Monash University • Clayton's School of Information Technology

CSE3313 Computer Graphics

Lecture 25: Research in Computer Graphics at Monash University.

Where can I learn more about graphics?

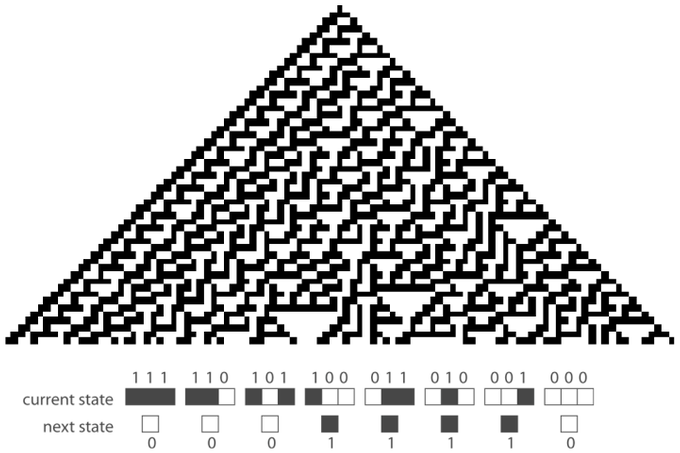
- CSE3301 Project run by Jon McCormack (not available in 2007)
- CSSE Honours level:
  - CSE415 – Advanced Image Synthesis.
  - CSE450 – Procedural modelling, animation and artificial life in computer graphics.
- Masters degree (Research)
- PhD (Research)
- **Jobs:**
  - Film & Television Industry
  - Games
  - Visualization Sciences
    - Medicine, Architecture, Defense, Design
    - Astronomy, Meteorology, Biotechnology

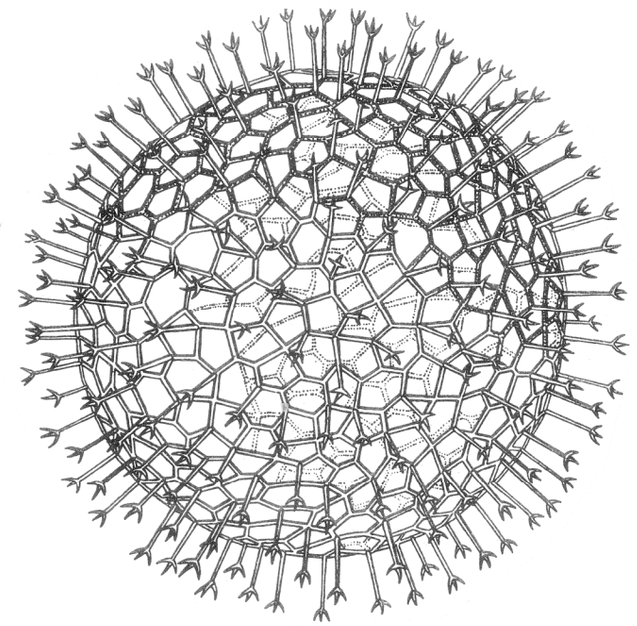
Active Research Topics

- Creative and artistic applications of graphics technology and research:
  - Electronic art;
  - Computer Music;
  - Virtual Reality;
  - Human Computer Interaction.
- Artificial Life and Generative Systems (Graphics Applications):
  - L-systems and developmental models;
  - Philosophy of Artificial Life and Visualization;
  - Adaptive and evolutionary agents.
- Graphics Research:
  - Convolution Surfaces
  - Texture Synthesis
  - Advanced geometric modelling, animation & rendering

Developmental Morphogenesis

- Some **big** problems:
  - model the growth and development of complex multi-cellular organisms.
  - develop a general theory of morphogenesis.
  - understand *emergence* in its broadest sense, in both nature and machine.
  - towards an expanded definition (hence understanding) of *life*.





L-systems

- DOL-Systems:

$G = \langle \Sigma, P, \omega \rangle$, where

$\Sigma = \{s_1, s_2, \ldots, s_n\}$ is the alphabet

$P \subset \Sigma \times \Sigma^*$ a set of productions

$\omega \in \Sigma^+$ a non-empty word (axio

A production $(s, \chi) \in P$ is writte

$s \rightarrow \chi$, where $\chi \in \Sigma^*$

Starting with the axiom, productions are matched to symbols and applied in parallel.

$\mu = s_1 s_2 \ldots s_m, \mu \in \Sigma^+, p: s \rightarrow \chi$, matches $s_i, 1 \le i \le m$, if $s = s_i$

Production:

s_i a χ signifies production

$\nu = \chi_1 \ldots \chi_m \in \Sigma^*$ is derrived from μ:

$\mu \Rightarrow \nu$, iff s_i a $\chi_i \forall i = 1, \ldots m$

ν is generated by G in a derivation of length n:

$\exists \mu_0, \mu_1, \ldots, \mu_n \ni \mu_0 = \omega, \mu_n = \nu \wedge \mu_0 \Rightarrow \mu_1 \Rightarrow \ldots \Rightarrow \mu_n$

A Simple Example:

- The L-system:

$$\Sigma = \{F, R, L, [,]\}$$

$$\omega : F$$

$$P : F \rightarrow FFR[RFLFLF]L[LFRFRF]$$

Generates:

Axiom: F
Iteration 1: FFR[RFLFLF]L[LFRFRF]
Iteration 2: FFR[RFLFLF]L[LFRFRF]FFR[RFLFLF]L[LFRFRF]R[RFFR[RFLFLF]
L[LFRFRF]LFFR[RFLFLF]L[LFRFRF]FFR[RFLFLF]L[LFRFRF]]L[LFF
R[RFLFLF]L[LFRFRF]RFFR[RFLFLF]L[LFRFRF]RFFR[RFLFLF]L[LFRFRF]]

Turtle Interpretation

- The produced string can be interpreted by a ‘turtle’ that moves and draws on a surface. Each command is interpreted relative to the current position.

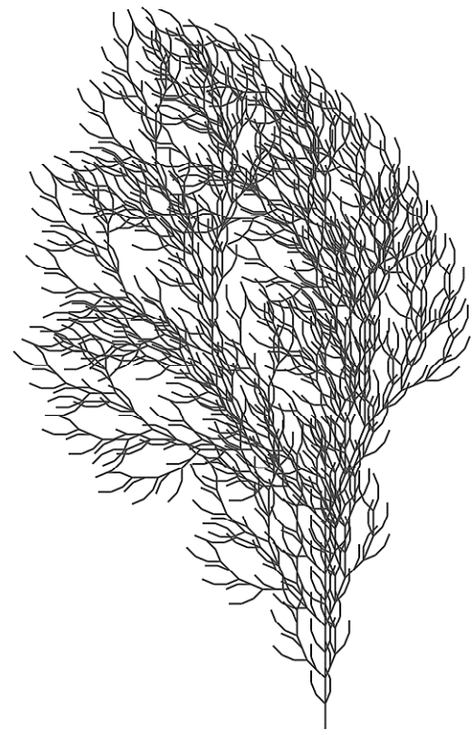
F — move forward while drawing a line

L — turn left

R — turn right

[— save the current position on a stack

] — restore the current position from the stack



Example: Lilacs

surfaceK

$n = 10, \delta = 60°$

ω :	A K	axiom
p_1 :	$A \rightarrow [-/K][+/K]I(0)/(90)A$	subapical development
p_2 :	$I(t): t \neq 2 \rightarrow FI(t+1)$	linear elongation of intern
p_3 :	$I(t): t = 2 \rightarrow I(t+1)[-FFA][+FFA]$	lateral axes

```
a(t) : t>0 : -> [&(70)L]/(137.5)I(10)a(t-1);
a(t) : t==0.0 : -> [&(70)L]/(137.5)I(10)A;
A -> [&(18)u(4)F F I(10)I(5)X(5)K K K K]/(137.5)I(8)A;
I(t) : t>0 : -> F I(t-1);
I(t) : t<=0 : -> F;
u(t) : t>0 : -> &(9)u(t-1);
u(t) : t<=0 : -> &(9);
L -> ['{.-F I(7)+F I(7) + F I(7)}]['{.+ F I(7) - F I(7) - F I(7)}];
K -> [&"{.+F I(2)- - F I(2)}][&"{.-F I(2)+ + F I(2)}]/(90);
X(t) : t > 0 : -> X(t-1);
X(t) : t <= 0 : -> ^(50)[[- G G G G + + [G G G[+ + G"' {.].].]. + + G G G G .
                - - G G G . - - G .}]%;

object k2039583 {
        length = 0.1;
        radius = 0.025;
        level = 30;
        delta = 20;
} 'I(9)a(13);

/* scene { [i,4,k948271^(i*6,0,0,40 - i * 20)]; } */
scene { [i,1,k2039583(38)];}
```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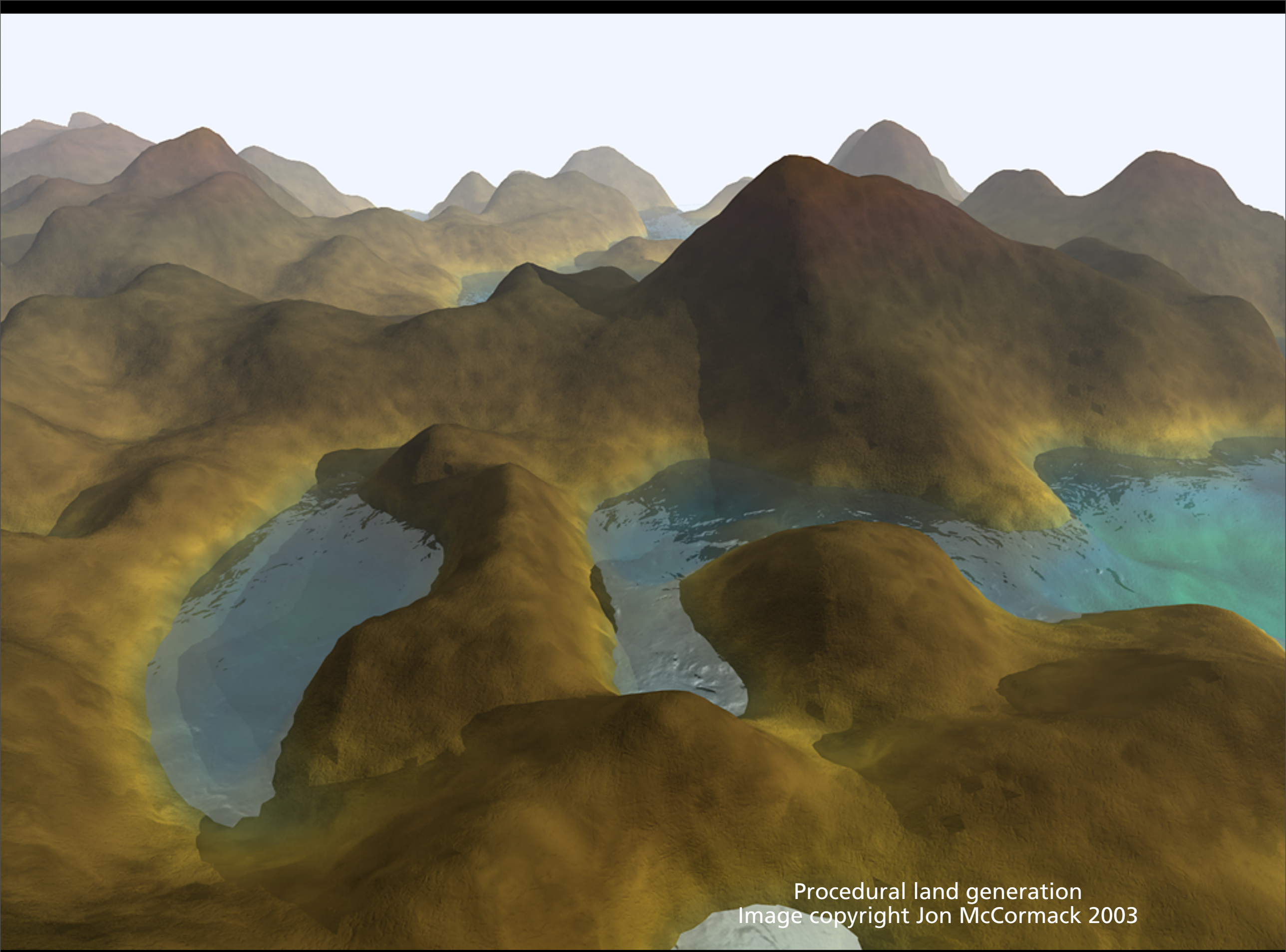
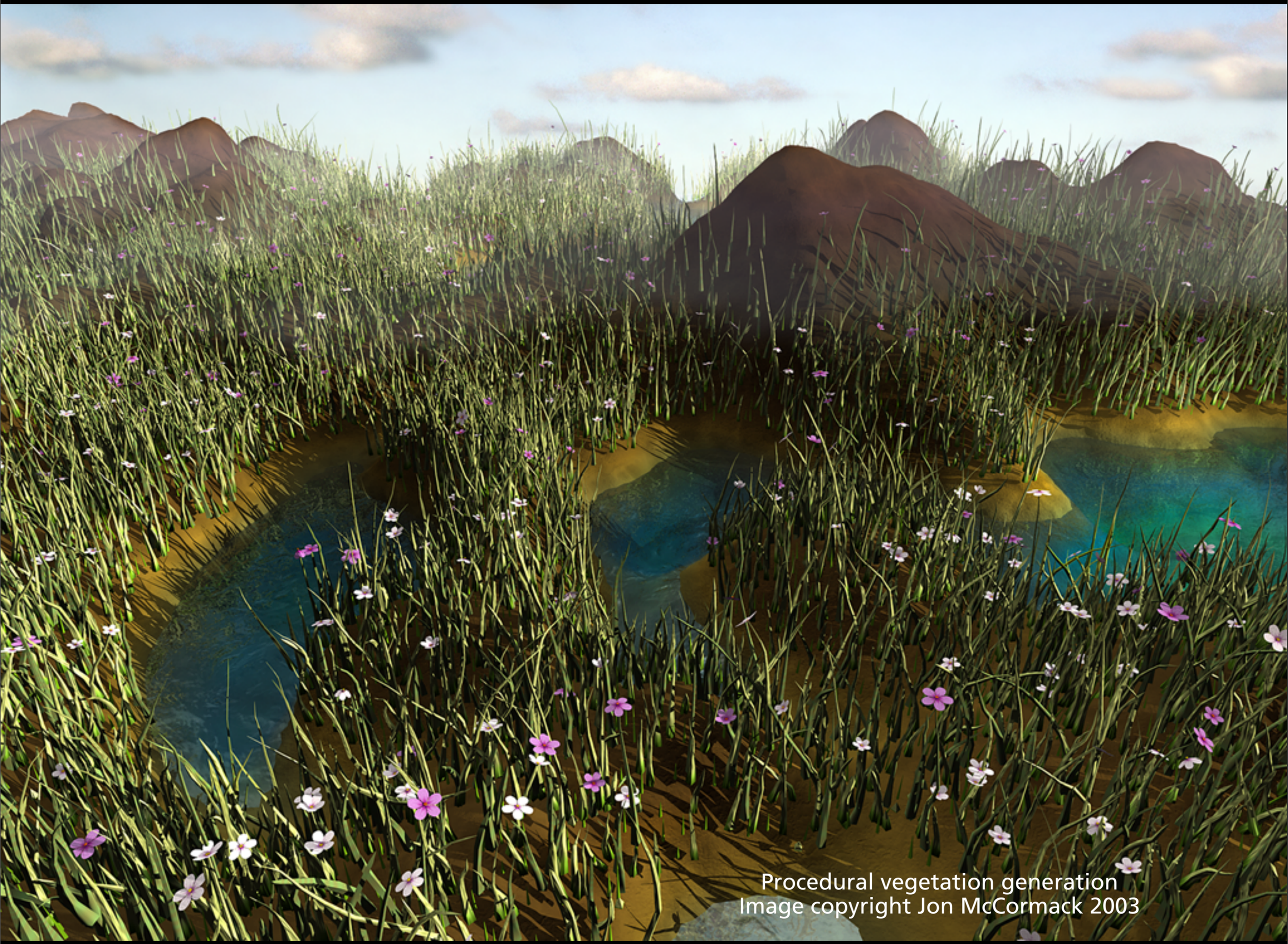


Procedural land generation
Image copyright Jon McCormack 2003


Procedural vegetation generation
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