Time-lapse microscopy in creation living cells state trajectory

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Abstract

Living cells are dynamic objects which occupy certain region of space and time. A time-lapse microscopy experiment is the best way how to observe behavior of cell's dynamic and predict their future. The methodology, which was discovered in our Institute, is based in the general stochastic systems theory which allows us to define the cell states, trajectory and the system itself.

We extracted the region of the cell in order to analyze information about the cell state from spatial structure of cells and chemical composition of observed objects. For maximization of information gain we calculated the point information gain entropy density (PIE/points, Stys et al. 2011). We determine the information contribution of each data point to the object by calculation of difference in Renyi entropy between datasets containing and excluding the examined data point. This procedure we perform for representative set of alpha coefficients and obtain a set of point information gains (PIG). Sum of PIG values for certain alpha is the appropriate PIE/points. Set of PIE/points is a point in the tentative phase space which is unique for each image.

Using statistical procedure of Principal Component Analysis (PCA) and Clustering Analysis we were able to separate the state space in regions occupied by similar images (Stys et al. 2012). The sequence of regions is an objectively determined cell state trajectory, a series of structurally and chemically distinct structures which are stable for certain period of time. For the cell cycle, we found that regions in the cell state space may be identified with known terminology, i.e. we were able to find cell state corresponding to each of the clusters. Such detailed analysis is extremely computationally intensive; however, it might be of high value for rapid diagnostics in medicine, biotechnology and any other discipline utilizing cell biology results.

Key words: cells state trajectory, image processing and analysis, information Entropy, Renyi entropy.

References:

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