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Group # 1 Artificial Life

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15) Describe the system called von Neumann's Universal Constructor.

⇒ Von Neumann's Universal Constructor is a system based on Two-Dimensional (2D) Cellular automaton of 29 states. The Universal Constructor is divided into two different parts: a tape that contains the description of the cellular machine to construct and the constructor itself that reads the tape and builds the new corresponding machine with a dedicated cellular arm. If the tape contains the description of the constructor and if the constructor, in addition to its building abilities, can also copy the tape information, then the resulting system is a self replicating one.

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16) Explain how Chou-Reggia's Loop is reproducing itself. Depict the development of the first 3 steps of Chou-Reggia's Loop.

K = 8, Von Neumann, S = 5, P = 15

B	B	
G	Y	B

t = 0

B	Y	
B	G	P

t = 1

Y	G	S	
B	B	G	S
		S	

t = 2

G	B	S	S
Y	B	B	S
		S	S

t = 3

2 × 2 body 1 cell construction arm:

G → Green

B → Blue

P → Pink

Y → Yellow

S → light blue.

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17) ~~18)~~ How is the space requirement $S(g)$ of Langton's Loop developing with respect to the number of generations g?

$g \rightarrow$ number of generations.

$$\text{width} \overset{\text{max}}{\uparrow}_2 \xrightarrow[\text{complexity}]{\text{size}} O(g)$$

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$$\text{height} \uparrow_2 \longrightarrow O(g)$$

$$\begin{aligned} S(g) &= \text{width} \times \text{height} \\ &= O(g) \times O(g) \\ &= \underline{\underline{O(g^2)}}. \end{aligned}$$

18) Create and specify a Lindenmayer system with exactly three rules that will create in step 5 the 32 symbol string shown below, starting with the Axiom A in step 0:

Step 5: ABBCBCCABCCACAABBCCACAABCAABABBC.

Variables: A, B, C

Constant

Axiom: A

~~Rules:~~

Rules:

R_1: $A \rightarrow AB$

R_2: $B \rightarrow BC$

R_3: $C \rightarrow CA$

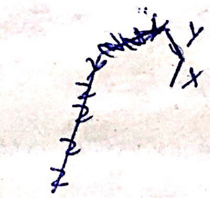
~~2^0~~ Step	0 :	A	2^0
~~2~~	1 :	AB	2^1
	2 :	ABBC	2^2
	3 :	ABBCBCCA	2^3
	4 :	ABBCBCCABCCACAAB	2^4
	5 :	ABBCBCCABCCACAABBCCACAABCAABABBC	2^5

3

19)

a) We have lindenmayer system that grows as clockwise direction and creates spiral pattern as following rules after executing each step

variables = ~~X~~ Y
constant = Z, +
axiom = X
rule 1 = X → Y + X
rule 2 = Y → ZZY
α = 45°
step = ~~10~~



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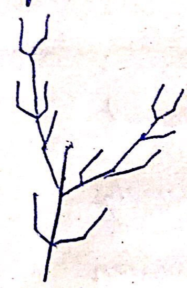
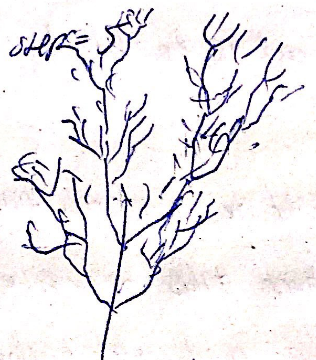
b) for this L-system, we can create tree structure with following rules;

variables = X, F, C0, C1, C2
axiom = FX.
rule 1 = FC0FF −[C1−F+F]+[C2+F−F]
α = ~~1~~5





c) 4 bit gray code is listed as adjacent elements by specific condition as ~~follows~~ 16 elements.
L-system can encode 16 4-bit gray code of item i to the i+1 elements by mod 16

values = 0, 1
axiom = 0000
rules = 0000 → 0001
0001 → 0011
0011 → 0010
0010 → 0110
0110 → 0111
0111 → 0101
0101 → 0100
0100 → 1100
1100 → 1101
1101 → 1111
1111 → 1110
1110 → 1010
1010 → 1011
1011 → 1001
1001 → 1000
1000 → 0000

L-system generates i+1 by mod 16

20) L-system B

variables = A, C

axiom = C

rules = $C \to A$

$A \to CA$ where C=children, A=adult.

fibonacci is defined as $F_n = F_{n-1} + F_{n-2}$ where $n \geq 2$

$F_1 = F_0 = 1$

Let l_i denote number of symbols and i is generation number

$l_i = c_i + a_i$ where $a_i = a_{i-1} + c_{i-1}$ and $c_i = a_{i-1}$

$l_i = a_{i-1} + \underbrace{a_{i-1} + c_{i-1}}_{l_{i-1}}$

$l_i = l_{i-1} + a_{i-1}$ for $i \geq 0$

$l_i = l_{i-1} + \underbrace{a_{i-2} + c_{i-2}}_{l_{i-2}}$

$l_i = l_{i-1} + l_{i-2}$ for $i \geq 2$ and by $l_0 = l_1 = 1$, this is fibonacci series alike.

21) Musical L-systems is one of the l-systems that generates musical sequences based on algorithm that takes recursive loops and apply rewriting system. It can produce sounds and transmit this information to interact with the environment and receivers. Two and more dimensional spaces can be applied for the music environment. L-system can define rewriting rules to encode input information recursively with updating feedback and it can create complex patterns how to transmit data from start. Thus, algorithm can define different levels of production, parsing and mapping that makes easy to revise and adjust tune system [1].

References =

[1] https://modularbrains.net/ (accessed 16/05/2020)