Lecture 12: The Evolution of L-System Plants

1. Examples of L-Systems
2. Evolving L-Systems to Generate Virtual Plants
3. Summary
out recursively.

using a set of rewriting rules or productions. The rewriting can be carried
define complex objects by successively replacing parts of a simple object
Central to L-systems is the notion of rewriting, where the basic idea is to
later extended to higher plants.

description of the development of simple multicellular organisms and was
production. This model, known as L-systems, originally provided a formal
Lindenmayer proposed a model of development based on rewriting rules or
The third step of rewriting: \( a ba \)

The second step of rewriting: \( aq \)

The first step of rewriting: \( a \)

Assume the axiom consist of a single letter \( b \).

The rewriting process starts from a distinguished string called the axiom.

Rewriting rules: \( a \rightarrow aq \), \( q \rightarrow q \)

Consider strings built of two letters \( a \) and \( b \)
All other symbols are ignored by the turtle (the turtle preserves its current state).

+ \text{Turn left by angle } b, \text{ The next state of the turtle is } (x', y', a + q).

- \text{Turn left by angle } b, \text{ The next state of the turtle is } (x', y', a - q).

\text{turtle changes as above.}

\text{Move forward a step of length } d \text{ without drawing a line. The state of the turtle is drawn.}

\text{between points } (x) \text{ and } (x'), (y) \text{ and } (y'), \text{ where } x'(a), (x, b) \text{ and } y'(a), (y, b).

\text{Move forward a step of length } d. \text{ The state of the turtle changes to}

\textbf{Geometric Interpretation of T-Systems}
Production: $F \rightarrow F F + F - F - F F + F F - F + F$.

Axiom: $F$. Creating the Koch Island
1. Wildwood generates a population of $L$-system representations at random.

2. The representations are rendered to the screen as plant individuals and a fitness function is applied to each individual.

3. The most fit plants survive and the plants for the next generation are constructed by combining the $L$-system representation of the parent individuals from the current generation.

4. The process continues until the user intervenes.
In Wheatwood, the rotation angle \( \theta \) was preset to 30 degrees.

- Pop and return to state of last push.

- Push current angle/position on stack.

- Brokets have been introduced to model branching behavior.

- Single line.

- Connected "head to tail" to each other. The resulting figure remains just a

- The turtle interprets a character string as a sequence of line segments.

- Broketed L-Systems
To ensure balanced brackets, the probability of a balance increases proportionally.

At random to fill the string.

A random rule length is first computed. For simplicity, a length between 4 and 20 was selected. Then, terms from the set $\{A, f, \}^+$ were selected.
Randomly generated string.

- Mutation: select a valid substring and then replace the substring with a

then.

- Crossover: randomly select valid substrings from each parent, and then swap

Genetic Operations
where $\delta$ is parameter.

$$F = M_{\text{Height(plant)}} + H/S$$

size, ability to withstand wind, etc. For example, a plant's survival may depend upon its height, root depth, leaf environment. Simulation: Fitness produced by the simulated environment.

- plants look.
- Hand bred plants: Fitness decided by the users. For example, how interesting

Evaluation
Summary

Virtual Environments: International Conference on Evolutionary Computation (ICEC’98) available from:


References:

- entich virtual worlds.
- Wildwood represents exploratory technology created with the Internet to
- fractals.
- I-systems are simple program fragments that can define plantlike and other
- simple dynamical rules can lead to complex behaviour in GA.
- Simple geometric rules can lead to complex structures in fractals, while

http://www.math.uic.edu/~alan往往是