# Assignment 6: Time Series Analysis

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## OVERVIEW

This exercise accompanies the lessons in Hydrologic Data Analysis on time series analysis

## Directions

1. Change "Student Name" on line 3 (above) with your name.
2. Work through the steps, **creating code and output** that fulfill each instruction.
3. Be sure to **answer the questions** in this assignment document.
4. When you have completed the assignment, **Knit** the text and code into a single pdf file.
5. After Knitting, submit the completed exercise (pdf file) to the dropbox in Sakai. Add your last name into the file name (e.g., "A06_Salk.html") prior to submission.

The completed exercise is due on 11 October 2019 at 9:00 am.

## Setup

1. Verify your working directory is set to the R project file,
2. Load the tidyverse, lubridate, trend, and dataRetrieval packages.
3. Set your ggplot theme (can be theme_classic or something else)
4. Load the ClearCreekDischarge.Monthly.csv file from the processed data folder. Call this data frame ClearCreekDischarge.Monthly.

```
getwd()
```

```
## [1] "/Users/ethanready/Hydrologic_Data_Analysis/Assignments"
```

```
library(tidyverse)
```

```
## -- Attaching packages --------------------------- tidyverse 1.2.1 --

## v ggplot2 3.2.1     v purrr   0.3.2
## v tibble  2.1.3     v dplyr   0.8.3
## v tidyr   0.8.3     v stringr 1.4.0
## v readr   1.3.1     v forcats 0.4.0

## -- Conflicts ------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(lubridate)
```

```
##
## Attaching package: 'lubridate'
```

```
## The following object is masked from 'package:base':
##
##     date
```

```
library(trend)
library(dataRetrieval)

theme_set(theme_classic())

filename<-file.path(path.expand("~"), "Hydrologic_Data_Analysis", "Data", "Processed", "ClearCreekDischa

ClearCreekDischarge.Monthly<-read_csv(filename)
```

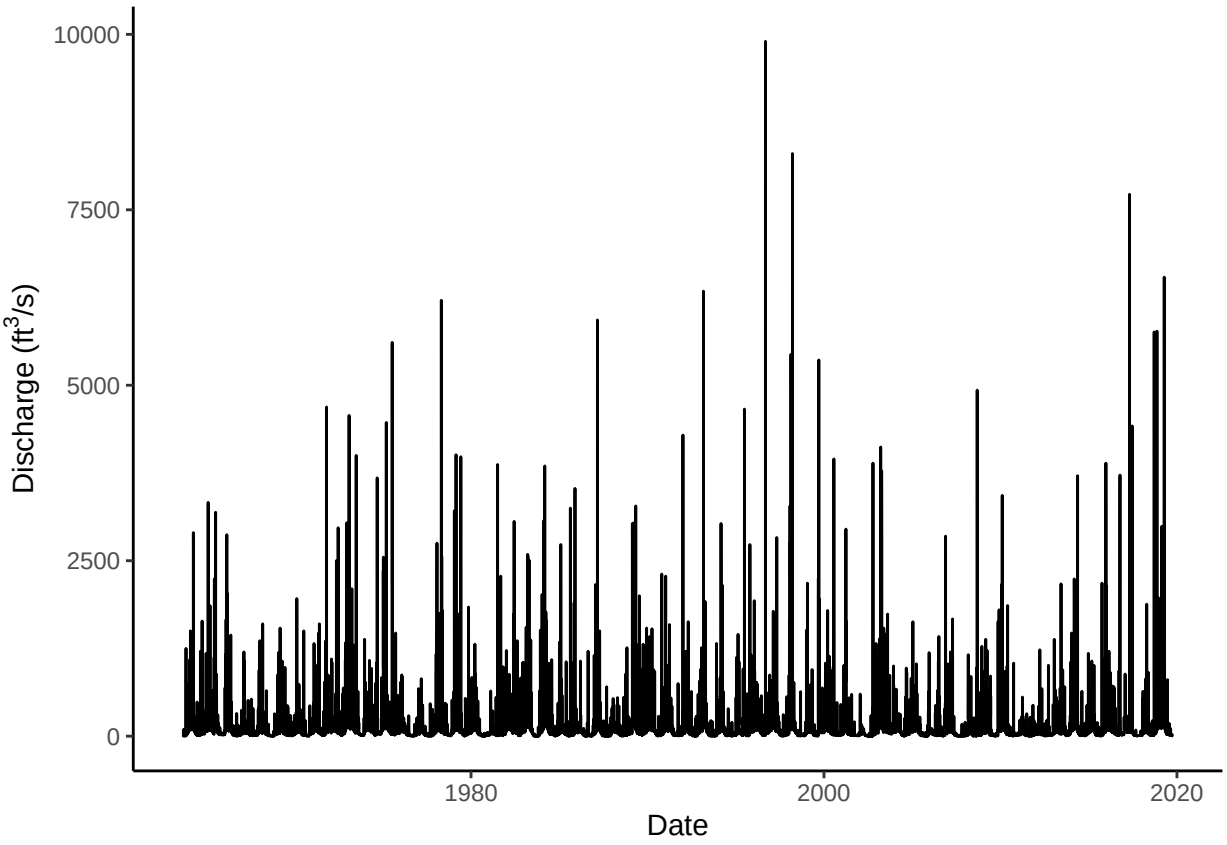
```
## Parsed with column specification:
## cols(
##   Year = col_double(),
##   Month = col_double(),
##   Discharge = col_double()
## )
```

## Time Series Decomposition

5. Create a new data frame that includes daily mean discharge at the Eno River for all available dates (`siteNumbers = "02085070"`). Rename the columns accordingly.
6. Plot discharge over time with geom_line. Make sure axis labels are formatted appropriately.
7. Create a time series of discharge
8. Decompose the time series using the `stl` function.
9. Visualize the decomposed time series.

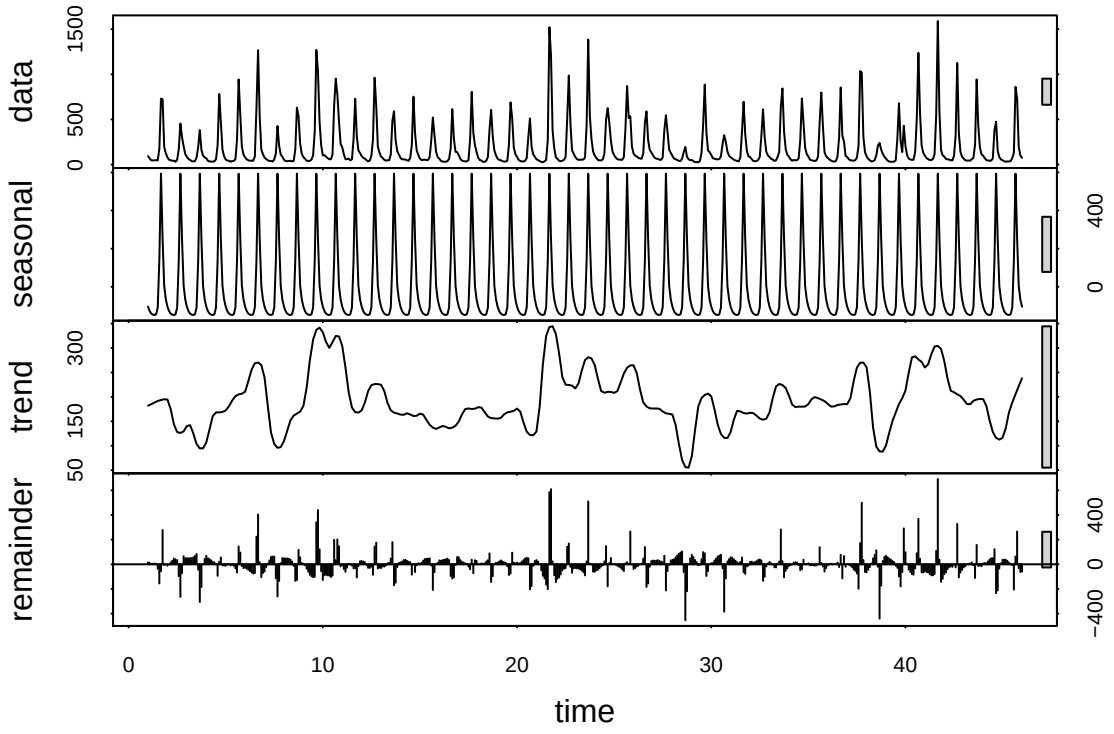
```
Eno.Discharge<-readNWISdv(siteNumbers = "02085070",
           parameterCd = "00060")%>%
  renameNWISColumns()

Discharge.Plot<-ggplot(Eno.Discharge, aes(x=Date, y=Flow))+
  geom_line()+
  labs(x = "Date", y = expression("Discharge (ft"^3*"/s)"))
Discharge.Plot
```




```
ClearCreekDischarge.ts<-ts(ClearCreekDischarge.Monthly[[3]], frequency = 12)

ClearCreekDecomposed<-stl(ClearCreekDischarge.ts, s.window = "periodic")
plot(ClearCreekDecomposed)
```




10. How do the seasonal and trend components of the decomposition compare to the Clear Creek discharge dataset? Are they similar in magnitude?

    Seasonal: Regular pattern with maximum of 600. Dataset has maximum of 1500.

    Trend: Lots of noise with max at 350. Peaks and troughs seem to follow those of the dataset.

## Trend Analysis

Research question: Has there been a monotonic trend in discharge in Clear Creek over the period of study?

11. Generate a time series of monthly discharge in Clear Creek from the ClearCreekDischarge.Monthly data frame. This time series should include just one column (discharge).
12. Run a Seasonal Mann-Kendall test on the monthly discharge data. Inspect the overall trend and the monthly trends.

```
ClearCreekDischarge.ts<-ts(ClearCreekDischarge.Monthly[[3]], frequency = 12)

ClearCreek.smk<-smk.test(ClearCreekDischarge.ts)
summary(ClearCreek.smk)
```

```
##
##  Seasonal Mann-Kendall trend test (Hirsch-Slack test)
```

```
##
## data: ClearCreekDischarge.ts
## alternative hypothesis: two.sided
##
## Statistics for individual seasons
##
## H0
##                      S  varS    tau      z Pr(>|z|)
## Season 1:   S = 0   64 11154  0.062  0.597 0.550828
## Season 2:   S = 0   24 10450  0.024  0.225 0.821984
## Season 3:   S = 0   30 10450  0.030  0.284 0.776650
## Season 4:   S = 0   35 10449  0.035  0.333 0.739425
## Season 5:   S = 0    4 10450  0.004  0.029 0.976588
## Season 6:   S = 0  204 10450  0.206  1.986 0.047054 *
## Season 7:   S = 0  230 10450  0.232  2.240 0.025081 *
## Season 8:   S = 0  148 10450  0.149  1.438 0.150434
## Season 9:   S = 0   94 10450  0.095  0.910 0.362951
## Season 10:   S = 0 -54 10450 -0.055 -0.518 0.604135
## Season 11:   S = 0 -99 10449 -0.100 -0.959 0.337703
## Season 12:   S = 0 -90 10450 -0.091 -0.871 0.383958
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
ClearCreek.smk
```

```
##
##  Seasonal Mann-Kendall trend test (Hirsch-Slack test)
##
## data:  ClearCreekDischarge.ts
## z = 1.6586, p-value = 0.09719
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##      S   varS
##    590 126102
```

13. Is there an overall monotonic trend in discharge over time? If so, is it positive or negative?

    The seasonal Mann-Kendall test did not find a significant monotonic trend, as the p-value was above 0.05. The sample estimate for S, while not significant for data analysis, was 590.

14. Are there any monthly monotonic trends in discharge over time? If so, during which months do they occur and are they positive or negative?

    June and July both had significant monotonic trends. Both were positive. This would suggest a steady increase in discharge over time in June and July, with insignificant long-terms trends in the other months.

## Reflection

15. What are 2-3 conclusions or summary points about time series you learned through your analysis?

1) It's hard to visualize/understand what a time series is. 2) There's lots of different things you can do with time series to visualize changes in data over time.

16. What data, visualizations, and/or models supported your conclusions from 12?

    I'm guessing that this question meant to ask about #15. The seasonal Mann-Kendall test gave a lot of information but I'm not really sure where its coming from.

17. Did hands-on data analysis impact your learning about time series relative to a theory-based lesson? If so, how?

    Yes, using the test helped me better understand what it was specifically telling me and unpack some of the pieces of the test.

18. How did the real-world data compare with your expectations from theory?

    I didn't really have any expectations