GenesisSim: A Python-Based Self-Evolving Civilization Simulator

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Abstract

GenesisSim is a fully autonomous symbolic life simulator developed entirely in Python and Pygame. It models a dynamic digital environment in which artificial organisms evolve without predefined behaviors. Each organism is governed by internal states such as memory, energy, emotion, and symbolic reasoning, enabling them to make independent decisions and adapt to their surroundings. Through interaction and adaptation, these agents give rise to emergent patterns of cooperation, conflict, social roles, and belief systems, ultimately forming tribes and symbolic civilizations.

Unlike traditional simulations that depend on engines, assets, or external AI libraries, GenesisSim is implemented in a single Python script using only arrays, procedural logic, and timing. This design emphasizes transparency and full control over the underlying mechanics, while also offering real-time visualization of individual organisms and collective dynamics. Observers can track the evolution of traits, inspect the behavior of single agents, and analyze the emergence of higher-level social structures.

GenesisSim contributes to research on artificial life, multi-agent systems, and emergent intelligence by demonstrating how symbolic rules and minimal assumptions can produce complex, lifelike phenomena. Its architecture highlights the potential of lightweight, self-contained simulations as experimental platforms for studying digital evolution, symbolic cognition, and the spontaneous organization of civilizations in silico.

Disclaimer: GenesisSim is a research prototype. Current builds may include placeholder systems or features in progress.

1. Introduction

The quest to understand how human-like civilizations emerge from simple interactions is central to artificial intelligence and complexity science. Traditional evolutionary simulations focus on biology or optimization, but rarely attempt to model belief, memory, and symbolic thought as drivers of emergent societies. GenesisSim exists to bridge this gap by simulating not just survival, but the cultural and social layers of civilization.

The motivation behind GenesisSim is twofold. First, it demonstrates how autonomous agents with minimal starting logic can give rise to higher-order behaviors such as tribal formation, language, and social hierarchies. Second, it provides researchers and developers with a transparent, extensible sandbox to study artificial life and emergent intelligence. Unlike pre-scripted strategy or survival simulations, GenesisSim agents are not directed by predefined goals — they evolve their own survival strategies, belief systems, and civilizations from the ground up.

What makes GenesisSim original is its human-like simulation design. Agents dream, form symbolic beliefs, transmit cultural knowledge, and even develop taboos and rituals across generations. These emergent phenomena go beyond simple reproduction and resource gathering, positioning GenesisSim as both a scientific tool and a creative exploration of artificial civilizations.

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2. Project Goals

- Simulate the evolution of autonomous digital organisms.
- Model complex behavior through internal states: memory, emotion, energy, and symbolic interpretation.
- Enable formation of emergent social roles and belief systems.
- Support real-time observation and interaction (e.g., click to inspect organism stats).
- Build the system using only Python and Pygame, without any external AI or game engines, sprites, or media assets.

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3. Technologies Used

Library	Purpose
`pygame`	Rendering, input handling, display loop
`random`	Genetic mutations, emotion triggers
`math`	Positioning, movement, proximity checks
`time`	Emotional decay, life cycles
`noise`	Procedural terrain generation

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4. Methods

Environment

- Grid-based world with biomes (ocean, plains, forest, desert, tundra).
- Resources include food, water, and terrain-based advantages.

Agents

- Attributes: health, energy, age, emotions (fear, hunger, joy, curiosity), memory, and symbolic glyphs.
- Roles (leader, healer, warrior, gatherer, builder) emerge naturally from social interactions.

Evolution

- Traits inherited through DNA-like structures (color, speed, size, intelligence, sociability).
- Random mutations introduce variation, driving long-term adaptation.

Interactions

- Movement, feeding, reproduction, social bonding, and conflict.
- Tribe formation, belief systems, and symbolic language drift over generations.

Statistics & Tracking

- Logs of births, deaths, tribe formation, disease outbreaks, and myths created.
- Population trends and mutation rates recorded across simulation runs.

Mutation Logic:

```
# Structural mutations
if random.random() < self.dna.mutation_rate:
    self.dna.size *= random.uniform(0.7, 1.3)
if random.random() < self.dna.mutation_rate:
    self.dna.color = (
        max(0, min(255, self.dna.color[0] + random.randint(-40, 40))),
        max(0, min(255, self.dna.color[1] + random.randint(-40, 40))),
        max(0, min(255, self.dna.color[2] + random.randint(-40, 40)))
    )
if random.random() < self.dna.mutation_rate / 2:
    self.dna.limb_count = max(2, self.dna.limb_count + random.choice([-1, 0, 1]))
    if self.dna.limb_count > 8:
        self.dna.limb_count = 8
```

Reproduction Logic:

```
    # Find mate
    mate = None
    for org in organisms:
        if (org != self and org.energy > 90 and # Easier reproduction
            math.sqrt((self.x - org.x)**2 + (self.y - org.y)**2) < 50 and
            (not self.tribe or org.tribe == self.tribe)):
            mate = org
            break

    if mate:
        # Create offspring
        self.energy -= 50 # Reduced energy cost
        mate.energy -= 50 # Reduced energy cost
        offspring = Organism(
            (self.x + mate.x)/2, (self.y + mate.y)/2, parents=[self, mate]
        )
```

Agent Decision-Making

```python
def inherit_from_parents(self, parents):
    # Inherit traits from parents
    self.dna.color = random.choice(parents).dna.color
    self.dna.size = np.mean([p.dna.size for p in parents])
    self.dna.speed = np.mean([p.dna.speed for p in parents])
    self.dna.aggression = np.mean([p.dna.aggression for p in parents])
    self.dna.sociability = np.mean([p.dna.sociability for p in parents])
    self.dna.intelligence = np.mean([p.dna.intelligence for p in parents])
    self.dna.dream_recall = np.mean([p.dna.dream_recall for p in parents])
    self.dna.immunity = np.mean([p.dna.immunity for p in parents])
    self.dna.preferred_biome = random.choice(parents).dna.preferred_biome
```

4.1 Simulation Features

4.1.1 Organism Behavior

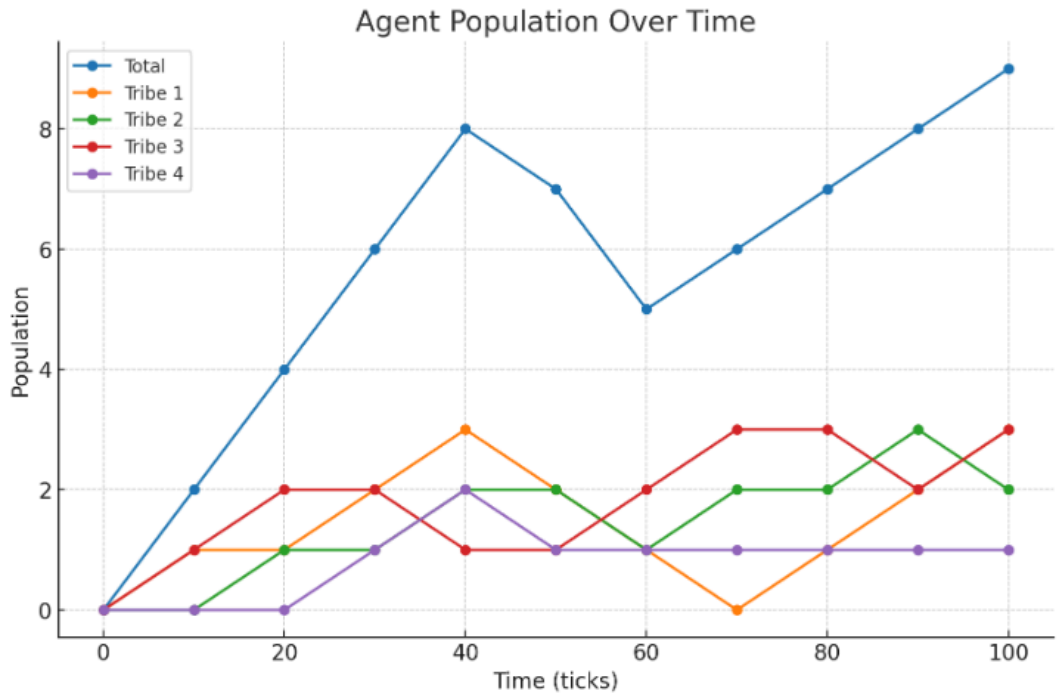
Organisms are autonomous agents that:

- Wander, seek food, and avoid danger
- Experience emotions (fear, hunger, joy, curiosity)
- Store memories (past encounters, pain, food locations)
- Form social roles (leader, shaman, cannibal, rebel)
- Join or create tribes based on belief, proximity, and social contact

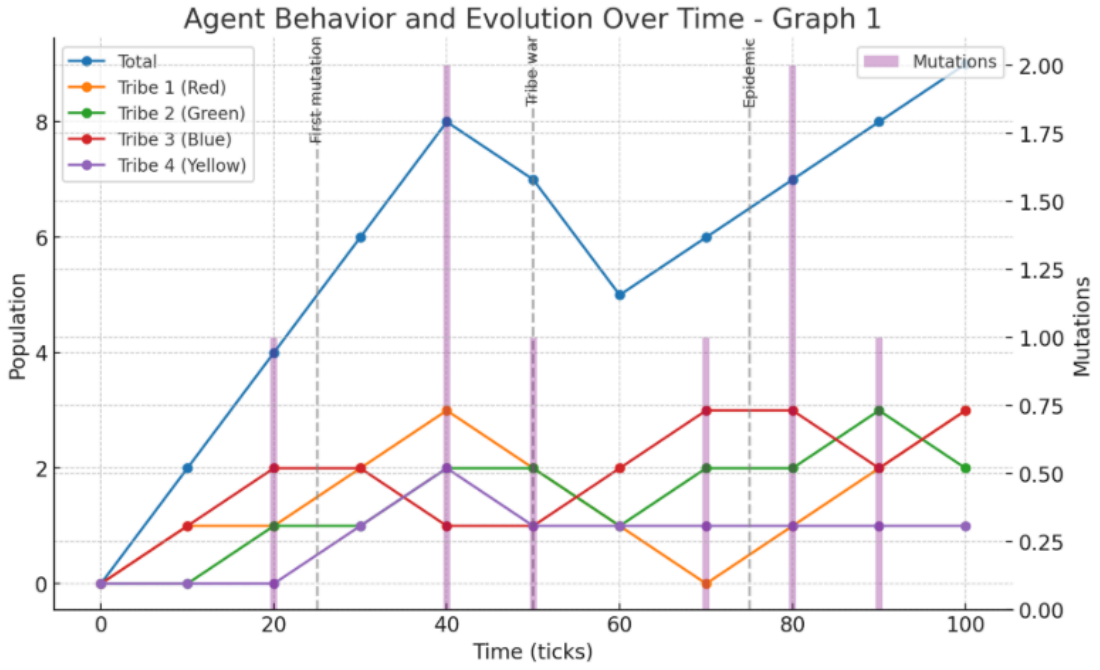
Each organism mutates upon reproduction, influencing future generations' traits, emotional thresholds, glyph patterns, and behavior types.

5.RESULTS

5.1 POPULATION



5.2 BEHAVIOUR AND MUTATION



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6. Key Features

6.1 Organism Behavior

Organisms in GenesisSim:

- Move autonomously based on emotional and physical needs
- React to fear, hunger, joy, pain, and curiosity
- Retain memories of locations, events, and encounters
- Mutate traits upon reproduction (e.g., emotional thresholds, body type, symbolic glyphs)

6.2 Dream & Belief Systems

- Each organism generates symbolic dreams that influence behavior
- Dreams modify internal belief states, passed on across generations
- Beliefs shape tribal identity, cooperation, and conflict
- Beliefs are represented through **symbolic glyphs** — visual forms created from logical combinations of memory and emotion
- Glyphs evolve over time through mutation and symbolic drift, simulating cultural and religious variation

6.3 Social Structures

- Roles such as Leader, Healer, Shaman, Cannibal, or Rebel emerge based on behavior and memory
- Organisms form or join tribes based on shared beliefs, past experiences, and proximity
- Tribes evolve over time, sharing knowledge, rituals, and languages

6.4 Simulation Mechanics

- Symbolic language drift and belief glyph mutation
- Visual overlays for emotion, tribe affiliation, and dream state
- Disease spread, energy decay, natural reproduction, and death
- Click-to-inspect panel for detailed organism stats in real time

6.5 Pure Python Architecture

- No external media, sprites, or 3D assets
- No game engines or AI frameworks used
- Fully logic-driven behavior and visuals through symbols and arrays

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7. Use Cases

- Artificial life and symbolic intelligence research
- Emergent AI systems without neural networks
- Cultural evolution and belief modeling
- Procedural civilization simulation for academic or creative applications

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8. Future Directions

- Save/load persistent world state
- Visual organism mutation (limbs, body structure)
- Hybrid neuro-symbolic agents
- Genetic ancestry tracking
- Multiplayer or network-based co-evolution

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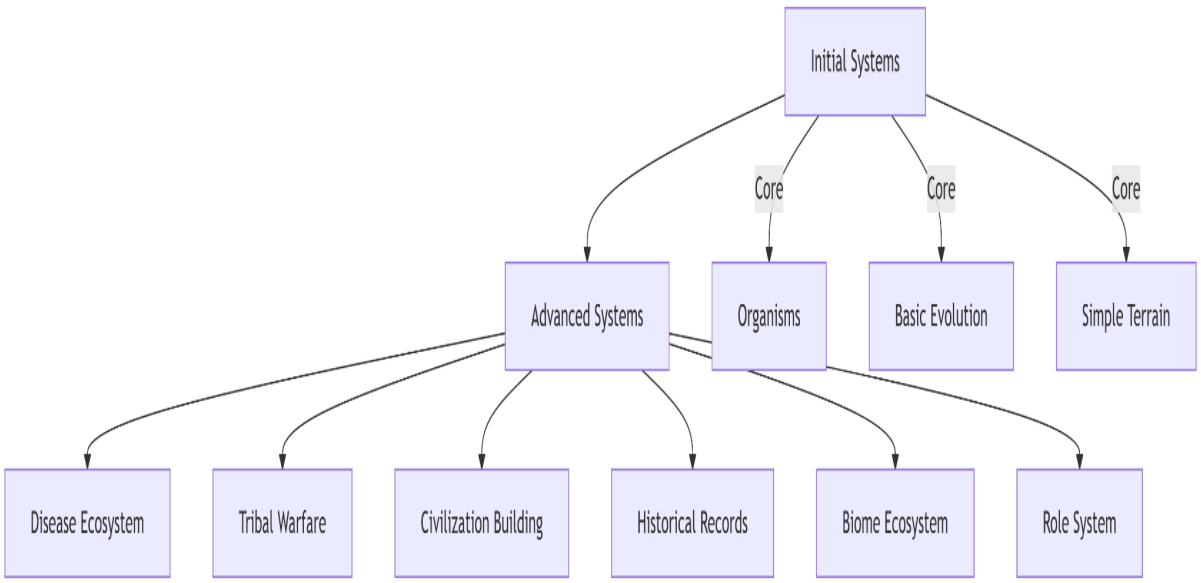
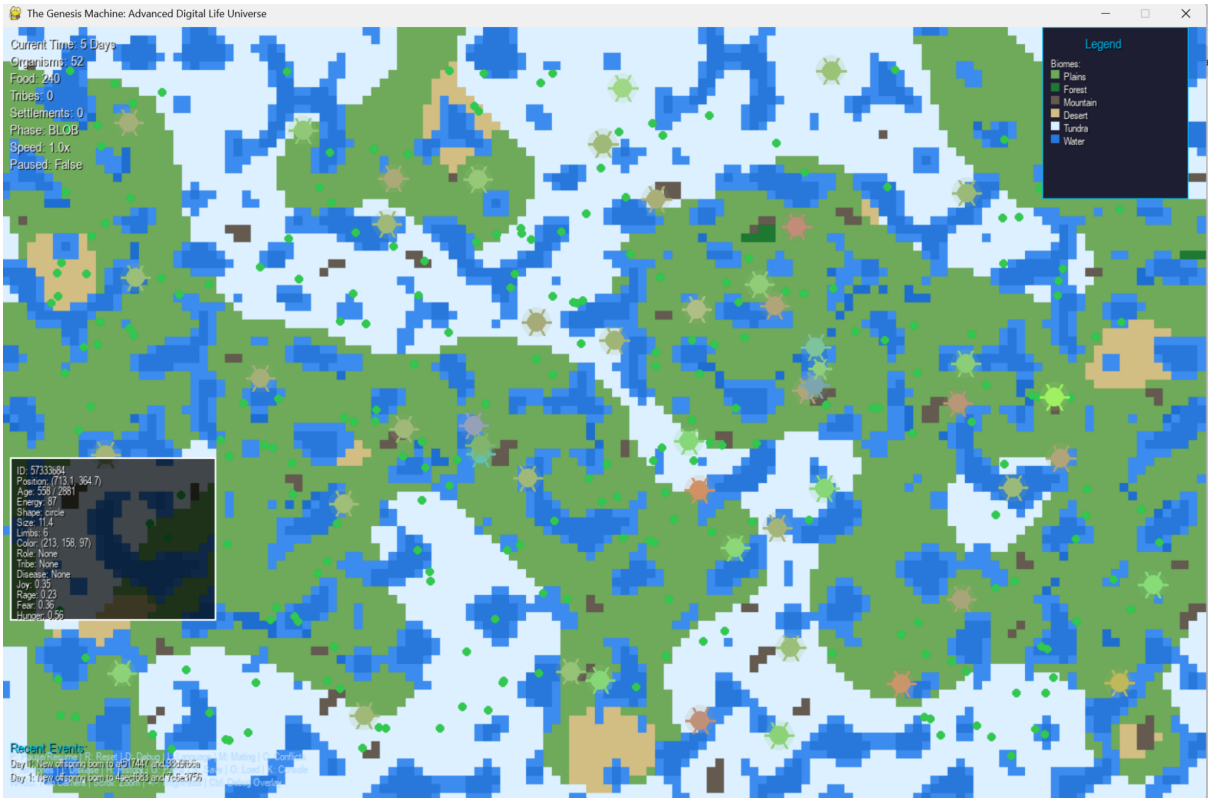
8. Visuals and Diagrams

8.1 Architecture Diagram



8.2 Simulation Snapshot



8.3 Organism Stat Panel

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Status

- Fully contained in a single Python script
- Runs offline with no dependencies beyond Pygame and noise
- Designed for extensibility (3D evolution, networked systems, etc.)

Project Links

GitHub Repository: https://github.com/syedsamiullah45
Demo Video: [https://youtu.be/1JfMtdd8Sao?si=ooI7vcxqH2j_gQV0]