

A Novel Gene Regulatory Model for Embryonic Cell Differentiation in *Drosophila melanogaster*

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Introduction

Gene Regulation Modeling involves building a comprehensive framework that explains and predicts the action of genes.

It is the **next big challenge** after gene sequencing.

Boolean logic gene model is one of the most popular discrete gene models.

Threshold logic has been proposed as an alternative to Boolean logic to model gene action (details in poster).

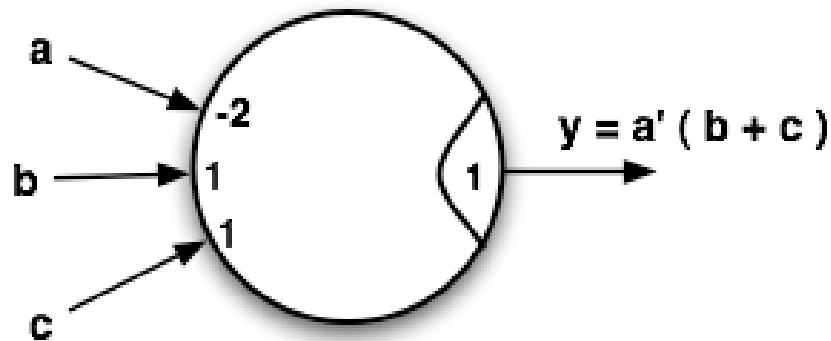
Threshold logic has been shown to be capable of accurately modeling the genes involved in the **embryogenesis of *Drosophila***. We discuss the D-V model in this presentation.

Threshold Logic (TL)

Definition:

$$y = \begin{cases} 1 & \text{if } \sum_{i=0}^n w_i x_i \geq T \\ 0 & \text{otherwise} \end{cases}$$

Example:



Inputs	a	b	c	y	Sum of weights
Weights	-2	1	1	1	
	0	0	0	0	0
	0	0	1	1	1
	0	1	0	1	1
	0	1	1	1	1
	1	0	0	0	0
	1	0	1	0	0
	1	1	0	0	0
	1	1	1	0	0

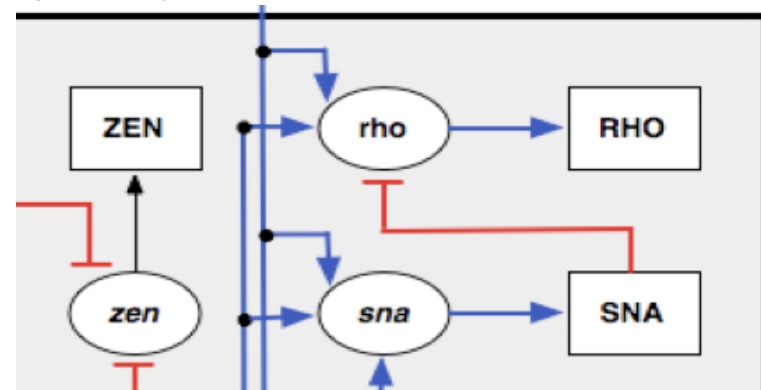
Modeling of Drosophila

We have developed 2 models for Drosophila, one each for the A-P and the D-V development.

Overview:

- The **gene interaction graph** (GIG) is constructed.

- A portion of the D-V GIG:



- From the GIG TL regulation rules are obtained for each gene product. **Rules are simulated** to get a steady state.
- This **steady state** is compared to the biologically observed steady state.

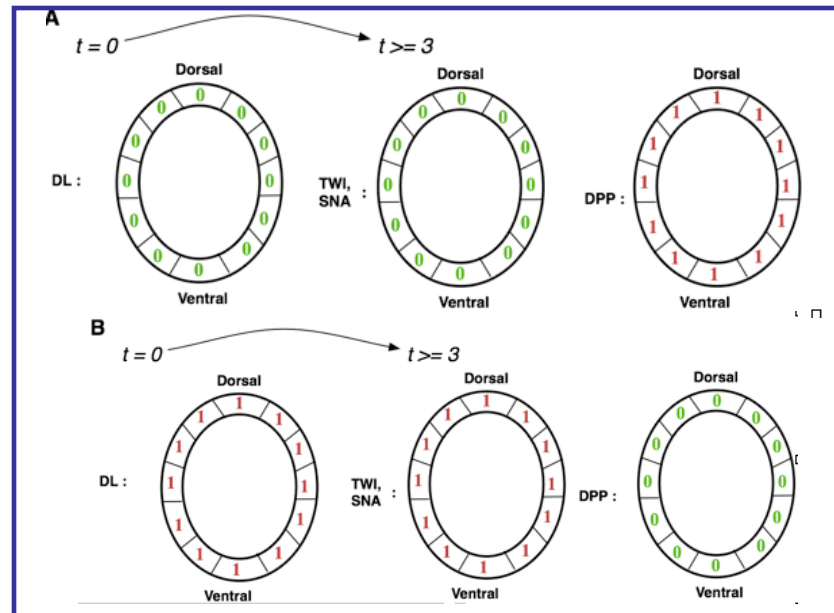
RESULTS: Other Predictions

The model can be simulated starting from different initial states to predict the effect of malfunctioning genes.

Sample predictions:

❑ Dorsalized /

Ventralized embryos:



❑: Over-expression of
twist gene

