Assignment 7: High Frequency Data

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OVERVIEW

This exercise accompanies the lessons in Hydrologic Data Analysis on high frequency data

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., "A07_Chamberlin.pdf") prior to submission.

The completed exercise is due on 16 October 2019 at 9:00 am.

Setup

1. Verify your working directory is set to the R project file,
2. Load the StreamPULSE, streamMetabolizer and tidyverse packages.
3. Set your ggplot theme (can be theme_classic or something else)

```
getwd()
```

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

```
library(devtools)
```

```
## Loading required package: usethis
```

```
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()
```

```
packages <- c(
  "tidyverse",
  "StreamPULSE",
  "streamMetabolizer"
  )
invisible(
  suppressPackageStartupMessages(
    lapply(packages, library, character.only = TRUE)
    )
  )

theme_set(theme_classic(base_size = 12))
```

4. Download data from the Stream Pulse portal using `request_data()` for the Kansas River, ("KS_KANSASR"). Download the discharge (`Discharge_m3s`), disolved oxygen (`DO_mgL`) and nitrate data (`Nitrate_mgL`) for the entire period of record

```
Kansas.Dat<-request_data(
  sitecode = "KS_KANSASR",
  variables = c("Discharge_m3s", "DO_mgL", "Nitrate_mgL"),
)
```

```
## You may omit the "variables" parameter to automatically retrieve
##  all variables necessary for metabolism modeling.
```

```
##
## API call: https://data.streampulse.org/api?sitecode=KS_KANSASR&variables=Discharge_m3s,DO_mgL,Nitrat
##
## Retrieved the following variables:
##   DO_mgL, Discharge_m3s, Nitrate_mgL
```

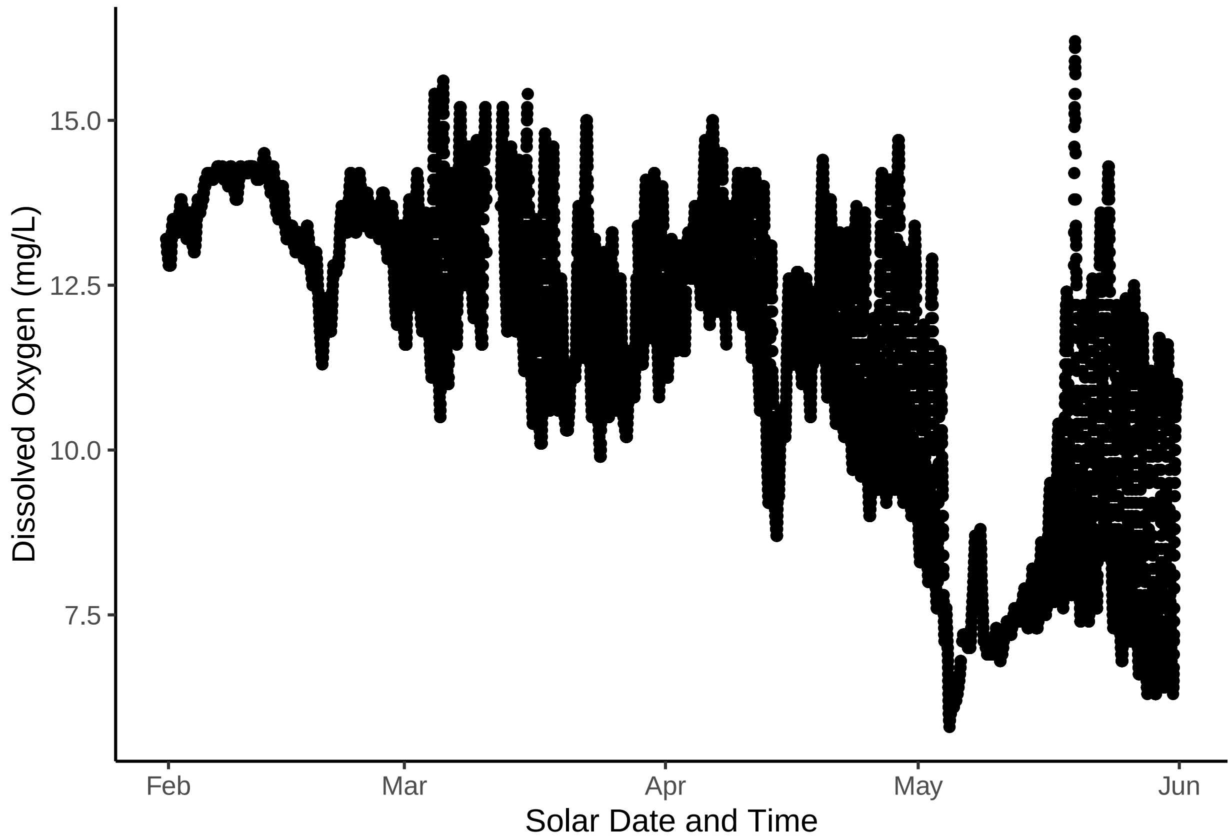
5. Reformat the data into one dataframe with columns DateTime_UTC, DateTime_Solar (using `convert_UTC_to_solartime()`), SiteName, DO_mgL, Discharge_m3s, and Nitrate_mgL.

```
Kansas.df<-select(Kansas.Dat[[1]], DateTime_UTC, value, variable)

Kansas.df<-spread(Kansas.df, value = value, key = variable)

Kansas.df<- mutate(Kansas.df, DateTime_Solar = convert_UTC_to_solartime(DateTime_UTC, Kansas.Dat[[2]]$l
```

6. Plot each of the 3 variables against solar time for the period of record

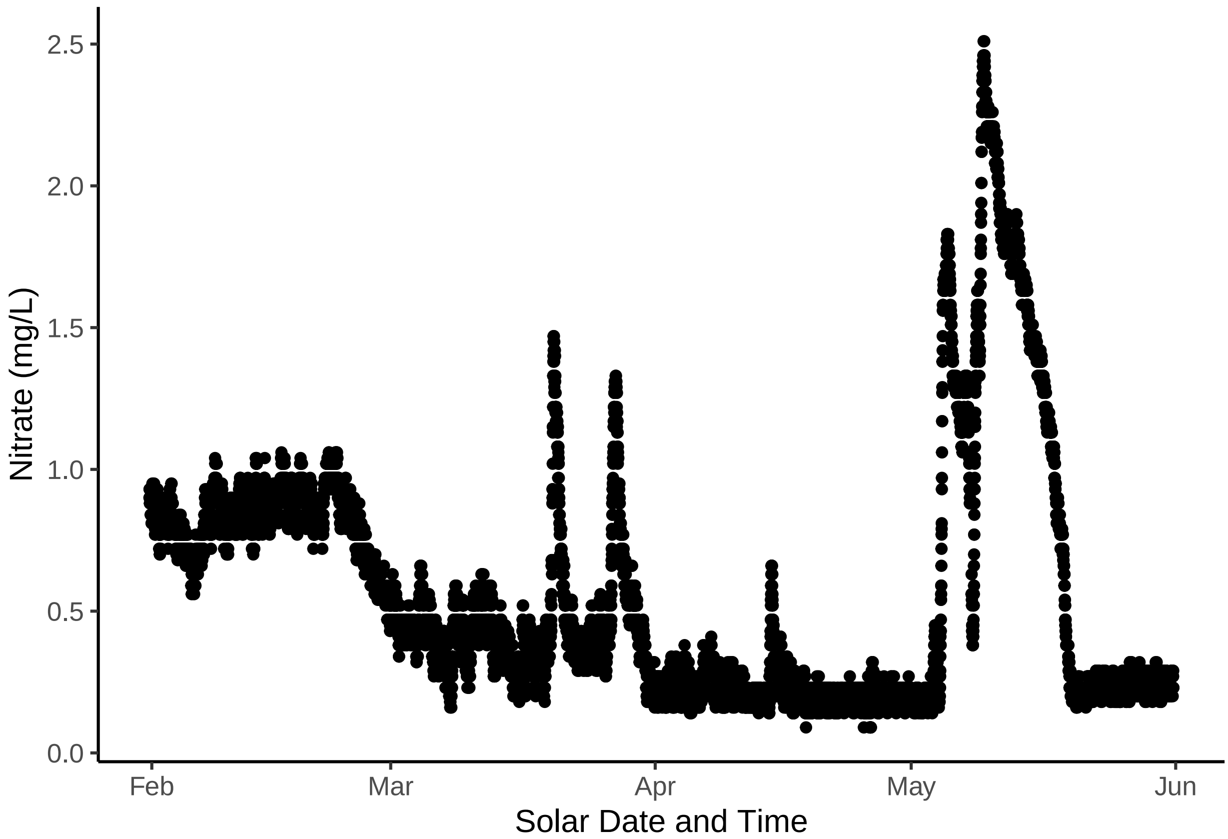
```
ggplot(Kansas.df, aes(x=DateTime_Solar))+
  geom_point(aes(y=DO_mgL))+
  labs(x="Solar Date and Time", y= "Dissolved Oxygen (mg/L)")
```

```
## Warning: Removed 259 rows containing missing values (geom_point).
```



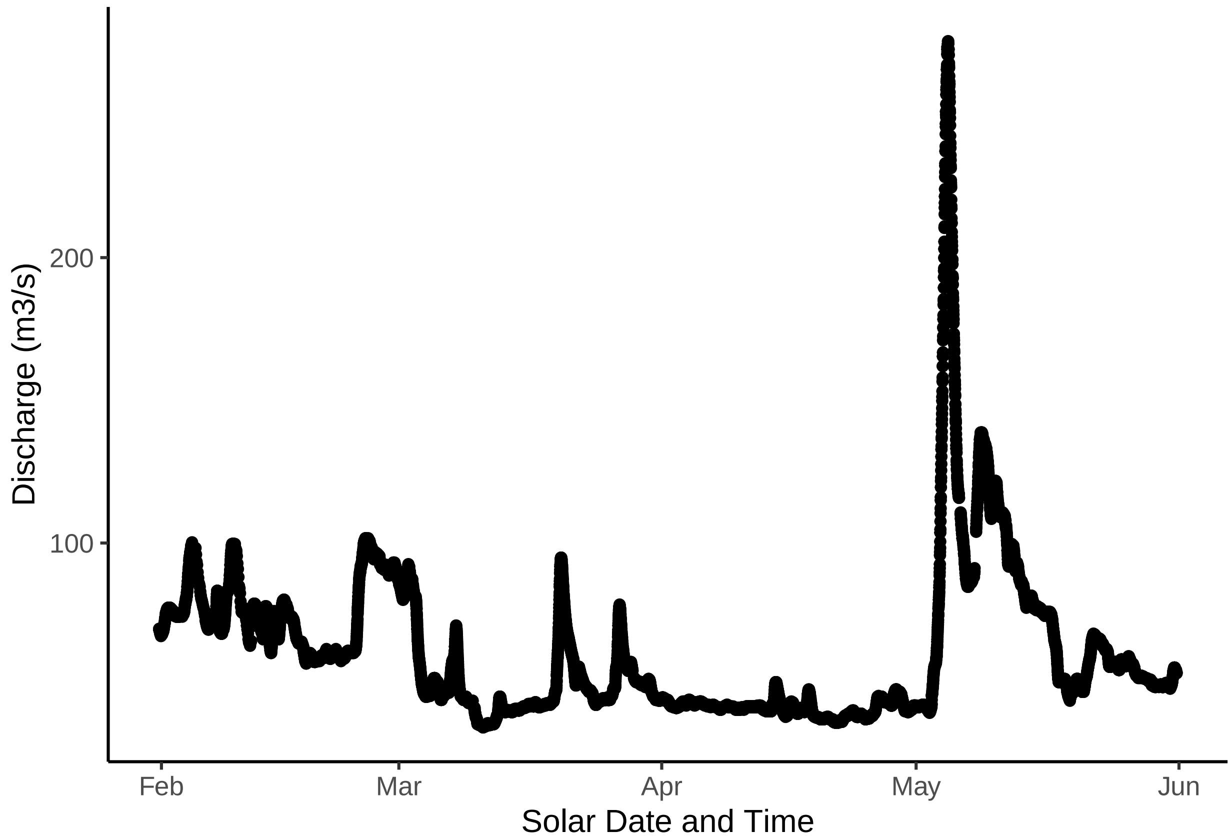

```
ggplot(Kansas.df, aes(x=DateTime_Solar))+
  geom_point(aes(y=Nitrate_mgL))+
  labs(x="Solar Date and Time", y= "Nitrate (mg/L)")
```

```
## Warning: Removed 120 rows containing missing values (geom_point).
```




```r
ggplot(Kansas.df, aes(x=DateTime_Solar))+
  geom_point(aes(y=Discharge_m3s))+
  labs(x="Solar Date and Time", y= "Discharge (m3/s)")
```

```
## Warning: Removed 640 rows containing missing values (geom_point).
```



7. How will you address gaps in these dataseries?

   I will omit all rows with missing data

8. How does the daily amplitude of oxygen concentration swings change over the season? What might cause this?

   It's higher in months with more sunlight because more primary production is happening.

Baseflow separation

9. Use the `EcoHydRology::BaseflowSeparation()` function to partition discharge into baseflow and quickflow, and calculate how much water was exported as baseflow and quickflow for this time period. Use the DateTime_UTC column as your timestamps in this analysis.

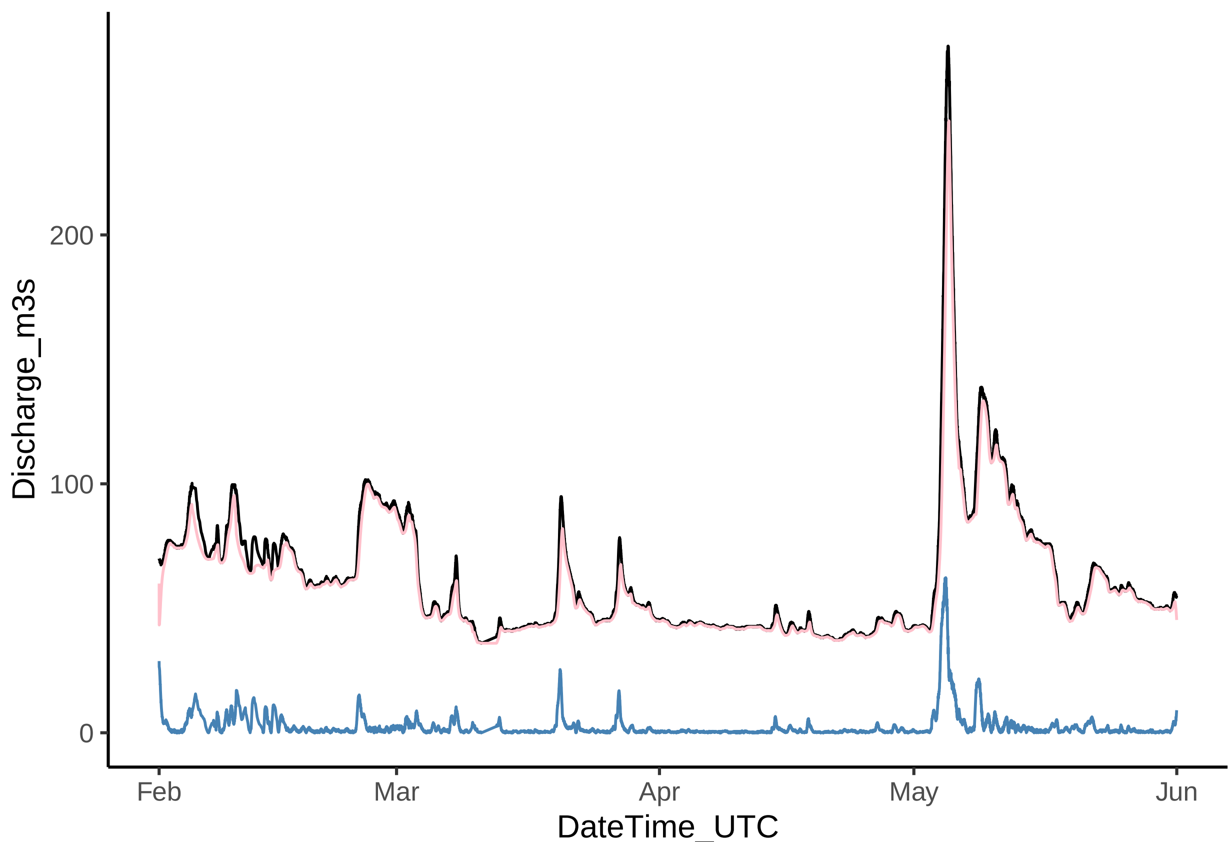
```
Kansas.no.na<-na.omit(Kansas.df)

Kansas.baseflow<-EcoHydRology::BaseflowSeparation(Kansas.no.na$Discharge_m3s,
                                    filter_parameter = 0.925,
                                    passes = 3)

Kansas.new<-cbind(Kansas.no.na, Kansas.baseflow)

Kansas.flow.diff<-mutate(Kansas.new, timestep = c(diff(as.numeric(DateTime_UTC)),NA_real_),
```

```
         baseflow.gross = bt*timestep,
         quickflow.gross = qft*timestep)

Kansas.flow.diff<-summarize(Kansas.flow.diff, BF.total = sum(baseflow.gross, na.rm = TRUE),
            QF.total = sum(quickflow.gross, na.rm = TRUE),
            flow.total = BF.total+QF.total,
            BF.percent = BF.total/flow.total,
            QF.percent = QF.total/flow.total)
```

The `package::function()` notation being asked here is a way to call a function without loading the library. Sometimes the EcoHydRology package can mask tidyverse functions like pipes, which will cause problems for knitting. In your script, instead of just typing `BaseflowSeparation()`, you will need to include the package and two colons as well.

10. Create a ggplot showing total flow, baseflow, and quickflow together.

```
ggplot(Kansas.new, aes(x = DateTime_UTC))+
  geom_line(aes(y = Discharge_m3s))+
  geom_line(aes(y = bt), color = "pink")+
  geom_line(aes(y = qft), color = "steelblue")
```



11. What percentage of total water exported left as baseflow and quickflow from the Kansas River over this time period?

    Baseflow: 95.7%, Quickflow: 4.3%

12. This is a much larger river and watershed than the 2 we investigated in class. How does the size of the watershed impact how flow is partitioned into quickflow and baseflow?

    A larger watershed probably has more baseflow and isn't as volatile as the Eno or other smaller creeks. A big watershed means that a storm probably doesn't hit the whole area at once, allowing a tributary to stabilize others that may be hit by quickflow during a big storm.

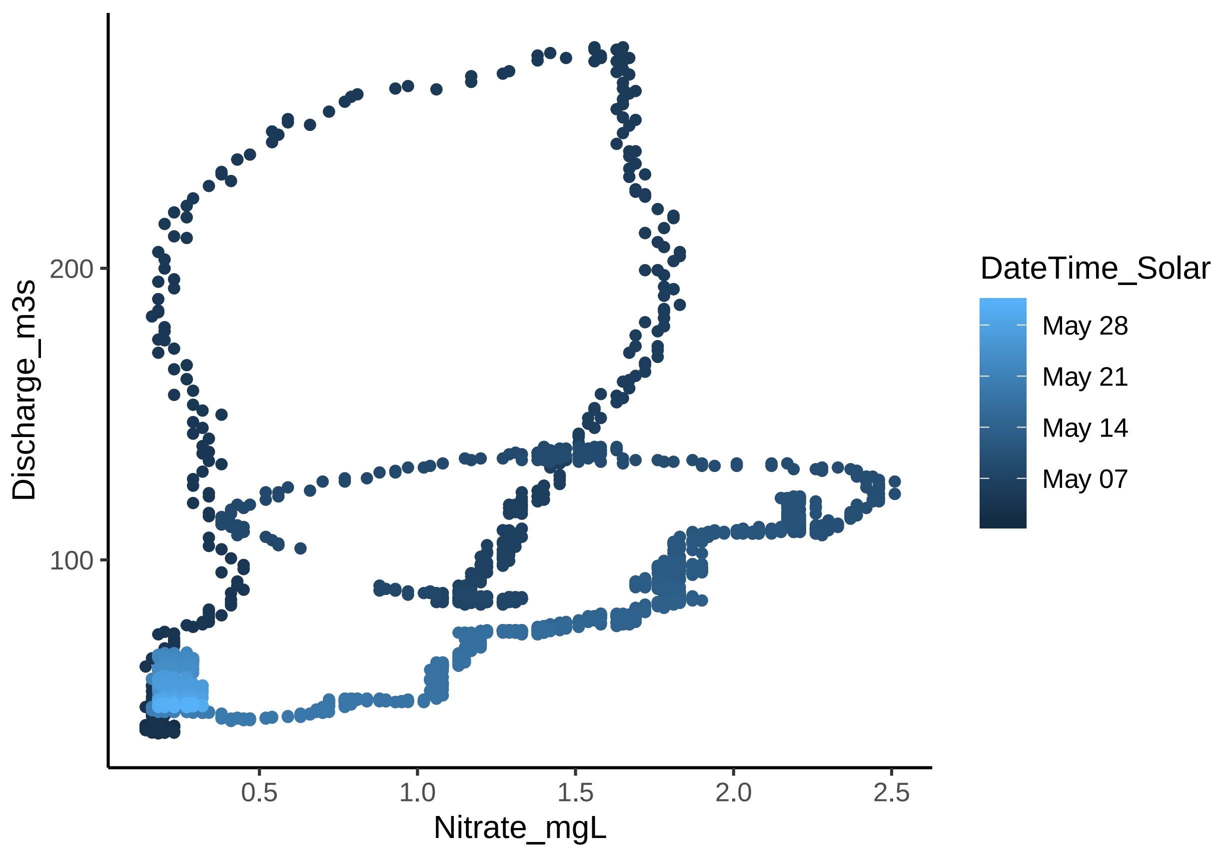
13. The site we are looking at is also further down in its river network (i.e. instead of being a headwater stream, this river has multiple tributaries that flow into it). How does this impact your interpretation of your results?

    Each tributary will react to different regional storms, minimizing the impact that one storm has on a watershed.

Chemical Hysteresis

14. Create a ggplot of flow vs. nitrate for the large storm in May (~May 1 - May 20). Use color to represent Date and Time.

```
Kansas.storm<-
  filter(Kansas.no.na, DateTime_UTC> "2018-05-1" & DateTime_UTC < "2018-05-31")

ggplot(Kansas.storm, aes(x = Nitrate_mgL, y = Discharge_m3s, color = DateTime_Solar))+
  geom_point()
```



15. Does this storm show clockwise or counterclockwise hysteresis? Was this storm a flushing or diluting storm?

    I'm confused, because in class we plotted discharge on the x and nitrate on the y, but this question asked for them flipped. In class, we discussed that a countrclockwise loop was a diluting storm because it suggests that quickflow has lower nutrient levels, which is what this storm appears to be. If its actually supposed to be discharge on y then my answer would be flipped.

16. What does this mean for how nitrate gets into the river from the watershed?

    This would mean that more nitrate gets into the watershed from baseflow.

Reflection

17. What are 2-3 conclusions or summary points about high frequency data you learned through your analysis?

    EcoHydRology masks pipes. It's important which axis you plot things on.

18. What data, visualizations, and/or models supported your conclusions from 17?

    The Hysterysis plot

19. Did hands-on data analysis impact your learning about high frequency data relative to a theory-based lesson? If so, how?

    yes I understood how frustrating R can be

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

    It made sense once I looked at it, but I didn't really have many expectations going in.