CMPT 373
Software Development Methods

Building Software

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  - Really.
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  - Build Configuration?
  - Build Automation?
  - Dependency Management?
  - Continuous Integration?
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*Just getting something to compile reproducibly can be nontrivial*
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  - version control integration
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- It is the foundation of getting anything done.
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- You should at least ask yourself:
  - What tools do you use?
  - What workflow?
  - What benefits do you get?
  - What are the painful points?
  - Why haven't you made them less painful?
Modeling a Build

- To build software, we must consider:
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  – Components & Objectives
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This defines the *dependency graph* of a project.
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What must the build system perform?

- JSON
- Formatting
- Library
- Client
- Server
- Project
- All
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- Client
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- JSON
- Networking
- Formatting

- format.cpp
- libformat.a
- json.cpp
- libjson.a
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- fmt.cpp
- <...>/format.h
- <...>/libformat.a
- libjson.a
- format.cpp
- libformat.a

Client

JSON

Networking

Formatting
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    Even if a dependency uses a new library, the build system should detect it.
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Linked libraries for Client should change
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- Let’s dive into one specific system to see....
What will be be using?

- **CMake**
  - Cross-platform build management tool
  - Used by large projects like KDE, Wireshark, LLVM, ...
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- **What does it do?**
  - Given a specification & configuration of your project, CMake creates the build commands for you
  - Analogous to autoconf (but easier to use)
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What does this add?

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    • Compilers
    • Libraries
    • Build Modes
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    - ...
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  - **Specification can clearly capture**
    - Libraries, versions, & even how to download them automatically
    - Semantics of compilation & how to use in analysis tools
What does this add?

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  - Replace “make” with analogous scalable tools (“ninja”)
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[DEMO]
Preliminary: Out of source builds

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- Pollutes version control
- Makes clean builds complicated
Preliminary: Out of source builds

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- Use “out of source” builds instead
Using CMake

- **CMakeLists.txt**
  - A script in every directory of your project that controls how to build “things” in that directory
Using CMake

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  - A script in every directory of your project that controls how to build “things” in that directory

- Simple syntax
  - Case insensitive commands
    ```
    command( argument1 argument2 argument3 ...)
    ```
  - Let's revisit demo 1!
**Targets & Commands**

- CMake allows you to specify targets
  - Executables, libraries, “objects”

```bash
add_executable(helloworld)
add_library(hellohelper STATIC)
```
Targets & Commands

- CMake allows you to specify targets
  - Executables, libraries, “objects”

```c
add_executable(helloworld)
add_library(hellohelper STATIC)
```

- And commands that can describe how to build those targets
  - Automatic for executable & library
  - `add_custom_command` can build others
    - Documentation
    - Media
Specifying Requirements

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Using Libraries

- You can simply specify the libraries that a target directly uses

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- Transitive interface dependences of libraries will be linked in as required
- Include directories, etc. From libraries will also be inferred

```cpp
<...>/libhellohelper.a
<...>/libfancyformatting.a
<...>/hello.h
bin/helloworld
```
Using Libraries

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CMake has several other mundane build system facilities...
General project management

- **Specifying project properties**
  - Define a project to access variables that control that project
  
  `project(projectname)`
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- Print information out during the build process
  `message("Built with flags: ${CMAKE_CXX_FLAGS}\")`
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    project (projectname)
    ```

- Print information out during the build process
  ```
  message("Built with flags: ${CMAKE_CXX_FLAGS}")
  ```

- Controlling where things are built
  ```
  set(CMAKE_RUNTIME_OUTPUT_DIRECTORY
       "${PROJECT_BINARY_DIR}/bin")
  set(CMAKE_LIBRARY_OUTPUT_DIRECTORY
       "${PROJECT_BINARY_DIR}/lib")
  ```
General project management

- Finding a resource that you need to use
  
  ```
  find_package(externalproject)
  find_library(library)
  ```
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- Installation
  
  ```
  install(TARGETS target1 target2 ... 
  DESTINATION /tmp/)
  ```
Control structures

- IF

\[
\begin{cases}
  \text{if}(\text{condition}) \\
  \text{elsif}(\text{condition2}) \\
  \text{else}() \\
  \text{endif}()
\end{cases}
\]
Control structures

- **IF**
  ```
  if(condition)
  elsif(condition2)
  else()
  endif()
  ```

- **Looping**
  ```
  foreach(loop_var arg1 arg2 ...)
  command(${loop_var})
  endforeach(loop_var)
  ```

- **Looping**
  ```
  while(condition)...
  ```
Control structures

- **IF**
  - if(condition)
  - elsif(condition2)
  - else()
  - endif()

- **Looping**
  - foreach(loop_var arg1 arg2 ...)
  - command(${loop_var})
  - endforeach(loop_var)
  - while(condition)...

- **Functions**
  - function(function_name arg1 arg2 ...)
  - command(${arg1})
  - endFunction(function_name)
Analyzing Project Structure

- CMake can dump out the dependence graph in graphviz format
  
  ```
  cmake -graphviz=deps.gv <path to project>
  dot -Tpng deps.gv -o deps.svg
  ```
In Summary

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- A modern build system leverages the dependency graph of a project
- Dependency graphs enable
  1) inference of build and usage requirements
  2) compositional reasoning about modules and build management
- One dominant system for C and C++ is Cmake
- You will get more personal experience with it over the semester if you have not already