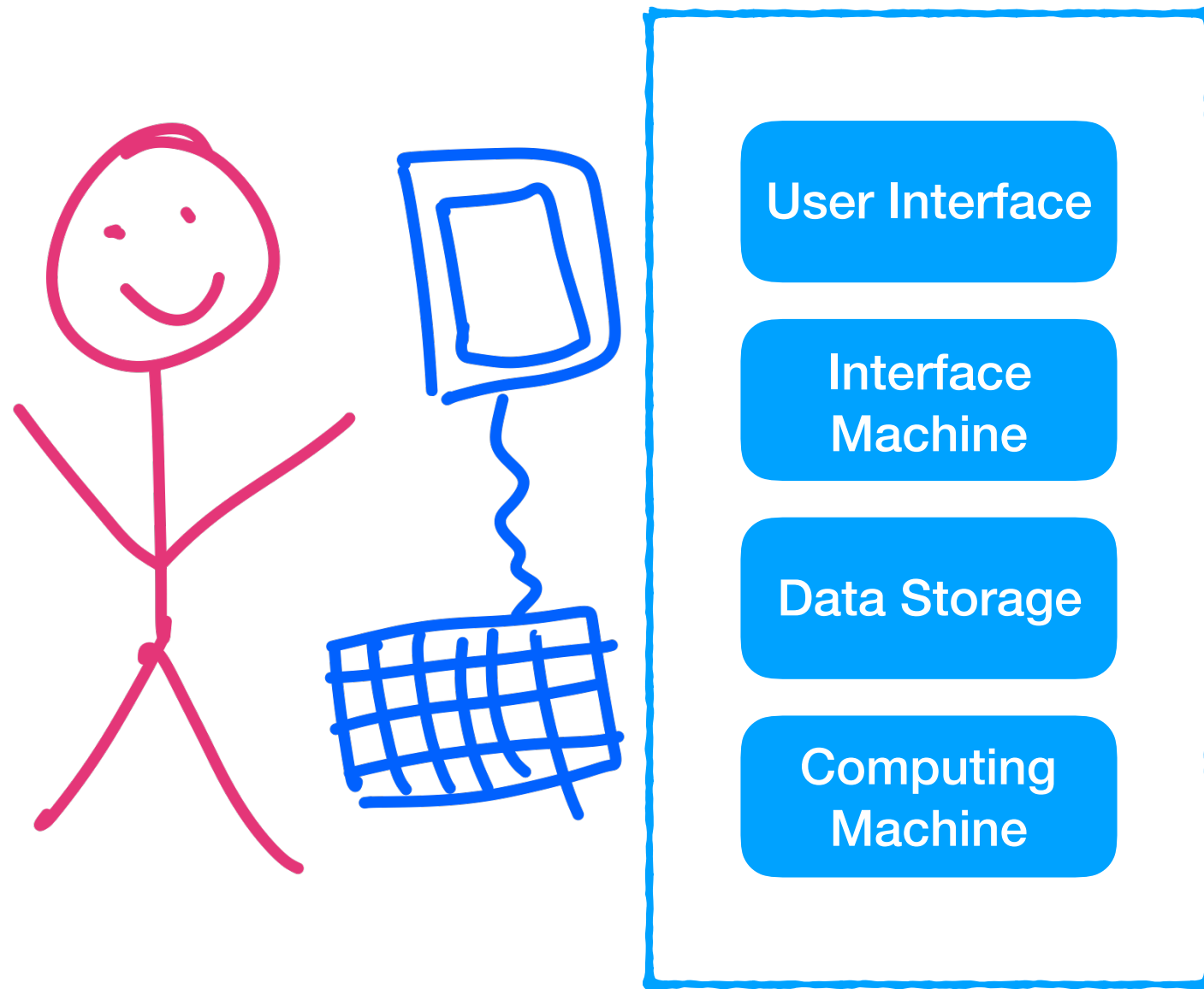


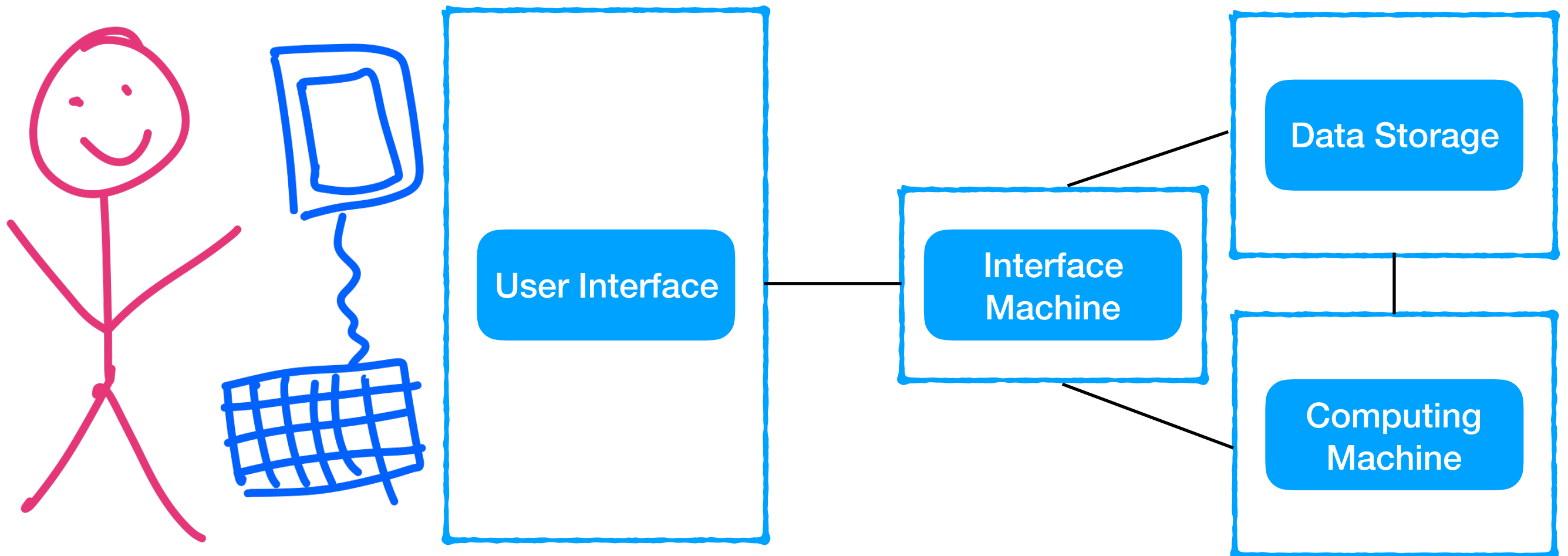
# Deploying Algorithms

Biostatistics 140.712

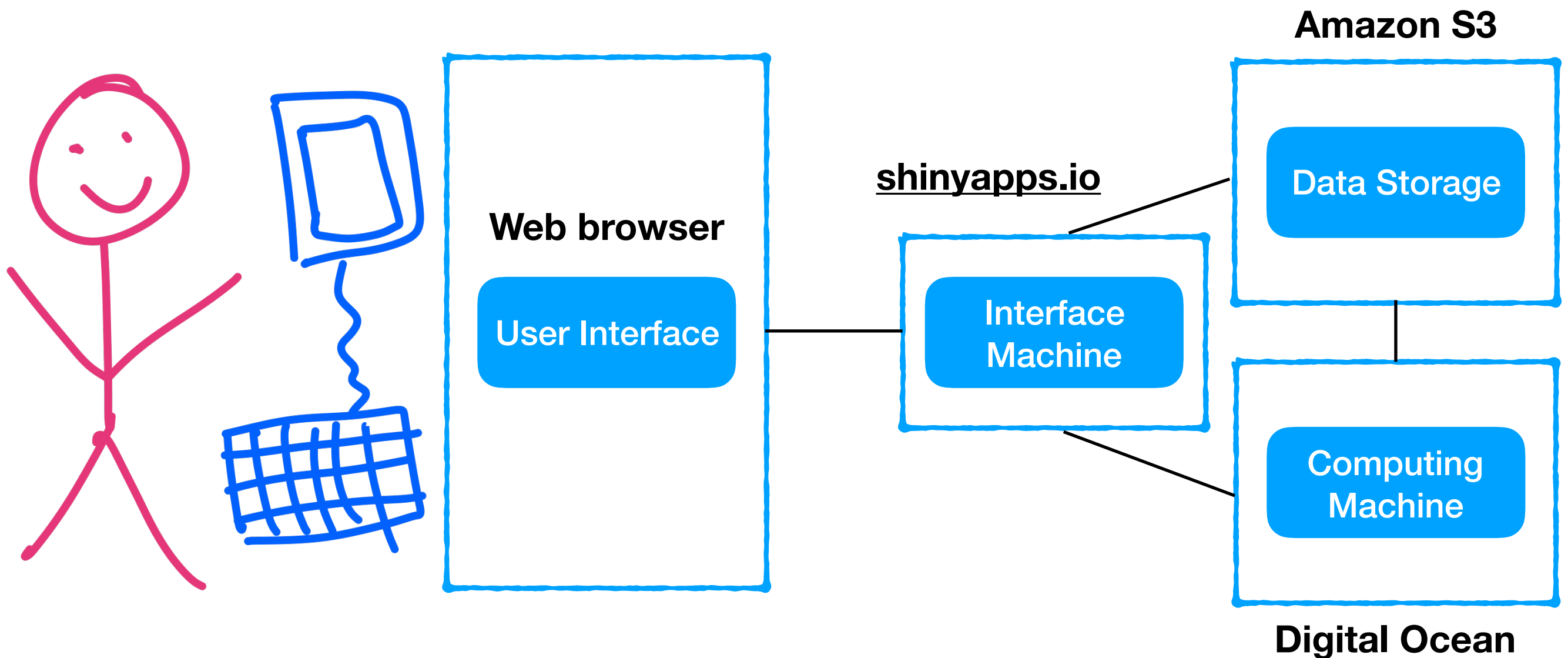
# Running Your Algorithm



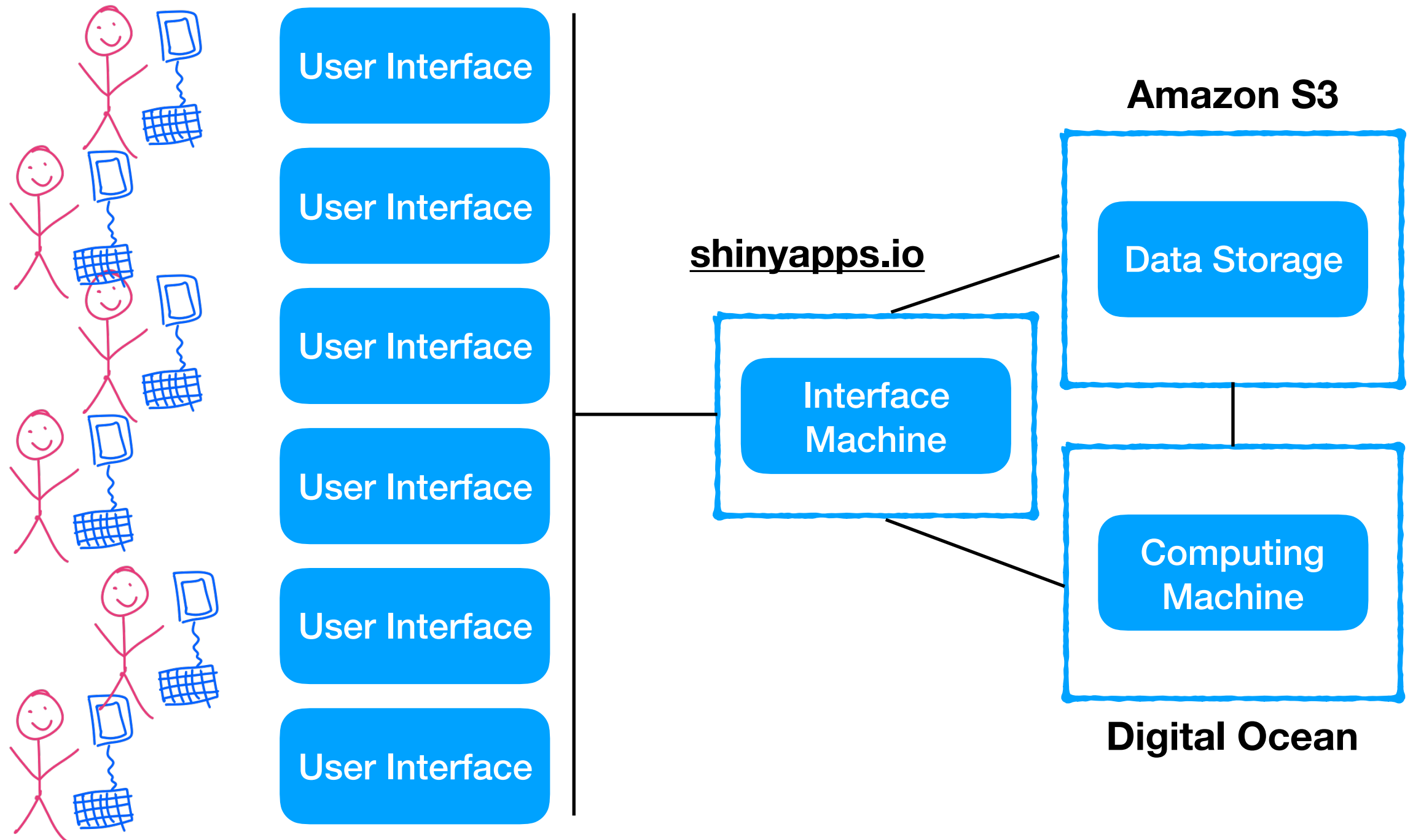
# Running Your Algorithm



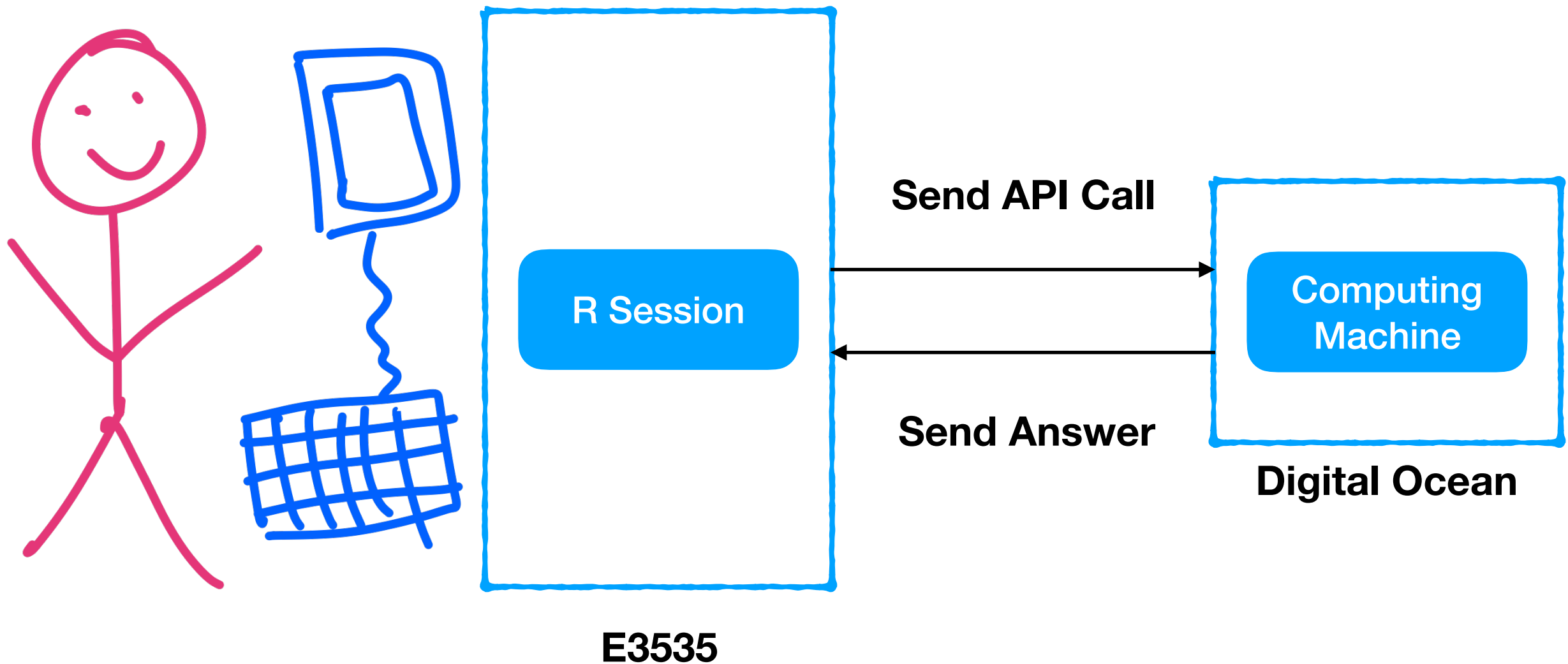
# Running Your Algorithm



# Running Your Algorithm



# Running Your Algorithm



# Deployment Strategy

- The **plumber** package converts an R function into a REST API
- Part of the “RStudio Universe” but does not require RStudio
- Can run on a server running R and provide a web interface
- Requires writing R code with a few extra markups (like roxygen2)

# Ozone Prediction

- Given a temperature value, what level of ozone should we expect?
- This is a “hard problem” but is easily solved with regression
- We can provide a web interface that can take temperature as input and provide predicted ozone as output



# Server: Ozone Prediction

```
## Predict Ozone Levels Given Temperature
library(splines)
library(datasets)
fit <- lm(Ozone ~ ns(Temp, 2), data = airquality)

## Predict Ozone from Temperature
## @param temp The temperature input
## @get /ozone
ozone_predict <- function(temp) {
  ## Check input type
  temp <- as.numeric(temp)

  ## Make prediction from fitted model
  p <- predict(fit, data.frame(Temp = temp))

  ## Return predicted value
  as.numeric(p)
}
```

# Client: Ozone Prediction

```
library(jsonlite); library(curl); library(glue)

ozone_predict_remote <- function(temp) {
  ## Construct API URL
  cmd <- glue("http://68.183.100.128:8000/ozone?",
             "temp={temp}")

  ## Open connection to the web server
  con <- curl(cmd)

  ## Read the answer from the server
  ans <- readLines(con, 1, warn = FALSE)

  ## Close server connection
  close(con)

  ## Convert answer from JSON and return
  fromJSON(ans)
}
```

# Run Function

# Sending More Data

- Typical web APIs are expecting lightweight inputs
- Not realistic to pass large data objects via URL strings
- For larger input data we need a different strategy where data can be stored/retrieved elsewhere
- The **aws.s3** package can be used to store/retrieve data from S3

# Confidence Intervals for the Median

- No closed-form solution
- Use the bootstrap to compute!
- Write a function called `confint_median(x, N)` that takes a vector of observations and a number of bootstrap iterations
- Return a vector containing the lower 2.5% and upper 97.5% of the median via the bootstrap

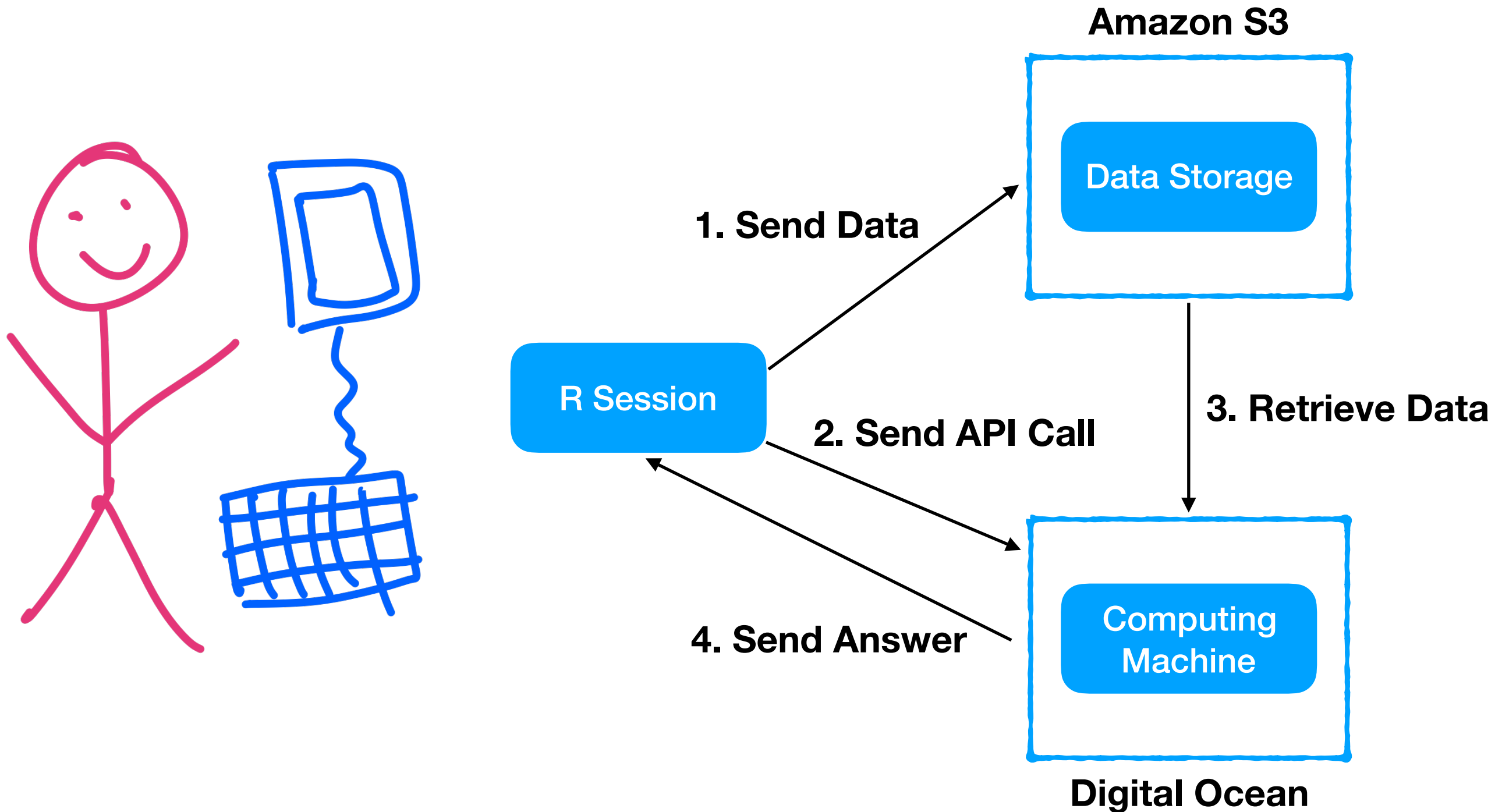
# Confidence Intervals for the Median

```
confint_median <- function(x, N = 1000) {  
  ## Coerce to numeric  
  x <- as.numeric(x)  
  
  ## Remove missing values  
  x <- x[!is.na(x)]  
  
  if(length(x) == 0L)  
    stop("no non-missing data values")  
  nobs <- length(x)  
  med <- replicate(N, {  
    x.new <- sample(x, nobs, replace = TRUE)  
    median(x.new)  
  })  
  quantile(med, c(0.025, 0.975))  
}
```

# Deploying This Function

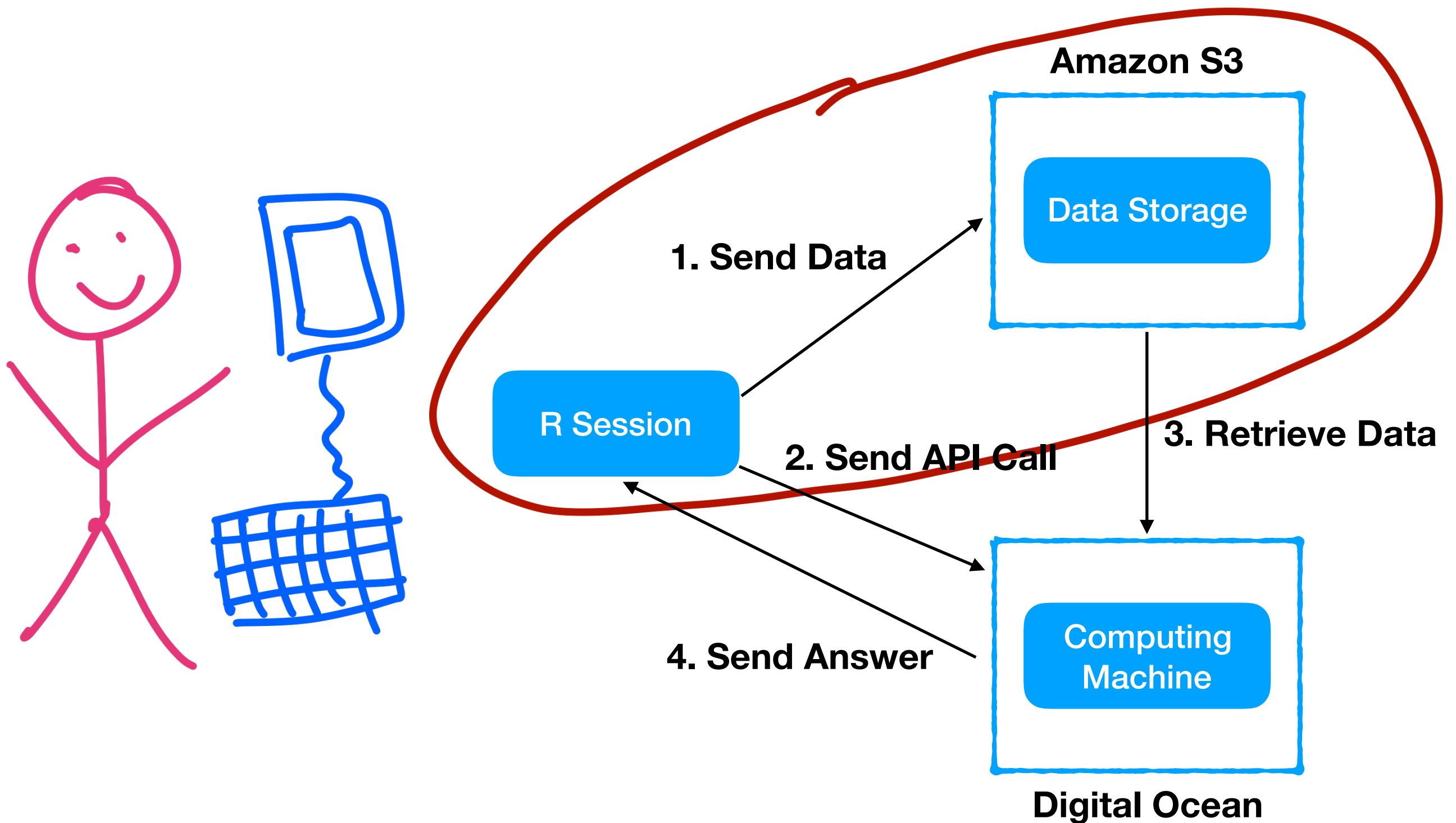
- Storage
  - Copy input data from user to a the storage server
- Compute
  - Deploy the CI algorithm to the compute server
  - Read data from the storage server
  - Compute answer and return to the user

# Running Your Algorithm



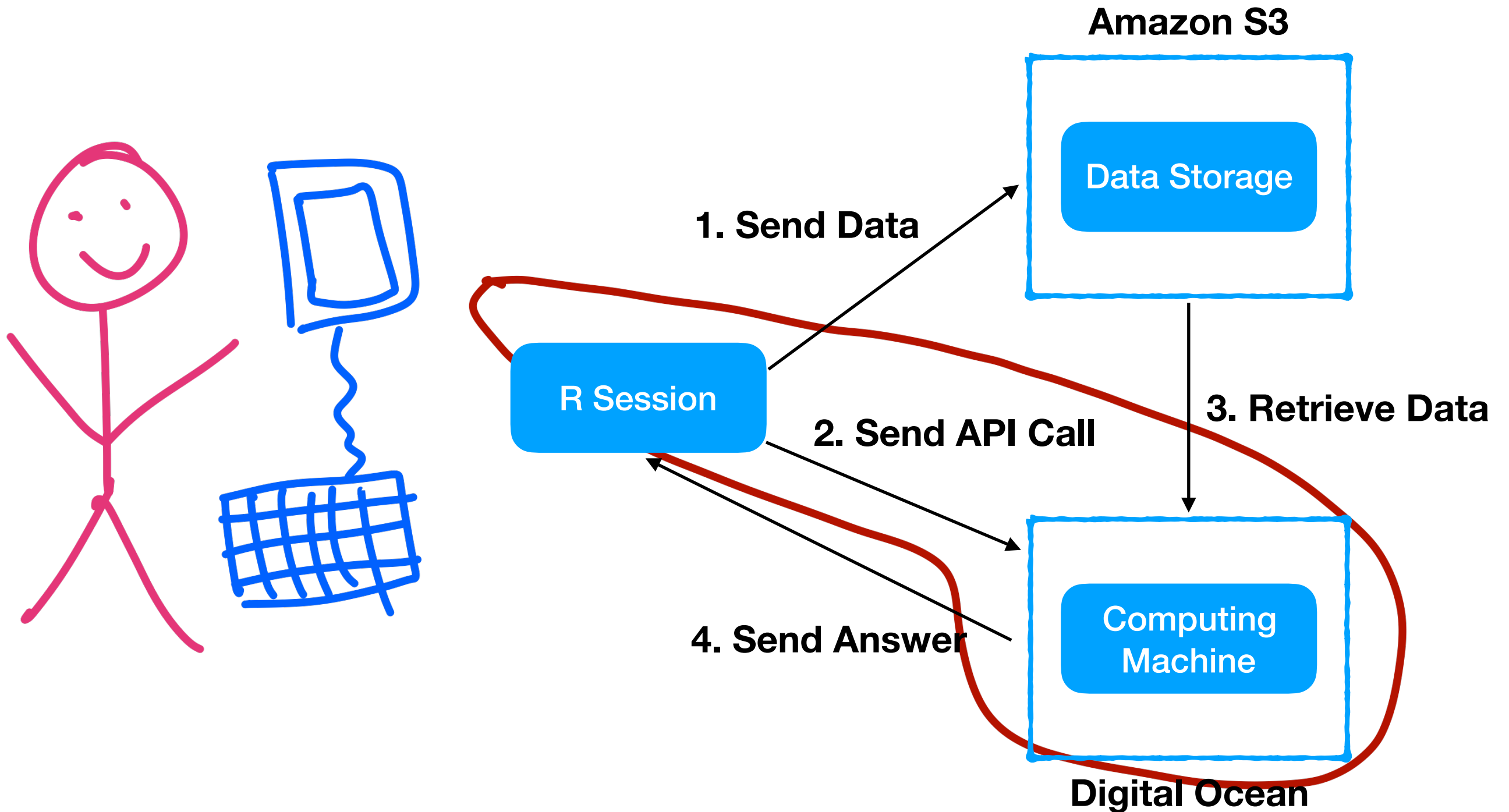


# Running Your Algorithm



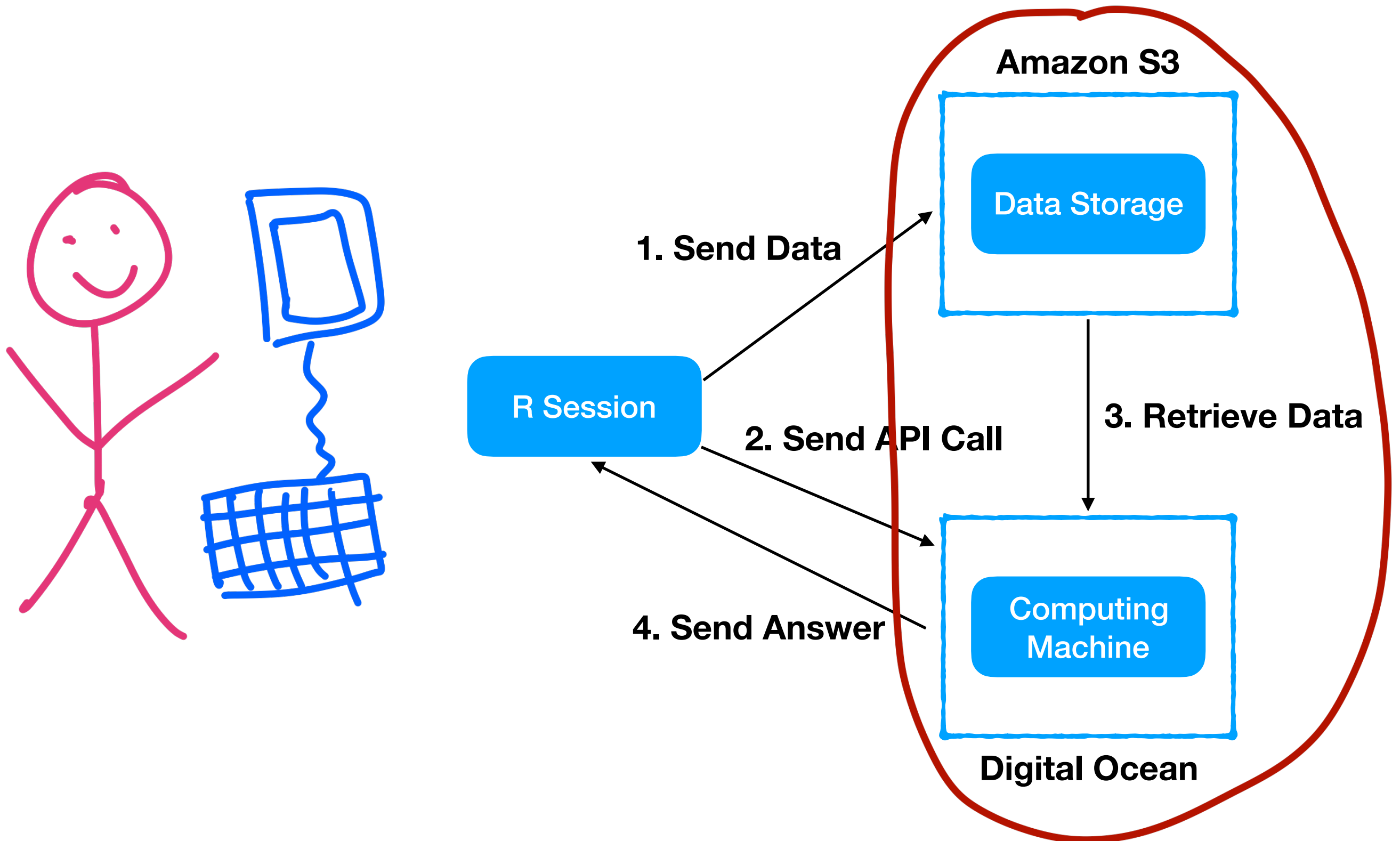
# Amazon S3

# Running Your Algorithm



# API Demo

# Running Your Algorithm



# Retrieving Data from S3

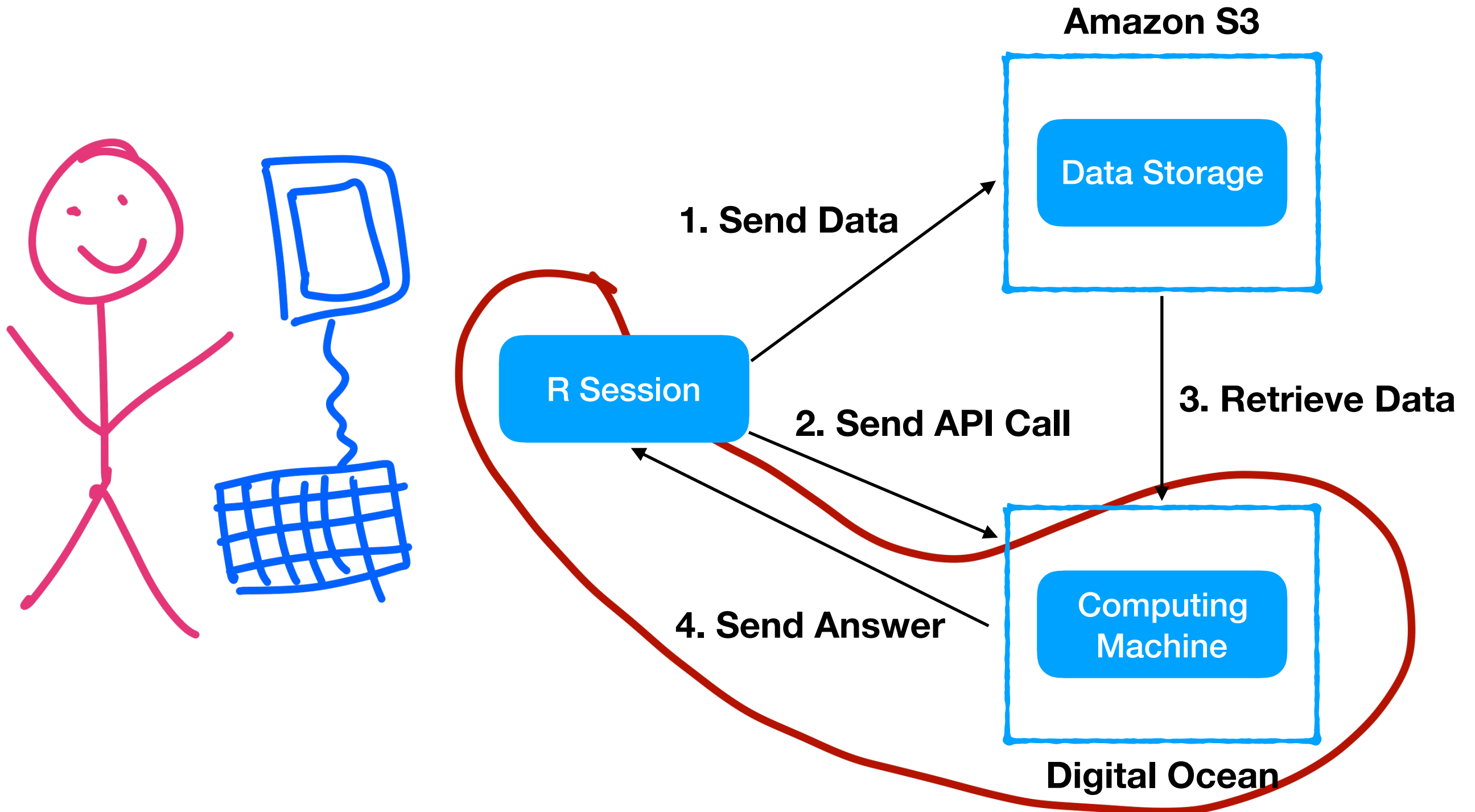
```

#* Compute the 95% bootstrap confidence interval for the median
#* @param key the S3 key for the data
#* @param bucket the name of the bucket where the data live
#* @param N the number of bootstrap iterations
#* @get /confint
confint_median_compute <- function(key, bucket, N) {
  ## Make sure data is proper type
  key <- as.character(key)
  bucket <- as.character(bucket)
  N <- as.integer(N)

  ## Read data from S3
  x <- s3readRDS(key, bucket = bucket)

  ## Compute the confidence interval
  confint_median(x, N)
}
```

# Running Your Algorithm



# Summary

- Creating APIs allows non-R-programmers access to your code in a standardized manner
- The plumber package translates R functions in to web API interfaces
- Amazon S3 can serve as a data intermediary if needed (via the aws.s3 package)
- Getting all the pieces to work right is tricky and everything will be different next month