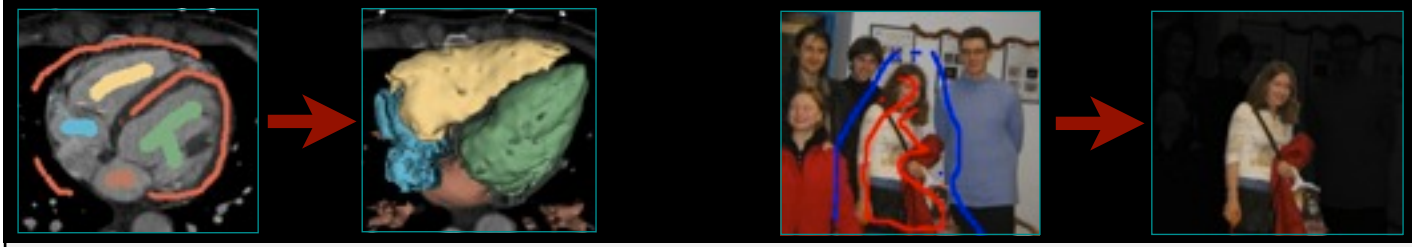
Student Project

Bacterial Dynamics and Cellular Automata for Image Segmentation

University of Zurich[UZH]



Topic

Image segmentation is the method dividing and classifying the given image into homogenous regions. It is a very active research topic, since many application for (autonomous) navigation, object detection and semantic labeling rely on it.

Cellular Automata (CA)

CA were initiated in the early 1950s as a general framework for modeling complex structures capable of self-reproduction and self-repair. They have also been applied successfully to several image processing applications, such as edge detection and segmentation.

A CA is a population of cells (in image processing, pixels) on a grid of predefined shape and it is evolved through a number of discrete time steps according to a set of transition rules. These rules are based on the state of a neighborhood and they are applied iteratively for as many time steps as required. CA can also be designed in a parallel structure, which results in real-time processing speeds.

Assignment

The aim of this project is to develop a segmentation technique based on CA, in order to segment efficiently the objects in color or grayscale images. To do this, we will first estimate different features and cues of the image (e.g. human-based perceptual metrics, contour cues, texture cues, etc.) and then we will exploit this information in order to pre-segment the input image. In the next step, a technique will select the seed pixels for the initial CA population, relying mainly on the previously computed features, while for the image segmentation, an evolutionary CA mechanism will be developed, assigning each pixel of the image one of the possible labels automatically. Using a biological metaphor, we can simulate this pixel labeling process (i.e. segmentation) as a bacterial growth and expansion model including a competition behavior and cooperation. In such a model, the bacteria will start to grow from the seed pixels and will try to occupy the whole image. At each discrete time step, each cell will try to 'attack' its neighboring cells in order to conquer them, while defending also its own position. The final result of these competitions will reveal the strongest bacteria, leading at the same time to a segmented image.

Focus could be given to biomedical imaging or to general real-world images.

Requirements

Interest in graphics and image processing. Application development in Matlab or C++.

Work Load

- 50% theory
- 40% implementation
- 10% testing

Project Type

Based on the scope of the topic and optional tasks, this project can be done as Bachelor or Master thesis. Goals are adjusted depending on the project type and number of students.

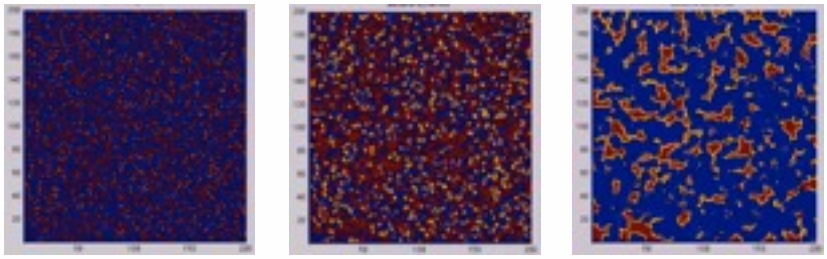
Supervision

Prof. Dr. Renato Pajarola
Georgios-Tsampikos Michailidis (Assistant)

Contact

Write an E-Mail to gtmichail@ifi.uzh.ch

CA rule set example.



CA bacterial dynamics simulation (E. Coli).

VISUALIZATION AND MULTIMEDIA LAB

Prof. Dr. Renato Pajarola
Visualization and MultiMedia Lab
Department of Informatics
University of Zürich