# Novel Simulation Models for VR

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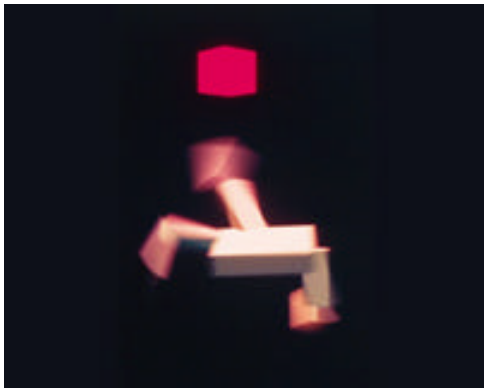
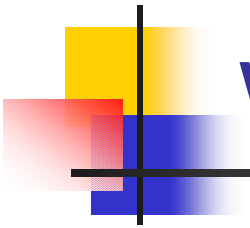
HPC2N

# Buzzers...

AI
Alife
Chaos, Fractals
Optimization
Emergence
Adaption
Evolution

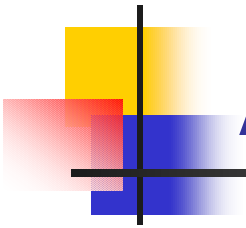


These fields are not at all distinct!
On the opposite, it all hangs together...



# Why?

- For pleasure and beauty
- For complexity and surprise
- For realism
- For efficiency
- To avoid explicit and detailed design



# AI & VR

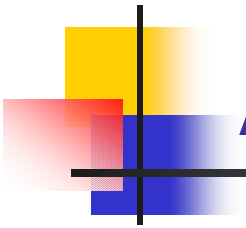
Everything from the AI course and everything else...

Often simply an algorithm for mastering a game or a specific problem, finding a path etc.

More general applications use a basic finite state machine.

Rare examples of reinforcement learning, neural networks, emergent AI from multi agent systems.

See e.g. *Making them behave*, John Funge.



# Alife

Term first recognized by Chris Langton,
then at Santa Fé Institute

Life-like behaviour, alternative biology, ...

Multi-agent systems:

1. Simple rules define an agent
2. Many agents interact
3. Interaction gives complex behaviour and:
4. Emergent collective behaviour

# Alife - examples

Evolving virtual creatures, Karl Sims 1994

Physically modelled blockie creatures with sensors, actuators, energy uptake and a digital DNA. Evolve for specific tasks.

# Alife - examples

Flocks, herds, schools and boids

E.g. birds, fish, insects, ...

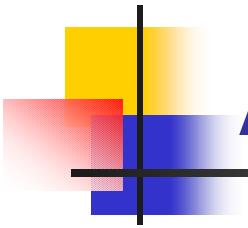
Rules, e.g.

- avoindance (avoid obstacles and other boids)
- copy (average velocity)
- center (go in the direction of high density)
- (view (move to get free sight))

No master plan.

Craig Reynolds, SIGGRAPH 1987,

now at Sony.



# Alife - examples

Game of Life

Food collecting ants, slime, fireflies, termites, bees, other insects

Agents on the stock market

# Multi-agent software

See: alife.org

Swarm
Starlogo

Various game engines and game modules.
Research tools, e.g. for individual behaviour in Ecology.

# Fractals

*The development of an organism ... may be considered as the execution of a ”developmental program” present in the fertilized egg. ... A central task of developmental biology is to discover the underlying algorithm from the course of development.*

- Aristid Lindenmayer and Grzegorz Rozenberg

*Nature uses as little as possible of anything.*

- Johannes Kepler

# Fractals

Lindenmayer systems (L-systems)

A class of fractals that can model landscapes, flowers, trees, human organs, and other structures in nature

Example: 2D Tree grammar

1. A → AA
2. B → A[B]A(AB)

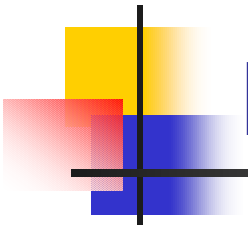
Start with B:

1. B
2. A[B]A(AB)
3. AA[A[B]A(AB)]AA(AAA[B]A(AB))

A and B are the stem.

[] are branches to the left and () branches to the right.

Example – Turtle graphics.



# L-systems

Self repeating structures
Thus highly compressed representations
Evolves under influence of physical laws

The grammar is usually probabilistic

Examples:

Blueberry (1, 2, 3) (Real-Time Simulation/Rendering!)

Simulating Nature, SIGGRAPH 2000 (PDF)

WCS (1, 2, 3)