

# Pkg.jl

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## **Part I**

### **1. Introduction**

Welcome to the documentation for Pkg, Julia's package manager. The documentation covers many things, for example managing package installations, developing packages, working with package registries and more.

Throughout the manual the REPL interface to Pkg, the Pkg REPL mode, is used in the examples. There is also a functional API, which is preferred when not working interactively. This API is documented in the [API Reference](#) section.

## Chapter 1

# Background and Design

Pkg is a complete rewrite of Julia's old package manager<sup>1</sup> and was released together with Julia v1.0. Unlike traditional package managers, which install and manage a single global set of packages, Pkg is designed around “environments”: independent sets of packages that can be local to an individual project or shared and selected by name. The exact set of packages and versions in an environment is captured in a manifest file which can be checked into a project repository and tracked in version control, significantly improving reproducibility of projects. If you’ve ever tried to run code you haven’t used in a while only to find that you can’t get anything to work because you’ve updated or uninstalled some of the packages your project was using, you’ll understand the motivation for this approach. In Pkg, since each project maintains its own independent set of package versions, you’ll never have this problem again. Moreover, if you check out a project on a new system, you can simply materialize the environment described by its manifest file and immediately be up and running with a known-good set of dependencies.

Since environments are managed and updated independently from each other, “dependency hell” is significantly alleviated in Pkg. If you want to use the latest and greatest version of some package in a new project but you’re stuck on an older version in a different project, that’s no problem – since they have separate environments they can just use different versions, which are both installed at the same time in different locations on your system. The location of each package version is canonical, so when environments use the same versions of packages, they can share installations, avoiding unnecessary duplication of the package. Old package versions that are no longer used by any environments are periodically “garbage collected” by the package manager.

Pkg’s approach to local environments may be familiar to people who have used Python’s `virtualenv` or Ruby’s `bundler`. In Julia, instead of hacking the language’s code loading mechanisms to support environments, we have the benefit that Julia natively understands them. In addition, Julia environments are “stackable”: you can overlay one environment with another and thereby have access to additional packages outside of the primary environment. This makes it easy to work on a project, which provides the primary environment, while still having access from the REPL to all your usual dev tools like profilers, debuggers, and so on, just by having an environment including these dev tools later in the load path.

Last but not least, Pkg is designed to support federated package registries. This means that it allows multiple registries managed by different parties to interact seamlessly. In particular, this includes private registries which can live behind corporate firewalls. You can install and update your own packages from a private registry with exactly the same tools and workflows that you use to install and manage official Julia packages. If you urgently need to apply a hotfix for a public package that’s critical to your company’s product, you can tag a private version of it in your company’s internal registry and get a fix to your developers and ops teams quickly and easily without having to wait for an upstream patch to be accepted and published. Once an official fix is published, however, you can just upgrade your dependencies and you’ll be back on an official release again.

---

<sup>1</sup>Often denoted Pkg2, now archived as OldPkg at [github.com/JuliaAttic/OldPkg.jl](https://github.com/JuliaAttic/OldPkg.jl).





## **Part II**

### **2. Getting Started**

What follows is a quick overview of Pkg, Julia's package manager. It should help new users become familiar with basic Pkg features.

## Chapter 2

# Basic Usage

Pkg comes with a REPL. Enter the Pkg REPL by pressing `J` from the Julia REPL. To get back to the Julia REPL, press backspace or `^C`.

### Note

This guide relies on the Pkg REPL to execute Pkg commands. For non-interactive use, we recommend the Pkg API. The Pkg API is fully documented in the [API Reference](#) section of the Pkg documentation.

Upon entering the Pkg REPL, you should see a similar prompt:

```
| (v1.1) pkg>
```

To add a package, use `add`:

```
| (v1.1) pkg> add Example
```

### Note

Some Pkg output has been omitted in order to keep this guide focused. This will help maintain a good pace and not get bogged down in details. If you require more details, refer to subsequent sections of the Pkg manual.

We can also specify multiple packages at once:

```
| (v1.1) pkg> add JSON StaticArrays
```

To remove packages, use `rm`:

```
| (v1.1) pkg> rm JSON StaticArrays
```

So far, we have referred only to registered packages. Pkg also supports working with unregistered packages. To add an unregistered package, specify a URL:

```
| (v1.1) pkg> add https://github.com/JuliaLang/Example.jl
```

Use `rm` to remove this package by name:

```
| (v1.1) pkg> rm Example
```

Use `update` to update an installed package:

```
| (v1.1) pkg> update Example
```

To update all installed packages, use `update` without any arguments:

```
| (v1.1) pkg> update
```

## Chapter 3

# Getting Started with Environments

Up to this point, we have covered basic package management: adding, updating and removing packages. This will be familiar if you have used other package managers. Pkg offers significant advantages over traditional package managers by organizing dependencies into **environments**.

You may have noticed the (v1.1) in the REPL prompt. This lets us know v1.1 is the **active environment**. The active environment is the environment that will be modified by Pkg commands such as add, rm and update.

Let's set up a new environment so we may experiment. To set the active environment, use activate:

```
(v1.1) pkg> activate tutorial  
[ Info: activating new environment at `/tmp/tutorial/Project.toml`.
```

Pkg lets us know we are creating a new environment and that this environment will be stored in the /tmp/tutorial directory.

Pkg has also updated the REPL prompt in order to reflect the new active environment:

```
(tutorial) pkg>
```

We can ask for information about the active environment by using status:

```
(tutorial) pkg> status  
Status `/tmp/tutorial/Project.toml`  
(empty environment)
```

/tmp/tutorial/Project.toml is the location of the active environment's **project file**. A project file is where Pkg stores metadata for an environment. Notice this new environment is empty. Let us add a package and observe:

```
(tutorial) pkg> add Example  
...  
(tutorial) pkg> status  
Status `/tmp/tutorial/Project.toml`  
[7876af07] Example v0.5.1
```

We can see tutorial now contains Example as a dependency.

## Chapter 4

# Modifying A Dependency

Say we are working on `Example` and feel it needs new functionality. How can we modify the source code? We can use `develop` to set up a git clone of the `Example` package.

```
(tutorial) pkg> develop --local Example
...

(tutorial) pkg> status
  Status `~/tmp/tutorial/Project.toml`
 [7876af07] Example v0.5.1+ [`dev/Example`]
```

Notice the feedback has changed. `dev/Example` refers to the location of the newly created clone. If we look inside the `/tmp/tutorial` directory, we will notice the following files:

```
tutorial|—
 dev|
   |— Example|—
 Manifest.toml|—
 Project.toml
```

Instead of loading a registered version of `Example`, Julia will load the source code contained in `tutorial/dev/Example`.

Let's try it out. First we modify the file at `tutorial/dev/Example/src/Example.jl` and add a simple function:

```
| plusone(x::Int) = x + 1
```

Now we can go back to the Julia REPL and load the package:

```
| julia> import Example
```

### Warning

A package can only be loaded once per Julia session. If you have run `import Example` in the current Julia session, you will have to restart Julia and rerun `activate tutorial` in the Pkg REPL. [Revise.jl](#) can make this process significantly more pleasant, but setting it up is beyond the scope of this guide.

Julia should load our new code. Let's test it:

```
| julia> Example.plusone(1)  
| 2
```

Say we have a change of heart and decide the world is not ready for such elegant code. We can tell Pkg to stop using the local clone and use a registered version instead. We do this with `free`:

```
| (tutorial) pkg> free Example
```

When you are done experimenting with `tutorial`, you can return to the **default environment** by running `activate` with no arguments:

```
| (tutorial) pkg> activate  
| (v1.1) pkg>
```

## Chapter 5

# Asking for Help

If you are ever stuck, you can ask Pkg for help:

```
| (v1.1) pkg> ?
```

You should see a list of available commands along with short descriptions. You can ask for more detailed help by specifying a command:

```
| (v1.1) pkg> ?develop
```

This guide should help you get started with Pkg. Pkg has much more to offer in terms of powerful package management, read the full manual to learn more!



## **Part III**

# **3. Managing Packages**

## Chapter 6

# Adding packages

There are two ways of adding packages, either using the `add` command or the `dev` command. The most frequently used is `add` and its usage is described first.

### 6.1 Adding registered packages

In the Pkg REPL, packages can be added with the `add` command followed by the name of the package, for example:

```
(v1.0) pkg> add Example
  Cloning default registries into /Users/kristoffer/.julia/registries
  Cloning registry General from "https://github.com/JuliaRegistries/General.git"
  Updating registry at `~/.julia/registries/General`
  Updating git-repo `https://github.com/JuliaRegistries/General.git`
  Resolving package versions...
  Updating `~/.julia/environments/v1.0/Project.toml`
  [7876af07] + Example v0.5.1
  Updating `~/.julia/environments/v1.0/Manifest.toml`
  [7876af07] + Example v0.5.1
  [8dfed614] + Test
```

Here we added the package `Example` to the current project. In this example, we are using a fresh Julia installation, and this is our first time adding a package using Pkg. By default, Pkg clones Julia's General registry, and uses this registry to look up packages requested for inclusion in the current environment. The status update shows a short form of the package UUID to the left, then the package name, and the version. Since standard libraries (e.g. `Test`) are shipped with Julia, they do not have a version. The project status contains the packages you have added yourself, in this case, `Example`:

```
(v1.0) pkg> st
  Status `Project.toml`
  [7876af07] Example v0.5.1
```

The manifest status shows all the packages in the environment, including recursive dependencies:

```
(v1.0) pkg> st --manifest
  Status `Manifest.toml`
  [7876af07] Example v0.5.1
  [8dfed614] Test
```

It is possible to add multiple packages in one command as `pkg> add A B C`.

After a package is added to the project, it can be loaded in Julia:

```
julia> using Example

julia> Example.hello("User")
"Hello, User"
```

A specific version can be installed by appending a version after a `@` symbol, e.g. `@v0.4`, to the package name:

```
(v1.0) pkg> add Example@0.4
Resolving package versions...
Updating `~/julia/environments/v1.0/Project.toml`
[7876af07] + Example v0.4.1
Updating `~/julia/environments/v1.0/Manifest.toml`
[7876af07] + Example v0.4.1
```

If a branch (or a certain commit) of `Example` has a hotfix that is not yet included in a registered version, we can explicitly track that branch (or commit) by appending `#branchname` (or `#commitSHA1`) to the package name:

```
(v1.0) pkg> add Example#master
Updating git-repo `https://github.com/JuliaLang/Example.jl.git`
Resolving package versions...
Updating `~/julia/environments/v1.0/Project.toml`
[7876af07] ~ Example v0.5.1 → v0.5.1+ #master (https://github.com/JuliaLang/Example.jl.git)
Updating `~/julia/environments/v1.0/Manifest.toml`
[7876af07] ~ Example v0.5.1 → v0.5.1+ #master (https://github.com/JuliaLang/Example.jl.git)
```

The status output now shows that we are tracking the master branch of `Example`. When updating packages, updates are pulled from that branch.

### Note

If we would specify a commit id instead of a branch name, e.g. `add Example#025cf7e`, then we would effectively "pin" the package to that commit. This is because the commit id always point to the same thing unlike a branch, which may be updated.

To go back to tracking the registry version of `Example`, the command `free` is used:

```
(v1.0) pkg> free Example
Resolving package versions...
Updating `~/julia/environments/v1.0/Project.toml`
[7876af07] ~ Example v0.5.1+ #master (https://github.com/JuliaLang/Example.jl.git) → v0.5.1
Updating `~/julia/environments/v1.0/Manifest.toml`
[7876af07] ~ Example v0.5.1+ #master (https://github.com/JuliaLang/Example.jl.git) → v0.5.1
```

## 6.2 Adding unregistered packages

If a package is not in a registry, it can be added by specifying a URL to the repository:

```
(v1.0) pkg> add https://github.com/fredrikekre/ImportMacros.jl
  Updating git-repo `https://github.com/fredrikekre/ImportMacros.jl`
  Resolving package versions...
Downloaded MacroTools - v0.4.1
  Updating `~/.julia/environments/v1.0/Project.toml`
[e6797606] + ImportMacros v0.0.0 # (https://github.com/fredrikekre/ImportMacros.jl)
  Updating `~/.julia/environments/v1.0/Manifest.toml`
[e6797606] + ImportMacros v0.0.0 # (https://github.com/fredrikekre/ImportMacros.jl)
[1914dd2f] + MacroTools v0.4.1
```

The dependencies of the unregistered package (here MacroTools) got installed. For unregistered packages we could have given a branch name (or commit SHA1) to track using #, just like for registered packages.

If you want to add a package using the SSH-based git protocol, you have to use quotes because the URL contains a @. For example,

```
(v1.0) pkg> add "git@github.com:fredrikekre/ImportMacros.jl.git"
  Cloning git-repo `git@github.com:fredrikekre/ImportMacros.jl.git`
  Updating git-repo `git@github.com:fredrikekre/ImportMacros.jl.git`
  Updating registry at `~/.julia/registries/General`
  Resolving package versions...
  Updating `~/.julia/environments/v1/Project.toml`
[92a963f6] + ImportMacros v1.0.0 `git@github.com:fredrikekre/ImportMacros.jl.git#master`
  Updating `~/.julia/environments/v1/Manifest.toml`
[92a963f6] + ImportMacros v1.0.0 `git@github.com:fredrikekre/ImportMacros.jl.git#master`
```

## 6.3 Adding a local package

Instead of giving a URL of a git repo to add we could instead have given a local path to a git repo. This works similar to adding a URL. The local repository will be tracked (at some branch) and updates from that local repo are pulled when packages are updated. Note tracking a package through add is distinct from develop: changes to files in the local package repository will not immediately be reflected when loading that package. The changes would have to be committed and the packages updated in order to pull in the changes.

In addition, it is possible to add packages relatively to the Manifest.toml file, see [Developing packages](#) for an example.

## 6.4 Developing packages

By only using add your Manifest will always have a "reproducible state", in other words, as long as the repositories and registries used are still accessible it is possible to retrieve the exact state of all the dependencies in the project. This has the advantage that you can send your project (Project.toml and Manifest.toml) to someone else and they can "instantiate" that project in the same state as you had it locally. However, when you are developing a package, it is more convenient to load packages at their current state at some path. For this reason, the dev command exists.

Let's try to dev a registered package:

```
(v1.0) pkg> dev Example
  Updating git-repo `https://github.com/JuliaLang/Example.jl.git`
```

```

Resolving package versions...
Updating `~/.julia/environments/v1.0/Project.toml`
[7876af07] + Example v0.5.1+ [~/.julia/dev/Example`]
Updating `~/.julia/environments/v1.0/Manifest.toml`
[7876af07] + Example v0.5.1+ [~/.julia/dev/Example`]

```

The dev command fetches a full clone of the package to `~/.julia/dev/` (the path can be changed by setting the environment variable `JULIA_PKG_DEVDIR`, the default being `joinpath(DEPOT_PATH[1], "dev")`). When importing Example julia will now import it from `~/.julia/dev/Example` and whatever local changes have been made to the files in that path are consequently reflected in the code loaded. When we used add we said that we tracked the package repository, we here say that we track the path itself. Note the package manager will never touch any of the files at a tracked path. It is therefore up to you to pull updates, change branches etc. If we try to dev a package at some branch that already exists at `~/.julia/dev/` the package manager we will simply use the existing path. For example:

```

(v1.0) pkg> dev Example
Updating git-repo `https://github.com/JuliaLang/Example.jl.git`
[ Info: Path `~/Users/kristoffer/.julia/dev/Example` exists and looks like the correct package, using
↪ existing path instead of cloning

```

Note the info message saying that it is using the existing path. When tracking a path, the package manager will never modify the files at that path.

If dev is used on a local path, that path to that package is recorded and used when loading that package. The path will be recorded relative to the project file, unless it is given as an absolute path.

```

(v1.0) pkg> dev /Users/kristoffer/Desktop/Example

```

To stop tracking a path and use the registered version again, use free:

```

(v1.0) pkg> free Example
Resolving package versions...
Updating `~/.julia/environments/v1.0/Project.toml`
[7876af07] ↓ Example v0.5.1+ [~/.julia/dev/Example`] ⇒ v0.5.1
Updating `~/.julia/environments/v1.0/Manifest.toml`
[7876af07] ↓ Example v0.5.1+ [~/.julia/dev/Example`] ⇒ v0.5.1

```

It should be pointed out that by using dev your project is now inherently stateful. Its state depends on the current content of the files at the path and the manifest cannot be "instantiated" by someone else without knowing the exact content of all the packages that are tracking a path.

Note that if you add a dependency to a package that tracks a local path, the Manifest (which contains the whole dependency graph) will become out of sync with the actual dependency graph. This means that the package will not be able to load that dependency since it is not recorded in the Manifest. To synchronize the Manifest, use the REPL command `resolve`.

In addition to absolute paths, add and dev can accept relative paths to packages. In this case, the relative path from the active project to the package is stored. This approach is useful when the relative location of tracked dependencies is more important than their absolute location. For example, the tracked dependencies can be stored inside of the active project directory. The whole directory can be moved and Pkg will still be able to find the dependencies because their path relative to the active project is preserved even though their absolute path has changed.

## 6.5 Adding a package in a subdirectory of a repository

If the package you want to add by URL is not in the root of the repository, then you need to manually pass the `subdir` keyword to `Pkg.add` or `PackageSpec`. For instance, to add the `SnoopCompileCore` package in the `SnoopCompile` repository:

```
julia> Pkg.add(url="https://github.com/timholly/SnoopCompile.jl.git", subdir="SnoopCompileCore")
    Cloning git-repo `https://github.com/timholly/SnoopCompile.jl.git`
    Updating git-repo `https://github.com/timholly/SnoopCompile.jl.git`
    Resolving package versions...
    Updating `~/.julia/environments/v1.6/Project.toml`
[e2b509da] + SnoopCompileCore v2.7.0
↪ `https://github.com/timholly/SnoopCompile.jl.git:SnoopCompileCore#master`
    Updating `~/.julia/environments/v1.6/Manifest.toml`
[e2b509da] + SnoopCompileCore v2.7.0
↪ `https://github.com/timholly/SnoopCompile.jl.git:SnoopCompileCore#master`
[9e88b42a] + Serialization
```

Another way is to use the Pkg REPL with `<repo_url>:<subdir>` format:

```
pkg> add https://github.com/timholly/SnoopCompile.jl.git:SnoopCompileCore # git HTTPS protocol
...

pkg> add "git@github.com:timholly/SnoopCompile.jl.git":SnoopCompileCore # git SSH protocol
...
```

### Julia 1.5

The Pkg REPL for packages in subdirectory requires at least Julia 1.5.

## Chapter 7

### Removing packages

Packages can be removed from the current project by using `pkg> rm Package`. This will only remove packages that exist in the project; to remove a package that only exists as a dependency use `pkg> rm --manifest DepPackage`. Note that this will remove all packages that depend on `DepPackage`.

## Chapter 8

# Updating packages

When new versions of packages that the project is using are released, it is a good idea to update. Simply calling `up` will try to update all the dependencies of the project to the latest compatible version. Sometimes this is not what you want. You can specify a subset of the dependencies to upgrade by giving them as arguments to `up`, e.g:

```
| (v1.0) pkg> up Example
```

If `Example` has a dependency which is also a dependency for another explicitly added package, that dependency will not be updated. If you only want to update the minor version of packages, to reduce the risk that your project breaks, you can give the `--minor` flag, e.g:

```
| (v1.0) pkg> up --minor Example
```

Packages that track a local repository are not updated when a minor upgrade is done. Packages that track a path are never touched by the package manager.



## Chapter 9

### Pinning a package

A pinned package will never be updated. A package can be pinned using `pin`, for example:

```
(v1.0) pkg> pin Example
Resolving package versions...
Updating `~/.julia/environments/v1.0/Project.toml`
[7876af07] ~ Example v0.5.1 ⇒ v0.5.1
Updating `~/.julia/environments/v1.0/Manifest.toml`
[7876af07] ~ Example v0.5.1 ⇒ v0.5.1
```

Note the pin symbol `~` showing that the package is pinned. Removing the pin is done using `free`

```
(v1.0) pkg> free Example
Updating `~/.julia/environments/v1.0/Project.toml`
[7876af07] ~ Example v0.5.1 ⇒ v0.5.1
Updating `~/.julia/environments/v1.0/Manifest.toml`
[7876af07] ~ Example v0.5.1 ⇒ v0.5.1
```

## Chapter 10

# Testing packages

The tests for a package can be run using `testcommand`:

```
(v1.0) pkg> test Example
Testing Example
Testing Example tests passed
```

## Chapter 11

# Building packages

The build step of a package is automatically run when a package is first installed. The output of the build process is directed to a file. To explicitly run the build step for a package, the build command is used:

```
(v1.0) pkg> build MbedTLS
Building MbedTLS → `~/julia/packages/MbedTLS/h1Vu/deps/build.log`

julia> print(read("~/julia/packages/MbedTLS/h1Vu/deps/build.log", String))
└ Warning: `wait(t::Task)` is deprecated, use `fetch(t)` instead.
  caller = macro expansion at OutputCollector.jl:63 [inlined]
└ @ Core OutputCollector.jl:63
...
[ Info: using prebuilt binaries
```

## Chapter 12

# Interpreting and resolving version conflicts

An environment consists of a set of mutually-compatible packages. Sometimes, you can find yourself in a situation in which two packages you'd like to use simultaneously have incompatible requirements. In such cases you'll get an "Unsatisfiable requirements" error:

```
pkg> add A
Unsatisfiable requirements detected for package D [756980fe]:
D [756980fe] log:
├possible versions are: 0.1.0-0.2.1 or uninstalled
├restricted by compatibility requirements with B [f4259836] to versions: 0.1.0
| └B [f4259836] log:
|   ├──possible versions are: 1.0.0 or uninstalled
|   └restricted to versions * by an explicit requirement, leaving only versions 1.0.0
└restricted by compatibility requirements with C [c99a7cb2] to versions: 0.2.0 – no versions left
  └C [c99a7cb2] log:
    ├──possible versions are: 0.1.0-0.2.0 or uninstalled
    └restricted by compatibility requirements with A [29c70717] to versions: 0.2.0
      └A [29c70717] log:
        ├──possible versions are: 1.0.0 or uninstalled
        └restricted to versions * by an explicit requirement, leaving only versions 1.0.0
```

This message means that a package named D has a version conflict. Even if you have never added D directly, this kind of error can arise if D is required by other packages that you are trying to use.

The error message has a lot of crucial information. It may be easiest to interpret piecewise:

```
Unsatisfiable requirements detected for package D [756980fe]:
D [756980fe] log:
├possible versions are: [0.1.0, 0.2.0-0.2.1] or uninstalled
```

means that D has three released versions, v0.1.0, v0.2.0, and v0.2.1. You also have the option of not having it installed at all. Each of these options might have different implications for the set of other packages that can be installed.

Crucially, notice the stroke characters (vertical and horizontal lines) and their indentation. Together, these connect messages to specific packages. For instance the right stroke of `├` indicates that the message to its right (possible versions...) is connected to the package pointed to by its vertical stroke (D). This same principle applies to the next line:

```
| └restricted by compatibility requirements with B [f4259836] to versions: 0.1.0
```

The vertical stroke here is also aligned under D, and thus this message is in reference to D. Specifically, there's some other package B that depends on version v0.1.0 of D. Notice that this is not the newest version of D.

Next comes some information about B:

```
| | └─B [f4259836] log:
| |   └─possible versions are: 1.0.0 or uninstalled
| |   └─restricted to versions * by an explicit requirement, leaving only versions 1.0.0
```

The two lines below the first have a vertical stroke that aligns with B, and thus they provide information about B. They tell you that B has just one release, v1.0.0. You've not specified a particular version of B (restricted to versions \* means that any version will do), but the explicit requirement means that you've asked for B to be part of your environment, for example by `pkg> add B`. You might have asked for B previously, and the requirement is still active.

The conflict becomes clear with the line

```
| └─
| restricted by compatibility requirements with C [c99a7cb2] to versions: 0.2.0 – no versions left
```

Here again the vertical stroke aligns with D: this means that D is also required by another package, C. C requires v0.2.0 of D, and this conflicts with B's need for v0.1.0 of D. This explains the conflict.

But wait, you might ask, what is C and why do I need it at all? The next few lines introduce the problem:

```
| └─C [c99a7cb2] log:
|   └─possible versions are: [0.1.0-0.1.1, 0.2.0] or uninstalled
|   └─restricted by compatibility requirements with A [29c70717] to versions: 0.2.0
```

These provide more information about C, revealing that it has 3 released versions: v0.1.0, v0.1.1, and v0.2.0. Moreover, C is required by another package A. Indeed, A's requirements are such that we need v0.2.0 of C. A's origin is revealed on the next lines:

```
|   └─A [29c70717] log:
|     └─possible versions are: 1.0.0 or uninstalled
|     └─restricted to versions * by an explicit requirement, leaving only versions 1.0.0
```

So we can see that A was explicitly required, and in this case it's because we were trying to add it to our environment.

In summary, we explicitly asked to use A and B, but this gave a conflict for D. The reason was that B and C require conflicting versions of D. Even though C isn't something we asked for explicitly, it was needed by A.

To fix such errors, you have a number of options:

- try [updating your packages](#). It's possible the developers of these packages have recently released new versions that are mutually compatible.
- remove either A or B from your environment. Perhaps B is left over from something you were previously working on, and you don't need it anymore. If you don't need A and B at the same time, this is the easiest way to fix the problem.
- try reporting your conflict. In this case, we were able to deduce that B requires an outdated version of D. You could thus report an issue in the development repository of B.jl asking for an updated version.
- try fixing the problem yourself. This becomes easier once you understand Project.toml files and how they declare their compatibility requirements. We'll return to this example in [Fixing conflicts](#).

## Chapter 13

# Garbage collecting old, unused packages

As packages are updated and projects are deleted, installed package versions and artifacts that were once used will inevitably become old and not used from any existing project. Pkg keeps a log of all projects used so it can go through the log and see exactly which projects still exist and what packages/artifacts those projects used. If a package or artifact is not marked as used by any project, it is added to a list of orphaned packages. Packages and artifacts that are in the orphan list for 30 days without being used again are deleted from the system on the next garbage collection. This timing is configurable via the `collect_delay` keyword argument to `Pkg.gc()`. A value of 0 will cause anything currently not in use immediately, skipping the orphans list entirely; If you are short on disk space and want to clean out as many unused packages and artifacts as possible, you may want to try this, but if you need these versions again, you will have to download them again. To run a typical garbage collection with default arguments, simply use the `gc` command at the `pkg>` REPL:

```
(v1.0) pkg> gc
Active manifests at:
  `~/BinaryProvider/Manifest.toml`
  ...
  `~/Compat.jl/Manifest.toml`
Active artifacts:
  `~/src/MyProject/Artifacts.toml`

Deleted ~/.julia/packages/BenchmarkTools/1cAj: 146.302 KiB
Deleted ~/.julia/packages/Cassette/BXVB: 795.557 KiB
...
Deleted ~/.julia/artifacts/e44cdf2579a92ad5cbacd1cddb7414c8b9d2e24e` (152.253 KiB)
Deleted ~/.julia/artifacts/f2df5266567842bbb8a06acca56bcabf813cd73f` (21.536 MiB)

Deleted 36 package installations (113.205 MiB)
Deleted 15 artifact installations (20.759 GiB)
```

Note that only packages in `~/.julia/packages` are deleted.

## Chapter 14

### Offline Mode

In offline mode Pkg tries to do as much as possible without connecting to internet. For example, when adding a package Pkg only considers versions that are already downloaded in version resolution.

To work in offline mode use `import Pkg; Pkg.offline(true)` or set the environment variable `JULIA_PKG_OFFLINE` to "true".

## Chapter 15

# Pkg client/server

### Julia 1.4

Pkg client/server feature requires at least Julia 1.4. It is opt-in for Julia 1.4 and is enabled by default since Julia 1.5.

When you add a new registered package, usually three things would happen:

1. update registries,
2. download source codes of the package,
3. if not available, download [artifacts](#) required by the package.

The [General](#) registry and most packages in it are developed on Github, while the artifacts data are hosted in various platforms. When the network connection to Github and AWS S3 is not stable, it is usually not a good experience to install or update packages. Fortunately, the pkg client/server feature improves the experience in the sense that:

1. If set, pkg client would first try to download data from the pkg server,
2. if that fails, then it falls back to download from the original sources (e.g., Github).

Since Julia 1.5, <https://pkg.julialang.org> provided by the JuliaLang org. is used as the default pkg server. In most cases this should be transparent, but users can still set/unset an pkg server upstream via the environment variable `JULIA_PKG_SERVER`.

```
# manually set it to some pkg server
julia> ENV["JULIA_PKG_SERVER"] = "pkg.julialang.org"
"pkg.julialang.org"

# unset to always download data from original sources
julia> ENV["JULIA_PKG_SERVER"] = ""
""
```

For clarification, some sources are not provided by Pkg server

- packages/registries fetched via git



- `]add https://github.com/JuliaLang/Example.jl.git`
  - `]add Example#v0.5.3` (Note that this is different from `]add Example@0.5.3`)
  - `]registry add https://github.com/JuliaRegistries/General.git`, including registries installed by Julia before 1.4.
- artifacts without download info
    - `TestImages`

**Note**

If you have a new registry installed via pkg server, then it's impossible for old Julia versions to update the registry because Julia before 1.4 don't know how to fetch new data. Hence, for users that frequently switches between multiple Julia versions, it is recommended to still use git-controlled registries.

For the deployment of pkg server, please refer to [PkgServer.jl](#).

## **Part IV**

### **4. Working with Environments**

The following discusses Pkg's interaction with environments. For more on the role environments play in code loading, including the "stack" of environments from which code can be loaded, see [this section in the Julia manual](#).

## Chapter 16

# Creating your own projects

So far we have added packages to the default project at `~/.julia/environments/v1.0`. It is however easy to create other, independent, projects. It should be pointed out that when two projects use the same package at the same version, the content of this package is not duplicated. In order to create a new project, create a directory for it and then activate that directory to make it the "active project", which package operations manipulate:

```
julia> mkdir("MyProject")

julia> cd("MyProject")
/Users/kristoffer/MyProject

# we can now use "." instead of a longer relative or full path:
(v1.0) pkg> activate .

(MyProject) pkg> st
Status `Project.toml`
```

Note that the REPL prompt changed when the new project is activated. Since this is a newly created project, the status command shows that it contains no packages, and in fact, it has no project or manifest file until we add a package to it:

```
julia> readdir()
0-element Array{String,1}

(MyProject) pkg> add Example
Updating registry at `~/.julia/registries/General`
Updating git-repo `https://github.com/JuliaRegistries/General.git`
Resolving package versions...
Updating `Project.toml`
[7876af07] + Example v0.5.1
Updating `Manifest.toml`
[7876af07] + Example v0.5.1
[8dfed614] + Test
Precompiling project...
 1 dependency successfully precompiled in 2 seconds

julia> readdir()
2-element Array{String,1}:
"Manifest.toml"
```

```
"Project.toml"

julia> print(read("Project.toml", String))
[deps]
Example = "7876af07-990d-54b4-ab0e-23690620f79a"

julia> print(read("Manifest.toml", String))
[[Example]]
deps = ["Test"]
git-tree-sha1 = "8eb7b4d4ca487caade9ba3e85932e28ce6d6e1f8"
uuid = "7876af07-990d-54b4-ab0e-23690620f79a"
version = "0.5.1"

[[Test]]
uuid = "8dfed614-e22c-5e08-85e1-65c5234f0b40"
```

This new environment is completely separate from the one we used earlier.

## Chapter 17

# Project Precompilation

By default any package that is added to a project or updated in a `Pkg` action will be automatically precompiled, along with its dependencies. The exception is the `develop` command, which neither builds nor precompiles the package, when that happens is left up to the user to decide.

If a package that has been updated is already loaded in the session, the precompilation process will go ahead and precompile the new version, and any packages that depend on it, but will note that the package cannot be used until session restart.

To disable this auto-precompilation, set `ENV["JULIA_PKG_PRECOMPILE_AUTO"]=0`, after which precompilation can be triggered manually either serially via code loading

```
julia> using Example
[ Info: Precompiling Example [7876af07-990d-54b4-ab0e-23690620f79a]
```

or the parallel precompilation, which can be significantly faster when many dependencies are involved, via

```
pkg> precompile
Precompiling project...
 23 dependencies successfully precompiled in 36 seconds
```

## Chapter 18

# Using someone else's project

Simply clone their project using e.g. `git clone`, `cd` to the project directory and call

```
(v1.0) pkg> activate .  
(SomeProject) pkg> instantiate
```

If the project contains a manifest, this will install the packages in the same state that is given by that manifest. Otherwise, it will resolve the latest versions of the dependencies compatible with the project.

### Specifying project on startup

Instead of using `activate` from within Julia you can specify the project on startup using the `--project=<path>` flag. For example, to run a script from the command line using the environment in the current directory you can run

```
$ julia --project=. myscript.jl
```

## **Part V**

# **5. Creating Packages**



A package is a project with a name, uuid and version entry in the `Project.toml` file, and a `src/PackageName.jl` file that defines the module `PackageName`. This file is executed when the package is loaded.

## Chapter 19

# Generating files for a package

### Note

The `PkgTemplates` package offers a very easy, repeatable, and customizable way to generate the files for a new package. We recommend that you use `PkgTemplates` for creating new packages instead of using the minimal `pkg> generate` functionality described below.

To generate files for a new package, use `pkg> generate`.

```
| (v1.0) pkg> generate HelloWorld
```

This creates a new project `HelloWorld` with the following files (visualized with the external `tree` command):

```
julia> cd("HelloWorld")

shell> tree .
.
├── Project.toml
└── src
    └── HelloWorld.jl

1 directory, 2 files
```

The `Project.toml` file contains the name of the package, its unique UUID, its version, the authors and potential dependencies:

```
name = "HelloWorld"
uuid = "b4cd1eb8-1e24-11e8-3319-93036a3eb9f3"
version = "0.1.0"
authors = ["Some One <someone@email.com>"]

[deps]
```

The content of `src/HelloWorld.jl` is:

```
module HelloWorld

greet() = print("Hello World!")

end # module
```

We can now activate the project and load the package:

```
pkg> activate .  
  
julia> import HelloWorld  
  
julia> HelloWorld.greet()  
Hello World!
```

## Chapter 20

# Adding dependencies to the project

Let's say we want to use the standard library package `Random` and the registered package `JSON` in our project. We simply add these packages (note how the prompt now shows the name of the newly generated project, since we activated it):

```
(HelloWorld) pkg> add Random JSON
Resolving package versions...
  Updating "~/Documents/HelloWorld/Project.toml"
[682c06a0] + JSON v0.17.1
[9a3f8284] + Random
  Updating "~/Documents/HelloWorld/Manifest.toml"
[34da2185] + Compat v0.57.0
[682c06a0] + JSON v0.17.1
[4d1e1d77] + Nullables v0.0.4
...
```

Both `Random` and `JSON` got added to the project's `Project.toml` file, and the resulting dependencies got added to the `Manifest.toml` file. The resolver has installed each package with the highest possible version, while still respecting the compatibility that each package enforces on its dependencies.

We can now use both `Random` and `JSON` in our project. Changing `src/HelloWorld.jl` to

```
module HelloWorld

import Random
import JSON

greet() = print("Hello World!")
greet_alien() = print("Hello ", Random.randstring(8))

end # module
```

and reloading the package, the new `greet_alien` function that uses `Random` can be called:

```
julia> HelloWorld.greet_alien()
Hello aT157rHV
```

## Chapter 21

# Adding a build step to the package

The build step is executed the first time a package is installed or when explicitly invoked with `build`. A package is built by executing the file `deps/build.jl`.

```
julia> print(read("deps/build.jl", String))
println("I am being built...")

(HelloWorld) pkg> build
  Building HelloWorld → `deps/build.log`
  Resolving package versions...

julia> print(read("deps/build.log", String))
I am being built...
```

If the build step fails, the output of the build step is printed to the console

```
julia> print(read("deps/build.jl", String))
error("Ooops")

(HelloWorld) pkg> build
  Building HelloWorld → `deps/build.log`
  Resolving package versions...
└─ Error: Error building `HelloWorld`:
└─ ERROR: LoadError: Ooops
└─ Stacktrace:
└─ [1] error(::String) at ./error.jl:33
└─ [2] top-level scope at none:0
└─ [3] include at ./boot.jl:317 [inlined]
└─ [4] include_relative(::Module, ::String) at ./loading.jl:1071
└─ [5] include(::Module, ::String) at ./sysimg.jl:29
└─ [6] include(::String) at ./client.jl:393
└─ [7] top-level scope at none:0
└─ in expression starting at /Users/kristoffer/.julia/dev/Pkg/HelloWorld/deps/build.jl:1
└─ @ Pkg.Operations Operations.jl:938
```

## Chapter 22

# Adding tests to the package

When a package is tested the file `test/runtests.jl` is executed:

```
julia> print(read("test/runtests.jl", String))
println("Testing...")

(HelloWorld) pkg> test
  Testing HelloWorld
Resolving package versions...
Testing...
  Testing HelloWorld tests passed
```

Tests are run in a new Julia process, where the package itself, and any test-specific dependencies, are available, see below.

### 22.1 Test-specific dependencies in Julia 1.2 and above

#### Julia 1.2

This section only applies to Julia 1.2 and above. For specifying test dependencies on previous Julia versions, see [Test-specific dependencies in Julia 1.0 and 1.1](#).

#### Note

The exact interaction between `Project.toml`, `test/Project.toml` and their corresponding `Manifest.tomls` are not fully worked out, and may be subject to change in future versions. The old method of adding test-specific dependencies, described in the next section, will therefore be supported throughout all Julia 1.X releases.

In Julia 1.2 and later the test environment is given by `test/Project.toml`. Thus, when running tests, this will be the active project, and only dependencies to the `test/Project.toml` project can be used. Note that `Pkg` will add the tested package itself implicitly.

#### Note

If no `test/Project.toml` exists `Pkg` will use the old style test-setup, as described in [Test-specific dependencies in Julia 1.0 and 1.1](#).

To add a test-specific dependency, i.e. a dependency that is available only when testing, it is thus enough to add this dependency to the `test/Project.toml` project. This can be done from the Pkg REPL by activating this environment, and then use `add` as one normally does. Lets add the Test standard library as a test dependency:

```
(HelloWorld) pkg> activate ./test
[ Info: activating environment at `~/HelloWorld/test/Project.toml`.

(test) pkg> add Test
Resolving package versions...
Updating `~/HelloWorld/test/Project.toml`
 [8dfed614] + Test
Updating `~/HelloWorld/test/Manifest.toml`
 [...]
```

We can now use Test in the test script and we can see that it gets installed when testing:

```
julia> print(read("test/runtests.jl", String))
using Test
@test 1 == 1

(HelloWorld) pkg> test
Testing HelloWorld
Resolving package versions...
Updating `/var/folders/64/76tk_g152sg6c6t0b4nkn1vw0000gn/T/tmpPzUPPw/Project.toml`
 [d8327f2a] + HelloWorld v0.1.0 [~/dev/Pkg/HelloWorld]
 [8dfed614] + Test
Updating `/var/folders/64/76tk_g152sg6c6t0b4nkn1vw0000gn/T/tmpPzUPPw/Manifest.toml`
 [d8327f2a] + HelloWorld v0.1.0 [~/dev/Pkg/HelloWorld]
Testing HelloWorld tests passed``
```

## 22.2 Test-specific dependencies in Julia 1.0 and 1.1

### Note

The method of adding test-specific dependencies described in this section will be replaced by the method from the previous section in future Julia versions. The method in this section will, however, be supported throughout all Julia 1.X releases.

In Julia 1.0 and Julia 1.1 test-specific dependencies are added to the main `Project.toml`. To add Markdown and Test as test-dependencies, add the following:

```
[extras]
Markdown = "d6f4376e-aef5-505a-96c1-9c027394607a"
Test = "8dfed614-e22c-5e08-85e1-65c5234f0b40"

[targets]
test = ["Markdown", "Test"]
```

## Chapter 23

# Package naming guidelines

Package names should be sensible to most Julia users, even to those who are not domain experts. The following guidelines applies to the General registry, but may be useful for other package registries as well.

Since the General registry belongs to the entire community, people may have opinions about your package name when you publish it, especially if it's ambiguous or can be confused with something other than what it is. Usually you will then get suggestions for a new name that may fit your package better.

1. Avoid jargon. In particular, avoid acronyms unless there is minimal possibility of confusion.
  - It's ok to say USA if you're talking about the USA.
  - It's not ok to say PMA, even if you're talking about positive mental attitude.
2. Avoid using Julia in your package name or prefixing it with Ju.
  - It is usually clear from context and to your users that the package is a Julia package.
  - Package names already have a `.jl` extension, which communicates to users that `Package.jl` is a Julia package.
  - Having Julia in the name can imply that the package is connected to, or endorsed by, contributors to the Julia language itself.
3. Packages that provide most of their functionality in association with a new type should have pluralized names.
  - `DataFrames` provides the `DataFrame` type.
  - `BloomFilters` provides the `BloomFilter` type.
  - In contrast, `JuliaParser` provides no new type, but instead new functionality in the `JuliaParser.parse()` function.
4. Err on the side of clarity, even if clarity seems long-winded to you.
  - `RandomMatrices` is a less ambiguous name than `RndMat` or `RMT`, even though the latter are shorter.
5. A less systematic name may suit a package that implements one of several possible approaches to its domain.
  - Julia does not have a single comprehensive plotting package. Instead, `Gadfly`, `PyPlot`, `Winston` and other packages each implement a unique approach based on a particular design philosophy.



- In contrast, `SortingAlgorithms` provides a consistent interface to use many well-established sorting algorithms.
6. Packages that wrap external libraries or programs should be named after those libraries or programs.
    - `CPLEX.jl` wraps the CPLEX library, which can be identified easily in a web search.
    - `MATLAB.jl` provides an interface to call the MATLAB engine from within Julia.
  7. Avoid naming a package closely to an existing package
    - `Websocket` is too close to `WebSockets` and can be confusing to users. Rather use a new name such as `SimpleWebsockets`.

## Chapter 24

# Registering packages

Once a package is ready it can be registered with the [General Registry](#) (see also the [FAQ](#)). Currently packages are submitted via [Registrator](#). In addition to Registrator, [TagBot](#) helps manage the process of tagging releases.

## Chapter 25

# Best Practices

Packages should avoid mutating their own state (writing to files within their package directory). Packages should, in general, not assume that they are located in a writable location (e.g. if installed as part of a system-wide depot) or even a stable one (e.g. if they are bundled into a system image by [PackageCompiler.jl](#)). To support the various usecases in the Julia package ecosystem, the Pkg developers have created a number of auxilliary packages and techniques to help package authors create self-contained, immutable and relocatable packages:

- [Artifacts](#) can be used to bundle chunks of data alongside your package, or even allow them to be downloaded on-demand. Prefer artifacts over attempting to open a file via a path such as `joinpath(@__DIR__, "data", "my_dataset.csv")` as this is non-relocatable. Once your package has been precompiled, the result of `@__DIR__` will have been baked into your precompiled package data, and if you attempt to distribute this package, it will attempt to load files at the wrong location. Artifacts can be bundled and accessed easily using the `artifact"name"` string macro. Artifacts are available from Julia 1.3 onward.
- [Scratch.jl](#) provides the notion of "scratch spaces", mutable containers of data for packages. Scratch spaces are designed for data caches that are completely managed by a package and should be removed when the package itself is uninstalled. For important user-generated data, packages should continue to write out to a user-specified path that is not managed by Julia or Pkg. Scratch is usable from Julia 1.5 onward.
- [Preferences.jl](#) allows packages to read and write preferences to the top-level `Project.toml`. These preferences can be read at runtime or compile-time, to enable or disable different aspects of package behavior. Packages previously would write out files to their own package directories to record options set by the user or environment, but this is highly discouraged now that Preferences is available. Preferences are available from Julia 1.6 onward.

## **Part VI**

# **6. Compatibility**

Compatibility refers to the ability to restrict the versions of the dependencies that your project is compatible with. If the compatibility for a dependency is not given, the project is assumed to be compatible with all versions of that dependency.

Compatibility for a dependency is entered in the `Project.toml` file as for example:

```
[compat]
julia = "1.0"
Example = "0.4.3"
```

After a compatibility entry is put into the project file, up can be used to apply it.

The format of the version specifier is described in detail below.

### Info

There is currently no way to give compatibility from the Pkg REPL mode so for now, one has to manually edit the project file.

## Chapter 26

# Version specifier format

Similar to other package managers, the Julia package manager respects [semantic versioning](#) (semver). As an example, a version specifier given as e.g. `1.2.3` is therefore assumed to be compatible with the versions `[1.2.3 - 2.0.0)` where `)` is a non-inclusive upper bound. More specifically, a version specifier is either given as a **caret specifier**, e.g. `^1.2.3` or as a **tilde specifier**, e.g. `~1.2.3`. Caret specifiers are the default and hence `1.2.3 == ^1.2.3`. The difference between a caret and tilde is described in the next section. The union of multiple version specifiers can be formed by comma separating individual version specifiers, e.g.

```
[compat]
Example = "1.2, 2"
```

will result in `[1.2.0, 3.0.0)`. Note leading zeros are treated differently, e.g. `Example = "0.2, 1"` would only result in `[0.2.0 - 0.3.0) ∪ [1.0.0 - 2.0.0)`. See the next section for more information on versions with leading zeros.

### 26.1 Behavior of versions with leading zeros (0.0.x and 0.x.y)

While the semver specification says that all versions with a major version of 0 (versions before 1.0.0) are incompatible with each other, we have decided to only apply that for when both the major and minor versions are zero. In other words, 0.0.1 and 0.0.2 are considered incompatible. A pre-1.0 version with non-zero minor version (`0.a.b` with `a != 0`) is considered compatible with versions with the same minor version and smaller or equal patch versions (`0.a.c` with `c <= b`); i.e., the versions 0.2.2 and 0.2.3 are compatible with 0.2.1 and 0.2.0. Versions with a major version of 0 and different minor versions are not considered compatible, so the version 0.3.0 might have breaking changes from 0.2.0. To that end, the `[compat]` entry:

```
[compat]
Example = "0.0.1"
```

results in a versionbound on `Example` as `[0.0.1, 0.0.2)` (which is equivalent to only the version 0.0.1), while the `[compat]` entry:

```
[compat]
Example = "0.2.1"
```

results in a versionbound on `Example` as `[0.2.1, 0.3.0)`.

In particular, a package may set `version = "0.2.4"` when it has feature additions compared to 0.2.3 as long as it remains backward compatible with 0.2.0. See also [The version field](#).

## 26.2 Caret specifiers

A caret (^) specifier allows upgrade that would be compatible according to semver. This is the default behavior if no specifier is used. An updated dependency is considered compatible if the new version does not modify the left-most non zero digit in the version specifier.

Some examples are shown below.

```
[compat]
PkgA = "^1.2.3" # [1.2.3, 2.0.0)
PkgB = "^1.2"   # [1.2.0, 2.0.0)
PkgC = "^1"     # [1.0.0, 2.0.0)
PkgD = "^0.2.3" # [0.2.3, 0.3.0)
PkgE = "^0.0.3" # [0.0.3, 0.0.4)
PkgF = "^0.0"   # [0.0.0, 0.1.0)
PkgG = "^0"     # [0.0.0, 1.0.0)
```

## 26.3 Tilde specifiers

A tilde specifier provides more limited upgrade possibilities. When specifying major, minor and patch versions, or when specifying major and minor versions, only the patch version is allowed to change. If you only specify a major version, then both minor and patch versions are allowed to be upgraded (~1 is thus equivalent to ^1). For example:

```
[compat]
PkgA = "~1.2.3" # [1.2.3, 1.3.0)
PkgB = "~1.2"   # [1.2.0, 1.3.0)
PkgC = "~1"     # [1.0.0, 2.0.0)
PkgD = "~0.2.3" # [0.2.3, 0.3.0)
PkgE = "~0.0.3" # [0.0.3, 0.0.4)
PkgF = "~0.0"   # [0.0.0, 0.1.0)
PkgG = "~0"     # [0.0.0, 1.0.0)
```

For all versions with a major version of 0 the tilde and caret specifiers are equivalent.

## 26.4 Equality specifier

Equality can be used to specify exact versions:

```
[compat]
PkgA = "=1.2.3" # [1.2.3, 1.2.3]
PkgA = "=0.10.1, =0.10.3" # 0.10.1 or 0.10.3
```

## 26.5 Inequality specifiers

Inequalities can also be used to specify version ranges:

```
[compat]
PkgB = ">= 1.2.3" # [1.2.3, ∞)
PkgC = "≥ 1.2.3" # [1.2.3, ∞)
PkgD = "< 1.2.3" # [0.0.0, 1.2.3) = [0.0.0, 1.2.2]
```

## 26.6 Hyphen specifiers

Hyphen syntax can also be used to specify version ranges. Make sure that you have a space on both sides of the hyphen.

```
[compat]
PkgA = "1.2.3 - 4.5.6" # [1.2.3, 4.5.6]
PkgA = "0.2.3 - 4.5.6" # [0.2.3, 4.5.6]
```

Any unspecified trailing numbers in the first end-point are considered to be zero:

```
[compat]
PkgA = "1.2 - 4.5.6" # [1.2.0, 4.5.6]
PkgA = "1 - 4.5.6" # [1.0.0, 4.5.6]
PkgA = "0.2 - 4.5.6" # [0.2.0, 4.5.6]
PkgA = "0.2 - 0.5.6" # [0.2.0, 0.5.6]
```

Any unspecified trailing numbers in the second end-point will be considered to be wildcards:

```
[compat]
PkgA = "1.2.3 - 4.5" # 1.2.3 - 4.5.* = [1.2.3, 4.6.0)
PkgA = "1.2.3 - 4" # 1.2.3 - 4.*.* = [1.2.3, 5.0.0)
PkgA = "1.2 - 4.5" # 1.2.0 - 4.5.* = [1.2.0, 4.6.0)
PkgA = "1.2 - 4" # 1.2.0 - 4.*.* = [1.2.0, 5.0.0)
PkgA = "1 - 4.5" # 1.0.0 - 4.5.* = [1.0.0, 4.6.0)
PkgA = "1 - 4" # 1.0.0 - 4.*.* = [1.0.0, 5.0.0)
PkgA = "0.2.3 - 4.5" # 0.2.3 - 4.5.* = [0.2.3, 4.6.0)
PkgA = "0.2.3 - 4" # 0.2.3 - 4.*.* = [0.2.3, 5.0.0)
PkgA = "0.2 - 4.5" # 0.2.0 - 4.5.* = [0.2.0, 4.6.0)
PkgA = "0.2 - 4" # 0.2.0 - 4.*.* = [0.2.0, 5.0.0)
PkgA = "0.2 - 0.5" # 0.2.0 - 0.5.* = [0.2.0, 0.6.0)
PkgA = "0.2 - 0" # 0.2.0 - 0.*.* = [0.2.0, 1.0.0)
```

### Julia 1.4

Hyphen specifiers requires at least Julia 1.4, so it is strongly recommended to also add

```
[compat]
julia = "1.4"
```

to the project file when using them.



## Chapter 27

# Fixing conflicts

Version conflicts were introduced previously with an [example](#) of a conflict arising in a package D used by two other packages, B and C. Our analysis of the error message revealed that B is using an outdated version of D. To fix it, the first thing to try is to `pkg> dev B` so that you can modify B and its compatibility requirements. If you open its `Project.toml` file in an editor, you would probably notice something like

```
[compat]
D = "0.1"
```

Usually the first step is to modify this to something like

```
[compat]
D = "0.1, 0.2"
```

This indicates that B is compatible with both versions 0.1 and version 0.2; if you `pkg> up` this would fix the package error. However, there is one major concern you need to address first: perhaps there was an incompatible change in v0.2 of D that breaks B. Before proceeding further, you should update all packages and then run B's tests, scanning the output of `pkg> test B` to be sure that v0.2 of D is in fact being used. (It is possible that an additional dependency of D pins it to v0.1, and you wouldn't want to be misled into thinking that you had tested B on the newer version.) If the new version was used and the tests still pass, you can assume that B didn't need any further updating to accommodate v0.2 of D; you can safely submit this change as a pull request to B so that a new release is made. If instead an error is thrown, it indicates that B requires more extensive updates to be compatible with the latest version of D; those updates will need to be completed before it becomes possible to use both A and B simultaneously. You can, though, continue to use them independently of one another.

## **Part VII**

### **7. Registries**

Registries contain information about packages, such as available releases and dependencies, and where they can be downloaded. The General registry (<https://github.com/JuliaRegistries/General>) is the default one, and is installed automatically if there are no other registries installed.

## Chapter 28

# Managing registries

### Julia 1.1

Pkg's registry handling requires at least Julia 1.1.

Registries can be added, removed and updated from either the Pkg REPL or by using the functional API. In this section we will describe the REPL interface. The registry API is documented in the [Registry API Reference](#) section.

### 28.1 Adding registries

A custom registry can be added with the `registry add` command from the Pkg REPL. Usually this will be done with a URL to the registry.

Adding a custom registry might cause the General registry to not be added automatically. In that case, we can simply add the General registry manually:

```
pkg> registry add https://github.com/JuliaRegistries/General
Cloning registry from "https://github.com/JuliaRegistries/General"
Added registry `General` to `~/.julia/registries/General`
```

and now all the packages registered in General are available for e.g. adding. To see which registries are currently installed you can use the `registry status` (or `registry st`) command

```
pkg> registry st
Registry Status
[23338594] General (https://github.com/JuliaRegistries/General.git)
```

Registries are always added to the user depot, which is the first entry in `DEPOT_PATH` (cf. the [Glossary](#) section).

### 28.2 Removing registries

Registries can be removed with the `registry remove` (or `registry rm`) command. Here we remove the General registry

```
pkg> registry rm General
Removing registry `General` from ~/.julia/registries/General
```

```
| pkg> registry st  
| Registry Status  
| (no registries found)
```

In case there are multiple registries named `General` installed you have to disambiguate with the `uuid`, just as when manipulating packages, e.g.

```
| pkg> registry rm General=23338594-aafe-5451-b93e-139f81909106  
| Removing registry `General` from ~/.julia/registries/General`
```

### 28.3 Updating registries

The registry update (or `registry up`) command is available to update registries. Here we update the `General` registry:

```
| pkg> registry up General  
| Updating registry at `~/.julia/registries/General`  
| Updating git-repo `https://github.com/JuliaRegistries/General`
```

and to update all installed registries just do:

```
| pkg> registry up  
| Updating registry at `~/.julia/registries/General`  
| Updating git-repo `https://github.com/JuliaRegistries/General`
```

### 28.4 Creating and maintaining registries

Pkg only provides client facilities for registries, rather than functionality to create or maintain them. However, [Registrator.jl](#) and [LocalRegistry.jl](#) provide ways to create and update registries, and [RegistryCI.jl](#) provides automated testing and merging functionality for maintaining a registry.

## **Part VIII**

### **8. Artifacts**

**Julia 1.3**

Pkg's artifacts functionality requires at least Julia 1.3.

Pkg can install and manage containers of data that are not Julia packages. These containers can contain platform-specific binaries, datasets, text, or any other kind of data that would be convenient to place within an immutable, life-cycled datastore. These containers, (called "Artifacts") can be created locally, hosted anywhere, and automatically downloaded and unpacked upon installation of your Julia package. This mechanism is also used to provide the binary dependencies for packages built with [BinaryBuilder.jl](#).

## Chapter 29

# Basic Usage

Pkg artifacts are declared in an `Artifacts.toml` file, which can be placed in your current directory or in the root of your package. Currently, Pkg supports downloading of tarfiles (which can be compressed) from a URL. Following is a minimal `Artifacts.toml` file which will permit the downloading of a `socrates.tar.gz` file from `github.com`. In this example, a single artifact, given the name `socrates`, is defined.

```
# a simple Artifacts.toml file
[socrates]
git-tree-sha1 = "43563e7631a7eafae1f9f8d9d332e3de44ad7239"

[[socrates.download]]
url = "https://github.com/staticfloat/small_bin/raw/master/socrates.tar.gz"
sha256 = "e65d2f13f2085f2c279830e863292312a72930fee5ba3c792b14c33ce5c5cc58"
```

If this `Artifacts.toml` file is placed in your current directory, then `socrates.tar.gz` can be downloaded, unpacked and used with `artifact"socrates"`. Since this tarball contains a folder `bin`, and a text file named `socrates` within that folder, we could access the content of that file as follows.

```
using Pkg.Artifacts

rootpath = artifact"socrates"
open(joinpath(rootpath, "bin", "socrates")) do file
    println(read(file, String))
end
```

If you have an existing tarball that is accessible via a url, it could also be accessed in this manner. To create the `Artifacts.toml` you must compute two hashes: the `sha256` hash of the download file, and the `git-tree-sha1` of the unpacked content. These can be computed as follows.

```
using Tar, Inflate, SHA

filename = "socrates.tar.gz"
println("sha256: ", bytes2hex(open sha256, filename)))
println("git-tree-sha1: ", Tar.tree_hash(IOBuffer(Inflate.gzip(filename))))
```

To access this artifact from within a package you create, place the `Artifacts.toml` at the root of your package, adjacent to `Project.toml`. Then, make sure to add Pkg in your `deps` and set `julia = "1.3"` or higher in your `compat` section.



## Chapter 30

# Artifacts.toml files

Pkg provides an API for working with artifacts, as well as a TOML file format for recording artifact usage in your packages, and to automate downloading of artifacts at package install time. Artifacts can always be referred to by content hash, but are typically accessed by a name that is bound to a content hash in an `Artifacts.toml` file that lives in a project's source tree.

### Note

It is possible to use the alternate name `JuliaArtifacts.toml`, similar to how it is possible to use `JuliaProject.toml` and `JuliaManifest.toml` instead of `Project.toml` and `Manifest.toml`, respectively.

An example `Artifacts.toml` file is shown here:

```
# Example Artifacts.toml file
[socrates]
git-tree-sha1 = "43563e7631a7eafae1f9f8d9d332e3de44ad7239"
lazy = true

[[socrates.download]]
url = "https://github.com/staticfloat/small_bin/raw/master/socrates.tar.gz"
sha256 = "e65d2f13f2085f2c279830e863292312a72930fee5ba3c792b14c33ce5c5cc58"

[[socrates.download]]
url = "https://github.com/staticfloat/small_bin/raw/master/socrates.tar.bz2"
sha256 = "13fc17b97be41763b02cbb80e9d048302cec3bd3d446c2ed6e8210bddcd3ac76"

[[c_simple]]
arch = "x86_64"
git-tree-sha1 = "4bdf4556050cb55b67b211d4e78009aaec378cbc"
libc = "musl"
os = "linux"

[[c_simple.download]]
sha256 = "411d6befd49942826ea1e59041bddf7dbb72fb871bb03165bf4e164b13ab5130"
url = "https://github.com/JuliaBinaryWrappers/c_simple_jll.jl/releases/download/c_simple+v1.2.3+0/c_simple.v1.2.3.x86_64-linux-musl.tar.gz"

[[c_simple]]
arch = "x86_64"
git-tree-sha1 = "51264dbc770cd38aeb15f93536c29dc38c727e4c"
```

```
os = "macos"

[[c_simple.download]]
sha256 = "6c17d9e1dc95ba86ec7462637824afe7a25b8509cc51453f0eb86eda03ed4dc3"
url = "https://github.com/JuliaBinaryWrappers/c_simple_jll.jl/releases/download/c_simple+v1
.2.3+0/c_simple.v1.2.3.x86_64-apple-darwin14.tar.gz"

[processed_output]
git-tree-sha1 = "1c223e66f1a8e0fae1f9fcb9d3f2e3ce48a82200"
```

This `Artifacts.toml` binds three artifacts; one named `socrates`, one named `c_simple` and one named `processed_output`. The single required piece of information for an artifact is its `git-tree-sha1`. Because artifacts are addressed only by their content hash, the purpose of an `Artifacts.toml` file is to provide meta-data about these artifacts, such as binding a human-readable name to a content hash, providing information about where an artifact may be downloaded from, or even binding a single name to multiple hashes, keyed by platform-specific constraints such as operating system or `libgfortran` version.

## Chapter 31

### Artifact types and properties

In the above example, the `socrates` artifact showcases a platform-independent artifact with multiple download locations. When downloading and installing the `socrates` artifact, URLs will be attempted in-order until one succeeds. The `socrates` artifact is marked as `lazy`, which means that it will not be automatically downloaded when the containing package is installed, but rather will be downloaded on-demand when the package first attempts to use it.

The `c_simple` artifact showcases a platform-dependent artifact, where each entry in the `c_simple` array contains keys that help the calling package choose the appropriate download based on the particulars of the host machine. Note that each artifact contains both a `git-tree-sha1` and a `sha256` for each download entry. This is to ensure that the downloaded tarball is secure before attempting to unpack it, as well as enforcing that all tarballs must expand to the same overall tree hash.

The `processed_output` artifact contains no `download` stanza, and so cannot be installed. An artifact such as this would be the result of code that was previously run, generating a new artifact and binding the resultant hash to a name within this project.

## Chapter 32

# Using Artifacts

Artifacts can be manipulated using convenient APIs exposed from the `Pkg.Artifacts` namespace. As a motivating example, let us imagine that we are writing a package that needs to load the [Iris machine learning dataset](#). While we could just download the dataset during a build step into the package directory, and many packages currently do precisely this, that has some significant drawbacks:

- First, it modifies the package directory, making package installation stateful, which we want to avoid. In the future, we would like to reach the point where packages can be installed completely read-only, instead of being able to modify themselves after installation.
- Second, the downloaded data is not shared across different versions of our package. If we have three different versions of the package installed for use by various projects, then we need three different copies of the data, even if it hasn't changed between those versions. Moreover, each time we upgrade or downgrade the package, unless we do something clever (and probably brittle), we have to download the data again.

With artifacts, we will instead check to see if our `iris` artifact already exists on-disk and only if it doesn't will we download and install it, after which we can bind the result into our `Artifacts.toml` file:

```
using Pkg.Artifacts

# This is the path to the Artifacts.toml we will manipulate
artifact_toml = joinpath(@__DIR__, "Artifacts.toml")

# Query the `Artifacts.toml` file for the hash bound to the name "iris"
# (returns `nothing` if no such binding exists)
iris_hash = artifact_hash("iris", artifact_toml)

# If the name was not bound, or the hash it was bound to does not exist, create it!
if iris_hash == nothing || !artifact_exists(iris_hash)
    # create_artifact() returns the content-hash of the artifact directory once we're finished
    ↪ creating it
    iris_hash = create_artifact() do artifact_dir
        # We create the artifact by simply downloading a few files into the new artifact directory
        iris_url_base = "https://archive.ics.uci.edu/ml/machine-learning-databases/iris"
        download("$(iris_url_base)/iris.data", joinpath(artifact_dir, "iris.csv"))
        download("$(iris_url_base)/bezdekIris.data", joinpath(artifact_dir, "bezdekIris.csv"))
        download("$(iris_url_base)/iris.names", joinpath(artifact_dir, "iris.names"))
    end
end
```

```
# Now bind that hash within our `Artifacts.toml`. `force = true` means that if it already
↪ exists,
# just overwrite with the new content-hash. Unless the source files change, we do not expect
# the content hash to change, so this should not cause unnecessary version control churn.
bind_artifact!(artifact_toml, "iris", iris_hash)
end

# Get the path of the iris dataset, either newly created or previously generated.
# this should be something like `~/.julia/artifacts/dbd04e28be047a54fbe9bf67e934be5b5e0d357a`
iris_dataset_path = artifact_path(iris_hash)
```

For the specific use case of using artifacts that were previously bound, we have the shorthand notation `artifact"name"` which will automatically search for the `Artifacts.toml` file contained within the current package, look up the given artifact by name, install it if it is not yet installed, then return the path to that given artifact. An example of this shorthand notation is given below:

```
using Pkg.Artifacts

# For this to work, an `Artifacts.toml` file must be in the current working directory
# (or in the root of the current package) and must define a mapping for the "iris"
# artifact. If it does not exist on-disk, it will be downloaded.
iris_dataset_path = artifact"iris"
```

## Chapter 33

# The Pkg.Artifacts API

The Artifacts API is broken up into three levels: hash-aware functions, name-aware functions and utility functions.

- **Hash-aware** functions deal with content-hashes and essentially nothing else. These methods allow you to query whether an artifact exists, what its path is, to verify that an artifact satisfies its content hash on-disk, etc. Hash-aware functions include: `artifact_exists()`, `artifact_path()`, `remove_artifact()`, `verify_artifact()` and `archive_artifact()`. Note that in general you should not use `remove_artifact()` and should instead use `Pkg.gc()` to cleanup artifact installations.
- **Name-aware** functions deal with bound names within an `Artifacts.toml` file, and as such, typically require both a path to an `Artifacts.toml` file as well as the artifact name. Name-aware functions include: `artifact_meta()`, `artifact_hash()`, `bind_artifact!()`, `unbind_artifact!()`, `download_artifact()` and `ensure_artifact_installed()`.
- **Utility** functions deal with miscellaneous aspects of artifact life, such as `create_artifact()`, `ensure_all_artifacts_installed()` and even the `@artifact_str` string macro.

For a full listing of docstrings and methods, see the [Artifacts Reference](#) section.

## Chapter 34

# Overriding artifact locations

It is occasionally necessary to be able to override the location and content of an artifact. A common use case is a computing environment where certain versions of a binary dependency must be used, regardless of what version of this dependency a package was published with. While a typical Julia configuration would download, unpack and link against a generic library, a system administrator may wish to disable this and instead use a library already installed on the local machine. To enable this, Pkg supports a per-depot `Overrides.toml` file placed within the artifacts depot directory (e.g. `~/.julia/artifacts/Overrides.toml` for the default user depot) that can override the location of an artifact either by content-hash or by package UUID and bound artifact name. Additionally, the destination location can be either an absolute path, or a replacement artifact content hash. This allows sysadmins to create their own artifacts which they can then use by overriding other packages to use the new artifact.

```
# Override single hash to absolute path
78f35e74ff113f02274ce60dab6e92b4546ef806 = "/path/to/replacement"

# Override single hash to new artifact content-hash
683942669b4639019be7631caa28c38f3e1924fe = "d826e316b6c0d29d9ad0875af6ca63bf67ed38c3"

# Override package bindings by specifying the package UUID and bound artifact name
# For demonstration purposes we assume this package is called `Foo`
[d57dbccd-ca19-4d82-b9b8-9d660942965b]
libfoo = "/path/to/libfoo"
libbar = "683942669b4639019be7631caa28c38f3e1924fe"
```

Due to the layered nature of Pkg depots, multiple `Overrides.toml` files may be in effect at once. This allows the "inner" `Overrides.toml` files to override the overrides placed within the "outer" `Overrides.toml` files. To remove an override and re-enable default location logic for an artifact, insert an entry mapping to the empty string:

```
78f35e74ff113f02274ce60dab6e92b4546ef806 = "/path/to/new/replacement"
683942669b4639019be7631caa28c38f3e1924fe = ""

[d57dbccd-ca19-4d82-b9b8-9d660942965b]
libfoo = ""
```

If the two `Overrides.toml` snippets as given above are layered on top of each other, the end result will be mapping the content-hash `78f35e74ff113f02274ce60dab6e92b4546ef806` to `"/path/to/new/replacement"`, and mapping `Foo.libbar` to the artifact identified by the content-hash `683942669b4639019be7631caa28c38f3e1924fe`. Note that while that hash was previously overridden, it is no longer, and therefore `Foo.libbar` will look directly at locations such as `~/.julia/artifacts/683942669b4639019be7631caa28c38f3e1924fe`.

Most methods that are affected by overrides have the ability to ignore overrides by setting `honor_overrides=false` as a keyword argument within them. For UUID/name based overrides to work, `Artifacts.toml` files must be loaded with the knowledge of the UUID of the loading package. This is deduced automatically by the `artifacts""` string macro, however if you are for some reason manually using the `Pkg.Artifacts` API within your package and you wish to honor overrides, you must provide the package UUID to API calls like `artifact_meta()` and `ensure_artifact_installed()` via the `pkg_uuid` keyword argument.



## Chapter 35

# Extending Platform Selection

### Julia 1.7

Pkg's extended platform selection requires at least Julia 1.7, and is considered experimental.

New in Julia 1.6, Platform objects can have extended attributes applied to them, allowing artifacts to be tagged with things such as CUDA driver version compatibility, microarchitectural compatibility, julia version compatibility and more! Note that this feature is considered experimental and may change in the future. If you as a package developer find yourself needing this feature, please get in contact with us so it can evolve for the benefit of the whole ecosystem. In order to support artifact selection at `Pkg.add()` time, Pkg will run the specially-named file `<project_root>/ .pkg/select_artifacts.jl`, passing the current platform triplet as the first argument. This artifact selection script should print a TOML-serialized dictionary representing the artifacts that this package needs according to the given platform, and performing any inspection of the system as necessary to auto-detect platform capabilities, if they are not explicitly provided by the given platform triplet. The format of the dictionary should match that returned from `Artifacts.select_downloadable_artifacts()`, and indeed most packages should simply call that function with an augmented Platform object. An example artifact selection hook definition might look like the following, split across two files:

```
# .pkg/platform_augmentation.jl
using Libdl, Base.BinaryPlatforms
function augment_platform!(p::Platform)
    # If this platform object already has a `cuda` tag set, don't augment
    if haskey(p, "cuda")
        return p
    end

    # Open libcuda explicitly, so it gets `dlclose()`'ed after we're done
    dlopen("libcuda") do lib
        # find symbol to ask for driver version; if we can't find it, just silently continue
        cuDriverGetVersion = dlsym(lib, "cuDriverGetVersion"; throw_error=false)
        if cuDriverGetVersion != nothing
            # Interrogate CUDA driver for driver version:
            driverVersion = Ref{Cint}()
            ccall(cuDriverGetVersion, UInt32, (Ptr{Cint},), driverVersion)

            # Store only the major version
            p["cuda"] = div(driverVersion, 1000)
        end
    end
end
```

```

    # Return possibly-altered `Platform` object
    return p
end

using TOML, Artifacts, Base.BinaryPlatforms
include("../platform_augmentation.jl")
artifacts_toml = joinpath(dirname(@__DIR__), "Artifacts.toml")

# Get "target triplet" from ARGS, if given (defaulting to the host triplet otherwise)
target_triplet = get(ARGS, 1, Base.BinaryPlatforms.host_triplet())

# Augment this platform object with any special tags we require
platform = augment_platform!(HostPlatform(parse(Platform, target_triplet)))

# Select all downloadable artifacts that match that platform
artifacts = select_downloadable_artifacts(artifacts_toml; platform)

# Output the result to `stdout` as a TOML dictionary
TOML.print(stdout, artifacts)

```

In this hook definition, our platform augmentation routine opens a system library (libcuda), searches it for a symbol to give us the CUDA driver version, then embeds the major version of that version number into the `cuda` property of the `Platform` object we are augmenting. While it is not critical for this code to actually attempt to close the loaded library (as it will most likely be opened again by the CUDA package immediately after the package operations are completed) it is best practice to make hooks as lightweight and transparent as possible, as they may be used by other Pkg utilities in the future. In your own package, you should also use augmented platform objects when using the `@artifact_str` macro, as follows:

```

include("../.pkg/platform_augmentation.jl")

function __init__()
    p = augment_platform!(HostPlatform())
    global my_artifact_dir = @artifact_str("MyArtifact", p)
end

```

This ensures that the same artifact is used by your code as Pkg attempted to install.

## **Part IX**

### **9. Glossary**

**Project:** a source tree with a standard layout, including a `src` directory for the main body of Julia code, a `test` directory for testing the project, a `docs` directory for documentation files, and optionally a `deps` directory for a build script and its outputs. A project will typically also have a project file and may optionally have a manifest file:

- **Project file:** a file in the root directory of a project, named `Project.toml` (or `JuliaProject.toml`), describing metadata about the project, including its name, UUID (for packages), authors, license, and the names and UUIDs of packages and libraries that it depends on.
- **Manifest file:** a file in the root directory of a project, named `Manifest.toml` (or `JuliaManifest.toml`), describing a complete dependency graph and exact versions of each package and library used by a project.

**Package:** a project which provides reusable functionality that can be used by other Julia projects via `import X` or `using X`. A package should have a project file with a `uuid` entry giving its package UUID. This UUID is used to identify the package in projects that depend on it.

#### Note

For legacy reasons it is possible to load a package without a project file or UUID from the REPL or the top-level of a script. It is not possible, however, to load a package without a project file or UUID from a project with them. Once you've loaded from a project file, everything needs a project file and UUID.

**Application:** a project which provides standalone functionality not intended to be reused by other Julia projects. For example a web application or a command-line utility, or simulation/analytics code accompanying a scientific paper. An application may have a UUID but does not need one. An application may also provide global configuration options for packages it depends on. Packages, on the other hand, may not provide global configuration since that could conflict with the configuration of the main application.

#### Note

##### Projects vs. Packages vs. Applications:

1. **Project** is an umbrella term: packages and applications are kinds of projects.
2. **Packages** should have UUIDs, applications can have a UUIDs but don't need them.
3. **Applications** can provide global configuration, whereas packages cannot.

**Environment:** the combination of the top-level name map provided by a project file combined with the dependency graph and map from packages to their entry points provided by a manifest file. For more detail see the manual section on code loading.

- **Explicit environment:** an environment in the form of an explicit project file and an optional corresponding manifest file together in a directory. If the manifest file is absent then the implied dependency graph and location maps are empty.
- **Implicit environment:** an environment provided as a directory (without a project file or manifest file) containing packages with entry points of the form `X.jl`, `X.jl/src/X.jl` or `X/src/X.jl`. The top-level name map is implied by these entry points. The dependency graph is implied by the existence of project files inside of these package directories, e.g. `X.jl/Project.toml` or `X/Project.toml`. The dependencies of the `X` package are the dependencies in the corresponding project file if there is one. The location map is implied by the entry points themselves.

**Registry:** a source tree with a standard layout recording metadata about a registered set of packages, the tagged versions of them which are available, and which versions of packages are compatible or incompatible with each other. A registry is indexed by package name and UUID, and has a directory for each registered package providing the following metadata about it:

- name – e.g. DataFrames
- UUID – e.g. a93c6f00-e57d-5684-b7b6-d8193f3e46c0
- repository – e.g. <https://github.com/JuliaData/DataFrames.jl.git>
- versions – a list of all registered version tags

For each registered version of a package, the following information is provided:

- its semantic version number – e.g. v1.2.3
- its git tree SHA-1 hash – e.g. 7ffb18ea3245ef98e368b02b81e8a86543a11103
- a map from names to UUIDs of dependencies
- which versions of other packages it is compatible/incompatible with

Dependencies and compatibility are stored in a compressed but human-readable format using ranges of package versions.

**Depot:** a directory on a system where various package-related resources live, including:

- environments: shared named environments (e.g. v1.0, devtools)
- clones: bare clones of package repositories
- compiled: cached compiled package images (.ji files)
- config: global configuration files (e.g. startup.jl)
- dev: default directory for package development
- logs: log files (e.g. manifest\_usage.toml, repl\_history.jl)
- packages: installed package versions
- registries: clones of registries (e.g. General)

**Load path:** a stack of environments where package identities, their dependencies, and entry-points are searched for. The load path is controlled in Julia by the `LOAD_PATH` global variable which is populated at startup based on the value of the `JULIA_LOAD_PATH` environment variable. The first entry is your primary environment, often the current project, while later entries provide additional packages one may want to use from the REPL or top-level scripts.

**Depot path:** a stack of depot locations where the package manager, as well as Julia's code loading mechanisms, look for registries, installed packages, named environments, repo clones, cached compiled package images, and configuration files. The depot path is controlled by the Julia `DEPOT_PATH` global variable which is populated at startup based on the value of the `JULIA_DEPOT_PATH` environment variable. The first entry is the “user depot” and should be writable by and owned by the current user. The user depot is where: registries are cloned, new package versions are installed, named environments are created and updated, package repos are cloned, newly compiled package image files are saved, log files are written, development packages are checked out by default, and global configuration data is saved. Later entries in the depot path are treated as read-only and are appropriate for registries, packages, etc. installed and managed by system administrators.

## **Part X**

### **10. Project.toml and Manifest.toml**

Two files that are central to Pkg are `Project.toml` and `Manifest.toml`. `Project.toml` and `Manifest.toml` are written in TOML (hence the `.toml` extension) and include information about dependencies, versions, package names, UUIDs etc.

**Note**

The `Project.toml` and `Manifest.toml` files are not only used by the package manager; they are also used by Julia's code loading, and determine e.g. what using `Example` should do. For more details see the section about [Code Loading](#) in the Julia manual.

## Chapter 36

# Project.toml

The project file describes the project on a high level, for example the package/project dependencies and compatibility constraints are listed in the project file. The file entries are described below.

### 36.1 The authors field

For a package, the optional authors field is a list of strings describing the package authors, in the form NAME <EMAIL>. For example:

```
authors = ["Some One <someone@email.com>",  
          "Foo Bar <foo@bar.com>"]
```

### 36.2 The name field

The name of the package/project is determined by the name field, for example:

```
name = "Example"
```

The name must be a valid [identifier](#) (a sequence of Unicode characters that does not start with a number and is neither true nor false). For packages it is recommended to follow the [package naming guidelines](#). The name field is mandatory for packages.

### 36.3 The uuid field

uuid is a string with a [universally unique identifier](#) for the package/project, for example:

```
uuid = "7876af07-990d-54b4-ab0e-23690620f79a"
```

The uuid field is mandatory for packages.

#### Note

It is recommended that `UUIDs.uuid4()` is used to generate random UUIDs.

### 36.4 The version field

version is a string with the version number for the package/project. It should consist of three numbers, major version, minor version and patch number, separated with a `.`, for example:

```
version = "1.2.5"
```



Julia uses [Semantic Versioning](#) (SemVer) and the version field should follow SemVer. The basic rules are:

- Before 1.0.0, anything goes, but when you make breaking changes the minor version should be incremented.
- After 1.0.0 only make breaking changes when incrementing the major version.
- After 1.0.0 no new public API should be added without incrementing the minor version. This includes, in particular, new types, functions, methods and method overloads, from Base or other packages.

See also the section on [Compatibility](#).

Note that Pkg.jl deviates from the SemVer specification when it comes to versions pre-1.0.0. See the section on [pre-1.0 behavior](#) for more details.

### 36.5 The [deps] section

All dependencies of the package/project are listed in the [deps] section. Each dependency is listed as a name-uuid pair, for example:

```
[deps]
Example = "7876af07-990d-54b4-ab0e-23690620f79a"
Test = "8dfed614-e22c-5e08-85e1-65c5234f0b40"
```

Typically it is not needed to manually add entries to the [deps] section; this is instead handled by Pkg operations such as add.

### 36.6 The [compat] section

Compatibility constraints for the dependencies listed under [deps] can be listed in the [compat] section. Example:

```
[deps]
Example = "7876af07-990d-54b4-ab0e-23690620f79a"

[compat]
Example = "1.2"
```

The [Compatibility](#) section describes the different possible compatibility constraints in detail. It is also possible to list constraints on julia itself, although julia is not listed as a dependency in the [deps] section:

```
[compat]
julia = "1.1"
```

## Chapter 37

# Manifest.toml

The manifest file is an absolute record of the state of the packages in the environment. It includes exact information about (direct and indirect) dependencies of the project. Given a `Project.toml` + `Manifest.toml` pair, it is possible to instantiate the exact same package environment, which is very useful for reproducibility. For the details, see [Pkg.instantiate](#).

### Note

The `Manifest.toml` file is generated and maintained by Pkg and, in general, this file should never be modified manually.

### 37.1 Manifest.toml entries

Each dependency has its own section in the manifest file, and its content varies depending on how the dependency was added to the environment. Every dependency section includes a combination of the following entries:

- uuid: the UUID for the dependency, for example uuid = "7876af07-990d-54b4-ab0e-23690620f79a".
- deps: a vector listing the dependencies of the dependency, for example deps = ["Example", "JSON"].
- version: a version number, for example version = "1.2.6".
- path: a file path to the source code, for example path = /home/user/Example.
- repo-url: a URL to the repository where the source code was found, for example repo-url = "https://github.com/Juli".
- repo-rev: a git revision, for example a branch repo-rev = "master" or a commit repo-rev = "66607a62a83cb07ab18c0b".
- git-tree-shal: a content hash of the source tree, for example git-tree-shal = "ca3820cc4e66f473467d912c4b2b3ae5".

### Added package

When a package is added from a package registry, for example by invoking `pkg> add Example` or with a specific version `pkg> add Example@1.2`, the resulting `Manifest.toml` entry looks like:

```
[[Example]]
deps = ["DependencyA", "DependencyB"]
git-tree-sha1 = "8eb7b4d4ca487caade9ba3e85932e28ce6d6e1f8"
uuid = "7876af07-990d-54b4-ab0e-23690620f79a"
version = "1.2.3"
```

Note, in particular, that no `repo-url` is present, since that information is included in the registry where this package were found.

### Added package by branch

The resulting dependency section when adding a package specified by a branch, e.g. `pkg> add Example#master` or `pkg> add https://github.com/JuliaLang/Example.jl.git`, looks like:

```
[[Example]]
deps = ["DependencyA", "DependencyB"]
git-tree-sha1 = "54c7a512469a38312a058ec9f429e1db1f074474"
repo-rev = "master"
repo-url = "https://github.com/JuliaLang/Example.jl.git"
uuid = "7876af07-990d-54b4-ab0e-23690620f79a"
version = "1.2.4"
```

Note that both the branch we are tracking (`master`) and the remote repository url ("`https://github.com/JuliaLang/Example.jl`") are stored in the manifest.

### Added package by commit

The resulting dependency section when adding a package specified by a commit, e.g. `pkg> add Example#cf6ba6cc0be0bb5f5684` looks like:

```
[[Example]]
deps = ["DependencyA", "DependencyB"]
git-tree-sha1 = "54c7a512469a38312a058ec9f429e1db1f074474"
repo-rev = "cf6ba6cc0be0bb5f56840188563579d67048be34"
repo-url = "https://github.com/JuliaLang/Example.jl.git"
uuid = "7876af07-990d-54b4-ab0e-23690620f79a"
version = "1.2.4"
```

The only difference from tracking a branch is the content of `repo-rev`.

### Developed package

The resulting dependency section when adding a package with `develop`, e.g. `pkg> develop Example` or `pkg> develop /path/to/local/folder/Example`, looks like:

```
[[Example]]
deps = ["DependencyA", "DependencyB"]
path = "/home/user/.julia/dev/Example/"
uuid = "7876af07-990d-54b4-ab0e-23690620f79a"
version = "1.2.4"
```

Note that the path to the source code is included, and changes made to that source tree is directly reflected.

### Pinned package

Pinned packages are also recorded in the manifest file; the resulting dependency section for e.g. `pkg> add Example; pin Example` looks like:

```
[[Example]]
deps = ["DependencyA", "DependencyB"]
git-tree-sha1 = "54c7a512469a38312a058ec9f429e1db1f074474"
pinned = true
uuid = "7876af07-990d-54b4-ab0e-23690620f79a"
version = "1.2.4"
```

The only difference is the addition of the `pinned = true` entry.

### Multiple package with the same name

Julia differentiates packages based on UUID, which means that the name alone is not enough to identify a package. It is possible to have multiple packages in the same environment with the same name, but with different UUID. In such a situation the `Manifest.toml` file looks a bit different. Consider for example the situation where you have added A and B to your environment, and the `Project.toml` file looks as follows:

```
[deps]
A = "ead4f63c-334e-11e9-00e6-e7f0a5f21b60"
B = "edca9bc6-334e-11e9-3554-9595dbb4349c"
```

If A now depends on `B = "f41f7b98-334e-11e9-1257-49272045fb24"`, i.e. another package named B there will be two different B packages in the `Manifest.toml` file. In this case the full `Manifest.toml` file, with `git-tree-sha1` and `version` fields removed for clarity, looks like:

```
[[A]]
uuid = "ead4f63c-334e-11e9-00e6-e7f0a5f21b60"

[A.deps]
B = "f41f7b98-334e-11e9-1257-49272045fb24"

[[B]]
uuid = "f41f7b98-334e-11e9-1257-49272045fb24"

[[B]]
uuid = "edca9bc6-334e-11e9-3554-9595dbb4349c"
```

There is now an array of the two B packages, and the `[deps]` section for A has been expanded in order to be explicit about which B package A depends on.

## **Part XI**

# **11. REPL Mode Reference**

This section describes available commands in the Pkg REPL. The Pkg REPL mode is mostly meant for interactive use, and for non-interactive use it is recommended to use the functional API, see [API Reference](#).

## Chapter 38

# package commands

```
| add [--preserve=<opt>] pkg[=uuid] [@version] [#rev] ...
```

Add package `pkg` to the current project file. If `pkg` could refer to multiple different packages, specifying `uuid` allows you to disambiguate. `@version` optionally allows specifying which versions of packages to add. Version specifications are of the form `@1`, `@1.2` or `@1.2.3`, allowing any version with a prefix that matches, or ranges thereof, such as `@1.2-3.4.5`. A git revision can be specified by `#branch` or `#commit`.

If a local path is used as an argument to `add`, the path needs to be a git repository. The project will then track that git repository just like it would track a remote repository online. If the package is not located at the top of the git repository, a subdirectory can be specified with `path:subdir/path`.

`Pkg` resolves the set of packages in your environment using a tiered approach. The `--preserve` command line option allows you to key into a specific tier in the resolve algorithm. The following table describes the command line arguments to `--preserve` (in order of strictness).

Argument	Description
<code>all</code>	Preserve the state of all existing dependencies (including recursive dependencies)
<code>direct</code>	Preserve the state of all existing direct dependencies
<code>semver</code>	Preserve semver-compatible versions of direct dependencies
<code>none</code>	Do not attempt to preserve any version information
<code>tiered</code>	Use the tier which will preserve the most version information (this is the default)

After the installation of new packages the project will be precompiled. For more information see `pkg> ?precompile`.

### Julia 1.5

Subdirectory specification requires at least Julia 1.5.

### Examples

```
| pkg> add Example
| pkg> add --preserve=all Example
| pkg> add Example@0.5
| pkg> add Example#master
| pkg> add Example#c37b675
| pkg> add https://github.com/JuliaLang/Example.jl#master
| pkg> add git@github.com:JuliaLang/Example.jl.git
| pkg> add "git@github.com:JuliaLang/Example.jl.git"#master
| pkg> add Example=7876af07-990d-54b4-ab0e-23690620f79a
```

```
| build [-v|--verbose] pkg[=uuid] ...
```

Run the build script in `deps/build.jl` for `pkg` and all of its dependencies in depth-first recursive order. If no packages are given, run the build scripts for all packages in the manifest. The `-v/--verbose` option redirects build output to `stdout/stderr` instead of the `build.log` file. The `startup.jl` file is disabled during building unless julia is started with `--startup-file=yes`.

```
| [dev|develop] [--preserve=<opt>] [--shared|--local] pkg[=uuid] ...
| [dev|develop] [--preserve=<opt>] path
```

Make a package available for development. If `pkg` is an existing local path, that path will be recorded in the manifest and used. Otherwise, a full git clone of `pkg` is made. The location of the clone is controlled by the `--shared` (default) and `--local` arguments. The `--shared` location defaults to `~/.julia/dev`, but can be controlled with the `JULIA_PKG_DEVDIR` environment variable.

When `--local` is given, the clone is placed in a `dev` folder in the current project. This is not supported for paths, only registered packages.

This operation is undone by `free`.

### Examples

```
| pkg> develop Example
| pkg> develop https://github.com/JuliaLang/Example.jl
| pkg> develop ~/mypackages/Example
| pkg> develop --local Example
```

```
| free pkg[=uuid] ...
| free [--all]
```

Free pinned packages, which allows it to be upgraded or downgraded again. If the package is checked out (see `help develop`) then this command makes the package no longer being checked out.

```
| generate pkgname
```

Create a minimal project called `pkgname` in the current folder. For more featureful package creation, please see `PkgTemplates.jl`.

```
| pin pkg[=uuid] ...
| pin [--all]
```

Pin packages to given versions, or the current version if no version is specified. A pinned package has its version fixed and will not be upgraded or downgraded. A pinned package has the symbol `⌘` next to its version in the status list.

### Examples

```
| pkg> pin Example
| pkg> pin Example@0.5.0
| pkg> pin Example=7876af07-990d-54b4-ab0e-23690620f79a@0.5.0
| pkg> pin --all
```

```
| [rm|remove] [-p|--project] pkg[=uuid] ...
| [rm|remove] [-p|--project] [--all]
```

Remove package `pkg` from the project file. Since the name `pkg` can only refer to one package in a project this is unambiguous, but you can specify a `uuid` anyway, and the command is ignored, with a warning, if package name and UUID do not match. When a package is removed from the project file, it may still remain



in the manifest if it is required by some other package in the project. Project mode operation is the default, so passing `-p` or `--project` is optional unless it is preceded by the `-m` or `--manifest` options at some earlier point. All packages can be removed by passing `--all`.

```
[rm|remove] [-m|--manifest] pkg[=uuid] ...
[rm|remove] [-m|--manifest] [--all]
```

Remove package `pkg` from the manifest file. If the name `pkg` refers to multiple packages in the manifest, `uuid` disambiguates it. Removing a package from the manifest forces the removal of all packages that depend on it, as well as any no-longer-necessary manifest packages due to project package removals. All packages can be removed by passing `--all`.

```
| test [--coverage] pkg[=uuid] ...
```

Run the tests for package `pkg`. This is done by running the file `test/runtests.jl` in the package directory. The option `--coverage` can be used to run the tests with coverage enabled. The `startup.jl` file is disabled during testing unless `julia` is started with `--startup-file=yes`.

```
[up|update] [-p|--project] [opts] pkg[=uuid] [@version] ...
[up|update] [-m|--manifest] [opts] pkg[=uuid] [@version] ...

opts: --major | --minor | --patch | --fixed
```

Update `pkg` within the constraints of the indicated version specifications. These specifications are of the form `@1`, `@1.2` or `@1.2.3`, allowing any version with a prefix that matches, or ranges thereof, such as `@1.2-3.4.5`. In `--project` mode, package specifications only match project packages, while in `--manifest` mode they match any manifest package. Bound level options force the following packages to be upgraded only within the current major, minor, patch version; if the `--fixed` upgrade level is given, then the following packages will not be upgraded at all.

After any package updates the project will be precompiled. For more information see `pkg> ?precompile`.

## Chapter 39

# registry commands

```
| registry add reg...
```

Add package registries `reg...` to the user depot. Without arguments it adds known registries, i.e. the General registry and registries served by the configured package server.

### Julia 1.1

Pkg's registry handling requires at least Julia 1.1.

### Julia 1.5

`registry add` without arguments requires at least Julia 1.5.

### Examples

```
| pkg> registry add General  
| pkg> registry add https://www.my-custom-registry.com  
| pkg> registry add
```

```
| registry [rm|remove] reg...
```

Remove package registries `reg...`

### Julia 1.1

Pkg's registry handling requires at least Julia 1.1.

### Examples

```
| pkg> registry [rm|remove] General
```

```
| registry [st|status]
```

Display information about installed registries.

### Julia 1.1

Pkg's registry handling requires at least Julia 1.1.

### Examples

```
| pkg> registry status
```

```
| registry [up|update]  
| registry [up|update] reg...
```

Update package registries `reg . . .`. If no registries are specified all registries will be updated.

### **Julia 1.1**

Pkg's registry handling requires at least Julia 1.1.

### **Examples**

```
| pkg> registry up  
| pkg> registry up General
```

## Chapter 40

### Other commands

```
activate
activate [--shared] path
activate --temp
```

Activate the environment at the given path, or the home project environment if no path is specified. The active environment is the environment that is modified by executing package commands. When the option `--shared` is given, path will be assumed to be a directory name and searched for in the environments folders of the depots in the depot stack. In case no such environment exists in any of the depots, it will be placed in the first depot of the stack. Use the `--temp` option to create temporary environments which are removed when the julia process is exited.

```
gc [-v|--verbose] [--all]
```

Free disk space by garbage collecting packages not used for a significant time. The `--all` option will garbage collect all packages which can not be immediately reached from any existing project. Use verbose mode for detailed output.

```
[?|help]
```

List available commands along with short descriptions.

```
[?|help] cmd
```

If `cmd` is a partial command, display help for all subcommands. If `cmd` is a full command, display help for `cmd`.

```
instantiate [-v|--verbose]
instantiate [-v|--verbose] [-m|--manifest]
instantiate [-v|--verbose] [-p|--project]
```

Download all the dependencies for the current project at the version given by the project's manifest. If no manifest exists or the `--project` option is given, resolve and download the dependencies compatible with the project.

After packages have been installed the project will be precompiled. For more information see `pkg> ?precompile`.

```
precompile
precompile pkgs...
```

Precompile all or specified dependencies of the project in parallel. The `startup.jl` file is disabled during precompilation unless julia is started with `--startup-file=yes`.

Errors will only throw when precompiling the top-level dependencies, given that not all manifest dependencies may be loaded by the top-level dependencies on the given system.

This method is called automatically after any Pkg action that changes the manifest. Any packages that have previously errored during precompilation won't be retried in auto mode until they have changed. To disable automatic precompilation set the environment variable `JULIA_PKG_PRECOMPILE_AUTO=0`. To manually control the number of tasks used set the environment variable `JULIA_NUM_PRECOMPILE_TASKS`.

```
| resolve
```

Resolve the project i.e. run package resolution and update the Manifest. This is useful in case the dependencies of developed packages have changed causing the current Manifest to be out of sync.

```
| [st|status] [-d|--diff] [-o|--outdated] [pkgs...]
| [st|status] [-d|--diff] [-o|--outdated] [-p|--project] [pkgs...]
| [st|status] [-d|--diff] [-o|--outdated] [-m|--manifest] [pkgs...]
| [st|status] [-c|--compat] [pkgs...]
```

Show the status of the current environment. Packages marked with `^` have new versions that can be installed, e.g. via `pkg> up`. Those marked with `⌘` have new versions available, but that cannot be installed. To see why use `pkg> status --outdated` which shows any packages that are not at their latest version and if any packages are holding them back.

In `--project` mode (default), the status of the project file is summarized. In `--manifest` mode the output also includes the recursive dependencies of added packages given in the manifest. If there are any packages listed as arguments the output will be limited to those packages. The `--diff` option will, if the environment is in a git repository, limit the output to the difference as compared to the last git commit. The `--compat` option alone shows project compat entries.

### Julia 1.1

`pkg> status` with package arguments requires at least Julia 1.1.

### Julia 1.3

The `--diff` option requires at least Julia 1.3. In earlier versions `--diff` is the default for environments in git repositories.

### Julia 1.8

The `^` and `⌘` indicators were added in Julia 1.8 The `--outdated` and `--compat` options require at least Julia 1.8.

## **Part XII**

# **12. API Reference**

This section describes the functional API for interacting with `Pkg.jl`. It is recommended to use the functional API, rather than the Pkg REPL mode, for non-interactive usage, for example in scripts.

## Chapter 41

# General API Reference

Certain options are generally useful and can be specified in any API call. You can specify these options by setting keyword arguments.

### 41.1 Redirecting output

Use the `io::IOBuffer` keyword argument to redirect `Pkg` output. For example, `Pkg.add("Example"; io=devnull)` will discard any output produced by the `add` call.



## Chapter 42

# Package API Reference

In the Pkg REPL mode, packages (with associated version, UUID, URL etc) are parsed from strings, for example "Package#master", "Package@v0.1", "www.mypkg.com/MyPkg#my/feature".

In the functional API, it is possible to use strings as arguments for simple commands (like `Pkg.add(["PackageA", "PackageB"])`), but more complicated commands, which e.g. specify URLs or version range, require the use of a more structured format over strings. This is done by creating an instance of `PackageSpec` which is passed in to functions.

`Pkg.PackageSpec` – Type.

```
PackageSpec(name::String, [uuid::UUID, version::VersionNumber])
PackageSpec(; name, url, path, subdir, rev, version, mode, level)
```

A `PackageSpec` is a representation of a package with various metadata. This includes:

- The name of the package.
- The package's unique uuid.
- A version (for example when adding a package). When upgrading, can also be an instance of the enum `UpgradeLevel`.
- A url and an optional git revision. `rev` can be a branch name or a git commit SHA1.
- A local path. This is equivalent to using the `url` argument but can be more descriptive.
- A `subdir` which can be used when adding a package that is not in the root of a repository.

Most functions in Pkg take a Vector of `PackageSpec` and do the operation on all the packages in the vector.

### Julia 1.5

Many functions that take a `PackageSpec` or a `Vector{PackageSpec}` can be called with a more concise notation with `NamedTuples`. For example, `Pkg.add` can be called either as the explicit or concise versions as:

Explicit	Concise
<code>Pkg.add(PackageSpec(name="Package"))</code>	<code>Pkg.add(name = "Package")</code>
<code>Pkg.add(PackageSpec(url="www.myhost.com/MyPkg"))</code>	<code>Pkg.add(name = "Package")</code>
<code>Pkg.add([PackageSpec(name="Package"), PackageSpec(path="/MyPkg")])</code>	<code>Pkg.add([(;name="Package"), (;path="MyPkg")])</code>

REPL	API
Package	PackageSpec("Package")
Package@0.2	PackageSpec(name="Package", version="0.2")
Package=a67d...	PackageSpec(name="Package", uuid="a67d...")
Package#master	PackageSpec(name="Package", rev="master")
local/path#feature	PackageSpec(path="local/path"; rev="feature")
www.mypkg.com	PackageSpec(url="www.mypkg.com")
--major Package	PackageSpec(name="Package", version=PKGLEVEL_MAJOR)

Below is a comparison between the REPL mode and the functional API:

source

[Pkg.PackageMode](#) – Type.

```
| PackageMode
```

An enum with the instances

- PKGMODE\_MANIFEST
- PKGMODE\_PROJECT

Determines if operations should be made on a project or manifest level. Used as an argument to [Pkg.rm](#), [Pkg.update](#) and [Pkg.status](#).

source

[Pkg.UpgradeLevel](#) – Type.

```
| UpgradeLevel
```

An enum with the instances

- UPLEVEL\_FIXED
- UPLEVEL\_PATCH
- UPLEVEL\_MINOR
- UPLEVEL\_MAJOR

Determines how much a package is allowed to be updated. Used as an argument to [PackageSpec](#) or as an argument to [Pkg.update](#).

source

[Pkg.add](#) – Function.

```
| Pkg.add(pkg::Union{String, Vector{String}}; preserve=PRESERVE_TIERED)
| Pkg.add(pkg::Union{PackageSpec, Vector{PackageSpec}}; preserve=PRESERVE_TIERED)
```

Add a package to the current project. This package will be available by using the `import` and using keywords in the Julia REPL, and if the current project is a package, also inside that package.

### Resolution Tiers

Pkg resolves the set of packages in your environment using a tiered algorithm. The `preserve` keyword argument allows you to key into a specific tier in the resolve algorithm. The following table describes the argument values for `preserve` (in order of strictness):

### Examples

Value	Description
PRESERVE_ALL	Preserve the state of all existing dependencies (including recursive dependencies)
PRESERVE_DIRECT	Preserve the state of all existing direct dependencies
PRESERVE_SEMVER	Preserve semver-compatible versions of direct dependencies
PRESERVE_NONE	Do not attempt to preserve any version information
PRESERVE_TIERED	Use the tier which will preserve the most version information (this is the default)

```

Pkg.add("Example") # Add a package from registry
Pkg.add("Example"; preserve=Pkg.PRESERVE_ALL) # Add the `Example` package and preserve existing
↪ dependencies
Pkg.add(name="Example", version="0.3") # Specify version; latest release in the 0.3 series
Pkg.add(name="Example", version="0.3.1") # Specify version; exact release
Pkg.add(url="https://github.com/JuliaLang/Example.jl", rev="master") # From url to remote
↪ gitrepo
Pkg.add(url="/remote/mycompany/juliapackages/OurPackage") # From path to local gitrepo
Pkg.add(url="https://github.com/Company/MonoRepo", subdir="juliapkg/Package.jl") # With subdir

```

After the installation of new packages the project will be precompiled. See more at [Project Precompilation](#).

See also [PackageSpec](#), [Pkg.develop](#).

[source](#)

[Pkg.develop](#) – Function.

```

Pkg.develop(pkg::Union{String, Vector{String}}; io::IO=stderr)
Pkg.develop(pkgs::Union{PackageSpec, Vector{PackageSpec}}; io::IO=stderr)

```

Make a package available for development by tracking it by path. If pkg is given with only a name or by a URL, the package will be downloaded to the location specified by the environment variable JULIA\_PKG\_DEVDIR, with joinpath(DEPOT\_PATH[1], "dev") being the default.

If pkg is given as a local path, the package at that path will be tracked.

### Examples

```

# By name
Pkg.develop("Example")

# By url
Pkg.develop(url="https://github.com/JuliaLang/Compat.jl")

# By path
Pkg.develop(path="MyJuliaPackages/Package.jl")

```

See also [PackageSpec](#), [Pkg.add](#).

[source](#)

[Pkg.activate](#) – Function.

```

Pkg.activate([s::String]; shared::Bool=false, io::IO=stderr)
Pkg.activate(; temp::Bool=false, shared::Bool=false, io::IO=stderr)

```

Activate the environment at s. The active environment is the environment that is modified by executing package commands. The logic for what path is activated is as follows:

- If `shared` is `true`, the first existing environment named `s` from the depots in the depot stack will be activated. If no such environment exists, create and activate that environment in the first depot.
- If `temp` is `true` this will create and activate a temporary environment which will be deleted when the julia process is exited.
- If `s` is an existing path, then activate the environment at that path.
- If `s` is a package in the current project and `s` is tracking a path, then activate the environment at the tracked path.
- Otherwise, `s` is interpreted as a non-existing path, which is then activated.

If no argument is given to `activate`, then activate the home project. The home project is specified by either the `--project` command line option to the julia executable, or the `JULIA_PROJECT` environment variable.

### Examples

```
Pkg.activate()
Pkg.activate("local/path")
Pkg.activate("MyDependency")
Pkg.activate(; temp=true)
```

### Julia 1.4

the `temp` option requires at least Julia 1.4.

[source](#)

`Pkg.rm` – Function.

```
Pkg.rm(pkg::Union{String, Vector{String}}; mode::PackageMode = PKG_MODE_PROJECT)
Pkg.rm(pkg::Union{PackageSpec, Vector{PackageSpec}}; mode::PackageMode = PKG_MODE_PROJECT)
```

Remove a package from the current project. If `mode` is equal to `PKG_MODE_MANIFEST` also remove it from the manifest including all recursive dependencies of `pkg`.

See also [PackageSpec](#), [PackageMode](#).

[source](#)

`Pkg.update` – Function.

```
Pkg.update(; level::UpgradeLevel=UPLEVEL_MAJOR, mode::PackageMode = PKG_MODE_PROJECT)
Pkg.update(pkg::Union{String, Vector{String}})
Pkg.update(pkg::Union{PackageSpec, Vector{PackageSpec}})
```

Update a package `pkg`. If no positional argument is given, update all packages in the manifest if `mode` is `PKG_MODE_MANIFEST` and packages in both manifest and project if `mode` is `PKG_MODE_PROJECT`. If no positional argument is given, `level` can be used to control by how much packages are allowed to be upgraded (major, minor, patch, fixed).

After any package updates the project will be precompiled. See more at [Project Precompilation](#).

See also [PackageSpec](#), [PackageMode](#), [UpgradeLevel](#).

[source](#)

`Pkg.test` – Function.

```
Pkg.test(; kwargs...)
Pkg.test(pkg::Union{String, Vector{String}}; kwargs...)
Pkg.test(pkgs::Union{PackageSpec, Vector{PackageSpec}}; kwargs...)
```

#### Keyword arguments:

- `coverage::Bool=false`: enable or disable generation of coverage statistics.
- `julia_args::Union{Cmd, Vector{String}}`: options to be passed the test process.
- `test_args::Union{Cmd, Vector{String}}`: test arguments (ARGS) available in the test process.

#### Julia 1.3

`julia_args` and `test_args` requires at least Julia 1.3.

Run the tests for package `pkg`, or for the current project (which thus needs to be a package) if no positional argument is given to `Pkg.test`. A package is tested by running its `test/runtests.jl` file.

The tests are run by generating a temporary environment with only `pkg` and its (recursive) dependencies in it. If a manifest exists, the versions in that manifest are used, otherwise a feasible set of packages is resolved and installed.

During the tests, test-specific dependencies are active, which are given in the project file as e.g.

```
[extras]
Test = "8dfed614-e22c-5e08-85e1-65c5234f0b40"

[targets]
test = ["Test"]
```

The tests are executed in a new process with `check-bounds=yes` and by default `startup-file=no`. If using the startup file (`~/.julia/config/startup.jl`) is desired, start julia with `--startup-file=yes`. Inlining of functions during testing can be disabled (for better coverage accuracy) by starting julia with `--inline=no`.

[source](#)

**Pkg.build** – Function.

```
Pkg.build(; verbose = false, io::IO=stderr)
Pkg.build(pkg::Union{String, Vector{String}}; verbose = false, io::IO=stderr)
Pkg.build(pkgs::Union{PackageSpec, Vector{PackageSpec}}; verbose = false, io::IO=stderr)
```

Run the build script in `deps/build.jl` for `pkg` and all of its dependencies in depth-first recursive order. If no argument is given to `build`, the current project is built, which thus needs to be a package. This function is called automatically on any package that gets installed for the first time. `verbose = true` prints the build output to `stdout/stderr` instead of redirecting to the `build.log` file.

[source](#)

**Pkg.pin** – Function.

```
Pkg.pin(pkg::Union{String, Vector{String}}; io::IO=stderr)
Pkg.pin(pkgs::Union{PackageSpec, Vector{PackageSpec}}; io::IO=stderr)
```

Pin a package to the current version (or the one given in the `PackageSpec`) or to a certain git revision. A pinned package is never updated.

#### Examples

```
| Pkg.pin("Example")
| Pkg.pin(name="Example", version="0.3.1")
```

source

**Pkg.free** – Function.

```
| Pkg.free(pkg::Union{String, Vector{String}}; io::IO=stderr)
| Pkg.free(pkgs::Union{PackageSpec, Vector{PackageSpec}}; io::IO=stderr)
```

If pkg is pinned, remove the pin. If pkg is tracking a path, e.g. after **Pkg.develop**, go back to tracking registered versions.

### Examples

```
| Pkg.free("Package")
```

source

**Pkg.instantiate** – Function.

```
| Pkg.instantiate(; verbose = false, io::IO=stderr)
```

If a Manifest.toml file exists in the active project, download all the packages declared in that manifest. Otherwise, resolve a set of feasible packages from the Project.toml files and install them. verbose = true prints the build output to stdout/stderr instead of redirecting to the build.log file. If no Project.toml exist in the current active project, create one with all the dependencies in the manifest and instantiate the resulting project.

After packages have been installed the project will be precompiled. See more at [Project Precompilation](#).

source

**Pkg.resolve** – Function.

```
| Pkg.resolve(; io::IO=stderr)
```

Update the current manifest with potential changes to the dependency graph from packages that are tracking a path.

source

**Pkg.gc** – Function.

```
| Pkg.gc(; collect_delay::Period=Day(7), io::IO=stderr)
```

Garbage-collect package and artifact installations by sweeping over all known Manifest.toml and Artifacts.toml files, noting those that have been deleted, and then finding artifacts and packages that are thereafter not used by any other projects, marking them as "orphaned". This method will only remove orphaned objects (package versions, artifacts, and scratch spaces) that have been continually un-used for a period of collect\_delay; which defaults to seven days.

source

**Pkg.status** – Function.

```
| Pkg.status([pkgs...]; mode::PackageMode=PKGMODE_PROJECT, diff::Bool=false, compat::Bool=false,
| ↪ io::IO=stdout)
```

Print out the status of the project/manifest.

Packages marked with `^` have new versions that can be installed, e.g. via [Pkg.up](#). Those marked with `⌘` have new versions available, but that cannot be installed. To see why use the outdated kwarg.

Setting `outdated=true` will only show packages that are not on the latest version, their maximum version and why they are not on the latest version (either due to other packages holding them back due to compatibility constraints, or due to compatibility in the project file). As an example, a status output like:

```
pkg> Pkg.status(; outdated=true)
Status `Manifest.toml`^
[a8cc5b0e] Crayons v2.0.0 [<v3.0.0], (<v4.0.4)⌘
[b8a86587] NearestNeighbors v0.4.8 (<v0.4.9) [compat]⌘
[2ab3a3ac] LogExpFunctions v0.2.5 (<v0.3.0): SpecialFunctions
```

means that the latest version of Crayons is 4.0.4 but the latest version compatible with the `[compat]` section in the current project is 3.0.0. The latest version of NearestNeighbors is 0.4.9 but due to `compat` constraints in the project it is held back to 0.4.8. The latest version of LogExpFunctions is 0.3.0 but SpecialFunctions is holding it back to 0.2.5.

If mode is `PKG_MODE_PROJECT`, print out status only about the packages that are in the project (explicitly added). If mode is `PKG_MODE_MANIFEST`, print status also about those in the manifest (recursive dependencies). If there are any packages listed as arguments, the output will be limited to those packages.

Setting `diff=true` will, if the environment is in a git repository, limit the output to the difference as compared to the last git commit.

See [Pkg.project](#) and [Pkg.dependencies](#) to get the project/manifest status as a Julia object instead of printing it.

### Julia 1.1

`Pkg.status` with package arguments requires at least Julia 1.1.

### Julia 1.3

The `diff` keyword argument requires at least Julia 1.3. In earlier versions `diff=true` is the default for environments in git repositories.

### Julia 1.8

The `^` and `⌘` indicators were added in Julia 1.8. The `outdated` keyword argument requires at least Julia 1.8.

#### source

[Pkg.compat](#) – Function.

```
| Pkg.compat()
```

Interactively edit the `[compat]` entries within the current Project.

```
| Pkg.compat(pkg::String, compat::String)
```

Set the `[compat]` string for the given package within the current Project.

See [Compatibility](#) for more information on the project `[compat]` section.

#### source

[Pkg.precompile](#) – Function.

```
Pkg.precompile(; strict::Bool=false)
Pkg.precompile(pkg; strict::Bool=false)
Pkg.precompile(pkgs; strict::Bool=false)
```

Precompile all or specific dependencies of the project in parallel.

#### Note

Errors will only throw when precompiling the top-level dependencies, given that not all manifest dependencies may be loaded by the top-level dependencies on the given system. This can be overridden to make errors in all dependencies throw by setting the kwarg `strict` to `true`

#### Note

This method is called automatically after any `Pkg` action that changes the manifest. Any packages that have previously errored during precompilation won't be retried in auto mode until they have changed. To disable automatic precompilation set `ENV["JULIA_PKG_PRECOMPILE_AUTO"]=0`. To manually control the number of tasks used set `ENV["JULIA_NUM_PRECOMPILE_TASKS"]`.

#### Julia 1.3

This function requires at least Julia 1.3. On earlier versions you can use `Pkg.API.precompile()` or the `precompile` `Pkg` REPL command.

#### Julia 1.8

Specifying packages to precompile requires at least Julia 1.8.

### Examples

```
Pkg.precompile()
Pkg.precompile("Foo")
Pkg.precompile(["Foo", "Bar"])
```

[source](#)

`Pkg.offline` – Function.

```
Pkg.offline(b::Bool=true)
```

Enable (`b=true`) or disable (`b=false`) offline mode.

In offline mode `Pkg` tries to do as much as possible without connecting to internet. For example, when adding a package `Pkg` only considers versions that are already downloaded in version resolution.

To work in offline mode across Julia sessions you can set the environment variable `JULIA_PKG_OFFLINE` to `"true"`.

#### Julia 1.5

`Pkg`'s offline mode requires Julia 1.5 or later.

[source](#)

`Pkg.setprotocol!` – Function.

```
setprotocol!(;
    domain::AbstractString = "github.com",
    protocol::Union{Nothing, AbstractString}=nothing
)
```



Set the protocol used to access hosted packages when adding a url or developing a package. Defaults to delegating the choice to the package developer (protocol == nothing). Other choices for protocol are "https" or "git".

### Examples

```
julia> Pkg.setprotocol!(domain = "github.com", protocol = "ssh")

julia> Pkg.setprotocol!(domain = "gitlab.mycompany.com")
```

[source](#)

**Pkg.dependencies** – Function.

```
Pkg.dependencies()::Dict{UUID, PackageInfo}
```

### Julia 1.4

This feature requires Julia 1.4, and is considered experimental.

Query the dependency graph. The result is a Dict that maps a package UUID to a PackageInfo struct representing the dependency (a package).

### PackageInfo fields

Field	Description
name	The name of the package
version	The version of the package (this is Nothing for stdlibs)
is_direct_dep	The package is a direct dependency
is_tracking_path	Whether a package is directly tracking a directory
is_pinned	Whether a package is pinned
source	The directory containing the source code for that package
dependencies	The dependencies of that package as a vector of UUIDs

[source](#)

**Pkg.project** – Function.

```
Pkg.project()::ProjectInfo
```

### Julia 1.4

This feature requires Julia 1.4, and is considered experimental.

Request a ProjectInfo struct which contains information about the active project.

### ProjectInfo fields

Field	Description
name	The project's name
uuid	The project's UUID
version	The project's version
dependencies	The project's direct dependencies as a Dict which maps dependency name to dependency UUID
path	The location of the project file which defines the active project

[source](#)

[Pkg.undo](#) – Function.

| `undo()`

Undoes the latest change to the active project. Only states in the current session are stored, up to a maximum of 50 states.

See also: [redo](#).

[source](#)

[Pkg.redo](#) – Function.

| `redo()`

Redoes the changes from the latest [undo](#).

[source](#)

## Chapter 43

# Registry API Reference

### Julia 1.1

Pkg's registry handling requires at least Julia 1.1.

The functional API for registries uses [RegistrySpecs](#), similar to [PackageSpec](#).

[Pkg.RegistrySpec](#) - Type.

```
RegistrySpec(name::String)
RegistrySpec(; name, url, path)
```

A [RegistrySpec](#) is a representation of a registry with various metadata, much like [PackageSpec](#).

Most registry functions in Pkg take a Vector of [RegistrySpec](#) and do the operation on all the registries in the vector.

### Julia 1.1

Pkg's registry handling requires at least Julia 1.1.

### Examples

Below is a comparison between the REPL mode and the functional API::

REPL	API
Registry	<code>RegistrySpec("Registry")</code>
Registry=a67d...	<code>RegistrySpec(name="Registry", uuid="a67d...")</code>
local/path	<code>RegistrySpec(path="local/path")</code>
www.myregistry.com	<code>RegistrySpec(url="www.myregistry.com")</code>

[source](#)

[Pkg.Registry.add](#) - Function.

```
Pkg.Registry.add(registry::RegistrySpec)
```

Add new package registries.

The no-argument `Pkg.Registry.add()` will install the default registries.

### Julia 1.1

Pkg's registry handling requires at least Julia 1.1.

**Examples**

```
Pkg.Registry.add("General")
Pkg.Registry.add(RegistrySpec(uuid = "23338594-aafe-5451-b93e-139f81909106"))
Pkg.Registry.add(RegistrySpec(url = "https://github.com/JuliaRegistries/General.git"))
```

source

`Pkg.Registry.rm` – Function.

```
Pkg.Registry.rm(registry::String)
Pkg.Registry.rm(registry::RegistrySpec)
```

Remove registries.

**Julia 1.1**

Pkg's registry handling requires at least Julia 1.1.

**Examples**

```
Pkg.Registry.rm("General")
Pkg.Registry.rm(RegistrySpec(uuid = "23338594-aafe-5451-b93e-139f81909106"))
```

source

`Pkg.Registry.update` – Function.

```
Pkg.Registry.update()
Pkg.Registry.update(registry::RegistrySpec)
Pkg.Registry.update(registry::Vector{RegistrySpec})
```

Update registries. If no registries are given, update all available registries.

**Julia 1.1**

Pkg's registry handling requires at least Julia 1.1.

**Examples**

```
Pkg.Registry.update()
Pkg.Registry.update("General")
Pkg.Registry.update(RegistrySpec(uuid = "23338594-aafe-5451-b93e-139f81909106"))
```

source

`Pkg.Registry.status` – Function.

```
Pkg.Registry.status()
```

Display information about available registries.

**Julia 1.1**

Pkg's registry handling requires at least Julia 1.1.

**Examples**

```
Pkg.Registry.status()
```

source

## Chapter 44

# Artifacts API Reference

### Julia 1.3

Pkg's artifacts API requires at least Julia 1.3.

`Pkg.Artifacts.create_artifact` - Function.

```
| create_artifact(f::Function)
```

Creates a new artifact by running `f(artifact_path)`, hashing the result, and moving it to the artifact store (`~/.julia/artifacts` on a typical installation). Returns the identifying tree hash of this artifact.

### Julia 1.3

This function requires at least Julia 1.3.

[source](#)

`Pkg.Artifacts.remove_artifact` - Function.

```
| remove_artifact(hash::SHA1; honor_overrides::Bool=false)
```

Removes the given artifact (identified by its SHA1 git tree hash) from disk. Note that if an artifact is installed in multiple depots, it will be removed from all of them. If an overridden artifact is requested for removal, it will be silently ignored; this method will never attempt to remove an overridden artifact.

In general, we recommend that you use `Pkg.gc()` to manage artifact installations and do not use `remove_artifact()` directly, as it can be difficult to know if an artifact is being used by another package.

### Julia 1.3

This function requires at least Julia 1.3.

[source](#)

`Pkg.Artifacts.verify_artifact` - Function.

```
| verify_artifact(hash::SHA1; honor_overrides::Bool=false)
```

Verifies that the given artifact (identified by its SHA1 git tree hash) is installed on- disk, and retains its integrity. If the given artifact is overridden, skips the verification unless `honor_overrides` is set to `true`.

**Julia 1.3**

This function requires at least Julia 1.3.

source

`Pkg.Artifacts.bind_artifact!` - Function.

```
bind_artifact!(artifacts_toml::String, name::String, hash::SHA1;
                platform::Union{AbstractPlatform,Nothing} = nothing,
                download_info::Union{Vector{Tuple},Nothing} = nothing,
                lazy::Bool = false,
                force::Bool = false)
```

Writes a mapping of name -> hash within the given (Julia)Artifacts.toml file. If platform is not nothing, this artifact is marked as platform-specific, and will be a multi-mapping. It is valid to bind multiple artifacts with the same name, but different platforms and hash'es within the same artifacts\_toml. If force is set to true, this will overwrite a pre-existent mapping, otherwise an error is raised.

download\_info is an optional vector that contains tuples of URLs and a hash. These URLs will be listed as possible locations where this artifact can be obtained. If lazy is set to true, even if download information is available, this artifact will not be downloaded until it is accessed via the artifact"name" syntax, or ensure\_artifact\_installed() is called upon it.

**Julia 1.3**

This function requires at least Julia 1.3.

source

`Pkg.Artifacts.unbind_artifact!` - Function.

```
unbind_artifact!(artifacts_toml::String, name::String; platform = nothing)
```

Unbind the given name from an (Julia)Artifacts.toml file. Silently fails if no such binding exists within the file.

**Julia 1.3**

This function requires at least Julia 1.3.

source

`Pkg.Artifacts.download_artifact` - Function.

```
download_artifact(tree_hash::SHA1, tarball_url::String, tarball_hash::String;
                  verbose::Bool = false, io::IO=stderr)
```

Download/install an artifact into the artifact store. Returns true on success, returns an error object on failure.

**Julia 1.3**

This function requires at least Julia 1.3.

**Julia 1.8**

As of Julia 1.8 this function returns the error object rather than false when failure occurs

source

`Pkg.Artifacts.ensure_artifact_installed` – Function.

```
ensure_artifact_installed(name::String, artifacts_toml::String;
                        platform::AbstractPlatform = HostPlatform(),
                        pkg_uuid::Union{Base.UUID,Nothing}=nothing,
                        verbose::Bool = false,
                        quiet_download::Bool = false,
                        io::IO=stderr)
```

Ensures an artifact is installed, downloading it via the download information stored in `artifacts_toml` if necessary. Throws an error if unable to install.

### Julia 1.3

This function requires at least Julia 1.3.

source

`Pkg.Artifacts.ensure_all_artifacts_installed` – Function.

```
ensure_all_artifacts_installed(artifacts_toml::String;
                             platform = HostPlatform(),
                             pkg_uuid = nothing,
                             include_lazy = false,
                             verbose = false,
                             quiet_download = false,
                             io::IO=stderr)
```

Installs all non-lazy artifacts from a given (Julia)Artifacts.toml file. `package_uuid` must be provided to properly support overrides from `Overrides.toml` entries in depots.

If `include_lazy` is set to true, then lazy packages will be installed as well.

This function is deprecated and should be replaced with the following snippet:

```
artifacts = select_downloadable_artifacts(artifacts_toml; platform, include_lazy)
for name in keys(artifacts)
    ensure_artifact_installed(name, artifacts[name], artifacts_toml; platform=platform)
end
```

### Julia 1.3

This function requires at least Julia 1.3.

### Warning

This function is deprecated in Julia 1.6 and will be removed in a future version. Use `select_downloadable_artifacts()` and `ensure_artifact_installed()` instead.

source

`Pkg.Artifacts.archive_artifact` – Function.

```
archive_artifact(hash::SHA1, tarball_path::String; honor_overrides::Bool=false)
```

Archive an artifact into a tarball stored at `tarball_path`, returns the SHA256 of the resultant tarball as a hexadecimal string. Throws an error if the artifact does not exist. If the artifact is overridden, throws an error unless `honor_overrides` is set.

**Julia 1.3**

This function requires at least Julia 1.3.

[source](#)