Tämä skripti sisältää kandidaatintyöhön sisältyvän testauksen. Siinä on useita osioita, ja ne ovat siinä järjestyksessä, miten testit ovat edenneet.

Init

```
% Poista kaikki entiset muuttujat, ikkunat ja komentohistoria
clc
clear all
close all

% Lisää alihakemistot
mainfolder = getPath;
addpath(genpath(strcat(mainfolder,'\Algorithms')));
addpath(genpath(strcat(mainfolder,'\Tools')));
addpath(genpath(strcat(mainfolder,'\ignore')));
addpath(genpath(strcat(mainfolder,'\data')));
```

Tallenna data

```
choose = "saved"
```

```
choose =
"saved"
```

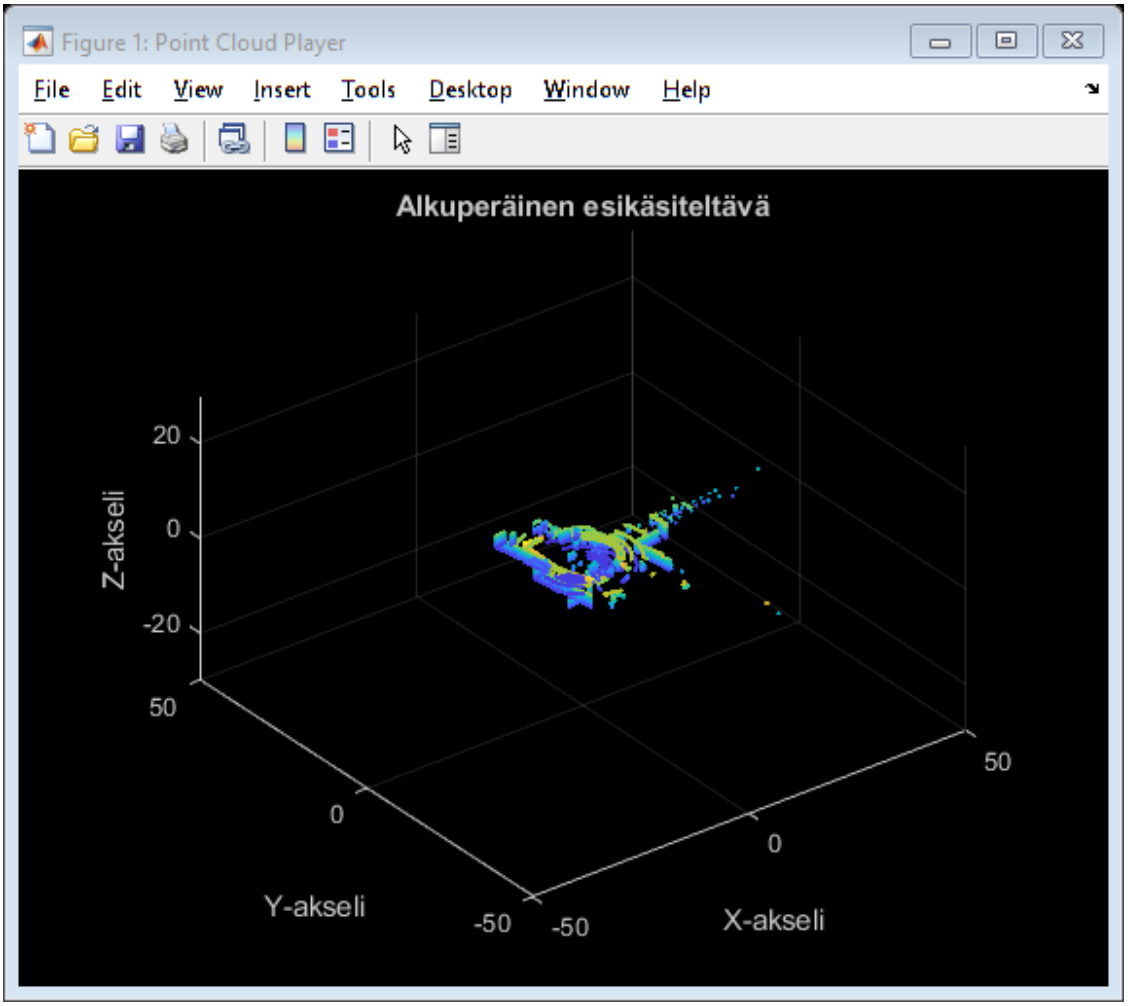
```
if choose == "sensor"
    % tallenna anturista
    time = 60;
    topic = "velodyne_points";
    IP_address = "127.0.0.1";
    pcSet = saveRosData(time, topic, IP_address);

elseif choose == "saved"
    % Vaihtoehtoisesti käytetään tallennettua dataa.
    % Tallenna datapaketti osoitteesta:
```

https://tuni-my.sharepoint.com/:f:/g/personal/markus_hautala_tuni_fi/EqMrzbfX0W1BkObC2WGypbwBZJshim-_KwTy8prTLD4_nw?e=M3OFuB

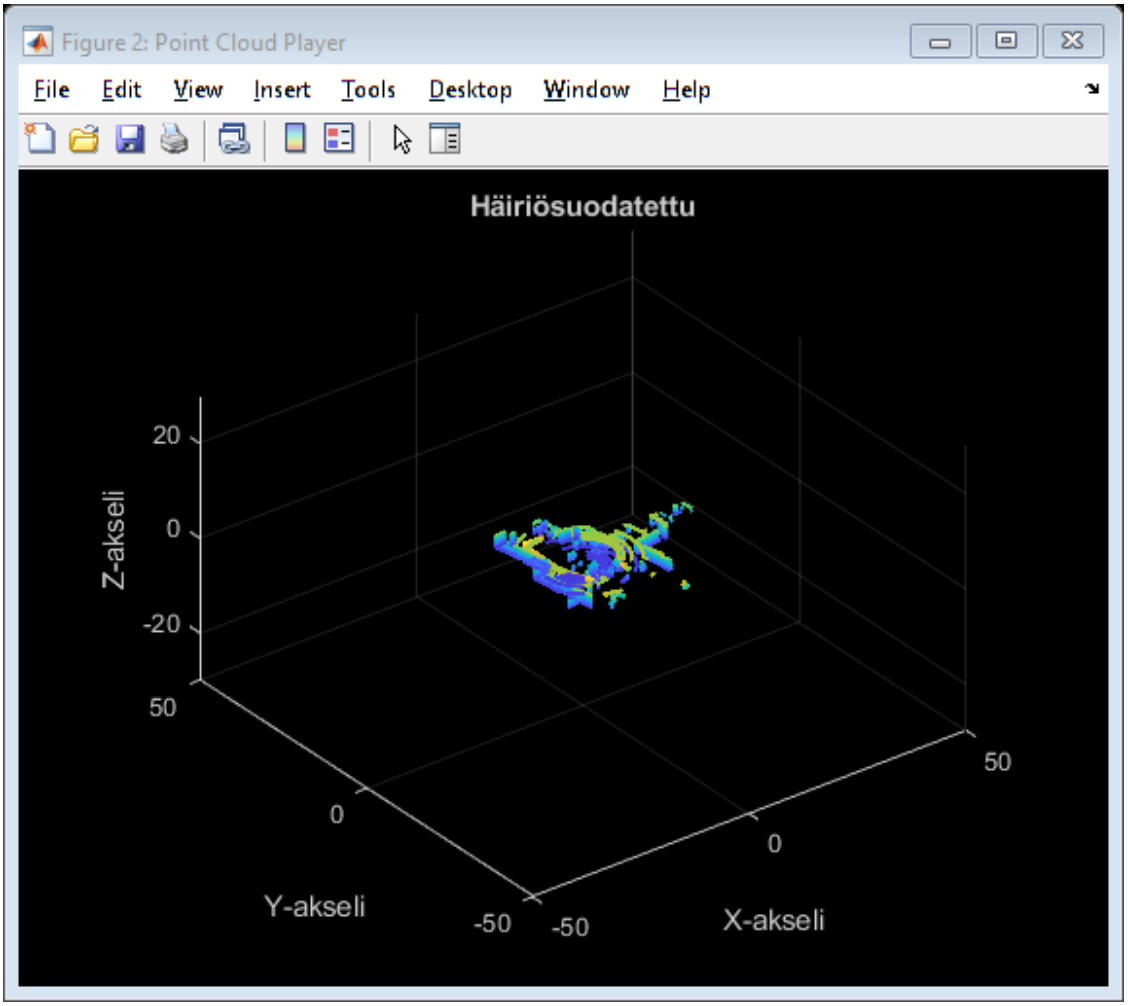
```
    %load("savedData.mat")
    load("savedData_final.mat")

end
```

Esikäsittelytestaus yksittäiselle pistepilvelle

```
show1 = showPc('Alkuperäinen esikäsiteltävä', pc);
```




```
%% Häiriösuodatus
pc_denoised = pcdenoise(pc);
show2 = showPc('Häiriösuodatettu', pc_denoised);
```



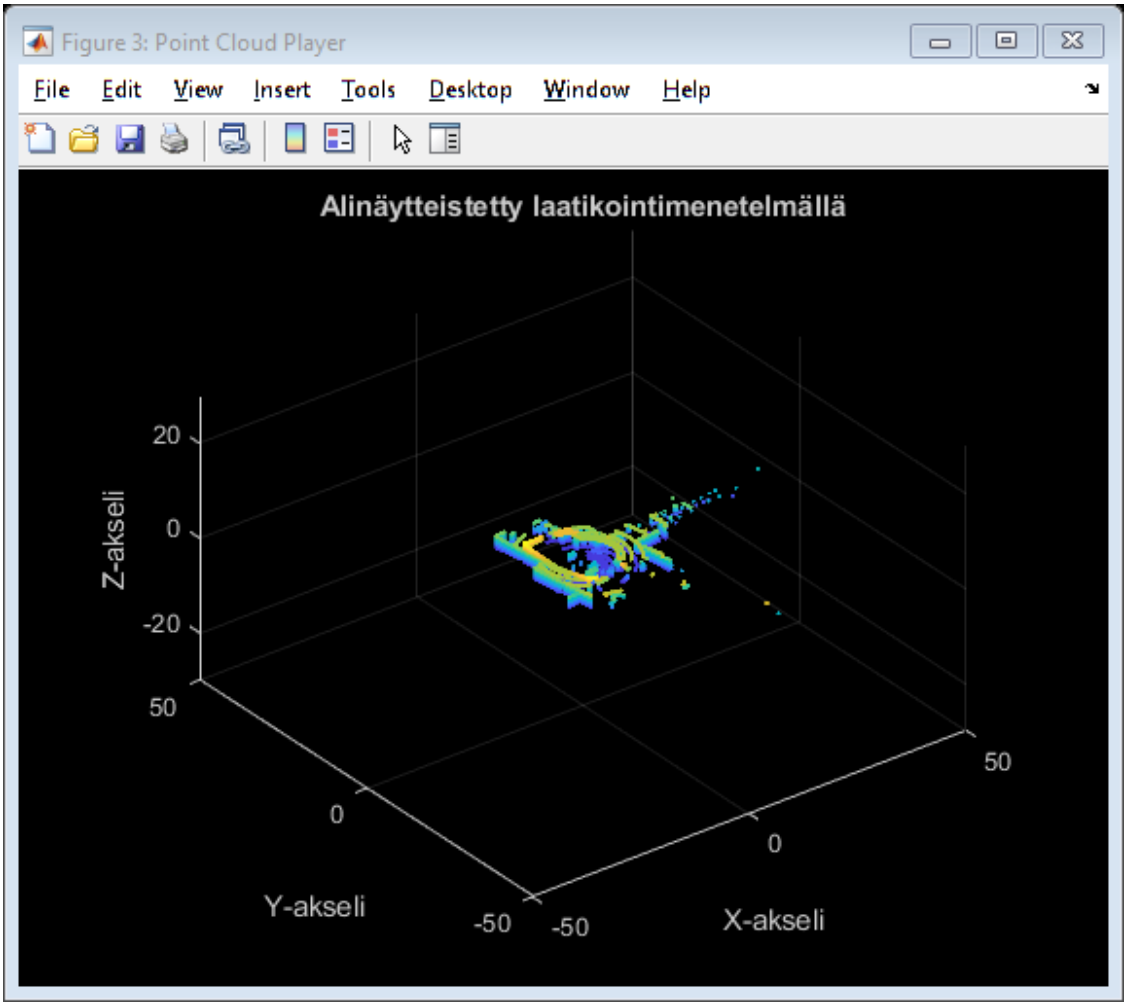

```
% Kuinka paljon pisteitä hävisi:
losed_points = size_of_pc(pc) - size_of_pc(pc_denoised)
```

```
losed_points = 35
```

```
%% Alinäytteistys
laatikon_koko = 0.1; % (m)
tic
pc_downsampled_grid = pcdownsample(pc, 'gridAverage', laatikon_koko);
time_of_grid = toc
```

```
time_of_grid = 0.0476
```

```
show3 = showPc('Alinäytteistetty laatikointimenetelmällä', pc_downsampled_grid);
```



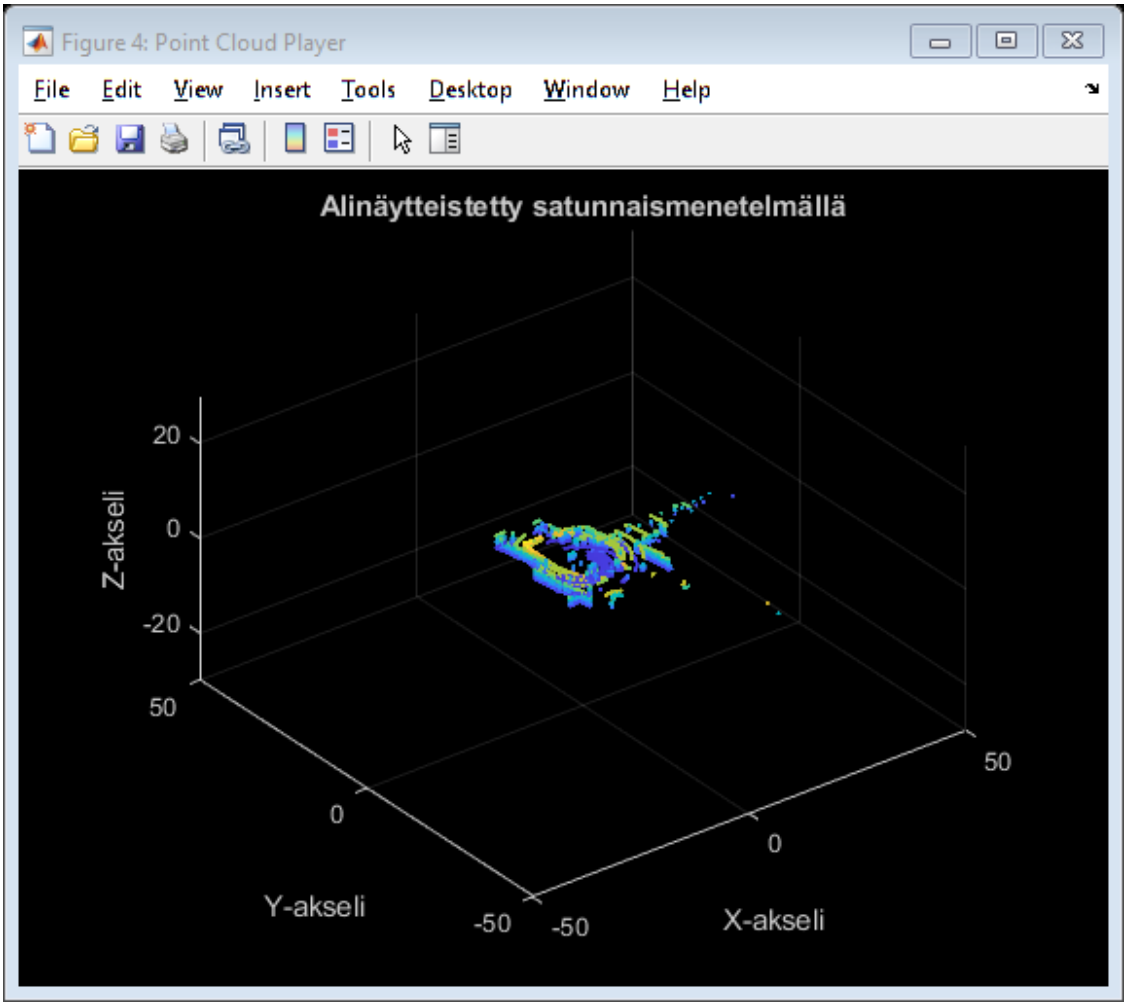

```
% Prosentuaalinen pistepilven koko verrattuna ennen alinäytteistystä:
pros_koko = size_of_pc(pc_downsampled_grid) / size_of_pc(pc)
```

```
pros_koko = 0.3844
```

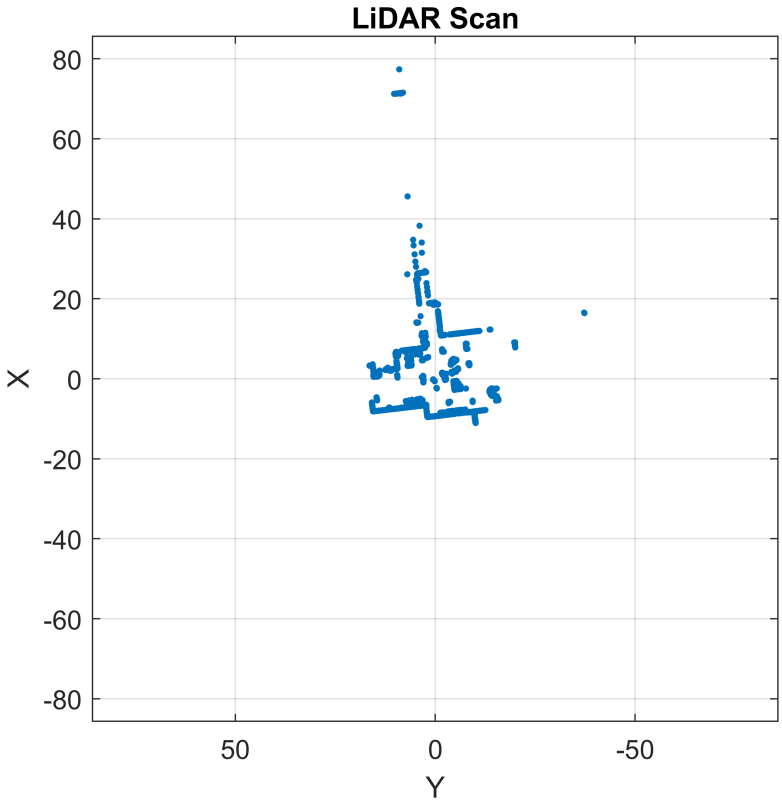
```
% Verrataan satunnaismenetelmään:
tic
pc_downsampled_rand = pcdownsample(pc, "random", pros_koko);
time_of_random = toc
```

```
time_of_random = 0.0499
```

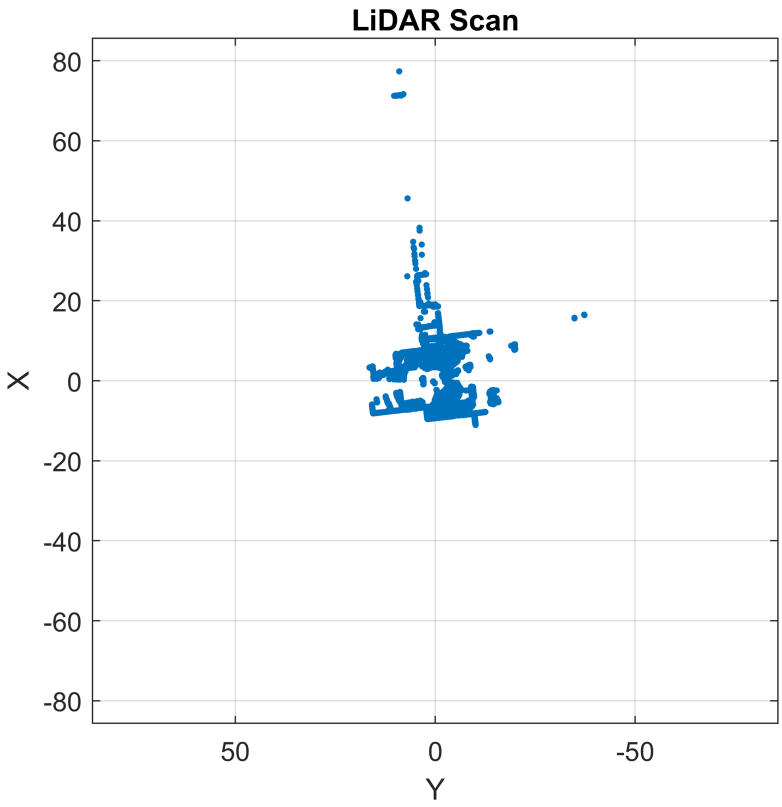
```
show4 = showPc('Alinäytteistetty satunnaismenetelmällä', pc_downsampled_rand);
```




```
% 3D to 2D
lidarScan_limited = pc2laser({pc}, -0.5, 1.5);
figure
plot(lidarScan_limited{1});
```




```
lidarScan_unlimited = pc2laser({pc}, -50, 50);
figure
plot(lidarScan_unlimited{1});
```



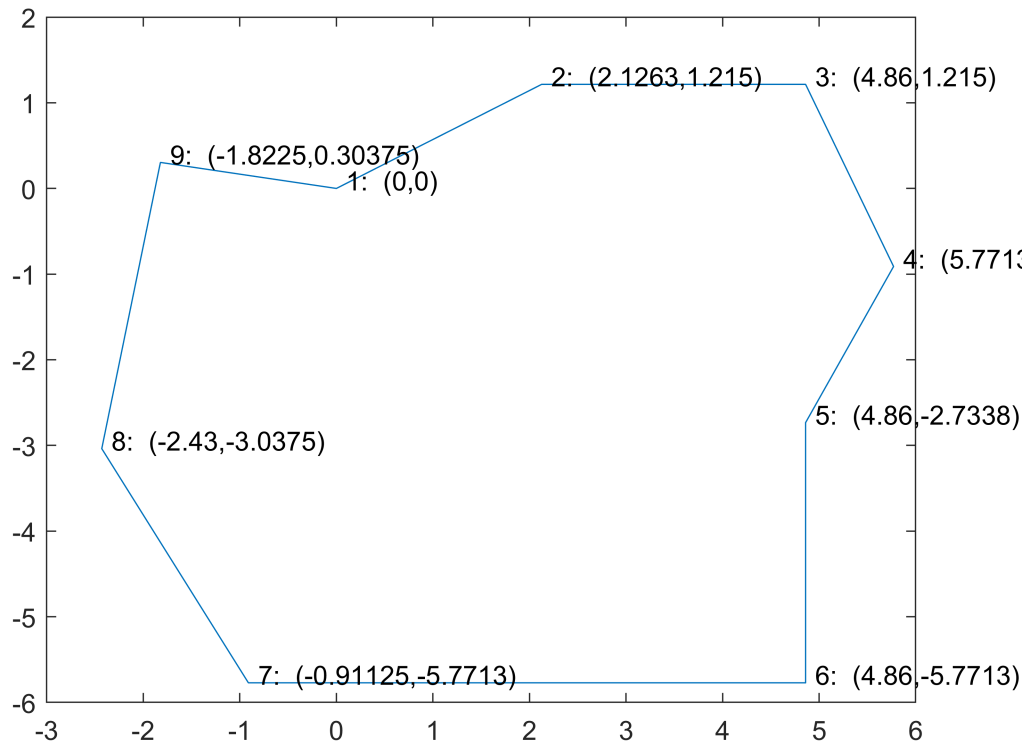
Esikäsittely SLAM algoritmeille

```
eachFrame = 2;
preprocessedpcSet = preprocess(pcSet, eachFrame);
lidarSet = pc2laser(preprocessedpcSet, -0.5, 1.5);
size_of_psSet(preprocessedpcSet)
```

```
ans = 323
```

Reaalikartta

```
figure
x = groundTruth(:,1);
y = groundTruth(:,2);
plot(x, y)
for t = 1:9
  text(x(t)+0.1,y(t)+0.1,[num2str(t), ':  (', num2str(x(t)), ',', num2str(y(t)), ')'])
end
```

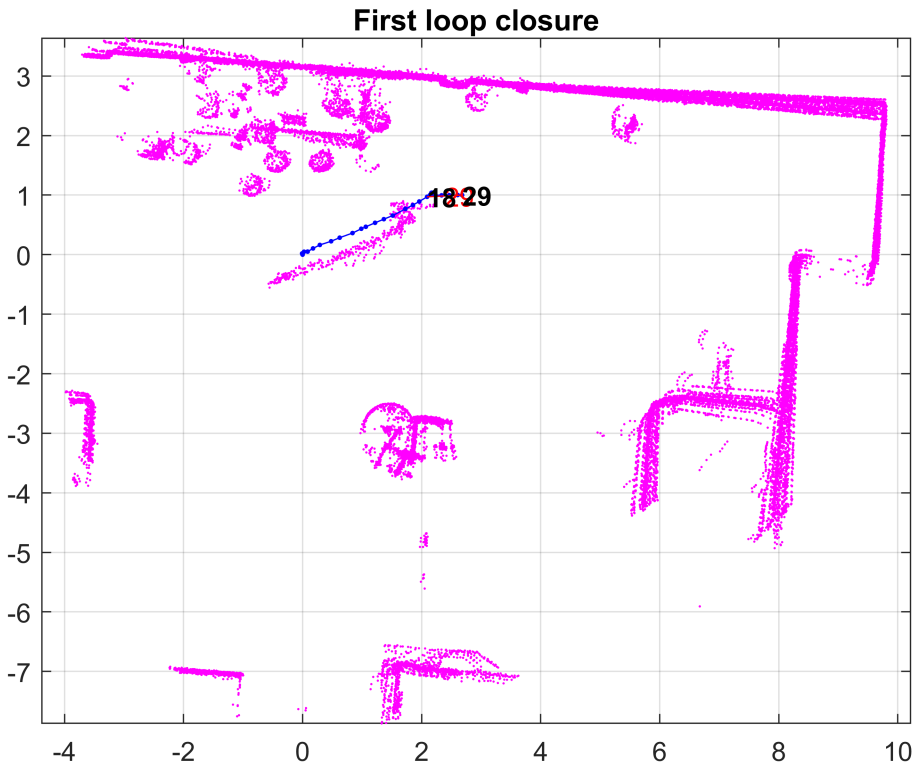


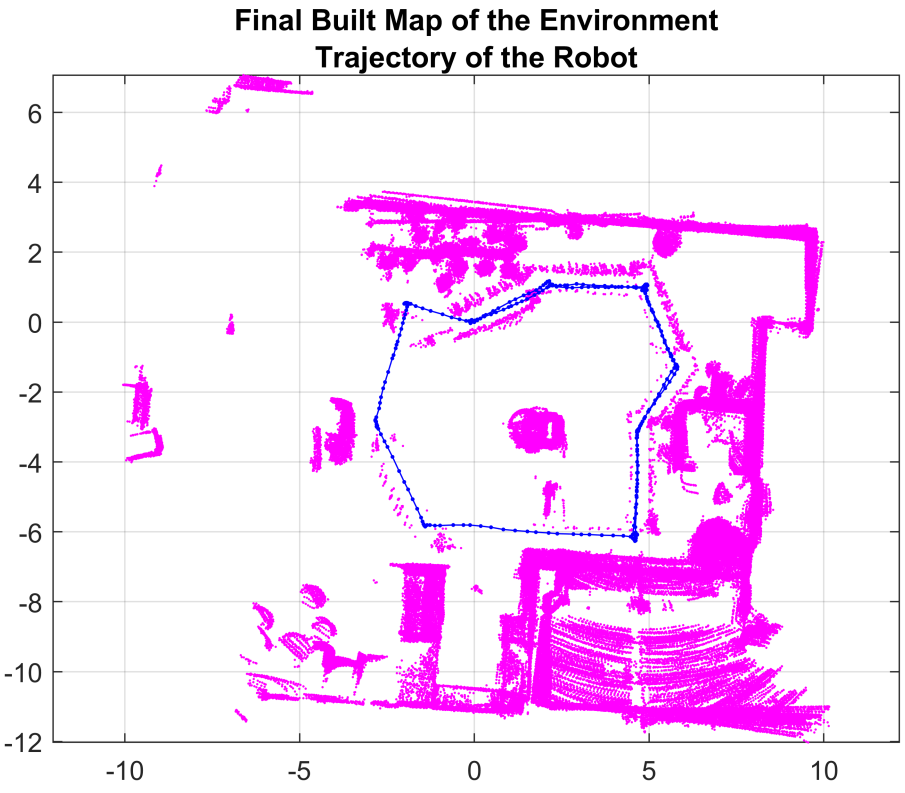
SLAM algoritmit

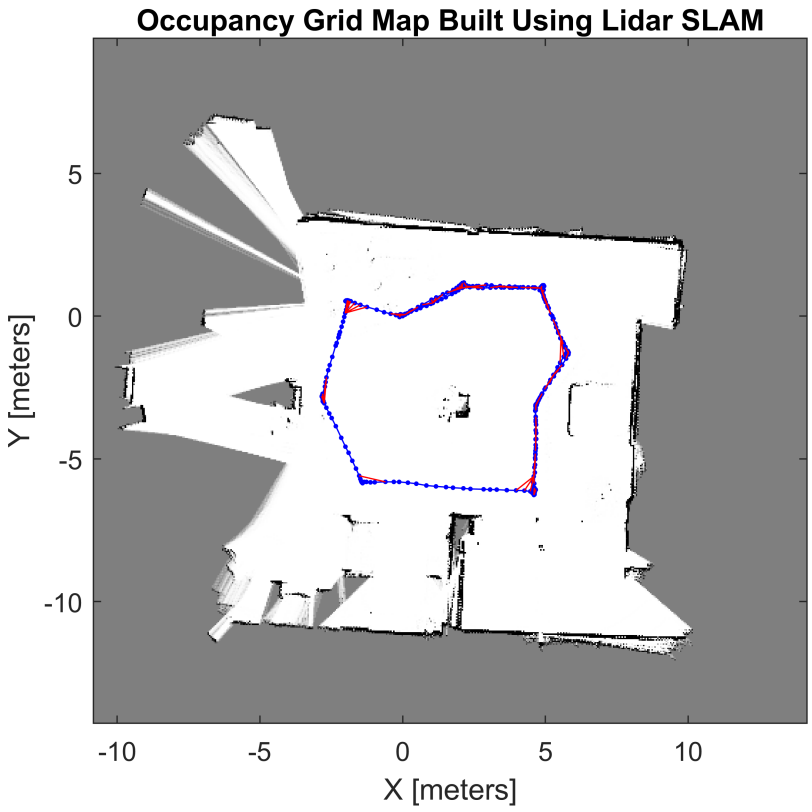
```
disp('Navigation Toolbox')
```

```
Navigation Toolbox
```

```
tic
optimizedPoses = navigationTB_example(lidarSet)
```


First loop closure
1829


Final Built Map of the Environment
Trajectory of the Robot



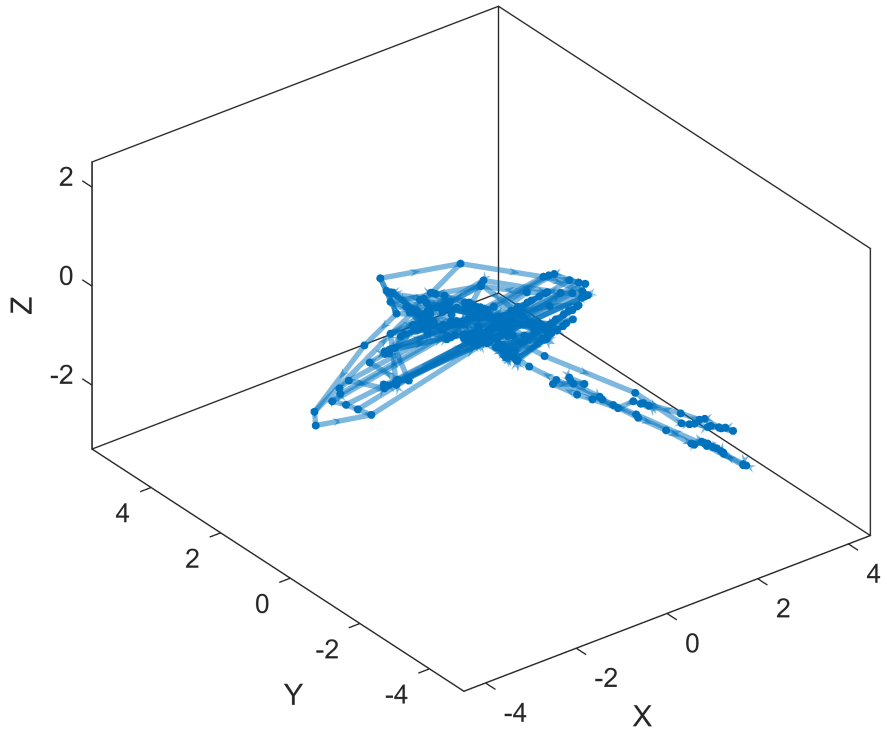

```
optimizedPoses = 323×3
         0         0         0
   -0.0078    0.0199    0.2136
    0.0245    0.0485    0.2068
    0.0849    0.0507    0.2066
    0.1752    0.1033    0.2271
    0.2892    0.1609    0.2283
    0.4785    0.2211    0.2354
    0.6219    0.2805    0.2469
    0.8371    0.3573    0.2751
    0.9839    0.4286    0.2861
      ⋮
```

```
navigationTB_time = toc;
[routelengths_navi, distances_navi] = getResults(optimizedPoses, groundTruth, eachFrame);
```

```
disp('Computer vision toolbox')
```

```
Computer vision toolbox
```

```
tic
computerVisionTB_example1
```




```
computerVisionTB1_time = toc;
[routelengths_vision, distances_vision] = getResults(pcViewSet2vect(vSet), groundTruth, eachFra
```

```
tic
%computerVisionTB_example2
computerVisionTB2_time = toc;
```

```
disp('Lidar toolbox')
```

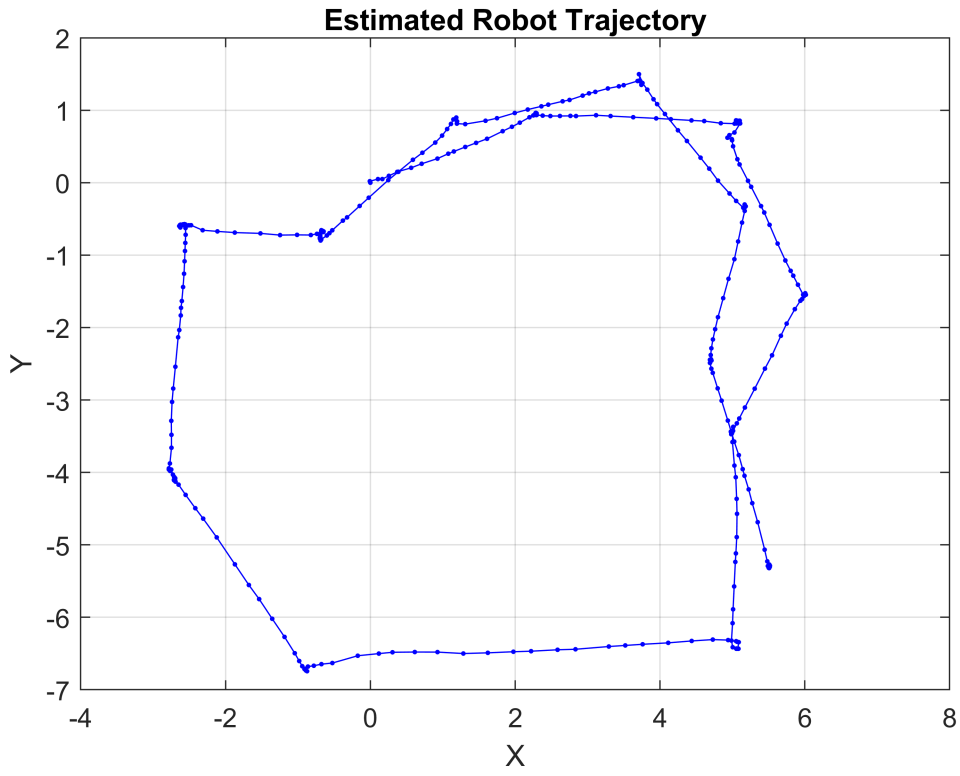
```
Lidar toolbox
```

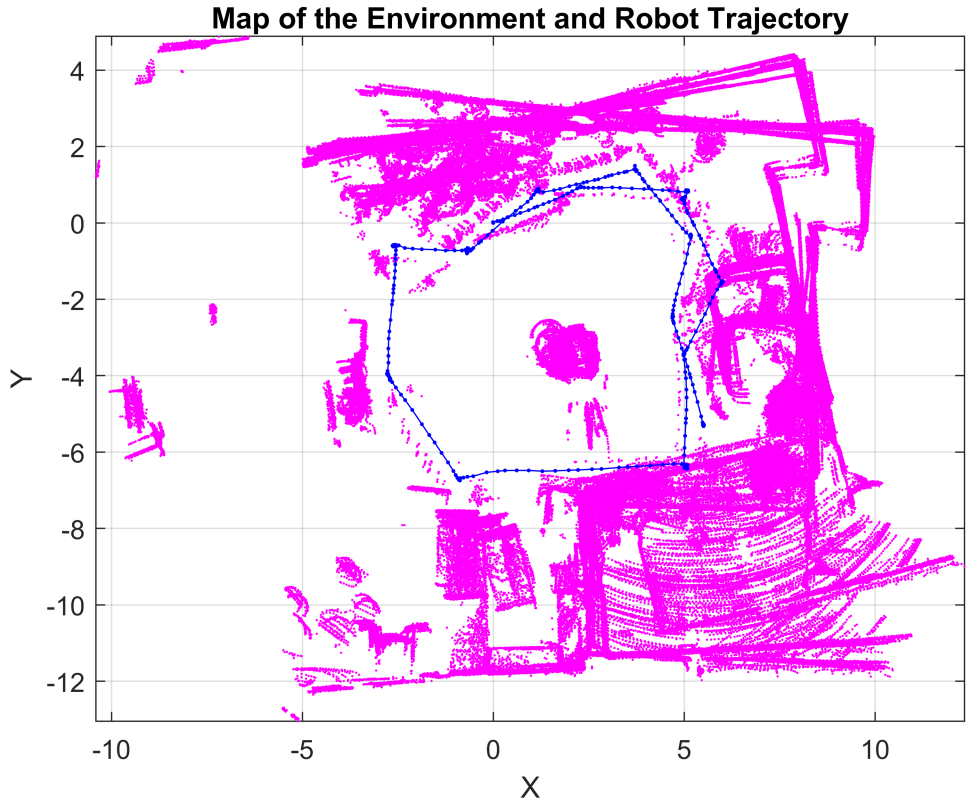
```
tic
lidarTB_example
```

```
scans = 1×323 cell
```

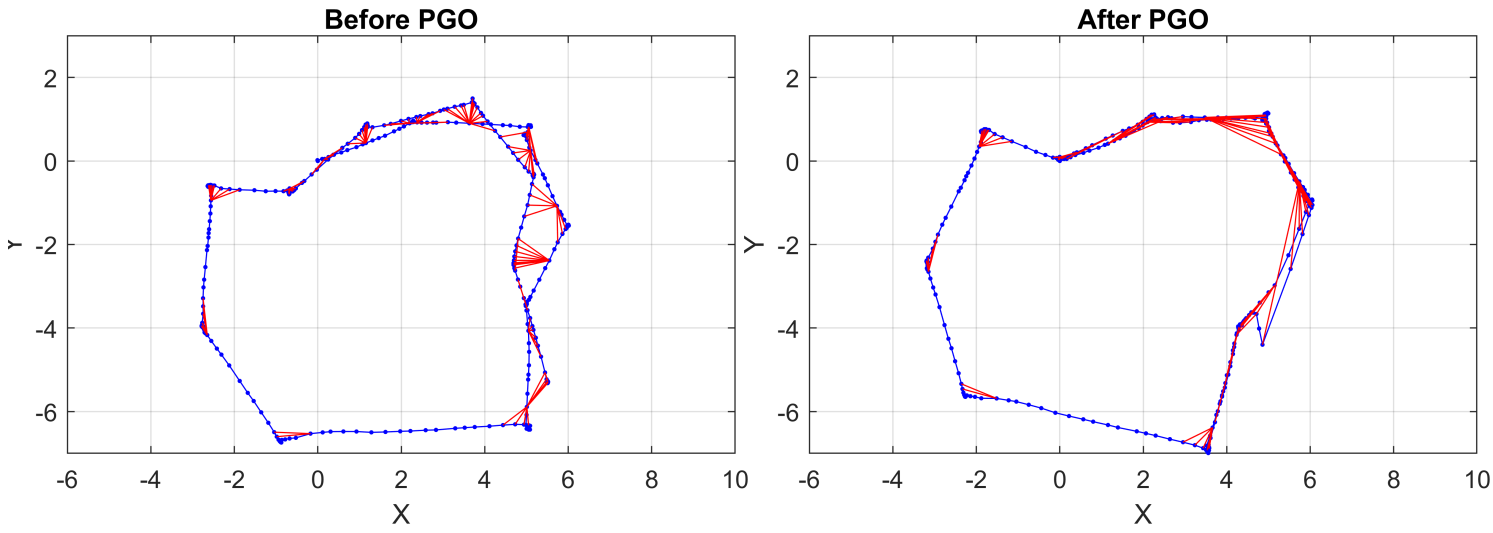
...

	1	2	3	4	5	6	7
1	1×1 lidarScan	1×1 lidarScan	1×1 lidarScan	1×1 lidarScan	1×1 lidarScan	1×1 lidarScan	1×1 lidarScan

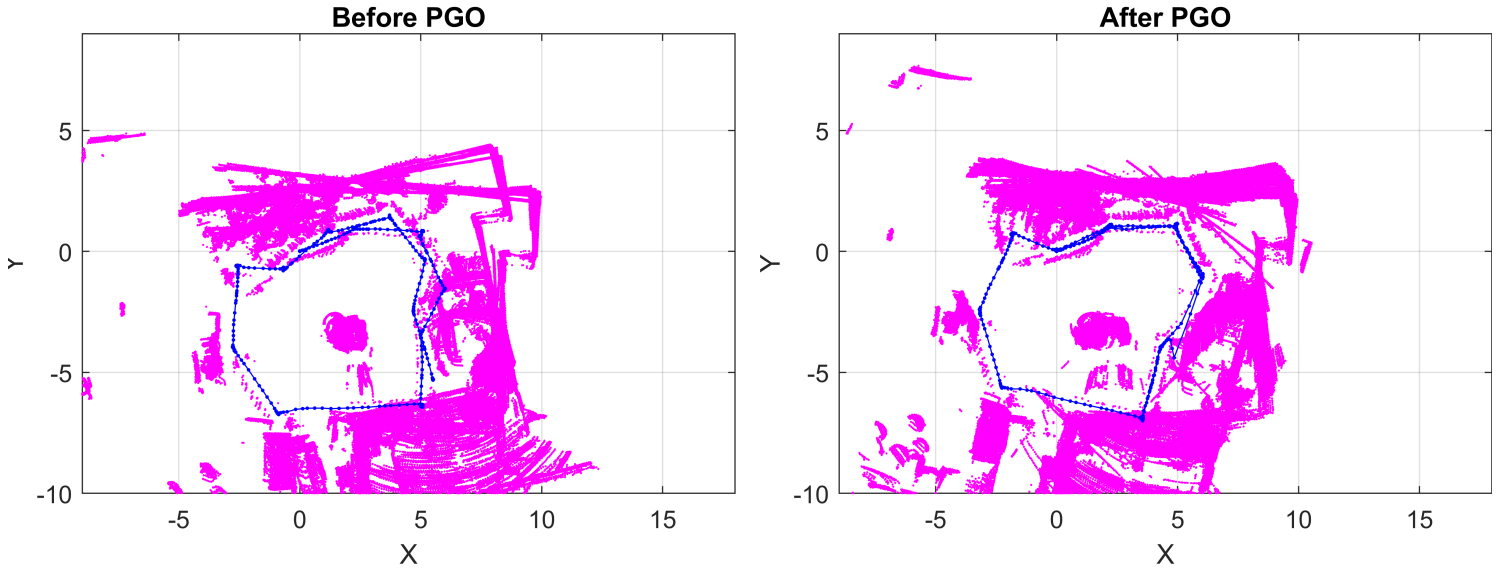

Estimated Robot Trajectory
2
1
0
-1
-2
-3
-4
-5
-6
-7
Y
-4
-2
0
2
4
6
8
X


Map of the Environment and Robot Trajectory
4
2
0
-2
-4
-6
-8
-10
-12
Y
-10
-5
0
5
10
X

Robot Trajectory



Map of the Environment and Robot Trajectory




```
lidarTB_time = toc;
[routelengths_lidar, distances_lidar] = getResults(updatedPGraph.nodeEstimates, groundTruth, ea
```

```
calculateResults
```

```
routelengths_keskiarvo = 1×3 single row vector
    0.2056    4.4341    0.4989
distances_keskiarvo = 1×3 single row vector
    0.2831    5.0297    0.7012
final_tulos = 1×3 single row vector
   40.1825  920.1517  139.7887
```

```
orig_data = preprocessedpcSet;
```

Esikäsittelytestausten testaus parhaammalla SLAM algoritmilla = navigation TB

```
% Alinäytteistys vs näytteenottotaajuus
downsampleVSsamplerate1 = SLAMprocess(pcSet, groundTruth);
downsampleVSsamplerate1.eachFrame = 4*1;
downsampleVSsamplerate1.performPcDenoise = false;
downsampleVSsamplerate1.downsamplemethod = 'random';
downsampleVSsamplerate1.downsampleToPointAmount = 4*2000;
downsampleVSsamplerate1 = downsampleVSsamplerate1.runAll
```

```
downsampleVSsamplerate1 =
  SLAMprocess with properties:

                eachFrame: 4
          performPcDenoise: 0
          downsamplemethod: 'random'
    downsampleToPointAmount: 8000
                        fov: 60
                  zLimits: [-0.5000 1.5000]
                    pcSet: {1×646 cell}
         pcSet_preprocessed: {1×162 cell}
                  lidarSet: {1×162 cell}
               groundTruth: [15×3 double]
            optimizedPoses: [162×3 double]
           time_preprocess: 36.2506
                 time_SLAM: 682.0596
              routeLengths: [15×1 double]
                 distances: [15×1 double]
```

```
downsampleVSsamplerate2 = SLAMprocess(pcSet, groundTruth);
downsampleVSsamplerate2.eachFrame = 1*1;
downsampleVSsamplerate2.performPcDenoise = false;
downsampleVSsamplerate2.downsamplemethod = 'random';
downsampleVSsamplerate2.downsampleToPointAmount = 1*2000;
downsampleVSsamplerate2 = downsampleVSsamplerate2.runAll
```

```
downsampleVSsamplerate2 =
  SLAMprocess with properties:

                eachFrame: 1
          performPcDenoise: 0
          downsamplemethod: 'random'
    downsampleToPointAmount: 2000
                        fov: 60
                  zLimits: [-0.5000 1.5000]
                    pcSet: {1×646 cell}
         pcSet_preprocessed: {1×646 cell}
                  lidarSet: {1×646 cell}
```

```
            groundTruth: [15×3 double]
         optimizedPoses: [646×3 double]
        time_preprocess: 133.3434
              time_SLAM: 936.0287
           routeLengths: [15×1 double]
              distances: [15×1 double]
```

```
% Häiriösuodatuksen vaikutus
pcdenoise_results1 = SLAMprocess(pcSet, groundTruth);
pcdenoise_results1.eachFrame = 2;
pcdenoise_results1.performPcDenoise = true;
pcdenoise_results1.downsamplemethod = 'random';
pcdenoise_results1.downsampleToPointAmount = 10000;
pcdenoise_results1 = pcdenoise_results1.runAll
```

```
pcdenoise_results1 =
  SLAMprocess with properties:

                eachFrame: 2
          performPcDenoise: 1
          downsamplemethod: 'random'
    downsampleToPointAmount: 10000
                      fov: 60
                   zLimits: [-0.5000 1.5000]
                     pcSet: {1×646 cell}
         pcSet_preprocessed: {1×323 cell}
                  lidarSet: {1×323 cell}
               groundTruth: [15×3 double]
            optimizedPoses: [323×3 double]
           time_preprocess: 186.8853
                 time_SLAM: 1.9588e+03
              routeLengths: [15×1 double]
                 distances: [15×1 double]
```

```
pcdenoise_results2 = SLAMprocess(pcSet, groundTruth);
pcdenoise_results2.eachFrame = 2;
pcdenoise_results2.performPcDenoise = false;
pcdenoise_results2.downsamplemethod = 'random';
pcdenoise_results2.downsampleToPointAmount = 10000;
pcdenoise_results2 = pcdenoise_results2.runAll
```