Analysis of DUNs (Dynamically unregulated nodes)

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Three State Formalism

The three state formalism with the following rules renders the node with canalising strength 0 incapable of any forward regulation and affecting the state of other nodes at each time step.

$S_j = 1$ if $\sum_i adj[i][j] * S_i > 0$

$S_j = -1$ if $\sum_i adj[i][j] * S_i < 0$

$S_j = 0$ if $\sum_i adj[i][j] * S_i = 0$

Story so far

Simulating biological networks via three state formalism results in dissapearance of all hybrid states.

Dynamic InCanalising Strength

It quantifies how much activating or inhibhiting regulation and node is under at a certain time step. It is defined as follows for the J'th node

$$\sum_i adj[i][j] * S_i$$

Here, S_i denotes the state of I'th node and adj refers to the adjacency matrix of the network

Average DyIncan

1000 random inputs are evolved according to the rules of the three state formalism and at time steps spaced apart equally, the average of incan values over all the different random input is measured and plotted

Evolution of DyInCan

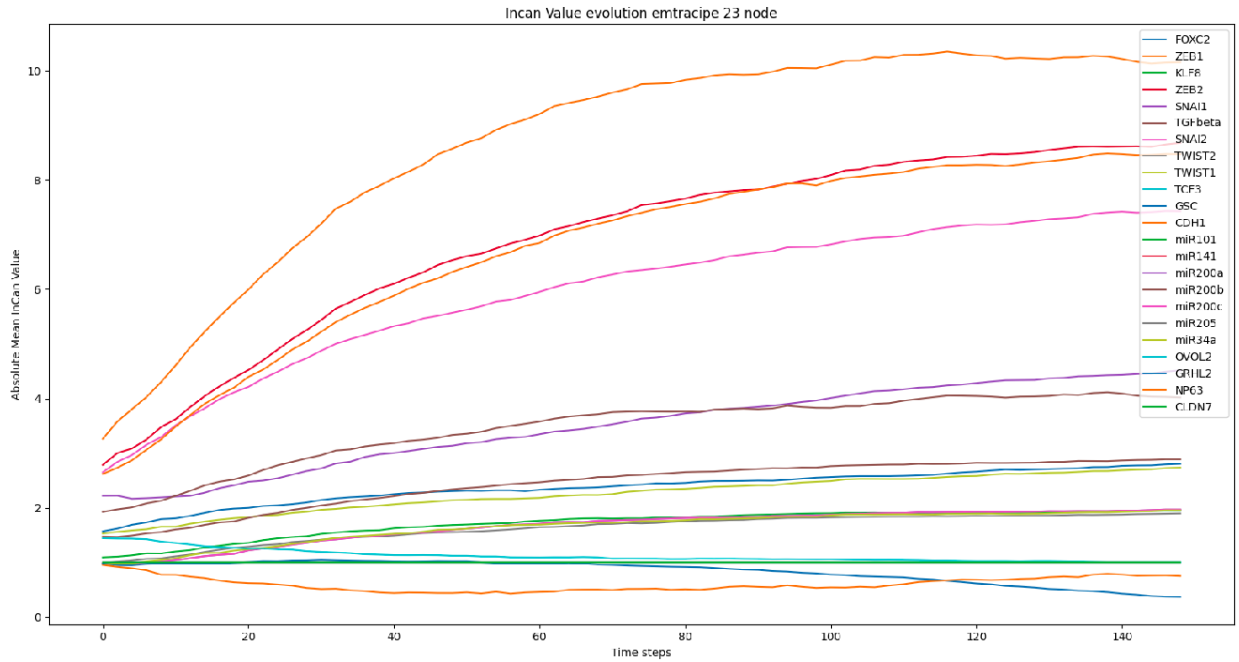


Figure: 23 Node EMT network

Ideal Network

Ideally, the DyInCan value should eventually become equal to the indegree of the node since all the inhibitory edges (which are between the teams) should contribute positively to the incan value when one team gets turned off

Normalized DyInCanValue

To compare nodes with different indegrees and to properly measure how "ideal" a node is, I looked at the NormDyInCan Value which is the dynamic incan value divided by the indegree of the node and is defined for a node S_j with indegree I_j as

$$\frac{|\sum_i adj[i][j] * S_i|}{I_j}$$

Biological Networks have some nodes which are consistently unregulated

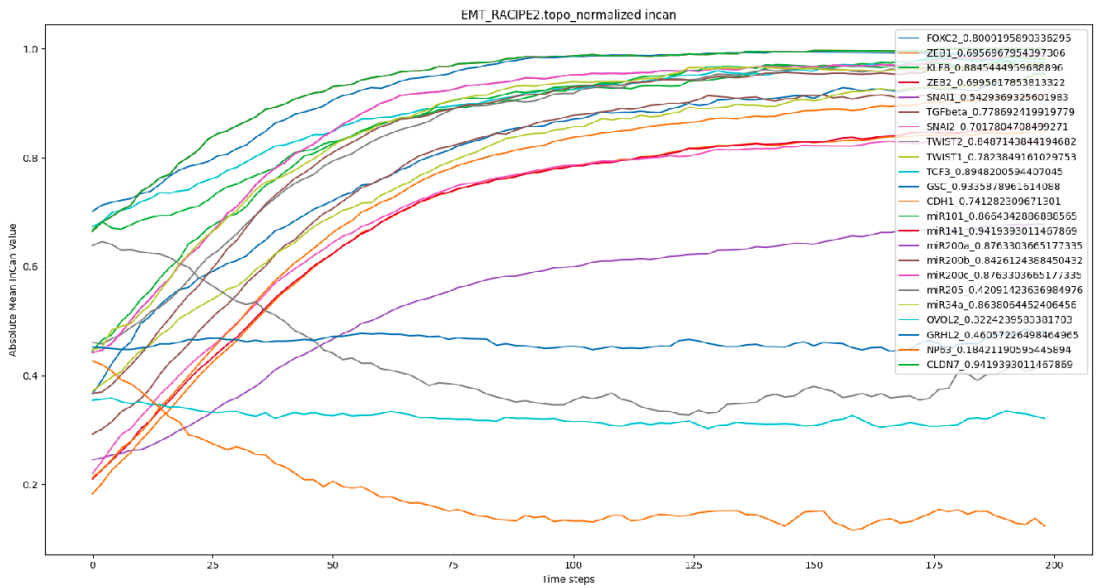


Figure: 23 node EMT network, x axis: time, y axis: mean incan

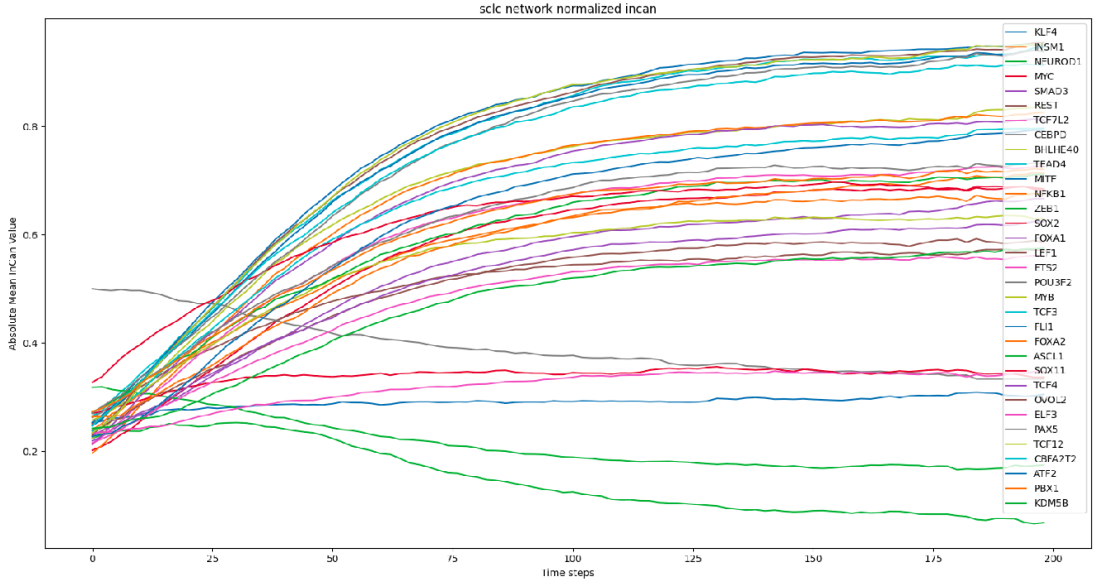
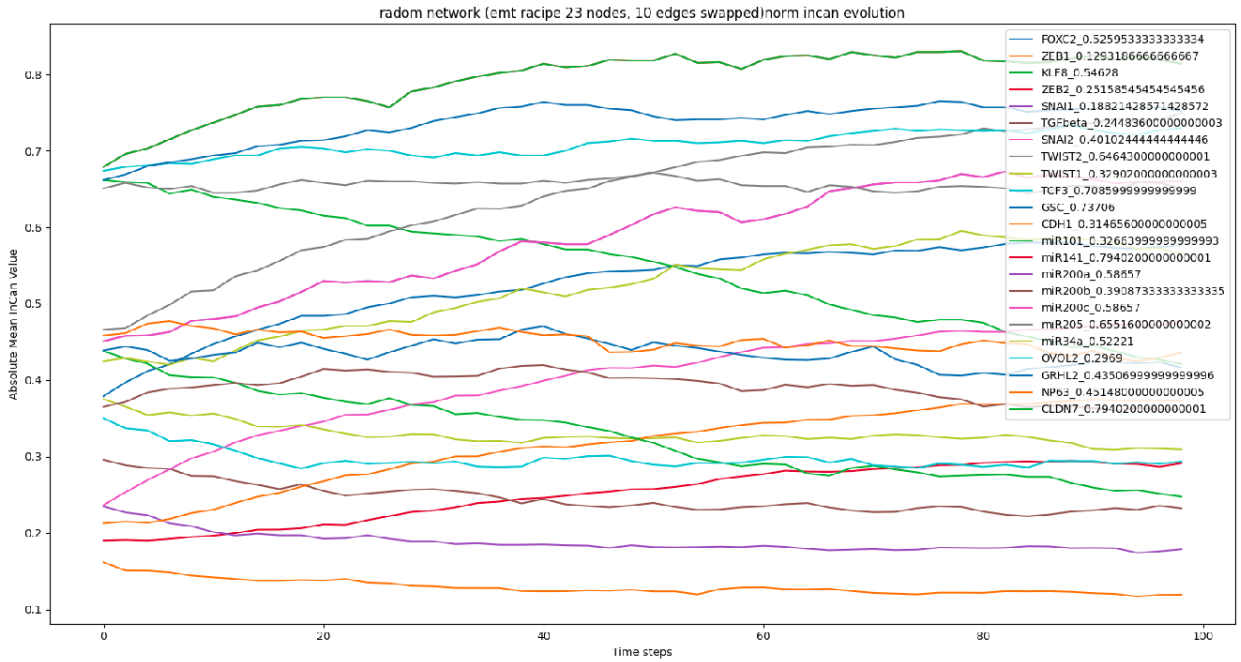


Figure: sclc 33 node network, x axis: time, y axis: Mean incan

Random networks have more consistently unregulated nodes



Artificial Networks Lack consistently unregulated nodes

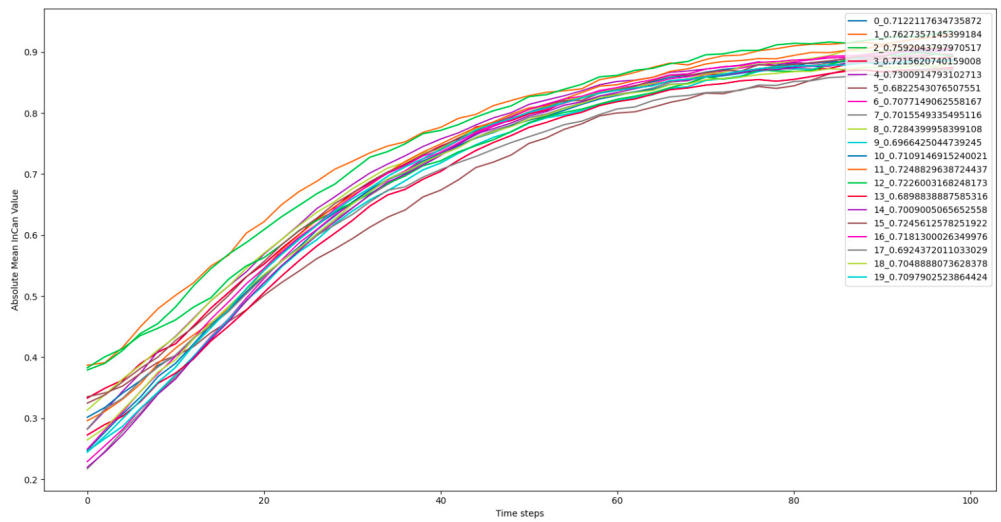


Figure: Artificial network with teams structure

Static normIncan and Dynamic Incan overlap

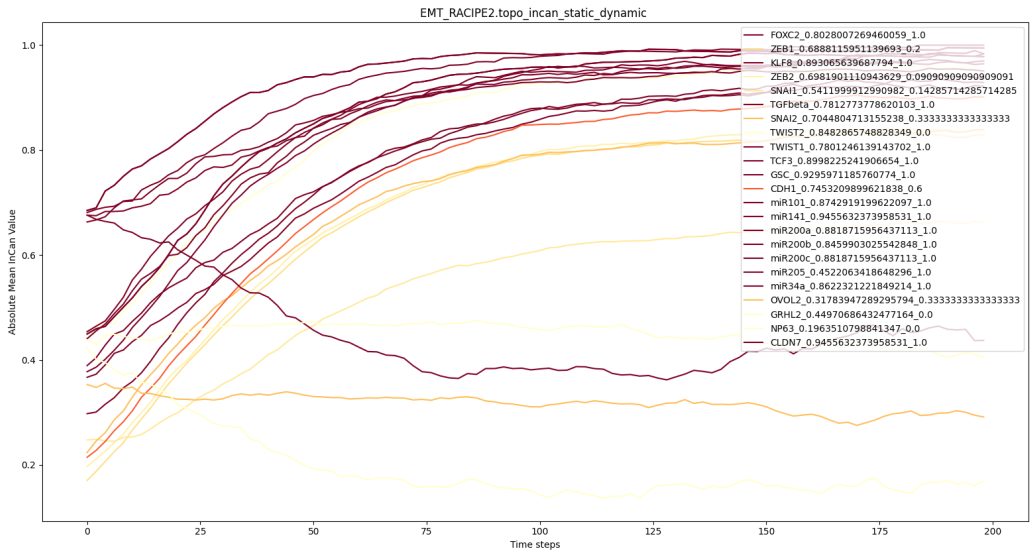


Figure: 23 node EMT network