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Getting Started with Bazel

About the trainer

bmuschko

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Introduction to Bazel

Core Concepts, Project Structure and Lifecycle,
Using the Bazel Command Line

What is Bazel?

Open-source build automation tool

https://bazel.build/

- Evolved from Google-internal tool named Blaze
- Opinionated about code organization and modeling
- Main focus on monorepos, standardization, and fast execution speeds
- Depending on automation requirements, Bazel may be a good fit

Why Should I Use It?

Functional and non-functional features

- Declarative language
  - Build logic uses higher-level language called Starlark
  - Hides implementation complexities like compilation/linking
  - Runtime behavior can be fine-tuned

- Reproducibility
  - Sandboxed build execution by enforcing the definition of all of its dependencies
  - Includes execution environment

Why Should I Use It?

Functional and non-functional features

- Scalability
    - Focus is on projects with large codebases in monorepos
    - Fine-grained definition of modules (called *packages*)

- Parallel and distributed execution
    - Can execute its work in parallel (on a single machine)
    - Can execute its work in a distributed fashion (on multiple machines)

Why Should I Use It?

Functional and non-functional features

- Building polyglot projects
  - Support for different languages (e.g. Java, Go, Python, …)
  - Embraces modern toolchains and frameworks (Docker, Kubernetes, gRPC, ...)

- Extensibility
  - Fosters abstraction of build logic with *macros*
  - Reusability of build logic with *rules* for a wider audience

Runtime Installation Options

All major operating system are supported

- Installation instructions for Ubuntu Linux, MacOS, and Windows
- MacOSX distribution requires installation of XCode
- Windows distribution requires installation of Visual C++ Redistributable
- Container image available for Continuous Integration purposes

User-Friendly Launcher

Automatic installation of Bazel runtime

- Install the binary Bazelisk which is used for triggering the build
- The `.bazelversion` file defines the compatible Bazel version and is meant to be checked into version control
- Upon runtime, the tool downloads and installs the Bazel runtime and executes the build with it

Project Building Blocks

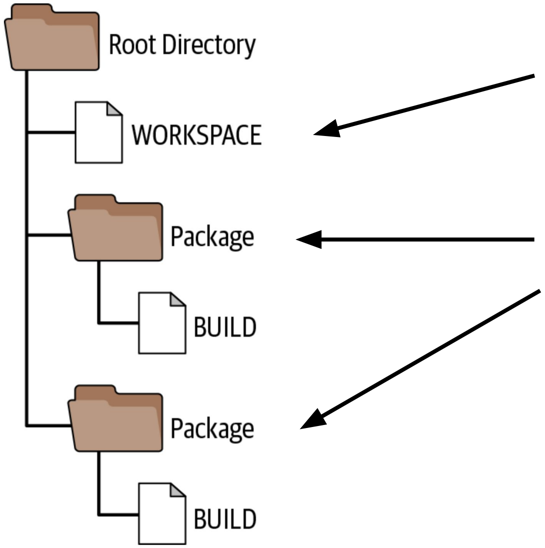
Two core concepts represented in every Bazel project

- **Workspace**
  - Represented by a `WORKSPACE` file in project root directory
  - Designates the directories containing source code
  - Defines external dependencies for specific language support

- **Package**
  - Represents a module containing software functionality that belongs together with specific visibility to other packages
  - Defined in a `BUILD` file located at the package directory-level

Project Structure

# of packages depends on functional code organization



Bazel enforces existence of a single workspace file

A Bazel package can be more fine-grained than a Java package

Build Logic Concepts

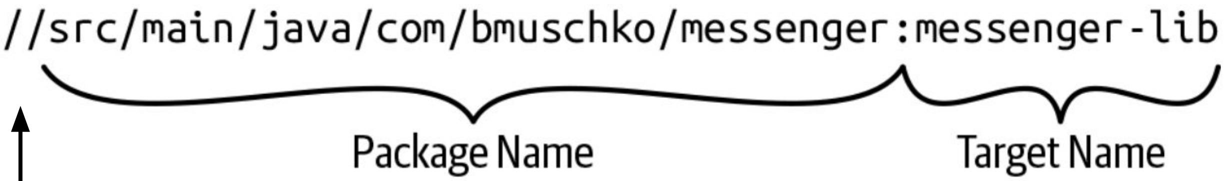
Important for applying reusable logic and executing it

- **Rule**
  - Defines executable logic, so-called actions
  - Usually requires definition of inputs and outputs
- **Target**
  - A package can contain a set of targets
  - Targets represent a file or a rule
  - Invoked from the command line

Executing a Target From the CLI

A label combines the package name and target name

```
$ bazel <command> <options> ...
```



```
//src/main/java/com/bmuschko/messenger:messenger-lib
```

// refers to root directory

Commonly-Used Commands

The daily bread and butter of developers

- `query`: Prints the dependency graph of a label.
- `build`: Builds the provided label. A target implements a “unit of work” like compiling source code, assembling artifacts etc.
- `test`: Executes the tests for a provided label. Builds the “code under test” and the test source code so it can be made available at test runtime.

Build Everything!

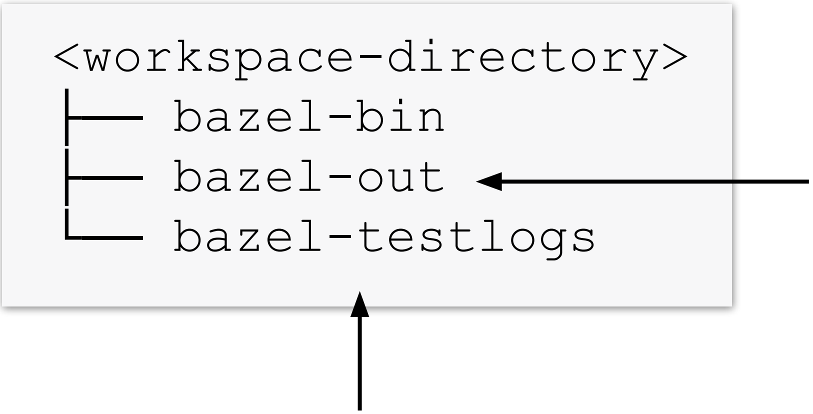
Compile/assemble/test for the whole project

- `bazel build //...`
- `bazel test //...`

Select all packages recursively
from the root directory

Output and Cache Directories

Not to be checked into version control!



```
<workspace-directory>
├── bazel-bin
├── bazel-out
└── bazel-testlogs
```

Built binary artifacts & artifacts retrieved from external locations

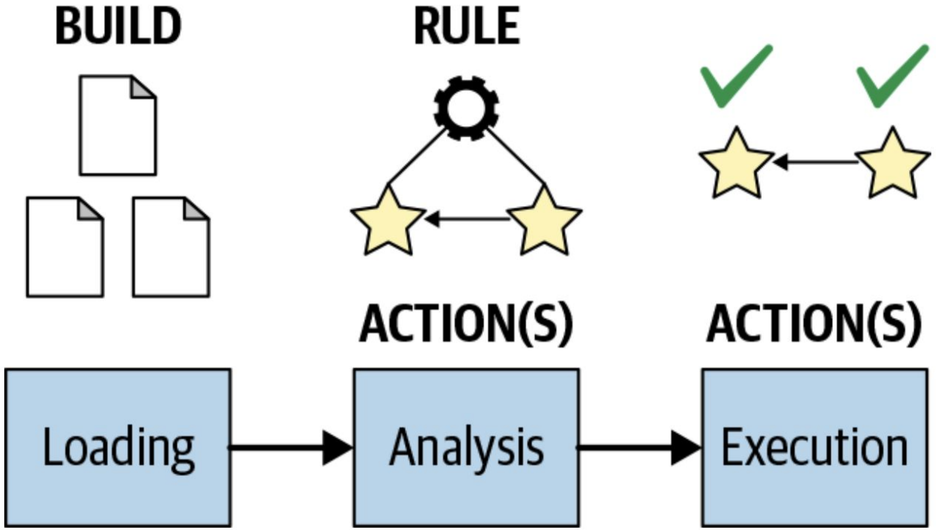
Test log files created by test runner

EXERCISE

“Hello World” in
Bazel

Lifecycle of a Bazel Build

Build executes as part of a three-part, phased process



Lifecycle Phases

Failure at any phase will stop build

- **Loading Phase:** Fast syntactic check of build logic.
- **Analysis phase:** Evaluation of build configuration and construction of the build execution graph.
- **Execution phase:** Runs the actions and distributes workload if configured.

Bazel Configuration File

Set common build configuration in a single location

- Stored in the file `.bazelrc` located in workspace directory and/or user home directory

- Bazel command + CLI option(s), grouping by using `--config`

```
build --show_timestamps
build:memcheck --strip=never --test_timeout=3600
```

Programming Language Rules

Common functionality + language-specific functionality

- **<language>_binary:** Builds an executable artifact.
- **<language>_library:** Builds an artifact containing reusable functionality.
- **<language>_test:** Executes tests for one or many packages.

Language-specific tutorials

Basic Automation for a Java Project

Exploring Java rules, Project Structure, Source Code Compilation, JAR assembly, IDE Support

Typical Java Rules

Common developer-focused rules for Java projects

- **java_binary:** Builds an executable JAR file.
- **java_library:** Builds a JAR file containing reusable functionality.
- **java_test:** Executes tests for one or many packages.

Reference of all Java rules

Simple Java Application Project

Single package project with a main class

```
.
├── BUILD
├── WORKSPACE
└── src
    └── main
        └── java
            └── com
                └── bmuschko
                    ├── HelloWorld.java
                    └── messenger
                        └── Messenger.java
```

Main class that prints a message to standard output

Instantiated by main class and method called from there

Modeling the Binary Package

Application is represented by a binary

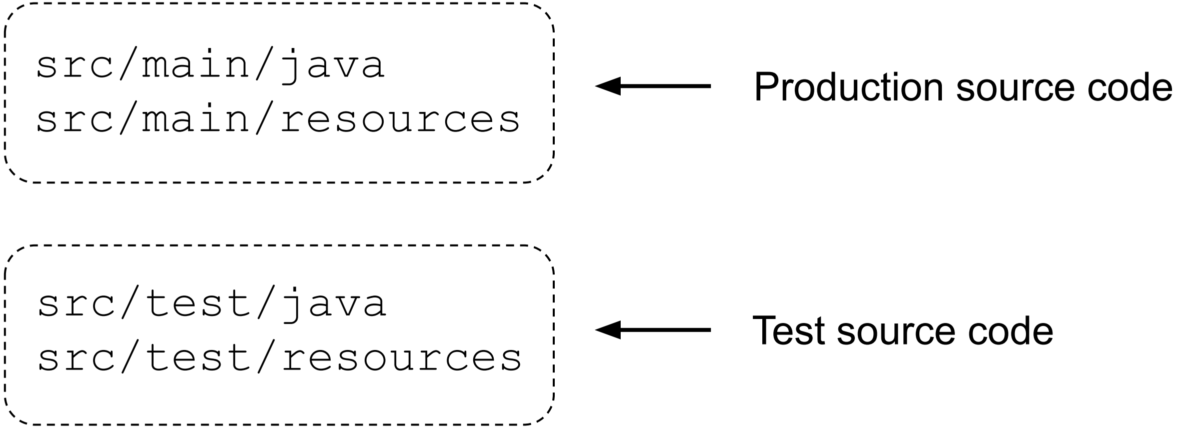
BUILD

```
java_binary(
    name = "hello-world",
    srcs = glob(["src/main/java/com/bmuschko/**/*.java"]),
    main_class = "com.bmuschko.HelloWorld",
)
```

Implemented by the java_binary rule

Standard Industry Conventions

*Does **not** prescribe standard directories like Maven/Gradle*



```
src/main/java
src/main/resources
```

Production source code

```
src/test/java
src/test/resources
```

Test source code

Modeling the Workspace

The application doesn’t define dependencies

WORKSPACE

```
<empty>
```

Java rules are built into Bazel runtime and therefore don’t need to be declared as dependency

Building hello-world Package

Package has been defined on the root-level of project

```
$ bazel build //:hello-world
...
INFO: Found 1 target...
Target //:hello-world up-to-date:
  bazel-bin/hello-world.jar
  bazel-bin/hello-world
INFO: Elapsed time: 23.491s, Critical Path: 4.23s
INFO: 3 processes: 2 darwin-sandbox, 1 worker.
INFO: Build completed successfully, 7 total actions
```

Produced artifact

The command `build` *builds* the specified target

Contents of Binary

Contains class files organized by package + manifest

```
$ jar tf bazel-bin/hello-world.jar
META-INF/
META-INF/MANIFEST.MF
com/
com/bmuschko/
com/bmuschko/HelloWorld.class
com/bmuschko/messenger/
com/bmuschko/messenger/Messenger.class
```

Running the Application

Builds the artifact if it hasn't been built yet

```
$ bazel run //:hello-world
...
INFO: Found 1 target...
Target //:hello-world up-to-date:
  bazel-bin/hello-world.jar
  bazel-bin/hello-world
INFO: Elapsed time: 0.092s, Critical Path: 0.00s
INFO: 1 process: 1 internal.
INFO: Build completed successfully, 1 total action
Hello World!
```

Standard output from main class

EXERCISE

Building an
Executable
Program in Java

Driving the Build from the IDE

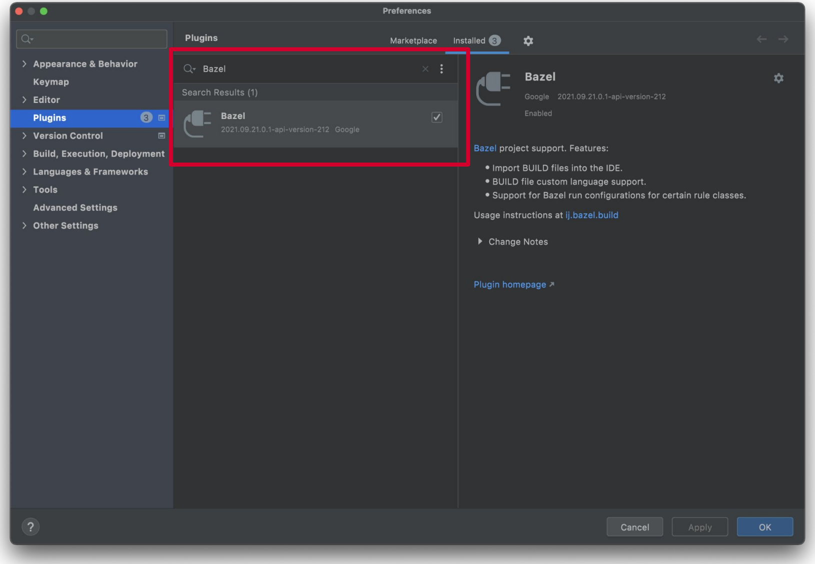
Auto-completion, syntax highlighting, running targets

IntelliJ plugin

VSCode plugin

Installing the IntelliJ Plugin

IntelliJ IDEA > Preferences... > Plugins



Bazel

Search Results (1)

Bazel ☑
2021.09.21.0.1-api-version-212 Google

Bazel
Google 2021.09.21.0.1-api-version-212
Enabled

Bazel project support. Features:

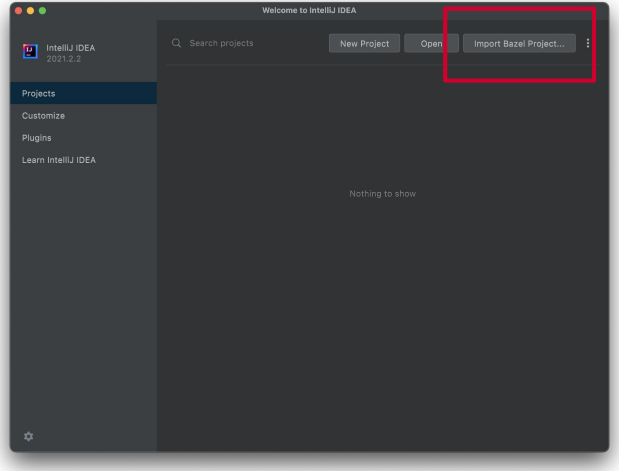
- Import BUILD files into the IDE.
- BUILD file custom language support.
- Support for Bazel run configurations for certain rule classes.

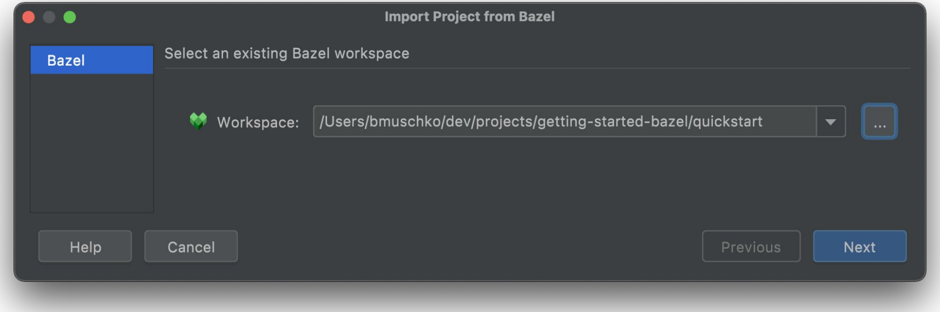
Usage instructions at ij.bazel.build

Search for “Bazel”
and install the plugin

Opening a Project

File > Open… > Import Bazel Project...



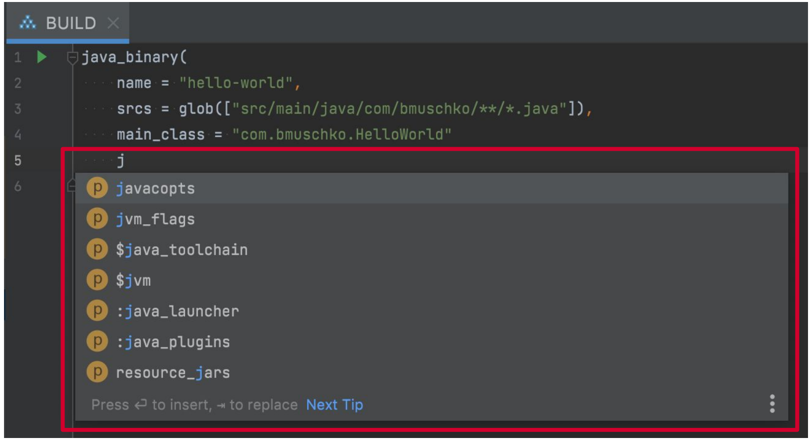


Select an existing Bazel workspace

Workspace: /Users/bmuschko/dev/projects/getting-started-bazel/quickstart

Auto-Completion in Bazel Files

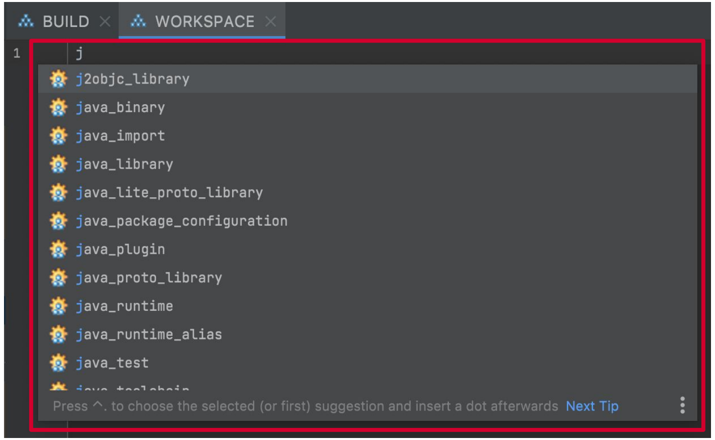
Within the Bazel file start typing



```
java_binary(
    name = "hello-world",
    srcs = glob(["src/main/java/com/bmuschko/**/*.java"]),
    main_class = "com.bmuschko.HelloWorld"
    j
```

- javacopts
- jvm_flags
- $java_toolchain
- $jvm
- :java_launcher
- :java_plugins
- resource_jars

Press ⏎ to insert, ⇥ to replace Next Tip



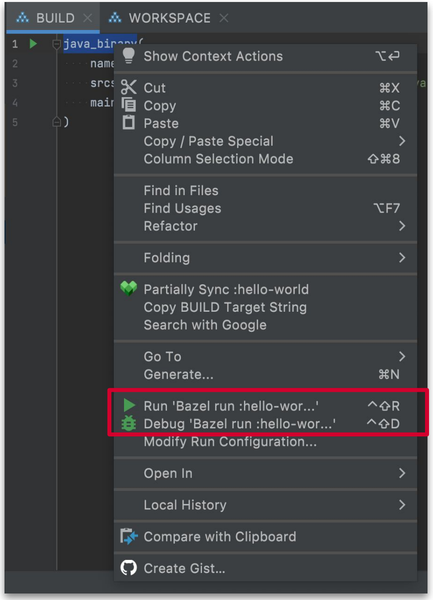
```
j
```

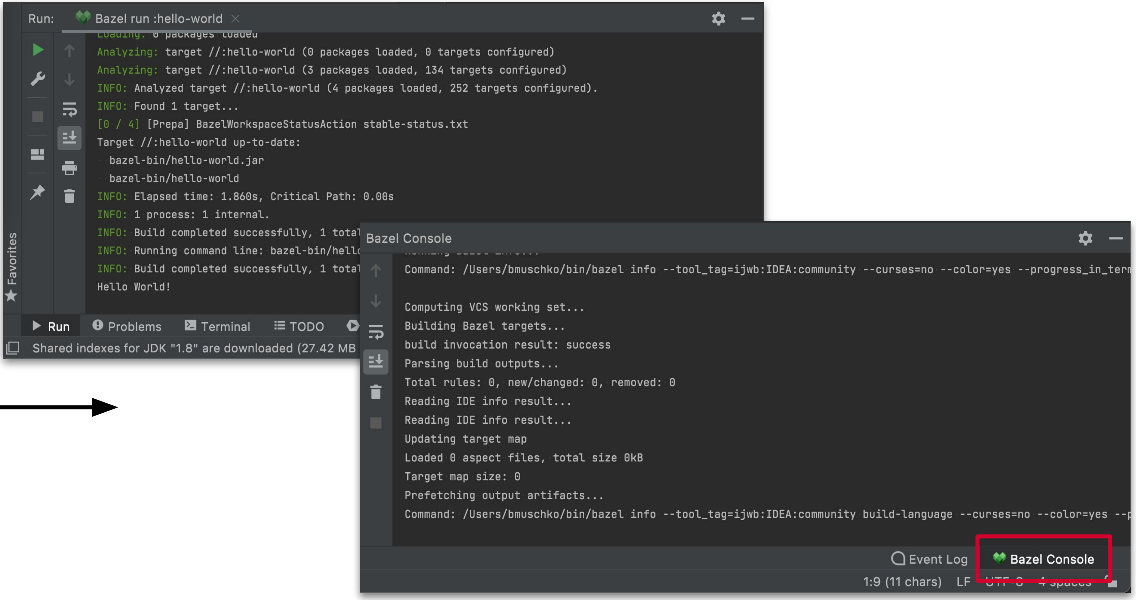
- j2objc_library
- java_binary
- java_import
- java_library
- java_lite_proto_library
- java_package_configuration
- java_plugin
- java_proto_library
- java_runtime
- java_runtime_alias
- java_test
- java_toolchain

Press ^. to choose the selected (or first) suggestion and insert a dot afterwards Next Tip

Executing Targets

Context menu on rule in BUILD file





```
Loading: 0 packages loaded
Analyzing: target //:hello-world (0 packages loaded, 0 targets configured)
Analyzing: target //:hello-world (3 packages loaded, 134 targets configured)
INFO: Analyzed target //:hello-world (4 packages loaded, 252 targets configured).
INFO: Found 1 target...
[0 / 4] [Prepa] BazelWorkspaceStatusAction stable-status.txt
Target //:hello-world up-to-date:
  bazel-bin/hello-world.jar
  bazel-bin/hello-world
INFO: Elapsed time: 1.860s, Critical Path: 0.00s
INFO: 1 process: 1 internal.
INFO: Build completed successfully, 1 total
INFO: Running command line: bazel-bin/hello
INFO: Build completed successfully, 1 total
Hello World!
```

```
Command: /Users/bmuschko/bin/bazel info --tool_tag=ijwb:IDEA:community --curses=no --color=yes --progress_in_term

Computing VCS working set...
Building Bazel targets...
build invocation result: success
Parsing build outputs...
Total rules: 0, new/changed: 0, removed: 0
Reading IDE info result...
Reading IDE info result...
Updating target map
Loaded 0 aspect files, total size 0kB
Target map size: 0
Prefetching output artifacts...
Command: /Users/bmuschko/bin/bazel info --tool_tag=ijwb:IDEA:community build-language --curses=no --color=yes --p
```

EXERCISE

Installing and Using
Bazel IDE Support

Q & A

5 mins

BREAK

5 mins

Dependency Management and Automated Testing

Definition and Resolution of Dependencies, Writing and Executing Tests

Types of Dependencies

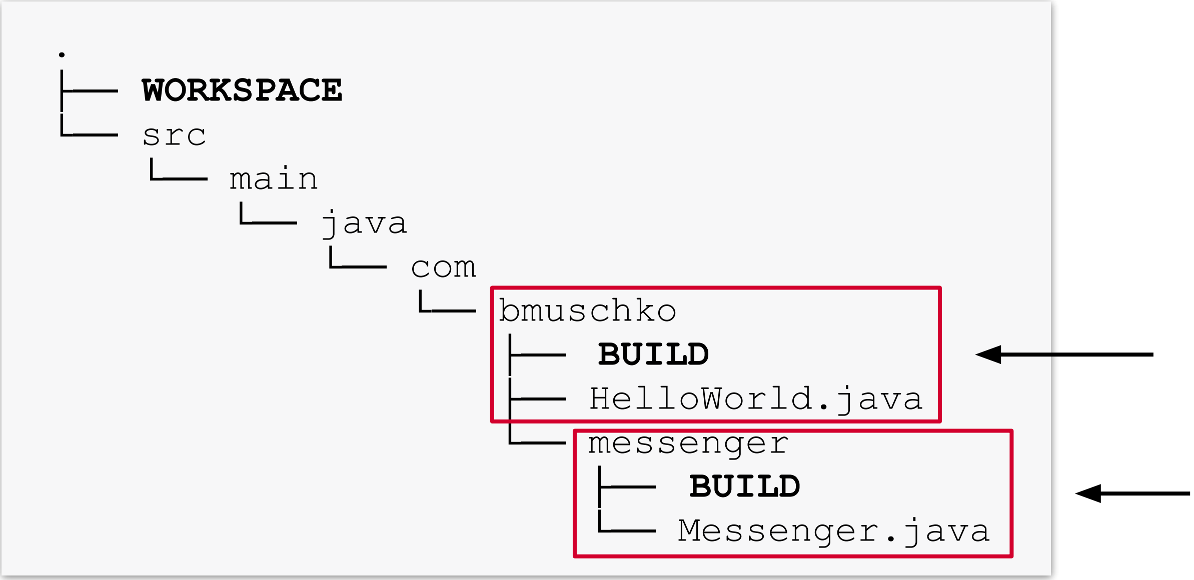
Two different use cases that can be combined

- **Package Dependencies:** One package depends on the produced output of another package e.g. the class files. Allows for more fine-grained definition of traditional functional modules.

- **External Dependencies:** Source code that lives in a package needs the API and/or implementation of an external library in the form of a Git repository, an archive accessible via HTTP or file in the local file system.

Multi-Package Project

Allows for fine-grained definition with dependencies



```
.
├── WORKSPACE
└── src
    └── main
        └── java
            └── com
                └── bmuschko
                    ├── BUILD
                    ├── HelloWorld.java
                    └── messenger
                        ├── BUILD
                        └── Messenger.java
```

Package A containing the main class

Package B containing classes used by package 1

Modeling the Library Package

Library that bundles class files represented as JAR file

BUILD

```
java_library(
     name = "messenger-lib",
     srcs = ["Messenger.java"]
)
```

Implemented by the java_library rule

Package Dependencies

Compile-time dependency on the messenger-lib target

BUILD

```
java_binary(
    name = "hello-world",
    srcs = ["HelloWorld.java"],
    main_class = "com.bmuschko.HelloWorld",
    deps = ["//src/main/java/com/bmuschko/messenger:messenger-lib"],
)
```

Failing to Resolve Dependency

By default, packages are isolated

```
$ bazel build //src/main/java/com/bmuschko:hello-world
...
ERROR: .../src/main/java/com/bmuschko/BUILD:1:12: in java_binary rule
//src/main/java/com/bmuschko:hello-world: target
'//src/main/java/com/bmuschko/messenger:messenger-lib' is not visible
from target '//src/main/java/com/bmuschko:hello-world'. Check the
visibility declaration of the former target if you think the dependency
is legitimate
ERROR: Analysis of target '//src/main/java/com/bmuschko:hello-world'
failed; build aborted: Analysis of target
'//src/main/java/com/bmuschko:hello-world' failed
```

Visibility of Targets

Targets of package cannot be used by other packages

BUILD

```
java_library(
    name = "messenger-lib",
    srcs = ["Messenger.java"],
    visibility = ["//src/main/java/com/bmuschko:__pkg__"]
)
```

Make “all rules in the package” available to assigned package

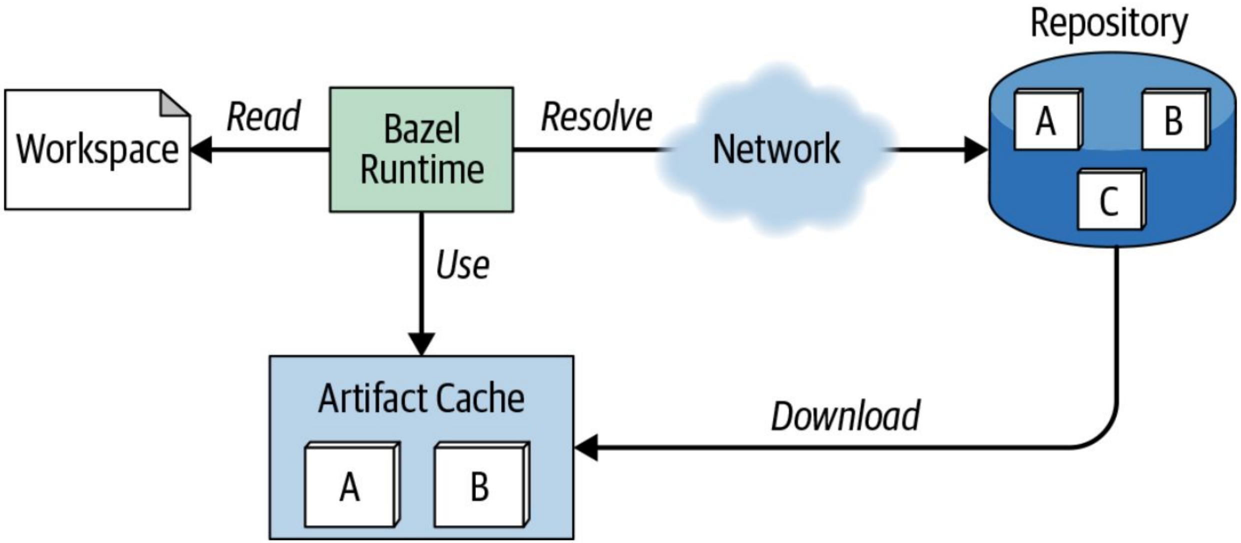
Building the Dependent Targets

Resolves declared dependencies and uses them

```
$ bazel build //src/main/java/com/bmuschko:hello-world
...
INFO: Found 1 target...
Target //src/main/java/com/bmuschko:hello-world
up-to-date:
  bazel-bin/src/main/java/com/bmuschko/hello-world.jar
  bazel-bin/src/main/java/com/bmuschko/hello-world
INFO: Elapsed time: 19.924s, Critical Path: 4.55s
INFO: 9 processes: 4 internal, 3 darwin-sandbox, 2 worker.
INFO: Build completed successfully, 9 total actions
```

External Library Dependencies

Artifacts live in repository and are downloaded to cache



Rules for JVM Dependencies

Functionality exists as rules on a GitHub repository

- Download rules archive with a specific tag and commit hash via HTTP. Load rules for usage.

- Define repositories used to resolve dependencies.

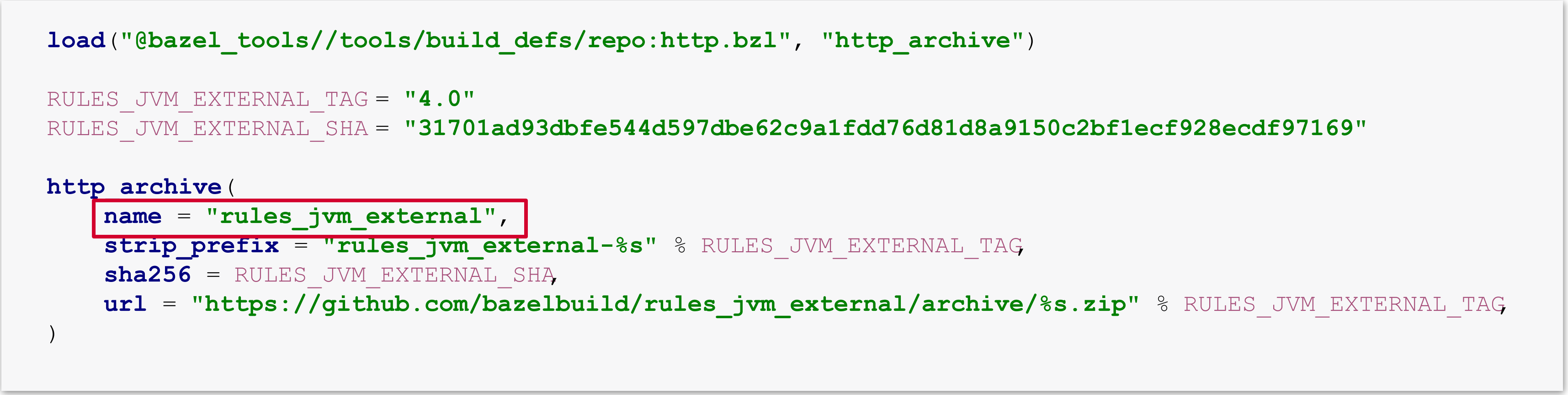
- Define dependencies with group, artifact ID, and version (GAV).

Implemented by rules_jvm_external

Declaring JVM Rules External

Load rules for consumption as HTTP archive

WORKSPACE



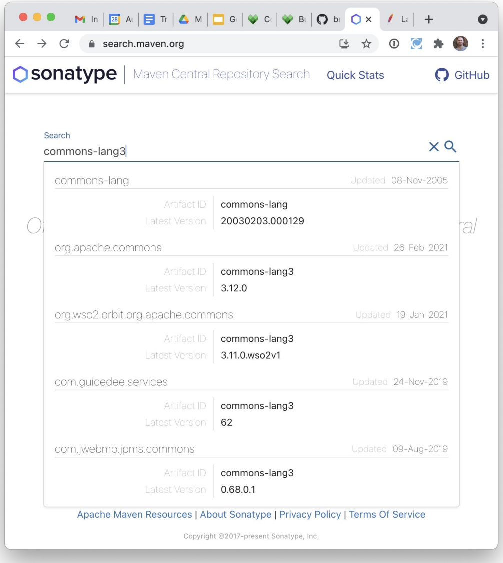
```
load("@bazel_tools//tools/build_defs/repo:http.bzl", "http_archive")

RULES_JVM_EXTERNAL_TAG = "4.0"
RULES_JVM_EXTERNAL_SHA = "31701ad93dbfe544d597dbe62c9a1fdd76d81d8a9150c2bf1ecf928ecdf97169"

http_archive(
    name = "rules_jvm_external",
    strip_prefix = "rules_jvm_external-%s" % RULES_JVM_EXTERNAL_TAG,
    sha256 = RULES_JVM_EXTERNAL_SHA,
    url = "https://github.com/bazelbuild/rules_jvm_external/archive/%s.zip" % RULES_JVM_EXTERNAL_TAG,
)
```

Example JVM Dependency

Apache Commons Lang 3 - find via search.maven.org



search.maven.org

sonatype | Maven Central Repository Search   Quick Stats   GitHub

Search
commons-lang3

commons-lang   Updated 08-Nov-2005
Artifact ID commons-lang
Latest Version 20030203.000129

org.apache.commons   Updated 26-Feb-2021
Artifact ID commons-lang3
Latest Version 3.12.0

org.wso2.orbit.org.apache.commons   Updated 19-Jan-2021
Artifact ID commons-lang3
Latest Version 3.11.0.wso2v1

com.guicedee.services   Updated 24-Nov-2019
Artifact ID commons-lang3
Latest Version 62

com.jwebmp.jpms.commons   Updated 09-Aug-2019
Artifact ID commons-lang3
Latest Version 0.68.0.1

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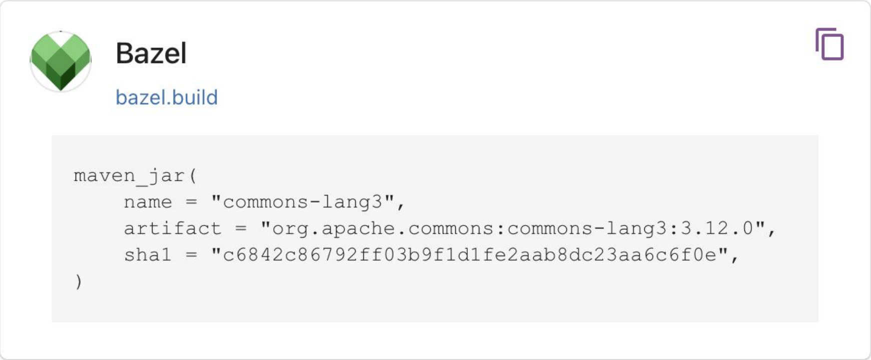


Bazel

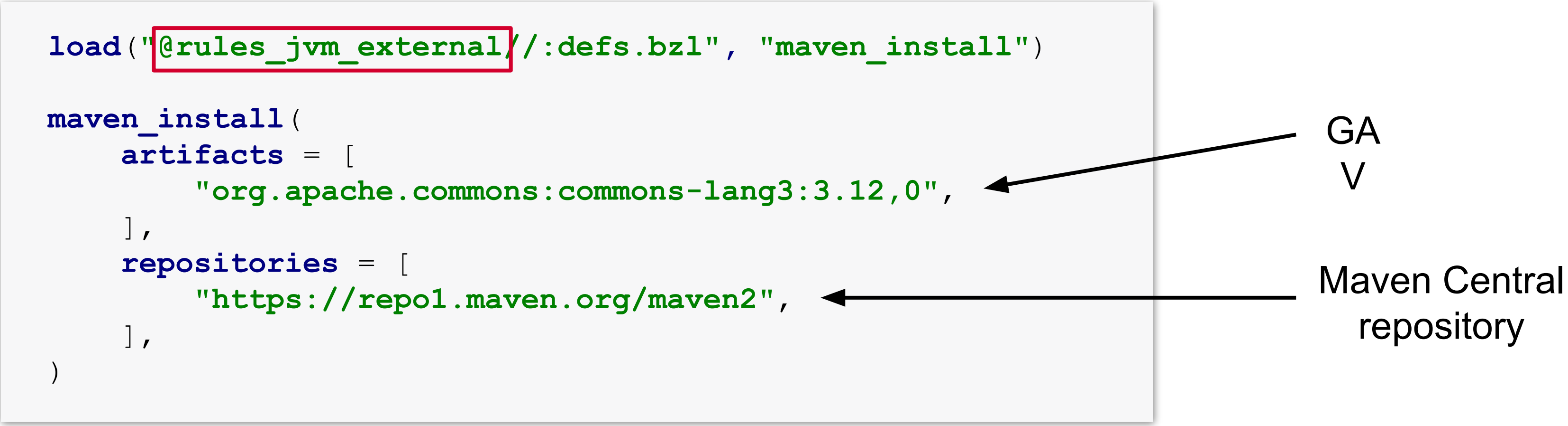
bazel.build

```
maven_jar(
    name = "commons-lang3",
    artifact = "org.apache.commons:commons-lang3:3.12.0",
    sha1 = "c6842c86792ff03b9f1d1fe2aab8dc23aa6c6f0e",
)
```

Definition of Dependency

Explicit declaration of GAVs and repositories

WORKSPACE



```
load("@rules_jvm_external//:defs.bzl", "maven_install")

maven_install(
    artifacts = [
        "org.apache.commons:commons-lang3:3.12,0",
    ],
    repositories = [
        "https://repo1.maven.org/maven2",
    ],
)
```

GA
V

Maven Central
repository

Consuming a Maven Dependency

Dependencies can be scoped for compile or runtime

BUILD

```
java_library(
     name = "messenger-lib",
     srcs = ["Messenger.java"],
     visibility = ["//src/main/java/com/bmuschko:__pkg__"],
     deps = [
          "@maven//:org_apache_commons_commons_lang3"
     ]
)
```

Only the group and artifact IDs are required

Substitute non-alphanumeric characters with underscores

Import of External Library Class

Made available on the compilation classpath

Messenger.java

```java
package com.bmuschko.messenger;

import org.apache.commons.lang3.StringUtils;

public class Messenger {
    public String getMessage() {
        return StringUtils.upperCase("Hello World!");
    }
}
```

Import of class

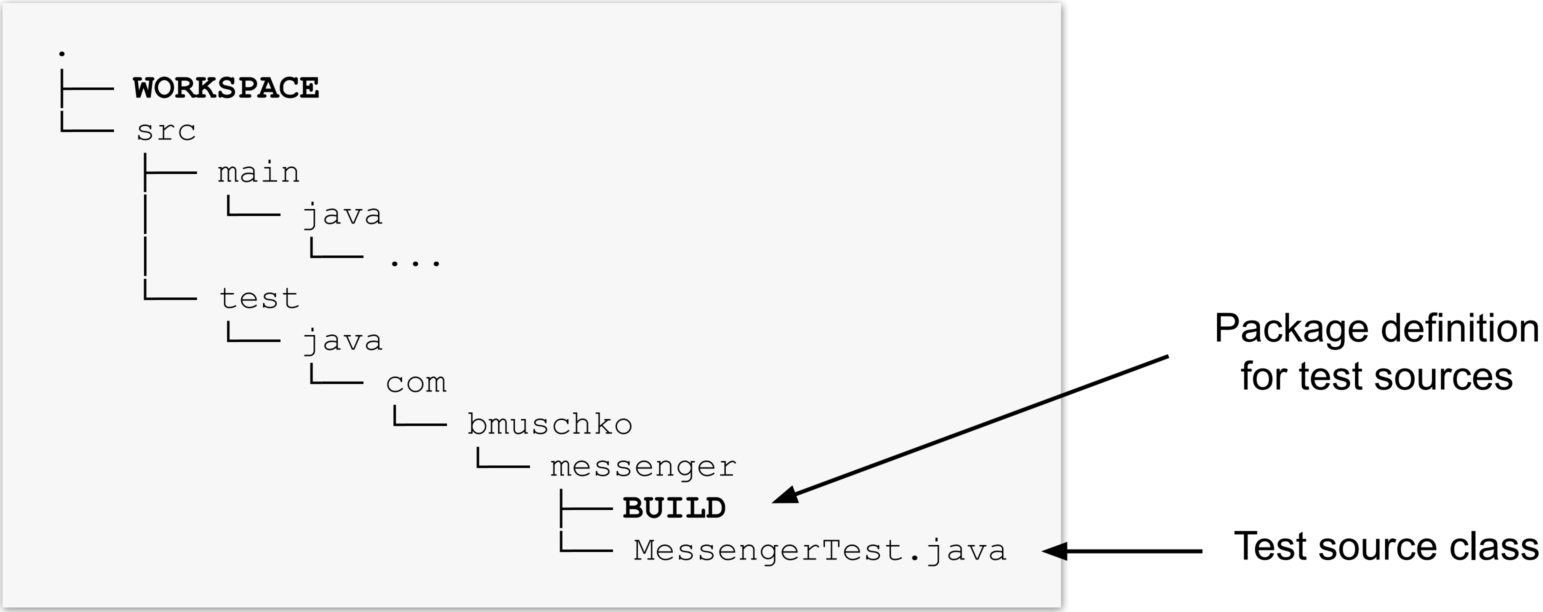
Usage of class

EXERCISE

Declaring a Dependency on a Package and an External Library

Separating Test Source Code

Distinguish different types of tests



```
.
├── WORKSPACE
└── src
    ├── main
    │   └── java
    │       └── ...
    └── test
        └── java
            └── com
                └── bmuschko
                    └── messenger
                        ├── BUILD
                        └── MessengerTest.java
```

Package definition for test sources

Test source class

Declaring Test Dependencies

Needs “code under test” and test framework libraries

BUILD

```
java_test(
    name = "messenger-test",
    srcs = ["MessengerTest.java"],
    test_class = "com.bmuschko.messenger.MessengerTest",
    deps = [
        "//src/main/java/com/bmuschko/messenger:messenger-lib",
        "@maven//:junit_junit"
    ]
)
```

Implemented by java_test rule

Executing Tests

Renders executed tests and their outcome on console

```
$ bazel test //src/test/java/com/bmuschko/messenger:messenger-test
...
INFO: Found 1 test target...
Target //src/test/java/com/bmuschko/messenger:messenger-test up-to-date:
  bazel-bin/src/test/java/com/bmuschko/messenger/messenger-test.jar
  bazel-bin/src/test/java/com/bmuschko/messenger/messenger-test
...
//src/test/java/com/bmuschko/messenger:messenger-test        PASSED in 0.5s

Executed 1 out of 1 test: 1 test passes.
```

Test Reporting

Java rules do not produce a human-readable report

```
bazel-testlogs
└── src
    └── test
        └── java
            └── com
                └── bmuschko
                    └── messenger
                        └── messenger-test
                            ├── ...
                            ├── test.log
                            └── test.xml
```

XML test results can be used for further processing

EXERCISE

Declaring the JUnit Dependency and Executing Tests

Publishing a Java Library

Sharing JAR for consumption from a binary repository

BUILD

```
load("@rules_jvm_external//:defs.bzl", "java_export")

java_export(
    name = "messenger-exported-lib",
    maven_coordinates = "com.bmuschko:messenger:1.0.0",
    pom_template = "pom.tmpl",
    srcs = glob(["*.java"]),
    deps = [
        "@maven//:org_apache_commons_commons_lang3"
    ]
)
```

GAV for library in Maven repository

POM information is not derived automatically

Q & A

5 mins

Outlook on Advanced Topics

An Introduction to In-Depth Features and Scenarios

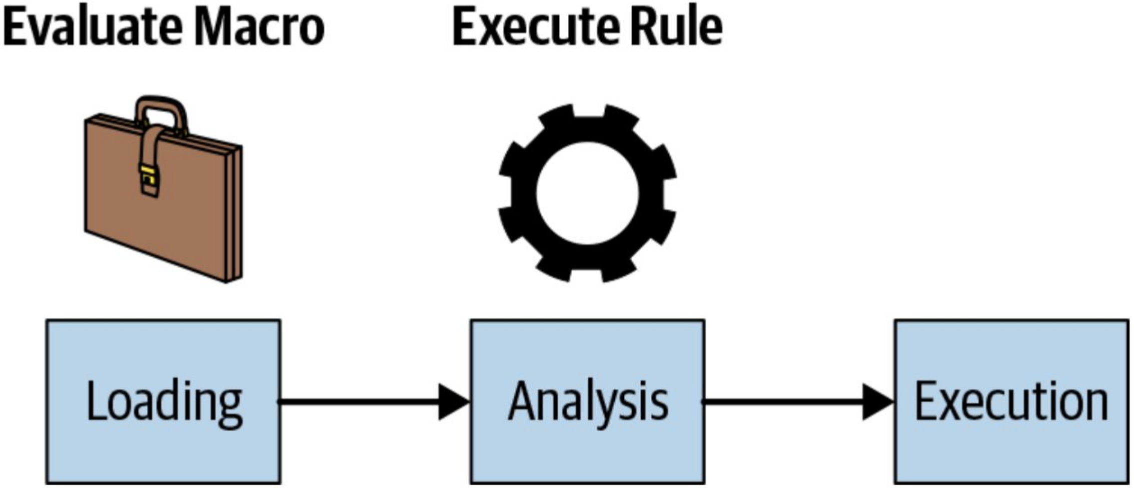
Extension Mechanisms

You can enhance the built-in Bazel capabilities

- **Rule:** Full control over Bazel’s internals, can configure other rules, and introduces elaborate features that are complex in nature.
- **Macros:** A way to better organize build logic within the same project e.g. call a rule with parameters you want to set by default.

When Are They Executed?

Invoked during a specific phase of the Bazel lifecycle



Evaluate Macro

Execute Rule

Loading

Analysis

Execution

Starlark Build Language

Implementing build scripts and extensions

- Dialect of Python 3 with restrictions e.g. access to filesystem.
- Achieve optimal build execution performance by supporting parallel and remote execution and to allow multithreaded processing of build logic.

More information on Starlark

Writing and Using a Macro

Lives in a file with a .bzl extension

```
.
├── WORKSPACE
├── macros
│   ├── BUILD
│   └── mymacro.bzl
└── src
    └── ...
```

BUILD

```
load("//macros:mymacro.bzl", "mymacro")

mymacro(
        ...
)
```

Call macro and configure it

Load macro

Macro Example

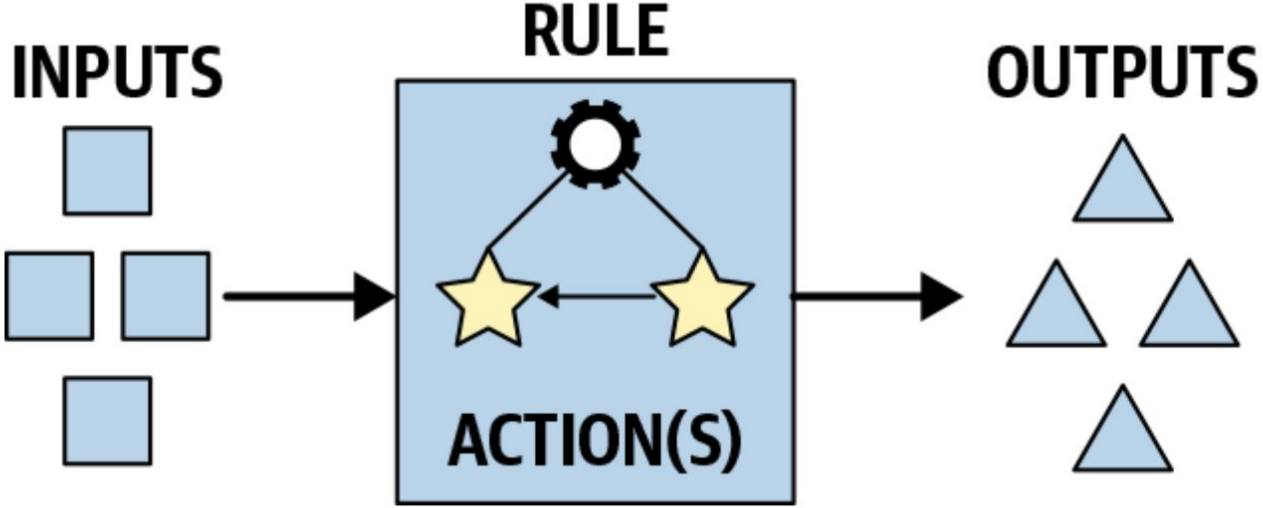
Configuring JUnit 5 to run tests

- Pre-configures the rule java_test
  - Defines JUnit Jupiter dependencies
  - Sets the main class for launching test execution
  - Declares default arguments

- Exposes end-user configuration options
  - Allows for providing additional compile-time and runtime-dependencies
  - Option for selecting specific test packages

Key Mechanics of a Rule

Inputs processed by actions that produce outputs

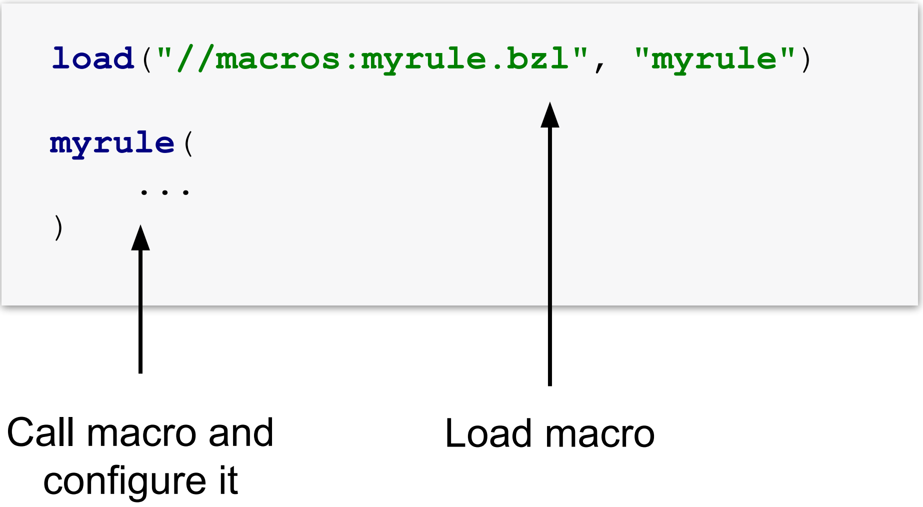


Writing and Using a Rule

Same organizational structure and usage as macro

```
.
├── WORKSPACE
├── rules
│   ├── BUILD
│   └── myrule.bzl
└── src
    └── ...
```

BUILD



```
load("//macros:myrule.bzl", "myrule")

myrule(
      ...
)
```

Call macro and configure it

Load macro

Rule Example

The rule java_library to create a Java library archive

- **Inputs:** The Java source files, dependencies, and compiler options

- **Actions:** Compiling the source code and packaging the class files into JAR file(s)

- **Outputs:** The Java archive containing the class files and a Java archive containing the source code

Remote Caching and Execution

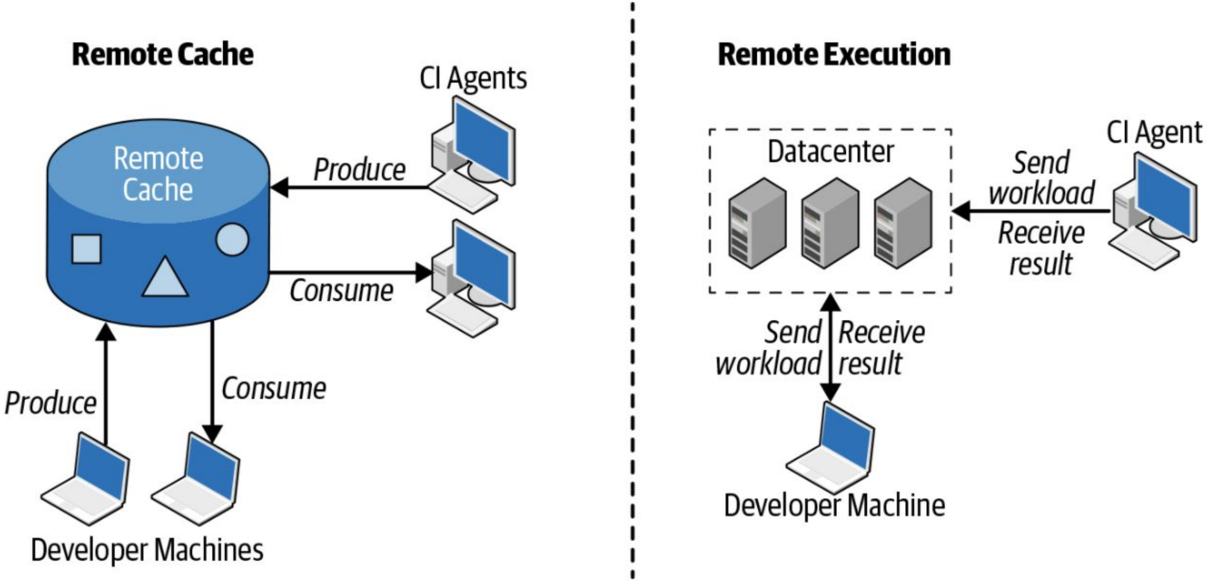
Faster build execution and feedback

- **Remote Caching:** Sharing and reusing build results across multiple, physically separated machines (e.g., developer machines and CI infrastructure)

- **Remote Execution:** Offloading build execution to high-performance computing nodes in a datacenter and using those results on the originating build machine

10,000 Foot View

Both concepts can and should be used together



Remote Caching

Share build outputs across multiple machines

- Based on the concept of a rule, hashes of input and outputs
- Reuses local cache result if existing or reaches out to remote server
- Uploads result if remote cache misses entry
- Remote cache can be used by developer machines or CI agents

Technical Implementation

Two step approach

- Stand up server that acts as the cache's backend
- Server options: nginx, bazel-remote, Google Cloud Storage
- Configure the Bazel build to use the remote cache via `--remote_cache` CLI option

Setup instructions for each solution

Remote Execution

Distribute build and test actions across multiple machines

- Motivation: developer machine doesn’t have to extremely powerful
- Faster builds by farming out build execution to remote machines
- Uses gRPC protocol for communication
- Free and commercial implementations

Continuous Integration (CI)

Trigger an automated build for every commit

- Integrates changes into master/main branch
- Fast feedback by executing the build
- Use the same build tool as on a developer machine
- Standardizes on Bazel runtime version used

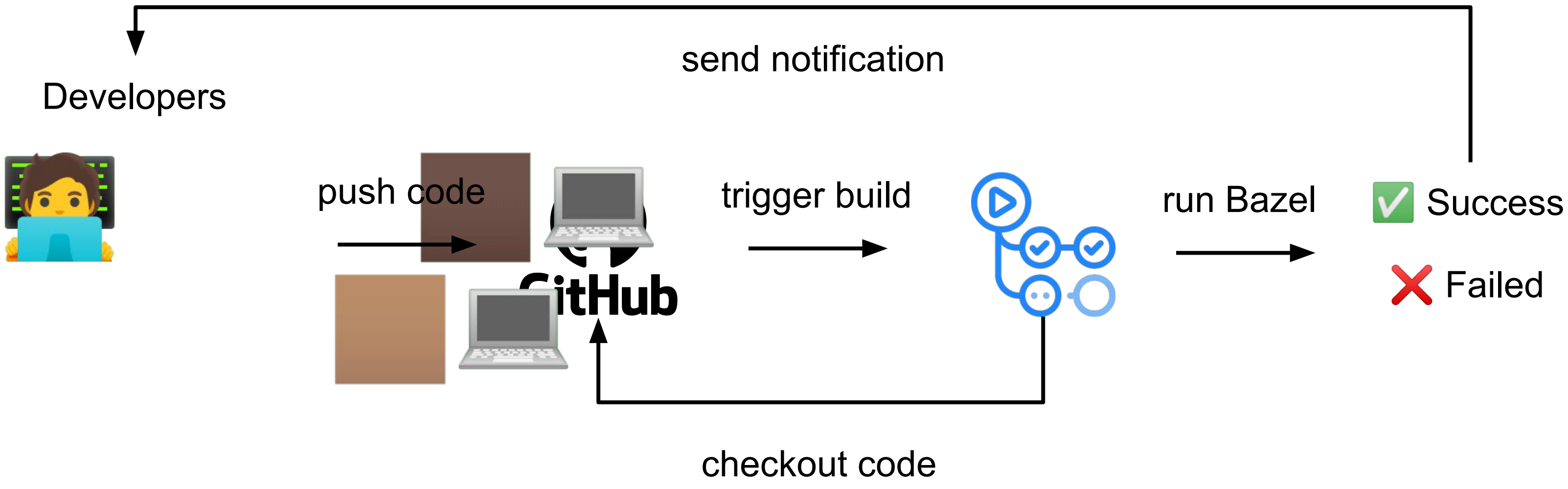
The CI Product GitHub Actions

Fully-integrated CI solution with GitHub repository

- Definition of build using a “configuration as code” approach
- Fast feedback by executing the build upon pushing a commit
- Use Bazelisk to standardize and bootstrap the Bazel runtime
- Use the same build tool and logic as on a developer machine

Basic Workflow

GitHub Actions reacts on an emitted repository event



Terminology

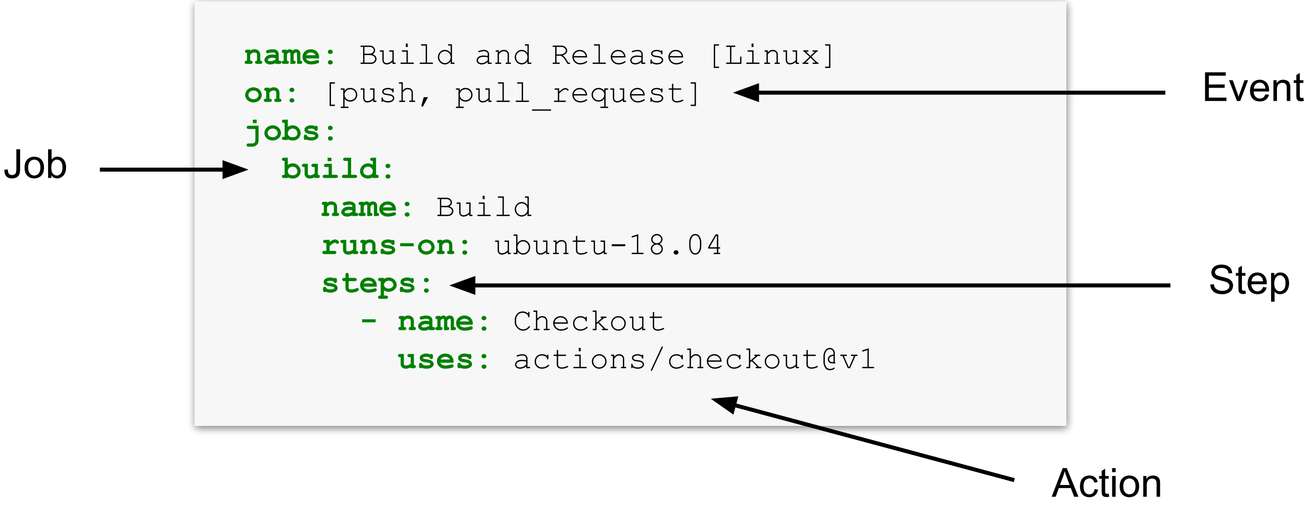
Essential for understanding a workflow definition

- **Event:** Repository activity that triggers a workflow
- **Job:** Set of steps that execute automation logic
- **Step:** Task that can run a command in a job
- **Action:** Reusable functionality provided by GitHub community

Typical Elements of Workflow File

Defines automation logic checked in GitHub repository

.github/workflows/build.yml



```yaml
name: Build and Release [Linux]
on: [push, pull_request]
jobs:
  build:
    name: Build
    runs-on: ubuntu-18.04
    steps:
      - name: Checkout
        uses: actions/checkout@v1
```

Event

Job

Step

Action

Using the Bazelisk Action

Downloads and uses Bazel runtime

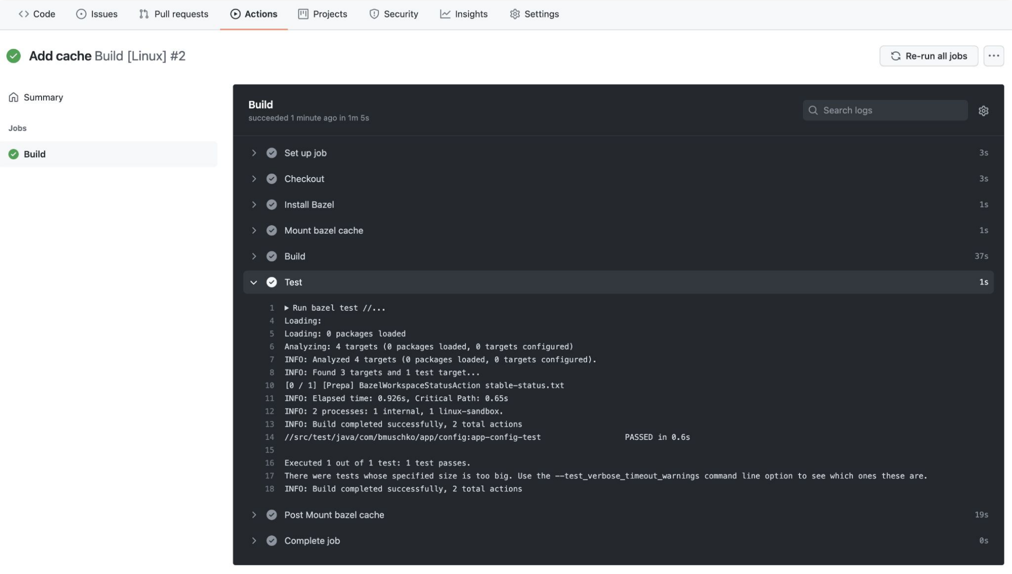
.github/workflows/build.yml

```yaml
steps:
- uses: actions/checkout@v2
- uses: bazelbuild/setup-bazelisk@v1
- name: Mount bazel cache  # Optional
  uses: actions/cache@v2
  with:
    path: "~/.cache/bazel"
    key: bazel
- run: bazel build //...
```

Setup Bazelisk Action page

Actions in the Repository

Click on “Actions” tab at the top



Add cache Build [Linux] #2

Build
succeeded 1 minute ago in 1m 5s

```
Set up job            3s
Checkout              3s
Install Bazel         1s
Mount bazel cache     1s
Build                 37s
Test                  1s
```

```
▶ Run bazel test //...
Loading:
Loading: 0 packages loaded
Analyzing: 4 targets (0 packages loaded, 0 targets configured)
INFO: Analyzed 4 targets (0 packages loaded, 0 targets configured).
INFO: Found 3 targets and 1 test target...
[0 / 1] [Prepa] BazelWorkspaceStatusAction stable-status.txt
INFO: Elapsed time: 0.926s, Critical Path: 0.65s
INFO: 2 processes: 1 internal, 1 linux-sandbox.
INFO: Build completed successfully, 2 total actions
//src/test/java/com/bmuschko/app/config:app-config-test                 PASSED in 0.6s

Executed 1 out of 1 test: 1 test passes.
There were tests whose specified size is too big. Use the --test_verbose_timeout_warnings command line option to see which ones these are.
INFO: Build completed successfully, 2 total actions
```

```
Post Mount bazel cache    19s
Complete job              0s
```

EXERCISE

Using GitHub
Actions for a Bazel
Project

Q & A

5 mins

Wrap Up

Summary and Lessons Learned

O'REILLY®

Thank you