Building a Toolbox for Quantitative Image Analysis of Yeast Cells for Systems Biology Using CellProfiler

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Excellent image processing software for biological applications exists, but some are commercial packages, others are not readily available (i.e. proprietary), and still others are better suited for more general image processing tasks (e.g. ImageJ). In this poster, we describe early work-in-progress toward developing an open-source quantitative image processing toolbox specific for yeast systems biology. The key is that we are building this toolbox using the CellProfiler platform. CellProfiler is image analysis software designed for biologists to measure quantitative phenotypes from thousands of images automatically (Carpenter et al., 2006); it is built on top of MATLAB.

Yeast cells present special challenges for automated quantitative image analysis because of their small size. We have made minor changes to existing functionality in CellProfiler, as well as written new functions and modules. Some of the tasks to be performed by the toolbox include (1) identification of yeast cells from bright-field or fluorescence images, (2) characterizing the dimensions and morphological features (e.g. bud) of cells, (3) quantitating fluorescence intensity over different sections of the cell, (4) extracting morphological and fluorescence intensity changes (e.g. formation and direction of mating projection) from a time-lapse sequence, (5) quantitating the colocalization of two fluorescent markers, and (6) creating pipelines for carrying out a complex series of tasks for a particular type of experiment (e.g. gradient-sensing microfluidics experiment). Ultimately, the spatial dynamics of yeast cells will be captured by high-throughput microscopy and the images fed into the toolbox, which in a semi-automated fashion would extract quantitative information that can be used for constructing, identifying, or validating mathematical models of the system.

As soon as we achieve an adequate level of functionality, we will make the toolbox freely available. We believe the tools will be useful for those in the yeast systems biology community, and in addition, can be adapted to those working on other types of cells or living systems as part of the extended CellProfiler package.

Carpenter, A. E., Jones, T. R., Lamprecht, M. R., Clarke, C., Kang, I. H., Friman, O., Guertin, D. A., Chang, J. H., Lindquist, R. A., Moffat, J., *et al.* (2006). CellProfiler: Image analysis software for identifying and quantifying cell phenotypes. Genome Biology *7*, R100.