Program MRS1D in C

```
#include <stdio.h>
#include "mpi.h"
#include "dmumps_c.h"
#define JOB_INIT -1
#define JOB_END -2
#define USE_COMM_WORLD -987654
#define MAX_NZ 10000
#define MAX_N 100
int main(int argc, char ** argv)
{
 int N = 10; //number of finite difference intervals
 double h = 1.0/N;
 DMUMPS_STRUC_C id;
 int n = (N+1);
 int nz = 3*(N-1)+2;

 if(n>MAX_N)
 {
  printf("Increase MAX_N (%2d)\n",MAX_N);
  return -1;
 }
 if(nz>MAX_NZ) {
  printf("Increase MAX_NZ (%2d)\n",MAX_NZ);
  return -1;
 }
 int irn[MAX_NZ];
 int jcn[MAX_NZ];
 double a[MAX_NZ];
 double rhs[MAX_N];
```

```
 int myid, ierr;
 ierr = MPI_Init(&argc, &argv);
 ierr = MPI_Comm_rank(MPI_COMM_WORLD, &myid);
 // Define A and rhs
 //in C tables are indexed from 0
 //(fortran based MUMPS reads them from 0 entry as 1st entry)
 int k=0;  irn[k]=1; jcn[k]=1; a[k]=1.0;
 irn[k]=N+1; jcn[k]=N+1; a[k]=1.0;
 //in C tables are index from 0
 rhs[0]=0.0;rhs[N]=1.0;
 int i;
 for(i=2;i<=N;i++) {
  k++; irn[k]=i; jcn[k]=i; a[k]=-2.0/(h*h);
  k++; irn[k]=i; jcn[k]=i-1; a[k]=1.0/(h*h);
  k++; irn[k]=i; jcn[k]=i+1; a[k]=1.0/(h*h);
  rhs[i-1]=0.0;
 }
 // Initialize a MUMPS instance. Use MPI_COMM_WORLD.
 id.job=JOB_INIT; id.par=1; id.sym=0;
 id.comm_fortran=USE_COMM_WORLD;
 dmumps_c(&id);
 // Define the problem on the host
 if (myid == 0) {
   id.n = n; id.nz =nz; id.irn=irn; id.jcn=jcn;
   id.a = a; id.rhs = rhs;
 }
#define ICNTL(I) icntl[(I)-1] // macro s.t. indices match
documentation
 // Outputs for debugging
 id.ICNTL(1)=6; id.ICNTL(2)=6; id.ICNTL(3)=6; id.ICNTL(4)=0;
```

```
 // Call the MUMPS package.
 id.job=6;
 dmumps_c(&id);
 if (myid == 0) {
  printf("Solution is:\n");
  int i;
  for(i=0;i<=N;i++)
   printf("%8.2f\n", id.rhs[i]);
 }
 id.job=JOB_END; dmumps_c(&id); // Terminate instance

 return 0;
}
```

Makefile:

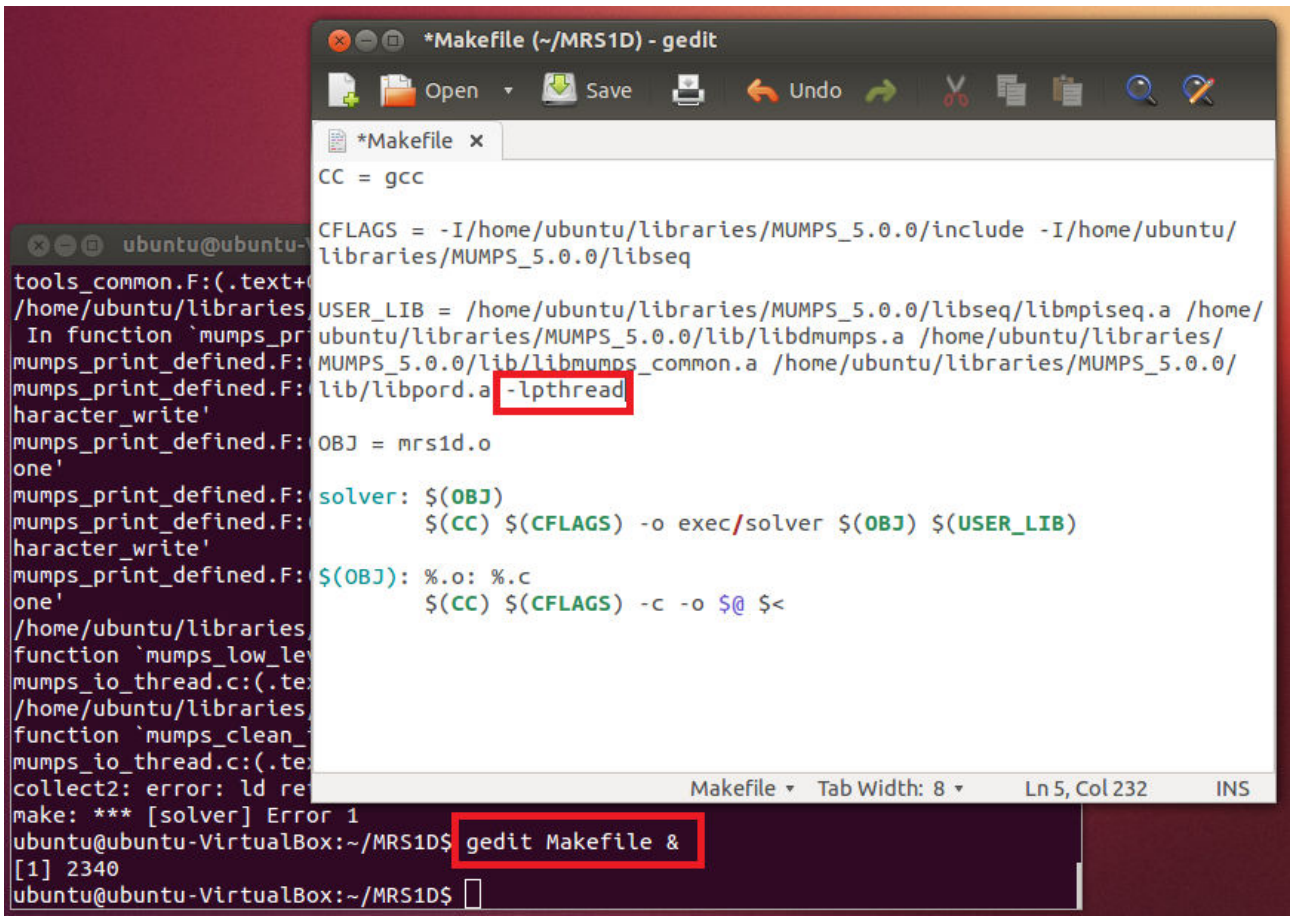
```
CC = gcc

CFLAGS = -I/home/ubuntu/libraries//MUMPS_5.0.0/include -
I/home/ubuntu/libraries//MUMPS_5.0.0/libseq

USER_LIB = /home/ubuntu/libraries//MUMPS_5.0.0/libseq/libmpiseq.a
/home/ubuntu/libraries//MUMPS_5.0.0/lib/libdmumps.a
/home/ubuntu/libraries//MUMPS_5.0.0/lib/libmumps_common.a
/home/ubuntu/libraries//MUMPS_5.0.0/lib/libpord.a

OBJ = mrs1d.o

solver: $(OBJ)
  $(CC) $(CFLAGS) -o exec/solver $(OBJ) $(USER_LIB)
$(OBJ): %.o: %.c
  $(CC) $(CFLAGS) -c -o $@ $<
```

```
ubuntu@ubuntu-VirtualBox:~$ cd MRS1D/
ubuntu@ubuntu-VirtualBox:~/MRS1D$ ls
exec  Makefile  mrs1d.c  mrs1d.o
ubuntu@ubuntu-VirtualBox:~/MRS1D$ make
gcc -I/home/ubuntu/libraries/MUMPS_5.0.0/include -I/home/ubuntu/libraries/MUMPS_5.0.0
/libseq -o exec/solver mrs1d.o /home/ubuntu/libraries/MUMPS_5.0.0/libseq/libmpiseq.a
/home/ubuntu/libraries/MUMPS_5.0.0/lib/libdmumps.a /home/ubuntu/libraries/MUMPS_5.0.0
/lib/libmumps_common.a /home/ubuntu/libraries/MUMPS_5.0.0/lib/libpord.a
```

many errors:

```
tools_common.F:(.text+0x3384): undefined reference to `_gfortran_transfer_integer_wri
te'
tools_common.F:(.text+0x3398): undefined reference to `_gfortran_transfer_integer_wri
te'
tools_common.F:(.text+0x33a0): undefined reference to `_gfortran_st_write_done'
/home/ubuntu/libraries/MUMPS_5.0.0/lib/libmumps_common.a(mumps_print_defined.o): In f
unction `mumps_print_if_defined_':
mumps_print_defined.F:(.text+0x3d): undefined reference to `_gfortran_st_write'
mumps_print_defined.F:(.text+0x55): undefined reference to `_gfortran_transfer_charac
ter_write'
mumps_print_defined.F:(.text+0x5d): undefined reference to `_gfortran_st_write_done'
mumps_print_defined.F:(.text+0x83): undefined reference to `_gfortran_st_write'
mumps_print_defined.F:(.text+0x9b): undefined reference to `_gfortran_transfer_charac
ter_write'
mumps_print_defined.F:(.text+0xa3): undefined reference to `_gfortran_st_write_done'
/home/ubuntu/libraries/MUMPS_5.0.0/lib/libmumps_common.a(mumps_io_thread.o): In funct
ion `mumps_low_level_init_ooc_c_th':
mumps_io_thread.c:(.text+0x2be): undefined reference to `pthread_create'
/home/ubuntu/libraries/MUMPS_5.0.0/lib/libmumps_common.a(mumps_io_thread.o): In funct
ion `mumps_clean_io_data_c_th':
mumps_io_thread.c:(.text+0x57f): undefined reference to `pthread_join'
collect2: error: ld returned 1 exit status
make: *** [solver] Error 1
ubuntu@ubuntu-VirtualBox:~/MRS1D$
```

Link pthread

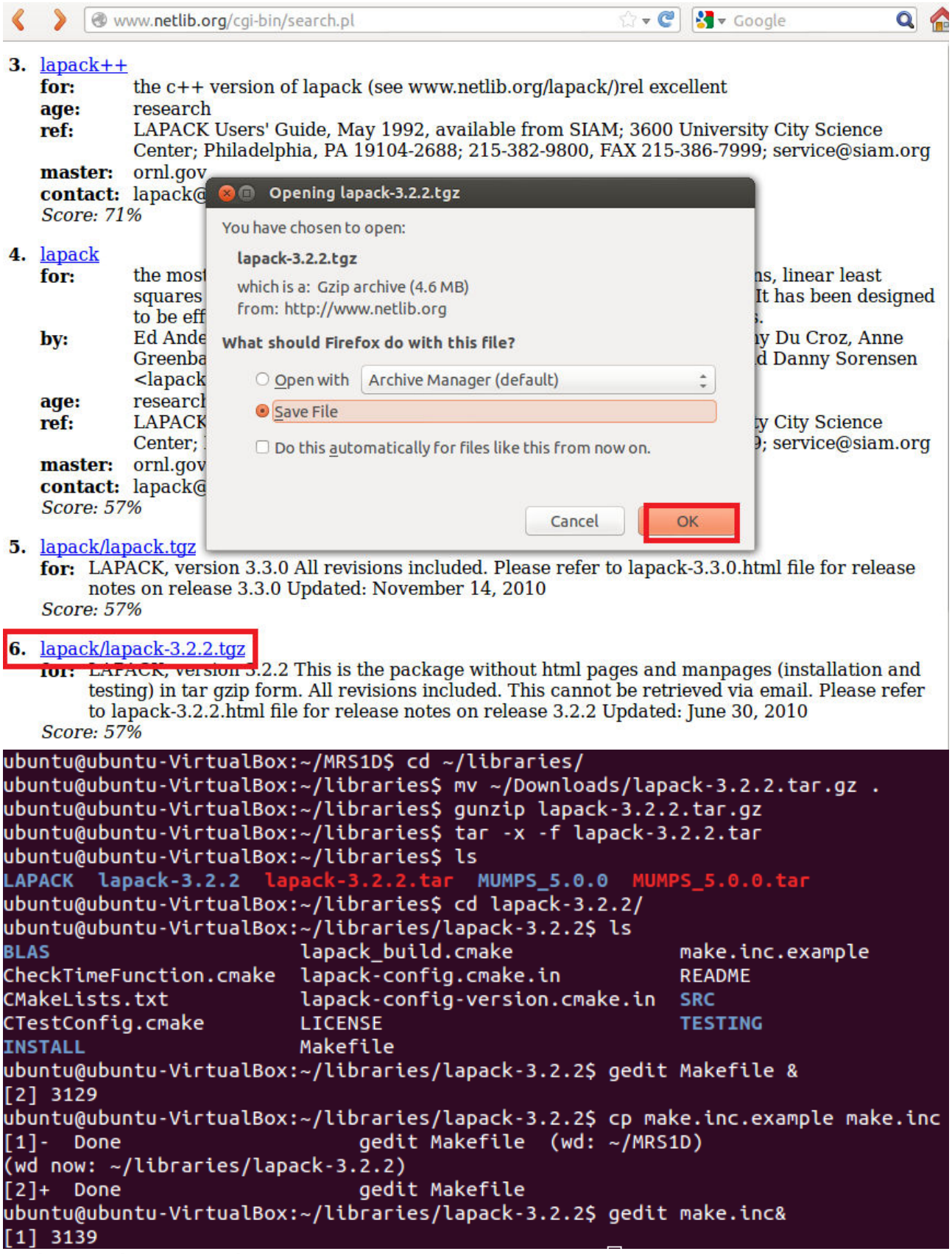


Googl problem with undefined reference _gfortran_st_write

```
CC = gcc
FC = gfortran

CFLAGS = -DAdd_ -I/home/ubuntu/libraries/MUMPS_5.0.0/include -I/home/ubuntu/libraries/
MUMPS_5.0.0/libseq

USER_LIB = /home/ubuntu/libraries/MUMPS_5.0.0/libseq/libmpiseq.a /home/ubuntu/libraries/
MUMPS_5.0.0/lib/libdmumps.a /home/ubuntu/libraries/MUMPS_5.0.0/lib/libmumps_common.a /home/
ubuntu/libraries/MUMPS_5.0.0/lib/libpord.a -lpthread -L/usr/bin/gfortran

OBJ = mrs1d.o

solver: $(OBJ)
        $(FC) -o exec/solver $(OBJ) $(USER_LIB)

$(OBJ): %.o: %.c
        $(CC) $(CFLAGS) -c -o $@ $<
```

We need to download and install LAPACK and BLAS

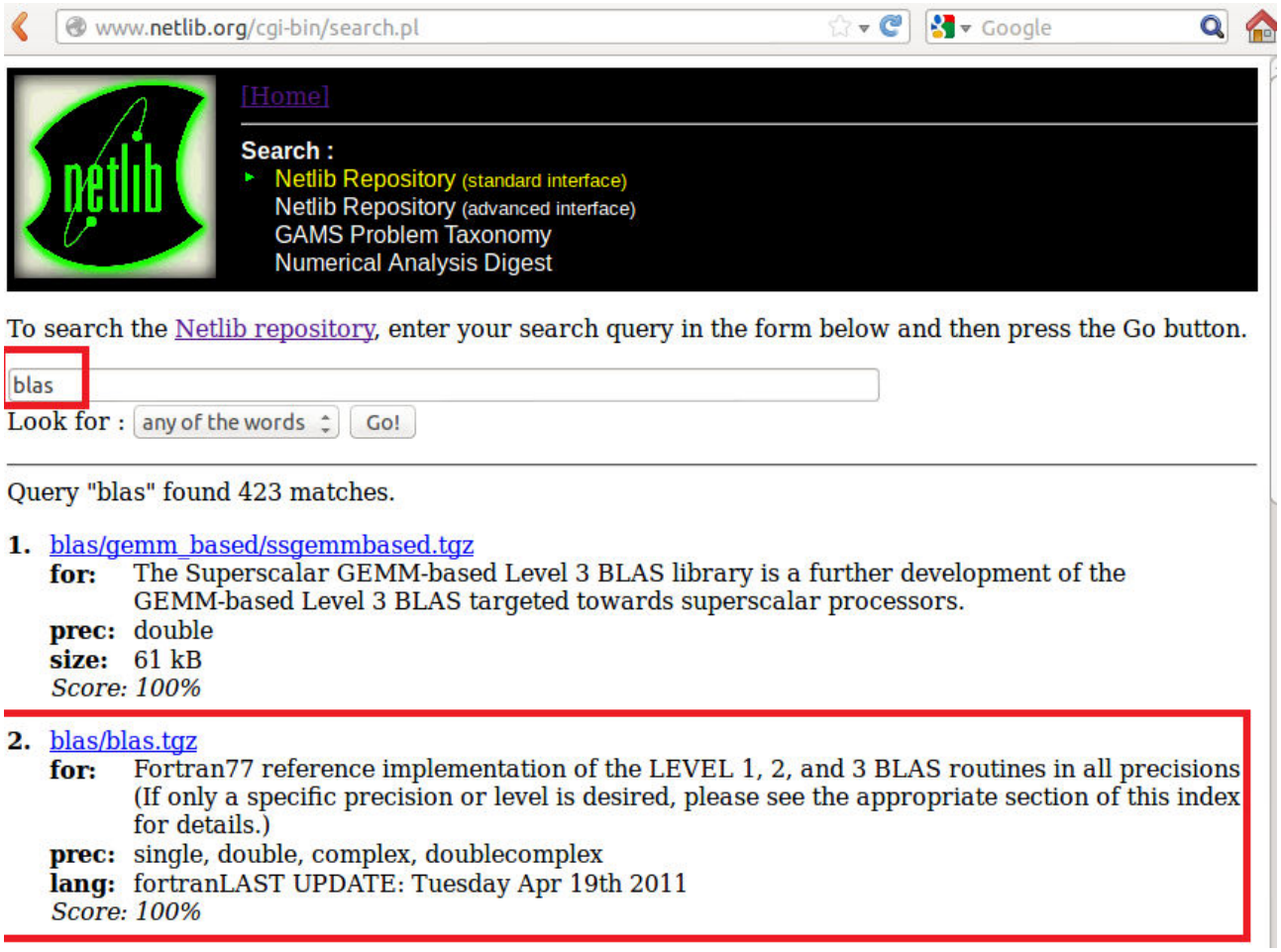

The Netlib
www.netlib.org
Google
netlib
Netlib Repository at UTK and ORNL
Netlib is a collection of mathematical software, papers, and databases.
There have been 845,647,052 requests to this repository as of Tue May 5 00:47:31 EDT 2015 .
Software, papers, etc.
Browse the Netlib repository
Search the Netlib repository
Services provided at Netlib
netlib
[Home]
Search :
Netlib Repository (standard interface)
Netlib Repository (advanced interface)
GAMS Problem Taxonomy
Numerical Analysis Digest
To search the Netlib repository, enter your search query in the form below and then press the Go button.
lapack
Look for : any of the words Go!
Query "lapack" found 1568 matches.
1. lapack/lapack-3.2.1-CMAKE.zipfile lapack/lapack-3.2.1-CMAKE.tgz
for: LAPACK, version 3.2.1 CMAKE package for UNIX Make, MAC xcode, Windows (Nmake, Visual Studio all versions) 32 or 64 bits. [REQUIRE CMAKE - http://www.cmake.org/ Running doc: http://www.cmake.org/cmake/help/runningcmake.html] FEEDBACK WELCOME --> http://icl.cs.utk.edu/lapack-forum Please refer to lapack-3.2.1.html file for release notes on release 3.2.1 Updated: January 26, 2010
Score: 100%




```
ubuntu@ubuntu-VirtualBox:~/MRS1D$ cd ~/libraries/
ubuntu@ubuntu-VirtualBox:~/libraries$ mv ~/Downloads/lapack-3.2.2.tar.gz .
ubuntu@ubuntu-VirtualBox:~/libraries$ gunzip lapack-3.2.2.tar.gz
ubuntu@ubuntu-VirtualBox:~/libraries$ tar -x -f lapack-3.2.2.tar
ubuntu@ubuntu-VirtualBox:~/libraries$ ls
LAPACK  lapack-3.2.2  lapack-3.2.2.tar  MUMPS_5.0.0  MUMPS_5.0.0.tar
ubuntu@ubuntu-VirtualBox:~/libraries$ cd lapack-3.2.2/
ubuntu@ubuntu-VirtualBox:~/libraries/lapack-3.2.2$ ls
BLAS                    lapack_build.cmake              make.inc.example
CheckTimeFunction.cmake lapack-config.cmake.in          README
CMakeLists.txt          lapack-config-version.cmake.in  SRC
CTestConfig.cmake       LICENSE                         TESTING
INSTALL                 Makefile
ubuntu@ubuntu-VirtualBox:~/libraries/lapack-3.2.2$ gedit Makefile &
[2] 3129
ubuntu@ubuntu-VirtualBox:~/libraries/lapack-3.2.2$ cp make.inc.example make.inc
[1]-  Done                    gedit Makefile  (wd: ~/MRS1D)
(wd now: ~/libraries/lapack-3.2.2)
[2]+  Done                    gedit Makefile
ubuntu@ubuntu-VirtualBox:~/libraries/lapack-3.2.2$ gedit make.inc&
[1] 3139
```

Nothing to change in make.inc

make




```
ubuntu@ubuntu-VirtualBox:~/libraries/lapack-3.2.2$ cd ..
ubuntu@ubuntu-VirtualBox:~/libraries$ mv ~/Downloads/blas.tgz .
ubuntu@ubuntu-VirtualBox:~/libraries$ gunzip blas.tgz
ubuntu@ubuntu-VirtualBox:~/libraries$ tar -x -f blas.tar
ubuntu@ubuntu-VirtualBox:~/libraries$ ls
BLAS       LAPACK         lapack-3.2.2.tar  MUMPS_5.0.0.tar
blas.tar   lapack-3.2.2   MUMPS_5.0.0
ubuntu@ubuntu-VirtualBox:~/libraries$ cd BLAS
ubuntu@ubuntu-VirtualBox:~/libraries/BLAS$ ls
caxpy.f   crotg.f   dcopy.f   dsymv.f   lsame.f   srotmg.f  strsm.f   zher.f
ccopy.f   cscal.f   ddot.f    dsyr2.f   Makefile  ssbmv.f   strsv.f   zherk.f
cdotc.f   csrot.f   dgbmv.f   dsyr2k.f  make.inc  sscal.f   xerbla.f  zhpmv.f
cdotu.f   csscal.f  dgemm.f   dsyr.f    sasum.f   sspmv.f   zaxpy.f   zhpr2.f
cgbmv.f   cswap.f   dgemv.f   dsyrk.f   saxpy.f   sspr2.f   zcopy.f   zhpr.f
cgemm.f   csymm.f   dger.f    dtbmv.f   scabs1.f  sspr.f    zdotc.f   zrotg.f
cgemv.f   csyr2k.f  dnrm2.f   dtbsv.f   scasum.f  sswap.f   zdotu.f   zscal.f
cgerc.f   csyrk.f   drot.f    dtpmv.f   scnrm2.f  ssymm.f   zdrot.f   zswap.f
cgeru.f   ctbmv.f   drotg.f   dtpsv.f   scopy.f   ssymv.f   zdscal.f  zsymm.f
chbmv.f   ctbsv.f   drotm.f   dtrmm.f   sdot.f    ssyr2.f   zgbmv.f   zsyr2k.f
chemm.f   ctpmv.f   drotmg.f  dtrmv.f   sdsdot.f  ssyr2k.f  zgemm.f   zsyrk.f
chemv.f   ctpsv.f   dsbmv.f   dtrsm.f   sgbmv.f   ssyr.f    zgemv.f   ztbmv.f
cher2.f   ctrmm.f   dscal.f   dtrsv.f   sgemm.f   ssyrk.f   zgerc.f   ztbsv.f
cher2k.f  ctrmv.f   dsdot.f   dzasum.f  sgemv.f   stbmv.f   zgeru.f   ztpmv.f
cher.f    ctrsm.f   dspmv.f   dznrm2.f  sger.f    stbsv.f   zhbmv.f   ztpsv.f
cherk.f   ctrsv.f   dspr2.f   icamax.f  snrm2.f   stpmv.f   zhemm.f   ztrmm.f
chpmv.f   dasum.f   dspr.f    idamax.f  srot.f    stpsv.f   zhemv.f   ztrmv.f
chpr2.f   daxpy.f   dswap.f   isamax.f  srotg.f   strmm.f   zher2.f   ztrsm.f
chpr.f    dcabs1.f  dsymm.f   izamax.f  srotm.f   strmv.f   zher2k.f  ztrsv.f
ubuntu@ubuntu-VirtualBox:~/libraries/BLAS$ make
```

```
gfortran -O3 -c xerbla.f -o xerbla.o
ar cr blas_LINUX.a isamax.o sasum.o saxpy.o scopy.o sdot.o snrm2.o srot.o srotg
o sscal.o sswap.o sdsdot.o srotmg.o srotm.o sgemv.o sgbmv.o ssymv.o ssbmv.o ssp
v.o strmv.o stbmv.o stpmv.o strsv.o stbsv.o stpsv.o sger.o ssyr.o sspr.o ssyr2.
 sspr2.o sgemm.o ssymm.o ssyrk.o ssyr2k.o strmm.o strsm.o  idamax.o dasum.o dax
y.o dcopy.o ddot.o dnrm2.o drot.o drotg.o dscal.o dsdot.o dswap.o drotmg.o drot
.o dgemv.o dgbmv.o dsymv.o dsbmv.o dspmv.o dtrmv.o dtbmv.o dtpmv.o dtrsv.o dtbs
.o dtpsv.o dger.o dsyr.o dspr.o dsyr2.o dspr2.o dgemm.o dsymm.o dsyrk.o dsyr2k.
 dtrmm.o dtrsm.o scabs1.o scasum.o scnrm2.o icamax.o caxpy.o ccopy.o cdotc.o cd
tu.o csscal.o crotg.o cscal.o cswap.o csrot.o cgemv.o cgbmv.o chemv.o chbmv.o c
pmv.o ctrmv.o ctbmv.o ctpmv.o ctrsv.o ctbsv.o ctpsv.o cgerc.o cgeru.o cher.o ch
r.o cher2.o chpr2.o cgemm.o csymm.o csyrk.o csyr2k.o ctrmm.o ctrsm.o chemm.o ch
rk.o cher2k.o dcabs1.o dzasum.o dznrm2.o izamax.o zaxpy.o zcopy.o zdotc.o zdotu
o zdscal.o zrotg.o zscal.o zswap.o zdrot.o zgemv.o zgbmv.o zhemv.o zhbmv.o zhpm
.o ztrmv.o ztbmv.o ztpmv.o ztrsv.o ztbsv.o ztpsv.o zgerc.o zgeru.o zher.o zhpr.
 zher2.o zhpr2.o zgemm.o zsymm.o zsyrk.o zsyr2k.o ztrmm.o ztrsm.o zhemm.o zherk
o zher2k.o lsame.o xerbla.o
ranlib blas_LINUX.a
ubuntu@ubuntu-VirtualBox:~/libraries/BLAS$ ls
blas_LINUX.a  csrot.o   dger.o    dtpsv.o   sgemm.o   stpmv.o   zher2.o
caxpy.f       csscal.f  dnrm2.f   dtrmm.f   sgemv.f   stpsv.f   zher.f
caxpy.o       csscal.o  dnrm2.o   dtrmm.o   sgemv.o   stpsv.o   zherk.f
ccopy.f       cswap.f   drot.f    dtrmv.f   sger.f    strmm.f   zherk.o
ccopy.o       cswap.o   drotg.f   dtrmv.o   sger.o    strmm.o   zher.o
cdotc.f       csymm.f   drotg.o   dtrsm.f   snrm2.f   strmv.f   zhpmv.f
cdotc.o       csymm.o   drotm.f   dtrsm.o   snrm2.o   strmv.o   zhpmv.o
cdotu.f       csyr2k.f  drotmg.f  dtrsv.f   srot.f    strsm.f   zhpr2.f
cdotu.o       csyr2k.o  drotmg.o  dtrsv.o   srotg.f   strsm.o   zhpr2.o
cgbmv.f       csyrk.f   drotm.o   dzasum.f  srotg.o   strsv.f   zhpr.f
cgbmv.o       csyrk.o   drot.o    dzasum.o  srotm.f   strsv.o   zhpr.o
cgemm.f       ctbmv.f   dsbmv.f   dznrm2.f  srotmg.f  xerbla.f  zrotg.f
cgemm.o       ctbmv.o   dsbmv.o   dznrm2.o  srotmg.o  xerbla.o  zrotg.o
cgemv.f       ctbsv.f   dscal.f   icamax.f  srotm.o   zaxpy.f   zscal.f
cgemv.o       ctbsv.o   dscal.o   icamax.o  srot.o    zaxpy.o   zscal.o
cgerc.f       ctpmv.f   dsdot.f   idamax.f  ssbmv.f   zcopy.f   zswap.f
cgerc.o       ctpmv.o   dsdot.o   idamax.o  ssbmv.o   zcopy.o   zswap.o
cgeru.f       ctpsv.f   dspmv.f   isamax.f  sscal.f   zdotc.f   zsymm.f
```

```
ubuntu@ubuntu-VirtualBox:~/libraries/BLAS$ cd ../lapack-3.2.2/
ubuntu@ubuntu-VirtualBox:~/libraries/lapack-3.2.2$ gedit make.inc&
```

make.inc ×

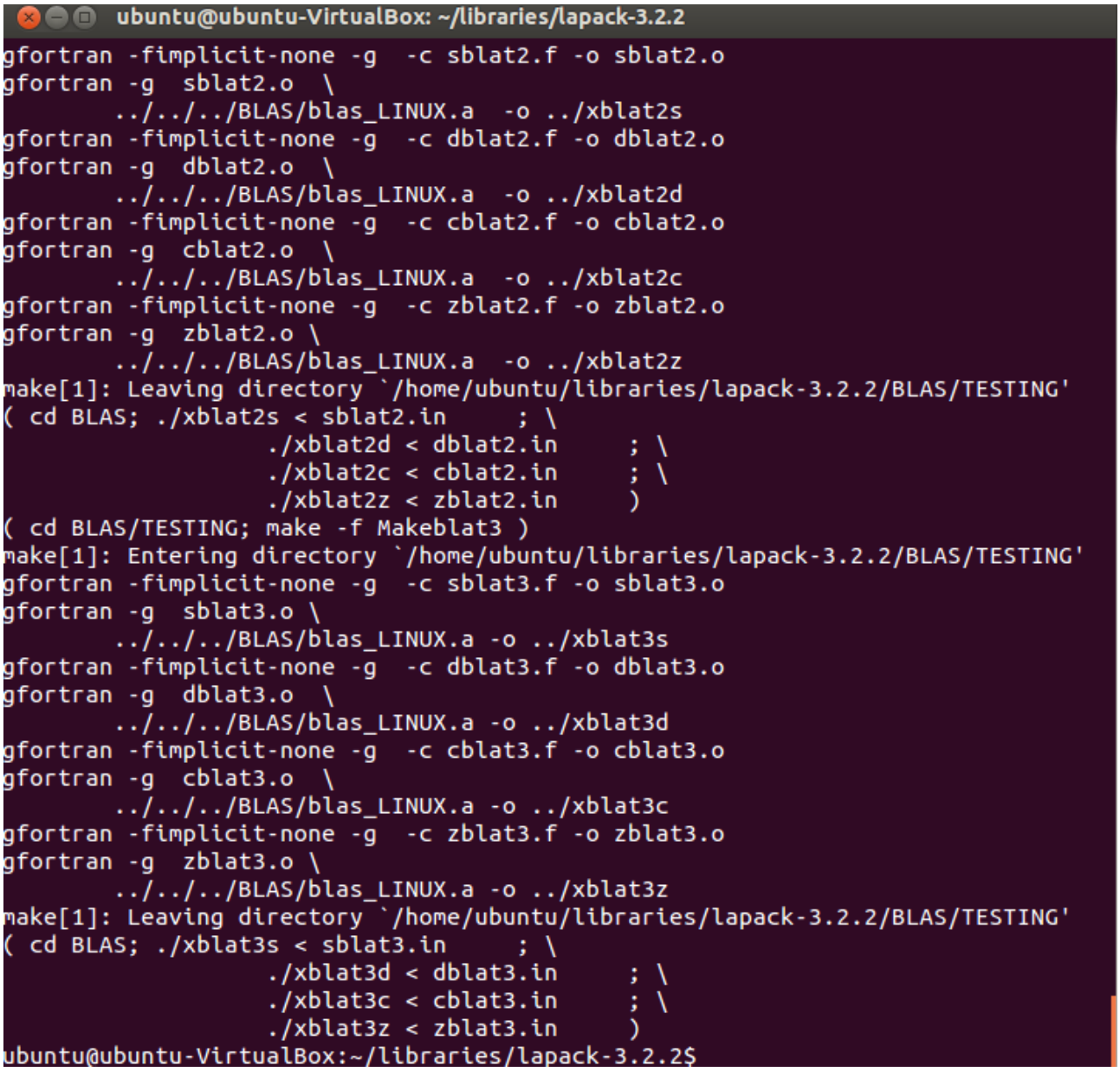
```
# SECOND and DSECND will use a call to the Fortran standard INTERNAL
FUNCTION CPU_TIME
TIMER    = INT_CPU_TIME
# If neither of this works...you can use the NONE value... In that
case, SECOND and DSECND will always return 0
# TIMER     = NONE
#
#  The archiver and the flag(s) to use when building archive (library)
#  If you system has no ranlib, set RANLIB = echo.
#
ARCH     = ar
ARCHFLAGS= cr
RANLIB   = ranlib
#
#  The location of BLAS library for linking the testing programs.
#  The target's machine-specific, optimized BLAS library should be
#  used whenever possible.
#
BLASLIB      = ../../../BLAS/blas$(PLAT).a
#
#  Location of the extended-precision BLAS (XBLAS) Fortran library
#  used for building and testing extended-precision routines.  The
#  relevant routines will be compiled and XBLAS will be linked only if
```

make.inc ×

```
# SECOND and DSECND will use a call to the Fortran standard INTERNAL
FUNCTION CPU_TIME
TIMER    = INT_CPU_TIME
# If neither of this works...you can use the NONE value... In that
case, SECOND and DSECND will always return 0
# TIMER     = NONE
#
#  The archiver and the flag(s) to use when building archive (library)
#  If you system has no ranlib, set RANLIB = echo.
#
ARCH     = ar
ARCHFLAGS= cr
RANLIB   = ranlib
#
#  The location of BLAS library for linking the testing programs.
#  The target's machine-specific, optimized BLAS library should be
#  used whenever possible.
#
BLASLIB      = ../BLAS/blas$(PLAT).a
#
#  Location of the extended-precision BLAS (XBLAS) Fortran library
#  used for building and testing extended-precision routines.  The
#  relevant routines will be compiled and XBLAS will be linked only if
```

And now you can make LAPACK so it runs the tests.

cd ~/lapack-3.2.2
make



The order of linking is important - otherwise you will have some linking problems

```
mumps_part9.F:(.text+0x1aaf9): undefined reference to `mpi_allreduce_
/home/student/LIBRARIES/MUMPS_4.9.2/lib/libmumps_common.a(mumps_part9.o): In fun
ction `mumps_abort_on_overflow_':
mumps_part9.F:(.text+0x1d452): undefined reference to `mpi_abort_'
/home/student/LIBRARIES/MUMPS_4.9.2/lib/libmumps_common.a(mumps_part9.o): In fun
ction `mumps_abort_':
mumps_part9.F:(.text+0x1d479): undefined reference to `mpi_abort_'
/home/student/LIBRARIES/MUMPS_4.9.2/lib/libmumps_common.a(mumps_static_mapping.o
): In function `mumps_static_mapping_mp_mumps_427_':
mumps_static_mapping.F:(.text+0x1c510): undefined reference to `mpi_comm_rank_'
mumps_static_mapping.F:(.text+0x1c549): undefined reference to `mpi_comm_rank_'
mumps_static_mapping.F:(.text+0x1c76b): undefined reference to `mpi_allreduce_'
/home/student/LIBRARIES/MUMPS_4.9.2/lib/libmumps_common.a(mumps_static_mapping.o
): In function `mumps_static_mapping_mp_mumps_430_.':
mumps_static_mapping.F:(.text+0x1d2cc): undefined reference to `mpi_get_processo
r_name_'
mumps_static_mapping.F:(.text+0x1d428): undefined reference to `mpi_bcast_'
mumps_static_mapping.F:(.text+0x1d551): undefined reference to `mpi_bcast_'
/opt/intel/Compiler/11.1/072/lib/ia32/libifcore.so.5: undefined reference to `dl
sym'
collect2: ld returned 1 exit status
make: *** [solver] Error 1
student@student-desktop:~/MRS1D$
```

then you need to check if order of linking and play with different order configurations, e.g.:

make.inc × Makefile ×

```
CC = gcc
FC = gfortran

CFLAGS = -I/home/ubuntu/libraries/MUMPS_5.0.0/include -I/home/ubuntu/
libraries/MUMPS_5.0.0/libseq

USER_LIB = /home/ubuntu/libraries/MUMPS_5.0.0/lib/libdmumps.a /home/
ubuntu/libraries/MUMPS_5.0.0/lib/libmumps_common.a /home/ubuntu/
libraries/MUMPS_5.0.0/lib/libpord.a /home/ubuntu/libraries/MUMPS_5.0.0/
libseq/libmpiseq.a /home/ubuntu/libraries/lapack-3.2.2/lapack_LINUX.a /
home/ubuntu/libraries/BLAS/blas_LINUX.a -lpthread

OBJ = mrs1d.o

solver: $(OBJ)
        $(FC) -o exec/solver $(OBJ) $(USER_LIB)

$(OBJ): %.o: %.c
        $(CC) $(CFLAGS) -c -o $@ $<
```

```
ubuntu@ubuntu-VirtualBox:~/MRS1D$ make
gfortran -o exec/solver mrs1d.o /home/ubuntu/libraries/MUMPS_5.0.0/lib/libdmumps
.a /home/ubuntu/libraries/MUMPS_5.0.0/lib/libmumps_common.a /home/ubuntu/librar
es/MUMPS_5.0.0/lib/libpord.a /home/ubuntu/libraries/MUMPS_5.0.0/libseq/libmpise
.a /home/ubuntu/libraries/lapack-3.2.2/lapack_LINUX.a /home/ubuntu/libraries/BL
S/blas_LINUX.a -lpthread
ubuntu@ubuntu-VirtualBox:~/MRS1D$
```

```
student@student-desktop:~/MRS1D$ make
gcc  -I/home/student/LIBRARIES/MUMPS_4.9.2/include -I/home/student/LIBRARIES/MUM
PS_4.9.2/libseq -c -o mrs1d.o mrs1d.c
gcc  -I/home/student/LIBRARIES/MUMPS_4.9.2/include -I/home/student/LIBRARIES/MUM
PS_4.9.2/libseq -o exec/solver mrs1d.o /lib/libpthread.so.0 /home/student/LIBRAR
IES/MUMPS_4.9.2/lib/libdmumps.a /home/student/LIBRARIES/MUMPS_4.9.2/lib/libmumps
_common.a /home/student/LIBRARIES/MUMPS_4.9.2/lib/libpord.a -L/opt/intel/Compile
r/11.1/072/lib/ia32 -lifcore -lsvml /home/student/LIBRARIES/BLAS/blas_LINUX.a /h
ome/student/LIBRARIES/MUMPS_4.9.2/libseq/libmpiseq.a -ldl
student@student-desktop:~/MRS1D$ ./exec/solver

***********CONTROL PARAMETERS (ICNTL)**************

ICNTL(1)   Output stream for error messages        =         5
ICNTL(2)   Output stream for diagnostic messages   =         5
ICNTL(3)   Output stream for global information    =         5
ICNTL(4)   Level of printing                       =         0
ICNTL(5)   Matrix format  ( keep(55) )             =         0
ICNTL(6)   Maximum transversal  ( keep(23) )       =         7
ICNTL(7)   Ordering                                =         7
ICNTL(12)  LDLT ordering strat ( keep(95) )        =         1
ICNTL(13)  Parallel root (0=on, 1=off)             =         0
ICNTL(18)  Distributed matrix  ( keep(54) )        =         0
ICNTL(19)  Schur option ( keep(60) 0=off else=on ) =         0
...
 GLOBAL STATISTICS
 RINFOG(2)  OPERATIONS DURING NODE ASSEMBLY     = 9.000D+00
 ------(3)  OPERATIONS DURING NODE ELIMINATION  = 2.700D+01
 INFOG (9)  REAL SPACE FOR FACTORS              =          31
 INFOG(10)  INTEGER SPACE FOR FACTORS           =         160
 INFOG(11)  MAXIMUM FRONT SIZE                  =           2
 INFOG(29)  NUMBER OF ENTRIES IN FACTORS        =          27
 INFOG(13) NB OF OFF DIAGONAL PIVOTS      =           0
 INFOG(12)  NUMBER OF DELAYED PIVOTS      =           0
 INFOG(14)  NUMBER OF MEMORY COMPRESS           =           0
 KEEP8(108) Extra copies due to IP stacking     =           0
 On return from DMUMPS, INFOG(1)=         -10
 On return from DMUMPS, INFOG(2)=           1
Solution is:
    0.00
    0.00
    0.00
    0.00
    0.00
    0.00
    0.00
    0.00
    0.00
    0.00
    1.00
student@student-desktop:~/MRS1D$
```

INFOG(1)=-10 means that matrix is singular and system of linear equations has not been solved
(see MUMPS user_guide)

We have to correct the code:

```
  int k=0;  irn[k]=1; jcn[k]=1; a[k]=1.0;
  irn[k]=N+1; jcn[k]=N+1; a[k]=1.0;
```

into

```
  int k=0;  irn[k]=1; jcn[k]=1; a[k]=1.0;
  k++; irn[k]=N+1; jcn[k]=N+1; a[k]=1.0;
```

```
student@student-desktop:~/MRS1D$ make
gcc  -I/home/student/LIBRARIES/MUMPS_4.9.2/include -I/home/student/LIBRARIES/MUM
PS_4.9.2/libseq -c -o mrs1d.o mrs1d.c
gcc  -I/home/student/LIBRARIES/MUMPS_4.9.2/include -I/home/student/LIBRARIES/MUM
PS_4.9.2/libseq -o exec/solver mrs1d.o /lib/libpthread.so.0 /home/student/LIBRAR
IES/MUMPS_4.9.2/lib/libdmumps.a /home/student/LIBRARIES/MUMPS_4.9.2/lib/libmumps
_common.a /home/student/LIBRARIES/MUMPS_4.9.2/lib/libpord.a -L/opt/intel/Compile
r/11.1/072/lib/ia32 -lifcore -lsvml /home/student/LIBRARIES/BLAS/blas_LINUX.a /h
ome/student/LIBRARIES/MUMPS_4.9.2/libseq/libmpiseq.a -ldl
student@student-desktop:~/MRS1D$ ./exec/solver

***********CONTROL PARAMETERS (ICNTL)**************

ICNTL(1)   Output stream for error messages        =         5
ICNTL(2)   Output stream for diagnostic messages   =         5
ICNTL(3)   Output stream for global information    =         5
ICNTL(4)   Level of printing                       =         0
ICNTL(5)   Matrix format  ( keep(55) )             =         0
ICNTL(6)   Maximum transversal  ( keep(23) )       =         7
ICNTL(7)   Ordering                                =         7
ICNTL(12)  LDLT ordering strat ( keep(95) )        =         1
ICNTL(13)  Parallel root (0=on, 1=off)             =         0
ICNTL(18)  Distributed matrix  ( keep(54) )        =         0
ICNTL(19)  Schur option ( keep(60) 0=off else=on ) =         0
...
ICNTL(9)   Solve A x=b (1) or A'x = b (else)       =         0
ICNTL(10)  Max steps iterative refinement          =         0
ICNTL(11)  Error analysis ( 0= off, else=on)       =
ICNTL(14)  Percent of memory increase              =        20
Solution is:
    0.00
    0.10
    0.20
    0.30
    0.40
    0.50
    0.60
    0.70
    0.80
    0.90
    1.00
student@student-desktop:~/MRS1D$
```