**Name:** *Michael Levin*

**Date:** *7/5/2020*

**Project:** You will carry out a project by creating a python program that executes some important task or tasks, ideally related to your research. The program must be more sophisticated than, for example, simply making a static plot from a dataset. The project will build on knowledge gained in the individual assignments and lectures, though will be larger in scope than the more targeted and structured assignments. Expect to work on it throughout the term. The program could control hardware, conduct some advanced analysis of data/images, provide a user interface for some specific purpose, etc. The project is open ended and a wide array of possibilities will be acceptable, but the project MUST be submitted to the Professors on Monday June 30, 2020.

**Topic** (1-2 sentence summary):

*My project is an image analysis on MG-63 cells (human osteosarcoma type) and MC3T3-E1 cells (mouse precursor, osteoblast type). The goal is 1) to determine a cell being alive or dead, 2) to determine how strong they’re adhering to their environment, 3) to determine if these cells are undergoing proliferation or differentiation at that moment, inferring cell’s viability as a result, and 4) to determine if these morphogenesis processes are normal.*

**Inputs** (data streams, user inputs etc. Be as specific as possible):

*The inputs are three types of images: Red fluorescence, Green fluorescence, and Phase Contrast microscope images. The cells will be stained with Live/Dead Stain batch to distinguish alive and dead ones. The cells alive will be in green fluorescence and cells dead will be in red fluorescence. Phase Contrast cells will reveal all characteristics of a cell such as mitochondria, nucleus, rough ER, etc. that Live/Dead Stain batches won’t reveal to you. Comparing these three types of images together would make image analysis and thus research discussion easier and rewarding.*

**Do you need data to be supplied to you?**

*So far, I have some of these images available to me. But, I’m planning to make more of these images to make my programming system stronger, to allow room for machine learning programming involved.*

**How will inputs be manipulated**—what processes will be undertaken? (broadly, details not needed now):

*The first task is to distinguish what’s a cell and what’s not by 1) identifying cell’s membrane that boarder its own environment from the extracellular using greyscale values and 2) segment that cell. Then, verify if that cell is alive and undergoing either proliferation or differentiation. A cell can’t be considered “dead” if it’s doing any of these morphogenesis processes. Also, I need to analyze if these cells are showing strong adherence to their surroundings. Proliferation and differentiation won’t work if they don’t have some level of adherence to their surrounding. Adherence, proliferation, and differentiation analyses involves 1) reading cell membrane’s shape pattern to identify those processes (most likely involving mathematical equations and plotting) in Phase Contrast and 2) compare that to Green and/or Red Fluorescence of that same image. Then, using that cell membrane’s shape reading from second task, the next task is to verify 1) if the cell is healthy and 2) if it’s undergoing interaction with its own environment to initiate bonding and bone regeneration.*

**Outputs** (what will be the output of your code?):

*As I obtain each image, this coding system will help me answer these questions along the way, as a trouble-shooting method:*

* *In Phase Contrast, is it a cell, specifically MG-63 or MC3T3-E1 type?*
* *Is that cell alive and proliferating or differentiating?*
* *How strong are they adhering to their environment*
* *Is any of these two processes normal?*
* *Does that differentiation indicate bone cell’s interaction to the environment?*
  + *Is that interaction part of bone regeneration process?*

**Why is it important to you or others?**  What is the value?

*It’s part of my Master’s Thesis research that can help me with these reasons:*

* *To identify if there’s potential error with my experimental techniques, avoiding more errors as the result, and leads to more productive results.*
  + *We have old and new Live/Dead Stain batches. The old ones could be outdated and thus lose its function. One instance is when one cell show Green and Red fluorescence, which is realistically impossible because these fluorescence indicates cell being alive or dead. There are certain, biological properties that would indicate cell’s viability and functionality by looking at its cell membrane shape. It’s very hard or time-consuming to see that under human eye. Thus, a computer’s greyscale measurements should answer that better.*
* *Verify if these data are credible and reproducible.*
* *This programming system can help move my research progress forward and with obtaining intellectual insights along the way.*
  + *One example is the meaning of cell’s shape pattern: is that differentiation part of regeneration or not? And if it isn’t, does that mean the cell’s sick or something else is involved?*