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Working with the R-ArcGIS Bridge

Michael G. Leahy PhD - mleahy@esri.ca
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Agenda

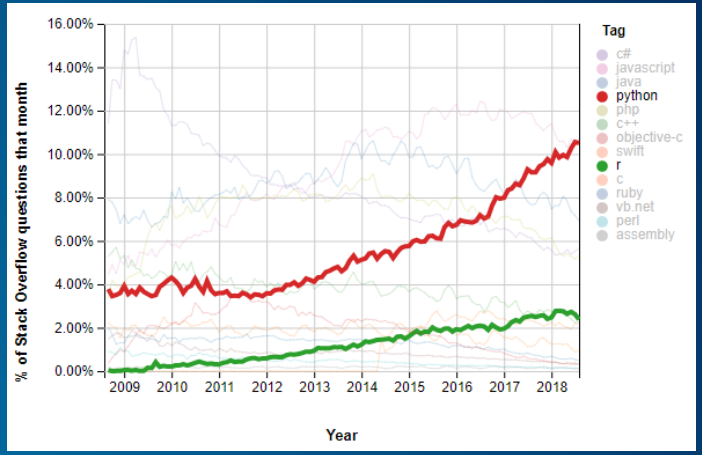
- Introduction / Overview
- R Scripting basics
- Basic use of the R-ArcGIS package in R scripts
- Building geoprocessing script tools using R-ArcGIS

Introduction

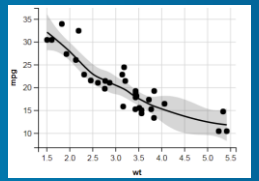
An overview of R and the R-ArcGIS bridge

About

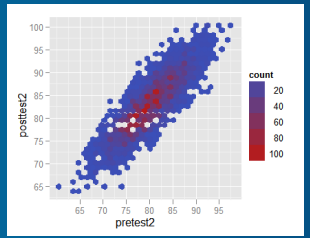
- Open Source system for statistical computation and graphics – has become de facto standard language for statisticians
- Over 13,000 packages available from the Comprehensive R Archive Network (about 11,000 a year ago, more than doubled since 2016)
- Powerful language and packages for generating plots and graphics



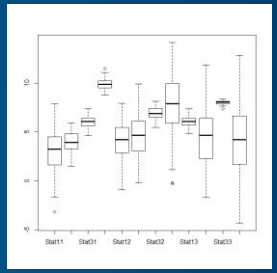
Source: StackOverflow



ggvis.rstudio.com



r4stats.com



www.r-bloggers.com

About the R-ArcGIS bridge

Enable execution of R functions in ArcGIS applications as Geoprocessing script tools

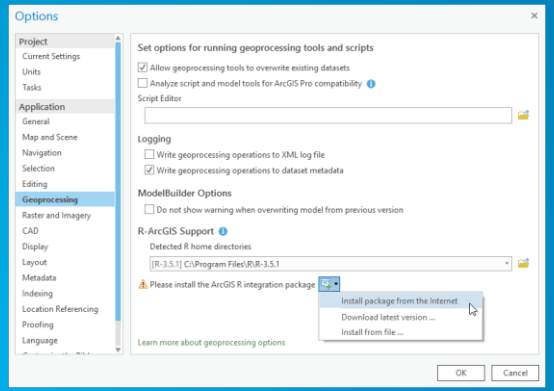
https://r-arcgis.github.io/

Setup Steps

1. **Install ArcGIS Pro 1.1+ (or ArcGIS 10.3.1+)**
2. **Install R 3.3.2+ or later (https://www.r-project.org/ or https://mran.microsoft.com/open)**
3. **Install the `arcgisbinding` package:**

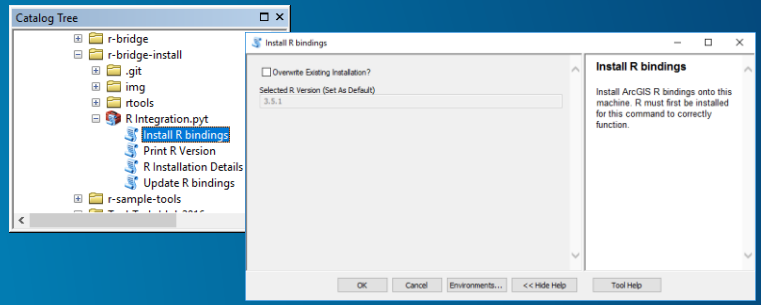
ArcGIS Pro

Project -> Options -> Geoprocessing



ArcGIS Desktop (e.g., ArcMap)

Run the Install tool in the R Integration toolbox



Detailed Instructions: https://github.com/R-ArcGIS/r-bridge-install

Getting Started

- **Choose/install an IDE for editing R code:**
  - **Default R-GUI**
  - **RStudio**
  - **Visual Studio / Visual Studio Code**
- **Learn R basics:**
  - **https://highered-esricanada.github.io/r-arcgis-tutorials/**
- **R-ArcGIS vignette, manual, samples:**
  - **https://r-arcgis.github.io/assets/arcgisbinding-vignette.html**
  - **https://r-arcgis.github.io/assets/arcgisbinding.pdf**
  - **https://github.com/R-ArcGIS/r-sample-tools**

R – Third-party Packages

- **Common packages for plotting and working with data objects:**
  - `ggplot2, dplyr, tidyr, ...`
- **Statistical modelling:**
  - `car, lme4, caret, mgcv`
- **Spatial data / analysis:**
  - `arcgisbinding, sp, sf, maptools, spdplyr / mclust, spgwr, spatstat, lctools ...`
- **CRAN Task Views for categorized view of packages (e.g., 'Spatial')**
  - https://cran.r-project.org/web/views/

R Basics

- **Basic Object Types**

  `Vector, Lists, Matrices, Arrays, Factors, Data Frames, Time Series`

- **Basic Data Types:**

  `Logical, Numeric, Integer, Character, Complex, Raw`

- **Variable Assignment:**

```
# Creates a numeric vector with one value ( = works too… *)
x <- 1
```

- **Vectors with multiple values:**

```
# Character vector w/ 3 values
x <- c('apples', "bananas", 'oranges')
```

- **Install/load packages:**

```
# Install CRAN packages (includes dependencies)
packages.install('sp')

# Load a package in current R workspace
library(spgwr)
```

R – the `dplyr` package

- A fast and consistent tool for working with tabular data frames
- Adds a variety of essential methods for data frame manipulation

  `filter`, `arrange`, `select`, `mutate`, `summarize`, ...

- Works with the forward-pipe operator (from the `magrittr` package), enabling more efficient and concise workflows in R:

```
arranged_data <- survey_data %>% filter(age > 15) %>%
  select(education, income, age) %>% arrange(income, age)
```

Instead of:

```
filtered_data <- filter(survey_data, age > 15)
selected_data <- select(filtered_data, education, income, age)
arranged_data <- arrange(arranged_data, income, age)
```

Tutorial: R Basics

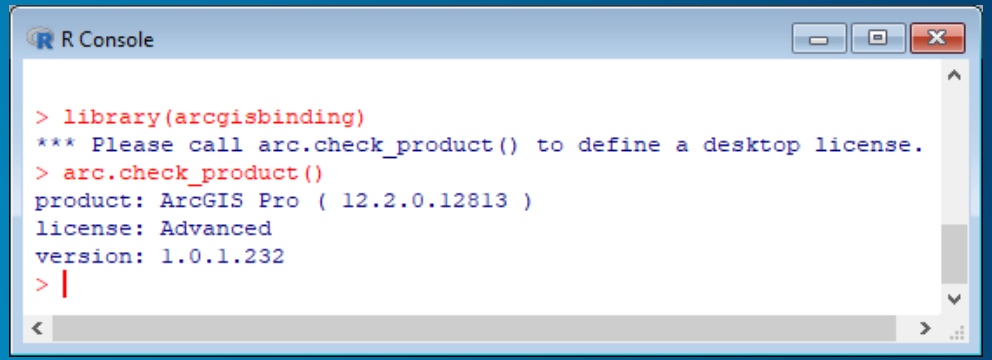
Using the R-ArcGIS Bridge in R

Using the `arcgisbinding` package in R

Loading the library in R

- To start working with `arcgisbinding` in R:

```
> library(arcgisbinding)
> arc.check_product()
```



Note: only needed for standalone R scripts

Using the `arcgisbinding` package in R

Working with ArcGIS datasets

- **Connect to data:**

```
gis_data <- arc.open(<path>)
```

- **Load data:**

```
features_df <- arc.select(gis_data, ...)
raster_obj <- arc.raster(gis_data, ...)
```

- **Convert projections between WKT & Proj.4:**

```
arc.fromP4ToWkt("+proj=latlong +datum=wgs84")
arc.fromWktToP4(gis_data$shapefinfo$WKT)
arc.fromWktToP4(4326)
```

- **Convert data (to `sp`, `sf`, or `raster`):**

```
data_sp <- arc.data2sp(features_df)
data_sf <- arc.data2sf(features_df)
data_raster <- as.raster(raster_obj)

...
```

- **Write data:**

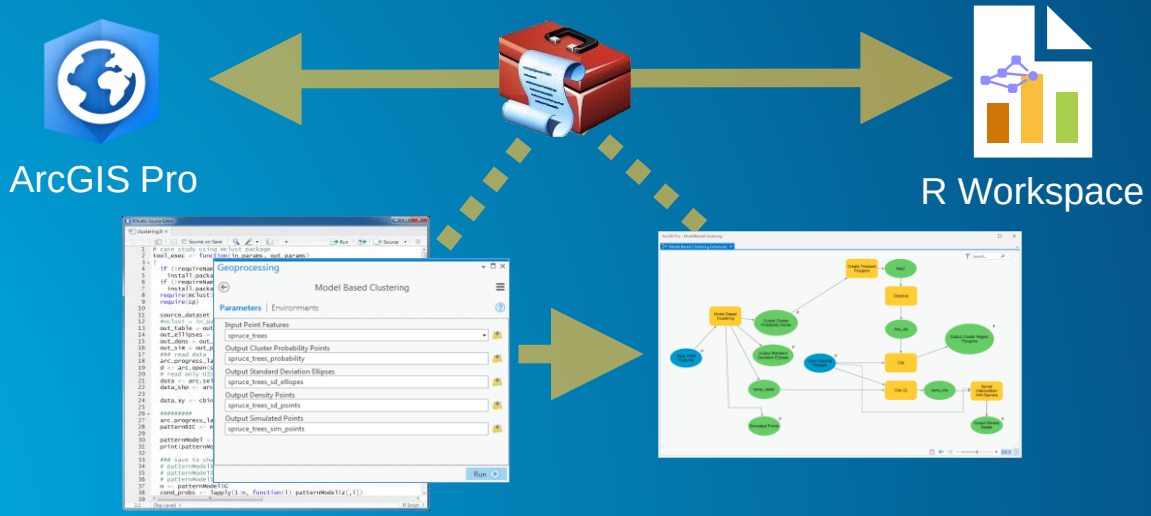
```
arc.write(path=<path>, data=data_sp)
```

Tutorial: Using the `arcgisbinding` package in R

Building R Script Tools

R-ArcGIS Script Tools

- **Make R statistical functionality accessible to users/applications across the ArcGIS Platform:**



R-ArcGIS Script Tools

Basic structure

- **Main entry point for an R-script to be used as a script tool:**

```
tool_exec <- function(in_params, out_params) { ... <code> ... }
```

- **Get/set input and output parameters as named properties:**

```
feature_data <- arc.select(arc.open(in_params$in_data), ...)
out_params$result <- sum(feature_data$values)
arc.write(path=out_params$out_data, data=feature_data)
```

- **Return output parameters when function is finished:**

```
return(out_params)
```

R-ArcGIS Script Tools

Messaging & Feedback

- **Set progress label/position for UI feedback:**

```
arc.progress_label("Analysis in progress...")
arc.progress_pos(50)
```

- **Print messages and warnings in the Geoprocessing window:**

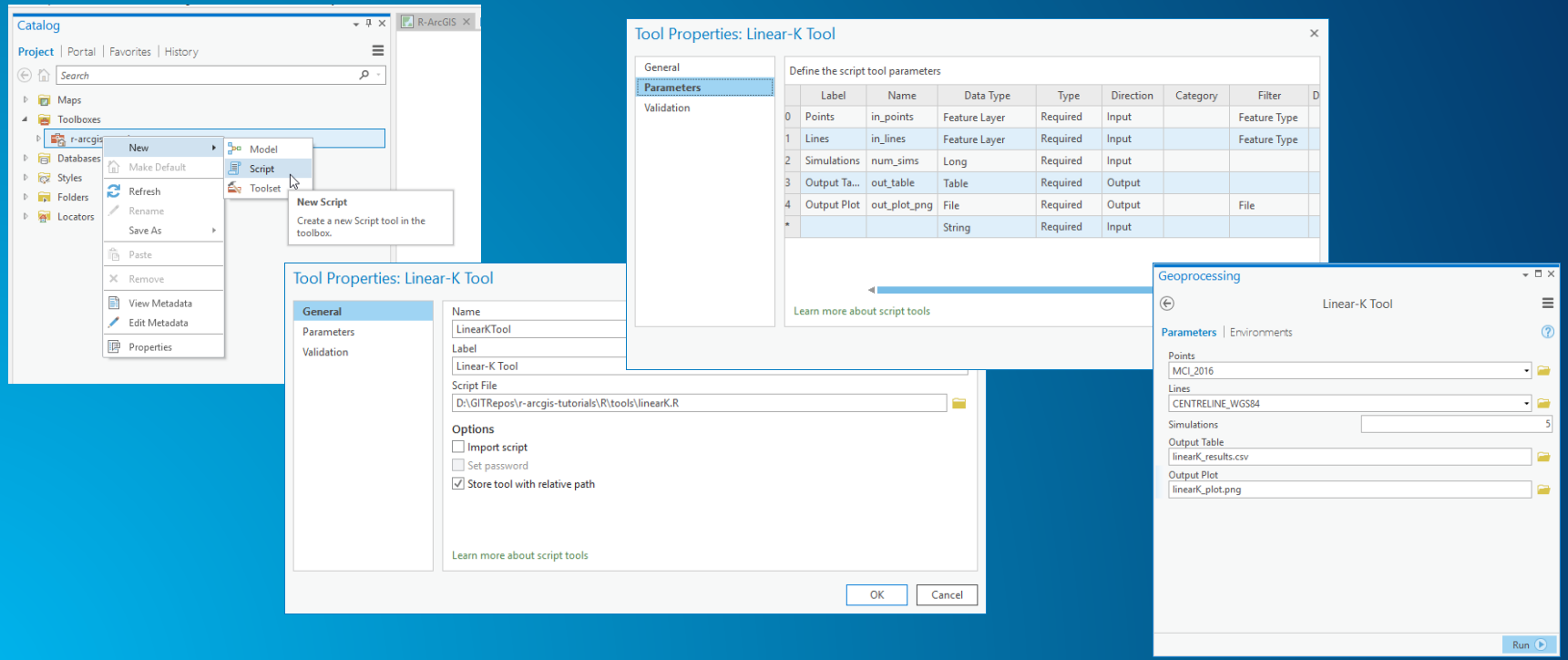
```
message(paste(c("Input value: ", in_params$in_val), collapse="")))
warning("Input parameter not set, defaulting to x ...")
```

- **Raise errors (and stop execution):**

```
stop("Invalid input data.")
```

R-ArcGIS Script Tools

Toolbox configuration



Tutorial: Build an R Script Tool

Integration of R Script Tools

Using R tools in a complete workflow for analysis

Integration with ArcPy and Model Builder

randomGLMScript.py - C:\Users\hlawrence\Documents\ArcGIS\Projects\TorontoUCOct11\randomGLMScript.py (2.7.13)

File Edit Format Run Options Window Help

```
import arcpy
from arcpy.sa import *

# Check out the ArcGIS Spatial Analyst extension license
arcpy.CheckOutExtension("Spatial")

arcpy.AddMessage("")
toolboxLocation_input = arcpy.GetParameterAsText(0)
samplePointsTable_input = arcpy.GetParameterAsText(1)
trainingPointsTable_input = arcpy.GetParameterAsText(2)
outputCellSize_input = arcpy.GetParameterAsText(3)

arcpy.ImportToolbox(toolboxLocation_input)

arcpy.AddMessage("Starting Process")
samplePoints_internal = 'samplePoints_internal'
probs_internal = 'probabilities_randomforest_glm_internal'
raster_output = 'raster_output'

if arcpy.Exists("probabilities_randomforest_glm_internal"):
    arcpy.Delete_management("probabilities_randomforest_glm_internal")

arcpy.AddMessage("Processing Point Table")
#USED FOR ARCMAP
arcpy.MakeXYEventLayer_management(samplePointsTable_input, "x", "y", samplePoints_internal)
#USED FOR ARCGIS PRO
#arcpy.management.XYTableToPoint(samplePointsTable_input, samplePoints_internal)

arcpy.AddMessage("Calculating Predictions")
arcpy.predictionTools.probmodelsRGLM(samplePoints_internal, trainingPointsTable_input, probs_internal)

arcpy.AddMessage("Running IDW")
raster_output_internal = Idw(probs_internal, 'prob', outputCellSize_input, 2, RadiusFixed(outputCellSize_input, 0))

arcpy.AddMessage("Creating Output")
arcpy.MakeRasterLayer_management(raster_output_internal, "probabilitySurfaceRGLM")
arcpy.SetParameter(4, "probabilitySurfaceRGLM")
```

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R / R-ArcGIS Resources

- **R-ArcGIS Project page:**
  https://r-arcgis.github.io

- **R Cheatsheets:**
  https://www.rstudio.com/resources/cheatsheets/

- **Package Vignettes – E.g.:**
  - **R-ArcGIS Bridge (arcgisbinding):**
    https://r-arcgis.github.io/assets/arcgisbinding-vignette.html
  - **Geographically Weighted Regression (spgwr):**
    https://cran.r-project.org/web/packages/spgwr/vignettes/GWR.pdf
  - **Spatial Inequalities (lctools):**
    https://cran.r-project.org/web/packages/lctools/vignettes/SpatialInequalities.pdf

- **Samples, Blogs, GeoNet, Videos/Tutorials, etc.:**
  - https://github.com/R-ArcGIS/r-sample-tools
  - https://github.com/R-ArcGIS/CHANS-tools
  - https://www.r-bloggers.com/
  - https://www.r-project.org/help.html
  - https://geonet.esri.com/groups/rstats
  - http://hed.esri.ca/resourcefinder/#/search=r/lang=en
  - https://learn.arcgis.com/en/projects/analyze-crime-using-statistics-and-the-r-arcgis-bridge/
  - https://youtu.be/i6Pc8SwWpyM?list=PLaPDDLTCmy4Z27yCYMJkyxj3WHtFBW08l