Artificial Brains as Networks of Computational Building Blocks

Telmo Menezes and Ernesto Costa

The Goal

- Evolutionary computational intelligence for multi-agent simulations

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Current Approaches

- Symbolic / Rule-based
- Simplistic
- Computational limitations

Current Approaches

- Neural Networks
- Black boxes
- Evolvability of computational constructs?

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Current Approaches

- Fixed sensory / actuator interfaces
- Disregard of digital computer architecture

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Gridbrain Concepts

- Multi-layered (sensory / decision grids)
- Variable-sized sensory data
- Computational building blocks
- Evolutionary complexification

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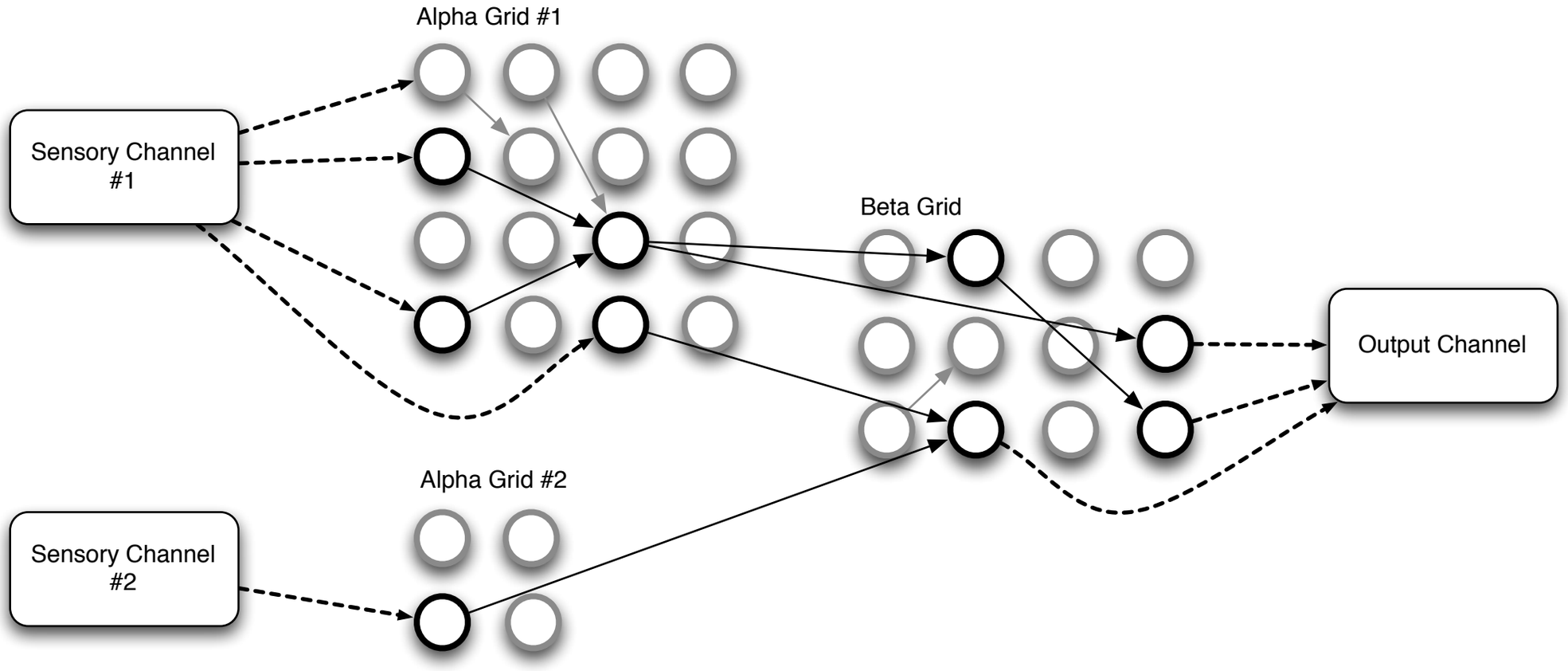
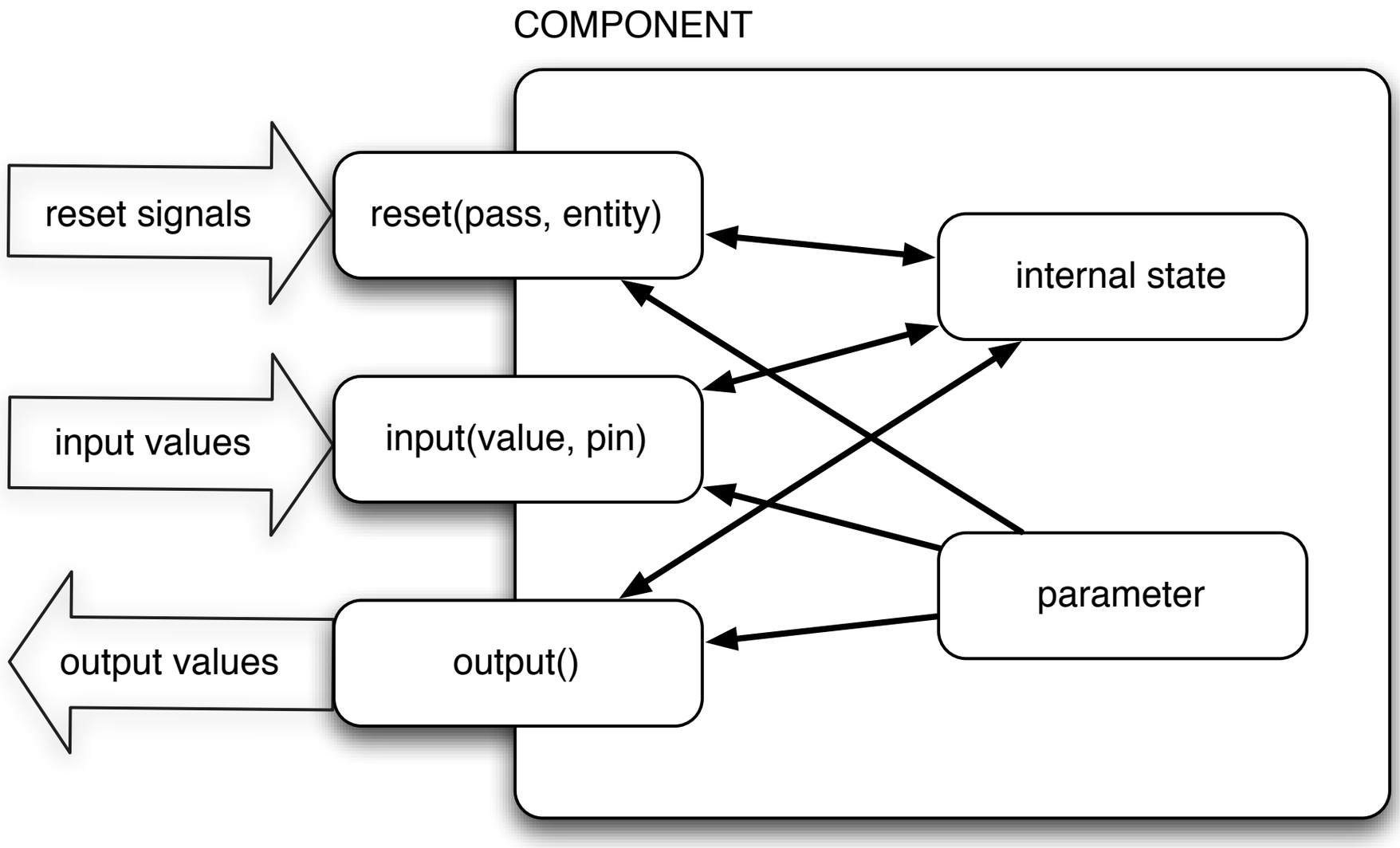
Gridbrain Model



Component Model



Component Types

Component Type	State Persistence
Operator	Grid Evaluation
Aggregator	Alpha Stage
Memory	Gridbrain Lifespan

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A Component Set

Name	Description	Type	Consumer/Producer
IN	Input	Input/Output	Producer
OUT	Output	Input/Output	Consumer
AND	Boolean AND	Operator	
NOT	Boolean NOT	Operator	Producer
SUM	Sum	Operator	
MUL	Multiply	Operator	
INV	Inverse	Operator	
NEG	Negative	Operator	
MOD	Module	Operator	
AMP	Amplify	Operator	
RAND	Random value	Operator	Producer
EQ	Is equal	Operator	
GTZ	Is greater than zero	Operator	
ZERO	Is zero	Operator	Producer
MAX	Maximum	Aggregator	
MIN	Minimum	Aggregator	
AVG	Average	Aggregator	
MEM	Memory cell	Memory	
SEL	Select entity	Memory	
DMUL	Delayed multiplier	Memory	
CLK	Clock	Memory	Producer
TMEM	Temporary memory	Memory	

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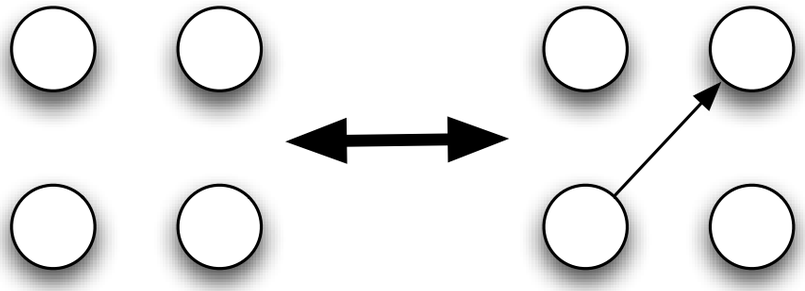
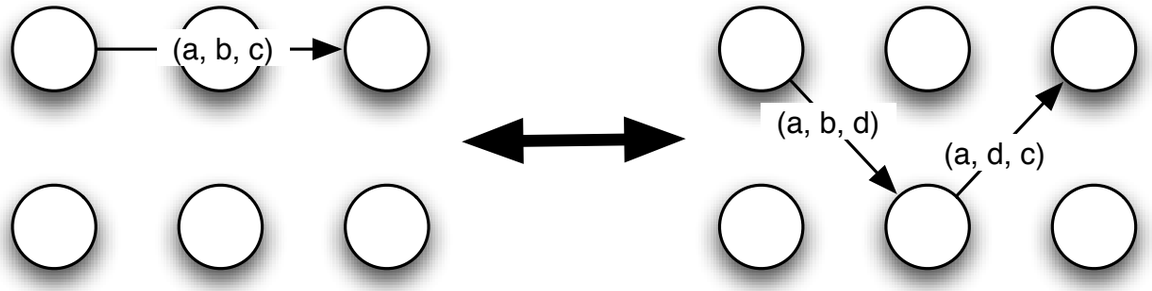
Mutation Operators

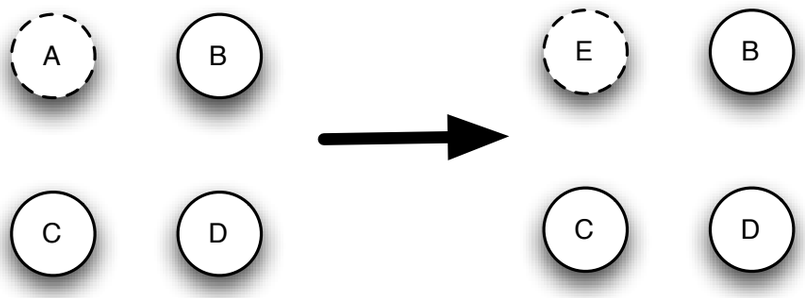
a) Add/Remove Connection



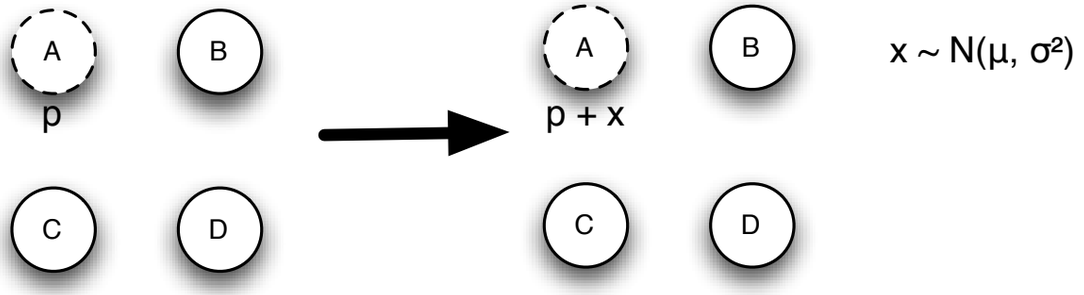
b) Split/Join Connections



c) Change Component



d) Change Parameter



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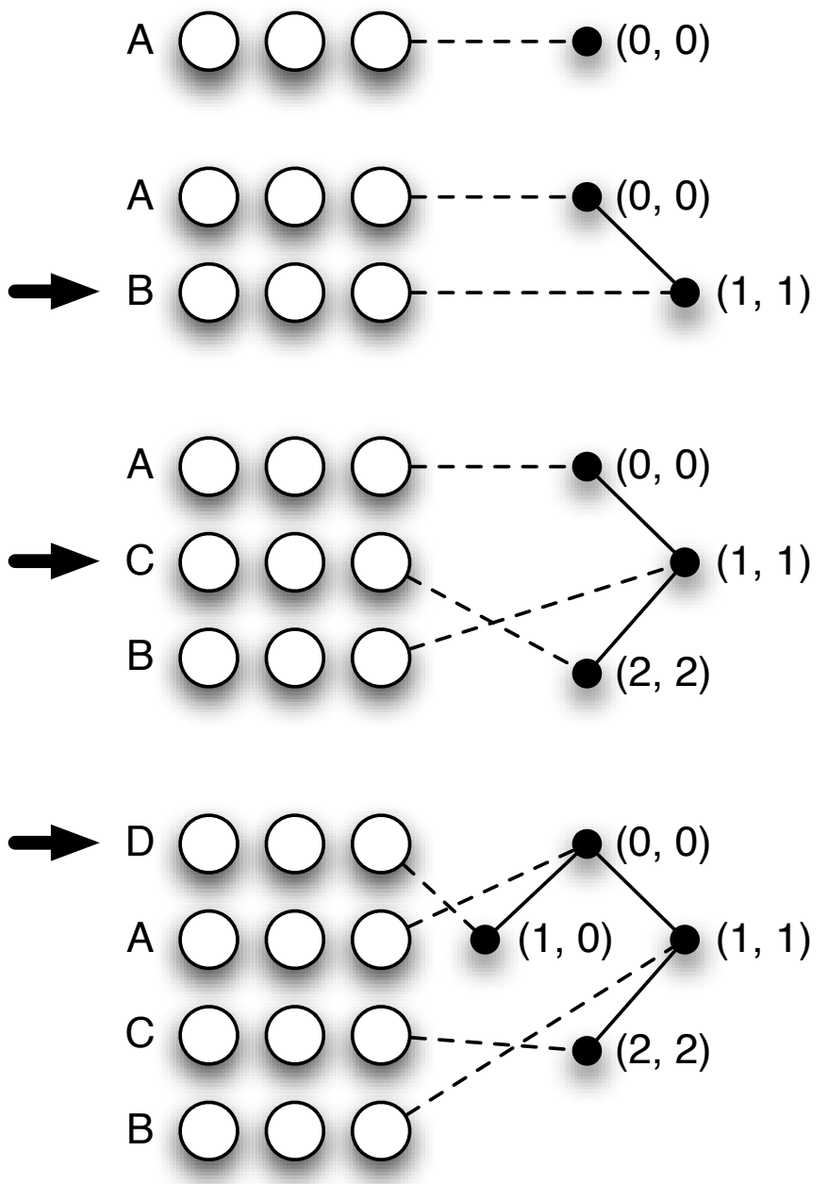
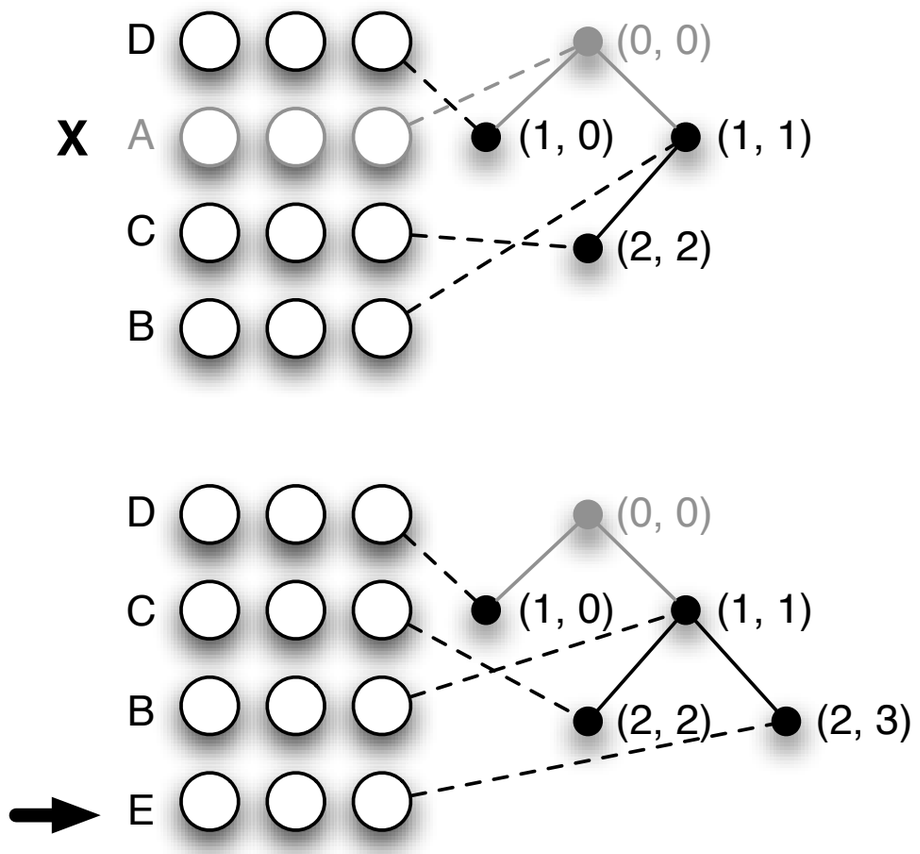
Connection Tags

- Tag: (g, o, t) [group, origin, target]
- Assigned or generated when brain enters the population

Row/Columns IDs





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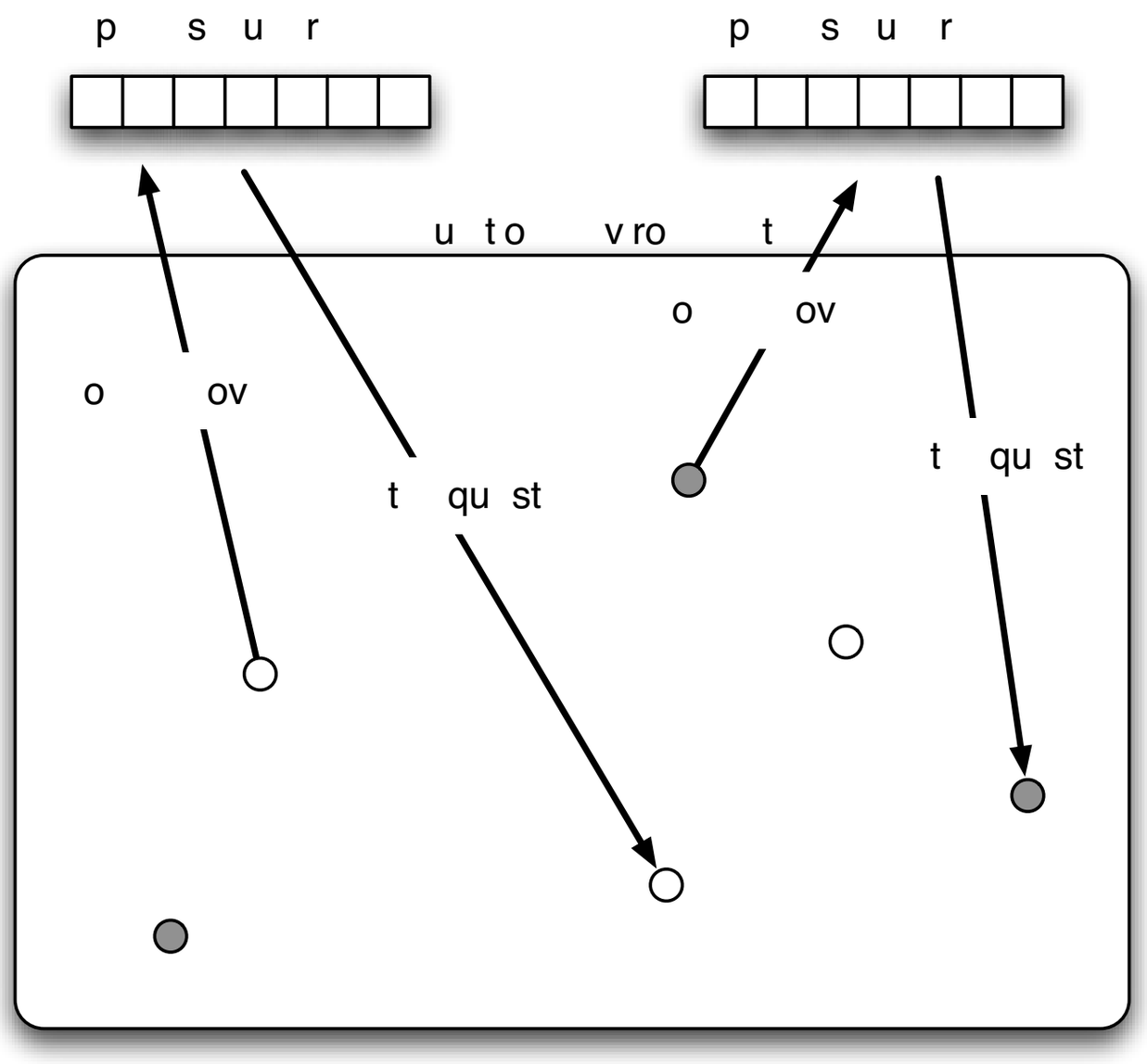
Recombination

- Create the child gridbrain: same sizes, same column/row IDs of parent A;
- Recombine connection groups from parents A and B to child;
- Recombine components from parents A and B to child.

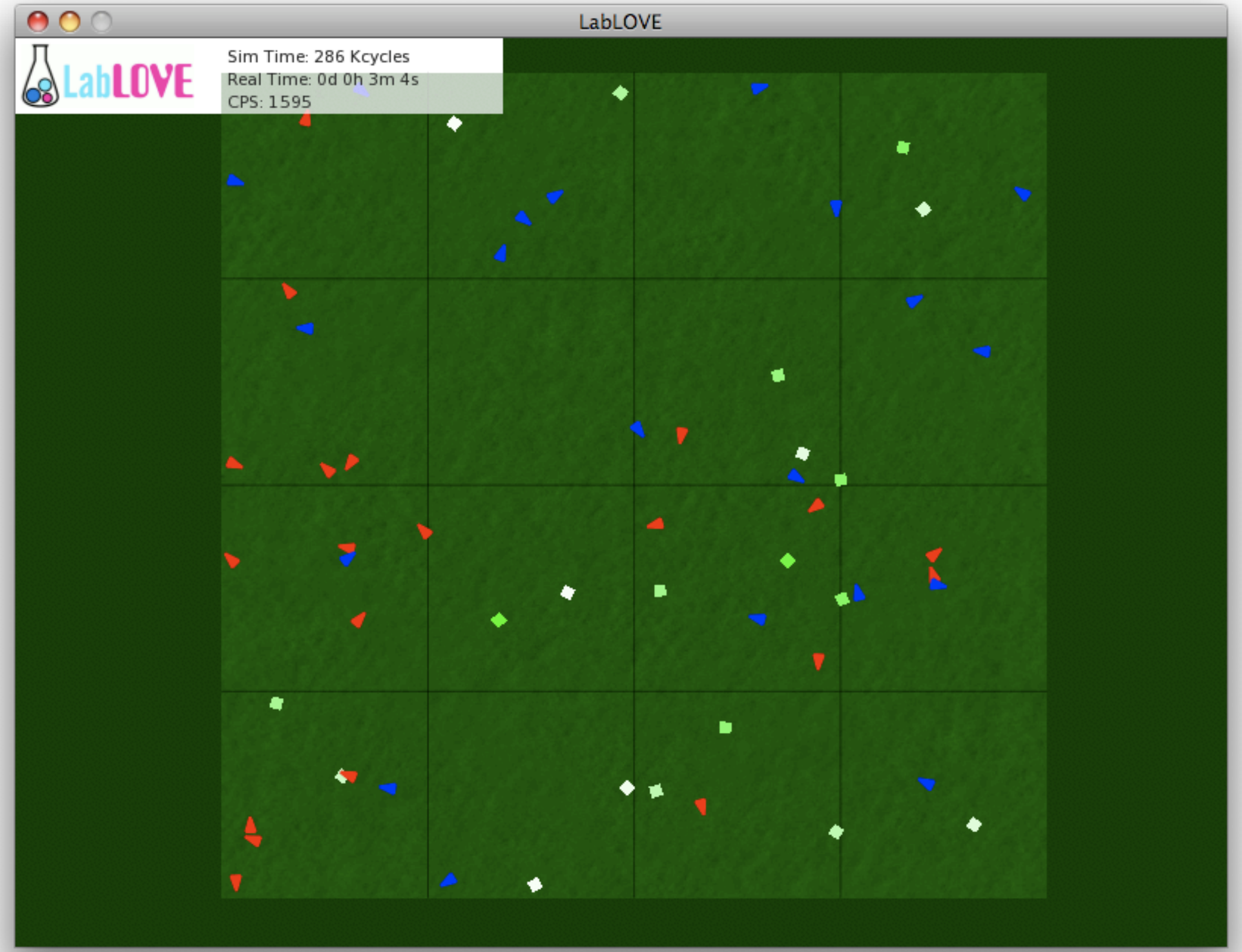
Formating

- Gridbrain shape adjusted to allow:
  - Add connection between active;
  - Add intra-grid connection to/from any active;
  - Branch active output to inactive in any column;
  - Split any active connection.

SEGA



LabLOVE



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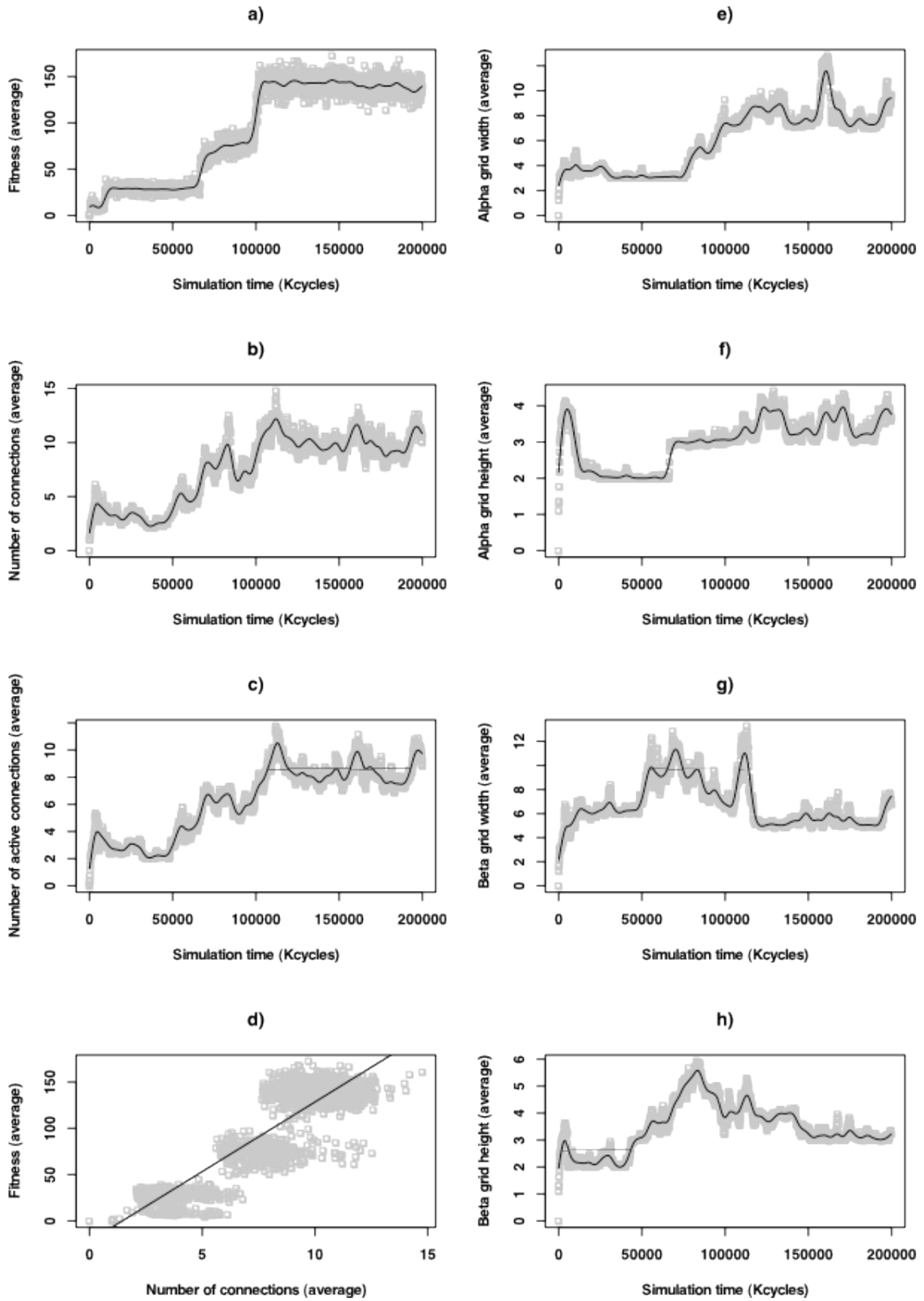
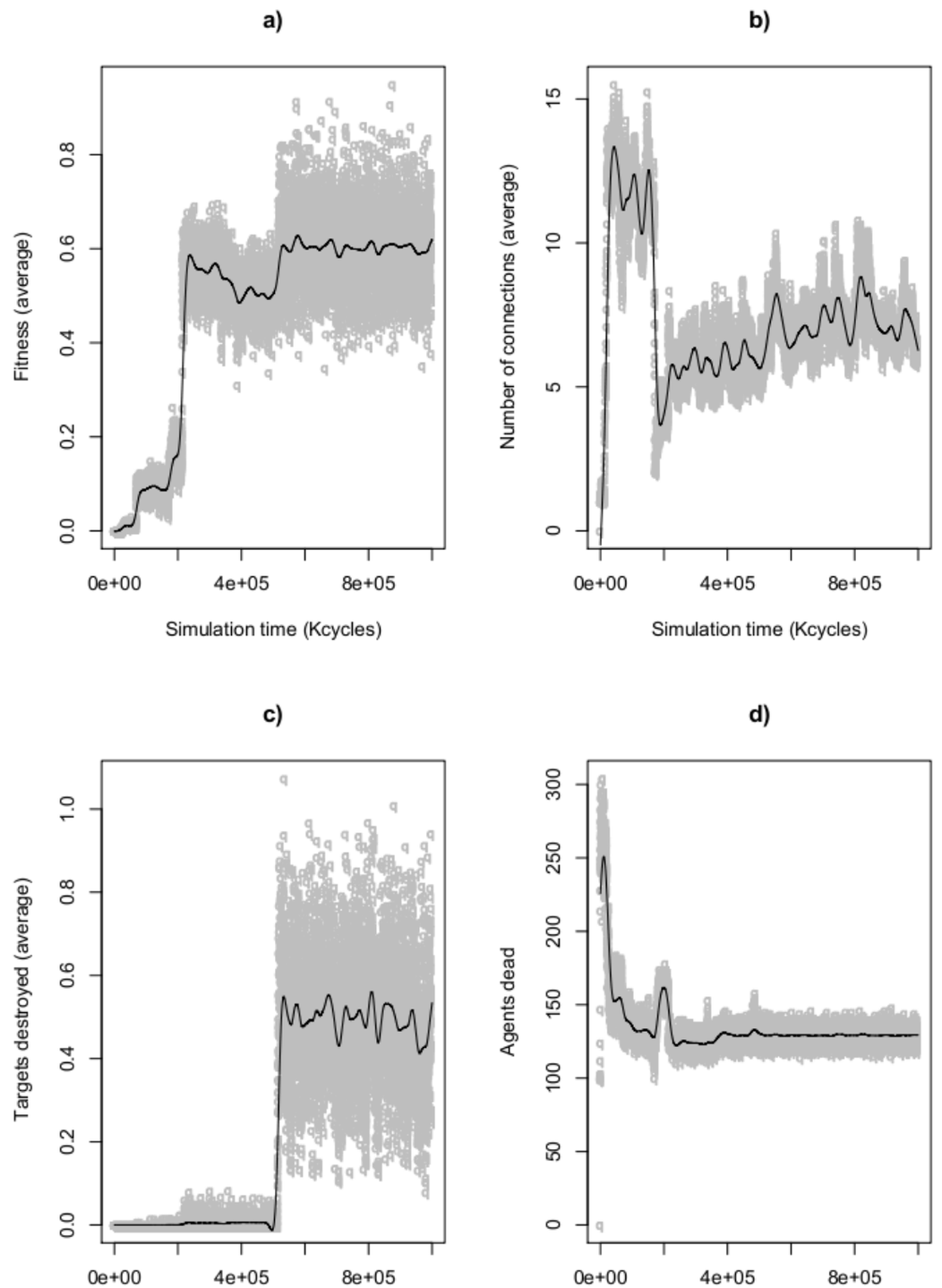
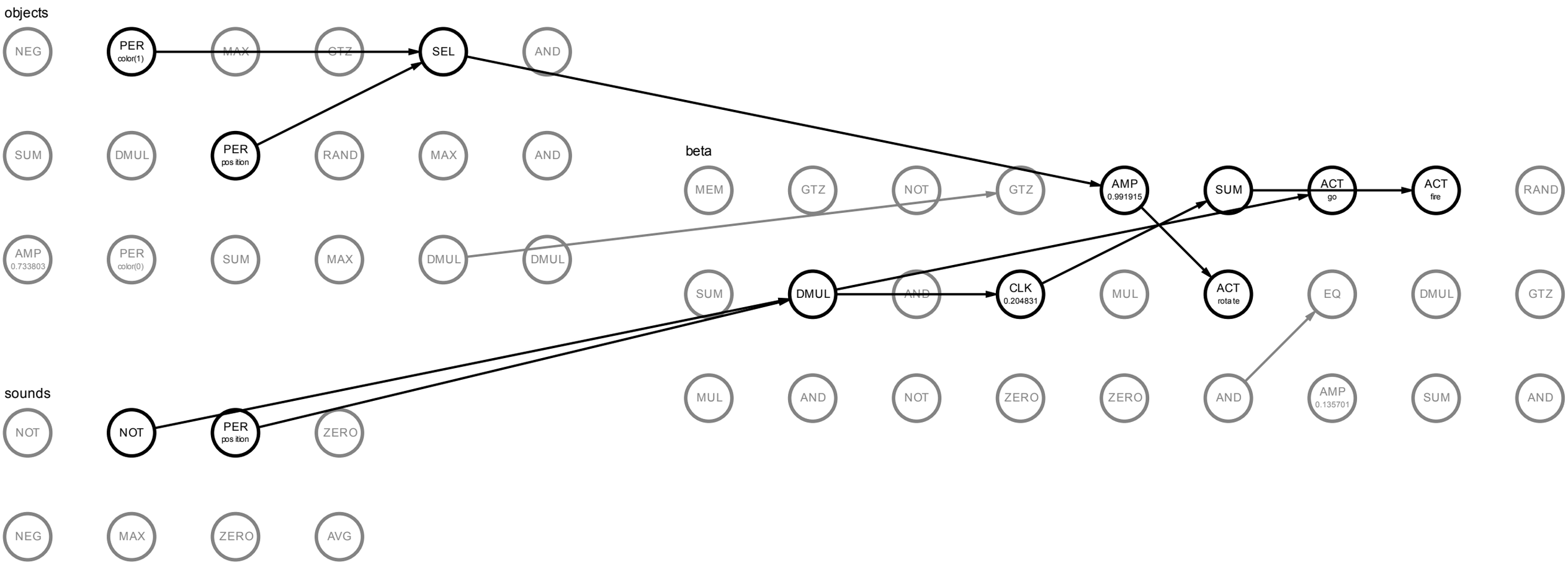
Evolution - Poison



Evolution - Targets



Evolved Gridbrain



Thank You!

- telmo@telmomenezes.com
- http://sourceforge.net/projects/lablove

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