

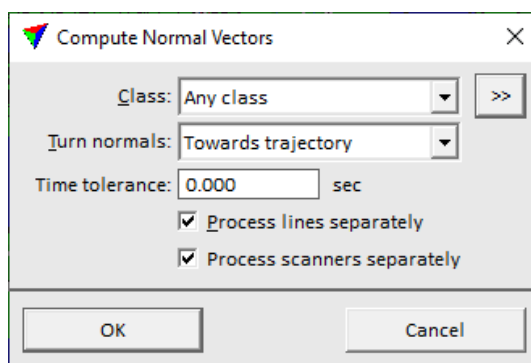
Pre-processing of LiDAR point clouds with FME & Terrascan

1. Reclassification of misclassified trunks with Terrascan & FME

The reclassification step aims to recover misclassified trunk-points and to integrate them to the class 4 – *Medium Vegetation*. It has to be executed prior to the cleaning step. The process is the following:

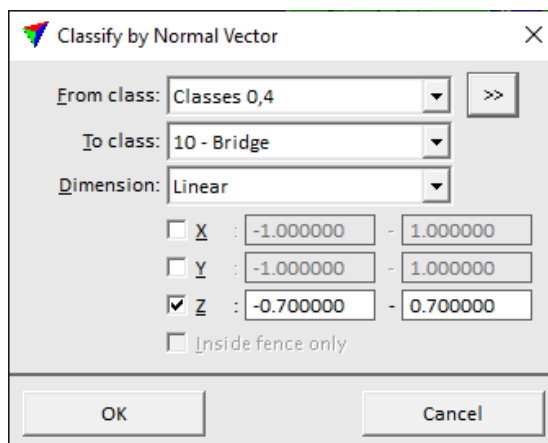
1. Computation of the normal vectors based on the trajectory lines of the acquisition flight.

Terrascan > Tools > Compute normal vectors



2. Reclassification of linear objects based on normal vectors. The classification is made on points of the class 0 – Unclassified and 4 – Medium Vegetation. The selected points will be moved to an empty class (Here : class 10)

Terrascan > Classify > Routine > By normal vectors



3. The reclassified points in class 10 will be integrated in the class 4 during the cleaning process in FME. Some other unwanted linear objects (poles, power lines, etc) will also be recovered during this reclassification process. However, they will be eliminated of the vegetation classes during the cleaning process, as in most cases, they won't be situated under a higher canopy.

2. Cleaning of the point cloud with FME

The cleaning step aims to filter as many “non-trunk” points as possible out of the class 4 – *Medium Vegetation* in order to isolate real trees from the rest of the vegetation. Vegetation will be considered as tree when higher than 3m. In addition, the cleaning model also include the last step of the reclassification process.

The point cloud is cleaned with a FME model processing every las tile one after another. In addition to the las tiles, it requires two raster datasets as inputs:

1. A Digital Canopy Surface Layer (raster format).

A Canopy surface model in a vector format has been produced following a methodology produced by the City of Geneva (cf. *Rapport_Stage_GG_SEVE_CJB_CCG_2021.pdf* included in the folder). It has been then rasterized. Canopy pixels have been attributed an arbitrary value (*here*: 3.5), other pixels are No Data.

2. A Cadastre of the walls Layer (raster format).

The cadastre of the walls has also been rasterized. Wall pixels have been attributed an arbitrary value (*here*: 1), other pixels are No Data.

2.1 FME Model (*LAS_Preprocess_2021_cleaning.fmw*)

- **Inputs (Readers)**
 - i. Original LAS file
 - ii. Cadastre of walls with 50 cm buffer and rasterized (pixel value = 3.5)
 - iii. Canopy cover layer rasterized (pixel value = 1)
- **Outputs (Writers)**
 - i. Cleaned LAS file
- **Process**
 - Filtering of the points of class 4
 - Attribution of the information whether the point is situated under higher canopy or not.
 - If the value is equal to 1: the point is situated under higher canopy and thus can stay in the class 4.
 - If the value is different than 1: the point is NOT situated under higher canopy and thus is moved to class 3 (“Low vegetation”, empty).
 - Attribution of the information whether the point is situated above a wall or not.
 - If the wall-cadastre value is different than 3.5: the point is not situated above a wall and thus can stay in the class 4.
 - If the wall-cadastre value is equal to 3.5: the point is situated above a wall and thus is moved to class 3 (“Low vegetation”).
 - Writing of the cleaned LAS file with filtered points reclassified as “Low vegetation” (3).

2.2 Alternative FME model (*LAS_Preprocess_2021_cleaning_alternative.fmw*)

The production of Canopy cover layer used as input in the previous model needs some processing that can be time consuming. In order to simplify the process, an alternative model has been designed that doesn't need this layer as an input. Instead, it produces a Canopy Elevation Model directly through FME. The advantage is that it can be used "stand-alone", but the result can be slightly less precise and the processing time is longer.

- **Inputs (Readers)**
 - i. Original LAS file
 - ii. Cadastre of walls with 50 cm buffer and rasterized (pixel value = 3)
- **Outputs (Writers)**
 - i. Cleaned LAS file
- **Process**
 - Creation of a Digital Height Model (DEM) using classes 2 (ground) and 9 (water).
 - Based on the DEM, calculation of the height of the vegetation points (classes 4-5)
 - Creation of a Digital Canopy Height Model (DCHM) with pixel values corresponding to the highest point of the pixel.
 - Attribution to each point of class 4 the value of the DCHM.
 - Filtering of the points of class 4
 - If the DCHM value is greater than 3 m: the point is situated under higher canopy and thus can stay in the class 4.
 - If the DCHM value is lower or equal to 3 m: the point is NOT situated under higher canopy and thus is moved to class 3 ("Low vegetation", empty).
 - With the remaining points of class 4: Attribution of the information whether the point is situated above a wall or not.
 - Filtering of the points of class 4
 - If the wall-cadastre value is different than 3.5: the point is not situated above a wall and thus can stay in the class 4.
 - If the wall-cadastre value is equal to 3.5: the point is situated above a wall and thus is moved to class 3 ("Low vegetation").
 - Writing of the cleaned LAS file with filtered points reclassified as "Low vegetation" (3).