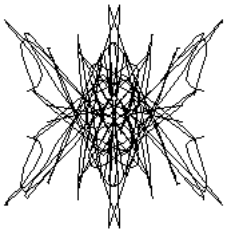
Evolving Line Drawings



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May 19, 1994

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

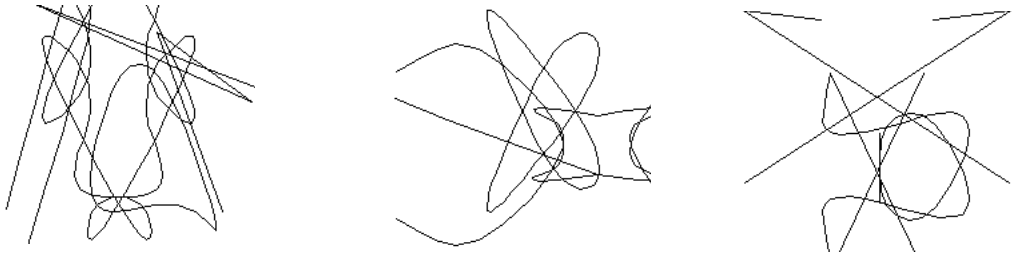
- Can we use interactive evolution to create specific images?
- Does this technique produce images that would be difficult to produce with MacDraw-like tools?
- Is the tool engaging?
- What is needed to make it useful?
- What are the areas in which interactive evolution is particularly powerful? weak?

Representation

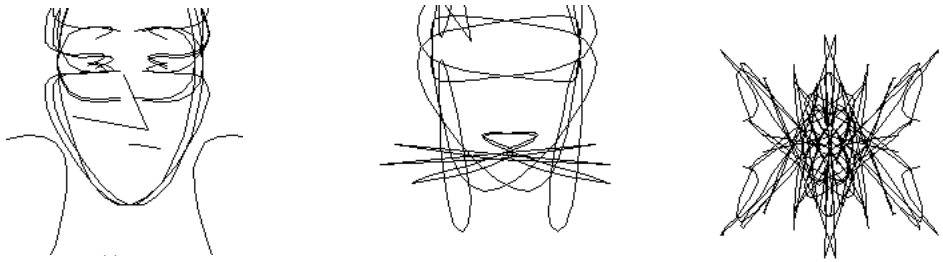
- **Drawing is represented as a collection of *strokes*.**
- **A stroke is:**
  - **a collection of points**
  - **stroke type**
  - **a symmetry property**
  - **a connection type**
  - **a perturbation factor**
  - **a mutation rate**

Getting Started

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

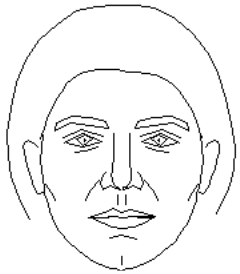


- **Random: Evolved Drawings**



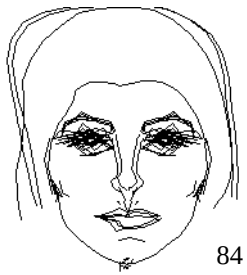
Getting Started (2)

- **User-Input: Initial Image**



- **User-Input: Evolved Images**

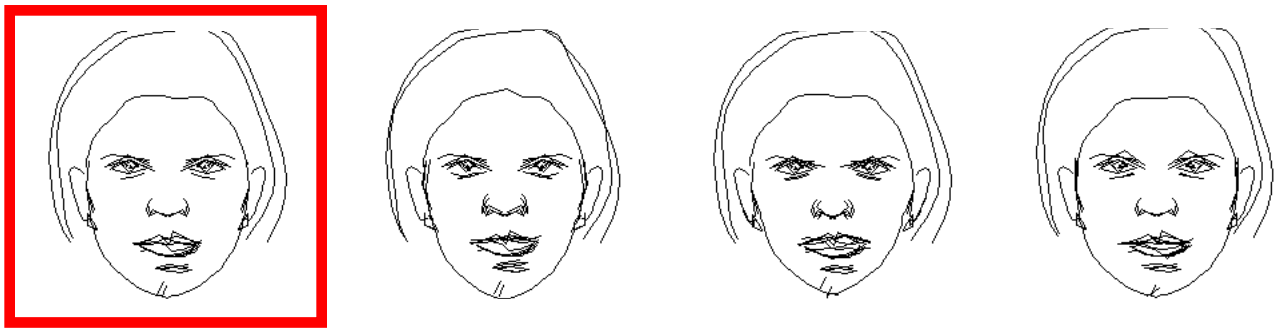
49



84

Mutating

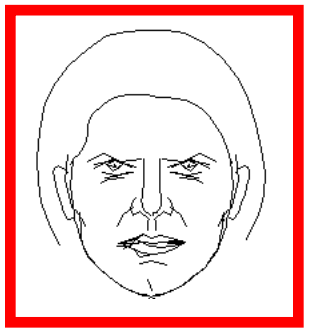
- **Specify constraints to keep images in “face space”.**
- **Randomly perturb points.**

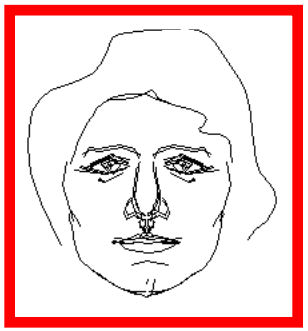


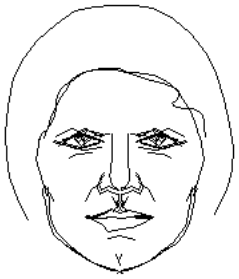
Mating

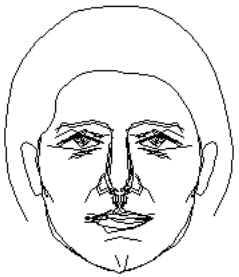
- **Uniform Mating**
  - Independently select each stroke in each parent.
  - Optionally weight stokes for inclusion.
  - Face Application uses weightings of 0.3 - 0.7
- **ID-Based Mating**
  - Group strokes into units (e.g. eyes, nose, mouth).
  - Select entire group from one parent.
- **Hybrid Mating**
  - For each set of strokes, select either Uniform or ID.

Uniform Mating

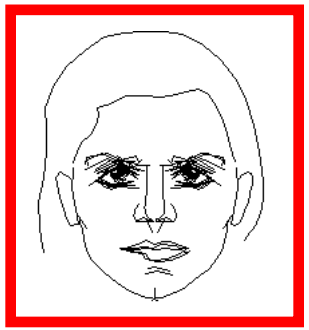


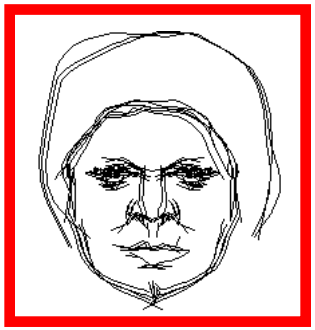


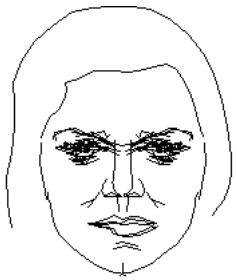




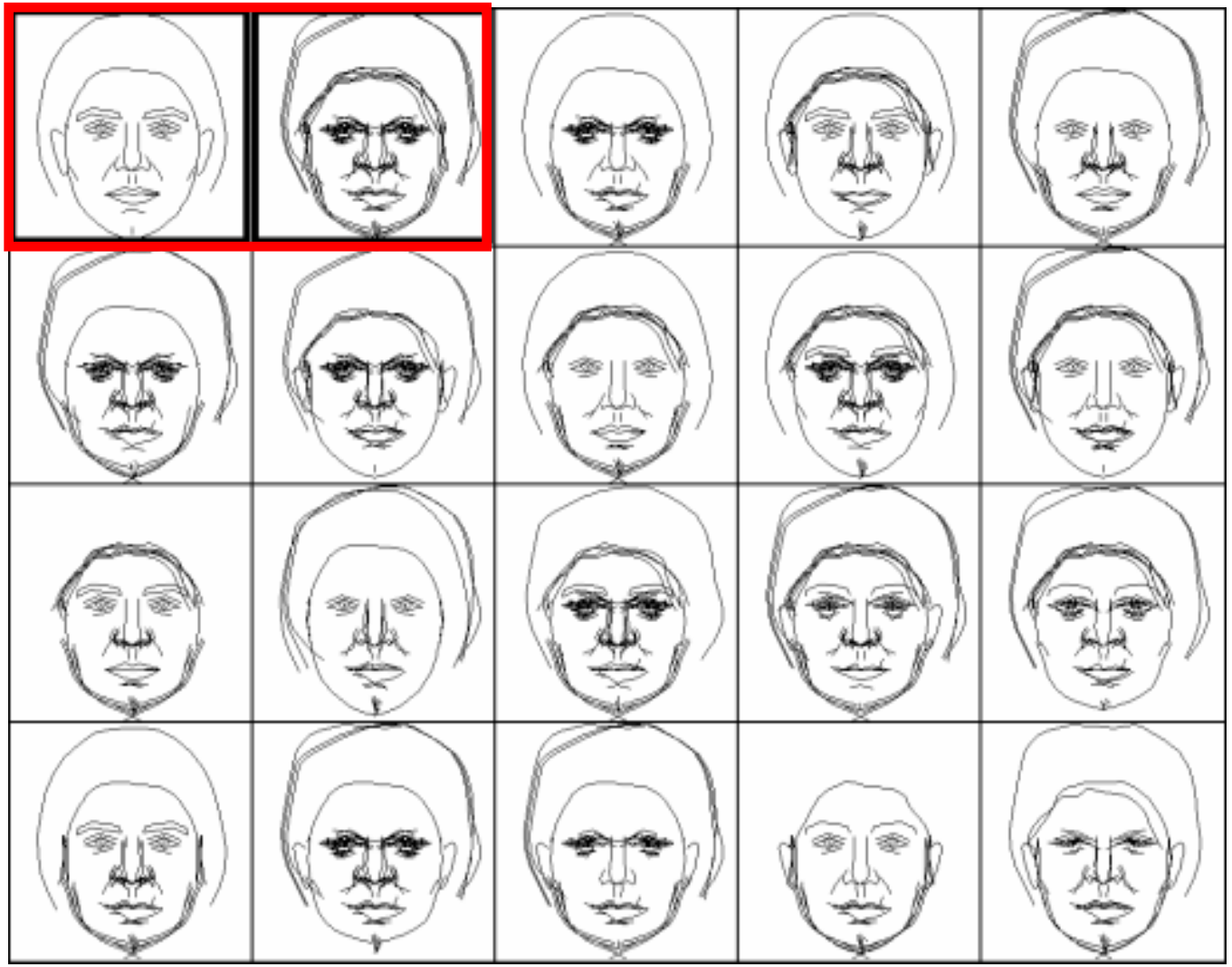
ID-Based Mating



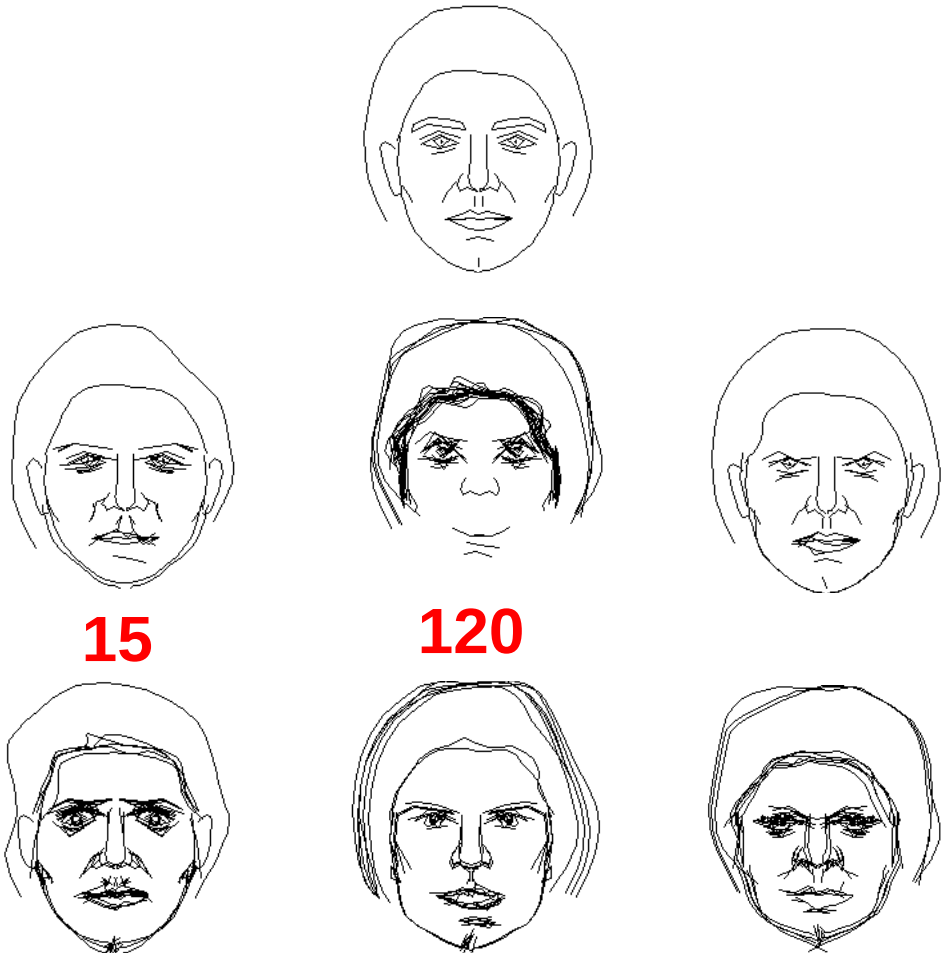




Hybrid Mating



Resulting Images



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.**