Genius Personae: A procedural visualization of lifespan brain topology

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1. **Description of the Project**

Neuroscience Background

The human brain does not stay the same throughout life. Its structure changes in noticeable stages, almost like chapters in a book. Recent research by Mousley and colleagues shows that the brain's network, the way different regions connect and communicate, shifts at four key ages: around 9, 32, 66, and 83 years old. These turning points mark moments when the brain begins organizing itself in a new way.

In the first years of life, the brain grows quickly. It starts with far more connections than it actually needs. Over time, it "cleans up" the weaker ones and strengthens the important ones so communication becomes faster and more reliable. This process is similar to trimming extra branches off a tree so the main branches can grow stronger. During this stage, the brain is learning how to balance two things: sending information quickly across long distances and building strong teamwork inside small groups of nearby regions.

Around age 9, the brain reaches the end of its first epoch (0–9 years), the early phase of rapid growth and cleanup. This marks the first big shift in how the brain organizes itself. From about 9 to 32 the second epoch begins, the brain becomes both more efficient and more specialized. Long-distance communication improves, and small clusters of brain regions become experts at specific tasks, helping thinking, planning, and learning become more sophisticated. This is the stage when the brain reaches its strongest and most flexible form.

After the early 30's the brain enters its third epoch (32–66 years), where the network slowly begins to change direction. Connections become more separated into distinct groups, and communication becomes a bit less smooth, reflecting a gradual shift in how the brain balances efficiency and specialization. By the late 60s and into the early 80s, the fourth epoch (66–83 years) occurs in which the brain relies more on a few key regions to keep communication flowing as overall connectivity weakens. Finally, in the fifth epoch (83–90 years), the brain's network becomes more fragile and simplified, depending heavily on central hubs to maintain structure. These later-life patterns match known changes in aging, such as slower processing and reduced white-matter integrity.

Keywords:
- Neural communications
- Lifespan
- Turning points
- Patterns

Art-Science Proposition

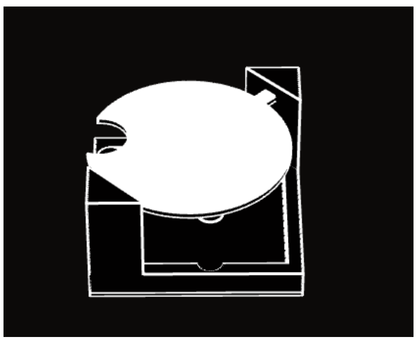
<u>Materials used: Screen or Flip Dot display suspended on a wall, IR camera, depth sensor.</u>

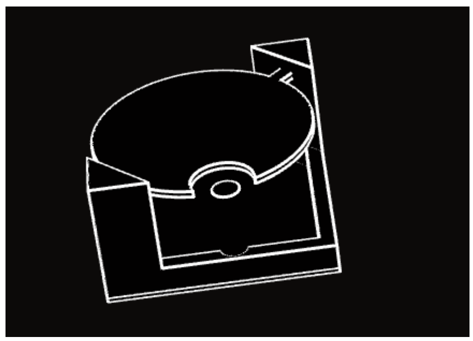
The proposed installation would take one of 2 forms, either of which rely on an interactive showcase of a grid and squares of changing colors following the rules of John Conway'S Game of Life;

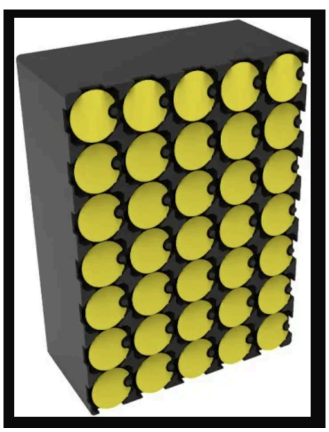
-A digital screen or projection showing a custom Blender or Touch Designer application we would program to display a Game of Life instance occurring.

-A Flip Dot display whose network of light and dark cells shift according to rulesets inspired by John Conway's Game of Life.

In either case, an IR camera and depth sensor would be used to detect and restrict the range of detection of persons walking by the installation. Upon detection of a person, a seed input for the game is taken and starts. Using machine learning models, certain body gestures would alter either the patterns formed on the screen, and a second person entering alters the ruleset used by the application computing the game, changing the type and form of patterns formed on the display. With this, we seek to engage the manipulation of topographies, networks, and the rules governing the growth of the latter. We're also thinking of the progression, through phases distinct from each other, of these networks; the experience has distinct phases that are cycled through in response to distinct human behavior.







We want the public to experience this as a leisurely, competitive and collaborative human computer interaction. As such, we want to exemplify and demonstrate the potency of the concept visually to the public. We seek to communicate the game of life's rules' "simplicity yielding complexity" quality clearly and quickly through the visuals of the artwork.
Also, we must make the affordances of the interactivity available to users clear as quickly as possible once their interaction starts, so they can experiment with the piece on its terms rather than be confused by it.
Through trial and error, players must collaborate to reach a self-sustaining animation in the grid, or any number of other goals or win conditions yet to be created, as the ruleset evolves over time.
The panel will cycle through phases that represent each of the periods of brain development, with the possibility for interaction with users upon them entering the sensors' detection range. The game of life yields a lot of previously discovered self sustaining patterns that we can use as abstractions of different stages of the brain's life. As such, the cycle of the display would be determined by patterns generated on the grid that would change every 2 minutes or so, with a clear visual demarcation or animation on the grid when a phase change occurs. Each phase would clear the grid and produce a new starting set of cells that would reach a different self-sustaining pattern, until the grid would be cleared again for the next phase. The phases would cycle, from birth to death, and the display would be bare of any activity for about a minute, symbolizing the death, before the cycle could begin anew.

Science Materiality walkthrough

Keywords from the scientific paper:

Terrain, cycles, phases, development, affordances, maturation, non-linearity, lifespan, neural communications turning points, patterns.

Materials from keywords:

- State: liquid and solid at once, both flowing together. The result of 1000s of small parts forming a whole that behaves like a liquid.
- Size: small, particulate
- Smell: quarry, salt cultivation site, invades nasal cavity (scratchy nose)
- Taste: salty, airy mouthfeel
- Sound: soft grinding, small smooth rocks sliding on each along a river bed.

Feelings from materials:

- Changing mental state
- Shifting mood
- Itchy
- Soothed
- At the ready, attentive to changes

2. Outline

Timeline:

- Week 1 – Concept Exploration
  - Finalize the main idea: representing the five brain epochs through a generative system.
  - Gather reference material from neuroscience and visual examples of cellular automata.
- Week 2 – Research & Sketching
  - Read about the five lifespan epochs and identify simple visual behaviors for each one.
  - Make early sketches of what each epoch might look like.
- Week 3 – Technical Tests
  - Experiment with Conway's Game of Life or similar systems.
  - Try small prototypes in Blender Geometry Nodes (or another tool) to see what is possible.
- Week 4 – Visual Language Development
  - Decide on the basic visual style (nodes, particles, lines, etc.).
  - Test color palettes, movement patterns, and overall atmosphere.
- Week 5 – Epoch 1 Prototype
  - Create a simple generative pattern representing the 0–9 year stage (overgrowth + pruning).
  - Focus on capturing "lots of local clusters."
- Week 6 – Epoch 2 Prototype
  - Build a version showing more global connections forming (9–32 years).
  - Test smooth transitions from Epoch 1 → Epoch 2.
- Week 7 – Epoch 3 Prototype
  - Develop visuals for 32–66 years (weakened global links, strong local groups).
  - Improve the algorithmic behavior based on earlier tests.

- Week 8 – Epoch 4 + 5 Explorations
    - Create simplified versions of the later-life stages (compensation + fragility).
    - Keep visuals expressive rather than scientifically exact.
- Week 9 – Linking the Epochs
    - Test how the system transitions from one epoch to the next.
    - Experiment with time-based changes or interactive sliders.
- Week 10 – Refinement
    - Polish the generative animations.
    - Adjust color, timing, movement, and clarity.
- Week 11 – Final Assembly
    - Combine all epochs into one cohesive experience (video or interactive piece).
    - Add titles, explanations, or minimal narration if needed.
- Week 12 – Documentation + Presentation
    - Prepare final visuals and write a short explanation.
    - Rehearse the presentation and finalize your lineup of images or demo.

3. Contribution to Art Practice

Given the current state of the projection/ installation community, this project would allow us a unique opportunity to explore the recursive implications of both physical and digital interpretations of the game of life.

With plans to explore alternate rulesets for the game and their effects, this project could yield new understandings of the social implications of the Game. The interactivity of our piece will generate a web of new interactions that will be mined for their meaning as to the social implications of the mathematical experience. Our discernment will be required to extract for the behaviors we witness useful data points, like, for example, a propensity for users to act closer to any one of the strategic theories within Game Theory, when confronted with certain rulesets in the installation and goal to accomplish.

In other words, if a user has a win condition that's explained to them for their interaction with our installation, like using hand gestures to yield a specific pattern with the board or screen, and others can choose to help or hinder them in the pursuit of this goal, how might they choose to act to accomplish that goal, in relation to other users involved in the installation at the same time? What does Game Theory tell us about how they will act, and how we can categorize and analyse that behavior?

4. Fees to be paid

Budget

The financial situation of this project is going to be largely dependent on how tangible we conclude the artefact will require to be. What form and what material we will use is subject to exploration and experimentation. And as such, it is largely difficult to accurately predict what the final costs will be.

We can, however, speculate and budget according to resources and material we currently know to be available and/or of interest. Specifically, we have experience with applying to SPG grants from FASA to fund these sorts of multimedia artistic endeavours. And as a group of 3 individuals, we are eligible for a maximum of 200$ of financing from that grant. We also have access to certain equipment from the CLAB, CDA and other organizations at Concordia to borrow and work with specialized computer equipment for display, input and processing (computers, projectors, monitors, motion tracking devices and sensors, etc.).

Basing this off some of the ideas we brainstormed, potential purchases and expenditures for the project include or could potentially include:

- Grid-based physical displays, for a physical installation directly based on / inspired by Conway's game of life.
    - RGB LED Matrix from Adafruit. In the ballpark of 60$ per unit considering tax and delivery fees.
    - XY5 Flip-Dot Board. Price only given when asking for a quote but it would be a fair assumption that their price is comparable to a LED grid display.
    - Custom-built 3D printed solutions and PCBs, price may vary but should very well fit into a 200$ budget.
- Software/asset licenses. Ex. TouchDesigner commercial license for advanced functionalities and display, commercial Blender or Unreal Engine assets, etc.
- Rental of equipment not available through university sources.
- Rental of equipment *through* university sources (which require membership fees of usually around 50$).
- Other necessary electrical or mechanical components (arduinos, electrical wiring, resistors, breadboards, etc.)

Again, due to the explorative nature of the project it is best practice to consider a budget of 200$ (basing off the notion that we are approved for an SPG grant by FASA, which seems to be the most likely and accessible source of funding for this particular project) for expenditure rather than creating a static and precise list of fees and purchases that we must unerringly adhere to. Design, art and creation is an iterative process that requires this kind of flexibility.

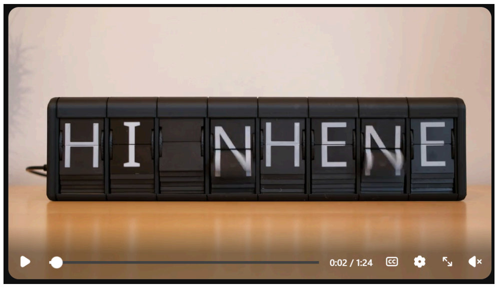
5. Safety

Given the feasibility of our proposal, either in its digital or physical form, a few risks for both us as purveyors of the installation and the users come to mind. Electrical work such as soldering, circuit making and wiring will be required, necessitating appropriate safety equipment and measures for us to undertake to avoid shock injuries.

Next, the weight of our final build could be an issue, if built physically as a flip dot board. The high number of moving parts required for this to function to our specifications increase its weight, and with it the need for us to think about securing the final device properly in the exhibition space, so as to keep it from falling over and injuring either users or technicians installing the piece, while also planning for the artwork to be able to withstand some accidental nudges and shoves as a result of users' movements without breaking or falling over. Encasing the screen in a polyurethane housing comes to mind.

6. Support Materials

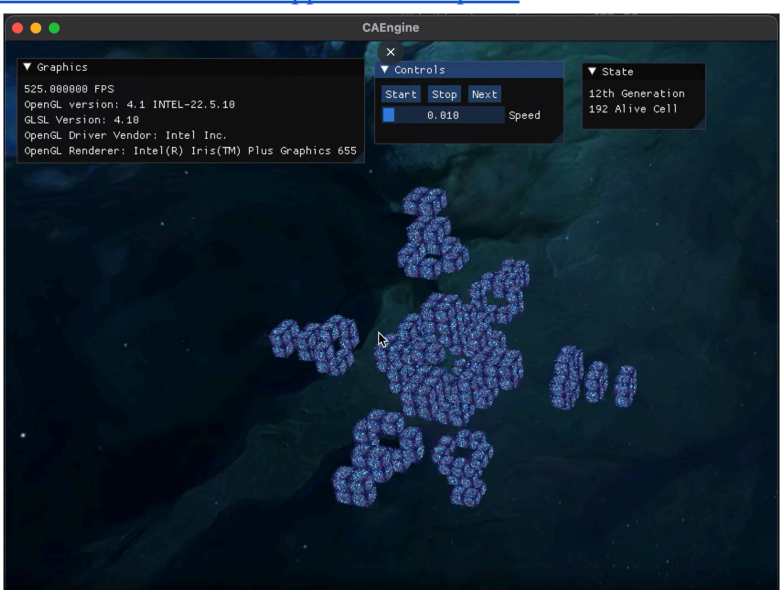
[3D printed split flap display:]



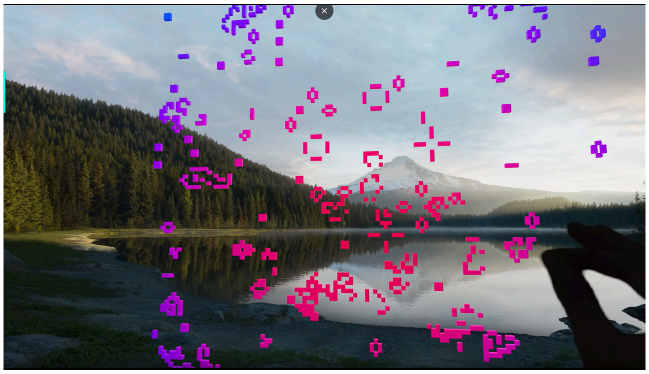
[Interactive flip dot display:]

[more projects with the game of life/ fractals with the game of life]

[Game of life with rules applied in 3D space:]

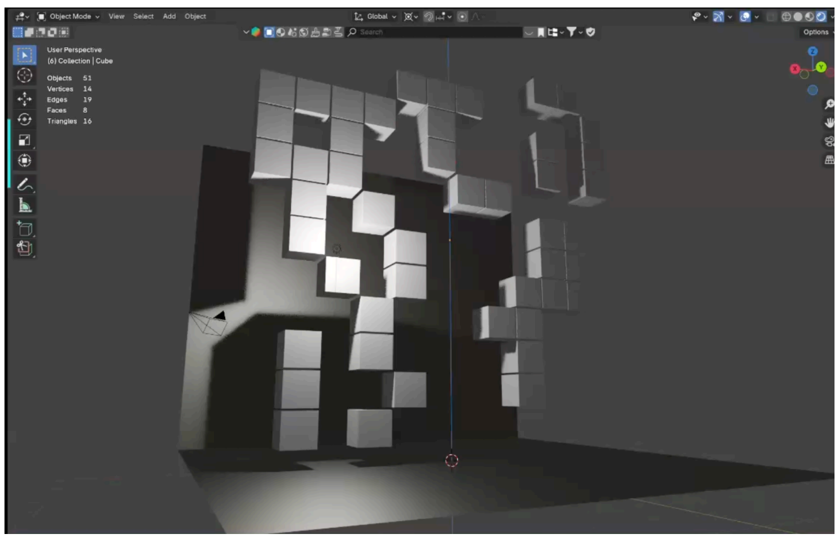


[Interactive VR GoL experience built within Apple Vision Pro framework.]



7. Maquette

The maquette is attached as a video in the project folder in moodle.



Maquette preview

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