Computational Creativity Autumn School

Lectures 2 and 3

Building an Automated Painter
(Practical and Cultural Aspects)

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www.doc.ic.ac.uk/ccg

Aims

• To give you an introduction to The Painting Fool project and automated painting in general

• To provide some technical details about how to get software to creatively produce images

• To make you aware of some cultural issues which are raised when you talk about creative software in artistic circles
Project Overview

- Aim: to build a system which is - one day - taken seriously as a creative artist in its own right.

- Involves graphics (NPR), AI and vision: painting is very much a cognitive process

- Around 7 years of work (a decade of software)

www.thepaintingfool.com

“Simulating artistic techniques means also simulating human thinking and reasoning, especially creative thinking. This is impossible to do using algorithms or information processing systems”

Strothotte and Schlechtweg
Non-Photorealistic Computer Graphics
Morgan Kaufmann, 2002
Stages of Development

• Non-photorealistic rendering (skill)
• Emotional modelling (appreciation)
• Generative art (imagination)
• Multimedia art (skill and imagination)

Stage 1:
Non-photorealistic Rendering (Skills)
Stage 1

Build a non-photorealistic rendering system for photos. Uses image filtering, image segmentation, curve fitting, natural media simulation, filling routines, transformations, etc.

Skill-based Graphics Workflow

- Input
- Settings
- Image Filter
- Annotated Image
- Ground Part
- Segmentation
- Layer Painting
- Paint Region Painting
- Border
- Fill

Vision

Rendering
Demonstration 1

- Filter Feast software

Image Segmentation
Example - 1000 regions
Image Segmentation

Finding Regions of Similar Colour

- Need to measure how far one pixel is from another
  - In terms of their RGB colours
  - Euclidean distance in RGB space of two pixels P1 and P2:
    - \( \text{dist}(P1,P2) = \sqrt{([P1]_R-[P2]_R)^2 + ([P1]_G-[P2]_G)^2 + ([P1]_B-[P2]_B)^2} \)
  - Similar distances involving the HSV measures

Simulating Natural Media

- Need to simulate three things:
  - Backing materials: papers, canvases, etc.
  - Painting implements: brushes, palette knives, etc.
  - Pigment materials: pastels, paints, pencils, etc.
- We’ll concentrate on achieving the look of pencils, acrylic paints and watercolours
Simulating Natural Media

Watercolour brush from Adobe Illustrator

- Simple method:
  - Scale, rotate and bend a fixed rendering process/template to fit the stroke path
  - This is effective, but there is too little variety in the strokes

Brush Paths

More Examples (from Adobe Photoshop)
Brush Paths
Adding Sophistication

- Enable ridging to simulate bristle paint load/height differences
- Enable starting and ending differences: brush head and/or transparency
- Rotate the brush head to match the curvature of the stroke
- Enable paints to mix as they are painted
- Simulate unmixed paints
- Simulate smudging and paint dispersion

Made with Art Rage: http://www.artrage.com/

Brush Paths
Adding Sophistication

Increasing bristle colour variance

Increasing intro/exit transparency

Becoming increasingly grainy

Bristle size
Dispersion
Smudging
Dispersion and bristle size

Made by The Painting Fool: www.thepaintingfool.com
Stages of Development

Stage 2
Emotional Modelling
(Appreciation)

Stage 2.1

- Externalise the parameters which define styles: colour palettes, abstraction levels, fill styles, natural media, etc; enable search over sets of parameters; match emotion enhancement to styles; build KB; enable control via emotion keywords;
Stage 2.1

- Externalise the parameters which define styles: colour palettes, abstraction levels, fill styles, natural media, etc; enable search over sets of parameters; match emotion enhancement to styles; build KB; enable control via emotion keywords;

Melancholy?  Fear?
Amelie’s Progress Gallery

222 pictures from 22 images; emotional direction

Stage 2.2
Emotional Enhancements

- For the BCS machine intelligence competition (Dec. 2007)
- Combined The Painting Fool with the emotion detection system of Maja Pantic and Michel Valstar
  - Uses a machine-learned boosted classifier based which uses the movements of facial anchor points
- Uses video clips of someone expressing an emotion and detects (i) apex image (ii) feature locations and (iii) one of six emotions - which is passed to The Painting Fool
- The Painting Fool chooses its painting style according to the knowledge base of emotion-enhancing styles
Skill-based Graphics Workflow

Input ───────────── Annotated Image
Settings ─ Image Filter
Settings ─ Ground Part
Segmentation
Layer Painting
Paint Region Painting
Settings ─ Border
Settings ─ Fill

Vision
Rendering

Appreciation-based Graphics Workflow

Input ─────── Video
Settings ─

Emotion Detection
Annotated Image
Ground Part
Segmentation

Rendering
Settings

Vision
Example: Mike Swain

More Portraits
Stages of Development

Stage 3
Generative Art
(Imagination)
Stage 3.1

Automatic Scene Construction
Scenes with repetitive elements

Approach 1: Evolutionary

- Scenes are: a set of geometric shapes, e.g., rectangles
- Randomly generate a scene by defining:
  - The colour, position and shape of 100s of elements
- Search for aesthetically pleasing scenes:
  - User-defined fitness function (see next slides)
- Randomly generate scenes, then crossover chunks of shapes in evolutionary approach
- Also use a hill-climbing approach
Random Example:

Inspiring Example:

Fitness Functions

• Parameters of the scene elements:
  • Height, width, x, y, hue, saturation, brightness
  • Position in the ordered scene list
• Calculations using these parameters:
  • Depth of scene elements, distance from centre
• Aspects of the fitness function:
  • Correlations between the parameters
Correlations Required

- Using Pearson Product-Moment Correlations
- Distance from centre
  - Positively correlated with: y coordinate
  - Negatively correlated with: height, width and saturation
- Depth:
  - Positively correlated with: height
  - Negatively correlated with: saturation, brightness

Results
To the Meta-Level...

- Automatically invent the fitness function using HR
- See lecture 4 of mine for details about HR software
- Because deriving a fitness function is essentially mathematical modeling
- HR is given the same background knowledge that the correlations use, namely:
  - Objects of interest are scenes
  - Subobjects are scene elements
  - X,Y,W,H, Hue, Sat, Bri, Dist, Depth are the background concepts

Fitness Function Invention

<table>
<thead>
<tr>
<th>Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>S: scene overview specifications (number of scene elements, scene width &amp; height)</td>
</tr>
<tr>
<td>E: scene element attributes and ranges for the attributes</td>
</tr>
<tr>
<td>R: rendering specifications</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Using E, R and S, TPF generates five scenes randomly with 10 elements</td>
</tr>
<tr>
<td>2. TPF translates the scenes into a HR input file</td>
</tr>
<tr>
<td>3. TPF invokes HR to produce a theory using 1000 steps</td>
</tr>
<tr>
<td>4. HR translates its theory into a Java class, J, and compiles it</td>
</tr>
<tr>
<td>5. TPF constructs a random population, P of 100 scenes according to S</td>
</tr>
<tr>
<td>6. while (maxfitness(P,F) &lt; 0.4 or maxfitness(P,F) &gt; 0.8) TPF builds a fitness function F by choosing 3 to 6 correlation concepts from J and giving them equal weights</td>
</tr>
<tr>
<td>7. TPF evolves a best scene, B, according to F using setup D (see section 3)</td>
</tr>
<tr>
<td>8. TPF hill-climbs to improve B using repetition factor 10 (setup D again)</td>
</tr>
<tr>
<td>9. TPF translates B into a segmentation, G</td>
</tr>
<tr>
<td>10. TPF renders G according to R</td>
</tr>
</tbody>
</table>
Illustrative Result

\[
\begin{align*}
\text{cor(brightness, x-coord)} &= 1 \\
\text{cor(y-coord - x-coord, brightness)} &= -1 \\
\text{cor(y-coord * x-coord, height)} &= 1 \\
\text{cor(brightness, height)} &= 1 \\
\text{cor(saturation, height)} &= -1
\end{align*}
\]

Cityscape Results
Cityscape Results

• Each scene exhibits at least two patterns, and there are some surprises...

Permanent Exhibition at Imperial Pencils, Pastels and Paint
Stage 3.2

Automatic Scene Construction
Scenes with discernible objects

- Evolutionary method absorbed into a teaching interface for The Painting Fool
- Artists are influenced, inspired and taught by many diverse teachers, not just one programmer!
- Modules include:
  - Evolutionary approach; image filtering; constraint generator and solver; evolutionary art; context free design grammars; animation generation;
A Teaching Interface

CFDG Module
Fish Fingers Series

After AARON Series
Countryside Series
Evolutionary Art Module
Ask me for details...
Stage 3.3

Automatic Scene Construction
Constructing scenes for a purpose

- 2009 MSc. Project of Anna Krzeczkowska
- Joint with Jad El-Hage and Stephen Clark (CompLab, Cambridge)
- Deals (partially) with the question of intent in creative systems:
  - Usually the user supplies all the intentionality in creative projects, software acts as a (possibly intelligent) tool
  - Idea is to react to news stories to paint pictures which make people think more about certain issues

Automated Collage Generation
Illustrative Result

- Guardian news story on the war in Afghanistan
- Keywords: afghanistan, brown, forces, troops, nato, british, speech, country, more and afghan
- Images retrieved from Flickr
- Highlights the potential for poignancy
• Guardian news story on the war in Afghanistan
• Keywords: afghanistan, brown, forces, troops, Nato, British, speech, country, more and afghan
• Highlights the potential for poignancy
Illustrative Result #2

Guardian news story on the war in Afghanistan

Keywords: afghanistan, brown, forces, troops, nato, british, speech, country, more and afghan

Highlights the potential for poignancy
Interesting Observation

- All of these words are affect-neutral
  - afghanistan, brown, forces, troops, nato, british, speech, country, more and afghan
- Raises questions of intentionality
- 5 agents at work here: programmer, software, journalist, audience, flickr taggers
- Future work will involve increasing the explicit intentionality of The Painting Fool (opinion forming)
Stages of Development

Stage 4
Multimedia
(Skill and Imagination)

Multimedia

• Moving into video, text, sculpture and gallery design
• Into the third and fourth dimensions!
• Aims:
  • To enable The Painting Fool to produce art that couldn’t be produce by people
  • Enable it to produce more sophisticated artworks
• With a knowledge of space/light/arrangement
(Bad) Poetry

Stupid and Imitating You
You are harmful like the fowlness of a hyena
You are scary like the works of a devil
You are ugly like the heart of a witch
You are insensitive like the face of a pig
Why are you such an annoying and vicious dream?

Happy and Gallant You
You are merry like the colours of a flamingo
You are brilliant like the life of a bird
You are strong like the grin of a sunflower
You are sweet like the peace of a meadow
Why are you such a rich and proud creation?

Sculptures

Made with Afflatus.UCD.ie
Sculptures

3D Scene Generation
Paint Dance Animations

Technical Issues

- Choosing a representative subset of paint strokes from the set of original paintings
- K-means clustering
- Assigning strokes from the representative set back to the paintings without losing too much fidelity
- Producing smooth animations without a vertical crossover effect
Skill-based Graphics Workflow

Input → Annotated Image → Ground Part → Segmentation → Layer Painting → Paint Region Painting → Vision

Settings → Image Filter

Settings

Rendering

Imagination-based Graphics Workflow

Evo → Collage → Constraint → Photo Based → CFDG → Hand-drawn

Layer specification → Segmentation → Rendering
Multimedia-based

Graphics Workflow

Layer specification

Segmentation

Rendering

Text Video Pictures Sculptures Music

Galleries

Recent and Future Exhibitions
No Photos Harmed
Exhibition

- Joint exhibition with Eileen Chen
  - Dialogue on the nature of handing over creative responsibility in artistic processes
- Two weeks with a vernissage (100 people), middisage (10 people) and finissage (60 people)
- My contribution: two large pieces which emphasise that computer generated art can be neither fractals nor photoshopped, hence “no photos harmed”
  - And a continuous live painting session (around 8 hours)
The Four Seasons
The Dancing Salesman Problem
Growth Exhibition

- Joint exhibition with members of the Sony CSL team
- “Performing Sciences”, including visual arts, musical performances and sculptures
- At La Maison Rouge contemporary art space in Paris
- I presented a timeline of important pieces from 10 years of The Painting Fool
- Aim is to highlight the growth that software goes through, how it becomes more sophisticated through training

Timeline

Ten Years of Development
Timeline
Ten Years of Development
Proposed Exhibitions

• “Who’s the Robot”
  • People are used to construct/paint pieces
  • Subverts usual user/tool model of software
• “You Don’t Know my Mind”
  • Interactive art - your pose put into Dancing Salesman pieces
  • However.... The Painting Fool will often refuse to put you in the painting, or will choose to paint something else entirely
  • It will have a daily-changing aesthetic based on symmetry and colour
  • It will have a mood based on sentiment analysis on news
  • Highlights the fact that software can be unpredictable and moody

Future Work

• Five year project into “Computational Creativity Theory”
• Many practical projects using The Painting Fool
  • Co-creation with physically challenged people
  • Exploring the overlap between linguistic and visual creativity
• Robotic painting
Committee Splitting

- Committee splitting
  - An attempt to get the software to develop its own aesthetic considerations (avoid being mini-me!)
- Use crowd sourcing
  - Give people images and ask for quantitative and qualitative feedback
  - Develop mathematical models of value changing and process changing dependent on the feedback
- React only to the most divisive pieces

Multimedia-based Graphics Workflow

- Evo
- Collage
- Constraint
- Photo Based
- CFDG
- Hand-drawn
- Layer specification
- Segmentation
- Rendering
  - Text
  - Video
  - Pictures
  - Sculptures
  - Music
  - Galleries
Other Technical Talks
I could have given

- About the paint dance animations
- In detail about non-photorealistic rendering
- In detail about shape grammars
- In detail about evolutionary art
- About the evolutionary generative approach more
- In detail about the constraint generative approach
- In more detail about the collage generation
- And I can give a demo of The Painting Fool anytime
“We hope that people will eventually take The Painting Fool seriously as a creative artist, because they can no longer find a good reason why it is not”

• How can a scientist train an artist?
  • The teaching interface; work with RCA students*
• The Painting Fool only produces what people can produce
  • Multi-media workflow; abstract art; video pieces
• The Painting Fool doesn’t intend to paint
  • Collage generation; opinion forming/sentiment analysis*
• The Painting Fool is not creative because it doesn’t have appreciation or imagination
  • Emotion detection; generative art; fitness function generation; committee splitting*;
• The Painting Fool will always do just what you tell it to do
  • Generative art; collage generation; text-based projects; You Don’t Know my Mind exhibition*;
Questions?

www.thepaintingfool.com

Portraits of the Artist's Programmer as a Grotesque Younger Man, Paris 2011