Edwin (Bonny) Sparkes
9-8-21

Lab 03 - Orders of Growth

1) a. $\log_2 n \rightarrow \log_2 4n - \log_2 n = \log_2\left(\frac{4n}{n}\right) = \log_2(4) = 2$

b. $\sqrt{n} \rightarrow \sqrt{4n}/\sqrt{n} = \sqrt{4} = 2$ [2x longer for 4x larger]

c. $n \rightarrow 4n/n = 4$ [4x longer for 4x larger]

d. $n^2 \rightarrow (4n)^2/n^2 = \frac{16n^2}{n^2} = 16$ [16x longer for 4x larger]

e. $n^3 \rightarrow (4n)^3/n^3 = \frac{64n^3}{n^3} = 64$ [64x longer for 4x larger]

f. $2^n \rightarrow 2^{4n}/2^n = 2^{4n-n} = 2^{3n}$ [bad, just really bad]

2) proof.

$$\frac{\log_2 a}{\log_a b} \stackrel{?}{=} \frac{\ln a}{\ln b} = \frac{\log_2 a \cdot \log_e 2}{\log_2 b \cdot \log_e 2} = \frac{\log_2 a}{\log_2 b} \checkmark$$

$$\lim_{x\to\infty} \log(4x)/\log(x) = \lim_{x\to\infty} \frac{\log 4}{\log n} + 1 = 0 + 1 = 1$$

3) $$\frac{|mil|^2 + \sqrt{|mil|}}{1000^2 + \sqrt{1000}} = \frac{(1000\cdot 1000)^2 + \sqrt{1000\cdot 1000}}{1000^2 + \sqrt{1000}}$$

$$\Rightarrow \frac{\frac{1000^2}{1000^2}}{\frac{1000^2 + \sqrt{1000}}{1000^2}} \approx \frac{1000\cdot 1000 + 0}{1 + 0}$$

or

$$= \frac{|mil|^2}{1000^2} + \frac{\sqrt{|mil|}}{\sqrt{1000}} = 1000^2 + \frac{1000}{32} \approx 1 \text{ million}$$

$$\approx 10^6 \cdot 2 \text{ min} = 1388 \text{ days}$$

$$\approx 3 \text{ years}$$

$= n^2 + \sqrt{n} \in \mathcal{O}(n^2)$

4) $25 \cdot n^2 \cdot \log_2(n) = \frac{25 \cdot 100{,}000^2 \cdot \log_2(100{,}000)}{25 \cdot 500^2 \cdot \log_2(500)}$

$= \frac{4.152 \times 10^{12}}{5.603 \times 10^{7}} \approx 74{,}102$ minutes or ≈ 51 days

5) $C_{avg}(n) = \frac{P(n+1)}{2} + n(1-P)$, $n = 10{,}000$

$P\%1 = 0.01(10{,}000+1)/2 + 10{,}000(1-0.01) = 9950.01$

$P\%20 = 0.2(10{,}000+1)/2 + 10{,}000(1-0.2) = 9000.1$

$P\%50 = 0.5(10{,}000+1)/2 + 10{,}000(1-0.5) = 7500.25$

$P\%80 = 0.8(10{,}000+1)/2 + 10{,}000(1-0.8) = 6000.4$

$P\%99 = .99(10{,}000+1)/2 + 10{,}000(1-0.99) = 5050.5$

6)

$C_1(n) = n^2 \quad C_2(n) = 10 \cdot n \cdot \log_2(n)$ $\left[\log_2(n) = \log_e n / \log_e 2\right]$

for all values > 60 n^2 will take substantially longer.

File Edit View Navigate Code Refactor Build Run Tools VCS Window Help Data_Structures_Lab_03 - main.c

Data_Structures_Lab_03 〉 main.c

Project

Data_Structures_Lab_03
External Libraries
Scratches and Consoles

main.c

```c
// Edwin (Sonny) Sparks
// September 8, 2021
#include <stdio.h>
#include <math.h>
#define SIZE 20

int main() {
    float ratios[SIZE];
    float n;
        printf( _Format: "The Values of n are: \n");
            for(int i=0;i<SIZE;i++) {
                n=10*(i+1);
                ratios[i] = (log( _X: 4 * n)/(log(n)));
                printf( _Format: "%.f\t", n);
    }
        printf( _Format: "\nThe Ratios for 10 to 200, incrementing by 10 is: \n");
            for(int i=0;i<SIZE;i++) {
                printf( _Format: "%.2f\t", ratios[i]);
    }
return 0;
}

```

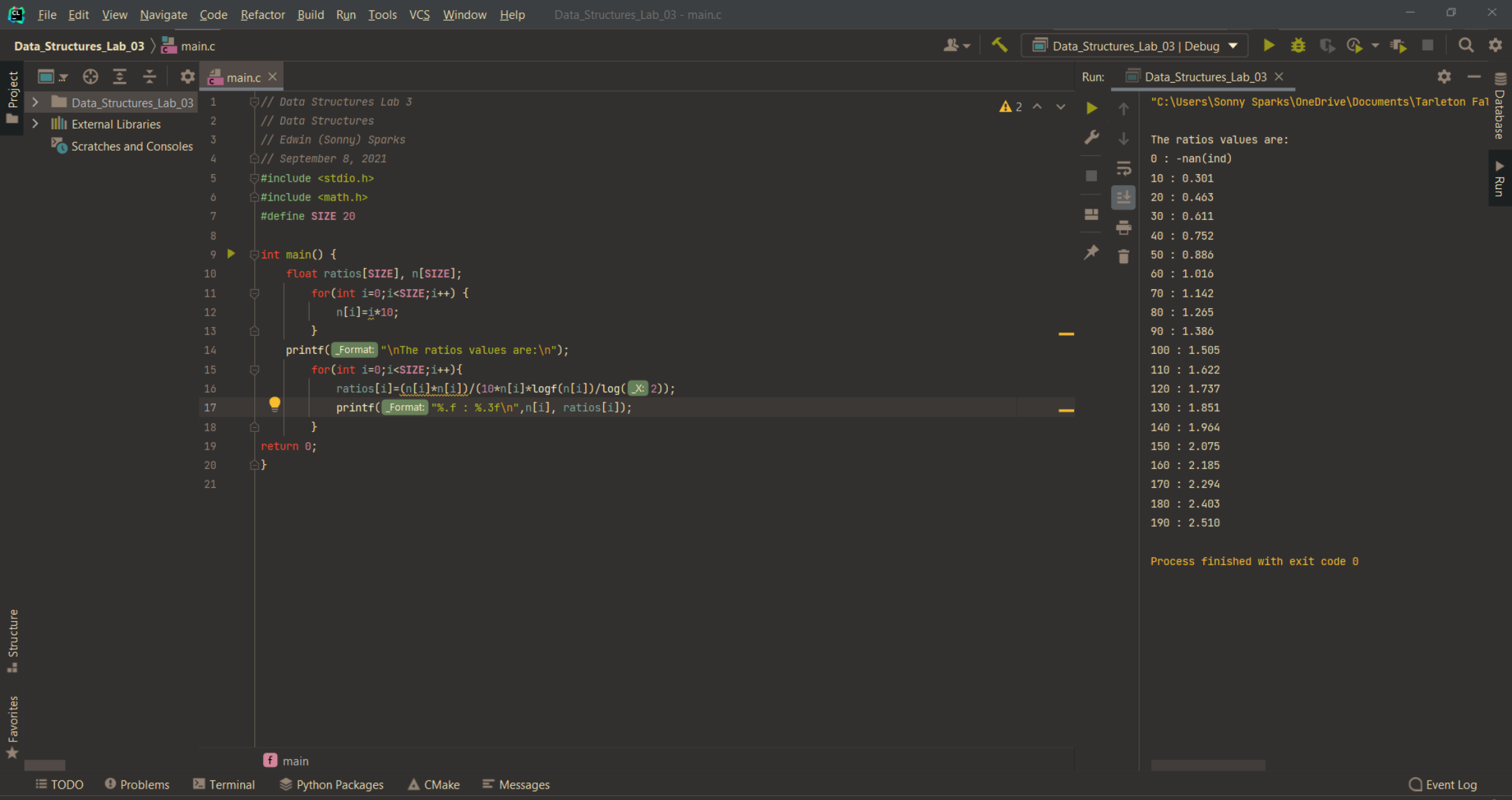
Run: Data_Structures_Lab_03

```
"C:\Users\Sonny Sparks\OneDrive\Documents\Tarleton Fall 21'\Data Structures Lab\Data_Structures_Lab_03\cmake-build-debug\Data_Structures_Lab_03.exe"
The Values of n are:
10      20      30      40      50      60      70      80      90      100     110     120     130     140     150
        160     170     180     190     200
The Ratios for 10 to 200, incrementing by 10 is:
1.60    1.46    1.41    1.38    1.35    1.34    1.33    1.32    1.31    1.30    1.29    1.29    1.28    1.28    1.28
        1.27    1.27    1.27    1.26    1.26
Process finished with exit code 0
```

Structure Favorites

Run TODO Problems Terminal Python Packages CMake Messages

Build finished in 980 ms (4 minutes ago)


File Edit View Navigate Code Refactor Build Run Tools VCS Window Help
Data_Structures_Lab_03 - main.c
Data_Structures_Lab_03 〉 main.c
Data_Structures_Lab_03 | Debug
Project
main.c
Data_Structures_Lab_03
External Libraries
Scratches and Consoles
1 // Data Structures Lab 3
2 // Data Structures
3 // Edwin (Sonny) Sparks
4 // September 8, 2021
5 #include <stdio.h>
6 #include <math.h>
7 #define SIZE 20
8
9 int main() {
10 float ratios[SIZE], n[SIZE];
11 for(int i=0;i<SIZE;i++) {
12 n[i]=i*10;
13 }
14 printf(_Format: "\nThe ratios values are:\n");
15 for(int i=0;i<SIZE;i++){
16 ratios[i]=(n[i]*n[i])/(10*n[i]*logf(n[i])/log(_X: 2));
17 printf(_Format: "%.f : %.3f\n",n[i], ratios[i]);
18 }
19 return 0;
20 }
21
2
main
Run:
Data_Structures_Lab_03
"C:\Users\Sonny Sparks\OneDrive\Documents\Tarleton Fal
The ratios values are:
0 : -nan(ind)
10 : 0.301
20 : 0.463
30 : 0.611
40 : 0.752
50 : 0.886
60 : 1.016
70 : 1.142
80 : 1.265
90 : 1.386
100 : 1.505
110 : 1.622
120 : 1.737
130 : 1.851
140 : 1.964
150 : 2.075
160 : 2.185
170 : 2.294
180 : 2.403
190 : 2.510
Process finished with exit code 0
Database
Run
Structure
Favorites
TODO
Problems
Terminal
Python Packages
CMake
Messages
Event Log