Howard University
College of Engineering and Architecture
Computer Organization II – Benchmark Project

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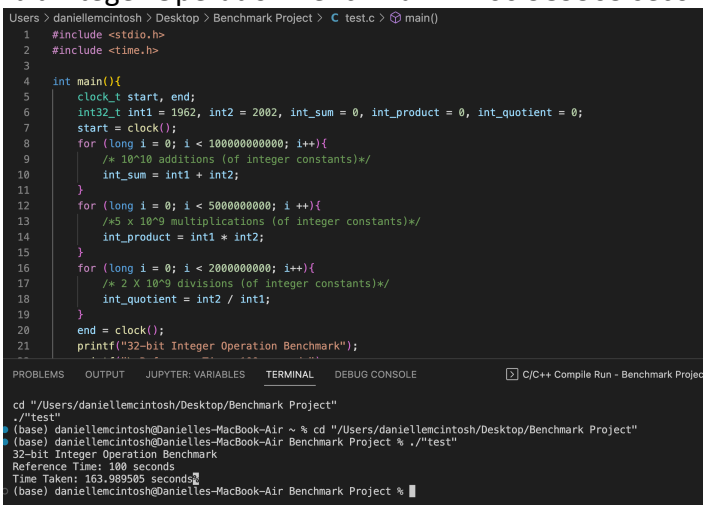
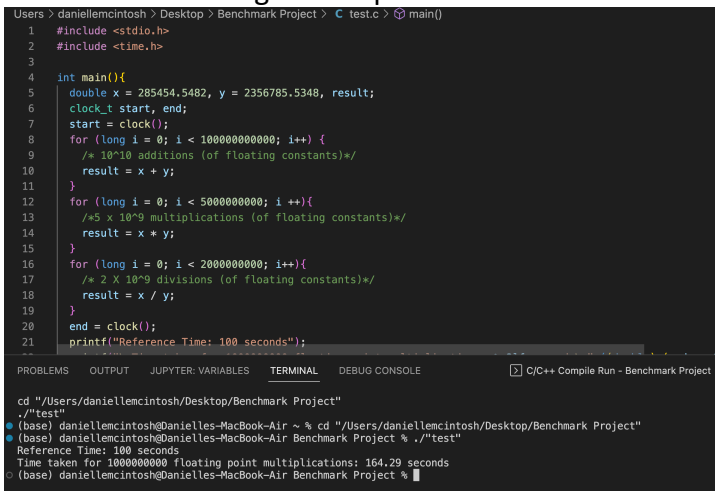
Computer Specifications:

- Brand of CPU: Apple Silicon M2
- Model of CPU: Apple M2
- Number of Cores on CPU: 8
- The Clock Rate of CPU in GHz: 1952 MHz
- Memory: 16 GB
- Speed of Memory: LPDDR5
- Capacity of Hard Drive: 512 GB
- Type of Hard Drive: SSD
- Max Sequential Read Speed: 3.5 GB/s
- Max Sequential Write Speed: 2.8 GB/s
- Max Random Read Speed: 1 GB/s
- Max Random Write Speed: 800 MB/s

32-bit Integer Operation Benchmark – 166.989505 seconds

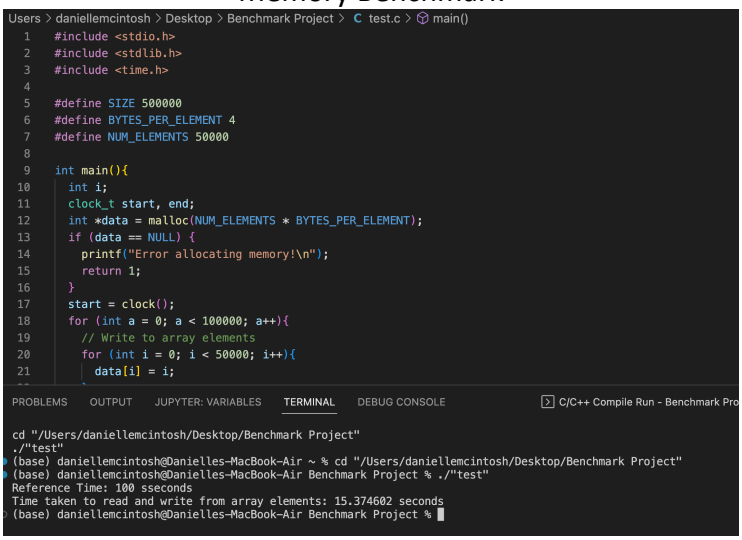


64-bit Floating Point Operation Benchmark



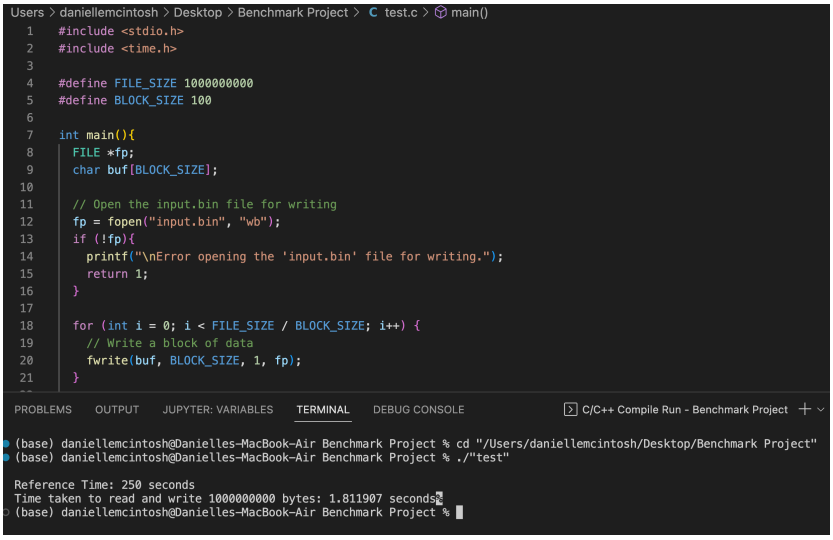
```
Users > daniellemcintosh > Desktop > Benchmark Project > C test.c > main()
#include <stdio.h>
#include <time.h>

int main(){
  double x = 285454.5482, y = 2356785.5348, result;
  clock_t start, end;
  start = clock();
  for (long i = 0; i < 100000000000; i++) {
    /* 10^10 additions (of floating constants)*/
    result = x + y;
  }
  for (long i = 0; i < 5000000000; i ++){
    /*5 x 10^9 multiplications (of floating constants)*/
    result = x * y;
  }
  for (long i = 0; i < 2000000000; i++){
    /* 2 X 10^9 divisions (of floating constants)*/
    result = x / y;
  }
  end = clock();
  printf("Reference Time: 100 seconds");

PROBLEMS  OUTPUT  JUPYTER: VARIABLES  TERMINAL  DEBUG CONSOLE  C/C++ Compile Run - Benchmark Project

cd "/Users/daniellemcintosh/Desktop/Benchmark Project"
./"test"
(base) daniellemcintosh@Danielles-MacBook-Air ~ % cd "/Users/daniellemcintosh/Desktop/Benchmark Project"
(base) daniellemcintosh@Danielles-MacBook-Air Benchmark Project % ./"test"
Reference Time: 100 seconds
Time taken for 1000000000 floating point multiplications: 164.29 seconds
(base) daniellemcintosh@Danielles-MacBook-Air Benchmark Project %
```

Memory Benchmark



```
Users > daniellemcintosh > Desktop > Benchmark Project > C test.c > main()
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

#define SIZE 500000
#define BYTES_PER_ELEMENT 4
#define NUM_ELEMENTS 50000

int main(){
  int i;
  clock_t start, end;
  int *data = malloc(NUM_ELEMENTS * BYTES_PER_ELEMENT);
  if (data == NULL) {
    printf("Error allocating memory!\n");
    return 1;
  }
  start = clock();
  for (int a = 0; a < 100000; a++){
    // Write to array elements
    for (int i = 0; i < 50000; i++){
      data[i] = i;

PROBLEMS  OUTPUT  JUPYTER: VARIABLES  TERMINAL  DEBUG CONSOLE  C/C++ Compile Run - Benchmark Pro

cd "/Users/daniellemcintosh/Desktop/Benchmark Project"
./"test"
(base) daniellemcintosh@Danielles-MacBook-Air ~ % cd "/Users/daniellemcintosh/Desktop/Benchmark Project"
(base) daniellemcintosh@Danielles-MacBook-Air Benchmark Project % ./"test"
Reference Time: 100 sseconds
Time taken to read and write from array elements: 15.374602 seconds
(base) daniellemcintosh@Danielles-MacBook-Air Benchmark Project %
```

Hard Drive Benchmark 1



Hard Drive Benchmark 2

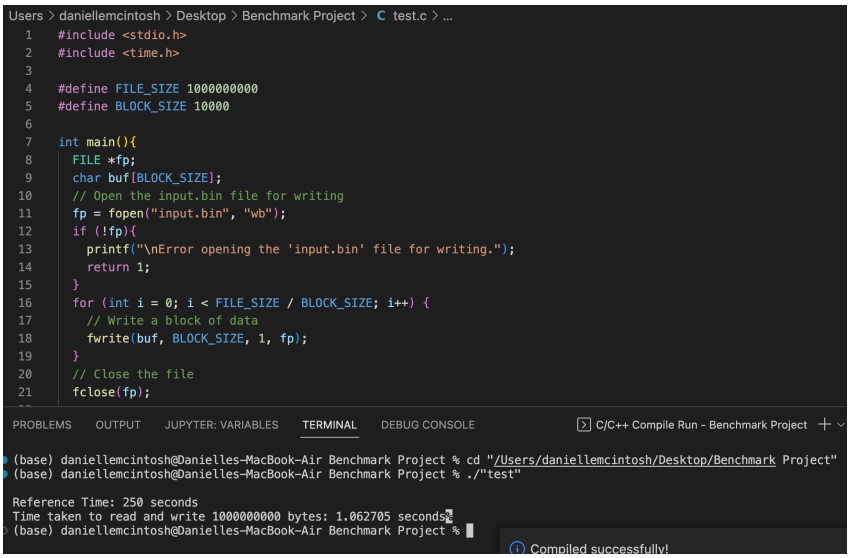


Table Showing Benchmark Results

	Reference Time (s)	Execution Time (s)	Reference: Execution Time
Integer	100	163.990	0.610
Float	100	164.290	0.609
Memory	100	15.375	6.504
Hard Drive 1	250	1.812	237.969
Hard Drive 2	10	1.063	9.407

Geometric Mean: $\sqrt[n]{\sum_{i=1}^{n} \text{Execution Time Ratio}_i}$

$=\sqrt[5]{0.610 \times 0.609 \times 6.504 \times 237.969 \times 9.407}$

$=\sqrt[5]{5408.77842}$

$=5.579815488$