Project 6: segmentation of multicellular tumor spheroids from confocal microscopy images

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Referent:

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1 Introduction

Solid tumors are complex entities composed of the tumor cell mass itself and a stromal microenvironnement providing a variety of cells from the host (fibroblasts, endothelial cells, immune cells). This heterogeneity cannot be reproduced in vitro by conventional bidimensional (2-D) cell culture. This justified attempts to develop tridimensional (3-D) cell culture that provide better tools for approaching tumor complexity. Among various 3-D technologies, tumor spheroids are more likely suited to provide in vitro platforms for apprehending specific aspects of different processes specifically defining each tumor category as well as testing drug delivery systems.

The objective of this project is to segment colorectal spheroids (HCT-116) from images acquired by laser confocal scanning microscopy. This microscopy technology allows to capture multiple two-dimensional images at different depths in a sample of spheroids, thus enabling the reconstruction of its three-dimensional structure.

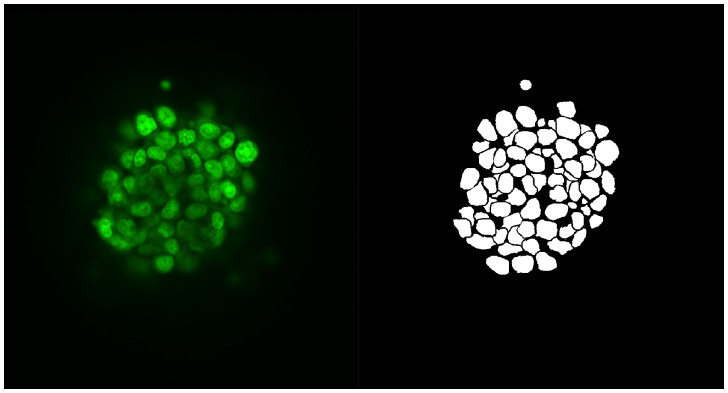

Figure 1: Spheroid sample observed by confocal microscopy (left), and the associated segmentation delimiting the cell outlines (right).

2 Material at disposal

You have at your disposal :

- **Database 1**, containing :
  - 1 set of 5 native two-dimensional images from 5 spheroid samples, acquired at different depths
  - 1 set of the associated binary images (masks), where spheroids were segmented by an expert

- **Database 2**, containing :
  - 1 native stack (= three-dimensional) image from 1 sheroid sample
  - the associated binary stack (the ground truth mask), where spheroids were segmented automatically (by deep learning)

3 Project schedule

The project includes a number of points to validate and illustrate in the defense.

3.1 Study of two-dimension images (work on Database 1)

1. Observe the native images. Identify qualitatively the noise.
2. Deduce one (or more) methods for a denoising step.
3. Implement 3 different segmentation method, which seem to you adapted. Justify your choices.
4. Quantify your segmentation results : search for pixel-wise metrics and cell-wise metric
5. Compare your different segmentation methods according to your chosen metrics. Discuss.

3.2 Study of three-dimension images (work on Database 2)

1. Repeat your processings on the spheroid stack, taking into account the spatial proximity of the successive slices.
2. Discuss and conclude.