

# Fuzzy Cellular Automata in the Generation Pseudorandom Numbers

CSI4900 Project Proposal

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## Objective

The main goal of the project is gather insight on the generation of pseudorandom numbers using Fuzzy Cellular Automata(FCA).

This includes:

- **Implementation Feasibility:** details of implementation, potential drawbacks, robustness.
- **Algorithmic Complexity:** efficiency, optimizations, performance bottlenecks.
- **Quality of Randomness:** performance in Diehard tests, comparison with existing pseudo-number generators.

## Tentative Side Objective

We can also attempt to find more details of the relationship between FCA and BCA, more specifically, how does the randomness of a FCA relate to the randomness of its corresponding BCA, according to a set of randomness criteria. [2]

## Rough Approach

1. Select subset of BCA Rules to be studied.
2. Implement and Apply Fuzzification Algorithm [1] to selected rules.
  - i. Evaluate potential optimizations
3. Extract outputs and perform randomness study.
  - i. Define output to be used as Random Number (ie. the equivalent of the centre columns in the Rule 30 generator [3])

- ii. Extract statistically significant output (ie. number of iterations, number of generations per rule)
- 4. Evaluate Quality of Randomness.

## Tentative Steps

- 5. Extract outputs from equivalent BCA and Evaluate Quality of Randomness
- 6. Identify relationship between BCA and its fuzzified counterpart(ie. is the randomness of a BCA the same as its fuzzified equivalent?)
  - i. Apply Diehard tests
  - ii. Apply BCA Randomness criteria [2]

## Projected Timeline

Milestone	Target Completion Date
Information Gathering and Planning	January 18th ~ January 22nd
BCA/FCA Implementation Development	February 15th ~ February 19th
Randomness Analysis(Planning Methodology and Generating Output)	March 8th ~ March 12th
Randomness Quality and BCA Relationship Evaluation	March 29th ~ April 2nd
Report Completion and Presentation Preparation	April 26th (Due Date)

## References

1. H. Betel, P. Flocchini. On the relationship between fuzzy and Boolean cellular automata, Theoretical Computer Science, 412(8-10): 703-713, 2011. [Web Link]
2. When are cellular automata random?, J. B. Coe, S. E. Ahnert and T. M. A. Fink, EPL (Europhysics Letters), 84, 50005 (2008). [Web Link]
3. Lex Fridman (2018-03-02), MIT AGI: Computational Universe (Stephen Wolfram), retrieved 2021-01-15 [Web Link]