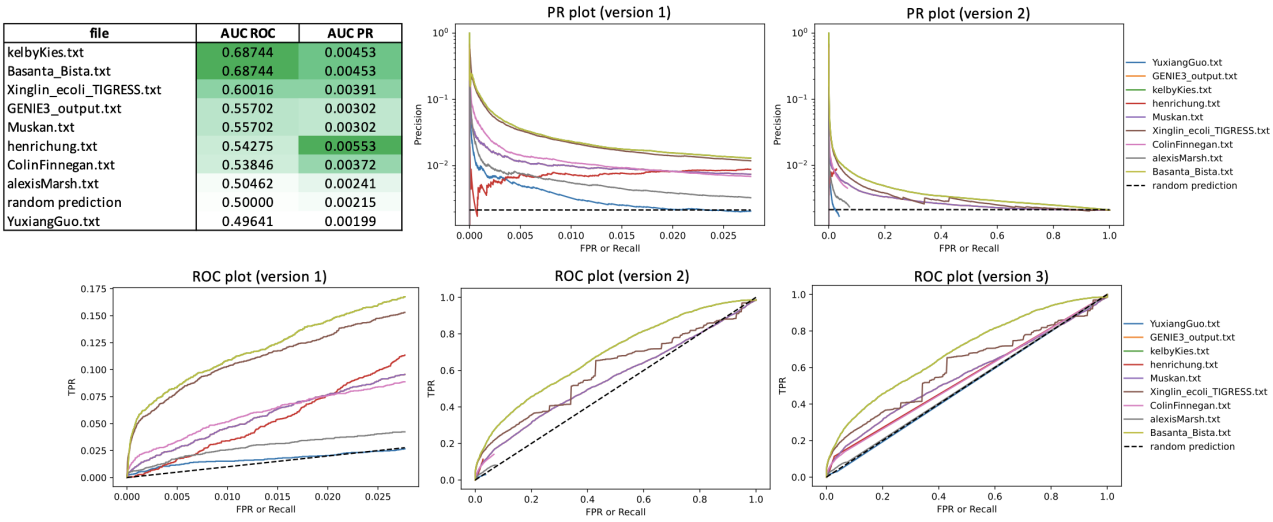
BCB 570 **Homework Network Dynamics** **80 points** **Due Tuesday, Mar 22 at 11:59pm**

DREAM Challenge Assessment

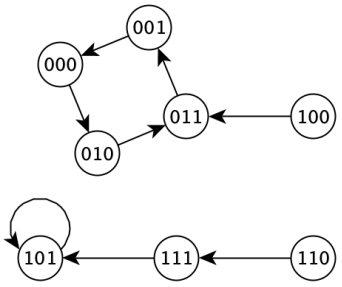
1. (20 pts) Take a look at the results from our internal DREAM challenge. Kelby and Basanta's GENIE3 implementation (exactly same prediction) wins based on the area under the ROC-curve. However, based on the area under the precision-recall curve, Henri's implementation wins. What is going on here? Which method do you believe performed actually best? Why?
   In your answer, include a discussion of the different versions of the PR and ROC plots. How do these different plots help us make sense of these contradictory results?
   Hint: The correct answer here is NOT up for discussion. There is clear reasoning that explains the contradictory results.

file	AUC ROC	AUC PR
kelbyKies.txt	0.68744	0.00453
Basanta_Bista.txt	0.68744	0.00453
Xinglin_ecoli_TIGRESS.txt	0.60016	0.00391
GENIE3_output.txt	0.55702	0.00302
Muskan.txt	0.55702	0.00302
henrichung.txt	0.54275	0.00553
ColinFinnegan.txt	0.53846	0.00372
alexisMarsh.txt	0.50462	0.00241
random prediction	0.50000	0.00215
YuxiangGuo.txt	0.49641	0.00199



Boolean Network models

The state space of a Boolean regulatory network model of 3 genes, $F = (f_1, f_2, f_3)$ is



1. (6 pts) How many different attractors and what type of attractors does the network have?
2. (12 pts) Express the update rules f_1, f_2, f_3 in logical form using $\wedge(AND), \vee(OR), \neg(NOT)$.
3. (8 pts) Draw the wiring diagram. Make sure to distinguish positive and negative interactions and only include essential variables as regulators.
4. (10 pts) Find the Derrida value of the network for a perturbation of size 1.
   Hint: It may be helpful to consider the eight states, $000, \ldots, 111$, as the vertices of a Boolean cube.

5. (10 pts) Let

$$P = \begin{bmatrix} p_1^{\uparrow} & p_2^{\uparrow} & p_3^{\uparrow} \\ p_1^{\downarrow} & p_2^{\downarrow} & p_3^{\downarrow} \end{bmatrix} = \begin{bmatrix} 0.9 & 0.8 & 1 \\ 0.5 & 1 & 0.3 \end{bmatrix}$$

describe the activation and degradation propensities. F together with P defines a stochastic discrete dynamical system (SDDS). Draw the stochastic state space.

6. (6 pts) Calculate the phenotypical robustness of the SDDS.

   Hint: Looking at the state space, this calculation should only take you a few seconds.

7. (8 pts) What is the lowest possible value for the phenotypical robustness of a probabilistic Boolean network (PBN) of 3 genes with at least two attractors. Explain! What about a PBN of 3 genes with at least three attractors?

   Hint: The lower bound is not 0.5 but a value greater than 0.5. Draw an example stochastic state space.