# A simple five-ish step process to get your Shiny app online (securely).

### Github, Docker-compose, EC2 version

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Photo by Nathan Waters on Unsplash

Figure 1: under construction

## Introduction

This is the first in a series of posts offering suggested strategies for leveraging open source technologies to provide straightforward solutions to one of the central challenges in the practice of data science, i.e. how to effectively communicate analysis results to clients and collaborators. The list of open-source technologies (software stack) we suggest for employment is: linux, R, Shiny, Docker, Git, and Caddy. In this post we'll make use of two cloud services Github and AWS. Further posts will describe alternate constructions, e.g. using the low cost cloud service: Hetzner.

Also described in other posts are strategies that avoid Github. This approach provides a simpler initial construction, but a more labor intensive updating process.

This initial post provides a minimal, proof-of-concept example of how to apply these technologies for hosting an interactive Shiny application.

In the following we start with a very simple, but hopefully still useful, stand-alone Shiny app developed on our local workstation. Then after some straightforward interfacing with the Amazon web service environment, We push the Shiny app into the cloud, and end up with a secure (encrypted and authenticated) app running on a website with a custom domain name.

## Methods

To begin, lets assume we're just finished developing a new Shiny app, named `power1` . (The methods described here apply generically to any Shiny app, but we'll use one of our own for illustration). See the `R/Shiny` code for our `power1` app (`power1.R`) here in appendix 1.

We can test the app locally by runnning it with the following command issued from the `power1` directory.

```
R -e "library(shiny); runApp('power1.R', launch=T)"
```

We can also think of the directory as a project or a repository. The directory can be located anywhere on your local system. This will in turn: run the R program, load the Shiny package, and launch the app in your default browser.

Figure 2 below shows the Shiny app running locally in a browser on our desktop, it consists of a widget to select the sample size and provide a dynamic visualization (2D plot) of the power as a function of the standardized effect size:

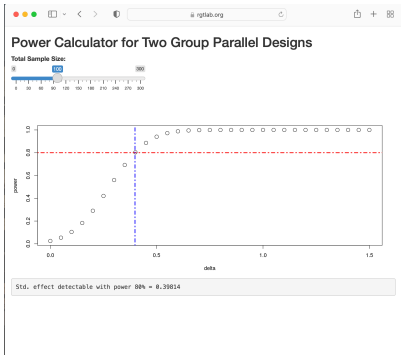



Figure 2: *Shiny app*

Once we determine our app is working as designed, we can move on to the task of hosting the app on a (virtual) server to share with our collaborators. There are many ways to accomplish this. Here we'll demonstrate a straightforward and efficient approach using mainstream cloud services and open source tools. That is, we'll describe how to 'spin' up a server on Amazon Web Service EC2 and in just a few steps, through the application of Docker, R, Shiny, and Caddy (webserver) functionality we'll have a fully functional web app to share with colleagues.

## Hosting

Figure 3 illustrates the tools we'll use and the flow of program and configuration files. In order to host `power1` online we'll need to complete the following tasks:

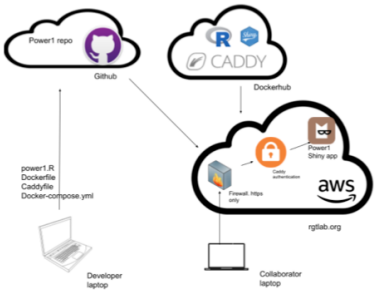



Figure 3: *Data flow*

1. create a virtual server (connected via ssh) with a firewall
2. obtain a static IP address (to identify the server online)
3. obtain a domain name (name for IP address)
4. install and configure a webserver (tool to interact with https protocol requests and respond)
5. obtain and install an SSL certificate (to allow encrypted communication)
6. setup an authentication method (password protection)
7. configure a reverse proxy method (translate https (port 443) requests to Shiny (port 3838)

At first glance these 7 requirements can appear daunting, but on closer inspection all can be met with relative ease and minimal cost ( using a cloud-hosting service, e.g. Amazon's EC2

or Digital Ocean, and a "leased" domain name from, e.g. GoDaddy, or Amazon's Route 53) or no cost( if you have your own server with IP address, and domain name)

## Select a hosting service

There are a number of cloud based server options: Microsoft Azure, Oracle, Google Cloud, Amazon AWS EC2, Digital Ocean to name a few. Each has their own approach to setting up a custom virtual server. Several have free or low-cost service tiers available.

An overview of the process with EC2 follows. (Detailed instructions for AWS EC2 are here in appendix 2.)

0. Create an account or sign in.
1. Set up an interactive environment with AWS server.
    a. define ssh key-pair.
    b. configure firewall.
    c. request static IP.
    d. obtain domain name.

Once the server is available connect via ssh and login, The only necessary software to install is docker, docker-compose and git. Install all 3 with the following command:

```
sudo apt install -y git
sudo snap install docker
```

Once the host is set up and the requisite software installedh we'll have a customized virtual server wtih a static IP address, and unique domain name and firewall in place. In other words, items 1, 2, and 3 from our list will be taken care of.

## Website

To configure the web server and containerize our app we need to add three files to the server, to go along with our Shiny app

in the `power1` directory (in the home directory for default user `ubuntu`).

The easiest way to do this is to add the three files to the `power1` directory on our workstation and then "push" a copy to github and from there we can access them from our server.

Details are in @appendix-1 Appendix 1.

Photo by Ian Taylor on Unsplash

These three configuation files are:

1. a Docker configuration file (default name `Dockerfile`)

We'll use docker to access R/Shiny, and docker-compose to access Caddy, our webserver. The first file is the dockerfile. Here is our minimal dockerfile with comments:

```
# Grab the latest rocker/Shiny image from Docker Hub to use as a base image.
FROM rocker/shiny
# Copy the Shiny code to the default location for shiny-server
# ?? not sure if need to change file name to app.R ??
COPY power1.R /srv/shiny-server/
# There is no non-root user on the image: shiny. Switch to user `shiny`
USER shiny
# Run the Shiny-server using the default app code
CMD ["/usr/bin/shiny-server"]
```

In this very simplest form the file instructs Docker to build a container based on a Rocker/Shiny image (which is a ubuntu image with R and Shiny installed) then copy into the container the `power1.R` code and finally launch Shiny on (default) port 3838. We placed the power1.R code in the default location `/srv/shiny-server` we only need to start the server and it will find the shiny program.

2. a Caddy web server configuration file (default name `Caddyfile`)

Lets discuss each. We'll use `Caddy` as our web server. Caddy is an open-source tool that has the very useful feature of automating the acquiring and installing of an SSL certificate. An

SSL cert is required by most browsers to use the encrypted communication protocol https.

Caddy is configured with a file named `Caddyfile`. We use the caddy configuration file to specify three critical things.

1. the site domain name.
2. the authentication pair login/hash-password, for each user and
3. the 'reverse proxy' map that redirects requests to port 443 (ssl port) to port 3838 (Shiny port).

Our barebones Caddyfile looks like this:

```
power1.net {
#auth credentials: bob/thebunny
basicauth * {
bob JDJhJDE0JElCQmRGaTA0ajY3bkZTLjRiWUZ4enVoZnVSQzVXVGVUMHlVcXJTaTRGYmpRQVFHLnYzN0tx
    }
    handle_path /power1/* {
        reverse_proxy power1:3838
    }
}
```

We can accomplish what we need for items 4, 5, 6 and 7 through the Caddyfile.

Note:

- power1.net is our domain name
- basicauth provides user login information. In this case `bob` is the username and `thebunny` is the password.
- `handle_path` maps all https requests to port 3838 where Shiny is listening.

Providing our servers domain name, `power1.net` is sufficient to initiate an exchange with `letsencrypt` to generates an SSL certificate.

And the third file is the docker compose file that containerizes our Shiny app, pulls a caddy webserver image from Docker Hub and creates a local network for the two containers to communicate in.

3. a Docker-compose configuration file (default name `docker-compose.yml`) (These are the default file names. If preferred, you can use custom names and point the program to the config file with command line options).

The docker-compose.yml file:

```
version: "3.7"

services:
  power1:
    build: .
  caddy:
    image: caddy:2.3.0-alpine
    ports:
      - "443:443"
    volumes:
      - $PWD/Caddyfile:/etc/caddy/Caddyfile
      - caddy_data:/data
volumes:
    caddy_data:
```

## Github

Once in place on your laptop push the four files (power1.R, Dockerfile, Caddyfile, docker-compose.yml) to github

```
git push
```

and then ssh login to server and clone repo.

```
git clone https://github.com/joe47/power1.git
```

Lastly, cd to `power1` directory and run

```
docker-compose up -d
```

and you're good to go!

The app `power1` can be accessed by 'bob' at the url

```
https://power1.net/power1
```

with password 'thebunny'

## Appendix-1

Consider an app that is a balance of simple and functional – one that calculates the power for a 2-sample t-test as a function of the standardized effect size. re is our shiny app `power1.R`:

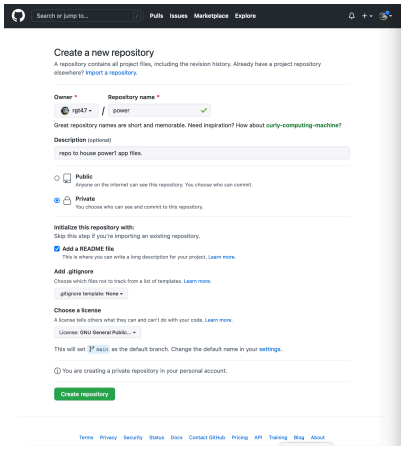
Consider the power1.R file:

```
ui <- fluidPage(
titlePanel("Power Calculator for Two Group Parallel Designs"),
sliderInput("N", "Total Sample Size:", min = 0, max = 300, value = 100),
plotOutput("plot"),
verbatimTextOutput("eff"))

server <- function(input, output, session) {
  delta = seq(0, 1.5,.05)
  pow = reactive(sapply(delta, function(x) power.t.test(input$N, d=x)$power ))
  eff =  renderText(power.t.test(input$N, power=.8)$d)
  output$plot <- renderPlot({
  plot(delta, pow(), cex=1.5, ylab="power")
  abline(h = .8,  col = "red", lwd =2.5, lty = 4)
  abline(v = eff(), col = "blue",lwd =2.5, lty = 4)})
  output$eff <- renderText(
    paste0("Std. effect detectable with power 80% = ", eff()) )
}
shinyApp(ui, server)
```

The app is designed to be maximally minimal. Using only base R functions, with a minimum of reactive widgets and layout commands to keep it simple while still performing a useful function.

## Appendix-4 {#appendix-4} Set up github repo




Start by creating a repo for the app on github.

- login to github (screenshot)

- click on `new` . Then in `repository name` field enter `power1`. (Make the
- repo private, we only want to share with Bob at this point).
- create repo. Click `Create repository` green button at the bottom of the page.
- back on your laptop: clone the repo:

```
git clone https://github.com/joe47/power1.git
```

then you can ssh into the new server with

```
sh> ssh ec2
```

### Tip 2: Add ubuntu to the docker group to allow docker to run without sudo.

### Tip 3:

Copy file contents to workstation without using editor with shell commands. * Copy file from blog * Issue the following shell command * paste the file contents * type EOF on a new line.

```
cat << EOF > Dockerfile
```

- install docker `sudo snap install docker`
- clone github repo joe47/power1. Note: You'll need to authenticate to github.

```
git clone https://github.com/joe47/power1.git
```

- back on laptop...
- add `Caddyfile` and `docker-compose.yml` files to `power1` repo. `Caddyfile`

```
power1app.org {
basicauth * {
        bob JDJhJDE0JElCQmRGaTA0ajY3bkZTLjRiWUZ4enVoZnVSQzVXVGVUMHlVcXJTaTRGYmpRQVFHLnYzN0tx
    }
    handle_path /power1/* {
        reverse_proxy power1:3838
    }
}
```

`docker-compose.yml`

```
version: "3.7"

services:
  power1:
    build: .
  caddy:
    image: caddy:2.3.0-alpine
    ports:
      - "443:443"
    volumes:
      - $PWD/Caddyfile:/etc/caddy/Caddyfile
      - caddy_data:/data
volumes:
    caddy_data:
```

- update (push to) github repo.

```
git add *
git commit -am "adding Caddyfile and docker-compose.yml"
git push
```

- back on server

Lastly, cd to `power1` directory and run

```
git pull
docker-compose up -d
```

## References

- Setup Jupyter Notebook for R article.

step 1 create directory for Shiny app power1_app in power1_app create a directory for the code: power1_shiny > mkdir -p ~/prj/power1_app/power1_shiny/

in power_shiny create app.R a shiny app as follows: > cd ~/prj/power1_app/power1_shiny/ > cat app.R

```
ui <- fluidPage(
titlePanel("Power Calculator for Two Group Parallel Designs"),
sliderInput("N", "Total Sample Size:", min = 0, max = 300, value = 100),
plotOutput("plot"),
verbatimTextOutput("eff"))

server <- function(input, output, session) {
  delta = seq(0, 1.5,.05)
  pow = reactive(sapply(delta, function(x) power.t.test(input$N, d=x)$power ))
  eff =  renderText(power.t.test(input$N, power=.8)$d)
  output$plot <- renderPlot({
  plot(delta, pow(), cex=1.5, ylab="power")
  abline(h = .8,  col = "red", lwd =2.5, lty = 4)
  abline(v = eff(), col = "blue",lwd =2.5, lty = 4)})
  output$eff <- renderText(
    paste0("Std. effect detectable with power 80% = ", eff()) )
}
shinyApp(ui, server)
```

test the Shiny app from the power1_app directory > R -e "library(shiny); runApp('app.R', launch=T)"

create a Dockerfile to build the docker container, like this: > cat Dockerfile

```
FROM rocker/shiny:4.2.0
COPY /power1_shiny/* /srv/shiny-server/
CMD ["/usr/bin/shiny-server"]
```

```
create a Caddyfile
> cat Caddyfile
rgtlab.org {
    root * /var/www/html
    handle_path /power1_shiny/* {
            reverse_proxy 0.0.0.0:3838
    }
    file_server
}
```

```
create a file index.html
> cat index.html
<!DOCTYPE html>
<html>
  <body>
    <h1>Power1 App</h1>
    <ul>
      <li><a href="./power1_shiny/">Hello app</a></li>
    </ul>
  </body>
</html>
```

copy power1_app directory to rgtlab.org > scp -i "~/.ssh/power1ssh.pem" -r ~/prj/power1_app/ ubuntu@rgtlab.org:~

log into rgtlab.org > ssh rgtlab.org install Docker and Caddy (do the 'long' way with sudo apt until I can figure how to get snap or homebrew working) » sudo apt install docker.io » sudo apt install -y debian-keyring debian-archive-keyring apt-transport-https » curl -1sLf 'https://dl.cloudsmith.io/public/caddy/stable/gpg.key' | sudo gpg –dearmor -o /usr/share/keyrings/caddy-stable-archive-keyring.gpg » curl -1sLf 'https://dl.cloudsmith.io/public/caddy/stable/debian.deb.txt' | sudo tee /etc/apt/sources.list.d/caddy-stable.list » sudo apt update » sudo apt install caddy

build the Docker container on rgtlab.org » cd power1_app » docker build -t power1_image . create container and run » docker run -d –name=power1_shiny -p 3838:3838 –restart=always power1_image

copy Caddyfile to location caddy expects in /etc/caddy directory » sudo cp ./Caddyfile /etc/caddy/Caddyfile

copy index.html to location caddy expects in /var/www/html directory » cp ./index.html /var/www/html/index.html

restart Caddy » sudo systemctl reload caddy

App launch page is now available at https://rgtlab.org

Bonus: Add basic authentication for bob/utter to the Caddyfile:

rgtlab.org { basicauth * { bob JDJhJDE0JElCQmRGaTA0ajY3bkZTLjRiWUZ4enVoZnVSQzVXVGVUMHlVcXJ
} root * /var/www/html handle_path /power1_shiny/* { reverse_proxy 0.0.0.0:3838 } file_server }

Restart Caddy. » sudo systemctl reload caddy