High Performance Python Lab
Term 2 2019/2020

Lecture 6

CuPy

Outline

- What is GPU?
- CUDA intro
- CUDA + Python (CuPy)
- Tasks ;)

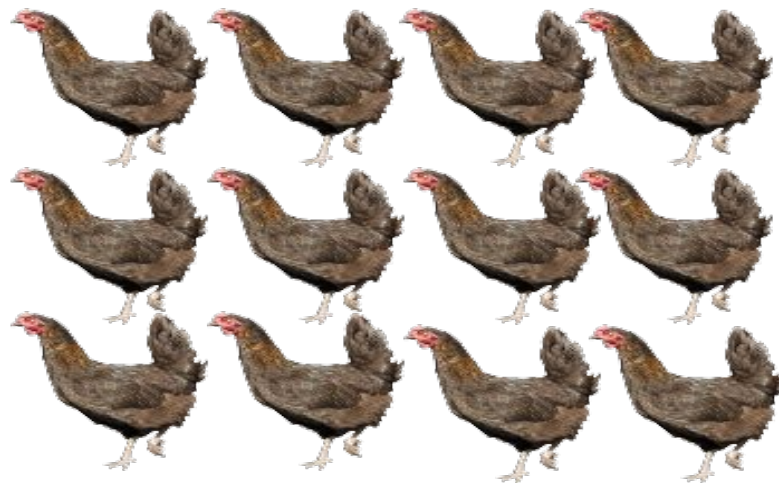# What is GPU?

NVidia Tesla V100

CPU vs GPU

"If you were plowing a field, which would you rather use: two strong oxen or
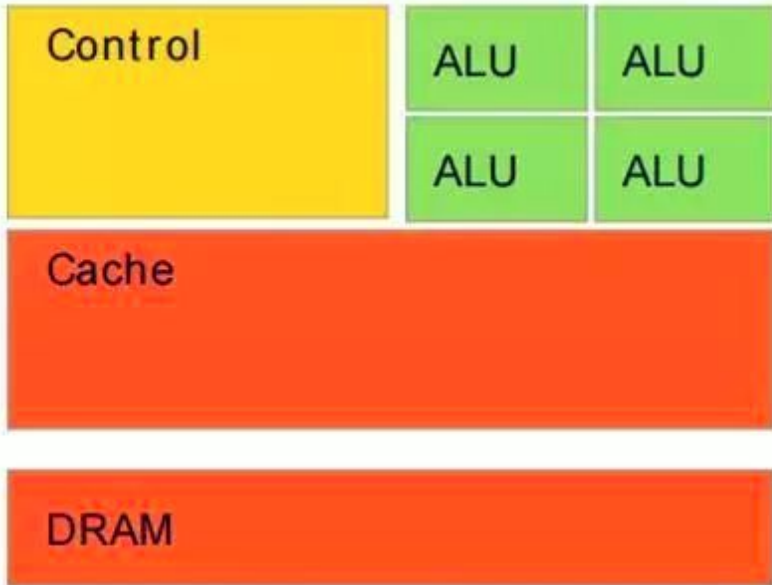1024 chickens?"

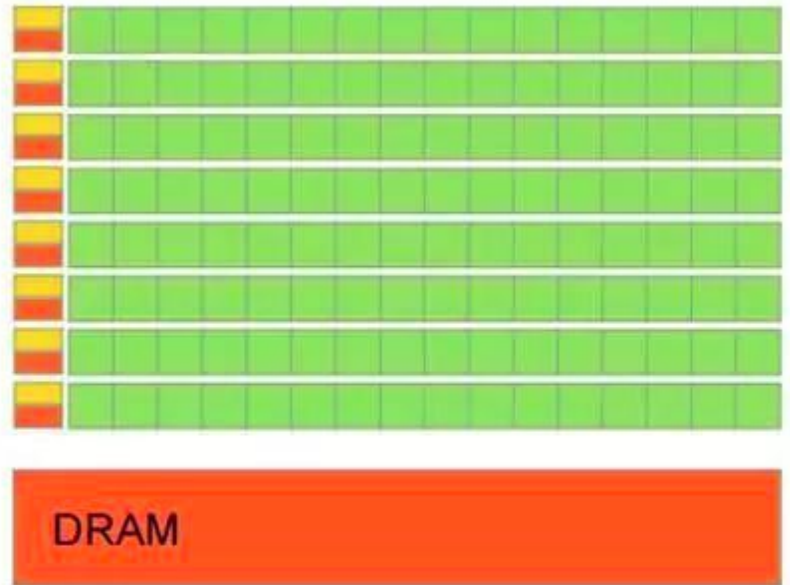Seymour Roger Cray

Modern CPU
~10 cores

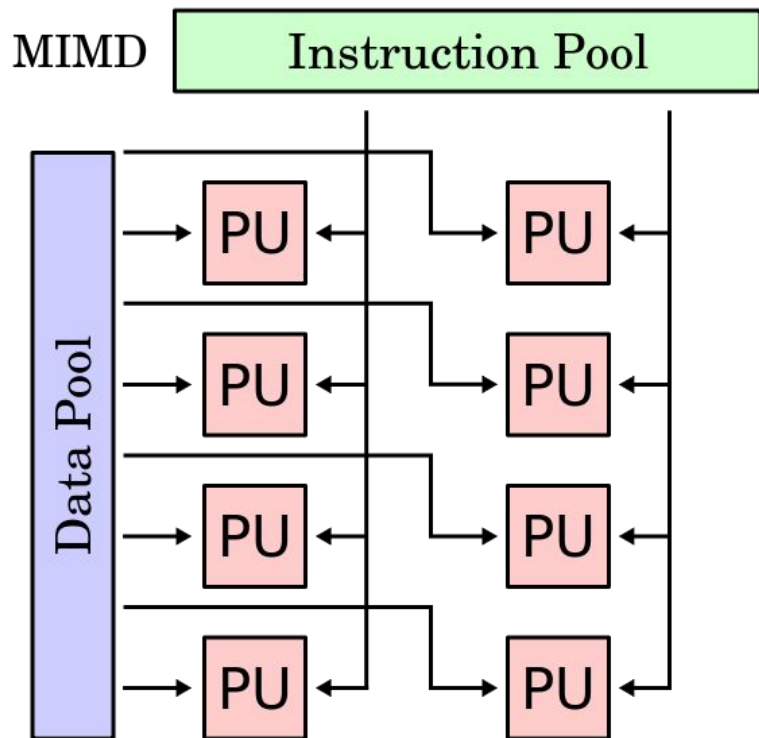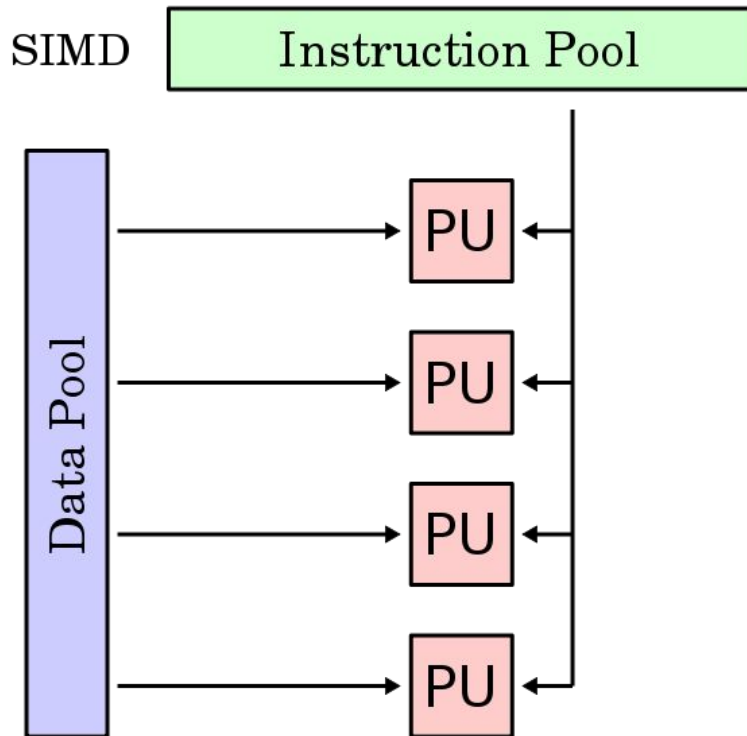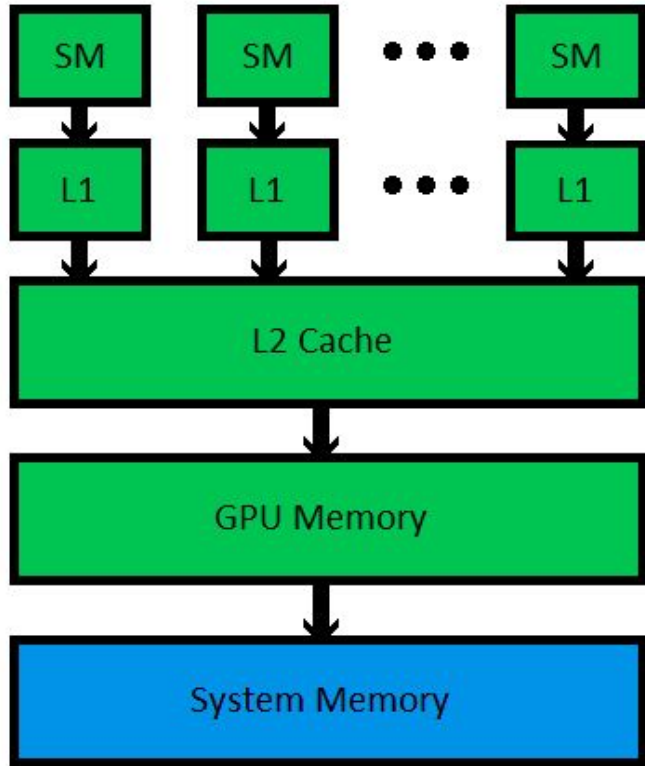Modern GPU
~5000 cores
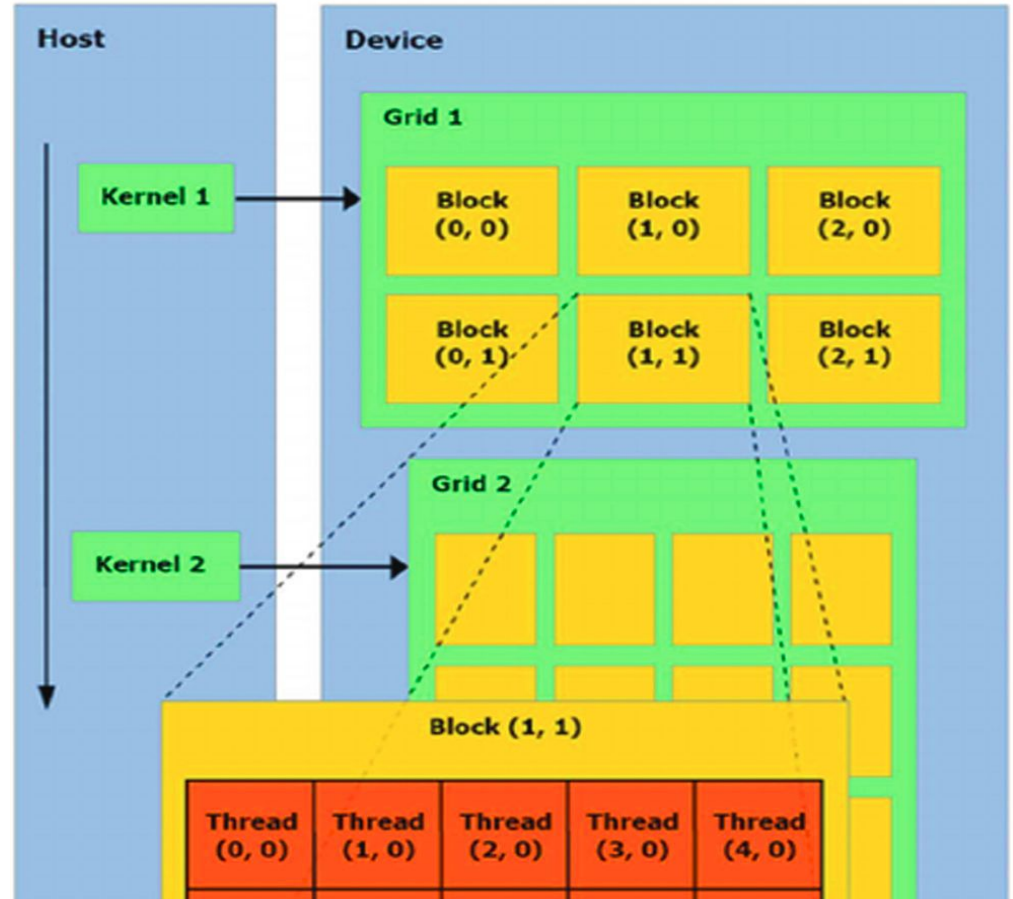
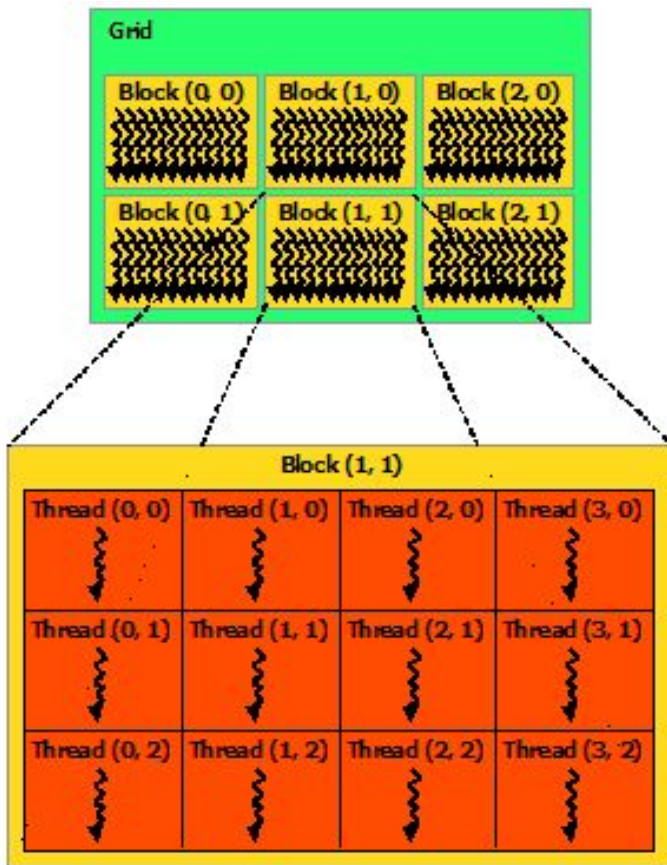# CPU vs GPU

CPU vs GPU

What is GPU?

Physically

Logically

Compute Unified Device Architechture (CUDA)

- Kernel is a serial program for one thread

- Each thread executes a kernel

- You can tell the GPU how many threads to launch

- Threads are grouped in blocks, blocks -- in grids

CUDA + Python (CuPy)

CuPy is...   https://cupy.chainer.org/

a library to provide NumPy-compatible features with GPU

```python
import numpy as np
X_cpu = np.zeros((10,))
W_cpu = np.zeros((10, 5))
y_cpu = np.dot(x_cpu, W_cpu)
```

```python
import cupy as cp
x_gpu = cp.zeros((10,))
W_gpu = cp.zeros((10, 5))
y_gpu = cp.dot(x_gpu, W_gpu)
```

```python
y_cpu = cp.asnumpy(y_gpu)
```

```python
y_gpu = cp.asarray(y_cpu)
```

CUDA + Python (CuPy)

- Elementwise kernels

- Reduction kernels

- "Raw" kernels (to use this -- a dive into C required)

More Info: **https://tinyurl.com/u8xqo9l**

Tasks

- Saxpy
- CuPy-based bifurcation map
- Histogram
- Image blur

Detailed tasks are in jupyter notebook

Task 10. Saxpy

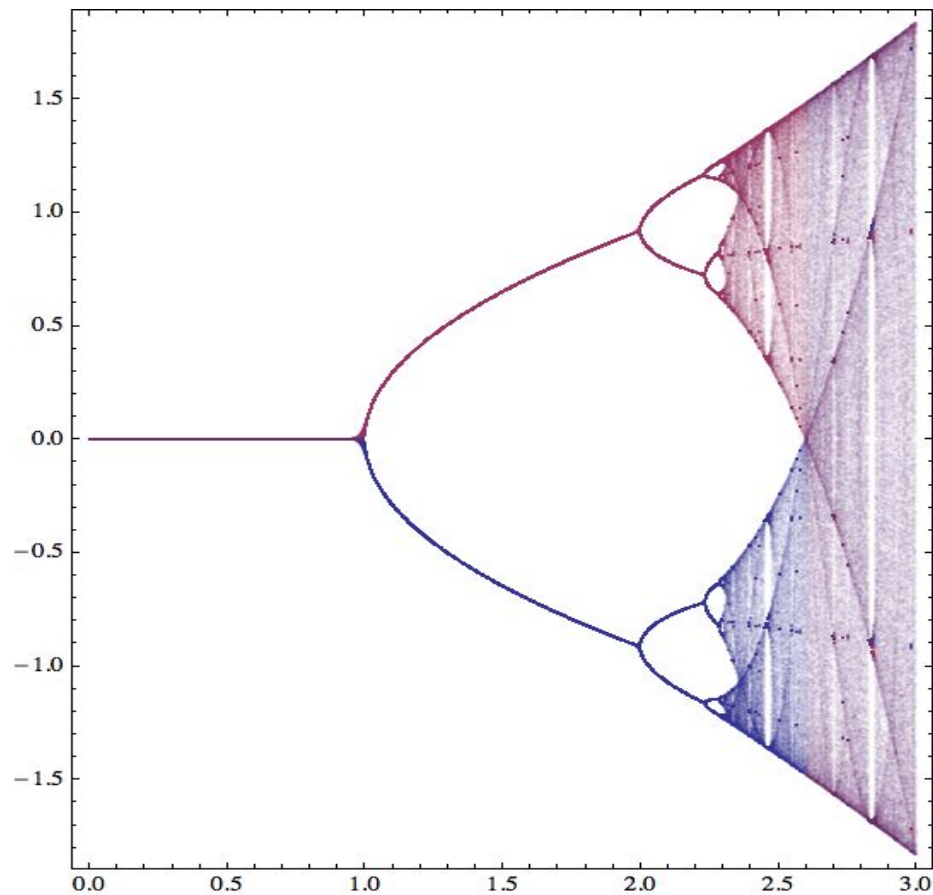Single precision Alpha X Plus Y (SAXPY)

Part of Basic Linear Algebra Subroutines (BLAS) Library
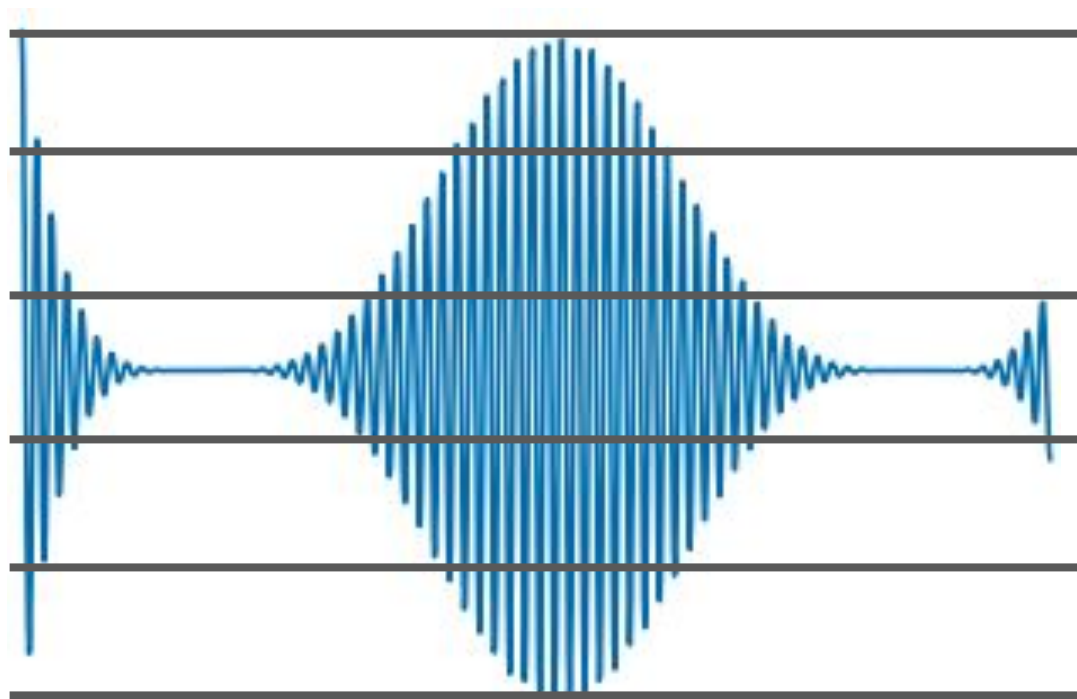
$$z = \alpha x + y$$

x, y, z : vector

α : scalar

Task 11: CuPy-based bifurcation map

Task 12: Histogram

- Take values of a function on some grid
- Calculate min & max
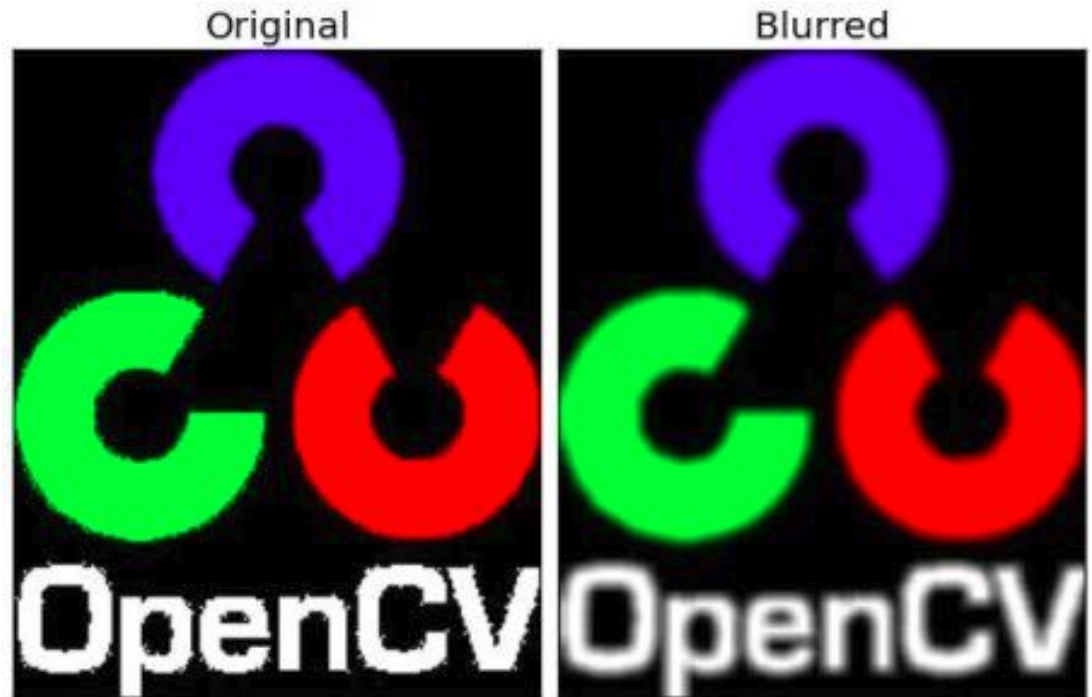- Calculate how many points are inside intervals

Task 13: Image blur

Example of a 3 by 3 filter:

1/25 3/25 1/25

3/25 9/25 3/25

1/25 3/25 1/25

Zhores sandbox

- PDF -- Guideline on how to run jupyter notebook on Zhores

- Tasks & Guideline on cluster usage
  -- inside archive "guidelines"

Thank you for your attention!