Bazel

{fast, correct} – choose two

Klaus Aehlig

February 4–5, 2017

Bazel

What is Bazel?

Bazel

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- Bazel is a build tool

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- Bazel is a build tool
  like `make`, *etc, it organises compiling/creating artifacts (libraries, executables, . . .) from sources*

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  - large code base in a single source tree ($\approx 10^7$ files)
  - majority of engineers ($\approx 10^{4.5}$) actively working on that single code base.

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- open-sourced only in 2015
  (in fact, still going on)

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- aggressive caching *without* losing correctness
  (i.e., all artifacts as if freshly built from source)

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    writing code *vs* choosing correct (cross) compiling strategy

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    writing code *vs* choosing correct (cross) compiling strategy
  - central maintenance point for build rules

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- from rules generate action graph
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on subsequent builds, update the graphs
(client-server architecture to keep graph in memory)

An Example

Let's look at a `helloworld` example.

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- main program `helloworld.c`

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```
#include "lib/hello.h"

int main(int argc, char **argv) {
  greet("world");
  return 0;
}
```

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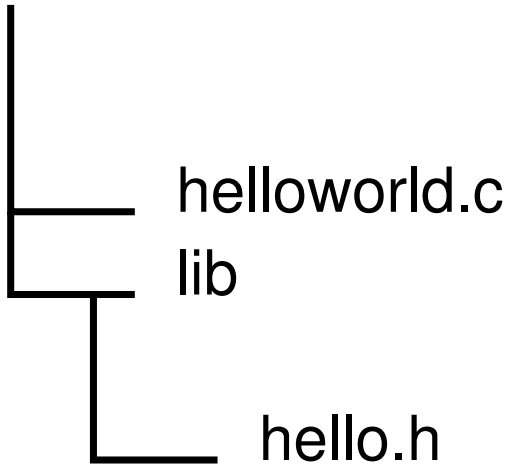
- main program `helloworld.c`, depending on a library
- a library with headers (`lib/hello.h`)



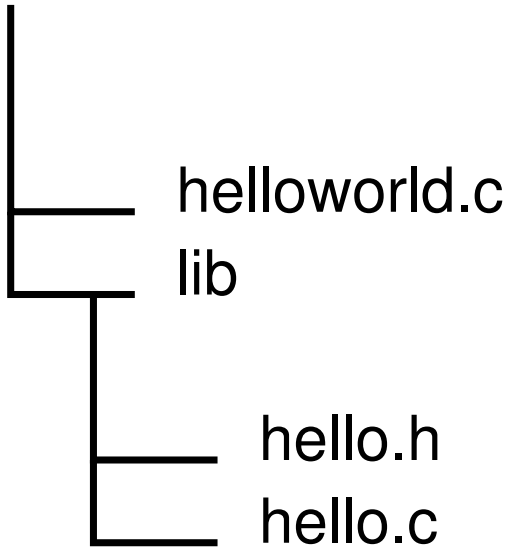

```
#ifndef HELLO_H
#define HELLO_H

void greet(char *);

#endif
```

An Example

- main program `helloworld.c`, depending on a library
- a library with headers (`lib/hello.h`)
  ... and implementation (`lib/hello.c`)




```
#include "hello.h"
#include <stdio.h>

void greet(char *it) {
  printf("Hello %s!", it);
}
```

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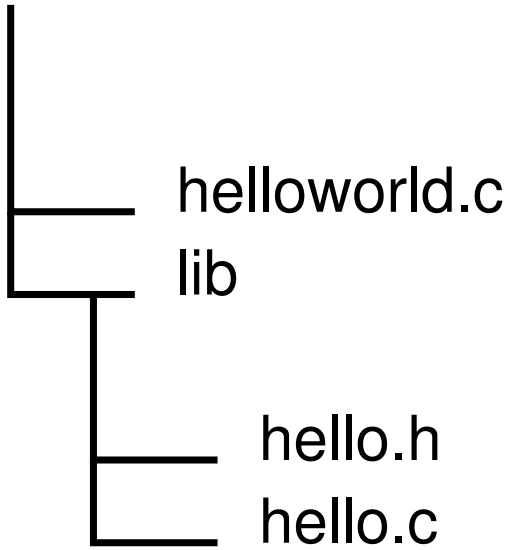

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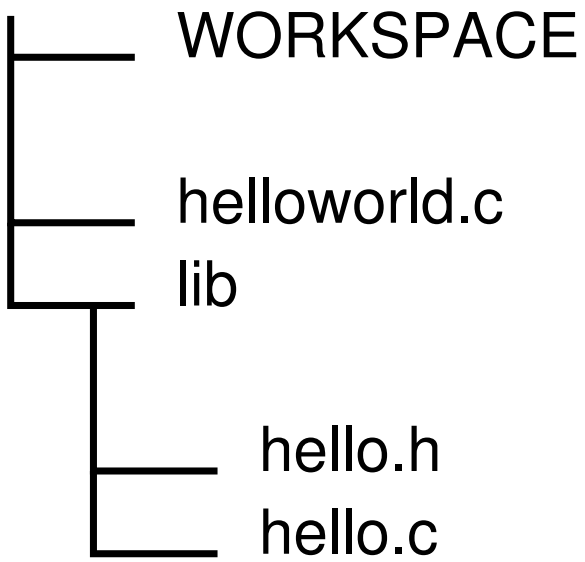

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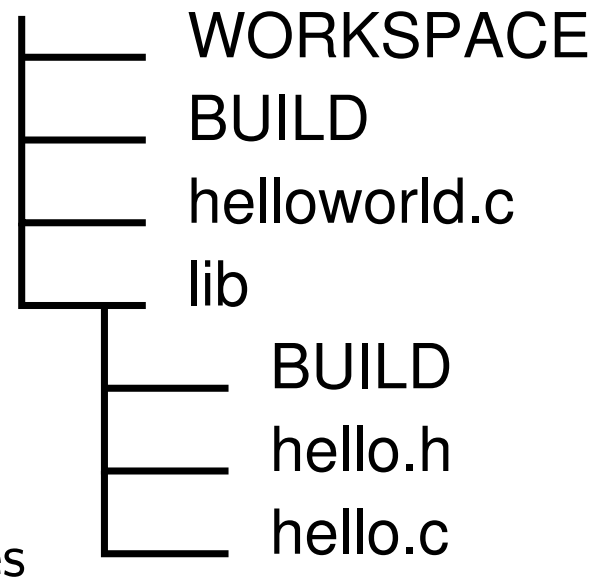

- main program `helloworld.c`, depending on a library
- a library with headers (`lib/hello.h`) ... and implementation (`lib/hello.c`)
- then we can have an empty `WORKSPACE` file ... and the following declarative `BUILD` files

```
cc_binary(
  name="helloworld",
  srcs=["helloworld.c"],
  deps=["//lib:hello"],
)
```

```
cc_library(
  name="hello",
  srcs=glob(["*.c"]),
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```

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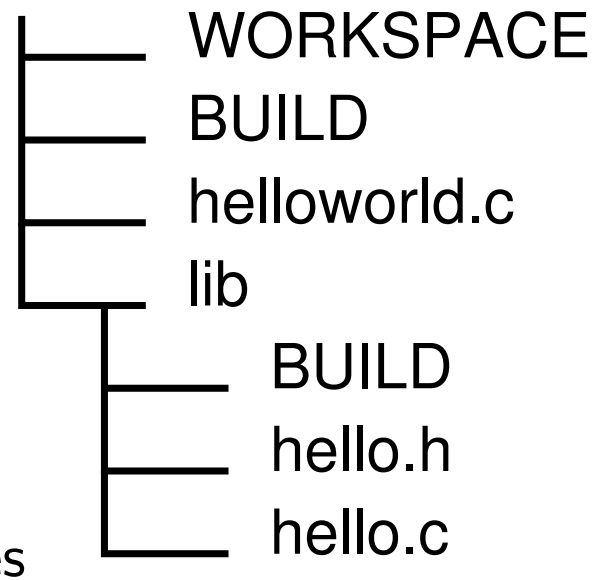

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  hdrs=glob(["*.h"]),
)
```

Note: `CC`, link options, host/target architecture, etc, taken care of elsewhere.

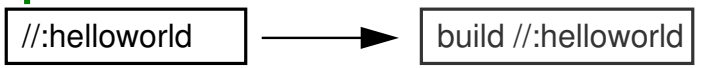
Example cont'd: Dependencies

build //:helloworld

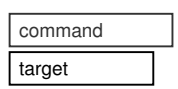
Now let's see what happens if we want to build `:helloworld`...

command

Example cont'd: Dependencies

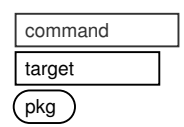


We look at the target `:helloworld`



Example cont'd: Dependencies

We look at the target `:helloworld`, in package `//`



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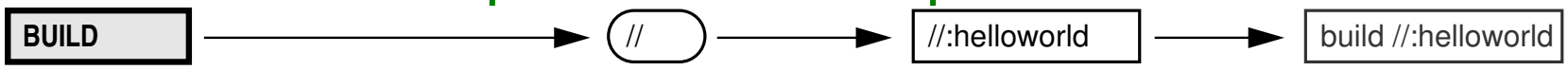
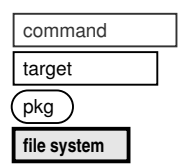


We look at the target `:helloworld`, in package `//`, in file `BUILD`



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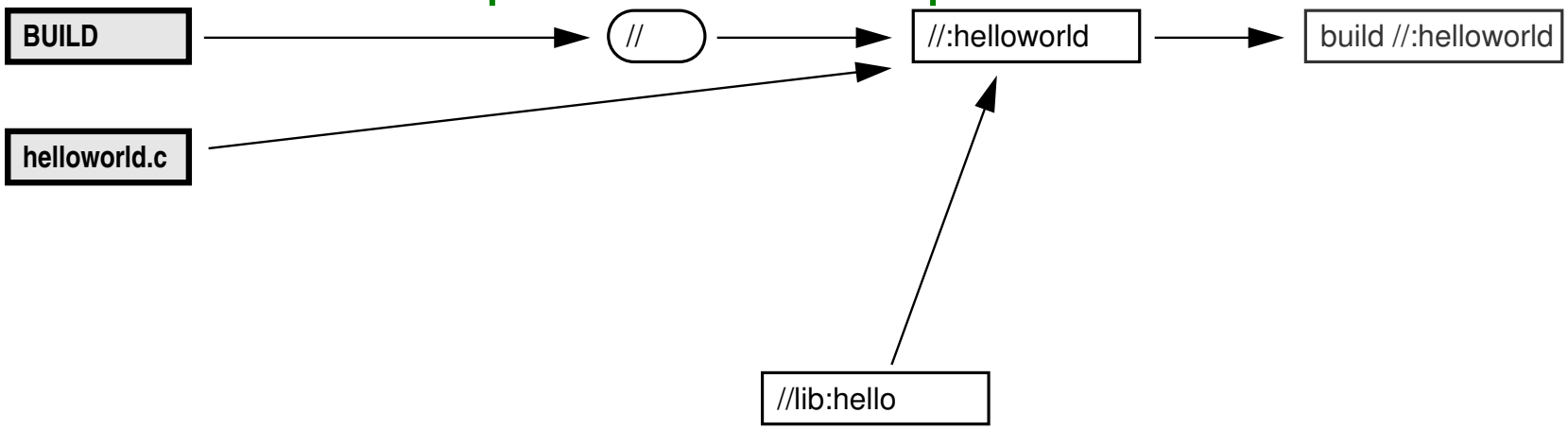
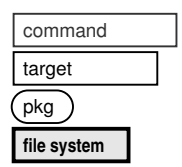


Two declared dependencies



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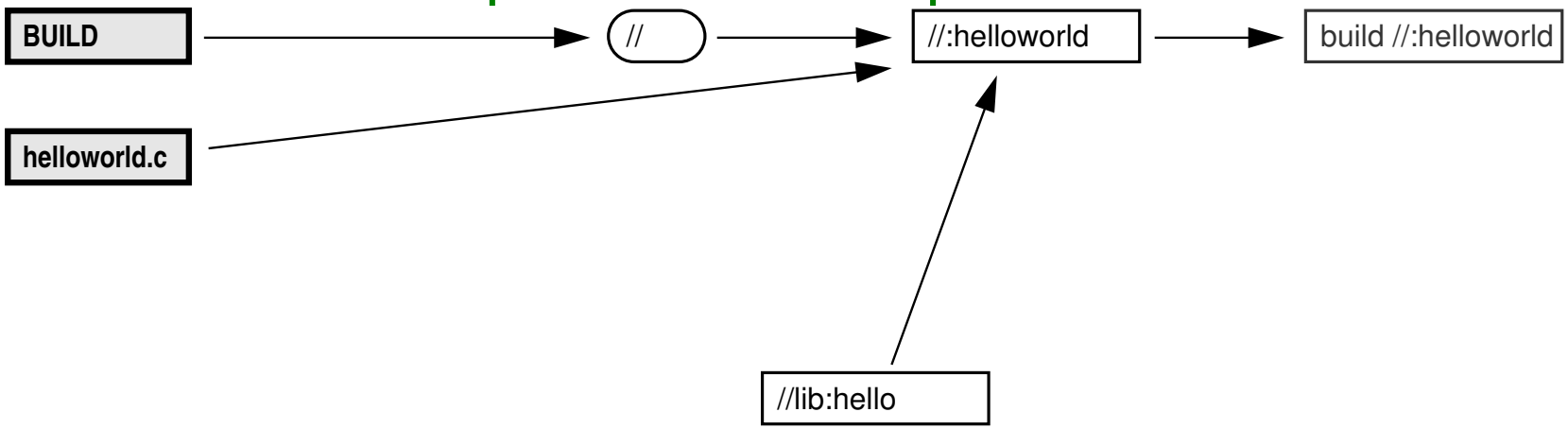
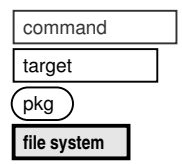


Two declared dependencies

. . . and implicit dependency on the `C` *tool chain (not drawn in this diagram)*



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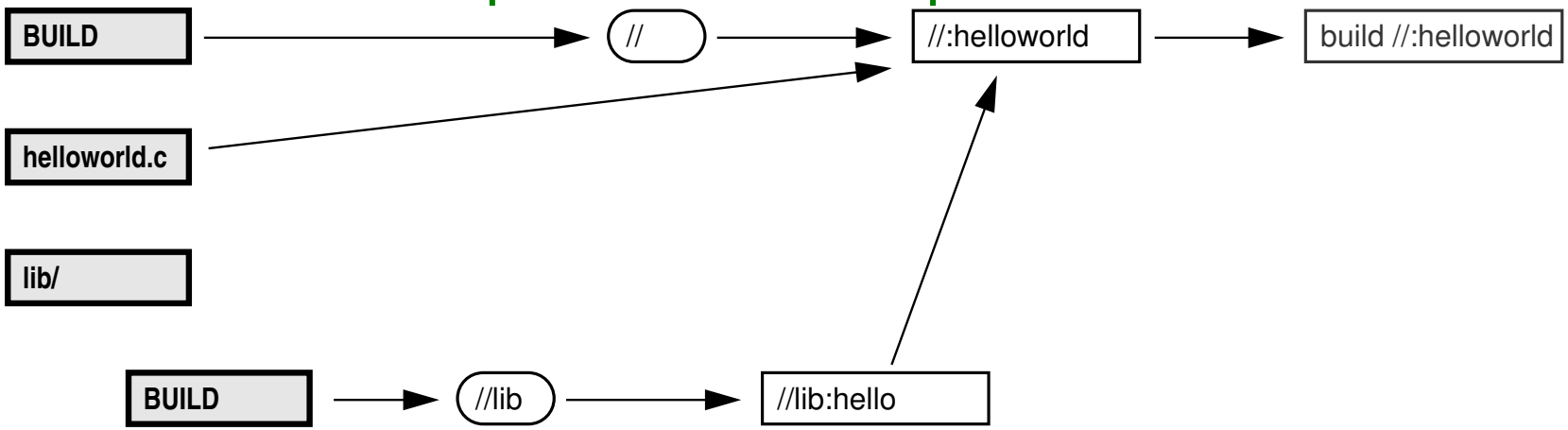
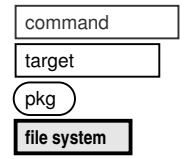


Two declared dependencies, one in a different package

Note: We construct dependency graph over package boundaries!

(no recursive calling)



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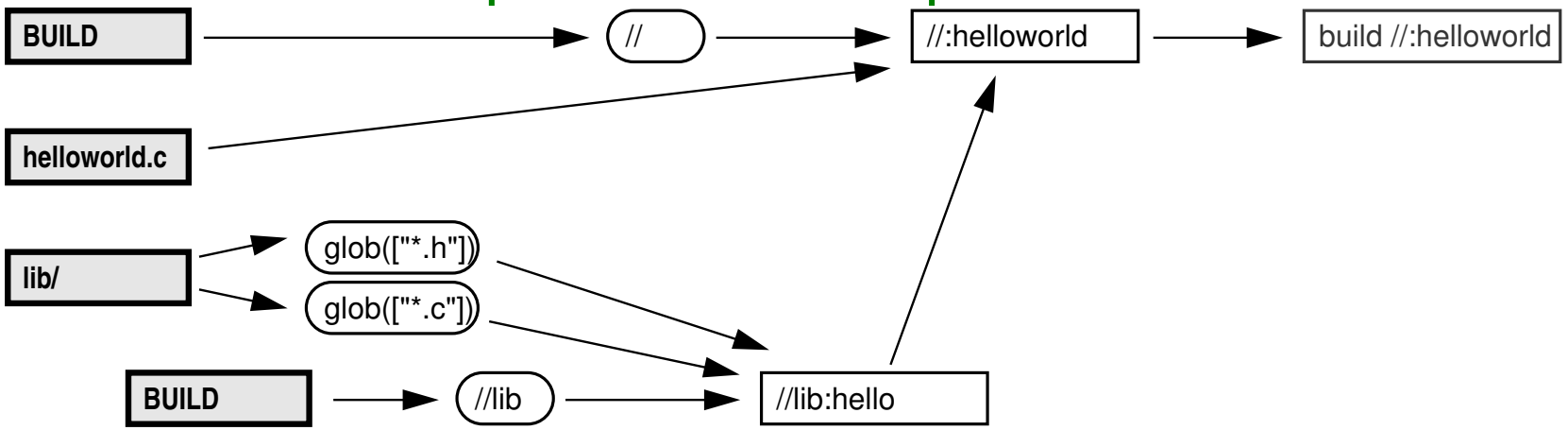
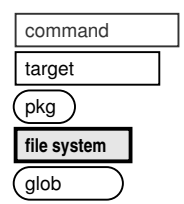


We discover `glob` expressions



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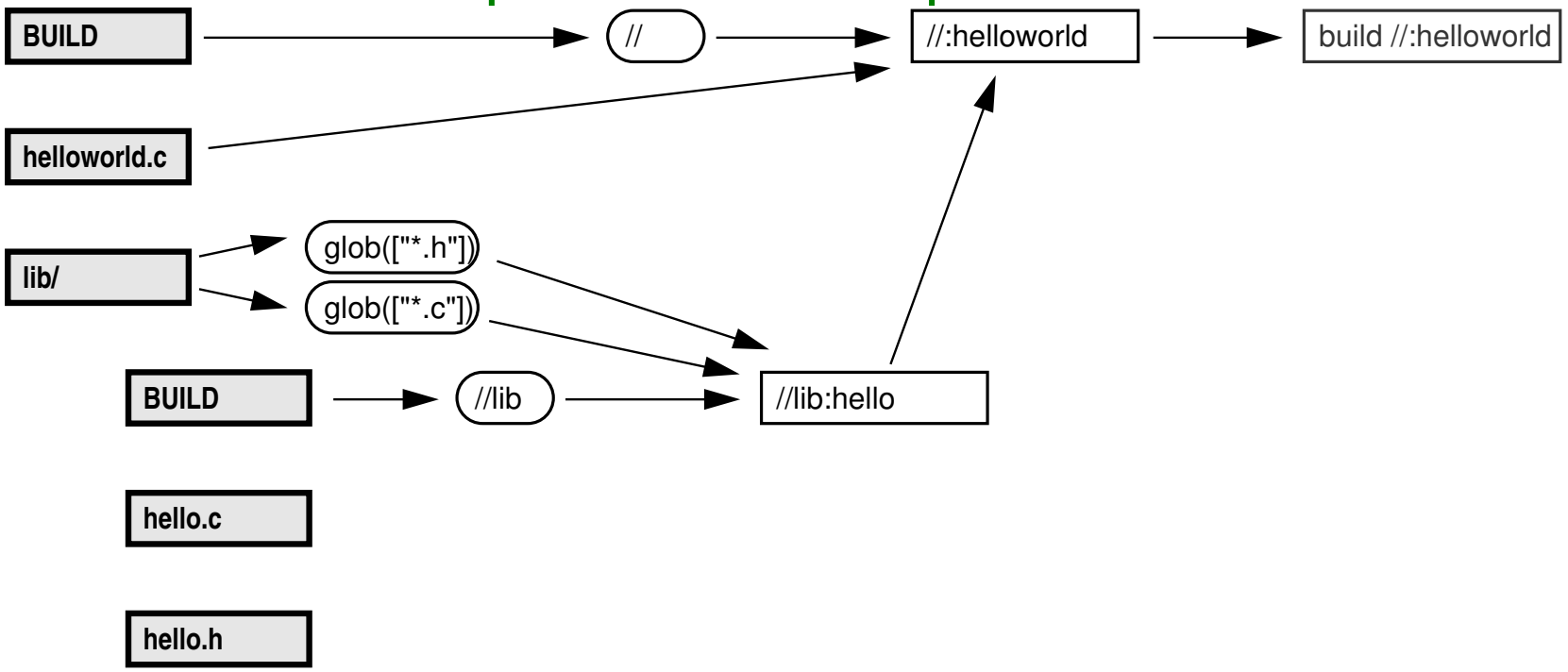
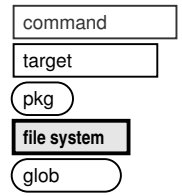


We discover `glob` expressions, and read the directory.



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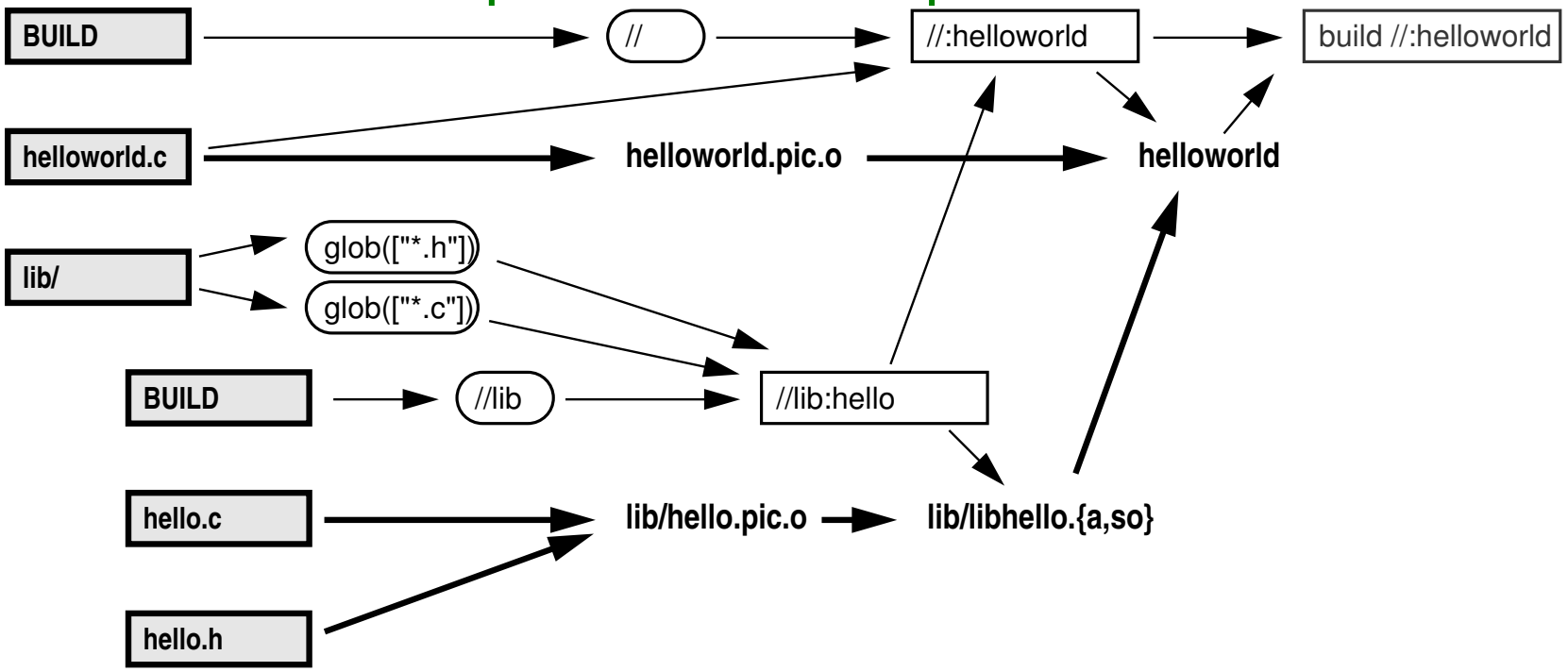
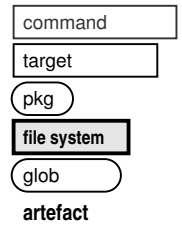


The rules tell us, which artifacts to build.



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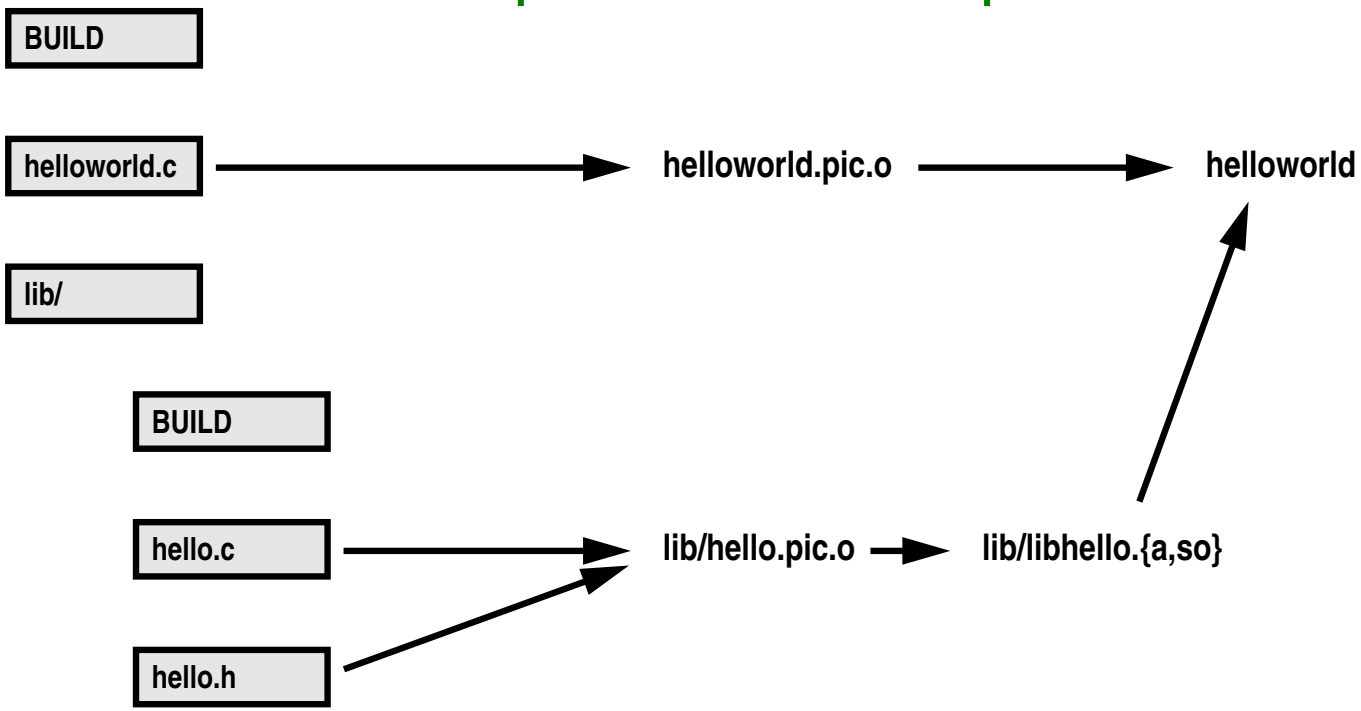

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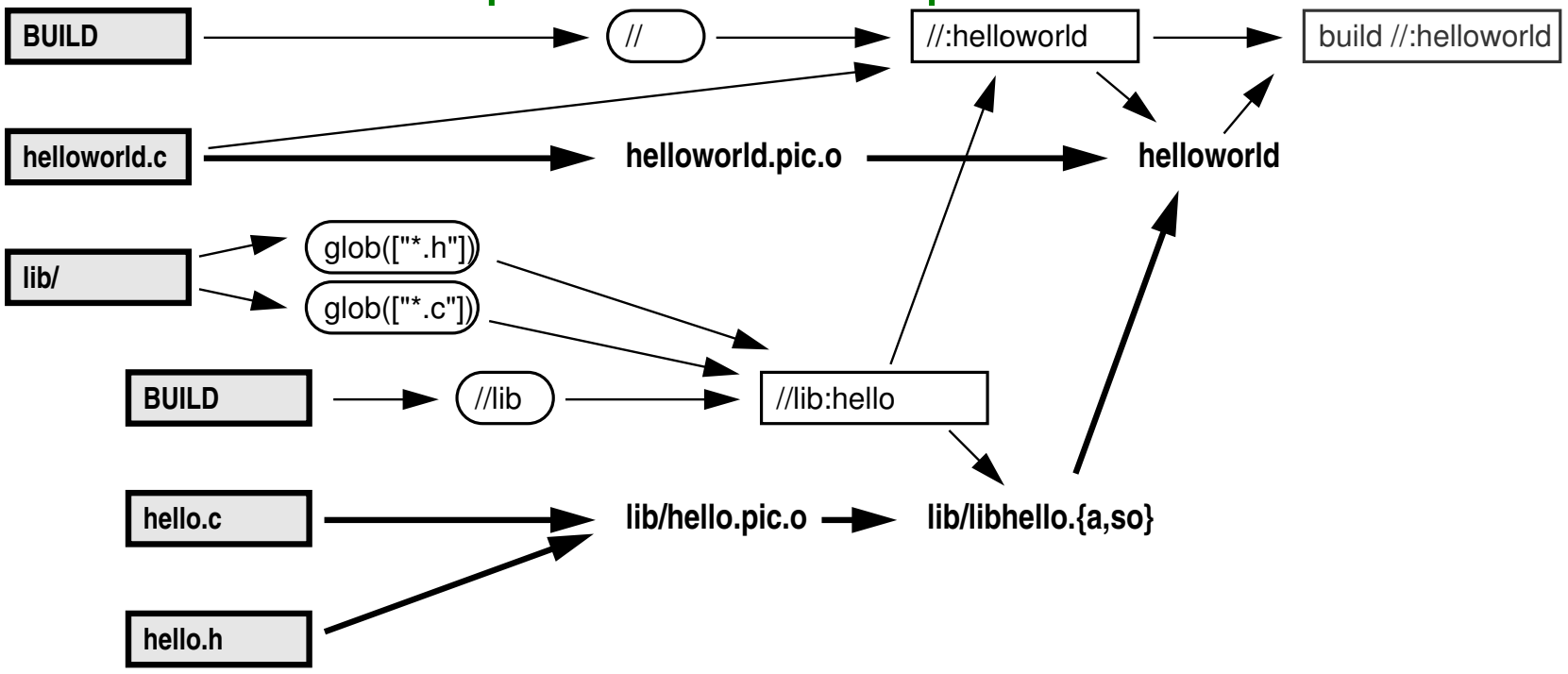

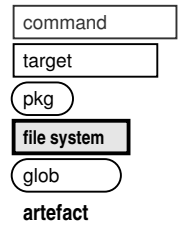

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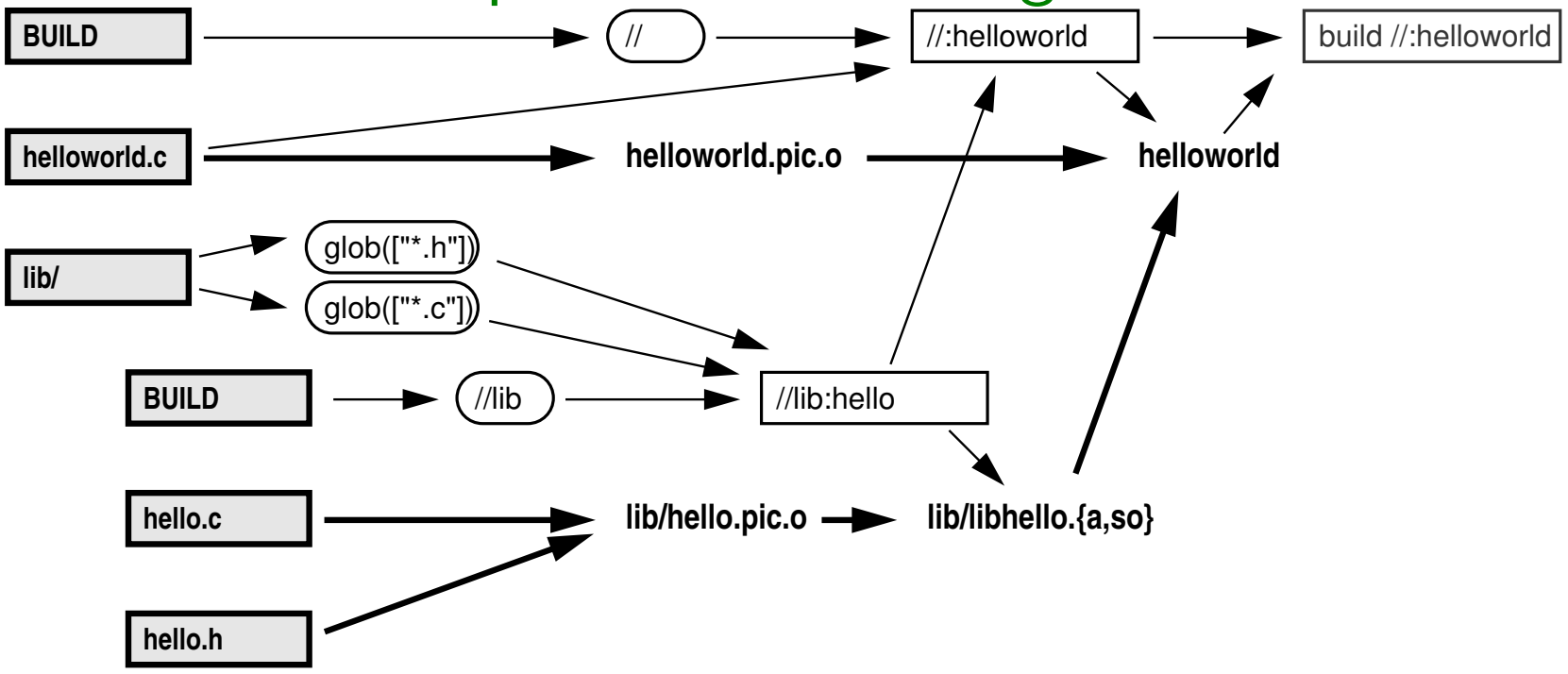

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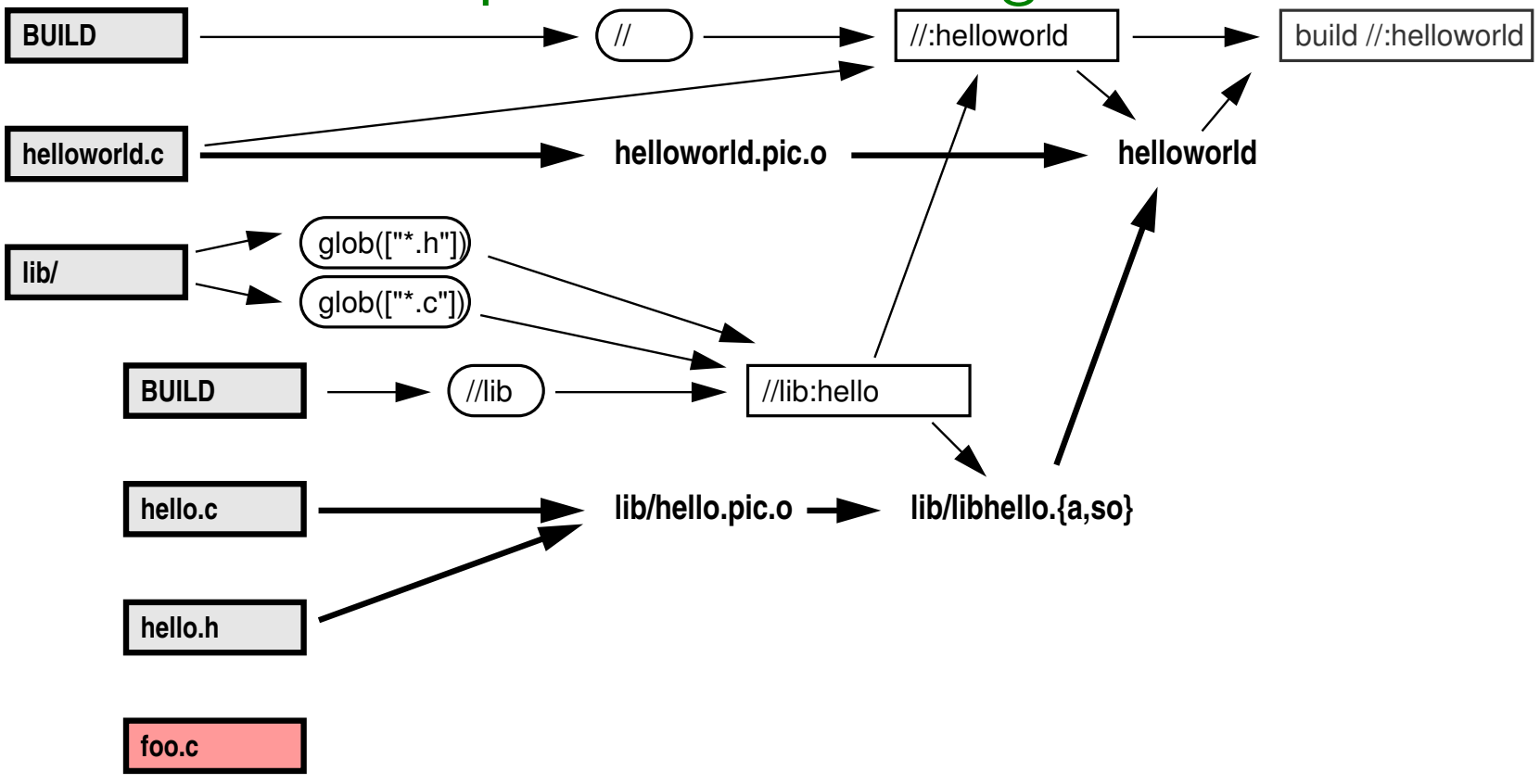

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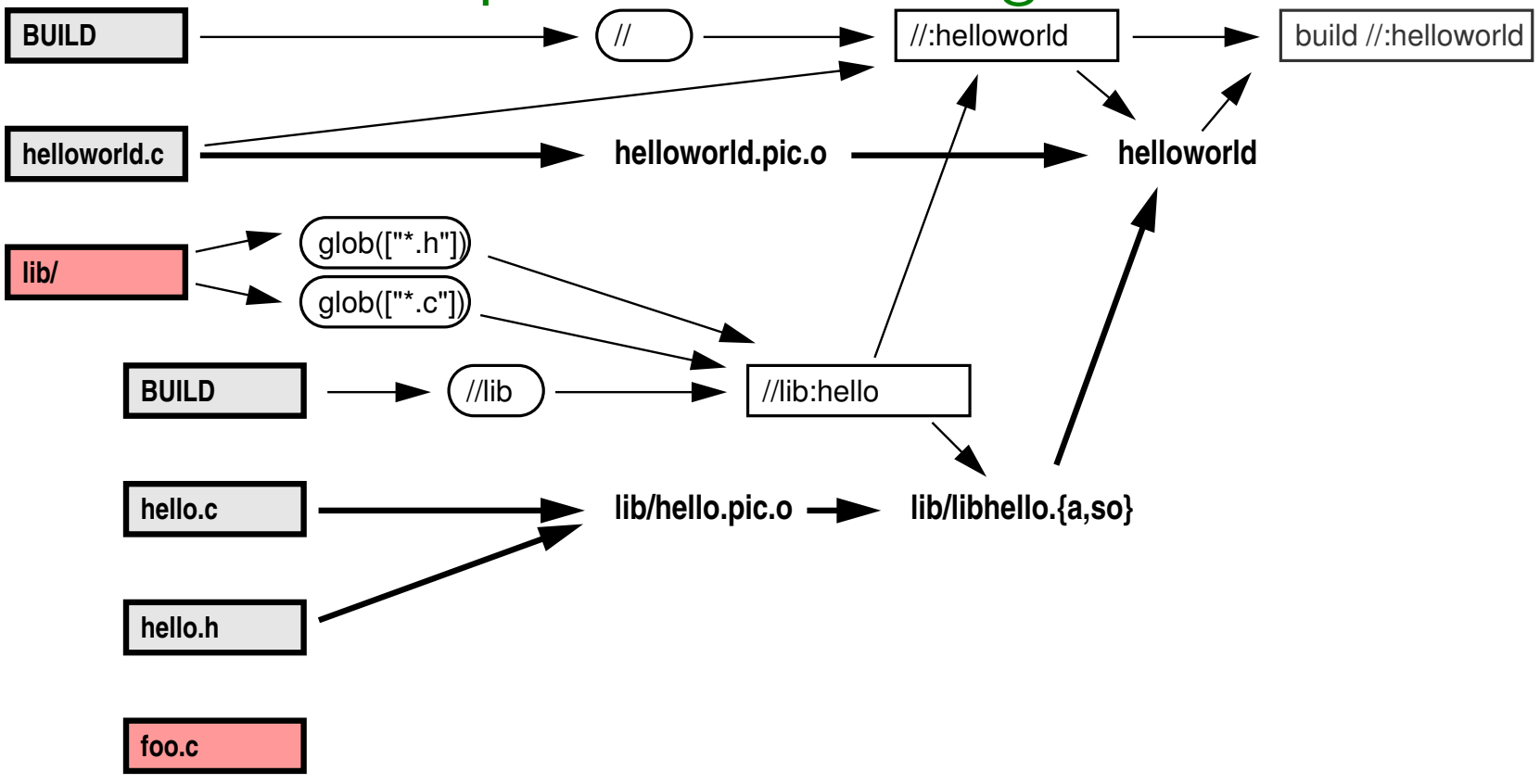

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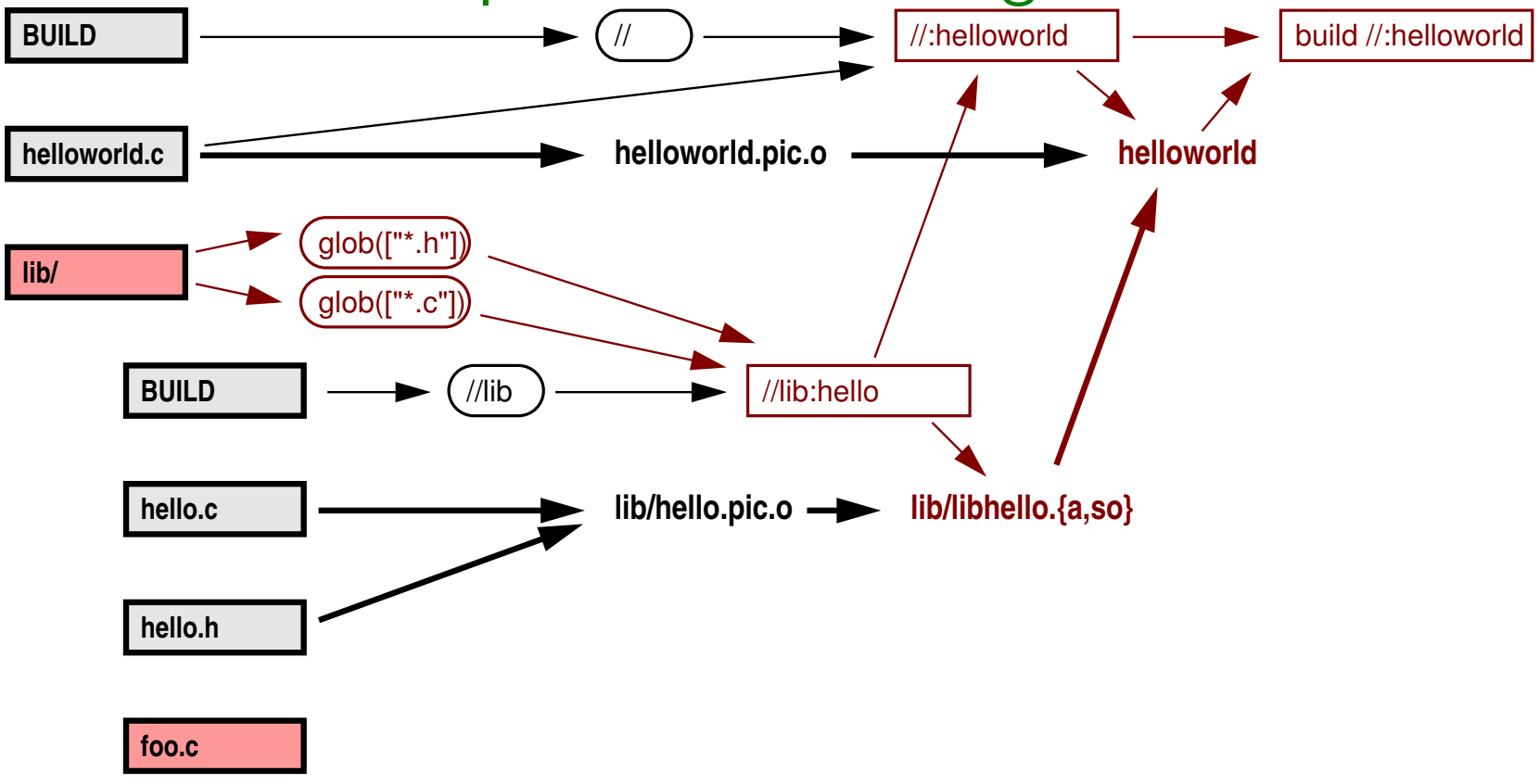

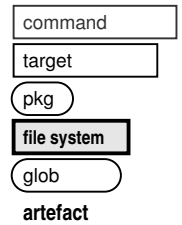

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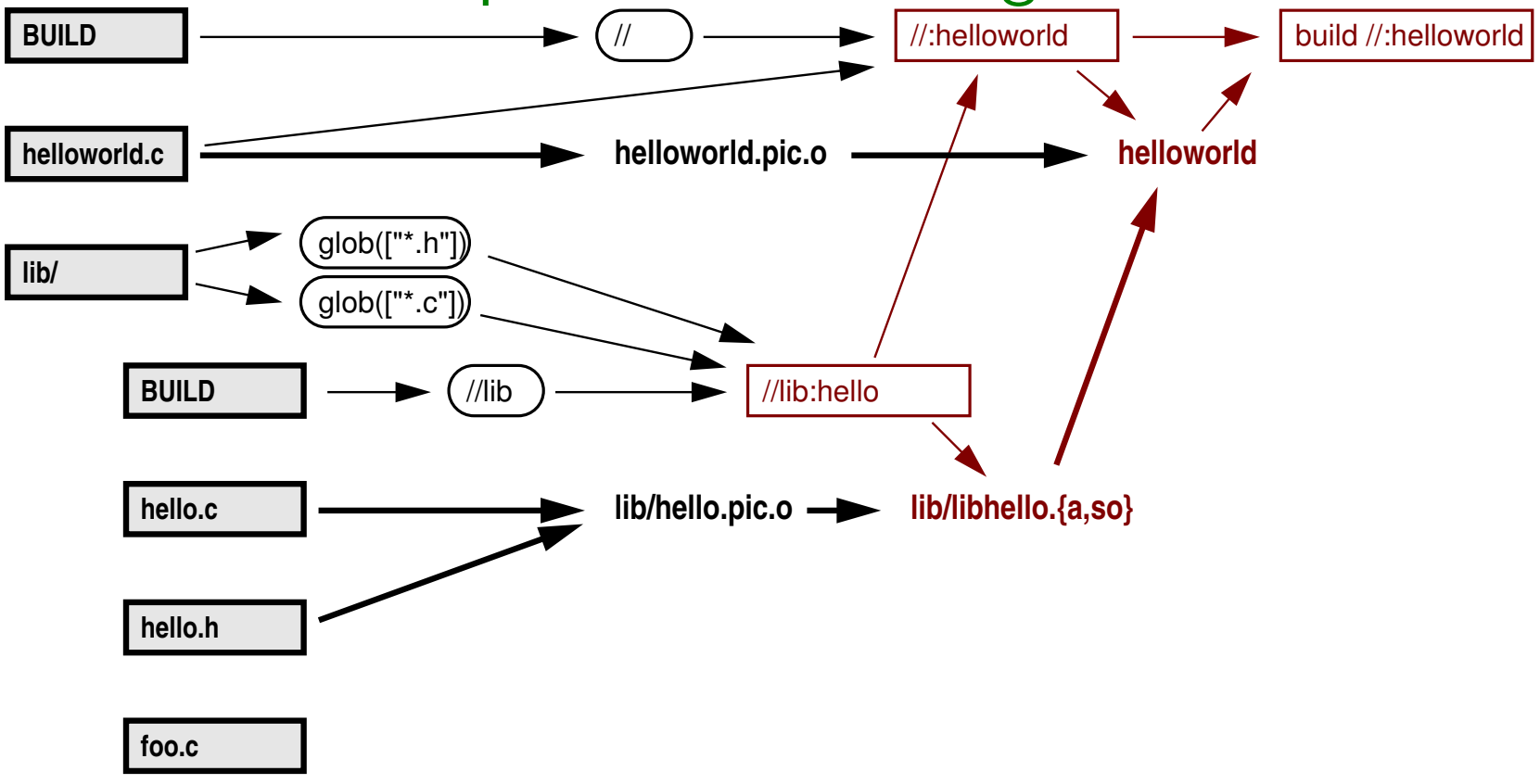

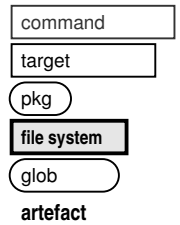

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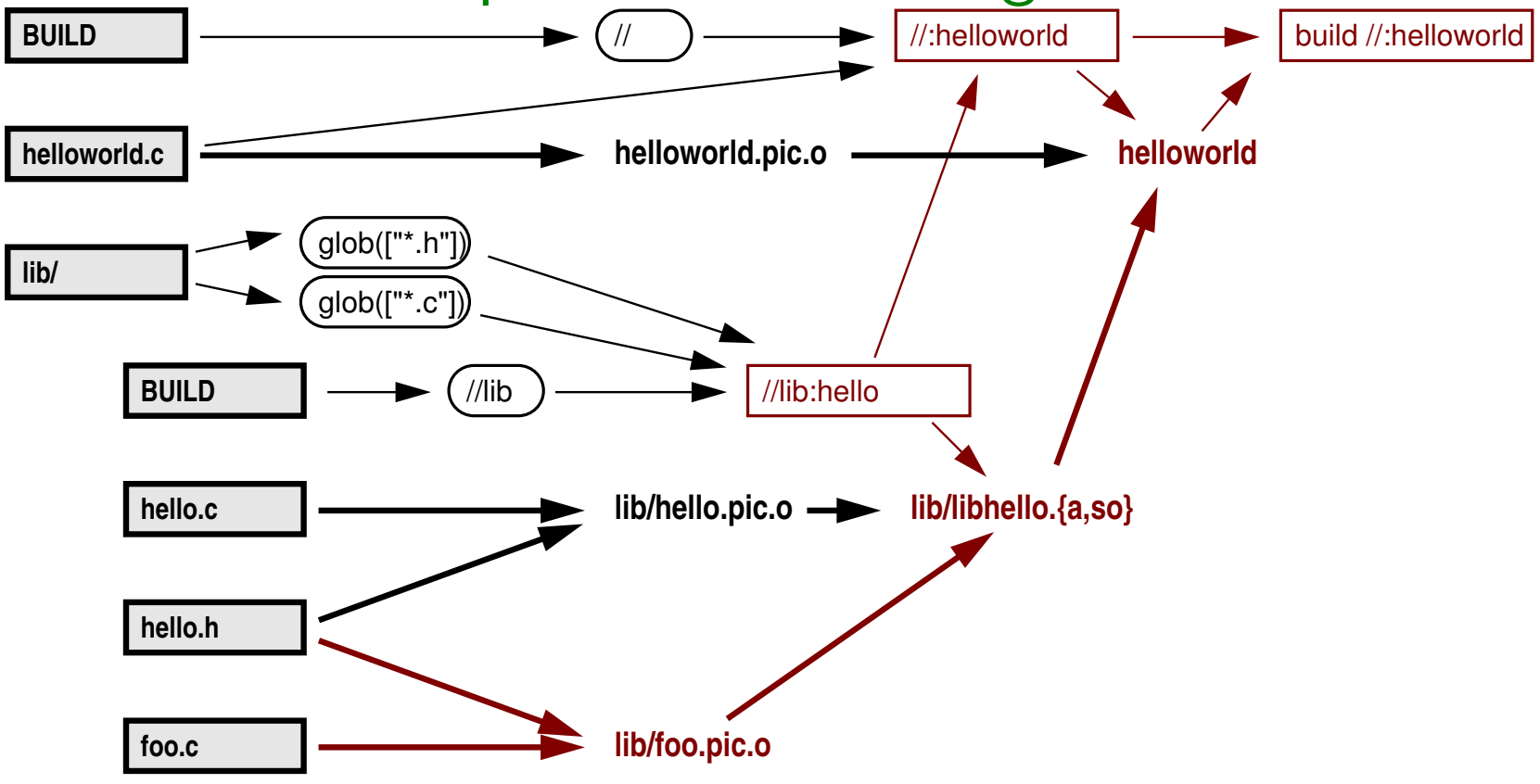

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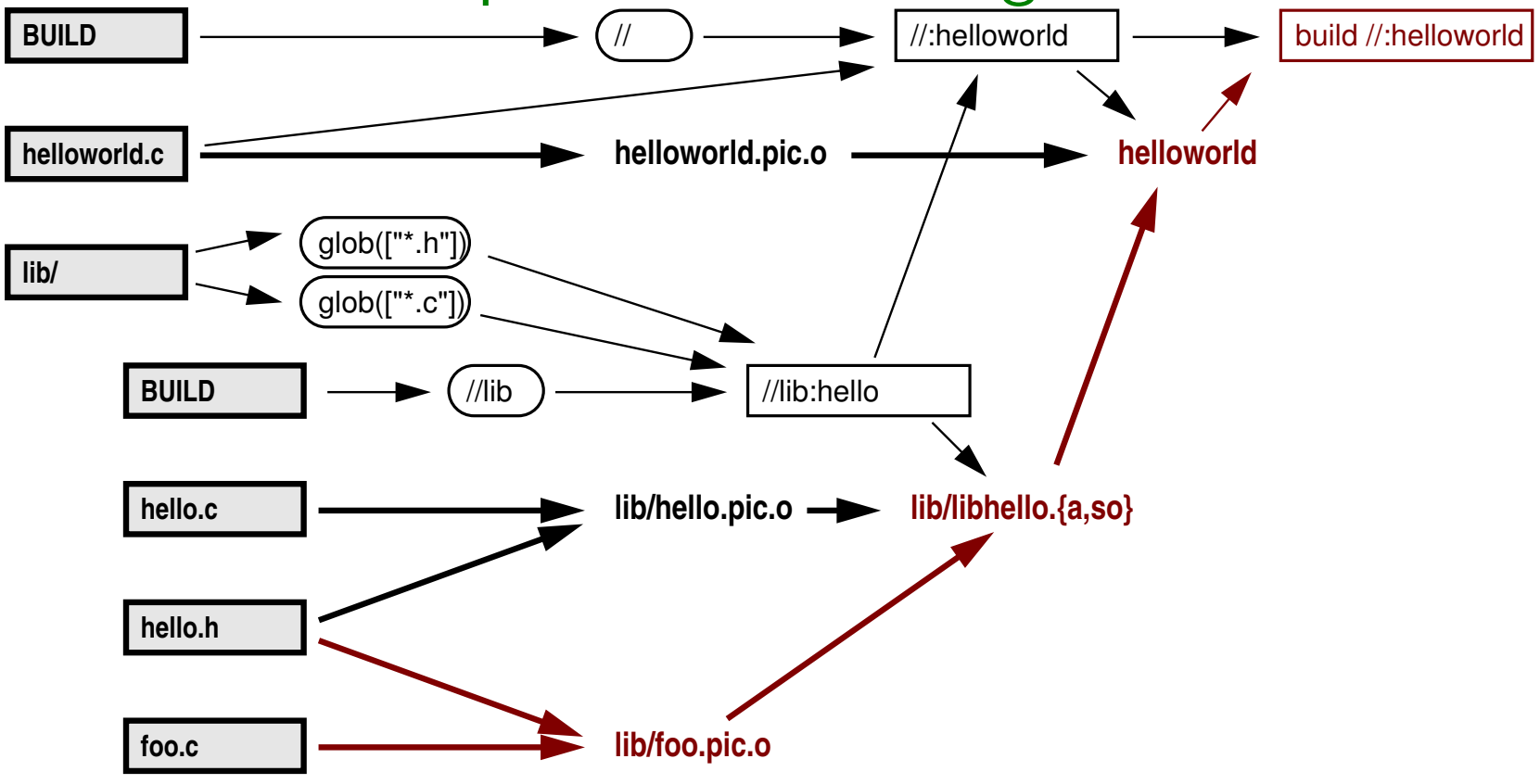

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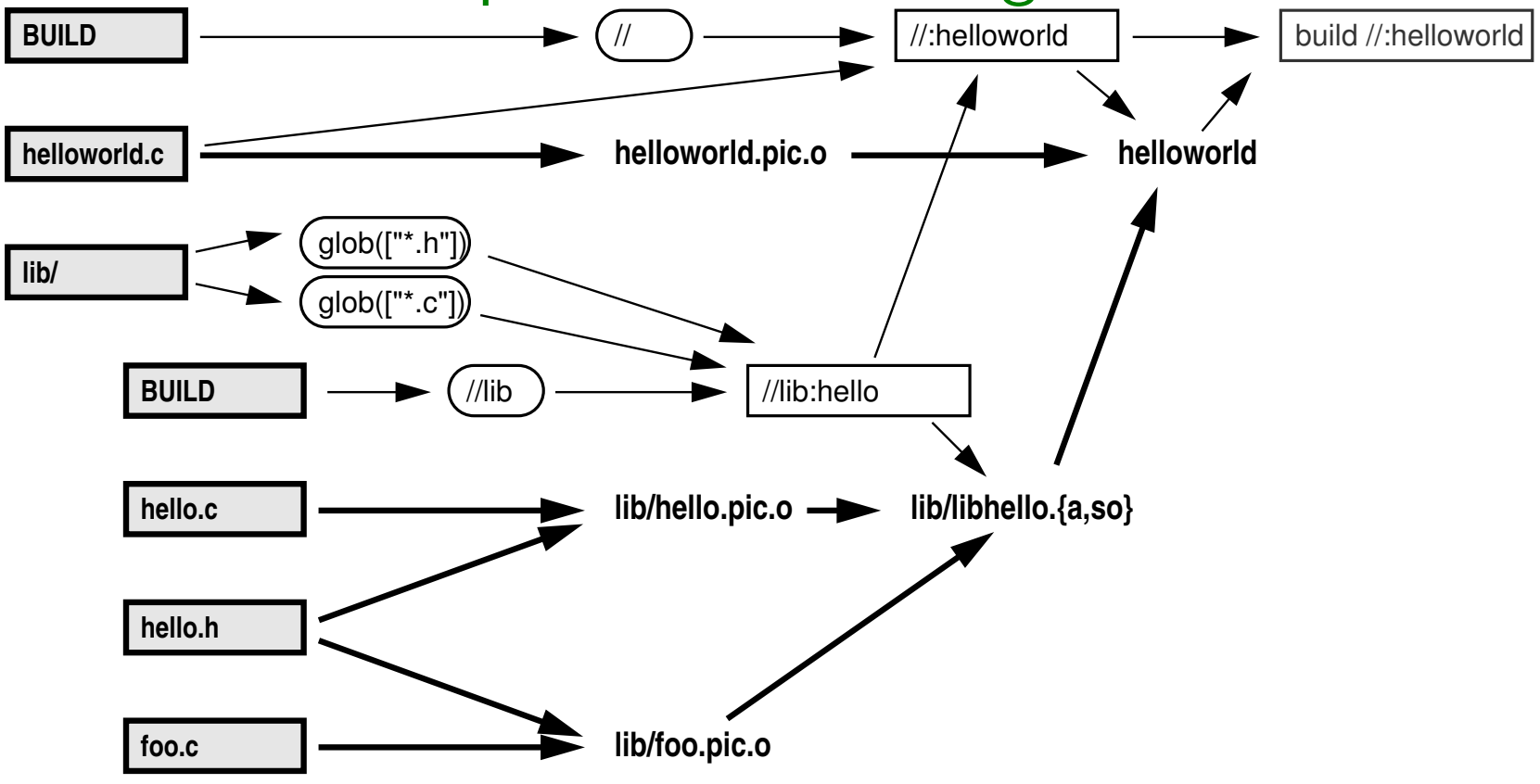

Actions

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  - so, no `.done_foo` targets,
  - and only reading *declared inputs*

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⇝ facilitate correct I/O by running actions in "sandboxes"
  - isolated environment
    - only declared inputs/tools present
    - only declared outputs copied out
  - depending on OS, different approaches (`chroot`, temp dir, . . .)

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- bonus: remote execution

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  - caching of input/output-relation itself

! requires all inputs/outputs to be known to `bazel`

⇝ facilitate correct I/O by running actions in "sandboxes"

- bonus: remote execution

  ⇒ enables shared caches.

  (All engineers working on the same code base!)

Extending Bazel

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    → just specify a shell command (with `$@`, `$<`, ...)
    (basically the only rule available in a `Makefile`*)*

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  without global state, complicated features, . . .

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  ⇝ deterministic, hermetic evaluation

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  "that `sh`*-script with these params; always create 5 targets . . ."*

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```
def mylang(name="", param="default", srcs=[]):
  script = str(Label("//rules/mylang:bld.sh"))
  native.genrule(
    name = name + "_out",
    tools = [script],
    cmd = "env ...  $(location " + script + ")"
          + "...  $@ $(SRCS)",
    ...)
  native....
```

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- simple case: can compose it from existing rules ⇝ macros
- all extensions are loaded in `BUILD` files
  `load("//....bzl", "mylang")`
- not so simple case: rules
  freely specify actions, argument declaration, ...

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  "We have those libs anyway, so let's just use them."

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  "I know all the uses of my interface, so I can easily change it."

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  "I know how my environment and how my compiler is called."

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    $\rightsquigarrow$ clear interfaces between bazel, and, e.g., Google’s use

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  Bazel more language agnostic tool

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  - ...

Summary

- declarative `BUILD` files
  . . . also supporting your own extensions
- *all* dependencies tracked $\rightsquigarrow$ correctness
  (sandboxes to ensure all I/O is known)
- full knowledge enables fast builds
  (caching of actions, remote execution, parallelism, . . .)
- open-source

Try Bazel

Try Bazel yourself.

- Homepage `https://bazel.build/`
- Mailing lists
  - `bazel-discuss@googlegroups.com`
  - `bazel-dev@googlegroups.com`
- Repository and issue tracker
  `https://github.com/bazelbuild/bazel`
- IRC `#bazel` on `irc.freenode.net`
- Release key fingerprint
  `71A1 D0EF CFEB 6281 FD04 37C9 3D59 19B4 4845 7EE0`

Thanks for your attention. Questions?