Scala 3 User's Manual

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Latest HTML version available at https://dotty.epfl.ch/docs/usage/

Contents

1 Getting Started: Users

1.1 Trying out Scala 3

1.1.1 In your web browser

Scastie, the online Scala playground, supports Dotty. This is an easy way to try Scala 3 without installing anything, directly in your browser.

1.1.2 `sbt`

The fastest way to create a new project compiled by Scala 3 is using `sbt`.

Create a simple Scala 3 project:

```
$ sbt new scala/scala3.g8
```

Or a Scala 3 project that cross compiles with Scala 2:

```
$ sbt new scala/scala3-cross.g8
```

You can then start a Scala 3 REPL directly from your sbt project:

```
$ sbt
> console
scala>
```

For more information, see the Scala 3 Example Project.

1.1.3 IDE support

Start using the Dotty IDE in any Dotty project by following the IDE guide.

1.1.4 Standalone installation

Releases are available for download on the Releases Section of the Dotty repository. Releases include three executables: - `scalac`, the Scala 3 compiler, - `scaladoc`, the Scaladoc and - `scala`, the Scala 3 REPL.

```
.
└── bin
    ├── scalac
    ├── scaladoc
    └── scala
```

Add these executables to your `PATH` and you will be able to run the corresponding commands directly from your console:

```
# Compile code using Scala 3
$ scalac HelloWorld.scala

# Run it with the proper classpath
```

```
$ scala HelloWorld

# Start a Scala 3 REPL
$ scala
Starting scala3 REPL...
scala>
```

If you're a Mac user, we also provide a homebrew package that can be installed by running:

```
brew install lampepfl/brew/dotty
```

In case you have already installed Dotty via brew, you should instead update it:

```
brew upgrade dotty
```

1.1.5 Scala 3 for Scripting

If you have followed the steps in "Standalone Installation" section and have the `scala` executable on your `PATH`, you can run `*.scala` files as scripts. Given a source file named `Test.scala`:

```
@main def Test(name: String): Unit =
  println(s"Hello ${name}!")
```

You can run: `scala Test.scala World` to get the output `Hello World!`.

A "script" is an ordinary Scala file which contains a main method. The semantics of the `scala Script.scala` command is as follows:

- Compile `Script.scala` with `scalac` into a temporary directory.
- Detect the main method in the `*.class` files produced by the compilation.
- Execute the main method.

2 Using Dotty with sbt

To try it in your project see the Getting Started User Guide.

3 IDE support for Dotty

IDE support for Scala 3 is available in IDEs based on Scala Metals (e.g., Visual Studio Code, vim) and in IntelliJ IDEA.

3.1 Using Visual Studio Code

To use Visual Studio Code on a Scala 3 project, ensure you have the Metals plugin installed. Then open the project directory in VS code and click the "Import build" button in notification.

3.1.1 Under the Hood

VS Code implements semantic features (such as completions, "go to definition") using the Language Server Protocol (LSP), so it needs a language server implementation. Metals is the implementation of LSP for Scala. It extracts semantic information from semanticdb, which is generated directly by the Scala 3 compiler.

You can read more about Scala 3 support in Metals in this blog post.

To communicate with the build tool (e.g., to import the project, trigger builds, run tests), Metals uses the Build Server Protocol (BSP). The default BSP implementation used by metals is Bloop, which supports Scala 3 projects. Alternatively, sbt can be used as a BSP server as it directly implements BSP since version 1.4.

3.2 Using IntelliJ IDEA

IntelliJ has its own implementation for semantic features, so it does not use Metals or the Language Server Protocol (LSP).

In order to import a project into IntelliJ there are two possibilities:

- Use the built-in feature to import `sbt` builds
- Use IntelliJ's support for the Build Server Protocol (BSP)

3.2.1 Importing the `sbt` build

To use IntelliJ's sbt import, go to "File" - "Open…" and select your project's `build.sbt` file.

In this mode, IntelliJ starts sbt with a custom plugin to extract the project structure. After importing, IntelliJ no longer interacts with other sbt sessions. Building and running the project within the IDE is done by separate processes.

3.2.2 Importing the project using BSP

To import a project using BSP, go to "File" - "New" - "Project from Existing Sources" and select the project directory. In the upcoming dialog select "BSP" to import the project. You may be asked to choose between "sbt" and "sbt with Bloop", the recommended option is "sbt".

If the project import fails ("Problem executing BSP job"), navigate to your project in a terminal and just start `sbt`. Once sbt is running, open the "bsp" tab in IntelliJ click the "Reload" button.

When using IntelliJ's BSP mode, build and run commands from the IDE are executed through sbt, so they have the same effect as building or running the project through sbt in the terminal.

4 Worksheet mode with Dotty IDE

A worksheet is a Scala file that is evaluated on save, and the result of each expression is shown in a column to the right of your program. Worksheets are like a REPL session on steroids, and enjoy 1st class editor support: completion, hyperlinking, interactive errors-as-you-type, etc. Worksheet use the file extension `.sc`.

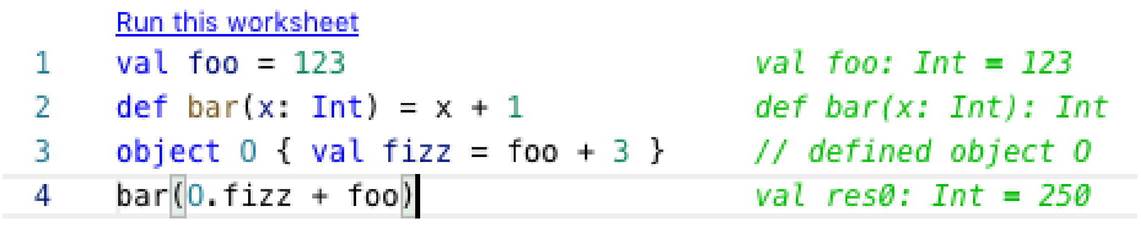
5 How to use the worksheets

The only supported client for the Worksheet mode is Visual Studio Code.

To use the worksheets, start Dotty IDE by following the instruction and create a new file `MyWorksheet.sc` and write some code:

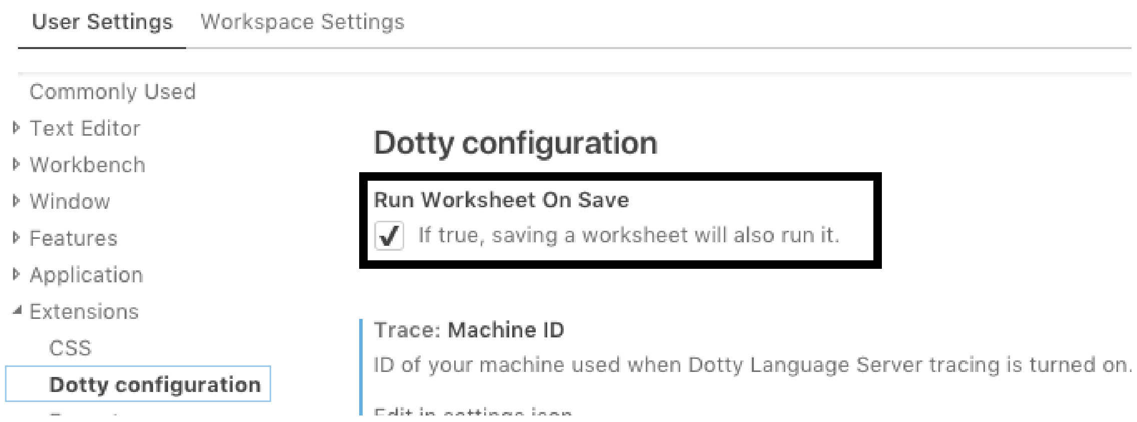
```
val xyz = 123
println("Hello, worksheets!")
456 + xyz
```

On top of the buffer, the message `Run this worksheet` appears. Click it to evaluate the code of the worksheet. Each line of output is printed on the right of the expression that produced it. The worksheets run with the classes of your project and its dependencies on their classpath.



```
Run this worksheet
val foo = 123                          val foo: Int = 123
def bar(x: Int) = x + 1                def bar(x: Int): Int
object O { val fizz = foo + 3 }        // defined object O
bar(O.fizz + foo)                      val res0: Int = 250
```

By default, the worksheets are also run when the file is saved. This can be configured in VSCode preferences:



Dotty configuration

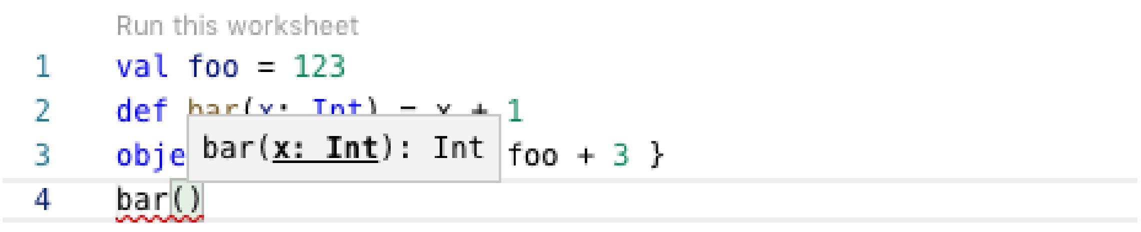
Run Worksheet On Save

✓ If true, saving a worksheet will also run it.

Trace: Machine ID

ID of your machine used when Dotty Language Server tracing is turned on.

Note that the worksheet are fully integrated with the rest of Dotty IDE: While typing, errors are shown, completions are suggested, and you can use all the other features of Dotty IDE such as go to definition, find all references, etc.



```
val foo = 123
def bar(x: Int) = x + 1
obje bar(x: Int): Int foo + 3 }
bar()
```

6 Implementation details

The implementation details of the worksheet mode and the information necessary to add support for other clients are available in Worksheet mode - Implementation details.

7 Language Versions

The default Scala language version currently supported by the Dotty compiler is `3.0`. There are also other language versions that can be specified instead:

- `3.0-migration`: Same as `3.0` but with a Scala 2 compatibility mode that helps moving Scala 2.13 sources over to Scala 3. In particular, it
  - flags some Scala 2 constructs that are disallowed in Scala 3 as migration warnings instead of hard errors,
  - changes some rules to be more lenient and backwards compatible with Scala 2.13
  - gives some additional warnings where the semantics has changed between Scala 2.13 and 3.0
  - in conjunction with `-rewrite`, offer code rewrites from Scala 2.13 to 3.0.
- `future`: A preview of changes introduced in the next versions after 3.0. In the doc pages here we refer to the language version with these changes as `3.1`, but it might be that some of these changes will be rolled out in later `3.x` versions.

Some Scala-2 specific idioms will be dropped in this version. The feature set supported by this version will be refined over time as we approach its release.

- `future-migration`: Same as `future` but with additional helpers to migrate from `3.0`. Similarly to the helpers available under `3.0-migration`, these include migration warnings and optional rewrites.

There are two ways to specify a language version.

- With a `-source` command line setting, e.g. `-source 3.0-migration`.
- With a `scala.language` import at the top of a compilation unit, e.g:

```
package p
import scala.language.`future-migration`

class C { ... }
```

Language imports supersede command-line settings in the compilation units where they are specified. Only one language import specifying a source version is allowed in a compilation unit, and it must come before any definitions in that unit.

8 Using Dotty with cbt

> NOTE: `cbt` support for Scala 3 is experimental and incomplete (for example, incremental compilation is not supported), we recommend using Scala 3 with sbt for now.

`cbt` comes with built-in Scala 3 support. Follow the cbt tutorial, then simply extend `Dotty` in the Build class.

```
// build/build.scala
import cbt.*
class Build(val context: Context) extends Dotty {
  ...
}
```

Also see the example project.

9 Scaladoc

scaladoc logo

scaladoc is a tool to generate documentation for your Scala 3 projects. It provides similar features to `javadoc` as well as `jekyll` or `docusaurus`.

As you probably have guessed, this whole site was created using scaladoc.

{% for post in site.posts %} ## {{ post.title }}

{{ post.excerpt }}

(read more)

{% endfor %}

9.1 Other extensions

We would love to have your feedback on what you think would be good in order to render the documentation you want! Perhaps you would like to render method definitions or members? Do you want to have runnable code snippets? Let us know by filing issues!

10 API Documentation

Scaladoc's main feature is creating API documentation from code comments.

By default, the code comments are understood as Markdown, though we also support Scaladoc's old Wiki syntax.

10.1 Syntax

10.1.1 Definition links

Our definition link syntax is quite close to Scaladoc's syntax, though we have made some quality-of-life improvements.

10.1.1.1 Basic syntax

A definition link looks as follows: `[[scala.collection.immutable.List]]`.

Which is to say, a definition link is a sequence of identifiers separated by `.`. The identifiers can be separated with # as well for Scaladoc compatibility.

By default, an identifier `id` references the first (in source order) entity named `id`. An identifier can end with `$`, which forces it to refer to a value (an object, a value, a given); an identifier can also end with `!`, which forces it to refer to a type (a class, a type alias, a type member).

The links are resolved relative to the current location in source. That is, when documenting a class, the links are relative to the entity enclosing the class (a package, a class, an object); the same applies to documenting definitions.

Special characters in links can be backslash-escaped, which makes them part of identifiers instead. For example, `[[scala.collection.immutable\.List]]` references the class named `` `immutable.List` `` in package `scala.collection`.

10.1.1.2 New syntax We have extended Scaladoc definition links to make them a bit more pleasant to write and read in source. The aim was also to bring the link and Scala syntax closer together. The new features are:

1. `package` can be used as a prefix to reference the enclosing package. Example:

   ```
   package utils
   class C {
     def foo = "foo".
   }
   /** See also [[package.C]]. */
   class D {
     def bar = "bar".
   }
   ```

   The `package` keyword helps make links to the enclosing package shorter and a bit more resistant to name refactorings.

2. `this` can be used as a prefix to reference the enclosing class. Example:

   ```
   class C {
     def foo = "foo"
     /** This is not [[this.foo]], this is bar. */
     def bar = "bar"
   }
   ```

   Using a Scala keyword here helps make the links more familiar, as well as helps the links survive class name changes.

3. Backticks can be used to escape identifiers. Example:

   ```
   def `([.abusive.])` = ???
   /** TODO: Figure out what [[`([.abusive.])`]] is. */
   def foo = `([.abusive.])`
   ```

   Previously (versions 2.x), Scaladoc required backslash-escaping to reference such identifiers. Now (3.x versions), Scaladoc allows using the familiar Scala backtick quotation.

10.1.1.3 Why keep the Wiki syntax for links? There are a few reasons why we've kept the Wiki syntax for documentation links instead of reusing the Markdown syntax. Those are:

1. Nameless links in Markdown are ugly: `[](definition)` vs `[[definition]]` By far, most links in documentation are nameless. It should be obvious how to write them.
2. Local member lookup collides with URL fragments: `[](#field)` vs `[[#field]]`
3. Overload resolution collides with MD syntax: `[](meth(Int))` vs `[[meth(Int)]]`

4. Now that we have a parser for the link syntax, we can allow spaces inside (in Scaladoc one needed to slash-escape those), but that doesn't get recognized as a link in Markdown: `[](meth(Int, Float))` vs `[[meth(Int, Float)]]`

None of these make it completely impossible to use the standard Markdown link syntax, but they make it much more awkward and ugly than it needs to be. On top of that, Markdown link syntax doesn't even save any characters.

11 Built-in blog

Scaladoc allows you to include a simple blog in your documentation. For now, it provides only basic features. In the future, we plan to include more advanced features like tagging or author pages.

12 Scaladoc-specific Tags and Features

Scaladoc extends Markdown with additional features, such as linking to API definitions. This can be used from within static documentation and blog posts to provide blend-in content.

12.1 Linking to API

Scaladoc allows linking to API documentation with Wiki-style links. Linking to `scala.collection.immutable.List` is as simple as `[[scala.collection.immutable.List]]`. For more information on the exact syntax, see doc comment documentation.

13 Static documentation

Scaladoc is able to generate static sites, known from Jekyll or Docusaurus. Having a combined tool allows to provide interaction between static documentation and API, thus allowing the two to blend naturally.

Creating a site is just as simple as in Jekyll. The site root contains the layout of the site and all files placed there will be either considered static, or processed for template expansion.

The files that are considered for template expansion must end in `*.{html,md}` and will from here on be referred to as "template files" or "templates".

A simple "hello world" site could look something like this:

```
├── docs
│   └── getting-started.md
└── index.html
```

This will give you a site with the following files in generated documentation:

```
index.html
docs/getting-started.html
```

Scaladoc can transform both files and directories (to organize your documentation into tree-like structure). By default directories has title based on file name and has empty content. There is an option to include `index.html` or `index.md` (not both) to provide both content and properties like title (see Properties).

13.1 Properties

Scaladoc uses the Liquid templating engine and provides a number of custom filters and tags specific to Scala documentation.

In Scaladoc, all templates can contain YAML front-matter. The front-matter is parsed and put into the `page` variable available in templates via Liquid.

Scaladoc uses some predefined properties to controls some aspect of page.

Predefined properties:

- title provide page title that will be used in navigation and html metadata.
- extraCss additional `.css` files that will be included in this page. Paths should be relative to documentation root. This setting is not exported to template engine.
- extraJs additional `.js` files that will be included in this page. Paths should be relative to documentation root. This setting is not exported to template engine.
- hasFrame when set to `false` page will not include default layout (navigation, breadcrumbs etc.) but only token html wrapper to provide metadata and resources (js and css files). This setting is not exported to template engine.
- layout - predefined layout to use, see below. This setting is not exported to template engine.

13.2 Using existing Templates and Layouts

To perform template expansion, Dottydoc looks at the `layout` field in the front-matter. Here's a simple example of the templating system in action, `index.html`:

```
---
layout: main
---

<h1>Hello world!</h1>
```

With a simple main template like this:

{% raw %}

```
<html>
    <head>
        <title>Hello, world!</title>
    </head>
    <body>
        {{ content }}
    </body>
</html>
```

Would result in `{{ content }}` being replaced by `<h1>Hello world!</h1>` from the `index.html` file. {% endraw %}

Layouts must be placed in a `_layouts` directory in the site root:

```
├── _layouts
│   └── main.html
├── docs
│   └── getting-started.md
└── index.html
```

14 Sidebar

Scaladoc by default uses layout of files in `docs` directory to create table of content. There is also ability to override it by providing a `sidebar.yml` file in the site root:

```
sidebar:
    - title: Blog
      url: blog/index.html
    - title: Docs
      url: docs/index.html
    - title: Usage
      subsection:
        - title: Dottydoc
          url: docs/usage/dottydoc.html
        - title: sbt-projects
          url: docs/usage/sbt-projects.html
```

The `sidebar` key is mandatory, as well as `title` for each element. The default table of contents allows you to have subsections - albeit the current depth limit is 2 however it accepts both files and directories and latter can be used to provide deeper structures.

The items which have on the `subsection` level does not accepts `url`.

```
├── blog
│   └── _posts
│       └── 2016-12-05-implicit-function-types.md
├── index.html
└── sidebar.yml
```

15 Dottydoc [Legacy]

Dottydoc is a tool to generate a combined documentation and API reference for your project.

In previous versions of the Scaladoc tool, there is a big divide between what is documentation and what is API reference. Dottydoc allows referencing, citing and rendering parts of your API in your documentation, thus allowing the two to blend naturally.

To do this, Dottydoc is very similar to what Jekyll provides in form of static site generation. As you probably guessed, this whole site was created using Dottydoc.

Creating a site is just as simple as in Jekyll. The site root contains the layout of the site and all files placed here will be either considered static, or processed for template expansion.

The files that are considered for template expansion must end in `*.{html,md}` and will from here on be referred to as "template files" or "templates".

A simple "hello world" site could look something like this:

```
├── docs
│   └── getting-started.md
└── index.html
```

This will give you a site with the following endpoints:

```
_site/index.html
_site/docs/getting-started.html
```

Just as with Jekyll, the site is rendered in a `_site` directory.

15.0.1 Using existing Templates and Layouts

Dottydoc uses the Liquid templating engine and provides a number of custom filters and tags specific to Scala documentation.

In Dottydoc, all templates can contain YAML front-matter. The front-matter is parsed and put into the `page` variable available in templates via Liquid.

To perform template expansion, Dottydoc looks at `layout` in the front-matter. Here's a simple example of the templating system in action, `index.html`:

```
---
layout: main
---

<h1>Hello world!</h1>
```

With a simple main template like this:

{% raw %}

```
<html>
    <head>
        <title>Hello, world!</title>
    </head>
    <body>
        {{ content }}
    </body>
</html>
```

Would result in `{{ content }}` being replaced by `<h1>Hello world!</h1>` from the `index.html` file. {% endraw %}

Layouts must be placed in a `_layouts` directory in the site root:

```
├── _layouts
│   └── main.html
├── docs
│   └── getting-started.md
└── index.html
```

It is also possible to use one of the default layouts that ship with Dottydoc.

15.0.2 Blog

Dottydoc also allows for a simple blogging platform in the same vein as Jekyll. Blog posts are placed within the `./blog/_posts` directory and have to be in the form `year-month-day-title.{md,html}`.

An example of this would be:

```
├── blog
│   └── _posts
│       └── 2016-12-05-implicit-function-types.md
└── index.html
```

To be rendered as templates, each blog post should have front-matter and a `layout` declaration.

The posts are also available in the variable `site.posts` throughout the site. The fields of these objects are the same as in `[BlogPost](dotty.tools.dottydoc.staticsite.BlogPost)`.

15.0.3 Includes

In Liquid, there is a concept of include tags, these are used in templates to include other de facto templates:

```
<div class="container">
    {% raw %}{% include "sidebar.html" %}{% endraw %}
</div>
```

You can leave out the file extension if your include ends in `.html`.

Includes need to be kept in `_includes` in the site root. Dottydoc provides a couple of default includes, but the user-specified includes may override these.

An example structure with an include file “sidebar.html”:

```
├── _includes
│   └── sidebar.html
├── blog
│   ├── _posts
│   │   └── 2016-12-05-implicit-function-types.md
│   └── index.md
└── index.html
```

15.0.4 Sidebar

Dottydoc gives you the ability to create your own custom table of contents, this can either be achieved by overriding the `toc.html` or by providing a `sidebar.yml` file in the site root:

```yaml
sidebar:
    - title: Blog
      url: blog/index.html
    - title: Docs
      url: docs/index.html
    - title: Usage
      subsection:
        - title: Dottydoc
          url: docs/usage/dottydoc.html
        - title: sbt-projects
          url: docs/usage/sbt-projects.html
```

The `sidebar` key is mandatory, as well as `title` for each element. The default table of contents allows you to have subsections - albeit the current depth limit is 2 – we would love to see this changed, contributions welcome!

The items which have the `subsection` key, may not have a `url` key in the current scheme. A site root example with this could be:

```
├── blog
│   └── _posts
│       └── 2016-12-05-implicit-function-types.md
├── index.html
└── sidebar.yml
```

15.0.5 Dottydoc Specific Tags and Behavior

15.0.5.1 Linking to API

If you for instance, want to link to `scala.collection.immutable.Seq` in a markdown file, you can simply use the canonical path in your url:

```
[Seq](scala.collection.immutable.Seq)
```

Linking to members is done in the same fashion:

```
[Seq](scala.collection.immutable.Seq.isEmpty)
```

Dottydoc denotes objects by ending their names in “$”. To select `List.range` you’d therefore write:

```
[List.range](scala.collection.immutable.List$.range)
```

15.1 Rendering Docstrings

Sometimes you end up duplicating the docstring text in your documentation, therefore Dottydoc makes it easy to render this inline:

```
{% raw %}{% docstring "scala.collection.immutable.Seq" %}{% endraw %}
```

15.2 Other extensions

We would love to have your feedback on what you think would be good in order to render the documentation you want! Perhaps you would like to render method definitions or members? Let us know by filing issues!

16 Default Layouts

16.1 main.html

A wrapper for all other layouts, includes a default `<head>` with included JavaScripts and CSS style-sheets.

16.1.1 Variables

- `content`: placed in `<body>` tag
- `extraCSS`: a list of relative paths to extra CSS style-sheets for the site
- `extraJS`: a list of relative paths to extra JavaScripts for the site
- `title`: the `<title>` of the page

16.2 sidebar.html

Sidebar uses `main.html` as its parent layout. It adds a sidebar generated from a YAML file (if exists), as well as the index for the project API.

16.2.1 Variables

- `content`: placed in a `<div>` with class `content-body`
- `docs`: the API docs generated from supplied source files, this is included by default and does not need to be specified.

16.3 doc-page.html

Doc page is used for pages that need a sidebar and provides a small wrapper for the included {% raw %}`{{ content}}`{% endraw %}.

16.4 api-page.html

The last two layouts are special, in that they are treated specially by Dottydoc. The input to the API page is a documented `[Entity](dotty.tools.dottydoc.model.Entity)`. As such, this page can be changed to alter the way Dottydoc renders API documentation.

16.5 blog-page.html

A blog page uses files placed in `./blog/_posts/` as input to render a blog.

17 Default Includes

- `scala-logo.svg`: the scala in Dotty version as svg
- `toc.html`: the default table of contents template