

# Non-linear Dynamics in the $A_n^*$ Plane

Matthew Trefilek

Computer Science and Math  
Northern Michigan University

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# Project Goal

Create a GUI tool for modelling non-linear dynamics in the  $A_n^*$  Lattice.

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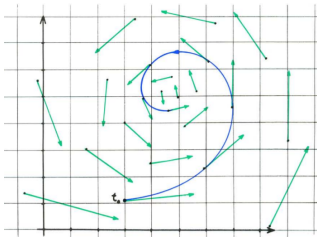
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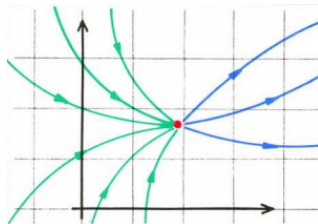
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# Non-linear Dynamics



(a) Vector Field around Trajectory



(b) Limit Point of a State Space

# Non-linear Dynamics Continued

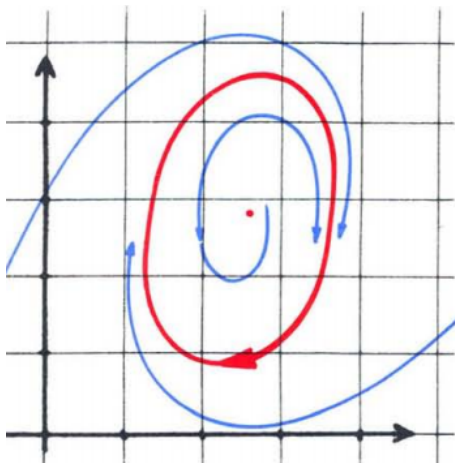


Figure 2: Attractor and Repeller Vector Field

# Braitenberg Vehicles

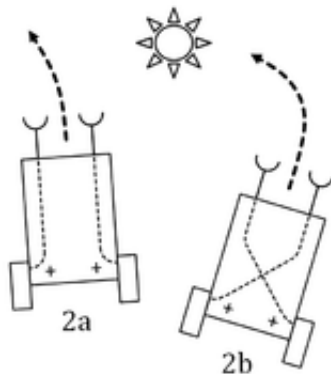


Figure 3: Example Braitenberg Vehicle



# Permutahedron

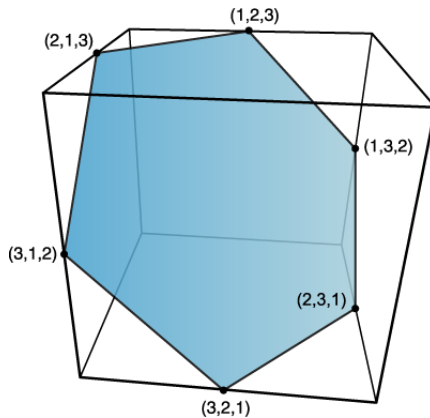


Figure 4: Order 2 Permutahedron the tiling of these make up the  $A_3^*$

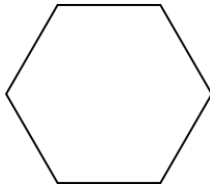


Figure 5: Level 0 Aggregate

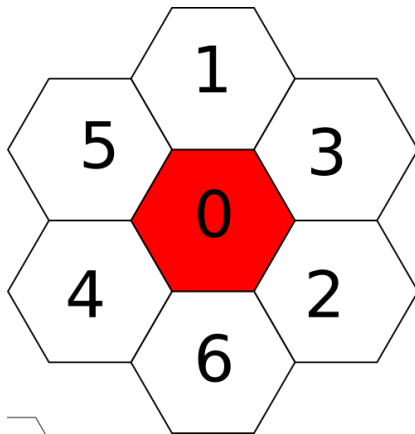


Figure 6: Level 1 Aggregate

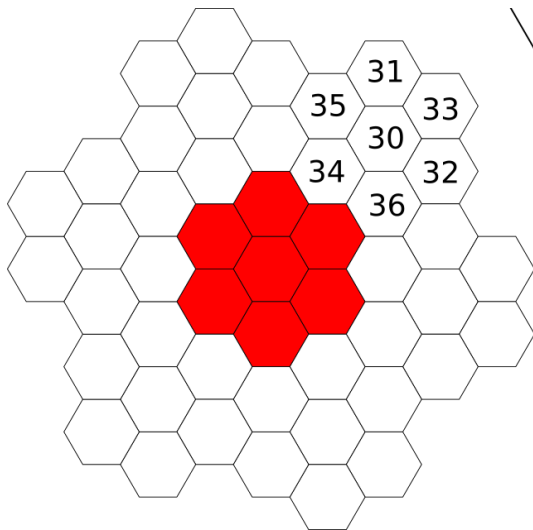


Figure 7: Level 2 Aggregate

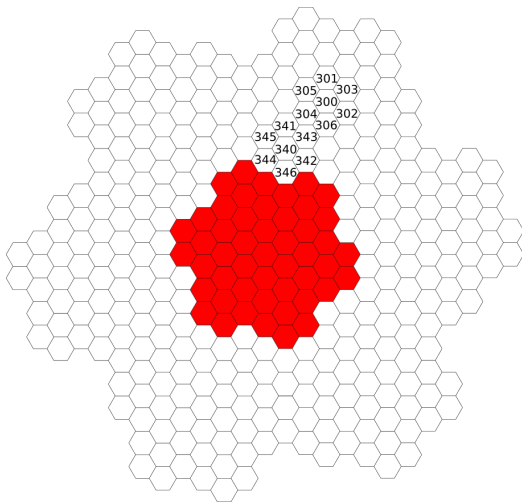


Figure 8: Level 3 Aggregate

# $A_3^*$ Addressing

## Canonical Address

Integer address in  $\mathbb{Z}/7\mathbb{Z}$ .

## Standard Address

Set of vectors with each digit of the canonical address written in binary.

## Examples

Example:

$$342 = \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix} \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$$

# B-Matrix

$$B = \begin{pmatrix} 2 & 0 & \cdots & 0 & -1 \\ -1 & 2 & \cdots & 0 & 0 \\ 0 & 0 & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & -1 & 2 \end{pmatrix} \quad B_2 = \begin{pmatrix} 2 & 0 & -1 \\ -1 & 2 & 0 \\ 0 & -1 & 2 \end{pmatrix}$$

## Address to Vector

$$x = V(t_0 + B_n t_1 + B_n^2 t_2 + \cdots + B_n^{k-1} t_{k-1})$$

which was programmed as:

---

```
1   for(int i = 1; i < m.getX(); i++){
2       ret = ret.add(Matrix.getBMatrix(m.getY()-1).pow(i)
3           ↪ .multiply(m.vectorAt(i)));
4   }
```

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# Square World

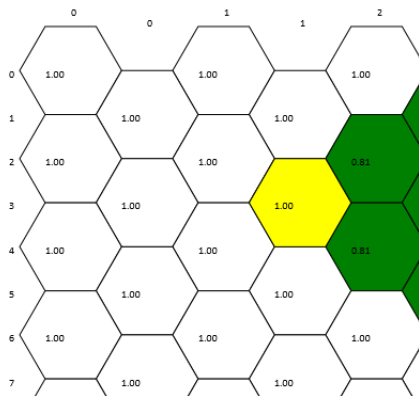


Figure 9: Square World

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# GUI

- ▶ JavaFX
- ▶ MVC
- ▶ Observer Pattern
- ▶ Visitor Pattern

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# Questions?

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## Research:

5/5pts      Advanced Knowledge of Java Swing

3/5pts      Understanding of the A\* Plane and Pathing Methods

10/10pts    Research into Cellular Automata and Braitenberg Vehicles

10/10pts    Research into Nonlinear Dynamics and Attractor Processes

**28/30**

## Develop a Data Storage and Addressing system:

5/7pts      Data Model Implementation

1/3pts      Abstraction of Paths from Data Model

**6/10**

# Grades

## Pathfinding Automata:

15/15pts Pathfinding Utilizing Attractors and Repellers

5/5pts Recovery of Individual Tracking Information

3/5pts Recording Attractor and Repeller Basins

5/10pts Analyzing and Displaying Examples of Emergent Behaviors

28/35

## Project Management

2/2pts git Version Control

2/2pts Object Oriented Project Management

6/6pts Unit Testing with JUnit4

10/10



## 2D Visualization Engine:

10/10pts MVC Design

5/5pts Swing GUI with Simulation Controls

5/5pts Representation of Hex Grid

10/10pts Automata Tracking and Displaying Paths

5/5pts Implementation of Observer Pattern

6/10pts Results View: Map of Attractor and Repeller Basins

41/45

# Scale

A 110-130

B 90-109

C 70-89

D 50-69

Grade

A - 113/130