CELLULAR AUTOMATA

DSP-Processing & Generative Music, 2013W

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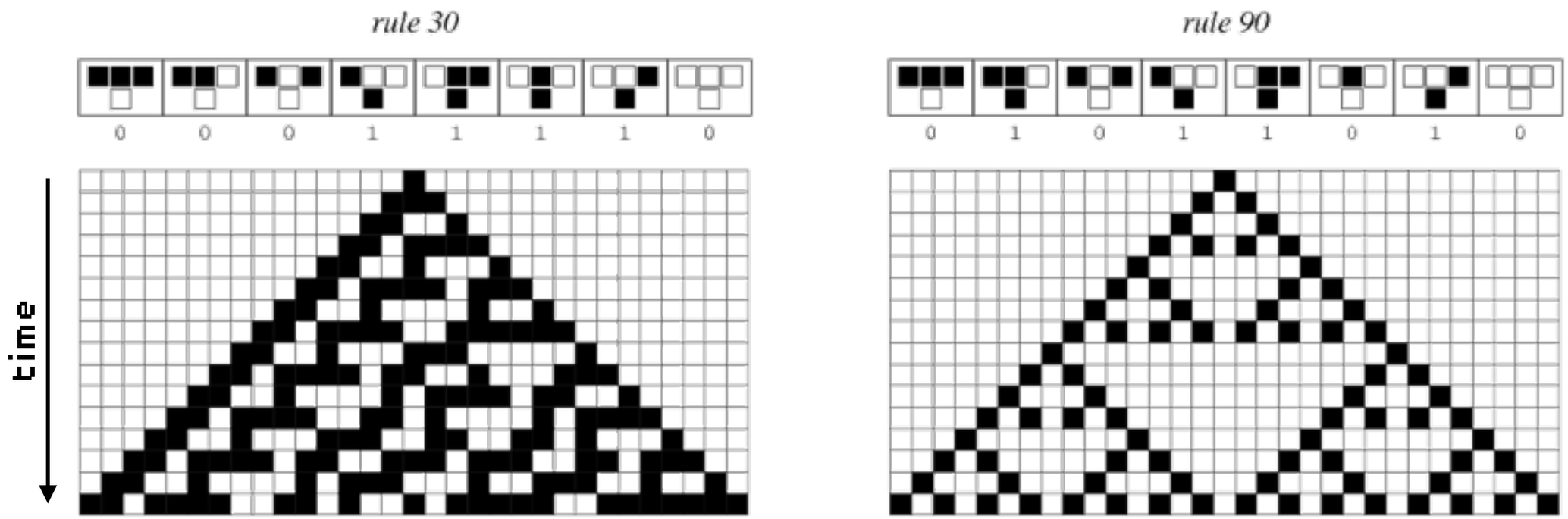
DEFINITION

- Discrete dynamic systems
- N-dimensional cell space
- Cells have finite number of states
- State defined by own and neighbor cells
- State transition rules for every cell

1-DIMENSIONAL



- Simple: 2 states depending on 2 neighbor cells
- Rule number from binary rules (00011110 = 30)
- Related to Lindenmayer system

1-DIMENSIONAL

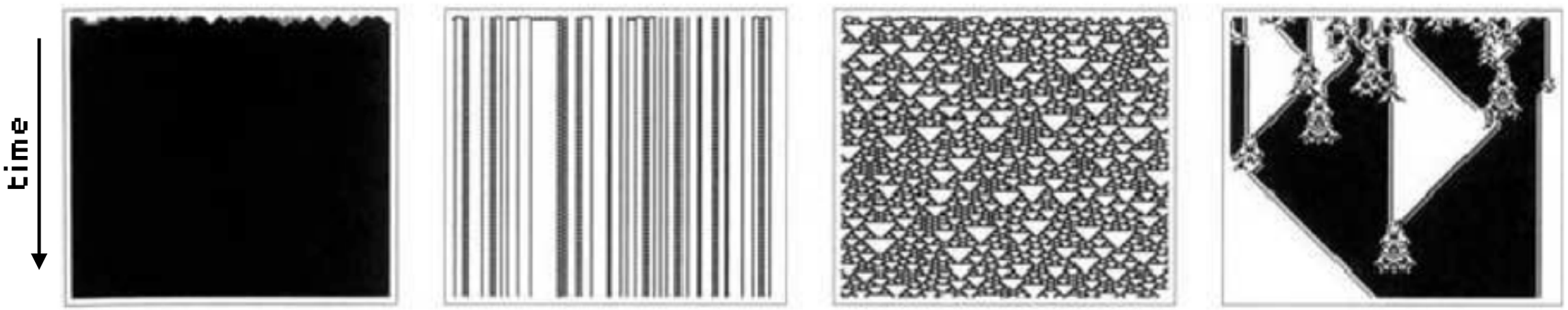
- Classified into 4 states [Steven Wolfram]

  1. Evolves to a **homogeneous** final state

  2. Stable or **periodically** appearing structures

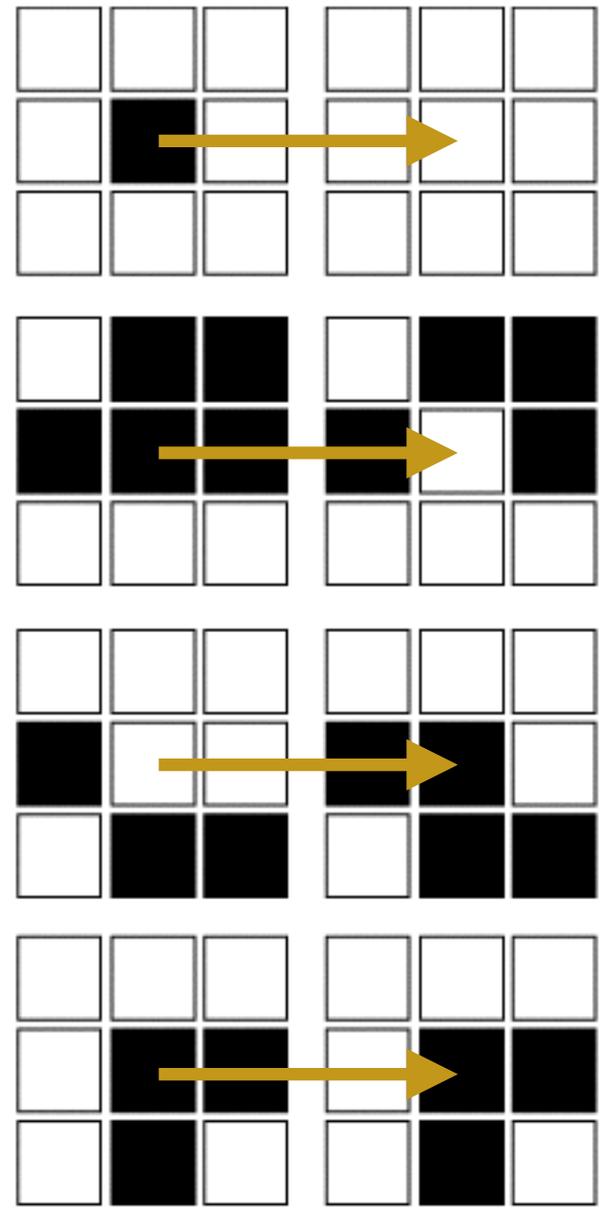
  3. **Chaotic** and random behavior

  4. **Complex** patterns (may repeat)

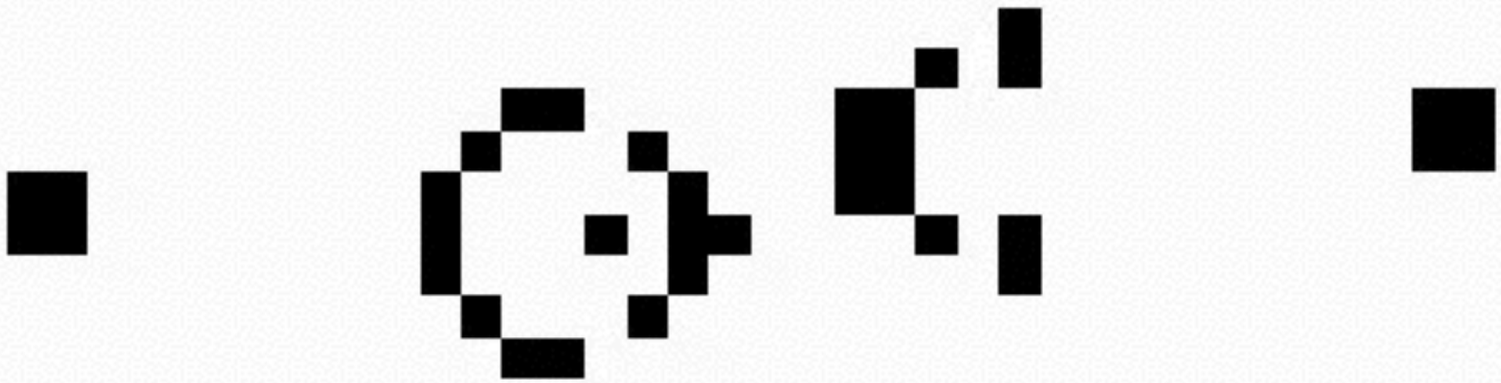


2-DIMENSIONAL

- Conway's Game of Life
- Grid with cells that are dead or alive
  - Dead cell with 3 neighbors gets alive
  - Alive cell with 2 or 3 neighbors stays alive
  - Otherwise it dies
- Gliders, space ships and other pattern

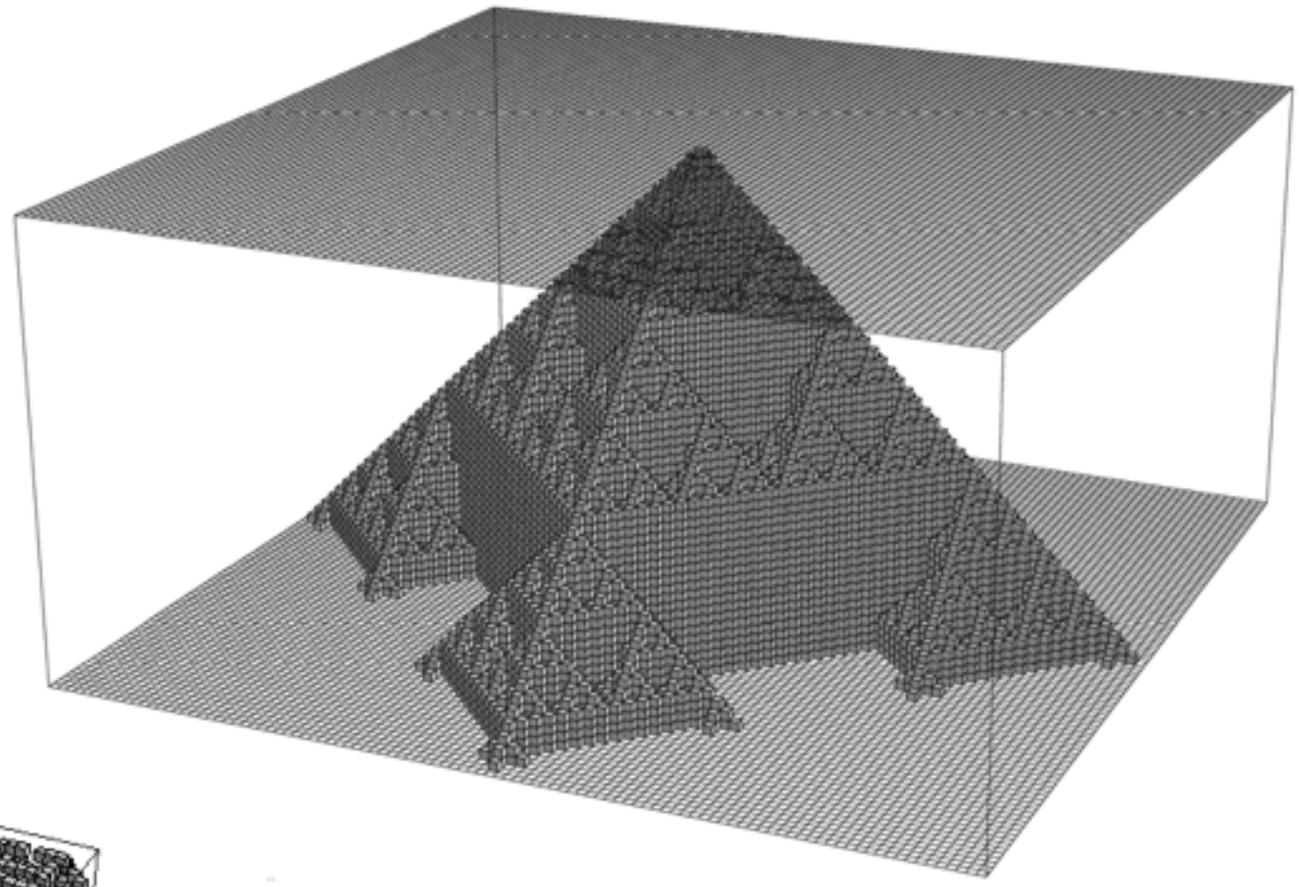


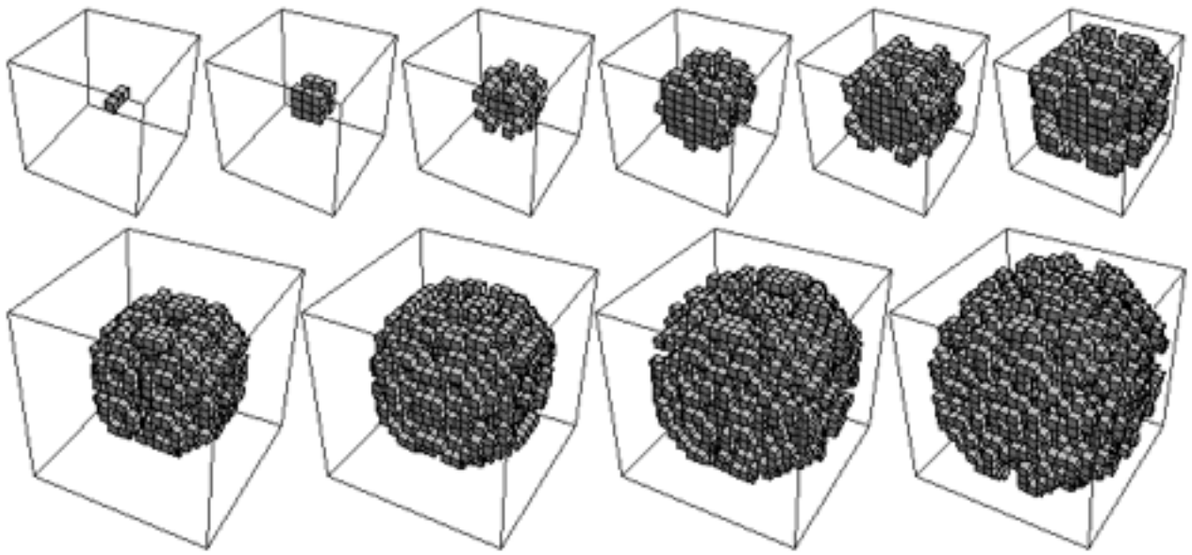
SEED



3-DIMENSIONAL

temporal evolution





rule based

University of York
MA/MSc in Music Technology

C A M U S

(V1.0 - July/91)

Cellular Automata MUSic generator

by
Eduardo Reck Miranda

x:0 y:0

counter: 0

overlap:

loop: 0

life rule
- 2 + - 4 +

death rule
- 2 + - 3 +

orchestration
- 2 +

loop limit
- 1 +

distribution #
uniform

articulation
- 0 +

speed: 9200
dynamics: 64
pitches

36	47	46	45
37	38	39	44
43	40	41	42

setup | quit | stop | clear

** null **

start step
- 0 +
end step
- 0 +

speed
- 9999 +
variation
- 0 +

dynamics
- 0 +
variation
- 0 +

pitches

12	12	12	12
12	12	12	12
12	12	12	12

- + 0

- +

ok

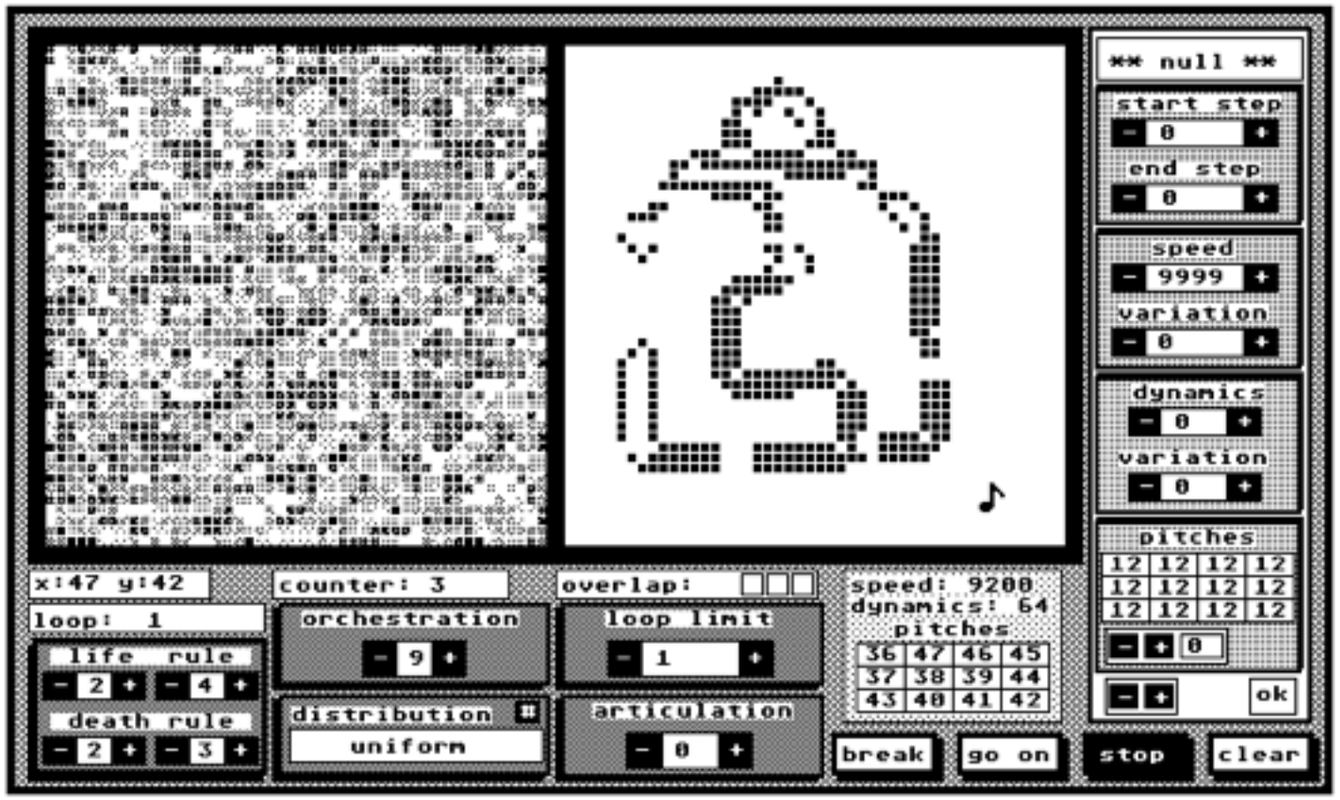
CAMUS

- CAMUS (Cellular Automata MUSic generator)

- Eduardo Reck Miranda

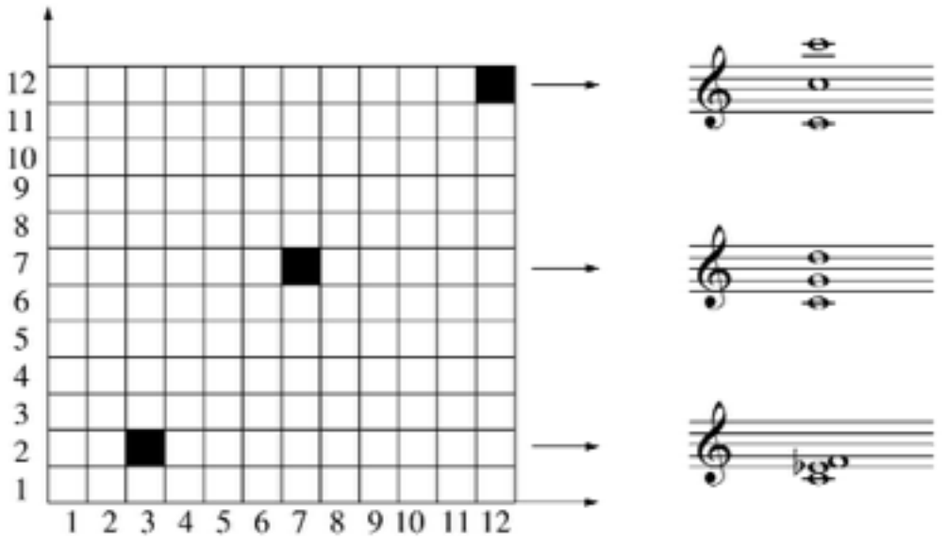
- Game of Life (pitches, duration)

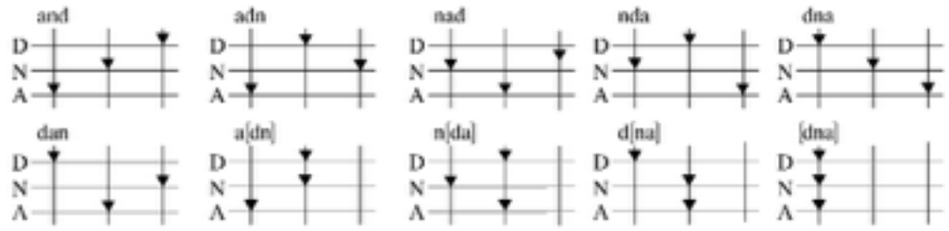
- Demon Cyclic Space (instrumentation, timbre)

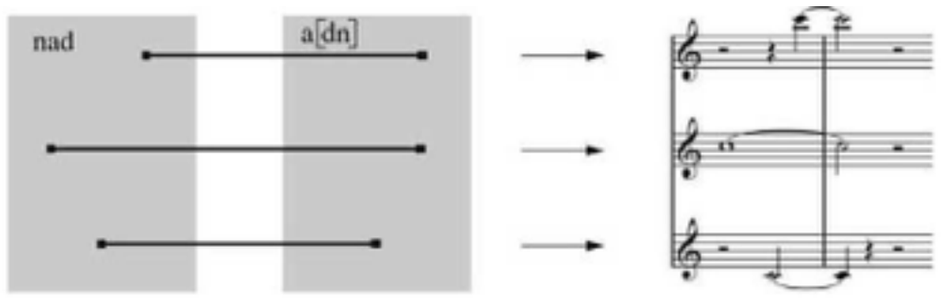


CAMUS

- Demon Cycle Space
  - More states, complex spreading patterns
- Musical parameter through coordinates as **triads**
- Neighboring cell states stored in binary lists w_1, w_2, w_3, w_4 (different state order)
- 10 configurations for succession combined through sublists
  - $w_1 + w_2$ = **temporal** order
  - $w_3 + w_4$ = **duration**







HANDS ON!

- CA with Novation Launchpad
  http://www.youtube.com/watch?v=rWq4AppMm8A

- Otomata
  http://www.earslap.com/projectslab/otomata

- WolFram Tones
  http://tones.wolfram.com

WHAT ELSE?

- Continuos automata [0..1]
- Probability based
- Different grid
- More than 3 dimensions
- Taking previous states into account
- ...

Any questions?

Image and video credits
http://www.stephenwolfram.com/publications/generation-form-a-new-kind-of-science/
http://tamw.atari-users.net/camus.htm
http://math-blog.com/2011/05/16/the-game-of-life-in-octave/
http://tvmny.blogspot.co.at/2006_08_01_archive.html
Algorithmic Composition: Paradigms of Automated Music Generation, Gerhard Nierhaus