THE UNIVERSITY OF UTAH

2024-2025
List of Senior Projects

LCAS Group, ECE Department, University of Utah

Jul 5, 2024

Laboratory of CIRCUITS & SYSTEMS (LCAS)
THE UNIVERSITY OF UTAH

List of Projects

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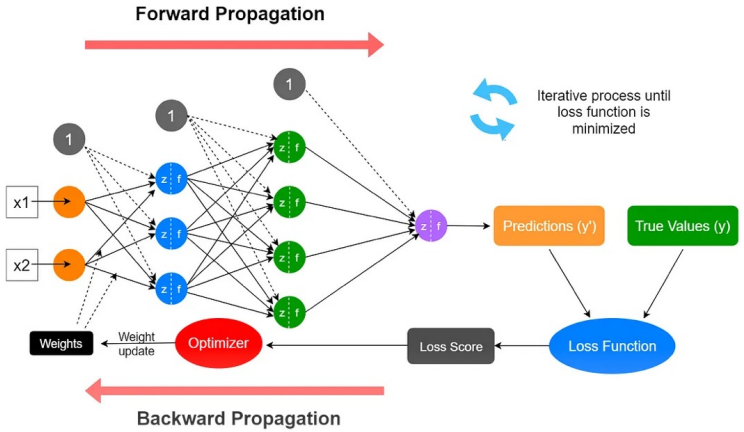
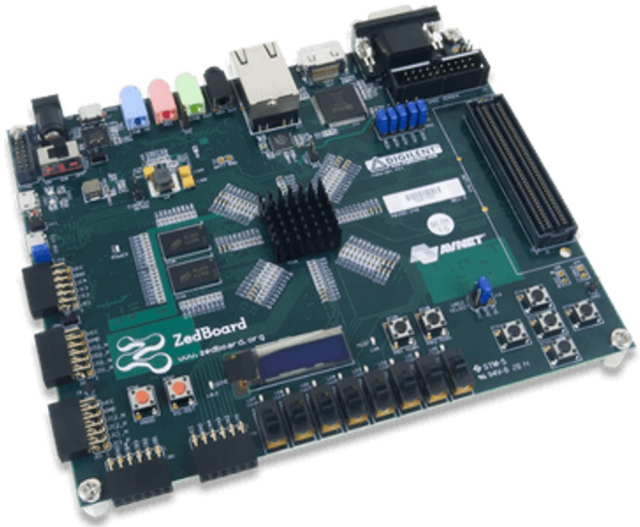
- Automated Neural Network Emulator
- Edge-based Machine Learning
- Side-Channel Attack Modeling
- Analog Design Methodology
- Measuring Performance of a Test Chip
- Automated Software for NN Analysis
- ML based Coil Design

Short Project Descriptions

Machine Learning
Automated Neural Network Emulator

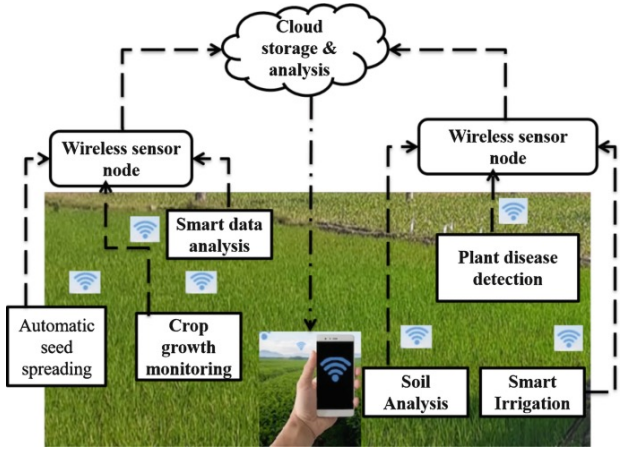
- **Description:** This project aims to develop an automated framework to quickly deploy and test different neural networks on an FPGA to simulate the performance of a neural network implemented in an integrated circuit (IC). Students will build a software to take existing state of the art neural networks, modify their behavior to simulate the effects observed when implementing in an IC, deploy and test the network on an FPGA, and automate the process to be both dataset and network agonistic.
- **Skills learned:** Participants will learn the basics of neural networks. In addition, they will develop software in high-level languages (Python, MATLAB, etc.) and write Verilog for an FPGA.
- **Prerequisites:** Students needs to have prior programming and FGPA experience. Minimum course requirements would be ECE 3700 and CS 1410 (or equivalent programming experience).
- **Contact:** Michael Keyser, michael.keyser@utah.edu, Office: MEB 1254.

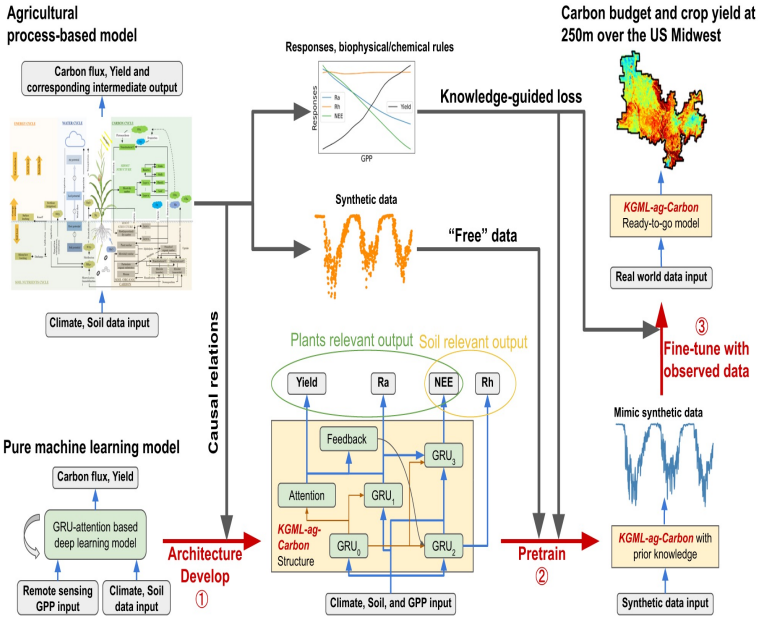




Machine Learning
Edge-Based Machine Learning

- **Description:** This project aims to integrate machine learning with IOT enabled monitoring systems in farming for knowledge-based agriculture. In precision agriculture smart sensors are deployed in the land for collecting data. data collected by sensors is analyzed using ML algorithms to make farming more controlled and optimized. As global warming is causing drastic changes in the weather conditions, monitoring and prediction of soil parameters (nutrients/moisture/carbon/fertilizer content) is essential to improve sustainable productivity and quality of the products. In addition to soil monitoring, crop yield/disease prediction, water stress identification, crop mapping/selection, ground water level prediction using computer vision are also part of precision agriculture.
- **Skills learned:** Participants will learn to design Analog/Digital circuitry in conjunction with µcontrollers to achieve signal processing tasks as well as using ML algorithms for further processing.
- **Prerequisites:** Students needs to have prior knowledge on signal processing as well as machine learning models (MATLAB/Python). Furthermore, they should have prior design experience with IOT systems (µcontrollers/RasPi) and programming them (C/Python).
- **Contact:** Farzad Ordubadi, farzad.ordubadi@utah.edu , Office: MEB 1254.





Hardware Security
Side-Channel Attack Modeling

- **Description:** Security of the hardware designed and used in industry is critically important. There are many different ways to attack personal data stored on a chip, thus it is necessary to employ advanced techniques to prevent information leakage. This project aims to develop a modeling tool to analyze sensitivity of digital circuit to different types of side-channel attacks. The tool will be used to quantify the level of sensitivity of circuits and make a comparative study among different architectures. The tool will be developed in Python (or Matlab), with the capability to analyze different types of attack (e.g., differential attack).
- **Skills learned:** Participants will learn about advanced topics such as hardware security, side-channel attacks, as well as digital circuit architectures.
- **Prerequisites:** Students needs to have prior knowledge on signal processing, digital circuits and systems. As Python and Matlab will be used in this work, having a good background on those topics will be required as well.
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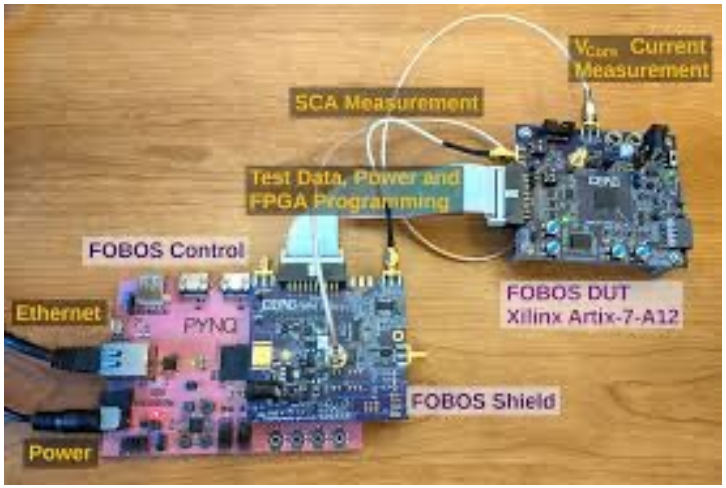

Circuit Design
Analog Design Methodology

- **Description:** Analog circuits are critical components in modern communications and computing systems. Analog circuits are widely used even in modern digital processors, enabling higher performance and lower energy consumption. This project aims to develop algorithms and libraries required to automatize design of basic analog circuits. The methodology will be based on some recently developed algorithms at the University of Utah. The developed algorithms will be published and shared as open-source tools for public usage.
- **Skills learned:** Participants will learn about some advanced topics, including but not limited to analog integrated circuit design, design algorithms, and tools used in industry to characterize analog integrated circuits.
- **Prerequisites:** Students needs to have prior knowledge on design of basic analog circuits, be familiar with electronic devices, i.e., MOSFETs, and be familiar with scripting languages, such as Python.
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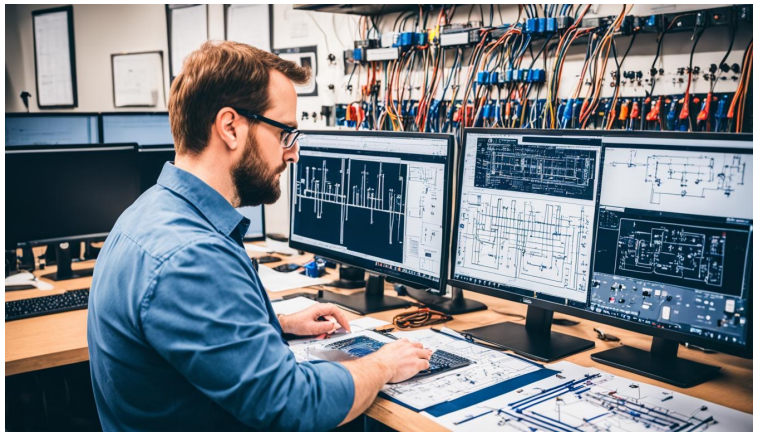

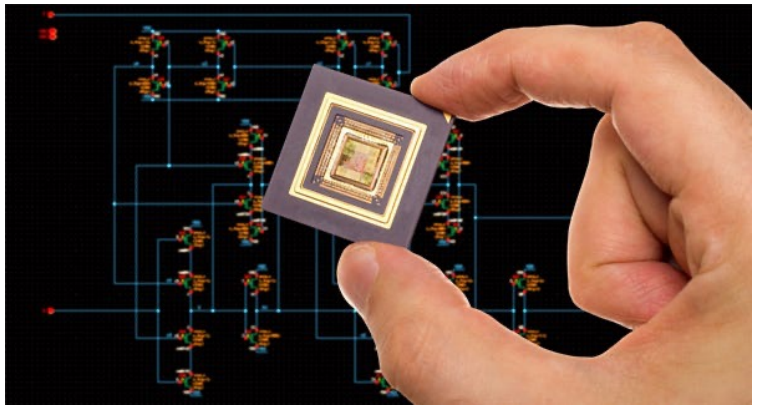

Lab Test
Measuring Performance of a Test Chip

- **Description:** This project aims to develop scripts to automatize chip measurements. Chips usually implement digital interface standards (I2C/SPI) and chip I/O can be written/read through these standards. Therefore, by developing specific scripts that represent inputs as a function for specific test setups characterizing chips in different environment (temperature/supplies/date/time) can be automatized.
- **Skills learned:** Participants will learn how to develop efficient test benches as scripts to inject inputs and read chip behavior through digital interfaces (µcontrollers/RasPi). Furthermore, they will learn how to design specialized PCBs to act as the connecting link between µcontrollers and the chip (DUT).
- **Prerequisites:** Students needs to have prior knowledge/experience with C/Python programming languages and exposure to PCB design with discrete DIP/SMD components.
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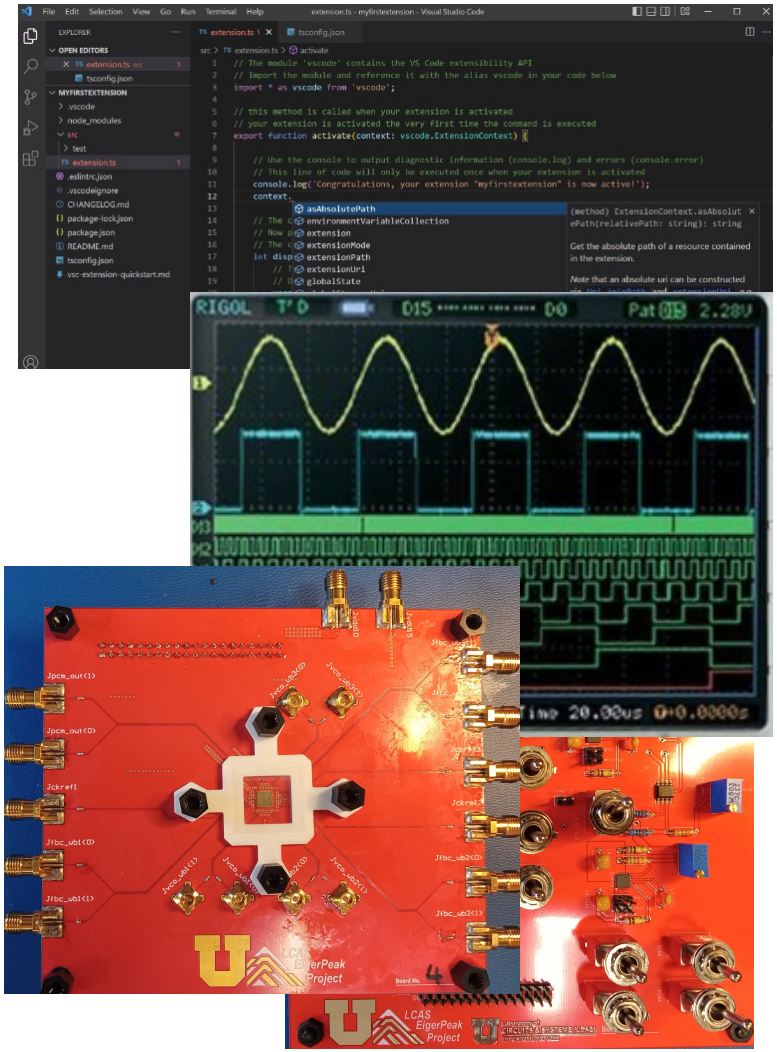
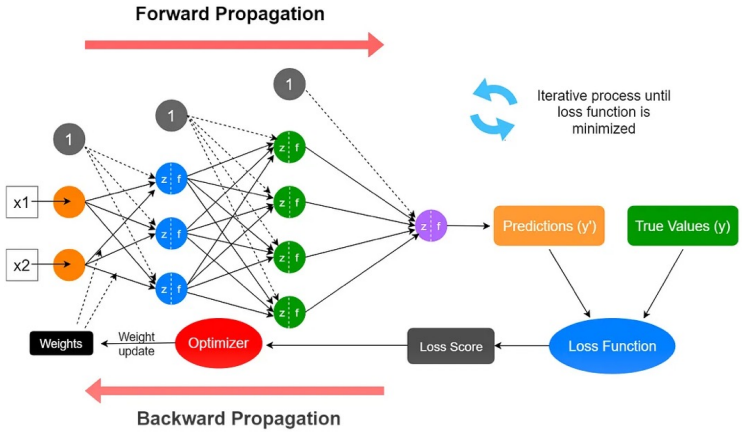


Neural Network Automated Software for NN Analysis

- **Description:** This project aims to develop an automated framework to investigate the effects of hardware nonidealities on a neural network implemented in an integrated circuit (IC). Students will build a software to take existing state of the art neural networks, modify their behavior to incorporate the effects observed when implementing in an IC, simulate the network in software, and automate the process to be both dataset and network agonistic.
- **Skills learned:** Participants will learn about the architecture of neural networks and the Python libraries to support their development. In addition, they will develop software in Python and other scripting languages, as necessary.
- **Prerequisites:** Students needs to have prior programming experiences with writing efficient and organized code. Minimum course requirements would be CS 2420 (or equivalent programming experience).
- **Contact:** Michael Keyser, michael.keyser@utah.edu, Office: MEB 1254.



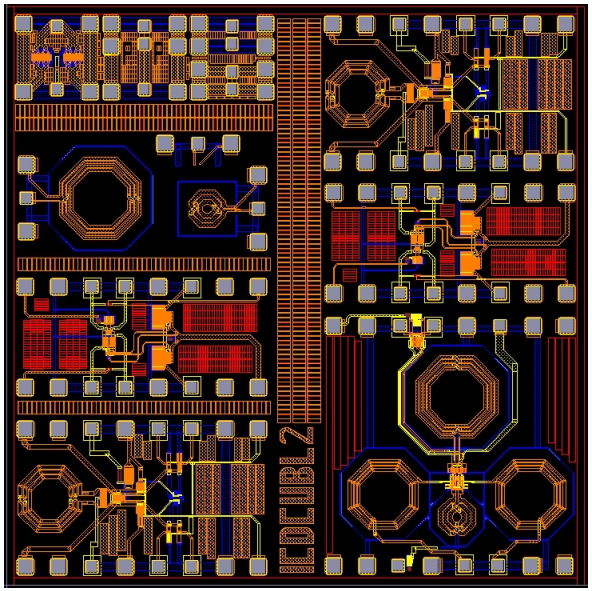
python

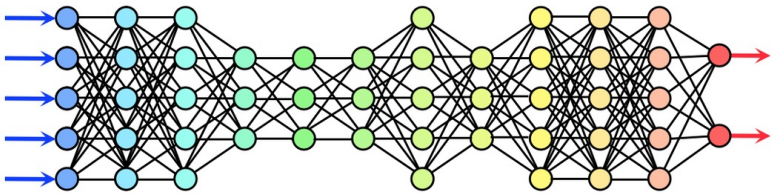
PyTorch

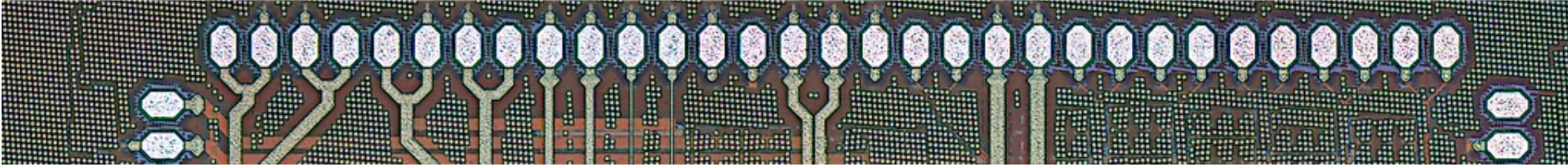
TensorFlow

Circuit Design
ML based Coil Design

- **Description:** This project aims to automatize the flow of designing coils for integrated circuits. Modern integrated circuits widely use coils to enhance operating speed of the systems. Examples are high-speed clock generators used in all advanced digital signal processors. Design of integrated coils is generally complex and requires a lot of trial-and-errors. As a result, design time can be excessively long, increase the time-to-market. In this project, proper neural networks will be developed and trained to model integrated coils.
- **Skills learned:** Participants will learn about integrated circuits, especially analog active and passive circuits. Moreover, students will learn about neural network, training process, and using them for optimization.
- **Prerequisites:** Students needs to have prior on electronic circuits, neural networks, and relevant tools such Python.
- **Contact:** Michael Keyser, michael.keyser@utah.edu, Office: MEB 1254.







LCAS Employs Advance Signal Processing, Communications, and Coding For Extreme High Performance & Energy Efficient Circuit Design

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