Geol 497D/GeoSci697D - Spring 2020
Programming and Data Analysis

William P. Clement and Scott Marshall

Lab 7: Vectorized Code

This laboratory exercise will involve you modifying code that you have previously written and vectorizing it. This means that your final code for this lab *should not contain* any loops or nested if statements. Make sure to comment your code and include the proper python header information. My hope is that this laboratory will show you that vectorizing existing code is not a difficult task in most cases.

Part I: Converting Temperatures . . . Again!

In last week's loops lab, you write a script called `processTemps.py` that reads a data file with several temperature time series, performs several quantitative tasks, and makes a plot. Your task is start with your existing script and vectorize it. This means you will need to remove any/all loops and perform the same procedure without looping. While your internal coding will differ, the results of your vectorized script should be identical to your previous script. If you forget what the script should do, refer to the loop lab description. Your final vectorized script should be named `processTemps2.py`.

Part II: A Tale of Three SoCal Earthquakes 1992 – 1999: Landers, Big Bear, and Hector Mine

Because I am a reasonable person, I will not make you vectorize your earthquake catalog code from last week. It is possible to vectorize that assignment, but it would be a bit messy and difficult. So, let's start with your `processesEQs.py` script and write some vectorized python code to filter the earthquake catalog and look at an interesting sequence of related earthquakes in eastern California. The three earthquakes are the 1992 M7.3 Landers, the 1992 M6.4 Big Bear, and the 1999 M7.1 Hector Mine earthquakes.
`http://scedc.caltech.edu/significant/landers1992.html`
`http://scedc.caltech.edu/significant/bigbear1992.html`
`http://scedc.caltech.edu/significant/hectormine1999.html`

1. We will use the same data files as last week's lab, your final vectorized function should be named `processEQs2.py`. Please start by loading in the earthquake catalog just as you did in the last lab. Use the same variable names as the previous lab.

2. To look at these three related events, let's first search for the group of earthquakes that could be related to the two 1992 events. You should create a temporal filter using only one line of code that identifies all earthquakes that occurred in either June or July of 1992 and stores all of the data columns in a matrix called `aShock`. Because both of these events happened on June 28$^{\text{th}}$ 1992, it is difficult to separate which earthquakes are aftershocks of which event, so we will just search for all of the earthquakes that could be aftershocks of either event. To keep things simple, we will not spatially filter this data. So, your selected events will be all events in southern California that occurred in June or July of 1992. The aftershock period for this event was much longer than this (at least several years), but identifying and plotting just the earthquakes that occurred in June or July of 1992 should be sufficient to show the spatial pattern of aftershocks from the Landers and Big Bear events.

3. To look at the general spatial pattern of the 1999 Hector Mine aftershock sequence, you should create a temporal filter using only one line of code that identifies all earthquakes occurred in October of 1999 and stores all of the data columns in a matrix called `aShock2`. Like before, we will keep things simple and not spatially filter this data. So, your selected events will be all events in southern California that occurred in October of 1999. The aftershock period for this event was much longer than this (at least several years), but identifying and plotting just the October 1999 earthquakes should be sufficient to show the spatial pattern of aftershocks in the Hector Mine rupture zone.

4. Make a 3x2 matrix called `largeEQs`, and store the epicenter locations of the three main shocks in a single matrix. The lon/lat locations are given below.

   Landers: -116.267, 34.600
   Big Bear: -116.827, 34.200
   Hector Mine: -116.433, 34.217

5. Your script should print out the following useful messages to the command window:

   Loaded x Total Earthquakes
   Found x Earthquakes in June – July 1992
   Found x Earthquakes in October 1999
   Elapsed time is x seconds.

   Make sure that the first three entries line up neatly. The first three entries should all be printed as integers, and the last entry can be directly printed using the `time` command.

6. To visualize your results, you need to make two plots in two separate figure windows. These are very similar to your plots from last week. The plots are both identical except that one shows the entire earthquake catalog region:

   $30.0 \leq$ Latitude ≤ 37.6
   $-122.5 \leq$ Longitude ≤ -113.0

   while the second plot shows a zoomed in view of the eastern California region:

   $33.75 \leq$ Latitude ≤ 35.0
   $-117.1 \leq$ Longitude ≤ -115.9

7. Each plot should have the following things plotted:
   (a) The raw/entire earthquake catalog should be plotted with red points/pixels
   (b) The earthquakes that you identified in June – July of 1992 should be plotted with blue points/pixels
   (c) The earthquakes that you identified in October of 1999 should be plotted with green points/pixels
   (d) The large mainshock event locations (stored in `largeEQs`) should be plotted as a yellow-filled pentagrams (size=12) with a black outline.
   (e) The California coastline should be plotted with a black line with a thickness of 2.