Project 1 Assignment

Objective:

Complete a working Python script for basic irrigation scheduling using weather data obtained from High Plain Regional Climate Center (HPRCC), the irrigation management basics you learned in class, and the Python coding techniques you learned so far in the labs.

Data Preparation:

- Obtain Automated Weather Data Network (AWDN) data for one of the Nebraska weather stations for a location you are interested in (e.g., hometown, research farm, or simply curious) from May 1st to October 31st of a particular year you are interested in. Make sure the data include daily air temperature, precipitation, and Nebraska reference ET (ET-NE). Detailed steps are presented in Appendix I.
- Data filtering to delete entries with an "M" (form missing data) or an "e" (estimate with limited confidence). Other flags are okay ("E" or "R"), though you may need to remove the letters from the numbers before calculations.

Part 1 – visualization (40 points):

- Plot Figure 1 as the averaged air temperature (for each day, the average of the high and low temperature) over time. Make x axis as the days in a year, and y axis as the temperature with a unit in Fahrenheit. Do a line plot here. Do not do any operation in Excel. Use the list data type in Python we practiced in labs. Also, recall the data visualization we practiced in the lab.
- Plot Figure 2 as the solar radiation over time. Make x axis as the days in a year, and y axis as the solar radiation with a unit in Langley. Do a line plot here.
- Plot Figure 3 as the precipitation over time. Make x axis as the days in a year, and y axis as the precipitation with a unit Inch. Plot in bar chart here to indicate a discrete data type.
- Plot the cumulative precipitation $\sum P$ over time also in Figure 3. Make x axis as the days in a year, and y axis as the cumulative precipitation $\sum P$ with a unit Inch. Plot in continuous line here.
- Plot Figure 4 as the reference ET over time. Make x axis as the days in a year, and y axis as the reference ET with a unit in Inch. Do a line plot here.
- Plot the cumulative ET $\sum ET$ over time also in Figure 4. Make x axis as the days in a year, and y axis as the cumulative ET $\sum ET$ with a unit in Inch.
- Plot Figure 5 including both cumulative precipitation $\sum P$ and cumulative ET $\sum ET$ in different color or/and line styles.
-

Part 2 – Basic Irrigation Decision Making (40 points):

- Come up with your plan for irrigation management for this particular area. Let's make a new variable called I for irrigation amount in inches.

- **Without** considering soil water depletion (lecture 2 page 18), program and apply 1 inch of irrigation whenever the $\sum ET$ is 1 inch or greater than the $\sum(P + I)$. Recall the if statement we practiced in the lab.
- Calculate a new variable $\sum(P + I)$as the cumulative sum of precipitation $\sum P$ and irrigation $\sum I$.
- Plot Figure 6 including $\sum P$, $\sum ET$, $\sum I$ and $\sum(P + I)$.

Part 3 – Advanced Irrigation Decision Making (30 bonus points):

- Now let's consider soil water depletion SWD (lecture 2 page 18), which is the amount of water (inches) that has been depleted below field capacity. In other words, SWD = 0 when the soil is at field capacity, and a large value of SWD indicates that the soil is very dry. Assume the soil water depletion on a particular day *n* is SWD_n. The SWD on the day before (*n-1*) is SWD_{n-1}. The relationship between SWD_n and the other variables we just worked on given a particular day can be represented as (lecture 2 page 25):

$$SWD_n = SWD_{n-1} + ET_{n-1} - P_{n-1} - I_{n-1}$$

- We usually assume prior to the beginning of the season (or in our case, the Day 0), all the variables equal to zero (i.e., at planting, the soil has a full profile from spring rain and is at field capacity, so SWD = 0).
- The Total Available Water (TAW) is the difference between field capacity and wilting point. Assume that, for your soil, TAW is 7 inches. We can allow a fraction of the TAW to be used without causing yield loss. Let's assume this fraction is 0.5; therefore, the Allowable Depletion (AD) is 3.5 inches. Your goal is to schedule irrigation in order to keep the soil wetter than this, i.e., SWD ≤ 3.5 inches.
- On each day, calculate the Latest Date (LD) that the field can be irrigated (lecture 2 page 19):

$$LD_n = \frac{AD - SWD_n}{ET_{forecasted}{}_n}$$

- For the forecasted ET (in/d), use the average of the ET from the past four days as an acceptable prediction of the daily ET for the next few days.
- On each day, decide whether or not to irrigate. It takes approximately 3 days for the center pivot to make a revolution around the field. Therefore, if LD ≤ 3 days, then trigger an irrigation event. For your simulation, assume that entire irrigation event takes place within a day. When you do irrigate, use an irrigation depth of 1 inch.
- Recall the for loop and if statement we practiced in the lab.
- Plot Figure 7 including $\sum P$, $\sum ET_{forecasted}$, $\sum I$, $\sum(P + I)$, and LD.
- Make sure all figures have proper axis labels and legends.

Due Date:

5 PM, Monday, February 14th in Canvas

Submission Package:

- The Automated Weather Data Network (AWDN) data in .csv or .xlsx format.

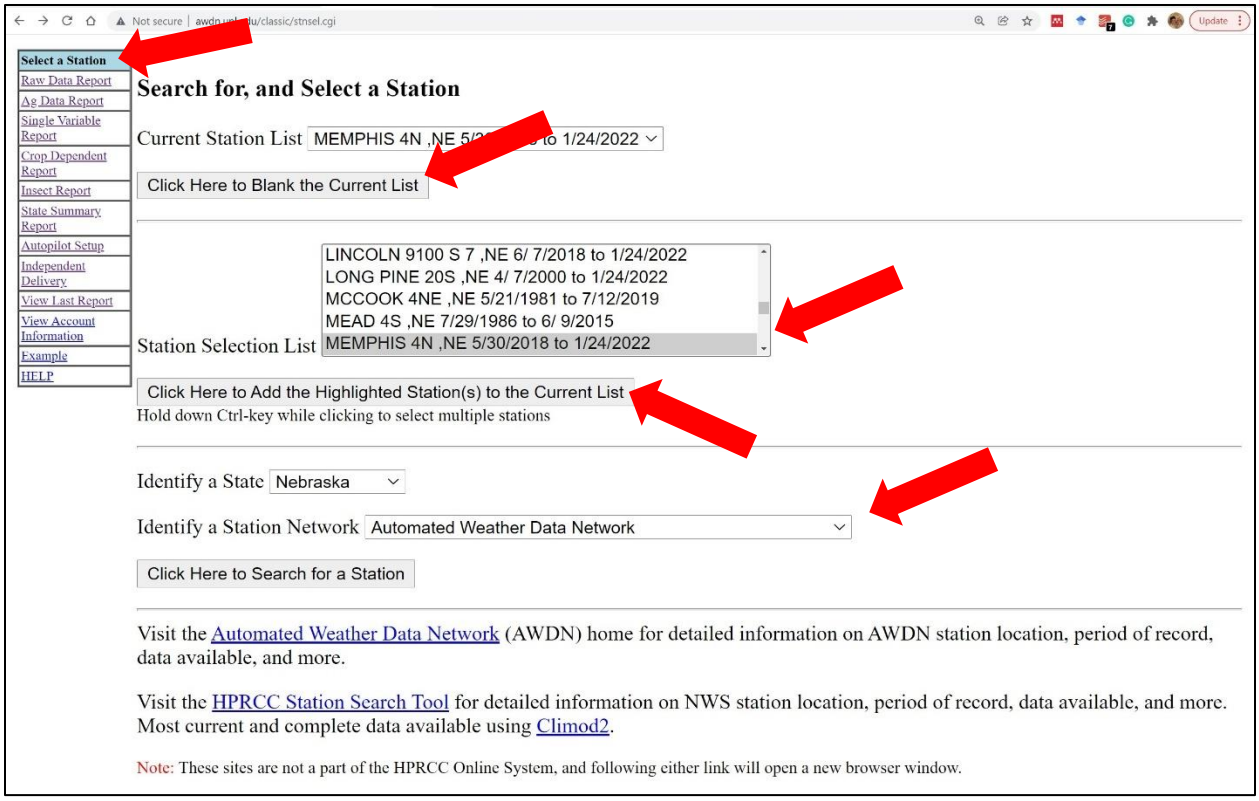
- Jupyter Notebook file .ipynb.
- Make sure you do extensive comments for your code to explain your thinking process. This accounts for 20% (20 points) of the total points.
- Make all your documents in a zip file and submit in Canvas.

Appendix I

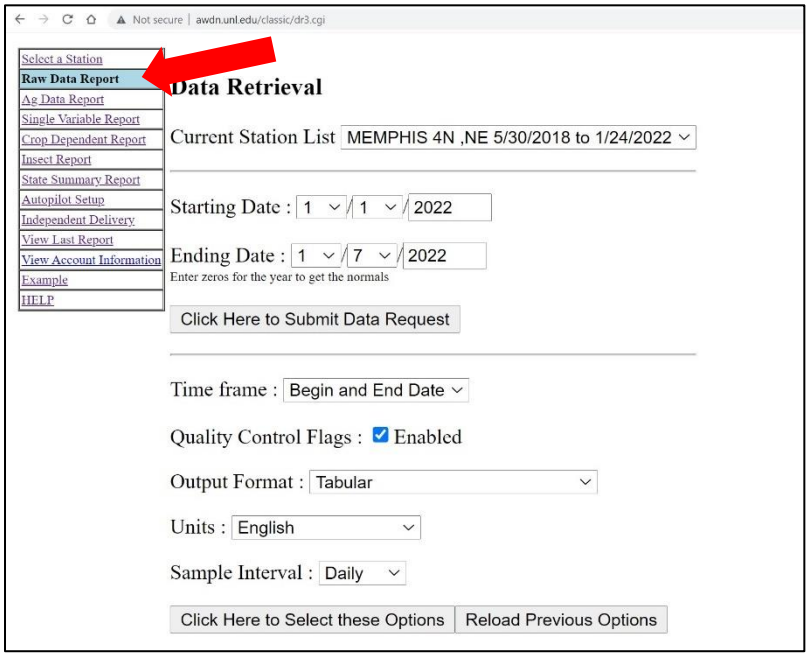
Instructions to Obtain Automated Weather Data Network (AWDN) data from High Plains Regional Climate Center (HPRCC)

- Go to https://hprcc.unl.edu/
- Click “Services” in the top main menu, then select “Online Data Services”.
- Select “Classic Online” module

- You may need to enter user account “bsewx” and passcode “!unlclimat3” to log in.
- Once you are on the page of “Classic Online”, on the left main menu, click on “Select a Station” (see figure below).
- Make sure you select “Automated Weather Data Network” for “Identify a Station Network”.
- Click “Click Here to Blank the Current List”.
- Browse and select the station you are interested in from the “Station Selection List” on the mid right section. Note that some of the station stopped operating as a AWDN station before 2021, for example the “McCook 4NE” station shown in the screenshot below stopped on 7/12/2019. So, if you are interested in 2021 data you may want to avoid selecting those stations. Click “Click Here to Add the Highlighted Sation(s) to the Current List”. The station you selected should appear by the “Current Station List” on the top.

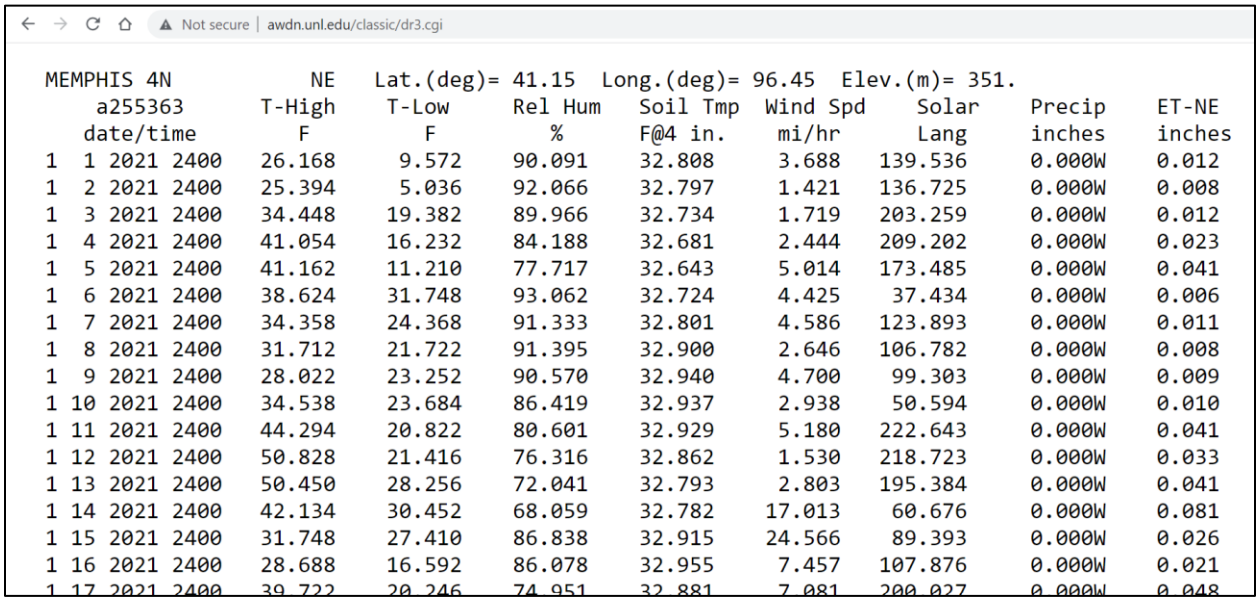


- Switch to the “Raw Data Report” on the left main menu. Change the settings as you want. Then click “Click Here to Submit Data Request” to go to the data page.



- Once you are on the data page, click your mouse anywhere on the page, then hold “Ctrl” key and press “A” key at the same time on your keyboard (Control + All) or something equivalent for Mac system. All the data should be highlighted and selected. Then hold “Ctrl” key

and press “C” key at the same time on your keyboard (Control + Copy) or something equivalent for Mac system. All the highlighted data should be copied.

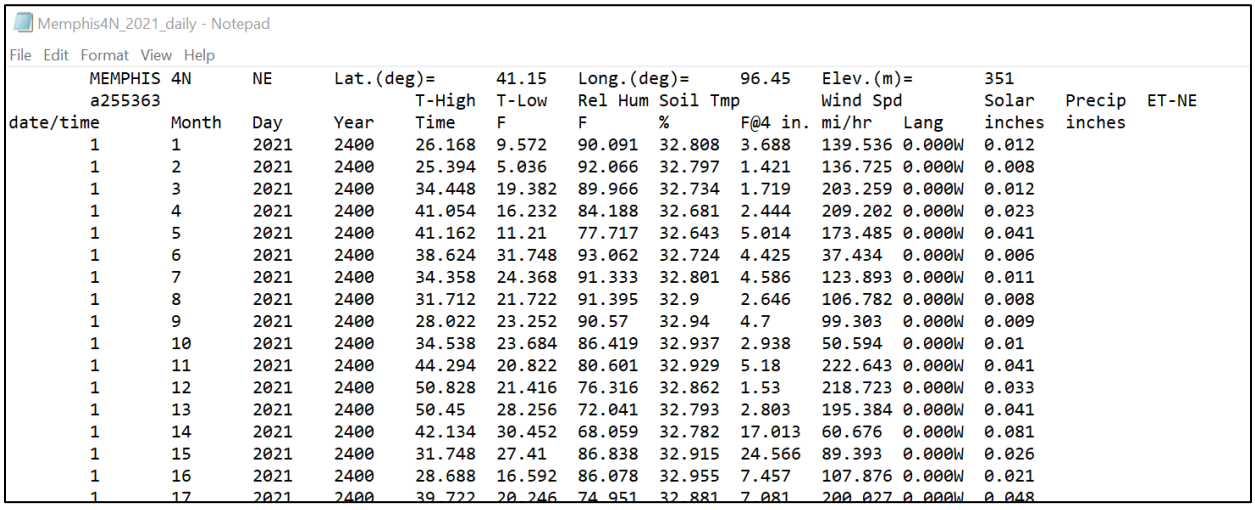


Not secure | awdn.unl.edu/classic/dr3.cgi

MEMPHIS 4N NE Lat.(deg)= 41.15 Long.(deg)= 96.45 Elev.(m)= 351.

	a255363 date/time	T-High F	T-Low F	Rel Hum %	Soil Tmp F@4 in.	Wind Spd mi/hr	Solar Lang	Precip inches	ET-NE inches
1	1 2021 2400	26.168	9.572	90.091	32.808	3.688	139.536	0.000W	0.012
1	2 2021 2400	25.394	5.036	92.066	32.797	1.421	136.725	0.000W	0.008
1	3 2021 2400	34.448	19.382	89.966	32.734	1.719	203.259	0.000W	0.012
1	4 2021 2400	41.054	16.232	84.188	32.681	2.444	209.202	0.000W	0.023
1	5 2021 2400	41.162	11.210	77.717	32.643	5.014	173.485	0.000W	0.041
1	6 2021 2400	38.624	31.748	93.062	32.724	4.425	37.434	0.000W	0.006
1	7 2021 2400	34.358	24.368	91.333	32.801	4.586	123.893	0.000W	0.011
1	8 2021 2400	31.712	21.722	91.395	32.900	2.646	106.782	0.000W	0.008
1	9 2021 2400	28.022	23.252	90.570	32.940	4.700	99.303	0.000W	0.009
1	10 2021 2400	34.538	23.684	86.419	32.937	2.938	50.594	0.000W	0.010
1	11 2021 2400	44.294	20.822	80.601	32.929	5.180	222.643	0.000W	0.041
1	12 2021 2400	50.828	21.416	76.316	32.862	1.530	218.723	0.000W	0.033
1	13 2021 2400	50.450	28.256	72.041	32.793	2.803	195.384	0.000W	0.041
1	14 2021 2400	42.134	30.452	68.059	32.782	17.013	60.676	0.000W	0.081
1	15 2021 2400	31.748	27.410	86.838	32.915	24.566	89.393	0.000W	0.026
1	16 2021 2400	28.688	16.592	86.078	32.955	7.457	107.876	0.000W	0.021
1	17 2021 2400	39.722	20.246	74.951	32.881	7.081	200.027	0.000W	0.048

- Go to your working folder. Right click and create a new Text Document. You can rename it. Open it and then paste all the data you just copied: hold “Ctrl” key and press “v” key at the same time on your keyboard (Control + Paste) or something equivalent for Mac system. You should see something like this (below), and you are done with obtaining the weather data:



Memphis4N_2021_daily - Notepad

File Edit Format View Help

MEMPHIS 4N NE Lat.(deg)= 41.15 Long.(deg)= 96.45 Elev.(m)= 351

	a255363			T-High	T-Low	Rel Hum	Soil Tmp		Wind Spd		Solar	Precip	ET-NE
date/time	Month	Day	Year	Time	F	F	%	F@4 in.	mi/hr	Lang	inches	inches	
1	1	2021	2400	26.168	9.572	90.091	32.808	3.688	139.536	0.000W	0.012		
1	2	2021	2400	25.394	5.036	92.066	32.797	1.421	136.725	0.000W	0.008		
1	3	2021	2400	34.448	19.382	89.966	32.734	1.719	203.259	0.000W	0.012		
1	4	2021	2400	41.054	16.232	84.188	32.681	2.444	209.202	0.000W	0.023		
1	5	2021	2400	41.162	11.21	77.717	32.643	5.014	173.485	0.000W	0.041		
1	6	2021	2400	38.624	31.748	93.062	32.724	4.425	37.434	0.000W	0.006		
1	7	2021	2400	34.358	24.368	91.333	32.801	4.586	123.893	0.000W	0.011		
1	8	2021	2400	31.712	21.722	91.395	32.9	2.646	106.782	0.000W	0.008		
1	9	2021	2400	28.022	23.252	90.57	32.94	4.7	99.303	0.000W	0.009		
1	10	2021	2400	34.538	23.684	86.419	32.937	2.938	50.594	0.000W	0.01		
1	11	2021	2400	44.294	20.822	80.601	32.929	5.18	222.643	0.000W	0.041		
1	12	2021	2400	50.828	21.416	76.316	32.862	1.53	218.723	0.000W	0.033		
1	13	2021	2400	50.45	28.256	72.041	32.793	2.803	195.384	0.000W	0.041		
1	14	2021	2400	42.134	30.452	68.059	32.782	17.013	60.676	0.000W	0.081		
1	15	2021	2400	31.748	27.41	86.838	32.915	24.566	89.393	0.000W	0.026		
1	16	2021	2400	28.688	16.592	86.078	32.955	7.457	107.876	0.000W	0.021		
1	17	2021	2400	39.722	20.246	74.951	32.881	7.081	200.027	0.000W	0.048		