Assessment: Graduate Student in Near-Surface Geophysics

October 11, 2021

Introduction

The goal of this assessment is to find out if you are suited to join the University of Alabama Planetary and Near-Surface Geophysics Research Group. The most important skill as a graduate student is to independently solve problems for which you were not trained. Because of this, grades and reference letters are poor predictors for student success.

It is of paramount importance that you **solve the tasks by yourself**, without the help of a friend or teacher. Obtaining help for the tasks will skew the outcome and risk that you lose years of your life without getting a degree.

All of the assessment tasks can be solved with free open-source software. All you need is a computer and internet access. No commercial software is required.

Process

- Solve the tasks in Section
- Create a single document with the resolved tasks in their order. If you skip a task, please write "task skipped".
- Email that document to `amplattner@ua.edu`
- I will respond to your email and, if your assessment shows promise, will set up a video or phone meeting to discuss the assessment.

Important: Solving the tasks is no guarantee for admission to the program, even if you solve every task perfectly! But if you do solve the tasks well, our video/phone chat shows me that you have strong potential, and there is funding available, then you may be a high priority candidate for admission.

If you believe you found a mistake in the assessment, perhaps a link is dead or so, then please let me know. Also, if you almost solved a task but you are stuck in one detail, then please also let me know and perhaps I can help. However, if you send me many emails asking question that you could have solved yourself, then this is a sign that you are not an independent problem solver and hence not suited for graduate school.

Tasks

Task 1

Develop a near-surface research project that you can lead to a publication (see `http://alainplattner.net/publications.html`) for examples of publishable research projects. Research projects can be in the fields of archaeology, groundwater studies, ore deposits, etc. Our group has a Ground Penetrating Radar system (Sensors & Software PulseEkko Pro with an Ultra receiver) with 50 MHz, 100 MHz, and 200 MHz antennae, an electrical resistivity tomogrphy and time-domain induced polarization system (ABEM Terrameter LS 2) with 48 electrodes and maximum electrode spacing 5 m. We also have a differential GPS system.

In your description, please also estimate the depth to the target you want to image and the material properties of the overburden, and base the choice of your strategy (method and setup) on these parameters.

The goal of this assessment is to get an idea of your understanding of near-surface geophysics and gauge your specific interests.

Hint: If you have no background in near-surface geophysics, or you would like to refresh your understanding of fieldwork planning, please see the free online near-surface textbook Geophysics for Practicing Geoscientists: `https://gpg.geosci.xyz/`. In Particular, please see their "seven-step framework for applied geophysics".

Task 2

Process and interpret the ground penetrating radar data given by the three files `GPRprofile.DT1` (data file), `GPRprofile.HD` (header file) and `GPRprofileGPS.xyz` (GPS coordinates of the profile)m which are available from

`http://alainplattner.net/downloads/assessments/GPRprofile.DT1`

`http://alainplattner.net/downloads/assessments/GPRprofile.HD`

`http://alainplattner.net/downloads/assessments/GPRprofileGPS.xyz`

Make sure the .HD file, which is a text file, gets saved with the correct filename extension.

Your task is to process, visualize, and interpret these data using the GPR software of your choice. I recommend using the free ground penetrating radar software GPRPy, which you can install from this website: `https://nsgeophysics.github.io/GPRPy/`.

In your processing, you will need the radar wave velocity of the subsurface. For this data set it is 0.1 m/ns.

To solve this task, please create images of the raw and processed data set, draw your interpretation on top of the image, describe the processing steps you used to turn the raw data into the image, and describe what you observe and how you would interpret the GPR data.

Hint: You can learn how to use GPRPy from these instructional videos created by a former graduate student:
`https://www.youtube.com/playlist?list=PLun08yBWFIpdztQQpLo_jYzpGS2JGGTDm`

Task 3

Process and interpret the electrical resistivity data given by the two files `ERTprofile.stg` (data file) and `ERTprofileGPS.csv` (Coordinates and elevation of the electrodes). The files are available from

`http://alainplattner.net/downloads/assessments/ERTprofile.stg`

`http://alainplattner.net/downloads/assessments/ERTprofileGPS.csv`

Make sure both files, which are text files, get saved with the correct filename extension.

Your task is to process, visualize, and interpret these data using the ERT software of your choice. Two excellent free ERT software packages as ResIPy (`https://gitlab.com/hkex/resipy#downloads`) and BERT (`http://resistivity.net/bert/install.html#`). ResIPy is much easier to use than BERT, because it comes with a graphical user interface. For BERT, you can either use the command line tools, or you will can write a Python script for the inversion of the data.

To solve this task, please create an image of the subsurface electrical resistivity, draw your interpretation on top of the image, describe the settings you used to obtain this image and describe what you observe and how you would interpret the ERT data.

Using BERT is much more difficult than ResIPy, but BERT allows for many more options and will thus be the software you will use as a grad student. Therefore, if you solve this task using BERT, you will show even more how well you are suited.

Hint: If you use ResIPy, set the protocol to "Sting", because these data were collected using an AGI SuperSting system. BERT can automatically recognize the data format.

Key

Independently and successfully solving Task 1 is the absolute minimal requirement for suitability for our graduate program in near-surface geophysics.

If you completed Task 1, but couldn't complete Task 2 and Task 3, then you may be suitable. However, prospective students who did solve Tasks 2 and 3 will have a higher priority.

If you solved Tasks 1 and 2 but not Task 3, then you are suitable for our graduate program in near-surface geophysics and will have moderate priority.

If you solved all three Tasks independently and can explain them well in our phone or video chat, then you demonstrated that you are well suited for our graduate program in near-surface physics. You will have high priority. If you solved all three Tasks and Task 3 using BERT, then you have the very highest priority.