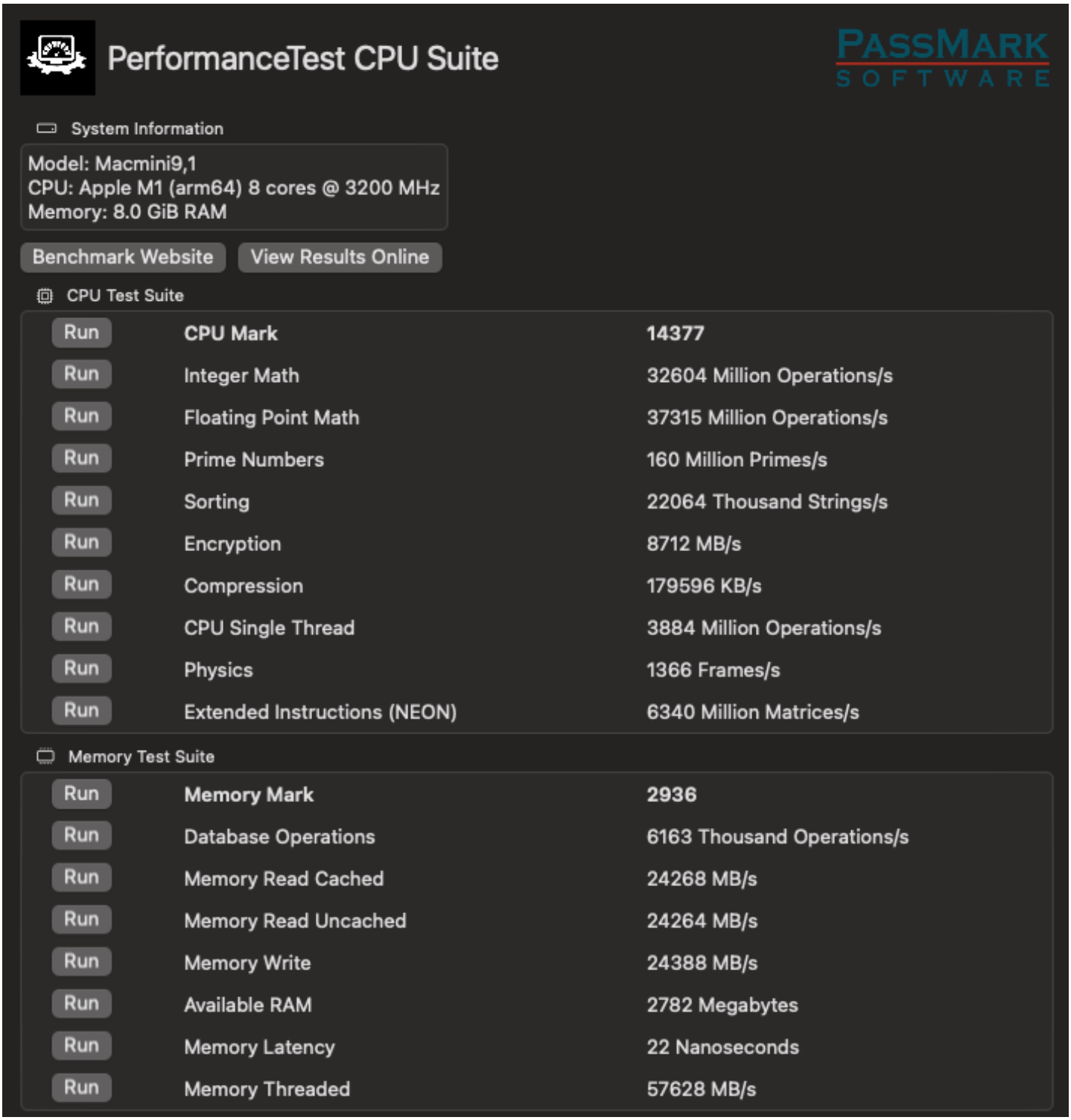
Laboratory 4:

Performance measurements
Mac Mini M1

1)



2)

```
Last login: Tue Apr  5 17:14:23 on ttys000
radama@MacminiRomen ~ % ls
Applications                    Music
Applications (Parallels)        Parallels
Cisco Packet Tracer 8.0.1       Pictures
Cisco Packet Tracer 8.1.0       Public
Desktop                         PycharmProjects
Documents                       Vector
Downloads                       VisualStudio Projects
Games                           Windows
IdeaProjects                    XcodeProjects
Library                         git_test
Movies                          lab4
radama@MacminiRomen ~ % ls
Applications                    Music
Applications (Parallels)        Parallels
Cisco Packet Tracer 8.0.1       Pictures
Cisco Packet Tracer 8.1.0       Public
Desktop                         PycharmProjects
Documents                       Vector
Downloads                       VisualStudio Projects
Games                           Windows
IdeaProjects                    XcodeProjects
Library                         git_test
Movies                          lab4
radama@MacminiRomen ~ % cd lab4
radama@MacminiRomen lab4 % ls
stream          stream.tgz
radama@MacminiRomen lab4 % cd stream
radama@MacminiRomen stream % gcc -c -o3 second_wall.c
radama@MacminiRomen stream % gcc -c -o3 stream_d.c
radama@MacminiRomen stream % gcc -o3 stream_d.o second_wall.o -o stream_d -ls
clang: error: no such file or directory: 'stream_d.o'
clang: error: no such file or directory: 'second_wall.o'
radama@MacminiRomen stream % gcc -c -O3 second_wall.c
radama@MacminiRomen stream % gcc -c -O3 stream_d.c
radama@MacminiRomen stream % gcc -o3 stream_d.o second_wall.o -o stream_d -ls
ld: library not found for -ls
clang: error: linker command failed with exit code 1 (use -v to see invocation)
radama@MacminiRomen stream % gcc -o3 stream_d.o second_wall.o -o stream_d -lm
radama@MacminiRomen stream % ./stream_d
-------------------------------------------------------------
This system uses 8 bytes per DOUBLE PRECISION word.
-------------------------------------------------------------
Array size = 1000000, Offset = 0
Total memory required = 22.9 MB.
Each test is run 10 times, but only
the *best* time for each is used.
-------------------------------------------------------------
Your clock granularity/precision appears to be 1 microseconds.
Each test below will take on the order of 684 microseconds.
   (= 684 clock ticks)
Increase the size of the arrays if this shows that
you are not getting at least 20 clock ticks per test.
-------------------------------------------------------------
WARNING -- The above is only a rough guideline.
For best results, please be sure you know the
precision of your system timer.
-------------------------------------------------------------
Function      Rate (MB/s)   RMS time     Min time     Max time
Copy:       54251.3048       0.0003       0.0003       0.0004
Scale:      39898.2545       0.0005       0.0004       0.0006
Add:        39866.6519       0.0007       0.0006       0.0008
Triad:      39553.3580       0.0007       0.0006       0.0008
radama@MacminiRomen stream %
```

```
-------------------------------------------------------------
This system uses 8 bytes per DOUBLE PRECISION word.
-------------------------------------------------------------
Array size = 1000000, Offset = 0
Total memory required = 22.9 MB.
Each test is run 10 times, but only
the *best* time for each is used.
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Your clock granularity/precision appears to be 1 microseconds.
Each test below will take on the order of 684 microseconds.
   (= 684 clock ticks)
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Scale:      39898.2545       0.0005       0.0004       0.0006
Add:        39866.6519       0.0007       0.0006       0.0008
Triad:      39553.3580       0.0007       0.0006       0.0008
radama@MacminiRomen stream % gcc -c -O3 second_wall.c
radama@MacminiRomen stream % gcc -c -O3 stream_d.c
radama@MacminiRomen stream % gcc -o3 stream_d.o second_wall.o -o stream_d -lm
radama@MacminiRomen stream % ./stream_d
-------------------------------------------------------------
This system uses 8 bytes per DOUBLE PRECISION word.
-------------------------------------------------------------
Array size = 500000, Offset = 0
Total memory required = 11.4 MB.
Each test is run 10 times, but only
the *best* time for each is used.
-------------------------------------------------------------
Your clock granularity/precision appears to be 1 microseconds.
Each test below will take on the order of 335 microseconds.
   (= 335 clock ticks)
Increase the size of the arrays if this shows that
you are not getting at least 20 clock ticks per test.
-------------------------------------------------------------
WARNING -- The above is only a rough guideline.
For best results, please be sure you know the
precision of your system timer.
-------------------------------------------------------------
Function      Rate (MB/s)   RMS time     Min time     Max time
Copy:       50686.4532       0.0002       0.0002       0.0003
Scale:      38086.7560       0.0003       0.0002       0.0003
Add:        36792.1404       0.0004       0.0003       0.0004
Triad:      37172.5613       0.0004       0.0003       0.0004
radama@MacminiRomen stream %
```

```
This system uses 8 bytes per DOUBLE PRECISION word.
-------------------------------------------------------------
Array size = 50000, Offset = 0
Total memory required = 1.1 MB.
Each test is run 10 times, but only
the *best* time for each is used.
-------------------------------------------------------------
Your clock granularity/precision appears to be 1 microseconds.
Each test below will take on the order of 15 microseconds.
   (= 15 clock ticks)
Increase the size of the arrays if this shows that
you are not getting at least 20 clock ticks per test.
-------------------------------------------------------------
WARNING -- The above is only a rough guideline.
For best results, please be sure you know the
precision of your system timer.
-------------------------------------------------------------
Function      Rate (MB/s)   RMS time     Min time     Max time
Copy:       53261.0032       0.0000       0.0000       0.0000
Scale:      39945.7524       0.0000       0.0000       0.0000
Add:        37560.9313       0.0000       0.0000       0.0000
Triad:      37560.9313       0.0000       0.0000       0.0001
radama@MacminiRomen stream %
radama@MacminiRomen stream % gcc -c -O3 second_wall.c
radama@MacminiRomen stream % gcc -c -O3 stream_d.c
radama@MacminiRomen stream % gcc -o3 stream_d.o second_wall.o -o stream_d -lm
radama@MacminiRomen stream % ./stream_d
-------------------------------------------------------------
This system uses 8 bytes per DOUBLE PRECISION word.
-------------------------------------------------------------
Array size = 10000, Offset = 0
Total memory required = 0.2 MB.
Each test is run 10 times, but only
the *best* time for each is used.
-------------------------------------------------------------
Your clock granularity/precision appears to be 1 microseconds.
Each test below will take on the order of 4 microseconds.
   (= 4 clock ticks)
Increase the size of the arrays if this shows that
you are not getting at least 20 clock ticks per test.
-------------------------------------------------------------
WARNING -- The above is only a rough guideline.
For best results, please be sure you know the
precision of your system timer.
-------------------------------------------------------------
Function      Rate (MB/s)   RMS time     Min time     Max time
Copy:       39475.8024       0.0000       0.0000       0.0000
Scale:      31956.6019       0.0000       0.0000       0.0000
Add:        30504.0291       0.0000       0.0000       0.0000
Triad:      30504.0291       0.0000       0.0000       0.0000
radama@MacminiRomen stream %
```

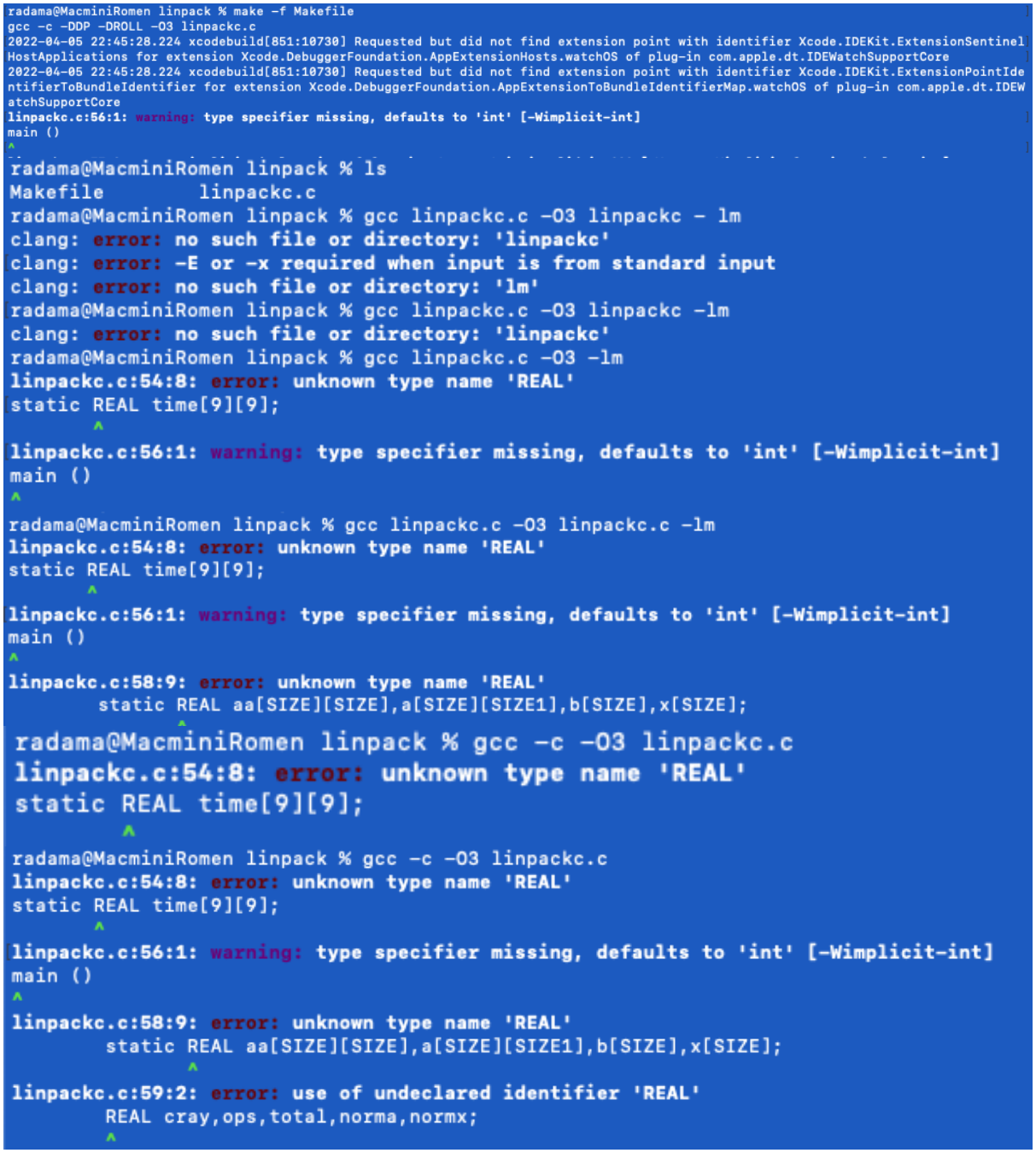
```
radama@MacminiRomen stream % gcc -c -O3 second_wall.c
radama@MacminiRomen stream % gcc -c -O3 stream_d.c
stream_d.c:97:5: warning: overflow in expression; result is -1294967296 with type 'int' [-Winteger-overflow]
       (3 * N * BytesPerWord) / 1048576.0);
        ^
1 warning generated.
radama@MacminiRomen stream % gcc -c -O3 stream_d.c
radama@MacminiRomen stream % gcc -o3 stream_d.o second_wall.o -o stream_d -lm
radama@MacminiRomen stream % ./stream_d
dyld[11640]: dyld cache '/System/Library/dyld/dyld_shared_cache_arm64e' not loaded: syscall to map cache into shared region failed
dyld[11640]: Library not loaded: /usr/lib/libSystem.B.dylib
  Referenced from: /Users/radama/lab4/stream/stream_d
  Reason: tried: '/usr/lib/libSystem.B.dylib' (no such file), '/usr/local/lib/libSystem.B.dylib' (no such file)
zsh: abort      ./stream_d
radama@MacminiRomen stream %
```

```
This system uses 8 bytes per DOUBLE PRECISION word.
-------------------------------------------------------------
Array size = 10000000, Offset = 0
Total memory required = 228.9 MB.
Each test is run 10 times, but only
the *best* time for each is used.
-------------------------------------------------------------
Your clock granularity/precision appears to be 1 microseconds.
Each test below will take on the order of 10478 microseconds.
   (= 10478 clock ticks)
Increase the size of the arrays if this shows that
you are not getting at least 20 clock ticks per test.
-------------------------------------------------------------
WARNING -- The above is only a rough guideline.
For best results, please be sure you know the
precision of your system timer.
-------------------------------------------------------------
Function      Rate (MB/s)   RMS time     Min time     Max time
Copy:       62183.8992       0.0034       0.0026       0.0075
Scale:      58800.3715       0.0039       0.0027       0.0090
Add:        58767.7599       0.0043       0.0041       0.0050
Triad:      58750.6105       0.0042       0.0041       0.0049
radama@MacminiRomen stream %
```

```
This system uses 8 bytes per DOUBLE PRECISION word.
-------------------------------------------------------------
Array size = 50000000, Offset = 0
Total memory required = 1144.4 MB.
Each test is run 10 times, but only
the *best* time for each is used.
-------------------------------------------------------------
Your clock granularity/precision appears to be 1 microseconds.
Each test below will take on the order of 38091 microseconds.
   (= 38091 clock ticks)
Increase the size of the arrays if this shows that
you are not getting at least 20 clock ticks per test.
-------------------------------------------------------------
WARNING -- The above is only a rough guideline.
For best results, please be sure you know the
precision of your system timer.
-------------------------------------------------------------
Function      Rate (MB/s)   RMS time     Min time     Max time
Copy:       60087.0870       0.0325       0.0133       0.0945
Scale:      59741.5376       0.0363       0.0134       0.1073
Add:        58298.0807       0.0208       0.0206       0.0212
Triad:      58422.5929       0.0208       0.0205       0.0223
radama@MacminiRomen stream %
```

3) The Make option was impossible to run into the mac M1 processor and SO.

```
Last login: Tue Apr  5 22:23:09 on ttys000
radama@MacminiRomen ~ % ls
Applications                    Music
Applications (Parallels)        Parallels
Cisco Packet Tracer 8.0.1       Pictures
Cisco Packet Tracer 8.1.0       Public
Desktop                         PycharmProjects
Documents                       Vector
Downloads                       VisualStudio Projects
Games                           Windows
IdeaProjects                    XcodeProjects
Library                         git_test
Movies                          lab4
radama@MacminiRomen ~ % cd lab4
radama@MacminiRomen lab4 % ls
linpack.tgz     stream          stream.tgz
radama@MacminiRomen lab4 % cd linpack
radama@MacminiRomen linpack % ls
Makefile        linpackc.c
radama@MacminiRomen linpack % make
gcc -c -DDP -DROLL -O3 linpackc.c
linpackc.c:56:1: warning: type specifier missing, defaults to 'int' [-Wimplicit-int]
main ()
^
linpackc.c:77:9: error: implicit declaration of function 'matgen' is invalid in C99 [-Werror,-Wimplicit-function-declaration]
        matgen(a,lda,n,b,&norma);
        ^
linpackc.c:79:9: error: implicit declaration of function 'dgefa' is invalid in C99 [-Werror,-Wimplicit-function-declaration]
        dgefa(a,lda,n,ipvt,&info);
        ^
linpackc.c:82:9: error: implicit declaration of function 'dgesl' is invalid in C99 [-Werror,-Wimplicit-function-declaration]
        dgesl(a,lda,n,ipvt,b,0);
        ^
linpackc.c:95:9: error: implicit declaration of function 'dmxpy' is invalid in C99 [-Werror,-Wimplicit-function-declaration]
        dmxpy(n,b,n,lda,x,a);
        ^
linpackc.c:123:2: error: implicit declaration of function 'print_time' is invalid in C99 [-Werror,-Wimplicit-function-declaration]
        print_time(0);
        ^
linpackc.c:262:1: warning: type specifier missing, defaults to 'int' [-Wimplicit-int]
print_time (row)
^
linpackc.c:268:1: warning: non-void function does not return a value [-Wreturn-type]
}
^
linpackc.c:271:1: warning: type specifier missing, defaults to 'int' [-Wimplicit-int]
matgen(a,lda,n,b,norma)
^
linpackc.c:298:1: warning: non-void function does not return a value [-Wreturn-type]
}
^
linpackc.c:301:1: warning: type specifier missing, defaults to 'int' [-Wimplicit-int]
dgefa(a,lda,n,ipvt,info)
^
linpackc.c:388:5: error: implicit declaration of function 'dscal' is invalid in C99 [-Werror,-Wimplicit-function-declaration]
                        dscal(n-(k+1),t,&a[lda*k+k+1],1);
                        ^
linpackc.c:398:6: error: implicit declaration of function 'daxpy' is invalid in C99 [-Werror,-Wimplicit-function-declaration]
                                daxpy(n-(k+1),t,&a[lda*k+k+1],1,
                                ^
linpackc.c:409:1: warning: non-void function does not return a value [-Wreturn-type]
}
^
linpackc.c:413:1: warning: type specifier missing, defaults to 'int' [-Wimplicit-int]
dgesl(a,lda,n,ipvt,b,job)
^
make: *** [linpackc.o] Error 1
radama@MacminiRomen linpack %
radama@MacminiRomen linpack % sudo apt install make
Password:
The operation couldn't be completed. Unable to locate a Java Runtime that supports apt.
Please visit http://www.java.com for information on installing Java.

radama@MacminiRomen linpack % sudo apt install make
The operation couldn't be completed. Unable to locate a Java Runtime that supports apt.
Please visit http://www.java.com for information on installing Java.

radama@MacminiRomen linpack % sudo apt install make
The operation couldn't be completed. Unable to locate a Java Runtime that supports apt.
Please visit http://www.java.com for information on installing Java.

radama@MacminiRomen linpack % exit

Saving session...
...copying shared history...
...saving history...truncating history files...
...completed.

[Process completed]
```


radama@MacminiRomen linpack % make -f Makefile
gcc -c -DDP -DROLL -O3 linpackc.c
2022-04-05 22:45:28.224 xcodebuild[851:10730] Requested but did not find extension point with identifier Xcode.IDEKit.ExtensionSentinel HostApplications for extension Xcode.DebuggerFoundation.AppExtensionHosts.watchOS of plug-in com.apple.dt.IDEWatchSupportCore
2022-04-05 22:45:28.224 xcodebuild[851:10730] Requested but did not find extension point with identifier Xcode.IDEKit.ExtensionPointIdentifierToBundleIdentifier for extension Xcode.DebuggerFoundation.AppExtensionToBundleIdentifierMap.watchOS of plug-in com.apple.dt.IDEWatchSupportCore
linpackc.c:56:1: warning: type specifier missing, defaults to 'int' [-Wimplicit-int]
main ()
^
radama@MacminiRomen linpack % ls
Makefile linpackc.c
radama@MacminiRomen linpack % gcc linpackc.c -O3 linpackc - lm
clang: error: no such file or directory: 'linpackc'
clang: error: -E or -x required when input is from standard input
clang: error: no such file or directory: 'lm'
radama@MacminiRomen linpack % gcc linpackc.c -O3 linpackc -lm
clang: error: no such file or directory: 'linpackc'
radama@MacminiRomen linpack % gcc linpackc.c -O3 -lm
linpackc.c:54:8: error: unknown type name 'REAL'
static REAL time[9][9];
^
linpackc.c:56:1: warning: type specifier missing, defaults to 'int' [-Wimplicit-int]
main ()
^
radama@MacminiRomen linpack % gcc linpackc.c -O3 linpackc.c -lm
linpackc.c:54:8: error: unknown type name 'REAL'
static REAL time[9][9];
^
linpackc.c:56:1: warning: type specifier missing, defaults to 'int' [-Wimplicit-int]
main ()
^
linpackc.c:58:9: error: unknown type name 'REAL'
static REAL aa[SIZE][SIZE],a[SIZE][SIZE1],b[SIZE],x[SIZE];
^
radama@MacminiRomen linpack % gcc -c -O3 linpackc.c
linpackc.c:54:8: error: unknown type name 'REAL'
static REAL time[9][9];
^
radama@MacminiRomen linpack % gcc -c -O3 linpackc.c
linpackc.c:54:8: error: unknown type name 'REAL'
static REAL time[9][9];
^
linpackc.c:56:1: warning: type specifier missing, defaults to 'int' [-Wimplicit-int]
main ()
^
linpackc.c:58:9: error: unknown type name 'REAL'
static REAL aa[SIZE][SIZE],a[SIZE][SIZE1],b[SIZE],x[SIZE];
^
linpackc.c:59:2: error: use of undeclared identifier 'REAL'
REAL cray,ops,total,norma,normx;
^

Macbook Air running Manjaro Linux OS

1)

CPU Benchmark Scores

611	1266
Single-Core Score	Multi-Core Score

Device Information

Name	MacBook Air (13-inch Early 2015)
Model Identifier	MacBookAir7,2
CPU	Intel Core i5-5250U
CPU Frequency	1600 MHz
CPUs	1
CPU Cores	2
CPU Threads	4

2)

	Test 1	Test 2	Test 3	Test 4	Test 5
Array Size	50000000	10000000	10000000	5000000	50000
Total Memory	1144.4MB	228.9 MB	228.9 MB	114.4 MB	1.1 MB

Macbook Air Early 2015

Function	Test 1	Test 2	Test 3	Test 4	Test 5
Copy Rate	18101.6211	17746.1561	17187.5692	17065.6251	28435.9593
Scale Rate	11433.8007	11434.2683	11076.4461	11256.4769	25811.1015
Add Rate	12654.0913	12516.2629	11779.1334	11678.6895	27807.5403
Triad Rate	12300.8835	12322.8988	11702.7211	11568.6322	27962.0267
Copy RMS time	0.045	0.0093	0.0095	0.0047	0
Scale RMS time	0.0701	0.0147	0.0149	0.0073	0
Add RMS time	0.0953	0.0202	0.0205	0.0104	0
Triad RMS time	0.0983	0.0199	0.0209	0.0106	0
Copy Min time	0.0442	0.009	0.0093	0.0047	0
Scale Min time	0.07	0.014	0.0144	0.0071	0
Add Min time	0.0948	0.0192	0.0204	0.0103	0
Triad Min time	0.0976	0.0195	0.0205	0.0104	0
Copy Max time	0.0484	0.0101	0.0101	0.0049	0
Scale Max time	0.0703	0.0172	0.0162	0.0078	0
Add Max time	0.0957	0.0254	0.0209	0.0105	0.0001
Triad Max time	0.0998	0.0219	0.021	0.0116	0.0001

3)

Rolled Double Precision Linpackc Array Size	Test 1 100000000	Test 2 178800	Test 3 1283	Test 4 123456789	Test 5 987654321

Function	Test 1	Test 2	Test 3	Test 4	Test 5
Norm. Resid	1.7	1.7	1.7	1.7	1.7
Resid	7.42E-14	7.42E-14	7.42E-14	7.42E-14	7.42E-14
Mached	2.22E-16	2.22E-16	2.22E-16	2.22E-16	2.22E-16
X[0]-1	-1.50E-14	-1.50E-14	-1.50E-14	-1.50E-14	-1.50E-14
X[0]-1	-1.89E-14	-1.89E-14	-1.89E-14	-1.89E-14	-1.89E-14
Rolled Double Precision 2255804 kflops	2255804	2275237	2186140	1799441	2236699