From Concentration to Regulation. Possible Approaches for Reconstructing Genetic Networks.

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Culture Conditions ↔ Expression Patterns

Different Culture Conditions RNAi Experiment
Approaches

- **Boolean Nets**
  - Popular approach
  - Mathematically accessible
  - Produced several proofs
  - Lacking biological realism

- **Genetic Programming**
  - Rarely used
  - Kind of black box
  - Can deal with realistic scenarios.
Boolean Nets

\[ v_1' = v_2 \quad v_2' = v_1 \text{ AND } v_3 \quad v_3' = \text{NOT } v_1 \]

![Diagram of Boolean nets](image)

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>( v_1 ) ( v_2 ) ( v_3 )</td>
<td>( v_1' ) ( v_2' ) ( v_3' )</td>
</tr>
<tr>
<td>0 0 0</td>
<td>0 0 1</td>
</tr>
<tr>
<td>0 0 1</td>
<td>0 0 1</td>
</tr>
<tr>
<td>0 1 0</td>
<td>1 0 1</td>
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<tr>
<td>0 1 1</td>
<td>1 0 1</td>
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<tr>
<td>1 0 0</td>
<td>0 0 0</td>
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<tr>
<td>1 0 1</td>
<td>0 1 0</td>
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<tr>
<td>1 1 0</td>
<td>1 0 0</td>
</tr>
<tr>
<td>1 1 1</td>
<td>1 1 0</td>
</tr>
</tbody>
</table>
Solutions

Examples

<table>
<thead>
<tr>
<th>$I_1$</th>
<th>$V_1$</th>
<th>$V_2$</th>
<th>$V_3$</th>
<th>$O_1$</th>
<th>$V_1'$</th>
<th>$V_2'$</th>
<th>$V_3'$</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>I_2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>I_3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

$G_1$

- $V_1' = V_3$
- $V_2' = V_2 \text{ AND (NOT } V_3 \text{)}$
- $V_3' = \text{ NOT } V_3$

$G_2$

- $V_1' = V_3$
- $V_2' = V_2 \text{ XOR } V_3$
- $V_3' = \text{ NOT } V_3$
Necessary Examples

The diagram shows the relationship between the number of examples (#examples) and the number of nodes (#nodes) for two different values of $K$: $K=2$ and $K=3$. The graph illustrates how the number of examples increases linearly with the number of nodes for each value of $K$. The data points are marked with circles and squares for $K=3$ and $K=2$, respectively.
What is Genetic Programming?

\[
\frac{\sqrt{2 \cdot a - b}}{2 \cdot a}
\]
Crossing Over

\[ \sqrt{(2^\sqrt{2}) \cdot a \cdot b \cdot c - b} \]

\[ \frac{2^2 \cdot a \cdot a}{2^2 \cdot a \cdot a} \]

\[ \sqrt{b \cdot b = (2 + 2) \cdot a \cdot c = b} \]

\[ (2 + 2) \cdot a \cdot a \cdot c \]
GP Representation of Biochemical Reaction Nets - I
GP Representation of Biochemical Reaction Nets - II

[Diagram showing biochemical reaction nets with nodes labeled EC3.1.1.3, EC3.1.1.23, EC3.1.3.21, EC2.7.1.30, C00165, C00162, C00116, C00008, C00003, C00009, C00002, ATP, ADP, sn-glycerol-3-phosphate, sn-glycerol-1-phosphatase, Acylglycerol Lipase, Triacylglycerol Lipase, Fatty Acid, Glycerol, Monoacyl-glycerol, Diacyl-glycerol, Glycerol Kinase, FIRST-PRODUCT, CR_2.1, CR_2.2, CR_1.2, PROGN, RPB0, RPB1.]
Result after 225 Generations
In silico RNAi

Knock down of enzyme 1
EXTRA