 -62.73311 -8.056566  
24 -62.72764 -8.062485  
25 -62.72462 -8.069198  
> plot(mapaRO$x1, mapaRO$x2, pch=16, cex=0.4)
```



```
> # Rondônia  
> mapaRO <- data.frame(shp$geometry[[1]][1])  
> head(mapaRO, 25)
```

	X1	X2
1	-62.86662	-7.975868
2	-62.86017	-7.982323
3	-62.85336	-7.987563
4	-62.84506	-7.986531
5	-62.84161	-7.994973
6	-62.83283	-7.994372
7	-62.82572	-8.007521
8	-62.82100	-8.014496
9	-62.81434	-8.018363
10	-62.81000	-8.025340
11	-62.80176	-8.025656
12	-62.79430	-8.027548
13	-62.78857	-8.026695
14	-62.78620	-8.026343
15	-62.78218	-8.029451
16	-62.77984	-8.031259
17	-62.77219	-8.031494
18	-62.76528	-8.036046
19	-62.75789	-8.038437
20	-62.75180	-8.043556
21	-62.74397	-8.045286
22	-62.73803	-8.050069
23	-62.73311	-8.056566
24	-62.72764	-8.062485
25	-62.72462	-8.069198

```
> plot(mapaRO$x1, mapaRO$x2, type="l", xlab="Longitude", ylab="Latitude")
```

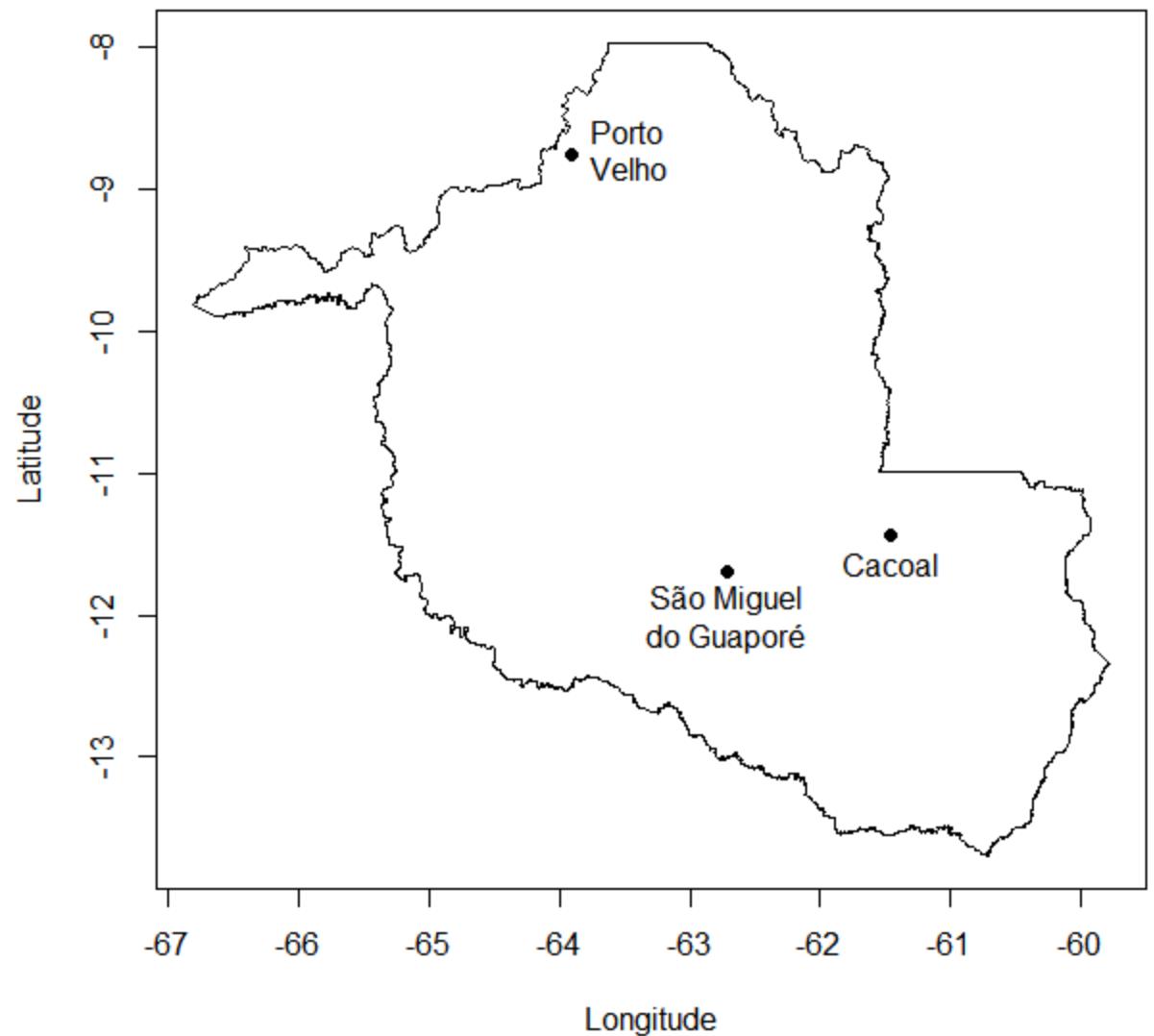


	Latitude	Longitude
Porto Velho	-8.761944	-63.903889
Cacoal	-11.437710	-61.455960
São Miguel do Guaporé	-11.696318	-62.717149

```

> plot(mapaRO$X1, mapaRO$X2, type="l",
      xlab="Longitude", ylab="Latitude")
>
>
> points(-63.903889, -8.761944, pch=19)
> points(-61.455960, -11.437710, pch=19)
> points(-62.717149, -11.696318, pch=19)
>
> text(-63.903889, -8.761944, "Porto\nVelho", pos=4)
> text(-61.455960, -11.437710, "Cacoal", pos=1)
> text(-62.717149, -11.696318, "São Miguel\nndo Guaporé",
      pos=1)

```



Dados de IDH das UF

Salvamento Automático IDH_UF_Brasil • Salvo neste PC

Arquivo Página Inicial Inserir Layout da Página Fórmulas Dados Revisão Exibir Ajuda Acrobat

Fonte Alinhamento Número Estilos

Área de Transfer... Formatação Condicional Formatar Tabela

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Rank	Uf nome	UF	IDH2021	E2021	R2021	L2021	IDH2010	E2010	R2010	L2010	IDH2000	E2000
2	16	Acre	AC	0,71	0,692	0,655	0,788	0,663	0,559	0,671	0,777	0,517	0,329
3	26	Alagoas	AL	0,684	0,679	0,63	0,748	0,631	0,52	0,641	0,755	0,471	0,281
4	25	Amapá	AP	0,688	0,647	0,648	0,778	0,708	0,629	0,694	0,813	0,577	0,424
5	18	Amazonas	AM	0,7	0,72	0,641	0,744	0,674	0,561	0,677	0,805	0,515	0,324
6	22	Bahia	BA	0,691	0,659	0,648	0,772	0,66	0,555	0,663	0,783	0,512	0,332
7	12	Ceará	CE	0,734	0,766	0,658	0,784	0,682	0,615	0,651	0,793	0,541	0,371
8	1	Distrito Fed	DF	0,814	0,817	0,821	0,803	0,824	0,742	0,863	0,873	0,725	0,581
9	6	Espírito Sa	ES	0,771	0,742	0,715	0,864	0,74	0,653	0,743	0,835	0,64	0,491
10	10	Goiás	GO	0,737	0,778	0,714	0,721	0,735	0,646	0,742	0,827	0,615	0,439
11	27	Maranhão	MA	0,676	0,716	0,603	0,715	0,639	0,562	0,612	0,757	0,476	0,312
12	11	Mato Grosso	MT	0,736	0,758	0,72	0,73	0,725	0,635	0,732	0,821	0,601	0,426
13	9	Mato Grosso	MS	0,742	0,741	0,733	0,751	0,729	0,629	0,74	0,833	0,613	0,449

Dados de IDH das UF

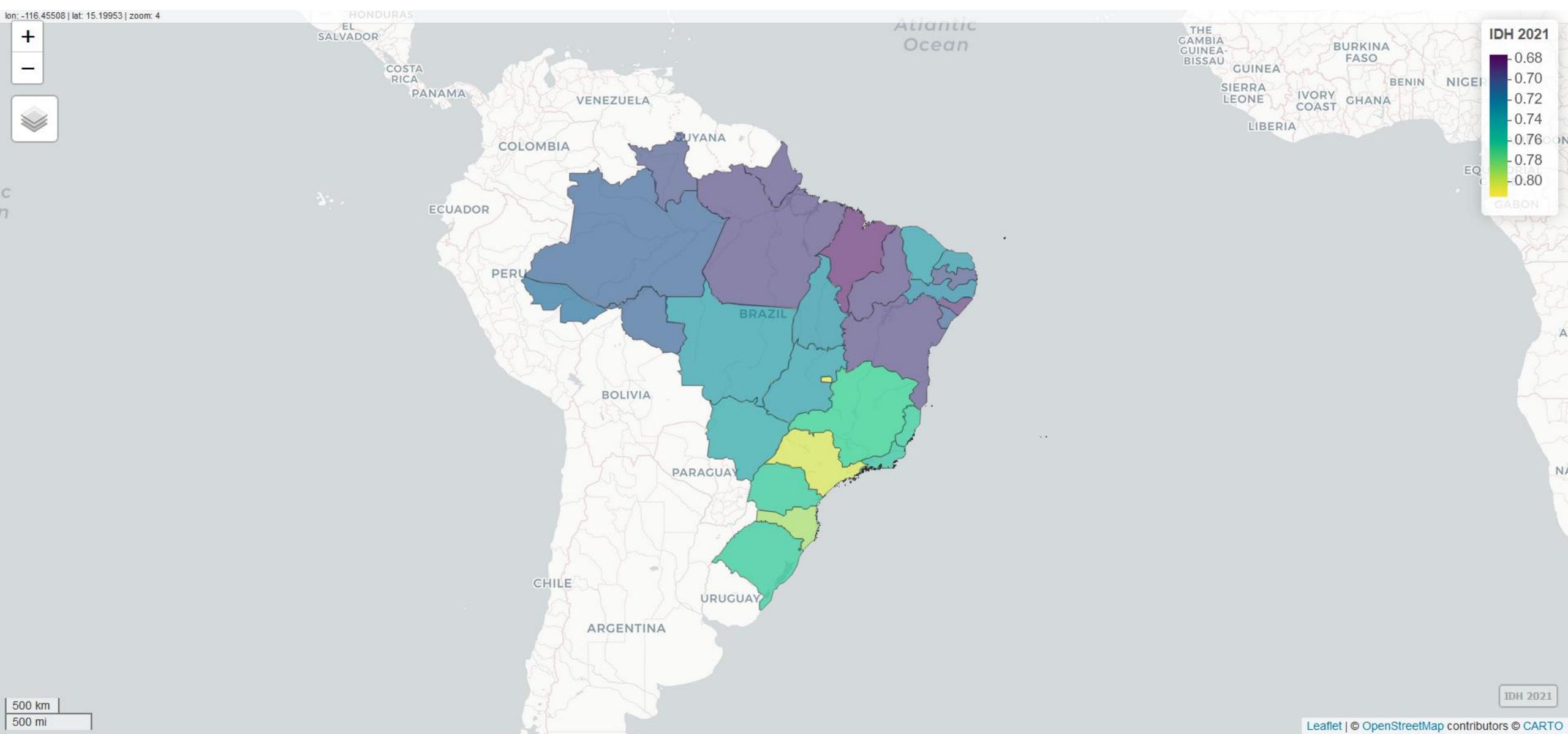
```
urlfile="https://raw.githubusercontent.com/edsonzmartinez/basesdedados/main/IDH_UF_Brasil.csv"
w  <- read.csv2(urlfile)
w2 <- data.frame(SIGLA=w$UF, IDH2021=w$IDH2021, E2021=w$E2021,
                  R2021=w$R2021, L2021=w$L2021)
shp.sf <- merge(x=shp, y=w2, by="SIGLA", all.x=FALSE)
mapview::mapview(shp.sf, zcol = "IDH2021", layer.name="IDH 2021")
```

The screenshot shows a GitHub repository page for the user 'edsonzmartinez' named 'spatial'. The repository is public. At the top, there are navigation links for Code, Issues, Pull requests, Actions, Projects, Wiki, Security, Insights, and Settings. Below the header, there's a summary bar showing 'main' branch, 1 Branch, 0 Tags, and a search bar labeled 'Go to file'. The main content area displays a file list: 'README.md' by 'edsonzmartinez' (last updated 2 days ago), 'BR_UF_2021.zip' (Add files via upload, last updated 2 days ago), and 'CARBayes Example 1.r' (CARBayes package - Example 01, last updated 2 days ago).

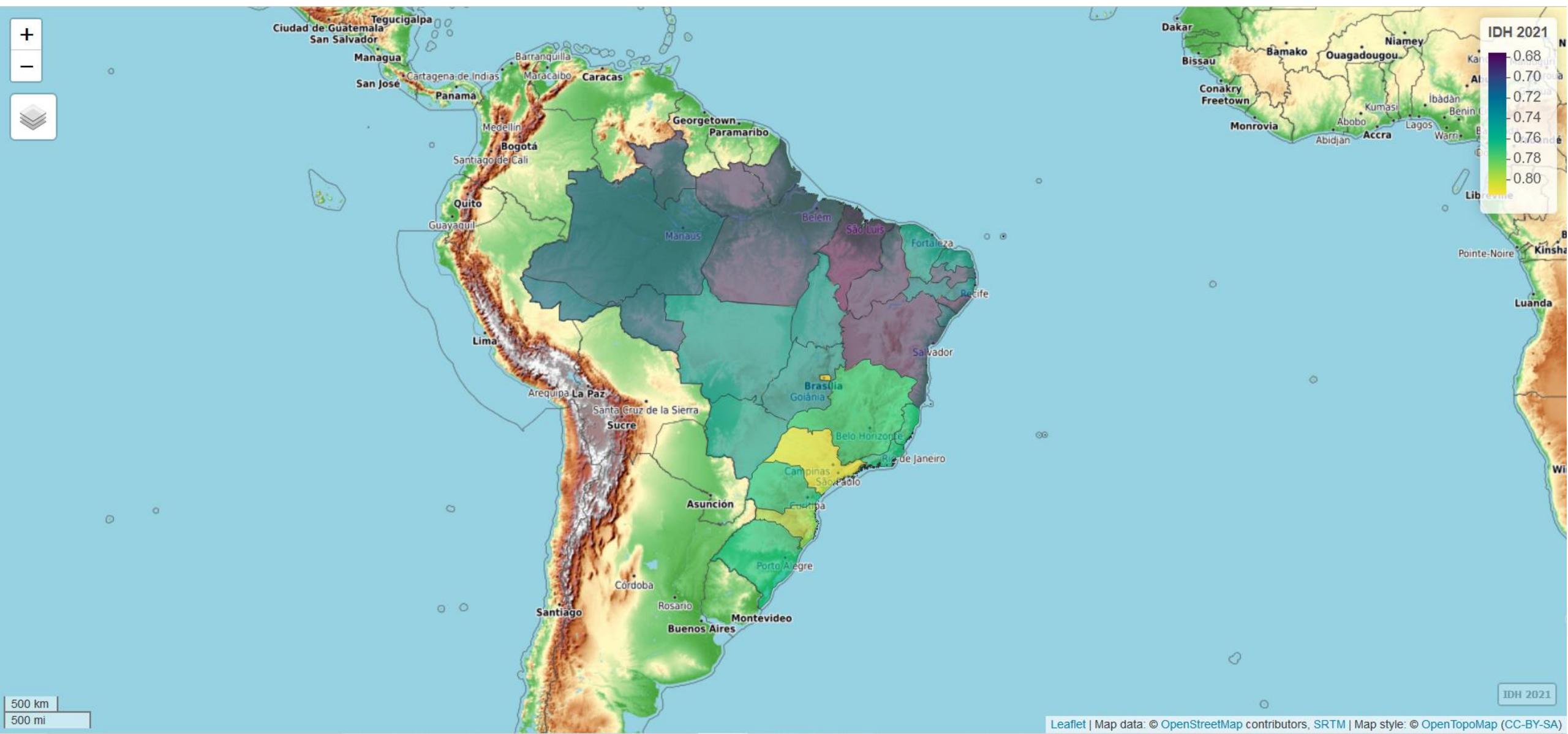
<https://github.com/edsonzmartinez/spatial>

Dados de IDH das UF

```
mapview::mapview(shp.sf, zcol = "IDH2021", layer.name="IDH 2021")
```



```
mapview::mapview(shp.sf, zcol = "IDH2021", layer.name="IDH 2021")
```



Dados de casos de AIDS, TABNET

The screenshot shows a Microsoft Excel spreadsheet titled "AIDS2020_2023 • Salvo neste PC". The ribbon menu is visible at the top, with "Página Inicial" selected. The formula bar shows the cell reference K13. The table below contains data for 11 rows, each representing a Brazilian state or federal district. The columns are labeled A through J, with some labels repeated. The columns include: Ufresidenc (row 1), SIGLA (row 1), AIDS2020 (row 1), AIDS2021 (row 1), AIDS2022 (row 1), AIDS2023 (row 1), POP2024 (row 1), POP2022 (row 1), and several other columns for other years. The cells for AIDS2022 and POP2022 are highlighted with red boxes.

	A	B	C	D	F	F	G	H	I	J
1	Ufresidenc	SIGLA	AIDS2020	AIDS2021	AIDS2022	AIDS2023	POP2024	POP2022		
2	Acre	AC		47	104	118	62	880631	830018	
3	Alagoas	AL		521	607	617	302	3220104	3127683	
4	Amapá	AP		168	217	223	93	802837	733759	
5	Amazonas	AM		1193	1678	1398	586	4281209	3941613	
6	Bahia	BA		1652	1908	2037	939	14850513	14141626	
7	Ceará	CE		1079	1137	1300	625	9233656	8794957	
8	Distrito Fed	DF		380	428	420	204	2982815	2817381	
9	Espírito Sa	ES		630	656	752	313	4102129	3833712	
10	Goiás	GO		936	1157	1264	577	7350483	7056495	
11	Maranhão	MA		905	1122	1333	577	7010960	6775805	

Dados de casos de AIDS, TABNET

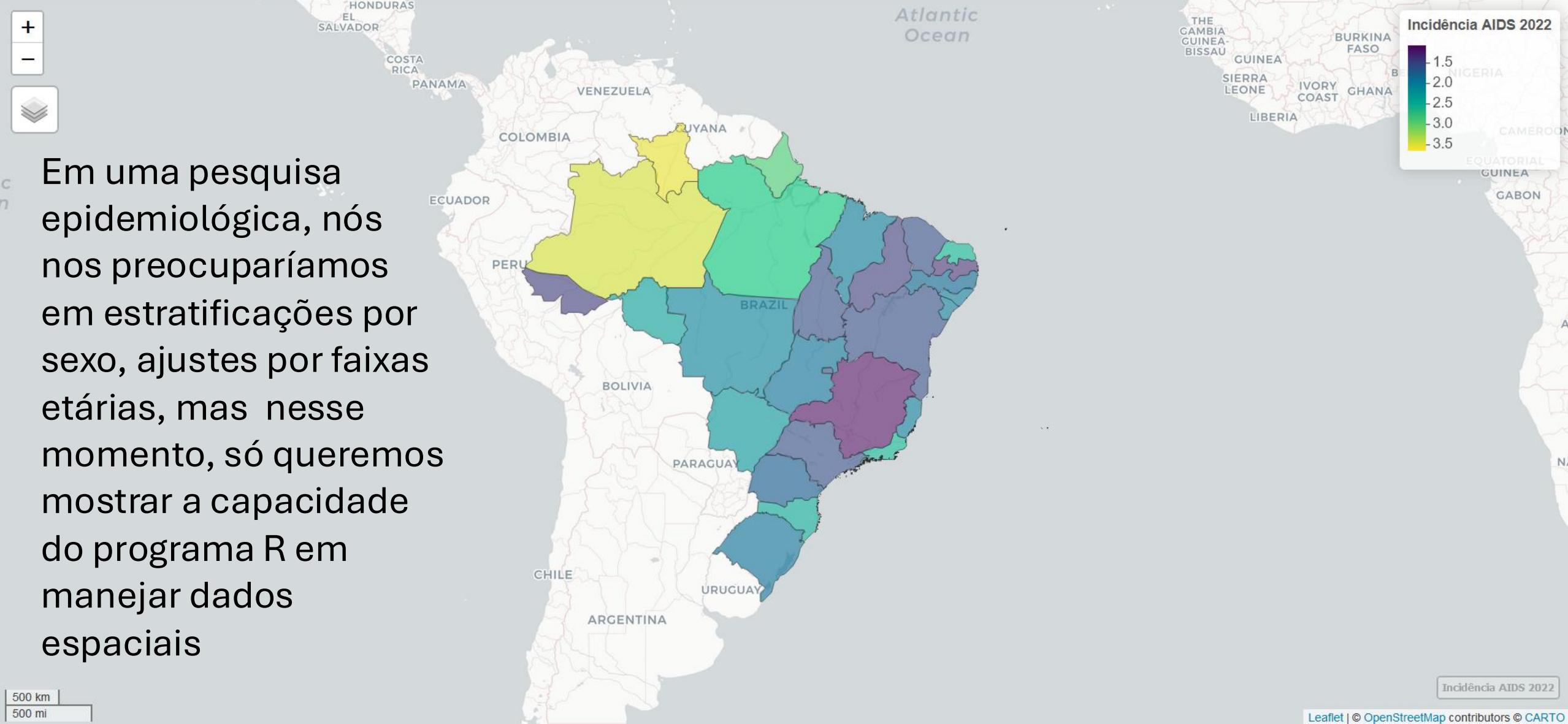
```
# AIDS
urlfile="https://raw.githubusercontent.com/edsonzmartinez/basesdedados/main/AIDS2020_2023.csv"
aids      <- read.csv2(urlfile)
aids$incd <- 10000*aids$AIDS2022/aids$POP2022
aids2     <- data.frame(SIGLA=aids$SIGLA, incd=aids$incd, AIDS2022=aids$AIDS2022,
                           pop2022=aids$POP2022)
shp.sf    <- merge(x=shp.sf, y=aids2, by="SIGLA", all.x=FALSE)

shp.sf
Simple feature collection with 27 features and 11 fields
Geometry type: MULTIPOLYGON
Dimension:      XY
Bounding box:   xmin: -73.99045 ymin: -33.75118 xmax: -28.84764 ymax: 5.271841
Geodetic CRS:   SIRGAS 2000
First 10 features:
  SIGLA CD_UF      NM_UF      NM_REGIAO IDH2021 E2021 R2021 L2021      incd AIDS2022 pop2022
1   AC    12       Acre        Norte  0.710 0.692 0.655 0.788 1.421656    118  830018 MULTIPOLYGON ((((-73.1655 -7...
2   AL    27     Alagoas     Nordeste 0.684 0.679 0.630 0.748 1.972706    617 3127683 MULTIPOLYGON ((((-35.75791 -...
3   AM    13   Amazonas     Norte  0.700 0.720 0.641 0.744 3.546771   1398 3941613 MULTIPOLYGON ((((-67.32609 2...
4   AP    16     Amapá       Norte  0.688 0.647 0.648 0.778 3.039145   223  733759 MULTIPOLYGON ((((-50.45011 2...
5   BA    29      Bahia     Nordeste 0.691 0.659 0.648 0.772 1.440428   2037 14141626 MULTIPOLYGON ((((-38.69616 -...
6   CE    23     Ceará       Nordeste 0.734 0.766 0.658 0.784 1.478120   1300  8794957 MULTIPOLYGON ((((-40.49582 -...
7   DF    53  Distrito Federal Centro-oeste 0.814 0.817 0.821 0.803 1.490746   420  2817381 MULTIPOLYGON ((((-47.41734 -...
8   ES    32 Espírito Santo     Sudeste 0.771 0.742 0.715 0.864 1.961545   752  3833712 MULTIPOLYGON ((((-40.8843 -2...
9   GO    52      Goiás     Centro-oeste 0.737 0.778 0.714 0.721 1.791258   1264  7056495 MULTIPOLYGON ((((-50.15002 -...
10  MA    21  Maranhão     Nordeste 0.676 0.716 0.603 0.715 1.967294   1333  6775805 MULTIPOLYGON ((((-44.66115 -...
```

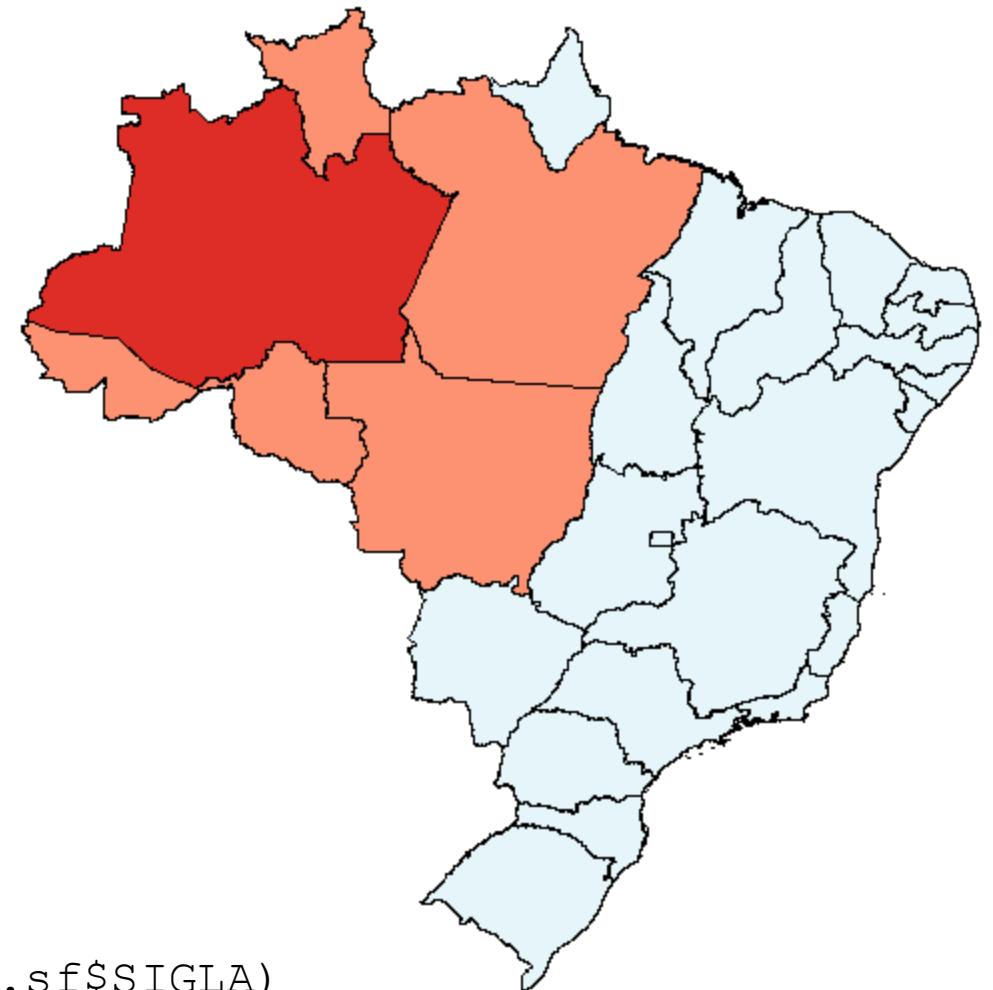
```
mapview::mapview(shp.sf, zcol = "incd", layer.name="Incidênci AIDS 2022")
```



```
mapview::mapview(shp.sf, zcol = "incd", layer.name="Incidência AIDS 2022")
```

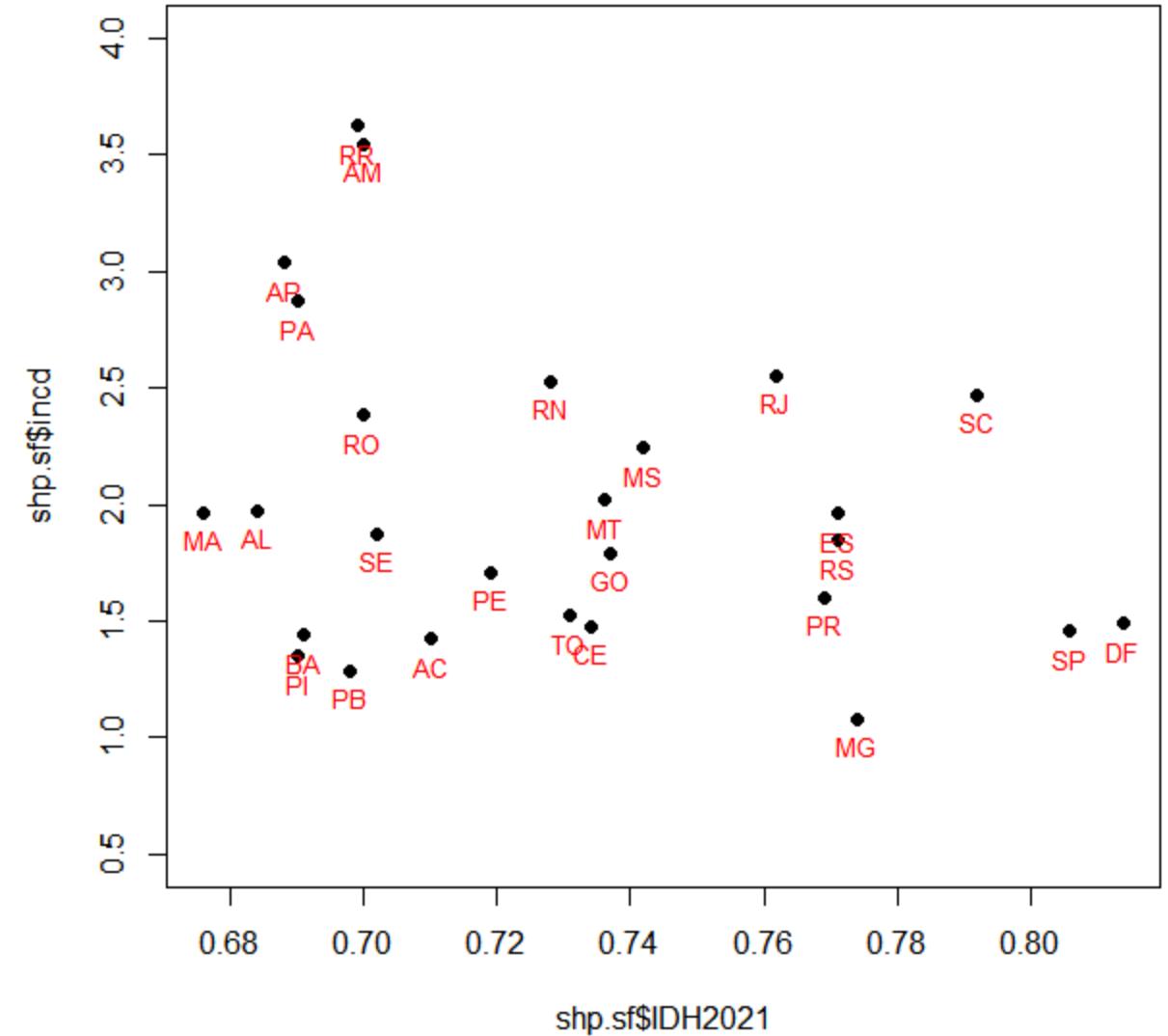


Vizinhanças



```
# Criando uma matriz de vizinhanças
W.nb    <- spdep::poly2nb(shp.sf, row.names = shp.sf$SIGLA)
W.list <- spdep::nb2listw(W.nb, style="B")
W      <- spdep::nb2mat(W.nb, style="B")
print(matrix(W, ncol=27, dimnames=list(shp.sf$SIGLA, shp.sf$SIGLA)))
```

```
> print(matrix(W, ncol=27, dimnames=list(shp.sf$SIGLA, shp.sf$SIGLA)))
```



```
plot(shp.sf$IDH2021, shp.sf$incd, ylim=c(0.5, 4), pch=19)
text(shp.sf$IDH2021, shp.sf$incd, shp.sf$SIGLA, pos=1, cex=0.8, col="red")
```

Regressão linear

$$Y_i = \beta_0 + \beta_1 IDH_i + \varepsilon_i$$

```
> # Modelo de regressão linear  
> model <- lm(incd ~ IDH2021, data=shp.sf)  
> summary(model)
```

Call:
`lm(formula = incd ~ IDH2021, data = shp.sf)`

Residuals:

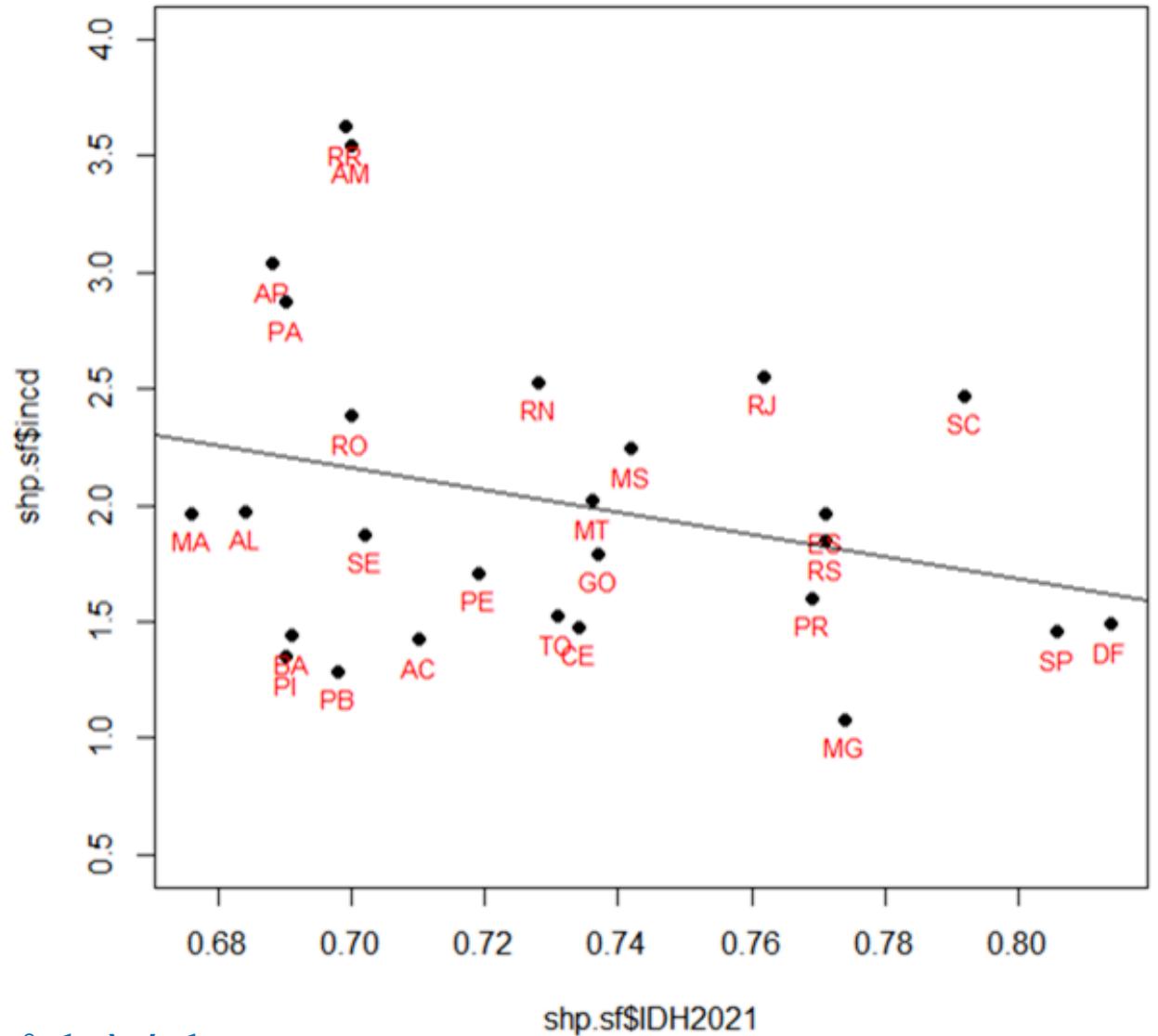
Min	1Q	Median	3Q	Max
-0.8856	-0.4284	-0.1954	0.3894	1.4591

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	5.522	2.357	2.343	0.0274 *
IDH2021	-4.797	3.224	-1.488	0.1492

Signif. codes: 0 '****' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6558 on 25 degrees of freedom
Multiple R-squared: 0.08136, Adjusted R-squared: 0.04462
F-statistic: 2.214 on 1 and 25 DF, p-value: 0.1492



Regressão linear

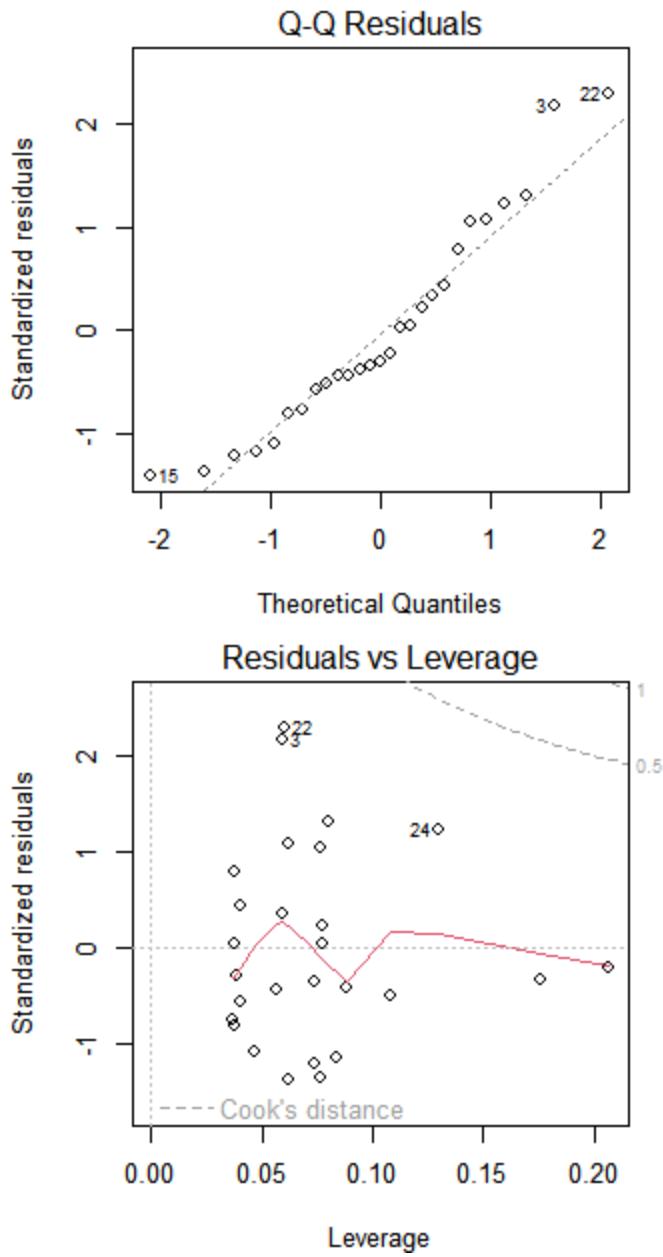
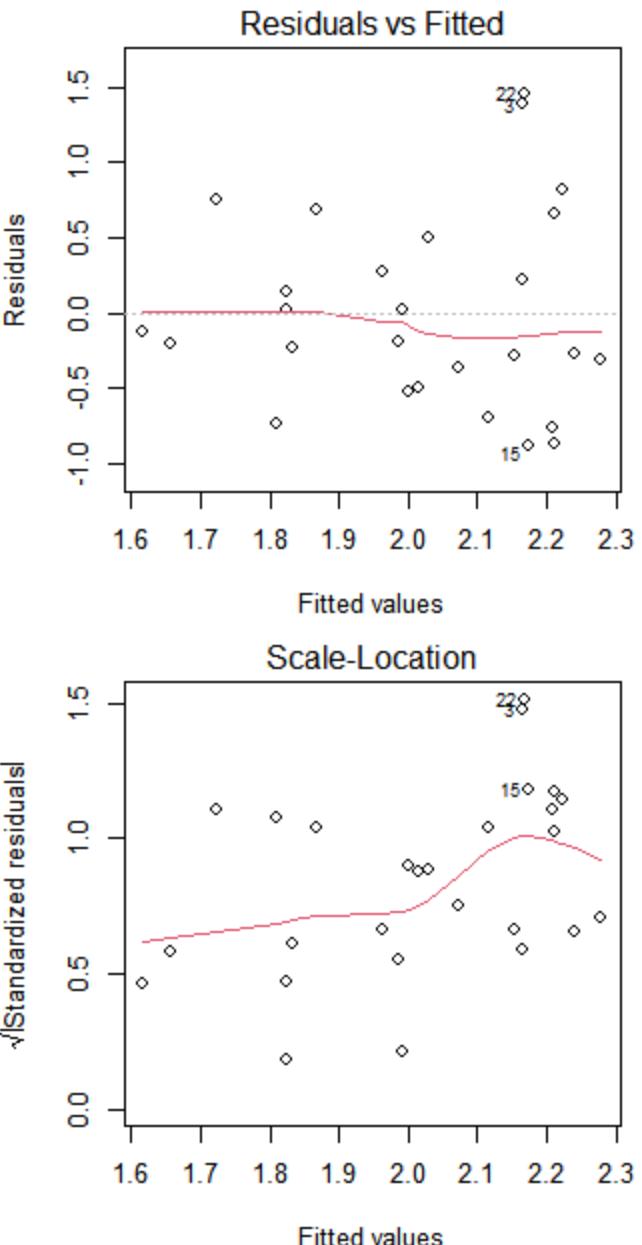
$$Y_i = \beta_0 + \beta_1 IDH_i + \varepsilon_i$$

```
> # Diagnósticos de resíduos  
> par(mar = c(4, 4, 2, 2), mfrow = c(2, 2))  
> plot(model)
```

3: Amazonas

15: Paraíba

22: Roraima

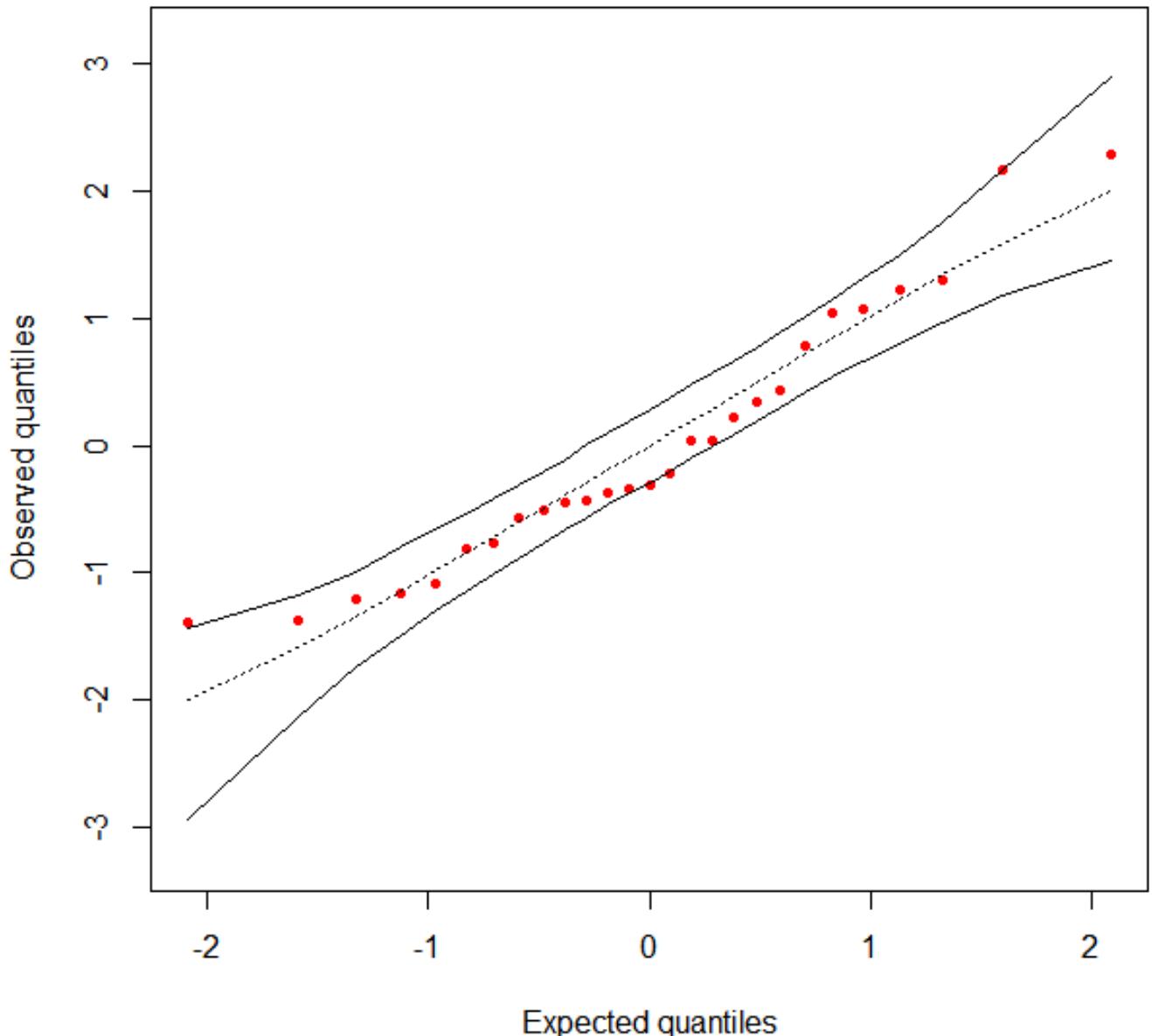


Regressão linear

$$Y_i = \beta_0 + \beta_1 IDH_i + \varepsilon_i$$

```
> glmtoolbox::envelope(model, rep=5000,  
  col="red", type="internal")
```

Normal QQ plot with simulated envelope
of internally studentized residuals



Regressão linear

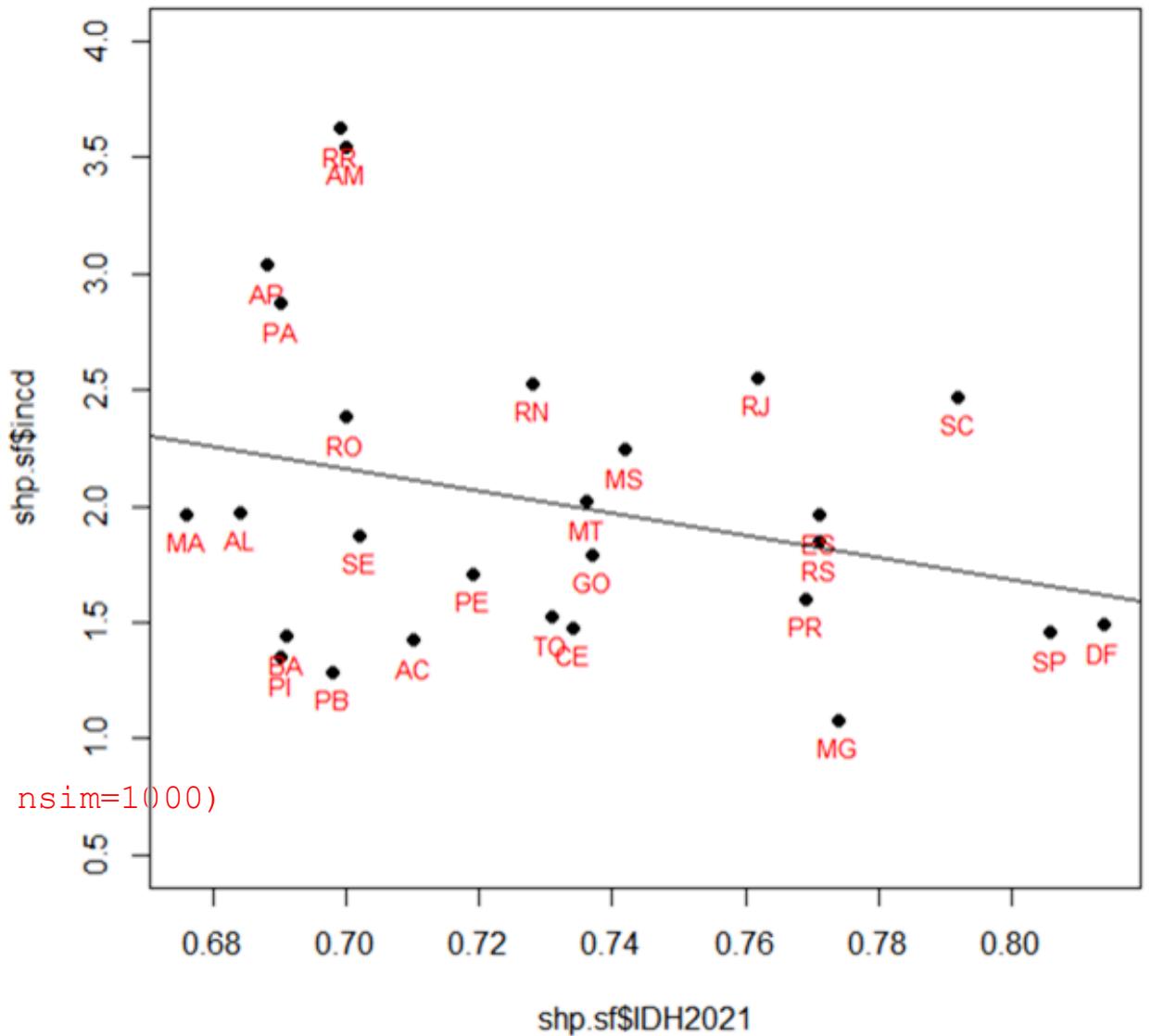
$$Y_i = \beta_0 + \beta_1 IDH_i + \varepsilon_i$$

```
> spdep::moran.mc(x=residuals(model), listw=W.list, nsim=1000)
```

Monte-Carlo simulation of Moran I

```
data: residuals(model)
weights: W.list
number of simulations + 1: 1001
```

```
statistic = 0.34042, observed rank = 995, p-value = 0.005994
alternative hypothesis: greater
```



Regressão de Poisson

$$O_i \sim Poisson(\theta_i \times Pop_i)$$

$$\log \theta_i = \beta_0 + \beta_1 IDH_i$$

```
> # Modelo de Poisson não espacial
> poisson.model <- glm(AIDS2022 ~ IDH2021 + offset(log(pop2022)), data=shp.sf, family = poisson(link = "log"))
> summary(poisson.model)
```

Call:

```
glm(formula = AIDS2022 ~ IDH2021 + offset(log(pop2022)), family = poisson(link = "log"),
  data = shp.sf)
```

Coefficients:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	-6.77749	0.08954	-75.69	<2e-16 ***
IDH2021	-2.45624	0.11972	-20.52	<2e-16 ***

Signif. codes: 0 '****' 0.001 '***' 0.01 '**' 0.05 '*' 0.1 '.' 1

(Dispersion parameter for poisson family taken to be 1)

```
Null deviance: 3423.2 on 26 degrees of freedom
Residual deviance: 3003.5 on 25 degrees of freedom
AIC: 3240.2
```

Regressão de Poisson

$$O_i \sim Poisson(\theta_i \times Pop_i)$$

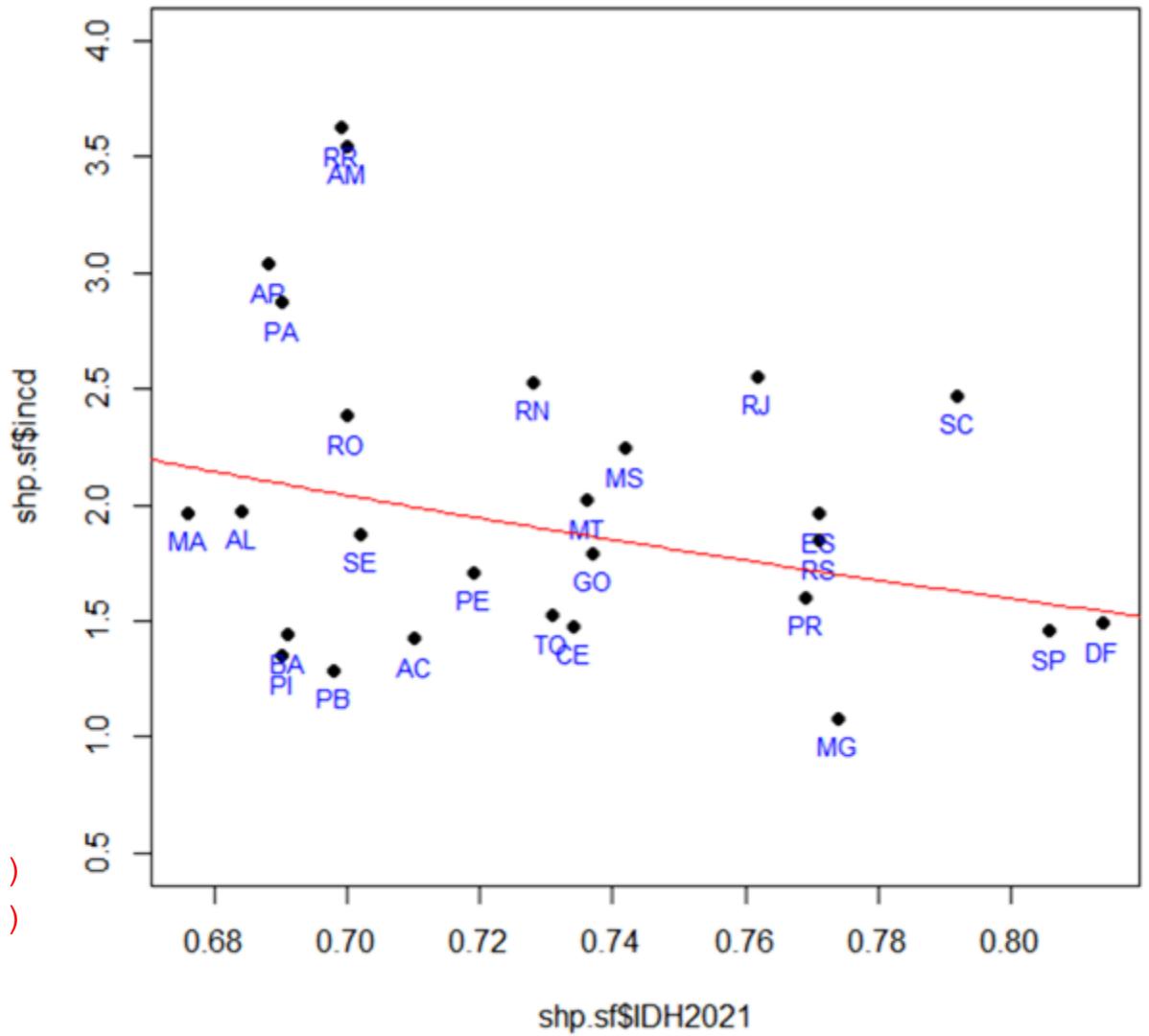
$$\log \theta_i = \beta_0 + \beta_1 IDH_i$$

```
> # Erros padrão robustos (Cameron and Trivedi, 2009)
> # Cameron, A. C. and Trivedi, P. K. 2009. Microeconometrics Using Stata. College Station, TX: Stata Press.
> # Cameron, A. C. and Trivedi, P. K. 1998. Regression Analysis of Count Data. New York: Cambridge Press.
> cov.ml <- vcovHC(poisson.model, type="HC0")
> std.err <- sqrt(diag(cov.ml))
> r.est <- cbind(Estimate= coef(poisson.model), "Robust SE" = std.err, "Pr(>|z|)" = 2 *
+ pnorm(abs(coef(poisson.model)/std.err), lower.tail=FALSE),
+ LL = coef(poisson.model) - 1.96 * std.err,
+ UL = coef(poisson.model) + 1.96 * std.err)
> r.est
      Estimate Robust SE     Pr(>|z|)         LL          UL
(Intercept) -6.777492  1.010257 1.963873e-11 -8.757595 -4.7973893
IDH2021      -2.456244  1.349272 6.869488e-02 -5.100818  0.1883298
> Pearson <- sum((shp.sf$AIDS2022 - poisson.model$fitted.values)^2 / poisson.model$fitted.values)
> message("Pearson's goodness-of-fit = ", round(Pearson, 3), ", p-value ", 1 - pchisq(Pearson, df =
poisson.model$df.residual))
Pearson's goodness-of-fit = 3122.855, p-value 0
> message("Estimated dispersion parameter = ", round(Pearson / poisson.model$df.residual, 4))
Estimated dispersion parameter = 124.9142
```

Regressão de Poisson

$$O_i \sim Poisson(\theta_i \times Pop_i)$$

$$\log \theta_i = \beta_0 + \beta_1 IDH_i$$



```
> a <- as.numeric(poisson.model$coefficients[1])
> b <- as.numeric(poisson.model$coefficients[2])
> x <- seq(0.5,1,0.001)
> curve <- function(x,a,b,pop) pop*exp(a+b*x)
> plot(shp.sf$IDH2021,shp.sf$incd,ylim=c(0.5,4),pch=19)
> text(shp.sf$IDH2021,shp.sf$incd,shp.sf$SIGLA,pos=1,cex=0.8,col="blue")
> points(x,curve(x,a,b,10000),type="l",col="red")
```

Regressão de Poisson

$$O_i \sim Poisson(\theta_i \times Pop_i)$$

$$\log \theta_i = \beta_0 + \beta_1 IDH_i$$

```
> spdep::moran.mc(x=residuals(poisson.model), listw=W.list, nsim=100000)
Monte-Carlo simulation of Moran I

data: residuals(poisson.model)
weights: W.list
number of simulations + 1: 100001

statistic = 0.16536, observed rank = 94302, p-value = 0.05699
alternative hypothesis: greater
```

Regressão Quasi Poisson

```
> # Modelo Quasi Poisson não espacial
> qpoisson.model <- glm(AIDS2022 ~ IDH2021 + offset(log(pop2022)), data=shp.sf, family =
quasipoisson(link = "log"))
> summary(qpoisson.model)
```

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-6.777	1.001	-6.773	4.25e-07 ***
IDH2021	-2.456	1.338	-1.836	0.0783 .

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for quasipoisson family taken to be 124.9143)

Null deviance: 3423.2 on 26 degrees of freedom
Residual deviance: 3003.5 on 25 degrees of freedom
AIC: NA

Number of Fisher Scoring iterations: 4

Regressão Quasi Poisson

```
> spdep:::moran.mc(x=residuals(qpoisson.model), listw=W.list, nsim=100000)
```

Monte-Carlo simulation of Moran I

```
data: residuals(qpoisson.model)
weights: W.list
number of simulations + 1: 100001
```

```
statistic = 0.16536, observed rank = 94248, p-value = 0.05753
alternative hypothesis: greater
```

Regressão de Poisson espacial

Besag-York-Mollie (BYM) CAR model

$$O_i \sim \text{Poisson}(\theta_i \times Pop_i)$$

$$\log \theta_i = \beta_0 + \beta_1 IDH_i + w_i$$

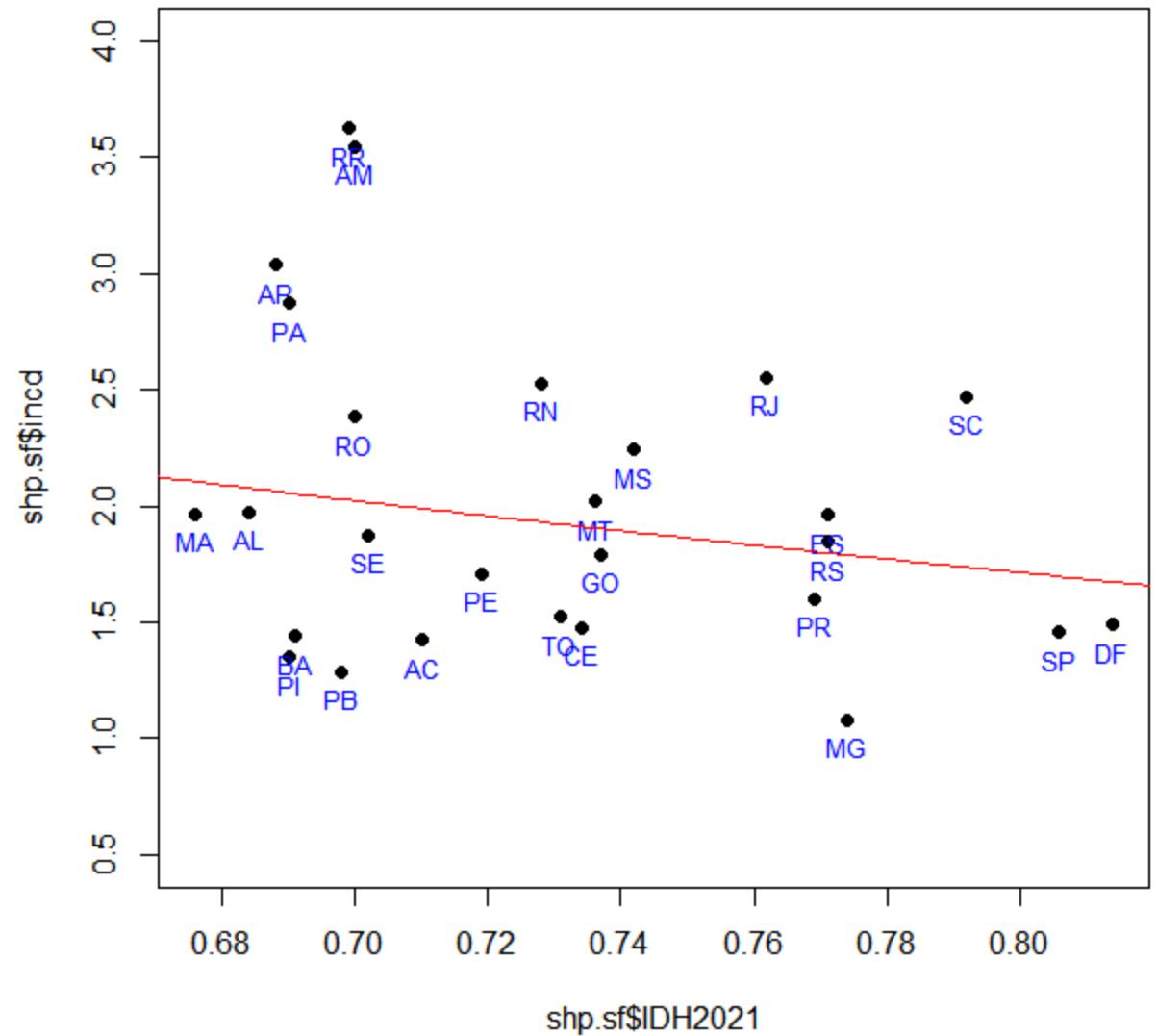
$$w_i = \phi_k + \psi_k$$

$$\psi_i \sim N(0, \sigma^2)$$

ϕ_i ~ Conditional Autoregressive (CAR) normal distribution

```
# Modelo de Poisson espacial
form <- AIDS2022 ~ IDH2021 + offset(log(pop2022))
chain <- CARBayes::S.CARbym(formula=form, data=shp.sf, family="poisson", W=W,
  burnin=100000, n.sample=300000, thin=100, n.chains=3, n.cores=3)
```

Regressão de Poisson espacial



Regressão de Poisson espacial

```
> summary.beta <- summary(chain$samples$beta, quantiles=c(0.025, 0.975))  
>  
> summary.beta
```

```
Iterations = 1:2000  
Thinning interval = 1  
Number of chains = 3  
Sample size per chain = 2000
```

1. Empirical mean and standard deviation for each variable,
plus standard error of the mean:

	Mean	SD	Naive SE	Time-series SE
[1,]	-7.344	1.666	0.02151	0.09665
[2,]	-1.659	2.282	0.02947	0.13242

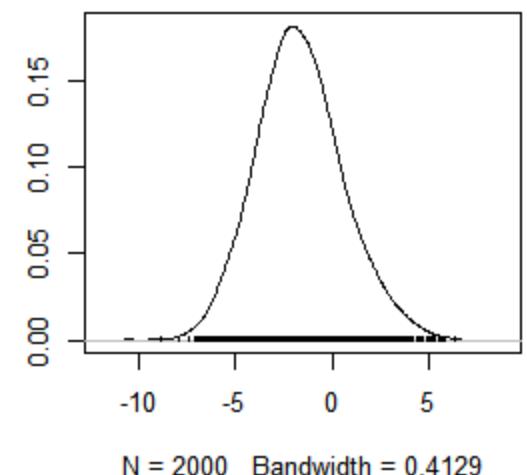
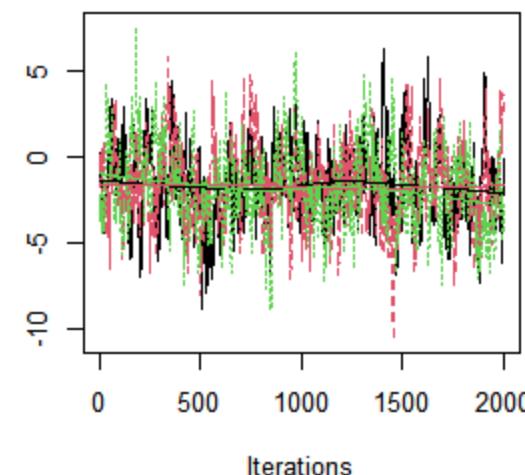
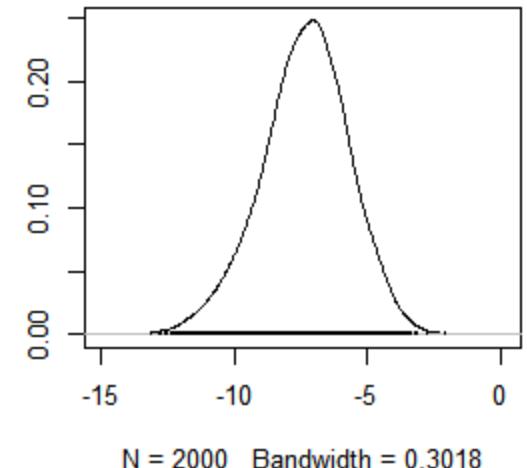
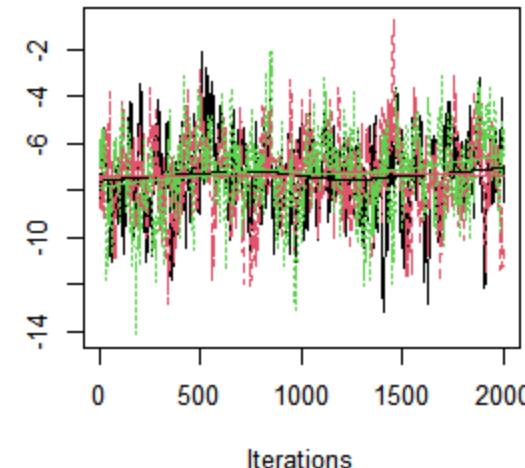
2. Quantiles for each variable:

	2.5%	97.5%
[1,]	-10.896	-4.273
[2,]	-5.864	3.219

Regressão de Poisson espacial

Monte Carlo em Cadeia de Markov (MCMC)

```
# Convergência  
plot(chain$samples$beta)
```



Regressão de Poisson espacial

Monte Carlo em Cadeia de Markov (MCMC)

```
> spdep::moran.mc(x=residuals(chain), listw=W.list, nsim=100000)
```

Monte-Carlo simulation of Moran I

```
data: residuals(chain)
weights: W.list
number of simulations + 1: 100001

statistic = -0.066249, observed rank = 42315, p-value = 0.5769
alternative hypothesis: greater
```

Aplicações
computacionais





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12º EPI

A Epidemiologia e
a complexidade dos
desafios sanitários

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