**AutoTerm Pipeline**

**Step 1 Install the deep learning method.**

* Follow the instructions on <https://github.com/enzezhang/FrontDL3>

**Step 2 Obtain data from Google Earth Engine**

* Prepare the glacier list. The format of the glacier list is as follows:
  + Glacier name/ID xmin xmax ymin ymax

**Note**: use GEE interface to preview and see if the ROI is set appropriately.

* Run “AutoTerm/GEE/python batch\_download\_direct.py”
  + This code will collect Landsat-5, Landsat-7, Landsat-8, Sentinel-1, and Sentinel-2. Change the period of collection if needed.
  + This code will read the glacier list and download the images to the local computer. The list name should be “Glacier\_ID\_list\_download\_1.txt”. Please change if necessary.
  + **Note**: this code will fail if the individual image file is larger than 35MB, which could be possible if the glacier size is too large, like GID85. In this case, use “​​batch\_download.py”. This code will download images from GEE to your Google drive. And you will need to download them from Google Drive to your local computer.
* The code will create folders based on the name format ${Glacier name}\_${satellite name}
* For Sentinel-1, it will create two folders: Sentinel-1\_D and Sentinel-1\_A. D means descending, and A means ascending. I separate these two because the georeferencing is different between D and A.
* Create a folder for each glacier (e.g., GID1), and mv all the satellite folder (e.g., GID1\_Landsat-8) to the glacier folder (GID1).
* Choose a folder on the server as your data directory. Upload all the data into the data directory.

**Step 3 Preprocess images**

* Please read the folder instruction as reference.
* Change the data directory for code: batch\_read\_box\_process.sh; batch\_process.sh, batch\_upsample.sh, batch\_generate\_para\_upsample.sh , batch\_generate\_truncating\_polygon.sh,  and build\_folder\_structure.sh
* Whenever run these following scripts, please check the list file quoted in the scripts is correct.
* Run “bash build\_folder\_structure.sh”
* Copy get\_roi.py get\_imagesize.py, remove\_partial\_images.py into the data directory
* Add script path in to ~/.bashrc:
  + In folder Front\_DL3 from the step1, create a folder called data\_processing
  + vim ~/.bashrc
  + add: export PATH=$HOME/Front\_DL3/data\_processing:$PATH; quit vim; run “source ~/.bashrc”. This assumes that the AutoTerm folder is in the home directory. By doing so, we can run the code batch\_process.sh  batch\_stretch.sh without specifying their full path. Run “which batch\_stretch.sh” to test if it is successfully added.
* In the data directory, create a Glacier\_ID\_list\_temp.txt file, which contains the list of glacier names/IDs.
* Upload the glacier list in Step2 to the data directory and name it as ID\_ROI.txt. Add the full path of ID\_ROI.txt in code get\_roi.py
* Run “bash batch\_read\_box\_process.sh”
* There is a list file in batch\_upsample.sh for looping the glaciers based on name/ID, be sure to use the right list file in batch\_upsample.sh; Run “bash batch\_upsample.sh”
* Run “bash batch\_generate\_para\_upsample.sh”
* Run “bash batch\_generate\_truncating\_polygon.sh”
  + This step is to shrink the ROI defined in the Step 2 to get a truncating polygon. But sometimes, such a shrunk truncating polygon is inappropriate. Might need to create a truncate polygon manually.
* Check the truncate polygon to see if we need to create one manually. If needed, name the polygon as ${Glacier name}\_cutting\_polygon.shp
* Run “ogr2ogr ​​${Glacier name}\_cutting\_polygon.gmt ${Glacier name}\_cutting\_polygon.shp”; only keep the coordinates.

**Step 4 Terminus inference, postprocessing and screening**

The core code for this step is batch\_inference\_plot\_mv\_figure\_dir.sh. This code includes major steps of the AutoTerm pipeline including terminus delineation, postprocessing, and various screening steps.

* Go to folder Front\_DL3, change para.ini
  + Working\_root is the full path of Front\_DL3
  + Data\_path is the data directory mentioned in Step2 and Step3.
  + Codes\_idr is in Front\_DL3/script, the script folder is created in Step1.
* Need to add following scripts into the data\_processing folder
  + batch\_stretch.sh
  + batch\_process\_Landsat-8\_images.sh
  + batch\_process\_Sentinel-1\_images.sh
  + batch\_process\_Sentinel-2\_images.sh
  + Batch\_process.sh
  + Batch\_process\_historical.sh
  + Remove\_duplicate.sh
  + Remove\_duplicate\_historical.sh
  + Split\_data\_by\_name.sh
  + Result\_plot.sh
  + Merge\_two\_calving2.sh
  + Calculate\_area2.sh
  + calculate\_area.sh
  + accumulate\_area\_length.sh
  + plot\_time\_series.sh
* Move all the code called in batch\_inference\_plot\_mv\_figure\_dir.sh to the folder Front\_DL3. Also for batch\_inference\_plot\_mv\_figure\_dir.sh
* Check if the Python codes’ paths are correct when calling them in ALL the Bash code. For instance, batch\_truncate\_termini.sh calls truncate\_termini.py. Change the path of the truncate\_termini.py to make it correct.
* Batch\_inference\_plot\_mv\_figure\_dir.sh will read a glacier list file called: “Glacier\_ID\_list\_temp.txt”. This list file should include the list of the glacier name/ID that the users want to generate termini for.
* Glacier\_ID\_list\_temp.txt should look like:

GID1

GID2

GID3

* Run “bash batch\_inference\_plot\_mv\_figure\_dir.sh drn54\_May5\_2022\_0.001\_batch16\_keep\_augmentation.tar ”
* drn54\_May5\_2022\_0.001\_batch16\_keep\_augmentation.tar is the file that contains all the parameters of the network.
* The termini will be generated and stored in the folder $HOME/Data\_directory/GID/truncate\_termini/$network\_name

**Folder instruction:**

Here I use GID to illustrate, but the folder name can be glacier names.

$HOME/Data\_directory

—figure\_check\_truncate

—GID1

—GID1\_Landsat-5

—GID1\_Landsat-7

—GID1\_Landsat-8

—GID1\_Sentinel-1\_A

—GID1\_Sentinel-1\_D

—GID1\_Sentinel-2

—truncate\_termini

— $network\_name(contains the termini from all sensors)

—${network\_name}\_time\_series (contains the time series of terminus variation)

—polygon (contains the truncate polygon)

—para.ini (file that contains glacier ID, ROI, image size)

—para\_upsample.ini (upsampled version of para.ini)

—GID2

—GID3

—GID4

figure\_check\_truncate contains the figures that pair generated termini and their source images. Users should go to this folder to check the data quality)