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Started on	Wednesday, August 3, 2022, 8:21 AM
State	Finished
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Time taken	5 mins 6 secs
Marks	20.00/20.00
Grade	**100.00** out of 100.00

Question 1

Correct

1.00 points out of 1.00

Flag question

1. Convolution

In our activity today, we will examine some ways to adjust seismic time series. The first approach is to use convolution to combine information from two time series. Since convolution is a new concept, it would be good to examine its effect on a very basic level. Fortunately, SAC has a convolve function to allow us to examine these effects.

For this activity, we will be re-using some seismograms that we analyzed during the source rupture velocity and directivity assignment that were stored in the rupture directory. So you will need to enter the directory called **rupture** inside your **sac** directory. Which of the following commands would achieve that?

Select one:

- a. mkdir rupture
- b. cd rupture
- c. mkdir ~/sac
- d. cd ~/sac/rupture ✓ Correct, please make sure you run this command now to enter the rupture directory.
- e. mkdir ~/sac/rupture
- f. cd ~/sac

Check

Correct
Marks for this submission: 1.00/1.00.

Question 2

Correct

1.00 points out of 1.00

Flag question

Go ahead and start sac. We will use the `funcgen` command to generate a simple boxcar time series to begin with. You can learn about how to generate a boxcar function with `funcgen` by using the `help` command.

```
(iris) jupyter-[your username]:~/sac/rupture> sac
SAC> help funcgen
```

Which of the following is the correct way to generate a boxcar function that has 30 data points spaced 1 second apart?

Select one:

- a. funcgen boxcar type 1 second 30 npts
- b. funcgen type boxcar npts 30 delta 1
- c. funcgen boxcar points 30 delta 1
- d. funcgen boxcar 1 second 30 npts
- e. funcgen boxcar npts 30 delta 1 ✓ Correct. If you have not already, please run this command.
- f. funcgen boxcar type 1 second 30 points
- g. funcgen boxcar 1 second 30 points
- h. funcgen type boxcar points 30 delta 1

Check

Correct
Marks for this submission: 1.00/1.00.

Question 3

Correct

1.00 points out of 1.00

Flag question

Now plot the results of the funcgen command. What does the result look like?

Select one:

- a. A time series that has a value of 0 from 0-10 s, value of 1 from 11-20, and value of 0 from 21 to 29. ✓
- b. A time series that has a value of 0 from 0-10 s, value of 1 from 11-20, and value of 1 from 21 to 29.
- c. A time series that has a value of 0 from 0-9 s, value of 1 from 10-19, and value of 1 from 20 to 29.
- d. A time series that has a value of 1 from 0-9 s, value of 0 from 10-19, and value of 1 from 20 to 29.
- e. A time series that has a value of 0 from 0-9 s, value of 1 from 10-19, and value of 0 from 20 to 29.
- f. A time series that has a value of 1 from 0-10 s, value of 0 from 11-20, and value of 1 from 21 to 29.

Check

Correct
Marks for this submission: 1.00/1.00.

Question 4

Correct

1.00 points out of 1.00

Flag question

Which command would help us confirm that the time series has 30 points with 1 sample point per second?

Select one:

- a. ls points delta
- b. ls points samples
- c. listhdr npts samples
- d. ls npts delta
- e. listhdr npts delta ✓
- f. listhdr points samples

Check

Correct
Marks for this submission: 1.00/1.00.

Question 5

Correct

1.00 points out of 1.00

Flag question

We can convolve two boxcar time series with one another using these commands:

```
SAC> funcgen boxcar npts 30 delta 1
SAC> p
SAC> write boxcar.out
SAC> convolve boxcar.out
SAC> p
```

The result should be a plot that looks like a triangle. Why does the convolution of two boxcar time series produces this shape?

Select one:

- a. As one boxcar function is gradually moved across the other, the value gradually increases as the overlap increases and then the value decreases again as the overlap decreases. ✓
- b. As one boxcar function is moved in the positive direction, the value gradually increases as the overlap increases. Then the value decreases as the boxcar function is flipped and moved in the negative direction.
- c. Since both signals are symmetric, the resulting function needs to be symmetric and represent decreasing values away from the center of symmetry.
- d. Since both input signals are the same, the resulting function needs to be symmetric and represent decreasing values away from the center of symmetry.

Check

Your answer is correct.
Correct
Marks for this submission: 1.00/1.00.

Question 6

Correct

1.00 points out of 1.00

Flag question

What is the peak of value of the resulting function after convolution of the two boxcars?

Answer: 10 ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 7

Correct

1.00 points out of 1.00

Flag question

Why does the peak of the convolution result have this value?

Select one:

- a. Because each boxcar is 10 points wide and has an amplitude of 1. ✓
- b. When the two boxcar functions fully overlap, multiplying their heights together results in a value of 10.
- c. The maximum value of the convolution is equal to the length of the longest input signal.
- d. The peak value is the time value when the two functions completely overlap.

Check

Your answer is correct.
Correct
Marks for this submission: 1.00/1.00.

Question 8

Correct

1.00 points out of 1.00

Flag question

2. Cross-Correlation

Next we will use the cross-correlation approach to examine and adjust seismic time series. We will be using cross-correlation to examine time offsets between similar signals. This is a very useful application when trying to get the best arrival time pick for a set of seismic waves. As you may recall, the arrival time picks of P and S waves are used to determine earthquake locations and earth velocity structure, so making the picks as precise as possible will ensure the locations and velocity structure are as accurate as possible. In our previous SAC tutorial on source rupture properties, we looked at several recordings of a 2007 Sumatra earthquake to examine the variations in the source time function over different azimuths. I had made the arrival time picks for you in that case, but I just made those picks by eye, so cross-correlation should be able to improve upon those estimated arrival time picks.

For the first example, we will compare the time series from stations ULN and MAJO, which are roughly north of the earthquake. To make the cross-correlation results easy to interpret, we will use the `cut` command to tell SAC to trim down each time series to 20 seconds total, with 10 seconds before the arrival time pick (A) and 10 seconds after.

```
SAC> cut A -10 10
```

Once you run this command, SAC will attempt to trim any files that are read into SAC after this. Which of the following commands would read the seismograms for stations ULN and MAJO?

Select one:

- a. r *ULN*.SAC *MAJO*.SAC ✓ Correct, please run this command if you have not already.
- b. r ULN*.SAC MAJO*.SAC
- c. r ULN.SAC MAJO.SAC
- d. r *ULN*.SAC*MAJO*.SAC
- e. r *ULN.SAC *MAJO.SAC

Check

Correct
Marks for this submission: 1.00/1.00.

Question 9

Correct

1.00 points out of 1.00

Flag question

Which command would plot these seismograms side by side relative to one another ignoring the absolute time differences between them?

Select one:

- a. p1 abs
- b. plot abs
- c. plot rel
- d. p2 abs
- e. p1 rel ✓ Correct, please run this command if you have not already.
- f. p2 rel

Check

Correct
Marks for this submission: 1.00/1.00.

Question 10

Correct

1.00 points out of 1.00

Flag question

I want you to compare the similarity of the waveforms in this plot, but I find the A time pick marker to be a bit distracting because those markers will be perfectly aligned based on how we trimmed the seismograms. I want you to look at the wave shapes instead, so we can turn the pick markers off. You can use the **help** command again to learn about how to use the picks command. Which of the following commands would prevent the pick markers from being displayed?

Select one:

- a. PICKS ON
- b. picks off ✓ Correct, please run this command if you have not already, and then run `p1 relagain`.
- c. PICKS T4 C T5 C T6 C W 0.3 H 0.1
- d. pick display off
- e. show picks off

Check

Correct
Marks for this submission: 1.00/1.00.

Question 11

Correct

1.00 points out of 1.00

Flag question

Now if you plot the seismograms again, you can examine the two time series by eye. How would characterize the timing of these seismograms based on how the arrival times have been picked?

Select one:

- a. These time series are not well aligned.
- b. The timing of the waveform shapes relative to the initial arrival time pick are different by about 2 seconds.
- c. These time series seem to be well aligned. ✓
- d. The timing of the waveform shapes relative to the initial arrival time pick are different by about 1 second.

Check

Correct
Marks for this submission: 1.00/1.00.

Question 12

Correct

1.00 points out of 1.00

Flag question

Now we can perform cross-correlation with the `correlate` command to see how well aligned these time series are quantitatively.

```
SAC> correlate
```

Go ahead an plot both seismograms. The top plot shows the "autocorrelation", which is the correlation of the ULN time series with itself. The bottom plot shows the correlation of the ULN time series with the MAJO time series. What do the plots look like and why?

Select one:

- a. The look like pulses at the beginning of the resulting time series
- b. The look like pulses at the end of the resulting time series
- c. They look like pulses centered in the middle of the resulting time series. ✓
- d. They look like flat lines

Check

Correct
Marks for this submission: 1.00/1.00.

Question 13

Correct

1.00 points out of 1.00

Flag question

Why are the correlation results 40 seconds long?

Select one:

- a. Because the original seismograms were 40 seconds long
- b. Because the original seismograms were 80 seconds long
- c. Because the original seismograms were 10 seconds long
- d. Because the original seismograms were 20 seconds long ✓ Correct. The 40 seconds results from one seismogram being moved along in time one data point at a time and compared with the other seismogram from the point where the two seismograms barely overlap to the point they completely overlap (that is 20 seconds) and then all the way until they do not overlap any more (that is another 20 seconds).

Check

Correct
Marks for this submission: 1.00/1.00.

Question 14
Correct
1.00 points out of 1.00
Flag question

Now focus on the cross-correlation between ULN and MAJO in the bottom plot. How does this compare to the autocorrelation of ULN in the top plot and what does it mean?

Select one:
- a. The cross-correlation is not similar to the autocorrelation, which means the arrival time pick for MAJO is very well aligned relative to that for ULN.
- b. The cross-correlation is not similar to the autocorrelation, which means the arrival time pick for MAJO is not well aligned relative to that for ULN.
- c. The cross-correlation is very similar to the autocorrelation, which means the arrival time pick for MAJO is not well aligned relative to that for ULN.
- d. The cross-correlation is very similar to the autocorrelation, which means the arrival time pick for MAJO is very well aligned relative to that for ULN. ✓ Correct, and this ultimately means that I did a good job picking the arrival time consistently between these two seismograms. So in this case, my qualitative pick by eye was as precise as a quantitative one using cross-correlation.

Check

Correct
Marks for this submission: 1.00/1.00.

Question 15
Correct
1.00 points out of 1.00
Flag question

For the second example, now we will compare station ULN with TARA, slightly further to the east. How do we read these files into SAC?

Select one:
- a. r ULN.SAC TARA.SAC
- b. r ULN*.SAC TARA*.SAC
- c. r *ULN*.SAC*TARA*.SAC
- d. r *ULN.SAC *TARA.SAC
- e. r *ULN*.SAC *TARA*.SAC ✓ Correct, please run this command if you have not already.

Check

Correct
Marks for this submission: 1.00/1.00.

Question 16
Correct
1.00 points out of 1.00
Flag question

After reading these seismograms, we have to make a slight adjustment to the sampling rate, because station TARA has a sampling rate of .025 instead of .05. We can correct for this with the `interpolate` function to adjust the sampling rate to be a common .05 for both time series. Since we have used this variable several times already today, which variable stores the sampling rate?

Select one:
- a. samples
- b. delta ✓ Correct, now run the command:
  `interpolate delta .05`
- c. rate
- d. npts
- e. points

Check

Correct
Marks for this submission: 1.00/1.00.

Question 17
Correct
1.00 points out of 1.00
Flag question

Make sure to run the `interpolate` command I provided in the feedback to the correct answer of the previous question. Now plot the seismograms side by side. How do the arrival times and waveform shapes compare?

Select one:
- a. TARA waveform shapes appear to be almost perfectly aligned with the ULN waveform shapes.
- b. TARA waveform shapes appear to be several seconds later than the ULN waveform shapes.
- c. TARA waveform shapes appear to be about a second earlier than the ULN waveform shapes. ✓
- d. TARA waveform shapes appear to be several seconds earlier than the ULN waveform shapes.
- e. TARA waveform shapes appear to be about a second later than the ULN waveform shapes.

Check

Correct
Marks for this submission: 1.00/1.00.

Question 18
Correct
1.00 points out of 1.00
Flag question

It may not seem like much variation between the seismograms, but you should go ahead and do the correlation and then examine how offset the bottom plot is from the top plot to determine how offset the original two time series are. How many seconds offset are the two time series based on the cross-correlation results?

Answer: 1 ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 19
Correct
1.00 points out of 1.00
Flag question

Are the waveform shapes in one seismogram earlier relative to the arrival time pick than the other?

Select one:
- a. No, they are very well aligned
- b. Yes, TARA has earlier waveform shapes than ULN ✓
- c. Yes, ULN has earlier waveform shapes than TARA

Check

Correct
Marks for this submission: 1.00/1.00.

Question 20
Correct
1.00 points out of 1.00
Flag question

Since we know that the arrival times are used to calculate earthquake locations, how big of an offset in the earthquake location could we get from an incorrect offset in the arrival time? For this case, we can assume that an average velocity for P wave arrivals is 10 km/s, and use our favorite equation velocity = distance / time.

Answer: 10 ✓ km

Check

Correct
Marks for this submission: 1.00/1.00.

Finish review