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Mapping species at the individual tree level using airborne lidar and contextual information at Black Brook

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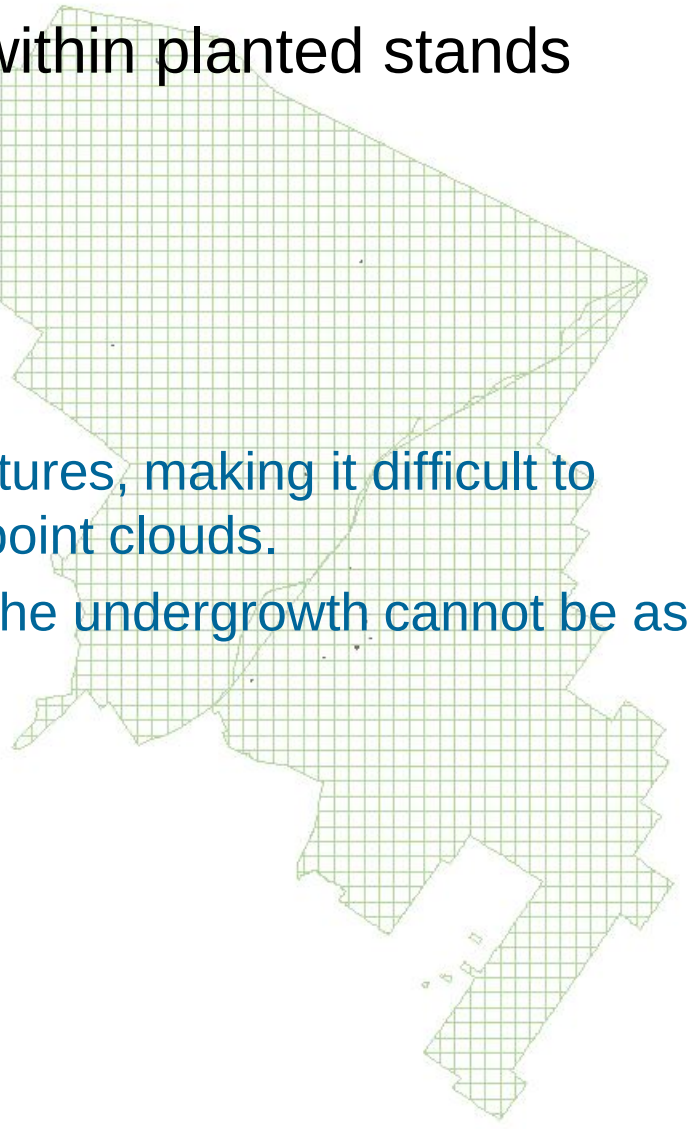
Research question

- General objective: improvement of species identification from lidar point clouds at single-tree level
- Research site: Black Brook forest, New-Brunswick.
- Species assessment will provide information for better management :
  - composition of stands
  - growth
  - spatial distribution
  - non-timber objectives.

Case-specific problematic at Black Brook forest

- Localisation of fir regeneration within planted stands
  - Undergrowth in older stands
  - Similar height in younger stands

- Challenges
  - Fir and spruces share similar structures, making it difficult to classify them based solely on the point clouds.
  - Delineatation of the smaller firs in the undergrowth cannot be as precise as the upper layer.



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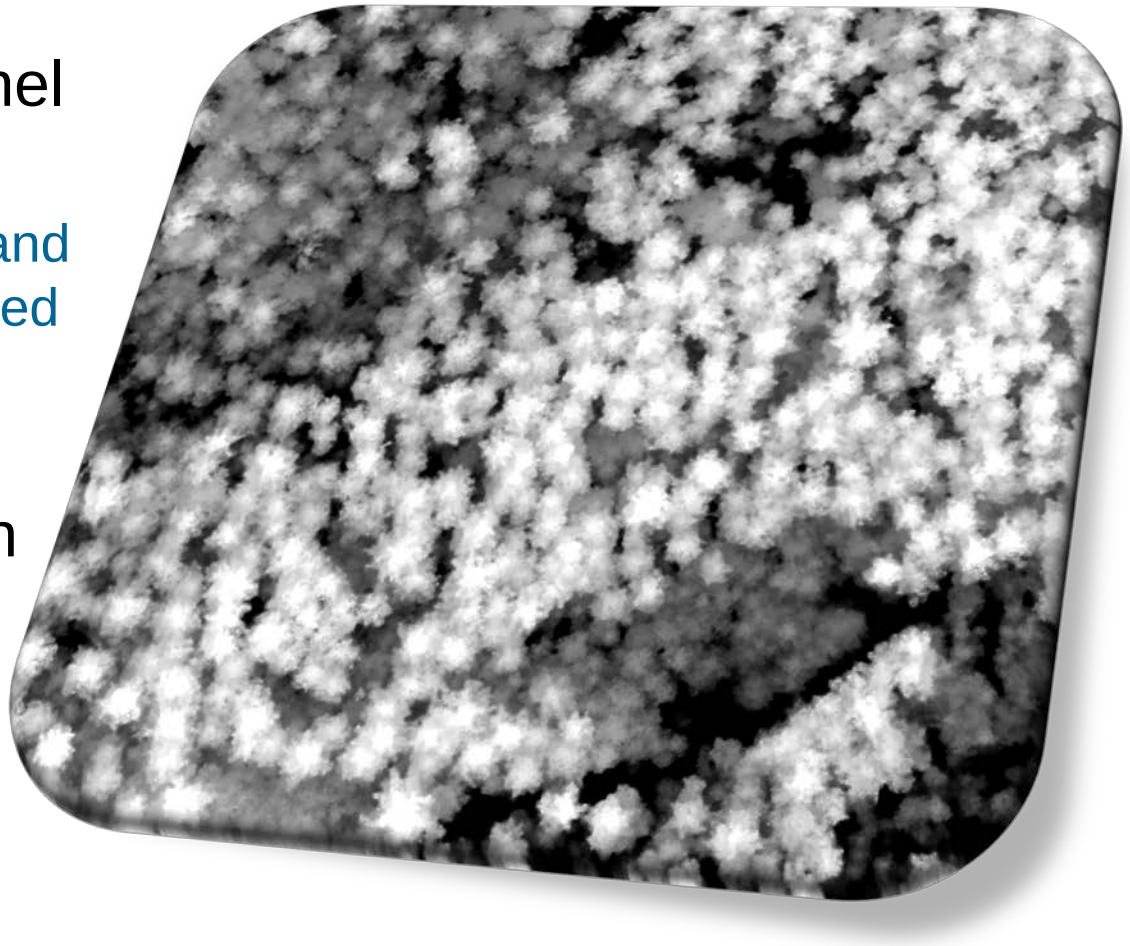
CASE 1: fir and spruces of comparable sizes

CASE 2: fir (and HW) undergrowth

Using monospectral lidar for species identification

- "Standard" lidar
- Only single channel intensity
  - i.e. no spectral band ratios or normalized indices
- Crown delineation from the CHM using SEGMA software.



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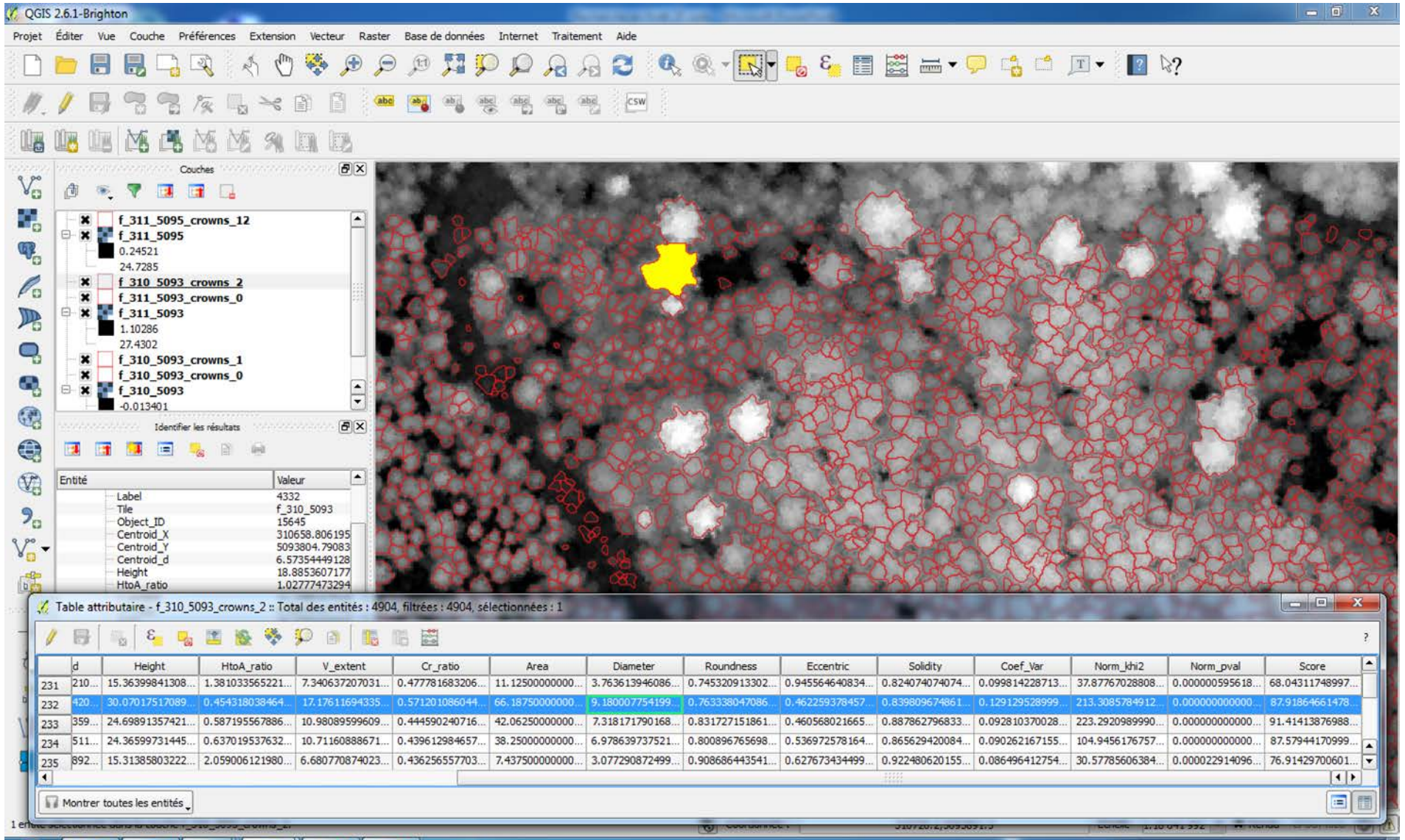
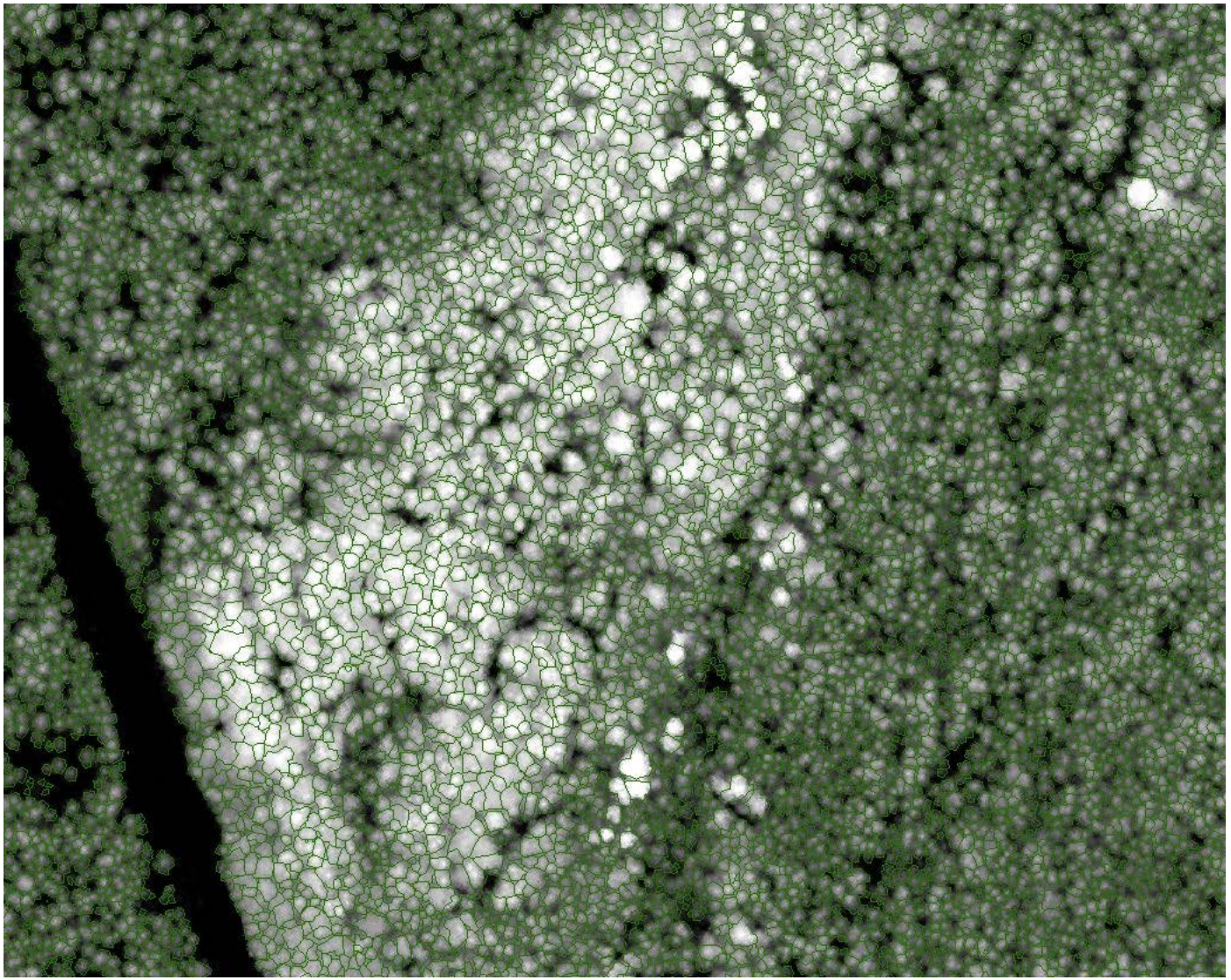
SEGMA output : single tree delineation and 2D attributes from lidar

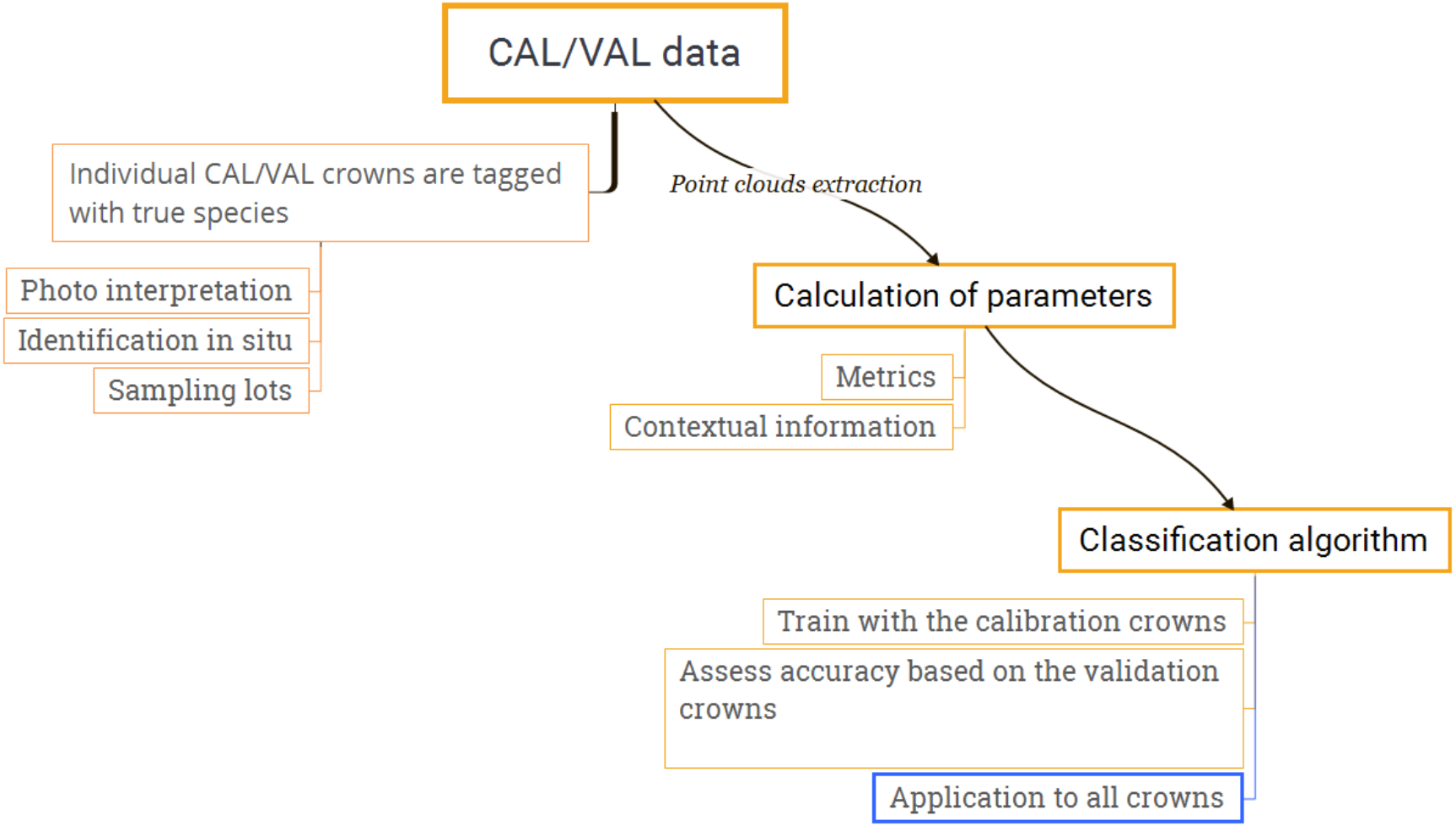


	d	Height	HtoA_ratio	V_extent	Cr_ratio	Area	Diameter	Roundness	Eccentric	Solidity	Coef_Var	Norm_khi2	Norm_pval	Score
231	210...	15.36399841308...	1.3810335652 21...	7.3406372070 31...	0.4777816832 06...	11.125000000000...	3.7636139460 86...	0.7453201330 02...	0.9455646408 34...	0.8240740740 74...	0.0998142287 13...	37.877670288 08...	0.0000005956 18...	68.043117489 97...
232	420...	30.07017517089...	0.4543180384 64...	17.176116943 35...	0.5712010860 44...	66.187500000000...	9.1800077541 99...	0.7633380470 86...	0.4622593784 57...	0.8398096748 61...	0.1291295289 99...	213.30857849 12...	0.0000000000 00...	87.918646614 78...
233	359...	24.69891357421...	0.5871955678 86...	10.980895996 09...	0.4445902407 16...	42.062500000000...	7.3181717901 68...	0.8317271518 61...	0.4605680216 65...	0.8878627968 33...	0.0928103700 28...	223.29209899 90...	0.0000000000 00...	91.414138769 88...
234	511...	24.36599731445...	0.6370195376 32...	10.711608886 71...	0.4396129846 57...	38.250000000000...	6.9786397375 21...	0.8008967656 98...	0.5369725781 64...	0.8656294200 84...	0.0902621671 55...	104.94561767 57...	0.0000000000 00...	87.579441709 99...
235	892...	15.31385803222...	2.0590061219 80...	6.6807708740 23...	0.4362565577 03...	7.4375000000000...	3.0772908724 99...	0.9086864435 41...	0.6276734344 99...	0.9224806201 55...	0.0864964127 54...	30.577856063 84...	0.0000229140 96...	76.914297006 01...

Tree crown delineation at Black Brook (JD Irving)

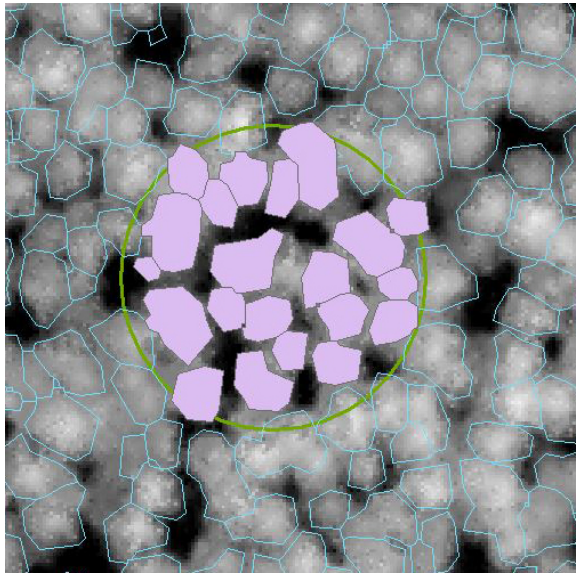


Identification process



Calibration data for Black Brook forest

Sampling method	Date	Number of crowns
Sampling plots	Fall 2014	879
Field identification	Fall 2015	1038
Photo interpretation	March 2016	272
	Total	**2189**



Sampling plots

Field identification

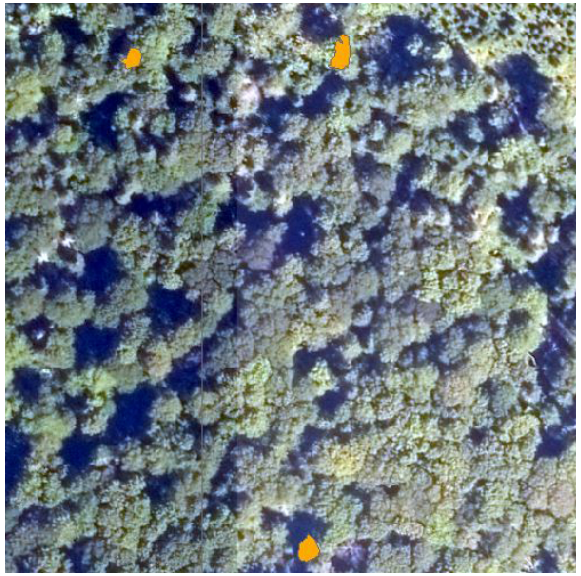
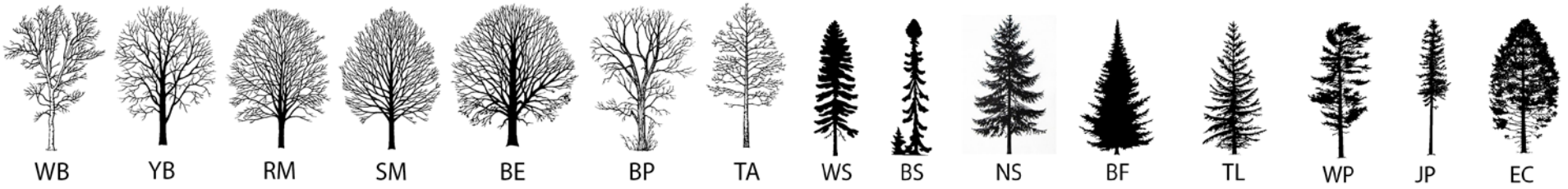


Photo-interpretation

Calibration data for Black Brook forest

- 15 species



HARDWOOD

Code	Species	Crowns
BF	Balsam fir	280
BS	Black spruce	507
EC	Eastern white cedar	70
JP	Jack Pine	2
NS	Norway spruce	162
TL	Eastern larch	66
WP	White pine	3
WS	White spruce	501
	Total	**1591**

SOFTWOOD

Code	Species	Crowns
BE	Beech	35
BP	Balsam poplar	4
RM	Red Maple	79
SM	Sugar maple	308
TA	Trembling aspen	60
WB	White birch	46
YB	Yellow birch	162
	Total	**694**

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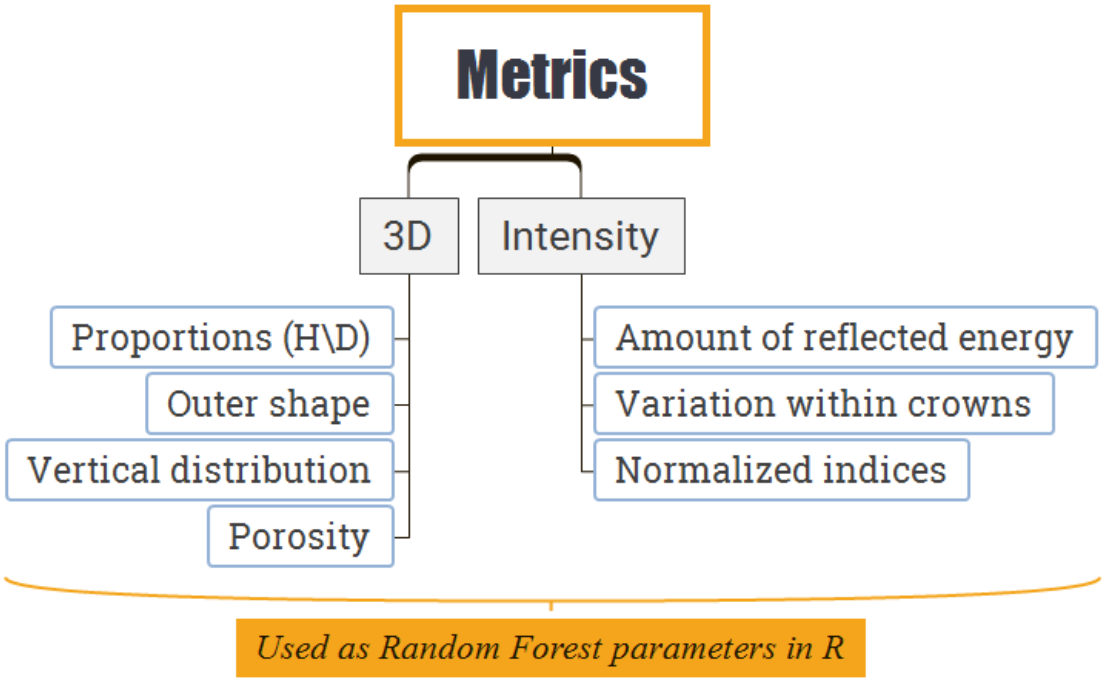
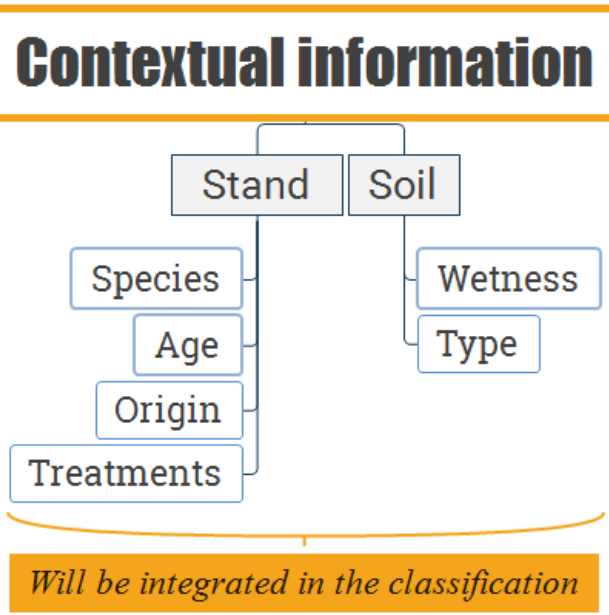
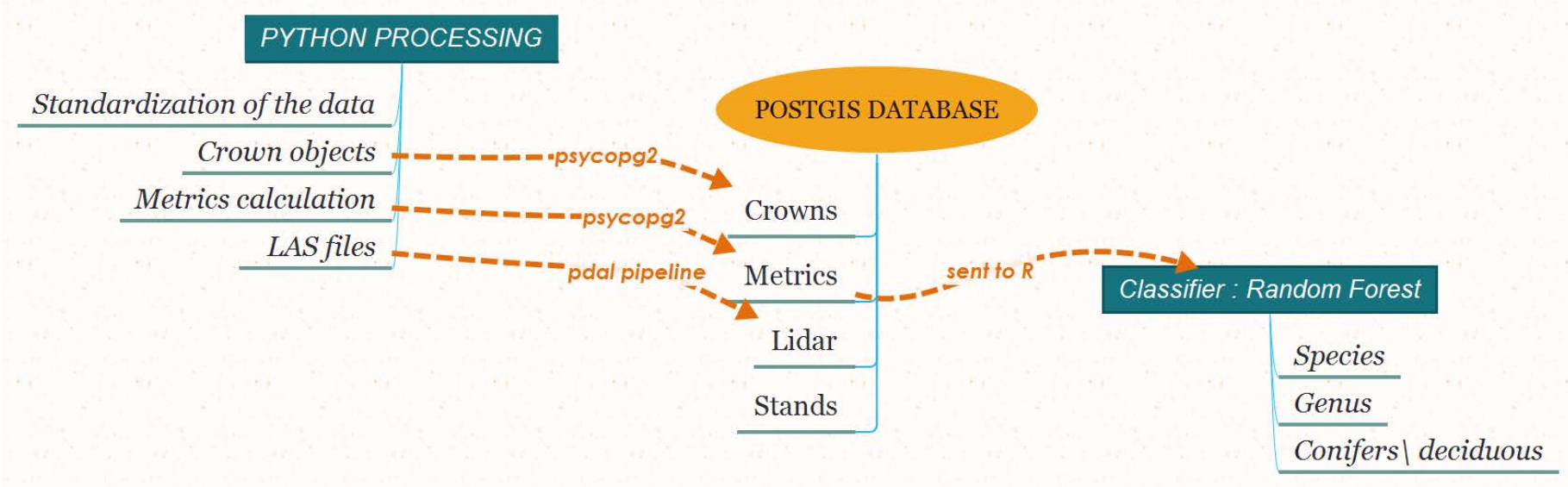
Classification parameters





Computational workflow



Black Brook species identification results

Hardwood vs Softwood classification

kappa: 0.86

	Softwood	Hardwood	% accurate classification
Softwood	**565**	18	96,9
Hardwood	33	**244**	88,1

Genus classification

kappa: 0.56

	abies	acer	betula	fagus	larix	picea	populus	thuya	% accurate classification
abies	**12**	6	0	0	2	72	0	4	12,5
acer	0	**125**	17	0	0	9	0	2	81,7
betula	1	50	**28**	0	0	9	0	0	31,8
fagus	0	5	6	**1**	0	1	0	0	7,7
larix	1	2	0	0	**6**	12	0	0	28,6
picea	3	7	1	0	2	**422**	0	2	96,6
populus	0	8	4	0	0	11	**0**	0	0,0
thuya	1	5	3	0	1	15	0	**4**	13,8

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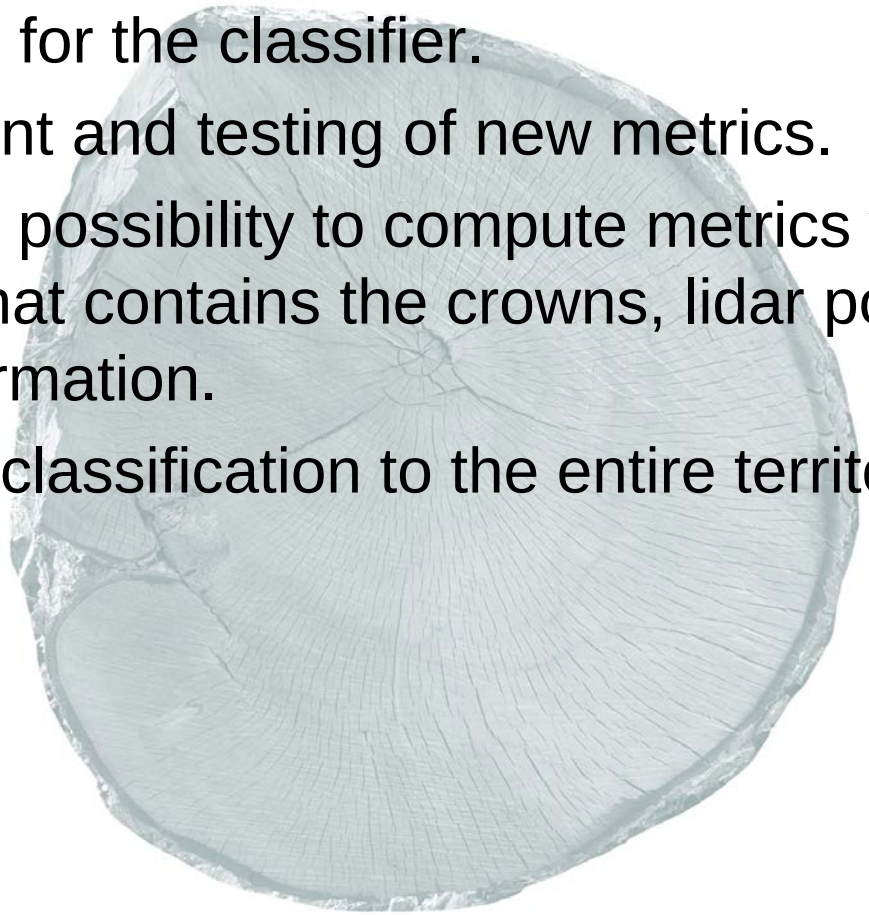
Black Brook species identification results

Species classification

kappa: 0.42

	BE	BF	BS	EC	NS	RM	SM	TA	TL	WB	WS	YB	% accurate classification
BE	1	0	0	0	0	0	6	0	1	0	1	4	7,7
BF	0	28	29	4	1	1	6	0	3	0	24	0	29,2
BS	0	8	158	2	0	0	1	0	2	0	28	0	79,4
EC	0	4	3	12	0	0	2	0	1	0	5	2	41,4
NS	0	1	19	0	7	0	0	0	0	0	17	0	15,9
RM	0	0	2	0	0	1	22	0	0	0	3	4	3,1
SM	1	1	0	3	0	0	103	0	0	1	2	10	85,1
TA	0	0	1	0	0	1	6	0	0	1	11	3	0,0
TL	0	3	3	0	0	0	2	0	9	0	4	0	42,9
WB	0	1	0	0	0	0	6	0	0	3	3	2	20,0
WS	0	11	51	2	7	1	3	0	0	0	118	1	60,8
YB	0	2	2	0	0	3	40	0	0	1	4	21	28,8

What's next ?

- Integration of the contextual data as additional parameters for the classifier.
- Development and testing of new metrics.
- Explore the possibility to compute metrics within a spatial database that contains the crowns, lidar points and stands information.
- Extend the classification to the entire territory.