

## Reconfigurable Logic - Based Acceleration of Cellular Automata Models

APOSTOLOS DOLLAS

*School of ECE*

*Technical University of Crete, Chania 73100, Greece*

*dollas@ece.tuc.gr • <https://www.ece.tuc.gr/index.php?id=4531&L=778>*

Cellular Automata (CA) have been used for many decades to model physical processes and dynamical systems. From the  $3 \times 3$  and  $5 \times 5$  neighborhoods of the 1950s, and typically on binary images, as recently as the mid-2010s the neighborhoods went up to  $15 \times 15$  on images with a few states. Field Programmable Gate Array (FPGA) technology, already applicable to CA model acceleration since the early 1990s, has reached such maturity levels that a small device can model large-neighborhood CA. In this work we present an architecture which we have fully implemented, that can execute CA models with up to  $29 \times 29$  neighborhoods on 256-state cells for Full High Definition (FHD) image input/output with real-time 60 frames-per-second capability [1]. Emphasis of the present work is on the game-changing opportunities that FPGA technology creates to the CA and dynamical systems communities [2]. We present results from the Greenberg-Hastings and Hodgspode models, as well as a large-neighborhood anisotropic model. Large neighborhoods may yield qualitatively different results vs. smaller neighborhoods, or lead to results which are merely impossible to produce with small neighborhoods [3].

### References

- [1] N. Kyparissas, A. Dollas, "Large-scale Cellular Automata on FPGAs: A New Generic Architecture and a Framework", *ACM Transactions on Reconfigurable Technology and Systems (TRETs)*, vol. 14, no. 2, Article No. 5, pp. 1-32, December, (2020).
- [2] N. Kyparissas, A. Dollas, Field Programmable Gate Array Technology as an Enabling Tool Towards Large-Neighborhood Cellular Automata on Cells with Many States, In *Proceedings of the 2019 International Conference on High Performance Computing & Simulation (HPCS)/The 5th Workshop on Cellular Automata Algorithms & Architectures (CAAA 2019)*, Jul. 5-7, Dublin, Ireland, IEEE Press (2019).
- [3] N. Kyparissas, A. Dollas, An FPGA-Based Architecture to Simulate Cellular Automata with Large Neighborhoods in Real Time, In *Proceedings of the 29th International Conference on Field Programmable Logic and Applications (FPL)*, pp. 95-99, Barcelona, Spain, Sep. 9-13, IEEE Press (2019).