In this chapter, you'll see:

- Models
- Views
- Controllers

CHAPTER 3

The Architecture of Rails Applications

One of the interesting features of Rails is that it imposes some fairly serious constraints on how you structure your web applications. Surprisingly, these constraints make it easier to create applications—a lot easier. Let's see why.

Models, Views, and Controllers

Back in 1979, Trygve Reenskaug came up with a new architecture for developing interactive applications. In his design, applications were broken into three types of components: models, views, and controllers.

The *model* is responsible for maintaining the state of the application. Sometimes this state is transient, lasting for just a couple of interactions with the user. Sometimes the state is permanent and is stored outside the application, often in a database.

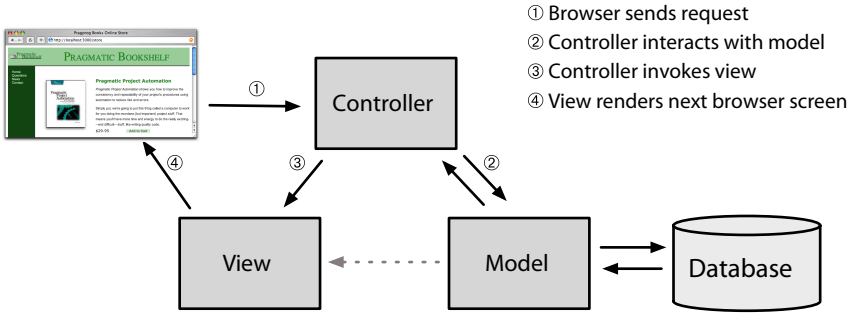
A model is more than data; it enforces all the business rules that apply to that data. For example, if a discount shouldn't be applied to orders of less than $20, the model enforces the constraint. This makes sense; by putting the implementation of these business rules in the model, we make sure that nothing else in the application can make our data invalid. The model acts as both a gatekeeper and a data store.

The *view* is responsible for generating a user interface, normally based on data in the model. For example, an online store has a list of products to be displayed on a catalog screen. This list is accessible via the model, but it's a view that formats the list for the end user. Although the view might present the user with various ways of inputting data, the view itself never handles incoming data. The view's work is done once the data is displayed. There may well be many views that access the same model data, often for different purposes. The online

store has a view that displays product information on a catalog page and another set of views used by administrators to add and edit products.

Controllers orchestrate the application. Controllers receive events from the outside world (normally, user input), interact with the model, and display an appropriate view to the user.

This triumvirate—the model, view, and controller—together form an architecture known as MVC. To learn how the three concepts fit together, see the following figure.



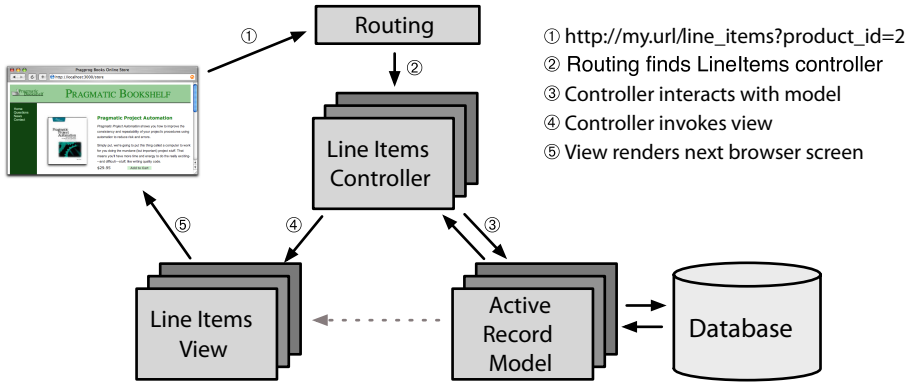
The MVC architecture was originally intended for conventional GUI applications, where developers found that the separation of concerns led to far less coupling, which in turn made the code easier to write and maintain. Each concept or action was expressed in a single, well-known place. Using MVC was like constructing a skyscraper with the girders already in place—it was a lot easier to hang the rest of the pieces with a structure already there. During the development of our application, we'll make heavy use of Rails' ability to generate *scaffolding* for our application.

Ruby on Rails is an MVC framework too. Rails enforces a structure for your application: you develop models, views, and controllers as separate chunks of functionality, and it knits them together as your program executes. One of the joys of Rails is that this knitting process is based on the use of intelligent defaults so that you typically don't need to write any external configuration metadata to make it all work. This is an example of the Rails philosophy of favoring convention over configuration.

In a Rails application, an incoming request is first sent to a router, which works out where in the application the request should be sent and how the request should be parsed. Ultimately, this phase identifies a particular method (called an *action* in Rails parlance) somewhere in the controller code. The action might look at data in the request, it might interact with the model, and

it might cause other actions to be invoked. Eventually the action prepares information for the view, which renders something to the user.

Rails handles an incoming request as shown in the following figure. In this example, the application has previously displayed a product catalog page, and the user has just clicked the Add to Cart button next to one of the products. This button posts to http://localhost:3000/line_items?product_id=2, where line_items is a resource in the application and 2 is the internal ID for the selected product.



The routing component receives the incoming request and immediately picks it apart. The request contains a path (/line_items?product_id=2) and a method (this button does a POST operation; other common methods are GET, PUT, PATCH, and DELETE). In this simple case, Rails takes the first part of the path, line_items, as the name of the controller and the product_id as the ID of a product. By convention, POST methods are associated with create() actions. As a result of all this analysis, the router knows it has to invoke the create() method in the LineItemsController controller class (we'll talk about naming conventions in Naming Conventions, on page 299).

The create() method handles user requests. In this case, it finds the current user's shopping cart (which is an object managed by the model). It also asks the model to find the information for product 2. It then tells the shopping cart to add that product to itself. (See how the model is being used to keep track of all the business data? The controller tells it *what* to do, and the model knows *how* to do it.)

Now that the cart includes the new product, we can show it to the user. The controller invokes the view code, but before it does, it arranges things so that the view has access to the cart object from the model. In Rails, this invocation is often implicit; again, conventions help link a particular view with a given action.

That's all there is to an MVC web application. By following a set of conventions and partitioning your functionality appropriately, you'll discover that your code becomes easier to work with and your application becomes easier to extend and maintain. That seems like a good trade.

If MVC is simply a question of partitioning your code a particular way, you might be wondering why you need a framework such as Ruby on Rails. The answer is straightforward: Rails handles all of the low-level housekeeping for you—all those messy details that take so long to handle by yourself—and lets you concentrate on your application's core functionality. Let's see how.

Rails Model Support

In general, we want our web applications to keep their information in a relational database. Order-entry systems will store orders, line items, and customer details in database tables. Even applications that normally use unstructured text, such as weblogs and news sites, often use databases as their back-end data store.

Although it might not be immediately apparent from the database queries you've seen so far, relational databases are designed around mathematical set theory. This is good from a conceptual point of view, but it makes it difficult to combine relational databases with object-oriented (OO) programming languages. Objects are all about data and operations, and databases are all about sets of values. Operations that are easy to express in relational terms are sometimes difficult to code in an OO system. The reverse is also true.

Over time, folks have worked out ways of reconciling the relational and OO views of their corporate data. Let's look at the way that Rails chooses to map relational data onto objects.

Object-Relational Mapping

Object-relational mapping (ORM) libraries map database tables to classes. If a database has a table called `orders`, our program will have a class named `Order`. Rows in this table correspond to objects of the class—a particular order is represented as an object of the `Order` class. Within that object, attributes are used to get and set the individual columns. Our `Order` object has methods to get and set the amount, the sales tax, and so on.

In addition, the Rails classes that wrap our database tables provide a set of class-level methods that perform table-level operations. For example, we might need to find the order with a particular ID. This is implemented as a class

method that returns the corresponding Order object. In Ruby code, that might look like this:

```
order = Order.find(1)
puts "Customer #{order.customer_id}, amount=$#{order.amount}"
```

Sometimes these class-level methods return collections of objects:

```
Order.where(name: 'dave').each do |order|
  puts order.amount
end
```

Finally, the objects corresponding to individual rows in a table have methods that operate on that row. Probably the most widely used is save(), the operation that saves the row to the database:

```
Order.where(name: 'dave').each do |order|
  order.pay_type = "Purchase order"
  order.save
end
```

So an ORM layer maps tables to classes, rows to objects, and columns to attributes of those objects. Class methods are used to perform table-level operations, and instance methods perform operations on the individual rows.

In a typical ORM library, you supply configuration data to specify the mappings between entities in the database and entities in the program. Programmers using these ORM tools often find themselves creating and maintaining a boatload of XML configuration files.

Active Record

Active Record is the ORM layer supplied with Rails. It closely follows the standard ORM model: tables map to classes, rows to objects, and columns to object attributes. It differs from most other ORM libraries in the way it's configured. By relying on convention and starting with sensible defaults, Active Record minimizes the amount of configuration that developers perform.

To show this, here's a program that uses Active Record to wrap our orders table:

```
require 'active_record'

class Order < ApplicationRecord
end

order = Order.find(1)
order.pay_type = "Purchase order"
order.save
```

This code uses the new Order class to fetch the order with an id of 1 and modify the pay_type. (For now, we've omitted the code that creates a database connection.) Active Record relieves us of the hassles of dealing with the underlying database, leaving us free to work on business logic.

But Active Record does more than that. As you'll see when we develop our shopping cart application, starting in Chapter 5, The Depot Application, on page 63, Active Record integrates seamlessly with the rest of the Rails framework. If a web form sends the application data related to a business object, Active Record can extract it into our model. Active Record supports sophisticated validation of model data, and if the form data fails validations, the Rails views can extract and format errors.

Active Record is the solid model foundation of the Rails MVC architecture.

Action Pack: The View and Controller

When you think about it, the view and controller parts of MVC are pretty intimate. The controller supplies data to the view, and the controller receives events from the pages generated by the views. Because of these interactions, support for views and controllers in Rails is bundled into a single component, Action Pack.

Don't be fooled into thinking that your application's view code and controller code will be jumbled up because Action Pack is a single component. Quite the contrary—Rails gives you the separation you need to write web applications with clearly demarcated code for control and presentation logic.

View Support

In Rails, the view is responsible for creating all or part of a response to be displayed in a browser, to be processed by an application, or to be sent as an email. At its simplest, a view is a chunk of HTML code that displays some fixed text. More typically, you'll want to include dynamic content created by the action method in the controller.

In Rails, dynamic content is generated by templates, which come in three flavors. The most common templating scheme, called Embedded Ruby (ERB), embeds snippets of Ruby code within a view document, in many ways similar to the way it's done in other web frameworks, such as PHP or JavaServer Pages (JSP). Although this approach is flexible, some are concerned that it violates the spirit of MVC. By embedding code in the view, we risk adding logic that should be in the model or the controller. As with everything, while

judicious use in moderation is healthy, overuse can become a problem. Maintaining a clean separation of concerns is part of the developer's job.

You can also use ERB to construct HTML fragments on the server that can then be used by the browser to perform partial page updates. This is great for creating dynamic Hotwired interfaces. We talk about these starting in Iteration F2: Creating a Hotwired Cart, on page 150.

Rails also provides libraries to construct XML or JSON documents using Ruby code. The structure of the generated XML or JSON automatically follows the structure of the code.

And the Controller!

The Rails controller is the logical center of your application. It coordinates the interaction among the user, the views, and the model. However, Rails handles most of this interaction behind the scenes; the code you write concentrates on application-level functionality. This makes Rails controller code remarkably easy to develop and maintain.

The controller is also home to a number of important ancillary services:

- It's responsible for routing external requests to internal actions. It handles people-friendly URLs extremely well.
- It manages caching, which can give applications orders-of-magnitude performance boosts.
- It manages helper modules, which extend the capabilities of the view templates without bulking up their code.
- It manages sessions, giving users the impression of ongoing interaction with our applications.

We've already seen and modified a controller in Hello, Rails!, on page 24, and we'll be seeing and modifying a number of controllers in the development of a sample application, starting with the products controller in Iteration C1: Creating the Catalog Listing, on page 101.

There's a lot to Rails. But before going any further, let's have a brief refresher—and for some of you, a brief introduction—to the Ruby language.