Integrating R and ArcGIS for Advanced Analysis

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Why Use R?

The R Language

• R is a free and open-source programming language.
  - Designed with data analysis in mind
    - Powerful core data structures and operations
  
• Unparalleled breadth of statistical routines
  - Both cutting-edge research and field specific methods

• CRAN: Over 12,700 available packages (doubled since 2016!)

• Versatile and powerful plotting
R Resources

The R Language

• A strong and engaged user community
  - Easy to find tutorials and resources for help
    - Cross-Validated - https://stats.stackexchange.com/
    - R-bloggers - https://www.r-bloggers.com/
    - Kaggle - https://www.kaggle.com/competitions
    - Hadley Wickham’s Advanced R - http://adv-r.had.co.nz/
    - Introduction to Statistical Learning with Applications in R - http://www-bcf.usc.edu/~gareth/ISL/
  - A variety of active user groups
    - R Consortium - https://www.r-consortium.org/
    - Meetup Communities – https://www.meetup.com/find/tech/
    - R-Ladies - https://rladies.org/
R Spatial Packages
Connecting R to spatial

• **Spatial data has a strong support framework**
  - Well-defined classes and methods for vector and raster data
  - Consistent handling across the language
  - Functions for simple tasks, like plotting, subsetting, and summarizing spatial objects
  - Functions for advanced, niche spatial analyses
  - Interfaces well with ArcGIS
R Spatial Packages
Connecting R to spatial

• **Working with feature data (points, lines, areas):**
  - Historically sp has been the main package for working with feature data
  - New effort going into the sf package, which contains more extensive integration, and a richer underlying data model
  - 100s of packages have interop

• **Working with raster data:**
  - GDAL and rgdal
  - raster package
  - Many others with specialized roles have interop

• [https://www.r-spatial.org/projects/](https://www.r-spatial.org/projects/)
Introducing the R-ArcGIS Bridge

The R-ArcGIS Bridge

- The R-ArcGIS bridge allows you to connect ArcGIS to R and enables the seamless transfer of data back and forth, along with the ability to integrate R and ArcGIS functionality.
Who Can Use the R-ArcGIS Bridge?

The R-ArcGIS Bridge

ArcGIS users

R users

ArcGIS developers
Requirements for the R-ArcGIS Bridge

Installing The Bridge

ArcGIS Pro

- ArcGIS Pro

  - 1.1 (or later)

R

- 3.2.2 (or later)

ArcMap

- ArcMap

  - 10.3.1 (or later)

RStudio

- RStudio

  - Optional
Vector Support
The R-ArcGIS Bridge

- Ability to read and write vector data
- Support for key R objects and spatial packages
  - R data frame object
  - Compatibility with sp
  - Compatibility with sf
- Customize data manipulations
  - Craft SQL queries to make selections
  - Subset by specific columns
  - Reproject data as needed
- Maintain spatial geometries when working with dplyr
Reading your ArcGIS vector data: part 1

**arcgisbinding** Package Functionality

1) Open ArcGIS data, tables, layers

- R workspace
- Load data
- ArcGIS

```r
gis_data <- arc.open(path = 'C:/Data/Data.gdb/AfricanBuffalo')
```

2) Load dataset to R data frame

```r
r_data <- arc.select(gis_data, fields, SQL, spatial ref)
```
Raster Support
The R-ArcGIS Bridge

• Ability to read and write raster data
  - Handle big data raster data with the ability to read in chunks by bands
  - Compatibility with CRF format and Mosaic Datasets

• Customize selections and subsets
  - Adjust raster spatial resolution
  - Resample options available
  - Select desired pixel format for specific analyses
  - Reproject data as needed
1) Open ArcGIS single band or multiband rasters:

```r
gis_data <- arc.open(path = 'C:/Data/MyRaster.tif')
```

2) Customize data details

```r
arc_data <- arc.raster(gis_data, nrow, ncol, bands, extent, pixel_type, resample_type)
```
R-ArcGIS Bridge Demo
Expanding Workflows and Creating Script Tools
Using the R-ArcGIS Bridge with Microsoft R

Microsoft Open R

- Microsoft Open R is a publicly available R-version

- Contains almost all CRAN libraries
  - It lags CRAN in functionality, Microsoft follows CRAN releases to update

- Provides integration to other Microsoft tools such as R-Server
Using the R-ArcGIS Bridge with Microsoft R

ArcGIS Bridge- Microsoft R Connection

- Connection to argsbinding package is same as CRAN version of R
- Can be used as the background R version within ArcGIS Pro
- Usage from Pro is exactly the same as CRAN
Comparing Different R Distributions

- Allows multi-thread parallelization
- Allows parallelization and remote computing
- Processing limited to 2 threads
- All processing is handled locally
- Microsoft’s implementation of R
- Publicly available
- Efficient matrix operations
- Open-source
- Contains newest libraries

CRAN
Microsoft R Open
Microsoft R Client
Microsoft R Server
Matrix Multiplication Benchmark on Rasters
Comparing Open R to CRAN R

n-by-n Raster Multiplication Benchmark

Run Time (sec) vs Raster Dimension

CRAN
Microsoft R
Using the R-ArcGIS Bridge

Microsoft R

- Image convolutions are matrix multiplications
- Window-based operations and image operators speed up drastically
- Integrates to bigger data platforms of Microsoft such as Azure and R-Server
Resources
Learn More on Using the R-ArcGIS Bridge

Resources from UC 2018:
- https://github.com/R-ArcGIS

Getting Started:
- Analyzing Crime Using Statistics and the R-ArcGIS Bridge Learn Lesson
- Using the R-ArcGIS Bridge Introductory Web Course

Creating R Script Tools:
- Integrating R Scripts into Geoprocessing Tools Web Course
- arcgisbinding Package Vignette

Powerful, In-depth Workflows in ArcGIS and R
- Identify an Ecological Niche for African Buffalo
Upcoming Sessions

A Deeper Dive

• Machine Learning in ArcGIS
  - Thursday, July 12th @ 2:30pm
• Beyond Where: Modeling and Making Spatial Predictions
  - Thursday, July 12th @ 4:00pm
Please Take Our Survey on the App

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Scroll down to find the feedback section

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