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Lab 05

Part 1

Steps 1 and 2 (cmake)

Code:

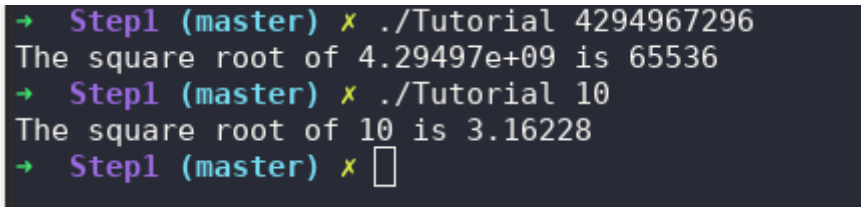
```
#include <cmath>
#include <iostream>
#include <string>
#include "TutorialConfig.h"
#ifdef USE_MYMATH
#include "MathFunctions.h"
#endif
int main(int argc, char* argv[])
{
  if (argc < 2) {

    std::cout << argv[0] << " Version " << Tutorial_VERSION_MAJOR    << "."
              << Tutorial_VERSION_MINOR << std::endl;
    std::cout << "Usage: " << argv[0] << " number" << std::endl;
    return 1;
  }

  // convert input to double
  const double inputValue = std::stod(argv[1]);
#ifdef USE_MYMATH
  const double outputValue = mysqrt(inputValue);
#else
  const double outputValue = sqrt(inputValue);
#endif

  std::cout << "The square root of " << inputValue << " is " << outputValue
            << std::endl;
  return 0;
}

```

CMakeLists.txt:

```
cmake_minimum_required(VERSION 3.10)
# set the project name and version
project(Tutorial VERSION 1.0)
# specify the C++ standard
set(CMAKE_CXX_STANDARD 11)
```

```
set(CMAKE_CXX_STANDARD_REQUIRED True)
option(USE_MYMATH "Use tutorial provided math implementation" ON)
configure_file(TutorialConfig.h.in TutorialConfig.h)
if(USE_MYMATH)
  add_subdirectory(MathFunctions)
  list(APPEND EXTRA_LIBS MathFunctions)
  list(APPEND EXTRA_INCLUDES "${PROJECT_SOURCE_DIR}/MathFunctions")
endif()
add_executable(Tutorial tutorial.cxx)
target_link_libraries(Tutorial PUBLIC ${EXTRA_LIBS})
target_include_directories(Tutorial PUBLIC
                           "${PROJECT_BINARY_DIR}"
                           ${EXTRA_INCLUDES}
                           )

```

Screenshot of program run:



Step 3:

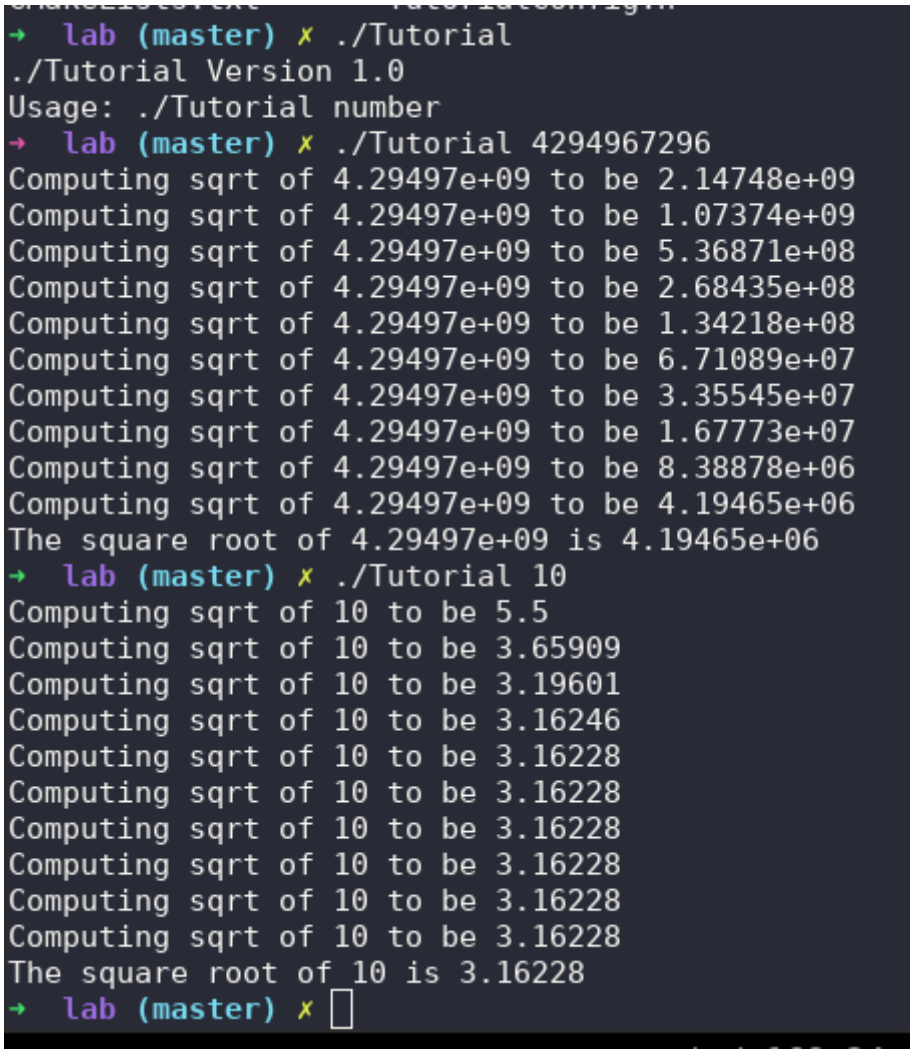
CMakeLists.txt:

```
cmake_minimum_required(VERSION 3.10)

# set the project name and version
project(Tutorial VERSION 1.0)

# specify the C++ standard
set(CMAKE_CXX_STANDARD 11)
set(CMAKE_CXX_STANDARD_REQUIRED True)

# should we use our own math functions
option(USE_MYMATH "Use tutorial provided math implementation" ON)

# configure a header file to pass some of the CMake settings
# to the source code
configure_file(TutorialConfig.h.in TutorialConfig.h)

# add the MathFunctions library
if(USE_MYMATH)
  add_subdirectory(MathFunctions)
  list(APPEND EXTRA_LIBS MathFunctions)
endif()

# add the executable
add_executable(Tutorial tutorial.cxx)

target_link_libraries(Tutorial PUBLIC ${EXTRA_LIBS})

# add the binary tree to the search path for include files
# so that we will find TutorialConfig.h

```

```
target_include_directories(Tutorial PUBLIC
                           "${PROJECT_BINARY_DIR}"
                           )
```

MathFunctions/CMakeLists.txt

```
target_include_directories(MathFunctions
          INTERFACE ${CMAKE_CURRENT_SOURCE_DIR}
          )

```



Step 4:

CMakeLists.txt:

```
cmake_minimum_required(VERSION 3.10)

# set the project name and version
project(Tutorial VERSION 1.0)

# specify the C++ standard
set(CMAKE_CXX_STANDARD 11)
set(CMAKE_CXX_STANDARD_REQUIRED True)

# should we use our own math functions
option(USE_MYMATH "Use tutorial provided math implementation" ON)

```

```
# configure a header file to pass some of the CMake settings
# to the source code
configure_file(TutorialConfig.h.in TutorialConfig.h)

# add the MathFunctions library
if(USE_MYMATH)
  add_subdirectory(MathFunctions)
  list(APPEND EXTRA_LIBS MathFunctions)
endif()

# add the executable
add_executable(Tutorial tutorial.cxx)

target_link_libraries(Tutorial PUBLIC ${EXTRA_LIBS})

# add the binary tree to the search path for include files
# so that we will find TutorialConfig.h
target_include_directories(Tutorial PUBLIC
                           "${PROJECT_BINARY_DIR}"
                           )
# add the install targets
install(TARGETS Tutorial DESTINATION bin)
install(FILES "${PROJECT_BINARY_DIR}/TutorialConfig.h"
  DESTINATION include
  )

# enable testing
enable_testing()

# does the application run
add_test(NAME Runs COMMAND Tutorial 25)

# does the usage message work?
add_test(NAME Usage COMMAND Tutorial)
set_tests_properties(Usage
  PROPERTIES PASS_REGULAR_EXPRESSION "Usage:.*number"
  )

# define a function to simplify adding tests
function(do_test target arg result)
  add_test(NAME Comp${arg} COMMAND ${target} ${arg})
  set_tests_properties(Comp${arg}
    PROPERTIES PASS_REGULAR_EXPRESSION ${result}
    )
endfunction(do_test)

# do a bunch of result based tests
do_test(Tutorial 4 "4 is 2")
do_test(Tutorial 9 "9 is 3")
do_test(Tutorial 5 "5 is 2.236")
do_test(Tutorial 7 "7 is 2.645")
do_test(Tutorial 25 "25 is 5")
do_test(Tutorial -25 "-25 is [-nan|nan|0]")
do_test(Tutorial 0.0001 "0.0001 is 0.01")

```

MathFunctions/CMakeLists.txt:

```
target_include_directories(MathFunctions
          INTERFACE ${CMAKE_CURRENT_SOURCE_DIR}
          )

# install rules
install(TARGETS MathFunctions DESTINATION lib)
install(FILES MathFunctions.h DESTINATION include)
```

Tests Output:

```
6: Computing sqrt of 7 to be 2.64575
6: Computing sqrt of 7 to be 2.64575
6: Computing sqrt of 7 to be 2.64575
6: Computing sqrt of 7 to be 2.64575
6: Computing sqrt of 7 to be 2.64575
6: The square root of 7 is 2.64575
6/9 Test #6: Comp7 ............................   Passed    0.00 sec
test 7
    Start 7: Comp25

7: Test command: /home/hotopb/Dropbox/Spring\ 2021/Open\ Source\ Soft
ware/labs/dump/cmake/Help/guide/tutorial/lab/Tutorial "25"
7: Test timeout computed to be: 10000000
7: Computing sqrt of 25 to be 13
7: Computing sqrt of 25 to be 7.46154
7: Computing sqrt of 25 to be 5.40603
7: Computing sqrt of 25 to be 5.01525
7: Computing sqrt of 25 to be 5.00002
7: Computing sqrt of 25 to be 5
7: Computing sqrt of 25 to be 5
7: Computing sqrt of 25 to be 5
7: Computing sqrt of 25 to be 5
7: Computing sqrt of 25 to be 5
7: The square root of 25 is 5
7/9 Test #7: Comp25 ...........................   Passed    0.00 sec
test 8
    Start 8: Comp-25

8: Test command: /home/hotopb/Dropbox/Spring\ 2021/Open\ Source\ Soft
ware/labs/dump/cmake/Help/guide/tutorial/lab/Tutorial "-25"
8: Test timeout computed to be: 10000000
8: The square root of -25 is 0
8/9 Test #8: Comp-25 ..........................   Passed    0.00 sec
test 9
    Start 9: Comp0.0001

9: Test command: /home/hotopb/Dropbox/Spring\ 2021/Open\ Source\ Soft
ware/labs/dump/cmake/Help/guide/tutorial/lab/Tutorial "0.0001"
9: Test timeout computed to be: 10000000
9: Computing sqrt of 0.0001 to be 0.50005
9: Computing sqrt of 0.0001 to be 0.250125
9: Computing sqrt of 0.0001 to be 0.125262
9: Computing sqrt of 0.0001 to be 0.0630304
9: Computing sqrt of 0.0001 to be 0.0323084
9: Computing sqrt of 0.0001 to be 0.0177018
9: Computing sqrt of 0.0001 to be 0.0116755
9: Computing sqrt of 0.0001 to be 0.0101202
9: Computing sqrt of 0.0001 to be 0.0100007
9: Computing sqrt of 0.0001 to be 0.01
9: The square root of 0.0001 is 0.01
9/9 Test #9: Comp0.0001 .......................   Passed    0.00 sec

100% tests passed, 0 tests failed out of 9

Total Test time (real) =   0.02 sec
➜  lab (master) ✗
```

Step 5:

CMakeLists.txt:

```
1  cmake_minimum_required(VERSION 3.10)
```

```
2
3  # set the project name and version
4  project(Tutorial VERSION 1.0)
5
6  # specify the C++ standard
7  set(CMAKE_CXX_STANDARD 11)
8  set(CMAKE_CXX_STANDARD_REQUIRED True)
9
10 # should we use our own math functions
11 option(USE_MYMATH "Use tutorial provided math implementation" ON)
12
13 # configure a header file to pass some of the CMake settings
14 # to the source code
15 configure_file(TutorialConfig.h.in TutorialConfig.h)
16
17 # add the MathFunctions library
18 if(USE_MYMATH)
19   add_subdirectory(MathFunctions)
20   list(APPEND EXTRA_LIBS MathFunctions)
21 endif()
22
23 # add the executable
24 add_executable(Tutorial tutorial.cxx)
25 target_link_libraries(Tutorial PUBLIC ${EXTRA_LIBS})
26
27 # add the binary tree to the search path for include files
28 # so that we will find TutorialConfig.h
29 target_include_directories(Tutorial PUBLIC
30                            "${PROJECT_BINARY_DIR}"
31                            )
32
33 # add the install targets
34 install(TARGETS Tutorial DESTINATION bin)
35 install(FILES "${PROJECT_BINARY_DIR}/TutorialConfig.h"
36   DESTINATION include
37   )
38
39 # enable testing
40 enable_testing()
41
42 # does the application run
43 add_test(NAME Runs COMMAND Tutorial 25)
44
45 # does the usage message work?
46 add_test(NAME Usage COMMAND Tutorial)
47 set_tests_properties(Usage
48   PROPERTIES PASS_REGULAR_EXPRESSION "Usage:.*number"
49   )
50
51 # define a function to simplify adding tests
52 function(do_test target arg result)
53   add_test(NAME Comp${arg} COMMAND ${target} ${arg})
54   set_tests_properties(Comp${arg}
55     PROPERTIES PASS_REGULAR_EXPRESSION ${result}
56     )
57 endfunction(do_test)
58
59 # do a bunch of result based tests
```

```
do_test(Tutorial 4 "4 is 2")
do_test(Tutorial 9 "9 is 3")
do_test(Tutorial 5 "5 is 2.236")
do_test(Tutorial 7 "7 is 2.645")
do_test(Tutorial 25 "25 is 5")
do_test(Tutorial -25 "-25 is [-nan|nan|0]")
do_test(Tutorial 0.0001 "0.0001 is 0.01")

```

MathFunctions/CMakeLists.txt:

```
target_include_directories(MathFunctions
          INTERFACE ${CMAKE_CURRENT_SOURCE_DIR}
          )

# does this system provide the log and exp functions?
include(CheckSymbolExists)
check_symbol_exists(log "math.h" HAVE_LOG)
check_symbol_exists(exp "math.h" HAVE_EXP)
if(NOT (HAVE_LOG AND HAVE_EXP))
  unset(HAVE_LOG CACHE)
  unset(HAVE_EXP CACHE)
  set(CMAKE_REQUIRED_LIBRARIES "m")
  check_symbol_exists(log "math.h" HAVE_LOG)
  check_symbol_exists(exp "math.h" HAVE_EXP)
  if(HAVE_LOG AND HAVE_EXP)
    target_link_libraries(MathFunctions PRIVATE m)
  endif()
endif()

# add compile definitions
if(HAVE_LOG AND HAVE_EXP)
  target_compile_definitions(MathFunctions
                             PRIVATE "HAVE_LOG" "HAVE_EXP")
endif()

# install rules
install(TARGETS MathFunctions DESTINATION lib)
install(FILES MathFunctions.h DESTINATION include)

```

Screenshots:

```
➜  lab (master) ✗ ./Tutorial
./Tutorial Version 1.0
Usage: ./Tutorial number
➜  lab (master) ✗ ./Tutorial 10
Computing sqrt of 10 to be 3.16228 using log and exp
The square root of 10 is 3.16228
➜  lab (master) ✗ ./Tutorial 4294967296
Computing sqrt of 4.29497e+09 to be 65536 using log and exp
The square root of 4.29497e+09 is 65536
➜  lab (master) ✗
```

Part 2

Makefile:

```
Program: library.a program.out
    gcc program.out library.a -o Program

program.out: program.c
    gcc -c program.c -o program.out

block.out: source/block.c
    gcc -fPIC -c source/block.c -o block.out

library.a: block.out
    ar qc library.a block.out

sharedlibrary.so: block.out
    gcc block.out -shared -o sharedlibrary.so

ProgramShared: sharedlibrary.so program.out
    gcc program.out sharedlibrary.so -o ProgramShared -Wl,-
rpath='$$ORIGIN'

```

CMakeList.txt:

```
cmake_minimum_required(VERSION 3.3)
project(aProgram)

set(CMAKE_CXX_STANDARD 11)
set(CMAKE_CXX_STANDARD_REQUIRED True)

add_library( alibrary STATIC ./source/block.c )
add_executable(aProgram program.c)
target_link_libraries(aProgram alibrary)

add_library(asharedlibrary SHARED ./source/block.c)
add_executable(aProgramShared program.c)
target_link_libraries(aProgramShared asharedlibrary)

```

Makefile created by Cmake:

```
# CMAKE generated file: DO NOT EDIT!
# Generated by "Unix Makefiles" Generator, CMake Version 3.16

# Default target executed when no arguments are given to make.
default_target: all

.PHONY : default_target

#=============================================================================
# Special targets provided by cmake.

# Disable implicit rules so canonical targets will work.
.SUFFIXES:


# Remove some rules from gmake that .SUFFIXES does not remove.
```

```
SUFFIXES =

.SUFFIXES: .hpux_make_needs_suffix_list


# Suppress display of executed commands.
$(VERBOSE).SILENT:


# A target that is always out of date.
cmake_force:

.PHONY : cmake_force

#=============================================================================
# Set environment variables for the build.

# The shell in which to execute make rules.
SHELL = /bin/sh

# The CMake executable.
CMAKE_COMMAND = /usr/bin/cmake

# The command to remove a file.
RM = /usr/bin/cmake -E remove -f

# Escaping for special characters.
EQUALS = =

# The top-level source directory on which CMake was run.
CMAKE_SOURCE_DIR = "/home/hotopb/Dropbox/Spring 2021/Open Source Software/labs/dump/CSCI-4470-OpenSource/Modules/05.BuildSystems/Lab-BuildSystemsExample"

# The top-level build directory on which CMake was run.
CMAKE_BINARY_DIR = "/home/hotopb/Dropbox/Spring 2021/Open Source Software/labs/dump/CSCI-4470-OpenSource/Modules/05.BuildSystems/Lab-BuildSystemsExample"

#=============================================================================
# Directory level rules for the build root directory

# The main recursive "all" target.
all: CMakeFiles/aProgramShared.dir/all
all: CMakeFiles/asharedlibrary.dir/all
all: CMakeFiles/aProgram.dir/all
all: CMakeFiles/alibrary.dir/all

.PHONY : all

# The main recursive "preinstall" target.
preinstall:

.PHONY : preinstall

# The main recursive "clean" target.
```

```
clean: CMakeFiles/aProgramShared.dir/clean
clean: CMakeFiles/asharedlibrary.dir/clean
clean: CMakeFiles/aProgram.dir/clean
clean: CMakeFiles/alibrary.dir/clean

.PHONY : clean

#=============================================================================
# Target rules for target CMakeFiles/aProgramShared.dir

# All Build rule for target.
CMakeFiles/aProgramShared.dir/all: CMakeFiles/asharedlibrary.dir/all
	$(MAKE) -f CMakeFiles/aProgramShared.dir/build.make CMakeFiles/aProgramShared.dir/depend
	$(MAKE) -f CMakeFiles/aProgramShared.dir/build.make CMakeFiles/aProgramShared.dir/build
	@$(CMAKE_COMMAND) -E cmake_echo_color --switch=$(COLOR) --progress-dir="/home/hotopb/Dropbox/Spring 2021/Open Source Software/labs/dump/CSCI-4470-OpenSource/Modules/05.BuildSystems/Lab-BuildSystemsExample/CMakeFiles" --progress-num=3,4 "Built target aProgramShared"
.PHONY : CMakeFiles/aProgramShared.dir/all

# Build rule for subdir invocation for target.
CMakeFiles/aProgramShared.dir/rule: cmake_check_build_system
	$(CMAKE_COMMAND) -E cmake_progress_start "/home/hotopb/Dropbox/Spring 2021/Open Source Software/labs/dump/CSCI-4470-OpenSource/Modules/05.BuildSystems/Lab-BuildSystemsExample/CMakeFiles" 4
	$(MAKE) -f CMakeFiles/Makefile2 CMakeFiles/aProgramShared.dir/all
	$(CMAKE_COMMAND) -E cmake_progress_start "/home/hotopb/Dropbox/Spring 2021/Open Source Software/labs/dump/CSCI-4470-OpenSource/Modules/05.BuildSystems/Lab-BuildSystemsExample/CMakeFiles" 0
.PHONY : CMakeFiles/aProgramShared.dir/rule

# Convenience name for target.
aProgramShared: CMakeFiles/aProgramShared.dir/rule

.PHONY : aProgramShared

# clean rule for target.
CMakeFiles/aProgramShared.dir/clean:
	$(MAKE) -f CMakeFiles/aProgramShared.dir/build.make CMakeFiles/aProgramShared.dir/clean
.PHONY : CMakeFiles/aProgramShared.dir/clean

#=============================================================================
# Target rules for target CMakeFiles/asharedlibrary.dir

# All Build rule for target.
CMakeFiles/asharedlibrary.dir/all:
	$(MAKE) -f CMakeFiles/asharedlibrary.dir/build.make CMakeFiles/asharedlibrary.dir/depend
	$(MAKE) -f CMakeFiles/asharedlibrary.dir/build.make CMakeFiles/asharedlibrary.dir/build
```

```
110     @$(CMAKE_COMMAND) -E cmake_echo_color --switch=$(COLOR) --progress-
    dir="/home/hotopb/Dropbox/Spring 2021/Open Source
    Software/labs/dump/CSCI-4470-OpenSource/Modules/05.BuildSystems/Lab-
    BuildSystemsExample/CMakeFiles" --progress-num=7,8 "Built target
    asharedlibrary"
111 .PHONY : CMakeFiles/asharedlibrary.dir/all
112
113 # Build rule for subdir invocation for target.
114 CMakeFiles/asharedlibrary.dir/rule: cmake_check_build_system
115     $(CMAKE_COMMAND) -E cmake_progress_start "/home/hotopb/Dropbox/Spring
    2021/Open Source Software/labs/dump/CSCI-4470-
    OpenSource/Modules/05.BuildSystems/Lab-BuildSystemsExample/CMakeFiles" 2
116     $(MAKE) -f CMakeFiles/Makefile2 CMakeFiles/asharedlibrary.dir/all
117     $(CMAKE_COMMAND) -E cmake_progress_start "/home/hotopb/Dropbox/Spring
    2021/Open Source Software/labs/dump/CSCI-4470-
    OpenSource/Modules/05.BuildSystems/Lab-BuildSystemsExample/CMakeFiles" 0
118 .PHONY : CMakeFiles/asharedlibrary.dir/rule
119
120 # Convenience name for target.
121 asharedlibrary: CMakeFiles/asharedlibrary.dir/rule
122
123 .PHONY : asharedlibrary
124
125 # clean rule for target.
126 CMakeFiles/asharedlibrary.dir/clean:
127     $(MAKE) -f CMakeFiles/asharedlibrary.dir/build.make
    CMakeFiles/asharedlibrary.dir/clean
128 .PHONY : CMakeFiles/asharedlibrary.dir/clean
129
130 #=============================================================================
    =====
131 # Target rules for target CMakeFiles/aProgram.dir
132
133 # All Build rule for target.
134 CMakeFiles/aProgram.dir/all: CMakeFiles/alibrary.dir/all
135     $(MAKE) -f CMakeFiles/aProgram.dir/build.make
    CMakeFiles/aProgram.dir/depend
136     $(MAKE) -f CMakeFiles/aProgram.dir/build.make
    CMakeFiles/aProgram.dir/build
137     @$(CMAKE_COMMAND) -E cmake_echo_color --switch=$(COLOR) --progress-
    dir="/home/hotopb/Dropbox/Spring 2021/Open Source
    Software/labs/dump/CSCI-4470-OpenSource/Modules/05.BuildSystems/Lab-
    BuildSystemsExample/CMakeFiles" --progress-num=1,2 "Built target
    aProgram"
138 .PHONY : CMakeFiles/aProgram.dir/all
139
140 # Build rule for subdir invocation for target.
141 CMakeFiles/aProgram.dir/rule: cmake_check_build_system
142     $(CMAKE_COMMAND) -E cmake_progress_start "/home/hotopb/Dropbox/Spring
    2021/Open Source Software/labs/dump/CSCI-4470-
    OpenSource/Modules/05.BuildSystems/Lab-BuildSystemsExample/CMakeFiles" 4
143     $(MAKE) -f CMakeFiles/Makefile2 CMakeFiles/aProgram.dir/all
144     $(CMAKE_COMMAND) -E cmake_progress_start "/home/hotopb/Dropbox/Spring
    2021/Open Source Software/labs/dump/CSCI-4470-
    OpenSource/Modules/05.BuildSystems/Lab-BuildSystemsExample/CMakeFiles" 0
145 .PHONY : CMakeFiles/aProgram.dir/rule
146
147 # Convenience name for target.
```

```
aProgram: CMakeFiles/aProgram.dir/rule

.PHONY : aProgram

# clean rule for target.
CMakeFiles/aProgram.dir/clean:
	$(MAKE) -f CMakeFiles/aProgram.dir/build.make CMakeFiles/aProgram.dir/clean
.PHONY : CMakeFiles/aProgram.dir/clean

#=============================================================================
# Target rules for target CMakeFiles/alibrary.dir

# All Build rule for target.
CMakeFiles/alibrary.dir/all:
	$(MAKE) -f CMakeFiles/alibrary.dir/build.make CMakeFiles/alibrary.dir/depend
	$(MAKE) -f CMakeFiles/alibrary.dir/build.make CMakeFiles/alibrary.dir/build
	@$(CMAKE_COMMAND) -E cmake_echo_color --switch=$(COLOR) --progress-dir="/home/hotopb/Dropbox/Spring 2021/Open Source Software/labs/dump/CSCI-4470-OpenSource/Modules/05.BuildSystems/Lab-BuildSystemsExample/CMakeFiles" --progress-num=5,6 "Built target alibrary"
.PHONY : CMakeFiles/alibrary.dir/all

# Build rule for subdir invocation for target.
CMakeFiles/alibrary.dir/rule: cmake_check_build_system
	$(CMAKE_COMMAND) -E cmake_progress_start "/home/hotopb/Dropbox/Spring 2021/Open Source Software/labs/dump/CSCI-4470-OpenSource/Modules/05.BuildSystems/Lab-BuildSystemsExample/CMakeFiles" 2
	$(MAKE) -f CMakeFiles/Makefile2 CMakeFiles/alibrary.dir/all
	$(CMAKE_COMMAND) -E cmake_progress_start "/home/hotopb/Dropbox/Spring 2021/Open Source Software/labs/dump/CSCI-4470-OpenSource/Modules/05.BuildSystems/Lab-BuildSystemsExample/CMakeFiles" 0
.PHONY : CMakeFiles/alibrary.dir/rule

# Convenience name for target.
alibrary: CMakeFiles/alibrary.dir/rule

.PHONY : alibrary

# clean rule for target.
CMakeFiles/alibrary.dir/clean:
	$(MAKE) -f CMakeFiles/alibrary.dir/build.make CMakeFiles/alibrary.dir/clean
.PHONY : CMakeFiles/alibrary.dir/clean

#=============================================================================
# Special targets to cleanup operation of make.

# Special rule to run CMake to check the build system integrity.
# No rule that depends on this can have commands that come from listfiles
# because they might be regenerated.
cmake_check_build_system:
```

```
191     $(CMAKE_COMMAND) -S$(CMAKE_SOURCE_DIR) -B$(CMAKE_BINARY_DIR) --check-
    build-system CMakeFiles/Makefile.cmake 0
192 .PHONY : cmake_check_build_system
193
```

Program Size Comparison:

```
-rwxrwxr-x 1 hotopb hotopb 16856 Mar  1 18:06 aProgram
-rwxrwxr-x 1 hotopb hotopb 16696 Mar  1 18:06 aProgramShared
```