Evolutionary Computing

Evolutionary Art

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What is Evolutionary Art?

- “Imagery produced by a process of simulated evolution inside a computer, guided by an artist’s aesthetic fitness selection”
  Steven Rooke at http://www.azstarnet.com/~srooke/glossary.html

- “… allows the artists to generate complex computer artwork without them needing to delve into the actual programming used”
  Andrew Rowbottom at http://www.netlink.co.uk/~snaffle/form/evolutio.html

- “… more akin to genetic engineering than to painting”
  Jeffrey Ventrella at http://www.ventrella.com/Art/Tweaks/tweaks.html
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

• Application evolving images in the style of Piet Mondriaan
• Programming assignment of my univ. course on evolutionary computing
• 1999 Dutch-Belgium AI Conference paper
• On-line “toy” at:
  
  http://www.cs.vu.nl/ci/Mondriaan

or

  http://www.xs4all.nl/~bcraenen/EArt/demo.html
Mondriaan evolver

- GUI shows population of 9 pictures
- User gives grades (thus defines fitness values)
- Computer performs one evolutionary cycle, i.e.
  - selection, based on this fitness (thus creates mating pool)
  - crossover & mutation (thus creates new population)
- Repeat
The Evolutionary Art Cycle 1

Population → Parent selection → Parent pool

- Recombination, mutation
- aesthetic selection
- subjective selection
Representation in Evolutionary Art

Phenotype level

User selection acts on this level

Decoding

Genotype level

Genetic operators act on this level

AGCTCTTA
Mondriaan representation
The Evolutionary Art Cycle 2

Population phenotypes

Decoding

Parent selection

Encoding

Recomb. mutation

Population genotypes

Parent pool phenotypes

Parent pool genotypes
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 (small changes): 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 the:
  - ICC in Tokyo from 1997 to 2000,
  - Interactive Computer Art, Lincoln, Mass.
  - Boston Cyberarts Festival 1999
Karl Sims, Galápagos

Box insect

Beaded arms

Multipus-green

Jellyfish

Bfly larva

Multipus-purple
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.
Component-based representations

P. Bentley used primitive shapes to construct novel designs.
Component-based representations

00: line forward
11: step forward
01: right turn
10: left turn

John Gero used ‘wall fragments’ to generate house floor plans
Some useful Web links

- Andrew Rowbottom, Organic, Genetic, and Evolutionary Art (incl. large software overview)
  http://snaffle.users.netlink.co.uk/form/evolutio.html
- Craig Reynolds, Evolutionary Computation and its application to art and design
  http://www.red3d.com/cwr/evolve.html
- Matthew Lewis, Visual Aesthetic Evolutionary Design Links
  http://www.accad.ohio-state.edu/~mlewis/aed.html
- Steven Rooke, Evolutionary Art, Glossary of Terms:
  http://www.azstarnet.com/~srooke/glossary.html
- Karl Sims, Homepage at GenArts, Inc.,
  http://www.genarts.com/karl/
- Linda Moss, Evolutionary Graphics
  http://www.marlboro.edu/~lmoss/planhome/index.html