

# **Combining R and Python for Scientific Computing**

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# Preface

Hello!

# 1 Introduction

## 1.1 Language Agnostic Data Science

The trend of the past few years is that Data Science is becoming more language-agnostic.

Tools such as [Quarto](#), [Apache Arrow](#)... enable working across languages with less friction.

RStudio (the company) renaming itself to “Posit” was also a clear statement of intent. Tools like [Shiny](#) and [Pins](#) are being ported to Python, and the latest exciting installment is Posit’s new IDE, [Positron](#).

We often receive questions from R users on whether we can deliver an “Introduction to Python” course, or something similar. While yes, we can certainly do that, the question really is... *but why?*

*“We would like Wi-fi... What’s Wi-fi?”*

Another aspect to this we have noticed, is that a lot of “Introduction to Python” courses are almost always aimed at complete beginners of programming *full stop*. Most, if not all R users know full-well what a variable or a dataframe is and how to `print("Hello World!")`. These courses are not pitched at the right level.

Returning to the question of why R users might want to learn Python, the answer is that there could be a plethora of reasons. But sometimes, simply being able to use R in combination with Python could be enough to achieve your aims.

This book aims to provide some guidance on where R and Python are different, but also show the ever-increasing range of methods to combine the two languages together.

Therefore this book is split in two major sections, **Python for the R user** and **Using R and Python together**.

## 1.2 Python for the R user

This chapter attempts to minimally break down the differences between R and Python, written for the R user.

Topics:

- matplotlib, instead of ggplot2
- numpy, instead of dplyr

## 1.3 Using R and Python together

This chapter outlines the range of tools available to implement R and Python together, and allow you to collaborate with Python users, without actually learning much Python.

Topics:

- Language bridges: reticulate / rpy2
- Quarto: language agnostic publishing
- Web Applications: Shiny for R / Shiny for Python
- In Production: Shell execution
- In Production: Managing environments

**Part I**

**Python for the R User**

## 2 Differences between R and Python

Differences

## **Part II**

# **Using R and Python Together**



### **3 Language bridges: reticulate / rpy2**

## **4 Quarto: language agnostic publishing**

## **5 Web Applications: Shiny for R / Shiny for Python**

## **6 Using R and Python in the shell**

# 7 Managing Environments

## 7.1 Context

This is a big one for the R user. When you are unfamiliar with how Python virtual environments work, it is probably one of the most frustrating concepts to pick up from scratch.

But fear not - to fully get to grips with how Python virtual environments work and package installation works, it is good to remind ourselves how this works in R.

### 7.1.1 How R package installation works

Well, *remind ourselves....* Package installation in R is likely something you have not really thought about, beyond writing `install.packages()`.

This is one of the huge benefits that makes R easy to pick up for “non-programmers”, a lot of this stuff is handled for you.

#### 7.1.1.1 Building from binaries vs. building from source

### 7.1.2 How Python package installation works

## 7.2 With conda

### 7.2.1 Setting up an environment from scratch

conda is ...

To create a project environment which manages both R (r-base) and Python (python):

```
conda create -n env_name r-base python=3.12
```

This sets up a new environment called `env_name` with both R and Python install.

Notice you can specify which version of R and/or Python to install.

You can then install Packages packages with:

```
conda install numpy
```

And R packages with the same command. Note that in this case, package names are pre-pended with `r-`:

```
conda install r-dplyr
```

All packages installed and used should now be recorded in the environment, with their appropriate version number.

To access and share your environment, run:

```
conda env export > environment.yml
```

This will create an `environment.yml` file in your project directory. This will allow for this environment to be set up on other systems.

## 7.2.2 Installing from an `environment.yml`

For others (or for yourself on a different system) to set up an identical environment, run:

```
conda -f create env_name environment.yml
```

If you can't (or don't want to) use conda, it is possible to manage the Python and R environments in the same project, but treat their management as separate processes.

## 7.3 Without conda

### 7.3.1 Python without conda

In Python, this is fairly straightforward, and you can use this method regardless of the level of permissions you have on your machine. Here, you would use `venv`, and `requirements.txt`.

### 7.3.1.1 Setting up a venv and requirements.txt

```
# To create your venv  
python -m venv env_name
```

This creates your virtual environment. To use it, and install your package you need to “activate” it.

```
# To activate your venv  
source env_name/bin/activate
```

Now you have activated your environment, you can install a packages using `pip`.

```
pip install pathlib
```

To keep track of the packages your project depends on, record them in a file called `requirements.txt`. It is a very simple file that looks like this:

```
configparser==7.1.0  
pathlib==1.0.1  
xarray==2024.6.0
```

All it records is `packagename==1.0.0`, very simple!

If you are not sure what packages you have imported.

```
pip freeze
```

This should print them in the terminal.

### 7.3.1.2 Installation in a new venv from a requirements.txt

To set up a new environment and install the required packages from a specified `requirements.txt`:

```
# To create your venv  
python -m venv env_name  
source env_name/bin/activate  
  
pip install -r requirements.txt
```

### 7.3.2 R without conda

To manage R dependencies, you have a couple of options, depending on the level of permissions you have on the system you are working on.

#### 7.3.2.1 With sudo permissions

If you have sudo permissions, when can use the **pak** package. The great things about **pak** is that, unlike `install.packages()` and `renv::install()` (more on `renv` later), it will automatically fetch the pre-built binaries for your operating system, distribution and version. More detail on **pak**, and how it operates in [R in Production](#).

It will also automatically install any system-level dependencies that your R package may require. This is especially useful on linux systems, where system dependency installation can vastly differ between distributions.

If we have sudo permissions, and are using **pak**, your approach could be as simple as providing an `install.R` file which installs the right packages for you.

First install **pak**:

```
Rscript -e install.packages('pak')
```

Now it can be called in your set up script. You would normally only run this once on deployment.

```
#!/usr/bin/env Rscript
# Usage R -f install.R

# Selecting p3m.dev is an optional step for linux distros
# It will speed up installation and prevents the risk of installation
# failing on external C libraries

# This is because CRAN only provides source packages for linux
# and not binary
# see: https://r-in-production.org/packages.html#installing-a-package-on-linux

# For Ubuntu 24.04
options(repos = c(CRAN = "https://p3m.dev/cran/__linux__/noble/latest"))

# For Rocky 9
# options(repos = c(CRAN = "https://p3m.dev/cran/__linux__/rhel9/latest"))
```



```
pak::pak("readr")
pak::pak("paws")
pak::pak("ini")
pak::pak("assertr")
pak::pak("dplyr")

# A package on Github:
pak::pak("thomaszwagerman/butterfly")
```

Call it with:

```
R -f install.R
```

### 7.3.2.2 Without sudo permission

Without sudo permission on your machine, you might have trouble running installation commands such as `install.packages()` or `pak::pak()`, as R might be trying to install your packages into a shared library, where you do not have ‘write’ permission.

In this case, the path of least resistance would be to use **renv**. To manage your environment.

If you have not used **renv** before, it is highly recommended you read [Getting Started with renv](#) before reading further.

To start using **renv**:

```
install.packages('renv')

renv::init()
```

This will install and set up **renv** for you. `renv::init()` generates a `renv.lock` file based on the packages you have installed and used.

An extract from a `renv.lock` is shown below. You will notice it specifies the version of R used, which repositories it has used for installation, as well as packages and their associated version and download source.

```
{
  "R": {
    "Version": "4.4.1",
    "Repositories": [
      {
```

```

      "Name": "P3M",
      "URL": "https://packagemanager.posit.co/cran/__linux__/centos7/latest"
    }
  ],
},
"Packages": {
  "MASS": {
    "Package": "MASS",
    "Version": "7.3-59",
    "Source": "Repository",
    "Repository": "CRAN",
    "Requirements": [
      "R",
      "grDevices",
      "graphics",
      "methods",
      "stats",
      "utils"
    ],
    "Hash": "0cafd6f0500e5deba33be22c46bf6055"
  },
  "R6": {
    "Package": "R6",
    "Version": "2.5.1",
    "Source": "Repository",
    "Repository": "CRAN",
    "Requirements": [
      "R"
    ],
    "Hash": "470851b6d5d0ac559e9d01bb352b4021"
  }
}
}

```

This destination is set to a specific operating system, **centos7**. This URL is obtained from the [Posit Package Manager](#).

When using **pak**, this is automatically fetched for us. Unfortunately for us, **renv** does not use **pak**. To prevent having to manually change this URL for each deployment on a different system, we need to insert this URL depending on the operating system we are working on.

[Shannon Pileggi](#)

With the above in mind, the `install.R` script would look like this:

```

#!/usr/bin/env Rscript
# Usage R -f hpc_setup.R
#
# This will not work with opensuse and sle,
# naming inconsistencies across distros is hard

# This is not an R project, so need to manually "activate" renv
source("renv/activate.R")

install.packages("pkgcache")

# Moving on to installing r and system dependencies with renv.lock
# Have R obtain the current platform distro and release
os <- data.frame(
  distribution = pkgcache::current_r_platform_data()$distribution,
  release = pkgcache::current_r_platform_data()$release
)

os$release <- round(as.numeric((os$release)))

# Some wrangling to make matching more reliable across distros
ppm_platforms <- pkgcache::ppm_platforms()

# Take the word "linux" out of distribution names
ppm_platforms$distribution <- gsub("linux", "", ppm_platforms$distribution)
# Makes matching rocky distro possible
ppm_platforms$release <- round(as.numeric((ppm_platforms$release)))

# Match with pak's ppm_platforms
os_table <- merge(
  os,
  ppm_platforms
)

if (os_table$os == "linux") {
  p3m_url <- paste0(
    "https://p3m.dev/cran/__linux__/",
    os_table$binary_url,
    "/latest"
  )
} else {
  p3m_url <- "https://p3m.dev/cran/latest"
}

```

```
}  
  
renv::lockfile_modify(repos = c(  
  P3M = p3m_url  
) |>  
renv::lockfile_write()  
  
renv::restore()
```

In summary, this script should:

1. Activate **renv** and install **pkgcache**.
2. Detect which **os**, **distribution** and **version** R is being run on.
3. Concatenate the **package manager URL** and the **os binary URL**.
4. Modify the **renv.lock** file to point the repos URL to the correct binary URL.