**Instructor: Thomas Day**

**Course: Image Analysis of Dynamic Biophysical Systems**

**Assignment:**

In this class, we have learned a great deal about image analysis techniques, algorithms for implementing them, some properties of diffusive and active processes and how to calculate these properties. This project is your chance to demonstrate some of the knowledge and skills you have learned. In particular, it is meant to assess the following learning objectives which we outlined at the beginning of the semester:

1. Perform automatic image analysis and evaluate its effectiveness through propagation of error statistics,
2. Calculate measurable quantities of diffusive and active processes,
3. List and apply some foundational cornerstones of image analysis techniques.

The task is as follows:

Choose an image dataset from your subfield. This dataset could be your own raw images (for example, from a microscope or a camera), a dataset obtained from a recently published paper in your field, or one of my sample image sets that I have provided. With this raw dataset, you will perform image analysis to extract important information. This information could be: the velocity of various particles, their displacement, or it could be the size distribution of some particles, their spatial distribution, or other such items. The measurements you make are up to your discretion; however, you will need to justify why they are relevant for your dataset. You will report your results in a short paper (3-5 pages) which will include the following sections:

1. Introduction: include where your dataset comes from, what the images are, and why others (such as your peers) could be interested in your images.
2. Methods: Describe your image analysis workflow: what did you do to manipulate your images, and how did you extract measurements from them? You should include one figure outlining the three most important steps of your image analysis.
3. Results: What are the results of the measurements that you made? What do these measurements tell you about your system? You should include at least one plot in this section.
4. Discussion: How effective are your measurements? How much error is there in your measurements, and where might any significant error be stemming from? In the future, could you have chosen a different dataset, or perhaps taken the images in such a way as to produce less noisy or more effective images?

Due date: February 12th. For every day past the due date that you submit the assignment, you will lose five percentage points. For example, if you turn in the assignment 3 days late, the best grade you can achieve is an 85%.

To perform well at this assignment, you will need to apply the following skills:

1. Explain what physical measurements are important and relevant for your study, and how your dataset may be capable of making these measurements.
2. Choose and perform some of the core ideas in basic digital image analysis properly.
3. Evaluate the effectiveness of your image analysis and the measurements you obtained from it.

**Rubric:**

This is the rubric that I will use to grade your assignments. Note here that I provide three categories for receiving points for your assignment. However, you may earn point totals in between these three categories based upon having some items of two different categories.

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| Item | No points | Half points | Full points |
| Completeness: Did you complete the task as assigned? (10 pts) | Two or more major pieces of the assignment are absent from the paper. | Either several minor pieces of the assignment are missing, or one major piece of the assignment is missing. | All major pieces of the assignment are completed; there may be one or two minor pieces missing. |
| Knowledge/accuracy: Did you accurately apply image analysis techniques and correctly calculate physical quantities? (10 pts) | The student demonstrates little or no skill and knowledge of image analysis measurements.  Calculations and measurements are either entirely incorrect or missing. There may be major errors in choice and implementation of image analysis techniques. | The student demonstrates **some** skill and knowledge of image analysis measurements.  Some calculations and measurements are precise and correct, though there are some instances where mistakes are made and affect the final results. Choice of image analysis algorithms may be improper in some cases. The image analysis techniques may be incorrectly applied, or they may be applied without skill. | The student demonstrates **ample** skill and knowledge of image analysis measurements.  All calculations are precise and correctly measured according to the given dataset. All image analysis algorithms are correctly implemented. Choice of image analysis algorithms is proper. There may be one or two minor mistakes made. |
| Clarity: Did you provide sufficiently clear writing and figures to demonstrate your skill? (5 pts) | Student writing is inaccessible or absent. Figures may be incomplete, incorrect, and/or difficult to understand. | Student writing is mostly clear, but there are some areas where it is unclear. Figures are complete and mostly understandable. | Student writing is clear, and so are their figures. |
| Evaluation of analysis: Did you sufficiently demonstrate that you can evaluate/analyze your own workflow’s effectiveness and gauge how improvements may be made? (10 pts) | Student did not evaluate the performance of their image analysis and measurements, or did so only superficially. | Student provided discussion on the performance of their image analysis and some ways that future studies might improve upon it. However, student suggestions may be limited, incorrect or improper; or they may incorrectly evaluate their own results as being too trustworthy or not trustworthy enough. | Student demonstrated that they can evaluate their image analysis for efficiency and accuracy. They provide correct and reasonable ideas for improvement of their analysis workflow. They reasonably contextualize their results. |