Ex04_p03

- To measure the CPU time of a for loop unrolled to the depths 1, 2, ... 32 I wrote a python script to generate six programs. These programs were then compiled with both -O0 and -O3 and executed n=100 times. Finally I used a python script to calculate the average CPU time of each program

unroll.py

```
def unroll_loop(degree: int) -> str:
    retval = ""
    if degree == 0:
        retval += f'a[i] = i;\n'
    else:
        retval += unroll_loop(degree - 1)
        if degree != 1:
            retval += f'\t\ta[i + {degree - 1}] = i +
{degree - 1};\n'
    return retval

def create_programs() -> None:
    i = 1
    while(i <= 32):
        program = \
f"""
#include <iostream>
#include <cstdint>
#include <chrono>

double unrolled_loop_{i}(int32_t *a, int size)
{{
    auto start = std::chrono::high_resolution_clock::now();
    for (int i = 0; i < size; i += {i}) {{
        {unroll_loop(i)[:-1]}
    }}
    auto finnish =
std::chrono::high_resolution_clock::now();
    std::chrono::duration<double> elapsed = finnish - start;

    return elapsed.count();
}}

int main()
{{
    int size = 1048576;
    int32_t a[size];
```

```
    double duration = unrolled_loop_{i}(a, size);
    std::cout << duration << std::endl;

    return 0;
}}
"""
        print('Creating program ...')
        print(f'Writing program to p03_{i}.cpp ...')
        with open(f'p03_{i}.cpp', 'w') as f:
            f.write(program)
        print('Done')

        i = i*2

def main() -> None:
    create_programs()

if __name__ == '__main__':
    main()
```

Results:

- As one can see, the difference in performance between -O0 and -O3 optimisation is very noticeable for every program except the one where the loop was unrolled to a depth of 32.

Output from medians.py

```
Average of out/p03_1_O0: 0.0012276153000000001 s
Average of out/p03_1_O3: 1.831e-08 s
Average of out/p03_2_O0: 0.0007998133200000002 s
Average of out/p03_2_O3: 2.3320000000000003e-08 s
Average of out/p03_4_O0: 0.00085169661 s
Average of out/p03_4_O3: 2.2480000000000003e-08 s
Average of out/p03_8_O0: 0.0007397689099999999 s
Average of out/p03_8_O3: 2.0040000000000003e-08 s
Average of out/p03_16_O0: 0.00069741491 s
Average of out/p03_16_O3: 2.4560000000000003e-08 s
Average of out/p03_32_O0: 0.0006616861200000002 s
Average of out/p03_32_O3: 0.0003581083600000001 s
```