

Instructions for the Workshop

This workshop will be held in three 90-minute sessions, each focussing on modeling and solving different types of optimization problems. Techniques will be described briefly so that more time is devoted to modeling and solving problems on a computer. Participants will be expected to install and run various solvers on a computer. Basic knowledge of linear optimization and familiarity with modeling linear programs, mathematical models, linux and C++ or object oriented programming is assumed. Session specific instructions are given after the following general instructions.

Reaching the Venue

The workshop will take place in BITS lab at the ground floor of the new computing center (CC) building next to School of Management (SOM). All participants should first report at the conference venue (VMCC, IIT Bombay), register at the conference desk, have lunch and assemble near the registration desk at 2:15pm. If you are late, you should still report at the registration desk first. You will be guided to the venue from there.

Bringing your own Computer

Bringing your own laptop is optional. If you plan to bring your laptop, make sure the software described below is installed and wifi is working. The venue is equipped with Ubuntu Desktops which we will use for all three sessions.

To use the network, connect to IITB-Guest

Username: orsi2018.wifi

Password: \$ERU#vJv

Instructions for Session-1

Linear and nonlinear optimization using FOSSEE Optimization Toolbox (FOT) on Scilab

Prerequisites if you work on your own laptop:

FOT runs on Scilab 5.5.2, on Ubuntu (16.04 to 17.10), and Windows (7 to 10) 64-bit operating systems.

1. Laptop with 64-bit Ubuntu (16.04 to 17.10) OR Windows (7/8/10) 64-bit operating systems.
2. Your laptop should be capable of connecting to a WiFi network.
3. Scilab 5.5.2 (64-bit) should be installed. See instructions below for details.

4. It is **mandatory** for the participants to know the basics of Scilab. To learn, refer to Tutorials 3 to 9 at https://spoken-tutorial.org/tutorial-search/?search_foss=Scilab&search_language=English
5. FOT should be installed and verified. See instructions below for details.

Note: This toolbox will NOT work on 32 bit systems, or on any other version of Scilab/OS. Please note that it will not work on Macintosh machines.

Instructions for Scilab installation:

- To install scilab on Windows, please do the following:
 - Go to <http://www.scilab.org/en/download/previous>
 - Download the correct version of Scilab 5.5.2 installer for your OS.
 - Run the downloaded installer and follow the Installation wizard.
- To install Scilab on Ubuntu Linux OS, do the following:
 - Connect to a network
 - Open the Terminal using Ctrl+Alt+T
 - Execute `sudo apt-get install scilab`. You will need root privileges to do this.
- If the above steps for installing Scilab on Linux did not work, please do the following:
 - Go to <http://www.scilab.org/en/download/previous>
 - Download the correct version of Scilab 5.5.2 installer for your OS.
 - Extract the file in the directory of your choice.
 - Open the Terminal using Ctrl+Alt+T
 - Execute `cd<space>path-to-scilab-5.5.2/bin`
 - Execute `bash scilab`
 - Scilab will launch without needing any installation.

Instructions for Toolbox installation:

- To install the FOSSEE Optimization Toolbox, go to the Scilab Console and type `atomsInstall("FOT")`. If no error message appears, then the toolbox is installed.
- Restart Scilab. You should see the toolbox getting loaded at startup. The following is how your Scilab console should look like:

```
Scilab 5.5.2 Console
Startup execution:
  loading initial environment

Start FOSSEE Optimization Toolbox
  Load macros
  Load gateways
  Load help
  Load demos

-->
```

- If you could not install FOT using the above steps, do the following:
 - Go to <http://atoms.scilab.org/toolboxes/FOT/>
 - Download the correct toolbox zip file for your OS.
 - Extract the file.
 - Navigate to the toolbox directory in Scilab.
 - On the Scilab Console, type `exec loader.sce`;
- If that doesn't work, please email us at toolbox@scilab.in with the relevant screenshots.
- If the toolbox installation is successful, do the following to **verify** it:
 - Type `[xopt,fopt] = linprog([2.5,[],[],[3],[5],[0],[6])`
 - Press Enter
 - Your console should display the following as the result:
 - Optimal Solution.
 - fopt =

4.1666667
 - xopt =
1.6666667

Instructions for Session-2

Mixed-Integer Nonlinear Optimization

Prerequisites if you bring your own laptop:

- Laptop with a working WiFi device
- Laptop with a 64-bit linux distribution.

To compile MINOTAUR:

1. Install the following (prerequisite) software: open a terminal (Ctrl+Alt+T) and type the command as mentioned in the second column of the following table, if the package is not present on your system. To check the installation, type the command in the third column.

Alternatively, multiple packages can be installed at the same time by naming them separated by spaces., like:

```
sudo apt install cmake pkg-config g++ gfortran libblas-dev liblapack-dev git
```

Software	Command	To check
CMake	<code>sudo apt install cmake</code>	<code>dpkg -s cmake</code>
pkg-config	<code>sudo apt install pkg-config</code>	<code>dpkg -s pkg-config</code>
g++	<code>sudo apt install g++</code>	<code>dpkg -s g++</code>
gfortran	<code>sudo apt install gfortran</code>	<code>dpkg -s gfortran</code>
blas and lapack	<code>sudo apt install libblas-dev</code>	<code>dpkg -s libblas-dev</code>
lapack	<code>sudo apt install liblapack-dev</code>	<code>dpkg -s liblapack-dev</code>
git	<code>sudo apt install git</code>	<code>dpkg -s git</code>

2. Open a terminal and type:

```
git clone https://github.com/minotaur-solver/minotaur.git
```
3. You must see a directory named *minotaur*. To compile third-party libraries, type the below commands on the terminal:

```
cd minotaur/third-party  
./build_third_party
```

See the below image to get an idea of how steps 2 and 3 written on a terminal look like. Look at the green underlined parts.

```

Terminal
prashant@brahma:~$ git clone https://github.com/minotaur-solver/minotaur.git
Cloning into 'minotaur'...
remote: Enumerating objects: 4754, done.
remote: Total 4754 (delta 0), reused 0 (delta 0), pack-reused 4754
Receiving objects: 100% (4754/4754), 3.85 MiB | 275.00 KiB/s, done.
Resolving deltas: 100% (3504/3504), done.
Checking connectivity... done.
prashant@brahma:~$ ls
a.out                               funval.m                             Music
BertsimasLinearOptimization.pdf     grad.m                               NocedalWright.pdf
cloud                                help                                  octave-workspace
comics                               hosts                                 odot
Desktop                              ieor-www.conf                       out.gif
Diagram1.dia                        jda_poster                          phpunit_run_fix_after_site_install_for_rules_modu
Diagram1.dia.autosave              maaDj.pdf                           Pictures
Diagram4.tex                        mcnbResults.ods_1ods               ppalkarEFSETScore.png
dia.tex                             Meenarli                             ppalkarEFSETScore.png
Documents                            Meenarli Sharma_Abstract_MODU2016.pdf pr_imp_wrkng.aux
Downloads                            minotaur                             pr_imp_wrkng.log
drupal.taxonomy_might_not_exist.patch mounts                                pr_imp_wrkng_Mar22.tex
fontconfig                          mozilla.pdf                          pr_imp_wrkng_Mar.aux

prashant@brahma:~$ cd minotaur/third-party/
prashant@brahma:~/minotaur/third-party$ ./build_third_party
--2018-12-04 22:53:13-- http://www.mcs.anl.gov/research/projects/minotaur/dist/minotaur-0.2.1-third-party-src.tar.gz
Resolving www.mcs.anl.gov (www.mcs.anl.gov)... 140.221.6.95
Connecting to www.mcs.anl.gov (www.mcs.anl.gov)[140.221.6.95]:80... connected.
HTTP request sent, awaiting response... 301 Moved Permanently
Location: https://www.mcs.anl.gov/research/projects/minotaur/dist/minotaur-0.2.1-third-party-src.tar.gz [following]
--2018-12-04 22:53:15-- https://www.mcs.anl.gov/research/projects/minotaur/dist/minotaur-0.2.1-third-party-src.tar.gz
Connecting to www.mcs.anl.gov (www.mcs.anl.gov)[140.221.6.95]:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 45101567 (43M) [application/x-gzip]
Saving to: 'minotaur-0.2.1-third-party-src.tar.gz'

42% [=====]

```

Completion of step 3 will look as in following picture

```

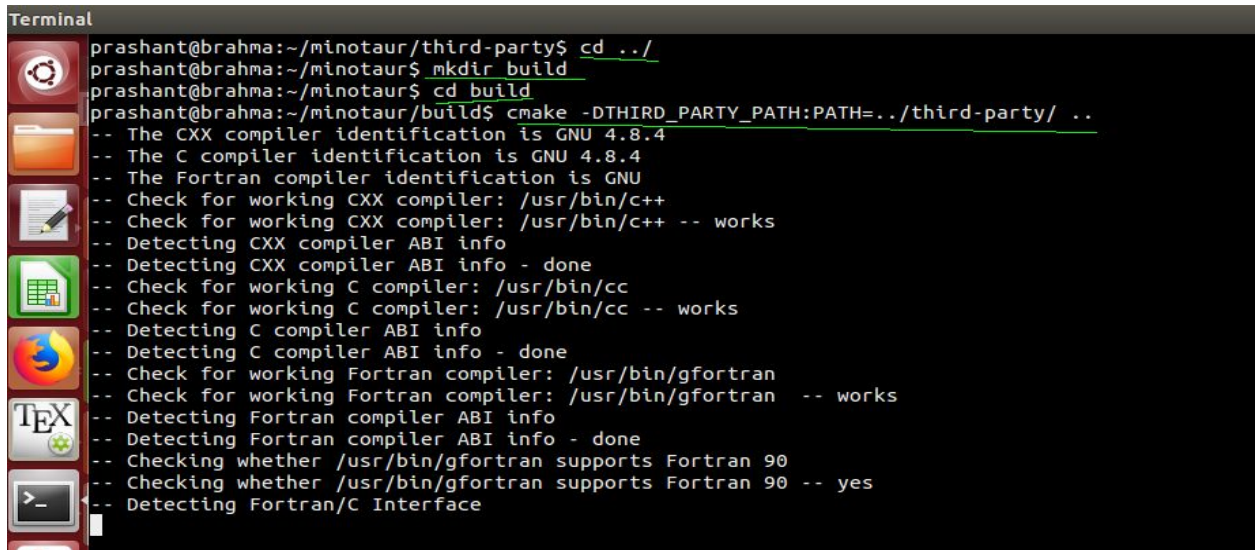
[ 97%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zunbdb2.f.o
[ 97%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zunbdb3.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zunbdb4.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zunbdb5.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zunbdb6.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zuncsd.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zuncsd2by1.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zgeqrt.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zgeqrt2.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zgeqrt3.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zgemqrt.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/ztpqrt.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/ztpqrt2.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/ztpmqrt.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/ztpqrfb.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/ztplqt.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/ztplqt2.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/ztpmlqt.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zgelqt.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zgelqt3.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zgemlqt.f.o
[ 98%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zgetsls.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zgeqr.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zlatsqr.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zlamtsqr.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zgemqr.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zgelq.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zlaswq.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zlamswq.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zgemlq.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zhetrd_2stage.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zhetrd_he2hb.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zhetrd_hb2st.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zhb2st_kernels.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zheevd_2stage.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zheev_2stage.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zheevx_2stage.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zheevr_2stage.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zhbev_2stage.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zhbevz_2stage.f.o
[ 99%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zhbevd_2stage.f.o
[100%] Building Fortran object SRC/CMakeFiles/lapack.dtr/zhegv_2stage.f.o
Linking Fortran static library ../lib/liblapack.a
[100%] Built target lapack
[ 7%] Built target blas
[100%] Built target lapack
Install the project...
-- Install configuration: "Release"
-- Installing: /home/prashant.palkar/minotaur/third-party/lib/x86_64-linux-gnu/cmake/lapack-3.7.1/lapack-targets.cmake
-- Installing: /home/prashant.palkar/minotaur/third-party/lib/x86_64-linux-gnu/cmake/lapack-3.7.1/lapack-targets-release.cmake
-- Installing: /home/prashant.palkar/minotaur/third-party/lib/x86_64-linux-gnu/pkgconfig/lapack.pc
-- Installing: /home/prashant.palkar/minotaur/third-party/lib/x86_64-linux-gnu/cmake/lapack-3.7.1/lapack-config.cmake
-- Installing: /home/prashant.palkar/minotaur/third-party/lib/x86_64-linux-gnu/cmake/lapack-3.7.1/lapack-config-version.cmake
-- Installing: /home/prashant.palkar/minotaur/third-party/lib/x86_64-linux-gnu/pkgconfig/blas.pc
-- Installing: /home/prashant.palkar/minotaur/third-party/lib/x86_64-linux-gnu/libblas.a
not compiling OsiCpx and OsiGrb
prashant@brahma:~/minotaur/third-party$

```

- To start compiling MINOTAUR, type the following commands:

```
cd ..
cd minotaur
mkdir build
cd build
cmake -DTHIRD_PARTY_PATH:PATH=../third-party/ ..
```

Commands in Step 4 should appear as in the following picture.

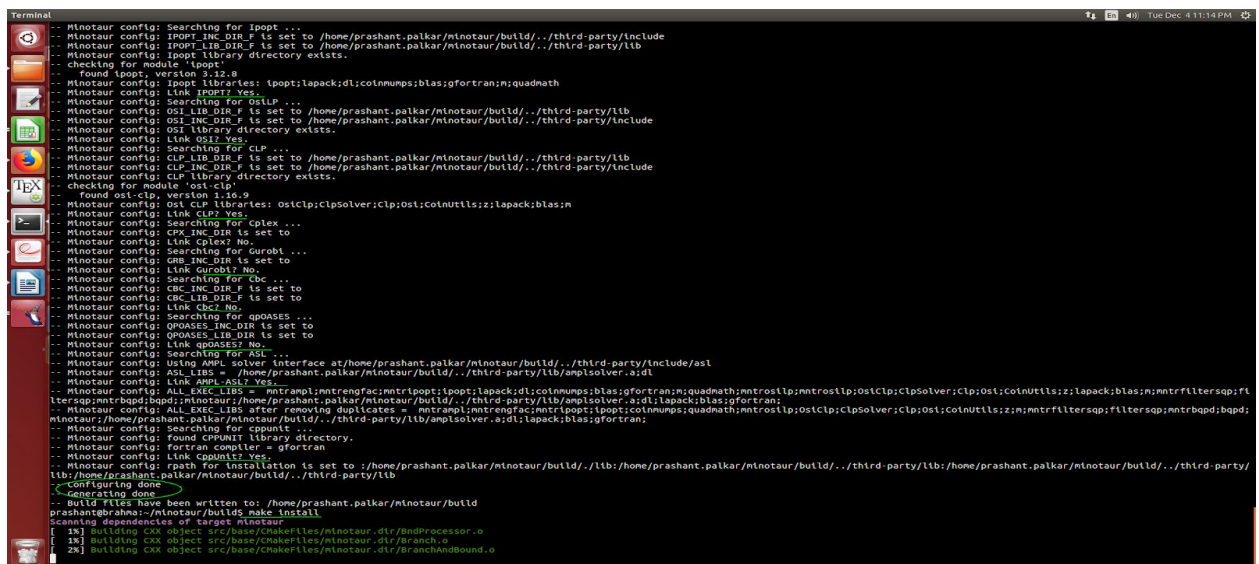


```
Terminal
prashant@brahma:~/minotaur/third-party$ cd ../
prashant@brahma:~/minotaur$ mkdir build
prashant@brahma:~/minotaur$ cd build
prashant@brahma:~/minotaur/build$ cmake -DTHIRD_PARTY_PATH:PATH=../third-party/ ..
-- The CXX compiler identification is GNU 4.8.4
-- The C compiler identification is GNU 4.8.4
-- The Fortran compiler identification is GNU
-- Check for working CXX compiler: /usr/bin/c++
-- Check for working CXX compiler: /usr/bin/c++ -- works
-- Detecting CXX compiler ABI info
-- Detecting CXX compiler ABI info - done
-- Check for working C compiler: /usr/bin/cc
-- Check for working C compiler: /usr/bin/cc -- works
-- Detecting C compiler ABI info
-- Detecting C compiler ABI info - done
-- Check for working Fortran compiler: /usr/bin/gfortran
-- Check for working Fortran compiler: /usr/bin/gfortran -- works
-- Detecting Fortran compiler ABI info
-- Detecting Fortran compiler ABI info - done
-- Checking whether /usr/bin/gfortran supports Fortran 90
-- Checking whether /usr/bin/gfortran supports Fortran 90 -- yes
-- Detecting Fortran/C Interface
```

- Last step of the compilation is:

make install

Completion of the last command in Step 4 and beginning of command in Step 5 appear as follows.



```
Terminal
-- Minotaur config: Searching For Ipopt ...
-- Minotaur config: IPOPT_INC_DIR_F is set to /home/prashant.palkar/minotaur/build/./third-party/include
-- Minotaur config: IPOPT_LIB_DIR_F is set to /home/prashant.palkar/minotaur/build/./third-party/lib
-- Minotaur config: Ipopt library directory exists.
-- checking for module 'Ipopt'
-- Found Ipopt, version 3.12.8
-- Minotaur config: Ipopt libraries: ipopt;lapack;dl;coinmumps;blas;gfortran;quadmath
-- Minotaur config: Link Ipopt? Yes.
-- Minotaur config: Searching for OSCLP ...
-- Minotaur config: OSI_LIB_DIR_F is set to /home/prashant.palkar/minotaur/build/./third-party/lib
-- Minotaur config: OSI_INC_DIR_F is set to /home/prashant.palkar/minotaur/build/./third-party/include
-- Minotaur config: OSI library directory exists.
-- Minotaur config: Link OSI? Yes.
-- Minotaur config: Searching for CLP ...
-- Minotaur config: CLP_LIB_DIR_F is set to /home/prashant.palkar/minotaur/build/./third-party/lib
-- Minotaur config: CLP_INC_DIR_F is set to /home/prashant.palkar/minotaur/build/./third-party/include
-- Minotaur config: CLP library directory exists.
-- checking for module 'ost-clp'
-- Found ost-clp, version 1.16.0
-- Minotaur config: Ost clp libraries: ostclp;clpsolver;clp;ost;coinutils;lapack;blas
-- Minotaur config: Link CLP? Yes.
-- Minotaur config: Searching for Cplex ...
-- Minotaur config: CPX_INC_DIR is set to
-- Minotaur config: Link Cplex? No.
-- Minotaur config: Searching for Gurobi ...
-- Minotaur config: GRB_INC_DIR is set to
-- Minotaur config: Link Gurobi? No.
-- Minotaur config: Searching for Cbc ...
-- Minotaur config: CBC_INC_DIR_F is set to
-- Minotaur config: CBC_LIB_DIR_F is set to
-- Minotaur config: Link CBC? No.
-- Minotaur config: Searching for QPOASES ...
-- Minotaur config: QPOASES_INC_DIR is set to
-- Minotaur config: QPOASES_LIB_DIR is set to
-- Minotaur config: Link QPOASES? No.
-- Minotaur config: Searching for ASL ...
-- Minotaur config: Using AMPL solver interface at/home/prashant.palkar/minotaur/build/./third-party/include/ast
-- Minotaur config: ASL_LIBS = /home/prashant.palkar/minotaur/build/./third-party/lib/ampsolver.a;dl
-- Minotaur config: ALL_EXEC_LIBS = mtrAMPL;mtrengfac;mtrIpopt;ipopt;lapack;dl;coinmumps;blas;gfortran;quadmath;mntroslp;mntroslp;ostclp;clpsolver;clp;ost;coinutils;lapack;blas;mntnrfltersap;fl
lter;gomp;mntbrahm;/home/prashant.palkar/minotaur/build/./third-party/lib/ampsolver.a;dl;lapack;blas;gfortran;
-- Minotaur config: ALL_EXEC_LIBS after removing duplicates = mtrAMPL;mtrengfac;mtrIpopt;ipopt;coinmumps;quadmath;mntroslp;ostclp;clpsolver;clp;ost;coinutils;lapack;blas;mntnrfltersap;flter;gomp;mntbrahm;/home/prashant.palkar/minotaur/build/./third-party/lib/ampsolver.a;dl;lapack;blas;gfortran;
-- Minotaur config: Searching for CPUNITE ...
-- Minotaur config: Found CPUNITE library directory.
-- Minotaur config: Fortran compiler = gfortran
-- Minotaur config: Link CPUNITE? Yes.
-- Minotaur config: Path for installation is set to /home/prashant.palkar/minotaur/build/./lib;/home/prashant.palkar/minotaur/build/./third-party/lib;/home/prashant.palkar/minotaur/build/./third-party/lib;/home/prashant.palkar/minotaur/build/./third-party/lib
-- configuring done
-- Generating done
-- Build files have been written to: /home/prashant.palkar/minotaur/build
prashant@brahma:~/minotaur/build$ make install
Scanning dependencies of target Minotaur
[ 2%] Building CXX object src/base/Chokefiles/Minotaur.dir/MinProcessor.o
[ 3%] Building CXX object src/base/Chokefiles/Minotaur.dir/Branch.o
[ 2%] Building CXX object src/base/Chokefiles/Minotaur.dir/BranchAndBound.o
```

Completion of Step 5 appears as in the below image.

```
prashant@brahma:~/minotaur/build$
-- Minotaur config: Link BOPD? Yes.
-- Minotaur config: Searching for Filter-SQP ...
-- Minotaur config: FILTER_LIB_DIR_F is set to /home/prashant.palkar/minotaur/build/./third-party/lib
-- Minotaur config: Filter-SQP library directory exists.
-- Minotaur config: Link Filter-SQP? Yes.
-- Minotaur config: Searching for Ipopt ...
-- Minotaur config: IPOPT_INC_DIR_F is set to /home/prashant.palkar/minotaur/build/./third-party/include
-- Minotaur config: IPOPT_LIB_DIR_F is set to /home/prashant.palkar/minotaur/build/./third-party/lib
-- Minotaur config: Ipopt library directory exists.
-- checking for module 'ipopt'
-- Found ipopt, version 3.12.8
-- Minotaur config: Ipopt libraries: ipopt;lapack;dl;colnmumps;blas;gfortran;m;quadmath
-- Minotaur config: Link IPOPT? Yes.
-- Minotaur config: Searching for OsiLP ...
-- Minotaur config: OSI_LIB_DIR_F is set to /home/prashant.palkar/minotaur/build/./third-party/lib
-- Minotaur config: OSI_INC_DIR_F is set to /home/prashant.palkar/minotaur/build/./third-party/include
-- Minotaur config: Osi library directory exists.
-- Minotaur config: Link Osi? Yes.
-- Minotaur config: Searching for CLP ...
-- Minotaur config: CLP_LIB_DIR_F is set to /home/prashant.palkar/minotaur/build/./third-party/lib
-- Minotaur config: CLP_INC_DIR_F is set to /home/prashant.palkar/minotaur/build/./third-party/include
-- Minotaur config: CLP library directory exists.
-- checking for module 'osi-clp'
-- Found osi-clp, version 1.16.9
-- Minotaur config: Osi CLP libraries: OsiClp;ClpSolver;Clp;Osi;ColnUtils;z;lapack;blas;m
-- Minotaur config: Link CLP? Yes.
-- Minotaur config: Searching for Cplex ...
-- Minotaur config: CPX_INC_DIR is set to
-- Minotaur config: Link Cplex? No.
-- Minotaur config: Searching for Gurobi ...
-- Minotaur config: GRB_INC_DIR is set to
-- Minotaur config: Link Gurobi? No.
-- Minotaur config: Searching for Cbc ...
-- Minotaur config: CBC_INC_DIR_F is set to
-- Minotaur config: CBC_LIB_DIR_F is set to
-- Minotaur config: Link Cbc? No.
-- Minotaur config: Searching for qpOASES ...
-- Minotaur config: QPOASES_INC_DIR is set to
-- Minotaur config: QPOASES_LIB_DIR is set to
-- Minotaur config: Link qpOASES? No.
-- Minotaur config: Searching for ASL ...
-- Minotaur config: Using AMPL solver interface at/home/prashant.palkar/minotaur/build/./third-party/include/asl
-- Minotaur config: ASL_LIBS = /home/prashant.palkar/minotaur/build/./third-party/lib/amplsolver.a;dl
-- Minotaur config: Link AMPL-ASL? Yes.
-- Minotaur config: ALL_EXEC_LIBS = mntrampl;mntrengfac;mntripopt;ipopt;lapack;dl;colnmumps;blas;gfortran;m;quadmath;
ltersq;mntrbpd;bqpd;minotaur;/home/prashant.palkar/minotaur/build/./third-party/lib/amplsolver.a;dl;lapack;blas;gf
-- Minotaur config: ALL_EXEC_LIBS after removing duplicates = mntrampl;mntrengfac;mntripopt;ipopt;colnmumps;quadmath;
minotaur;/home/prashant.palkar/minotaur/build/./third-party/lib/amplsolver.a;dl;lapack;blas;gfortran;
-- Minotaur config: Searching for cppunit ...
-- Minotaur config: Found CPPUNIT library directory.
-- Minotaur config: fortran compiler = gfortran
-- Minotaur config: Link CppUnit? Yes.
-- Minotaur config: rpath for installation is set to :/home/prashant.palkar/minotaur/build/./lib:/home/prashant.palkar
lib:/home/prashant.palkar/minotaur/build/./third-party/lib
-- configuring done
-- Generating done
-- Build files have been written to: /home/prashant.palkar/minotaur/build
prashant@brahma:~/minotaur/build$
```

6. If you have have successfully compiled MINOTAUR, you should see binaries in the *bin* directory as shown in the following picture:

ls bin

```
prashant@brahma:~/minotaur/build
prashant@brahma:~$ cd minotaur/build/
prashant@brahma:~/minotaur/build$ ls bin
bnb  glob  msbnb  qq  qpd
prashant@brahma:~/minotaur/build$
```

To run an example:

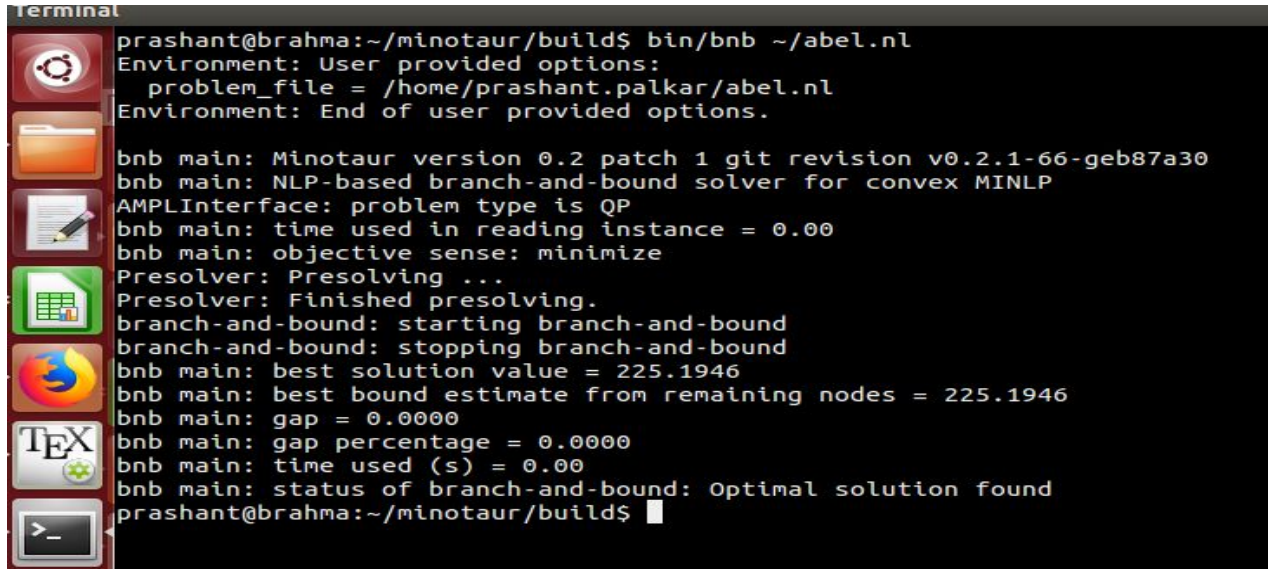
1. Download an instance (convex) using following link:

<http://www.minlplib.org/nl/abel.nl>

2. Run the instance (in *.nl* format) using any of the binaries in *bin* following the path where the instance is being downloaded. For example, if the instance *abel.nl* lies in your home directory, try running the nonlinear branch-and-bound algorithm from the build directory using the following command:

```
bin/bnb ~/abel.nl
```

The following figure shows the expected output.



```
terminal
prashant@brahma:~/minotaur/build$ bin/bnb ~/abel.nl
Environment: User provided options:
  problem_file = /home/prashant.palkar/abel.nl
Environment: End of user provided options.

bnb main: Minotaur version 0.2 patch 1 git revision v0.2.1-66-geb87a30
bnb main: NLP-based branch-and-bound solver for convex MINLP
AMPLInterface: problem type is QP
bnb main: time used in reading instance = 0.00
bnb main: objective sense: minimize
Presolver: Presolving ...
Presolver: Finished presolving.
branch-and-bound: starting branch-and-bound
branch-and-bound: stopping branch-and-bound
bnb main: best solution value = 225.1946
bnb main: best bound estimate from remaining nodes = 225.1946
bnb main: gap = 0.0000
bnb main: gap percentage = 0.0000
bnb main: time used (s) = 0.00
bnb main: status of branch-and-bound: Optimal solution found
prashant@brahma:~/minotaur/build$
```


Instructions for Session-3

Constrained Scaled Conjugate Gradient based Direct Search (CSCG-DS)

Prerequisites if you bring your own laptop:

1. Works on linux machines only.
2. Please install lapack and blas libraries. For e.g. in debian, ubuntu, gentoo etc:
\$sudo apt-get install libblas-dev liblapack-dev
3. Download files from <https://github.com/gcmouli1/CSCG-DS>

This algorithm solves optimization problems without any derivative/gradient information. Written completely in C with only external dependencies of blas and lapack. To run the algorithm, do following steps:

1. Goto the directory CSCG-DS and run the following commands on command prompt.
2. **\$make**
3. **\$/cscgds parameters.txt**

If it reports a final optimal solution value and number of function evaluations, then the installation is complete.