Quiz navigation

1 2 3 4 5 6
7 8 9 10 11 12
13 14 15 16 17 18
19 20 21 22 23 24
25 26 27 28 29 30

Show one page at a time

Finish review

Started on	Sunday, August 21, 2022, 8:11 AM
State	Finished
Completed on	Saturday, August 27, 2022, 6:23 AM
Time taken	5 days 22 hours
Marks	22.75/30.00
Grade	**75.83** out of 100.00

Question 1

Correct

0.67 points out of 1.00

Flag question

In this activity, you will get an opportunity to use some waveform analysis functions in the ObsPy library. In particular, we will use cross correlation to identify the similarity of nuclear explosion events in North Korea.

You can start by loading the read() function and then using it to read a seismogram recorded on station MDJ in eastern China.

```
from obspy import read
template = read('https://examples.obspy.org/IC.MDJ.2013.043.mseed')
```

This creates a Stream object named template, and for reference here is the manual on Stream objects again:

https://docs.obspy.org/packages/autogen/obspy.core.stream.Stream.html

One of the first steps for performing cross correlation to multiple waveforms is to ensure they have a similar frequency band. For this comparison, we will restrict to frequencies between 0.5 and 2. Which of these would be needed to accomplish this?

Select one or more:

- a. type='bandpass',
- b. template. ✓ 1 of 5 correct answers.
- c. 2)
- d. freqmax=2) ✓ 1 of 5 correct answers.
- e. filt(
- f. filter(✓ 1 of 5 correct answers.
- g. freqmin=0.5, ✓ 1 of 5 correct answers.
- h. read.
- i. 0.5,
- j. 'bandpass', ✓ 1 of 5 correct answers.

Check

Go ahead and run the full command: template.filter('bandpass', freqmin=0.5, freqmax=2)

Correct

Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 2

Correct

1.00 points out of 1.00

Flag question

Next we will extract a single seismogram as a Trace object from the Stream object.

```
trace = template[0]
```

You can read more about Trace objects here:

https://docs.obspy.org/packages/autogen/obspy.core.trace.Trace.html

A nice feature of the Trace object is that you can print some basic information about the seismogram using the stats extension:

```
print(trace.stats)
```

Go ahead and plot the template seismogram as well. Using the stats output and the plot, how long in seconds is this seismogram?

Answer: 299 ✓

Check

Correct

Marks for this submission: 1.00/1.00.

Question 3

Correct

1.00 points out of 1.00

Flag question

You can also obtain specific values from the Trace stats variable using additional extensions. For this assignment it will be important to know the sampling rate (number of sampled data points per second):

```
samprate = trace.stats.sampling_rate
```

What is the sampling rate of this seismogram?

Answer: 20.0 ✓

Check

Correct

Marks for this submission: 1.00/1.00.

Question 4

Correct

1.00 points out of 1.00

Flag question

Next you will pick the arrival time of the P wave using a triggering algorithm. In SAC, we often would do the arrival time picks manually, but ObsPy comes with a variety of auto-picking tools that utilize trigger detection alforithms. You can read about some of the built-in choices here:

https://docs.obspy.org/packages/autogen/obspy.signal.trigger.html

We will use the recursive_sta_lta() function since there is a nice study by Withers et al. [1998] that identified how this method worked reasonably well for a variety of situations. What does STA/LTA refer to?

Select one:

- a. ratio of short-term average to long-term average energy ✓
- b. ratio of station amplitude to latitude amplitude
- c. comparison of station attenuation to latitude attenuation
- d. comparison of short-term attenuation to long-term attenuation

Check

Correct

Marks for this submission: 1.00/1.00.

Question 5

Not answered

1.00 points out of 1.00

Flag question

In order to perform the auto-picking, you need to load the recursive_sta_lta() function:

```
from obspy.signal.trigger import recursive_sta_lta
```

And then you need to implement it on your data:

```
cf = recursive_sta_lta(trace.data, int(5 * samprate), int(10 * samprate))
```

The result is stored as the variable cf, which stands for characteristic function. Based on this command, how long were the short-term and long-term time windows set to (in seconds)?

long-term Choose...

short-term Choose...

Check

Correct

Marks for this submission: 1.00/1.00.

Question 6

Correct

0.33 points out of 1.00

Flag question

We can plot the resulting characteristic function and potential triggers using the plot_trigger() function. First you need to load the function:

```
from obspy.signal.trigger import plot_trigger
```

Then using the signal.trigger manual page in a previous question to help you, which of the following would be the correct input to show the seismogram and detection values, with a trigger on threshold of 1.2 and a trigger off threshold of 0.5?

Select one:

- a. plot_trigger(template, cf, 1.2, 0.5)
- b. plot_trigger(trace.data, cf.data, 1.2, 0.5)
- c. plot_trigger(trace.data, cf, 1.2, 0.5)
- d. plot_trigger(trace, cf.data, 1.2, 0.5)
- e. plot_trigger(template, cf.data, 1.2, 0.5)
- f. plot_trigger(trace, cf, 1.2, 0.5) ✓ Correct. Run this command now to perform the processing and bring up a plot.

Check

Correct

Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.33/1.00**.

Question 7

Correct

1.00 points out of 1.00

Flag question

After you run the command, it should pop up a plot that has the original seismogram on the top. The lower plot shows the characteristic function built from the ratio of the short-term average amplitude to the long-term average amplitude. Approximately how high does the peak go on the lower plot around the time of the P wave arrival?

Answer: 2.0 ✓

Check

Correct

Marks for this submission: 1.00/1.00.

Question 8

Correct

0.67 points out of 1.00

Flag question

Next we will load the trigger_onset() function and use that to get the specific trigger times:

```
from obspy.signal.trigger import trigger_onset
```

This function returns the point when the trigger occurs, but the number is in samples of the seismogram, not seconds of time. So we need to convert this number from samples to time in seconds. Which of the following would accomplish this?

Select one:

- a. trig = trigger_onset(cf.data, 1.2, 0.5) / samprate
- b. trig = trigger_onset(trace.data, 1.2, 0.5) / samprate
- c. trig = trigger_onset(trace, 1.2, 0.5) / samprate
- d. trig = trigger_onset(cf, 1.2, 0.5) * samprate
- e. trig = trigger_onset(cf.data, 1.2, 0.5) * samprate
- f. trig = trigger_onset(cf, 1.2, 0.5) / samprate ✓
- g. trig = trigger_onset(trace, 1.2, 0.5) * samprate
- h. trig = trigger_onset(trace.data, 1.2, 0.5) * samprate

Check

Correct

Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 9

Correct

1.00 points out of 1.00

Flag question

Go ahead and print the contents of the trig object. It should show a 2x2 array of numbers. These numbers are time in seconds relative to the beginning of the seismogram. Each row shows the beginning and end of when the trigger on and off thresholds were met. These correspond to the red and blue lines in the plots. Which number represents the time of the P arrival pick in seconds?

Answer: 44.95 ✓

Check

Correct

Marks for this submission: 1.00/1.00.

Question 10

Correct

1.00 points out of 1.00

Flag question

How would we set a variable called arrival to the part of the array that represents the P arrival pick in seconds?

Select one:

- a. arrival = trig[0][1]
- b. arrival = trig[1][2]
- c. arrival = trig[2][2]
- d. arrival = trig[1][0]
- e. arrival = trig[1][1]
- f. arrival = trig[2][1]
- g. arrival = trig[0][0] ✓ Correct. Go ahead and run this now.
- h. arrival = trig[2][2]

Check

Correct

Marks for this submission: 1.00/1.00.

Question 11

Correct

1.00 points out of 1.00

Flag question

In order to know when this arrival occurred in UTC time, we need to add this arrival time to the starting time of the seismogram. The starting time of the seismogram is available in the stats for the trace. Print those stats again (or scroll up in your Python window) to see which variable has that time stored in it. Which of these would create a variable to store the date and time of the first arrival in UTC using the beginning UTC time of the seismogram and the arrival time from the trigger algorithm?

Select one:

- a. pick = trace.starttime + arrival
- b. pick = stats.starttime + arrival
- c. pick = trace.stats.starttime + trig[1][1]
- d. pick = stats.starttime + trig[1][1]
- e. pick = trace.stats.starttime + arrival ✓ Correct. Go ahead and run this now.
- f. pick = template.starttime + trig[1][1]
- g. pick = template.starttime + arrival
- h. pick = trace.starttime + trig[1][1]

Check

Correct

Marks for this submission: 1.00/1.00.

Question 12

Correct

0.67 points out of 1.00

Flag question

What is the date and time of the first arrival in UTC?

Select one:

- a. 2013-02-12T02:58:44
- b. 2013-02-12T02:58:45 ✓
- c. 2017-09-03T03:30:45
- d. 2017-09-03T03:30:44

Check

Correct

Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 13

Correct

0.67 points out of 1.00

Flag question

For cross-correlation, the choice in length of time window for the template can have a significant impact on how well the correlation process works. It varies depending on the application, and particularly on the size of the earthquake, since the shaking from a larger earthquake lasts longer. For these nuclear blasts in North Korea, we will use 10 seconds before the P arrival and 150 seconds after the P arrival. We will use the trim() method for the Stream object to trim our seismogram down to this particular size. You can review Stream manual provider earlier for the format of this command. Which of the following would be needed to accomplish this?

Select one or more:

- a. trim
- b. -10,
- c. (0,
- d. (-10,
- e. (pick,
- f. 150)
- g. (pick - 10, ✓ 1 of 3 correct answers.
- h. template.trim ✓ 1 of 3 correct answers.
- i. pick + 150) ✓ 1 of 3 correct answers.

Check

Go ahead and run `template.trim(pick - 10, pick + 150)` and you can also run `template.plot()` to check that it has been trimmed.

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 14

Correct

0.67 points out of 1.00

Flag question

Now we are ready to cross correlate our template with another seismogram to look for a similar signal. We can download another seismogram recorded at MDJ from this url:

https://examples.obspy.org/IC.MDJ.2017.246.mseed

How would you load this seismogram into a object named **stream**?

Select one:

- a. stream.get_waveforms('https://examples.obspy.org/IC.MDJ.2017.246.mseed')
- b. stream = read(https://examples.obspy.org/IC.MDJ.2017.246.mseed)
- c. stream = get_waveforms(https://examples.obspy.org/IC.MDJ.2017.246.mseed)
- d. stream.get_waveforms(https://examples.obspy.org/IC.MDJ.2017.246.mseed)
- e. stream = get_waveforms('https://examples.obspy.org/IC.MDJ.2017.246.mseed')
- f. stream = read('https://examples.obspy.org/IC.MDJ.2017.246.mseed') ✓
- g. stream.read(https://examples.obspy.org/IC.MDJ.2017.246.mseed)
- h. stream.read('https://examples.obspy.org/IC.MDJ.2017.246.mseed')

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 15

Correct

1.00 points out of 1.00

Flag question

Now plot the seismogram to see what it looks like:

```
stream.plot()
```

How long is this seismogram in seconds?

Answer: 7200 ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 16

Correct

0.67 points out of 1.00

Flag question

Next you need to filter this seismogram in the same manner as the template seismogram. Which of these would be needed to accomplish this?

Select one or more:

- ☑ a. freqmax=2) ✓ 1 of 5 correct answers.
- ☐ b. type='bandpass',
- ☐ c. read.
- ☑ d. filter(✓ 1 of 5 correct answers.
- ☐ e. 2)
- ☑ f. stream. ✓ 1 of 5 correct answers.
- ☐ g. filt(
- ☑ h. 'bandpass', ✓ 1 of 5 correct answers.
- ☐ i. 0.5,
- ☑ j. freqmin=0.5, ✓ 1 of 5 correct answers.

Check

Go ahead and run the full command: `stream.filter('bandpass', freqmin=0.5, freqmax=2)`

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 17

Correct

0.33 points out of 1.00

Flag question

Now we are ready to perform the cross correlation, and we will use the correlation_detector() function for this. You can read about it here:

https://docs.obspy.org/packages/autogen/obspy.signal.cross_correlation.correlation_detector.html

First you need to load this function and see the key parameters:

```
from obspy.signal.cross_correlation import correlation_detector
height = 0.3 # similarity threshold
distance = 10 # distance between detections in seconds
```

Which of the following would perform the cross correlation and plot the results?

Select one:

- a. detections, sims = correlation_detector(stream, template, height, distance, plot=stream) ✓ Correct. Go ahead and run the full command.
- b. detections, sims = correlation_detector(stream, template, height, distance)
- c. detections = correlation_detector(stream, template, height, distance, plot=stream)
- d. detections, sims = cross_correlation(stream, template, height, distance, plot=stream)
- e. detections = cross_correlation(stream, template, height, distance, plot=stream)
- f. detections = cross_correlation(stream, template, height, distance)
- g. detections, sims = cross_correlation(stream, template, height, distance)
- h. detections = correlation_detector(stream, template, height, distance)

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.33/1.00**.

Question 18

Correct

1.00 points out of 1.00

Flag question

In the plot that comes up after running the correlation_detector(), how many events are detected above the similarity threshold of 0.3?

Answer: 1 ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 19

Correct

0.75 points out of 1.00

Flag question

There are two objects filled by the result: detections and sims. The sims object contains a trace of the similarity values for each time step which was shown in the lower plot. The detections object is a list (like a single column array), but each item in the list is a "dictionary". We haven't talked about dictionaries yet, but they are a collection of information where each item is a connected pair: a key and corresponding value. This summary page may provide some additional help in understanding them:

https://www.programiz.com/python-programming/dictionary

So let's take a look at what this detections object looks like:

```
print(detections)
```

As you saw in the last question, the number of detections is limited so there is only one dictionary in the list. If there were more detections, there would be a dictionary for each one. Which of the following are keys in the dictionary?

Select one or more:

- ☐ a. 369534
- ☐ b. template
- ☐ c. UTCDateTime
- ☑ d. similarity ✓ 1 of 3 correct answers
- ☑ e. template_id ✓ 1 of 3 correct answers
- ☑ f. time ✓ 1 of 3 correct answers

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.75/1.00**.

Question 20

Correct

0.33 points out of 1.00

Flag question

Now that you have identified how the dictionary functions, what is the maximum similarity value for the detection in this dictionary?

Answer: 0.4 ✓

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.33/1.00**.

Question 21

Correct

1.00 points out of 1.00

Flag question

You may have noticed in the similarities plot that there was another peak that was just below the similarity threshold. What can we adjust to ensure this event is also detected?

Select one:

- a. detections
- b. sims
- c. distance
- d. height ✓ Correct. Go ahead and reduce the height like this: `height = 0.2`
- e. stream
- f. template

Check

Correct
Marks for this submission: 1.00/1.00.

Question 22

Correct

1.00 points out of 1.00

Flag question

Run the detection algorithm again:

```
detections, sims = correlation_detector(stream, template, height, distance, plot=stream)
```

Make sure the second event is detected and then close the plot. You can print the detections again and hopefully see the dictionary for the second detection. Note that the UTCDateTime format in this dictionary is: year, month, day, hour, minutes, second, decimal seconds. How many seconds later is the second detection?

Answer: 513 ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 23

Correct

1.00 points out of 1.00

Flag question

Next we will create a figure to side-by-side compare the main detected event with the template event. To accomplish this, we need to trim the detection to the same 160 second length. We can use the detection time to help with trimming the detection seismogram. Considering that detections object is a list with a dictionary as each item of the list, which of the following would get the time and store it in a variable?

Select one:

- a. detect = detections[0]
- b. detect = detections["time"][0]
- c. detect = detections["time"]
- d. detect = detections[0][0]
- e. detect = detections[0]["time"] ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 24

Correct

0.67 points out of 1.00

Flag question

Which of the following would trim the seismogram to the correct length and leave ten seconds before the P wave arrival.

Select one:

- a. stream = trim(detect, detect + 160)
- b. stream = trim(detect, 0, 160)
- c. stream.trim(detect, 160)
- d. stream.trim(detect - 10, detect + 150)
- e. stream = trim(detect, 160)
- f. stream = trim(detect, -10, 150)
- g. stream.trim(detect, -10, 150)
- h. stream.trim(detect, detect + 160) ✓ Correct. Run this command now and then `stream.plot()` to confirm the seismogram has been trimmed.
- i. stream = trim(detect - 10, detect - 150)
- j. stream.trim(detect, 0, 160)

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 25

Correct

0.00 points out of 1.00

Flag question

Unfortunately, ObsPy does not come with native support for plotting side-by-side seismograms. However, there are plenty of options for accomplishing this in Python, so it will give us a chance to see how we can use NumPy and matplotlib with the results of ObsPy processing. Let's import these two libraries first:

```
import numpy as np
import matplotlib.pyplot as plt
```

Next we will need to create a plot that has two "subplots" since there are two seismograms to plot. Matplotlib does this with the subplot() function that you can read about here:

https://matplotlib.org/3.3.0/api/_as_gen/matplotlib.pyplot.subplot.html

It may take a little bit of time to understand their plotting logic, but we will need it for this question. Which of the following would create a subplot fo the upper half of the plot window?

Select one:

- a. plt.subplot(222)
- b. plt.subplot(212)
- c. plt.subplot(221)
- d. plt.subplot(121)
- e. plt.subplot(211) ✓ Correct. Run this command now.
- f. plt.subplot(112)
- g. plt.subplot(122)

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.00/1.00**.

Question 26

Correct

0.67 points out of 1.00

Flag question

Then we need to create a time series that can be plotted with matplotlib. There are several ways to do this, but one relatively quick way is to create set of time values using numpy.arange like we did during our first NumPy tutorial. As a reminder:

https://numpy.org/doc/stable/reference/generated/numpy.arange.html

We need to create a series of time points that go from 0 all the way to (and including) 160, with a time point for each sample of our seismogram. Which of the following would accomplish this?

Select one:

- a. t = np.arange(0, 160, 1/samprate)
- b. t = np.arange(0, 160 + 1/samprate, 1/samprate) ✓ Correct. Run this command now.
- c. t = np.arange(0, 160, samprate)
- d. t = np.arange(0, 160 + samprate, samprate)

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 27
Correct
0.00 points out of 1.00
Flag question

Now we need to send the time values and the data values to the plot() function. As in our earlier matplotlib tutorial, we will specify the x and y values as separate variables. We just created the x variable with np.arange, and we already have the y values stored in the template Stream object with a Trace inside of it (You may want to refer to the Stream and Trace manuals provided earlier to help with this). Which of the following would plot the template seismogram first?

Select one:
- a. plt.plot(template.data, t)
- b. plt.plot(t, template[0])
- c. plt.plot(t, template[0].data) ✓ Correct. Run this command now.
- d. plt.plot(t, template)
- e. plt.plot(t, template.data)
- f. plt.plot(template[0].data, t)
- g. plt.plot(template[0], t)
- h. plt.plot(template, t)

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.00/1.00**.

Question 28
Correct
1.00 points out of 1.00
Flag question

Which of the following would create the next subplot for the lower half of the plot window?

Select one or more:
- a. plt.subplot(211)
- b. plt.subplot(112)
- c. plt.subplot(221)
- d. plt.subplot(222)
- e. plt.subplot(122)
- f. plt.subplot(212) ✓ Correct. Run this command now.
- g. plt.subplot(121)

Check

Correct
Marks for this submission: 1.00/1.00.

Question 29
Correct
0.67 points out of 1.00
Flag question

Which of the following would plot the match seismogram in the second subplot?

Select one:
- a. plt.plot(stream[0], t)
- b. plt.plot(t, stream[0])
- c. plt.plot(t, stream[0].data) ✓ Correct. Run this command now.
- d. plt.plot(stream.data, t)
- e. plt.plot(t, stream.data)
- f. plt.plot(stream, t)
- g. plt.plot(stream[0].data, t)
- h. plt.plot(t, stream)

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 30
Correct
1.00 points out of 1.00
Flag question

Let's finish the plot with some labels and then show it:

```
plt.xlabel('Time [s]')
plt.suptitle('Template (top), Match (bottom)')
plt.show()
```

Describe in your words how the match seismogram compares to the template seismogram. Do you think the comparison would help folks to quickly assess whether the event in 2017 was also a nuclear blast at the North Korea test site?

Answer: Yes, It helps actually analysing the details. ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Finish review