Build Managers

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Outline

1 Build Managers

2 Some Sample Project Builds
   • Student Programming Assignment
   • Code Annotation Tool
   • Class Assignment Setup
   • Posting Slides and Lecture Notes

3 Types of Build Managers
   • IDE project managers
   • Dependency-Based Managers
   • Task-Based Managers
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A build manager is a tool for scripting the automated steps required to produce a software artifact.
What Should a Build Manager Do?

A good build manager should be

- easy to use
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- easy to set up for a given project
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- efficient in performing the build
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Some Sample Project Builds

Here are some of the project builds I have had to automate in the opening weeks of this semester (Spring 2013).
Set up to allow students to easily compile code for an assignment.

- Build each missing or out-of-date .o file by compiling a corresponding .cpp file.
  - Record which .cpp files and .h files were used during the compilation so that future builds can determine what would future source code changes would make this .o file outdated.
- Link all .o files to produce an executable
The code annotation tool is a program I use to convert C++ and Java code with optional markup comments like this:

```cpp
#include <iostream>
using namespace std; /**col*/

int main (int argc, char** argv)
{
    // Let's be friendly
    cout << "Hello world!" << endl;
    /***/return 0;/***/
}
```
...into this or this:

```cpp
#include <iostream>

using namespace std;  

int main (int argc, char** argv) 
{
    // Let’s be friendly 
    cout << "Hello world!" << endl; 
    return 0; 
}
```
Building the Code Annotation Tool

The steps involved in building this tool are:

1. Run the program **jflex** on each file in `src/main/jflex`, generating a pair of .java files that get placed in `src/main/java`.
2. Compile the Java files in `src/main/java`, placing the results in `target/classes`.
3. Compile the Java files in `src/test/java` (using the `target/classes` compilation results, placing the results in `target/test-classes`.
4. Run the JUnit tests in `target/test-classes`.
5. If all tests pass, package the compiled classes in `target/classes` into a .jar file.
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1. Run the program `jflex` on each file in `src/main/jflex`, generating a pair of `.java` files that get placed in `src/main/java`

2. Compile the Java files in `src/main/java`, placing the results in `target/classes`

3. Compile the Java files in `src/test/java` (using the `target/classes` compilation results, placing the results in `target/test-classes`.

4. Run the JUnit tests in `target/test-classes`.

5. If all tests pass, package the compiled classes in `target/classes` into a `.jar` file.

It’s worth noting how many of the steps in this project build are *not* simply compile and link steps.
Class Assignment Setup

In preparing to release a programming assignment to a class, the steps are:

1. **Setup:**
   1. Copy all of the files that I will provide to students from a Public directory into a Work directory.
   2. Copy all of the files from my Solution directory into that Work directory.

2. **Build solution**
   1. Compile any .cpp files in the Work directory.
   2. Link the resulting .o files.

3. Run the executable produced in the last step on each test*.dat in the Tests directory, capturing the output as a corresponding .out file.
Copy all source code from the Work directory into a winWork directory.

Use a cross-compiler to compile and link the .cpp files in winWork into a Windows executable.

Install:

1. Copy the two executables and the contents of the Public directory into a release area accessible to students.
2. Set the permissions on the copied files so that they can be accessed.
3. Copy any .html and graphics files for the assignment to the course website.
The lectures notes for this course are prepared through a process:

1. **Setup**
   - If the directory has a DocBook document and no corresponding TeX file, and if we are on a machine where `db2latex` is installed, run `db2latex` to create a TeX file.
   - Convert all graphics to PNG or PDF:
     1. For each desired document format, copy a corresponding template into this directory, substituting for various course properties (e.g., course name, website URL), saving this as a `.ltx` file.
     2. For each GIF file in the directory with no corresponding PNG file, run `convert` to produce a PNG.
     3. For each FIG file in the directory with no corresponding EPS file, run `fig2dev` to produce an EPS.
     4. For each Dia file in the directory with no corresponding EPS file, run `dia` to export as EPS.
For each EPS file in the directory with no corresponding PDF file, run **epstopdf** to create a PDF.

3. Annotate source code:
   1. For each C++ or Java file with no corresponding HTML file, use the code annotation tool to generate an HTML file.
   2. For each C++ or Java file with no corresponding TeX file, use the code annotation tool to generate an TeX file.

2. For each desired document format, run **latexmk** to produce a PDF for that format.

3. Deployment:
   1. Synchronize this directory with the corresponding directory of the website, or
   2. Prepare a zip file with the contents of this directory that can be uploaded to a remote webserver (e.g., Blackboard).
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Why Not Just Write a Script?

We could simply write a simple script to perform each of the steps in sequence...
Scripting

But how does this fare according to our earlier build manager goals?

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  ✔️

- easy to set up for a given project?  ❌

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IDE project managers

Most IDEs come with a built-in project manager.

- typically limited to compiling and linking
- maybe some support for packaging

Compare to our sample projects.
Some build managers are based on the idea of a *dependency graph*:

- Boxes are files.
- Arrows denote dependencies. “A depends on B” means that if B is missing or changed, then A must be (re)generated.
- Labels on arrows indicate the program used to generate the file at the base of the arrow.

Analysis of such a graph facilitates

  - efficiency - easy to tell what needs to be rebuilt after a change
  - incrementality - can determine required build step for any file, not just the “final” one

*make* is the canonical example of a build manager of this type.
Task-Based Managers

Other managers are based on the idea of interdependent tasks.

- Ellipses are tasks (activities). Each task can involve multiple steps.
- Arrows denote success dependencies. “A depends on B” means that A will be run after B and only if task B finished successfully.

This approach facilitates:

- easy to set up: usually less detailed than a full file-based dependency graph
- incrementality - can request any intermediate step
- ant is based on this approach.