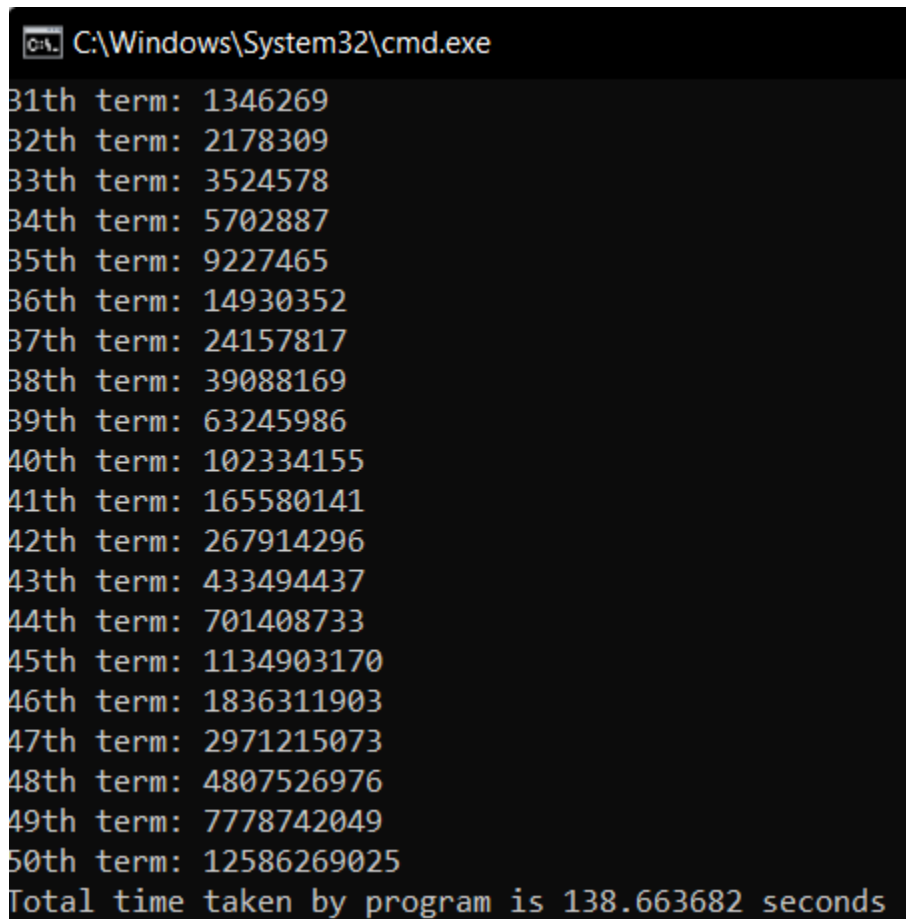


Ans. 1)

- a. The time to print the first 50 numbers of the Fibonacci sequence by the recursion function is 138.663682(Fig. 1)
The time complexity is 1.6^n
So, the time taken to print the first 100 numbers by the recursive function is thus $138.663682 \times (1.6^{50}) = 2.228 \times 10^{12}$ seconds.



```
C:\Windows\System32\cmd.exe
31th term: 1346269
32th term: 2178309
33th term: 3524578
34th term: 5702887
35th term: 9227465
36th term: 14930352
37th term: 24157817
38th term: 39088169
39th term: 63245986
40th term: 102334155
41th term: 165580141
42th term: 267914296
43th term: 433494437
44th term: 701408733
45th term: 1134903170
46th term: 1836311903
47th term: 2971215073
48th term: 4807526976
49th term: 7778742049
50th term: 12586269025
Total time taken by program is 138.663682 seconds
```

Fig 1

- b. The time to print the first 100 numbers of the Fibonacci sequence by the loop method is 0.053947 seconds.

```
C:\Windows\System32\cmd.exe
76th term: 3416454622906707
77th term: 5527939700884757
78th term: 8944394323791464
79th term: 14472334024676221
80th term: 23416728348467685
81th term: 37889062373143906
82th term: 61305790721611591
83th term: 99194853094755497
84th term: 160500643816367088
85th term: 259695496911122585
86th term: 420196140727489673
87th term: 679891637638612258
88th term: 1100087778366101931
89th term: 1779979416004714189
90th term: 2880067194370816120
91th term: 4660046610375530309
92th term: 7540113804746346429
93th term: 12200160415121876738
94th term: 1293530146158671551
95th term: 13493690561280548289
96th term: 14787220707439219840
97th term: 9834167195010216513
98th term: 6174643828739884737
99th term: 16008811023750101250
100th term: 3736710778780434371
Total time taken by program is 0.053947 seconds
```

Fig. 2

- c. The time to print the first 100 numbers of the Fibonacci sequence by the recursion and memoization method is 0.045024 seconds.

```
C:\Windows\System32\cmd.exe
73th term: -2015728079
74th term: -433386095
75th term: 1845853122
76th term: 1412467027
77th term: -1036647147
78th term: 375819880
79th term: -660827267
80th term: -285007387
81th term: -945834654
82th term: -1230842041
83th term: 2118290601
84th term: 887448560
85th term: -1289228135
86th term: -401779575
87th term: -1691007710
88th term: -2092787285
89th term: 511172301
90th term: -1581614984
91th term: -1070442683
92th term: 1642909629
93th term: 572466946
94th term: -2079590721
95th term: -1507123775
96th term: 708252800
97th term: -798870975
98th term: -90618175
99th term: -889489150
100th term: -980107325
Total time taken by program is 0.045024 seconds
```

Fig 3

- d. The time to print the first 100 numbers of the Fibonacci sequence by the loop and memoization method is 0.051582 seconds.

```

C:\Windows\System32\cmd.exe

75th term: 2111485077978050
76th term: 3416454622906707
77th term: 5527939700884757
78th term: 8944394323791464
79th term: 14472334024676221
80th term: 23416728348467685
81th term: 37889062373143906
82th term: 61305790721611591
83th term: 99194853094755497
84th term: 160500643816367088
85th term: 259695496911122585
86th term: 420196140727489673
87th term: 679891637638612258
88th term: 1100087778366101931
89th term: 1779979416004714189
90th term: 2880067194370816120
91th term: 4660046610375530309
92th term: 7540113804746346429
93th term: 12200160415121876738
94th term: 1293530146158671551
95th term: 13493690561280548289
96th term: 14787220707439219840
97th term: 9834167195010216513
98th term: 6174643828739884737
99th term: 16008811023750101250
100th term: 3736710778780434371
Total time taken by program is 0.051582 seconds
D:\CQA programs>

```

Fig 4

Program No.	Method	Time Taken (sec)	SpeedUp w.r.t. Program 1
1	Recursion	2.228×10^{12}	1
2	Loop	0.053947	4.13×10^{13}
3	Recursion and memoization	0.045024	4.958×10^{13}
4	Loop and Memoization	0.051582	4.32×10^{13}

Observations:

- The time taken by the recursion code is very high as compared to the other codes.
- The recursion and memoization code is the best code as it has the maximum speedUp.

Ans. 2)

a. For Bucket 1(Using C):

Integer

N=32

```
2 2030550930 1144171991 1958970119 2112829908 10420
Time taken by the meat program is 0.043981 seconds
Total time taken by the program is 0.044062 seconds
```

Fig 5

N=64

```
Time taken by the meat program is 0.195605 seconds
Total time taken by the program is 0.196089 seconds
```

Fig 6

N=128

```
Time taken by the meat program is 0.721546 seconds
Total time taken by the program is 0.723097 seconds
```

Fig 7

N=256

```
Time taken by the meat program is 5.979152 seconds
Total time taken by the program is 5.981044 seconds
```

Fig 8

N=512

```
Time taken by the meat program is 24.754822 seconds
Total time taken by the program is 24.762992 seconds
```

Fig 9

Double

N=32

```
00 0.000000 2.000000 1.000000 3.000000 1.000000
Time taken by the meat program is 0.046421 seconds
Total time taken by the program is 0.046483 seconds
```

N=64

```
Time taken by the meat program is 0.252000 seconds
Total time taken by the program is 0.252411 seconds
```

N=128

```
Time taken by the meat program is 0.997440 seconds
Total time taken by the program is 0.999019 seconds
```

N=256

```
Time taken by the meat program is 6.916168 seconds
Total time taken by the program is 6.919113 seconds
```

N=512

N	Integer (meat time)(sec)	Integer (Total time)(sec)	Double (meat time)	Double (total time)	Ratio (Integer)	Ratio (Double)
32	0.043981	0.044062	0.046421	0.046483	0.9981616813	0.998666179
64	0.195605	0.196089	0.252	0.252411	0.997531733	0.9983717033
128	0.721546	0.723097	0.99744	0.999019	0.9978550596	0.9984194495
256	5.979152	5.981044	6.916168	6.919113	0.9996836673	0.9995743674
512	24.754822	24.762992	25.951471	25.957403	0.9996700722	0.9997714717

B. For Bucket 2(Using Python):

Integer

N=32

```
Total time for the meat program in sec = 0.02475428581237793 sec
Total time of the program in sec = 0.046862125396728516 sec
```

N=64

```
Total time for the meat program in sec = 0.08868265151977539 sec
Total time of the program in sec = 0.15355825424194336 sec
```

N=128

```
279482 303940 320133 299790 320924 343999 323931 324044
Total time for the meat program in sec = 0.3207824230194092 sec
Total time of the program in sec = 0.436049222946167 sec
```

N=256

```
Total time for the meat program in sec = 2.338372230529785 sec
Total time of the program in sec = 2.9164342880249023 sec
```

N=512

```
1271807 1289071
Total time for the meat program in sec = 17.542900562286377 sec
Total time of the program in sec = 18.477815628051758 sec
```

Double

N=32

```
Total time for the meat program in sec = 0.032256126403808594 sec  
Total time of the program in sec = 0.07241296768188477 sec
```

N=64

```
Total time for the meat program in sec = 0.11471676826477051 sec  
Total time of the program in sec = 0.25203704833984375 sec
```

N=128

```
Total time for the meat program in sec = 0.3170816898345947 sec  
Total time of the program in sec = 0.688032865524292 sec
```

N=256

```
Total time for the meat program in sec = 2.129033088684082 sec  
Total time of the program in sec = 3.2581851482391357 sec
```

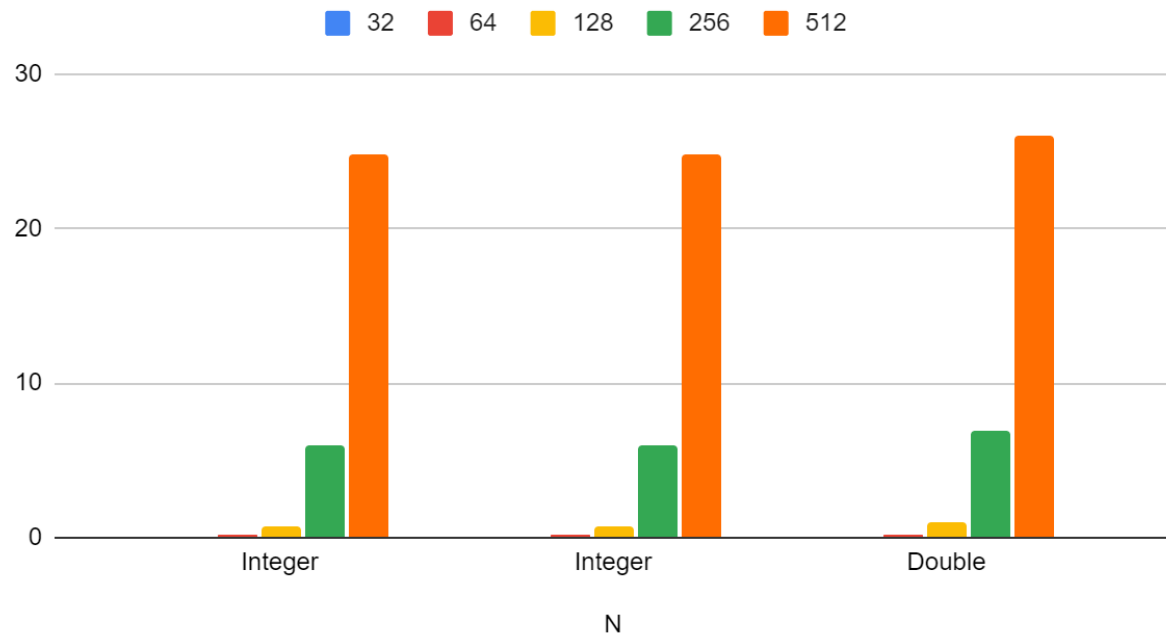
N=512

```
Total time for the meat program in sec = 16.259040594100952 sec  
Total time of the program in sec = 18.49653172492981 sec
```

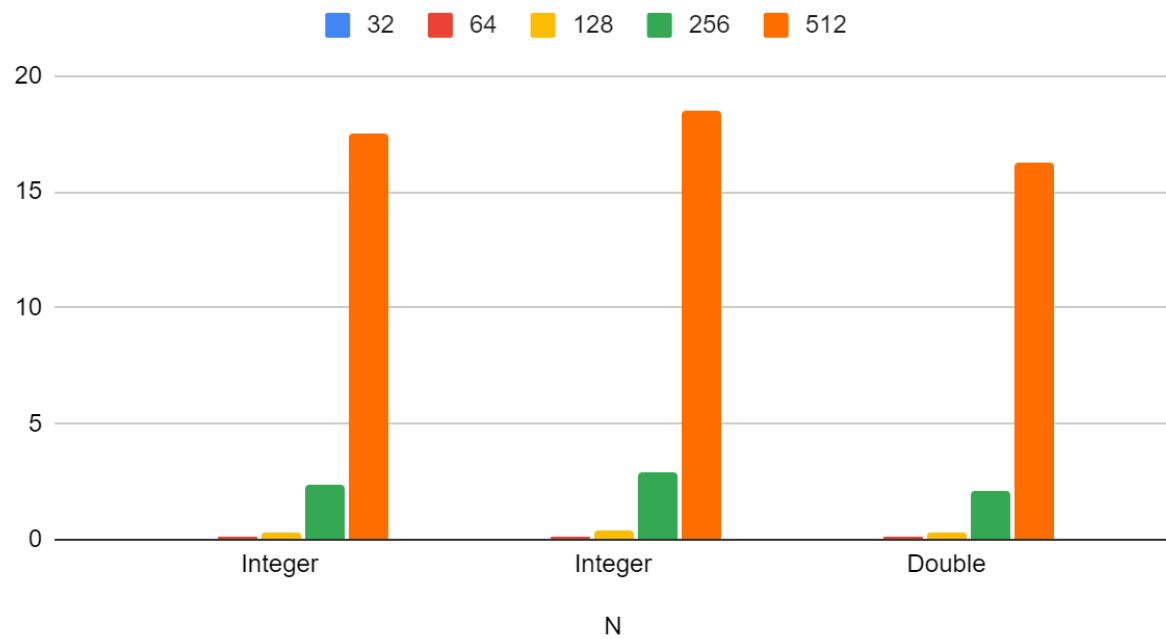
N	Integer (meat time)(sec)	Integer (Total time)(sec)	Double (meat time)	Double (total time)	Ratio (Integer)	Ratio (Double)
32	0.024754	0.046862	0.032256	0.072412	0.5282318296	0.4454510302
64	0.088683	0.153558	0.114716	0.252037	0.5775211972	0.4551553939
128	0.320782	0.436049	0.317082	0.688033	0.7356558552	0.4608528951
256	2.338372	2.916434	2.129033	3.258185	0.8017915029	0.6534414099
512	17.504901	18.477816	16.259041	18.496532	0.9473468618	0.8790318639

C.

Execution time C



Execution Time Python



Observations:

- The program takes more time for double data type than an integer data type.
- The execution time increases with the value of n.
- Python code runs faster than c code comparatively.