

End of RET Presentation 2018

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Courses Taught

AP Physics C:
Mechanics

Short Course on Python
for Physical System
Modeling

AP Physics C:
Electricity and
Magnetism

Short unit on energy
loss in computing

Physics II

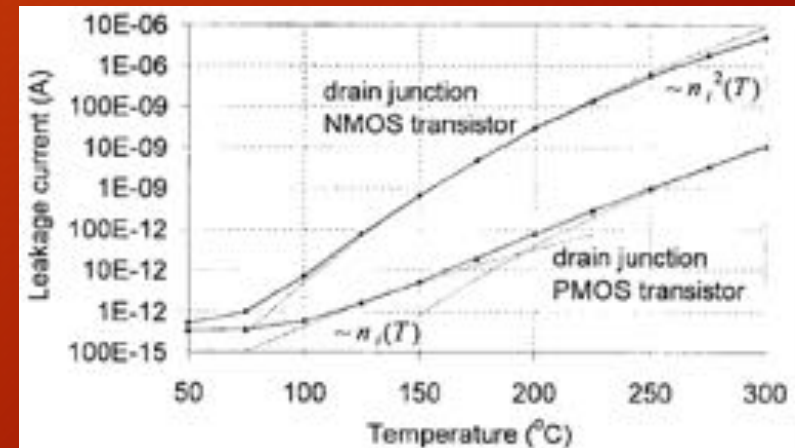
Semester Long Project
based learning
experience motivated
by AI, ML, and High
Performance
Computing

Python Programming

- Python Bootcamp
- Use Python through trinket.io
- Model Physical systems in Python
 - Force between charges (Coulombs Law)
 - Electric/Magnetic Field Interactions
- Develop enough Python experience to be able to manipulate Neural Network Code

Energy Loss

- Transistor current leakage
 - We will study current leakage as a function of temperature and type of transistor using a curve tracer
- Use FLIR IR camera and current sensors to measure power consumption by a PC running high performance code on the CPU and GPU



Machine Learning

Use CNN to motivate the needs for more efficient computing paradigms

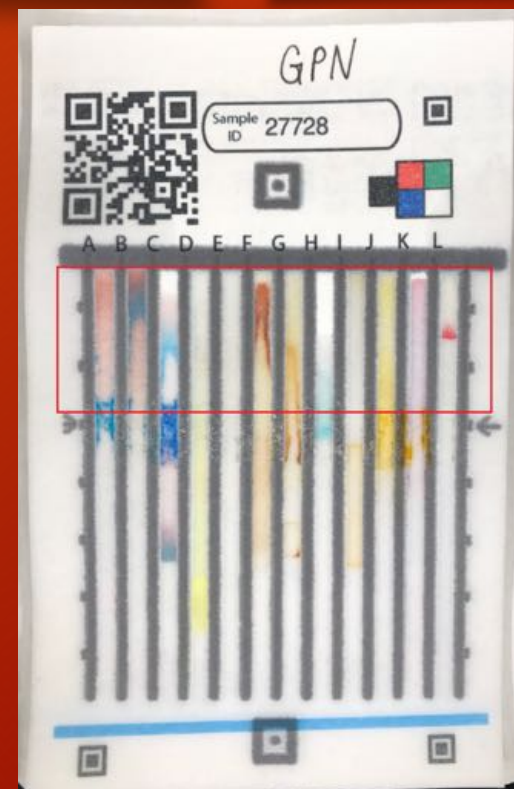
- Stacked processing etc..

Students will create their own data set to train a CNN to perform an image recognition task

- Using Tensorflow, Keras, and Theano

Research

- Training a CNN to perform image classification of the idPAD
- Each lane of the idPAD is a chemical color test which test for different functional groups of illicit drugs including;
 - Cocaine
 - Heroin
 - Methamphetamine
 - Crack Cocaine
- Based on the color produced by the combination of lanes (color barcode), a specific drug or combination of drugs can be determined



Research

- These devices will be put into field testing by local police departments including the NDPD, as of now image recognition requires training of the officers
- The end goal of the project is to have a portable device that can be used to detect the drug being indicated by the PAD
- The device has to be cheap and semi-disposable, because if it is used in actual field work leading to charges being filed against an individual, the device can be subpoenaed in court

Student Research Project

- I have been able to train a CNN to recognize the PAD images, however it is very low accuracy, throughout the school year my students will be working to do the following
 - Improve inference accuracy
 - Train the network
 - Implement the trained network on a raspberry pi, or similar device
 - Use a camera and the CNN on the raspberry pi to do real time image classification

Projects/Labs Influence by the RET

Transistor Leakage Lab

Electric Equivalent of Heat Lab

Final Project

Design a method that can be used to limit the power loss on a raspberry pi when completing the training and inferencing processes of a neural network. This may be a software or hardware manipulation.

Goal: Students should attempt to create a network with the greatest inference accuracy but with minimal energy loss

Final Project

- Develop a method to cool the raspberry pi as much as possible, this can be done using fans, heatsinks, liquid cooling, or other methods.
 - Nothing may be directly attached to the pi, and you must receive permission from the instructor before making any modifications to the pi.
 - As part of your cooling method you should write a short procedure that is used to test your cooling method, your procedure should include the create of some sort of visual that displays the change in temperature before and after the cooling method is applied.
 - You may also choose to test more than one cooling method and present data which shows the performance of each method.
- Make a change to the program so that the accuracy of the training is improved.
 - Produce a plot of speed of training vs. accuracy of the training
- Develop a method used to measure energy consumption by the pi while a neural network is being trained.
 - Use this method to produce a visual representation of training accuracy vs power consumption.
- Prepare a presentation to give to the class which contains the following information.
 - What was your cooling method, how well did it work, present your data
 - What program changes did you make, by how much did they improve the accuracy of training
 - You should give some justification of how important this accuracy increase may be. (is an increase from 98.3% to 99.2% a significant increase? Give some examples to support your reasoning.
 - Present your findings of energy consumption vs accuracy of a network. Do these findings have any significant applications to large scale uses of machine learning or data processing in general?
 - Find an application of machine learning or big data analysis and present the background and what improvements have been made in that specific area to negate the effects of energy loss or to improve the effectiveness of a network.

RET Material Usage

Gaming PC

- Used for training of CNN before implementation on Raspberry pi
- Used for demonstrations of current leakage, energy loss due to heating, and energy consumption for CNN accuracy

Curve Tracer

- Used to analyze current leakage and semiconductor quality testing

Raspberry pi Devices with Monitors

- Used for the final project as well as the research application of the CNN image classification for the idPAD