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Ecole Normale Supérieure de Lyon

January 20, 2017
Part I

Project 4 – Scale the Wall
Outline

1. Attempts to Find a Solution
2. Evaluation of Impossibility Proofs
First Steps

- Can not find a solution with an empty wall
First Steps

- Can not find a solution with an empty wall
- Solution: Add glue to the wall
First Steps

- Can not find a solution with an empty wall
- Solution: Add glue to the wall
- Glue on the wall with strength 2 can be simulated with glue on the wall with strength 1

![Diagram of a molecular program](attachment://diagram.png)
Simplified Attempt
Complicated Attempt

\[ \text{Seed} \]

\[ \begin{align*}
G & \quad * \\
F & \quad * \\
E & \quad A \\
D & \quad C \\
A & \quad B \\
A & \quad \\
\end{align*} \]

T=2
Outline

1. Attempts to Find a Solution

2. Evaluation of Impossibility Proofs
Proof Attempts
Proof Attempts
Proof Attempts
Proof Attempts
Proof Attempts
Proof Attempts
Proof Attempts
Proof Attempts
Part II

Project 5 – Rock Paper Scissors Reaction Networks
Trying to play shifumi with reaction networks

same guys as before

20 January 2017
Introduction
Two networks can play each other using chemicals:
Two networks can play each other using chemicals:

- For each player, $C_1$, $C_2$, $C_3$ concentrations represent the moves **Rock**, **Paper** and **Scissors**;
Two networks can play each other using chemicals:

- For each player, $C_1$, $C_2$, $C_3$ concentrations represent the moves **Rock**, **Paper** and **Scissors**;
- As soon as one concentration exceeds 1.0, the player is assumed to make a move;
Two networks can play each other using chemicals:

- For each player, $C_1, C_2, C_3$ concentrations represent the moves **Rock**, **Paper** and **Scissors**;
- As soon as one concentration exceeds 1.0, the player is assumed to make a move;
- $C_4, \ldots, C_{n-1}$ are “helper” chemicals product;
Two networks can play each other using chemicals:

- For each player, $C_1$, $C_2$, $C_3$ concentrations represent the moves **Rock**, **Paper** and **Scissors**;
- As soon as one concentration exceeds 1.0, the player is assumed to make a move;
- $C_4$, ..., $C_{n-1}$ are “helper” chemicals product;
- $C_n$ represents the fuel; each move consumes fuel.
Example of game

Figure 1 – Example of a game between two networks

same guys as before  Trying to play shifumi with reaction networks
Example of game

\[
\begin{array}{cccc}
1 & -1 & 0 & 0 \\
0 & 1 & -1 & 0 \\
-1 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 \\
\end{array}
\]

**Table 1 – Player 1**
Example of game

Table 1 – Player 1

<table>
<thead>
<tr>
<th>1</th>
<th>-1</th>
<th>0</th>
<th>0</th>
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<tbody>
<tr>
<td>0</td>
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<td>-1</td>
<td>0</td>
</tr>
<tr>
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<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 2 – Player 2

<table>
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<th>0</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Project
What has been done:
What has been done:

- Implementing a simulator;
What has been done:

- Implementing a simulator;
- Trying to find a good reaction network;
Using euler method with those equations:

\[
\begin{align*}
\frac{dx_i}{dt} &= 10^{-6} - 0.4x_i + \frac{x_n}{2 + x_n} \cdot \sum_{j > 0} a_{ij}x_j + 1 + \sum_{j > 0: a_{ij} > 0} a_{ij}x_j + 10 \sum_{j > 0: a_{ij} < 0} |a_{ij}|x_j \\
\frac{dx_n}{dt} &= 0.5 - \frac{x_n}{2 + x_n} \cdot \sum_{i > 0} a_{ij}x_j + 1 + \sum_{j > 0: a_{ij} > 0} a_{ij}x_j + 10 \sum_{j > 0: a_{ij} < 0} |a_{ij}|x_j
\end{align*}
\]
Simulator

During the simulation, do in a loop:
Simulator

During the simulation, do in a loop:

- For each player, for each chemical:
Simulator

During the simulation, do in a loop:

- For each player, for each chemical:
  - Update the chemical concentration;
Simulator

During the simulation, do in a loop:

- For each player, for each chemical:
  - Update the chemical concentration;
  - Update the fuel;
Simulator

During the simulation, do in a loop:

- For each player, for each chemical:
  - Update the chemical concentration;
  - Update the fuel;
- Update the scores.
Finding good networks to fight!

SPOILER:
Finding good networks to fight!

SPOILER:
Well it failed.
The idea

Taking random networks, simple networks like the previous one; 
LET THEM FIGHT
(Taking bad networks; 
Mutate them in bad networks (takes age...); 
Get bad networks.

same guys as before
Trying to play shifumi with reaction networks
The idea

Theory

- Taking random networks, simple networks like the previous one;
- **LET THEM FIGHT** (in a tournament);
- Take the best, mutate them, shuffle everything;
The idea

**Theory**
- Taking random networks, simple networks like the previous one;
- **LET THEM FIGHT** (in a tournament);
- Take the best, mutate them, shuffle everything;

**Practice**
- Have bad networks;
- Mutate them in bad networks (takes *age*...);
- Get bad networks.
MOAR Examples

**Figure 2** – I do not even know how I got this network
MOAR Examples

Figure 3 – Trivial variations
MOAR Examples

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
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<td>5.02106</td>
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<td>0.654704</td>
<td>1.26085</td>
</tr>
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<td>0.0215417</td>
<td>-0.82885</td>
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<td>-0.880956</td>
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<td>0.0116319</td>
<td>0.0846469</td>
<td>-0.868768</td>
<td>-0.0630371</td>
</tr>
</tbody>
</table>

Table 3 – Matrix of the trivial variation
Conclusion
**Genetic algorithm:** Well, why not but with good initialization heuristics.