

Co-operative Co-Evolution for Game Design (from a Computational Creativity Perspective)

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What on Earth is... Computational Creativity?

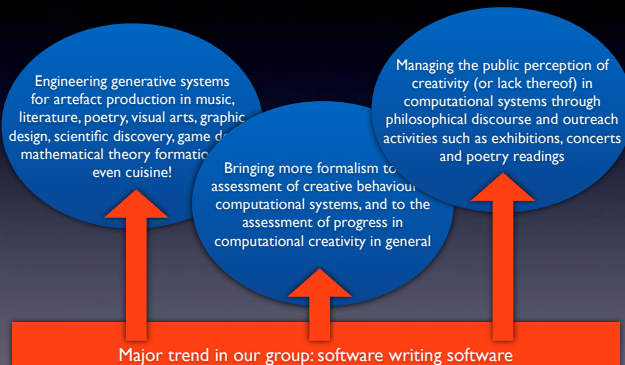
The philosophy, science and engineering of computational systems which, by taking on particular responsibilities, exhibit behaviours that unbiased observers would deem to be creative.

Creative responsibilities

Audience participation

Also note the deliberate lack of mention of value of generated artefacts (poems, paintings, theorems, etc.) and the lack of mention of comparison with people

Main Areas of Research



Co-Operative Co-Evolution for Game Design

The ANGELINA System by Michael Cook

Aims and Motivations

- Moving procedural content generation forward
 - We can generate so much more - mechanics, narratives, visuals, etc.
 - PCG can be an active, creative, contributing force in a game
 - Generating whole games means leaving nothing out - a big challenge
- Showing co-operative co-evolution's effectiveness in multi-faceted design scenarios such as game design
 - Frame videogame design as composed of many small design subtasks
 - Co-evolution has the potential to lead into human co-creation too

Cooperative Coevolution

- Proposed in Potter and De Jong (1994)
 - "A Cooperative Coevolutionary Approach to Function Optimization"
 - "... in order to evolve more and more complex structures, explicit notions of modularity need to be introduced ..."
- Split a problem into subproblems then evolve solutions within species to individual subproblems
- Key step: evaluate fitness of subproblems by combining them with solutions to the other subproblems
 - In addition to using local fitness measures
- e.g., Evolve level structure design and evaluate their fitness by combining them with rules and an object layout design

What's In A Videogame?

Definitions are handy for science, but we don't really believe games have a strict definition.

"We don't need to prove that the things we're making are Games and not 'interactive art.' ...Who cares?"

- Anna Anthropy (*dys4ia*)

"If you're constrained in what you make by definitions, then you're less likely to make something unique."

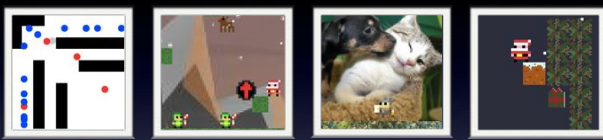
- Ed Key (*Proteus*)

With that said...

What's In (Some) Videogames?

- Different versions of ANGELINA have different models of a game depending on the target genre, including:
 - Level structure (walls, passable/impassable areas)
 - Layout of game objects (player, enemies, collectibles)
 - Rules (collision-based reactions, e.g. Player + Powerup Add Score)
 - Definitions of object behaviours (e.g. PAC-MAN ghosts chase the player)
 - Artistic direction (images and sound effects, music, etc.)
 - Game mechanics (how the player can influence the game world)

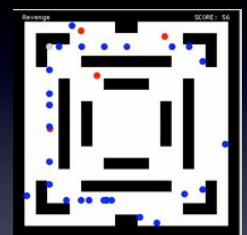
ANGELINA's Development



- ANGELINA 1 (2011) - Arcade games
- ANGELINA 2 (2011) - Metroidvania and platformers
- ANGELINA 3 (2012) - News-inspired Games
- *Mechanic Miner* (2012) - Mechanic design via code tweaking
- ANGELINA 4 (2013 and beyond) - 3D virtual world games

ANGELINA 1 - Arcade Games

- Co-operating design subtasks:
 - Levels (passable and impassable areas)
 - Layouts (starting positions for the game entities)
 - Rules (collision types and their effects)



Evaluate games by *combining the three components* and then simulating the gameplay of players with different playing styles

ANGELINA 2 - Metroidvania

- Co-operating design subtasks:
 - Levels (passable and impassable areas)
 - Layouts (start, exit, and enemy designs)
 - Powerups (modifiers to change player abilities)



"Space Station Invaders" - ANGELINA's first commission from the New Scientist

Again, combine members of each subtask's population to create a game, then simulate gameplay to evaluate the individual species

ANGELINA 3 - NewsGames

- Idea is to simulate inspiration coming from various sources
 - Such as social networks and news web sites
- Same three co-operating subtasks as ANGELINA 2
- Additional fourth subtask: collating and adding images and audio
- ANGELINA's first foray into computational creativity proper:
 - E.g., it produced a commentary on what it has done and what it has produced, and why
 - ANGELINA credited as designer for the first time on designer-curated FreeIndieGames blog
 - Example game: "Mandelson backs illegal logging firm, animals die!"



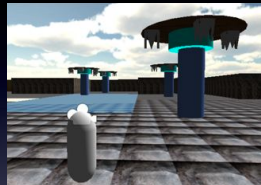
Interlude - Mechanic Miner

- Experimental work on evolving direct code modifications, e.g. multiplying a player's *acceleration* variable by -1 to flip gravity
- Check if modification produces a new, usable, mechanic
- Evolve a level which requires the usage of the invented mechanic
- We developed *A Puzzling Present*, a puzzle game with levels and game mechanics designed by ANGELINA
 - Three game mechanics invented, 10 levels given per mechanic
 - Players asked to evaluate in terms of enjoyment and difficulty
- Top 500 Android game, downloaded over 10,000 times across platforms



Creative Code Generation

- New EPSRC grant to take our research into code generation further
- Generating fully 3D games that can generate their own code at runtime
- Using CodeDOM and Unity 3D to generate C# code
- Bringing code generation into the evolutionary fold:
 - Evolutionary systems with hard black-and-white evaluation criteria to focus the process of code generation
- We're just getting started...



The Future for ANGELINA

- **Verbalising code** - getting software not only to write code, but to describe what it does
- **Self-modification** - software that can evaluate itself and make changes accordingly
- **Creativity** - software that has (and communicates) ideas so good that human game designers try to mimic them!



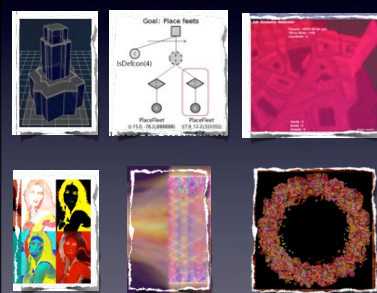
(very briefly...)

A Computational Creativity Context

ANGELINA

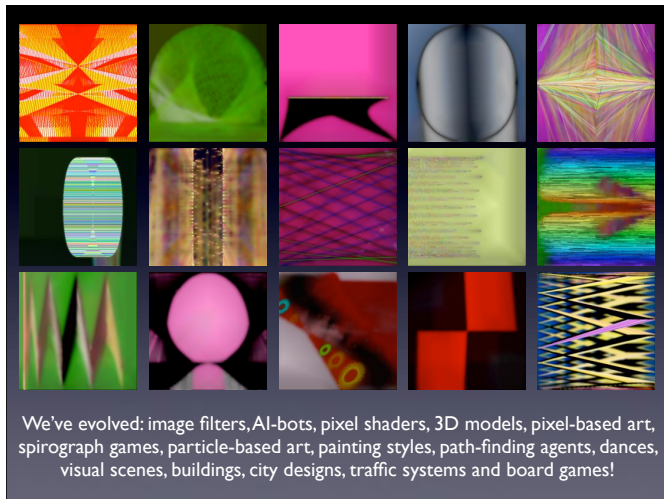


You Name it... ...we've Evolved it



Games: building; behaviour trees; pixel shaders

Visual art: image filters; abstract pieces; scene layout



Extending Machine Learning

The HR3 System

- Think... Inductive Logic Programming (the automatic production of logic programs to solve classification problems)
- Now drop the requirement to work in first-order logic
 - Production rules can manipulate data in any (terminating) way and output java code for concept definitions
- Next drop the rigid task definition (e.g., classification, association rule mining)
 - And think of a host of more creative uses of theories about data, e.g., outlier detection, bespoke concept construction, puzzle generation, etc.
- New applications in poetry generation, invariant discovery in formal methods
- Watch this space...

Flowchart Magic

- We're building a general purpose generative system based on flowcharts representations of scripts
- To be used by non-experts at the flowchart design level
- But - more importantly - the software itself will design flowcharts to incorporate developers' new nodes
- Will be used for automated ideation and process invention in the new WHIM, COINVENT FP7 projects



Each stanza is of the form ABBA, with A and B being tweets

As have equal footprints
Bs having end-rhyming

Line breaks at periods, or too long sentences

Edited by Russell Clark
(for children, and for grammar)
~ 5 minutes

Wrap Up

- Software writing software is a major theme in our group
- Mike is leading the way with the ANGELINA project, which is moving into interesting new territory
- There are a number of other projects in this theme
- Evolutionary approaches are particularly interesting as an AI technique for creative software
 - Sub-optimal solutions can be interesting
 - Possibility to work at meta-level: fitness function invention
- I'm looking to set up collaborations with CREST members, and those of similar groups...



Discussion?