



LSOracle: A Learning Based Oracle for Automatic Logic Optimization

Max Austin, Walter Lau, Scott Tempe, Xifan Tang, Pierre-Emmanuel Gaillardon
University of Utah Laboratory for Nanointegrated Systems



Design & Security: Intelligent Design of Electronics Assets (IDEA)



Motivations

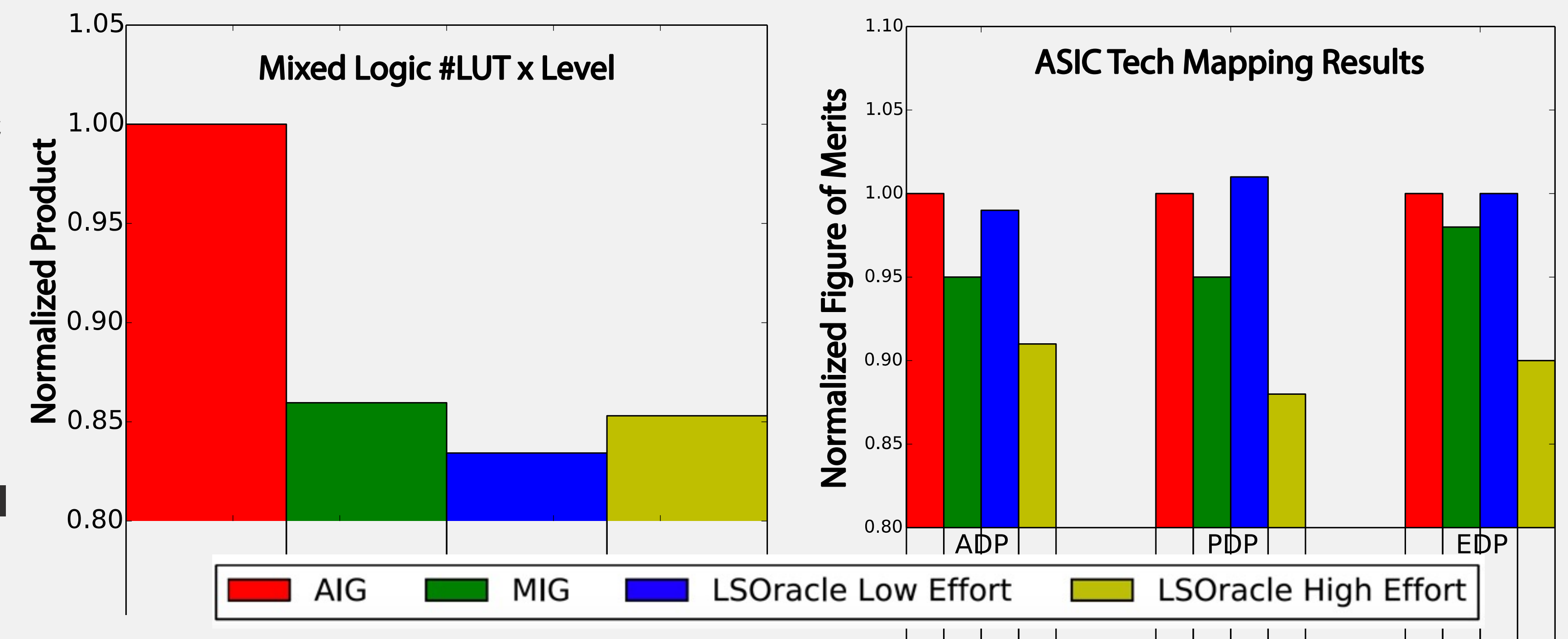
Logic optimization is complex: performance depends on algorithm and data structure selection

- And-Inverter Graphs (AIGs) - Control Logic
- Majority-Inverter Graphs (MIGs) - Arithmetic Logic
- Mixed control-arithmetic networks e.g. SoCs are difficult to optimize with either technique alone
- Status Quo: Human in the loop

LSOracle outperforms AIG and MIG optimization in circuits with both arithmetic and control logic

- FPGA – LSOracle + ABC (LUT technology mapping) ~15% improvement over AIG
- ASIC – LSOracle + Synopsys design compiler (standard cell mapping) ~10% improvement over AIG

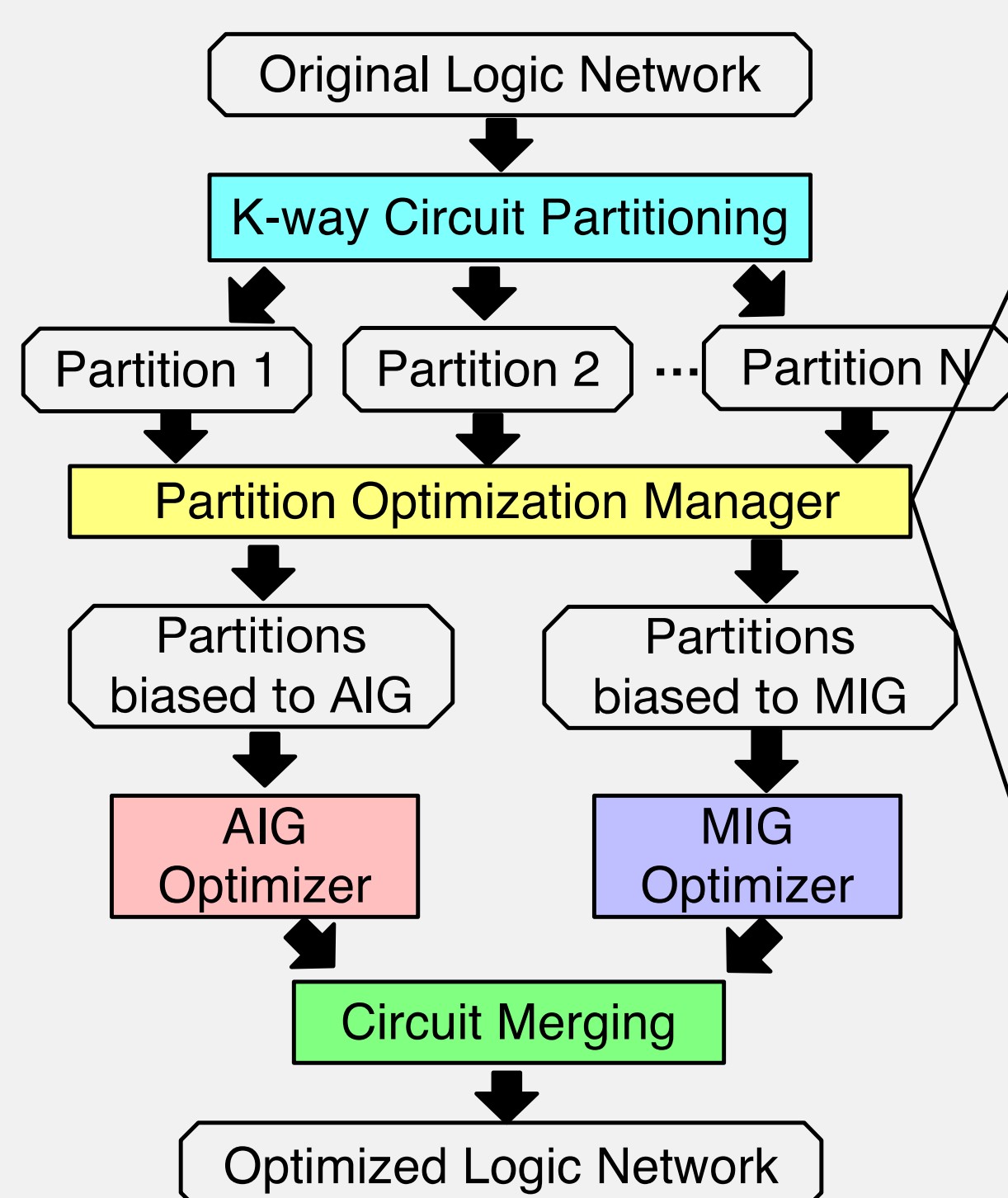
Preliminary Results



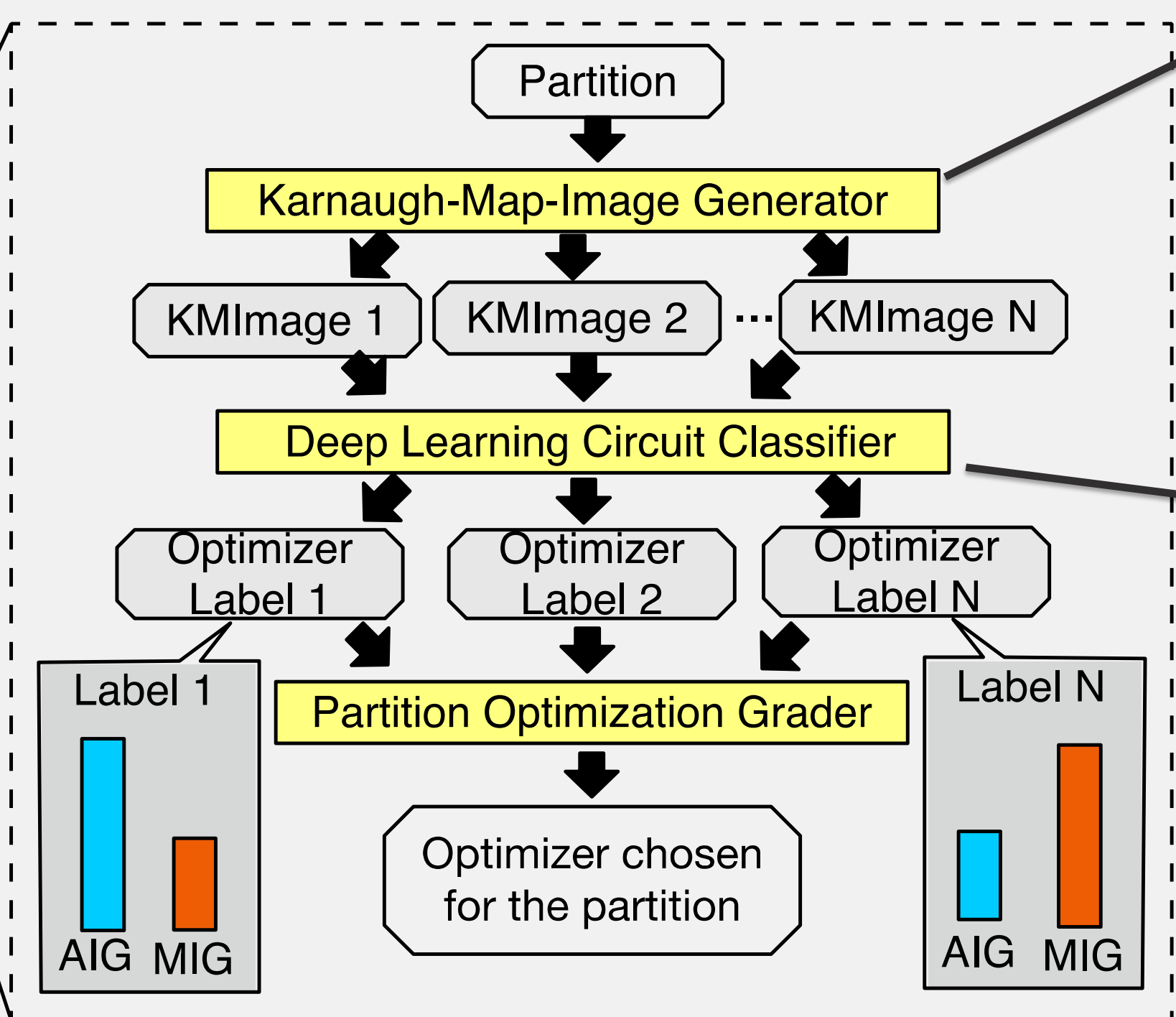
Our Approach: LSOracle

1. K-way hypergraph partitioning
2. Circuit classification: A bitmap is generated from a Karnaugh map of logic cones; a deep learning model selects the optimal data structure for each part and chooses an optimizer
3. Logic optimization: Two modes: Learning based, using prediction from classifier, or try both AIG and MIG and select the best Area-Delay Product (ADP)
4. Merging

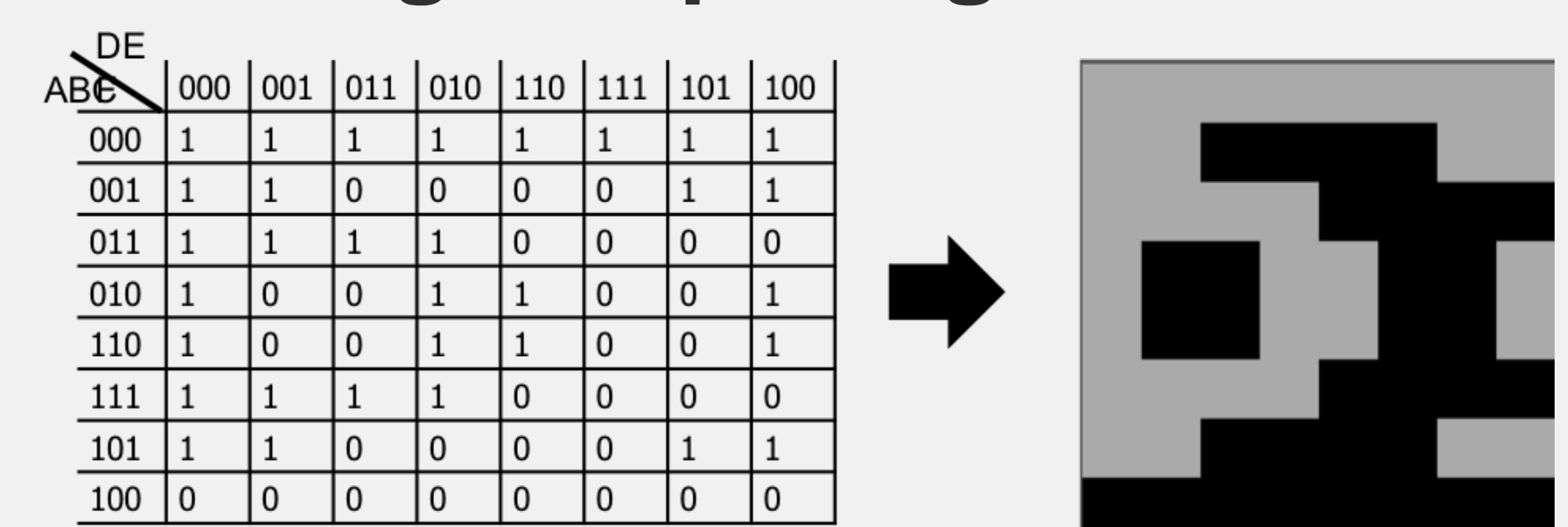
Overview



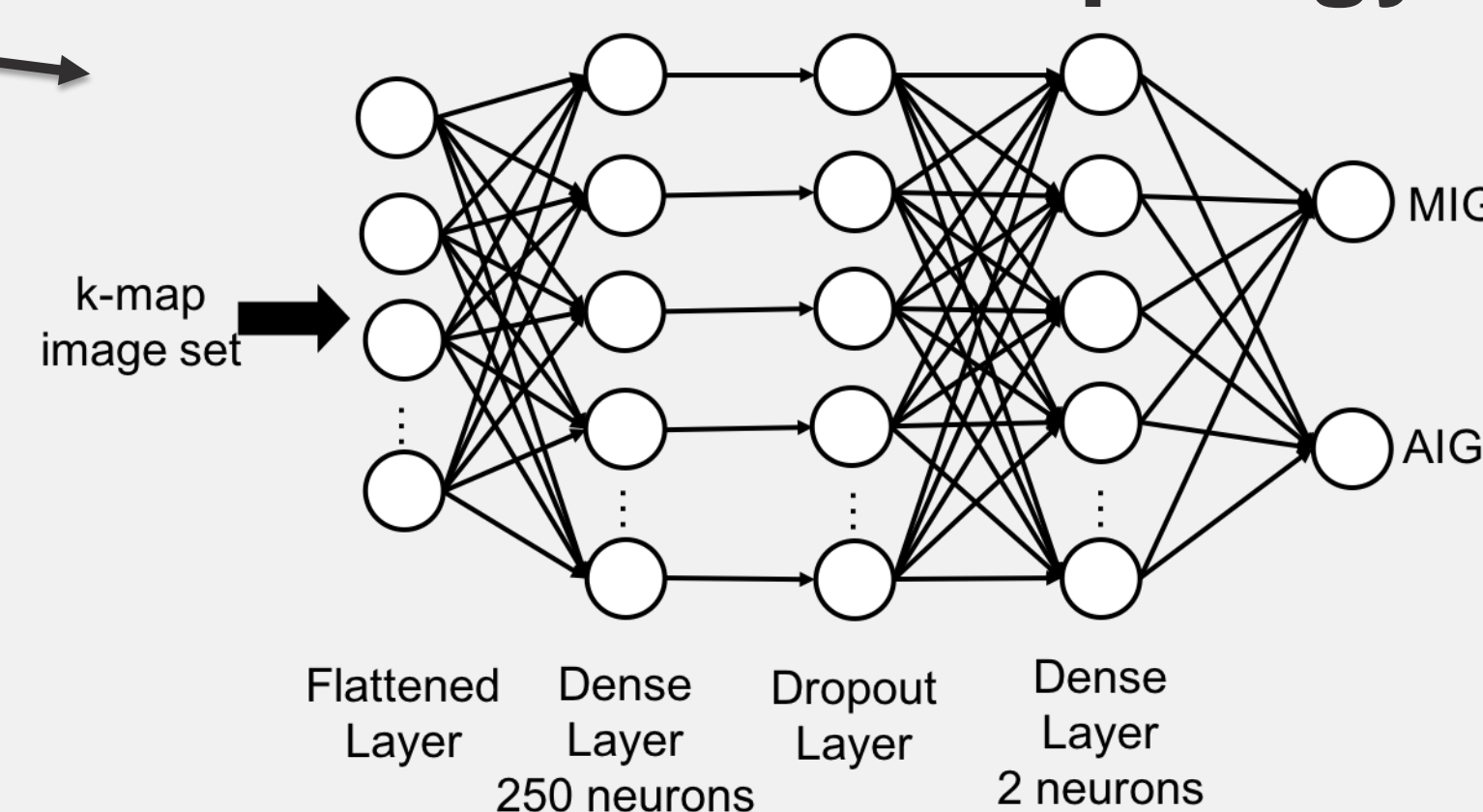
Partition Optimization Manager



Karnaugh Map Image Generator

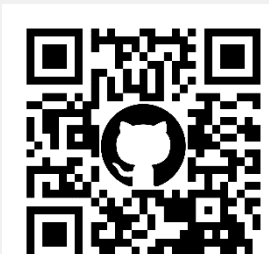


Neural Network Topology



Next Steps

1. New partitioner in Development
 - Old partitioner: up to 24.8% overhead
 - Low hanging fruit
2. Curate training set, retrain neural network
 - ASIC results suggest large performance gains
3. Timing driven synthesis
4. Support sequential rewriting



Github Repository: <https://github.com/LNIS-Projects/LSOracle/>
Online Documentation: <https://lsoracle.readthedocs.io/en/master/>



This research was developed with funding from the Defense Advanced Research Projects Agency (DARPA). The views, opinions and/or findings expressed are those of the author and should not be interpreted as representing the official views or policies of the Department of Defense or the U.S. Government.

Distribution Statement A – Approved for Public Release, Distribution Unlimited



THE ELECTRONICS RESURGENCE INITIATIVE