Evolving Line Drawings

Ellie Baker

Margo I. Seltzer

Harvard University
Division of Applied Sciences

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Goals

• Explore the power and limitations of interactive evolution
• Produce an artist’s assistant
  • achieve subtle highlighting and textural effects
  • use a compact representation that is easily modified and transformed
Outline

• Introduction
• Interactive Evolution
• The Drawing Evolver
• Conclusions
Genetic Algorithms

- Model the process of biological evolution.
- Use random perturbations of a genome to create a population of “creatures.”
- Apply a fitness criteria to select surviving creatures
- Repeat process
- Successfully applied to:
  - Traveling Salesman Problem
  - Graph Coloring
  - Newspaper layout
  - Animation of physically modeled figures
Interactive Evolution

- Use a human to provide fitness criteria
- Applicable where criteria is difficult to express computationally
- Previous applications
  - biomorphs (Dawkins)
  - face generation (Caldwell & Johnston)
  - 3D sculptures (Todd & Latham)
  - abstract color images (Sims)
- **Key component:**
  - evaluation of visual data
Drawing Evolver

• Use interactive evolution to create drawings.

• User need not be able to draw, just select desirable images.

• Use mutation to affect small changes to an existing drawing.

• Use mating to create a drawing with components of two parent drawings.
Key Questions

• Can we use interactive evolution to create specific images?
• Does this technique produce images that would be difficult to produce with MacDraw-like tools?
• Is the tool engaging?
• What is needed to make it useful?
• What are the areas in which interactive evolution is particularly powerful? weak?
Representation

- Drawing is represented as a collection of *strokes*.
- A stroke is:
  - a collection of points
  - stroke type
  - a symmetry property
  - a connection type
  - a perturbation factor
  - a mutation rate
Getting Started

• Two modes: Random and User-Input
  • Random: Initial Population

  ![Initial Population](image1)
  ![Initial Population](image2)
  ![Initial Population](image3)

• Random: Evolved Drawings

  ![Evolved Drawings](image4)
  ![Evolved Drawings](image5)
  ![Evolved Drawings](image6)
Getting Started (2)

- User-Input: Initial Image

- User-Input: Evolved Images
Mutating

• Specify constraints to keep images in “face space”.
• Randomly perturb points.
Mating

• **Uniform Mating**
  - Independently select each stroke in each parent.
  - Optionally weight strokes for inclusion.
  - Face Application uses weightings of 0.3 - 0.7

• **ID-Based Mating**
  - Group strokes into units (e.g. eyes, nose, mouth).
  - Select entire group from one parent.

• **Hybrid Mating**
  - For each set of strokes, select either Uniform or ID.
Uniform Mating

The Drawing Evolver
ID-Based Mating
Resulting Images

The Drawing Evolver
Conclusions

• Achieves effects that are difficult with MacDraw-style drawing tools.

• Goal-oriented evolution is very difficult.

• For most people, a collection of pre-evolved images made the tool more engaging.

• Engaging for exploration.