

EXPERIMENT #2
BASICS OF PYTHON, JETSON NANO AND ITS TOOLS

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ECE 498-07

Acknowledgment: I acknowledge all of the work (including figures and codes) belongs to me and/or persons who are referenced.

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Introduction

A. Purpose

The purpose of this lab is to set up the Jetson Nano and run some Python scripts. The following terms will be introduced:

- Jetson Nano single-board computer
- Linux development environment
- Python programming environment
- Jetson Nano developers' tools

B. Background

A. Description of Jetson Nano Single-Board Computer

Jetson Nano is a small, powerful single-board Linux computer developed by NVIDIA, which is optimized for image processing and neural networks. [1] Jetson Nano lets you run multiple neural networks in parallel for applications like image classification, object detection, segmentation, and speech processing. Compared with other single-board computers in wide use like Raspberry Pi, Jetson Nano has better performance in all applications of image processing and neural network, even when an extra compute stick is added to the Raspberry Pi. A Jetson Nano is equipped with the following components:

- GPU 128-core Maxwell
- CPU Quad-core ARM A57 @ 1.43 GHz
- Memory 4 GB 64-bit LPDDR4 25.6 GB/s
- Storage microSD (up to 1TB)
- Camera 2x MIPI CSI-2 DPHY lanes
- Connectivity Gigabit Ethernet, M.2 Key E
- Display HDMI and display port
- USB 4x USB 3.0, USB 2.0 Micro-B
- Others GPIO, I2C, I2S, SPI, UART
- Mechanical 69 mm x 45 mm, 260-pin edge connector

The image/video processing capability of Jetson Nano is as follows:

- Video Encode 4K@30 | 4x1080p@30 | 9x720p@30 (H.264/H.265)
- Video Decode 4K@60 | 2x4K@30 | 8x1080p@30 | 18x720p@30 (H.264/H.265)

The Jetson Nanos in this lab are installed with Linux4Tegra, a variation of Ubuntu 18.04 tailored for NVIDIA hardware, which itself is a widely used version of Linux operating system.

Advantages of using Jetson Nano in this lab is the following: First, Jetson Nano is a full-fledged microcomputer, equipped with CPU, GPU, RAM and ability to run large projects and interface a variety of peripheral devices. Second, Jetson Nano is equipped with modern technologies, such as USB 3.0 ports, networking via Ethernet, Wi-Fi and Bluetooth connectivity after expansion, and running an operating system, etc. Third, Jetson Nano is designed and optimized for image processing and neural networks, making it the ideal choice for edge computing and real time neural network applications. Moreover, it is easily reconfigured by re-programming, and has extensibility of adding many peripheral devices.

B. Description of Python and Related Tools

Python is a clear and powerful object-oriented programming language, comparable to Perl, Ruby, Scheme, or Java. [2]

Some of Python's notable features:

- Uses an elegant syntax, making the programs you write easier to read.
- Is an easy-to-use language that makes it simple to get your program working. This makes Python ideal for prototype development and other ad-hoc programming tasks, without compromising maintainability.
- Comes with a large standard library that supports many common programming tasks such as connecting to web servers, searching text with regular expressions, reading and modifying files.
- Python's interactive mode makes it easy to test short snippets of code. There's also a bundled development environment called IDLE.
- Is easily extended by adding new modules implemented in a compiled language such as C or C++.
- Can also be embedded into an application to provide a programmable interface.
- Runs anywhere, including Mac OS X, Windows, Linux, and Unix, with unofficial builds also available for Android and iOS.
- Is free software in two senses. It doesn't cost anything to download or use Python, or to include it in your application. Python can also be freely modified and re-distributed because while the language is copyrighted it's available under an open-source license.

Some programming-language features of Python are:

- A variety of basic data types are available: numbers (floating point, complex, and unlimited-length long integers), strings (both ASCII and Unicode), lists, and dictionaries.
- Python supports object-oriented programming with classes and multiple inheritances.
- Code can be grouped into modules and packages.
- The language supports raising and catching exceptions, resulting in cleaner error handling.
- Data types are strongly and dynamically typed. Mixing incompatible types (e.g. attempting to add a string and a number) causes an exception to be raised, so errors are caught sooner.
- Python contains advanced programming features such as generators and list comprehensions.
- Python's automatic memory management frees you from having to manually allocate and free memory in your code.

II. Lab Procedure and Equipment List

A. Equipment

Equipment

- Jetson Nano single-board computer
- Internet connectivity
- I/O devices (USB keyboard/mouse, etc.)
- External Monitor with HDMI/DP port

B. Procedure

Part A

1. Flash the OS to a microSD card.
2. Power supply, setup and boot up

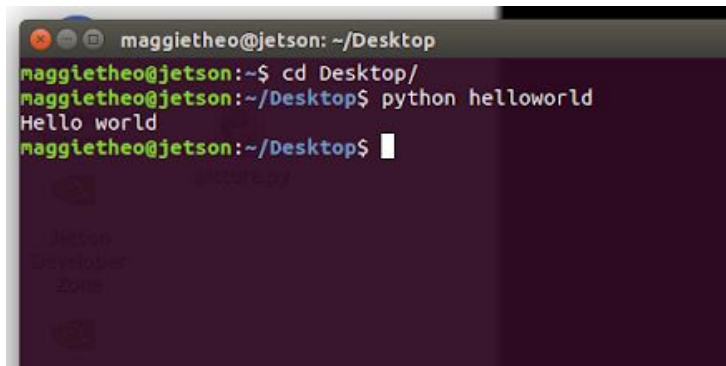
Part B

1. Create a working directory
2. Run a simple helloWorld program
3. Write the script of ex2.py and run it
4. Download Jetson-inference and run `imagenet-console.py --network=googlenet`

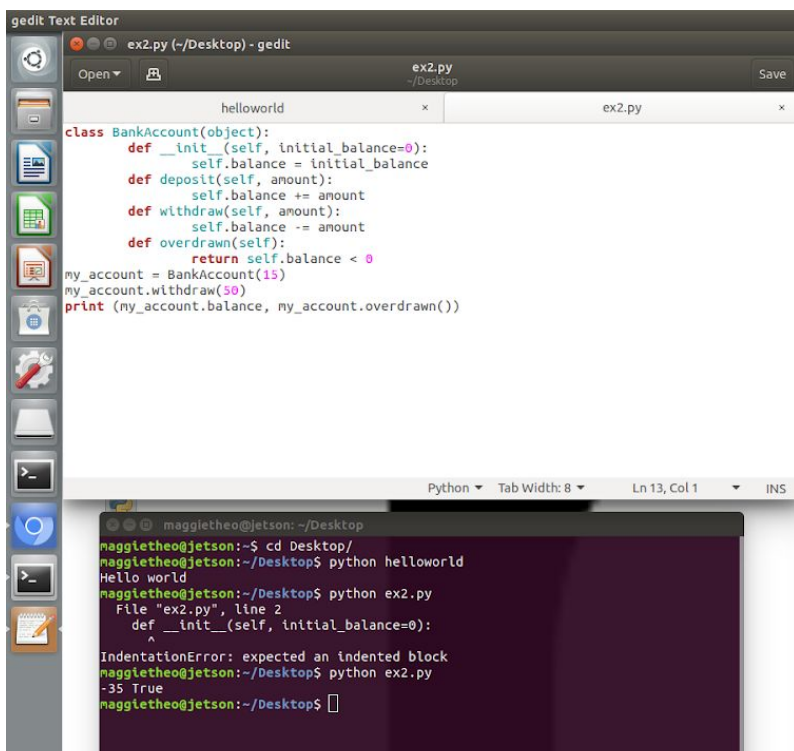
III. Results and Analysis

PART A - setup already completed

PART B

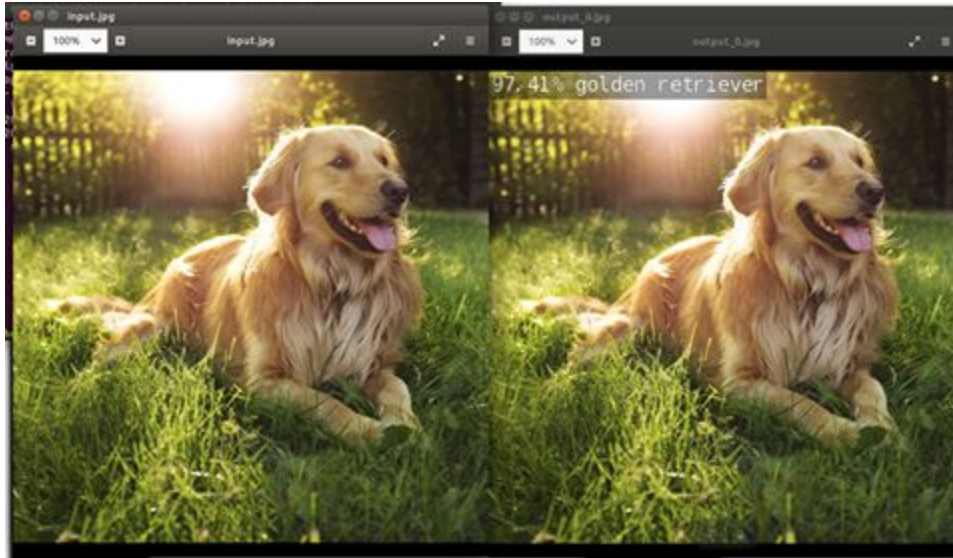


```
maggiethéo@jetson: ~/Desktop
maggiethéo@jetson:~$ cd Desktop/
maggiethéo@jetson:~/Desktop$ python helloworld
Hello world
maggiethéo@jetson:~/Desktop$
```



```
gedit Text Editor
ex2.py (~/Desktop) - gedit
Open Save
helloworld x ex2.py x
class BankAccount(object):
    def __init__(self, initial_balance=0):
        self.balance = initial_balance
    def deposit(self, amount):
        self.balance += amount
    def withdraw(self, amount):
        self.balance -= amount
    def overdrawn(self):
        return self.balance < 0
my_account = BankAccount(15)
my_account.withdraw(50)
print (my_account.balance, my_account.overdrawn())
Python Tab Width: 8 Ln 13, Col 1 INS
maggiethéo@jetson: ~/Desktop
maggiethéo@jetson:~$ cd Desktop/
maggiethéo@jetson:~/Desktop$ python helloworld
Hello world
maggiethéo@jetson:~/Desktop$ python ex2.py
File "ex2.py", line 2
    def __init__(self, initial_balance=0):
    ^
IndentationError: expected an indented block
maggiethéo@jetson:~/Desktop$ python ex2.py
-35 True
maggiethéo@jetson:~/Desktop$
```

Part 4



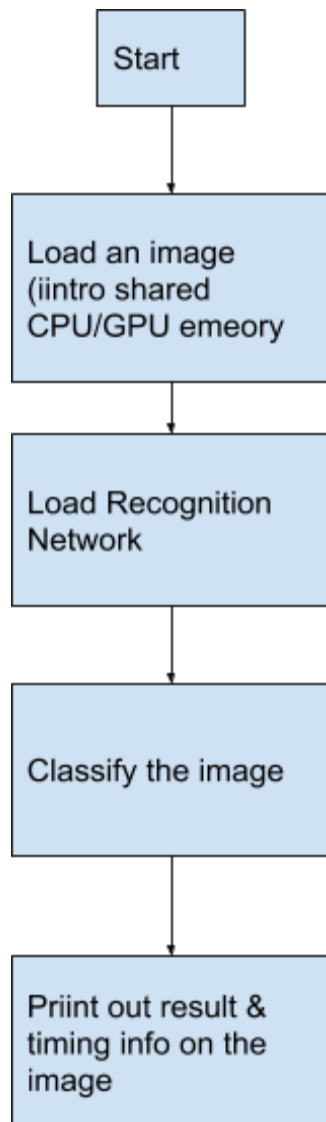
Questions

1. Comment on the advantages and disadvantages of Jetson Nano compared with other single-board computers. (10 pts)

The Jetson is optimized for image processing and neural networks. Though it has some disadvantages like lack of wifi capabilities without external hardware, it is a perfect single-board computer for image processing. You can run multiple neural networks in parallel, compared to others that would struggle to do this.

- 2.

Draw a flow chart to explain how the image segmentation script in part A works. (10 pts)



3. Why is it advantageous to connect the power supply to Jetson Nano using power jack instead of Micro-USB? (10 pts)

More power to the Jetson removes common issues like shutdowns and lagging video quality. To be able to handle hardware plugged into the jetson (keyboard, mouse, monitor, wifi adapter, camera) this power is necessary to perform all functions to their intended capacities, as well as prevent system shut down from now enough power.

4. If there is no cabled Ethernet connection available, how can you connect Jetson Nano to the Internet? Other ports/interfaces can be used. (10 pts)

We used a USB wifi adapter.

5. Why is the first running of the image recognition program slower than later runs? (10 pts)
The first image recognition program has to train the entire data since it has not been previously trained previously. This does not have to be done in later runs.

IV. Conclusions

In this lab, students built a deeper understanding of the Jetson Nano and how to set it up. The sample programs were tested and the results were as expected. Overall, this lab was successful.

References

[1] An introduction to Jetson Nano

<https://developer.nvidia.com/embedded/jetson-nano-developer-kit>

[2] Lab 2 manual