Time Series Analysis and Forecasting

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John Carlo P. Daquis
Assistant Professor 4
UP Diliman School of Statistics

Chapter Outline

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II. Introduction to RStudio

1. The RStudio Interface
2. Basic Data Management and Functions in RStudio
3. Creating Line Graphs

The RStudio Interface

The RStudio Interface

What is  ?

- R is an open-source software environment for statistical computing and graphics.
- It has a worldwide repository system called the Comprehensive R Archive Network (CRAN) http://cran.r-project.org to download the software and user-contributed add-on packages.
- The R language is **case sensitive**.

The RStudio Interface

What is RStudio?

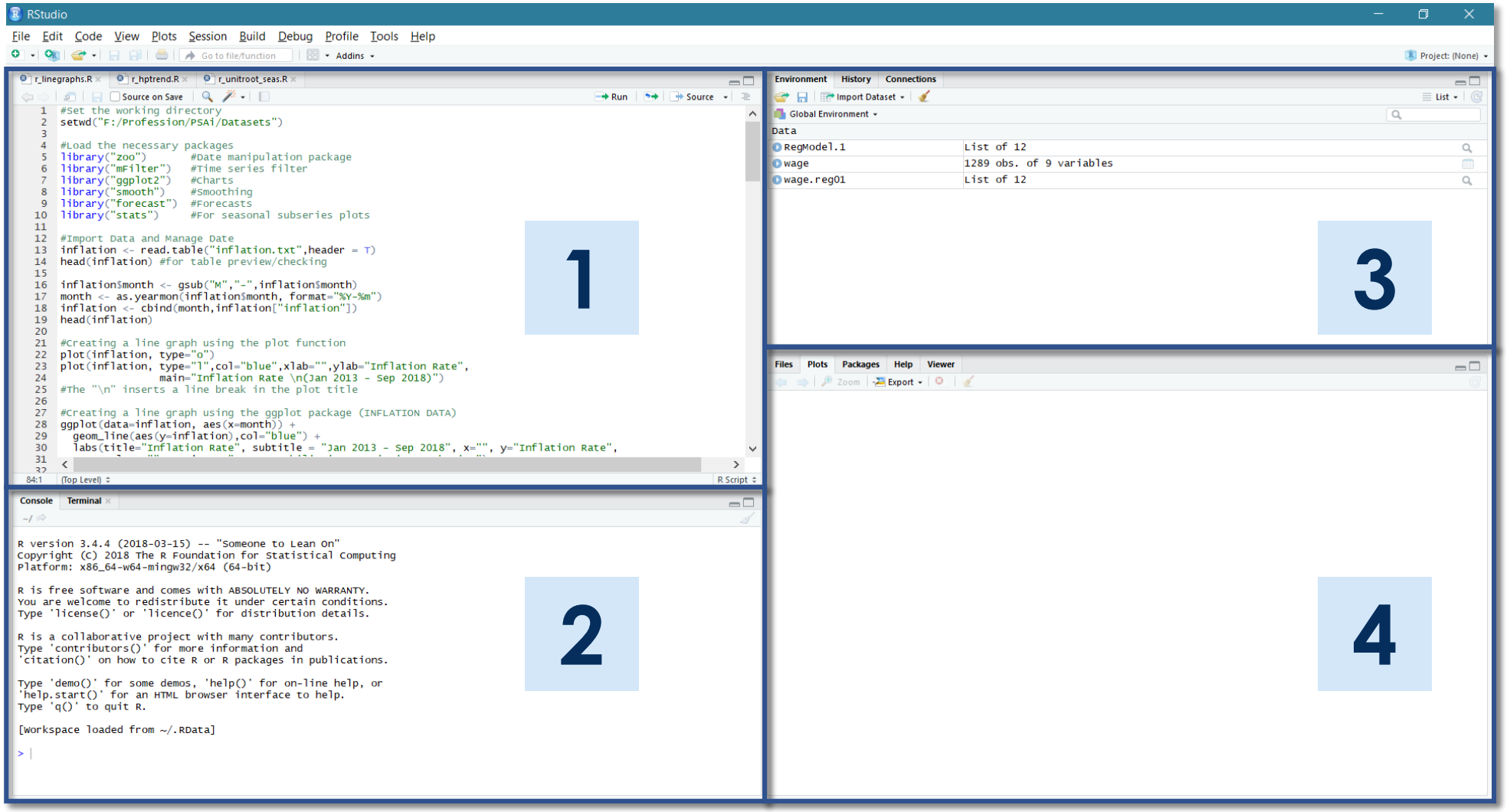
- RStudio is an Integrated Development Environment (IDE) that facilitates issuing of commands in R interactively.
- It has many convenient and easy-to-use tools for coding, plot management, object browsing, package management, among other things.
- To download Rstudio: https://www.rstudio.com/

The RStudio Interface

The RStudio 4-Panel Component Layout

- **Upper left:** Script window for editing R script files.
- **Lower left**: Console window for directly interacting with an R process.
- **Upper right:** Workspace and history browser
- **Lower right:** File browser, plot browser, package management, help browser.

The RStudio Interface



The RStudio Interface

The RStudio Script Window

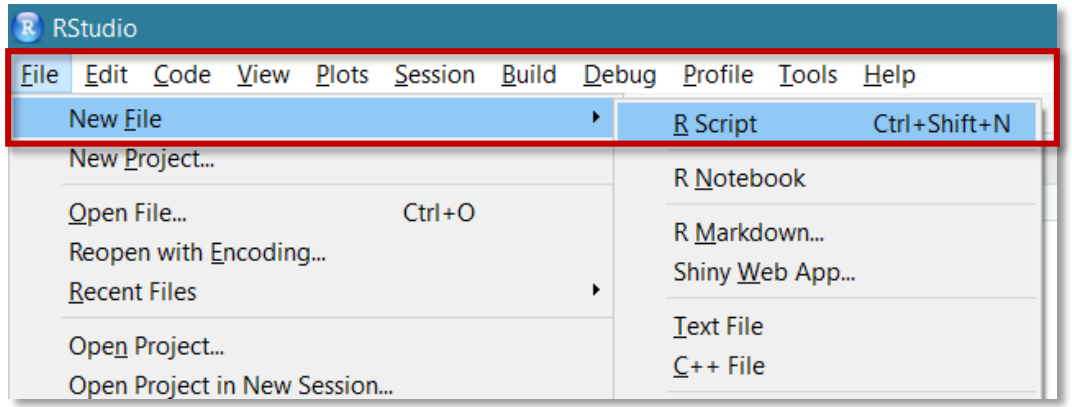
- RStudio's source editor includes a variety of productivity enhancing features including
  - syntax highlighting
  - selection running
  - code completion
  - multiple script file editing, and
  - find/replace.

Basic Data Management and Functions in RStudio

Basic Data Management and Functions in RStudio

The RStudio Script Window

- **Scripts.** The RStudio code is saved as a script with an **.R** extension.
- To create a new script, press the shortcut Ctrl+Shift+n or



Basic Data Management and Functions in RStudio

The RStudio Script Window

- **Working directories.** To set a working directory that contains the datasets to be used in the program, use the **setwd()** command. An example is:

```
#Set the working directory
setwd("F:/Profession/PSAi/Datasets")
```

- When copy-pasting directories, make sure to change \ to /.

Basic Data Management and Functions in RStudio

The RStudio Script Window

- **Comments.** These make source code easier for us to understand, and are generally ignored by the computer.

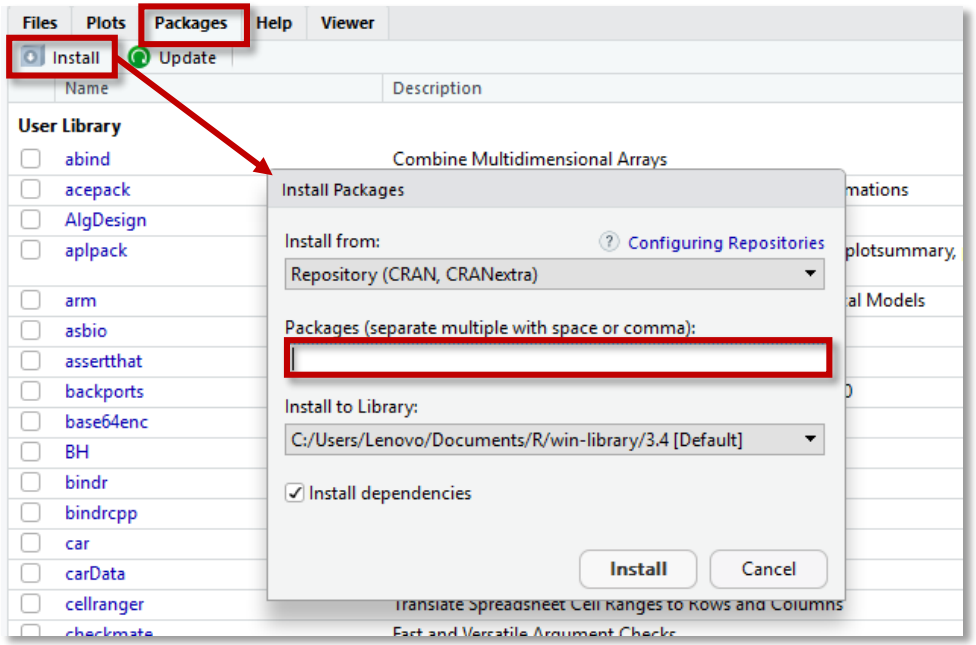
```
#Set the working directory
setwd("F:/Profession/PSAi/Datasets")
```

- Comments are preceded by the # symbol.

Basic Data Management and Functions in RStudio

Installing Packages

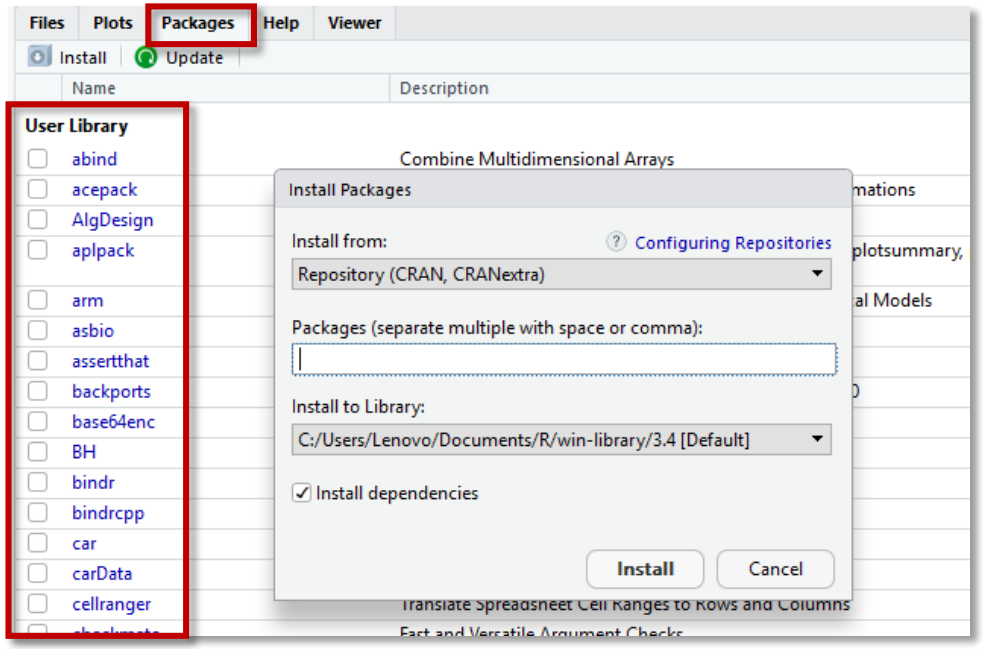
- The **packages** tab in the lower right panel can be used to install and load different packages.



Basic Data Management and Functions in RStudio

Installing Packages

- Loaded **packages** are marked with a check ✓ symbol.



Basic Data Management and Functions in RStudio

Installing Packages

- Alternatively, packages can be installed and loaded using **install.packages()** and **library()** commands, respectively.

```
install.packages("forecast")
library("forecast")
```

- While installation is a one-off process, needed packages are be loaded every time R is opened.

Basic Data Management and Functions in RStudio

Other Remarks

- More syntax will be added as we progress with the training.
- R syntax is **case-sensitive** (e.g., Variables x and X are different. Thus, creating objects with the same name but different case is highly discouraged.
- It is likely that a process can be coded and done in a number of ways in R.

Basic Data Management and Functions in RStudio

Other Remarks

- **Assignment operator.** R expressions at the right can be assigned to objects at its left using the assignment operator <-. Here, a dataset from the text file "inflation.txt" is assigned to an object at the left named "inflation".

```
inflation <- read.table("inflation.txt",header = T)
```

Creating Line Graphs

Line Graphs

What are line graphs?

- Line graphs or line charts are plots with time indices (e.g. months, quarters, years) on the x-axis and the time series values on the y axis;
- Line graphs are used to visualize the value of a variable over time.
- RStudio can output single, multiple and seasonal line graphs.

Line Graphs

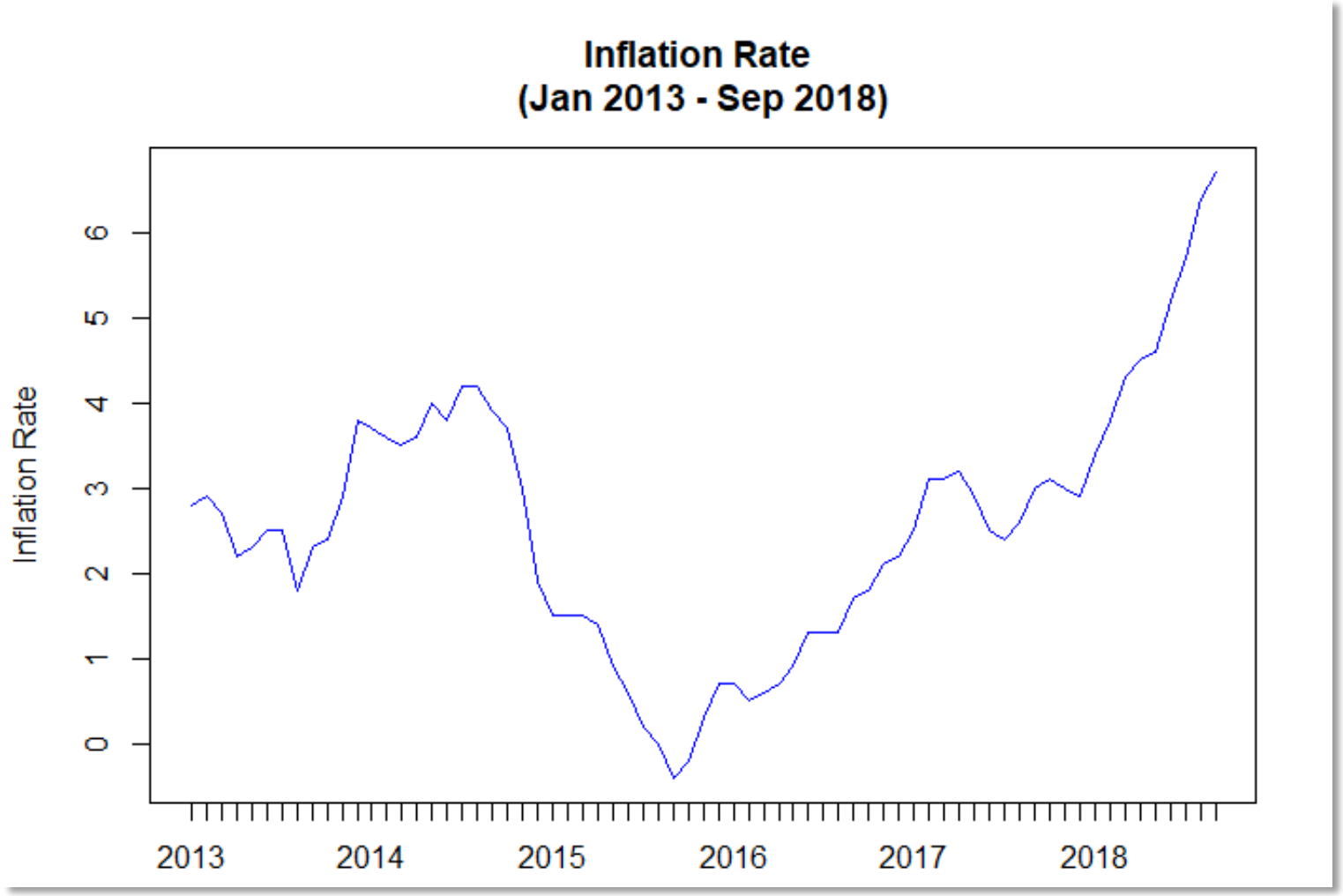
What are line graphs?

- These are used to obtain information about the movement and behavior of a time series.
- Multiple graphs allow for comparison across different time series.
- Seasonal graphs help the researcher know the seasonal behaviors of the time series and be able to analyze it across years.

Line Graphs

Graphs

Here's a single line graph of the time series.



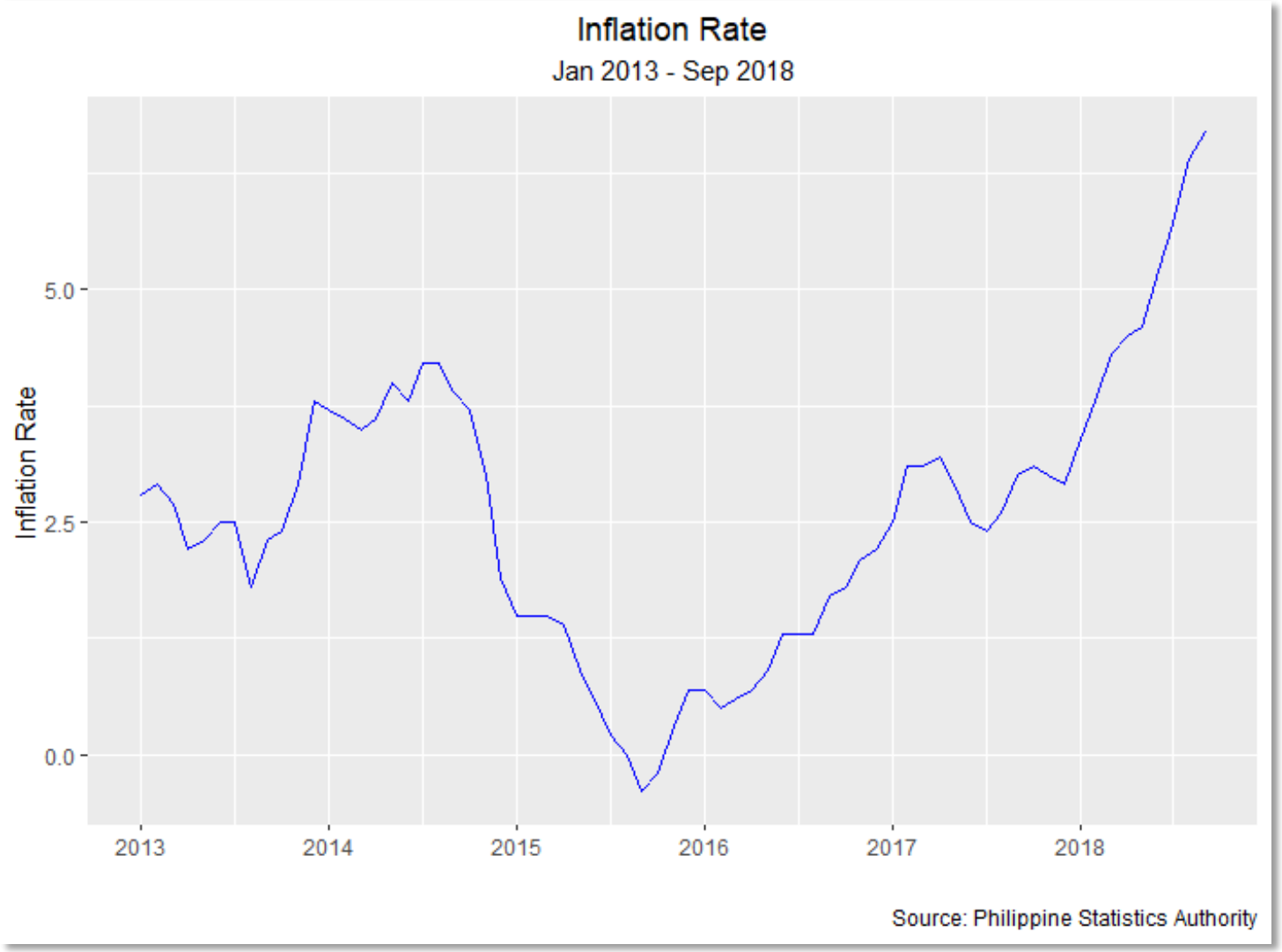
Line Graphs

```
#Import Data and Manage Date
inflation <- read.table("inflation.txt",header = T)
head(inflation) #for table preview/checking

inflation$month <- gsub("M","-",inflation$month)
month <- as.yearmon(inflation$month, format="%Y-%m")
inflation <- cbind(month,inflation["inflation"])
head(inflation)

#Creating a line graph using the plot function
plot(inflation, type="o")
plot(inflation, type="l",col="blue",xlab="",ylab="Inflation Rate",
                main="Inflation Rate \n(Jan 2013 - Sep 2018)")
#The "\n" inserts a line break in the plot title
```

Line Graphs

Graphs

Here's the same data, graphed using R's **ggplot2** package



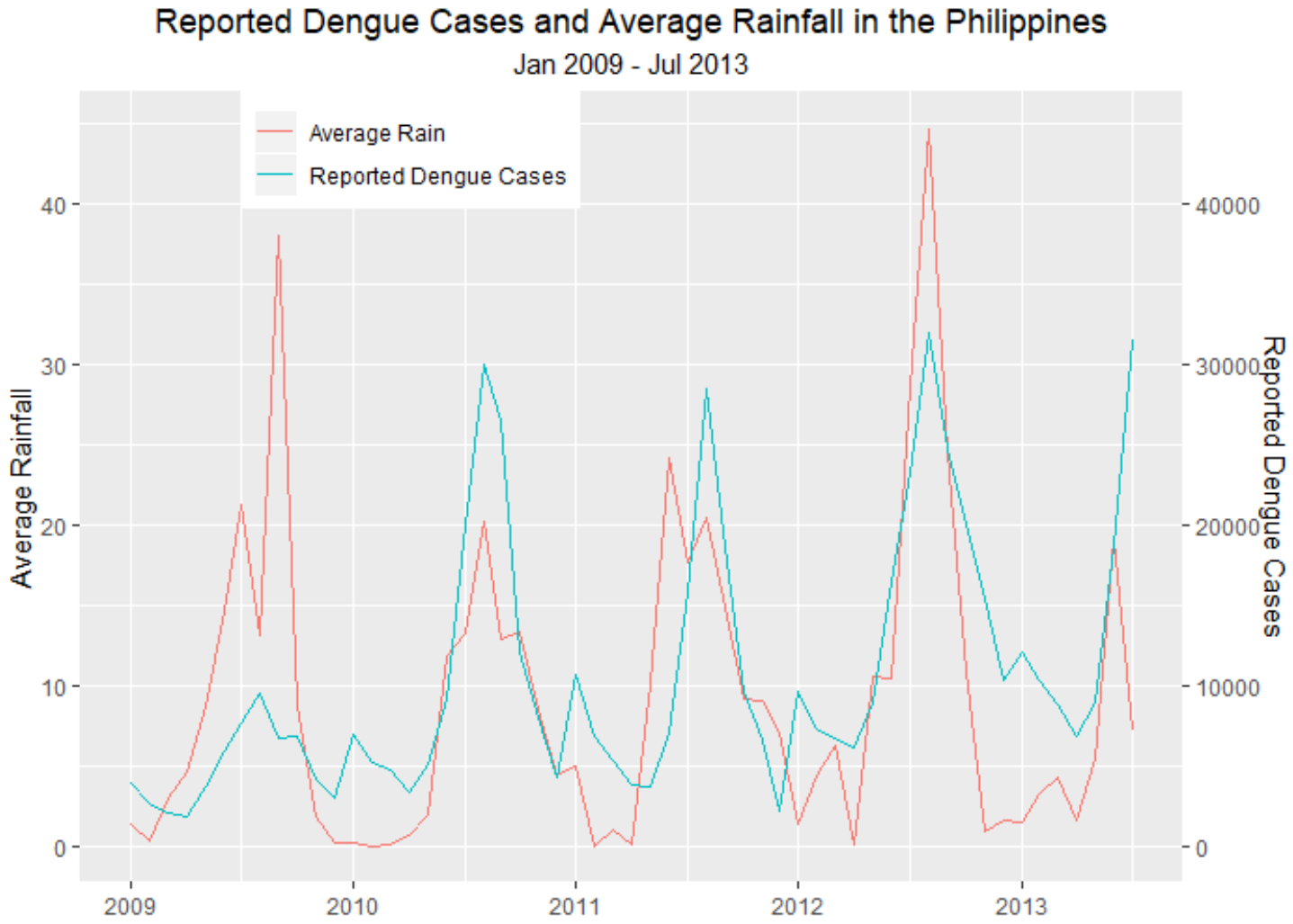
Line Graphs

```
#Creating a line graph using the ggplot package (INFLATION DATA)
ggplot(data=inflation, aes(x=month)) +
  geom_line(aes(y=inflation),col="blue") +
  labs(title="Inflation Rate", subtitle = "Jan 2013 - Sep 2018", x="",
       y="Inflation Rate",
       colour="",caption = "Source: Philippine Statistics Authority") +
  theme(plot.title = element_text(hjust = 0.5),
        plot.subtitle = element_text(hjust = 0.5))
```

Line Graphs

Graphs

Multiple graphs allow for comparison among different series.



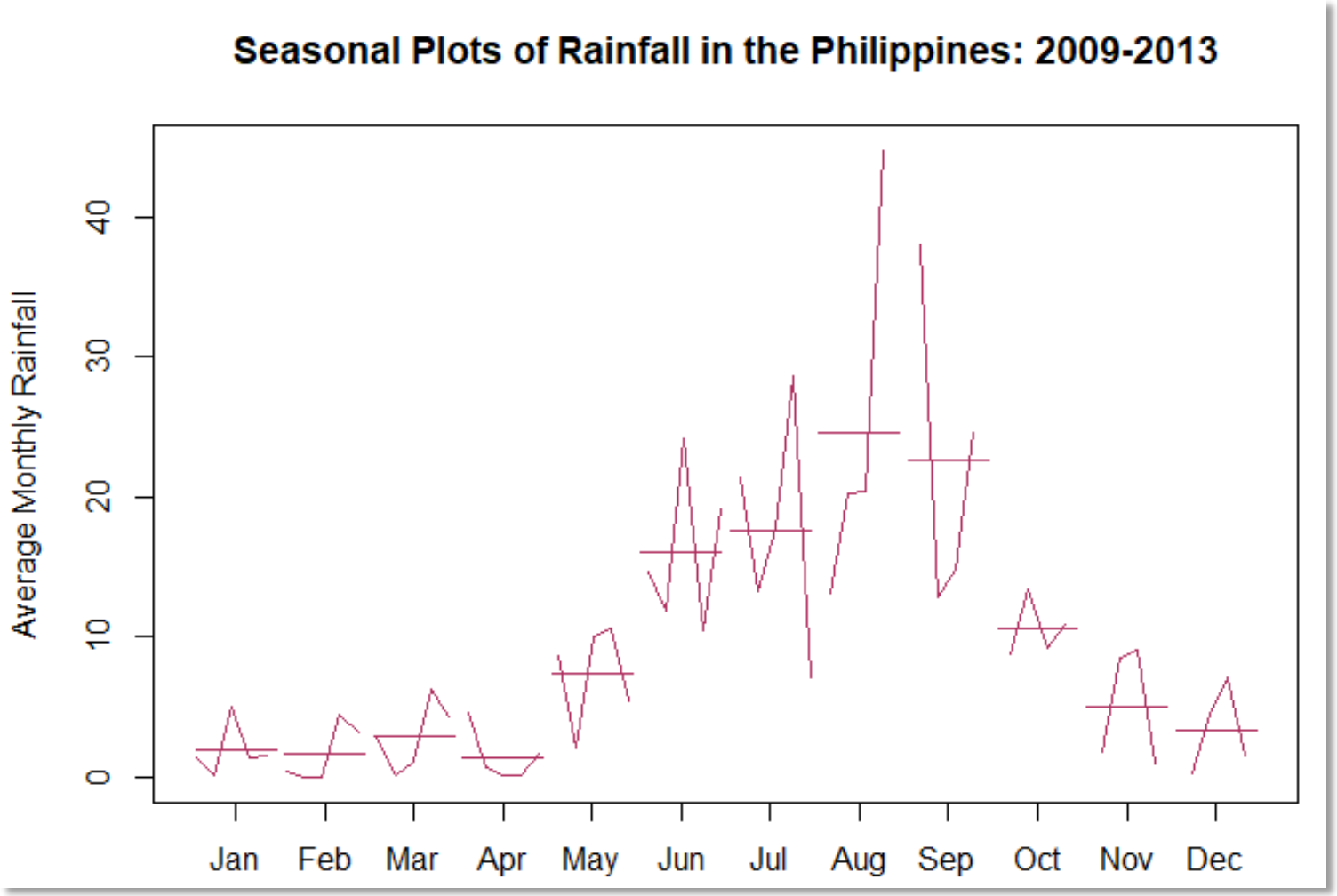
Line Graphs

```
#rainfall data (IMPORT AND LINE GRAPH)
rainfall <- read.table("rainfall.txt",header = T)
head(rainfall) #for table preview/checking

rainfall$month <- gsub("M","-",rainfall$month)
month <- as.yearmon(rainfall$month, format="%Y-%m")
rainfall <- cbind(month,rainfall["ave_rain"],rainfall["dengue"])
head(rainfall)

is.data.frame(rainfall)
ggplot(data=rainfall, aes(x=month,group = 1)) +
  geom_line(aes(y=ave_rain,colour="Average Rain")) +
  geom_line(aes(y=dengue*1/1000,colour="Reported Dengue Cases")) +
  labs(title="Reported Dengue Cases and Average Rainfall in the Philippines",
       subtitle = "Jan 2009 - Jul 2013", x="", y="Average Rainfall", colour="") +
  theme(plot.title = element_text(hjust = 0.5),
        plot.subtitle = element_text(hjust = 0.5),
        legend.position = c(.3, .95)) +
  scale_y_continuous(sec.axis = sec_axis(~.*1000/1,
                     name = "Reported Dengue Cases"))
```

Line Graphs

Graphs

Seasonal graphs reveal the seasonal behavior along with its mean (horizontal line).



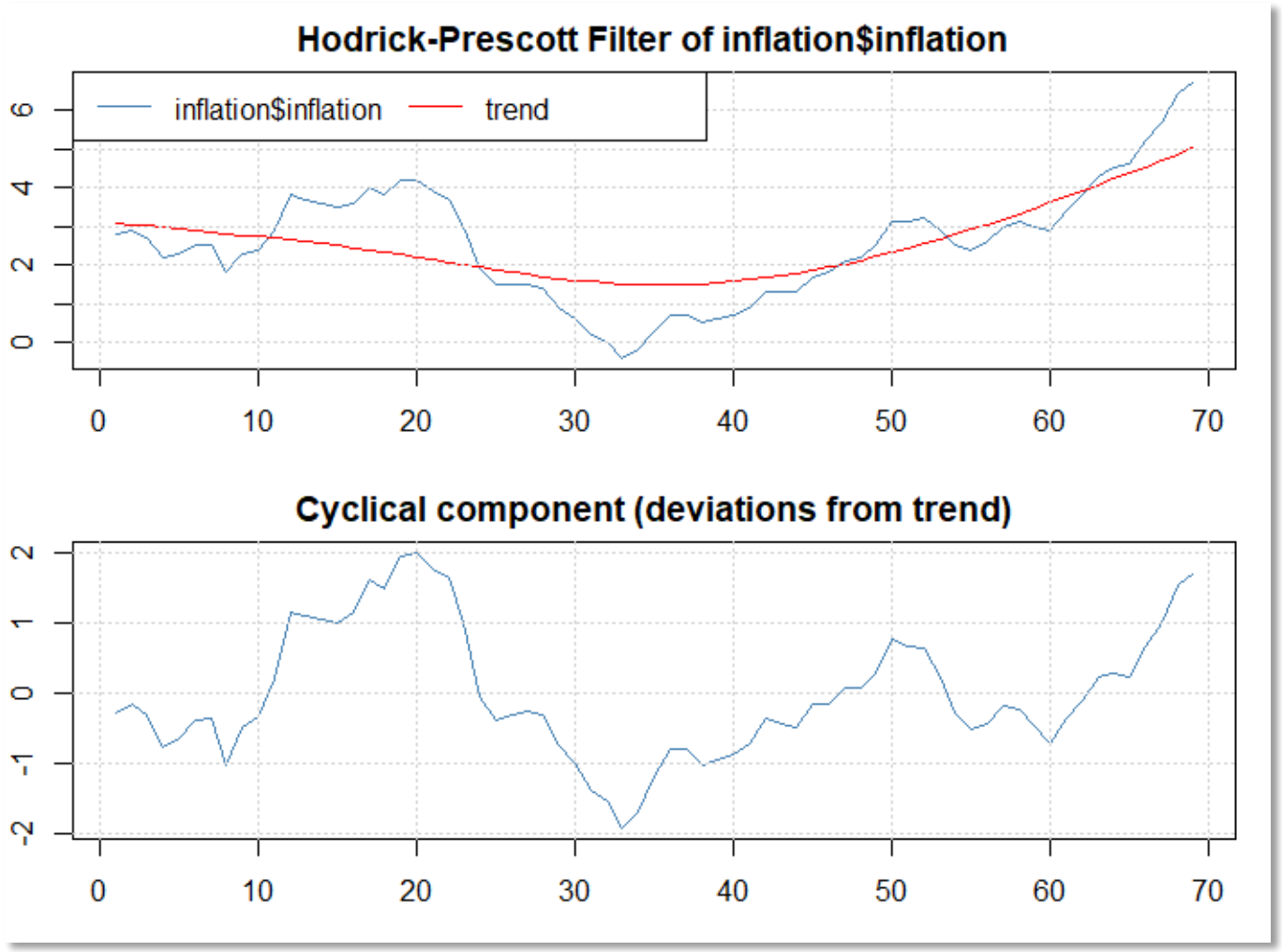
Line Graphs

```
#Rainfall data (for seasonal plots)
rain <- read.table("rain.txt",header = T)
rain <- ts(rain,frequency=12,start=c(2009,1),end=c(2013,7))
head(rain) #for table preview/checking

plot(rain,col="maroon",
     main="Average Rainfall in the Philippines: 2009-2013",
     xlab="",
     ylab="Average Monthly Rainfall")
monthplot(rain,labels = month.abb,col="maroon",
          main="Seasonal Plots of Rainfall in the Philippines: 2009-2013",
          ylab="Average Monthly Rainfall")
```

Line Graphs

Graphs

The **Hodrick-Prescott Filter** is a method that is used to obtain a smooth estimate of the long-term trend of a series.



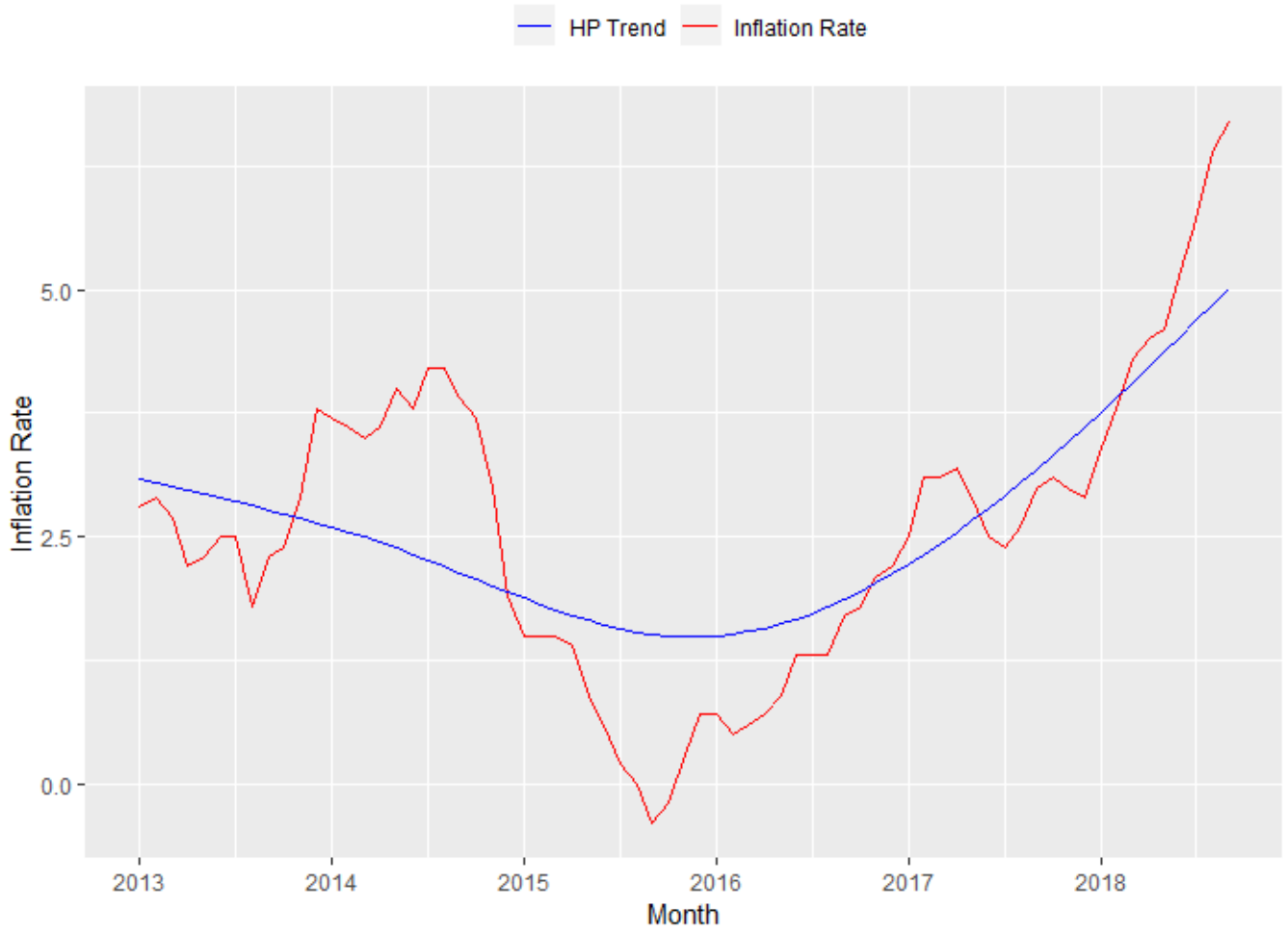
Line Graphs

```
#Hodrick-Prescott Filter
inflation.hp <- hpfilter(inflation$inflation, freq=14400, type="lambda")
#for freq values: monthly-1440, quarterly-1600, annual-100
plot(inflation.hp)

inflation <- cbind(inflation,inflation.hp$trend)
head(inflation)
colnames(inflation)[3] <- "hp_trend"
head(inflation)
```

Line Graphs

Graphs

Here's the same HP filter output dataset with added **ggplot2** formatting.



Line Graphs

```
#ggplot input: Dataframe
is.data.frame(inflation)
ggplot(data=inflation, aes(x=month)) +
  geom_line(aes(y=inflation, colour="Inflation Rate")) +
  geom_line(aes(y=hp_trend, colour="HP Trend")) +
  labs(x="Month", y="Inflation Rate", colour="") +
  theme(legend.position="top") +
  scale_colour_manual(values=c("blue","red"))
```

Workshop

Line Graphs

Workshop 1: Time Series Decomposition

Run the program below and comment on what happens.

```
#put the data into a time series
rgdp.ts <- ts(read.table("rgdp2.txt",header =
T),frequency=4,start=c(1998,1),end=c(2018,2))

#line plot with elements
plot(rgdp.ts, main="Quartely GDP of the Philippines: Q1 1998 - Q2 2018
               (at constant 2000 prices)",
     ylab="Real GDP (in Million Pesos)", xlab="")
```

Line Graphs

Workshop 1: Time Series Decomposition

Run the program below and comment on what happens.

```
#time series decomposition
decomp_rgdp <- decompose(rgdp.ts,"additive")

#plot components
par(mfrow=c(2,2)) #run this par if you want a single panel of four graphs
plot(rgdp.ts,ylab="Observed",xlab="")
plot(decomp_rgdp$trend,ylab="Trend-Cycle",xlab="")
plot(decomp_rgdp$seasonal,ylab="Seasonality",xlab="")
plot(decomp_rgdp$random,ylab="Irregular",xlab="")
par(mfrow=c(1,1)) #run this par if you to revert to a single panel of one graph
```

Line Graphs

Workshop 2: Hodrick-Prescott Filter

Write an R code that outputs a Hodrick-Prescott filter on *exports* data. Output graphs similar to that of slides #30 and #32.


Thank
You