Parallel Polynomial Univariate Multiplication

Build

Run `make` in the root directory to build `./poly_mul`.

Ensure that the `CUDA` path points to your local CUDA installation directory.

Run `make clean` to remove any build files and the executable itself.

Code

The `output.txt` file contains the output of the program when run as `./poly_mul`. The `output.csv` is parsed from `output.txt` using `parse_output.py`. The various graphs in the folder were created using `plot_output.py` and `output.csv`.

The main driver code is in `main.cu`, while the matrix multiplication kernels are found in `poly_mul.hpp`.

Results

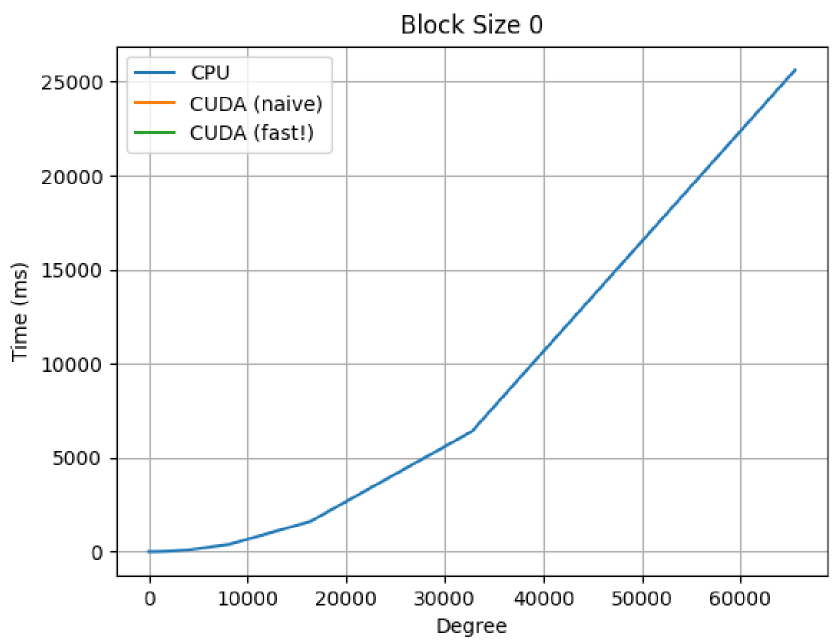
Running `fastest_block_size.py` takes the `output.csv` and computes which of the block sizes result in optimal performance for the fast CUDA kernel:

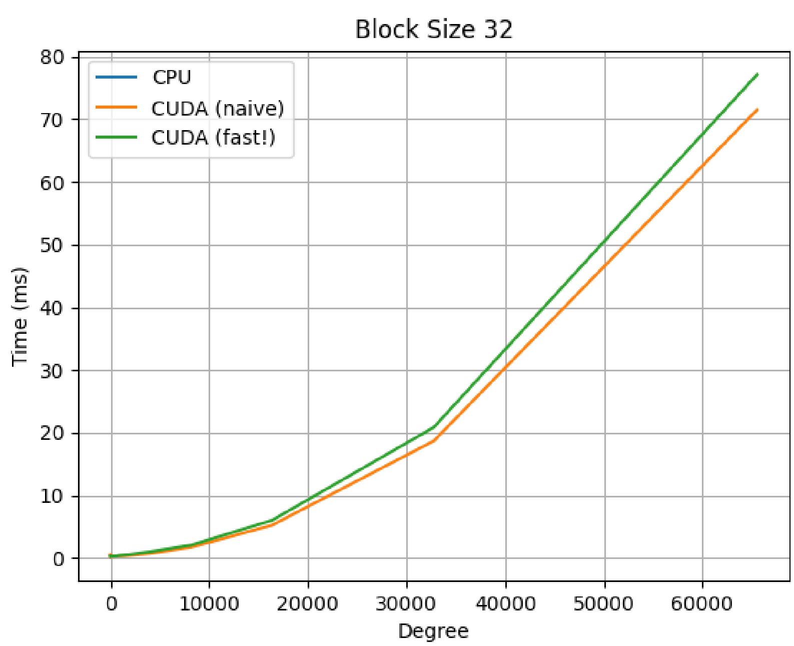
```
The block size with the fastest average time for CUDA (fast!) is 512
with an average time of 5.101166375 ms.
Additional information for degree 2^11 and 2^15 (CUDA fast!):
Degree 2^11:
    Execution Type  Degree  Block Size  Time (ms)
      cuda (fast!)    2048         512   0.537824
Degree 2^15:
    Execution Type  Degree  Block Size  Time (ms)
      cuda (fast!)   32768         512    15.9878
```

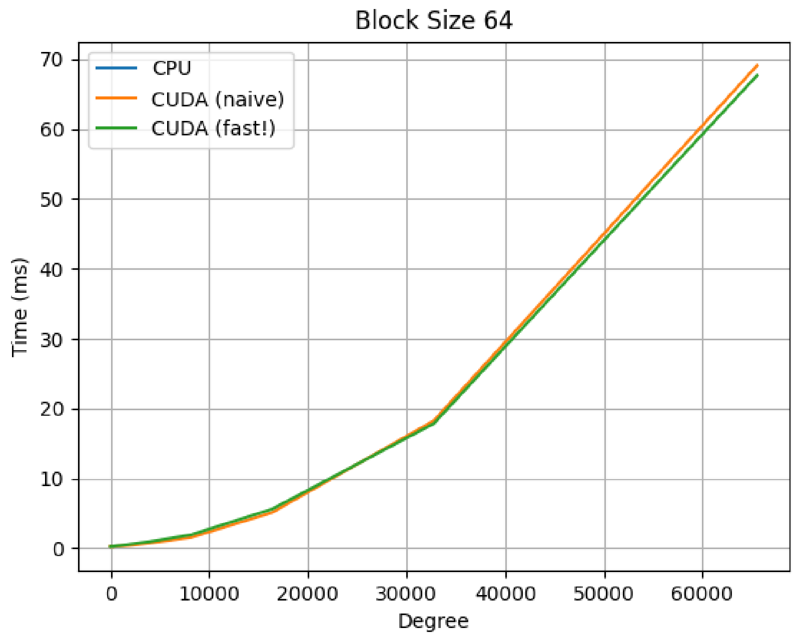
which shows that a block size of 512 is also the fastest for degrees 2^11 and 2^15, specifically.

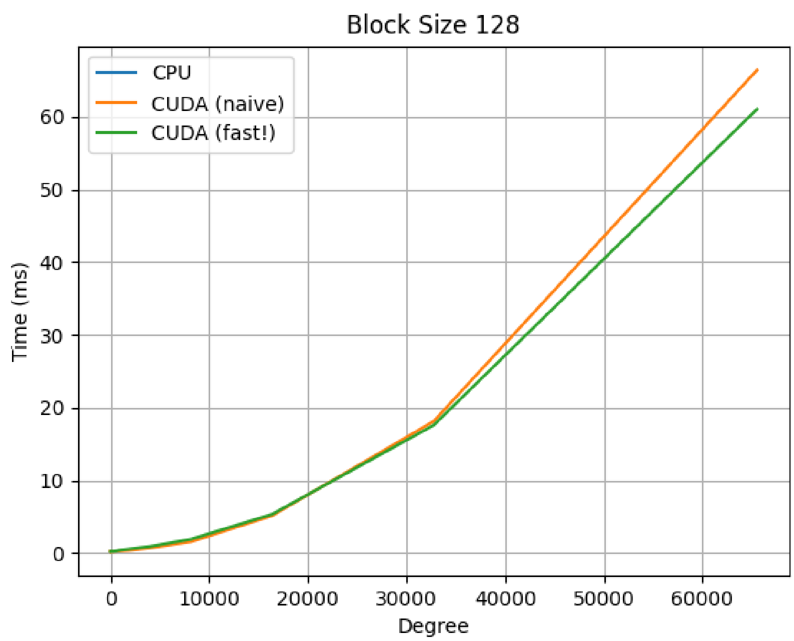
For additional comparisons, observe the below graphs, which compare a naive serial CPU implementation, the same naive implementation but on a CUDA kernel, and a faster CUDA kernel implementation, which uses a polyhedral method to re-parameterize the indices to allow for more efficient parallelization.

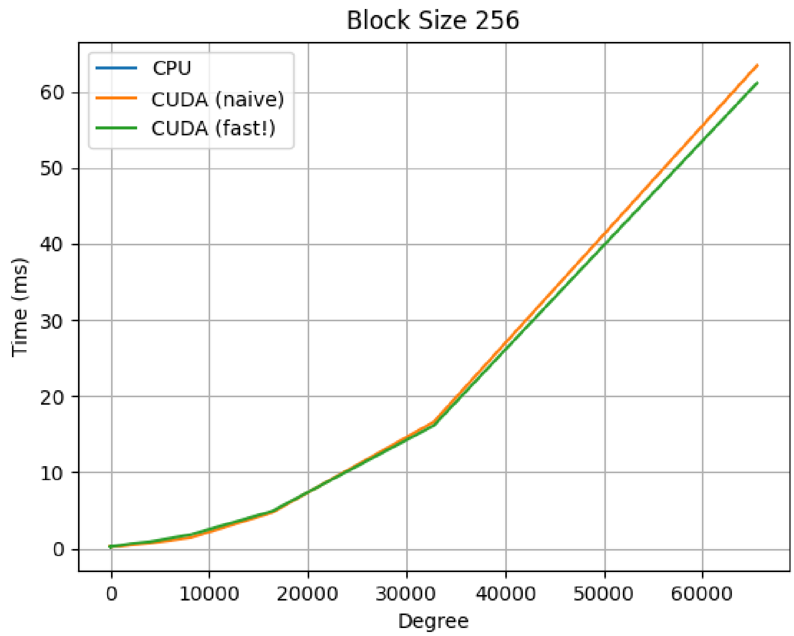
Note the y-axis for the CPU graph (blue curve): we observe almost a 500x speed-up using the CUDA kernels.

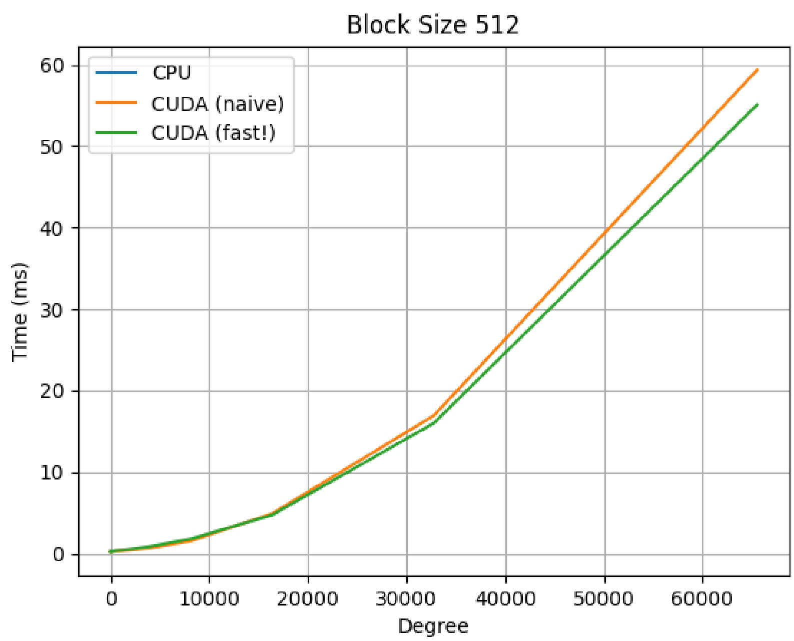

Block Size 0
CPU
CUDA (naive)
CUDA (fast!)
Time (ms)
25000
20000
15000
10000
5000
0
0
10000
20000
30000
40000
50000
60000
Degree


Block Size 32
CPU
CUDA (naive)
CUDA (fast!)
Time (ms)
80
70
60
50
40
30
20
10
0
0
10000
20000
30000
40000
50000
60000
Degree


Block Size 64
CPU
CUDA (naive)
CUDA (fast!)
Time (ms)
Degree
0
10
20
30
40
50
60
70
0
10000
20000
30000
40000
50000
60000


Block Size 128
CPU
CUDA (naive)
CUDA (fast!)
Time (ms)
Degree
0
10
20
30
40
50
60
0
10000
20000
30000
40000
50000
60000


Block Size 256
CPU
CUDA (naive)
CUDA (fast!)
Time (ms)
Degree
0
10
20
30
40
50
60
0
10000
20000
30000
40000
50000
60000


Block Size 512
CPU
CUDA (naive)
CUDA (fast!)
Time (ms)
Degree
0
10
20
30
40
50
60
0
10000
20000
30000
40000
50000
60000