Towards Unity

Emergence in the Mind's Eye

Agenda

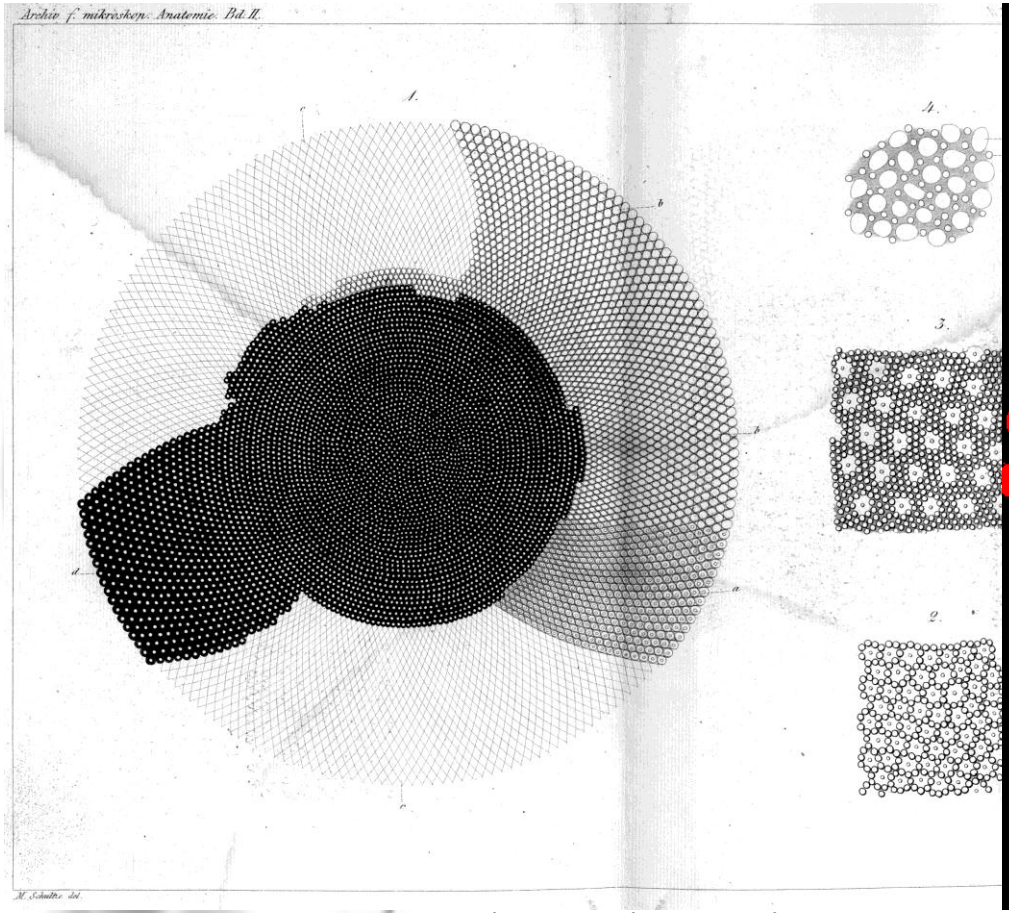
- Introduction
- Demonstrate Emergence
- Solution Overview
- What is Emergence?
  (A little bit of process philosophy)
- Conclusion

Introduction

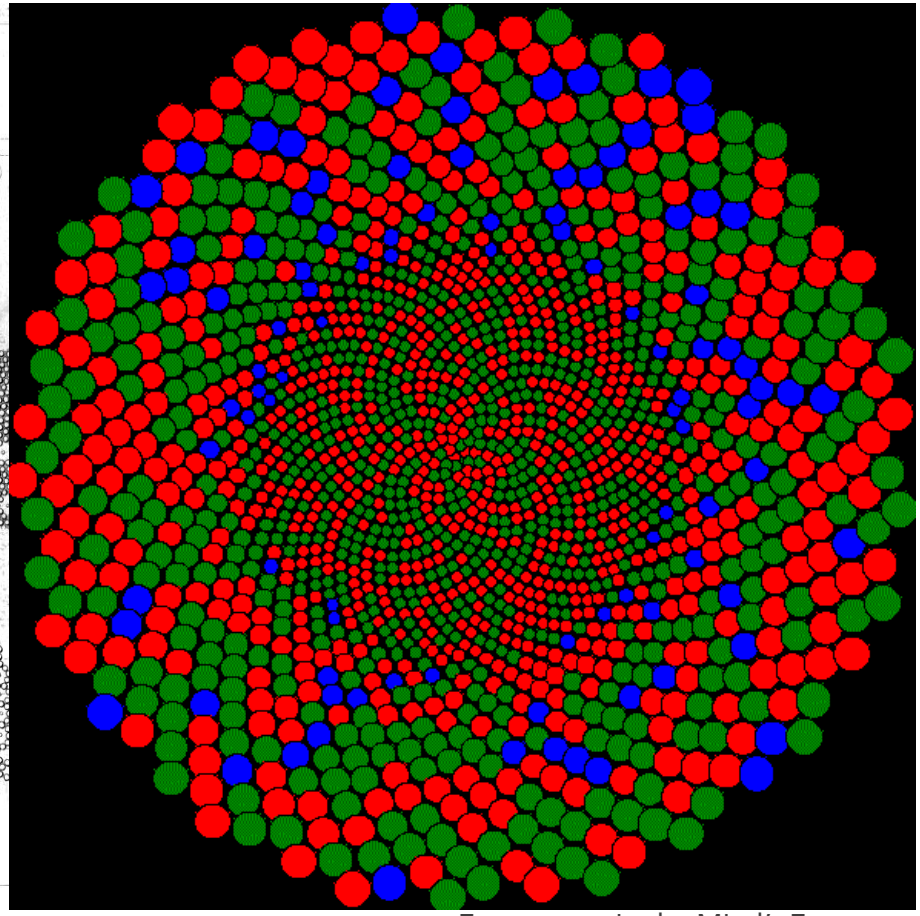
To make sense of demonstration

Photoreceptor Topology – Missing Data

- (Schultze, 1866)

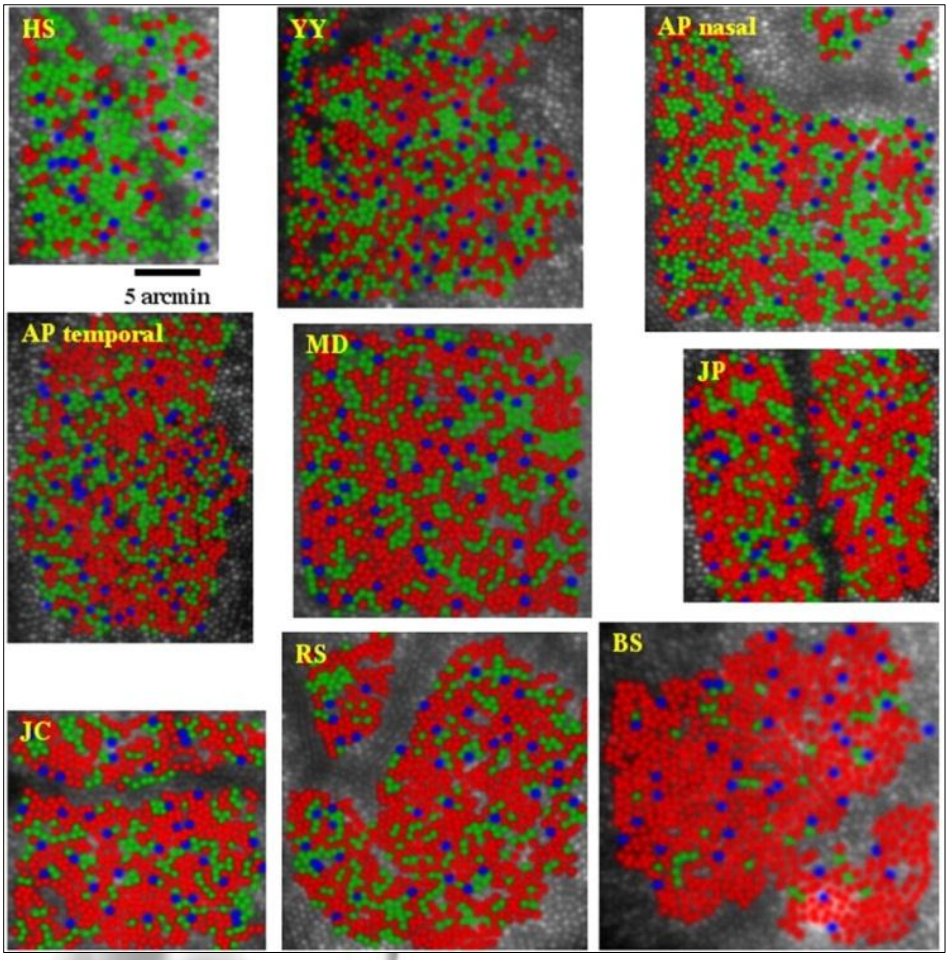


- ECM
  - Note: Blue-Free Region

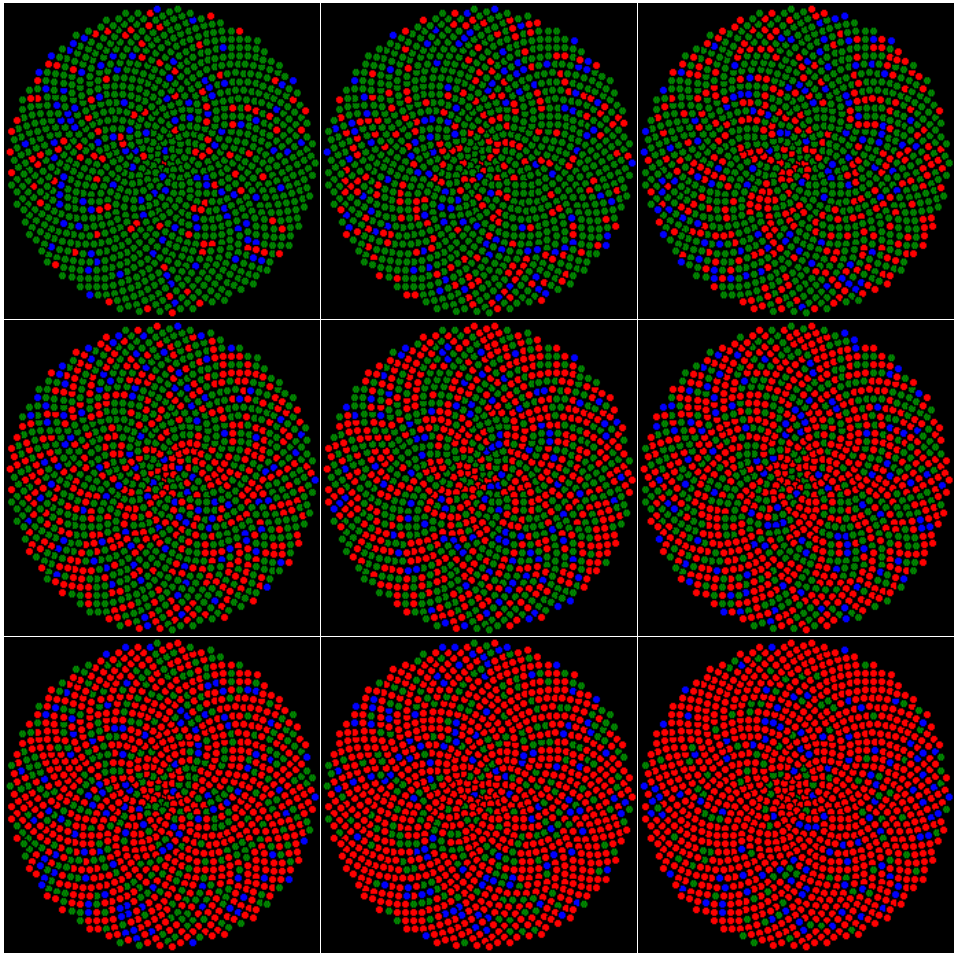


Photoreceptor Variance
How can a patch look smooth?

- (Hofer et al, 2005)



- ECM



Emergence Quickie

- Substance: The whole **is more** than the **sum** of the parts

- Process: When a **few** functional parts **cause more** behaviours (or phenomena)
  - But what is function?

Functional Parts (Purposeful, Intentional)

- Handle Missing Data
  - Missing Photoreceptors
  - Eye Blink
- Maintain Information Coherence
  - Eye motion

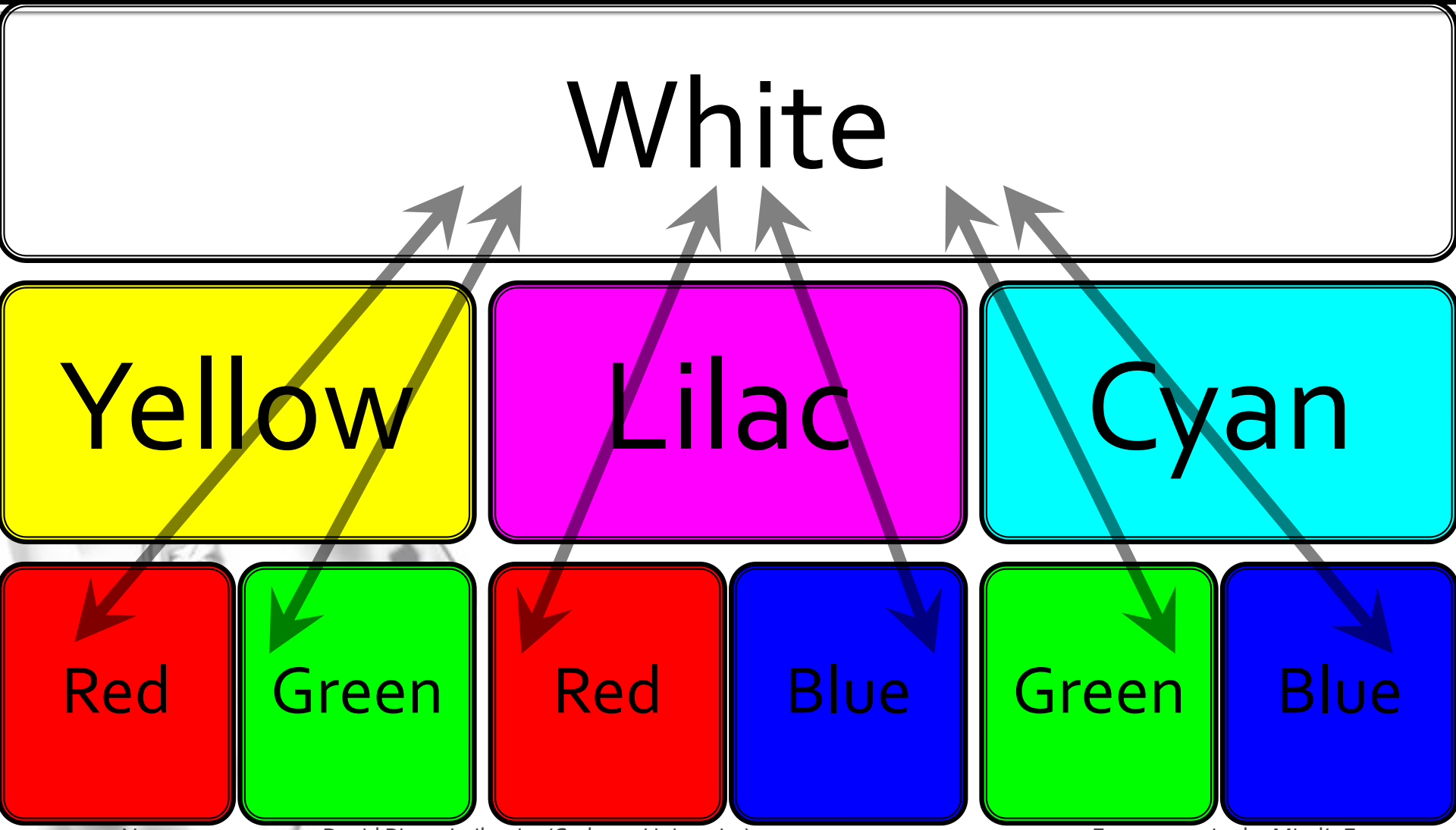
Phenomena Accounted For

- Filling-In
  - L/M Cone Clumping
  - S Cone Scarcity
  - S-Free Region
  - Colour Linearity & Homogeneity
  - Blind-Spot
- Filling-Out
- Image Stability
- Image Maintenance
  - Eye Blink
  - Brief Stimuli

Function, Structure & Tasks (task == behaviour)

- Cognitive Function is always context sensitive
  - Always 'function of a structure or task' in relation to other functions, structures and tasks
  - Cannot be understood without structure
- Cognitive Structure is always context sensitive
  - Do task, identify correlative structures
    - Brain region involved in task, the 'f' in fMRI
  - Need to infer function from task, related tasks, related functions, and related structures
  - Cannot be understood without function
- (Process philosophy loves paradox)

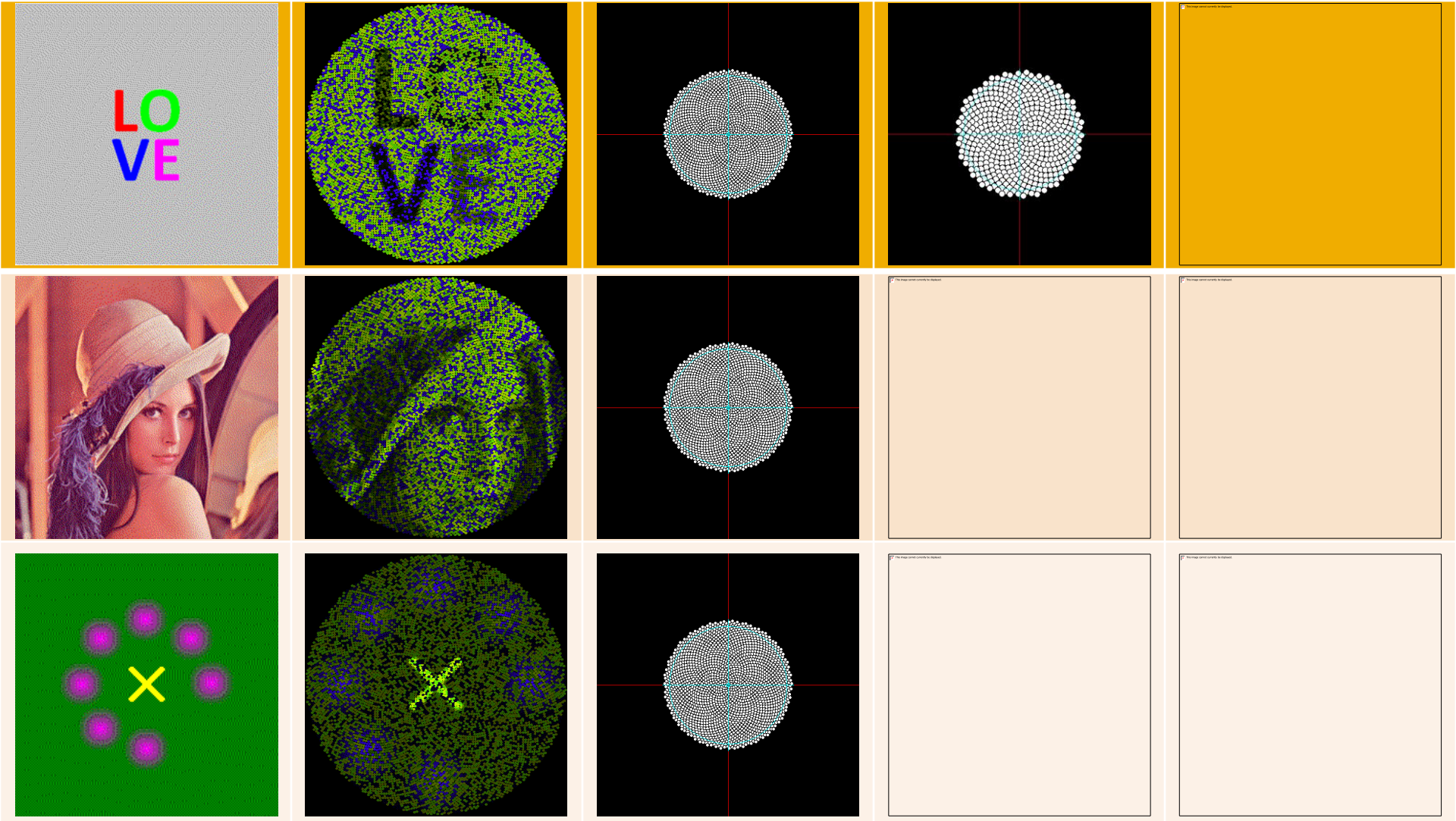
Task/Behaviour: Visual Summation
Function(s): Multi-Scale + ???
Structure: Receptive Field Hierarchy



Demonstrate Emergence

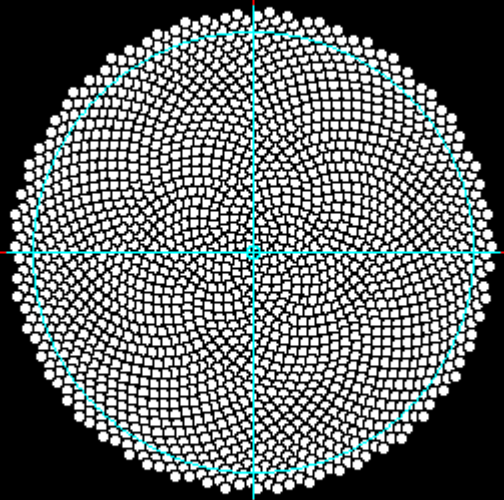
In the Mind's Eye

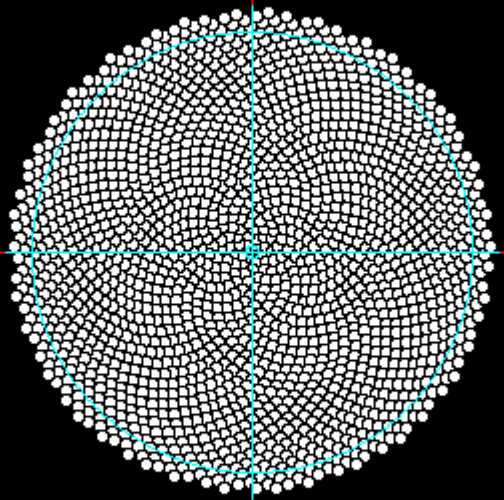
Gist Hierarchy 2.5 : 5.0 : 7.5



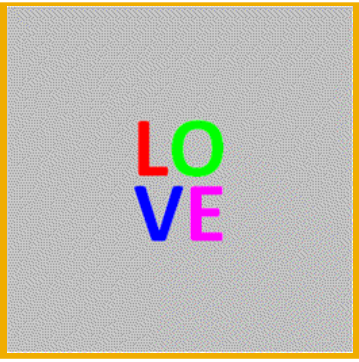
Jitter Detail

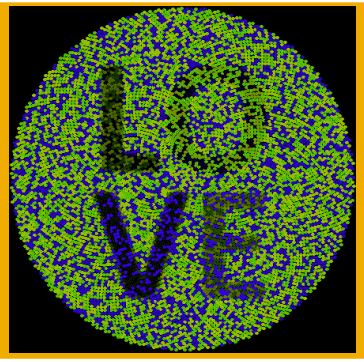
Infocentric

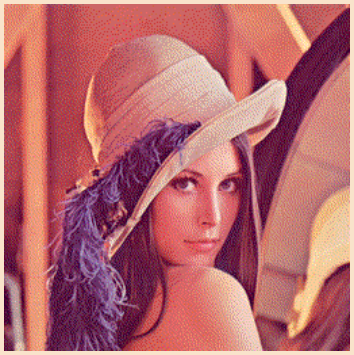


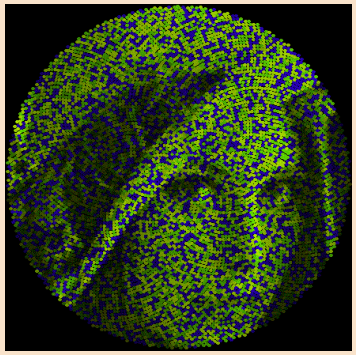


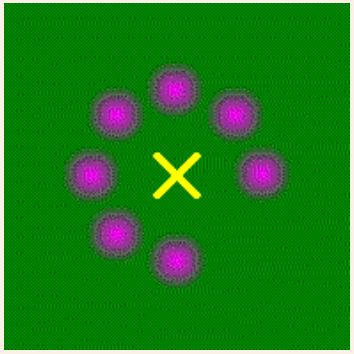
Temporal Edges

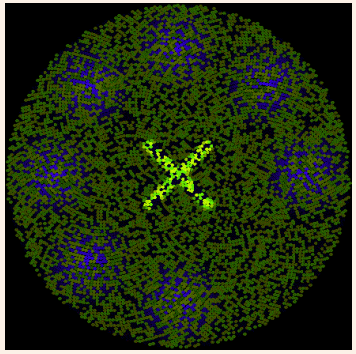




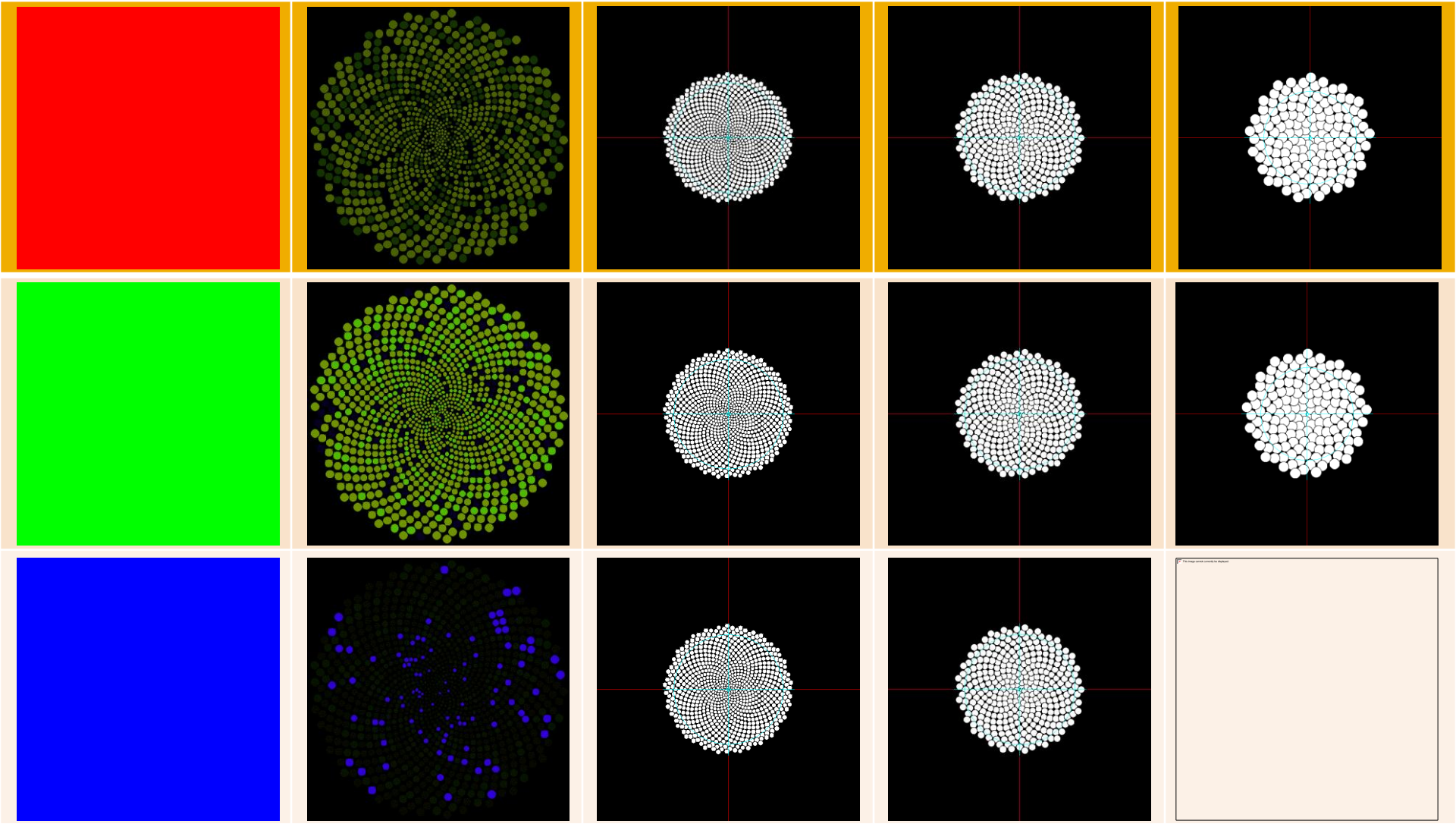






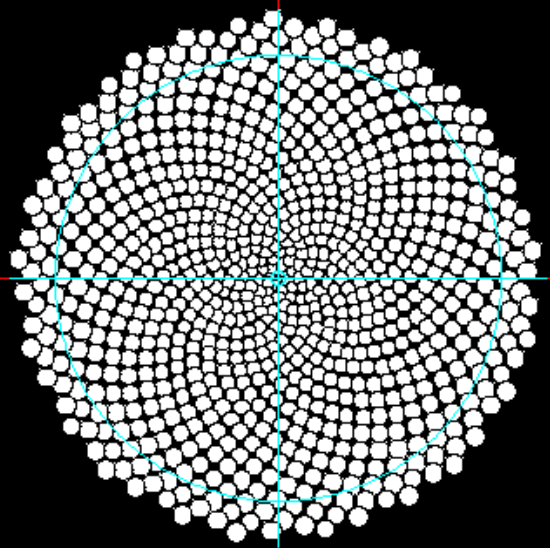


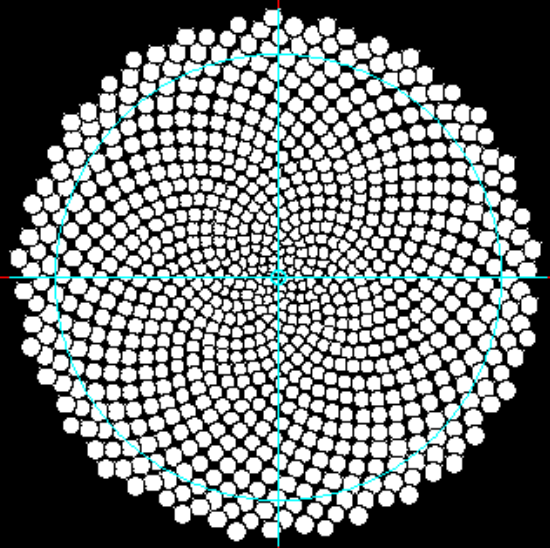
Filling-In L:M:S=700:300:100
Colour Homogeneity, Linearity



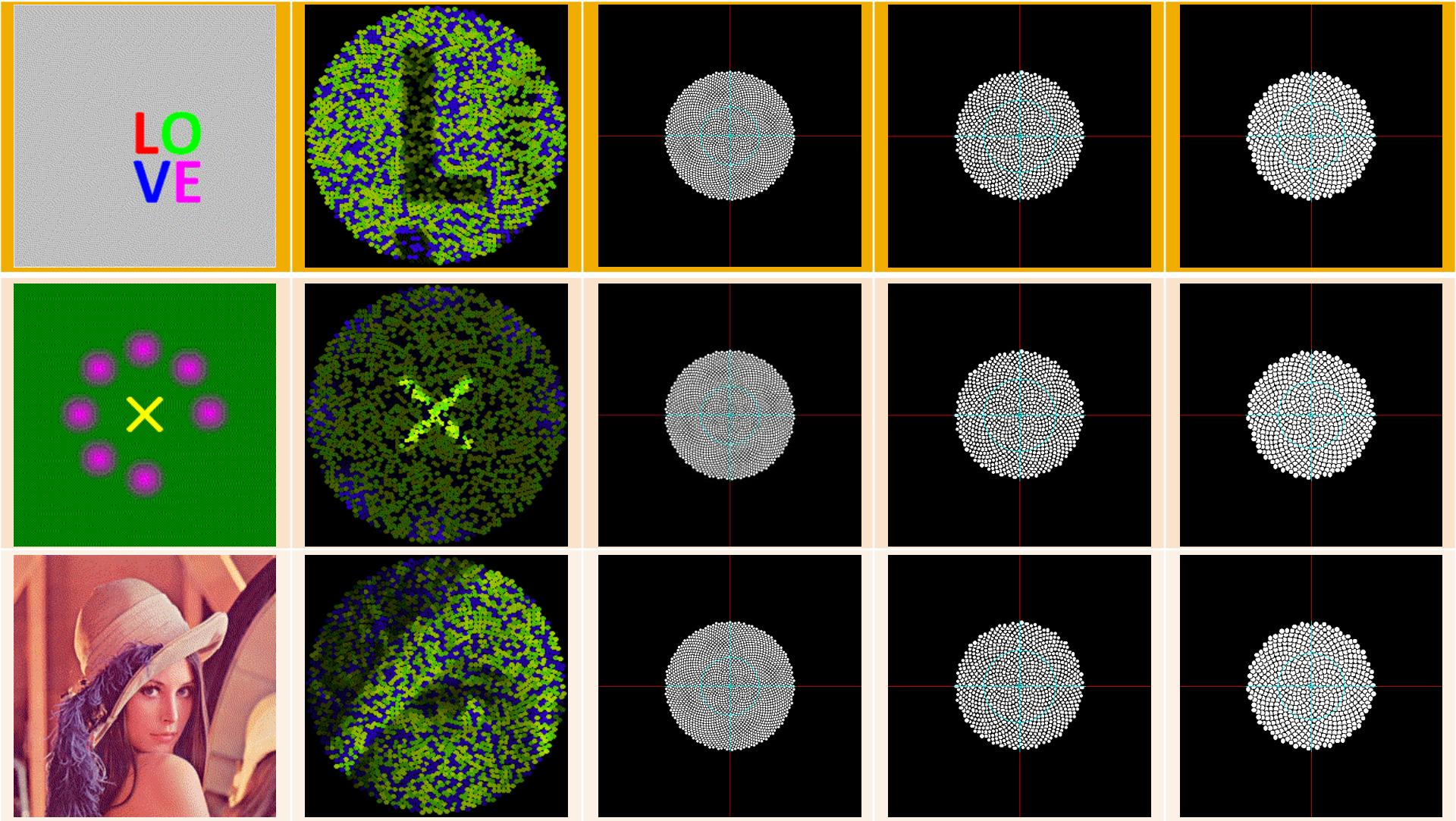
Colour Homogeneity Detail

Emergic Diffusion



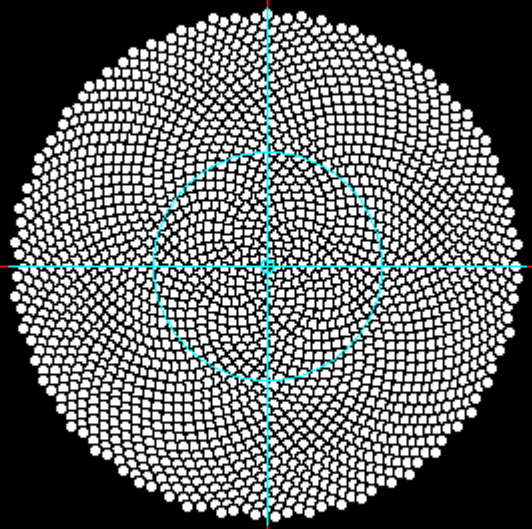


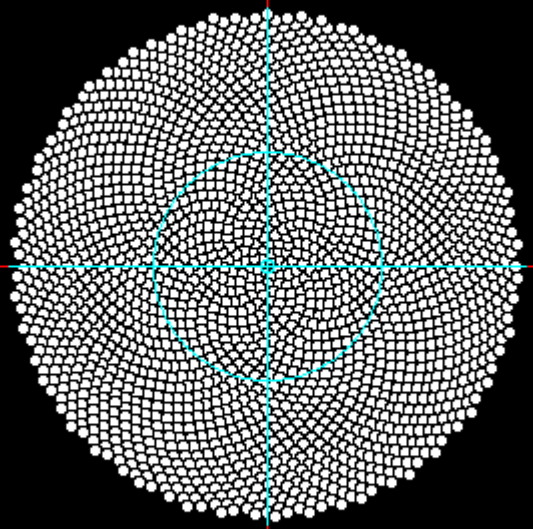
Filling-Out Imagination & Stability



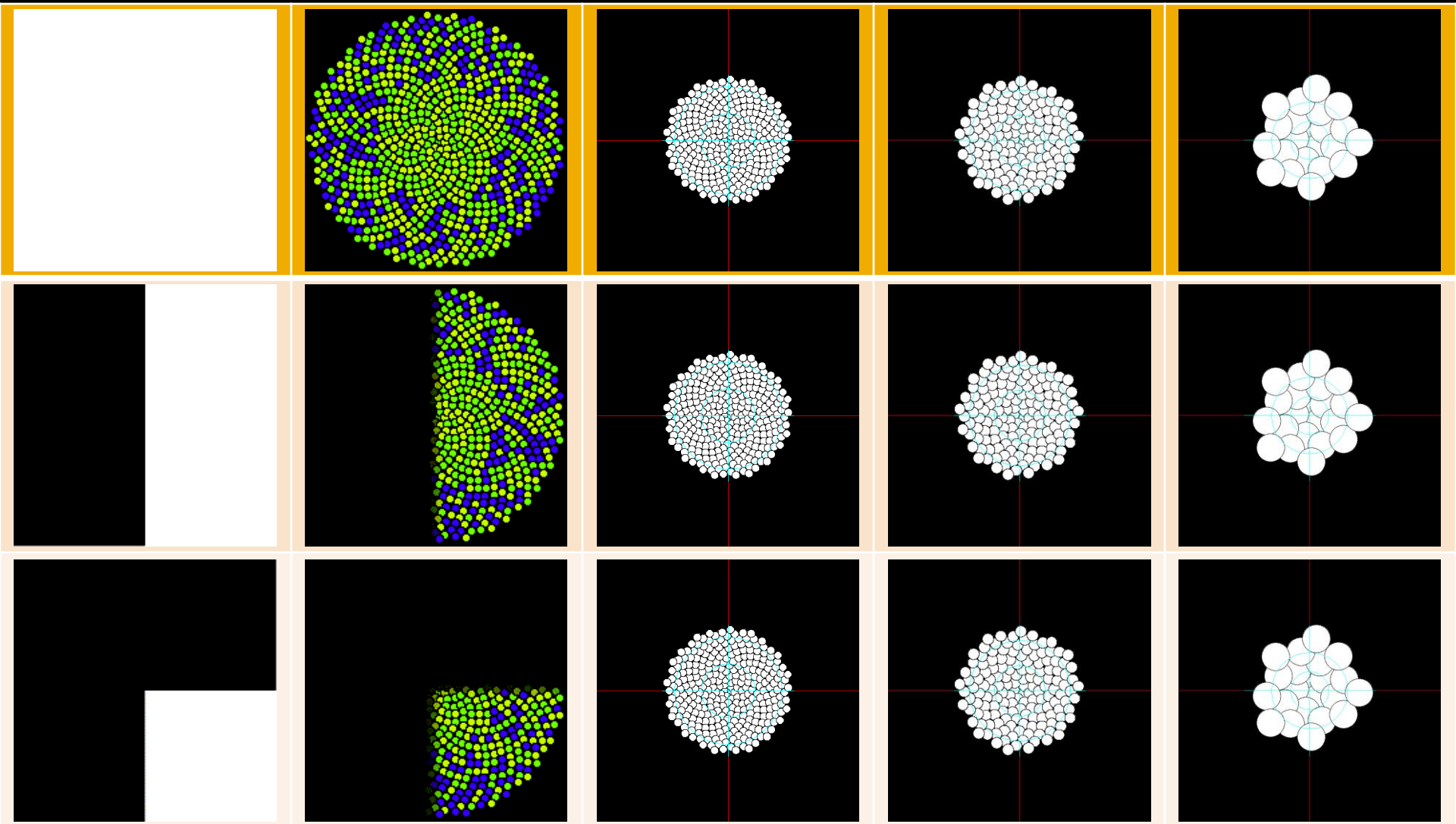
Filling-Out Details

Emergic Non-Optimized Memory



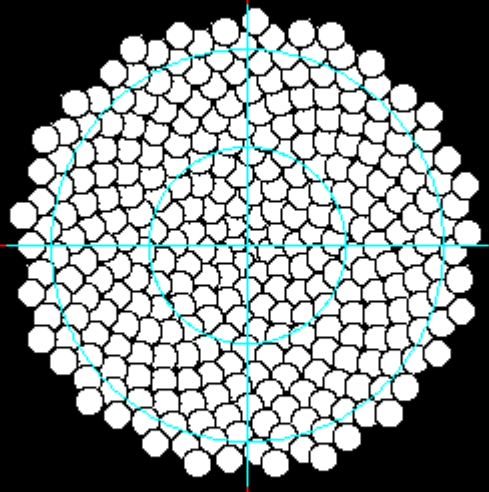


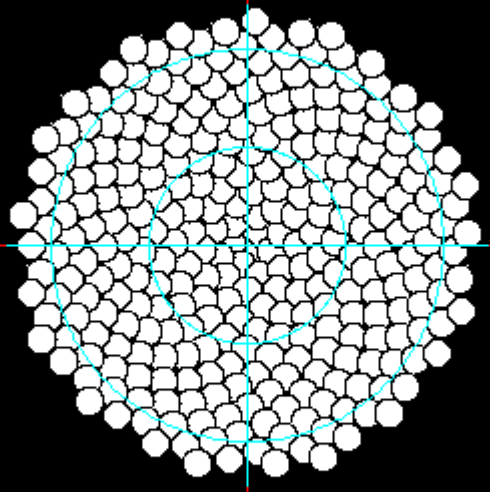
Filling-In Blue Scotoma



Blue Scotoma Details

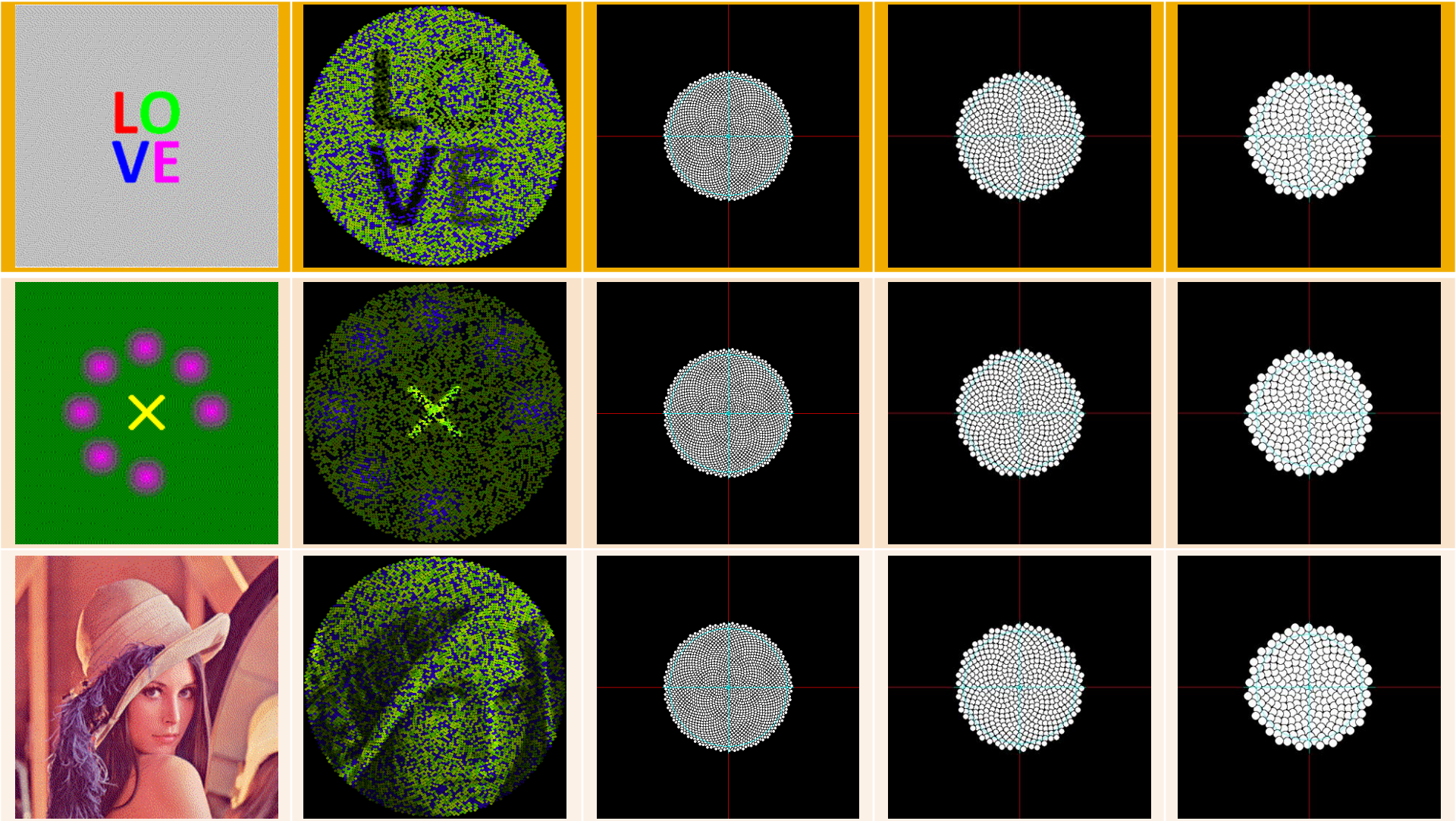
Emergic Diffusion





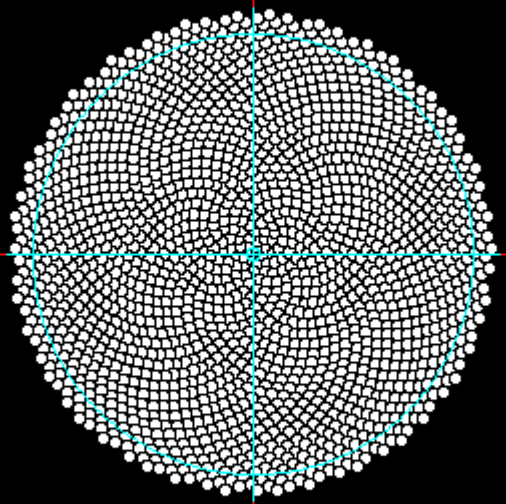
Emergic Border Control
(Different border for blue)

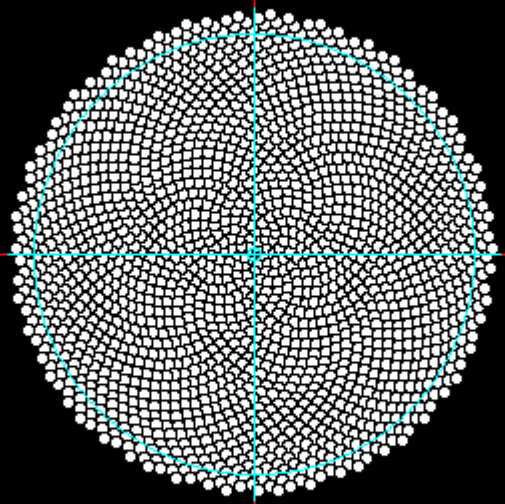
Flash Memories (On:1, Off:31) Positive Afterimage



Positive Afterimage Details

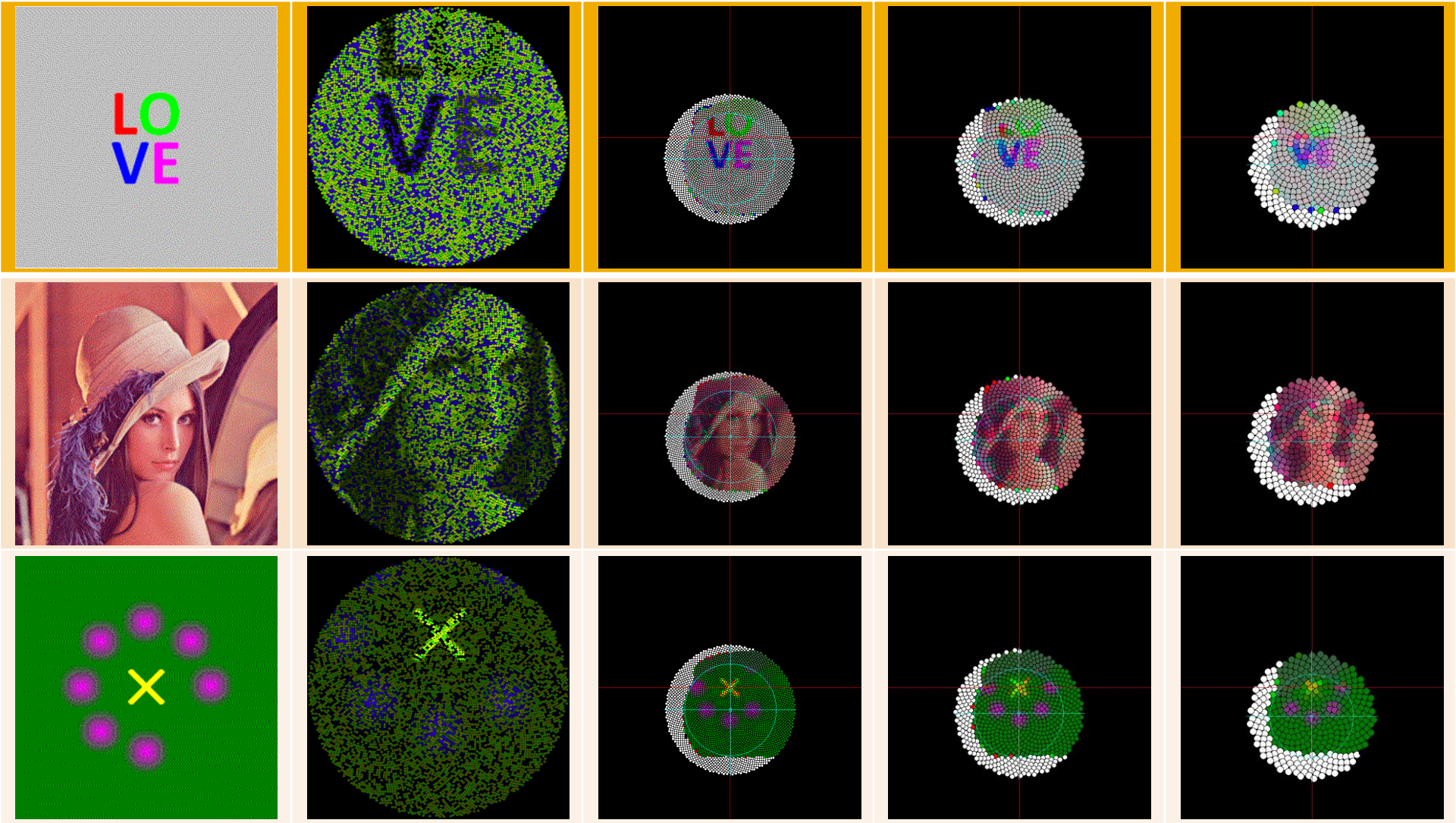
Emergic Diffusion





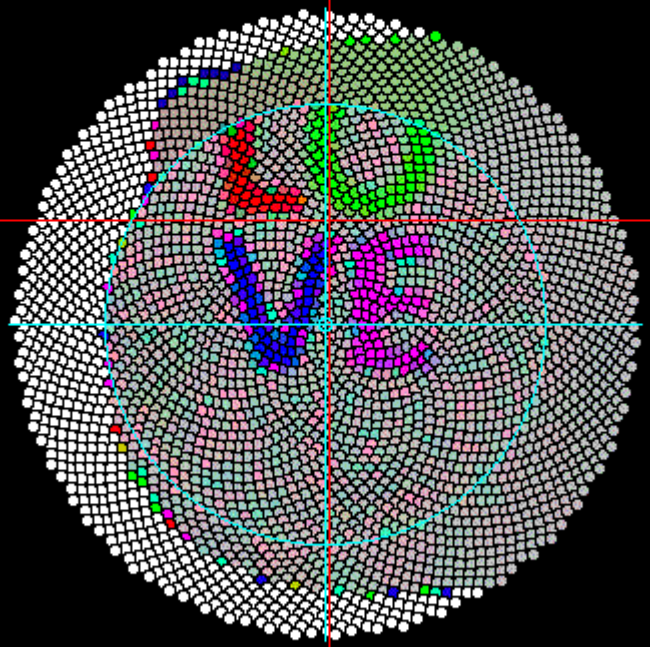
Emergic Non-Optimized Memories

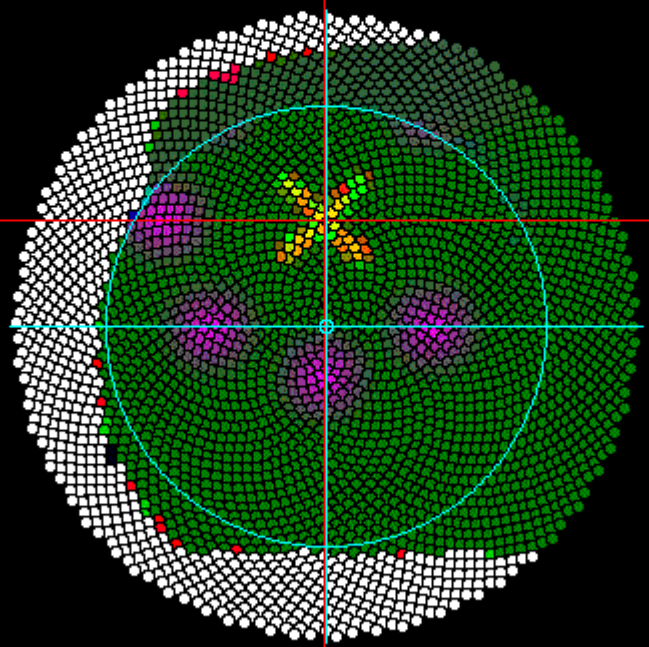
Stability Under (On:5, Off:3)x4 Blink Suppression & Motion



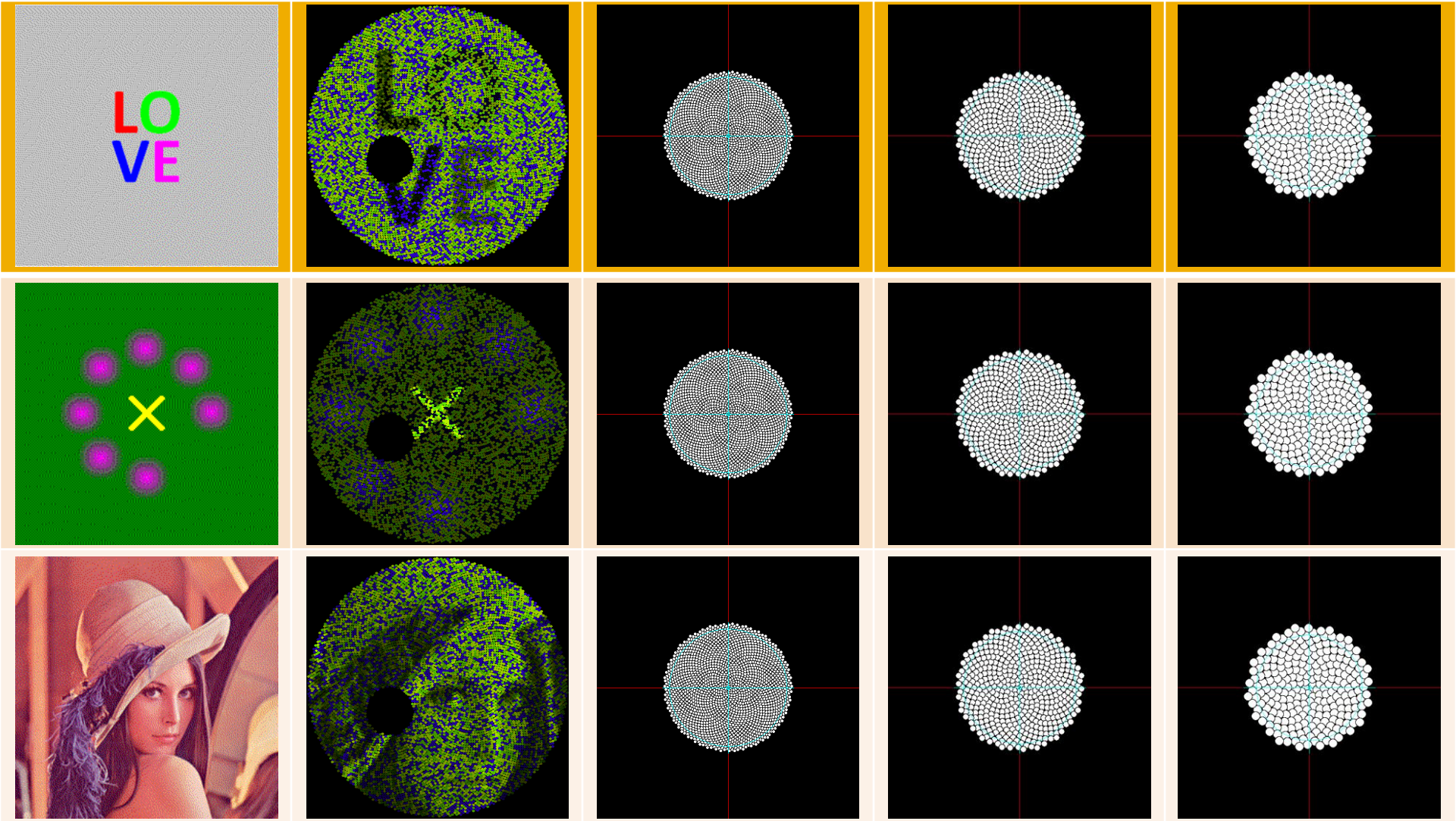
Blink Details

Emergic Non-Optimized Memories



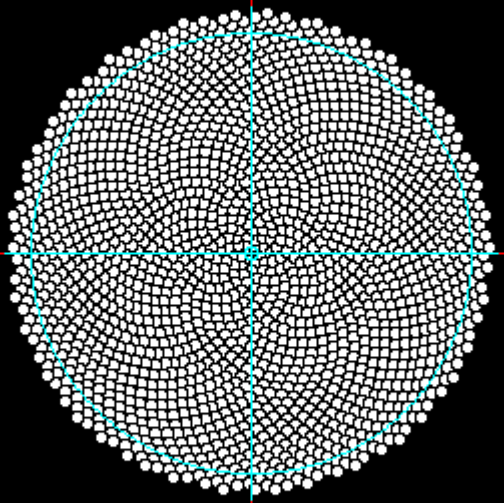


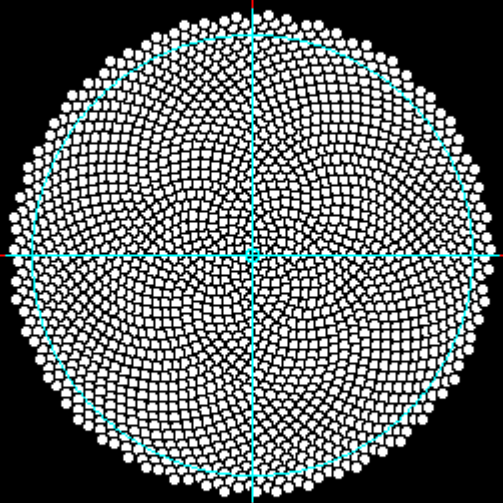
Blind-Spot Shifting-In



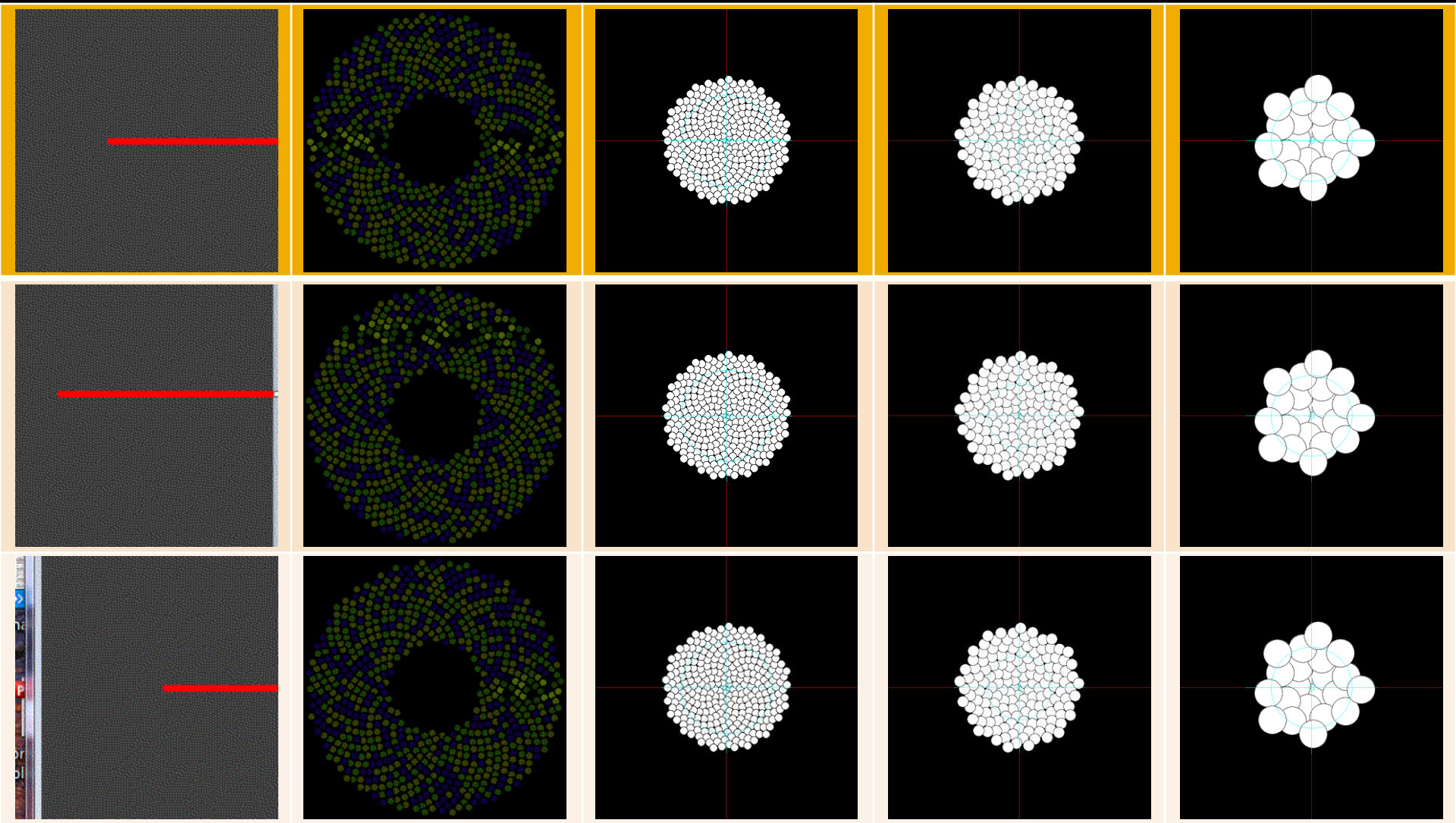
Blind-Spot Details

Emergic Infocentric Memories





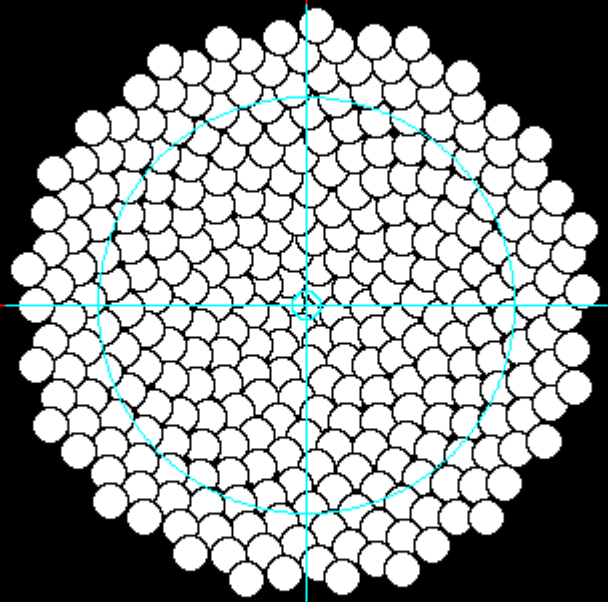
Blind-Spot Filling-In

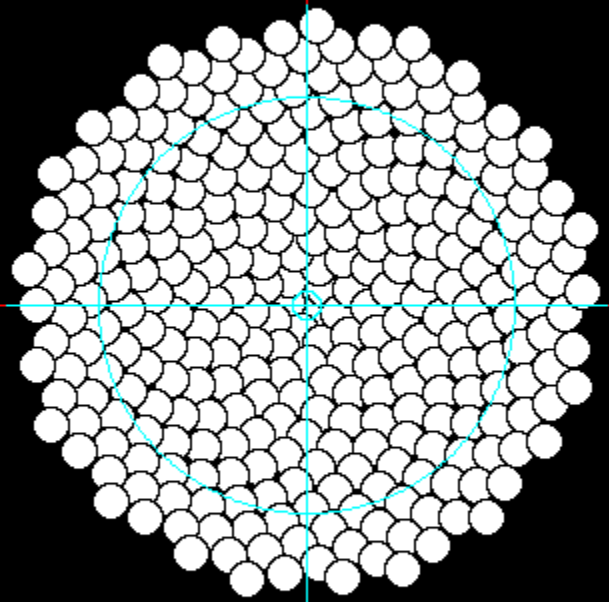


Dynamic Blind-Spot Details

Incomplete

Complete





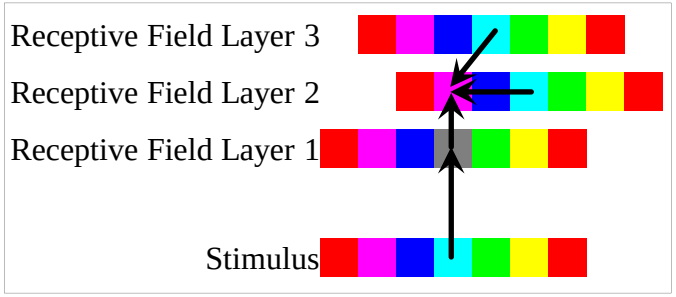
Emergic Border/Contour Completion

Solution Overview

Two cognitive functions – lots of emergic phenomena

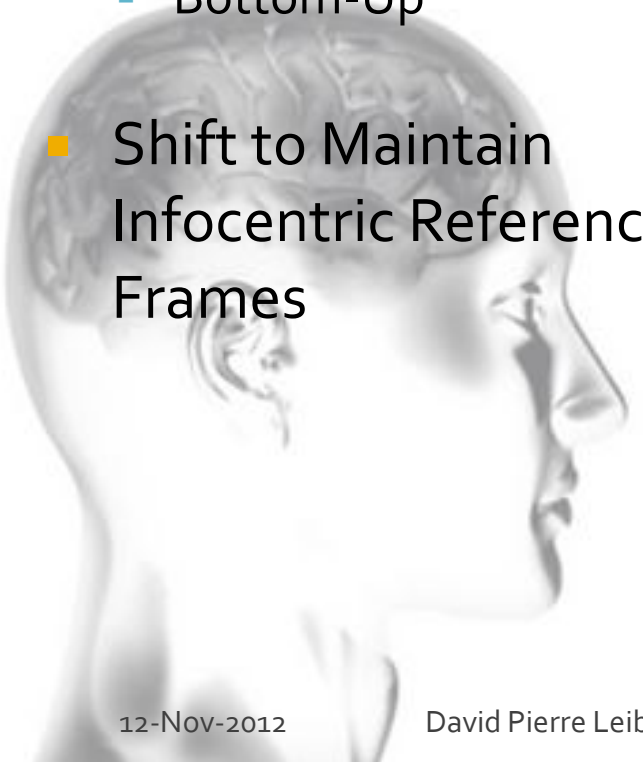
Maintain Information Coherence Cognitive Function#1

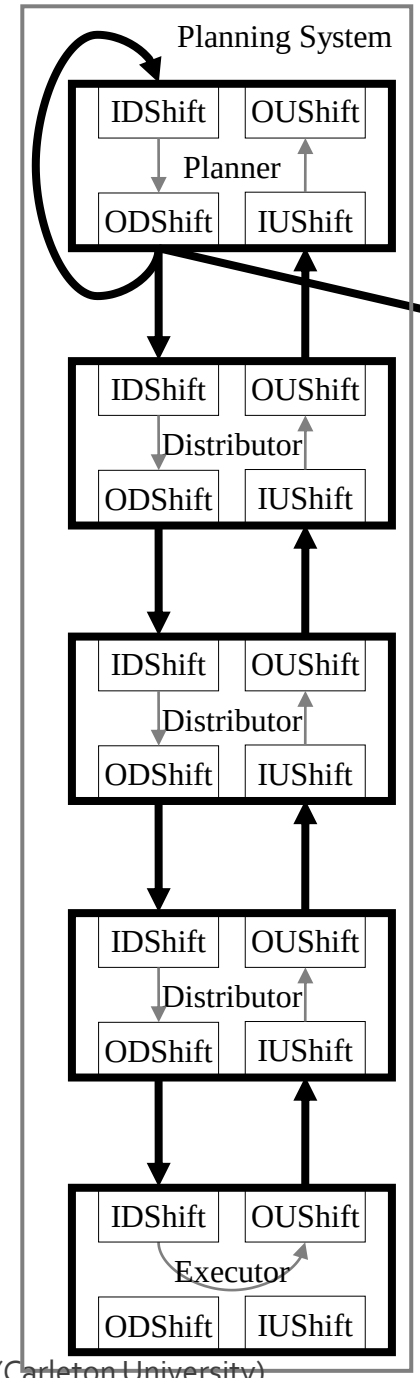
- This cognitive function is complex:
  - Distribute motor plans in advance
  - Shift coordinates to maintain infocentric reference frame
  - Broadcast information locally (~Local Area Network)
  - Tag information (~Internet protocol)

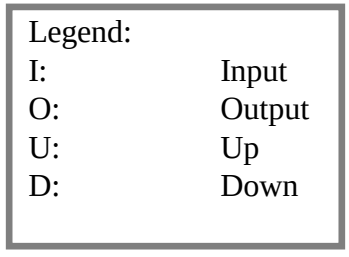


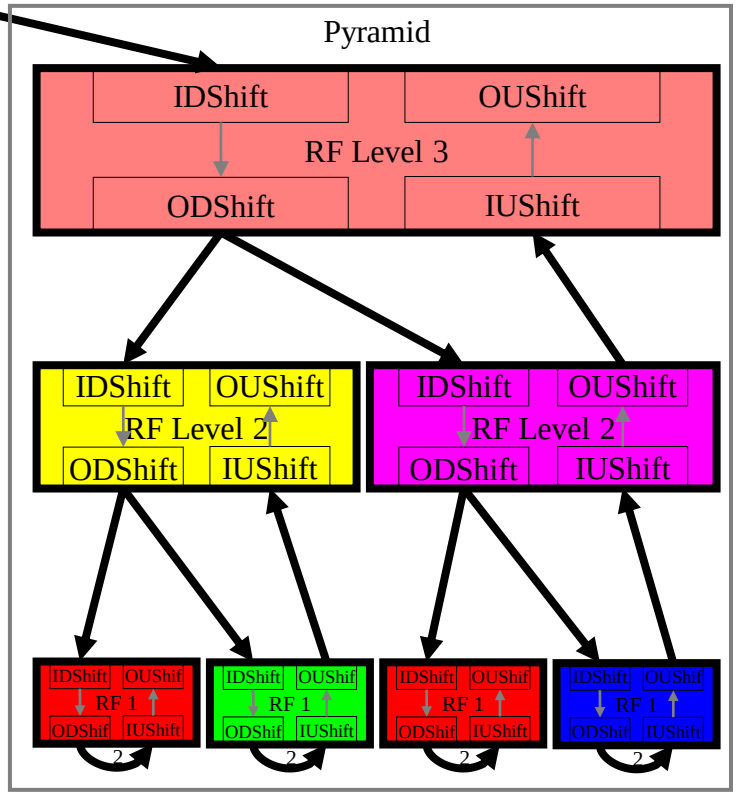
Information Coherence

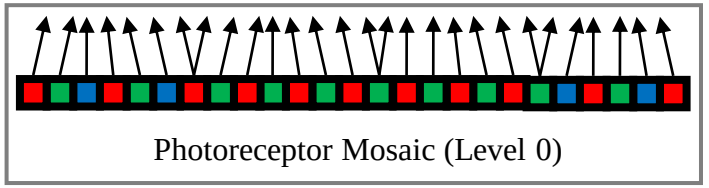
- Distribute Motor Plans in advance
  - Top-Down
  - Bottom-Up
- Shift to Maintain Infocentric Reference Frames





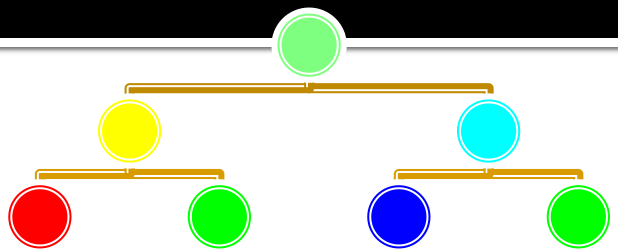






Broadcast Information

- Classical Hierarchy

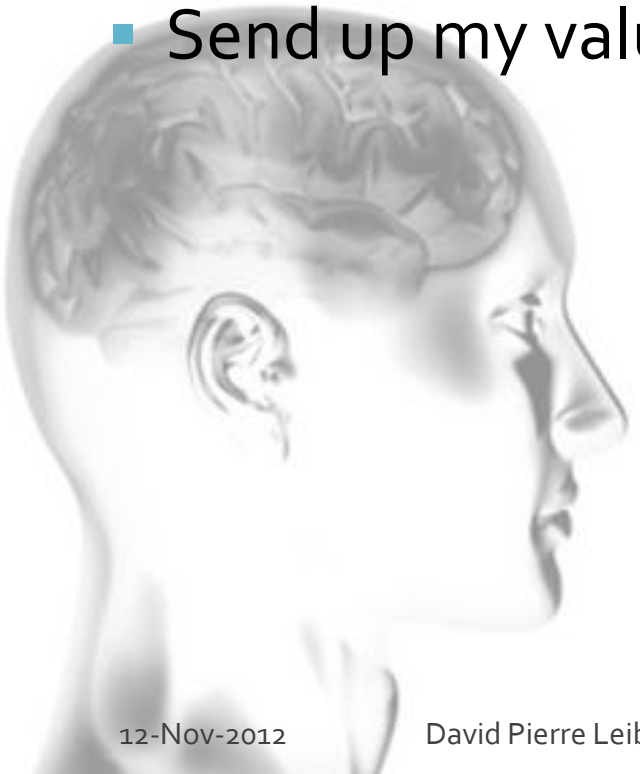


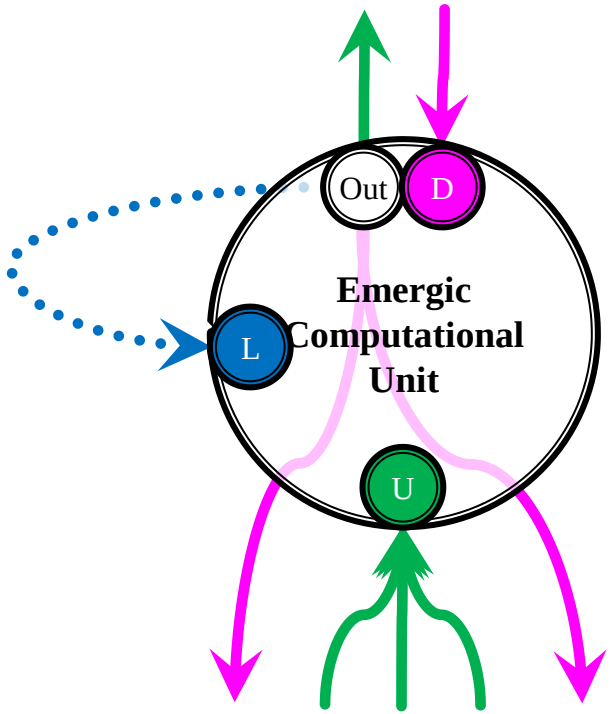
- Shifting Hierarchy
  - LAN
  - e.g., eye shifts 3 right, then send info 3 left

- Tag Info by Coordinate

Handle Missing Data Cognitive Function#2

- This Cognitive Function is Simple
  - If I don't have a bottom-up value, use lateral value
  - If I still don't have a value, use top-down value
  - Send up my value





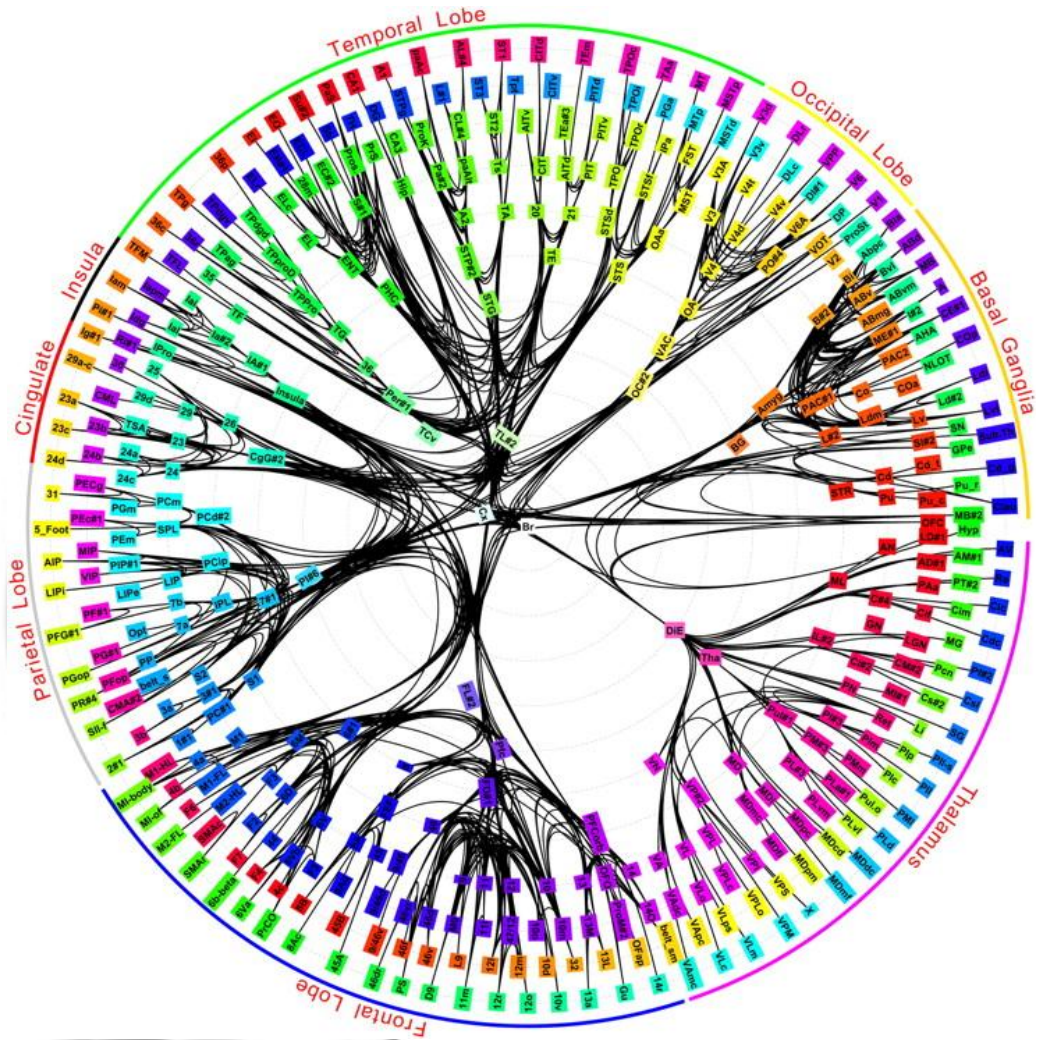
What is Emergence?

A little bit of process philosophy

Explaining Magic

- Once magic is explained, it becomes knowledge
  - Obvious!
  - Why didn't I think of that
- Nevertheless, decomposing behaviour/phenomena into interacting cognitive functional parts requires a change in mindset
- Why? Because the brain/mind, despite any possible modularity, is massively distributed & recurrent
  - Linear/additive analysis cannot suffice

Brain's Massive Recurrence



Emergence

- Cognitive Function#1 Independent (Orthogonal) to Cognitive Function#2
  - There is no explicit integration function
- After integration, what is the functional purpose of
  - Cognitive Function#1?
  - Cognitive Function#2?
- Once realized, a cognitive function is no longer functional
  - Cognitive functional decomposition useful for comprehension. They are epistemic.

Emergence? (Of Structure)

isArchlike() = Yes

Arbitrary epistemology, ontology

isArchlike() = No

Bricks

- Bricks parts are intended to create arbitrary structural wholes
- A brick is the 'Turing Machine' of structure
- (Nevertheless if 'isArchlike' a property of the relations/organization, then they must be of 'substance')

Lego Brick of Change

Any Behaviour/Phenomena

Any Turing Equivalent Operators

Logical Bricks

- There are 16 possible binary Boolean operators
- Only two (12.5%) are functionally complete (sole sufficient operators), i.e., the "bricks" of logic.
  - Logical NOR: Pierce's Arrow (↓) / Quine's Dagger (†)
  - Logical NAND: Sheffer Stroke (↑)

  Three or more operands can be built with these.

  Three or more domain values can be built with these.

- For 3-valued logic, there are 19683 binary operators with 3774 (19%) complete

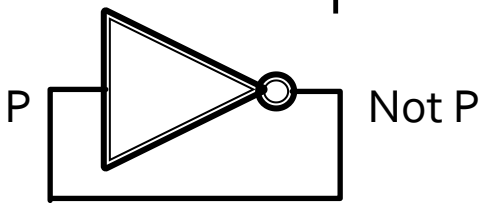
Behavioural Bricks

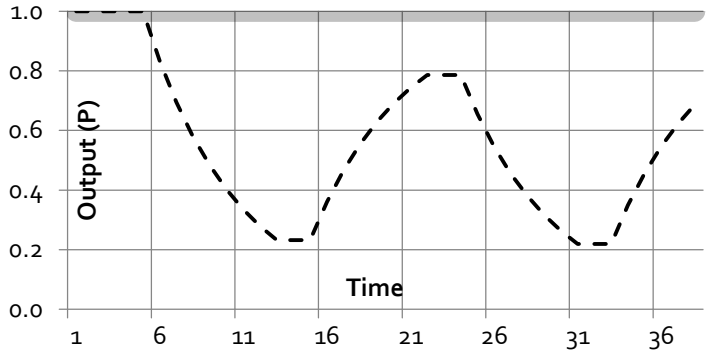
- Logic does not have behaviour "over time", but
  - NOR Gate
  - NAND Gate

  are functionally complete universal logic gates

- Logic (language?) have truth conditional semantics with paradox
  - "This phrase is false" means what?

- Behaviour based semantics more powerful and without paradox, e.g.,
  - Recurrent not circuit



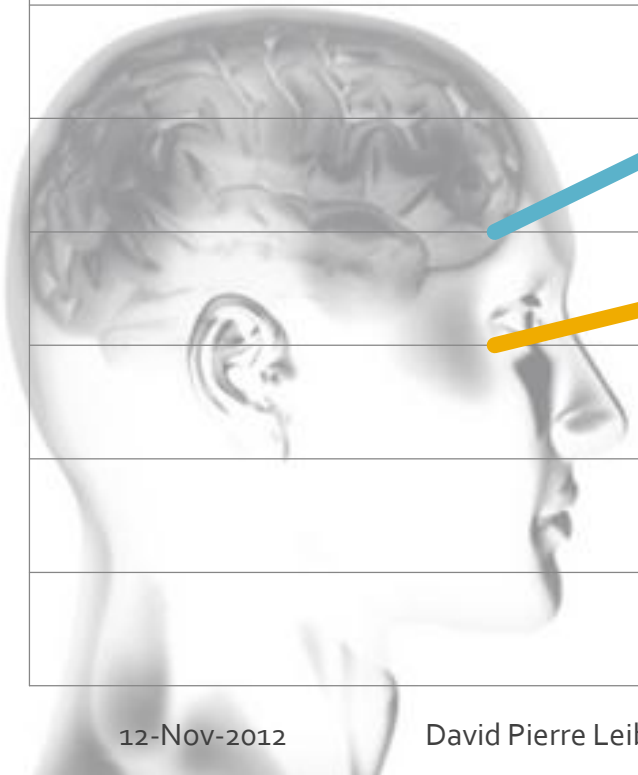


  - Means cyclical behaviour

Subtraction/Addition

- Subtraction is a sole sufficient operator, one instruction set computer and Turing Complete, e.g.,
  - A + B ::= A – (Ø – B)
  - Conceptually, our entire cognitive model is a set of recurrence relations – a form of **difference equations**, but programmed functionally
  - Allows for (inhibitory) negative feedback
  - Lego Brick of Change and Behaviour
- Addition is NOT a sole sufficient operator,
  - A – B ::= ???
- Linear decomposition ("sum of parts") is incomplete
  - Emergence arises from an incomplete choice of epistemology
  - Need to learn how to functionally decompose behaviour based on how changes (differences) influence changes

Model Interactions



Conclusion

- We have seen how 2 simple functional parts interact to cause numerous behaviours or phenomena to emerge in the Mind's Eye
  - Corollary: do not reify and model individual phenomena
  - Complexify locally as to simplify globally
  - Functions are micro-behaviours; interact with structure
- Of course, perception/consciousness is in the mind and not the eye.
- We have seen that emergence is based on a arbitrary subjective choice of epistemology. It too is in the mind of the uninformed beholder, but not in the explained ontology

End of Presentation

Q & A