CMPT 373
Software Development Methods

Building Software

Nick Sumner
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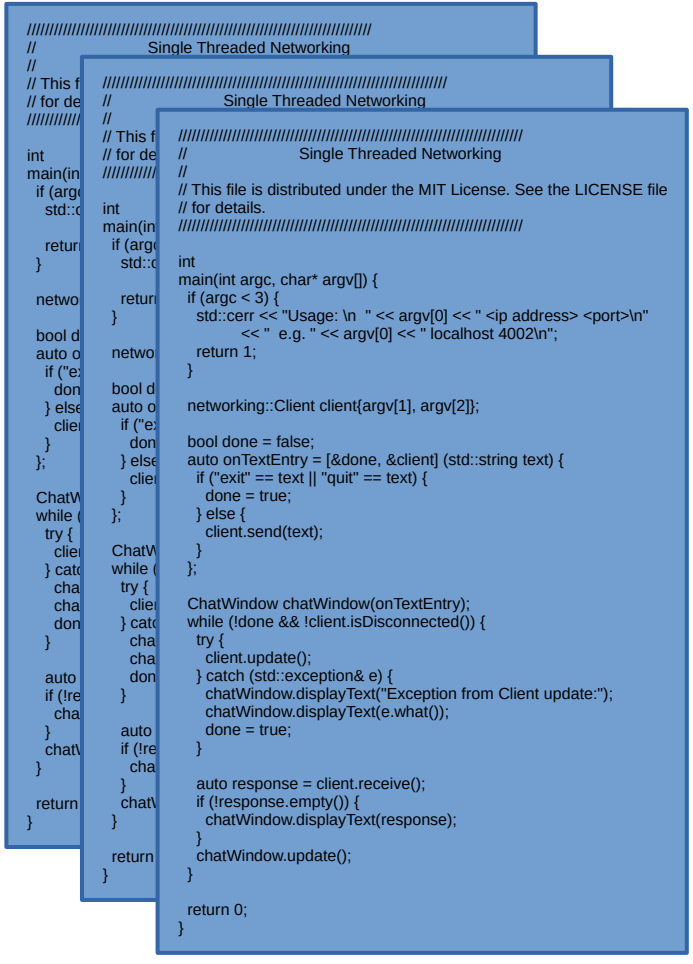
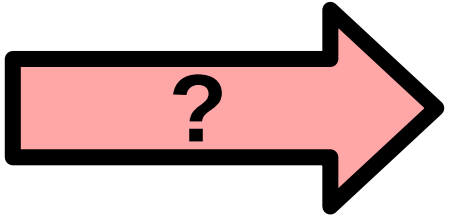
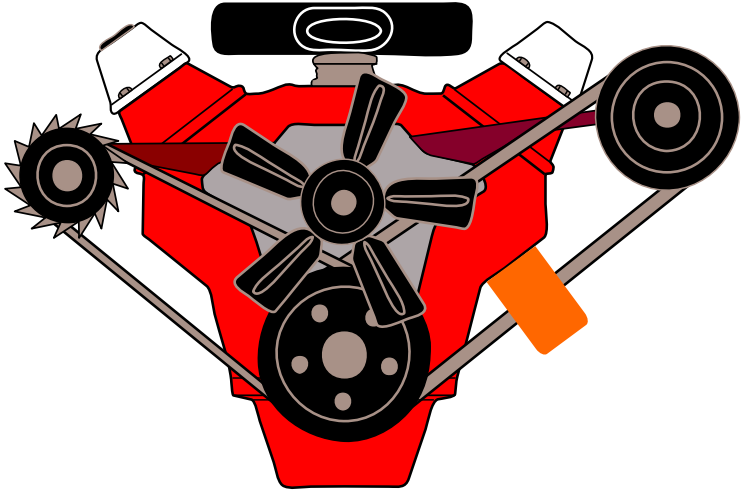
What does it take to build software?







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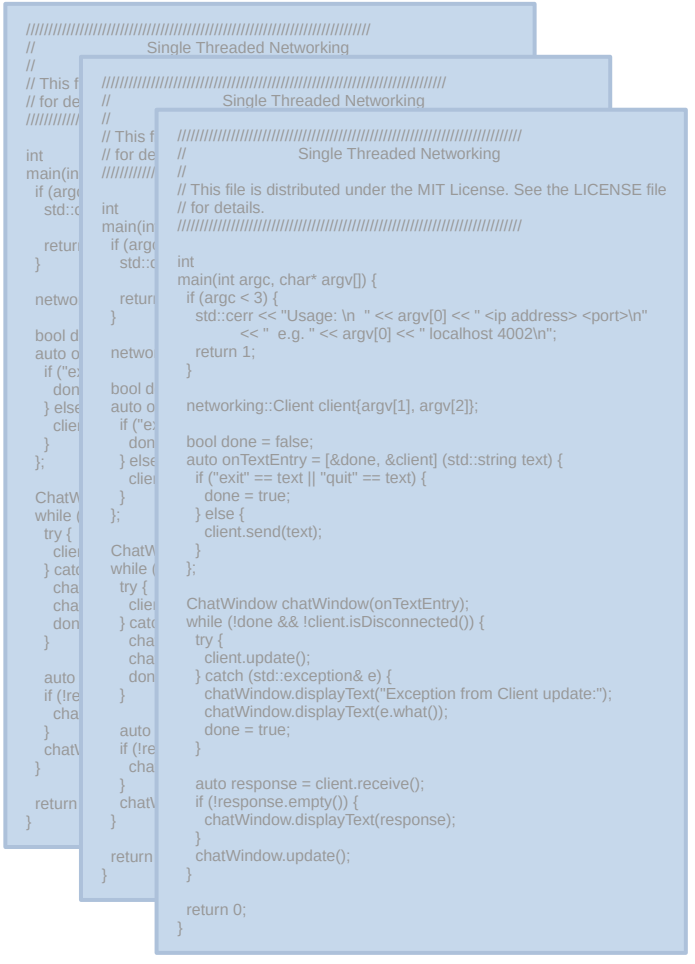

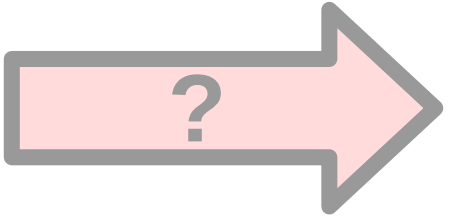

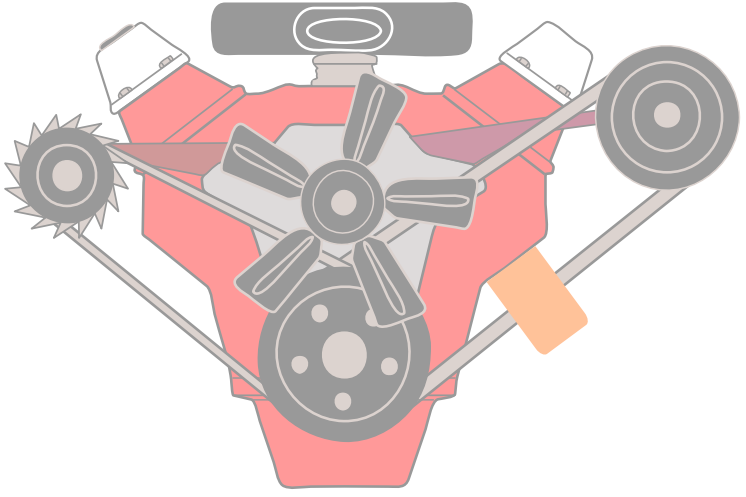

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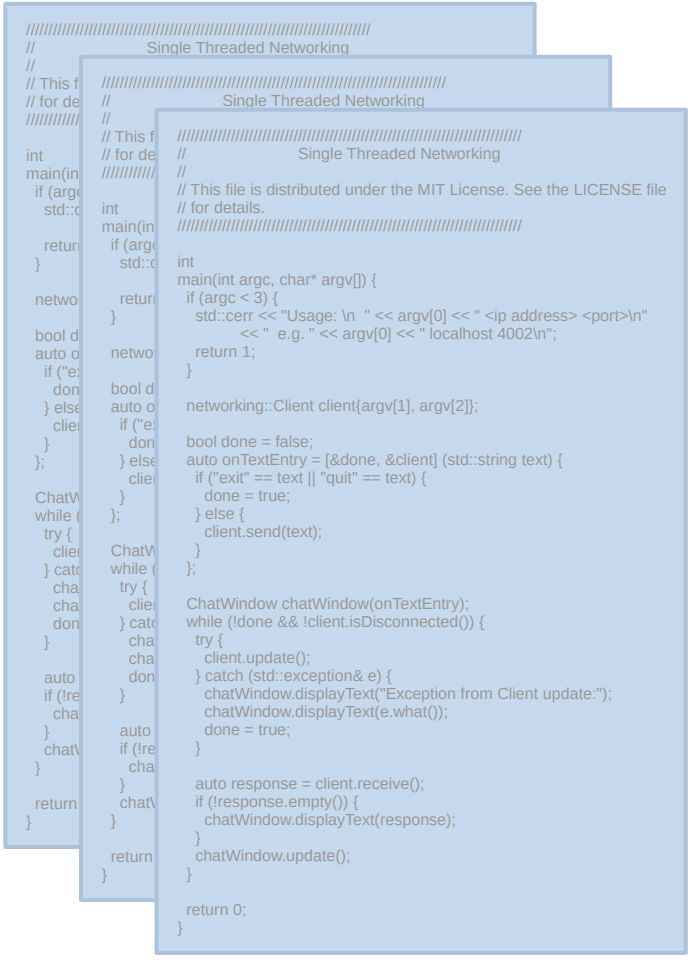

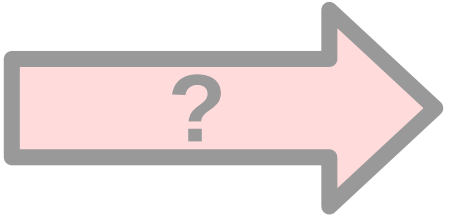

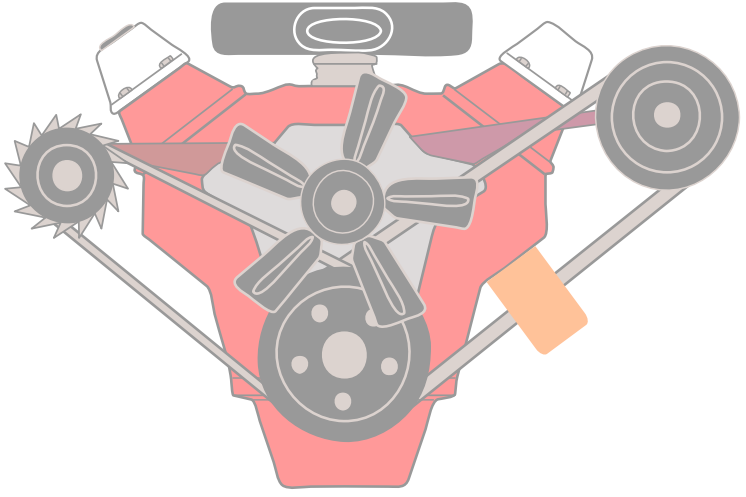

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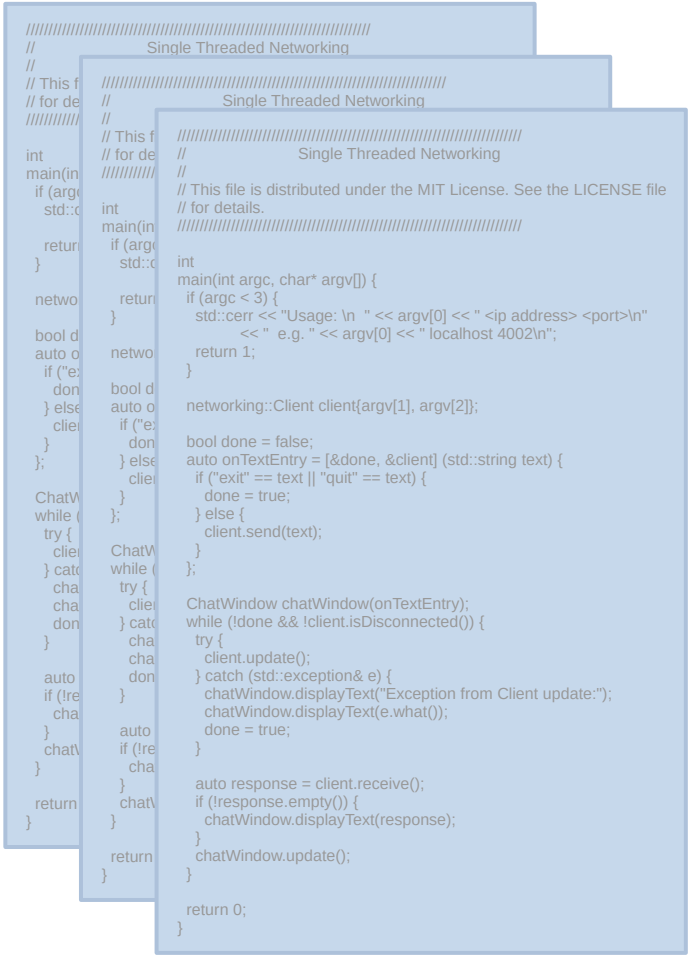

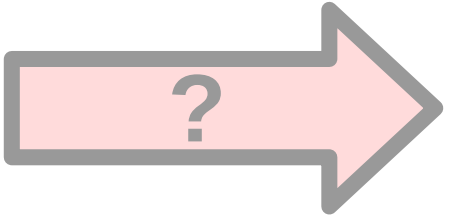

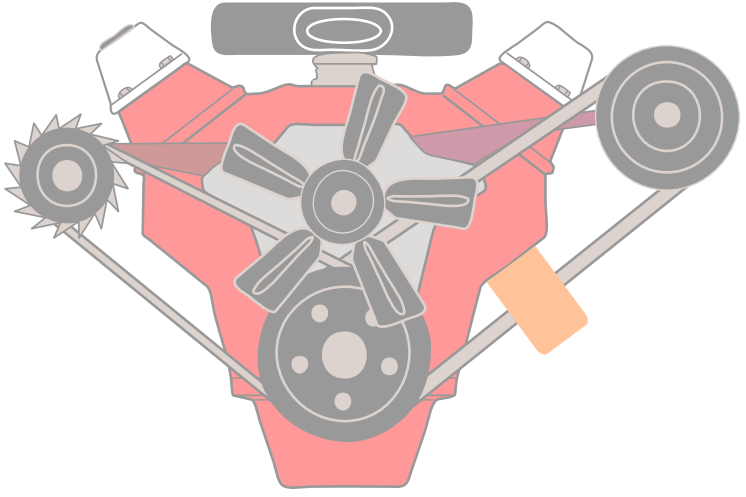

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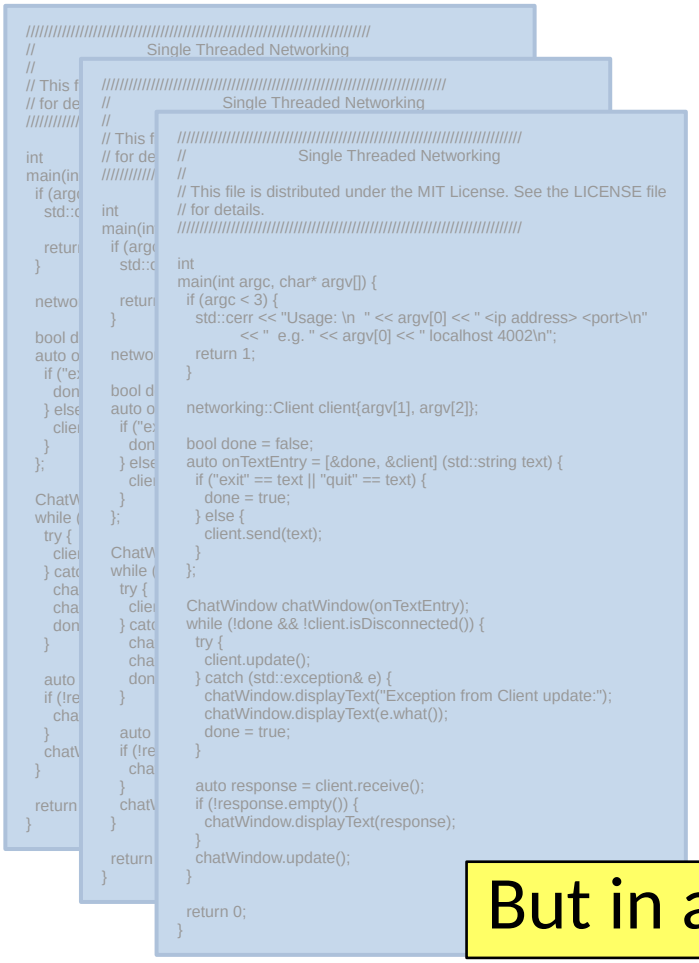

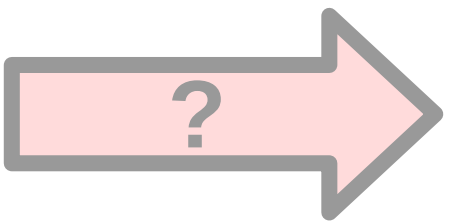

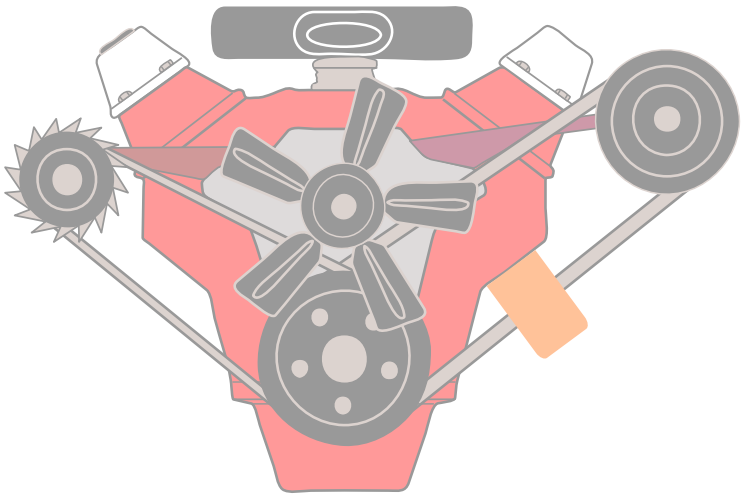

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But in a real project it can *involve* & *do* a lot more!

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- Build Engineering?
- Release Engineering?
- Build Configuration?
- Build Automation?
- Dependency Management?
- Continuous Integration?

A lot more.

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Just getting something to compile reproducibly can be nontrivial

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- It is the foundation of getting anything done.

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Grunt? Gulp? Cmake? Bazel? Gradle? Maven? Scons?
Incredibuild? CloudBuild?
Travis? Jenkins? CircleCI?
Junit? Cucumber? Pytest? Gtest?
Coverity? Clang Static Analyzer?
OpenTelemetry? Prometheus? Jaeger?
…

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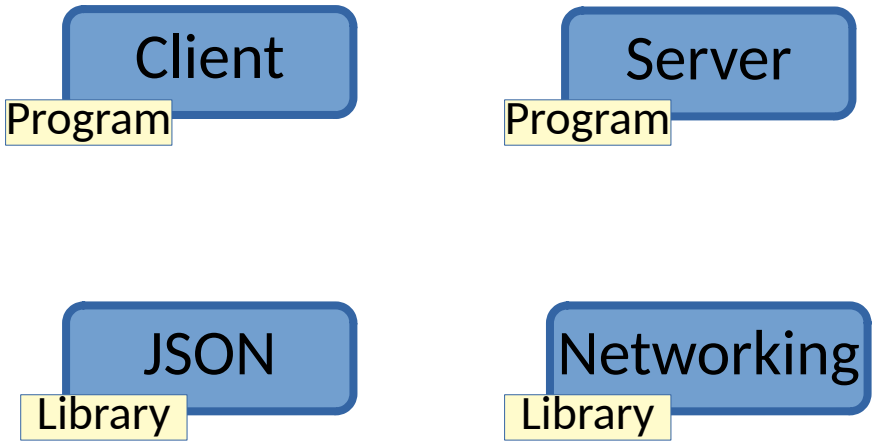

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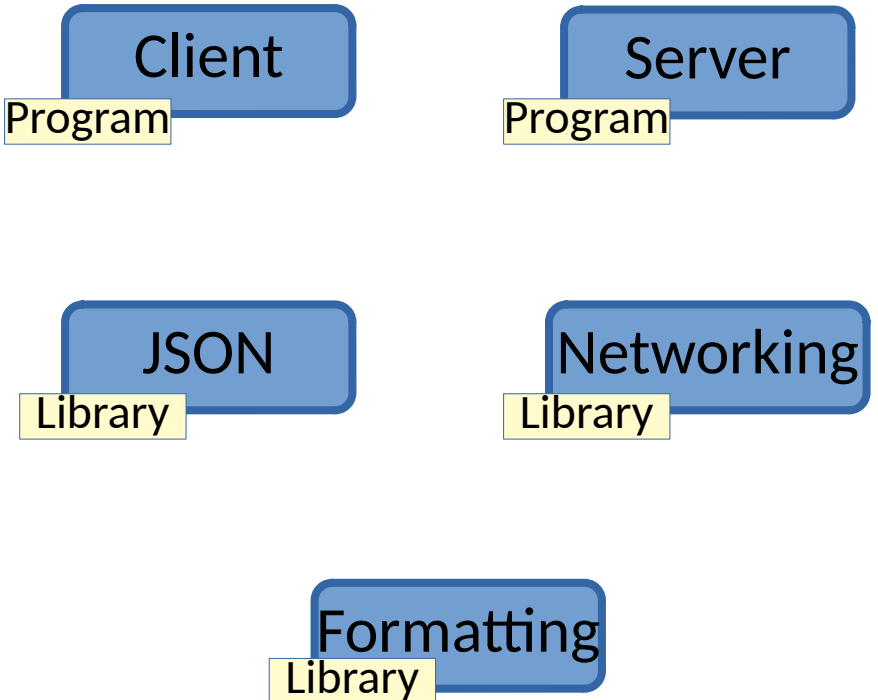

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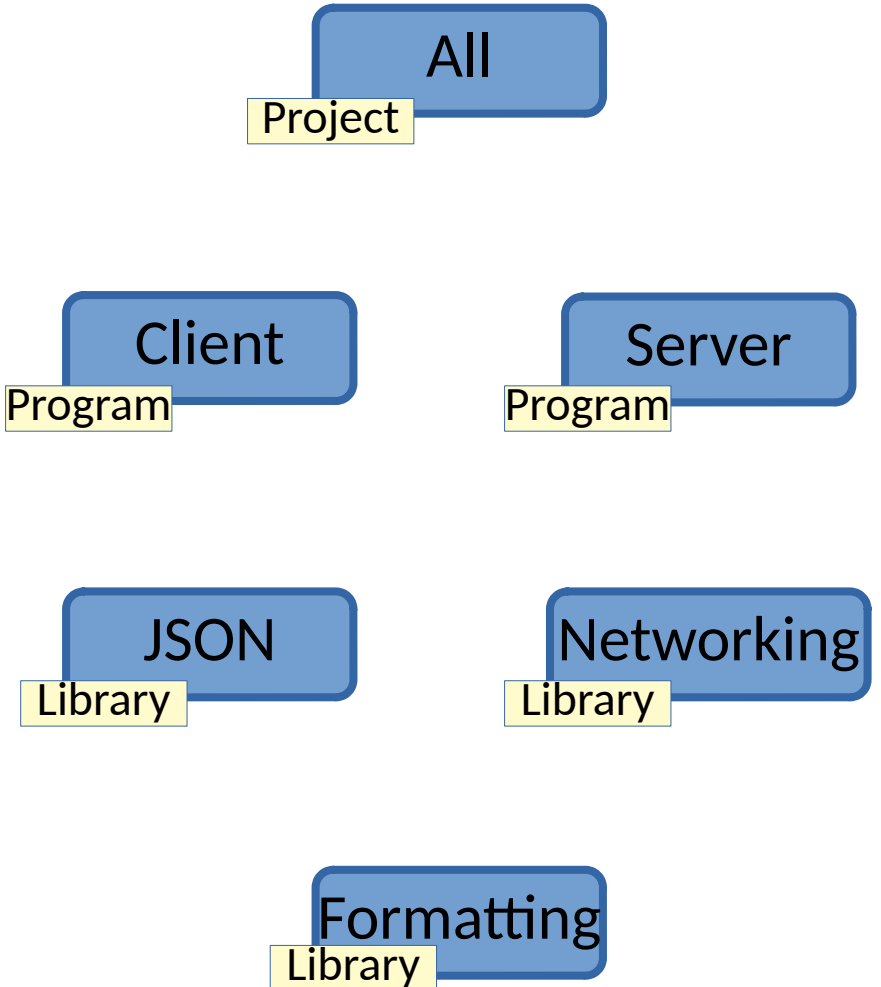

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- To build software, we must consider:
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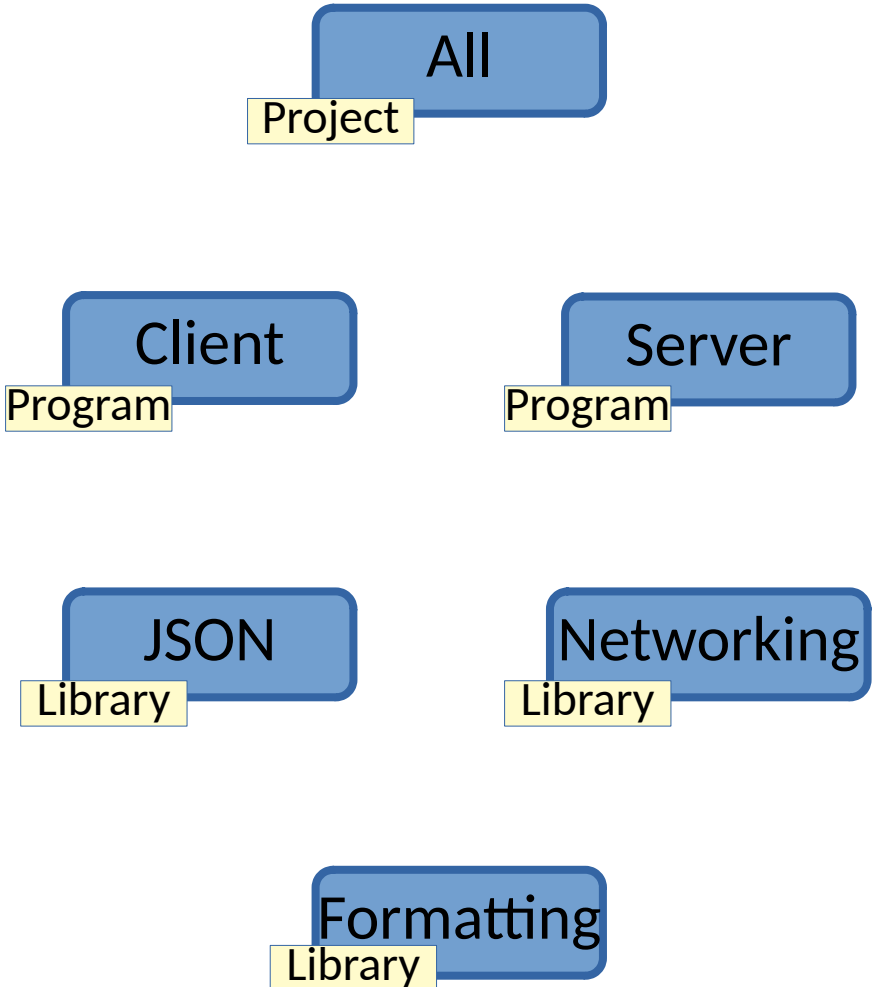
  - **Dependencies between them**



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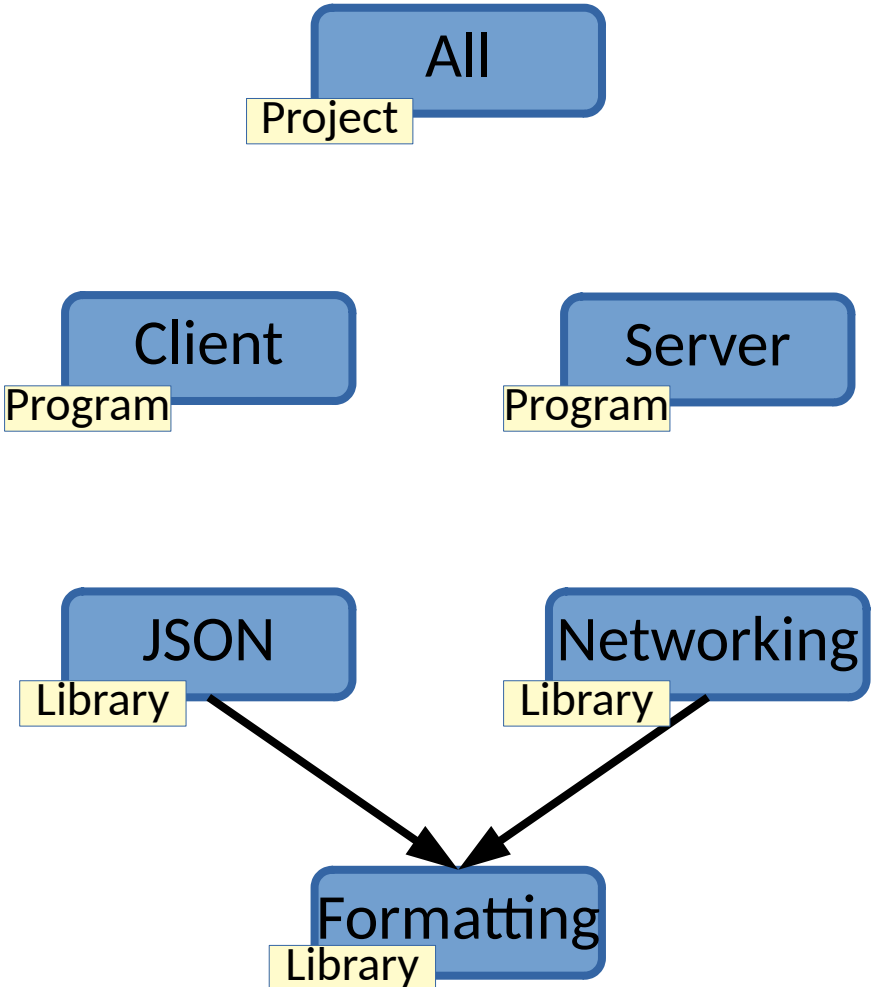

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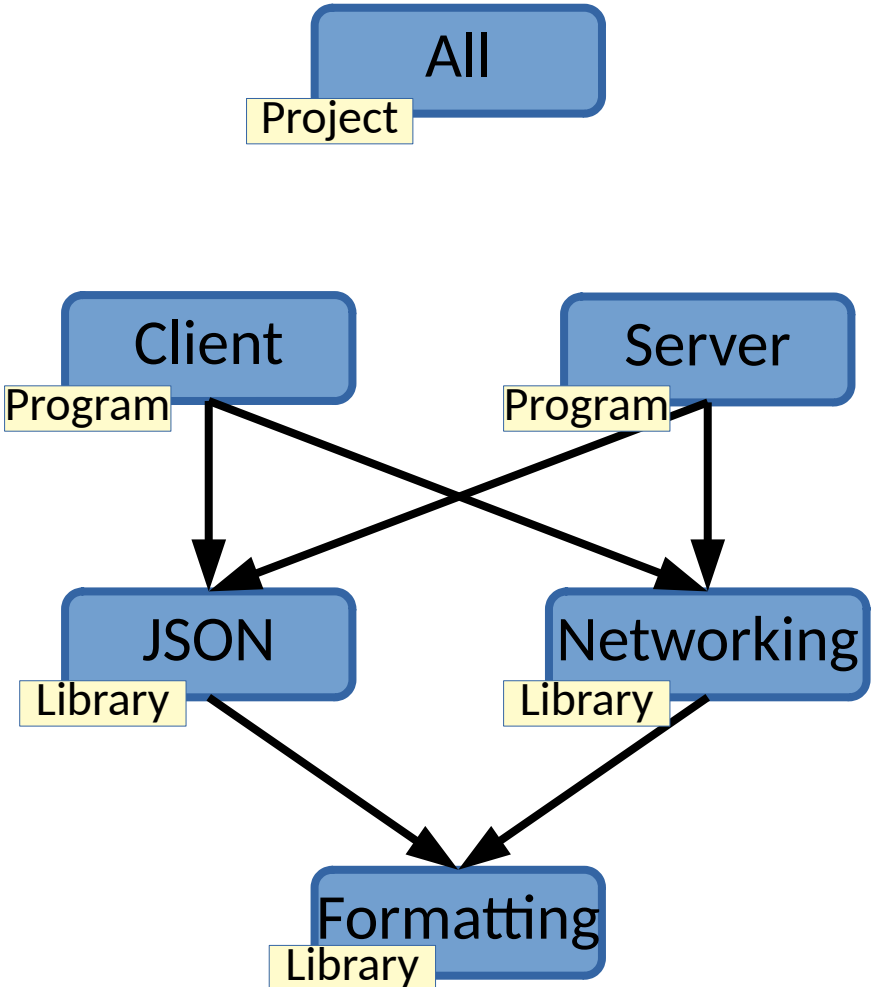

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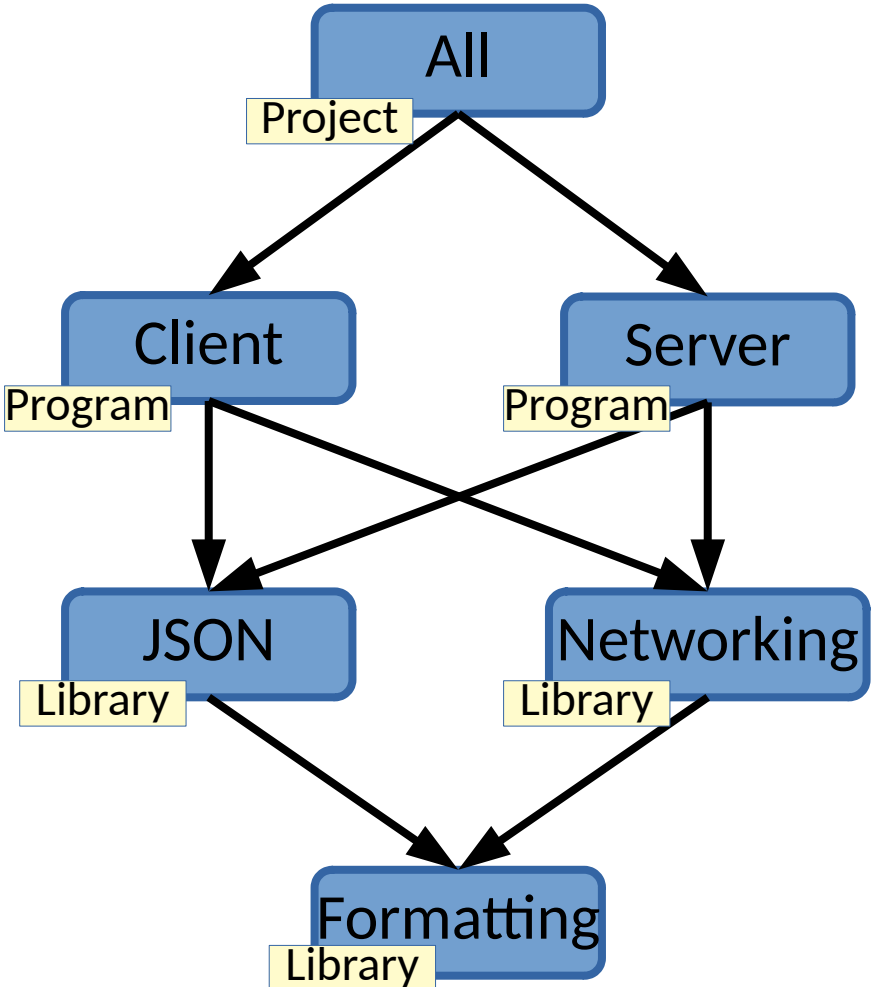

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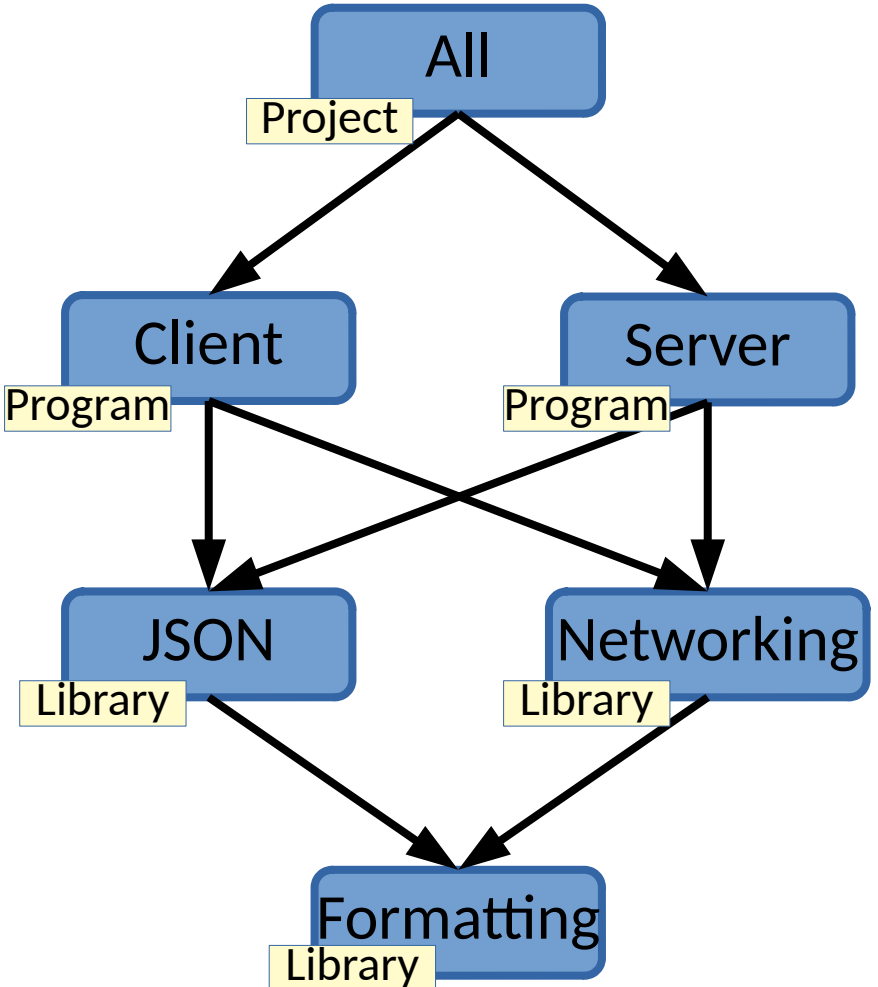
This defines the ***dependency graph*** of a project.



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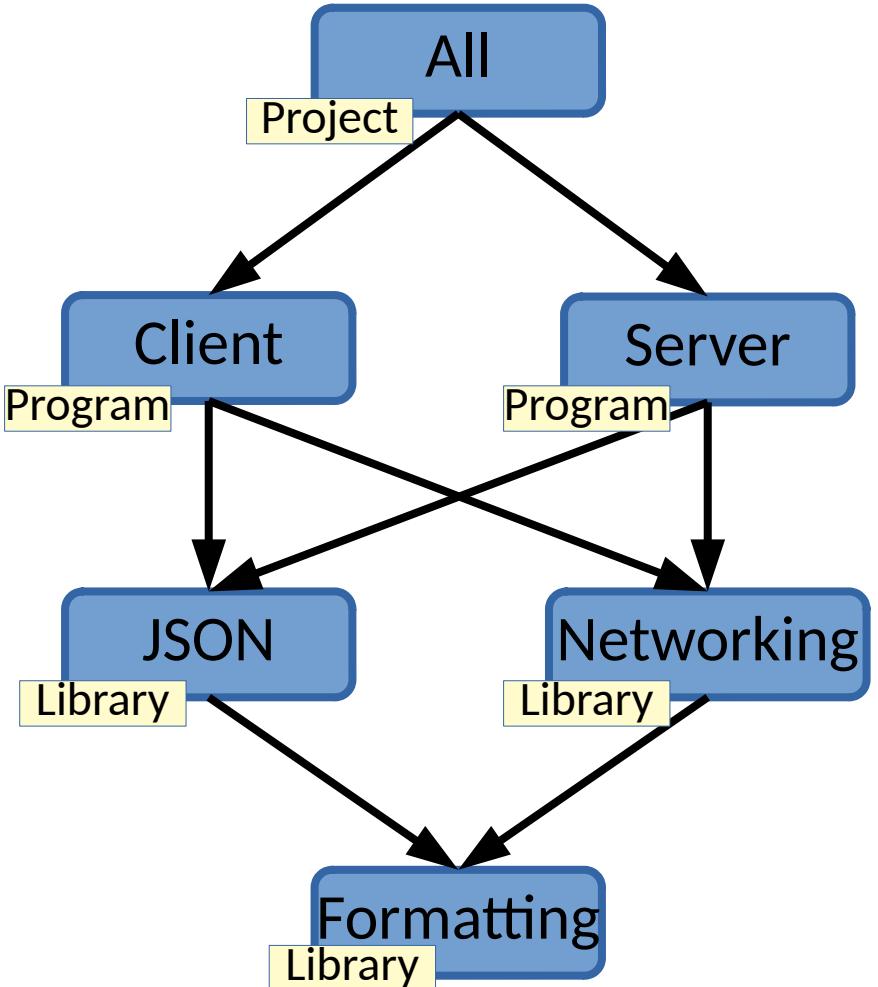

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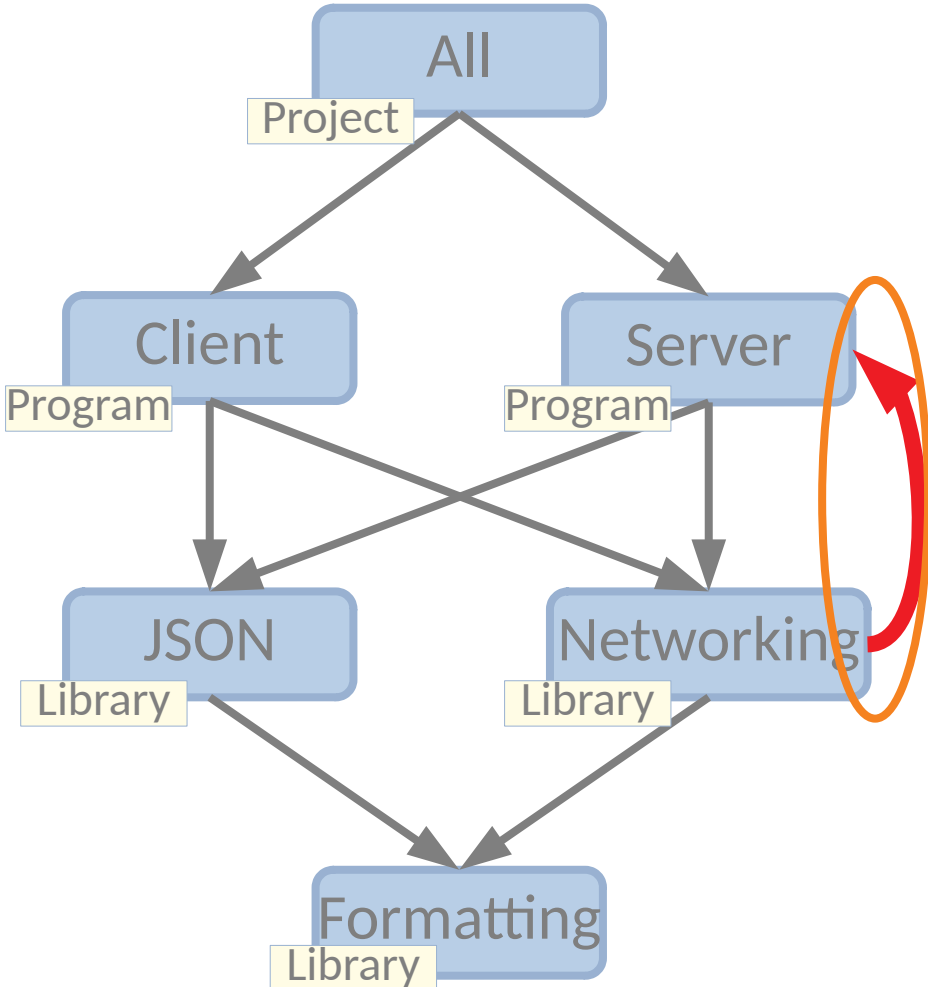

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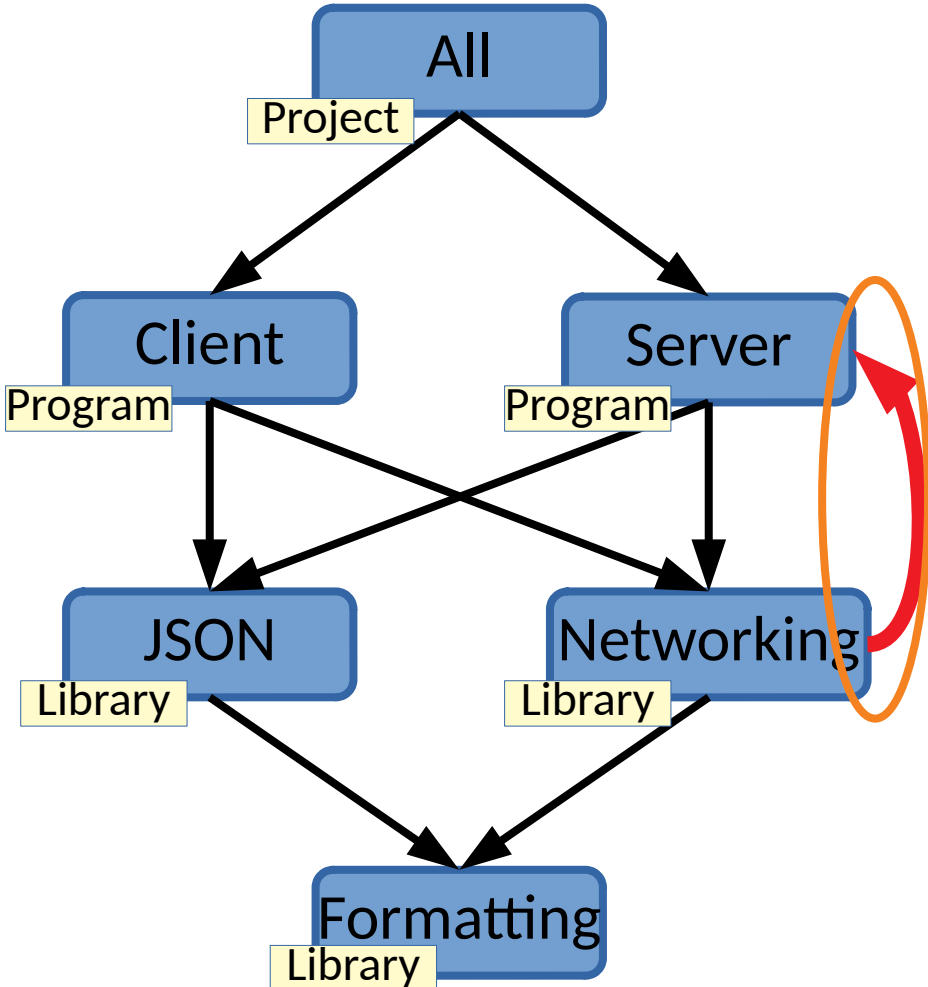

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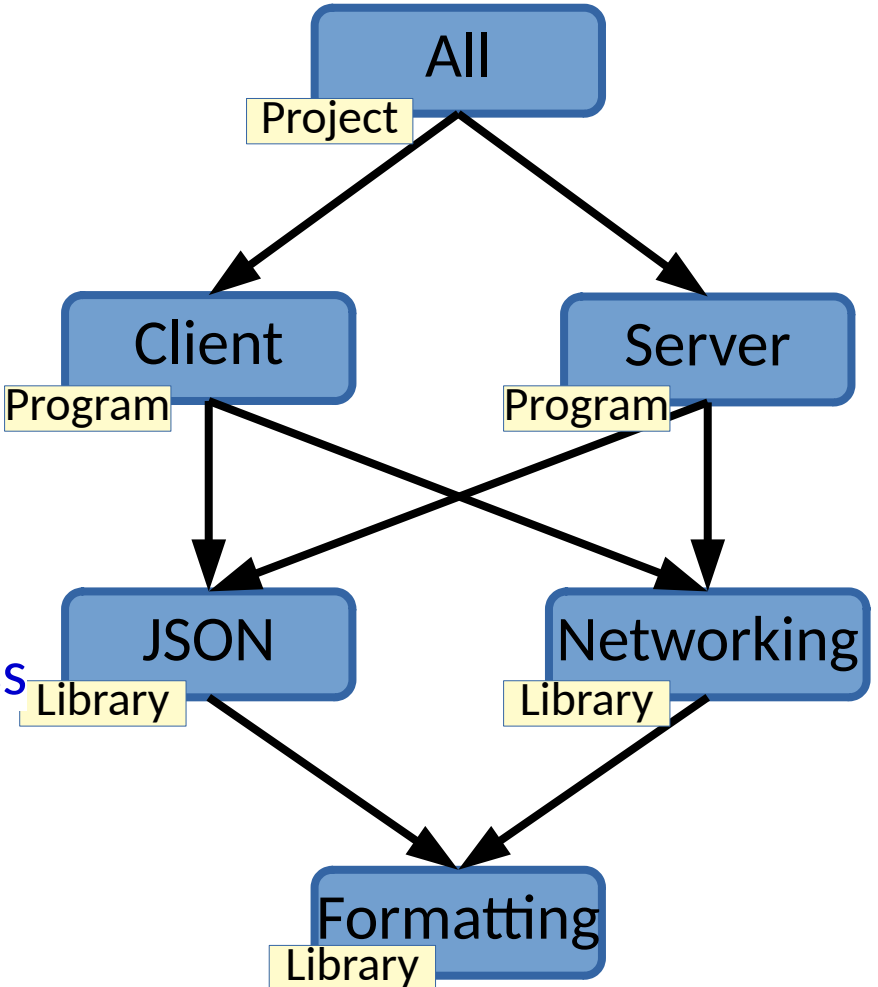

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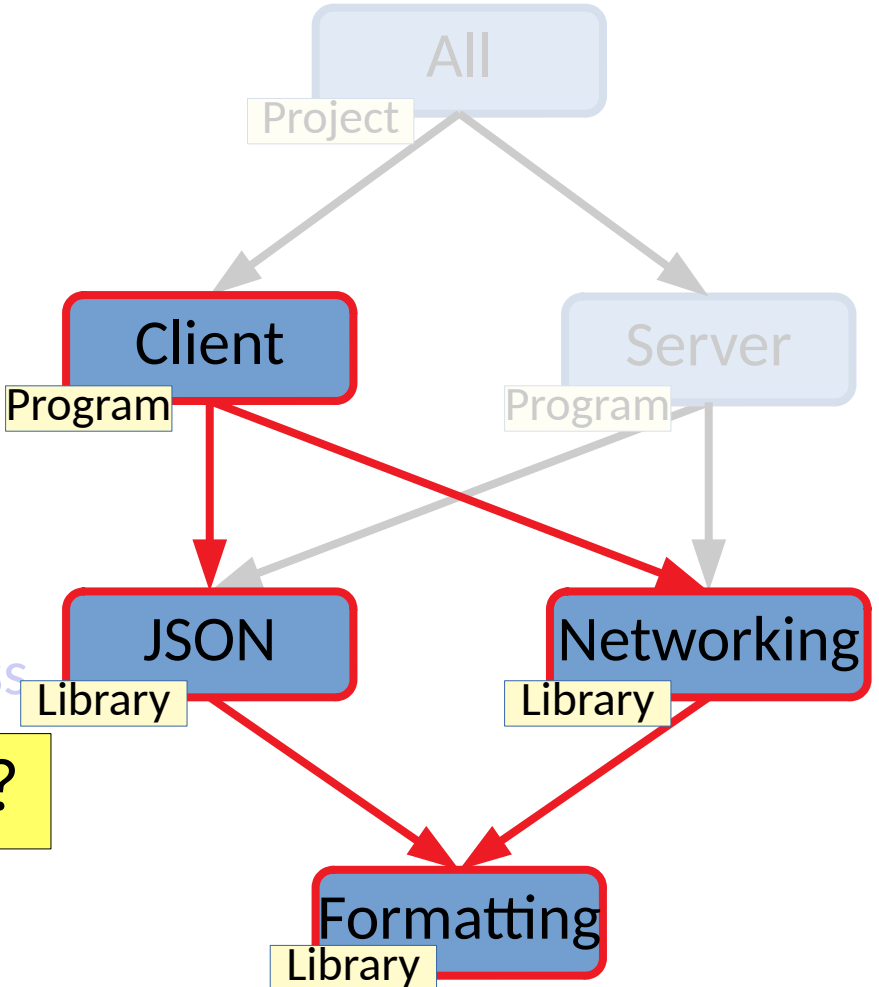
We can consider C++, but it applies in general (even for many dynamic languages)



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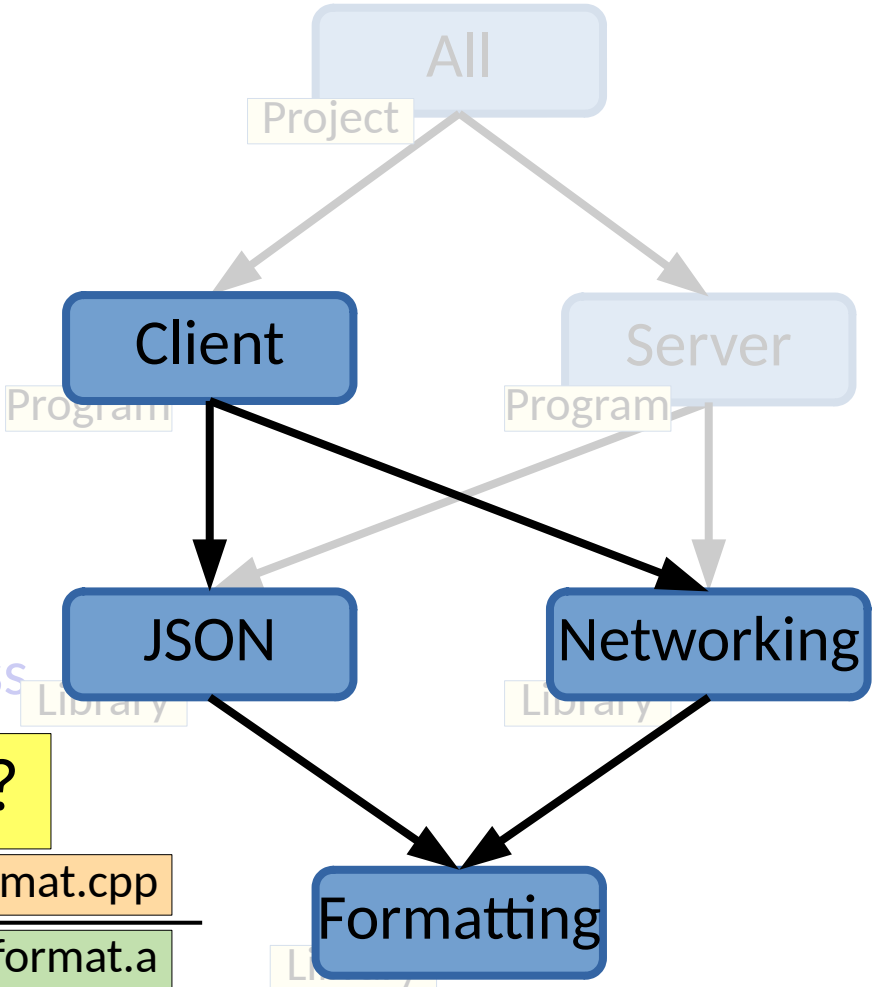

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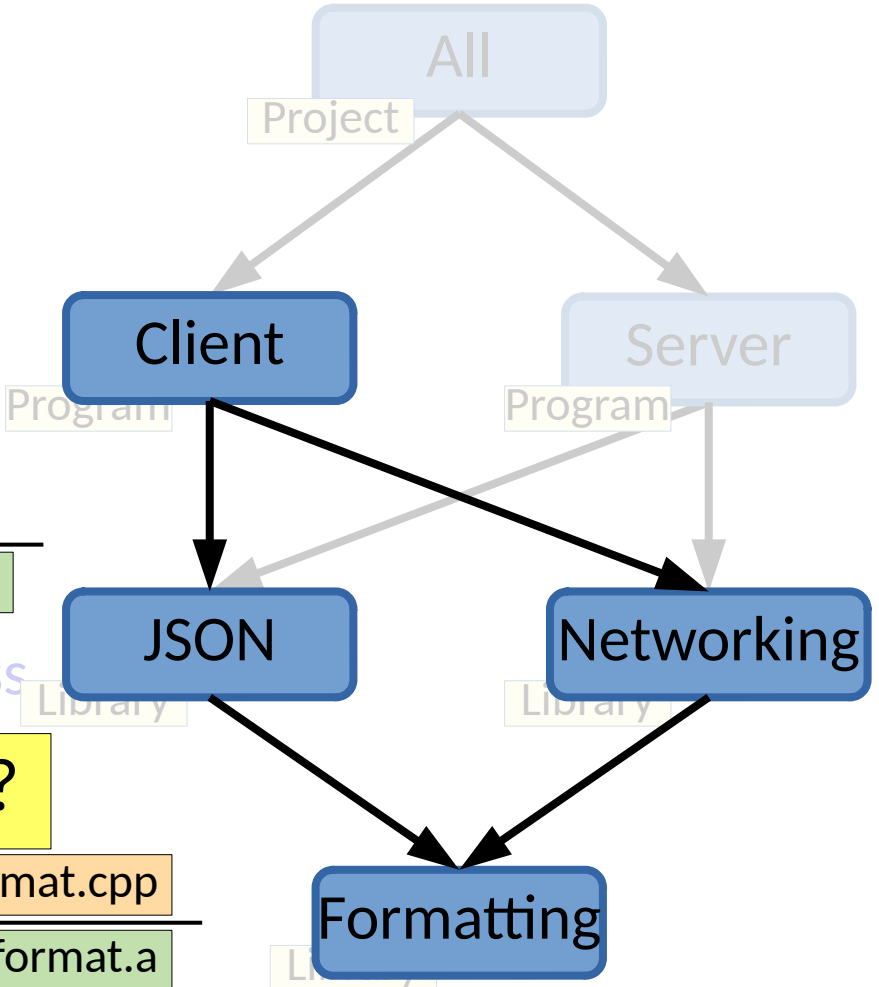

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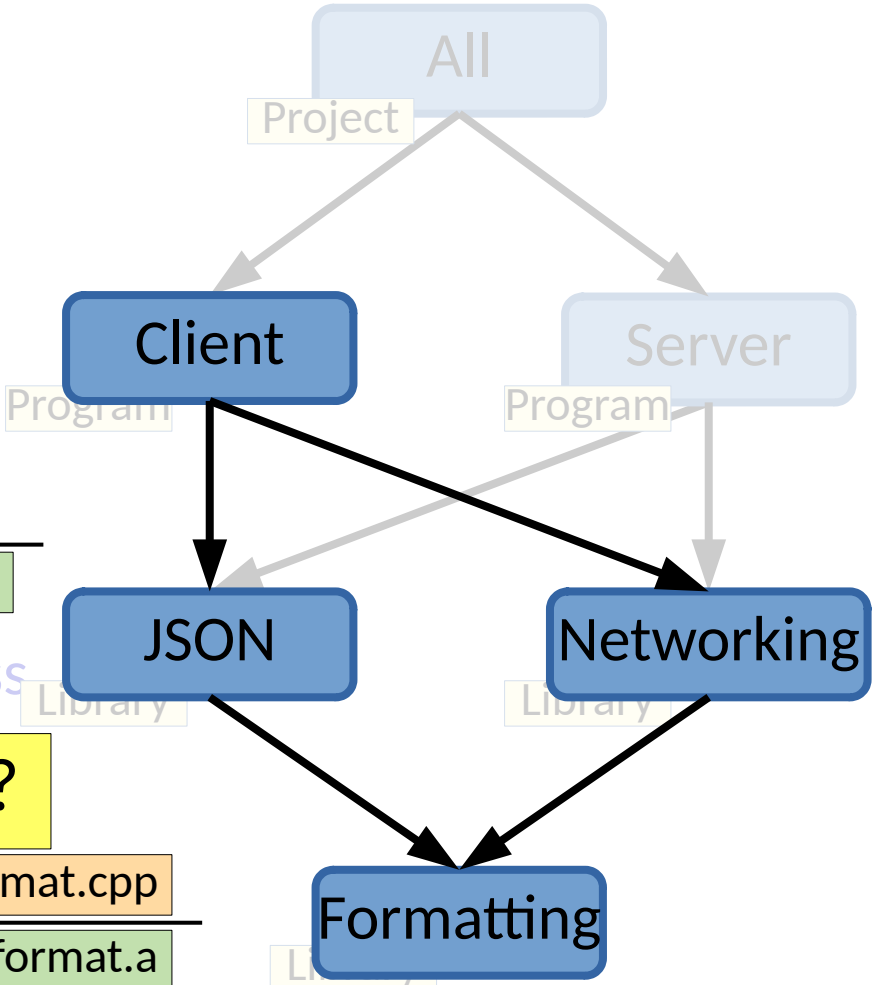

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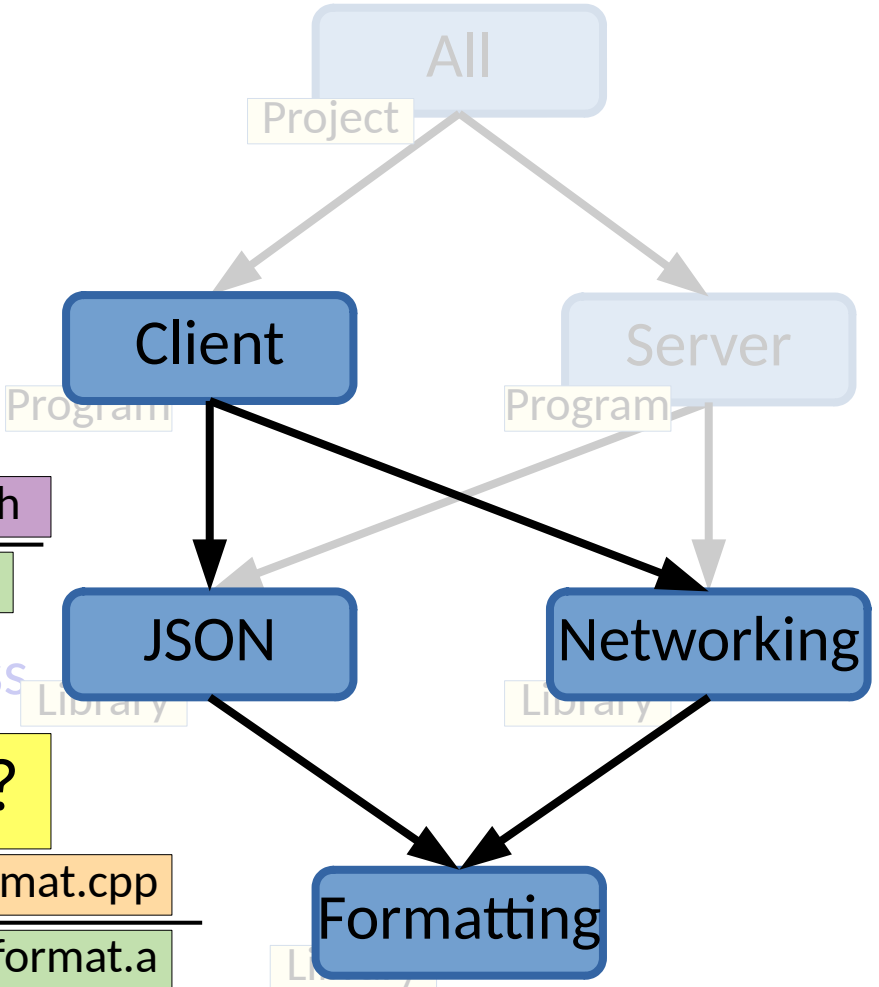

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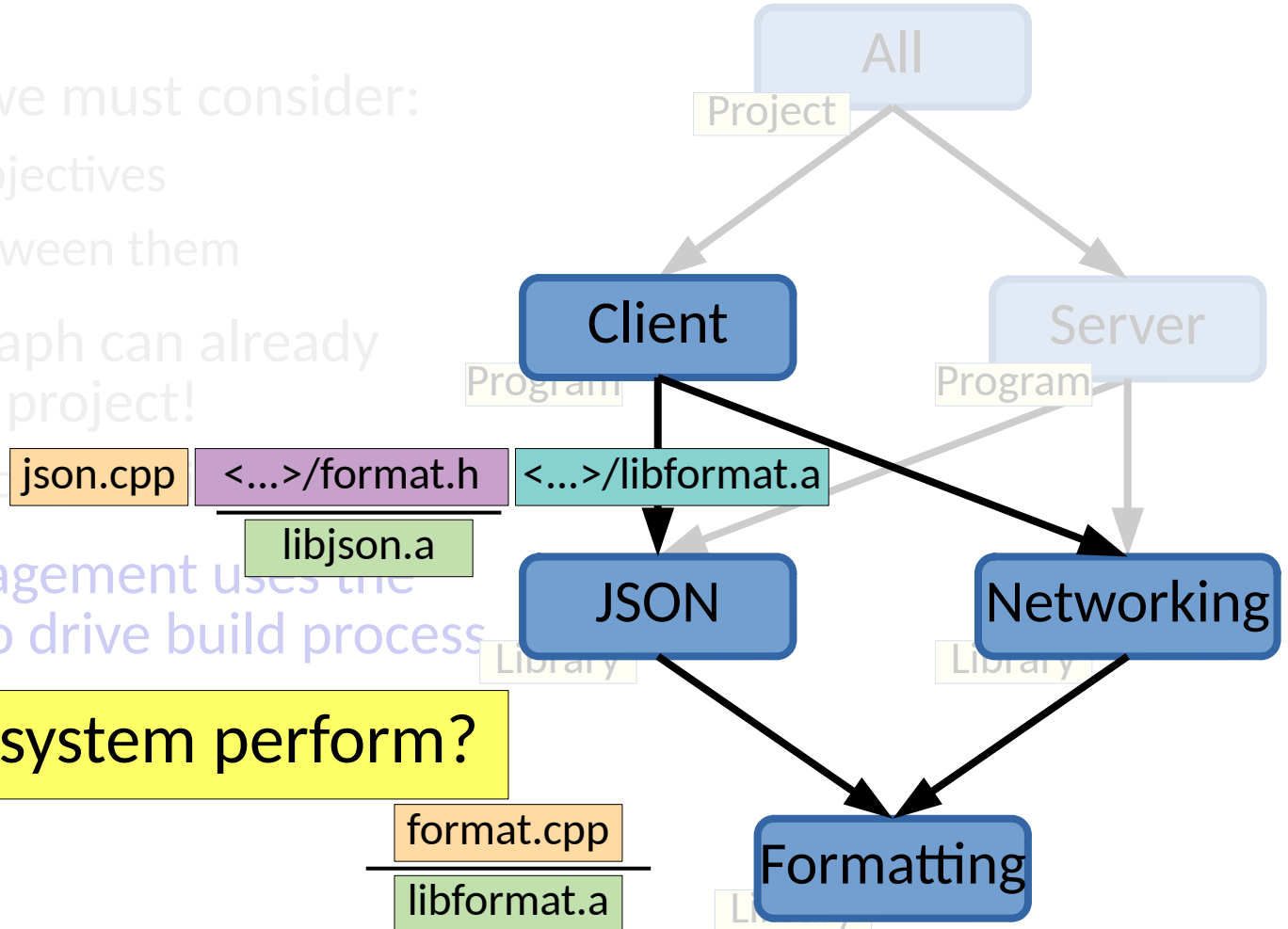

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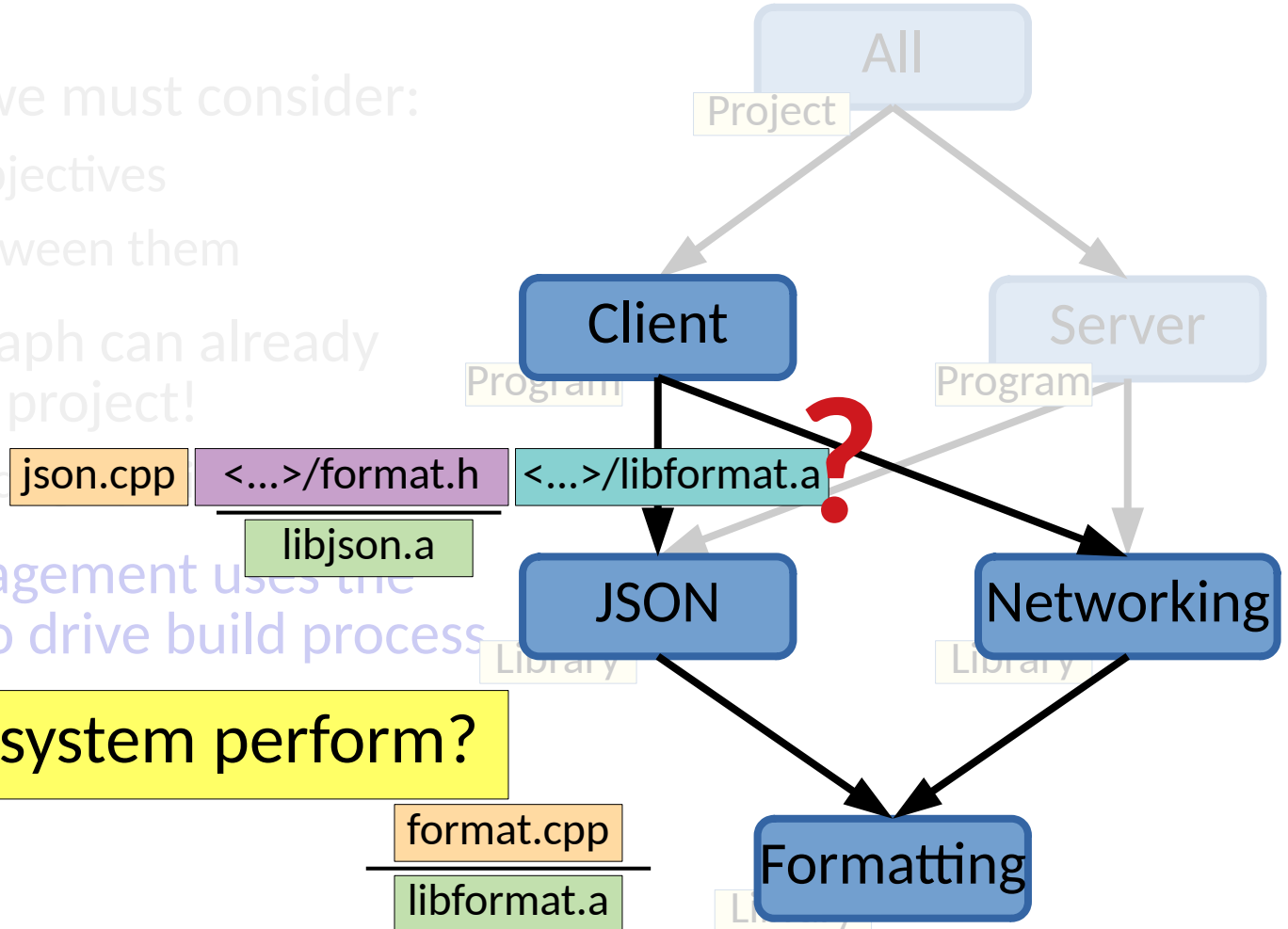

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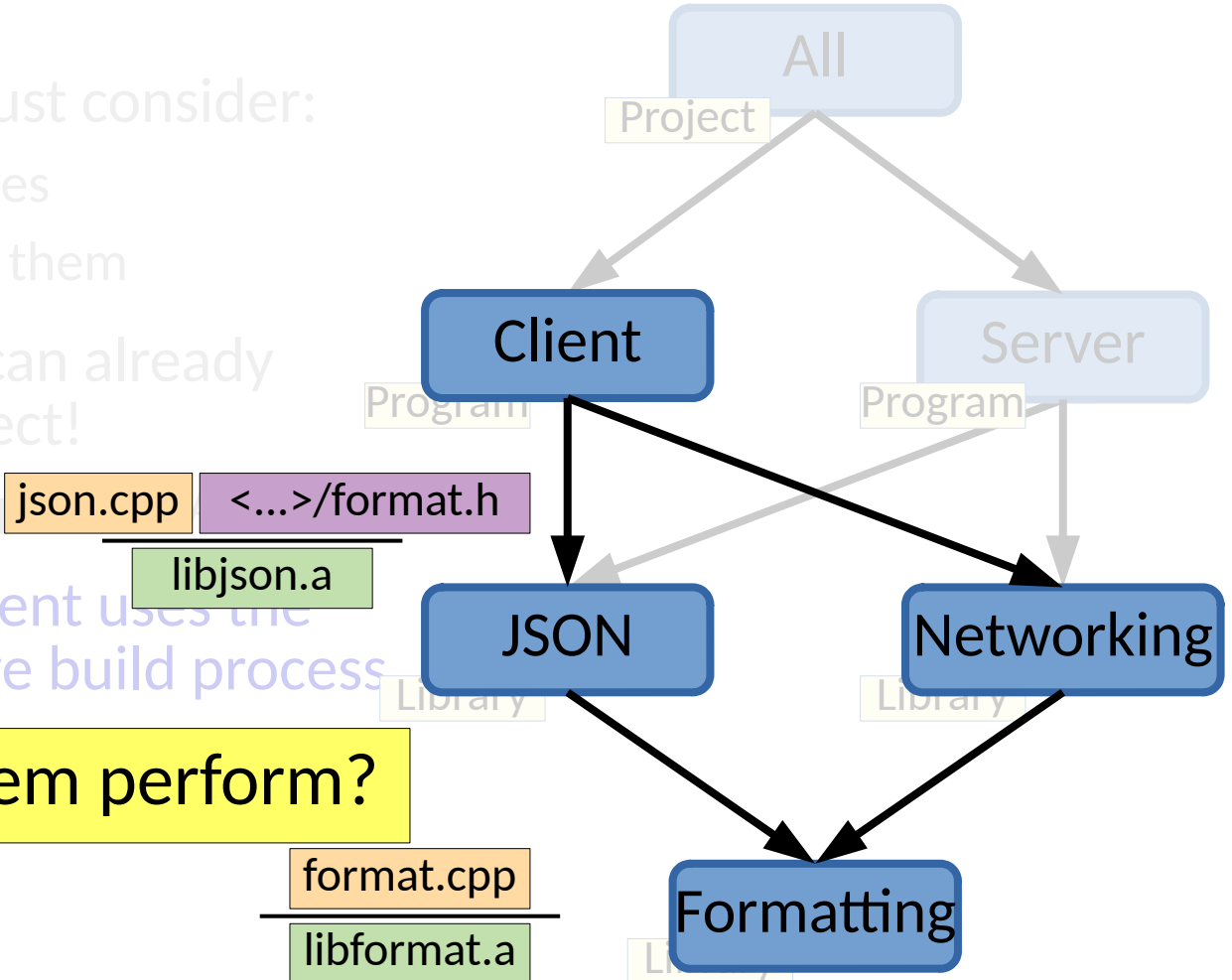

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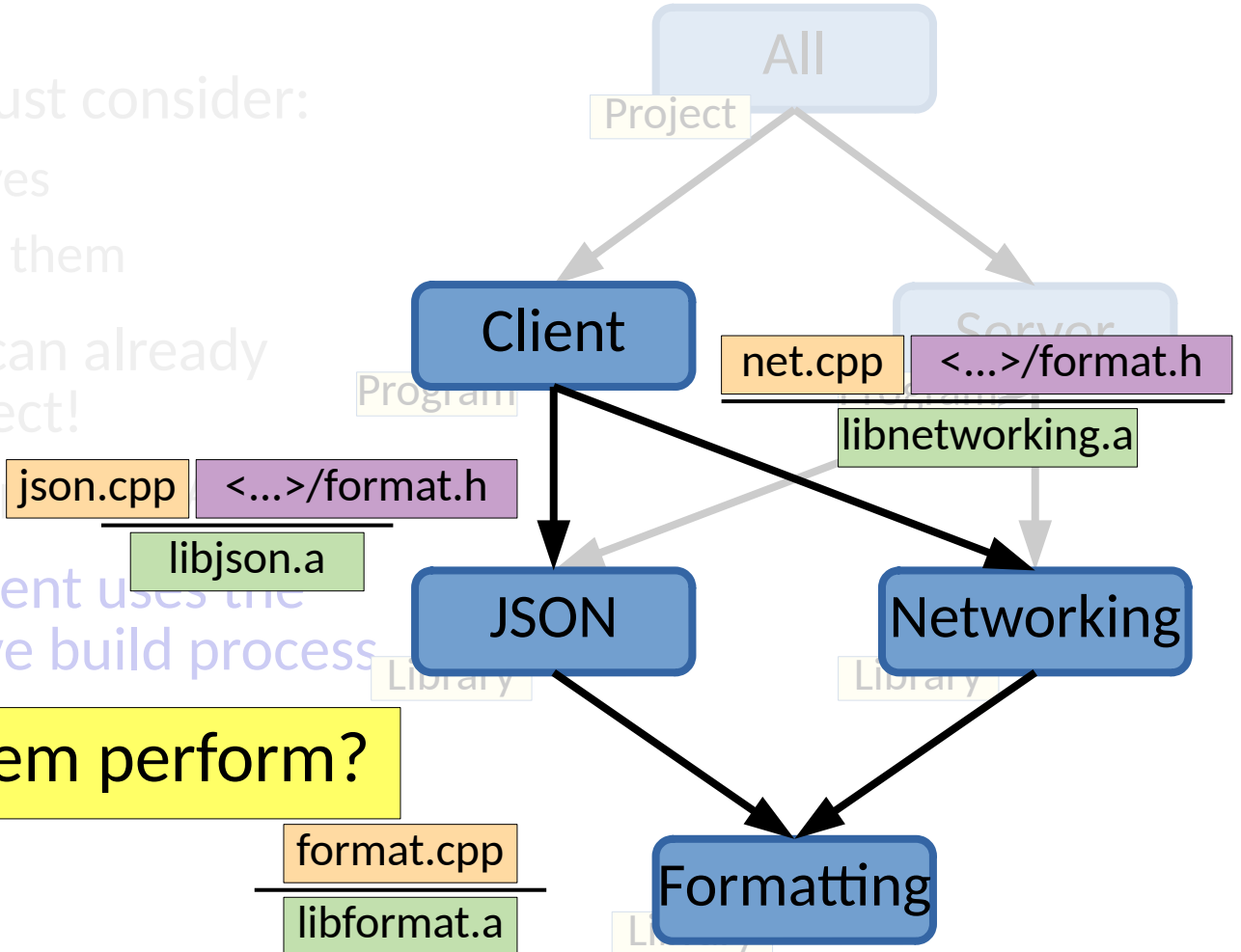

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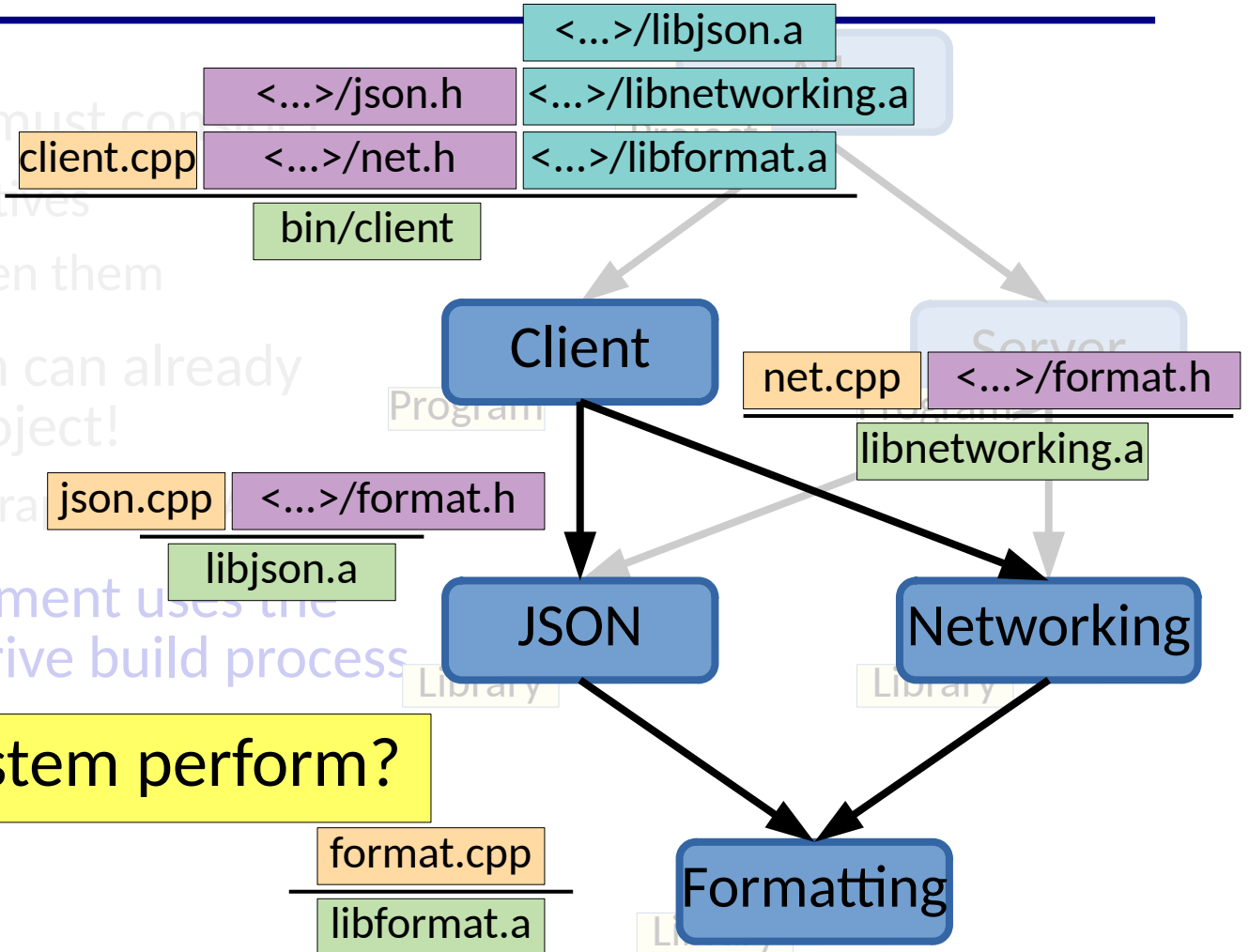

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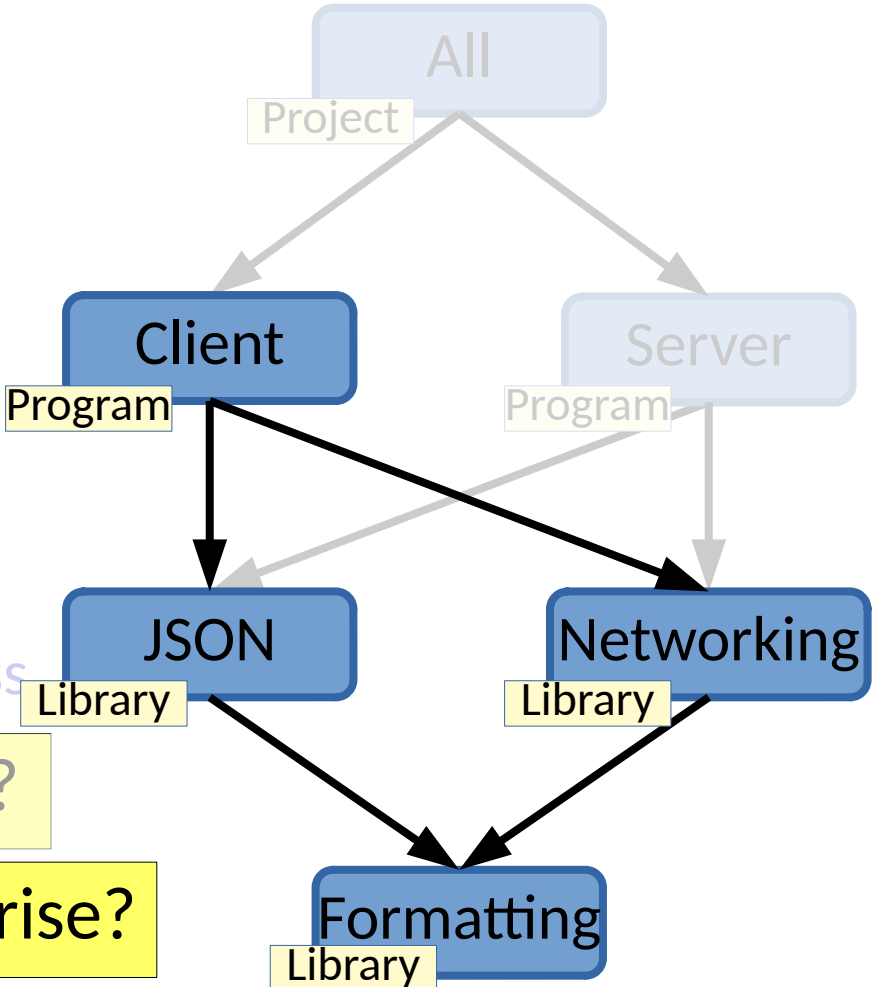

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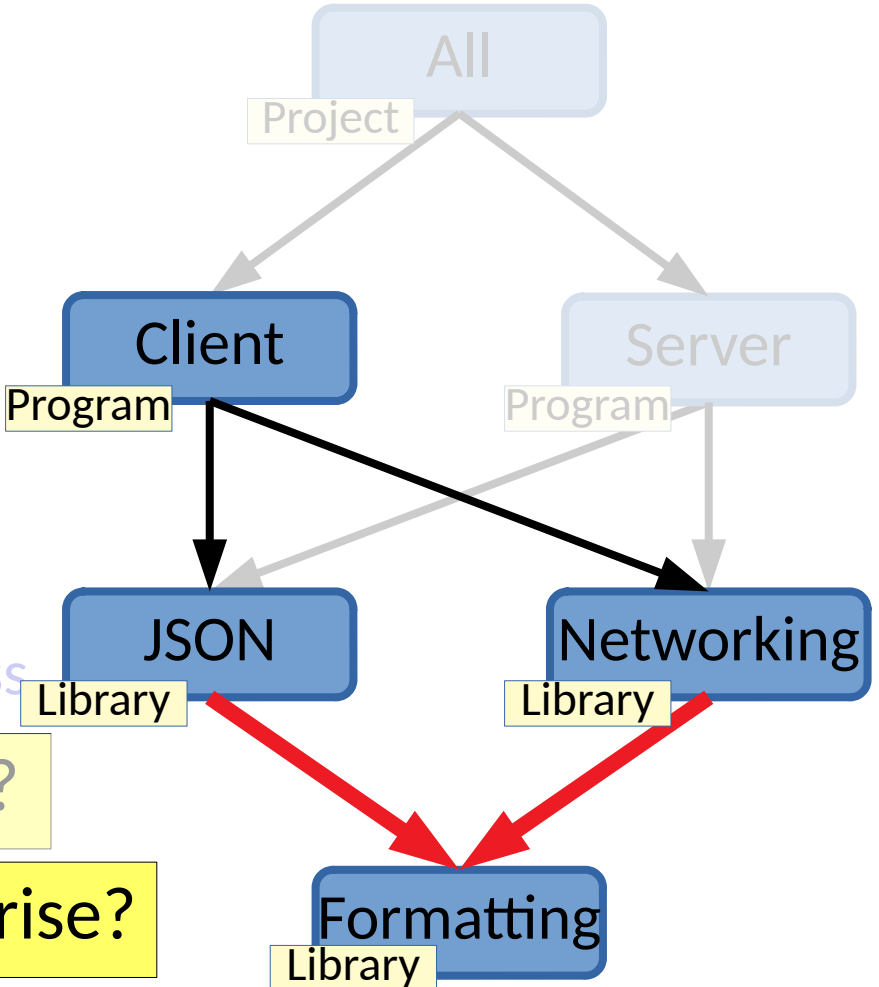

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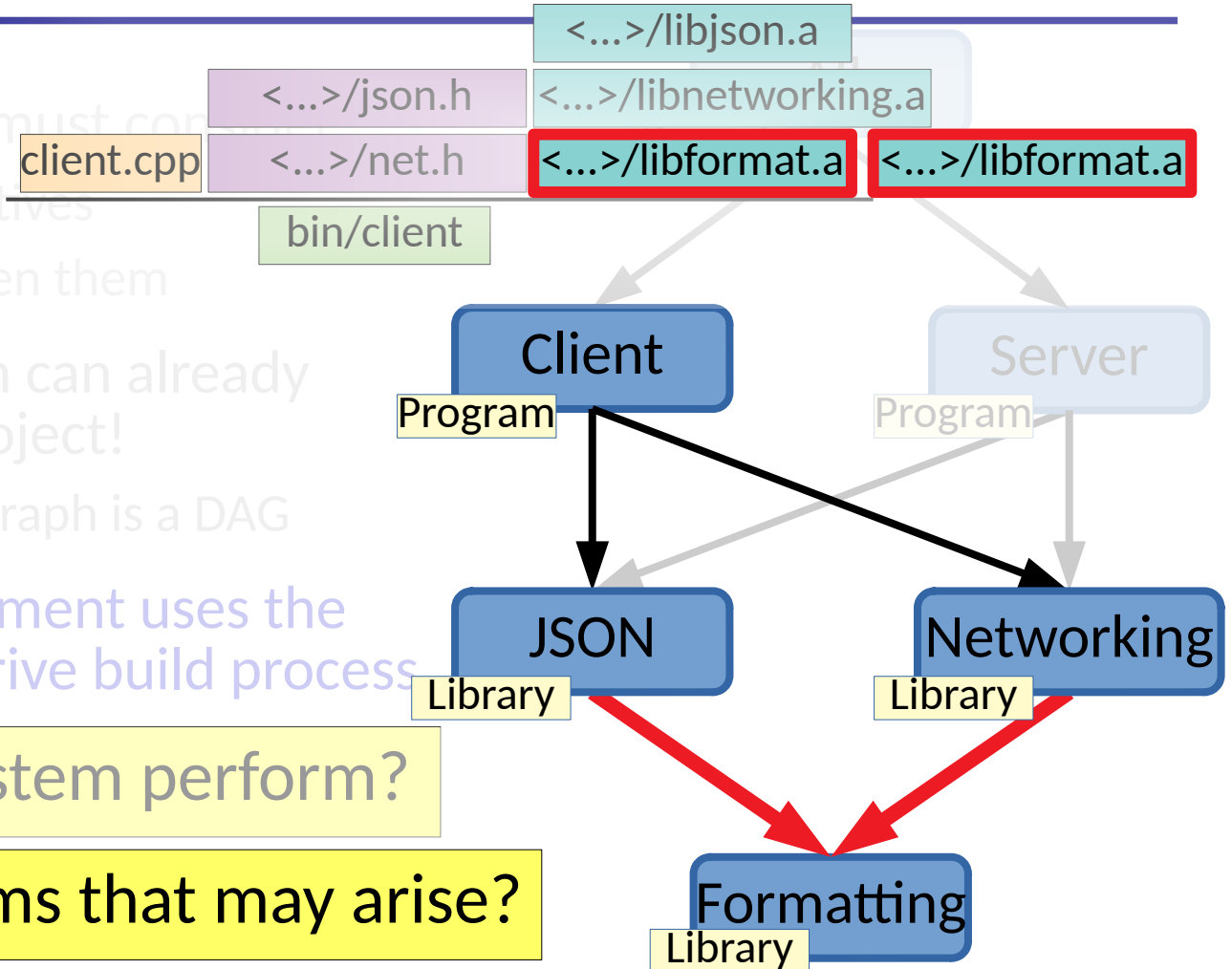

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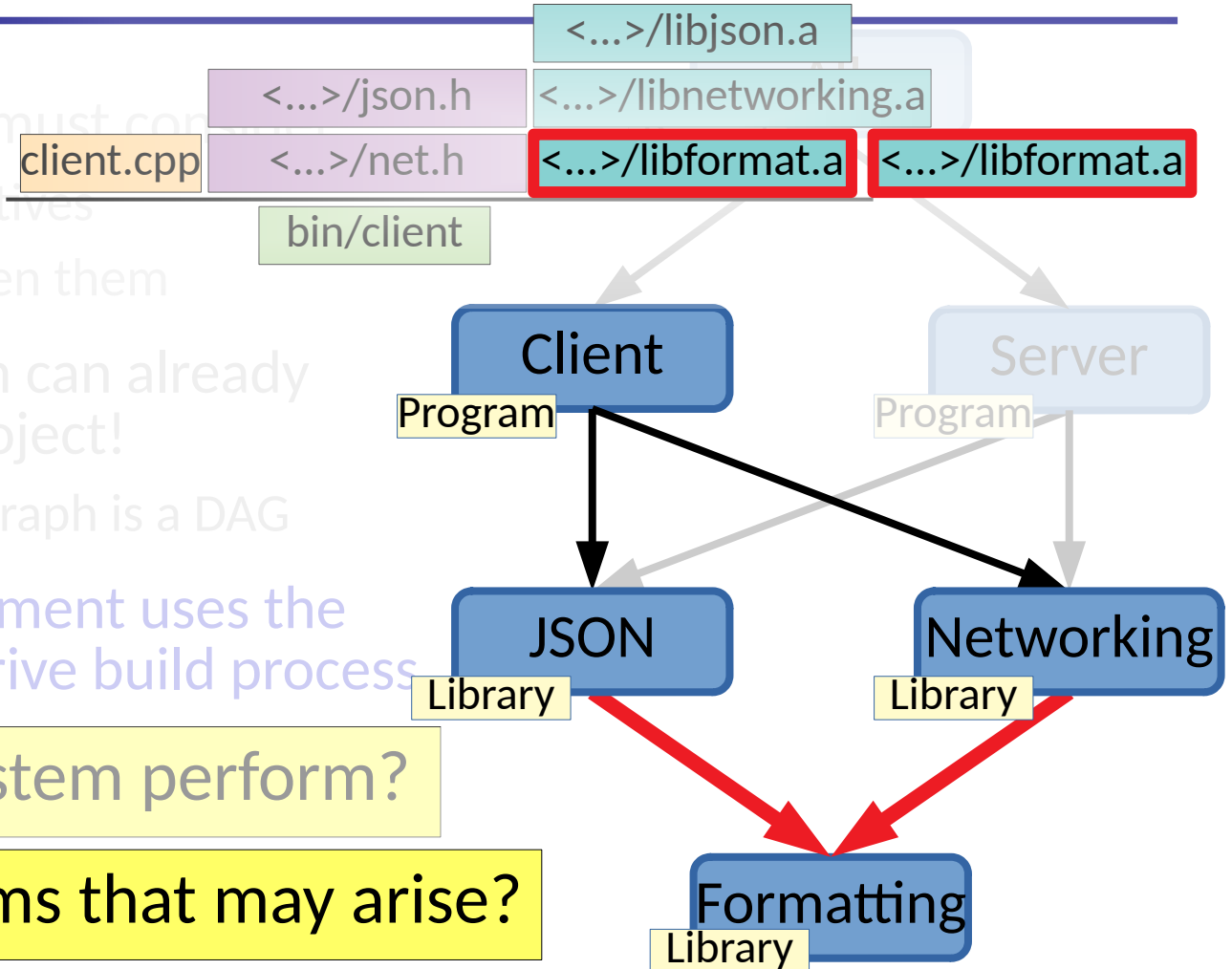

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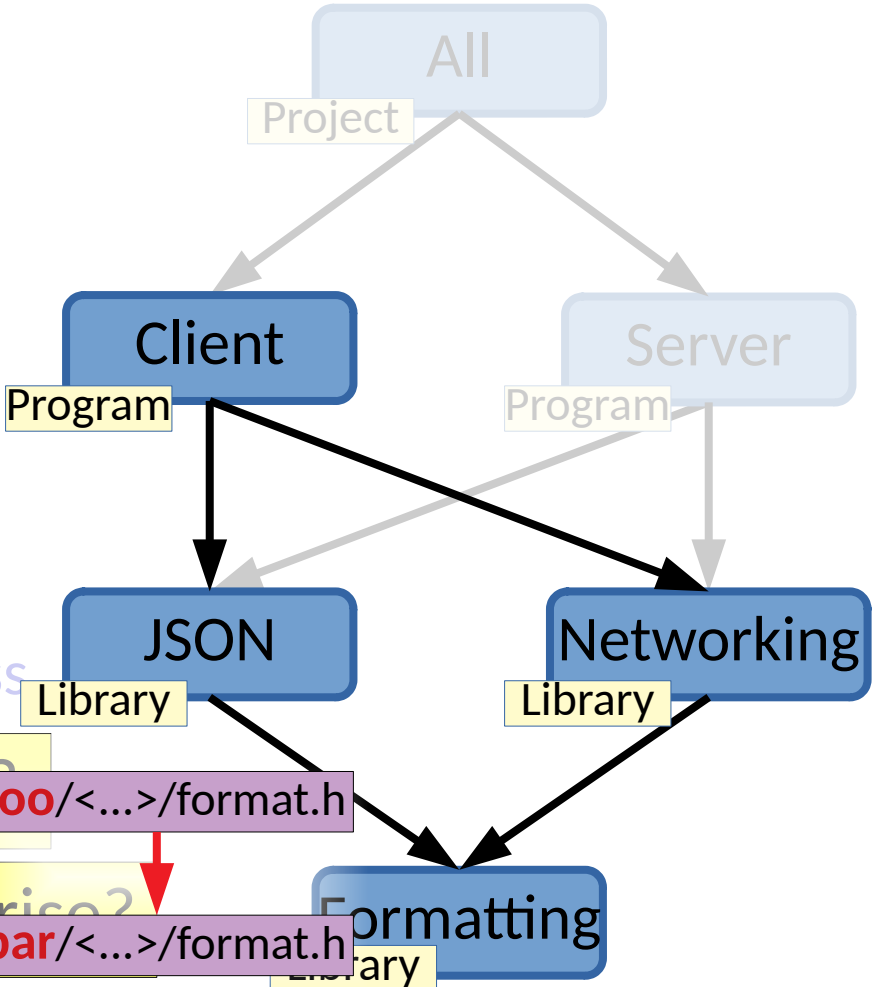

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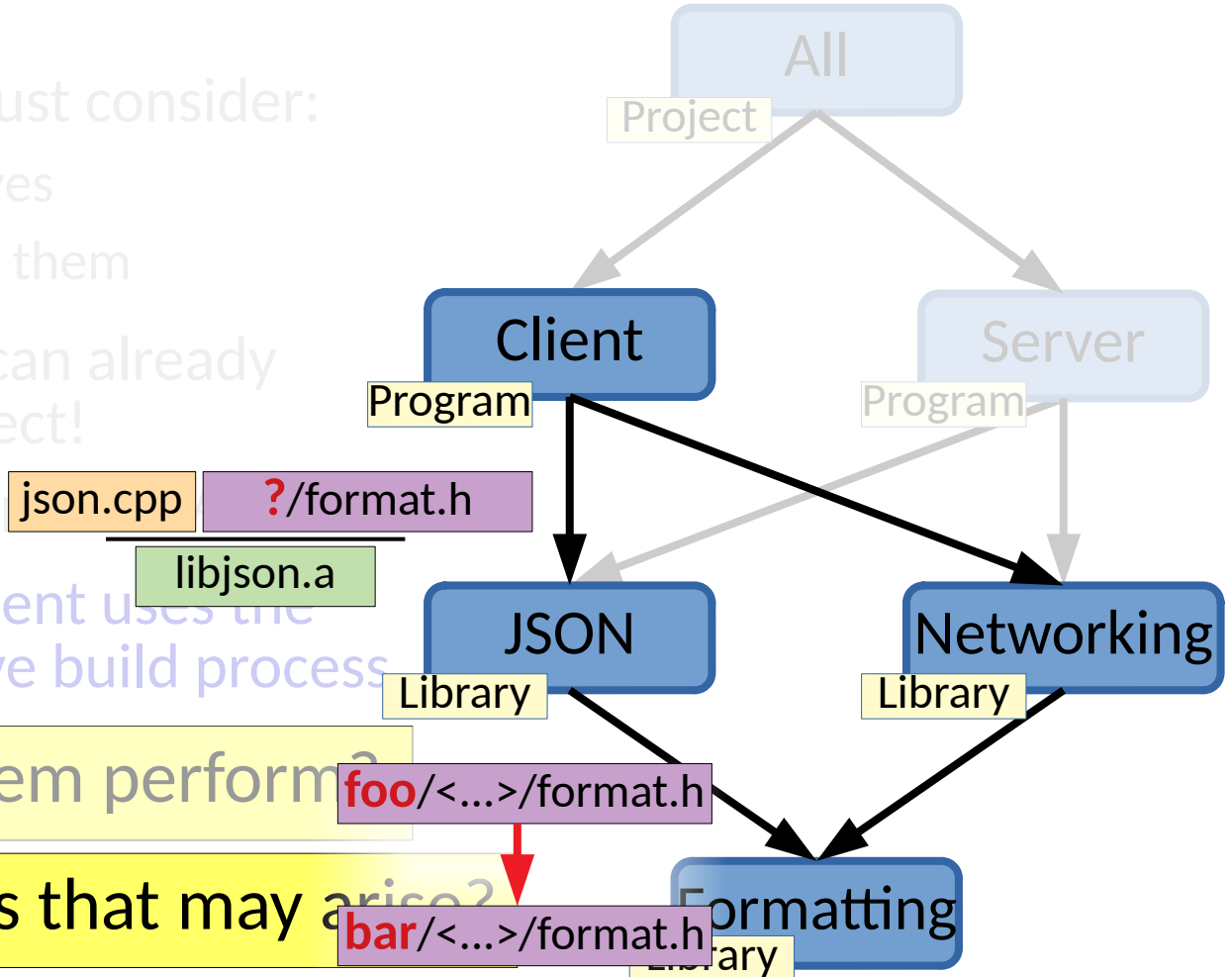

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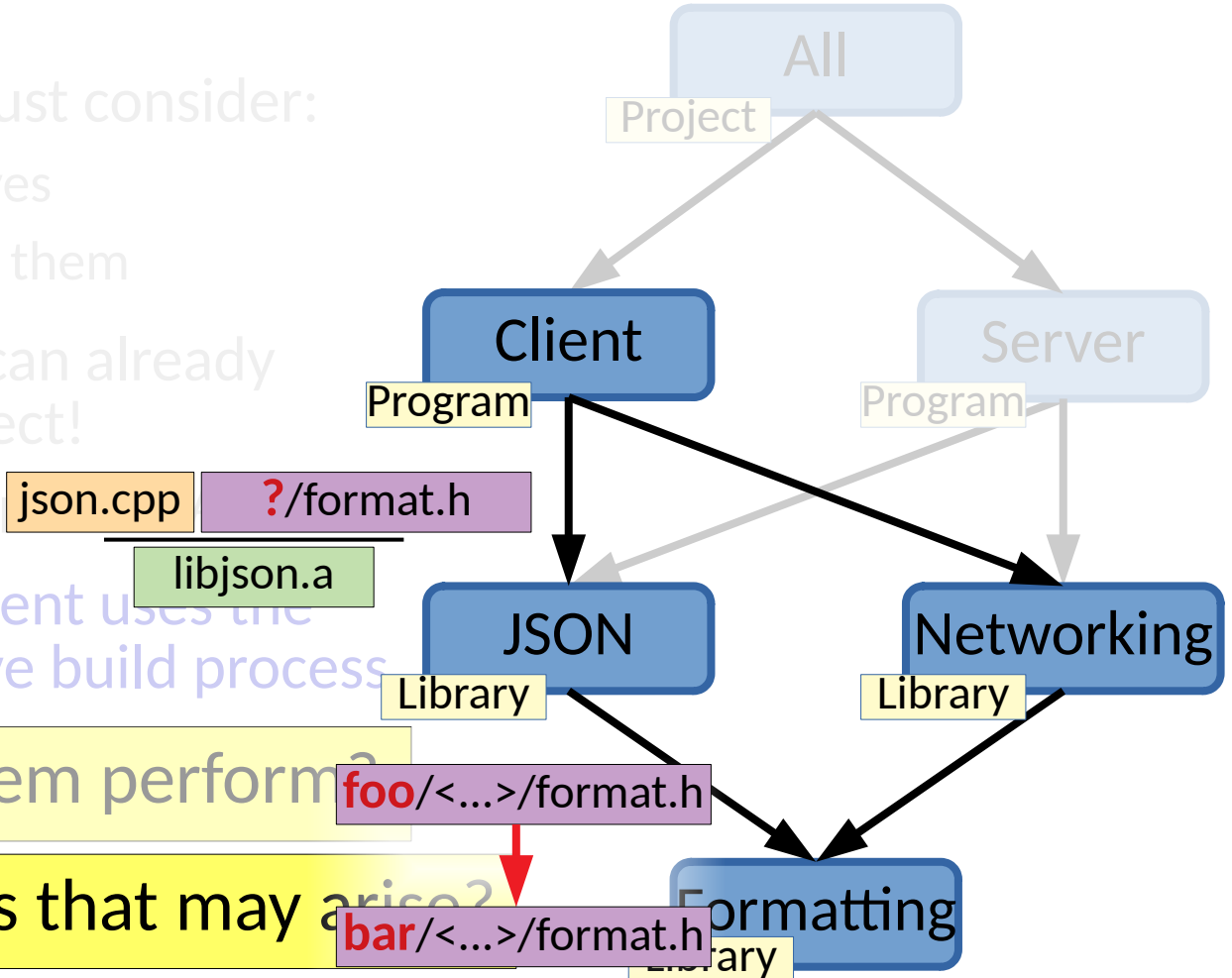
Decoupled Evolution



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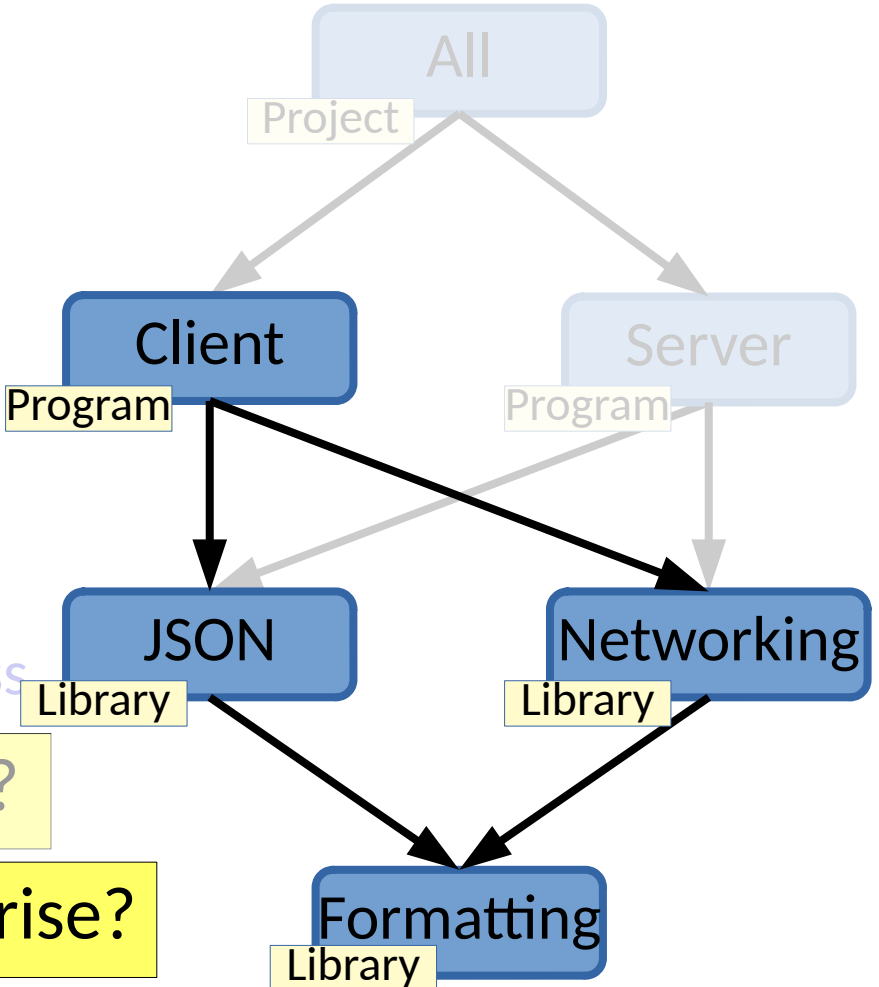

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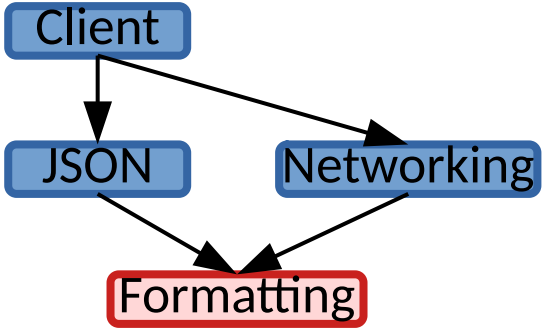

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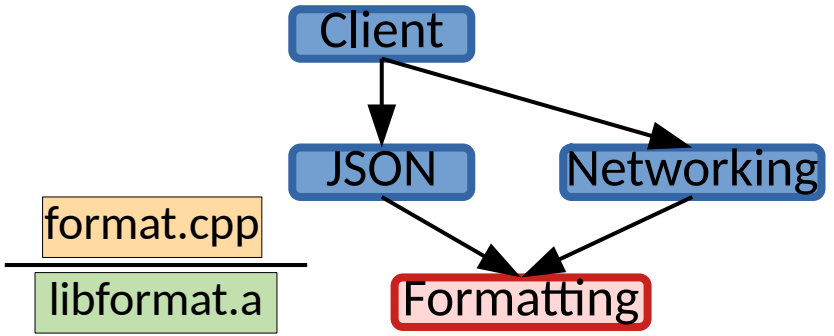

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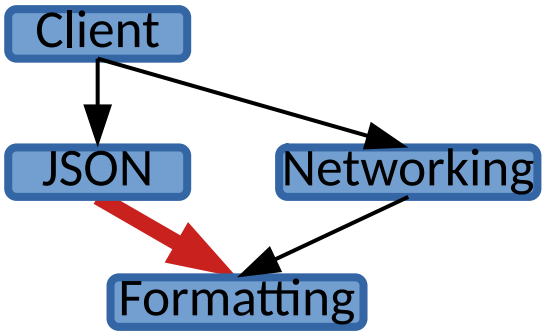

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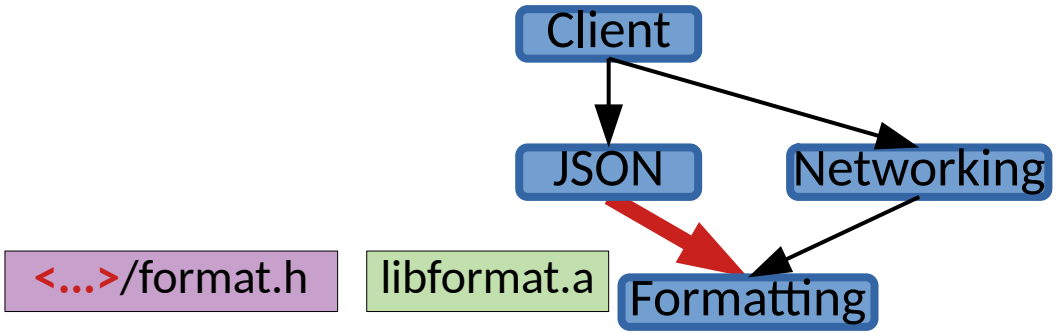

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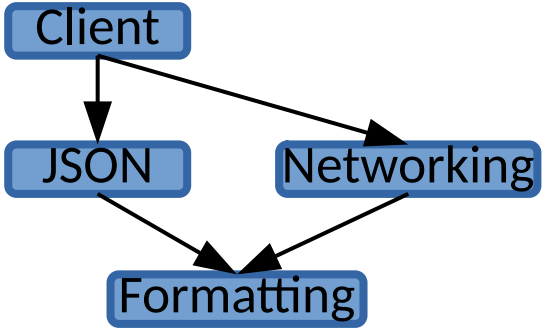

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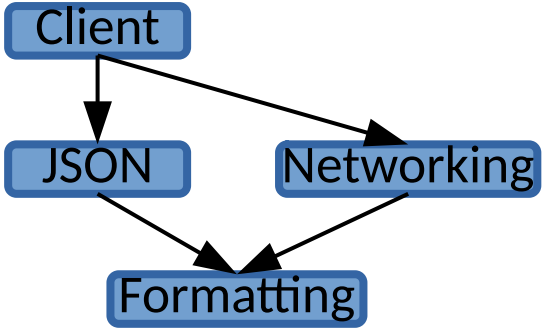

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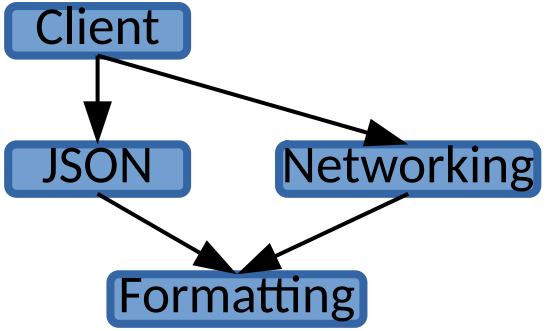

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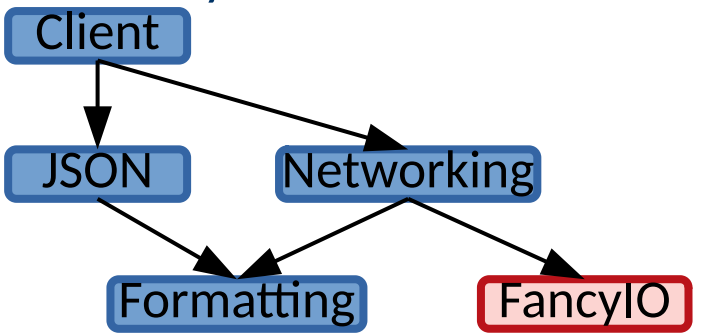

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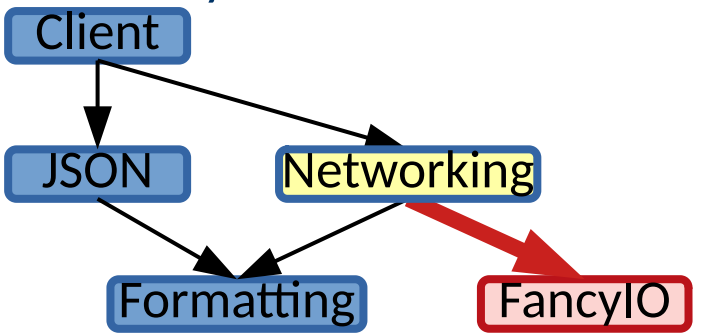

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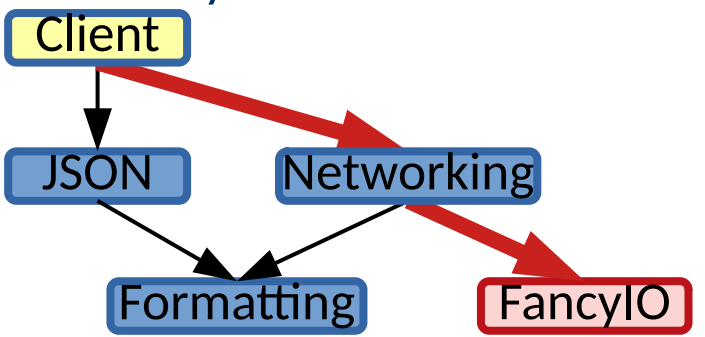

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- Let’s dive into one specific system to see how this is done….

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You describe the dependency graph.
It figures out how to build the software.

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[DEMO]

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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

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- Use “out of source” builds instead

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- Simple syntax
  - Case insensitive commands

```
command( argument1 argument2 argument3 ...)
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  - Let's revisit demo 1!

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

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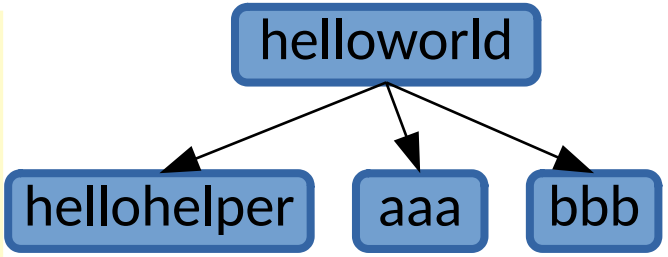

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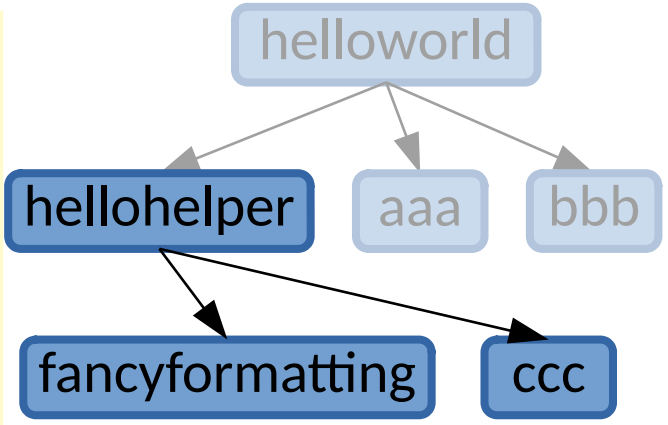

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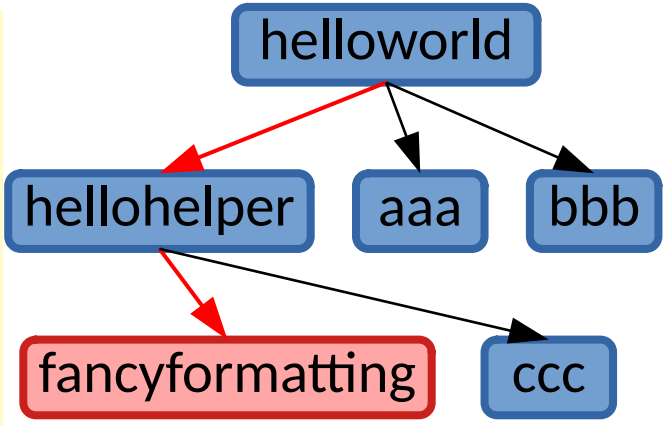

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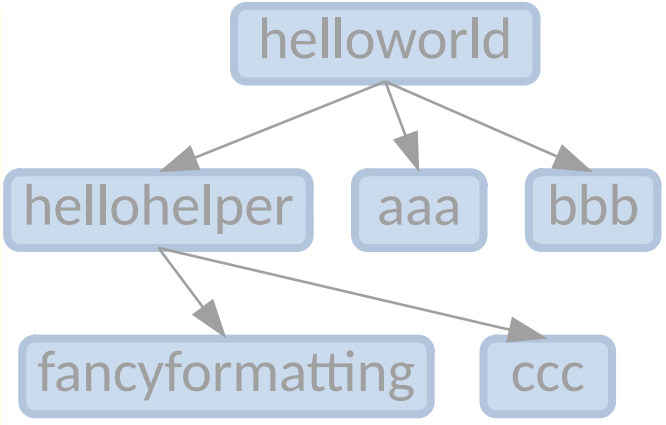

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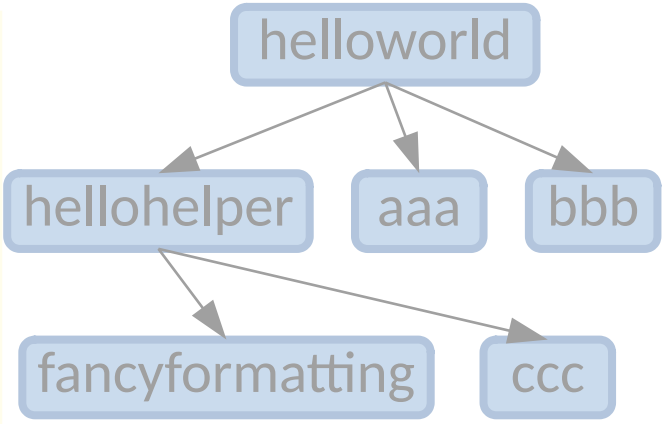

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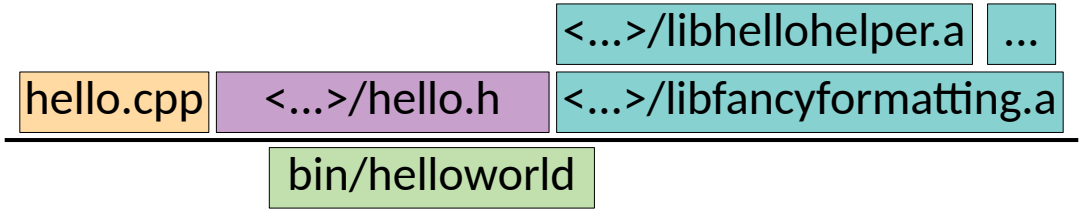

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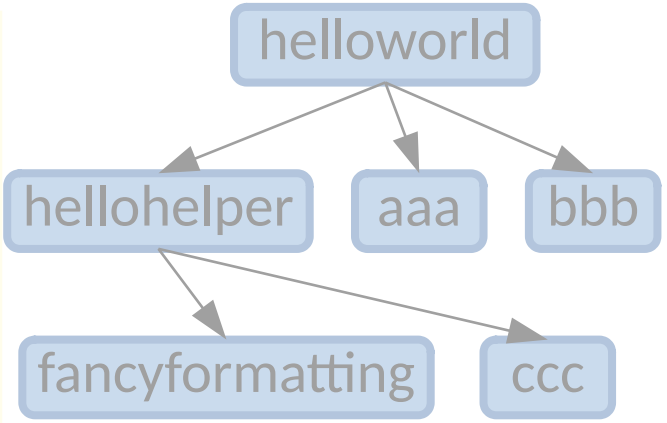

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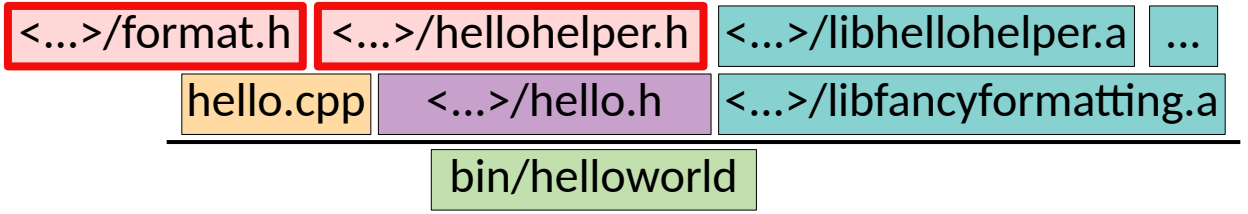

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Consider how this relates to SOA and microservices as well!

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CMake has several other mundane build system facilities…

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  `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")
```

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- Installation

```
install(TARGETS target1 target2 ...
  DESTINATION /tmp/
)
```

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Why might you want conditionals in a build process?

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- Looping

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- Functions

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function(function_name arg1 arg2 ...)
  command(${arg1})
endFunction(function_name)
```

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- Managing dependencies (e.g. with CPM)

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target_link_libraries(demo
  PRIVATE something
)
```

Pulling Remote Dependencies

- Managing dependencies (e.g. with CPM)

```
include(cmake/CPM.cmake)

CPMAddPackage(
  NAME something
  GIT_REPOSITORY https://github.com/nsumner/something.git
  GIT_TAG v0.0.1
)

target_link_libraries(demo
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```

What are the tradeoffs of this?

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
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CMake has extensive documentation,
and you can find additional CMake specific information online

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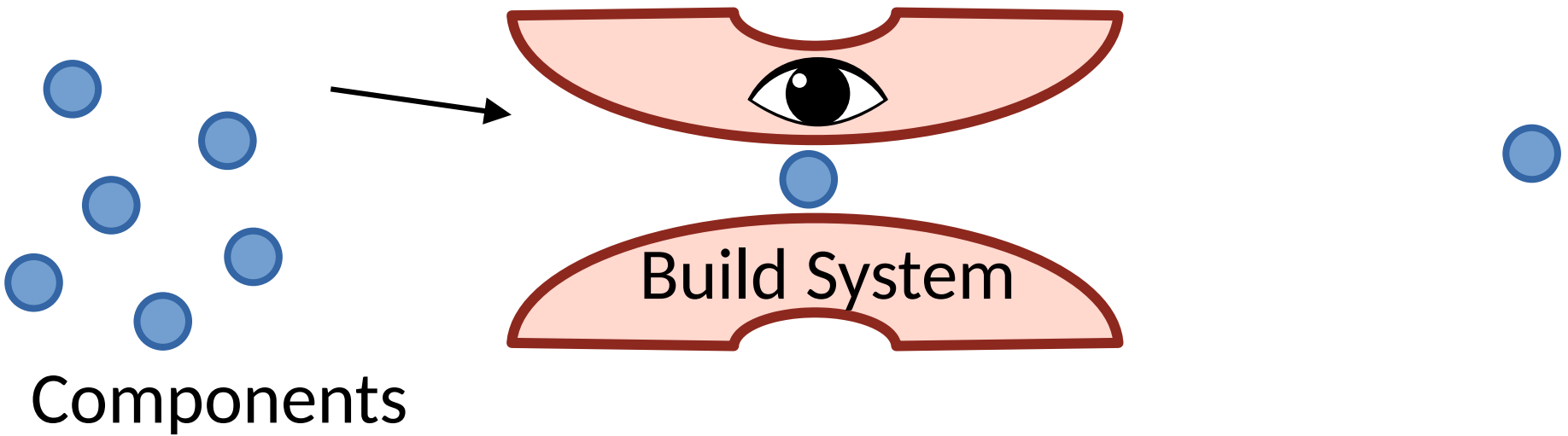

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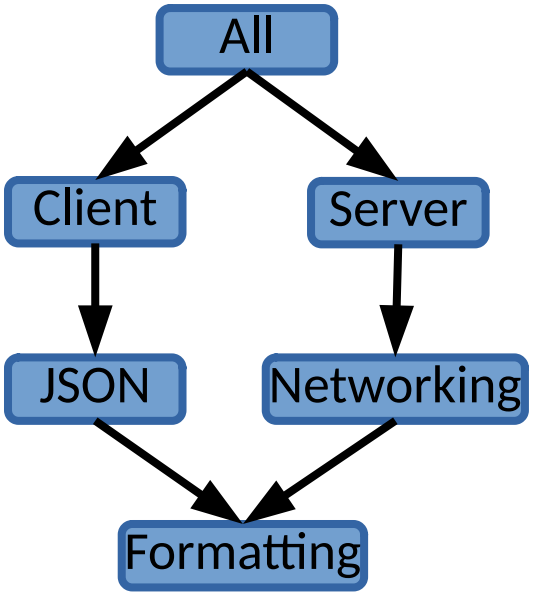

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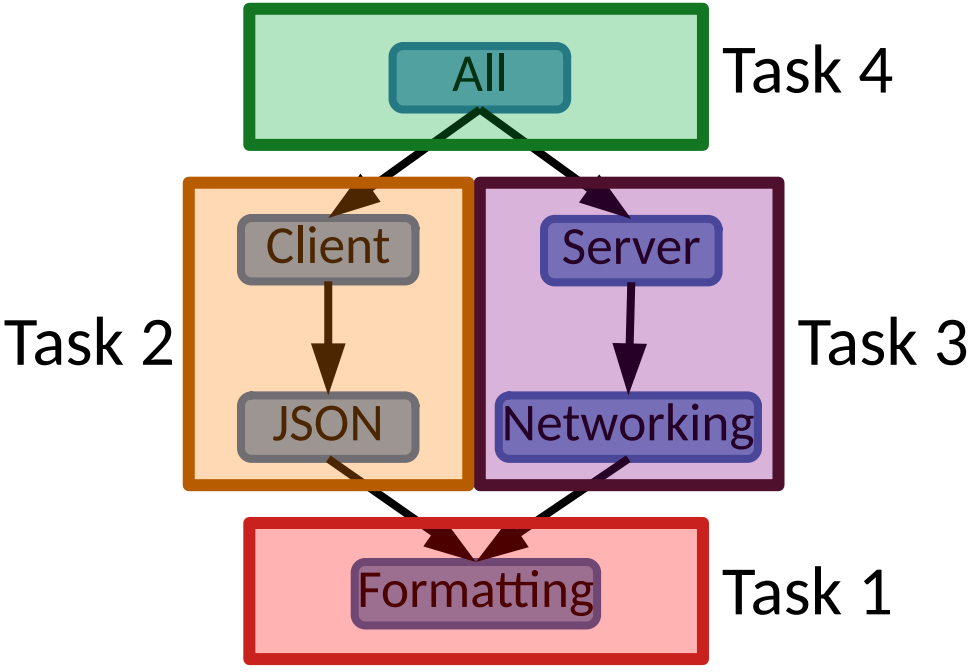

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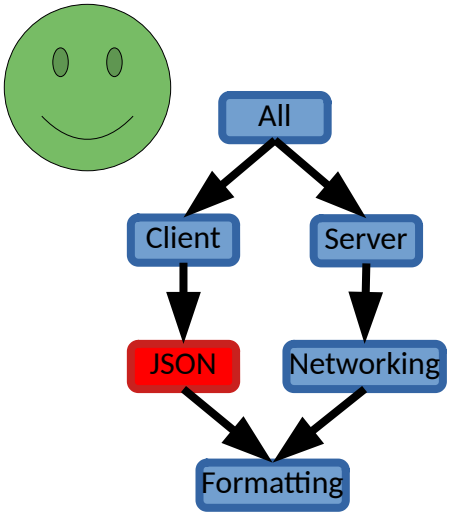

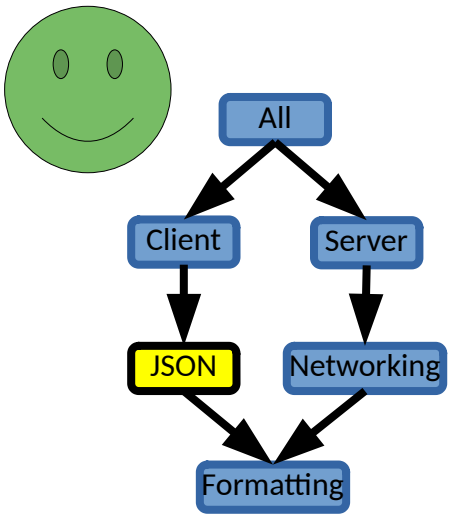

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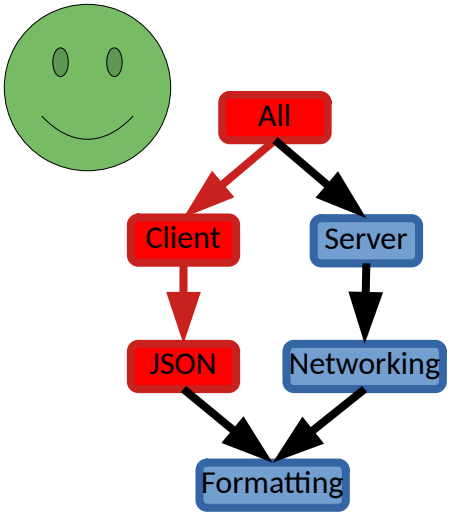

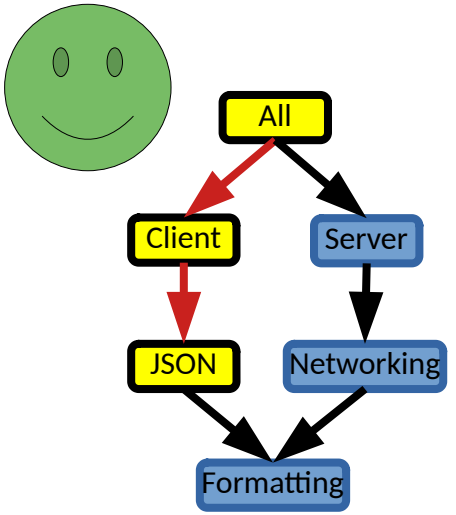

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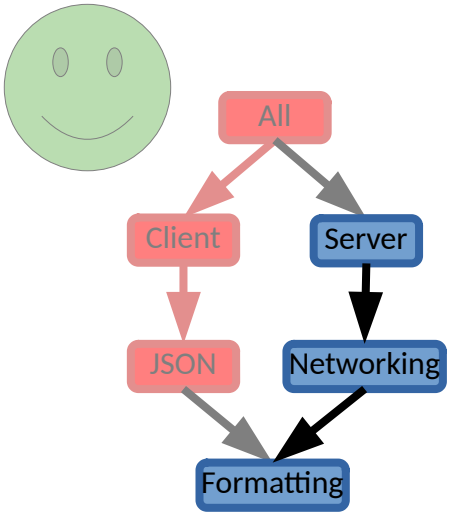

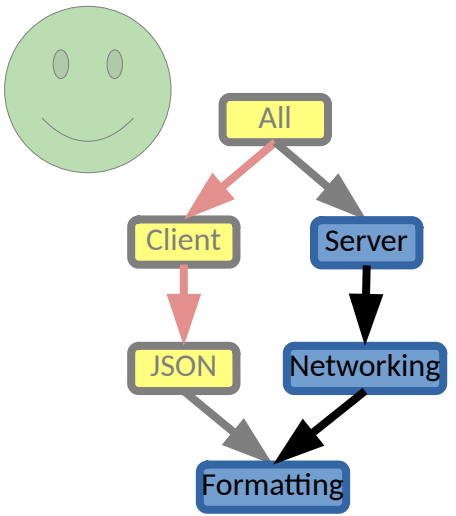

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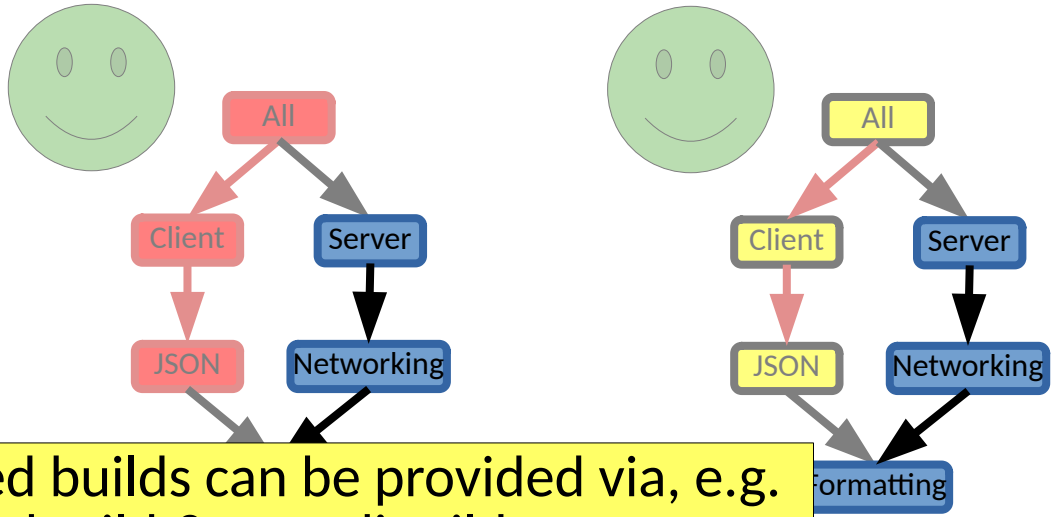

Distributed & cached builds can be provided via, e.g.
MS CloudBuild & IncrediBuild
Larger companies like Google have their own.

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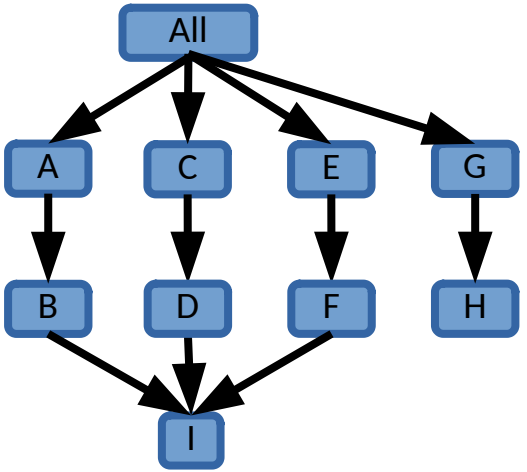

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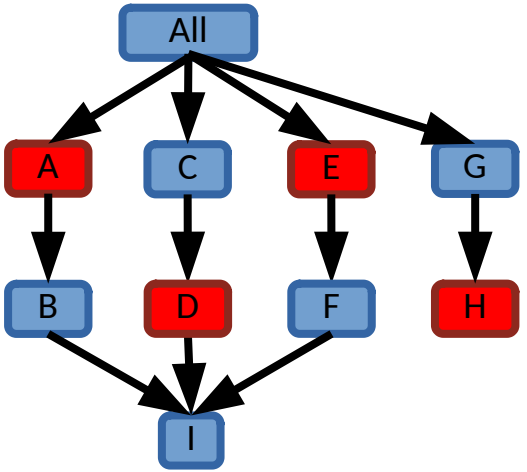
(high velocity, API churn, …)



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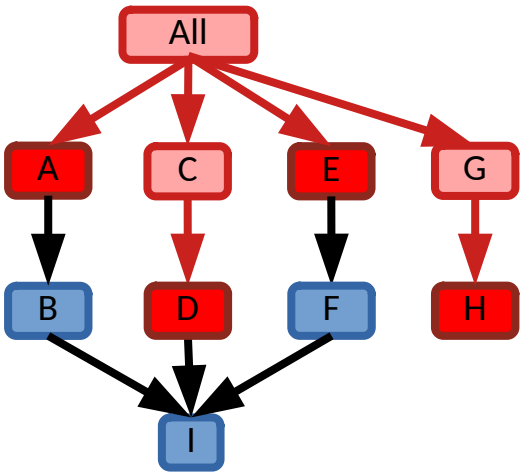

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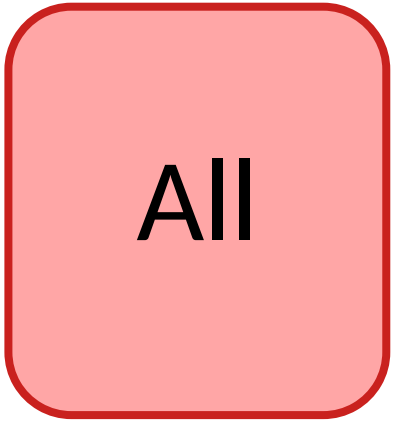

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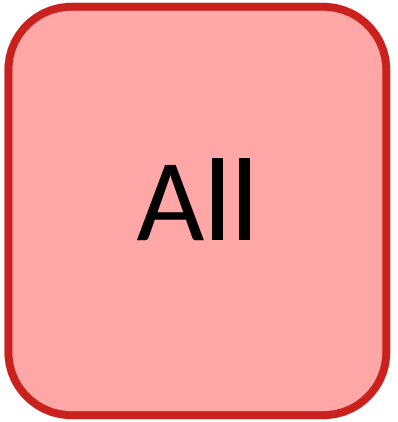

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“Unity builds” can be popular in game dev.

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- 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