	Sizes of the libraries	**Sizes of the executable images**
Static	3524	632332
Dynamic	7032	7177

Static-Linking Libraries:

```
M11212913@telnet:~/SystemSoftware/stclnk-demo$ ls -l
total 16
-rw-r--r-- 1 M11212913 telnet  98 2024-11-11 21:38 main.c
-rw-r--r-- 1 M11212913 telnet 285 2024-11-11 21:42 others.c
-rw-r--r-- 1 M11212913 telnet 153 2024-11-10 03:26 sayhelloA.c
-rw-r--r-- 1 M11212913 telnet 152 2024-11-11 21:36 sayhello.c
M11212913@telnet:~/SystemSoftware/stclnk-demo$ vim others.c
M11212913@telnet:~/SystemSoftware/stclnk-demo$ more others.c
#include <math.h>
#include <string.h>
#include <stdio.h>

void additinalFunction() {
        double value = sqrt(123456.789);
        printf("test: %f\n", value);
}

void stringMul() {
        char buffer[100];
        strcpy(buffer, "Hello World!\n");
        strcat(buffer, "How are you?\n");
        printf("%s", buffer);
}
M11212913@telnet:~/SystemSoftware/stclnk-demo$
```

多建一個 others.c. 在 main.c 中會呼叫這兩個函式

```
M11212913@telnet:~/SystemSoftware/stclnk-demo$ gcc -c sayhello.c sayhelloA.c others.c
M11212913@telnet:~/SystemSoftware/stclnk-demo$ ls -l
total 28
-rw-r--r-- 1 M11212913 telnet   98 2024-11-11 21:38 main.c
-rw-r--r-- 1 M11212913 telnet  285 2024-11-11 21:43 others.c
-rw-r--r-- 1 M11212913 telnet 1240 2024-11-11 21:44 others.o
-rw-r--r-- 1 M11212913 telnet  153 2024-11-10 03:26 sayhelloA.c
-rw-r--r-- 1 M11212913 telnet  984 2024-11-11 21:44 sayhelloA.o
-rw-r--r-- 1 M11212913 telnet  152 2024-11-11 21:36 sayhello.c
-rw-r--r-- 1 M11212913 telnet  984 2024-11-11 21:44 sayhello.o
M11212913@telnet:~/SystemSoftware/stclnk-demo$
```

gcc -c sayhello.c sayhelloA.c others.c

產生 object 檔。

ar rcs libfoo.a sayhello.o sayhelloA.o others.o

將三個 object 檔打包成名為 libfoo.a 的靜態函式庫。

gcc -static -o hello-s main.c -L. libfoo.a

將主程式 main.c 與 libfoo.a 進行靜態連結，生成可執行檔 hello-s。

執行 hello-s。

nm libfoo.a

libfoo.a 靜態函式庫的內容。

Dynamic Linking Library:

gcc -fPIC -c sayhello.o sayhelloA.o others.o

產生與位置無關的 object 檔。

```
M11212913@telnet:~/SystemSoftware/dynlnk-demo$ gcc -shared sayhello.o sayhelloA.c others.o -o libMyLibrary.so
M11212913@telnet:~/SystemSoftware/dynlnk-demo$ ls -l
total 36
-rwxr-xr-x 1 M11212913 telnet 7032 2024-11-12 18:44 libMyLibrary.so
-rw-r--r-- 1 M11212913 telnet   96 2024-11-12 15:54 main.c
-rw-r--r-- 1 M11212913 telnet  285 2024-11-12 15:51 others.c
-rw-r--r-- 1 M11212913 telnet 1540 2024-11-12 18:43 others.o
-rw-r--r-- 1 M11212913 telnet  154 2024-11-12 18:42 sayhelloA.c
-rw-r--r-- 1 M11212913 telnet 1256 2024-11-12 18:43 sayhelloA.o
-rw-r--r-- 1 M11212913 telnet  153 2024-11-12 18:41 sayhello.c
-rw-r--r-- 1 M11212913 telnet 1256 2024-11-12 18:43 sayhello.o
M11212913@telnet:~/SystemSoftware/dynlnk-demo$
```

gcc -shared sayhello.o sayhelloA.o others.o -o libMyLibrary.so

把所有 object 檔打包成名為 libMyLibrary.so 的共享函式庫。

```
M11212913@telnet:~/SystemSoftware/dynlnk-demo$ gcc -o hello-d main.c libMyLibrary.so
M11212913@telnet:~/SystemSoftware/dynlnk-demo$ ls -l
total 44
-rwxr-xr-x 1 M11212913 telnet 7177 2024-11-12 18:45 hello-d
-rwxr-xr-x 1 M11212913 telnet 7032 2024-11-12 18:44 libMyLibrary.so
-rw-r--r-- 1 M11212913 telnet   96 2024-11-12 15:54 main.c
-rw-r--r-- 1 M11212913 telnet  285 2024-11-12 15:51 others.c
-rw-r--r-- 1 M11212913 telnet 1540 2024-11-12 18:43 others.o
-rw-r--r-- 1 M11212913 telnet  154 2024-11-12 18:42 sayhelloA.c
-rw-r--r-- 1 M11212913 telnet 1256 2024-11-12 18:43 sayhelloA.o
-rw-r--r-- 1 M11212913 telnet  153 2024-11-12 18:41 sayhello.c
-rw-r--r-- 1 M11212913 telnet 1256 2024-11-12 18:43 sayhello.o
```

gcc -o hello-d main.c libMyLibrary.so

將主程式 main.c 與 libMyLibrary.so 進行動態連結，生成可執行檔 hello-d。

```
M11212913@telnet:~/SystemSoftware/dynlnk-demo$ export LD_LIBRARY_PATH="$LD_LIBRARY_PATH:."
M11212913@telnet:~/SystemSoftware/dynlnk-demo$ env
TERM=xterm-256color
SHELL=/bin/bash
SSH_CLIENT=140.122.21.166 62199 22
OLDPWD=/home/student/telnet/M11212913/SystemSoftware
SSH_TTY=/dev/pts/0
USER=M11212913
LD_LIBRARY_PATH=:.:.
LS_COLORS=rs=0:di=01;34:ln=01;36:mh=00:pi=40;33:so=01;35:do=01;35:bd=40;33;01:cd=40;33;01:or=40;31;01:su=37;41:sg=30;43:
ca=30;41:tw=30;42:ow=34;42:st=37;44:ex=01;32:*.tar=01;31:*.tgz=01;31:*.arj=01;31:*.taz=01;31:*.lzh=01;31:*.lzma=01;31:*.
tlz=01;31:*.txz=01;31:*.zip=01;31:*.z=01;31:*.Z=01;31:*.dz=01;31:*.gz=01;31:*.lz=01;31:*.xz=01;31:*.bz2=01;31:*.bz=01;31
:*.tbz=01;31:*.tbz2=01;31:*.tz=01;31:*.deb=01;31:*.rpm=01;31:*.jar=01;31:*.rar=01;31:*.ace=01;31:*.zoo=01;31:*.cpio=01;3
1:*.7z=01;31:*.rz=01;31:*.jpg=01;35:*.jpeg=01;35:*.gif=01;35:*.bmp=01;35:*.pbm=01;35:*.pgm=01;35:*.ppm=01;35:*.tga=01;35
:*.xbm=01;35:*.xpm=01;35:*.tif=01;35:*.tiff=01;35:*.png=01;35:*.svg=01;35:*.svgz=01;35:*.mng=01;35:*.pcx=01;35:*.mov=01;
35:*.mpg=01;35:*.mpeg=01;35:*.m2v=01;35:*.mkv=01;35:*.ogm=01;35:*.mp4=01;35:*.m4v=01;35:*.mp4v=01;35:*.vob=01;35:*.qt=01
;35:*.nuv=01;35:*.wmv=01;35:*.asf=01;35:*.rm=01;35:*.rmvb=01;35:*.flc=01;35:*.avi=01;35:*.fli=01;35:*.flv=01;35:*.gl=01;
35:*.dl=01;35:*.xcf=01;35:*.xwd=01;35:*.yuv=01;35:*.cgm=01;35:*.emf=01;35:*.axv=01;35:*.anx=01;35:*.ogv=01;35:*.ogx=01;3
5:*.aac=00;36:*.au=00;36:*.flac=00;36:*.mid=00;36:*.midi=00;36:*.mka=00;36:*.mp3=00;36:*.mpc=00;36:*.ogg=00;36:*.ra=00;3
6:*.wav=00;36:*.axa=00;36:*.oga=00;36:*.spx=00;36:*.xspf=00;36:
MAIL=/var/mail/M11212913
PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games
PWD=/home/student/telnet/M11212913/SystemSoftware/dynlnk-demo
LANG=en_US.UTF-8
SHLVL=1
HOME=/home/student/telnet/M11212913
LOGNAME=M11212913
SSH_CONNECTION=140.122.21.166 62199 140.122.185.7 22
LESSOPEN=| /usr/bin/lesspipe %s
LESSCLOSE=/usr/bin/lesspipe %s %s
_=/usr/bin/env
M11212913@telnet:~/SystemSoftware/dynlnk-demo$
```

export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:

設定動態連結執行時，用來尋找共享函式庫的環境變數。

```
M11212913@telnet:~/SystemSoftware/dynlnk-demo$ ./hello-d
dynamic-linking library routine: HelloWorld!
dynamic-linking library routine: HelloWorld!
test: 351.364183
Hello World!
How are you?
M11212913@telnet:~/SystemSoftware/dynlnk-demo$
```

執行 hello-d。

```
M11212913@telnet:~/SystemSoftware/dynlnk-demo$ ldd hello-d
        linux-gate.so.1 =>  (0xb7803000)
        libMyLibrary.so (0xb77fe000)
        libc.so.6 => /lib/i386-linux-gnu/libc.so.6 (0xb768f000)
        /lib/ld-linux.so.2 (0xb7804000)
M11212913@telnet:~/SystemSoftware/dynlnk-demo$
```

ldd hello-d

依賴的函式庫

```
M11212913@telnet:~/SystemSoftware/dynlnk-demo$ nm libMyLibrary.so
00001f20 a _DYNAMIC
00001ff4 a _GLOBAL_OFFSET_TABLE_
         w _Jv_RegisterClasses
00001f10 d __CTOR_END__
00001f0c d __CTOR_LIST__
00001f18 d __DTOR_END__
00001f14 d __DTOR_LIST__
00000828 r __FRAME_END__
00001f1c d __JCR_END__
00001f1c d __JCR_LIST__
00002020 A __bss_start
         w __cxa_finalize@@GLIBC_2.1.3
00000720 t __do_global_ctors_aux
00000500 t __do_global_dtors_aux
0000201c d __dso_handle
         w __gmon_start__
000005b7 t __i686.get_pc_thunk.bx
         U __stack_chk_fail@@GLIBC_2.4
00000700 t __stack_chk_fail_local
00002020 A _edata
00002028 A _end
00000758 T _fini
00000448 T _init
00000630 T additinalFunction
00002020 b completed.6155
00002024 b dtor_idx.6157
00000580 t frame_dummy
         U memcpy@@GLIBC_2.0
         U printf@@GLIBC_2.0
         U puts@@GLIBC_2.0
000005bc T sayhello
00000600 T sayhelloA
00000666 T stringMul
         U strlen@@GLIBC_2.0
M11212913@telnet:~/SystemSoftware/dynlnk-demo$
```

動態共享函式庫的內容