Computer Aided Cancer Diagnosis for serous effusion cytology
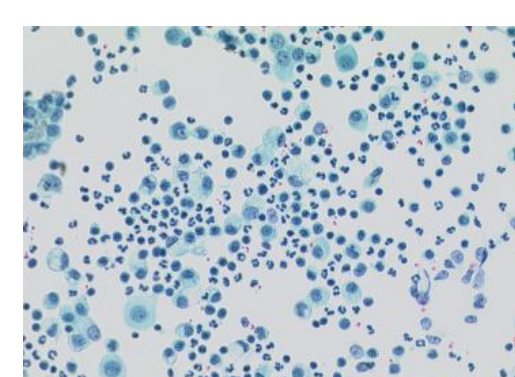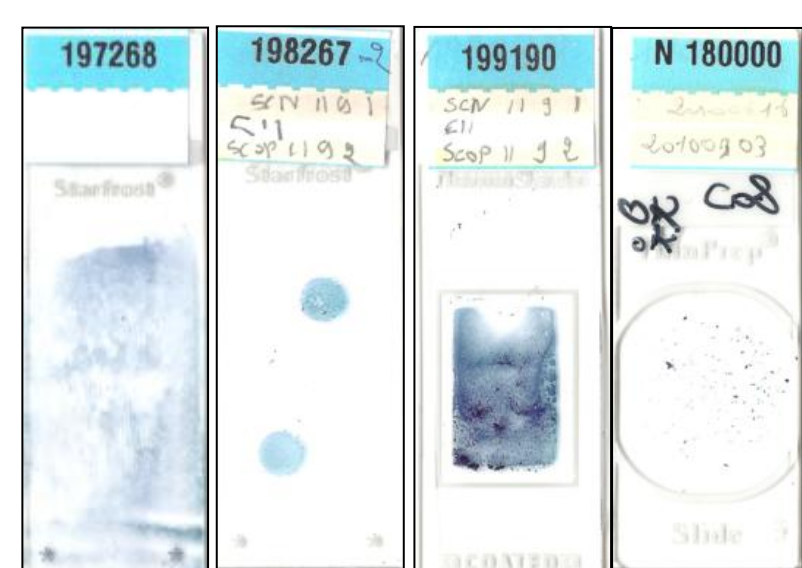
H. Elie[1], M. Lécluse[1], O. Lézoray[2], A. Elmoataz[2]

[1] Cherbourg Public Hospital Centre, Cherbourg, France
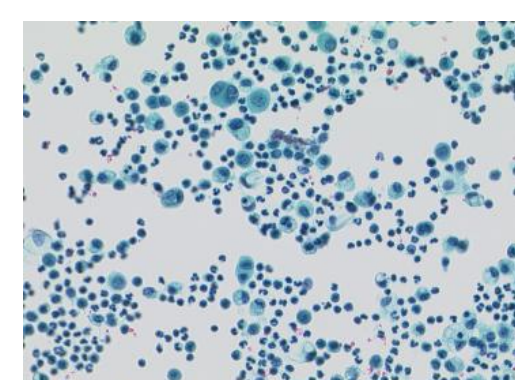[2] University of Caen and CNRS, Caen, France

Serous effusion cytology

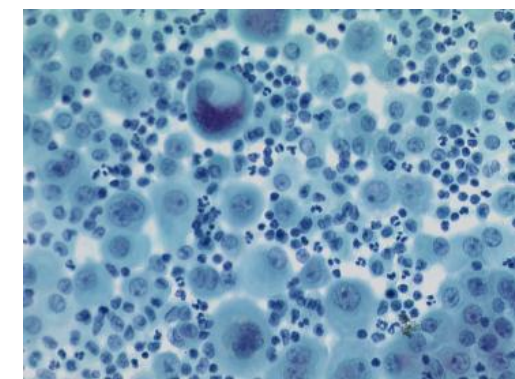Types of smears using Papanicolaou international stain :
- Conventional
- Cytospin
- Megafunal
- ThinPrep

268 images with WSI scanner Aperio

517 images 40000x30000

249 images with WSI scanner Leica SCN400

Partial scanning with a regular sampling (200 to 500 images per region of interest): >100.000 un-compressed images 1024x1024
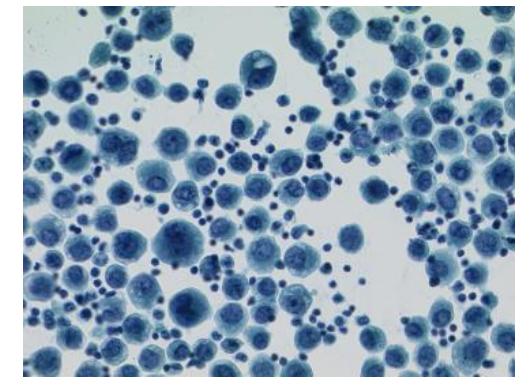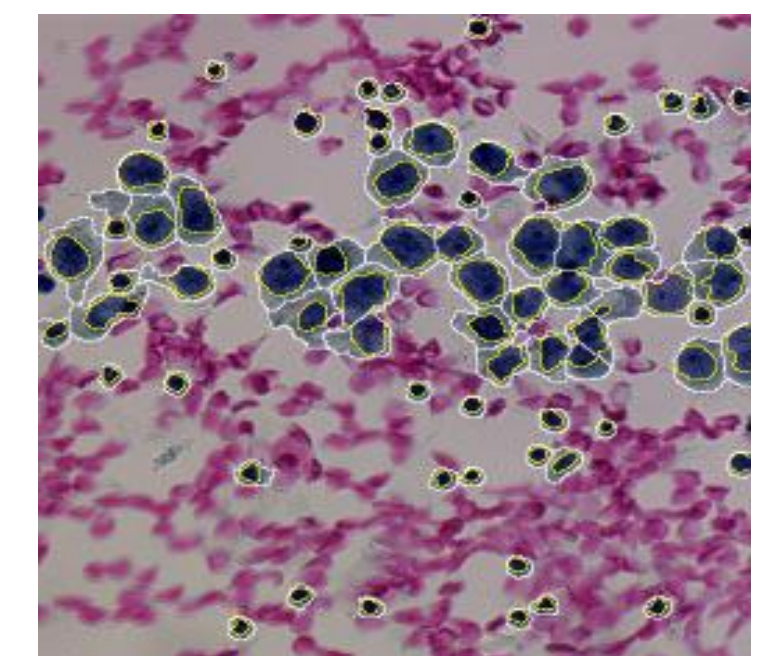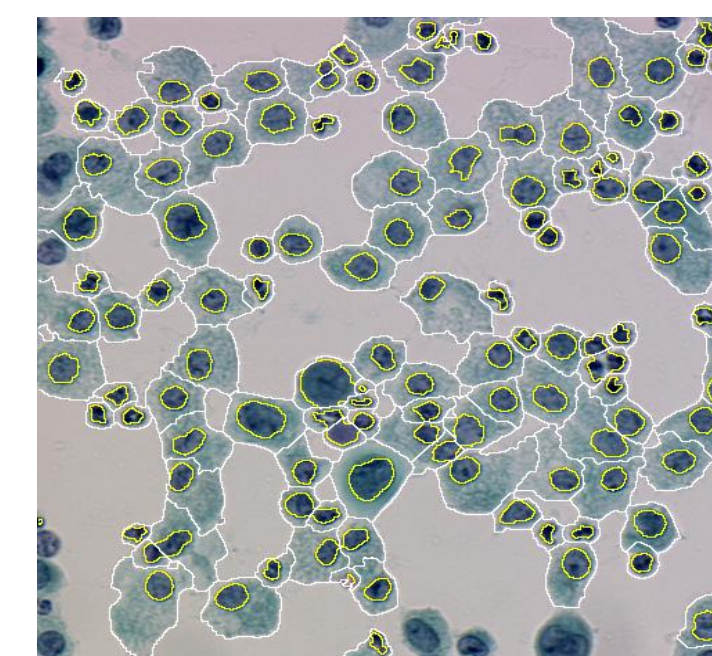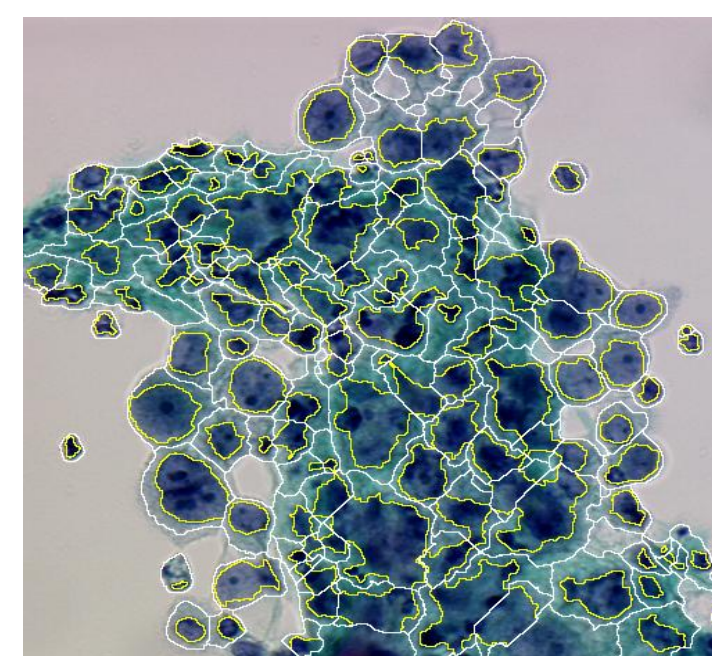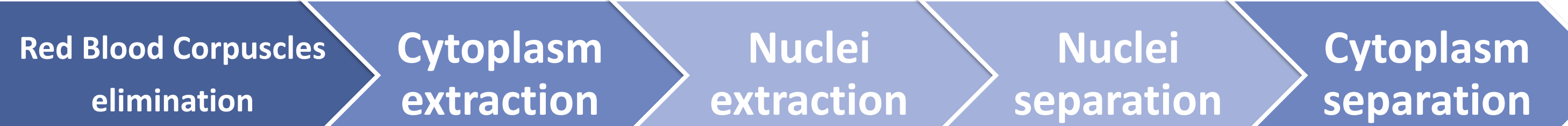
50 Normal cytologies with only inflammation

20 Sub-normal cytologies with clinical suspicion of tumor

50 Adenocarcinoma metastasis

20 Mesothelioma

System benefits

- Gallery of cells, cells formula
- Cell thumbnail and context
- Feature statistics
  - For a single cell
  - For cell populations
  - Between two cell databases
  - Histograms and plots
- Easy remote expertise with several pathologists (review only suspicious cells).

Each training images set comprises more than 3000 cells

Image Segmentation/ Analysis

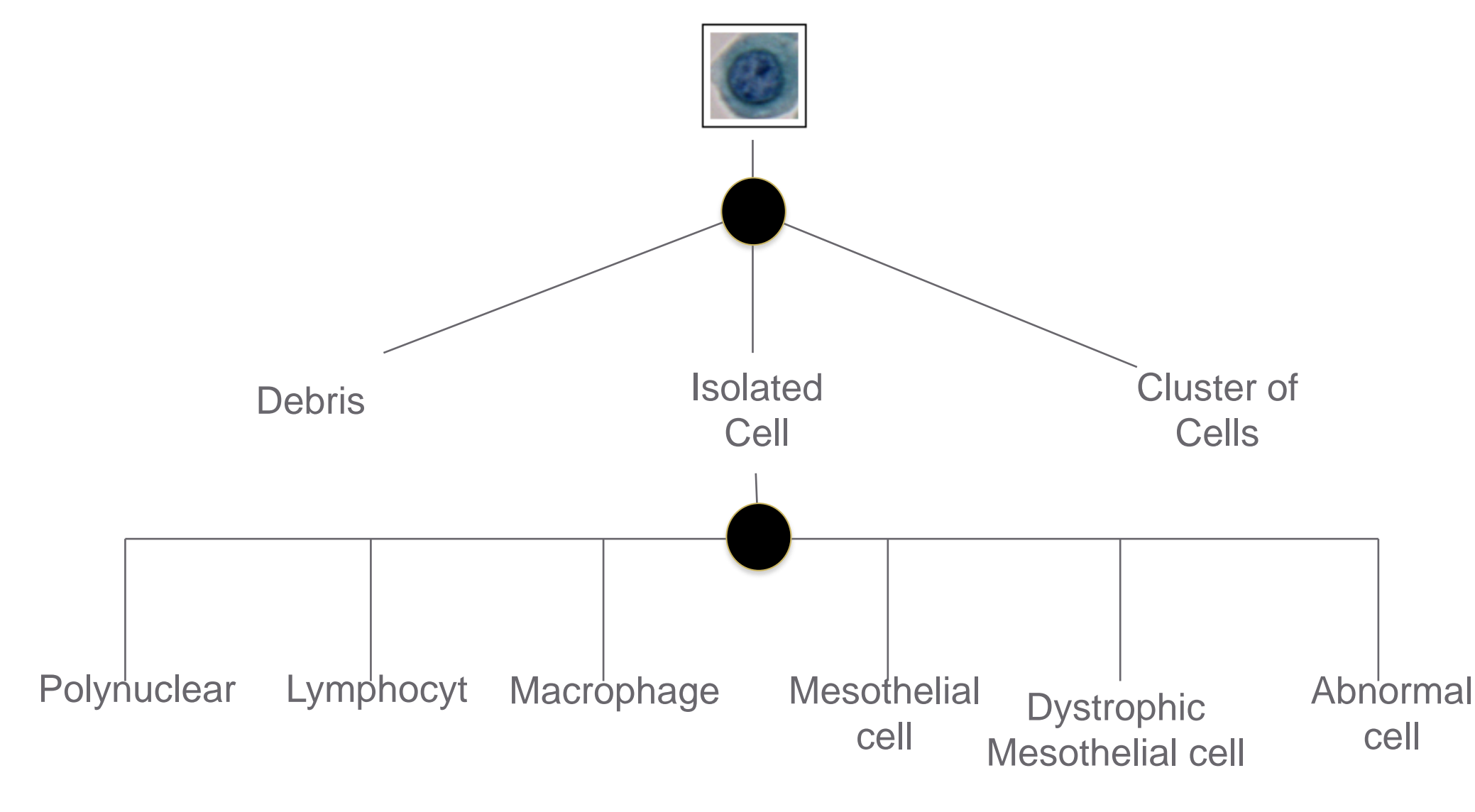| Red Blood Corpuscles elimination | Cytoplasm extraction | Nuclei extraction | Nuclei separation | Cytoplasm separation |

Features

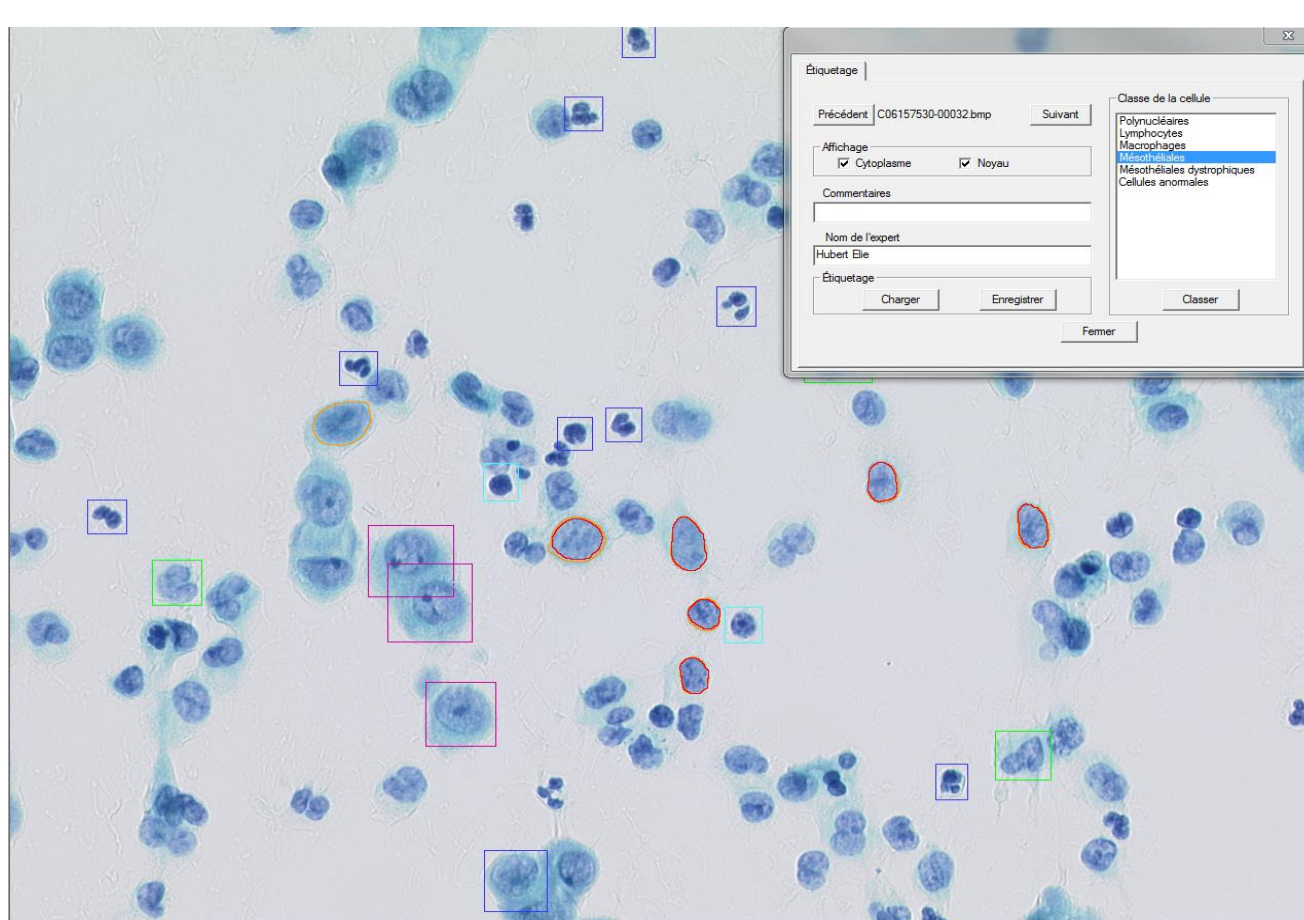Up to 100 features are computed per extracted cellular object:
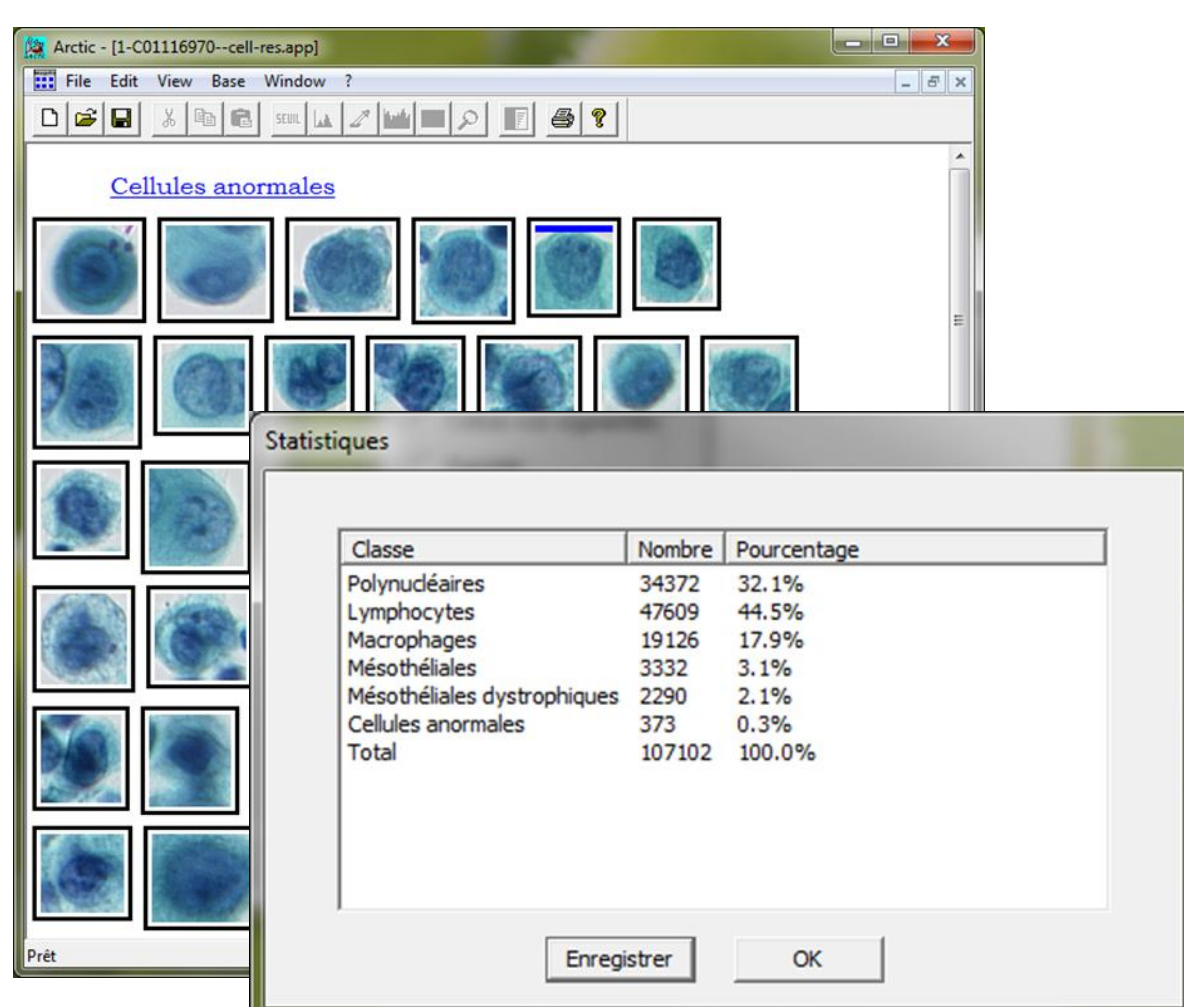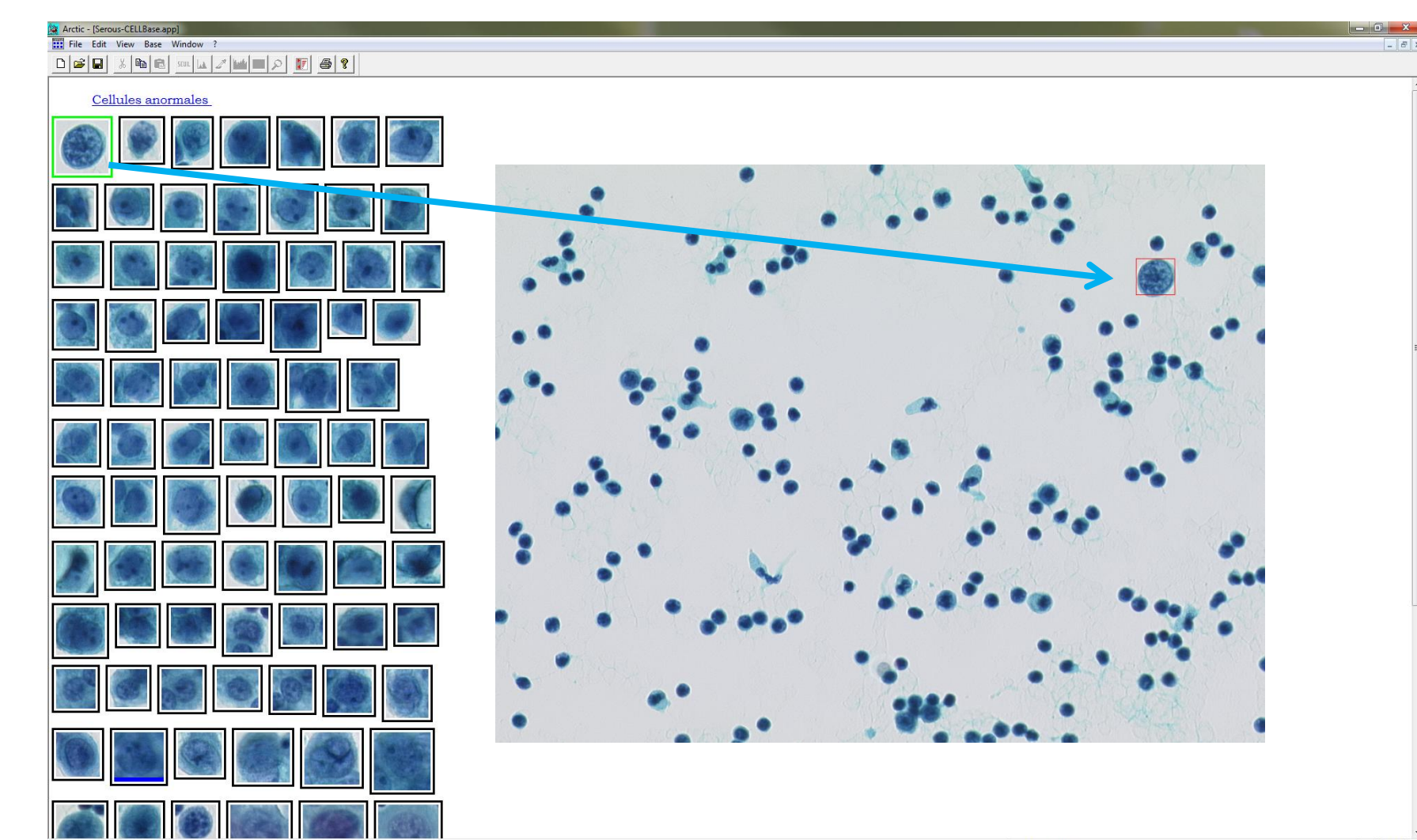- Size
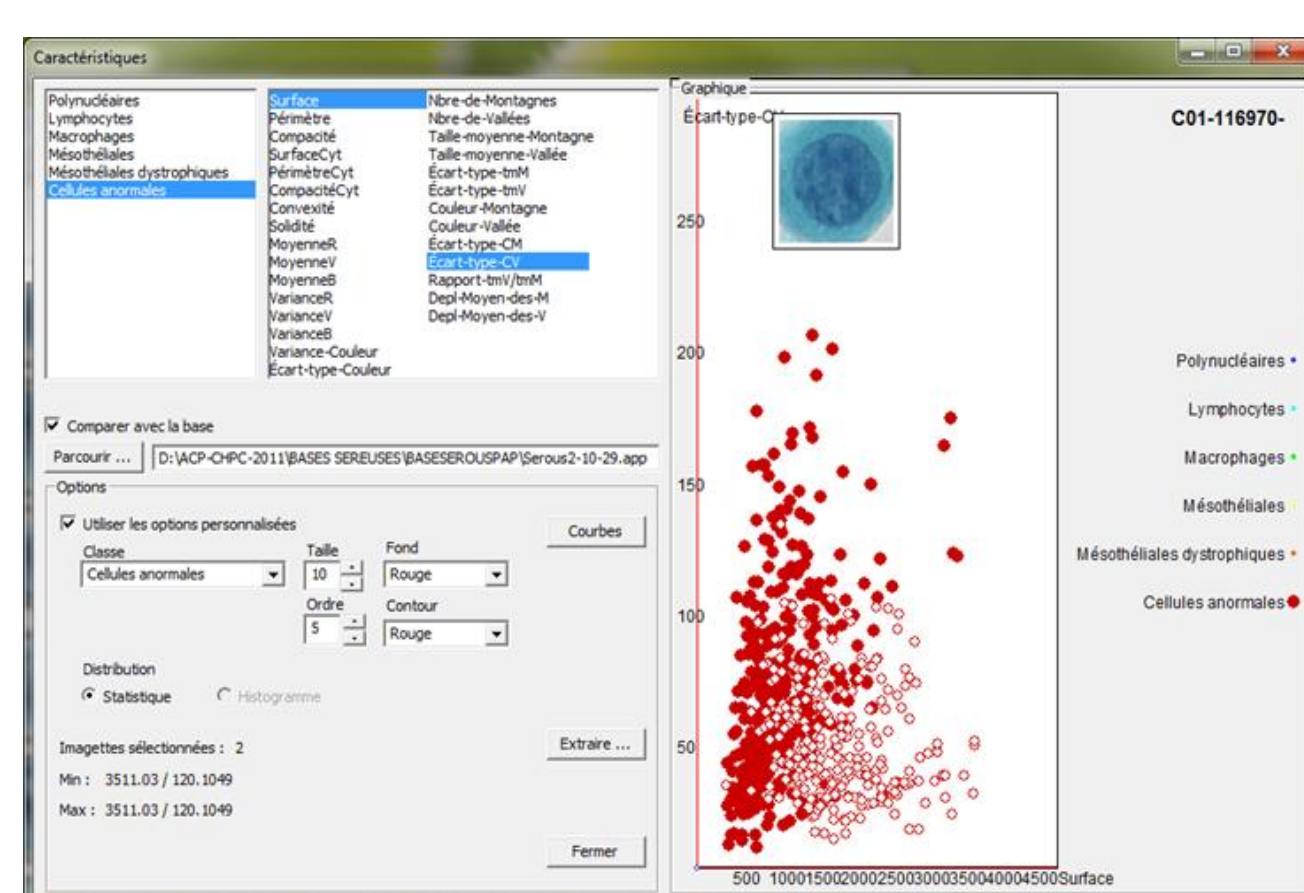- Shape
- Color
- Optical density
- Texture

Classification

An architecture of cascaded neural networks is used to classify extracted cellular objects:

Debris — Isolated Cell — Cluster of Cells

Polynuclear — Lymphocyt — Macrophage — Mesothelial cell — Dystrophic Mesothelial cell — Abnormal cell

Performance Evaluation

- 150 slides analyzed with certified tumor type : **98.5%** of these slides recognized by our system (the 1.5% false negatives were due to out of focus problems).

- Cases with a clinical notion of tumor : **2.5%** of cases diagnosed as negative by pathologists (3 out of 125) were evaluated as abnormal by our system (and it was really the case). **The pathologist is thus alerted.** For example the system extracted these rare abnormal cells:

- The system is efficient for rare event detection: on a specific case, 373 abnormal cells out of a total of 107,102 extracted cells were found (**0.3%**).

- 1000 cells sorted per second / processing time around 3 seconds per image (1024x1024 or 1360x1024 pixels)

Conclusion

- Digital cytopathology is a precious aid for pathologists in:
  - Early diagnosis of tumors
  - Quality control

- Our system can be easily adapted to other cytologies
  - Work in progress for the gynecological field

Our Partners