



Tree crown delineation software for airborne lidar CHMs

QUICK START GUIDE **SEGMA Version 0.3.2**

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LICENCE

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The redistribution of the demo data distributed with the software is forbidden.

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To get help

For help on SEGMA, information on preparing canopy height models, or the crown delineation services offered by geophoton.ca, etc., please write to:

Benoit St-Onge at: bs@geophoton.ca

Installing SEGMA and the demo data

The following installation procedure is designed for a 64-bit Windows operating system (e.g., Windows 10) and concerns only the bundled (“frozen”) version of SEGMA. Installation from source will soon be available.

To install SEGMA, simply unzip the SEGMA_v_0.3.2_EN.zip file on your computer.

To install the demo data, unzip the SEGMA_data.zip file on your computer.

Launching SEGMA

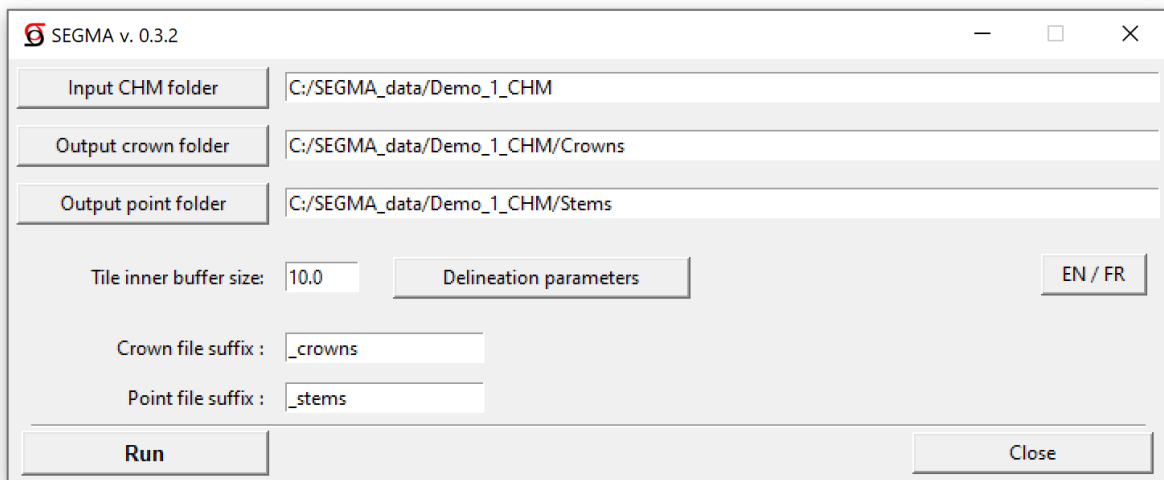
To launch SEGMA, open the SEGMA_v_0.3.2 folder and double click on the SEGMA_v_0.3.2.exe file. This will first open a console window and then, after a few seconds, the graphical user interface (GUI) of SEGMA.

Language settings

SEGMA is available in both English (EN) and French (FR). To change the language, click on the EN / FR button on the main window, select the desired language and press OK. SEGMA then needs to be closed and reopened for the new settings to be applied.

Running SEGMA

The main SEGMA window allows picking the input folder where the canopy height models (CHM) reside, the output folders for storing the results (ESRI shapefiles containing the crowns and the points), and the tile inner buffer size. It also allows to open the window showing the delineation parameters (next section) and the result file name suffixes.



We recommend doing trial runs of SEGMA with the demo data and the default delineation parameter values before going further. Consult the next section: “Testing SEGMA with the demo data”.

Testing SEGMA with the demo data

Two simple data examples are provided in the SEGMA_data folder: Demo_1_CHM and Demo_4_CHM. The former contains a single small CHM allowing a first rapid test. The second contains 4 CHMs forming a 2x2 tile block. Note that a 20 m buffer exists around each tile.

For a first trial run, use the select the SEGMA_data/Demo_1_CHM folder as the input folder (see the SEGMA window example on the previous page). Use the *Output crown folder* button to create and select a new “Crowns” folder, and the *Output point folder* button button to create and select a new “Stems” folder. You can also indicate what will be the suffix of the file names containing the crowns in the form of polygons (for example “_crowns”) as well as that of the files containing the location of the stems (crown centroids) in the form of points (for example “_stems”). Then click the run button. The console window should show the following:

```
Number of CHMs in input folder: 1
Processing of CHM 1 of 1: C:/SEGMA_data/Demo_1_CHM/CHM_SW.tif in progress...
```

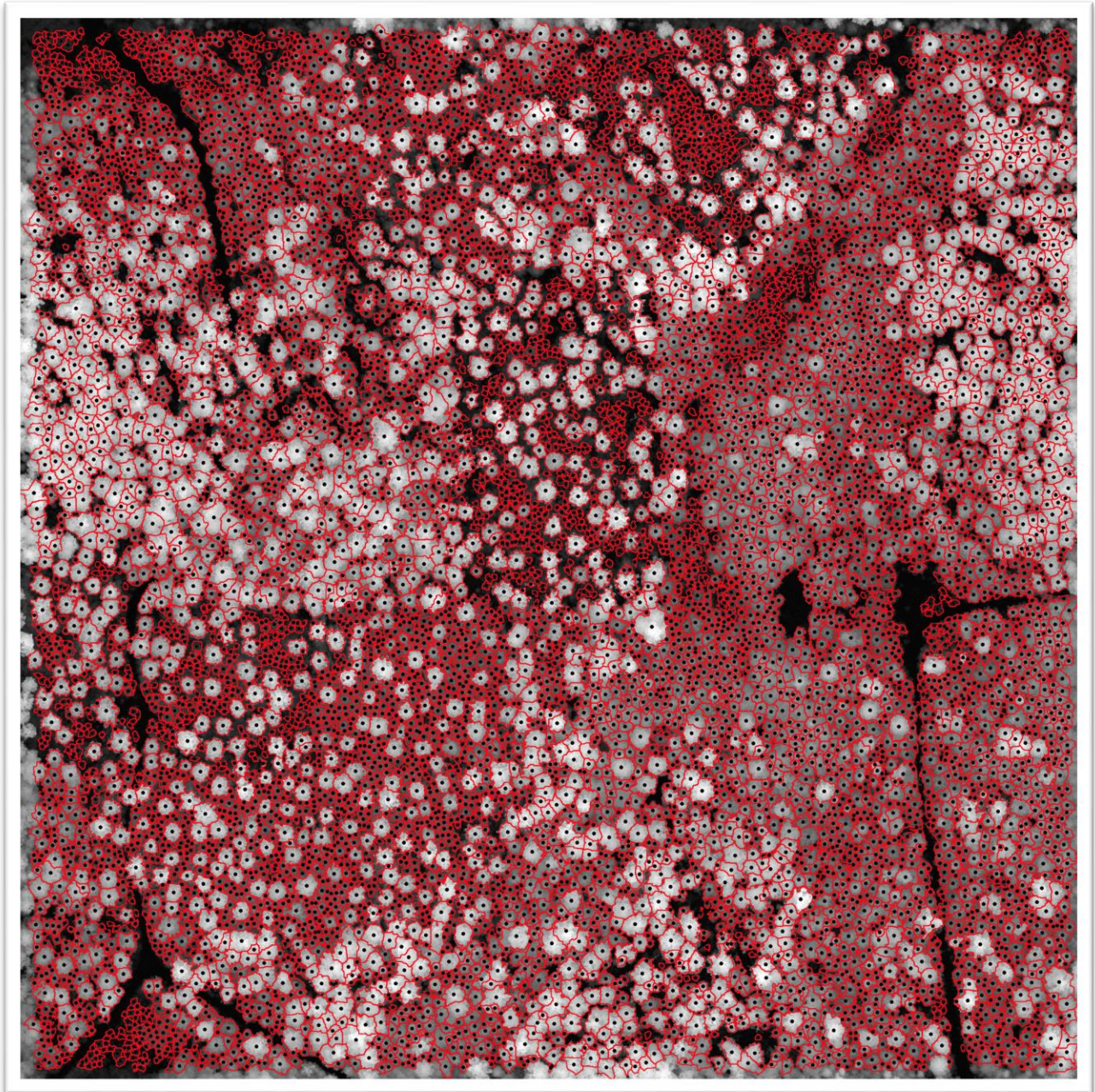
Other intermediary messages will appear that allow to follow progress. Upon completion (time may vary) the following message will appear:

```
Processing completed. Total processing time: 0:01:16.634245
```

Statistics on the number of delineated crowns and the processing time can be found in the segma.log file in the output crown folder. At any time, the processing can be aborted by clicking

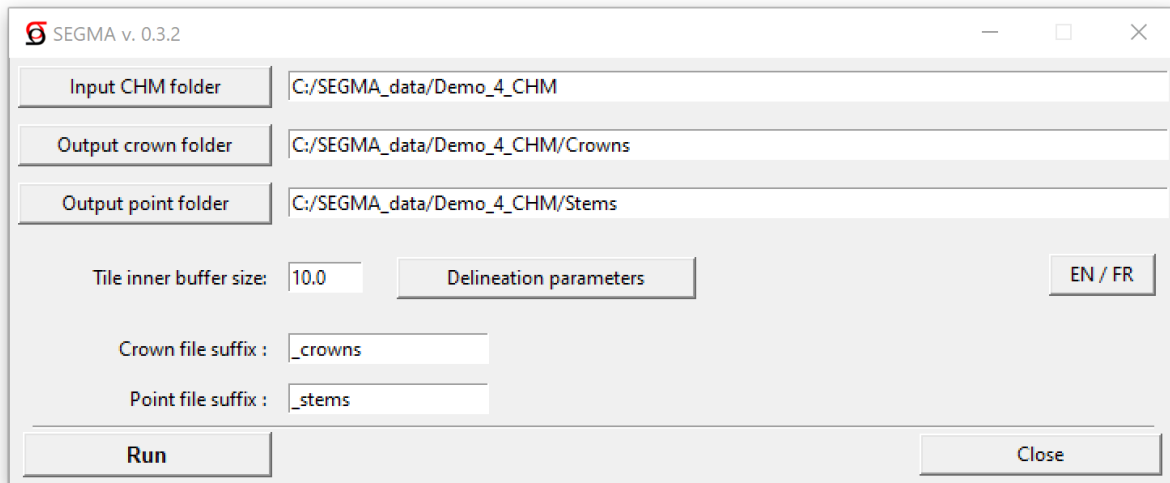
on the X icon (Close icon) of the console window. Aborting will leave some temporary files in the output folder. These should be deleted before the process is relaunched.

Now check the results in a GIS application by overlaying the resulting crowns and stems onto the CHM:

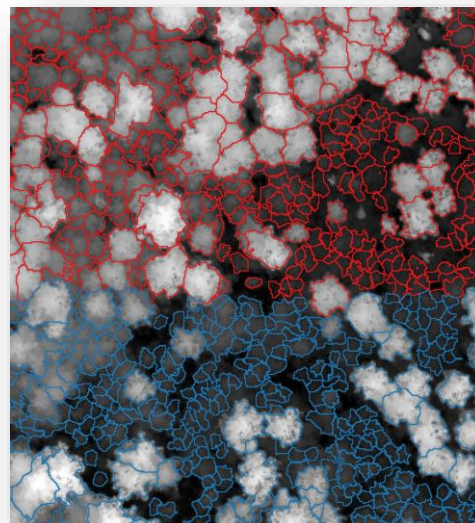
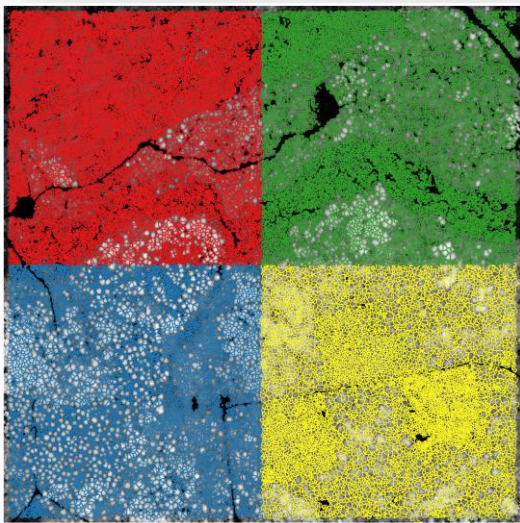


Notice that there are no incomplete crowns on the image border. This is made possible by the 10 m tile inner buffer (in the current example). Only crowns which have a centroid at least 10 m away from the tile's edge are kept.

Now run a test with the 4 adjacent CHM tiles:

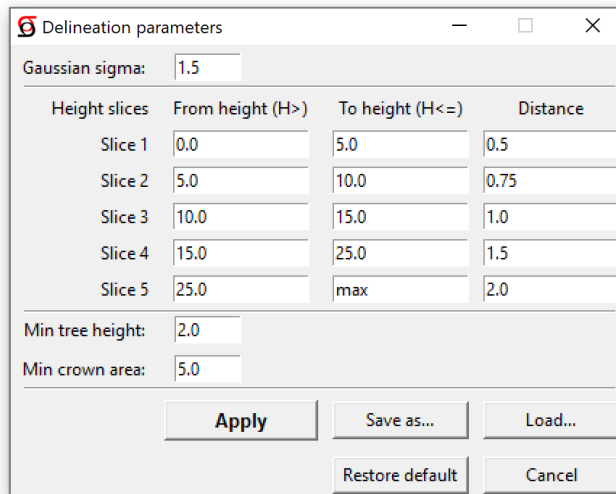


In the results, we see that because of the extra 20 m around each CHM tile, and the 10.0 m value of the *Tile inner buffer size* parameter, the border crowns of one tile will nest perfectly into those of the adjacent tile, leaving no missing, split, or incomplete crowns.



Changing the delineation parameters

To access the delineation parameters, click on the *Delineation parameter* button on the main SEGMA window. A sub-window appears that allows changing the default values.



Height slices	From height (H>)	To height (H<=)	Distance
Slice 1	0.0	5.0	0.5
Slice 2	5.0	10.0	0.75
Slice 3	10.0	15.0	1.0
Slice 4	15.0	25.0	1.5
Slice 5	25.0	max	2.0

Gaussian sigma

The sigma value affects the strength of a gaussian filter which is applied to the CHM before the local maxima are detected. It is used to rid the CHM of small protuberances to avoid detecting local maxima which may not be treetops. The higher the value, the more generalized the CHM will be. The strength of the gaussian filter is progressive from CHM heights of 10 m to 20 m. It has no effect below 10 m (to avoid suppressing small trees) and reaches its maximum effect (the sigma value) at 20 m (values above 20 m will be filtered with the same strength as those at 20 m).

Height slices

The height slices table controls how close two neighboring local maxima can be detected. In the case of small trees for example (say 5 m), we expect the treetops (the local maxima of the CHM) to be rather close (say, even less than 1 m from one another). For much larger trees, it is generally the case that the treetops cannot be very close from one another. However, especially for large deciduous trees, crown irregularities could be detected such that multiple local maxima instead of just one would be associated to a single crown. This would create multiple crowns in the output. So, in areas where the CHM is high, we prevent the detection of “sub-crowns” by applying a large exclusion distance. In the delineation parameter window above for

example, two neighboring local maxima cannot be both detected for CHM values between 15 m and 20 m if they are less than 1.5 m apart. The user can adjust the values of the five slices to fit the characteristics of the forests of a given area of interest.

Note that the *From height* value of a height slice should be equal to the *To height* value of the previous slice. No automatic verification is done to enforce this, and failure to follow this rule might cause the program to give sub-optimal results or to crash.

Minimum tree crown height and area

Finally, only tree crowns which are at least high as the *Min tree height*, and at least as large as the *Min crown area* values will be kept in the output.

Storing and restoring the parameter values

Pressing the *Apply* button will grab the new values and will close the delineation window. Pressing *Run* on the main window will preserve the user's parameter values for the next time SEGMA is launched.

The *Save as...* and *Load* buttons respectively allow storing and recalling specific delineation parameters (e.g., for different projects).

At any time, pressing the *Restore default* button will bring back the "factory settings" for all parameters.

Characteristics of the output crowns

The shapefiles containing the delineated crown polygons and the points will bear the name of the initial CHM tile, followed by the “_crowns” suffix. Each delineated crown is associated with a set of attributes found in the attribute table of the shapefile as follows:

Label	The initial raster label of the delineated crown.
Tile	The identifier of the tile. Corresponds to the root name of the .tif file containing the CHM.
Object_ID	A unique numerical ID identifying the crowns within the tile (numbers are not necessarily consecutive). IDs repeat over different tiles. Identifying a given tree across tiles is possible by combining <code>Tile</code> and <code>Object_ID</code> .
Centroid_X	The X value of the centroid of the crown, in the input coordinate system. Corresponds approximately to the tree stem locations.
Centroid_Y	The Y value of the centroid of the crown, in the input coordinate system. Corresponds approximately to the tree stem locations.
Centroid_d	An index based on the planimetric distance (in the units of the coordinate system, usually m) between the point defined by [<code>Centroid_X</code> , <code>Centroid_Y</code>] and the height-weighted centroid. The latter is defined by the mean of the following product: CHM pixel height times CHM pixel coordinate. Will be equal to zero for a perfectly symmetrical crown in 3D. Will differ from zero if the apex of the tree does not correspond, in XY, to the centroid of the footprint of the crown. The <code>Centroid_d</code> index is equal to the distance between the two centroids, divided by the diameter of the crown, and multiplied by 10000. Values below 5.0 are considered to be good.
Height	The maximum height in the crown, representing a good approximation of tree height.
HtoA_ratio	Equal to $\text{Height}/\text{Area}$ (usually m/m ² .)
V_extent	The vertical extent of the visible part of the crown (usually in m.) Corresponds to <code>Height</code> minus the value of the lowest visible CHM pixel within the crown.
Cr_ratio	Equal to $\text{V_extent}/\text{Height}$.
Area	Area of the crown footprint (usually in m ²)

Diameter	The diameter of a circle having an area equal to the value of the <code>Area</code> field.
Roundness	A value indicating the roundness of the crown defined as $\sqrt{\text{area}/\pi} * 2.0 * \pi$. Equals 1.0 for a perfectly circular crown. Become lower than 1.0 for crowns departing from circularity.
Eccentric	Eccentricity of the crown. See scikit-image definition: <i>“Eccentricity of the ellipse that has the same second-moments as the region. The eccentricity is the ratio of the focal distance (distance between focal points) over the major axis length. The value is in the interval [0, 1]. When it is 0, the ellipse becomes a circle.”</i> . In SEGMA, crowns are “regions”, <i>sensu</i> scikit-image.
Solidity	Solidity of the crown, defined as the <i>“ratio of pixels in the region to pixels of the convex hull image”</i> . In SEGMA, crowns are “regions”, <i>sensu</i> scikit-image.
Coef_var	Coefficient of variation (standard deviation divided by the mean) of the CHM height values within the crown. Values of 0.10 (10%) or less are preferable. Higher values may indicate the crowns has “leaked” onto neighbouring shrubs.
Score	An automatically calculated score from 0 to 100 indicating the quality of the delineation. This score is computed as a weighted mean of <code>Centroid_d</code> , <code>Eccentric</code> , <code>Solidity</code> , and <code>Coef_var</code> . Values above 80 usually indicate a very well-delineated crown.