**Day 1: Knowledge and Design of Cellular Automata.**

* Simple Cellular Automaton Designing
* Application of a rule vector on a set of all strings of size n
* Taking a size n, generating all possible strings, taking each string and applying random rule vector k times.
* Drawing Binary image of Single rules taking the standard string <0..010..0>
* Drawing Gray image of random rules.

**Day 2: Finding Number Conserving Cellular Automata Rules**

* Finding NCCA’s for 5, 6 &7 bit.
* Checking for Class promoting and class demoting rule vectors of 5, 6 & 7 bit strings.
* Drawing diagraph of a particular rule vector.

**Day 3: Neural network analysis**

* Creating transitions of rules of size 4 and of same pattern as < x x x x >
* Analysis of all rules like classifying them as in which layer it converges or continues to stay in that particular pattern, no of elements in each layer and no of hidden layer.
* Complete graph adjacency list of all the rule vectors with weight.

**Day:**

* For all uniform rule vectors of size n>4,

On selecting any rule and creating a uniform rule vector of size n (n>4) called R.

Selecting a binary string S of size n and apply R on S by using periodic boundary cellular automaton and let the output string be S’.

1. There are certain rules which doesn’t decrease the weight of the input string , for all input binary string combinations of size n.

i.e. weight(input string, S) <= weight(output string, S’)

\*\*here weight is count of 1’s in the binary string.

The rules which follow the same are :

[170, 171, 174, 175, 184, 185, 186, 187, 188, 189, 190, 191, 204, 205, 206, 207, 220, 221, 222, 223, 226, 227, 230, 231, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255]

Total of 46 rules are there.

1. Similarly, there are 46 no of rules which don’t increase the weight of the string over all possible binary strings of size n.

i.e. weight(input string, S) >= weight(output string, S’)

The rules which follow the same are:

[0, 2, 4, 8, 10, 12, 16, 24, 32, 34, 40, 42, 48, 56, 64, 66, 68, 72, 76, 80, 96, 98, 112, 128, 130, 132, 136, 138, 140, 144, 152, 160, 162, 168, 170, 176, 184, 192, 194, 196, 200, 204, 208, 224, 226, 240]

1. There are certain rules which fall in the common category of both i.e. weight increasing as well as weight decreasing, that is they are the rules which neither increase nor decrease but make the weight of output string same and constant as of the input.

Those rules are :

[170, 184, 204, 226, 240]

\*\*\* There are no such rule, which on forming a uniform rule vector strictly increases or strictly decreases the weight of the string.

Assumption :

[1, 3, 5, 6, 7, 9, 11, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 29, 30, 31, 33, 35, 36, 37, 38, 39, 41, 43, 44, 45, 46, 47, 49, 50, 51, 52, 53, 54, 55, 57, 58, 59, 60, 61, 62, 63, 65, 67, 69, 70, 71, 73, 74, 75, 77, 78, 79, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 97, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 129, 131, 133, 134, 135, 137, 139, 141, 142, 143, 145, 146, 147, 148, 149, 150, 151, 153, 154, 155, 156, 157, 158, 159, 161, 163, 164, 165, 166, 167, 169, 172, 173, 177, 178, 179, 180, 181, 182, 183, 193, 195, 197, 198, 199, 201, 202, 203, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 225, 228, 229, 232, 233]

[0, 128, 2, 130, 4, 132, 8, 136, 10, 138, 12, 140, 16, 144, 24, 152, 32, 160, 34, 162, 40, 168, 42, 48, 176, 56, 64, 192, 66, 194, 68, 196, 72, 200, 76, 80, 208, 96, 224, 98, 112]

[171, 174, 175, 185, 186, 187, 188, 189, 190, 191, 205, 206, 207, 220, 221, 222, 223, 227, 230, 231, 234, 235, 236, 237, 238, 239, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255]

**Some Conclusions**:

Let for input string s1 on apply of rule R output string is s2.

Defining some property on the set of all possible strings of size x on application of uniform rule R,

Let property of the strings on application of rule R be

**P1**: the weight of s1 = weight of s2

**P2**: the weight of s1 >= weight of s2

**P3**: the weight of s1 <= weight of s2

**P4**: no particular defined weight order i.e. may increase or decrease some string’s weight.

1. **To satisfy P1 for all strings of size x, the uniform rule vector R must be within these rules of set S1.**

**S1** : < 170, 184, 204, 226, 240 >

1. **To satisfy P2 for all strings of size x, the uniform rule vector R must be from these rules of set S1 U S2. (41 + 5 )**

**S2** : < 0, 128, 2, 130, 4, 132, 8, 136, 10, 138, 12, 140, 16, 144, 24, 152, 32, 160, 34, 162, 40, 168, 42, 48, 176, 56, 64, 192, 66, 194, 68, 196, 72, 200, 76, 80, 208, 96, 224, 98, 112 >

1. **To satisfy P3 for all strings of size x, the uniform rule vector R must be from these rules of set S1 U S3. (41 + 5)**

**S3** : < 171, 174, 175, 185, 186, 187, 188, 189, 190, 191, 205, 206, 207, 220, 221, 222, 223, 227, 230, 231, 234, 235, 236, 237, 238, 239, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255 > U set of rules in P1

1. **The following rules of set S4 satisfy the property P4 on all possible strings of size x. {169 = 255-(41+41+5) }**

**S4** :< 1, 3, 5, 6, 7, 9, 11, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 29, 30, 31, 33, 35, 36, 37, 38, 39, 41, 43, 44, 45, 46, 47, 49, 50, 51, 52, 53, 54, 55, 57, 58, 59, 60, 61, 62, 63, 65, 67, 69, 70, 71, 73, 74, 75, 77, 78, 79, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 97, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 129, 131, 133, 134, 135, 137, 139, 141, 142, 143, 145, 146, 147, 148, 149, 150, 151, 153, 154, 155, 156, 157, 158, 159, 161, 163, 164, 165, 166, 167, 169, 172, 173, 177, 178, 179, 180, 181, 182, 183, 193, 195, 197, 198, 199, 201, 202, 203, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 225, 228, 229, 232, 233 >

\*\*5. **For non uniform vector of size x, on all possible strings the following can be deduced.**

1. **Any combination of set S4 producing a non uniform rule vector R of size x, will only satisfy the property P4 only and can never satisfy properties P1 or P2 or P3. (**tested for 4 **<=** x **<=** 25**)**
2. **Any non uniform combinations of set P2 of size x producing a rule vector R, will either satisfy property P2 or P4 and nothing else. (**tested for random rules and 4 **<=** x **<=** 15**)**
3. **Any non uniform combinations of set P3 of size x producing a rule vector R, will either satisfy property P2 or P4 and nothing else. (**tested for random rules and 4 **<=** x **<=** 15**)**