



MODEM: Multi-Modal Digital Elevation Model Registration

QUICK START GUIDE

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Overview

- ▶ MODEM is an application for co-registering spatial data
 - ▶ Point clouds (LAS, LAZ, and BPF)
 - ▶ Digital Surface Models (GeoTIFF)
 - ▶ Meshes (PLY and OBJ)
- ▶ Two spatial data files are required:
 - ▶ **AOI** (Area of Interest): the data being registered
 - ▶ **Foundation**: the fixed data to which the AOI is being registered
- ▶ MODEM is run by executing commands in a terminal
 - ▶ Windows: Tested in the Windows 10 Command Prompt terminal
 - ▶ Linux: Tested in Ubuntu 20.04 and CentOS 7 terminals

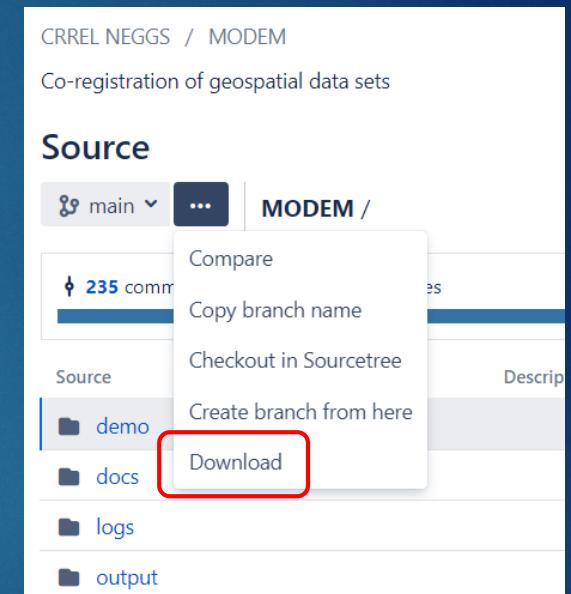
Installation Requirements

1. Conda

- ▶ MODEM is best installed inside a Conda environment
- ▶ Download and install Miniconda:
<https://docs.conda.io/en/latest/miniconda.html>
 - ▶ Recommended to check the box for “Add Anaconda to my PATH environment variable”

2. Project Files

- ▶ Assumption is that you have the project files
- ▶ If not, they can be downloaded from DI2E Bitbucket:
 - ▶ Go to <https://bitbucket.di2e.net/projects/CRRELNEGGS/repos/modem/browse>
 - ▶ Click the ellipsis (...) next to the branch dropdown and select Download
 - ▶ Unzip the files when the download is complete



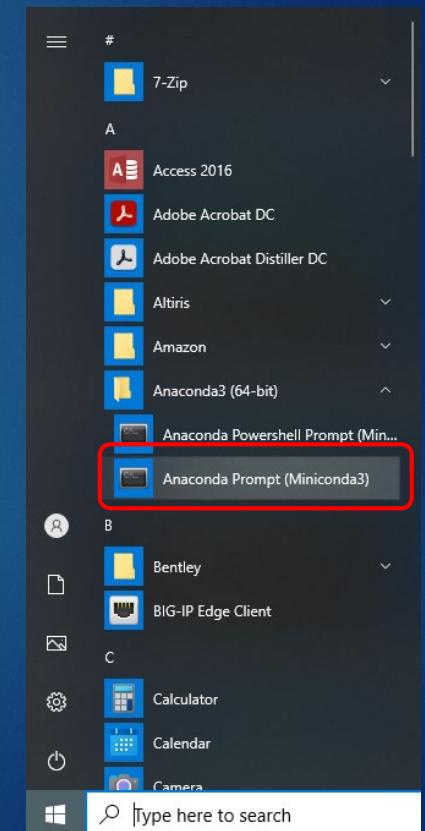
Installing MODEM

1. Open a terminal and navigate to the project root directory:

```
C:\>cd dev\modem  
C:\dev\modem>
```

2. Create a Conda environment containing the necessary dependencies:

```
C:\dev\modem>conda env create --file environment.yml  
Collecting package metadata (repodata.json): done  
Solving environment: done  
  
Downloading and Extracting Packages  
fsspec-2021.6.1      | 79 KB      | #####| 100%  
pillow-8.3.0          | 776 KB     | #####| 100%  
pkgconfig-1.5.4       | 13 KB      | #####| 100%  
libbrotlicommon-1.0. | 66 KB      | #####| 100%  
  
...  
  
C:\dev\modem>
```



- ▶ On Windows, if “conda is not recognized...”, switch to the Anaconda Prompt terminal

Installing MODEM

3. Activate the new Conda environment:

```
C:\dev\modem>conda activate modem  
(modem) C:\dev\modem>
```

4. Install MODEM into the Conda environment:

```
(modem) C:\dev\modem>pip install .  
Processing c:\dev\modem  
  DEPRECATION: A future pip version will change local packages to be built in-place without first copying  
  to a temporary directory. We recommend you use --use-feature=in-tree-build to test your packages with this  
  new behavior before it becomes the default.  
    pip 21.3 will remove support for this functionality. You can find discussion regarding this at  
    https://github.com/pypa/pip/issues/7555.  
Building wheels for collected packages: modem  
  Building wheel for modem (setup.py) ... done  
  Created wheel for modem: filename=modem-0.2-py3-none-any.whl size=27311  
  sha256=7d29cbb242f057b24fcfe2f430fab8418e9114fbb1acbe917e463a758fc40cf  
  Stored in directory: C:\Users\prest\AppData\Local\Temp\pip-ephem-wheel-cache-  
  1flumxza\wheels\ed\ef\11\648abe6e5c1bb6a13ab83bcb06407be208e80c40ea43543168  
Successfully built modem  
Installing collected packages: modem  
Successfully installed modem-0.2  
(modem) C:\dev\modem>
```

Installing MODEM

5. Test that MODEM was installed successfully

```
(modem) C:\dev\modem>modem --help
usage: modem [-h] [--min_resolution MIN_RESOLUTION] [--dsm_akaze_threshold DSM_AKAZE_THRESHOLD]
              [--dsm_lowes_ratio DSM_LOWES_RATIO] [--dsm_ransac_max_iter DSM_RANSAC_MAX_ITER]
              [--dsm_ransac_threshold DSM_RANSAC_THRESHOLD] [--dsm_solve_scale DSM_SOLVE_SCALE]
              [--dsm_strong_filter DSM_STRONG_FILTER] [--dsm_weak_filter DSM_WEAK_FILTER]
              [--icp_angle_threshold ICP_ANGLE_THRESHOLD] [--icp_distance_threshold ICP_DISTANCE_THRESHOLD]
              [--icp_max_iter ICP_MAX_ITER] [--icp_rmse_threshold ICP_RMSE_THRESHOLD] [--icp_robust ICP_ROBUST]
              [--icp_solve_scale ICP_SOLVE_SCALE] [--verbose VERBOSE]
              foundation_file aoi_file

MODEM: Multi-Modal Digital Elevation Model Registration

positional arguments:
  foundation_file      path to the the foundation file
  aoi_file             path to the area of interest file

optional arguments:
  -h, --help            show this help message and exit
  --min_resolution MIN_RESOLUTION, -min MIN_RESOLUTION
                        minimum pipeline data resolution

...
(modem) C:\dev\modem>
```

Installing MODEM

6. Test that MODEM runs correctly

```
(modem) C:\dev\modem>modem demo\Foundation-PointCloud.laz demo\AOI-Mesh.ply
    MODEM
    AUTHORS: Preston Hartzell &
              Jesse Shanahan
    DEVELOPED FOR: CRREL/NEGGS

    =====PARAMETERS=====
12:49:35 - INFO - FND_FILE = demo\Foundation-PointCloud.laz
12:49:35 - INFO - AOI_FILE = demo\AOI-Mesh.ply
12:49:35 - INFO - MIN_RESOLUTION = 1.0
...
12:50:19 - INFO - Saving ICP registration parameters to: C:\dev\modem\demo\registration_2021-08-05_12-49-35\registration.txt
    =====APPLYING REGISTRATION=====
12:50:20 - INFO - Registration has been applied to AOI-MESH and saved to: C:\dev\modem\demo\registration_2021-08-05_12-49-35\AOI-Mesh_registered.ply

    MODEM                               Stage: Performing Fine Registration      00:51
    Registration Process 100%|██████████| 100/100 [00:58<00:00, 1.71/s]
(modem) C:\dev\modem>
```

Running MODEM

1. Choose a Foundation data file and an AOI data file
 - ▶ Accepted formats = LAS, LAZ, BPF, GeoTIFF, PLY, OBJ
2. Enter the file paths to the chosen Foundation and AOI files following the **modem** command
 - ▶ The Foundation and AOI file paths are required positional arguments
 - ▶ The order is important: the Foundation file path must come before the AOI file path
 - ▶ Generic example:

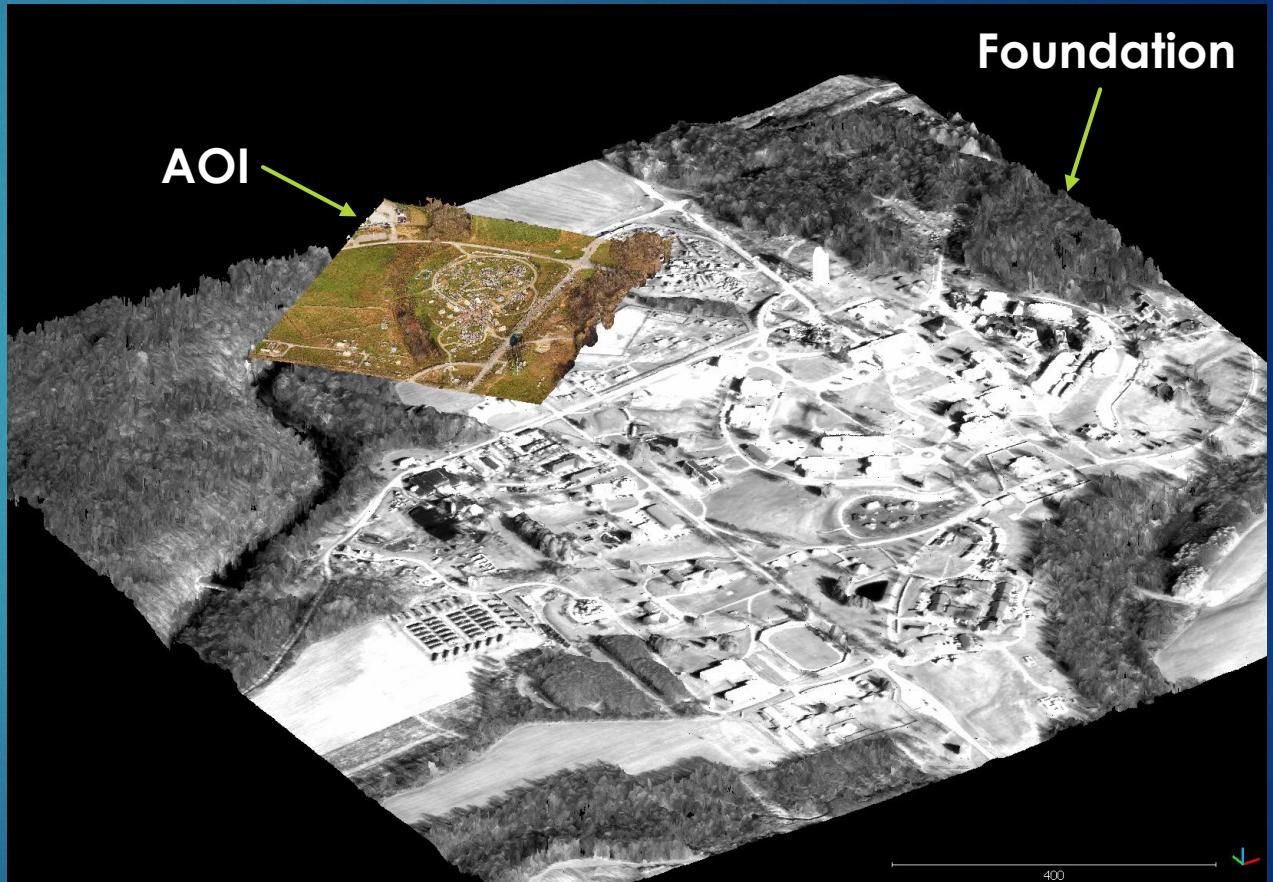
```
(modem) C:\dev\modem>modem my.foundation.laz my.aoi.dsm.tif
```
3. MODEM creates a registered copy of the AOI data file that can be examined
 - ▶ Saved inside a new directory created in the location of the original AOI data file
 - ▶ The new directory name is “registration_YYYY-MM-DD_HH-MM-SS”, where YYYY is the year and so on.
 - ▶ The phrase “_registered” is appended to the original AOI file name.

MODEM Registration Example

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Un-Registered Data

- ▶ Foundation
 - ▶ Grayscale Point Cloud
 - ▶ demo\Foundation-PointCloud.laz
- ▶ AOI
 - ▶ Color Mesh
 - ▶ demo\AOI-Mesh.ply



MODEM Registration Example

Terminal Command

```
(modem) C:\dev\modem>modem demo\Foundation-PointCloud.laz demo\AOI-Mesh.ply
    MODEM
    AUTHORS: Preston Hartzell &
              Jesse Shanahan
    DEVELOPED FOR: CRREL/NEGGS

=====PARAMETERS=====
12:49:35 - INFO - FND_FILE = demo\Foundation-PointCloud.laz
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Mesh_registered.ply

MODEM                               Stage: Performing Fine Registration      00:51
Registration Process 100%|██████████| 100/100 [00:58<00:00, 1.71/s]
(modem) C:\dev\modem>
```

MODEM Registration Example

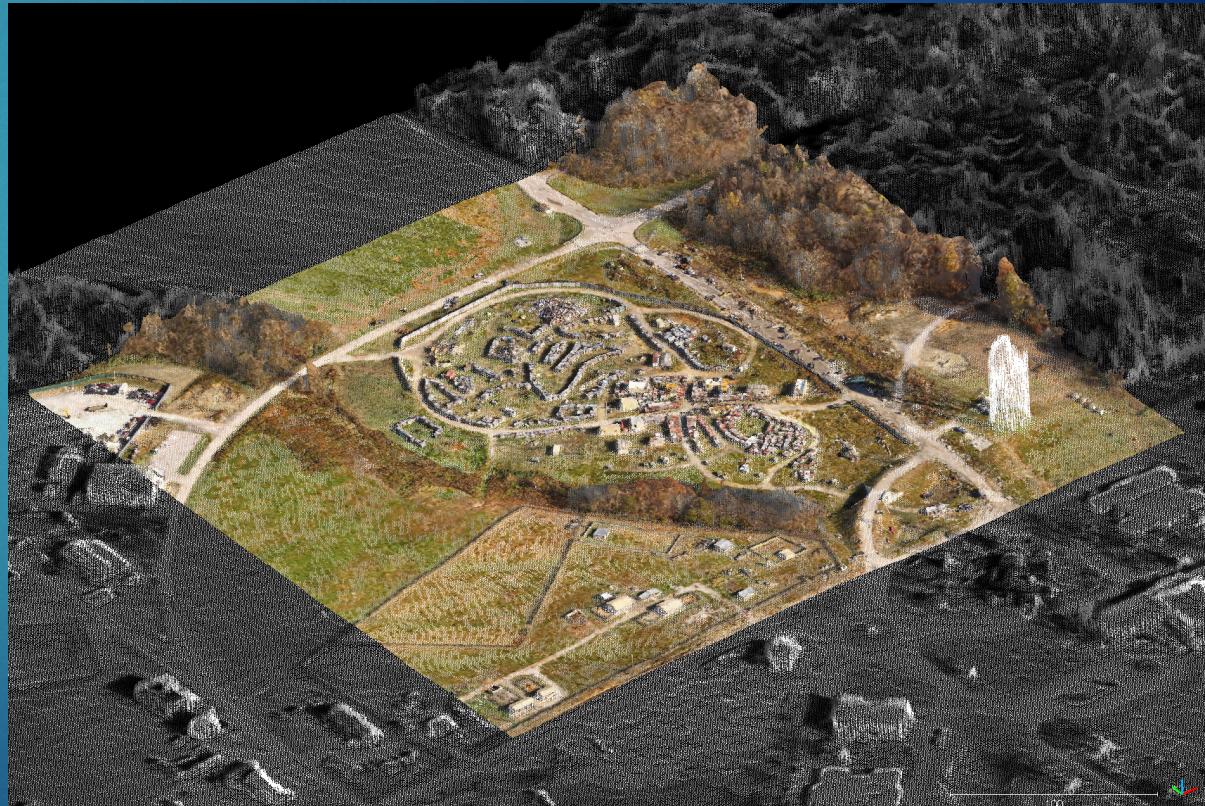
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Registration Results

- ▶ Registered File: C:\dev\modem\demo\registration_2021-08-05_12-49-35\AOI-Mesh_registered.ply
- ▶ Registration Transformation:

```
Transformation matrix:  
[[ 5.335051e-01 -8.387771e-01  4.641608e-02  3.919387e+06]  
 [ 8.384467e-01  5.350734e-01  3.213842e-02  1.484588e+06]  
 [-5.204526e-02  2.187744e-02  9.935502e-01 -6.202288e+04]  
 [ 0.000000e+00  0.000000e+00  0.000000e+00  1.000000e+00]]
```

```
Transformation Parameters:  
Omega = 1.261 degrees  
Phi = 2.998 degrees  
Kappa = 57.531 degrees  
X Translation = 3919387.343  
Y Translation = 1484588.665  
Z Translation = -62022.881  
Scale = 0.995153
```



Options & Information Resources

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- ▶ Options
 - ▶ There are a number of parameters that can be optionally tuned.
 - ▶ Run `modem --help` to list available options and brief descriptions
 - ▶ The default option values should be sufficient for most landscapes
 - ▶ Options are changed by entering the option name and value on the command line
 - ▶ Example: `modem demo\Foundation-PointCloud.laz demo\AOI-mesh.ply --min_resolution 2.0`
- ▶ Additional Information
 - ▶ Option explanations and default values: `docs\configuration.md`
 - ▶ Algorithm and operation details: `docs\details.md`