Bioinformatics 525 – Module 3 – Homework 3
Due 4/13/2017, 5 pm

Work through the exercises below, and provide your answers in either paper or electronic form to Lauren Jepsen (ljepsen@umich.edu) by the deadline.

Exercise 1 – Network modeling

Implement the solution that you gave to Exercise 1 of Homework 1 as a model in CellDesigner. For this exercise, we will only model the behavior under constant exposure to xylose (so production of all network components that are activated by xylose should occur at a constant rate). Set the initial concentration of CFP to 10, and all other initial concentrations to 0. It is acceptable (and recommended) to use the approach that we did in Lab 3 of combining transcription/translation into one process for the sake of having a simple model.

a) **Sketch your network design or provide an image from CellDesigner, and list the parameters used in your model.**
b) **Give a differential equation for the rate of change in concentration of any one of the entities in your network.**
c) **Simulate your network once with all parameters set to 1, and provide a plot or sketch of the resulting RFP and CFP levels.**
d) **Try changing one of the network parameters to at least two other values that span two orders of magnitude. Record the changes that you made and plot the RFP/CFP levels for each parameter set. Are any bifurcations in network behavior apparent across the parameter range that you tested?**

Exercise 2 – Constraint-based modeling

Load the E. coli core metabolism model into Sybil as we did in Lab 3. We would now like to screen for genes that become essential under anaerobic conditions.

Give an R command that will let you generate a modified model representing anaerobic conditions. Fit an FBA model to this constraint set – how does the growth rate compare with aerobic conditions?

Identify any differences in essential genes between normal and anaerobic conditions. Choose one gene that is essential only under anaerobic conditions, look up its function on ecocyc.org, and explain why it may become essential.