[Microstation and TerraScan software are used to create a project dealing with LiDAR data of the Lawrencetown area. The imported points are classified into groups of features using macro scripting.]

LiDAR Point Classification

REMS 6082 LiDAR Operations & Applications

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Overview

The goal of this assignment was to gain a familiarity with the newly introduced Microstation software and TerraScan extension by classifying LiDAR points into several categories, including ground, buildings, vegetation and isolated points. Setting up the block project demonstrates the particular processes in which to prepare for LiDAR work while the point classification is an essential step for future work with this type of data. In addition macros script development was used to automate the classification process; an invaluable method considering the size of most LiDAR datasets.

The coverage of the supplied LiDAR point data covers a portion of Annapolis County, Nova Scotia. In particular the village of Lawrencetown is a focal feature of this study area; this includes a variety of land cover that spans human alterations of landscape to natural terrain. As previewed in the LiDAR data (Figure 3 & Figure 4) these changes in land cover provide contrasting elevations that prove useful as classification parameters. In the case of water bodies the dropout of points, demonstrated in an "aerial" view (Figure 2), are visible by their lack of data. This is caused by the near infrared energy from the ALS sensors becoming absorbed by open water.

Figure 1. General view of study area. Google 2013.

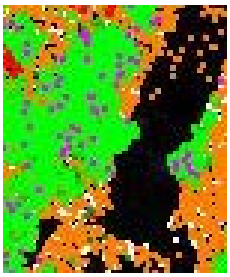


Figure 2. No data return along the Annapolis River

For the data that does exist there are a number of ways for the software to display and attribute the points. A particularly useful and familiar view offered by the returned data is displaying points based on the return intensity (Figure 5). For the required classification groups X, Y, and Z values of the points, and their distance from one another, was used as the search parameters. A detailed explanation parameters used for the required classes are discussed further in the Procedure section.

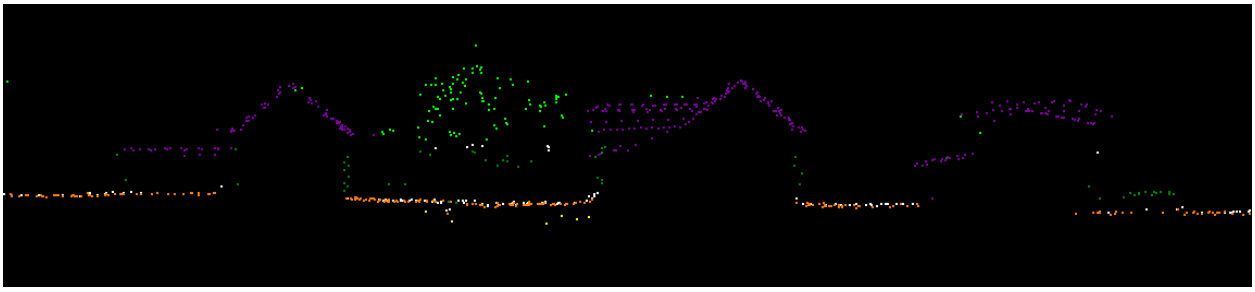


Figure 3. Profile view of block 15.

Procedure

Before any classification could take place, the project needed to be created and organized to facilitate the amount of data for the study area. This began with creating a .DGN file associated with Microstation. A number of levels were created to handle data in different levels. This included a default level, one for the study area and another for created blocks. The study area outline was provided in another .DGN and imported as a reference to be merged into the main project and stored in its separate level.

After establishing the Microstation "shell" features, TerraScan was used to create the project file that would deal with the majority of the LiDAR specific operations. For this project a block size of 1040 m was specified and a LAS 1.1 storage type. The former was chosen based on using a 20 m buffer around a 1 km tile. As each tile lines up a 20 m overlap occurs on all sides, with points falling into this area residing in both tiles that make up the overlap. This ensures that classification is better represented with a reference to neighboring tiles and contributes to faster processing.

Blocks were created manually in the Microstation environment by using the lower left and upper right extents of the study area outline. An initial orthogonal block was created in the lower left corner measuring 1040 m, from which an array was created using a spacing of 1000 m to create the overlap of 20 m on all sides. Those blocks without any coverage of the study area were then deleted. Once satisfied with the block coverage the block shapes were then imported into the TerraScan project. Subsequently the LiDAR points (provided according to flight line and stored as LAS 1.0 files) were loaded to the blocks and saved as LAS 1.1 in a separate folder location.

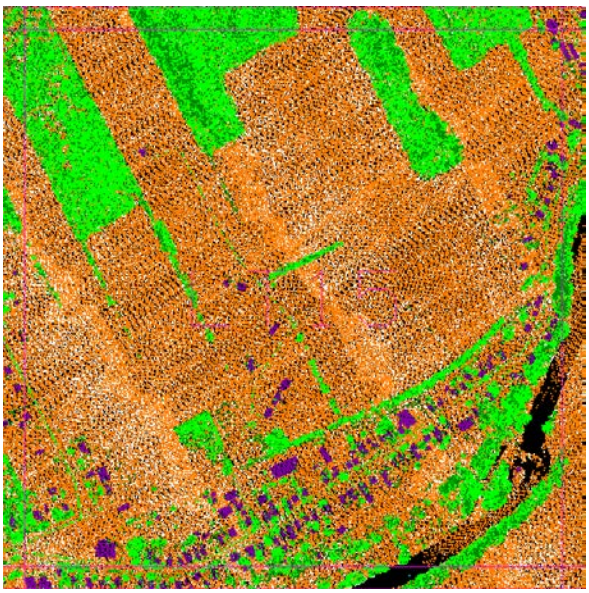


Figure 4. Aerial view of block 15. Classification in process.

Point classification was completed using a series of parameters in a macros script. To evaluate these parameters testing was focused on block 15 of the study area which exemplified the range of classification groupings to be used. These groups included a default class, isolated points, low lying points, ground, buildings, and varying heights of vegetation.

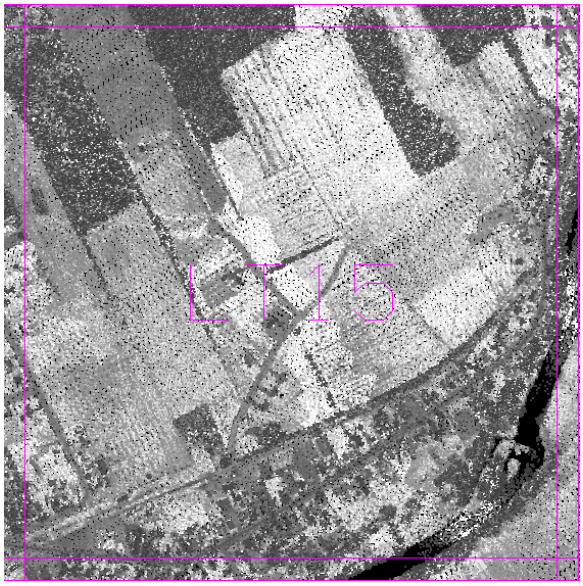


Figure 5. Preview based on intensity.

The default class was the initial process of the script. This entailed the movement of all points into this base classification, ignoring an automatic classification based on echo return. Isolated points were first selected out to avoid movement to other groupings. For a point to be considered isolated its distance was greater than 5 m from any other points. The next step was to isolate low lying points. These represent point locations that appear below the ground surface. In their selection low points had to exist 0.5 m lower than groups of points within 1 m.

For feature based classifications, ground was approached first as it could be used as a reference in the other class parameters. This was accomplished with the default settings of the ground macro routine which executed a series of iterations that compared an initial TIN (created with a low point from each cell) to all the lowest points. Angle and edge size also go towards this calculation, but ultimately it identifies points that form a ground surface. The building macro routine is one function that uses ground as a reference; its settings were altered to reflect a minimum building size of 30 m^2 and an increased z tolerance of 0.50 m. The goal was for smaller structures, like toolsheds and barns, to be identified with limited confusion to vegetation. Vegetation was grouped in small (0.5 – 1 m), medium (1 – 4 m) and high (4 – 60 m) groupings based on elevation above the ground.

Once the macros ran satisfactorily on block 15 it was tested on two semi random blocks (5 and 20) before being applied to all. A report was generated and saved with the new classifications outputted to the LiDAR points stored in the block .LAS files.

Results

In using an automated approach the majority of points were classified to their corresponding groupings; however the process is not perfect and some points are simply misclassified or overlooked by the parameters. The most prevalent issue was distinguishing buildings from vegetation and ground. In some instances parts of roofs were being classified as trees. By adjusting the z tolerance in the building routine settings some of these could be eliminated. For confusion with the ground (especially in what appears to be inside a building), an extra macros routine was set to select buildings points that had an elevation of 1 m below the ground or 0.50 m above. Another issue observed in the automation was the tendency of building sides to be classified as vegetation, particularly in the mid vegetation range. This is not altogether surprising as the medium vegetation is based solely on the elevation of points above the ground. While not attempted in this classification building side could be removed from the vegetation class by an angle or hard surface routine.

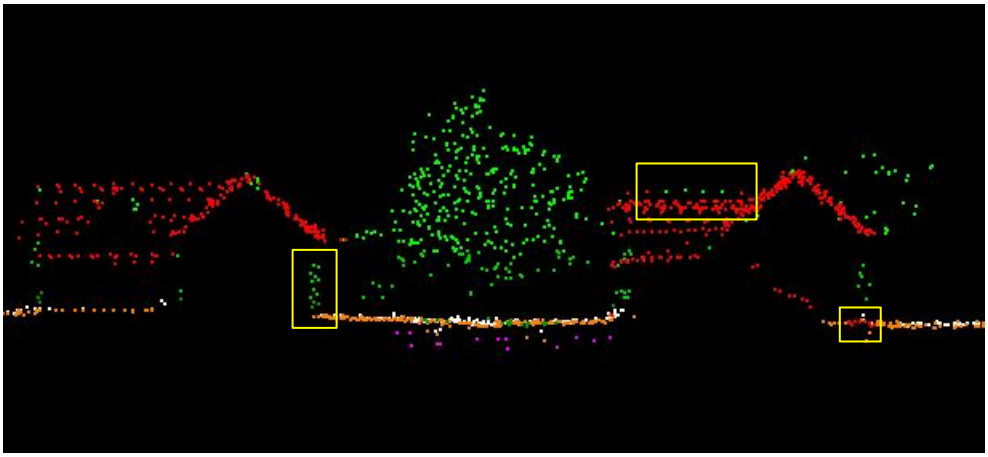


Figure 6. Errors in classification. From left to right: vegetation as building sides, vegetation as building roof and building as ground.

In future classifications the intensity of points could be used to further refine land cover types. For instance points classified as ground range in actual material such as grass, bare soil and pavement. To distinguish roads from more natural ground cover the intensity of roads can be pinpointed in order to select them out as a separate grouping. The key to making this macros setting work is the identification of intensity values. As of this lab no tool in TerraScan had been encountered to provide this specific information.

Despite refining some of the automatic settings points were still excluded from their most likely grouping. In a more thorough classification these instances can be corrected by manual methods. Some of these were tested, such as classifying by fence or brush, but was not systematically applied to the study area blocks as this detail was not required for the lab submission.

Appendix 1: Project Data

Source	Applied Geomatics Research Group (AGRG)
Acquisition Date	April 2, 2007/ Julian Day 92
Survey Area	Lawrencetown/ Clare
GPS Base	Middleton/ Clare
Aircraft	GP2L
Above Ground Level (AGL)	900 m
Rep Rate	50 kHz
Scan Frequency	33 Hz
Scan Angle	22°
File Format	LAS 1.0
Number of Flight Lines	9
Coordinate System	UTM 19 NAD83 CSRS98

Appendix 2: Data Organization

File path

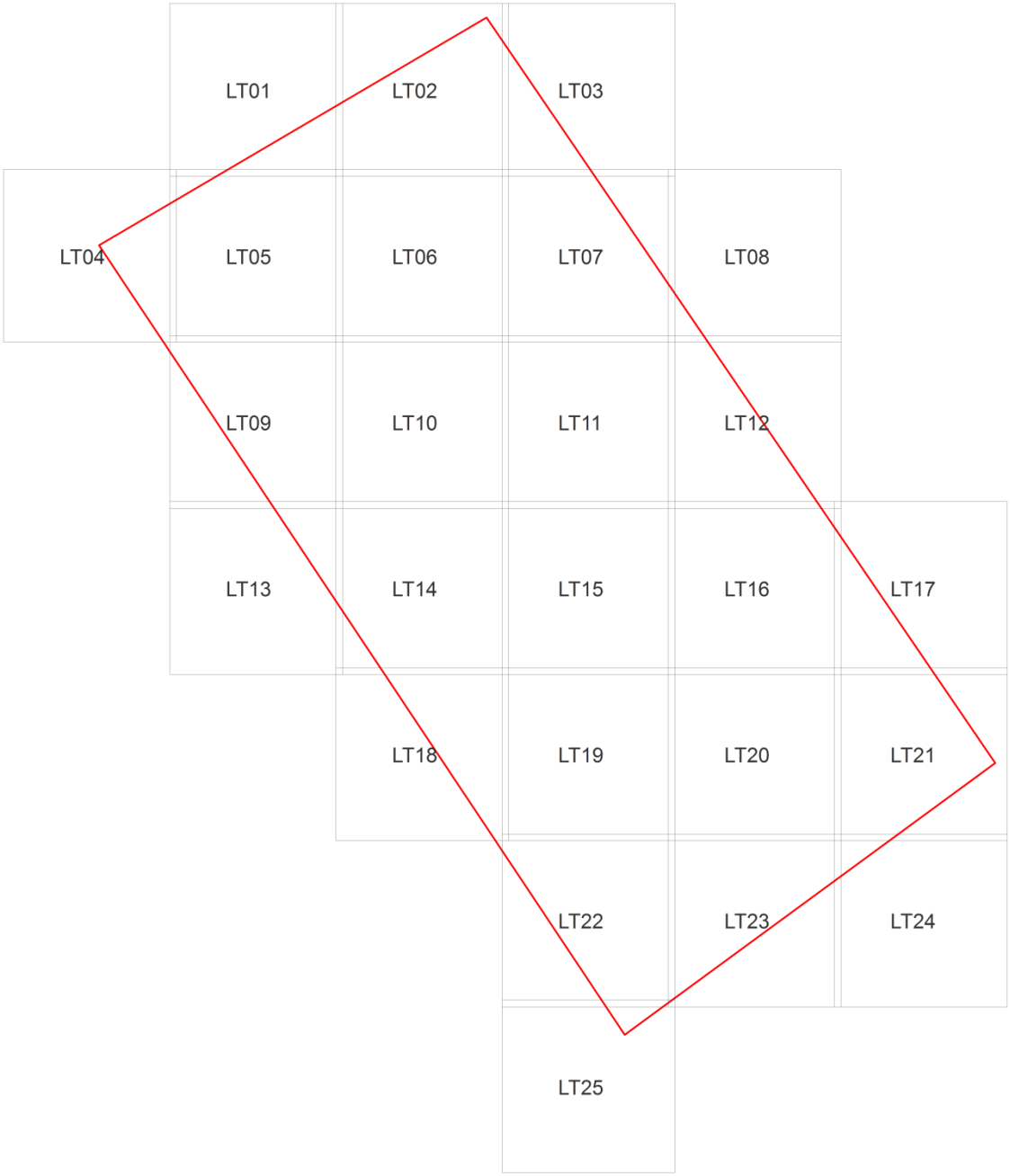
\\nscccovs2\RS\Submissions\w0235112\REMS6082_LiDAR\Lab1\

Subfolders

\Blocks
    LT01.las - LT25.las
\Documents
    lawrencetown_report.pdf
\Reference
    Ltown_aoi.dgn
\Reports
    block_import.txt
    classify_points.txt
\Scripts
    classify_points.mac
lawrencetown.prj
lawrencetown.dgn

Appendix 3: Project Properties

Project Blocks



DGN Levels

Default	Default location of created or imported drawings.
Study Area	Location of imported study area boundary from separate .DGN
Blocks	Location of created blocks. These have been used to generate project blocks for LiDAR data grouping.

Appendix 4: Scripts

Point Classification

```
[TerraScan macro]
Description=Lab 1 Classification
Author=S. Cyr
ByLine=0
ByScanner=0
SlaveCanRun=1
AnotherComputerCanRun=1
CanBeDistributed=1

FnScanClassifyClass(999,1,0)
FnScanClassifyIsolated("1",9,1,"1",5.00,0)
FnScanClassifyLow(1,7,10,0.50,1.00,0)
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)
```

Appendix 5: Reports

Block Import

```
0 from h:\lawrencetown\las\strip001.las. 1 117 594 ignored.
0 from h:\lawrencetown\las\strip002.las. 5 134 139 ignored.
8 339 873 from h:\lawrencetown\las\strip003.las. 97 520 ignored.
6 781 216 from h:\lawrencetown\las\strip004.las. 1 266 093 ignored.
7 704 022 from h:\lawrencetown\las\strip005.las.
6 919 843 from h:\lawrencetown\las\strip006.las. 294 903 ignored.
7 351 842 from h:\lawrencetown\las\strip007.las.
6 367 708 from h:\lawrencetown\las\strip008.las. 132 299 ignored.
6 829 566 from h:\lawrencetown\las\strip009.las. 12 615 ignored.

Imported 50 294 070 points from 9 files.
8 055 163 points were ignored.
```

Classify Points

```
Macro execution version 012.010
D:\lawrencetown\scripts\classify_points.mac

Block LT01.las
---------------------------------------------------------------
Loaded 406 109 points from active block
FnScanClassifyClass(999,1,0)  returned 406 109
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 5
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 5 694
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 241 812
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 2 831
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 114
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 80 834
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 19 870
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 2 502
Saved 406 109 points

Block LT02.las
---------------------------------------------------------------
Loaded 1 409 308 points from active block
FnScanClassifyClass(999,1,0)  returned 1 409 308
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 9
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 44 417
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 742 366
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 2 998
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 306
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 359 492
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 103 984
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 9 606
Saved 1 409 308 points

Block LT03.las
---------------------------------------------------------------
Loaded 386 355 points from active block
FnScanClassifyClass(999,1,0)  returned 386 355
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 6
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 163
```

```
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 343 873
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 662
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 417
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 1 390
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 1 085
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 180
Saved 386 355 points

Block LT04.las
------------------------------------------------------------
Loaded 659 402 points from active block
FnScanClassifyClass(999,1,0)  returned 659 402
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 1
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 14 773
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 453 104
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 643
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 336
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 95 236
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 28 948
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 3 089
Saved 659 402 points

Block LT05.las
------------------------------------------------------------
Loaded 2 939 052 points from active block
FnScanClassifyClass(999,1,0)  returned 2 939 052
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 3
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 126 834
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 740 235
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 10 767
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 251
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 1 480 215
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 244 158
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 43 910
Saved 2 939 052 points

Block LT06.las
------------------------------------------------------------
Loaded 3 636 535 points from active block
FnScanClassifyClass(999,1,0)  returned 3 636 535
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 6
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 72 368
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 1 097 652
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 414
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 241
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 1 514 936
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 231 534
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 71 058
Saved 3 636 535 points

Block LT07.las
------------------------------------------------------------
Loaded 2 076 439 points from active block
FnScanClassifyClass(999,1,0)  returned 2 076 439
```

```
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 7
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 30 608
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 1 047 000
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 6 940
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 987
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 404 390
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 81 016
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 11 429
Saved 2 076 439 points

Block LT08.las
------------------------------------------------------------
Loaded 237 016 points from active block
FnScanClassifyClass(999,1,0)  returned 237 016
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 1
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 15 603
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 64 980
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 72
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 70
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 117 032
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 16 975
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 1 992
Saved 237 016 points

Block LT09.las
------------------------------------------------------------
Loaded 2 987 307 points from active block
FnScanClassifyClass(999,1,0)  returned 2 987 307
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 4
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 88 091
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 736 020
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 129
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 80
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 1 442 917
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 255 339
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 47 868
Saved 2 987 307 points

Block LT10.las
------------------------------------------------------------
Loaded 3 971 473 points from active block
FnScanClassifyClass(999,1,0)  returned 3 971 473
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 10
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 63 891
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 1 098 213
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 5 931
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 912
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 1 584 591
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 292 912
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 71 176
Saved 3 971 473 points

Block LT11.las
------------------------------------------------------------
```

```
Loaded 4 282 475 points from active block
FnScanClassifyClass(999,1,0)  returned 4 282 475
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 18
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 78 437
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 1 145 659
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 9 537
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 921
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 1 948 429
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 271 277
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 75 645
Saved 4 282 475 points

Block LT12.las
------------------------------------------------------------
Loaded 1 689 988 points from active block
FnScanClassifyClass(999,1,0)  returned 1 689 988
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 18
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 52 945
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 589 346
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 8 576
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 1 210
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 693 612
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 107 043
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 21 071
Saved 1 689 988 points

Block LT13.las
------------------------------------------------------------
Loaded 619 778 points from active block
FnScanClassifyClass(999,1,0)  returned 619 778
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 1
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 41 071
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 143 245
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 0
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 0
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 316 258
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 53 203
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 6 543
Saved 619 778 points

Block LT14.las
------------------------------------------------------------
Loaded 2 791 821 points from active block
FnScanClassifyClass(999,1,0)  returned 2 791 821
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 11
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 34 005
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 1 193 220
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 32 087
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 2 590
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 679 426
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 147 537
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 31 700
Saved 2 791 821 points
```

```
Block LT15.las
---------------------------------------------------------------
Loaded 3 077 923 points from active block
FnScanClassifyClass(999,1,0)  returned 3 077 923
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 31
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 27 998
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 1 288 597
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 62 497
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 6 676
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 720 662
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 113 026
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 42 941
Saved 3 077 923 points

Block LT16.las
---------------------------------------------------------------
Loaded 2 566 259 points from active block
FnScanClassifyClass(999,1,0)  returned 2 566 259
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 31
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 22 929
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 1 299 167
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 10 151
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 1 942
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 505 130
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 99 826
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 27 761
Saved 2 566 259 points

Block LT17.las
---------------------------------------------------------------
Loaded 689 598 points from active block
FnScanClassifyClass(999,1,0)  returned 689 598
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 7
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 11 687
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 323 083
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 0
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 0
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 252 085
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 23 955
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 5 353
Saved 689 598 points

Block LT18.las
---------------------------------------------------------------
Loaded 1 256 142 points from active block
FnScanClassifyClass(999,1,0)  returned 1 256 142
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 30
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 34 702
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 514 150
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 16 527
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 1 173
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 429 732
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 69 823
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 13 034
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Saved 1 256 142 points

Block LT19.las
------------------------------------------------------------
Loaded 3 095 680 points from active block
FnScanClassifyClass(999,1,0)  returned 3 095 680
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 20
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 28 524
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 1 261 290
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 79 819
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 10 576
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 801 708
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 149 836
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 48 133
Saved 3 095 680 points

Block LT20.las
------------------------------------------------------------
Loaded 3 118 501 points from active block
FnScanClassifyClass(999,1,0)  returned 3 118 501
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 12
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 25 382
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 1 371 708
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 18 026
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 2 895
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 722 575
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 147 520
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 43 711
Saved 3 118 501 points

Block LT21.las
------------------------------------------------------------
Loaded 2 564 495 points from active block
FnScanClassifyClass(999,1,0)  returned 2 564 495
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 16
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 38 484
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 969 092
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 8 970
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 887
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 902 929
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 179 930
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 31 415
Saved 2 564 495 points

Block LT22.las
------------------------------------------------------------
Loaded 3 203 348 points from active block
FnScanClassifyClass(999,1,0)  returned 3 203 348
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 4
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 121 394
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 602 132
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 3 413
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 516
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 1 889 476
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FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 190 390
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 71 152
Saved 3 203 348 points

Block LT23.las
------------------------------------------------------------
Loaded 3 883 937 points from active block
FnScanClassifyClass(999,1,0)  returned 3 883 937
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 5
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 85 094
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 930 872
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 2 588
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 408
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 1 819 610
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 344 520
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 107 518
Saved 3 883 937 points

Block LT24.las
------------------------------------------------------------
Loaded 2 401 841 points from active block
FnScanClassifyClass(999,1,0)  returned 2 401 841
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 10
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 112 501
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 758 395
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 3 505
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 645
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 1 099 097
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 173 804
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 29 645
Saved 2 401 841 points

Block LT25.las
------------------------------------------------------------
Loaded 264 864 points from active block
FnScanClassifyClass(999,1,0)  returned 264 864
FnScanClassifyIsolated("1",9,1,"1",5.00,0)  returned 0
FnScanClassifyLow(1,7,10,0.50,1.00,0)  returned 18 738
FnScanClassifyGround(1,2,1,60.0,88.00,7.00,1.40,-1,3.0,0,2.0,0)
returned 37 373
FnScanClassifyBuilding(2,1,6,3,30.0,0.50,-1,0)  returned 0
FnScanClassifyHgtGrd(2,100.0,6,2,-1.00,0.50,0)  returned 0
FnScanClassifyHgtGrd(2,50.0,1,5,4.00,60.00,0)  returned 154 643
FnScanClassifyHgtGrd(2,50.0,1,4,1.00,4.00,0)  returned 22 721
FnScanClassifyHgtGrd(2,50.0,1,3,0.50,1.00,0)  returned 5 797
Saved 264 864 points
```