CMSC Project 1 Report

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Psudocode (1)

4-multiply

```
let z1, z2, result be complex numbers
r1 = z1.real * z2.real
r2 = z1.imaginary * z2.imaginary

i1 = z1.real * z2.imaginary
i2 = z2.imaginary * z2.real

result.real = r1 - r2
result.imaginary = i1 + i2
```

3-multiply

```
let z1, z2, result be complex numbers
t = (z1.real + z1.imaginary) * (z2.real + z2.imaginary)
r = z1.real * z2.real
s = z1.imaginary * z2.imaginary

result.real = r - s
result.imaginary = t - result.real
```

Time Analysis Theoretical (2)

(See related file analysis.pdf)

Time Analysis Empirical (3)

All lengths will be tried against 50 pairs of numbers

50 8-bit

Method | Trial, Time

- CMUL4

Mean: 0.0001851
Std Dev: 2.7449 E-5

- CMUL3

Mean: 0.00020416
Std Dev: 4.8762 E-5

50 8-bit

cmul4 0.00013144 2.139616597354181e-06

cmul3 0.0001326799999999998 1.2845137251910088e-05

50 10-bit

cmul4 0.00013516 6.041894553525275e-06

cmul3 0.00013694 1.0116484829530585e-05

50 20-bit

cmul4 0.00016426 1.18989109431348e-05

cmul3 0.00015854 1.293344028288763e-05

50 30-bit

cmul4 0.00019176 8.828432731226758e-06

cmul3 0.00017888 6.258512570238776e-06

50 40-bit

cmul4 0.00020176 1.2011151281290262e-05

cmul3 0.00019098 2.0468482491630987e-05

50 100-bit

cmul4 0.0005741 0.00016098539038797075

cmul3 0.00050008 0.00011840639806210142

50 200-bit

cmul4 0.00143554 0.0001250397830569886

cmul3 0.00115614 0.00011236311581617148

Machine Running Tests (4)

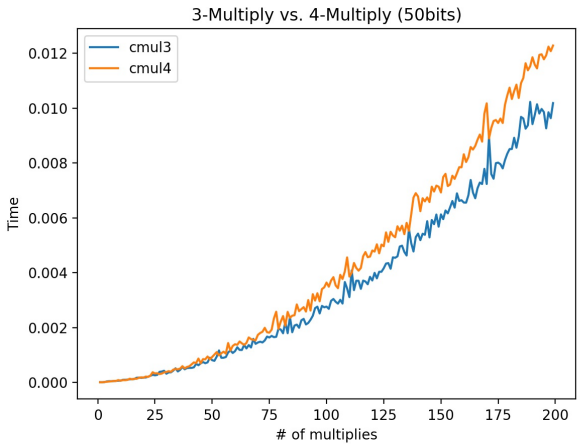
Processor 2GHz Intel Core i5
8GB RAM

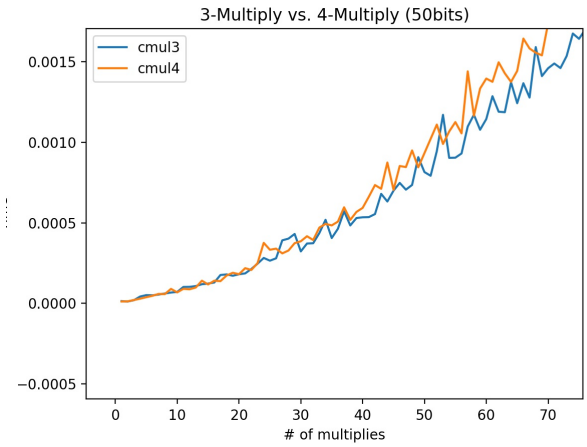
Crossover Point for bit length and num of multiplies

Below has graphs for many lists lengths and bit lengths. For a 50 bit number multiplied x times the crossover point is around 30 multiplies and starts to diverge more over increasing length.

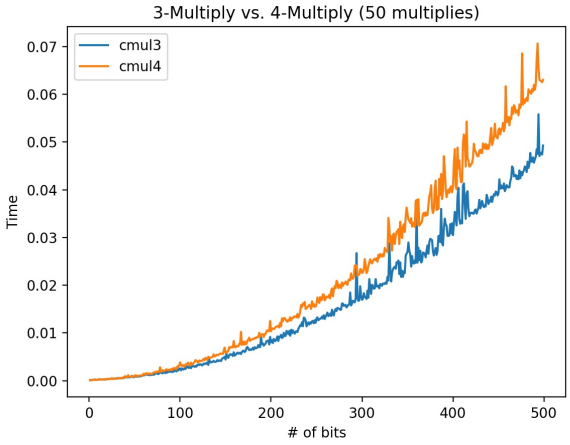
For 50 multiplies of x number of bits the cross over point where cmul3 takes over is around 60 bit numbers and begins to diverge more around 75+ bits.

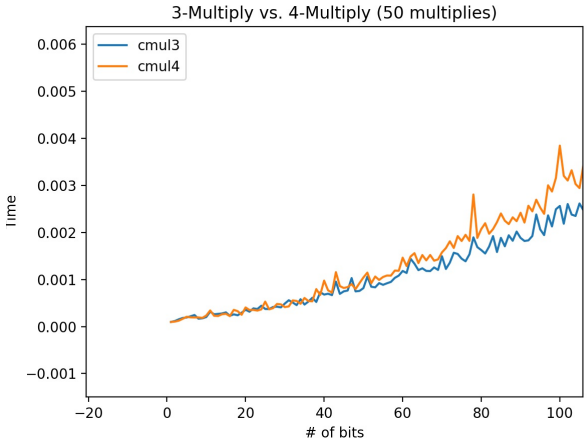
Closer look at 50 bit multiplies (5)



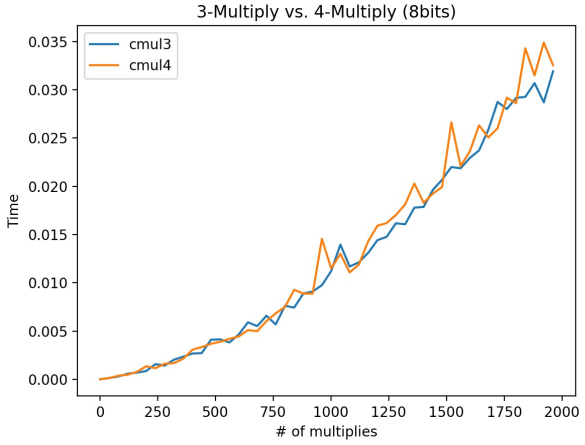


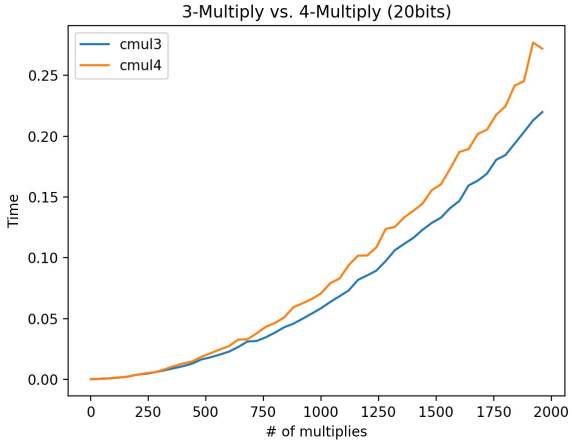
Closer look at x bit 50 multiplies (5)

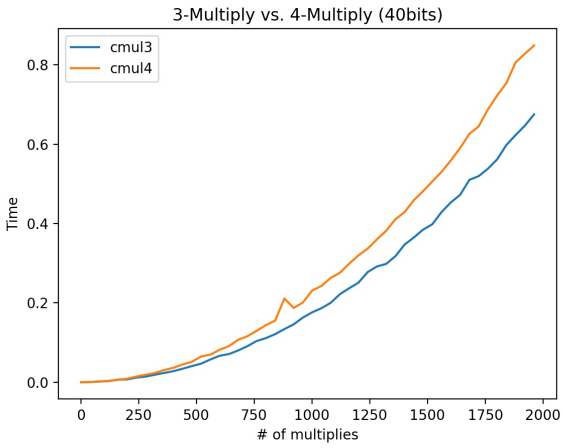


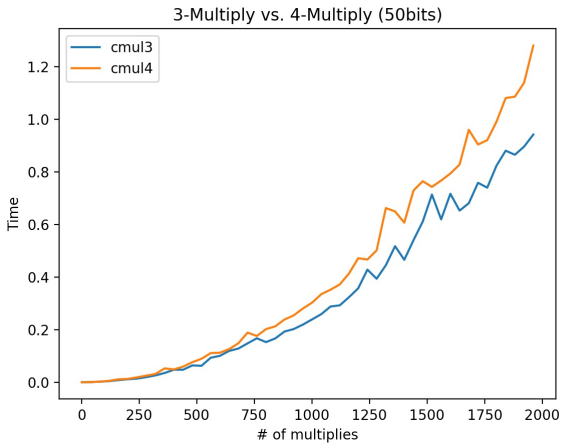


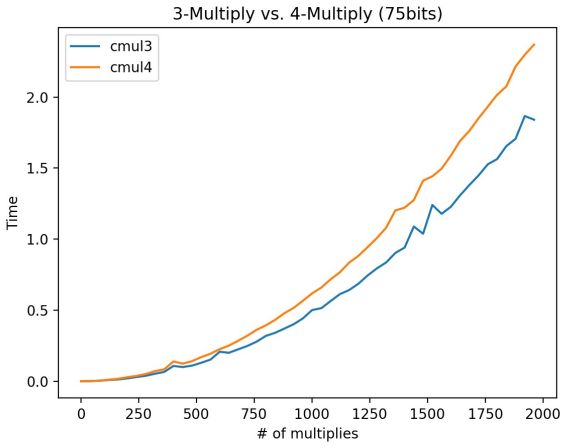
Graphs for x Bit multiplies (5)

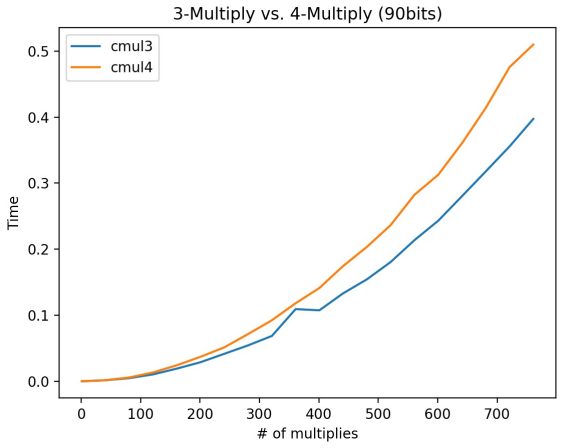


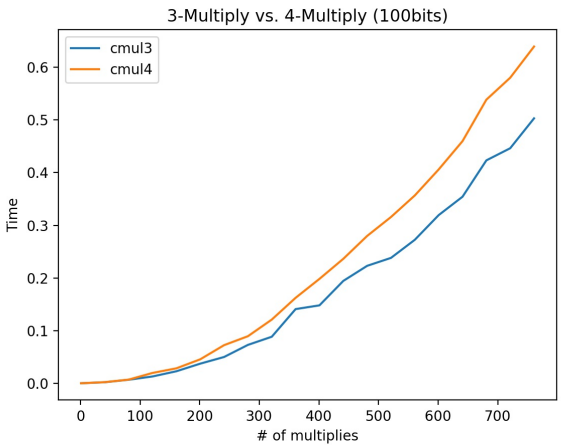


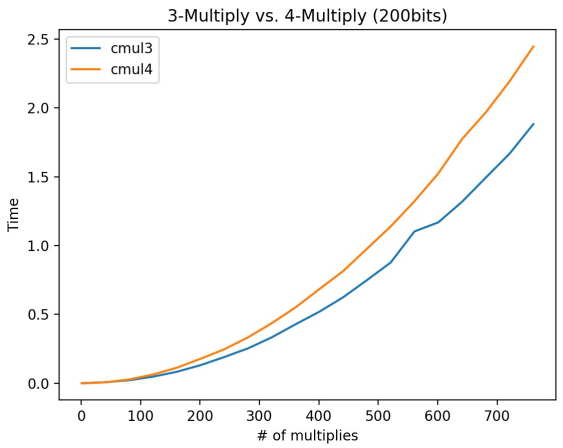

3-Multiply vs. 4-Multiply (40bits)
cmul3
cmul4
Time
# of multiplies
0.0
0.2
0.4
0.6
0.8
0
250
500
750
1000
1250
1500
1750
2000


3-Multiply vs. 4-Multiply (50bits)
cmul3
cmul4
Time
# of multiplies
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0
250
500
750
1000
1250
1500
1750
2000


3-Multiply vs. 4-Multiply (75bits)
cmul3
cmul4
Time
# of multiplies
0.0
0.5
1.0
1.5
2.0
0
250
500
750
1000
1250
1500
1750
2000


3-Multiply vs. 4-Multiply (90bits)
cmul3
cmul4
Time
# of multiplies
0.0
0.1
0.2
0.3
0.4
0.5
0
100
200
300
400
500
600
700


3-Multiply vs. 4-Multiply (100bits)
cmul3
cmul4
Time
# of multiplies
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0
100
200
300
400
500
600
700


3-Multiply vs. 4-Multiply (200bits)
cmul3
cmul4
Time
# of multiplies
0.0
0.5
1.0
1.5
2.0
2.5
0
100
200
300
400
500
600
700