A work-flow for using ICP on paired LiDAR Point Clouds

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A. Some useful session commands

ICP can take a long time to run. Session commands allow you to log in and out of the experiment session, as well as quickly re-type each command when a new experiment is started.

`screen`	creates a session
`[control] A D`	detaches from session, allowing you to close window
`screen –ls`	lists all active (attached + detached) sessions
`screen –r [name of session]`	attaches back into session

B. Running ICP

Create a directory containing your LiDAR data and run ICP from here. The three programs we use (texttopcd, registration, get_displacements) should be up one level of directory.

1. Pre- and post-event LAS files should first be converted into text files (e.g. using las2txt). In the text files, we only require the x, y and z values, separated by spaces. If the first line of the text file is a header, this should also be removed.

```
awk 'NR>1 {gsub(/,/," "); print $1, $2, $3}' pre-txt-file > pre-xyz-file

awk 'NR>1 {gsub(/,/," "); print $1, $2, $3}' post-txt-file > post-xyz-file
```

2. Use **texttopcd** to change xyz files to pcd (PCL-compatible) files by adding a header. It also removes an offset (x and y value) to reduce coordinates from 6-7 figures to 3-4 figures. Values for `x-offset` and `y-offset` should be round numbers near the center of the dataset and they should be the same for the pre and post dataset. Write them down!

`../texttopcd -h` (brings up usage for texttopcd program)

```
../texttopcd –i pre-xyz-file –s " " –o pre-pcd-file –x x-offset –y y-offset

../texttopcd –i post-xyz-file –s " " –o pre-post-file –x x-offset –y y-offset
```

3. Use **registration** to do the actual ICP analysis.

`mkdir x` (makes a directory called x)

`../registration -h` (brings up usage)

```
../registration -i pre-pcd-file -i post-pcd-file -t 5 -e 0.0001 --wx 100
--wy 100 --dx 10 --dy 10 | tee log-file
```

The options in this last step are as follows:

`-t`	distance threshold (in meters) for the closest point pairings. If the distance between a source point and its closest target point is greater than this value, the pair will be discarded until the next iteration. 5 m is a good value to start with.
`-e`	termination threshold for ICP. If the sum of the components of the 4 x 4 transformation matrix change by less than this value between one iteration and the next, ICP is regarded as having converged and the iterations stop. We suggest using 0.0001.
`--wx` and `--wy`	window dimensions of the pre-event data in the x and y directions, in meters. Here we use 100 m x 100 m.
`--dx` and `--dy`	the “fringe” of additional search space given to the post-event window in both the positive and negative x and y directions, also in meters. Here we use a 10 m fringe, so each post-event windows is 120 x 120 m in size

4. Use **get_displacements** to turn the log file into a final displacement file, and then use awk to geocode this file by adding back in the `x-offset` and `y-offset` values from stage 2. The columns for the final file are x, y, alpha, beta, gamma, E-displacement, N-displacement, Z-displacement. (I use the suffix .xyabcenz).

`../get_displacements -h` (brings up usage)

```
../get_displacements -i log-file -o displacement-file -b x/window- -x 0 -y 0
```

```
awk ‘{printf “%6.2f %7.2f %1.5f %1.5f  %1.5f  %1.5f  %1.5f %1.5f\n”, ($1+x-offset), ($2+y-offset), $3, $4, $5, $6, $7, $8}’ displacement-file > geo-displacement-file
```

```
mv x x-experiment-name
```

Remember to make a new directory called x for your next ICP experiment.

C. Adding synthetic earthquake displacements to a point cloud

Imagine a synthetic fault striking exactly NW–SE through your xyz point cloud. Find a point on the fault, and add its x and y UTM coordinates together to produce a value we'll call "*sum*". Let's move points NE of the fault 2 m to the SE, and raise them by 1 m.

```
awk '($1+$2)>=sum {printf "%6.2f %7.2f % %4.2f\n", ($1+1.41), ($2-1.41), ($3+1)}' xyz-file > xyz-NE-file
```

Now let's move points SE of the fault 2 m to the NW. (2 = sqrt((1.41)^2 + (-1.41)^2)

```
awk '($1+$2)<=sum {printf "%6.2f %7.2f % %4.2f\n", ($1-1.41), ($2+1.41), $3}' xyz-file > xyz-SW-file
```

Add together the two files for the final deformed dataset.

```
cat xyz-NE-file xyz-SE-file > xyz-deformed-file
```


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