# Interfacing QGIS spatial processing algorithms from R


Floris Vanderhaeghe
Dewey Dunnington
Nyall Dawson
Jan Caha
Jannes Muenchow
Jakub Nowosad
Robin Lovelace

html slides

useR! Salzburg 2024

Flanders State of the Art

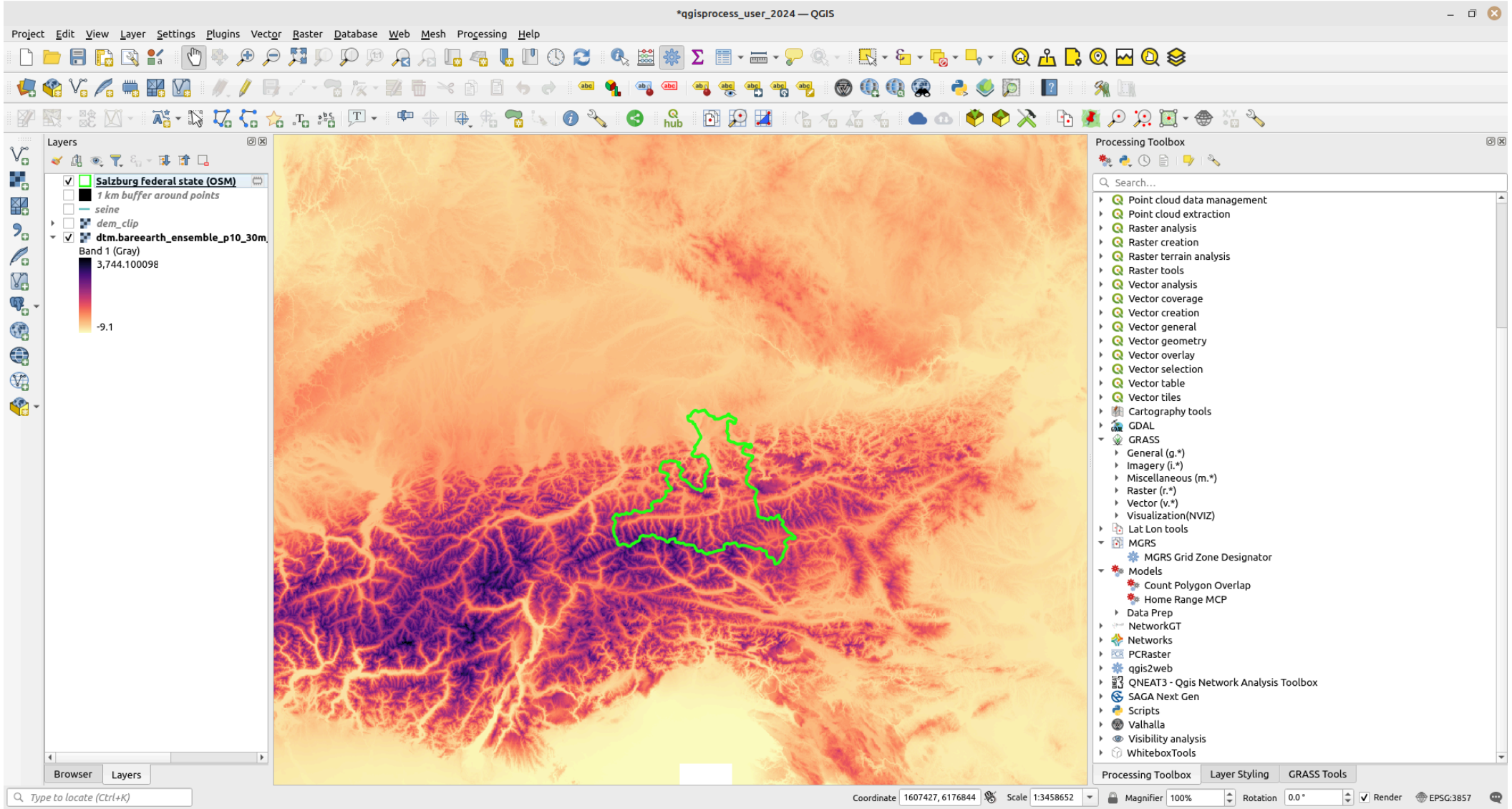
RESEARCH INSTITUTE NATURE AND FOREST

# About QGIS

# QGIS

Popular open-source geographic information system (GIS) program to:

- view geospatial data interactively
- create and edit spatial data layers
- perform advanced geoprocessing with algorithms of QGIS, GRASS GIS, GDAL ...
- make sophisticated maps, atlases and reports


*qgisprocess_user_2024 — QGIS
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Salzburg federal state (OSM)
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Point cloud extraction
Raster analysis
Raster creation
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Raster tools
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GDAL
GRASS
General (g.*)
Imagery (i.*)
Miscellaneous (m.*)
Raster (r.*)
Vector (v.*)
Visualization(NVIZ)
Lat Lon tools
MGRS
MGRS Grid Zone Designator
Models
Count Polygon Overlap
Home Range MCP
Data Prep
NetworkGT
Networks
PCRaster
qgis2web
QNEAT3 - Qgis Network Analysis Toolbox
SAGA Next Gen
Scripts
Valhalla
Visibility analysis
WhiteboxTools
Browser
Layers
Processing Toolbox
Layer Styling
GRASS Tools
Type to locate (Ctrl+K)
Coordinate 1607427, 6176844
Scale 1:3458652
Magnifier 100%
Rotation 0.0 °
Render
EPSG:3857

# Why interface QGIS processing from R?

# Main advantages

- Expand geospatial processing abilities in R
- Still have all other processing capabilities of R
- Reproducibility
- No QGIS project needed
- Unified interface to QGIS, GRASS GIS, SAGA, GDAL and other processing providers (1000+ geospatial algorithms)

# Interfacing QGIS processing from R

- Formerly: packages **RQGIS** and **RQGIS3** (Muenchow & Schratz) for QGIS 2 and 3
  - use the QGIS Python API
  - set QGIS environment variables
  - **RQGIS3** was hard to maintain wrt provider changes in QGIS; also, crashes were observed in RStudio IDE
  - no longer developed

# Interfacing QGIS processing from R

- Since QGIS 3.16: packages **qgisprocess** & **qgis**
  - use the recent standalone `qgis_process` shell command from QGIS = a unified entry to all providers and algorithms!
  - no more QGIS environment variables needed
  - actively developed

# Interfacing QGIS processing from R

```
$ qgis_process
QGIS Processing Executor - 3.38.0-Grenoble 'Grenoble' (3.38.0-Grenoble)
Usage: /usr/bin/qgis_process.bin [--help] [--version] [--json] [--verbose]
          [--no-python] [--skip-loading-plugins]
          [command] [algorithm id, path to model file, or path to Python script] [parameters]

...
```

```
$ qgis_process run <algorithm> [parameters]

$ qgis_process run <algorithm> -

$ qgis_process plugins
```

# Current R-packages

- **qgisprocess** (Dewey Dunnington et al.): direct interface to `qgis_process`
  - https://r-spatial.github.io/qgisprocess/

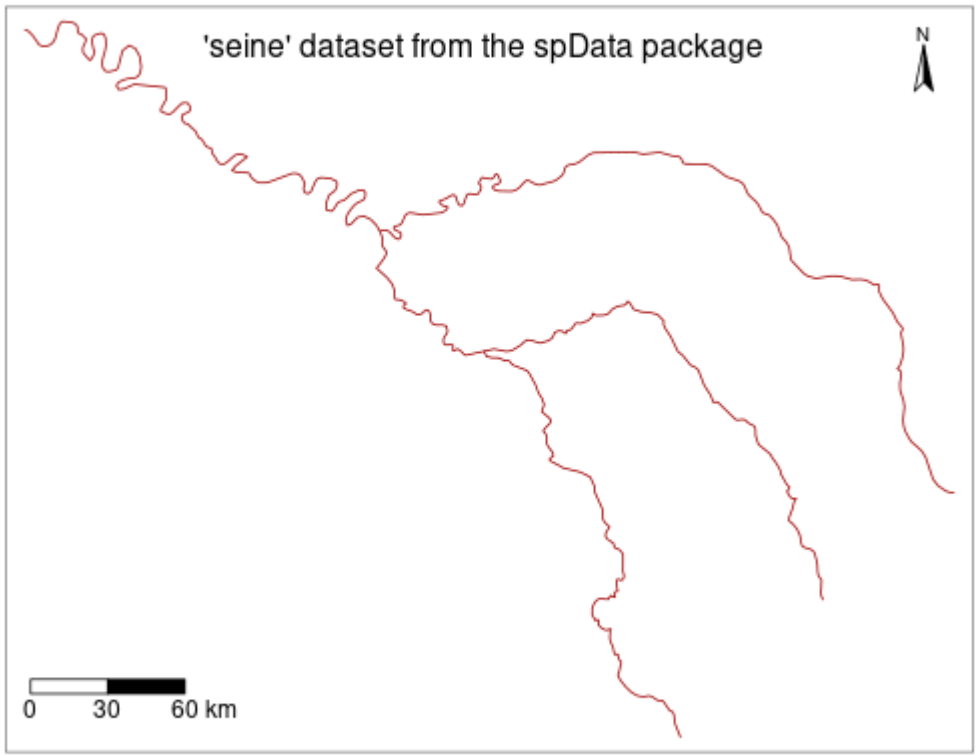
```
install.packages("qgisprocess")
```

- **qgis** (Jan Caha): functions for each algorithm; uses **qgisprocess** package
  - https://jancaha.github.io/r_package_qgis/

```
remotes::install_github("jancaha/qgis")
```

# A simple example

# Basic usage



# Basic usage

Load the R package:

```
library(qgisprocess)
```

```
#> Attempting to load the package cache ... Success!
#> QGIS version: 3.38.0-Grenoble
#> Having access to 2059 algorithms from 18 QGIS processing providers.
#> Run `qgis_configure(use_cached_data = TRUE)` to reload cache and get more details.
```

# Basic usage

```
seine_path <- "data/seine.gpkg"
```

```
(seine <- sf::read_sf(seine_path))
```

```
#> Simple feature collection with 3 features and 1 field
#> Geometry type: MULTILINESTRING
#> Dimension:     XY
#> Bounding box:  xmin: 518344.7 ymin: 6660431 xmax: 879955.3 ymax: 6938864
#> Projected CRS: RGF93 v1 / Lambert-93
#> # A tibble: 3 × 2
#>   name                                                          geom
#>   <chr>                                                <MULTILINESTRING [m]>
#> 1 Marne ((879955.3 6755725, 878440.9 6755688, 876653.8 6756227, 874212.2 675791…
#> 2 Seine ((828893.6 6713873, 828216.3 6715450, 827937.9 6716999, 828199.2 671851…
#> 3 Yonne ((773482.1 6660431, 771342.9 6665712, 771043 6667566, 770931.7 6669151,…
```

# Basic usage

Run algorithm:

```
result <- qgis_run_algorithm(
  algorithm = "native:pointsalonglines",
  INPUT = seine_path,
  DISTANCE = 1e4
)
#> Argument `START_OFFSET` is unspecified (using QGIS default value).
#> Argument `END_OFFSET` is unspecified (using QGIS default value).
#> Using `OUTPUT = qgis_tmp_vector()`
```

or:

```
result <- qgis::qgis_pointsalonglines(
  INPUT = seine_path,
  DISTANCE = 1e4
)
```

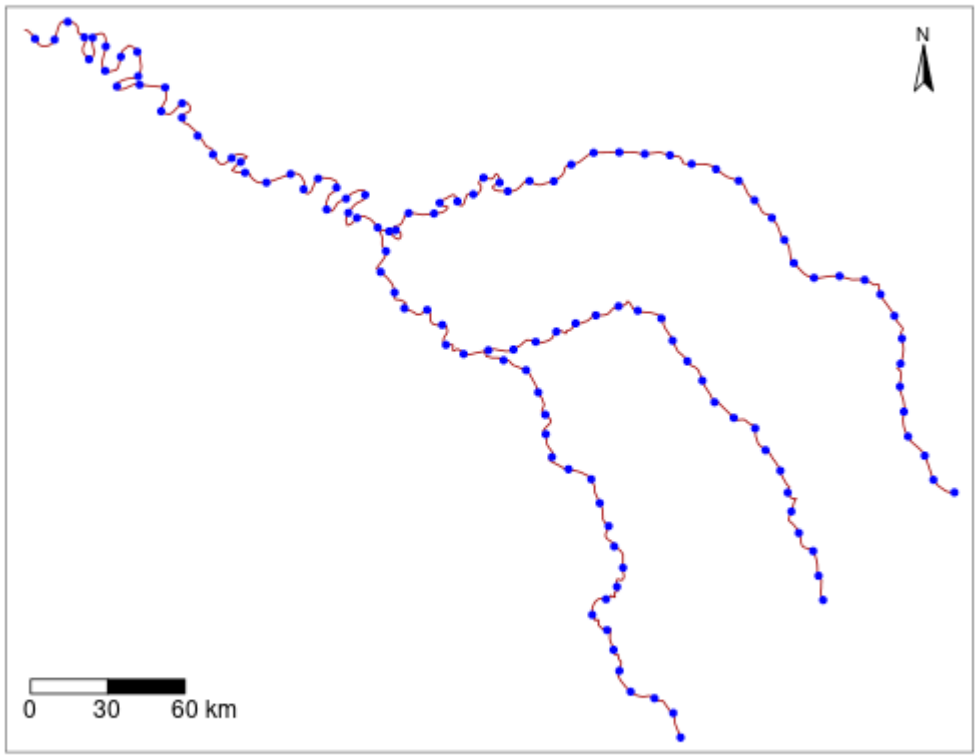
# Basic usage

Extract output (defaults to the `"OUTPUT"` element of `result`).

```
qgis_extract_output(result)
```

```
#> [1] "/tmp/RtmpUtuVpc/file5288578598f1/file52883dccf462.gpkg"
#> attr(,"class")
#> [1] "qgis_outputVector"
```

# Basic usage



# Convenient functions

# Finding algorithms

```
qgis_search_algorithms(algorithm = "point.*line")
```

| provider | algorithm | algorithm_title |
|---|---|---|
| gdal | gdal:pointsalonglines | Points along lines |
| native | native:interpolatepoint | Interpolate point on line |
| native | native:pointsalonglines | Points along geometry |
| native | native:randompointsonlines | Random points on lines |
| qgis | qgis:generatepointspixelcentroidsalongline | Generate points (pixel centroids) along line |
| qgis | qgis:randompointsalongline | Random points along line |
| sagang | sagang:convertpointstolines | Convert points to line(s) |
| sagang | sagang:pointtolinedistances | Point to line distances |
| sagang | sagang:snappointstolines | Snap points to lines |

# Finding algorithms

```
qgis_providers()
```

```
#> # A tibble: 18 × 3
#>    provider         provider_title                          algorithm_count
#>    <chr>            <chr>                                             <int>
#>  1 cartographytools Cartography tools                                   5
#>  2 gdal             GDAL                                               56
#>  3 grass            GRASS                                             307
#>  4 latlontools      Lat Lon tools                                      10
#>  5 model            Models                                              3
#>  6 NetworkGT        NetworkGT                                          33
#>  7 Networks         Networks                                           48
#>  8 pcraster         PCRaster                                          102
#>  9 qgis             QGIS                                               42
#> 10 3d               QGIS (3D)                                           1
#> 11 native           QGIS (native c++)                                 263
#> 12 pdal             QGIS (PDAL)                                        17
#> 13 qneat3           QNEAT3 - Qgis Network Analysis Toolbox             14
#> 14 sagang           SAGA Next Gen                                     587
#> 15 script           Scripts                                             1
#> 16 Valhalla         Valhalla                                           20
#> 17 visibility       Visibility analysis                                 4
#> 18 wbt              WhiteboxTools                                     546
```

# Finding algorithms

```
qgis_plugins()
```

```
#> # A tibble: 12 × 2
#>    name                    enabled
#>    <chr>                   <lgl>
#>  1 QNEAT3                  TRUE
#>  2 ViewshedAnalysis        TRUE
#>  3 cartography_tools       TRUE
#>  4 grassprovider           TRUE
#>  5 latlontools             TRUE
#>  6 network_gt              TRUE
#>  7 networks                TRUE
#>  8 pcraster_tools          TRUE
#>  9 processing              TRUE
#> 10 processing_saga_nextgen TRUE
#> 11 valhalla                TRUE
#> 12 wbt_for_qgis            TRUE
```

# Algorithm documentation

```
qgis_show_help("native:pointsalonglines")
```

```
## Points along geometry (native:pointsalonglines)
##
## ----------------
## Description
## ----------------
## Creates regularly spaced points along line features.
## This algorithm creates a points layer, with points distributed along the lines of an input vector layer. The dist
##
## Start and end offset distances can be defined, so the first and last point will not fall exactly on the line's fi
##
## ----------------
## Arguments
## ----------------
##
## INPUT: Input layer
##     Argument type:    source
##     Acceptable values:
##         - Path to a vector layer
## DISTANCE: Distance
##     Default value:    1
## .....
```

# Supports various R objects as input arguments

Spatial QGIS argument types

| input argument | R object |
|---|---|
| vector layer | **sf** or **terra** |
| raster layer | **stars**, **terra** and **raster** |
| multilayer | list (preferrably as `qgis_list_input()`) |
| extent | various 'bounding box' and 'extent' objects |
| crs | various CRS objects |

# Supports various R objects as input arguments

Non-spatial QGIS argument types:

| input argument | R object |
|---|---|
| expression | string |
| enum | integer or character |
| range | vector |
| matrix | matrix or dataframe |
| color | R color string |
| hierarchical types (e.g. aggregates) | nested list |
| ... | ... |

# Supports various R objects as input arguments

```
library(terra)
elev <- rast(system.file("ex/elev.tif", package = "terra"))
class(elev)
```

```
#> [1] "SpatRaster"
#> attr(,"package")
#> [1] "terra"
```

```
qgis_run_algorithm("native:rasterlayerstatistics", INPUT = elev, BAND = 1)
```

```
#> <Result of `qgis_run_algorithm("native:rasterlayerstatistics", ...)`>
#> List of 9
#>  $ COUNT           : num 4608
#>  $ MAX             : num 547
#>  $ MEAN            : num 348
#>  $ MIN             : num 141
#>  $ OUTPUT_HTML_FILE: 'qgis_outputHtml' chr "/tmp/RtmpUtuVpc/file5288578598f1/file52887ef8bb06"
#>  $ RANGE           : num 406
#>  $ STD_DEV         : num 80.2
#>  $ SUM             : num 1605135
#>  $ SUM_OF_SQUARES  : num 29646349
```

# Result handling

## Extracting elements from the result

By default, the `OUTPUT` element is selected by `qgis_extract_output()`.

- typically contains a file path

# Result handling

## Extracting elements from the result

Which output elements are generated by an algorithm?

```
qgis_get_output_specs("grass:r.flow")
```

```
#> # A tibble: 3 × 3
#>   name             description       qgis_output_type
#>   <chr>            <chr>             <chr>
#> 1 flowaccumulation Flow accumulation outputRaster
#> 2 flowlength       Flow path length  outputRaster
#> 3 flowline         Flow line         outputVector
```

So, sometimes you need to specify the output name:

```
qgis_extract_output(result, "flowline")
```

# Result handling

## Coercing output to R objects

Result object or output element can be coerced to an R object:

```
sf::st_as_sf(result) # takes OUTPUT by default
```

```
result |> qgis_extract_output("flowline") |> sf::st_as_sf()
```

```
qgis_as_terra(result)
```

```
qgis_as_raster(result)
```

```
stars::st_as_stars(result)
```

Extra!

Extra!

# Algorithm piping

```
seine_points_buffer <- seine |>
  qgis_run_algorithm_p("native:pointsalonglines", DISTANCE = 1e4) |>
  qgis_run_algorithm_p("native:buffer", DISTANCE = 1000,
                       OUTPUT = "data/buffer.gpkg")
seine_points_buffer
```

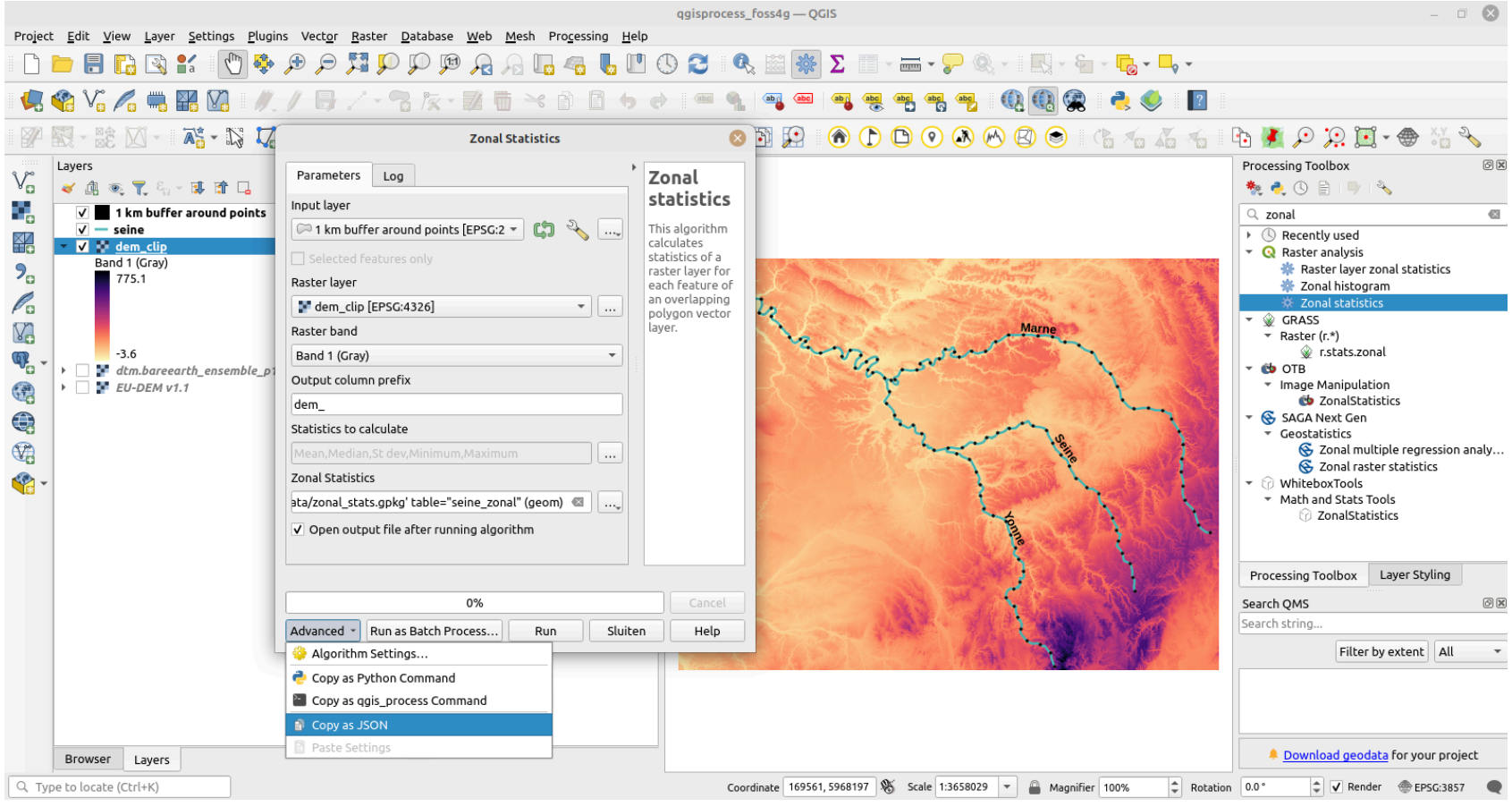
```
#> <Result of `qgis_run_algorithm("native:buffer", ...)`>
#> List of 1
#>  $ OUTPUT: 'qgis_outputVector' chr "data/buffer.gpkg"
```

Alternative with **qgis** package:

```
seine |>
  qgis::qgis_pointsalonglines(DISTANCE = 1e4) |>
  qgis_extract_output() |>
  qgis::qgis_buffer(DISTANCE = 1000)
```

```
#> <Result of `qgis_run_algorithm("native:buffer", ...)`>
#> List of 1
#>  $ OUTPUT: 'qgis_outputVector' chr "/tmp/RtmpUtuVpc/file5288578598f1/file528896a5b20.gpkg"
```

# Taking parameters from the QGIS GUI



# Taking parameters from the QGIS GUI

```
jsonlite::prettify(json_from_qgis)
```

```
#> {
#>     "area_units": "m2",
#>     "distance_units": "meters",
#>     "ellipsoid": "EPSG:7030",
#>     "inputs": {
#>         "COLUMN_PREFIX": "dem_",
#>         "INPUT": "/home/floris/git_repositories/foss4g-2023-qgisprocess/data/buffer.gpkg|layername=buffer",
#>         "INPUT_RASTER": "/home/floris/git_repositories/foss4g-2023-qgisprocess/data/dem_clip.tif",
#>         "OUTPUT": "ogr:dbname='/home/floris/git_repositories/foss4g-2023-qgisprocess/data/zonal_stats.gpkg' table
#>         "RASTER_BAND": 1,
#>         "STATISTICS": [
#>             2,
#>             3,
#>             4,
#>             5,
#>             6
#>         ]
#>     }
#> }
#>
```

# Taking parameters from the QGIS GUI

```
zonal_stats_result <- qgis_run_algorithm(
  "native:zonalstatisticsfb",
  .raw_json_input = json_from_qgis
)
```

```
zonal_stats_result
```

```
#> <Result of `qgis_run_algorithm("native:zonalstatisticsfb", ...)`>
#> List of 1
#>  $ OUTPUT: 'qgis_outputVector' chr "/home/floris/git_repositories/foss4g-2023-qgisprocess/data/zonal_stats.gpkg|l
```

# Result

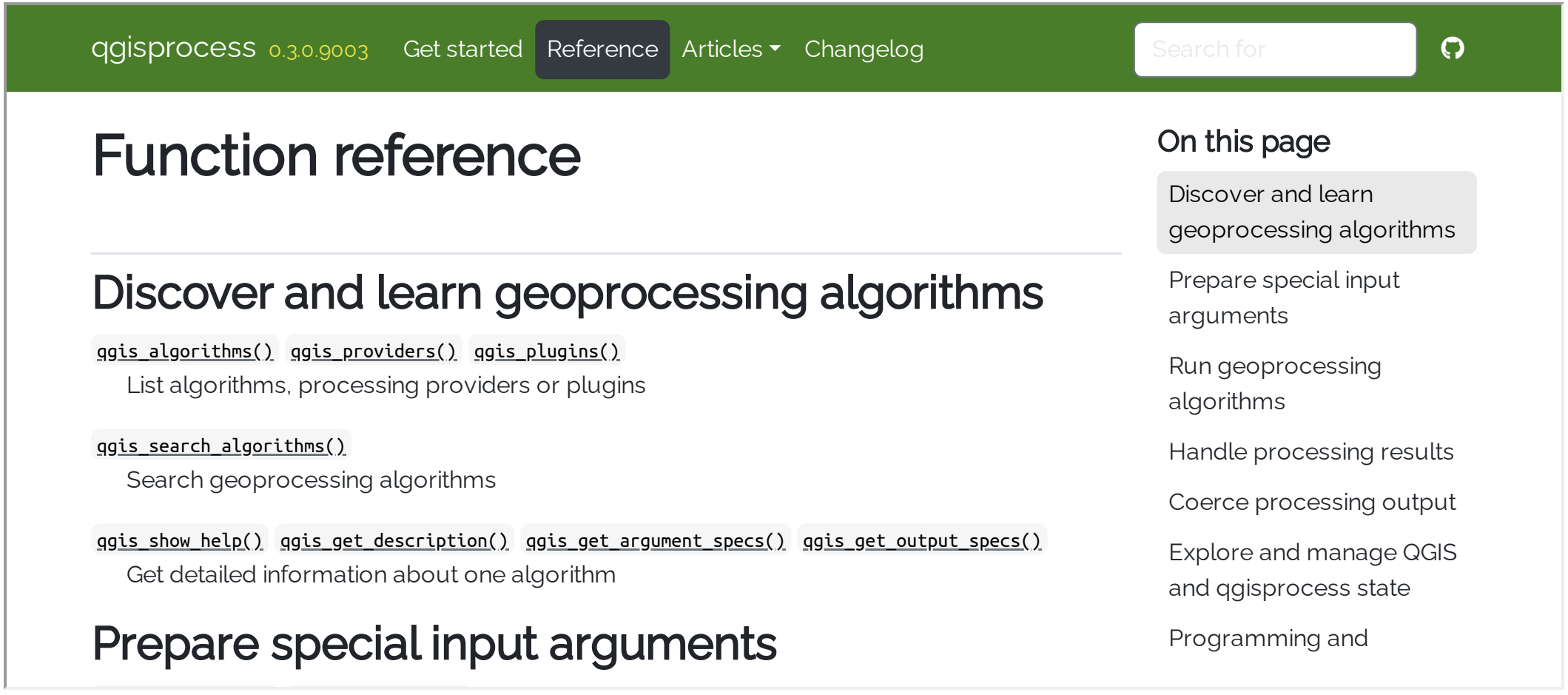
```
zonal_stats <- sf::st_as_sf(zonal_stats_result) |>
  sf::st_drop_geometry() |>
  mutate(distance = set_units(distance, "m") |> set_units("km"))

zonal_stats
```

```
#> # A tibble: 123 × 8
#>    name  distance  angle dem_mean dem_median dem_stdev dem_min dem_max
#>    <chr>     [km]  <dbl>    <dbl>      <dbl>     <dbl>   <dbl>   <dbl>
#>  1 Marne        0 269.       372.       366.      22.0    344.    412.
#>  2 Marne       10 322.       340.       338       21.9    309.    416.
#>  3 Marne       20 327.       331.       334.      23.9    287.    382.
#>  4 Marne       30 332.       296.       280.      29.5    264.    359.
#>  5 Marne       40   5.76     286.       295.      24.3    238.    317.
#>  6 Marne       50 358.       269.       254.      45.4    221.    378.
#>  7 Marne       60  22.4      235.       220.      32.7    201.    312.
#>  8 Marne       70 350.       202.       188.      24.8    183.    306.
#>  9 Marne       80 335.       196.       184.      26.9    167.    276
#> 10 Marne       90 334.       182.       184.      19.6    150.    209.
#> # ℹ 113 more rows
```

# Online documentation

# https://r-spatial.github.io/qgisprocess



# https://jancaha.github.io/r_package_qgis

## Reference

### QGIS

Algorithms provided directly by QGIS.

| | |
|---|---|
| `qgis_3d_tessellate()` | QGIS algorithm - Tessellate |
| `qgis_addautoincrementalfield()` | QGIS algorithm - Add autoincremental field |
| `qgis_addfieldtoattributestable()` | QGIS algorithm - Add field to attributes table |
| `qgis_adduniquevalueindexfield()` | QGIS algorithm - Add unique value index field |
| `qgis_addxyfields()` | QGIS algorithm - Add X/Y fields to layer |

Contents

# Cheat sheet !

# QGIS in R with qgisprocess :: CHEAT SHEET

## Mission

The goal of qgisprocess is to provide an R interface to the geoprocessing algorithms of QGIS, a popular and open source desktop geographic information system (GIS) program. This package is a re-implementation of the functionality provided by the archived **RQGIS** package, which was partially revived in the **RQGIS3** package.

## Features

This package makes it easier to use native processing algorithms and some from GDAL, GRASS and many others (like SAGA).

| Providers | Algorithms |
|---|---|
| qgis | 50 + 242 ( c ++) + 1 (3D) |
| gdal | 56 |
| grass | 304 |
| third-party providers | x |
| Total counts | 653 + x |

```
# Show a tibble with processing providers
> qgis_providers( )
# Show a tibble with algorithms
> qgis_algorithms( )
# Search algorithms using regular expressions
> qgis_search_algorithms(
      algorithm = <x>,
      provider = <y>,
      group = <z>
      )
```

## Installation

```
> install.packages("qgisprocess")
> library(qgisprocess)
```

**GNU/Linux, macOS, Windows**

If needed, specify path to QGIS installation before loading qgisprocess:

```
> options("qgisprocess.path" = "C:/Program Files/
    QGIS 3.30/bin/qgis_process-qgis.bat")
```

**Using docker**

1.Get started with the installation of docker in your machine.
2.Download the image of geocomputation

```
> docker pull geocompr/geocompr:qgis-ext
```

3. Run to image of geocomputation with docker

```
> docker run -d -p 8786:8787 -v $(pwd):/home/rstudio/
    data -e PASSWORD=pw geocompr/geocompr:qgis-ext
```

## Input functions

The package offers new functionalities of Input to have a workflow of an easy manner inside of R.

```
# Show a description of the function to use
> qgis_show_help(algorithm ="native:creategrid")

# Show all the parameters of the function
> qgis_get_argument_specs(algorithm = "native:
    creategrid")


# Run the algorithms
> qgis_run_algorithm(
    algorithm = "native:creategrid",
    TYPE = 4,
    EXTENT = c("794599, 798208, 8931775,8935384"),
    HSPACING = 1000 ,
    VSPACING = 1000,
    CRS = "EPSG:32717",
    OUTPUT = "grid"
      )

# Create a function based on the algorithm to use
> grid_fun <- qgis_function("native:creategrid")
> grid_fun(
   TYPE = 4,
   EXTENT = c("794599,798208,8931775,8935384"),
   HSPACING = 1000,
   VSPACING = 1000,
   CRS = "EPSG:32717",
   OUTPUT = "grid"
    )
```

## Output functions

qgisprocess give us new functionalities of output for vector, raster and other format file, and it is possible loads it to our environment work.

```
> qgis_extract_output(result_run_alg, "OUTPUT")


# A character vector indicating the location of a
    temporary file.
> qgis_tmp_base( )
> qgis_tmp_file( ".csv" )
> qgis_tmp_vector( )
> qgis_tmp_raster( )
```

## Pipe integration

qgisprocess also provides qgis_run_algorithm_p() that works better in pipelines.

```
# Buffer processing
> library(sf)
> system.file(
   "longlake/longlake_depth.gpkg",
   package = "qgisprocess"
   ) |>
 qgis_run_algorithm_p(
   algorithm = "native:buffer",
   DISTANCE = 100
   ) |> st_as_sf() |>
   plot()
```

## Workflow

**Vector data**

```
# Hexagrid of 400x400
> library(sf)
> grid_fun <- qgis_function("native:creategrid")
> grid_fun(
    TYPE = 4,
    EXTENT = c("409967, 411658, 5083354, 5084777"),
    HSPACING = 400,
    VSPACING = 400,
    CRS = "EPSG:26920",
    OUTPUT = "grid"
    ) |>
    st_as_sf() |>
    select(id) |>
    plot()
```

**Raster data**

```
# TWI processing
 > library(stars)
 > dem <- read_stars(
    system.file(
      "raster/nz_elev.tif",
       package = "spDataLarge")
      )
 > qgis_run_algorithm(
    algorithm ="sagang:sagawetnessindex",
    DEM = dem,
    TWI = "twi.sdat") |>
    qgis_extract_output("TWI") |>
    qgis_as_terra() |>
    plot(col = cptcity::cpt(pal = "ocal_blues"))
```

Created by Antony Barja — Revised by Floris Vanderhaeghe and updated: 23/06/2023

# Section in book 'Geospatial Computation with R'

Geocomputation with R

Search

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Foreword (1st Edition)

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Preface

1 Introduction

Foundations

2 Geographic data in R

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4 Spatial data operations

## 10.2 qgisprocess: a bridge to QGIS and beyond

QGIS is the most popular open-source GIS (Table 10.1; Graser and Olaya (2015)). QGIS provides a unified interface to QGIS's native geoalgorithms, GDAL, and — when they are installed — from other *providers* such as GRASS GIS, and SAGA (Graser and Olaya 2015). Since version 3.14 (released in summer 2020), QGIS ships with the `qgis_process` command line utility for accessing a bounty of functionality for geocomputation. `qgis_process` provides access to 300+ geoalgorithms in the standard QGIS installation and 1,000+ via plugins to external providers such as GRASS GIS and SAGA.

The **qgisprocess** package provides access to `qgis_process` from R. The package requires QGIS — and any other relevant plugins such as GRASS GIS and SAGA, used in this chapter — to be installed and available to the system. For installation instructions, see **qgisprocess**'s documentation.

Second Edition

Visit the geocompx website 🌐

Install updated packages

Open an issue ?

Chat on Discord

Check exercise solutions ✔

Support Ukraine 🇺🇦

On this page

10 Bridges to GIS software

https://r.geocompx.org

# Recent developments

# Recent developments

- Speed-up since QGIS 3.36 & **qgisprocess** 0.4.0
- Added vector support for R package **terra**
- Vignettes:
  - which R objects are accepted as algorithm arguments?
  - how to configure behaviour with options or environment variables?
  - how to pass QGIS expressions?
- Improved handling of deprecated algorithms

# Questions?

# Ideas?

Slides: https://florisvdh.github.io/user-2024-qgisprocess/