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MA-INF 4201 - Artificial Life
Exercise Sheet 4

Assignment 24

A loop with the double length of the edges needs twice more *msg.forward* blocks ■

Assignment 25

The reproduction of the *Chou-Reggia*-loop is basically identical to *Langton's loop*, except that in *Chou-Reggia*-loop all sheaths are removed. Instead of the extending arm, a *growth cap* is developed at the tip of the first *msg.forward* blocks. This *growth cap* provides a sense of orientation, replacing the function of the sheaths.

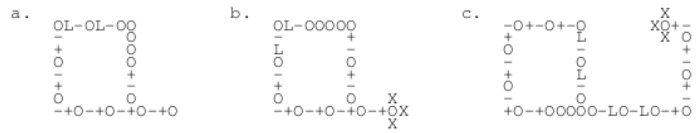


Figure 1: first three steps in replication of a *Chou-Reggia*-loop. From [01].

■

Assignment 27

Let "|" be the concatenation of words. Then we have the following recursion for the L-system from the example:

$$w_0 = C, w_1 = A$$
$$w_n = w_{n-2}|w_{n-1}$$
$$|w_n| = |w_{n-2}| + |w_{n-1}|$$

which is the recursion formula of the Fibonacci numbers ($|w_0| = |w_1| = 1$).

Proof of the recursion by induction:

Induction start: $n = 2$; $w_2 = w_0|w_1 = C|A = CA$

Induction step: $n \to n+1$; Using the induction hypothesis we conclude: $w_{n+1} = w_{(n+1)-2}|w_{(n+1)-1} = w_{n-1}|w_n$

■

Assignment 28

variables: R, S, T
axiom: R

rule 1: $R \to RS$
rule 2: $S \to ST$
rule 3: $T \to TR$

■

Assignment 29

a) The $B \rightarrow BC$ rule adds one unit length per turn, thus controls the length of the segments. The $A \rightarrow A + BC + BC$ concatenates the turns of the spiral

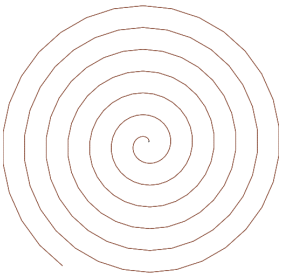
variables: A, B, C
constants: +,-
axiom: -A

rule 1: $A \rightarrow A + BC + BC$
rule 2: $B \rightarrow BC$

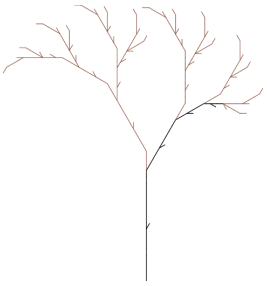
variables: B, C, D, E, F
constants: +,-
axiom: B

b)

rule 1: $B \rightarrow C[-B]E[+B]$
rule 2: $C \rightarrow F[-D]F$
rule 3: $F \rightarrow FF$



(a) spiral for $\alpha = 12°$, 100 iterations



(b) tree, for $\alpha = 30°$, 5 iterations

■

References

[01] Reggia, James A and Chou, Hui-Hsien and Lohn, Jason D: "Cellular automata models of self-replicating systems" published in "Advances in Computers", volume 47, pp. 141–183, *Elsevier*, 1998