Characterization of the quality of roundwood automatically: Recent results and perspectives

V.-T. NGUYEN, T. CONSTANT, F.COLIN, B.KERAUTRET, I. DEBLED-RENNESSON, A. PIBOULE

Which economic stakes about wood quality?

- Log selling price depends on the presence of defects

Price of Oak Logs of Decreasing quality

Classe	Longueur	Diamètre	Défaut	Prix
A	3m	>=55cm	Sans défaut	>= 560€
B	3m	>=50cm	Peu défauts	>= 345€
C	3m	>=35cm	Avec défauts	180€
D	1.5m		Beaucoup défauts	9€

From: Forêts de France (2017)

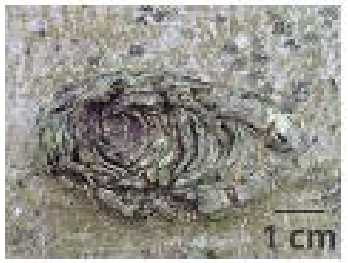
- Factors
  - Diameter → Volume → Global shape (Taper, Curvature)
  - Log Ends : Ring Width, Colour, Eccentricity, Rot,….
  - Number of surface defects / meter / type.

Surface defects :

(a) Branch scar on oak

(b) Branch scar on wild cherry

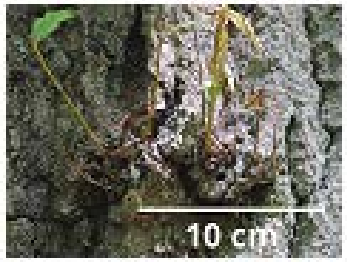
(c) Branch scar on beech



(d) Branch scar on beech

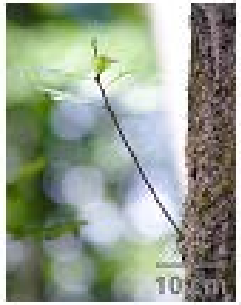

(e) Sequential branch

(f) Burl consisting of buds and an epicormic shoot



(g) Burl consisting of buds and short epicormic shoots

(h) Burl consisting of buds


(i) Epicormic shoot

(j) Bud cluster

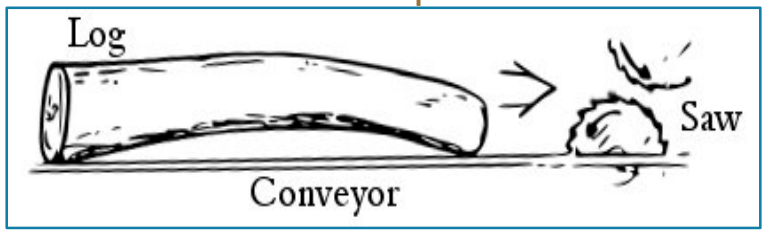
(k) Spheroblaste

(l) Picot

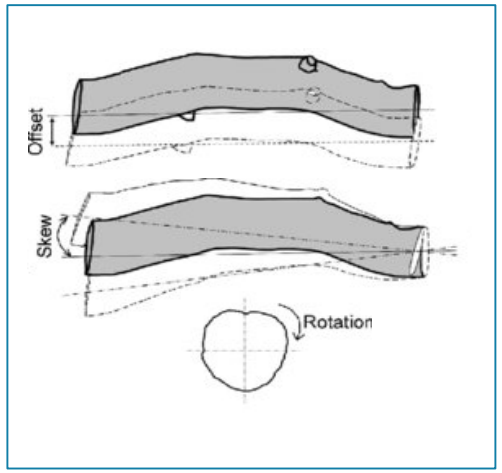
Which economic stakes about Wood Quality?

- To optimize from quality information the the first transformation

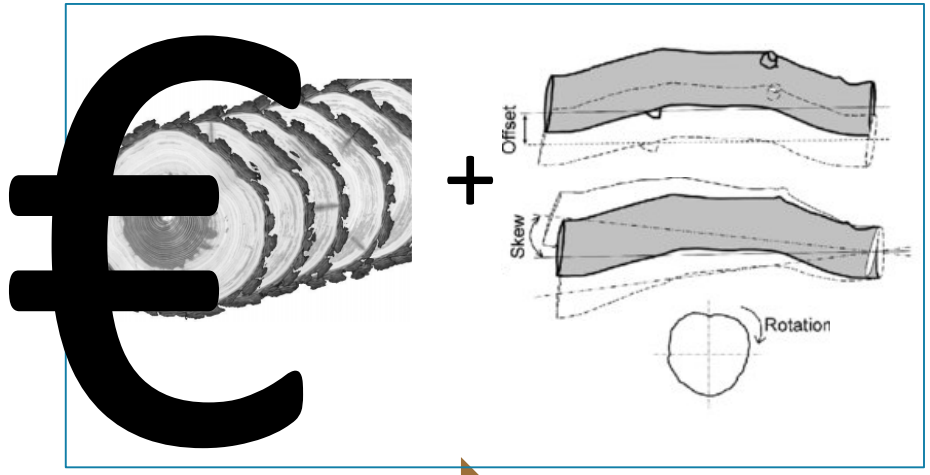
Horns down Sawing
= standard optimization



Optimization
on global shape



Optimization
from shape and knots

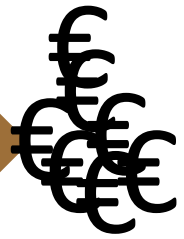


Recovery Value + 21%

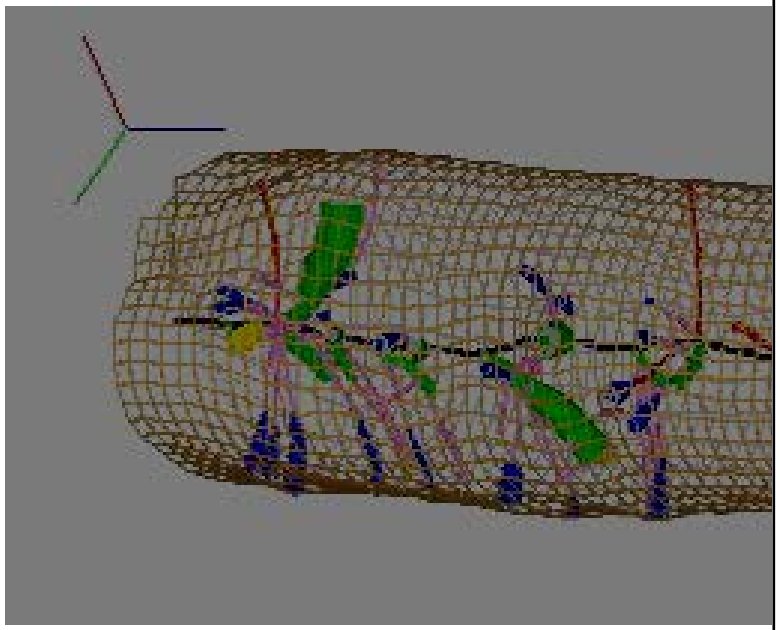
269 Logs Norway Spruce and Scots Pine

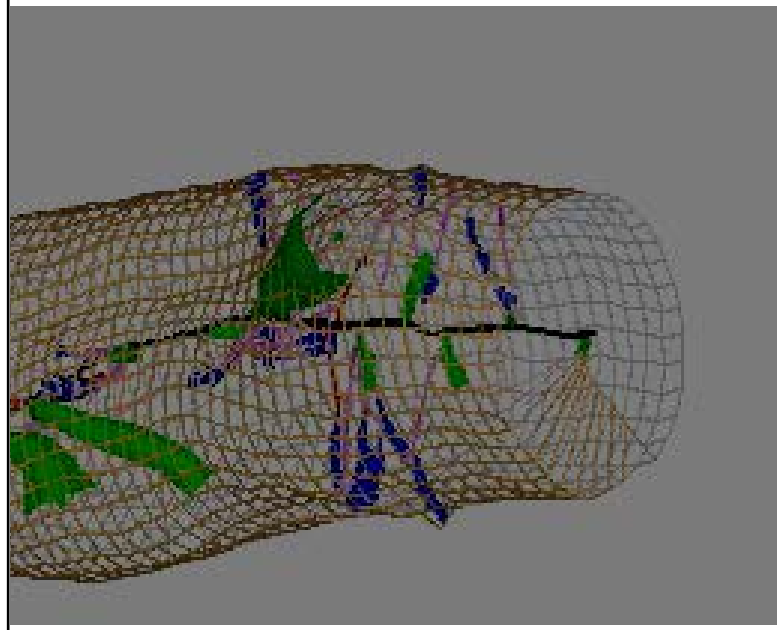
Fredriksson 2014

Recovery Value + 13%



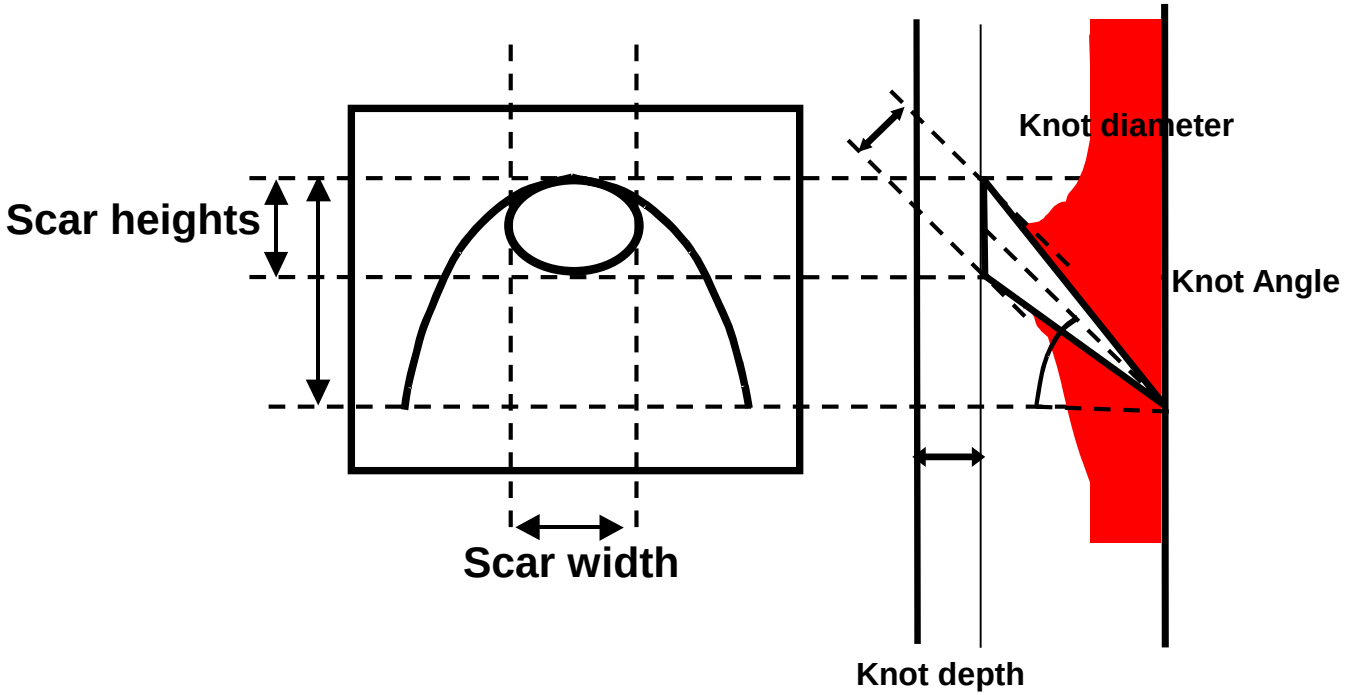
X-Ray scanner = ethod



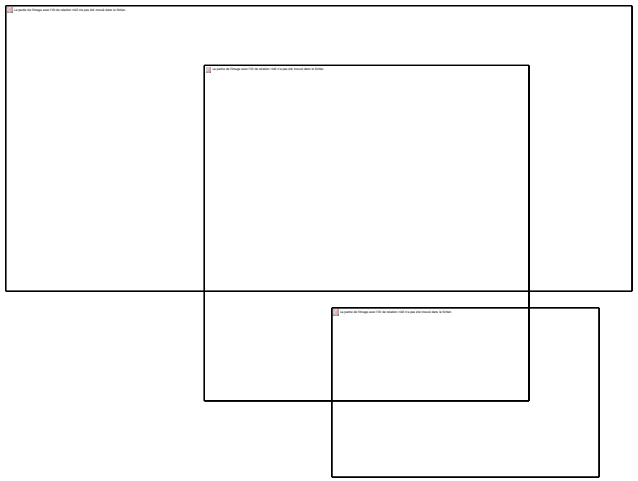


Geometrical model of the inne g coming from an X-Ray Scan

60 -80% of Internal defects are detectable from outside



Is it possible to characterize the inner part from outside automatically ?



Perhaps….but Several steps must be lifted

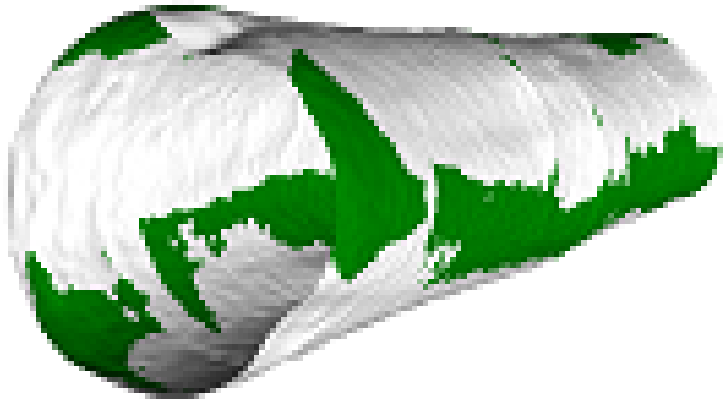
- To describe the bark surface with enough details:
  - T-LiDAR = Reference Method
    Providing detailed information on standing trees
- To detect the defect on bark
- To identify the defect type
- To measure its characteristics

} 3 Objectives of Van-Tho's PhD

- To link external features of the defect to inner ones ➡ ANR Project WoodSeer ?

Detection of the defect on the bark

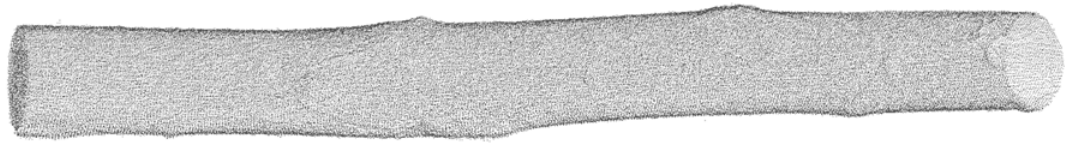
- A tricky objective which needs a reference surface



(b) Cylindrical based method

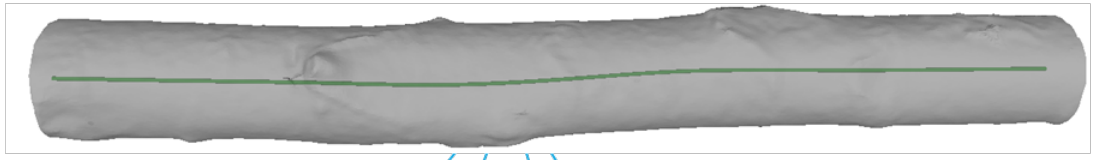
Algorithm for segmenting defect areas

Step 1:

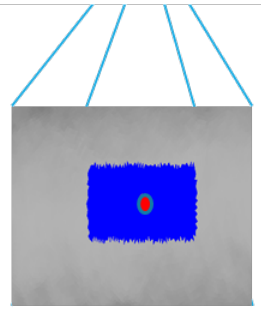


Step 2:

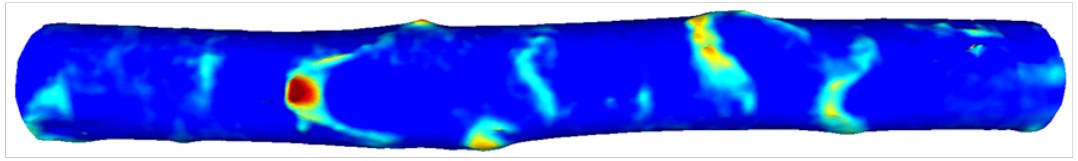
Step 3:



Step 4:



Step 5:



Step 6:

3D Cloud

Meshing

Central Line

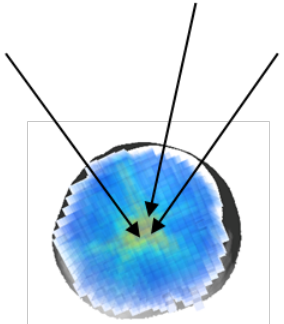
For each 3D Point

Real Distance D to the Central Line

Reference Distance Dref to the central line fitted from a neighbourhood of the point

D-Dref

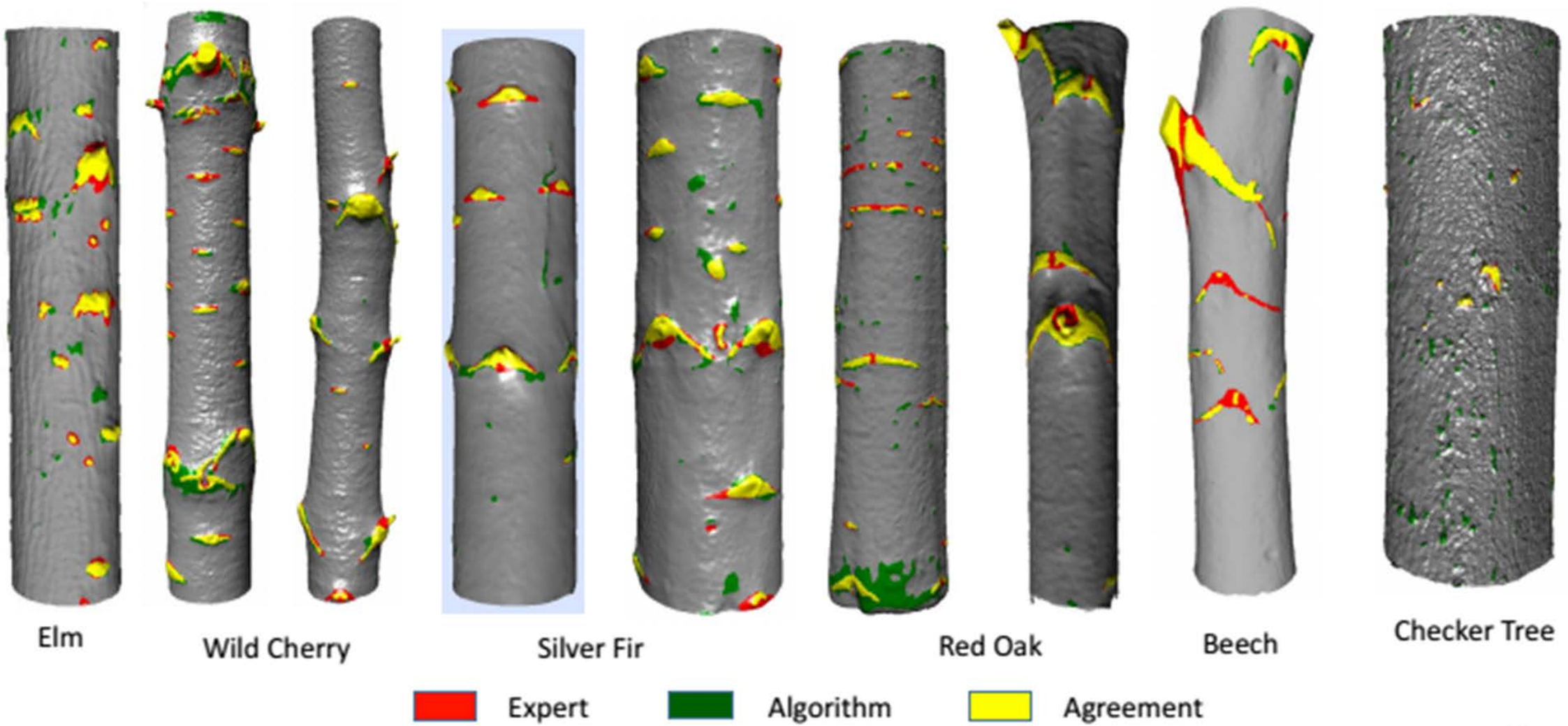
Thresholding



from Kerautret et al. 2012

Nguyen et al. 2016 a & b

Results


Elm
Wild Cherry
Silver Fir
Red Oak
Beech
Checker Tree
Expert
Algorithm
Agreement
16

Results about defect detection

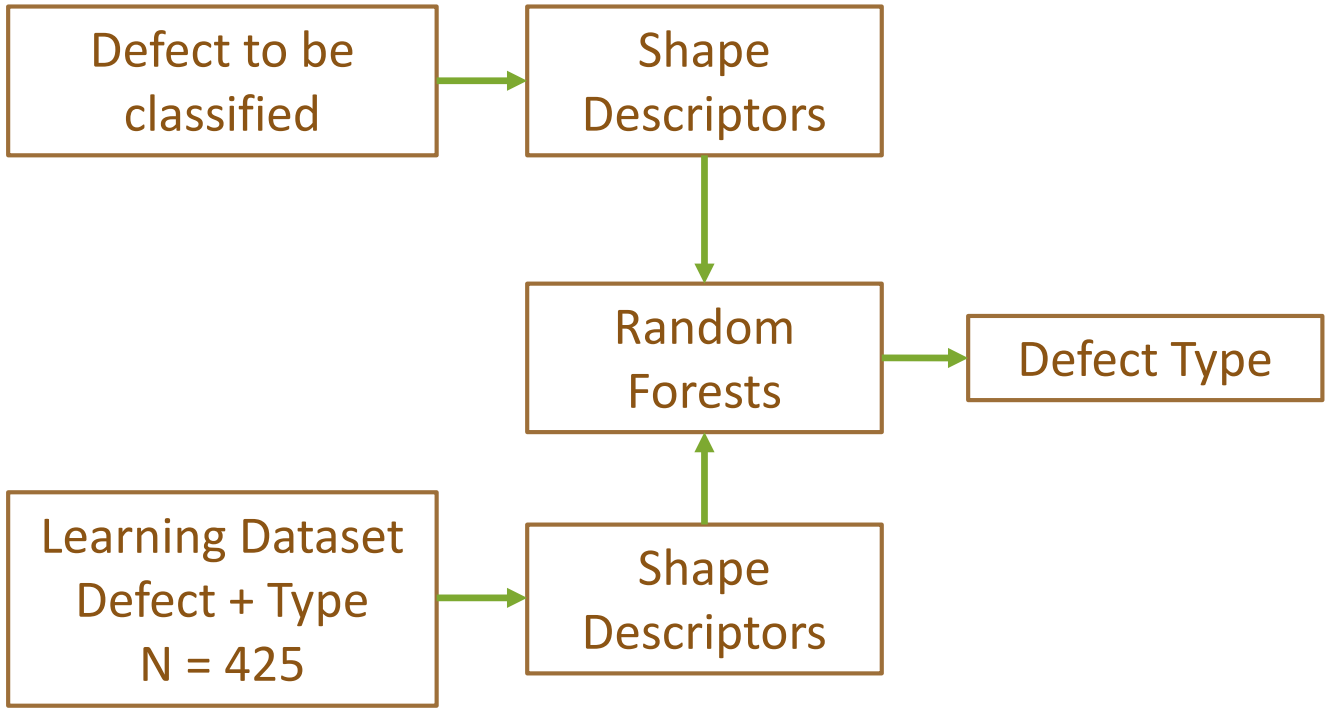
- Metrics

  - Precision $P = \frac{TP}{TP + FP}$
  - Recall $R = \frac{TP}{TP + FN}$
  - F1 value $F_1 = 2\frac{PR}{P + R}$

	Proposed method			Cyl.-based method[12]		
Log	Prec[1]	Recall	F1	Prec	Recall	F1
Fir 1	0.747	0.769	0.757	0.137	0.937	0.238
Fir 2	0.673	0.775	0.719	0.353	0.452	0.395
Wild cherry 1	0.696	0.765	0.728	0.683	0.512	0.584
Wild cher $F_1 = 2\frac{PR}{P+R}$	0.846	0.711	0.771	0.661	0.822	0.732
Red oak 1	0.749	0.742	0.744	0.479	0.444	0.459
Red oak 2	0.428	0.833	0.564	0.061	0.400	0.104
Beech	0.670	0.604	0.634	0.360	0.289	0.320
Birch	0.733	0.756	0.744	0.607	0.421	0.496
Elm	0.694	0.755	0.721	0.494	0.309	0.378
Wst[2]	0.247	0.741	0.370	0.057	0.463	0.100
Overall	0.685	0.740	0.710	0.289	0.563	0.380

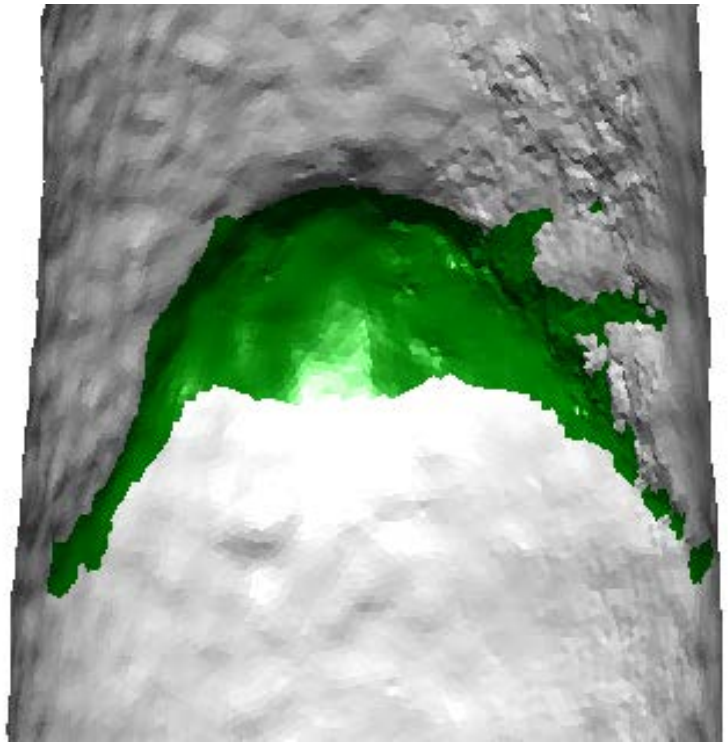
Classification of defects

- Five Classes
  - Branches (sequential and epicormic)
  - Branch scars
  - Burl
  - Small defects = (Picot, Sphéroblaste, Bud Cluster, bud)
  - *Bark*

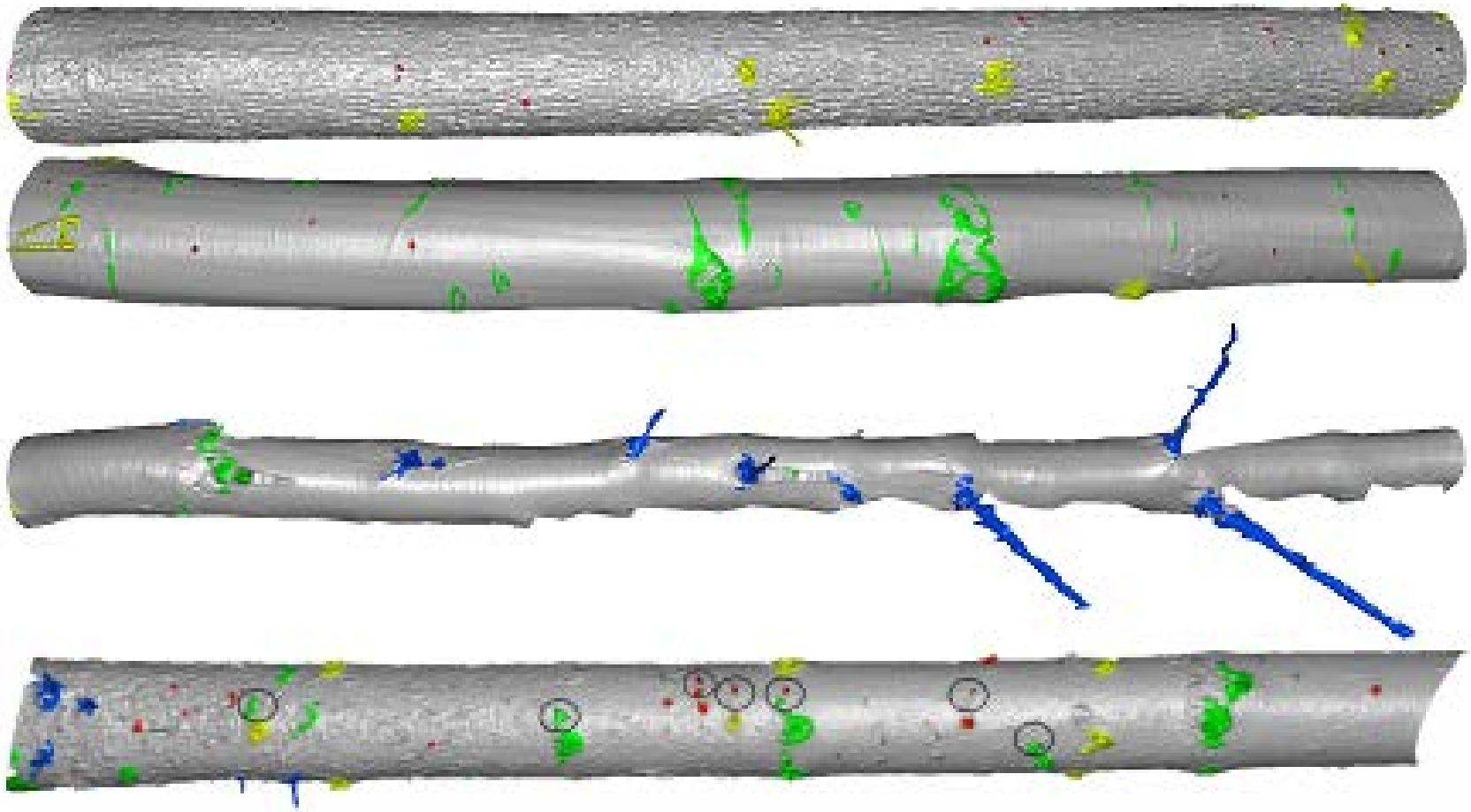


Classification of defects

- 15 Shape Descriptors
  - Species
  - Ratio between the nb of points of the defect and the volume of its bounding box
  - Hu invariant moments
  - Ratio between eigenvalues
  - Angle between trunk axis and 3rd eigen vector
  - ……



Results about classification



Oak

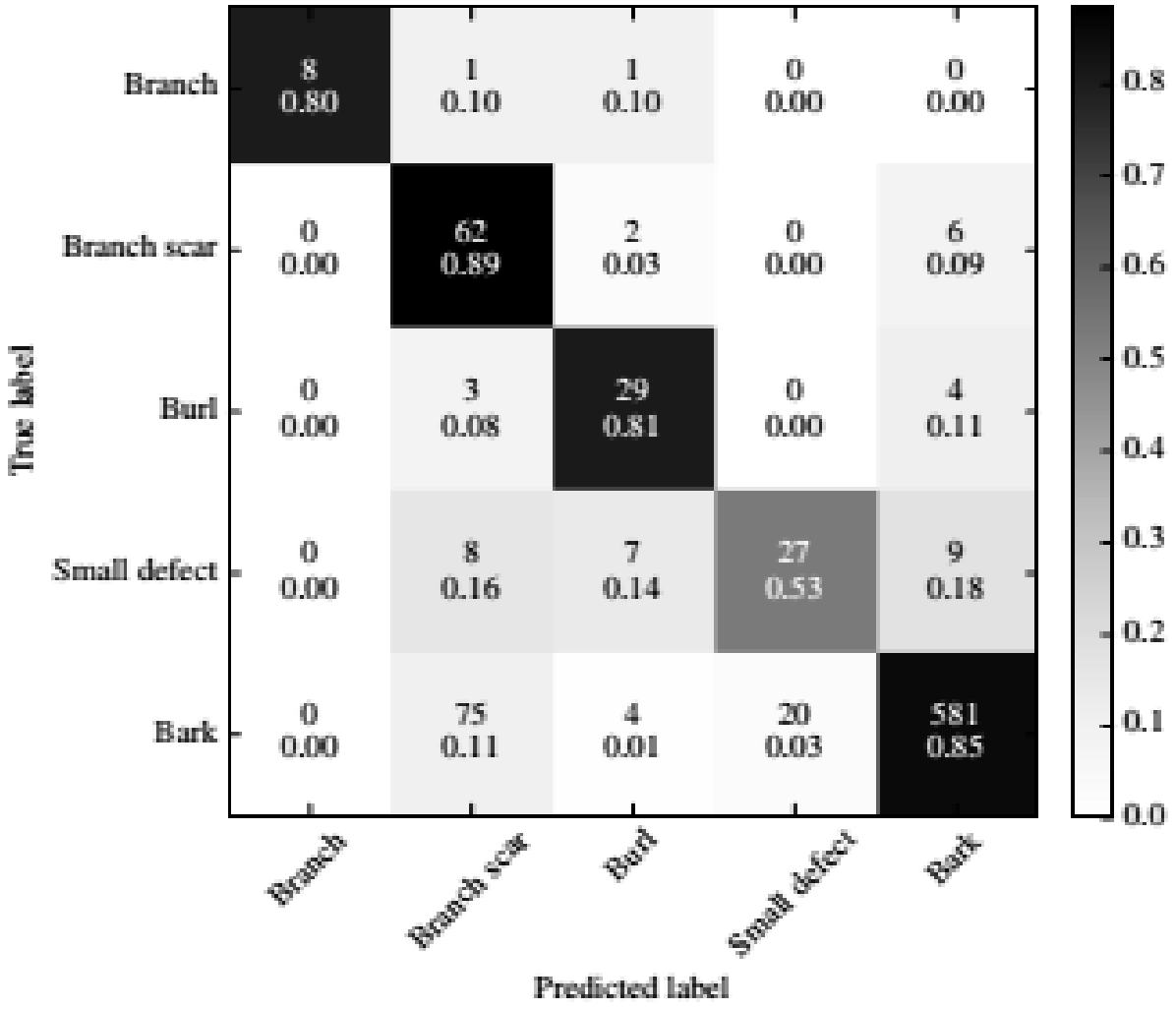
Beech

Wild Cherry

Norway Spruce

- Branch
- Branch Scar
- Burl
- Small Defect

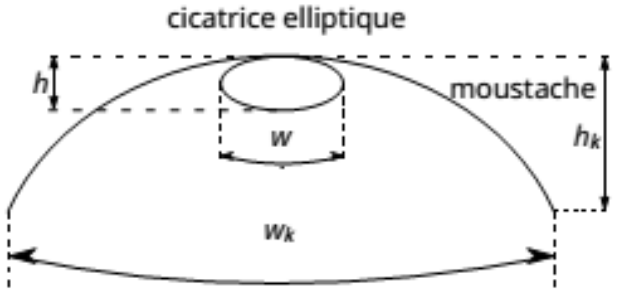
Classification Results



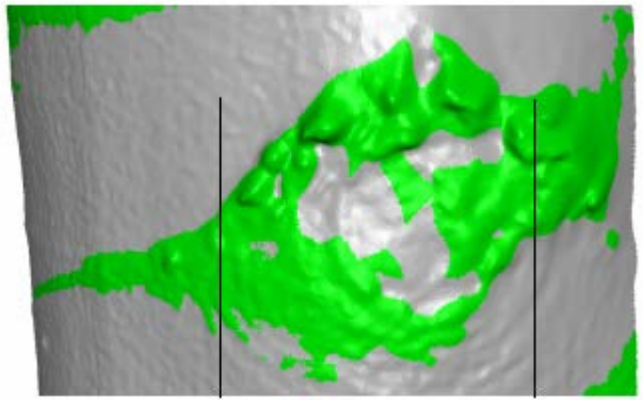
Characterization of the defect

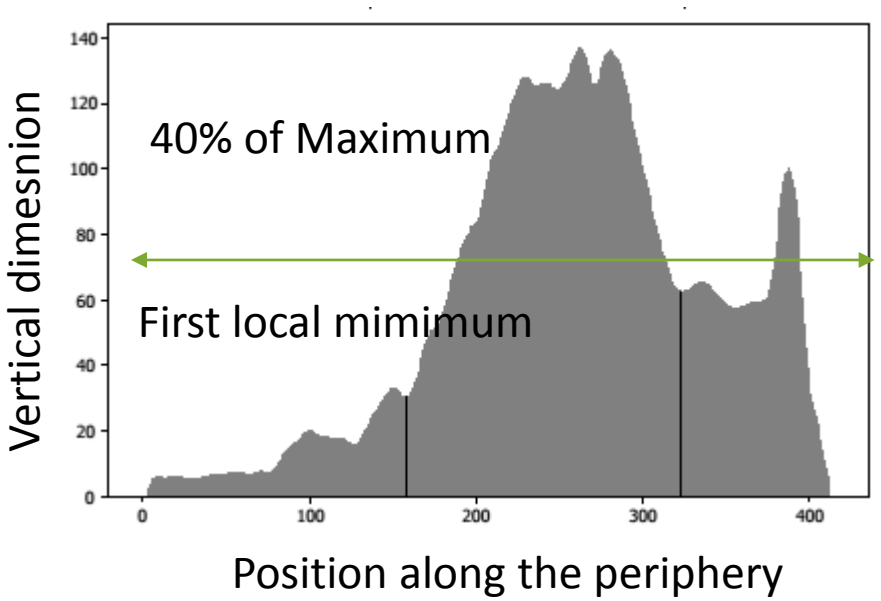
- To compare with human characterizationis a difficult task
- An example about the width of the knot scar (w)

Geometrical Model



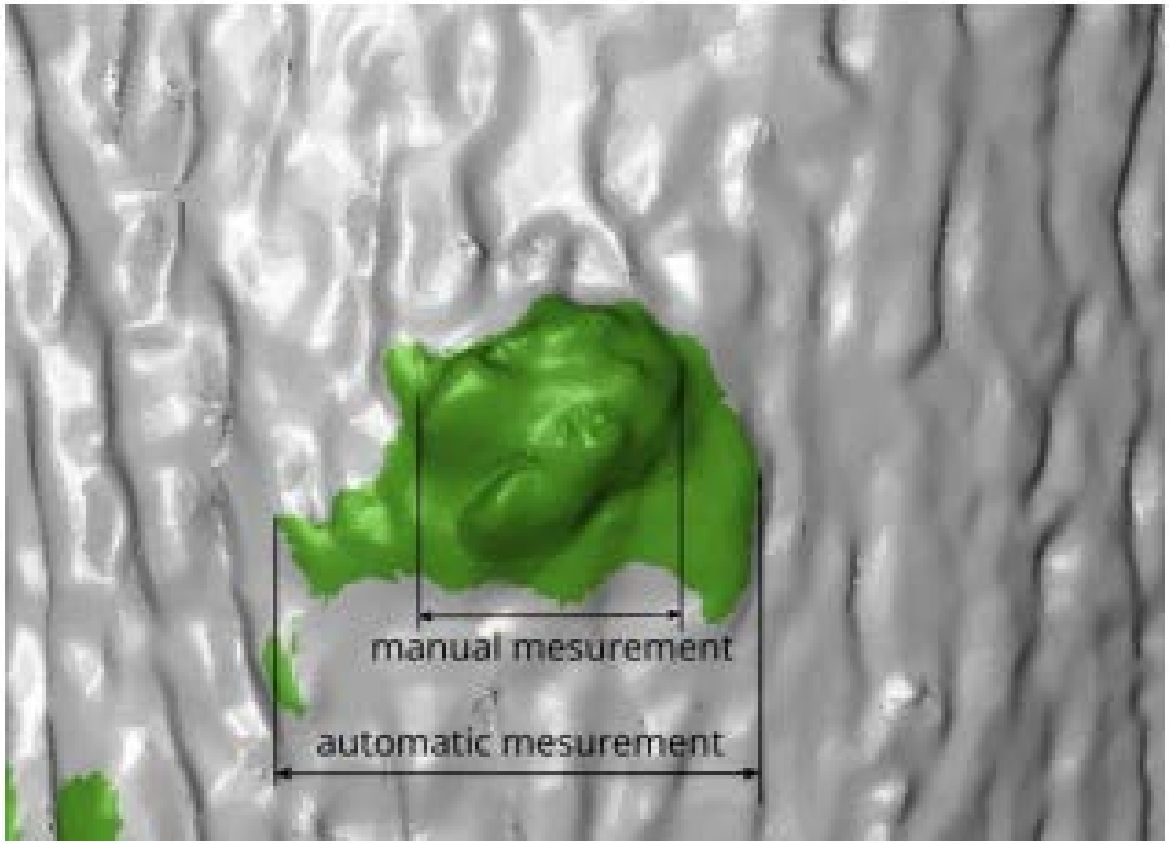
Data + Result





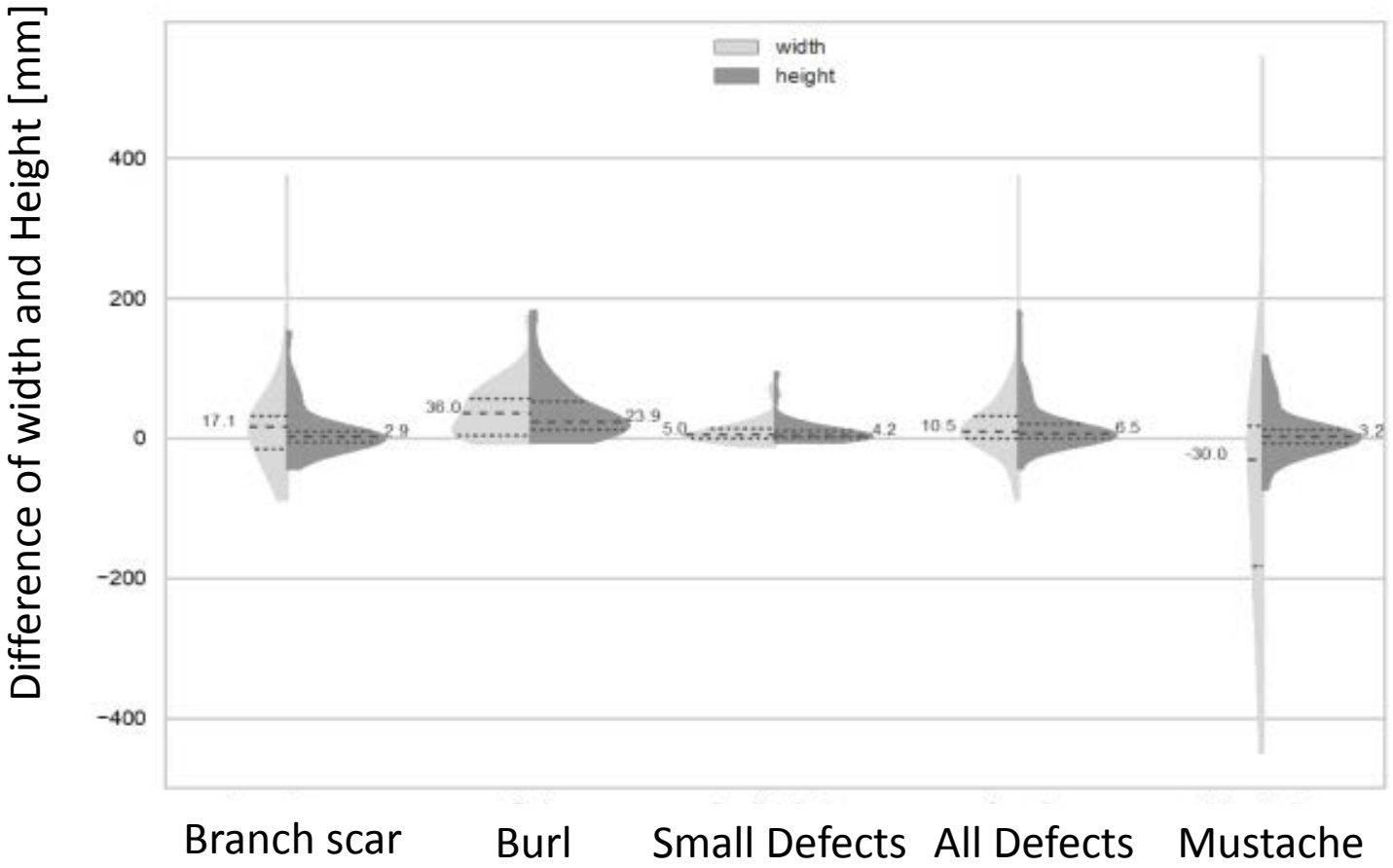
Characterization of defect

- A difficulty :
  - the definition of a defect area is not exactly the same between a human and algorithms.



Characterization of defect

- 141 Defects



- Overestimation of dimensions by algorithms
- Encouraging results
- Must be improved ….

Project ANR : WoodSeer

Task 1

- 4 species x 10 trees
  → Min 100 defects by species
- Diversification of data Acquisition True shape scanner
  - Handheld Cameras
- To provide a dataset with outer and inner 3D data of the same defects (X-Ray scans)
- Generation of Virtual Data to feed learning dataset for Deep Learning approaches

Task 2

- To improve the segmentation and classification steps
  - For outer surface data
  - For inner volume data
  - Deep Learning with geometrical cosntraints

Task 3

- To connect Outer and Inner part of the defect
  - By Deep Learning
  - By statistical model on characterisitics

Conclusions

- With respect to initial objectives :
  - Description of Trunk surface : T-LiDAR relevant but time costly
  - Detection of defects : Rather efficient method available
  - Classification of defects : Improvement needed
    - More data for learning dataset
    - To refine the classes ; Type +Size
  - Characterization of defects
    - Human-like characterization by algorithm difficult but not necessary for IA approaches
  - Connection to inner characteristics: To do

MERCI DE VOTRE ATTENTION