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] "Z:/Hydrologic_Data_Analysis2/Assignments"
```

```
library(tidyverse)
```

```
## -- Attaching packages -----------------------------------------------------------------------------------

## v ggplot2 3.2.1     v purrr   0.3.2
## v tibble  2.1.3     v dplyr   0.8.3
## v tidyr   1.0.0     v stringr 1.4.0
## v readr   1.3.1     v forcats 0.4.0

## -- Conflicts ---------------------------------------------------------------------------------- tid
## 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
```

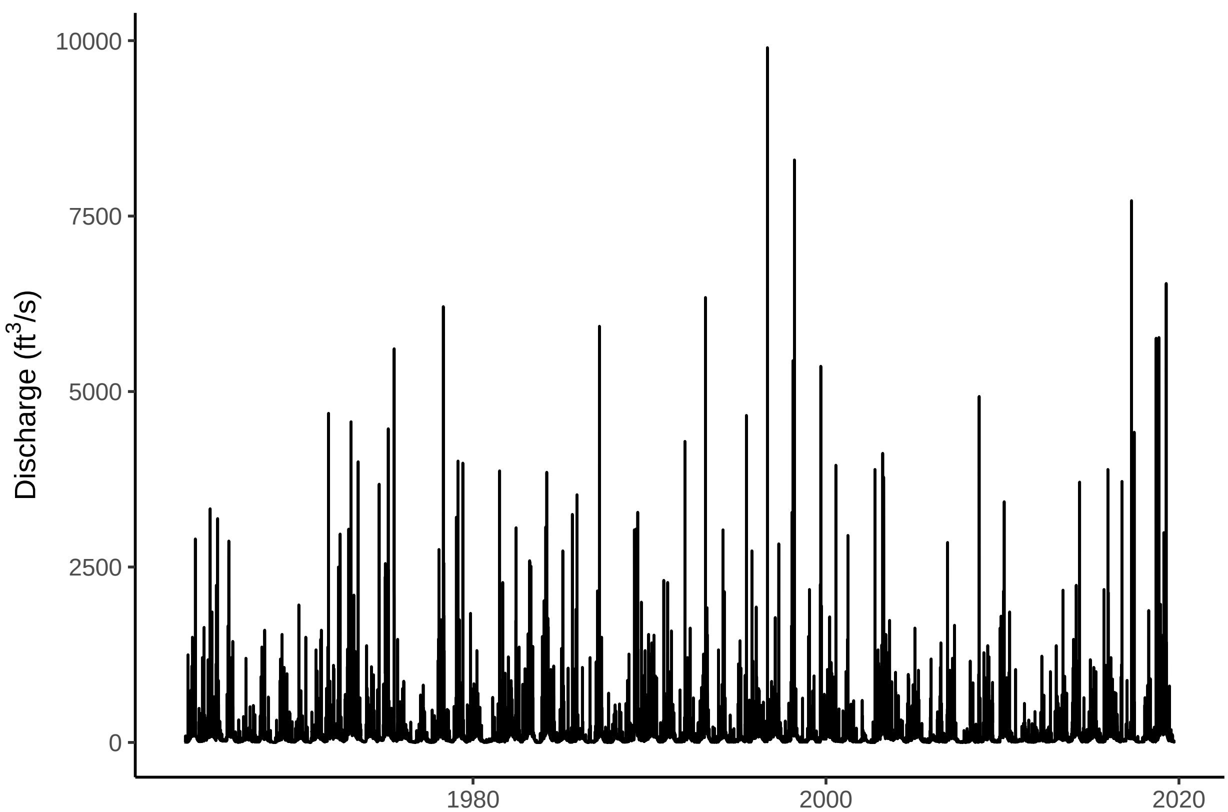
```
library(trend)
library(dataRetrieval)

theme_set(theme_classic())
```

```r
ClearCreekDischarge.Monthly <- read.csv("Z:/Hydrologic_Data_Analysis2/Data/Processed/ClearCreekDischarge
```

Time Series Decomposition

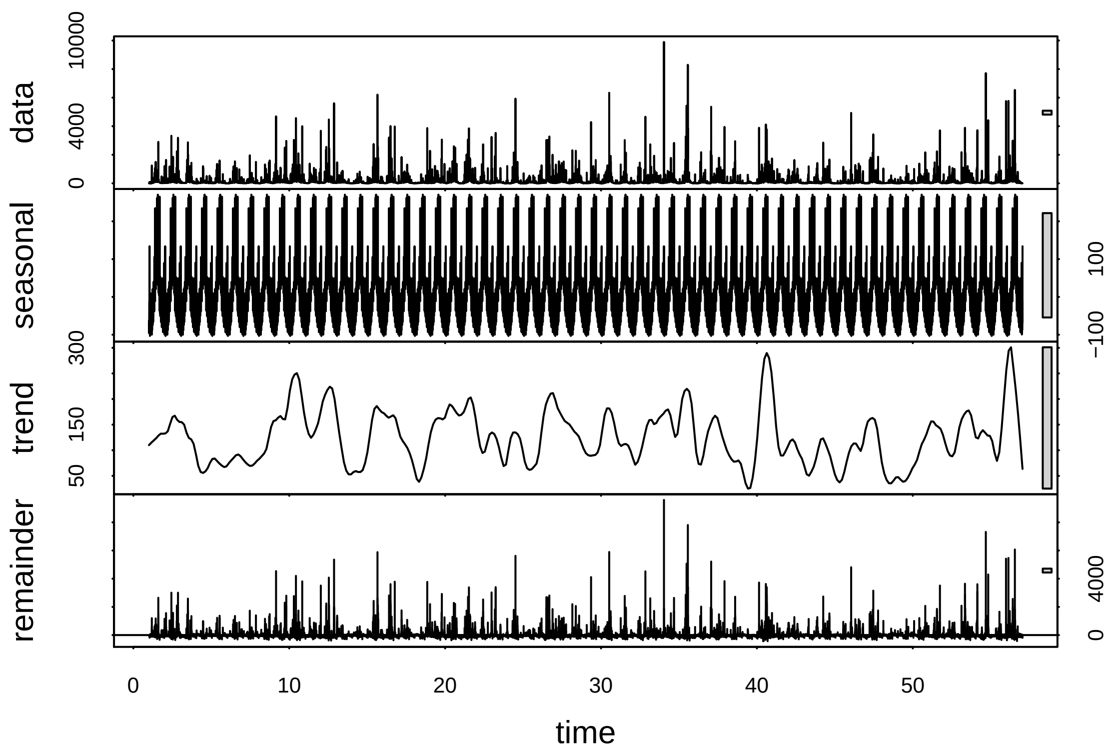
5. Create a new data frame that includes daily mean discharge at the Eno River for all available dates (`siteNumbers = "02085070"`). Rename the columns accordingly.
6. Plot discharge over time with geom_line. Make sure axis labels are formatted appropriately.
7. Create a time series of discharge
8. Decompose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

```r
EnoDischarge <- readNWISdv(siteNumbers = "02085070",
                         parameterCd = "00060",
                         startDate = "",
                         endDate = "")
names(EnoDischarge)[4:5] <- c("Discharge", "Approval.Code")

Enoplot <- ggplot(EnoDischarge, aes(x = Date, y = Discharge))+
  geom_line()+
  labs(x = "", y = expression("Discharge (ft"^3*"/s)"))

print(Enoplot)
```




```r
Enotimeseries <- ts(EnoDischarge[[4]], frequency = 365)

Eno_Decomposed <- stl(Enotimeseries, s.window = "periodic")
```

```r
plot(Eno_Decomposed)
```



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

    Seasonal: Clear Creek has a seasonal component magnitude peak of a little more than 600 cfs.The Eno River has a seasonal component magnitude peak of around 250 cfs.

    Trend: Clear Creek has a trend component magnitude peak of around 340 cfs, and it usually fluctuates between 75 and 250 cfs.The Eno River has a trend component magnitude peak of around 250-300 cfs, and it usually fluctuates between 50 and 175 cfs.

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.

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

ClearCreektrend <- smk.test(ClearCreek_ts)
ClearCreektrend
```

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

```
##
## data:  ClearCreek_ts
## z = 1.6586, p-value = 0.09719
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##      S   varS
##    590 126102
```

```r
summary(ClearCreektrend)
```

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

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

    There is not an overall monotonic trend in discharge over time, because the p-value is greater than 0.05; it is 0.097.

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?

    Two months have statistically significant monotonic trends in discharge over time. Both June and July show positive trends over time.

Reflection

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

    1) A timeseries' value is made up of three components: seasonal, trend, and remainder.
    2) Different creeks have different relative and absolute seasonal and trend components of their timeseries.
    3) A seasonal Mann Kendall test is a powerful tool for looking at trends month to month in a timeseries.

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

1) Plotting the timeseries I generated for the Eno River and Clear Creek as a summation of its three components. 2)Being asked to compare the time series plots for the Eno River and Clear Creek in question 10.
2) Peforming the seasonal Mann Kendall test and analyzing the results for questions 11-14 allowed me to make several important conclusions about discharge data in Clear Creek

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

    Any time I can visualize a theoretical concept, it helps me understand it. For example, the way R plots time series as a summation of its seasonal, trend, and remainder components helps me appreciate what a time series represents.

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

    I was surprised to see the trend component of the timeseries fluctuate so much. I was also surprised to see there was not an overall trend in discharge at Clear Creek, which would be an indicator of climate change; maybe there is a trend in variation as a result of climate change though.