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Dart 1 for Everyone

Fast, Flexible, Structured Code for the Modern Web

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The Pragmatic Programmers

Fast, Flexible,
Structured Code
for the Modern Web

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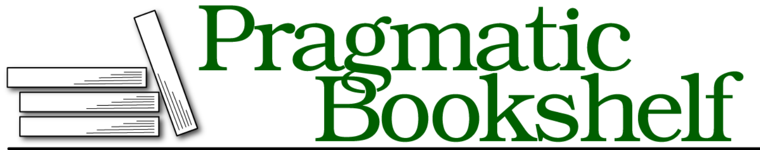

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CHAPTER 5

Dart and JavaScript

When Dart first came out, every major browser vendor, as well as the WebKit project, announced that they had absolutely no intention of embedding the Dart VM in their browsers. Many bristled at the very suggestion that a non-standard language[1] be supported even obliquely. How another language was supposed to become a standard seemed a tricky question. Fortunately, Google had a plan.

In the grand tradition of CoffeeScript,[2] the Dart project includes a compiler capable of compiling Dart into JavaScript. The goal is that, even if Dart does not become an overnight standard, web developers tired of the quirks of JavaScript have a choice. We can now code in a modern language for the Web but still support the wide variety of browsers on the market.

The JavaScript generated by the Dart compiler includes shim code for the various Dart libraries. There is generated JavaScript that translates Dart DOM calls into JavaScript. There is generated JavaScript that supports Dart Ajax. For just about every feature of Dart, there is a corresponding chunk of JavaScript that gets included in the compiled output.

If that sounds large, well, it is. When first released, the compiler generated tens of thousands of lines of JavaScript!

Of course, the compiler continues to improve. It now supports compression/optimization and is producing JavaScript libraries in the range of thousands of lines of code instead of tens of thousands. Considering that Dart does a good chunk of the work of many JavaScript libraries like jQuery, this is already a good start. And it is only going to get better.

1. Dart is now a standard supported by the same ECMA organization that is responsible for the JavaScript standard: http://www.ecma-international.org/publications/standards/Ecma-408.htm.
2. http://coffeescript.org/

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Compiling to JavaScript with dart2js

The tool provided to compile Dart down into JavaScript is dart2js. The dart2js compiler can be found among the Dart software development kit builds.[3] The SDK are the ones with "sdk" in the filename (as opposed to the "editor" builds that include the editor in addition to the SDK).

We see that, once unzipped, the SDK contains the entire Dart library (core, html, io, json).

```
+-- bin
    +-- dart
    +-- dart2js
    +-- dartanalyzer
    +-- dartdoc
    +-- pub
+-- include
+-- lib
|   +-- async
|   +-- chrome
|   +-- collection
|   +-- convert
|   +-- core
|   +-- html
|   +-- indexed_db
|   +-- io
|   +-- isolate
|   +-- js
|   +-- json
|   +-- math
|   +-- mirrors
|   +-- svg
|   +-- typed_data
|   +-- utf
|   +-- web_audio
|   +-- web_gl
|   +-- web_sql
+-- util
```

In addition to the core Dart libraries, the SDK contains library code to support documentation (dartdoc) and compiling to JavaScript (dart2js).

Using dart2js could not be more basic. It takes a single command-line argument—the Dart filename. There is also a single command-line option that can be used to set the filename of the resulting JavaScript (out.js by default):

```
$ dart2js -omain.dart.js main.dart
```

3. https://www.dartlang.org/tools/sdk/

There is no output from the compiler indicating success, but we now have a nice little JavaScript version of our script.

```
$ ls -lh
-rw-r--r-- 1 chris chris   33 Feb 17 12:47 main.dart
-rw-r--r-- 1 chris chris 7.2K Feb 17 12:47 main.dart.js
```

Well, maybe it's not "little."

If there are errors in the Dart code being compiled, dart2js does a very nice job of letting us know where the errors occur.

```
$ dart2js main.dart
main.dart:5:3: Warning: Cannot resolve "document".
  document.query('#foo');
  ^^^^^^^^
```

One thing to bear in mind when compiling JavaScript is that dart2js works only at the application level, not the class level. Consider the situation in which we are converting our comic book collection application to follow a hip MVC pattern.

```
comics.dart
Collection.Comics.dart
HipsterModel.dart
Models.ComicBook.dart
Views.AddComic.dart
Views.AddComicForm.dart
Views.ComicsCollection.dart
```

There is no way to compile individual classes into usable JavaScript.

```
$ dart2js Models.ComicBook.dart
Models.ComicBook.dart:1:1: Error: Could not find "main".
library models_comic_book;

Error: Compilation failed.
```

If the script containing the main() entry point references the other libraries or if those libraries reference other libraries, then everything will be slurped into the resulting JavaScript. The three libraries referenced in the following import statements will be pulled into the compiled JavaScript:

javascript/web/scripts/comics.dart

```
import 'Collections.Comics.dart' as Collections;
import 'Views.Comics.dart' as Views;

main() {
  // ...

}
```

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Similarly, the ComicBook model will also be included in the dart2js-generated JavaScript by virtue of being referenced in the collection class.

javascript/web/scripts/Collections.Comics.dart

```
library comics_collection;

import 'HipsterCollection.dart';
import 'Models.ComicBook.dart';

class Comics extends HipsterCollection {
  // ...

}
```

At some point, it might be nice to write classes in Dart and compile them into usable JavaScript. For now, however, we are relegated to compiling entire applications, not pieces.

Maintaining Dart and JavaScript Side by Side

As Dart and dart2js evolve, the performance of the generated JavaScript will improve. At this early stage, Dart code compiled to JavaScript rivals and sometimes surpasses code a typical JavaScripter might write.[4] But as fast as the compiled JavaScript gets, it will never be as fast as running Dart natively.

The question then becomes, how can we send Dart code to Dart-enabled browsers and send the compiled JavaScript to other browsers?

The answer is relatively simple: include a small JavaScript snippet that detects the absence of Dart and loads the corresponding JavaScript. As you saw in the previous section, if we compile a main.dart script, then dart2js will produce a corresponding main.dart.js JavaScript version.

The following JavaScript snippet will do the trick (placed after the closing </body> tag):

```
if (!/Dart/.test(navigator.userAgent)) {
  loadJsEquivalentScripts();
}

function loadJsEquivalentScripts() {
  var scripts = document.getElementsByTagName('script');
  for (var i=0; i<scripts.length; i++) {
    loadJsEquivalent(scripts[i]);
  }
}
```

4. See the Dart performance page for details on how that is determined: https://www.dart-lang.org/performance/.

```
function loadJsEquivalent(script) {
  if (!script.hasAttribute('src')) return;
  if (!script.hasAttribute('type')) return;
  if (script.getAttribute('type') != 'application/dart') return;

  var js_script = document.createElement('script');
  js_script.setAttribute('src', script.getAttribute('src') + '.js');
  document.body.appendChild(js_script);
}
```

There is a similar script in Dart core.[5] In most cases, that script should be preferred over ours because it does other things (such as start the Dart engine).

The check for an available Dart engine is a simple matter of checking the user agent string. If it contains the word "Dart," then it is Dart-enabled.

```
if (!/Dart/.test(navigator.userAgent))
```

That may come in handy elsewhere in our Dart adventures.

The remainder of the JavaScript is fairly simple. The loadJsEquivalentScripts() function invokes loadJsEquivalent() for every <script> tag in the DOM. This method has a few guard clauses to ensure that a Dart script is in play. It then appends a new .js <script> to the DOM to trigger the equivalent JavaScript load.

To use that JavaScript detection script, we save it as dart.js and add it to the web page containing the Dart <script> tag.

```
<script src="/scripts/dart.js"></script>

<script src="/scripts/main.dart"
        type="application/dart"></script>
```

A Dart-enabled browser will evaluate and execute main.dart directly. Other browsers will ignore the unknown "application/dart" type and instead execute the code in dart.js, creating new <script> tags that source the main.dart.js file that we compiled with dart2js.

In the end, we have superfast code for browsers that support Dart. For both Dart and non-Dart browsers, we have elegant, structured, modern code. Even this early in Dart's evolution, we get the best of both worlds.

5. It is part of the browser Pub package available at: http://pub.dartlang.org/packages/browser. We will talk more about Pub and library packages in Chapter 10, *Libraries*, on page ?.

Using JavaScript in Dart

Programmers new to Dart often look for a jQuery-like library or a way to call jQuery directly from Dart. As you have already seen, Dart's built-in DOM support obviates the need for jQuery, but there are still times when it is useful to call JavaScript from Dart. Happily, Dart makes this easy with the dart:js package.

We will talk more about libraries and packages in Chapter 10, *Libraries*, on page ?. For now it is enough to know that we need to import the dart:js package to interact with JavaScript:

javascript/test/calling_javascript_test.dart

```
import 'dart:js';
```

Since JavaScript throws everything into a top-level namespace, dart:js makes this available through its context property. This property provides access to top-level JavaScript variables, classes, and functions.

Let's first try to call a JavaScript function from Dart. Consider a simple add() function that adds two numbers in JavaScript:

javascript/lib/add.js

```
function add(num1, num2) {
  return num1 + num2;
}
```

Calling this from Dart is a simple matter of importing dart:js and using the callMethod() method on the top-level JavaScript context object. In the case of the add() method, we want to call it by name, supplying it with two arguments:

javascript/test/calling_javascript_test.dart

```
import 'dart:js';

// ...

var answer = context.callMethod('add', [19, 23]);
```

After executing this line, answer will be the integer 42. What is especially nice here is that the JavaScript compatibility library takes care of assigning the proper type to the value back in Dart.

The top-level JavaScript context variable is a JavaScript proxy object. It should come as no surprise that Dart facilitates creating our own JavaScript object proxies. Consider a simple Person in JavaScript:

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javascript/lib/person.js

```
function Person(name) {
  this.name = name;
  this.greet = function() {
    return 'Howdy, ' + this.name + '!';
  };
}
```

We can instantiate—with constructor arguments—a JavaScript proxy in Dart with dart:js's JsObject wrapper:

```
var person = new JsObject(context['Person'], ['Bob']);
```

To invoke the JavaScript greet() method, we again use callMethod(), this time on the Person wrapper instead of context:

```
person.callMethod('greet', []);
// => 'Howdy, Bob!'
```

Setting properties on JavaScript objects is even easier. We simply use the square bracket operator to look up and assign JavaScript properties:

```
person['name'] = 'Fred';

person.callMethod('greet', []);
// => 'Howdy, Fred!'
```

Lest we Dart programmers forget, JavaScript is the land of callback hell. So, from time to time it will be necessary for a JavaScript function or method to invoke a callback function. In most cases, dart:js lets us supply a *Dart* function to serve as a callback.

Examining the following simple JavaScript multiply(), we see that it takes two arguments, a numeric multiplier and a callback function:

javascript/lib/add.js

```
function multiply(multiplier, cb) {
  return multiplier * cb();
}
```

The result of this function is the multiplication product of multiplier and the result of the callback function cb().

Given a very simple Dart function that computes 84 divided by 4, we can call the callback-laden multiply() function from Dart as:

```
var answer = context.callMethod('multiply', [2, ()=> 84/4]);
```

Yet again, the answer in Dart will be 42.

Dart's JavaScript compatibility library is surprisingly easy. There are some limitations, however, mostly the kinds of values that can be sent back and forth. But even these limitations are not as restrictive as might be expected. Basic types (numbers, Booleans, and strings) can be sent to and from JavaScript. It is also possible to send DOM elements and collections, which comes in extremely handy when working with JavaScript browser libraries. It is even possible to send events, blobs, image data, and more!

More often than not, Dart and JavaScript interoperability just works as expected. Even though we might prefer writing Dart, we do not want to rewrite the wheel if someone else has already done it for us in JavaScript.

What's Next

The ability to compile Dart into JavaScript means that we do not have to wait for a tipping point of browser support before enjoying the power of Dart. Today, we can start writing web applications in Dart and expect that they will work for everyone. Plus, we can leverage existing codebases in JavaScript with ease. JavaScript compatibility is a good thing because, in the next chapters, we will be taking our simple Dart application to the next level and we wouldn't want to leave our nonhipster friends too far behind.