Evolutionary Art

Some slides are imported from “Getting creative with evolution” from P. Bentley, University College London
http://evonet.dcs.napier.ac.uk/summerschool2002/tutorials.html

What is Evolutionary Art?

- Imagery produced by a process of simulated evolution inside a computer, guided by an artist’s aesthetic fitness selection
  Andrew Rowbottom at http://www.netlink.co.uk/~snaffles/form/evolution.html
- Allows the artist to generate complex computer artwork without them needing to delve into the actual programming used
  Jeffrey Ventrella at http://www.ventrella.com/Art/Tweaks/tweaks.html
- “… more akin to genetic engineering than to painting”

What is Evolutionary Art?

Technically, it is creating pieces of art
- through human computer interaction, where
  - computer: runs evolutionary algorithm
  - human: applies subjective/aesthetic selection

The Roles in Evolutionary Art

- Role of computer:
  - offers choices, creates diversity
- Role of human:
  - makes choices, reduces diversity

Selection (aesthetic, subjective) steers generation process towards implicit user preferences

Q: who is creative here?

Example: Mondriaan evolver (Craenen, Eiben, van Hemert)

- Application evolving images in the style of Piet Mondriaan
- Programming assignment of my university course on evolutionary computing
- 1999 Dutch-Belgium AI Conference paper
- On-line “toy” at:
  - http://www.cs.vu.nl/ci/Mondriaan
  - http://www.xs4all.nl/~bcraenen/EArt/demo.html
- GUI shows population of 9 pictures
  - User-gives grades (subjective fitness values)
  - Computer performs one evolutionary cycle, i.e.:
    - selection, based on this fitness
    - crossover & mutation
    - thus creates new population
- Repeat
- See demo here

Mondriaan evolver

Composition with Red, Blue, and Yellow, 1930
The Evolutionary Art Cycle 1

Population → Parent selection → Recombination, mutation

Parent pool

Population

Recombination, mutation

Mutation

The Evolutionary Art Cycle 2

Population phenotypes → Parent selection → Encoding

Decoding

Population genotypes

Recombination, mutation

Genotype level

User selection acts on this level

Decoding

AGCTCTTA

Genetic operators act on this level

Mondriaan representation

white 0.5 green
split_y root red 0.33 white 0.5 green
split_x split_y
split_y root red 0.33 white 0.5 green
yellow 0.5 green

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Population phenotypes → Parent selection → Encoding

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Effects & hand-made mutations

1. Chromosomes consist of two parts: image + effect. They evolve together.

   AGCTCT+0000

2. User can try effects with preview and select one (some).

   AGCTCT+1000 AGCTCT+0100 AGCTCT+0001

Chosen effects are coded onto the chromosomes (Lamarck)

Points of attention

- Representation
  - phenotypes should be appealing ("fine art")
  - genotypes should be easy to manipulate (operators)
- Coding & decoding
  - should be fast
  - Lamarckian evolution in case of user-defined effects
- Operators
  - too disruptive: user sees no link between generations
  - too smooth: almost unchanged; evolution is too slow
- Selection
  - user grades are continuous (fitness values); hard to grade
  - user grades are binary (die/multiply); not enough differentiation
**Karl Sims, Galápagos**

- Galápagos is an interactive media installation that allows visitors to "evolve" 3D animated forms
- Exhibited at:
  - ICI in Tokyo from 1997 to 2000
  - Interactive Computer Art, Lincoln, Mass.
  - Boston Cyberarts Festival 1999

**Steven Rooke, Darwin meets Dali**

**Kleiweg, Evolutionary Art in PostScript**

**Eiben et al., Escher evolver**

- Exhibited for 6 months in City Museum The Hague
- Flat screens on walls show computer generated pictures
- Visitors vote on separate images (define fitness values)
- Computer performs one evolutionary cycle every 30 minutes
- Re-design: visitors choose between two images (split screen)

**How is this creativity achieved?**

- When evolution is told to build solutions from components, it becomes creative.
- Only those approaches that use component-based representations provide sufficient freedom.
- Evolution now explores new ways of putting components together to construct innovative solutions.
Instead of optimising selected elements of a given solution, we allow evolution to build new solutions from scratch, using component-based representations.

P. Bentley used primitive shapes to construct novel designs.

Steven Rooke uses GP functions and terminals.

John Gero used ‘wall fragments’ to generate house floor plans.

Creative Computers - What does this mean?

- We are now beginning to understand the benefits and pitfalls of creative evolutionary computation.
- Evolution can find solutions that disregard our conventions and theories.
- Efficient new designs have been evolved, and unusual art.

Some solutions do perform better, but their functioning is bizarre and difficult to understand (circuits, neural networks, computer programs).

Principle extraction (reverse engineering) is one way of overcoming the fears.

Rather than use directly the wacky evolved designs, we can learn new design techniques and then apply them ourselves.
**Creative Computers**

- Legal issues arise when computers are used as composition machines.
- For instance, the (British) law only recognises people as capable of music composition.
- When using a computer to evolve novel music, someone must be nominated to be the composer...
- Listen to sample from P. Bentley

**Conclusions**

- Creative computers allow more innovative ideas to be explored in a shorter time.
- Evolution is enabling our technology and arts to develop in surprising and exciting new ways.

**Some useful Web links**

- Andrew Rowbottom, Organic, Genetic, and Evolutionary Art
  [http://snaffles.netlink.co.uk/form/evolution.html](http://snaffles.netlink.co.uk/form/evolution.html)
- Craig Reynolds, Evolutionary Computation and its application to art and design
- Matthew Lewis, Visual Aesthetic Evolutionary Design Links
  [http://www.azstarnet.edu/~mlewis/design.html](http://www.azstarnet.edu/~mlewis/design.html)
- Steven Rooke, Evolutionary Art, Glossary of Terms
- Karl Sims, Homepage at GenArts, Inc.
- Linda Moss, Evolutionary Graphics
  [http://www.ma/tboro.edu/~lmossl/index.html](http://www.ma/tboro.edu/~lmossl/index.html)