Accurate detection and classification of aberrant cell nuclei

Marlies Verschuuren [1,2,3], Hannes Cattrysse [4], Jonas De Vylder [5], Winnok H. De Vos [2,3]

[1] Ph. D. fellowship of the Research Foundation - Flanders (FWO)
[2] Department of Veterinary Sciences, University of Antwerp, Antwerp, Belgium
[3] Department of Molecular Biotechnology, Ghent University, Ghent, Belgium
[4] Institute for Agricultural and Fisheries Research (ILVO), Merelbeke, Belgium
[5] Department of telecommunication and information processing, IPI, iMinds, Ghent university, Ghent, Belgium
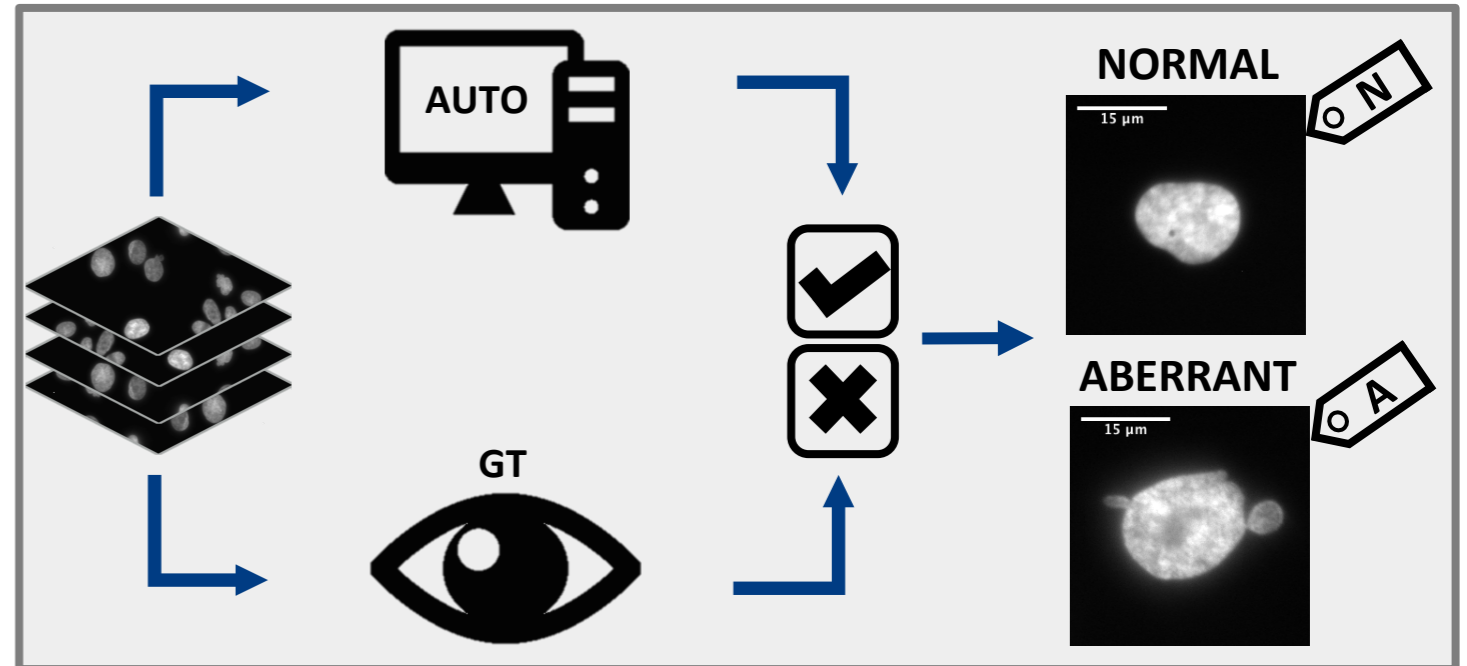
▶ Introduction

Nuclear shape changes are correlated with a broad range of **pathologies**. **Automated recognition** of aberrant nuclei may **accelerate diagnostics as well as fundamental research**.

To enable accurate detection of both severely and moderately deformed nuclei, we have developed a **segmentation method** based on:
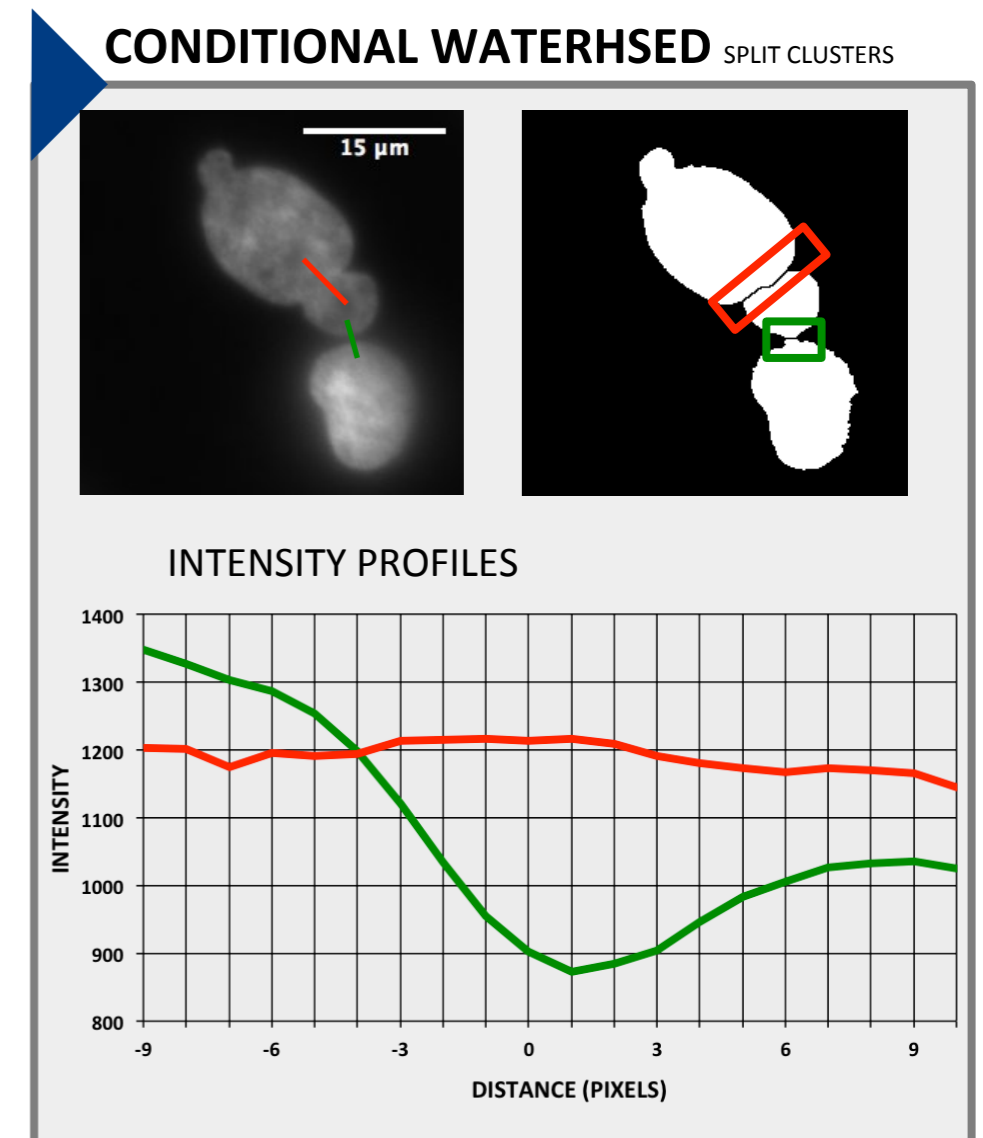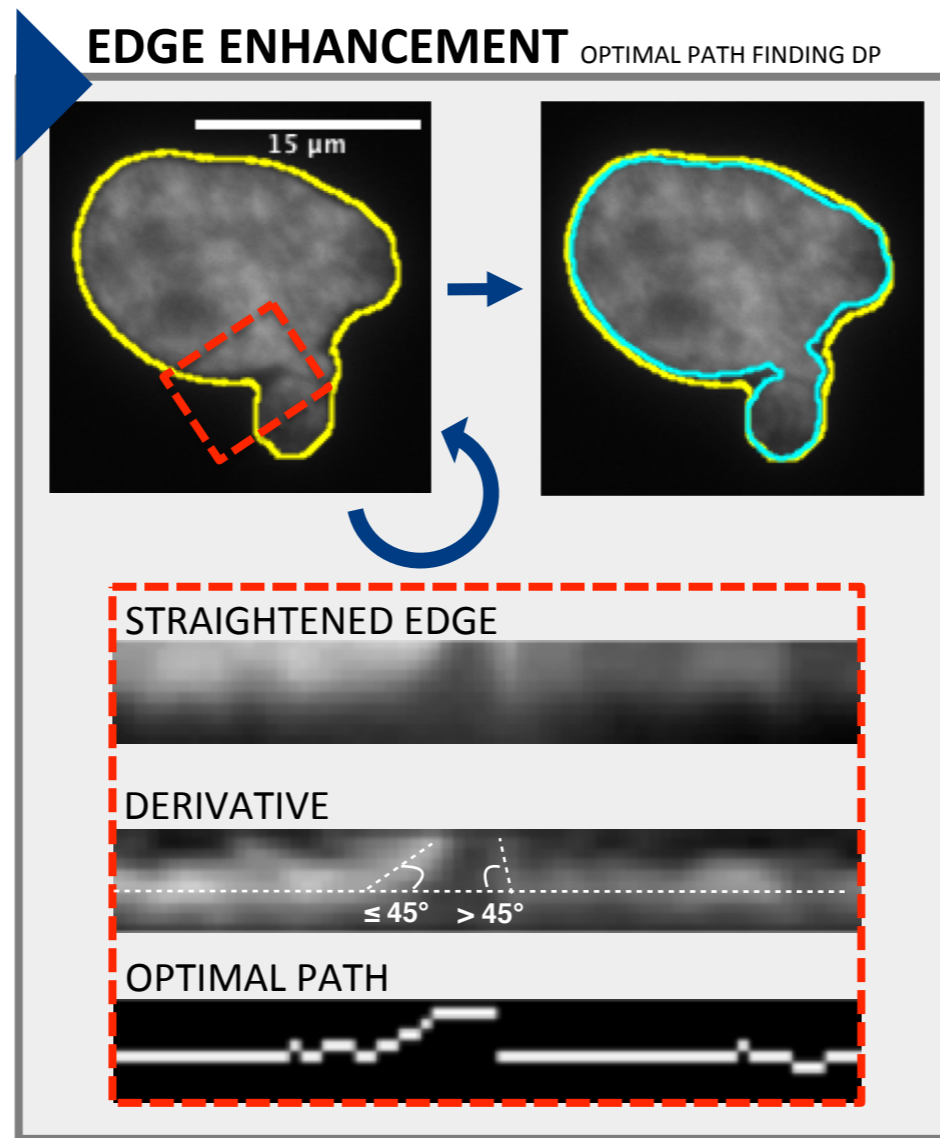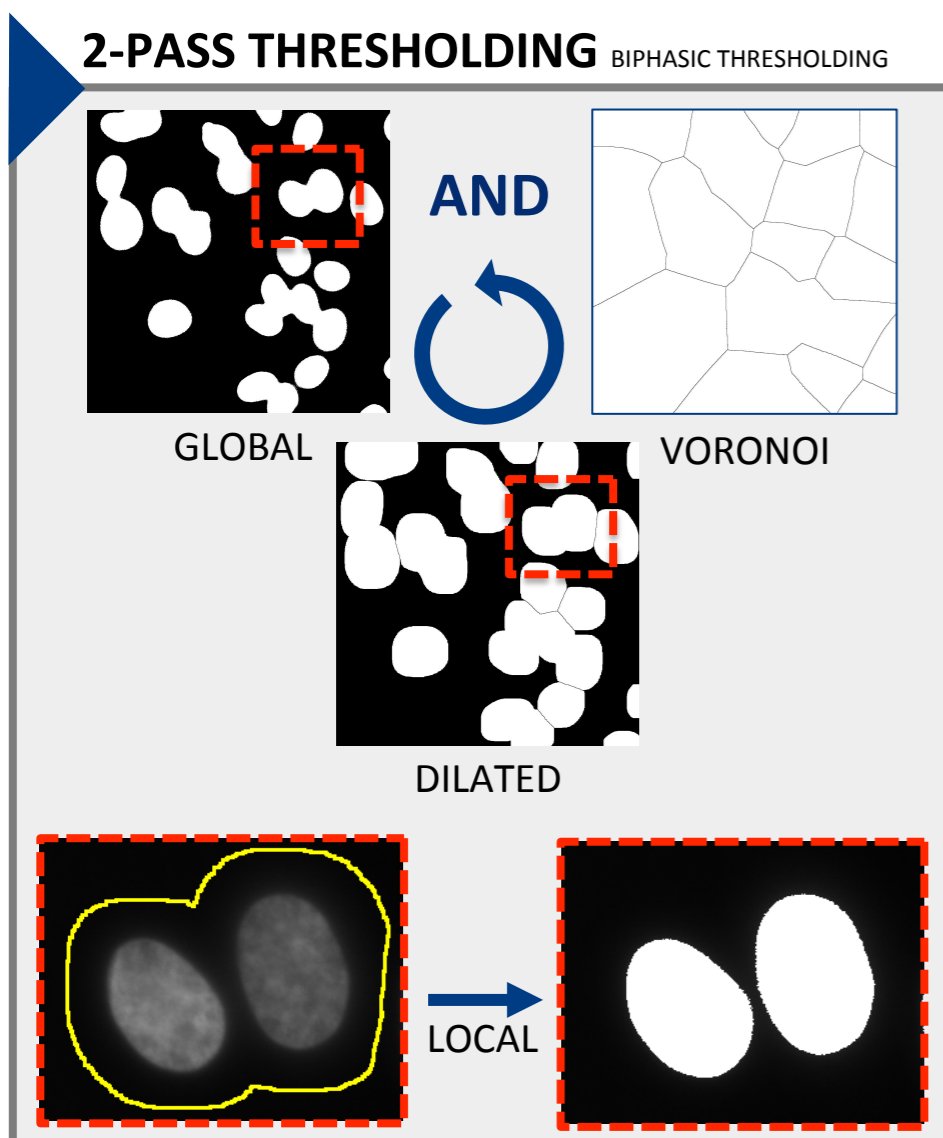- ▶ **2-PASS THRESHOLDING**: biphasic thresholding
- ▶ **EDGE ENHANCEMENT**: dynamic programming (DP) algorithm
- ▶ **CONDITIONAL WATERSHED:** split clustered nuclei

Validation was performed on a training set for which **ground truth (GT)** segmentation results were generated by three independent observers. Using a morpho-textural feature set a **classifier** was trained that can distinguish between normal and aberrant nuclei.
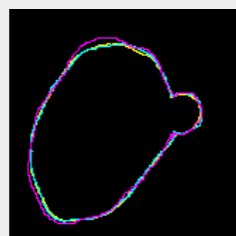
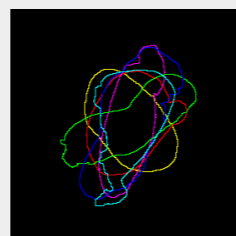## ▶ Workflow

🖥 Automated Detection

▶ 2-PASS THRESHOLDING BIPHASIC THRESHOLDING

GLOBAL   **AND**   VORONOI

DILATED

LOCAL

▶ EDGE ENHANCEMENT OPTIMAL PATH FINDING DP

STRAIGHTENED EDGE

DERIVATIVE
≤ 45°   > 45°

OPTIMAL PATH

▶ CONDITIONAL WATERHSED SPLIT CLUSTERS

INTENSITY PROFILES

☒☑ Validation

▶ QUALITY SCORE

	▶ POSITIVE CONTROL	▶ NEGATIVE CONTROL
GROUND TRUTH		

- ▶ **INTEGRATED PARAMETERS**
  - OVERLAP FRACTION
  - (AVERAGED) HAUSDORFF DISTANCE
  - SIMILARITY INDEX

▶ RESULTS

▶ PRECISION THAT **MATCHED** THE **INTER-INDIVIDUAL VARIABILITY** OF **3.11%**

Rank	Global GT	Local GT	Score	Rank	Global GT	Local GT	Score
1	GT 1	GT 0	1.057	6	Li	Li	1.017
2	GT0	GT 1	1.032	7	Triangle	Huang	1.008
3	Mean	Li	1.022	8	GT 0	GT 2	1.004
4	Triangle	Mean	1.021	9	Yen	Li	0.998
5	Triangle	Li	1.018	10	Huang	Li	0.997

▶ Classification
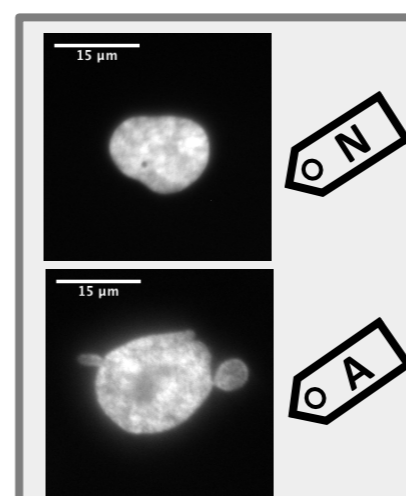
▶ **CONFUSION MATRIX** AFTER TRAINING **RANDOM FOREST** ALGORITHM

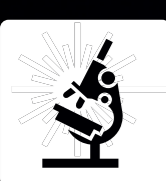|	Aberrant (%)	Normal (%)
Aberrant	50.93	0.00
Normal	4.63	44.44

▶ Applications

- ▶ **HIGH-CONTENT IMAGE ANALYSIS**
  Many descriptive parameters can be extracted from the accurate delineation of the nuclei.

- ▶ **INTELLIGENT IMAGING PROCEDURE**
  Implementing this algorithm in a software platform can enable real-time recognition in microscopic workflows.

Laboratory of Cell Biology & Histology
University of Antwerp

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