Hewlett Packard
Enterprise

Machine Learning in The Chapel Programming Language

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Background

Lightweight tensor and linear algebra library

Extends NumPy to support ML needs
(backpropogation, CUDA implementation)

Fully featured ML tools (uses TensorFlow)

Chapel

- High performance computing
- Sophisticated array programming
- Automatically utilize maximal resources
- Easily program parallel computations

My Project

- Implement ML programs in Chapel
- See what aspects of Chapel make it easier/harder to implement ML programs
- Performance comparison

My Chapel ML Implementation

- Tensor Library
  - Attempts to replicate much of NumPy's functionality
  - Arithmetic and linear algebra operations
  - Supporting helper functions
- Machine Learning Library
  - Implements various layer types: Dense, Conv2d, MaxPool, SoftMax, ReLU, TanH, Sigmoid, Flatten, …
  - Offers similar user interface as PyTorch or Keras

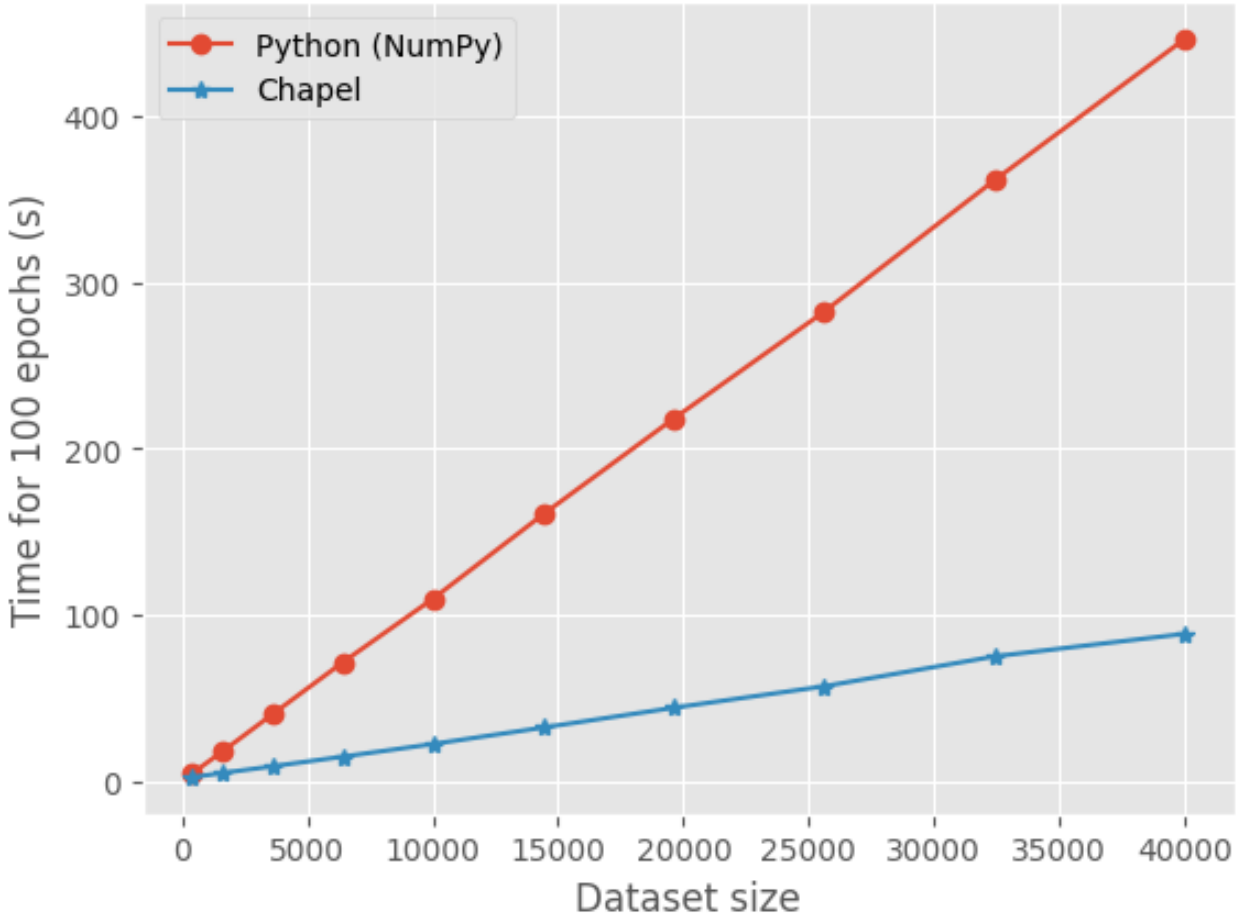
```
model = Sequential(
    Dense(4),
    Sigmoid(),
    Dense(3),
    Sigmoid(),
)
```

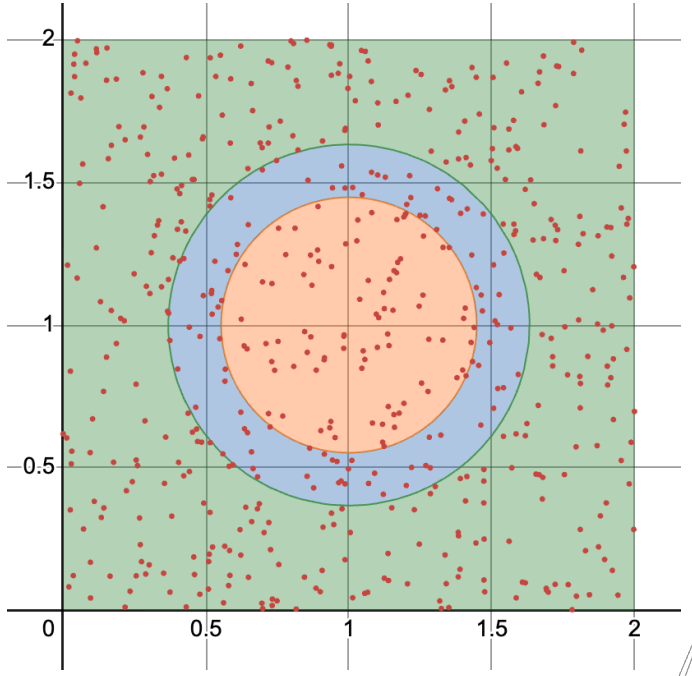
PyTorch

```
var model = new Sequential(
    new Dense(4),
    new Sigmoid(),
    new Dense(3),
    new Sigmoid()
);
```

CHAPEL

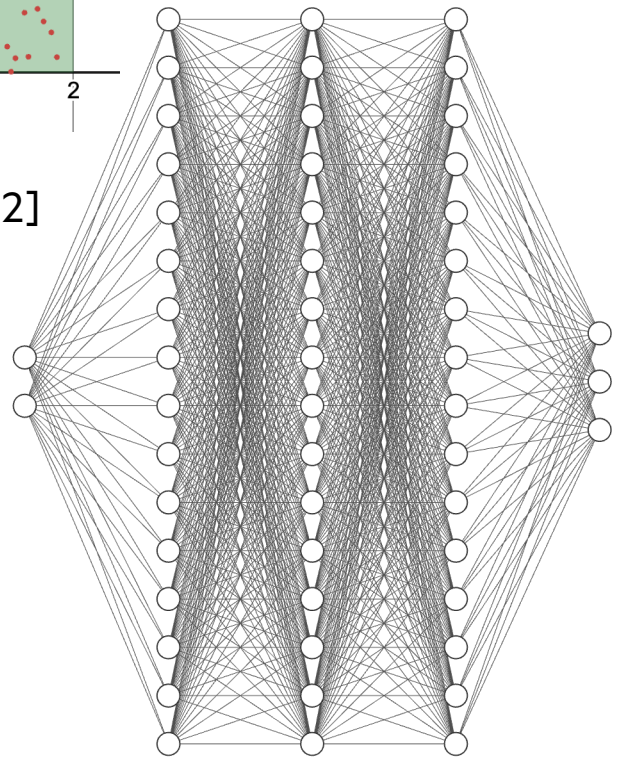
Speed Comparison (Simple Classification)



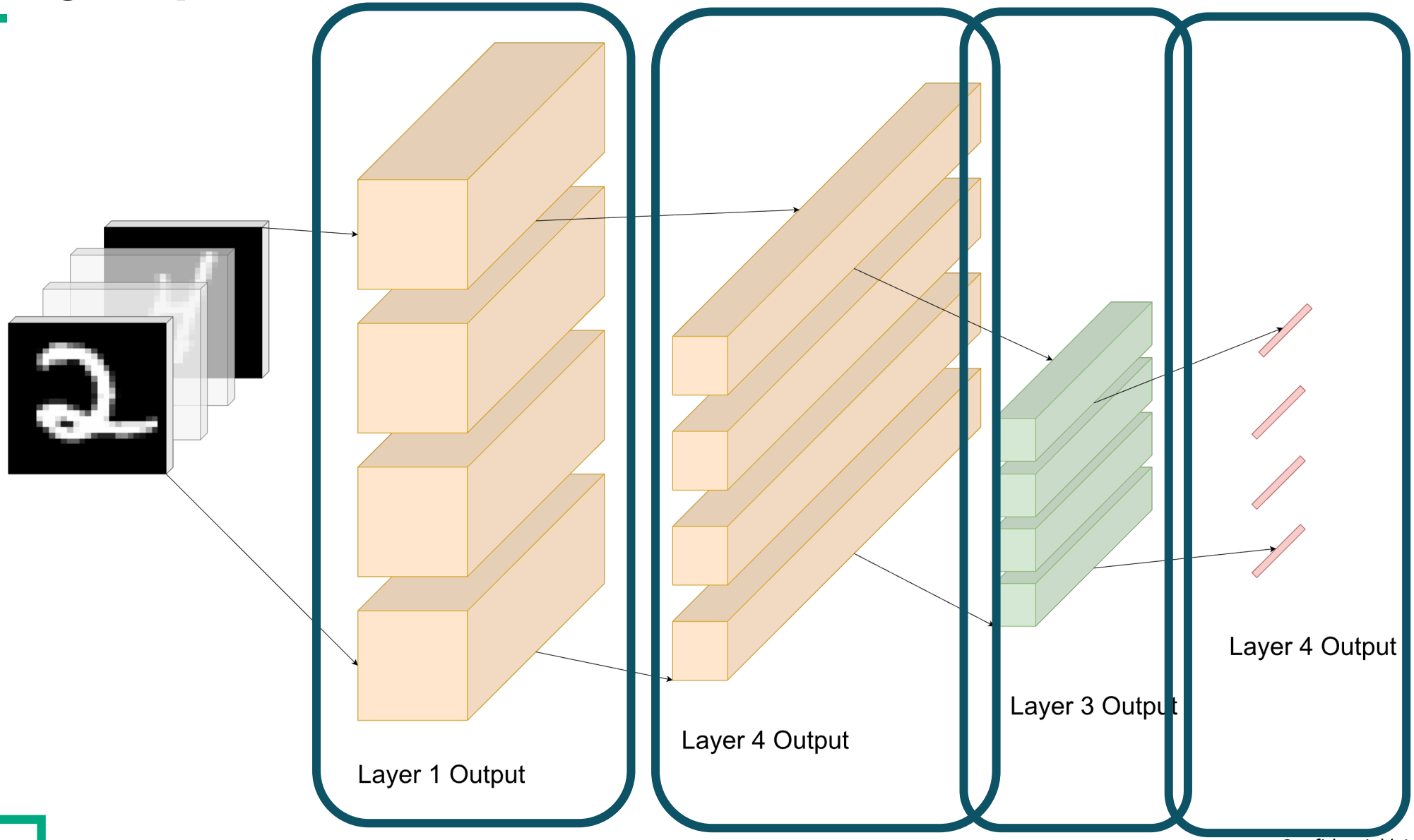


Input: N samples from [0,2] x [0,2]

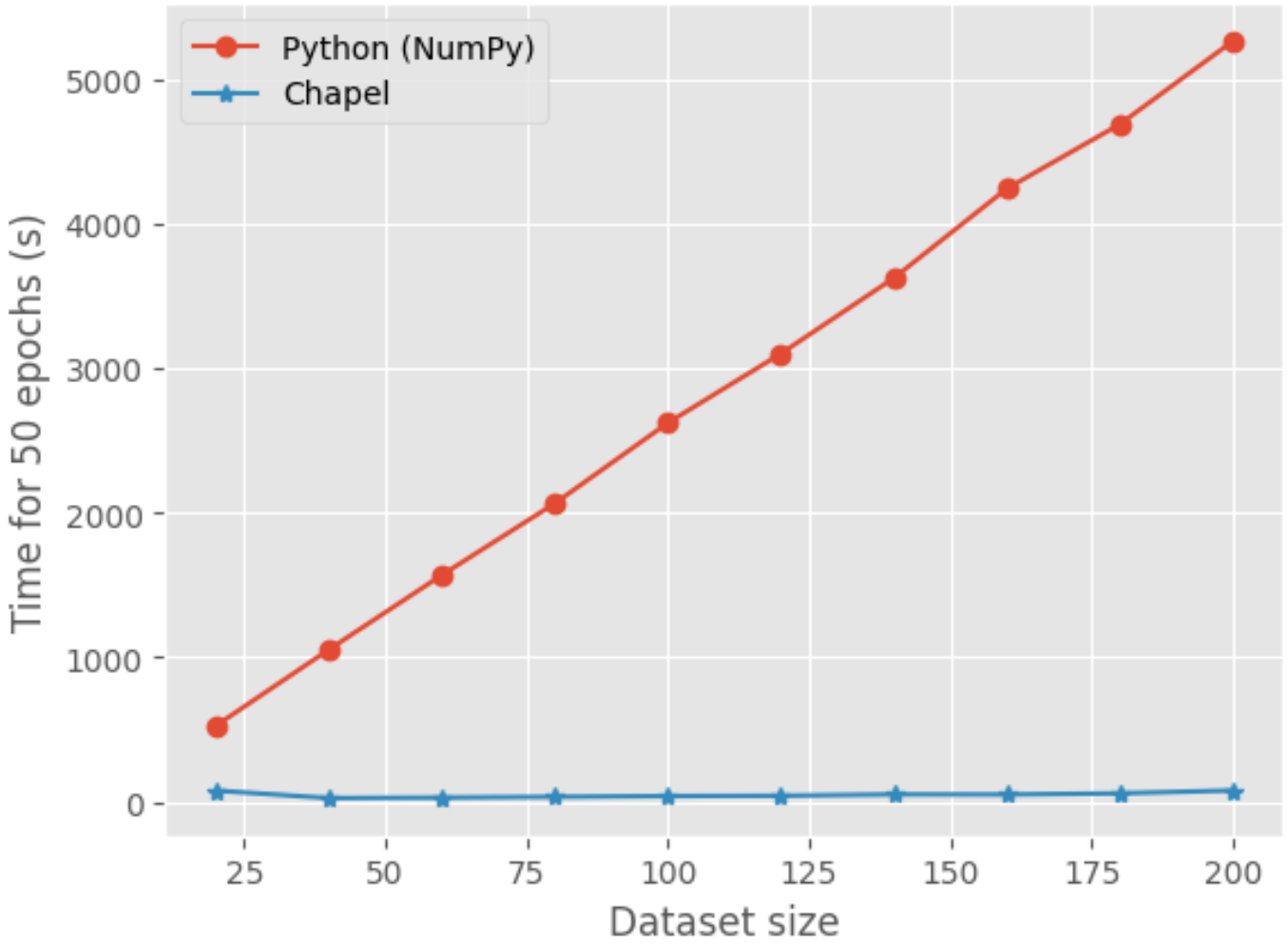
Output: 3 different categories



Utilizing Chapel's Parallelism Constructs

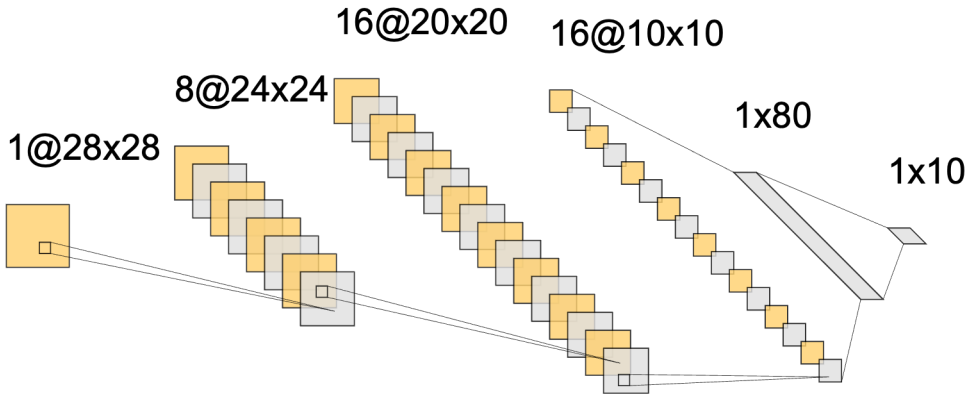


Speed Comparison (MNIST Classification)

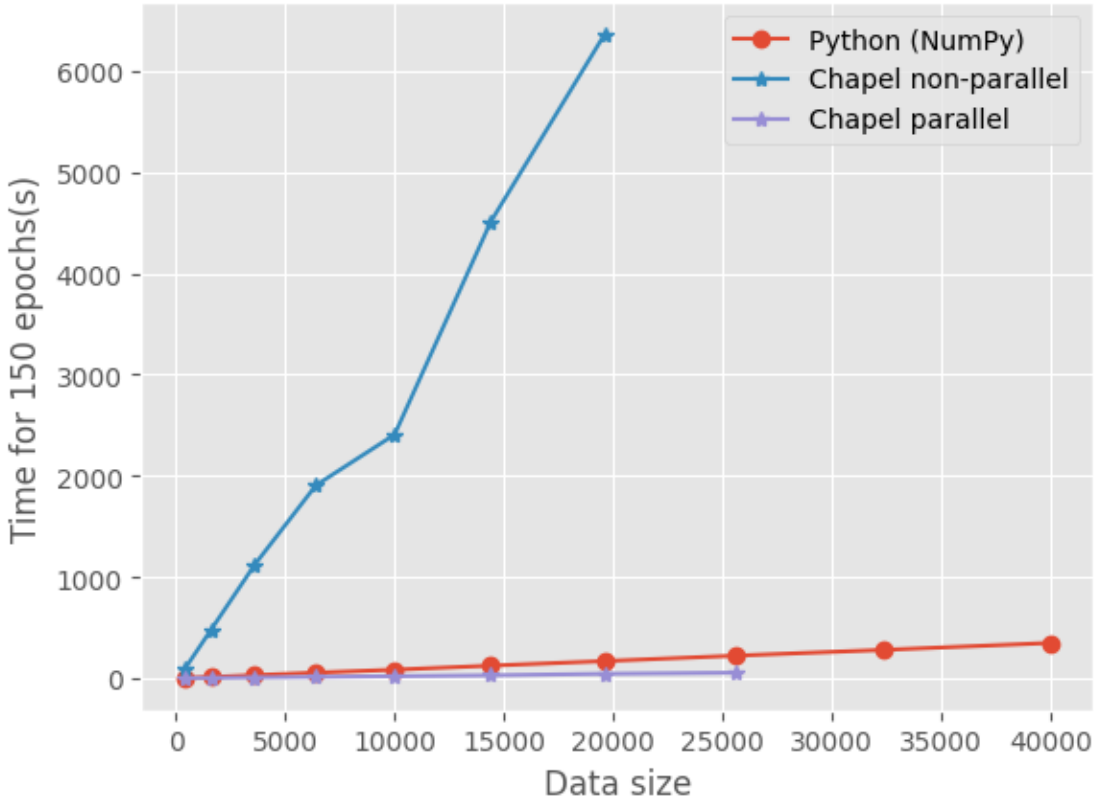


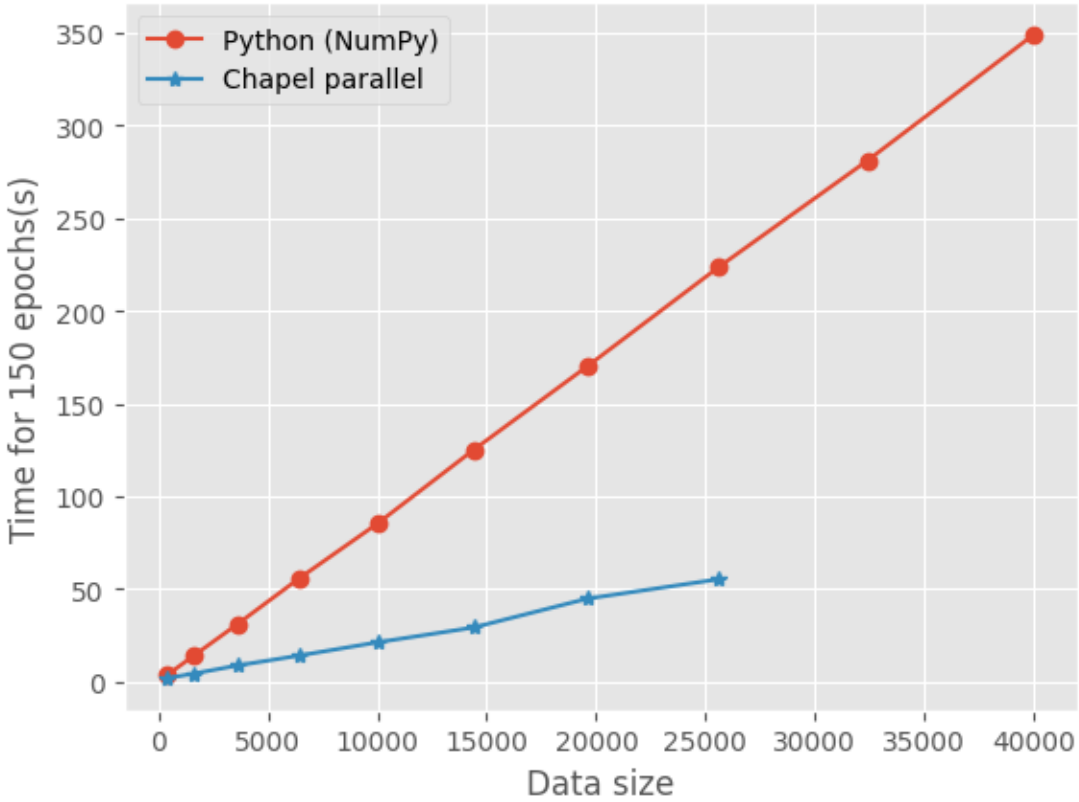
Input:

Output: 0,1,2,3,...,9



Thank you


Python (NumPy)
Chapel non-parallel
Chapel parallel
Time for 150 epochs(s)
Data size
0
1000
2000
3000
4000
5000
6000
0
5000
10000
15000
20000
25000
30000
35000
40000


Python (NumPy)
Chapel parallel
Time for 150 epochs(s)
Data size
0
50
100
150
200
250
300
350
0
5000
10000
15000
20000
25000
30000
35000
40000