Build a Geant4 application

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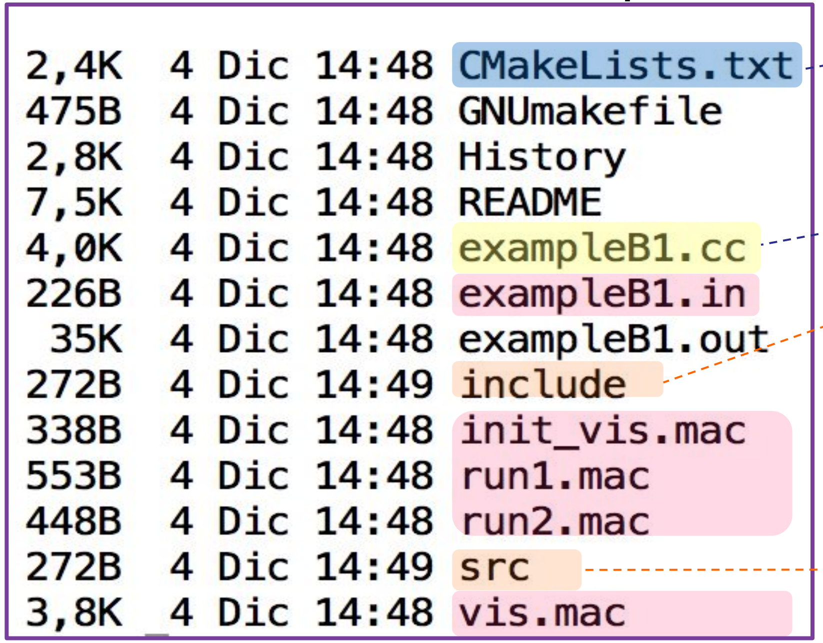
Application build process

1) Properly organize your code into directories
2) Prepare a CMakeLists.txt file
3) Create a build directory and run CMake
4) Compile (make) the application
5) Run the application

Application source structure in Geant4

Official basic/B1 example:



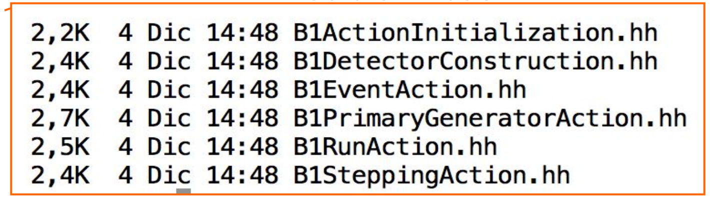
```
2,4K  4 Dic 14:48 CMakeLists.txt
475B  4 Dic 14:48 GNUmakefile
2,8K  4 Dic 14:48 History
7,5K  4 Dic 14:48 README
4,0K  4 Dic 14:48 exampleB1.cc
226B  4 Dic 14:48 exampleB1.in
 35K  4 Dic 14:48 exampleB1.out
272B  4 Dic 14:49 include
338B  4 Dic 14:48 init_vis.mac
553B  4 Dic 14:48 run1.mac
448B  4 Dic 14:48 run2.mac
272B  4 Dic 14:49 src
3,8K  4 Dic 14:48 vis.mac
```

Macro file containing the commands

The text file CMakeLists.txt is the CMake script containing commands which describe how to build the exampleB1 application

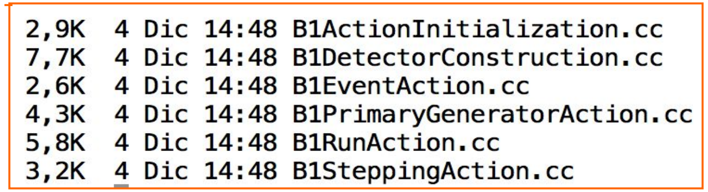
contains main() for the application

Header files



```
2,2K  4 Dic 14:48 B1ActionInitialization.hh
2,4K  4 Dic 14:48 B1DetectorConstruction.hh
2,4K  4 Dic 14:48 B1EventAction.hh
2,7K  4 Dic 14:48 B1PrimaryGeneratorAction.hh
2,5K  4 Dic 14:48 B1RunAction.hh
2,4K  4 Dic 14:48 B1SteppingAction.hh
```

Source files



```
2,9K  4 Dic 14:48 B1ActionInitialization.cc
7,7K  4 Dic 14:48 B1DetectorConstruction.cc
2,6K  4 Dic 14:48 B1EventAction.cc
4,3K  4 Dic 14:48 B1PrimaryGeneratorAction.cc
5,8K  4 Dic 14:48 B1RunAction.cc
3,2K  4 Dic 14:48 B1SteppingAction.cc
```

CMake (again)

- CMake is a build configuration tool
    - it takes configuration file (**CMakeLists.txt**)
    - it finds all dependencies (in our case, **Geant4**)
    - creates **Makefile** to run the compilation itself

- You have to write this **CMakeLists.txt** file

CMakeLists.txt

```
cmake_minimum_required(VERSION 2.6 FATAL_ERROR)

project(B1)
option(WITH_GEANT4_UIVIS "Build example with Geant4 UI and Vis drivers" ON)
if(WITH_GEANT4_UIVIS)
  find_package(Geant4 REQUIRED ui_all vis_all)
else()
  find_package(Geant4 REQUIRED)
endif()

include(${Geant4_USE_FILE})
include_directories(${PROJECT_SOURCE_DIR}/include)

file(GLOB sources ${PROJECT_SOURCE_DIR}/src/*.cc)
file(GLOB headers ${PROJECT_SOURCE_DIR}/include/*.hh)

add_executable(exampleB1 exampleB1.cc ${sources} ${headers})
target_link_libraries(exampleB1 ${Geant4_LIBRARIES})

set(EXAMPLEB1_SCRIPTS
  exampleB1.in
  exampleB1.out
  init_vis.mac
  run1.mac
  run2.mac
  vis.mac
  )

foreach(_script ${EXAMPLEB1_SCRIPTS})
  configure_file(
    ${PROJECT_SOURCE_DIR}/${_script}
    ${PROJECT_BINARY_DIR}/${_script}
    COPYONLY
    )
```

File structure

1) Cmake minimum version and **project name**
2) Find and configure G4
3) Configure the project to use G4 and B1 headers
4) List the **sources**
5) Define and link the **executable**
6) Copy any macro files to the build directory

Build directory and CMake

1) If modifying the Geant4 examples, copy them to your **$HOME** first:

```
$ cp -r /usr/local/geant4/geant4.11.0.1/examples/basic/B1 ~
```

2) Create a **build directory***, where the compiled application will be put:

```
$ mkdir -p ~/B1-build
$ cd ~/B1-build
```

***Note:** It is possible (though not recommended) to compile **inside** source directory.

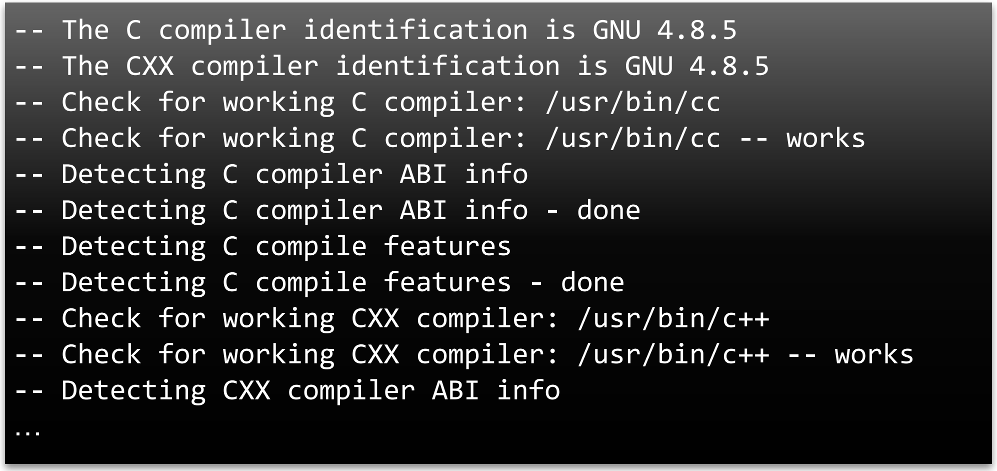
Run CMake

In the build directory you just created, run CMake:

Path to Geant4

```
$ cmake
-DGeant4_DIR=/usr/local/geant4/geant4.v11.1.1-install/lib/Geant4-1
1.1-1/ ~/B1/
```

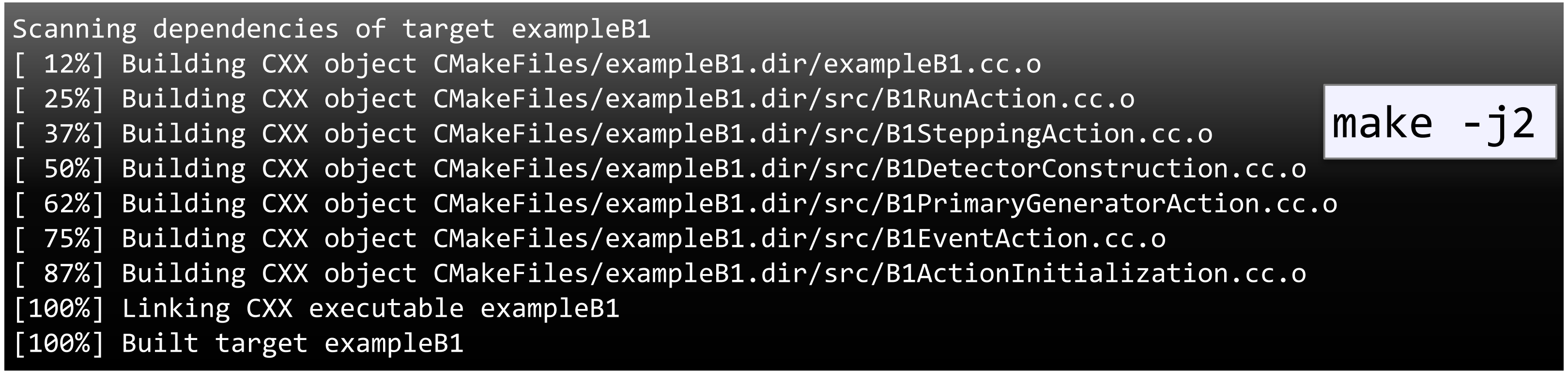
Path to source



```
-- The C compiler identification is GNU 4.8.5
-- The CXX compiler identification is GNU 4.8.5
-- 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
-- Detecting C compile features
-- Detecting C compile features - done
-- Check for working CXX compiler: /usr/bin/c++
-- Check for working CXX compiler: /usr/bin/c++ -- works
-- Detecting CXX compiler ABI info
…
```

Compilation

- In the build directory, run **make**
  - You have only a couple of files, it should be ready in a minute or two
  - An **executable** with the name of your application is created (e.g. **exampleB1**) in build directory
  - **Macros** and other auxiliary files are copied into build directory



```
Scanning dependencies of target exampleB1
[ 12%] Building CXX object CMakeFiles/exampleB1.dir/exampleB1.cc.o
[ 25%] Building CXX object CMakeFiles/exampleB1.dir/src/B1RunAction.cc.o
[ 37%] Building CXX object CMakeFiles/exampleB1.dir/src/B1SteppingAction.cc.o
[ 50%] Building CXX object CMakeFiles/exampleB1.dir/src/B1DetectorConstruction.cc.o
[ 62%] Building CXX object CMakeFiles/exampleB1.dir/src/B1PrimaryGeneratorAction.cc.o
[ 75%] Building CXX object CMakeFiles/exampleB1.dir/src/B1EventAction.cc.o
[ 87%] Building CXX object CMakeFiles/exampleB1.dir/src/B1ActionInitialization.cc.o
[100%] Linking CXX executable exampleB1
[100%] Built target exampleB1
```

```
make -j2
```

Do never modify files in the build directory

Remember that the **build directory** must be thought as a **temporary** directory.
Every time you run your **`make`**, you may **erase** or **overwrite** the files stored in build.

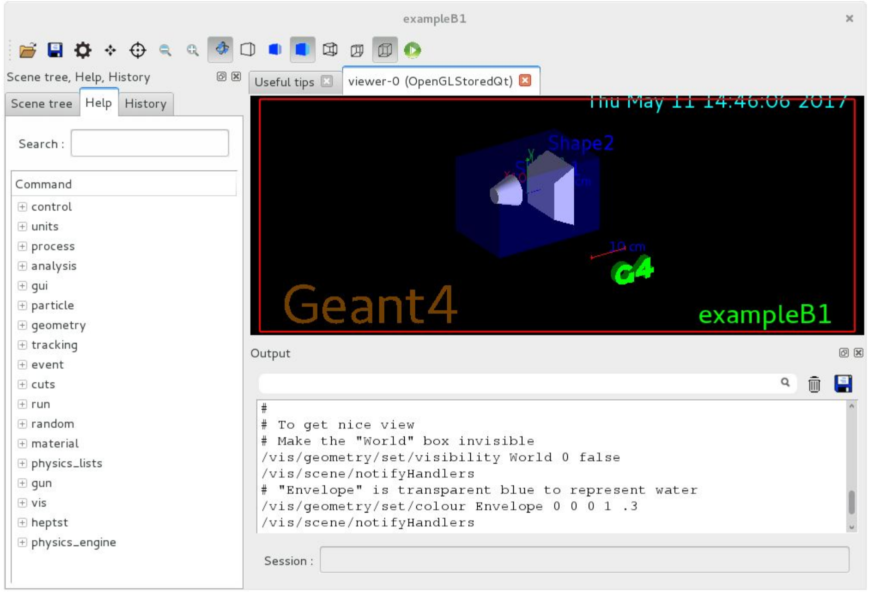
↓

If you want to **change anything** at all (also macros) change the file in the **source directory**, with a **`make`**, everything will be updated accordingly in the build directory (if everything is configured correctly).

Run the application - GUI

Just type the name of your application, including the **./** identifier of current directory (e.g. **./exampleB1**)

```
$ ./exampleB1
```



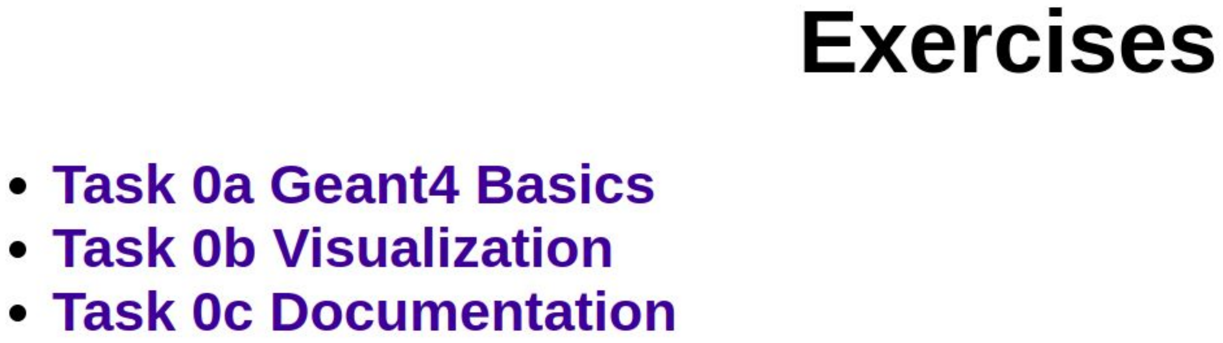
```
#
# To get nice view
# Make the "World" box invisible
/vis/geometry/set/visibility World 0 false
/vis/scene/notifyHandlers
# "Envelope" is transparent blue to represent water
/vis/geometry/set/colour Envelope 0 0 0 1 .3
/vis/scene/notifyHandlers
```

Task 0

Link to the Tasks:

http://geant4.lns.infn.it/alghero2023/task0

Task 0 - Geant4 basics


Exercises

- Task 0a Geant4 Basics
- Task 0b Visualization
- Task 0c Documentation