Accelerating Python

Accelerating scientific computing in as few lines as possible.

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The Problem

Most Python code, with the exception of Cuda for DL, runs sequential, and is slow.

There is a clear need for fast Python code, but without spending days/weeks writing highly optimized C/C++ modules.

The takeaway of this workshop should be to give you ‘Hello World’ copy pasteable examples that allow you to speed up your code with a factor of 1-2 orders of magnitude in 15 minutes or less.*

Typical use cases:

- Hyperparameter optimization
- Augmentation, preprocessing
- Simulation, 3D point clouds processing, ...

* Add half a day if you have issues with Python dependencies

What we (me) will do

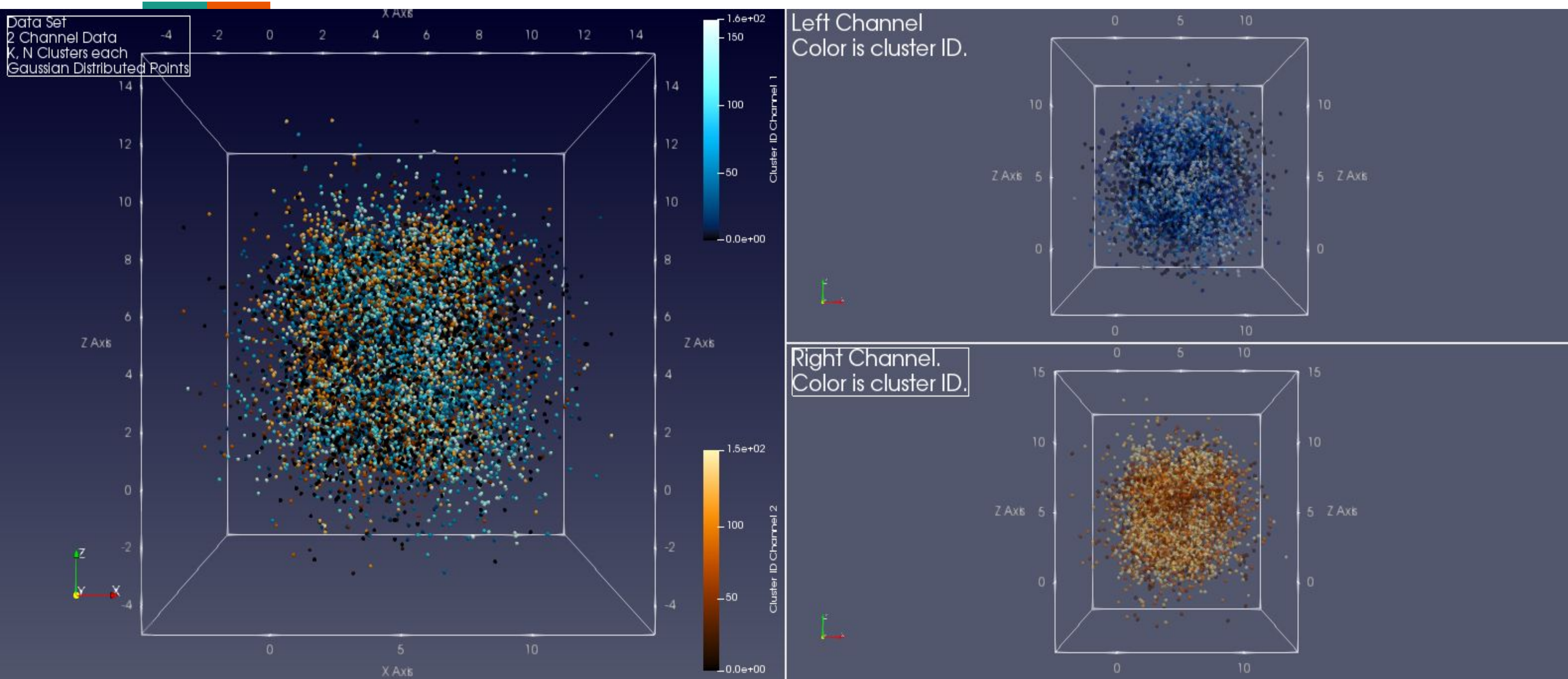
- Accelerate Sequential Code
  - Cython
  - Numba
  - Map - Reduce
- Parallelize Sequential Code
- Problems
  - Synthetic: A N^4 computation loop
  - Use Case:
    - Pairing of clusters of 3D points using Chamfer Distance
- Speedups observed:
  - Synthetic
    - Sequential speedup: 3-500
    - Parallel : linear in # threads
  - Use Case
    - Sequential speedup: 15-30
    - Parallel: (0.7 - 0.95) * # threads

What we (me) will not do

- Vectorization

Use Case

Pair Clusters in 2-Channel Data



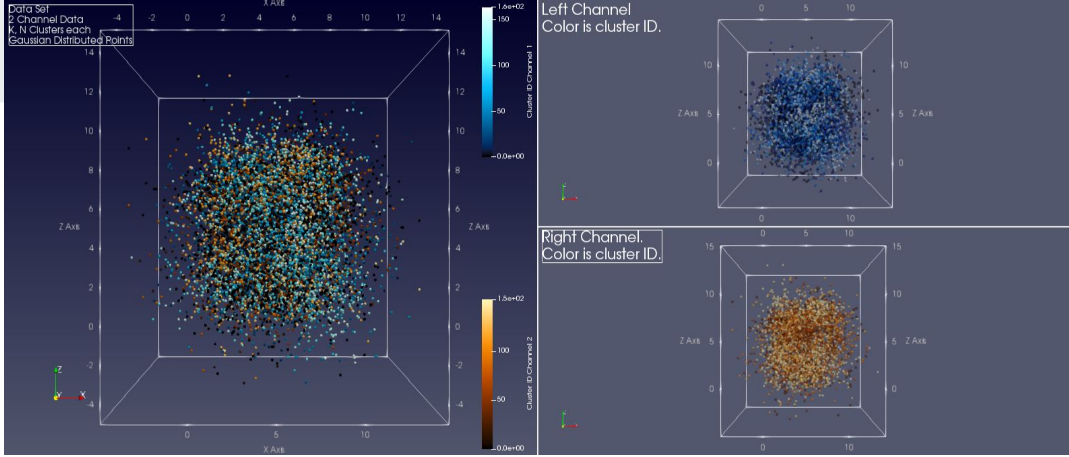
Data Set
2 Channel Data
K, N Clusters each
Gaussian Distributed Points

Left Channel
Color is cluster ID.

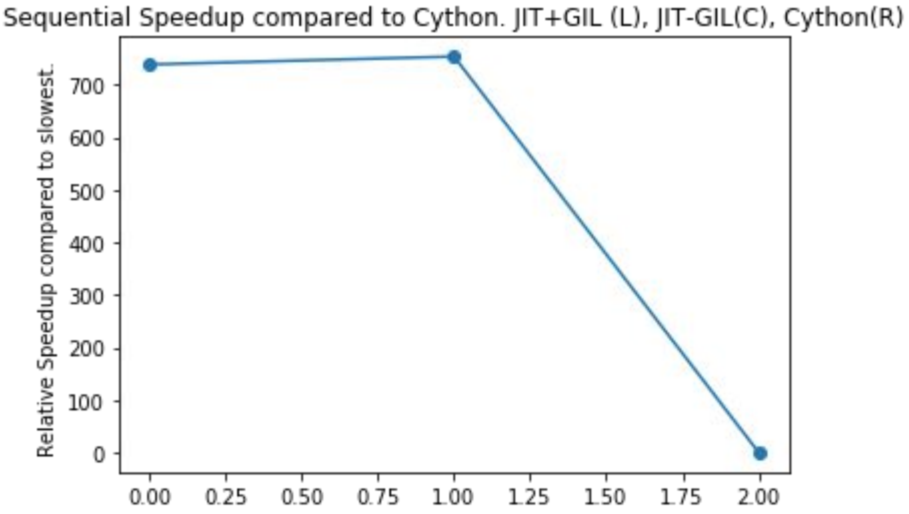
Right Channel.
Color is cluster ID.

Use Case

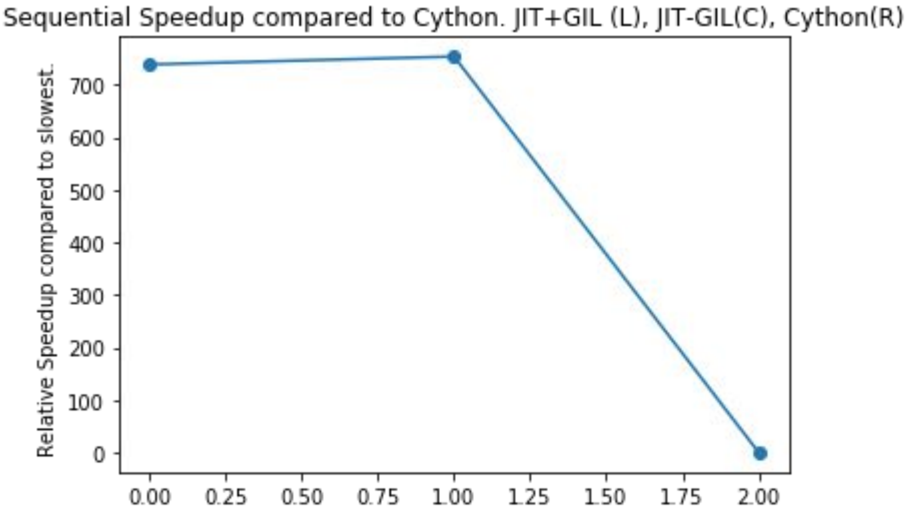
2 Channels
3D Points
M,N clusters per channel.
Pair clusters using Chamfer distance.



Sequential Synthetic -- Python vs Cython

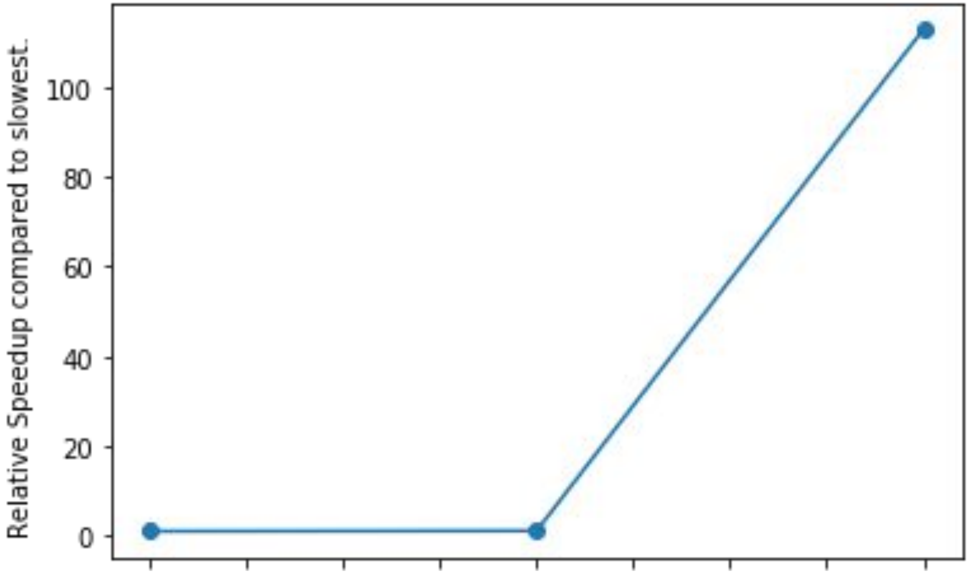


Sequential Synthetic -- JIT vs Cython

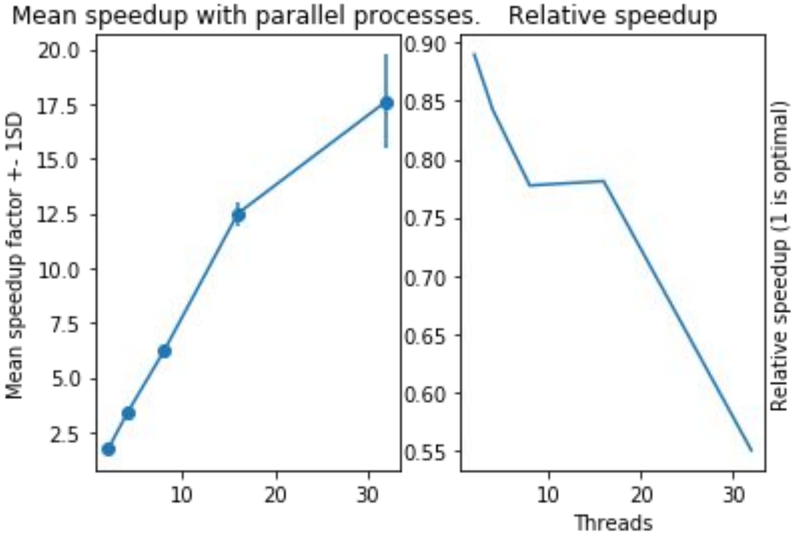


Sequential Use Case -- JIT

Sequential Speedup compared to Pure Python. Python (L), MapReduce(C), Numba(R)

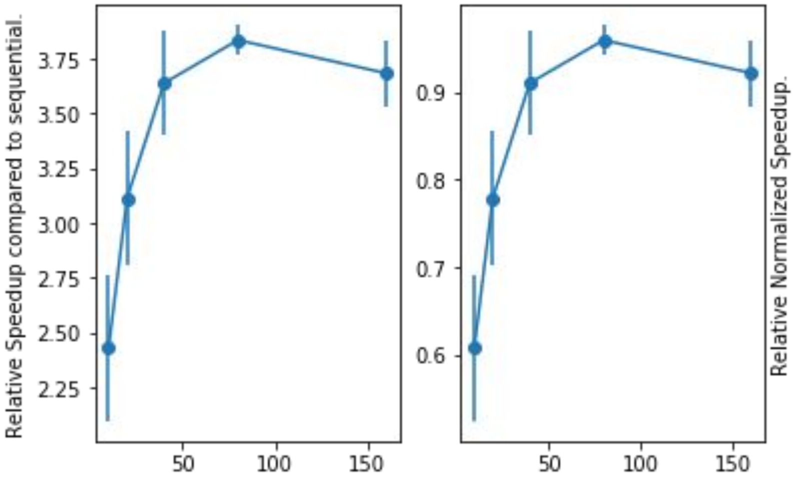


Parallel Use Case -- Weak Scaling



Parallel Use Case -- Strong Scaling

Strong scaling with doubling input size.



Conclusions

Accelerating your code:

- Add 1 decorator:
    - Speedup 1-2 orders of magnitude for numerical code
- Add 5 lines of code to parallelize (strip the benchmark code)
    - Linear parallel speedup in number of threads
- Combined:
    - Dual core hyperthreading i5 laptop (5 years old)
        - X **400** faster code for my (actual) use case

Extra

- Parallel IO (IO for the cluster)
- Numba
- Cython
- Joblib
- Cedar Summer School docs