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

Show one page at a time

Finish review

Started on	Wednesday, August 3, 2022, 7:39 AM
State	Finished
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Time taken	9 mins 24 secs
Marks	28.50/29.00
Grade	**98.28** out of 100.00

Question 1

Correct

1.00 points out of 1.00

Flag question

1. What is SAC?

SAC stands for Seismic Analysis Code. SAC is a general purpose interactive program designed for the study of sequential data, especially time-series data. Emphasis has been placed on analysis tools needed by research seismologists in the detailed study of seismic events. As such, it is used for quick preliminary analyses, for routine processing, for testing new techniques, for detailed research, and for creating publication quality graphics. It is used by both computer novices and experts. In order to make SAC quick to learn and easy to use, default values for all operational parameters were carefully chosen. At the same time, almost all of these parameters are under direct user control. This design combines ease of use with significant flexibility.

Mode of Operation

Each signal is stored in a separate data file. Each data file contains a header that describes the contents of that file. See the section on Data File Format for details. Signals are read from disk into memory using the READ command. SAC can process up to 200 signals of arbitrary size at a time. Once data is in memory other commands are typed at the terminal (or read from a macro file) to perform operations on these signals. All operations work concurrently on all signals in memory. You can look at the results at any time using the plot commands. There are several plot formats to choose from. You have control over titles and labels, plot limits, file identifications, axes and tick mark locations, etc. You can also save the results of these operations at any time. All of the commands are described briefly in the sections on Analysis Capabilities and Graphics Capabilities of the User's Manual and documented in detail in the Commands Reference Manual.

This tutorial will show you by example how the basic SAC commands work. If you want to learn more about a particular command, see the Command Reference Manual . For general information on how SAC works, how to create and use SAC macros, on the structure of SAC data files, and how to interface other programs to SAC see the User's Manual.

Note: SAC is a large program with many capabilities and options. It can be confusing at first. Don't despair. The most important commands are discussed in this guide. You need to learn about the rest of the commands only as you need them. Common sense defaults exist for most options. SAC does a lot of error checking so you can't get into too much trouble.

To make sure you are understanding how SAC works, which of the following are true? Choose all that apply.

Select one or more:

- [ ] a. SAC can plot data but not process it
- [ ] b. SAC can process data but not plot it
- [x] c. SAC commands work on all signals at the same time ✓
- [ ] d. SAC commands work on one signal at a time
- [x] e. SAC can process data and plot it ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 2

Correct

1.00 points out of 1.00

Flag question

2. Using SAC

We will access SAC in the same way we have been running other commands on Linux. Please open and login to OpenSARlab now, and then click to open a regular Terminal command window. Now we should make a new directory in your home directory called **sac** for our SAC tutorials, and then create an **act1** directory inside the **sac** directory where we can store our output from SAC in this tutorial. What is the correct order of commands below to create, check, and then enter these **sac** and **act1** directories?

ls act1	5 ✓
mkdir act1	4 ✓
ls sac	2 ✓
cd ~/sac	3 ✓
cd act1	6 ✓
mkdir ~/sac	1 ✓

Check

Please make sure you run these commands to ensure you are in the newly created ~/sac/act1 directory for our subsequent questions in this tutorial.

Correct
Marks for this submission: 1.00/1.00.

Question 3

Correct

1.00 points out of 1.00

Flag question

Then once inside the **act1** directory you can simply type "sac" at the command prompt.

```
(iris) jupyter-[your username]:~/sac/act1> sac
```

SAC will then print a short headline including the number and date of the version you have on your system. It may also print a bulletin giving some current information. SAC will then ask you for input by sending the prompt to type commands at:

```
SAC>
```

What is the current version you are using? I am just looking for the version number.

Answer: 102.0 ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 4

Correct

1.00 points out of 1.00

Flag question

SAC is an interactive command driven program. This means that you must type a command to get SAC to do something. It does not prompt you for input. Commands may be typed at the terminal or placed in a macro file (like the script files we have created for Linux). Symbols within a command are separated by spaces and commands within a given line may be separated by a semicolon.

SAC commands fall into three main categories: parameter-setting, action-producing, and data-set manipulation. The parameter-setting commands change values of internal SAC parameters. Action-producing commands perform some operation on the signals currently in selected memory based upon the values of these parameters. Data-set manipulation commands mainly involve writing signals to files on the hard disk, which are immediate and permanent. The effect of a parameter-setting command remains in effect until it is reset. The effect of an action-producing command is immediate and transitory. Action-producing commands also have options which normally remain in effect until reset. These options, however, apply only to that particular command. The underlying assumption is that you are more likely than not to want to use the same values the next time you execute the same command. When you start up SAC, default values are defined for all of these parameters. SAC can be reinitialized to this default state at any time by executing the INICM command.

Which of the following would be true if your internet lapses and you have to restart SAC?

Select one or more:

- [x] a. Any changes to action options you set in SAC would be lost and you would need to set them again ✓ 1 of 3 correct answers.
- [ ] b. Any data file manipulation you made with SAC would be lost and you would need to adjust the data files again
- [x] c. Any actions you performed on signals in SAC memory will be lost and you would need to perform those actions again ✓ 1 of 3 correct answers.
- [x] d. Any parameters you had set in SAC would be lost and you would need to set them again ✓ 1 of 3 correct answers.

Check

Correct
Marks for this submission: 1.00/1.00.

Question 5

Correct

1.00 points out of 1.00

Flag question

3. A Simple Example

We can start practicing with SAC by creating a simple function:

```
SAC> FUNCGEN IMPULSE
```

Note: The SAC> prompt in the previous line is to help represent what your screen should look like when SAC is running. You do not need to typeSAC>because it should be there on your screen already, telling you that SAC is ready for you to enter a command.

Note 2: It is common for folks to write SAC commands in capital letters, but this is not required because SAC is not case-sensitive to commands and options (It is for Linux filenames though!). So you could type the `funcgen impulse` command and it would still work.

The `FUNCGEN IMPULSE` command generates an impulse function and stores it in SAC's temporary memory. To see what this function looks like on your screen type:

```
SAC> BEGINDEVICES XWINDOWS
SAC> PLOT
```

In this example `XWINDOWS` is the name of the graphics device you are using, which should make the plot appear on your screen. This is also the default device for SAC, so you don't have to type the `BEGINDEVICES XWINDOWS` command before typing the `PLOT` command.

What does the impulse function look like?

Select one:

- [ ] a. Amplitude of 0 before time 0 with larger amplitude after time 0.
- [x] b. Zero amplitude at all points except a spike near time 50. ✓
- [ ] c. Zero amplitude at all points except a spike at time 0.
- [ ] d. Amplitude of 0 before time 50 with larger amplitude after time 50.
- [ ] e. Larger amplitude at all points except time 0 when it drops to 0 amplitude.
- [ ] f. Larger amplitude at all points except time 50 when it drops to 0 amplitude.

Check

Correct
Marks for this submission: 1.00/1.00.

Question 6

Correct

1.00 points out of 1.00

Flag question

Assuming the x-axis is time in seconds, how long is the time series FUNCGEN generated?

Answer: 100 ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 7

Correct

1.00 points out of 1.00

Flag question

At what time is the peak? It may be a little hard to see exactly, but I'd like you to estimate the value to the nearest integer as best you can.

Answer: 48 ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 8

Correct

1.00 points out of 1.00

Flag question

What is the amplitude of the peak?

Answer: 1 ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 9

Correct

1.00 points out of 1.00

Flag question

4. Abbreviations

There are abbreviations for the most used SAC commands. For example, FG, BD, and P are the abbreviations for FUNCGEN, BEGINDEVICE, and PLOT respectively. Most options also have abbreviations like X for XWINDOWS. There is a graphics device for generating hardcopy plots called SGF (stands for SAC Graphics File). Let's change the device from XWINDOWS TO the SAC Graphics File:

```
SAC> BD SGF
SAC> P
SAC> ls
```

The `ls` command is the same one you use on the UNIX command line to list files in the current directory.

What file does this command show?

Answer: f001.sgf ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 10

Correct

1.00 points out of 1.00

Flag question

It is often useful to keep a copy of plots made with SAC by changing to the SGF device, you just need to remember to change the device back to XWINDOWS to see plots on your screen:

Which two commands would you type to go back to seeing a plot of the impulse function on your screen? Remember that the order matters.

Select one:

- [ ] a. FG IMPULSE
  BD X
- [x] b. BD X
  P ✓ Correct. Now please run these commands in SAC if you have not already done so.
- [ ] c. BD X
  FG IMPULSE
- [ ] d. FG IMPULSE
  P
- [ ] e. P
  BD SGF
- [ ] f. BD SGF
  P
- [ ] g. P
  FG IMPULSE
- [ ] h. P
  BD X

Check

Correct
Marks for this submission: 1.00/1.00.

Question 11

Correct

1.00 points out of 1.00

Flag question

5. More Functions

The FUNCGEN command can generate a number of different functions. This is very useful when first learning how to use SAC because you can see how the other SAC operations work on these functions. For example, type:

```
SAC> FG SEISMOGRAM
SAC> P
```

This generates a sample seismic signal in SAC's memory. It also deletes the impulse generated earlier. The PLOT command allows you to see this seismogram on your screen.

When is this sample seismogram from?

Select one:

- [ ] a. March 29, 2011
- [x] b. March 29, 1981 ✓
- [ ] c. May 19, 1981
- [ ] d. May 19, 2011
- [ ] e. May 29, 1981
- [ ] f. March 19, 1981

Check

Correct
Marks for this submission: 1.00/1.00.

Question 12

Partially correct

0.50 points out of 1.00

Flag question

Now we can look at another function: the SINE wave

```
SAC> FG SINE 2 NPTS 200 DELTA 0.01
SAC> P
```

This is an example of a more complicated SAC command. This example generates a sine wave with a 2 Hz frequency in SAC's memory. The function will contain 200 data points and have a sampling interval of 0.01 seconds.

If there are 200 points with an interval of 0.01 seconds, what is the total length of the signal? I am looking for both the number and the unit.

Answer: 2.0 points per second

Check

You did not give the correct unit.

Partially correct
Marks for this submission: 0.50/1.00.

Question 13
Correct
1.00 points out of 1.00
Flag question

SAC Commands

There are several general points to be made at this point about SAC commands. All input is space delimited. The decimal point is optional wherever numeric input is needed. When you specify a value for a particular option, this value becomes the new current value. This means you don't have to keep entering values for options that you don't want to change. For example, you can now generate this same 2 Hz sine wave using the same sampling interval but with 400 data points by simply typing:

```
SAC> FG NPTS 400
```

What is the total length of this signal in seconds?

Answer: 4

Check

Correct
Marks for this submission: 1.00/1.00.

Question 14
Correct
1.00 points out of 1.00
Flag question

As mentioned earlier, SAC commands are typically either parameter-setting and action-producing. The parameter-setting commands basically change values of internal SAC parameters. Action-producing commands perform some operation on the data files currently in memory based upon the values of these same parameters. For example, the parameter-setting command, LINE, changes how SAC will make subsequent plots. The action-producing command, PLOT, does the actual plotting. Options to action-producing commands also remain in effect until reset just like parameter-setting commands. The underlying assumption is that you are likely to want to use the same values the next time you execute the same command.

What happens when you enter the following command:

```
SAC> LINE DOTTED
```

Select one:

- a. Nothing immediately, but when you enter the PLOT command, the sine wave changes to dotted. ✓
- b. Nothing changes.
- c. The frame of the plot changes to dotted.
- d. Nothing immediately, but when you enter the PLOT command, the frame of the plot changes to dotted.
- e. The sine wave changes to dotted.

Check

Correct
Marks for this submission: 1.00/1.00.

Question 15
Correct
1.00 points out of 1.00
Flag question

To learn more about a SAC command or if you forget the format or options for SAC command, you can use the `HELP` command to help explain how the command works. We should try this for the LINE command:

```
SAC> HELP LINE
```

Please review this explanation to help answer this question: What would the following command do:

```
SAC> LINE INCREMENT
```

If you need additional explanation, please see the page discussing the LINE command in the SAC User Manual (linked in this module).

Select one:

- a. It would increment the line color from black to grey to colored (etc.) for different signals in memory
- b. It would increment the signal lines so that they are shifted later
- c. It would increment the line style from solid to dotted to dashed (etc.) for different signals in memory ✓
- d. It would increment the signal lines so that they are shifted earlier

Check

Correct
Marks for this submission: 1.00/1.00.

Question 16
Correct
1.00 points out of 1.00
Flag question

6. Writing Data Files

SAC commands work on data already in SAC's working memory, not data on the hard drive. If you want to store data currently in SAC's memory into a file, use the `WRITE` command (abbreviated as `W`). The data files on disk are not modified by future changes to data in SAC's memory. In the example below, we will modify a file by multiplying the data in memory by a factor of two with the `MUL` command. At any time during your analysis, you may transfer this modified data back to disk using the `WRITE` command. You may overwrite the old data files on disk using the `OVER` option or create new ones by specifying their file names. Our first example will use the `WRITE` command to generate some data files, but we need to make sure you are still in your **act1** directory from the first part of the SAC tutorial.

Which of the following commands would ensure you are in this directory?

Select one:

- a. cd ~/sac/act1 ✓ Correct. Please run this command to make sure you are in this directory.
- b. cd sac
- c. cd act1
- d. cd ~/act1
- e. cd ~/groupwork/act1

Check

Correct
Marks for this submission: 1.00/1.00.

Question 17
Correct
1.00 points out of 1.00
Flag question

In our first example, we will use the `WRITE` command to generate a data file:

```
(iris) jupyter-[your username]:~/sac/act1> sac
SAC> FG SINE 2 NPTS 200 DELTA 0.01
SAC> P
SAC> WRITE SINE.2.SAC
```

Which command would you use to check to see if this file was actually created?

Select one:

- a. plot
- b. ls ✓
- c. cat
- d. check
- e. gv
- f. gedit

Check

Correct
Marks for this submission: 1.00/1.00.

Question 18
Correct
1.00 points out of 1.00
Flag question

Now we can use the `WRITE` command to generate some additional data files:

```
SAC> FG SINE 4
SAC> P
```

NOTE: If you had to quit SAC or lost your internet connection between this FG command and the one in the last question, then you need to specify the NPTS and DELTA options in your command. You can check whether this is a problem by looking at the time length of this SINE wave in your plot. If it is about 2 seconds long, then you are ok, but if it is about 100 seconds long, then you need to run FG SINE 4 NPTS 200 DELTA 0.01 instead.

Once you are certain the SINE wave looks correct in the plot window, you should run these commands:

```
SAC> W SINE.4.SAC
SAC> MUL 2
SAC> P
SAC> W SINE.4.SAC
```

Which of the following is true about what happened when the last command was entered? Choose all that apply.

Select one or more:

- a. A sine wave with a frequency of 2 Hz was written to the disk
- b. The SINE.2.SAC file has data with amplitudes that are twice as big as the data in SINE.4.SAC
- c. The SINE.4.SAC file has data with amplitudes that are twice as big as the data in SINE.2.SAC ✓ 1 of 3 correct answers
- d. A sine wave with a frequency of 4 Hz was written to the disk ✓ 1 of 3 correct answers
- e. A sine wave approximately 2 seconds long was written to the disk ✓ 1 of 3 correct answers
- f. A sine wave approximately 100 seconds long was written to the disk

Check

Correct
Marks for this submission: 1.00/1.00.

Question 19
Correct
1.00 points out of 1.00
Flag question

We can also use the `WRITE` command to generate one additional data file:

```
SAC> FG IMPULSE
SAC> P
```

AGAIN: If you had to quit SAC or lost your internet connection between this FG command and the one in the last question, then you need to specify the NPTS and DELTA options in your command. You can check whether this is a problem by looking at the time length of this IMPULSE fuction in your plot. If it is about 2 seconds long, then you are ok, but if it is about 100 seconds long, then you need to run FG IMPULSE NPTS 200 DELTA 0.01 instead.

Once you are certain the IMPULSE function looks correct in the plot window, you should run these commands:

```
SAC> W IMPULSE.SAC
SAC> ls
```

How many files ending in **.SAC** are now present?

Answer: 3

Check

Correct
Marks for this submission: 1.00/1.00.

Question 20
Correct
1.00 points out of 1.00
Flag question

7. Reading Data Files

The `READ` command is then used to transfer data from disk to memory (abbreviated as `R`). Up to 200 data files can be in memory at the same time. You can use wildcard characters in the `READ` command to represent groups of files which have a similar set of characters in their names. Each time you use the `READ` command to transfer data from disk to memory the data currently in memory is discarded. If you want this data saved, you must write it to disk before reading more data into memory. There is an option called `MORE` in the `READ` command that lets you read data into memory without discarding the old data.

```
SAC> READ SINE.2.SAC
SAC> P
SAC> R MORE SINE.4.SAC
SAC> P
```

Notice that the `PLOT` command only shows one data file at a time, and SAC will say `Waiting` which means SAC is waiting for you to hit the enter key in between each data file.

Using this command to compare the two data signals now present in SAC memory. Which of the following is true?

Select one:

- a. It is impossible to compare the frequencies of these two signals
- b. The first signal has a higher frequency wave
- c. The first signal has a lower frequency wave ✓
- d. The two signals have the same frequency

Check

Correct
Marks for this submission: 1.00/1.00.

Question 21
Correct
1.00 points out of 1.00
Flag question

It is common to have to re-write files to the disk after manipulating them in SAC. Here is an example:

```
SAC> MUL 2
SAC> W OVER
SAC> ls
```

Which of the following is true about what happened when the last command was entered? Choose all that apply.

Select one or more:

- a. The SINE.4.SAC file has data with amplitudes that are twice as big as the data in SINE.2.SAC ✓ Correct
- b. The OVER file has data with amplitudes that are twice as big as the data in SINE.4.SAC
- c. The SINE.2.SAC file has data with amplitudes that are twice as big as the data in SINE.4.SAC
- d. The OVER file has data with amplitudes that are twice as big as the data in SINE.2.SAC

Check

Correct
Marks for this submission: 1.00/1.00.

Question 22
Correct
1.00 points out of 1.00
Flag question

Several other plot formats are available. `PLOT1` plots each file along a common x axis but with a separate y axes (abbreviated `P1`). By default all files are placed on the same plot. Try this with all of the data files using a wildcard to help read the files.

```
SAC> R *.SAC
SAC> PLOT1
```

What is the order of files in the plot from top to bottom?

Sample seismogram	Not shown ✓
Sine wave with 2 Hz frequency	2 ✓
Impulse function	1 ✓
Sine wave with 4 Hz frequency	3 ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 23
Correct
1.00 points out of 1.00
Flag question

`PLOT2` is an overlay plot (abbreviated `P2`). Again all files are plotted together, this time using both a common X and a common Y axis.

```
SAC> PLOT2
```

Please match these signals with their amplitudes:

Impulse function	1 ✓
Sine wave with 4 Hz frequency	4 ✓
Sample seismogram	Not shown ✓
Sine wave with 2 Hz frequency	2 ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 24
Correct
1.00 points out of 1.00
Flag question

`PLOTPK` uses a format similar to `PLOT1` (abbreviated `PPK`). It lets you use the cursor to blow up parts of the plot, determine values of selected data points, pick phase arrival times, etc.

```
SAC> PPK
```

Using `PPK`: Place the cursor where you would like the zoomed in view to start and type the **X** key to mark it. Now move the cursor to where you want the zoomed view to end and type the **X** key again. The view should now be zoomed in to that range. With the mouse still highlighting the SAC graphics window, you can type the **O** key to return to the Old zoomed out level. Type the **Q** key to Quit from the `PPK` command.

Be careful, typing entering **Q** at the SAC command prompt instead of the SAC graphics window can result in SAC exiting entirely such that you would need to redo SAC commands from this tutorial again.

Using `PPK` to zoom into the peak in the Impulse function, at what time value does this peak occur at?

Answer: 0.99

Check

Correct

Marks for this submission: 1.00/1.00.

Question 25

Correct

1.00 points out of 1.00

Flag question

It is common for researchers to have a lot of signals in memory at one time, so it can be useful to plot one seismogram at time with PPK. This can be achieved with the PERPLOT option:

```
SAC> PPK PERPLOT 1
```

All of the same PPK keys apply for zooming, but now you can type the **N** key to change to the Next signal, and type the **B** key to go Back to the previous signal.

Use PPK to view the Sine wave with 2 Hz frequency and zoom into the first peak in the Sine wave. At what time value does this peak occur at?

Answer: 0.12

Check

Correct

Marks for this submission: 1.00/1.00.

Question 26

Correct

1.00 points out of 1.00

Flag question

Now we should modify the data and write it to new file names. Using the data currently in memory, we can downsample the data by a factor of five using DECIMATE (it also applies an anti-aliasing filter). Then we can write the results back to disk using the PREPEND option to change the file names. Finally, we can exit SAC with the QUIT command and list the files in this directory.

```
SAC> DECIMATE 5
SAC> W PREPEND DEC.
SAC> QUIT
```

```
(iris) jupyter-[your username]:~/sac/act1> ls
```

Using the output of the ls command, what are the new file names that were created by the DECIMATE command?

Answer: dec.impulse.sac dec.sine.2.sac dec.sine.4.sac

Check

Correct

Marks for this submission: 1.00/1.00.

Question 27

Correct

1.00 points out of 1.00

Flag question

We can go back into SAC to examine these files further:

```
(iris) jupyter-[your username]:~/sac/act1> sac
```

Now that you are back in SAC, how would you read all of the decimated data back into SAC?

Select one:

- a. R DEC.IMPULSE.SAC
- b. R MORE DEC.*.SAC
- c. R *.SAC
- d. R DEC.*.SAC ✓

Check

Correct

Marks for this submission: 1.00/1.00.

Question 28

Correct

1.00 points out of 1.00

Flag question

Now we should plot the decimated files:

```
SAC> P1
```

How have the signals changed?

Select one:

- a. The signals have not changed
- b. The signals are larger in amplitude
- c. The signals are smoother
- d. The signals have degraded in quality ✓

Check

Correct

Marks for this submission: 1.00/1.00.

Question 29

Correct

1.00 points out of 1.00

Flag question

At what time does the peak of the Impulse function occur after decimation?

Answer: 1

Check

Correct

Marks for this submission: 1.00/1.00.

Finish review