

This document describes how to install Bellhop on a Windows 10 machine. Bellhop is written in Fortran but a python wrapper has been constructed to run python and produce the plots that are the usual outputs of Bellhop. A Jupyter Notebook was created to make that easier for the user. Alternatively, you can call and run Bellhop in python exclusively.

The Bellhop Python Simulation Tools require the following libraries:

- Fortran compiler (optional for win10) – for MACs and Linux implementations
- Acoustic Toolbox
- Windows Binaries
- Arlpy (Bellhop wrapper for python)
- Python3
- Jupyter Notebook unless you want to run Bellhop standalone in Python

The instructions below install everything needed to run Bellhop in python and the Jupyter Notebook.

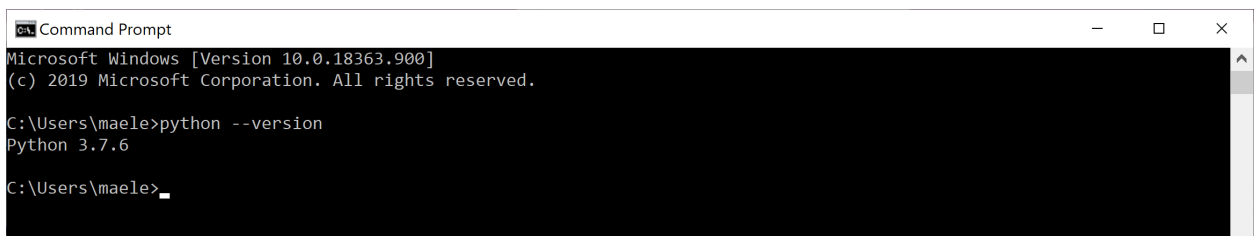
1. Install Python

Please check whether python2 or python3 is already installed on your Windows 10 machine.

open a Command Prompt and enter:

```
> python --version
```

If it is installed, it will reply with the version, i.e.:

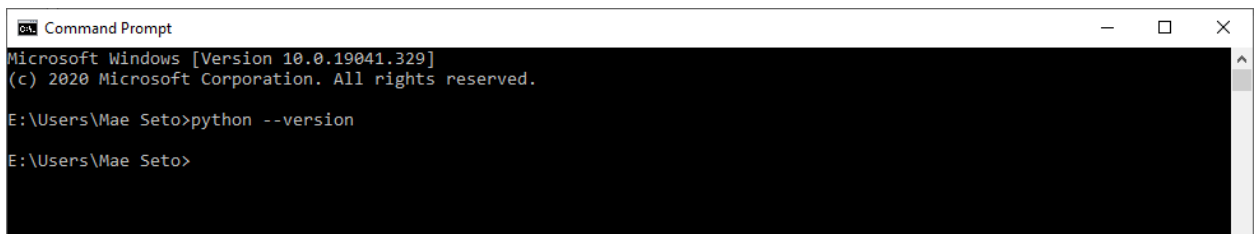


```
Command Prompt
Microsoft Windows [Version 10.0.18363.900]
(c) 2019 Microsoft Corporation. All rights reserved.

C:\Users\maele>python --version
Python 3.7.6

C:\Users\maele>
```

If it is not installed, the response is:



```
Command Prompt
Microsoft Windows [Version 10.0.19041.329]
(c) 2020 Microsoft Corporation. All rights reserved.

E:\Users\Mae Seto>python --version

E:\Users\Mae Seto>
```

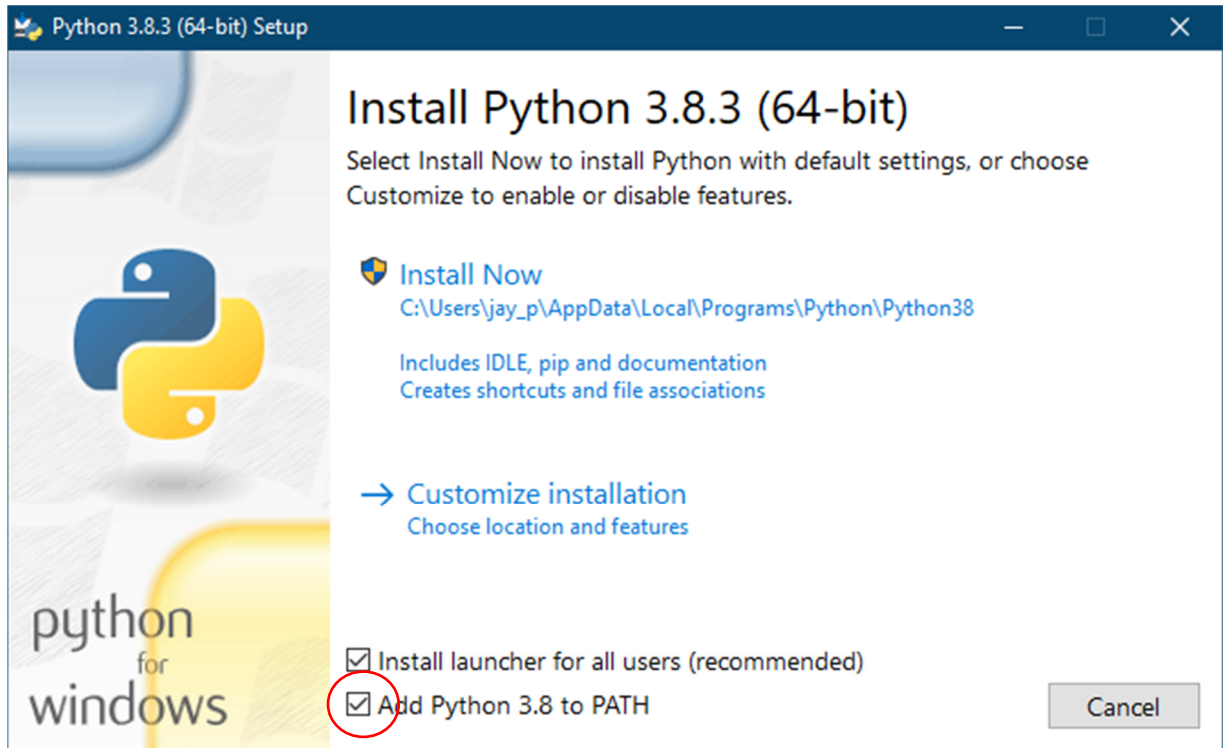
The general site for python downloads is at:

<https://www.python.org/downloads/>

If you have [Win 10 x86-64 bit], you can download it directly from:

<https://www.python.org/ftp/python/3.8.3/python-3.8.3-amd64.exe>

During installation it will ask whether to `Add Python 3.8 to PATH`. Select this option to add the path to your windows environment, i.e.



2. Install the Acoustic Toolbox (AT or at)

- i. Download the AT Toolbox from [this link](#)
- ii. Download the Windows binaries from [this link](#)

Both .zip files can be in the same folder
- iii. With the at.zip file from (i), use 7-zip or winzip to 'Extract Here'. This should create an 'at' folder with files in it. Ignore the _MACOSX folder which is for a MAC OS implementation.
- iv. With the atWin10_2020_6.zip file from (ii), use 7-zip or winzip to 'Extract Here'. Then, rename the folder, *atWin10_2020_6* to *bin*.

When you are done, your folder that you downloaded the .zip's into should appear as follows.

Name	Date modified	Type	Size
MS MACOSX	2020-06-30 3:12 PM	File folder	
at	2020-06-11 6:24 PM	File folder	
bin	2020-06-01 7:20 PM	File folder	
at.zip	2020-06-30 2:54 PM	WinZip File	34,271 KB
atWin10_2020_6.zip	2020-06-30 2:55 PM	WinZip File	4,016 KB

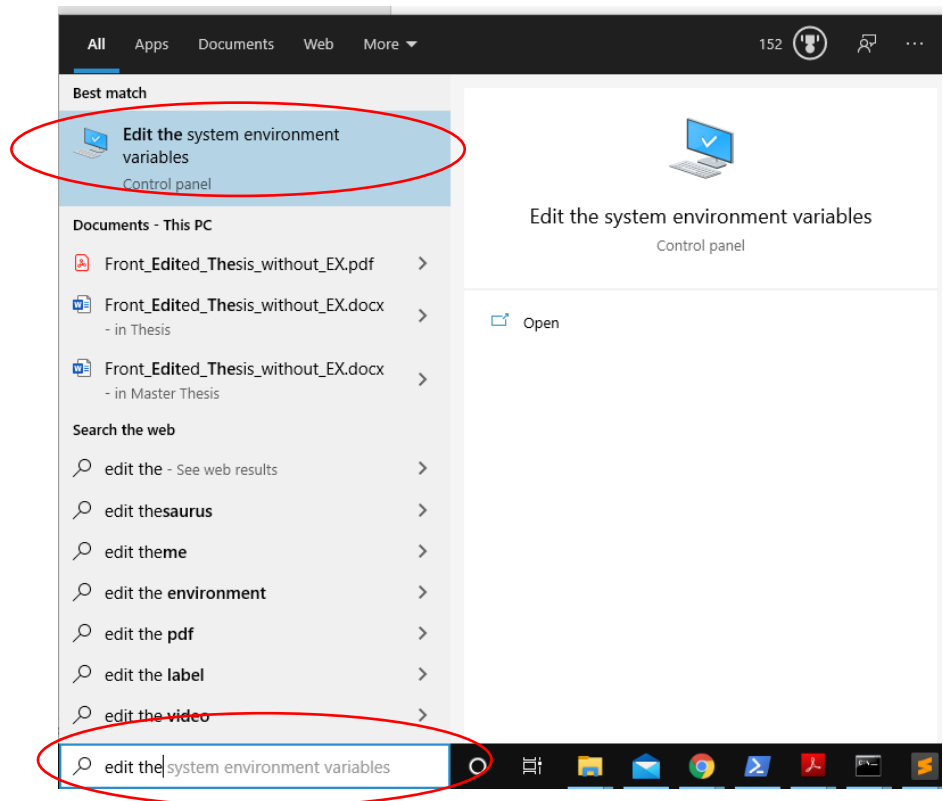
- v. Configurations must be made to the Windows System Variables (accessible to ALL user, for e.g. 'Path' must be set to your /at and /bin folders).

Configurations must also be made to the Windows User Variables (accessible to select users, for e.g. 'Path' must be set to your /at and /bin folders for users – like yourself).

System Variables are set before User Variables. The details for this are described next in the event you are unfamiliar with this.

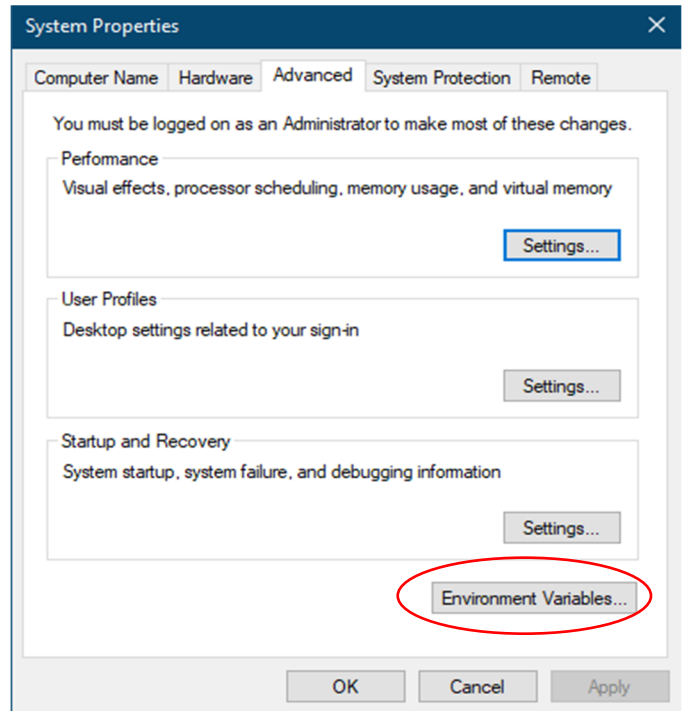
- go to the Windows Start Menu search bar and enter

edit the system environment variables



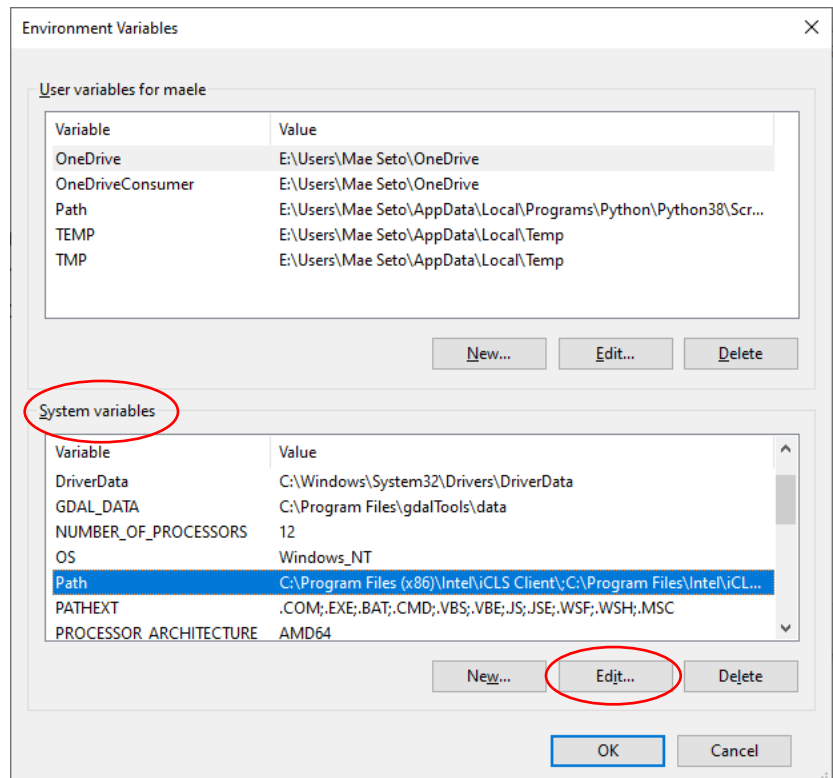
select 'Edit the system environment variables'

this spawns a box titled **System Properties**



select **Environment Variables**

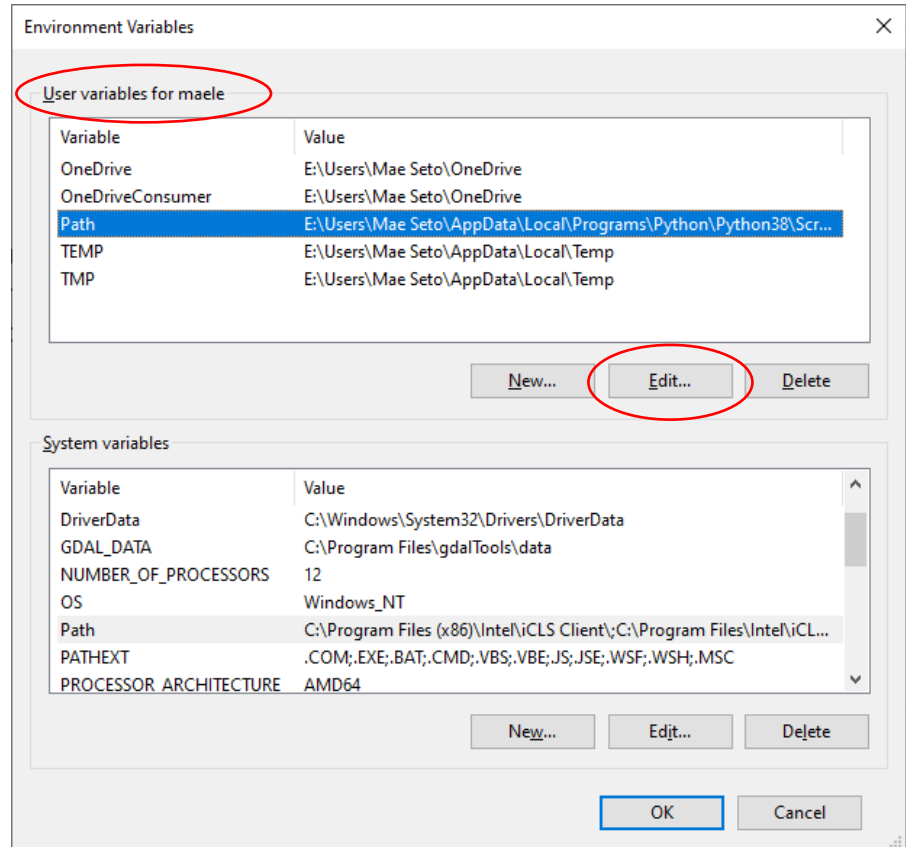
this spawns a box titled **Environment Variables**



go to 'System variables', select 'Path' (as highlighted) and enter 'Edit'

Add the direct paths to both your \bin and \at folders (you can 'Browse' to each folder or copy the path from Explorer and enter it under 'New')

Now, do the same under 'User Variable' in the 'Environment Variables' box, i.e.



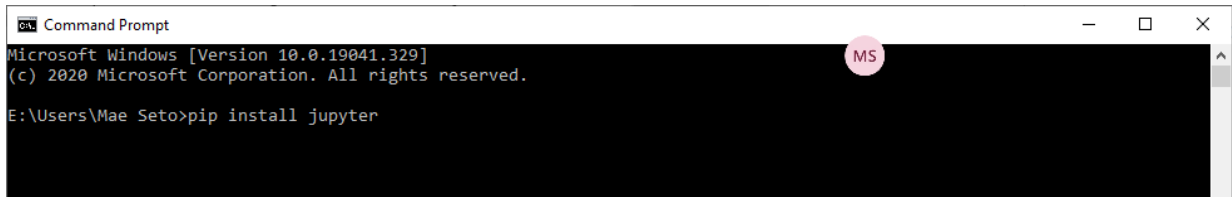
Add the direct paths to both your \bin and \at folders (you can 'Browse' to each folder or copy the path from Explorer and enter it under 'New')

The Acoustic Toolbox is now installed.

3. Install Jupyter Notebook

Get a Command Prompt to install the Jupyter notebook

> *pip install jupyter*



```
Command Prompt
Microsoft Windows [Version 10.0.19041.329]
(c) 2020 Microsoft Corporation. All rights reserved.

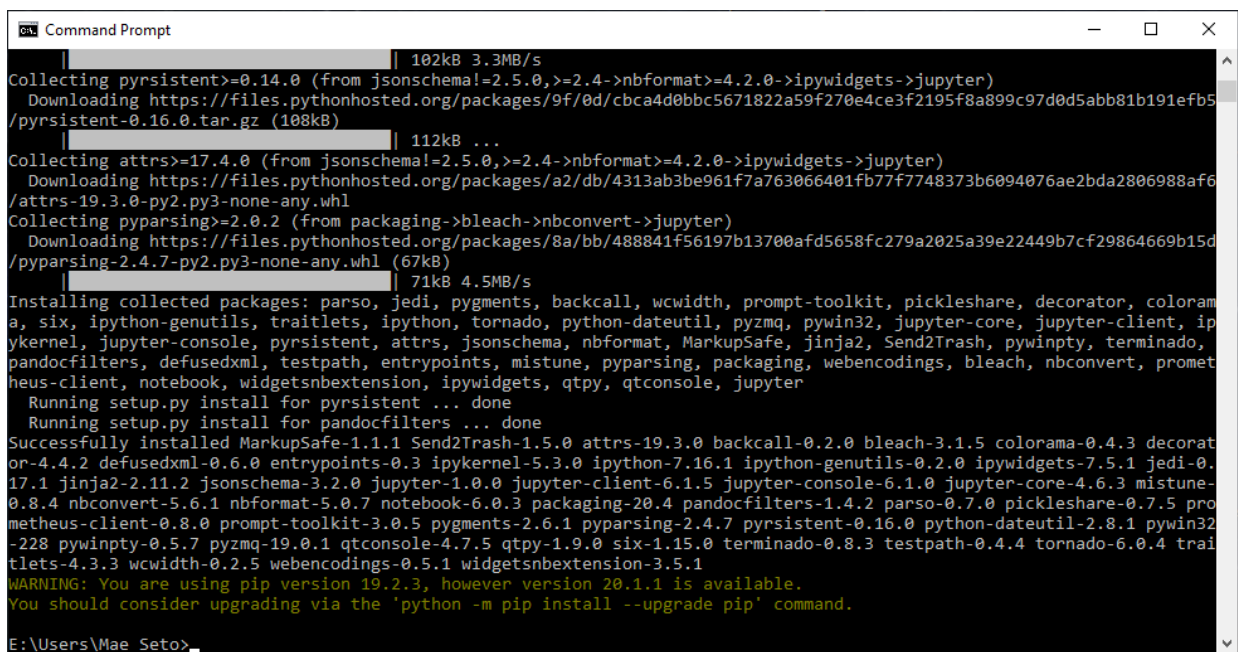
E:\Users\Mae Seto>pip install jupyter
```

[if python has been installed properly then this should work, test with

> *python --version*

]

when done it should look like:



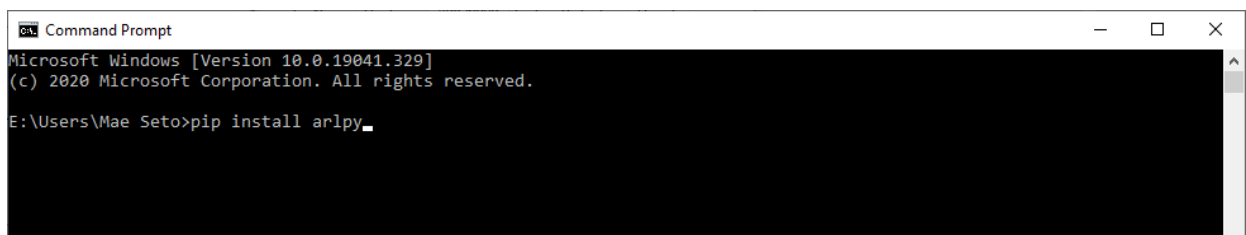
```
Command Prompt
Collecting pyrsistent<=0.14.0 (from jsonschema!=2.5.0,>=2.4->nbformat>=4.2.0->ipywidgets->jupyter)
  Downloading https://files.pythonhosted.org/packages/9f/0d/cbca4d0bbc5671822a59f270e4ce3f2195f8a899c97d0d5abb81b191efb5/pypersistent-0.16.0.tar.gz (108kB)
  | 102kB 3.3MB/s
Collecting attrs>=17.4.0 (from jsonschema!=2.5.0,>=2.4->nbformat>=4.2.0->ipywidgets->jupyter)
  Downloading https://files.pythonhosted.org/packages/a2/db/4313ab3be961f7a763066401fb77f7748373b6094076ae2bda2806988af6/attrs-19.3.0-py2.py3-none-any.whl
  | 112kB ...
Collecting pyparsing>=2.0.2 (from packaging->bleach->nbconvert->jupyter)
  Downloading https://files.pythonhosted.org/packages/8a/bb/488841f56197b1370afd5658fc279a2025a39e22449b7cf29864669b15d/pyparsing-2.4.7-py2.py3-none-any.whl (67kB)
  | 71kB 4.5MB/s
Installing collected packages: parso, jedi, pygments, backcall, wcwidth, prompt-toolkit, pickleshare, decorator, colorama, six, ipython-genutils, traitlets, ipython, tornado, python-dateutil, pyzmq, pywin32, jupyter-core, jupyter-client, ipykernel, jupyter-console, pyrsistent, attrs, jsonschema, nbformat, MarkupSafe, Jinja2, Send2Trash, pywinpty, terminado, pandocfilters, defusedxml, testpath, entrypoints, mistune, pyparsing, packaging, webencodings, bleach, nbconvert, prometheus-client, notebook, widgetsnbextension, ipywidgets, qtpy, qtconsole, jupyter
Running setup.py install for pyrsistent ... done
Running setup.py install for pandocfilters ... done
Successfully installed MarkupSafe-1.1.1 Send2Trash-1.5.0 attrs-19.3.0 backcall-0.2.0 bleach-3.1.5 colorama-0.4.3 decorator-4.4.2 defusedxml-0.6.0 entrypoints-0.3 ipykernel-5.3.0 ipython-7.16.1 ipython-genutils-0.2.0 ipywidgets-7.5.1 jedi-0.17.1 Jinja2-2.11.2 jsonschema-3.2.0 jupyter-1.0.0 jupyter-client-6.1.5 jupyter-console-6.1.0 jupyter-core-4.6.3 mistune-0.8.4 nbconvert-5.6.1 nbformat-5.0.7 notebook-6.0.3 packaging-20.4 pandocfilters-1.4.2 parso-0.7.0 pickleshare-0.7.5 prometheus-client-0.8.0 prompt-toolkit-3.0.5 pygments-2.6.1 pyparsing-2.4.7 pyrsistent-0.16.0 python-dateutil-2.8.1 pywin32-228 pywinpty-0.5.7 pyzmq-19.0.1 qtconsole-4.7.5 qtpy-1.9.0 six-1.15.0 terminado-0.8.3 testpath-0.4.4 tornado-6.0.4 traitlets-4.3.3 wcwidth-0.2.5 webencodings-0.5.1 widgetsnbextension-3.5.1
WARNING: You are using pip version 19.2.3, however version 20.1.1 is available.
You should consider upgrading via the 'python -m pip install --upgrade pip' command.

E:\Users\Mae Seto>
```

4. Install the arlpy python package

- install using below commands.

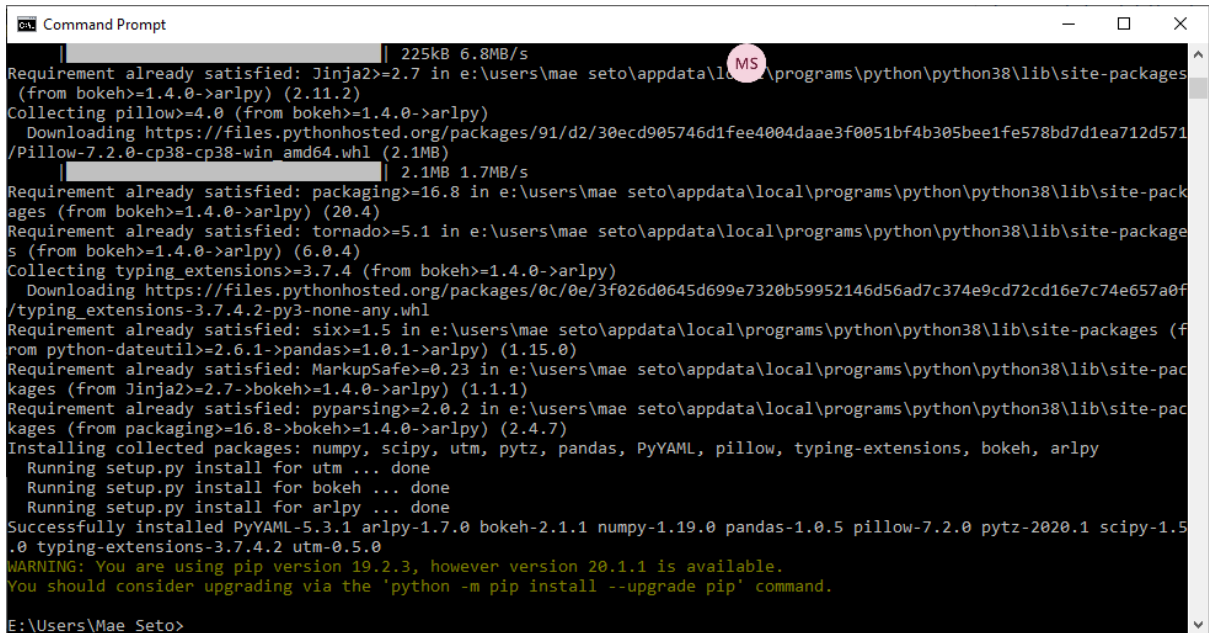
> *pip install arlpy*



```
Command Prompt
Microsoft Windows [Version 10.0.19041.329]
(c) 2020 Microsoft Corporation. All rights reserved.

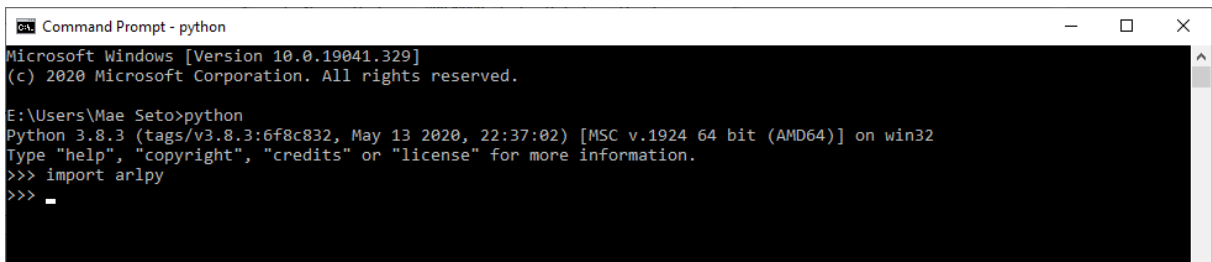
E:\Users\Mae Seto>pip install arlpy
```

when done, it should look like:



```
Command Prompt
225kB 6.8MB/s
Requirement already satisfied: Jinja2>=2.7 in e:\users\mae seto\appdata\local\programs\python\python38\lib\site-packages
(from bokeh>=1.4.0->arlpy) (2.11.2)
Collecting pillow>=4.0 (from bokeh>=1.4.0->arlpy)
  Downloading https://files.pythonhosted.org/packages/91/d2/30ecd905746d1fee4004daae3f051bf4b305bee1fe578bd7d1ea712d571/Pillow-7.2.0-cp38-cp38-win_amd64.whl (2.1MB)
  2.1MB 1.7MB/s
Requirement already satisfied: packaging>=16.8 in e:\users\mae seto\appdata\local\programs\python\python38\lib\site-packages
(from bokeh>=1.4.0->arlpy) (20.4)
Requirement already satisfied: tornado>=5.1 in e:\users\mae seto\appdata\local\programs\python\python38\lib\site-packages
(from bokeh>=1.4.0->arlpy) (6.0.4)
Collecting typing_extensions>=3.7.4 (from bokeh>=1.4.0->arlpy)
  Downloading https://files.pythonhosted.org/packages/0c/0e/3f026d0645d699e7320b59952146d56ad7c374e9cd72cd16e7c74e657a0f/typing_extensions-3.7.4.2-py3-none-any.whl
Requirement already satisfied: six>=1.5 in e:\users\mae seto\appdata\local\programs\python\python38\lib\site-packages (f
rom python-dateutil>=2.6.1->pandas>=1.0.1->arlpy) (1.15.0)
Requirement already satisfied: MarkupSafe>=0.23 in e:\users\mae seto\appdata\local\programs\python\python38\lib\site-pac
kages (from Jinja2>=2.7->bokeh>=1.4.0->arlpy) (1.1.1)
Requirement already satisfied: pyparsing>=2.0.2 in e:\users\mae seto\appdata\local\programs\python\python38\lib\site-pac
kages (from packaging>=16.8->bokeh>=1.4.0->arlpy) (2.4.7)
Installing collected packages: numpy, scipy, utm, pytz, pandas, PyYAML, pillow, typing-extensions, bokeh, arlpy
  Running setup.py install for utm ... done
  Running setup.py install for bokeh ... done
  Running setup.py install for arlpy ... done
Successfully installed PyYAML-5.3.1 arlpy-1.7.0 bokeh-2.1.1 numpy-1.19.0 pandas-1.0.5 pillow-7.2.0 pytz-2020.1 scipy-1.5
.0 typing-extensions-3.7.4.2 utm-0.5.0
WARNING: You are using pip version 19.2.3, however version 20.1.1 is available.
You should consider upgrading via the 'python -m pip install --upgrade pip' command.
E:\Users\Mae Seto>
```

Now enter 'python' in the command prompt and then, 'import arlpy'



```
Command Prompt - python
Microsoft Windows [Version 10.0.19041.329]
(c) 2020 Microsoft Corporation. All rights reserved.
E:\Users\Mae Seto>python
Python 3.8.3 (tags/v3.8.3:6f8c832, May 13 2020, 22:37:02) [MSC v.1924 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> import arlpy
>>> _
```

when you see '>>>' it is correctly done.

The arlpy package has been installed.

5. Running Bellhop in a Jupyter Notebook

Download the bellhop jupyter notebook, bellhop.ipynb, from the class sharepoint to a convenient location on your local drive.

In a Command Prompt window, cd to the directory where you have stored this jupyter notebook. Then launch jupyter notebook as follows:

```
> jupyter notebook
```

It should appear as follows:

ECED 6575 – Underwater Acoustics Engineering
Bellhop Installation in Python and Jupyter Notebook in Windows 10

```
Command Prompt - jupyter notebook
Microsoft Windows [Version 10.0.19041.329]
(c) 2020 Microsoft Corporation. All rights reserved.

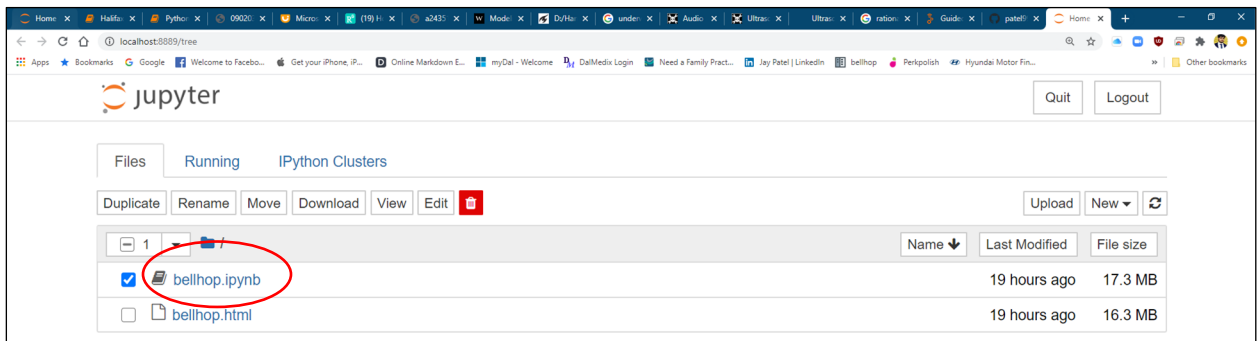
E:\Users\Mae Seto>l:

L:\>cd L:\ECED6575

L:\ECED6575>jupyter notebook
[I 18:16:06.084 NotebookApp] The port 8888 is already in use, trying another port.
[I 18:16:06.116 NotebookApp] Serving notebooks from local directory: L:\ECED6575
[I 18:16:06.116 NotebookApp] The Jupyter Notebook is running at:
[I 18:16:06.116 NotebookApp] http://localhost:8889/?token=4834fdf75388320892d60b7339cb96db65e52526686ffd7e
[I 18:16:06.116 NotebookApp] or http://127.0.0.1:8889/?token=4834fdf75388320892d60b7339cb96db65e52526686ffd7e
[I 18:16:06.116 NotebookApp] Use Control-C to stop this server and shut down all kernels (twice to skip confirmation).
[C 18:16:06.240 NotebookApp]

To access the notebook, open this file in a browser:
file:///E:/Users/Mae%20Seto/AppData/Roaming/jupyter/runtime/nbserver-8652-open.html
Or copy and paste one of these URLs:
http://localhost:8889/?token=4834fdf75388320892d60b7339cb96db65e52526686ffd7e
or http://127.0.0.1:8889/?token=4834fdf75388320892d60b7339cb96db65e52526686ffd7e
```

This will launch an interactive python notebook in your default browser. Click on the file name `bellhop.ipynb` and it will bring up the sample notebook which facilitates running the basic Bellhop.



The screenshot shows a Jupyter Notebook interface. At the top, it says 'jupyter bellhop Last Checkpoint: 19 hours ago (unsaved changes)'. The notebook content includes a title 'Underwater acoustic propagation modeling with arlpy and Bellhop', an introduction paragraph, a 'Prerequisites' section with two bullet points, a command prompt instruction, a code cell for installing arlpy, a 'Getting started' section, and two code cells for importing modules and listing models. The output of the second code cell is ['bellhop'].

Underwater acoustic propagation modeling with arlpy and Bellhop

The underwater acoustic propagation modeling toolbox (`uwapm`) in `arlpy` is integrated with the popular Bellhop ray tracer distributed as part of the [acoustics toolbox](#). In this notebook, we see how to use `arlpy.uwapm` to simplify the use of Bellhop for modeling.

Prerequisites

- Install [arlpy](#) (v1.5 or higher)
- Install the [acoustics toolbox](#) (6 July 2018 version or later)

You can install arlpy (in overall system) by typing this in your command prompt:

```
In [ ]: python3 -m pip install arlpy
```

Getting started

Start off with checking that everything is working correctly:

```
In [1]: import arlpy.uwapm as pm
import arlpy.plot as plt
import numpy as np
```

```
In [2]: pm.models()
Out[2]: ['bellhop']
```

The `bellhop` model should be listed in the list of models above, if everything is good. If it isn't listed, it means that `bellhop.exe` is not available on the

Everything works:

You should see the following output upon running `'pm.models()'`:

```
In [2]: pm.models()
Out[2]: ['bellhop']
```

The `bellhop` model should be listed in the list of models above, if everything is good. If it isn't listed, it means that `bellhop.exe` is not available on the PATH, or it cannot be correctly executed. Ensure that `bellhop.exe` from the acoustics toolbox installation is on your PATH (updated `.profile` or equivalent, if necessary, to add it in).

From here on we assume that the `bellhop` model is available, and proceed...

Trouble-shooting

If you run `'pm.models()'` and it returns `[]` (empty array), it means your bellhop is not in either the system or user path. Please check this.

The `'bellhop'` model should be listed in the list of models above when everything works. If it is not listed, it means that `'bellhop.exe'` is not available on the PATH, or it cannot be correctly executed. Ensure that `'bellhop.exe'` from the acoustics toolbox installation is on your PATH.

From here on we assume that the `'bellhop'` model is available, and proceed...

We will go over running Bellhop in class. Please try to install as much as you can.

APPENDIX A: Script to run Bellhop in python

put the following into a .py file to run it:

```
import os
import sys
import arlpy.uwapm as pm
import arlpy.plot as plt
import numpy as np

pm.models()

env = pm.create_env2d()
pm.print_env(env)

pm.plot_env(env, width=900)
```