Backbone.js on Rails

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2.1. Backbone.js online resources

This book is not an introduction, and assumes you have some knowledge of Javascript and of Backbone.js. Luckily, there is solid documentation available to get you up to speed on Backbone.

The online documentation for Backbone is very readable:

http://documentcloud.github.com/backbone/

The GitHub wiki for Backbone links to a large number of tutorials and examples:

https://github.com/documentcloud/backbone/wiki/Tutorials%2C-blog-posts-and-example-sites

PeepCode is producing a three-part series on getting up to speed on Backbone.js:

http://peepcode.com/products/backbone-js

2.2. JavaScript online resources and books

I cannot recommend *JavaScript: The Good Parts* by Douglas Crockford highly enough. It's concise, readable, and will make you a better JavaScript programmer.

http://www.amazon.com/exec/obidos/ASIN/0596517742/

Test-Driven JavaScript Development by Christian Johansen teaches not only the ins and outs how to test-drive your code, but covers good fundamental JavaScript development practices and takes a deep dive on language fundamentals:

http://tddjs.com/

3. Introduction (section unstarted)

3.1. Why use Backbone.js

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Rails 3.1.0.rc5

Ruby 1.9.2

Backbone.js and Underscore.js are the non-minified versions. This is for informational purposes, but also because the Rails 3.1 asset pipeline will compress and minify them.

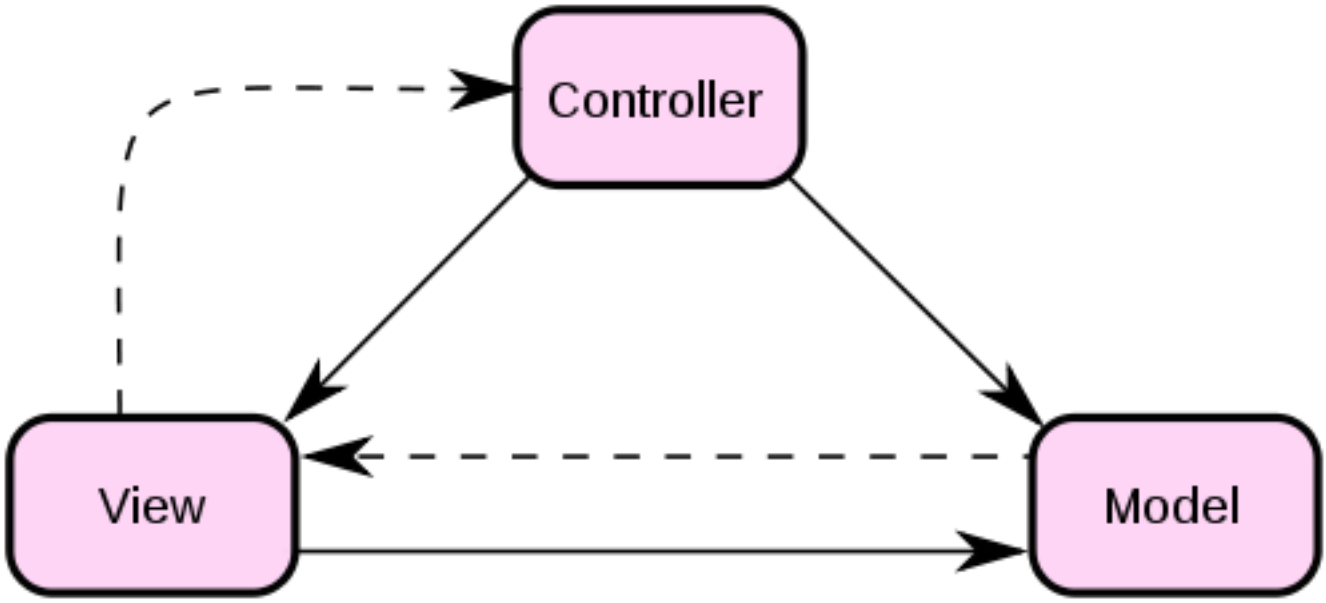
While Rails 3.1 defaults to CoffeeScript, we have decided to make all of the example code normal Javascript as we believe that will be the most understandable to the current readers.

4. Organization

4.1. Backbone.js and MVC

Model–View–Controller (MVC) is an architectural pattern used in many applications to isolate "domain logic" (the application logic for the user) from the user interface (input and presentation).

Figure 1. Model-view-controller concept



In the above diagram a solid line represents a direct association and a dashed line represents an indirect association (for example, via an observer).

As a user of Rails, you're likely already familiar with the concept of MVC and the benefits that the separation of concerns can give you. However, Rails itself is not doing "traditional" MVC. A traditional MVC is event-based. This means that the views trigger events which the controller figures out what to do with. It can be argued that the requests generated by the browser are the "events" in Rails; however, due to the single-threaded, request-response nature of the web, the control flow between the different levels of MVC is much more straightforward.

Given that Javascript has events, and that much of the interactions between the different components of Backbone.js in the browser are not limited to request/response, programming with Backbone.js is in a lot of ways more like working with a traditional MVC architecture.

That said, technically speaking, Backbone.js is *not* MVC, and the creators of Backbone.js acknowledged this when they renamed Controllers to Routers in version 0.5.0.

What is Backbone.js then, if not MVC? Technically speaking, it's just the Models and the Views with a Router to handle flow between them. In Backbone.js the views will handle many of the aspects that controllers would typically handle, such as actually figuring out what to do next and what to render.

While you could do it, the benefit of actually introducing a Controller in your application would be limited, and the more pragmatic approach is to realize the great organization that Backbone.js gives you is much better than what you had before. The fact that it doesn't have a nice name, or strict adherence to a pattern, isn't worth worrying about.

4.2. What Goes Where

Part of the initial learning curve of Backbone.js can be figuring out what goes where, and mapping it to your expectations set by working with Rails. In Rails we have Models, Views, Controllers, and Routers. In Backbone.js, we have Models, Collections, Views, Templates, and Routers.

The models in Backbone.js and Rails are analogous. Backbone.js collections are just ordered sets of models. Because it lacks controllers, Backbone.js routers and views work together to pick up the functionality provided by Rails controllers. Finally, in Rails, when we say views, we actually mean templates. In Backbone.js, however, you have a separation between the view and templates.

Once you introduce Backbone.js into your stack, you grow the layers in your stack by four levels. This can be daunting at first, and frankly, at times it can be difficult to keep everything going on in your application straight. Ultimately, the additional organization and functionality of Backbone.js outweighs the costs, so let's break it down.

Rails

- Model
- Controller
- View

Backbone.js

- Model and Collection
- Router
- View
- Template

In a typical Rails and Backbone.js application, the initial interaction between the layers will be as follows:

- A request from a user comes in the **Rails router** identifies what should handle the request based on the URL
- The **Rails controller action** to handle the request is called, some initial processing may be performed

- The **Rails view template** is rendered and returned to the user's browser
- The **Rails view template** will include **Backbone.js initialization**, usually this is populating some **Backbone collections** as sets of **Backbone models** with JSON data provided by the **Rails view**
- The **Backbone.js router** determines which of its methods should handle the display based on the URL
- The **Backbone.js router** method calls that method, some initial processing may be performed, and one or more **Backbone.js views** are rendered
- The **Backbone.js view** reads **templates** and uses **Backbone.js** models to render itself onto the page

At this point, the user will see a nice page in their browser and be able to interact with it. The user interacting with elements on the page will trigger actions to be taken at any level of the above sequence: **Backbone.js model**, **Backbone.js views**, **Backbone.js router**, or requests to the remote server.

Requests to the remote server may be any one of the following:

- At the **Backbone.js model** or **Backbone.js collection** level, communicating with Rails via JSON.
- Normal Ajax requests, not using Backbone.js at all.
- Normal requests that don't hit Backbone.js and trigger a full page reload.

Which of the above remote server interactions you use will depend upon the desired result, and the type of user interface. This book should help you understand which interaction you'll want to choose for each portion of your application.

4.3. Namespacing your application

You will want to create an object in Javascript for your Backbone.js application to reside. This variable will serve as a namespace for your Backbone.js application. Namespacing all of the Javascript is desirable to avoid potential collisions in naming. For example, it's possible that a Javascript library you want to use might also create a Task variable. If you didn't namespace your Task model then this would conflict.

This variable includes a place to hold Models, Collections, Views, and Routes, and an init method which will be called to initialize the application. It's very common to create a new Router in the init function, and Backbone.history.start() must be called in order to route the initial URL. This app variable will look like the following.

```
var ExampleApp = {
  Models: {},
  Collections: {},
  Views: {},
  Routers: {},
  init: function() {
    new ExampleApp.Routers.Tasks();
    Backbone.history.start();
  }
```

```
};
```

You can find this file in the example app in `app/assets/javascripts/example_app.js`.

4.4. Mixins

Backbone provides a basic mechanism for inheritance. Often you'll want to build a collection of related, reusable behavior and include that in several classes that already inherit from a Backbone base class. In these cases, you'll want to use a mixin [http://en.wikipedia.org/wiki/Mixin].

Backbone includes Backbone.Events [http://documentcloud.github.com/backbone/#Events] as an example of a mixin.

Here, we create a mixin named `Observer` that contains behavior for binding to events in a fashion that can be cleaned up later:

```
var Observer = {
  bindTo: function(source, event, callback) {
    source.bind(event, callback, this);
    this.bindings = this.bindings || [];
    this.bindings.push({ source: source, event: event, callback: callback });
  },

  unbindFromAll: function() {
    _.each(this.bindings, function(binding) {
      binding.source.unbind(binding.event, binding.callback);
    });
    this.bindings = [];
  }
};
```

We can mix `Observer` into a class by using Underscore's `_.extend` on the prototype of that class:

```
SomeCollectionView = Backbone.Collection.extend({
  initialize: function() {
    this.bindTo(this.collection, "change", this.render);
  },

  leave: function() {
    this.unbindFromAll(); // calling a method defined in the mixin
    this.remove();
  }
});

_.extend(SomeCollectionView.prototype, Observer);
```

5. Rails Integration

5.1. Organizing your Backbone.js code in a Rails app

When using Backbone.js in a Rails app, you'll have two kinds of Backbone.js-related assets: classes and templates.

5.2. Rails 3.0 and prior

With Rails 3.0 and prior, store your Backbone.js classes in `public/javascripts`:

```
public/
  javascripts/
    jquery.js
    jquery-ui.js
    collections/
      users.js
      todos.js
    models/
      user.js
      todo.js
    routers/
      users_router.js
      todos_router.js
    views/
      users/
        users_index.js
        users_new.js
        users_edit.js
      todos/
        todos_index.js
```

If you are using templates, we prefer storing them in `app/templates` to keep them separated from the server views:

```
app/
  views/
    pages/
      home.html.erb
      terms.html.erb
      privacy.html.erb
      about.html.erb
  templates/
    users/
      index.jst
      new.jst
      edit.jst
    todos/
      index.jst
      show.jst
```

On Rails 3.0 and prior apps, we use Jammit for packaging assets and precompiling templates:

http://documentcloud.github.com/jammit/

http://documentcloud.github.com/jammit/#jst

Jammit will make your templates available in a top-level JST object. For example, to access the above todos/index.jst template, you would refer to it as:

```
JST['todos/index']
```

Variables can be passed to the templates by passing a Hash to the template, as shown below.

```
JST['todos/index']({ model: this.model })
```

Note

Jammit and a JST naming gotcha

One issue with Jammit that we've encountered and worked around is that the JST template path can change when adding new templates.

When using Jammit, there is a slightly sticky issue as an app grows from one template subdirectory to multiple template subdirectories.

Let's say you place templates in app/templates. You work for a while on the "Tasks" feature, placing templates under app/templates/tasks. So, window.JST looks something like:

```
JST['form']
JST['show']
JST['index']
```

Now, you add another directory under app/templates, say app/templates/user. Now, all JST references are prefixed with their parent directory name so they are unambiguous:

```
JST['tasks/form']
JST['tasks/show']
JST['tasks/index']
JST['users/new']
JST['users/show']
JST['users/index']
```

This breaks existing JST references. You can work around this issue by applying the following monkeypatch to Jammit, in config/initializers/jammit.rb

```
Jammit::Compressor.class_eval do
  private
  def find_base_path(path)
    File.expand_path(Rails.root.join('app','templates'))
  end
end
```

As applications are moving to Rails 3.1, they're also moving to Sprockets for the asset packager. Until then, many apps are using Jammit for asset packaging. We have an open issue and workaround:

https://github.com/documentcloud/jammit/issues/192

5.3. Rails 3.1

Rails 3.1 introduces the asset pipeline:

http://edgeguides.rubyonrails.org/asset_pipeline.html

which uses the Sprockets library for preprocessing and packaging assets:

http://getsprockets.org/

To take advantage of the built-in asset pipeline, organize your Backbone.js templates and classes in paths available to the asset pipeline. Classes go in `app/assets/javascripts/`, and templates go alongside, in `app/assets/templates/`:

```
app/
  assets/
    javascripts/
      collections/
        todos.js
      models/
        todo.js
      routers/
        todos_router.js
      views/
        todos/
          todos_index.js
    templates/
      todos/
        index.jst.ejs
        show.jst.ejs
```

In Rails 3.1, jQuery is provided by the jquery-rails gem, and no longer needs to be included in your directory structure.

Using Sprockets' preprocessors, we can use templates as before. Here, we're using the EJS template preprocessor to provide the same functionality as Underscore.js' templates. It compiles the `*.jst` files and makes them available on the client side via the `window.JST` object. Identifying the `.ejs` extension and invoking EJS to compile the templates is managed by Sprockets, and requires the `ejs` gem to be included in the application Gemfile.

Note

Underscore.js templates: http://documentcloud.github.com/underscore/#template

EJS gem: https://github.com/sstephenson/ruby-ejs

Sprockets support for EJS: https://github.com/sstephenson/sprockets/blob/master/lib/sprockets/ejs_template.rb

To make the `*.jst` files available and create the `window.JST` object, require them in your application.js Sprockets manifest:

```
//  other application requires
//= require_tree ../templates
//= require_tree .
```

Additionally, load order for Backbone.js and your Backbone.js app is very important. jQuery and Underscore.js must be loaded before Backbone.js, then the Rails authenticity token patch must be applied. Then your models must be loaded before your collections (because your collections will reference your models) and then your routers and views must be loaded.

Fortunately, sprockets can handle this load order for us. When all is said and done your application.js Sprockets manifest will be as shown below.

```
//= require jquery
```

```
//= require jquery_ujs
//
//= require underscore
//= require backbone
//= require backbone.authtokenadapter
//
//= require example_app
//
//= require_tree ./models
//= require_tree ./collections
//= require_tree ./views
//= require_tree ./routers
//= require_tree ../templates
//= require_tree .
```

The above is taken from the example application included with this book. You can view it at example_app/app/assets/javascripts/application.js.

5.4. An Overview of the Stack: Connecting Rails and Backbone.js

By default Backbone.js communicates with your Rails application via JSON gets and posts. If you've ever made a JSON API for your Rails app, then for the most part this will be very similar.

If you've never made a JSON API for your Rails application before, lucky you, it's pretty straightforward.

5.4.1. Setting Up Rails Models

One important aspect to keep in mind as you plan out how your Backbone.js interface will behave, and how it will use your Rails back-end, is that there is no need to have a one-to-one mapping between your Rails models and your Backbone.js models.

The smaller an application is, the more likely that there will be a one-to-one mapping between both Backbone.js and Rails models and controllers.

However, if you have a sufficiently complex application, it's more likely that you *won't* have a one-to-one mapping due to the differences in the tools Backbone.js gives you and the fact that you're building a user-interface, not a back-end. Some of the reasons why you won't have a one to one mapping include:

- Because you're building a user interface, not a back-end, it's likely that some of your backbone models will aggregate information from multiple Rails models into one Backbone.js model.
- This Backbone.js model may or may not be named the same as one of your Rails models.
- Backbone.js gives you a new type of object not present in Rails: Collections.
- Backbone.js doesn't have the concept of relationships out of the box.

With that said, lets take the simple case first and look at how you might make a Backbone.js version of a Rails model.

In our example application, we have a Task model. The simplest Backbone.js representation of this model would be as shown below.

```
var Task = Backbone.Model.extend({
  urlRoot: '/tasks'
});
```

The urlRoot property above indicates to Backbone.js that the server url for instances of this model will be found at /tasks/:id.

In Rails, it's possible to access individual Tasks, as well as all Tasks (and query all tasks) through the same Task model. However, in Backbone.js models only represent the singular representation of a Task. Backbone.js splits out the plural representation of Tasks into what it calls Collections.

The simplest Backbone.js collection to represent our Tasks would be the following.

```
var Tasks = Backbone.Collection.extend({
  model: Task
});
```

If we specify the url for Tasks in our collection instead, then models within the collection will use the collection's url to construct their own URLs, and the urlRoot no longer needs to be specified in the model. If we make that change, then our collection and models will be as follows.

```
var Tasks = Backbone.Collection.extend({
  model: Task,
  url: '/tasks'
});

var Task = Backbone.Model.extend({});
```

Notice in the above model definitions that there is no specification of the attributes on the model. Like ActiveRecord, Backbone.js models get their attributes from the schema and data given to them. In the case of Backbone.js, this schema and data are the JSON from the server.

The default JSON representation of an ActiveRecord model is a Hash that includes all the model's attributes. It does not include the data for any related models or any methods on the model, but it does include the ids of any related models as those are stored in a `relation_name_id` attribute on the model.

The JSON representation of your ActiveRecord models will be retrieved by calling `to_json` on them. You customize the output of `to_json` by overriding the `as_json` method in your model. We'll touch on this more later in the section "Customizing your Rails-generated JSON."

5.4.2. Setting Up Rails Controllers

The Backbone models and collections will talk to your Rails controllers. While your models may not have a one-to-one mapping with their Rails counterparts, it is likely that you'll have at least one controller corresponding to every Backbone.js model.

Fortunately for us, Backbone.js models will communicate in the normal RESTful way that Rails controllers understand, using the proper verbs to support the standard RESTful Rails controller actions: index, show, create, update, and destroy. Backbone.js does not make any use the new action.

Therefore, it's just up to us to write a *normal* restful controller.

There are a few different ways you can write your controllers for interacting with you Backbone.js models and collections. However, the newest and cleanest way is to use the respond_with method introduced in Rails 3.0.

When using respond_with, in your controller you specify what formats are supported with the method respond_to. In your individual actions, you then specify the resource or resources to be delivered using respond_with, as shown in the example Tasks controller and index action below.

```
class TasksController < ApplicationController::Base
  respond_to :html, :json

  def index
    respond_with(@tasks = Task.all)
  end
end
```

In the above example Tasks controller, the respond_to line declares that this controller should respond to both the HTML and JSON formats. Then, in the index action, the respond_with call will perform the appropriate action for the requested format.

The above controller is equivalent to the following one, using the older respond_to method.

```
class TasksController < ApplicationController::Base
  def index
    @tasks = Task.all
    respond_to do |format|
      format.html
      format.json { render :json => @tasks }
    end
  end
end
```

Using respond_with you can create succinct controllers that respond with a normal web page, but also expose a JSON API that Backbone.js will use.

5.4.2.1. Validations and your HTTP API

If a Backbone.js model has a `validate` method defined, it will be validated before its attributes are set. If validation fails, no changes to the model will occur, and the "error" event will be fired. Your `validate` method will be passed the attributes that are about to be updated. You can signal that validation passed by returning nothing from your `validate` method. You can signify that validation has failed by returning something from the method. What you return can be as simple as a string, or a more complex object that describes the error in all its gory detail.

In practice, much of the validation logic for your models will continue to be handled on the server, as fully implementing validations on the client side would often require duplicating a lot of server-side business logic.

TODO: Is it possible to smoothly integrate Backbone.js and the client_side_validations gem?

Instead, your Backbone.js applications will likely rely on server-side validation logic. How to handle a failure scenario is passed in to Backbone.js model save call as a callback, as shown below.

```
task.save({title: "New Task title"}, {
  error: function(){
    // handle error from server
  }
});
```

The error callback will be triggered if your server returns a non-200 response. Therefore, you'll want your controller to return a non-200 HTTP response code if validations fail.

A controller that does this would be as shown in the following example.

```
class TasksController < ApplicationController::Base
  respond_to :json

  def create
    @task = Task.new(params[:task])
    if @task.save
      respond_with(@task)
    else
      respond_with(@task, :status => :unprocessable_entity)
    end
  end
end
```

Your error callback will receive both the model as it was attempted to be saved and the response from the server. You can take that response and handle the errors returned by the above controller in whatever way is fit for your application. For more information about handling and displaying errors, see the Form helpers section of the Views and Templates chapter.

5.4.3. Setting Up Views

Most Backbone.js applications will be a "single-page app". This means that your Rails application will render a single-page which properly sets up Backbone.js and the data it will use. From there, ongoing interaction with your Rails application occurs via the JSON APIs.

The most common page for this single-page application will be the index action of a controller, as in our example application and the tasks controller.

You will want to create an object in Javascript for your Backbone.js application to reside. For more information on this namespacing see the "Namespacing your application" section of the Organization chapter.

This namespace variable holds your Backbone.js application's Models, Collections, Views, and Routes, and has an init method which will be called to initialize the application.

This namespace variable will look like the following.

```
var ExampleApp = {
  Models: {},
  Collections: {},
  Views: {},
  Routers: {},
  init: function() {
    new ExampleApp.Routers.Tasks();
    Backbone.history.start();
```

```
  }
};
```

You can find this file in the example app in `app/assets/javascripts/example_app.js`.

Important

You must instantiate a Backbone.js router before calling Backbone.history.start() otherwise Backbone.history will be undefined.

Then, inside app/views/tasks/index.html.erb you will call the initialize method. This will appear as follows.

```
<%= content_for :javascript do -%>
  <%= javascript_tag do %>
    ExampleApp.init();
  <% end %>
<% end -%>
```

For performance reasons, you will almost always "prime the pump" and give Backbone.js its initial data within the HTML view for this page. In our example, the tasks have already been provided to the view in a @tasks instance variable, and that can be used to prime the pump, as shown below.

```
<%= content_for :javascript do -%>
  <%= javascript_tag do %>
    ExampleApp.init(<%== @tasks.to_json %>);
  <% end %>
<% end -%>
```

The above example uses Erb to pass the JSON for the tasks to the init method.

Once you make this change, the ExampleApp.init method then becomes:

```
var ExampleApp = {
  Models: {},
  Collections: {},
  Views: {},
  Routers: {},
  init: function(tasks) {
    new ExampleApp.Routers.Tasks();
    this.tasks = new ExampleApp.Collections.Tasks(tasks);
    Backbone.history.start();
  }
};
```

Finally, you must have a Router in place which knows what to do. We'll cover routers in more detail in the Routers, Views and Templates chapter. For a more in-depth presentation on writing and using routers please go there. However, routers are an important part of the infrastructure you need to start using Backbone.js and we can't make our example here work without them.

Backbone.js routers provide methods for routing application flow based on client-side URL fragments (#fragment).

```
ExampleApp.Routers.Tasks = Backbone.Router.extend({
  routes: {
    "": "index"
```

```
  },

  index: function() {
    // We've reached the end of Rails integration - it's all Backbone from here!

    alert('Hello, world!  This is a Backbone.js router action.');

    // Normally you would continue down the stack, instantiating a
    // Backbone.View class, calling render() on it, and inserting its element
    // into the DOM.
  }
});
```

A basic router consists of a routes hash which is a mapping between url fragments and methods on the router. If the current URL fragment, or one that is being visited matches one of the routes in the hash, its method will be called.

The example router above is all that is needed to complete our Backbone.js infrastructure. When a user visits `/tasks` the index.html.erb view will be rendered which properly initialized Backbone.js and its dependencies and the Backbone.js models, collections, routers, and views.

5.5. Customizing your Rails-generated JSON

There are a few common things you'll do in your Rails app when working with Backbone.js.

First, it's likely that you'll want to switch from including all attributes (the default) to delivering some subset.

This can be done by specifying explicitly only the attributes that are to be included (whitelisting), or specifying the attributes that should *not* be included (blacklisting). Which one you choose will depend on how many attributes your model has and how paranoid you are about something important appearing in the JSON when it shouldn't be there.

If you're concerned about sensitive data unintentionally being included in the JSON when it shouldn't be then you'll want to whitelist, to switch to everything being explicitly included in the JSON with the `:only` option:

```
def as_json(options = {})
  super(options.merge(:only => [ :id, :title ]))
end
```

The above `as_json` override will make it so that the JSON will *only* include the id and title attributes, even if there are many other attributes on the model.

If instead you want to include all attributes by default and just exclude a few, you accomplish this with the `:except` option:

```
def as_json(options = {})
  super(options.merge(:except => [ :encrypted_password ]))
end
```

Another common customization you will want to do in the JSON is include the output of methods (say, calculated values) on your model. This is accomplished with the `:methods` option, as shown in the following example.

```
def as_json(options = {})
  super(options.merge(:methods => [ :calculated_value ]))
end
```

The final thing you'll most commonly do with your JSON is include related objects. If the `Task` model `has_many :comments`, include all of the JSON for comments in the JSON for a Task with the `:include` option:

```
def as_json(options = {})
  super(options.merge(:include => [ :comments ]))
end
```

As you probably suspect, you can then customize the JSON for the comments by overriding the `as_json` method on the `Comment` model.

While these are the most common `as_json` options you'll use when working with Backbone.js, it certainly isn't all of them. The official, complete, documentation for the `as_json` method can be found here: http://apidock.com/rails/ActiveModel/Serializers/JSON/as_json

5.5.1. ActiveRecord::Base.include_root_in_json

Depending on the versions, Backbone.js and Rails may have different expectations about the format of JSON structures; specifically, whether or not a root key is present. When generating JSON from Rails, this is controlled by the ActiveRecord setting `ActiveRecord::Base.include_root_in_json`.

```
  > ActiveRecord::Base.include_root_in_json = false
  > Task.last.as_json
 => {"id"=>4, "title"=>"Enjoy a three mile swim"}

  > ActiveRecord::Base.include_root_in_json = true
  > Task.last.as_json
 => {"task"=>{"id"=>4, "title"=>"Enjoy a three mile swim"}}
```

In Rails 3.0, `ActiveRecord::Base.include_root_in_json` is set to true. In 3.1, it defaults to false. This reversal was made to simplify the JSON returned by default in Rails application, but it is fairly big change from the default behavior of Rails 3.0.

Practically speaking, this change is a good one, but take particular note if you're upgrading an existing Rails 3.0 application to Rails 3.1 and you already have a published API; you may need to expose a new version of your API.

From the Backbone.js side, the default behavior expects no root node. This behavior is defined in a few places: `Backbone.Collection.prototype.parse`, `Backbone.Model.prototype.parse`, and `Backbone.Model.prototype.toJSON`:

```
_.extend(Backbone.Collection.prototype, Backbone.Events, {
  // http://documentcloud.github.com/backbone/#Collection-parse
  parse : function(resp, xhr) {
    return resp;
  },

  // snip...
});

_.extend(Backbone.Model.prototype, Backbone.Events, {
```

```
  // http://documentcloud.github.com/backbone/#Model-toJSON
  toJSON : function() {
    return _.clone(this.attributes);
  },

  // http://documentcloud.github.com/backbone/#Model-parse
  parse : function(resp, xhr) {
    return resp;
  },

  // snip...
});
```

If you need to accept JSON with a root node, you can override `parse` in each of your models, or override the prototype's function. You'll need to override it on the appropriate collection(s), too.

If you need to send JSON back to the server that includes a root node, you can override `toJSON`, per-model or across all models. When you do this, you'll need to explicitly specify the name of the root key. We use a convention of a `modelName` function on your model to provide this:

```
Backbone.Model.prototype.toJSON = function() {
  var hashWithRoot = {};
  hashWithRoot[this.modelName] = this.attributes;
  return _.clone(hashWithRoot);
};

var Task = Backbone.Model.extend({
  modelName: "task",

  // ...
});
```

5.6. Converting an existing page/view area to use Backbone.js

We'll cover Backbone.js Views and Templates in more detail in the Routers, Views, and Templates chapter, but this section is meant to get you started understanding how Backbone.js views work by illustrating the conversion of a Rails view to a Backbone.js view.

Its important to note that a Rails view is not directly analogous to a Backbone.js view. A Rails view is more like a Backbone.js template, and Backbone.js views are more like Rails controllers. This can cause confusion with developers just started with Backbone.js.

Consider the following Rails view for a tasks index.

```
<h1>Tasks</h1>

<table>
  <tr>
    <th>Title</th>
    <th>Completed</th>
  </tr>

  <% @tasks.each do |task| %>
    <tr>
```

```
      <td><%= task.title %></td>
      <td><%= task.completed %></td>
    </tr>
  <% end %>
</table>
```

Assuming we have the Backbone.js Task model and collection and the Rails Task model and controller discussed above, and we're priming the pump with all the tasks, before we can convert the template we must create a Backbone.js view which will render the Backbone.js template.

A Backbone.js view is a class that is responsible for rendering the display of a logical element on the page. A view can also bind to events which may cause it to be re-rendered. For more detailed coverage of Backbone.js views, see the Routers, Views, and Templates chapter.

The most rudimentary view we could introduce at this point would be one that merely renders the above page markup, looping over each task in the Tasks collection. While this would be insufficient for most actual applications, in order to illustrate the building blocks of a Backbone.js view, such a view would be like the one shown below.

```
ExampleApp.Views.TasksIndex = Backbone.View.extend({
  initialize: function() {
    this.render();
  },

  render: function () {
    $(this.el).html(JST['tasks/index']({ tasks: ExampleApp.tasks }));
    $('body').html(this.el);

    return this;
  }
};
```

The Backbone.js view above has an initialize method which will be called when the view is instantiated. This initialize method calls the render method of the view. It's not necessary to immediately render upon initialization, but it's fairly common to do so.

The render method above then renders the *tasks/index* template, passing the collection of tasks into the template. It then sets the HTML of the body element of the page to be the rendered template.

Each Backbone.js view has an element which is stories in this.el. This element can be populated with content, but isn't on the page until placed there by you.

Finally, the Router must be changed to instantiate this view, as shown in the follow Tasks router.

```
ExampleApp.Routers.Tasks = Backbone.Router.extend({
  routes: {
    "": "index"
  },

  index: function() {
    new ExampleApp.Views.TasksIndex();
  }
});
```

Now that we have the Backbone.js view in place that renders the template, and its being called by the router, we can focus on converting the above Rails view to a Backbone.js template.

Backbone.js depends on Underscore.js which provides templating. Fortunately, the delimiter and basic concepts used for both Underscore.js and Erb are the same, making conversion relatively painless. For this reason, we recommend using Underscore.js templates when converting a larger, existing Rails application to Backbone.js.

The tasks index template does two things:

- Loops over all of the tasks
- For each task, it outputs the task title and completed attributes

Underscore.js provides many iteration functions that will be familiar to Rails developers. For example, each, map, and reject. Fortunately, Backbone.js also proxies to Underscore.js to provide 26 iteration functions on Backbone.Collection. This means that its possible to call the Underscore.js methods directly on Backbone.js collections.

So we'll use the each method to iterate through the Tasks collection that was passed to the view, as shown in the converted Rails template, which is now an Underscore.js template, below.

```
<h1>Tasks</h1>

<table>
  <tr>
    <th>Title</th>
    <th>Completed</th>
  </tr>

  <% tasks.each(function(model) { %>
    <tr>
      <td><%= model.escape('title') %></td>
      <td><%= model.escape('completed') %></td>
    </tr>
  <% }); %>
</table>
```

As you can see above in the above example, the same delimiter, and the use of the each method make the conversion of the Rails view to an Underscore.js template straightforward.

Finally, in Rails 3.0 and above template output is escaped. In order to ensure that we have the same XSS protection as we did in our Rails template, we access and output the Backbone.js model attributes using the escape method instead of the normal get method.

5.6.1. Breaking out the TaskView

As mentioned above, this simple conversion of the index which merely loops over each of the tasks is not one you'd likely see in a real Backbone.js application.

Backbone.js views should represent the logic pieces of your web page. In the above example, we have an index view, which is a logic piece, but then it is made up of the display of individual tasks. Each of those individual tasks should be represented by a new Backbone.js view, named TaskView.

The benefit of this logical separation is covered in more detail in the Views section, but know that one of the major features of Backbone.js is event binding. With each of the Task models represented by an

individual task view, when that individual model changes the view can be re-rendered automatically (by triggering events) and the entire page doesn't need to be re-rendered.

Continuing our task index example from above, a TaskView will be responsible for rendering just the individual table row for a Task, therefore, its template will appear as follows.

```
<tr>
  <td><%= model.escape('title') %></td>
  <td><%= model.escape('completed') %></td>
</tr>
```

And the Task index template will be changed to be as shown below.

```
<h1>Tasks</h1>

<table>
  <tr>
    <th>Title</th>
    <th>Completed</th>
  </tr>

</table>
```

As you can see above in the index template, the individual tasks are no longer iterated over and rendered inside the table. This will now happen in the TasksIndex and TaskView view, which is shown below.

```
ExampleApp.Views.TaskView = Backbone.View.extend({
  initialize: function() {
  },

  render: function () {
    $(this.el).html(JST['tasks/view']({ model: this.model }));
    return this;
  }
});
```

The TaskView view above is very similar to the one we saw previously for the TasksIndex view. However, unlike the TasksIndex view, the TaskView does not insert itself into the DOM. Instead, it only inserts its content into it's own element and the TasksIndex view be responsible for inserting the rendered task into the DOM, as shown below.

```
ExampleApp.Views.TasksIndex = Backbone.View.extend({
  initialize: function() {
    this.render();
  },

  render: function () {
    $(this.el).html(JST['tasks/index']({ tasks: ExampleApp.tasks }));

    var tasksIndexView = this;
    ExampleApp.tasks.each(function(task) {
      var taskView = new ExampleApp.Views.TaskView({model: task});
      tasksIndexView.$('table').append(taskView.render().el);
    });

    $('body').html(this.el);
```

```
    return this;
  }
});
```

In the new TasksIndex view above, the Tasks collection is iterated over. For each task, a new TaskView is instantiated, rendered, and then inserted into the DOM.

If you take a look at the output of the TasksIndex, it will appear as follows.

```
<div>
  <h1>Tasks</h1>

  <table>
    <tr>
      <th>Title</th>
      <th>Completed</th>
    </tr>

    <div>
      <tr>
        <td>Task 1</td>
        <td>true</td>
      </tr>
    </div>
    <div>
      <tr>
        <td>Task 2</td>
        <td>false</td>
      </tr>
    </div>
  </table>
</div>
```

Unfortunately, we can see that there is a problem with the above rendered view, and that is the surrounding div around each of the rendered tasks.

Each of the rendered tasks has a surrounding div because this is the element that each view has that is accessed via this.el, and what the view's content is inserted into. By default, this element is a div and therefore every view will be wrapped in an extra div. While sometimes this extra div doesn't really matter, as in the outermost div that wraps the entire index, other times this produced invalid markup.

Fortunately, Backbone.js provides us with a clean and simple mechanism for changing the element to something other than a div. In the case of the TaskView, we would like this element to be a tr, then the wrapping tr can be removed from the task view template.

The element to use is specified by the tagName member of the TaskView, as shown below.

```
ExampleApp.Views.TaskView = Backbone.View.extend({
  tagName: "tr",

  initialize: function() {
  },

  render: function () {
    $(this.el).html(JST['tasks/view']({ model: this.model }));
    return this;
  }
};
```

Given the above tagName customization, the task view template will be as follows.

```
<td><%= model.escape('title') %></td>
<td><%= model.escape('completed') %></td>
```

And the resulting output of the TasksIndex will be much cleaner, as shown below.

```
<div>
  <h1>Tasks</h1>

  <table>
    <tr>
      <th>Title</th>
      <th>Completed</th>
    </tr>

    <tr>
      <td>Task 1</td>
      <td>true</td>
    </tr>
    <tr>
      <td>Task 2</td>
      <td>false</td>
    </tr>
  </table>
</div>
```

That is the basic building blocks of converting Rails views to Backbone.js and getting a functional system. The majority of Backbone.js programming you will do will likely be in the Views and Templates and there is a lot more too them: event binding, different templating strategies, helpers, event unbinding, and more. All of which are covered in the Routers, Views, and Templates chapter.

5.7. Automatically using the Rails authentication token

When using Backbone.js in a Rails app, you will run into a conflict with the Rails built in Cross Site Scripting (XSS) protection.

When Rails XSS is enabled, each POST or PUT request to Rails should include a special token which is verified to ensure that the request originated from a user which is actually using the Rails app. In recent versions of Rails, Backbone.js Ajax requests are no exception.

To get around this, you have two options. Disable Rails XSS protection (not recommended), or make Backbone.js play nicely with Rails XSS.

To make Backbone.js play nicely with Rails XSS you can monkeypatch Backbone.js to include the Rails XSS token in any requests it makes.

The following is one such script.

```
//
// With additions by Maciej Adwent http://github.com/Maciek416
// If token name and value are not supplied, this code Requires jQuery
//
// Adapted from:
```

```
// http://www.ngauthier.com/2011/02/backbone-and-rails-forgery-protection.html
// Nick Gauthier @ngauthier
//

var BackboneRailsAuthTokenAdapter = {

  //
  // Given an instance of Backbone, route its sync() function so that
  // it executes through this one first, which mixes in the CSRF
  // authenticity token that Rails 3 needs to protect requests from
  // forgery. Optionally, the token's name and value can be supplied
  // by the caller.
  //
  fixSync: function(Backbone, paramName /*optional*/, paramValue /*optional*/){

    if(typeof(paramName)=='string' && typeof(paramValue)=='string'){
      // Use paramName and paramValue as supplied
    } else {
      // Assume we've rendered meta tags with erb
      paramName = $("meta[name='csrf-param']").attr('content');
      paramValue = $("meta[name='csrf-token']").attr('content');
    }

    // alias away the sync method
    Backbone._sync = Backbone.sync;

    // define a new sync method
    Backbone.sync = function(method, model, success, error) {

      // only need a token for non-get requests
      if (method == 'create' || method == 'update' || method == 'delete') {

        // grab the token from the meta tag rails embeds
        var auth_options = {};
        auth_options[paramName] = paramValue;

        // set it as a model attribute without triggering events
        model.set(auth_options, {silent: true});
      }

      // proxy the call to the old sync method
      return Backbone._sync(method, model, success, error);
    };
  },


  // change Backbone's sync function back to the original one
  restoreSync: function(Backbone){
    Backbone.sync = Backbone._sync;
  }
};

BackboneRailsAuthTokenAdapter.fixSync(Backbone);
```

The above patch depends on jQuery, and should be included in your after jQuery and Backbone.js are loaded. Using Jammit, you'd list it below the backbone.js file.

In Rails 3.1, you'll place this file in lib/assets/javascripts. In the example app, you can find this this in example_app/lib/assets/javascripts/backbone.authtokenadapter.js.

6. Routers, Views, and Templates

6.1. View explanation

A Backbone.js view is a class that is responsible for rendering the display of a logical element on the page. A view can also bind to events which may cause it to be re-rendered.

Its important to note that a Rails view is not directly analogous to a Backbone.js view. A Rails view is more like a Backbone.js template, and Backbone.js views are often more like Rails controllers, in that they are responsible for logic about what should be rendered and how and rendering the actual template file. This can cause confusion with developers just started with Backbone.js.

A basic Backbone.js view appears as follows.

```
ExampleApp.Views.ExampleView = Backbone.View.extend({
  tagName: "li",

  className: "example",

  id: "example_view",

  events: {
    "click a.save": "save"
  },

  initialize: function() {
    this.render();
  },

  render: function() {
    $(this.el).html(JST['example/view']({ model:  }));
    $('body').html(this.el);

    return this;
  },

  save: function() {
    // do something
  }
};
```

6.1.1. Initialization

The Backbone.js view above has an initialize function which will be called when the view is instantiated.

You only need to specify the initialize function if you wish to do something custom. For example, the above view's initialize function calls the render function of the view. It's not necessary to immediately render upon initialization, but it's relatively common to do so.

You create a new view by instantiating it with `new`. For example `new ExampleView()`. It is possible to pass in a hash of options with `new ExampleView(options)`. Any options you pass into the constructor will be available inside of the view in `this.options`.

There are a few special options that, when passed, will be assigned to other members in the view directly. These are `model`, `collection`, `el`, `id`, `className`, and `tagName`. For example, if you create a new view and give it a model option with `new ExampleView({ model: Task })` then inside of the view the model you passed in as an option will be available in `this.model`.

6.1.2. The View's Element

Each Backbone.js view has an element which is stores in `this.el`. This element can be populated with content, but isn't on the page until placed there by you. Using this strategy it is then possible to render views outside of the current DOM at any time, inserting the new elements all at once. In this way, high performance rendering of views can be achieved with as few reflows and repaints as possible.

It is possible to create a view that references an element already in the DOM, instead of a new element. To do this, pass in the existing element as an option to the view constructor with `new ExampleView({ el: existingElement })`.

You can use `tagName`, `className`, and `id` to customize the new element created for the view. If no customization is done, the element is an empty `div`.

6.1.3. Customizing the View's Element

You can use `tagName`, `className`, and `id` to customize the new element created for the view. If no customization is done, the element is an empty `div`.

`tagName`, `className`, and `id` can either be specified directly on the view or passed in as options at instantiation time. Since `id` is likely to be individual to each model, its most likely to pass that in as an option rather than declaring it statically in the view.

`tagName` will change the element that is created from a `div` to something else that you specify. For example, setting `tagName: "li"` will result in the view's element being an `li` rather than a `div`.

`className` will add an additional class to the element that is created for the view. For example, setting `className: "example"` on the view will result in view's element with that additional class like `<div class="example">`.

6.1.4. Rendering

The `render` function above renders the `example/view` template. Template rendering is covered in depth in the "Templating strategy" chapter. Suffice to say, nearly every view's render function will render some form of template. Once that template is rendered, any other actions to modify the view may be taken.

Typical functionality in `render` in addition to rendering a template would be to add additional classes or attributes to `this.el` or fire or bind other events.

Backbone.js, when used with jQuery (or Zepto) provides a convenience function of `this.$` that can be used for selecting elements inside of the view. `this.$(selector)` is equivalent to the jQuery function call `$(selector, this.el)`

A nice convention of the render function is to return `this` at the end of render to enable chained calls on the view.

6.1.5. Events

The view's `events` hash specifies a mapping of the events and elements that should have events bound, and the functions that should be bound to those events. In the example above the `click` event is being bound to the element(s) that match the selector `a.save` within the view's element. When that event fires, the `save` function will be called on the view.

Events bound automatically with the `events` hash, the DOM events are bound with the `$.delegate()` function. Backbone.js also takes care of binding the event handlers' `this` to the view instance using `_.bind()`.

Event binding is covered in great detail in the "Event binding" chapter.

6.2. Templating strategy

There's no shortage of templating options for JavaScript.

TODO: Link and/or describe one or more? http://ajaxpatterns.org/Browser-Side_Templating http://stackoverflow.com/questions/449780/recommended-javascript-html-template-library-for-jquery http://code.google.com/closure/templates/docs/helloworld_js.html

They generally fall into three categories:

- HTML with JavaScript expressions interpolated. Examples: `_.template`, EJS.
- HTML with other expressions interpolated, often logic-free. Examples: mustache, handlebars, `jQuery.tmpl`
- Selector-based content declarations. Examples: PURE, just using jQuery from view classes.

6.3. Choosing a strategy

Like any technology choice, there are tradeoffs to evaluate and external forces to consider when choosing a templating approach.

The scenarios we've encountered usually involve weighing these questions: do I already have server-side templates written that I'd like to "Backbone-ify," or am I writing new Backbone functionality from scratch?

Here are the scenarios we've gone through:

6.3.1. When you are adding Backbone to existing Rails views

If you are replacing existing Rails app pages with Backbone, you are already using a templating engine, and it's likely ERb. When making the switch to Backbone, change as few things as possible at a time, and stick with your existing templating approach.

If you're using ERb, give `_.template` a shot. It defaults to the same delimiters as ERb for interpolation and evaluation, `<%= %>` and `<% %>`, which can be a boon or can be confusing. If you'd like to change them, you can update `.templateSettings` - check the underscore docs.

If you're using Haml, check out the `jquery-haml` and `haml-js` projects.

If you're using Mustache.rb or Handlebars.rb, you're likely aware that JavaScript implementations of these both exist, and that your existing templates can be moved over much like the ERb case.

6.3.2. When you are writing new Backbone functionality from scratch

If you're not migrating from (or re-using) existing server-side view templates, you have more freedom of choice. Strongly consider the option of no templating at all, but rather using plain HTML templates, and then decorating the DOM from your view class.

You can build static HTML mockups of the application first, and pull these mockups directly in as templates, without modifying them.

```
<!-- snip -->
<section id="songs">
  <nav>
    <a class="home"    href="#/">Home</a>
    <a class="profile" href="/profile.html">My Profile</a>
  </nav>
  <ol>
    <li>Here is a song</li>
  </ol>
</section>
<!-- snip -->
```

```
MyView = Backbone.View.extend({
  render: function() {
    // TODO...
  }
});
```

TODO: Can you render with this.$(*#songs nav a.profile*).attr(…) before inserting into the DOM? That way, unpopulated HTML is never displayed to the user.

6.4. Routers

Routers are an important part of the Backbone.js infrastructure. Backbone.js routers provide methods for routing application flow based on client-side URL fragments (#fragment).

> **Note**
>
> Backbone.js now includes support for pushState, which can use real, full URLs instead of url fragments for routing.
>
> However, pushState support in Backbone.js is fully opt-in due to lack of browser support and that additional server-side work is required to support it.
>
> pushState support is current limited to the latest versions of Firefox, Chrome, and Safari and Mobile Safari. For a full listing of support and more information about the History API, of which pushState is a part, visit http://diveintohtml5.org/history.html#how
>
> Thankfully, if you opt-in to pushState in Backbone.js, browsers that don't support pushState will continue to use hash-based URL fragments, and if a hash URL is visited by a pushState-capable browser, it will be transparently upgraded to the true URL.

In addition to browser support, another hurdle to seamless use of pushState is that because the URL used are real URLs, your server must now how to render each of the URLs. For example, if your Backbone.js application has a route of /tasks/1, your server-side application must be able to respond to that page if the browser visits that URL directly.

For most applications, you can handle this by just rendering the content you would have for the root URL and letting Backbone.js handle the rest of the routing to the proper location. But for full search-engine crawlability, your server-side application will need to render the entire HTML of the requested page.

For all the reasons and complications above, the examples in this book all currently use URL fragments and not pushState.

A typical Backbone.js router will appear as shown below.

```
ExampleApp.Routers.ExampleRouter = Backbone.Router.extend({
  routes: {
    ""         : "index"
    "show/:id" : "show"
  },

  index: function() {
    // Render the index view
  }

  show: function(id) {
    // Render the show view
  }
});
```

6.4.1. The Routes Hash

The basic router consists of a routes hash which is a mapping between URL fragments and methods on the router. If the current URL fragment, or one that is being visited matches one of the routes in the hash, its method will be called.

Like Rails routes, Backbone.js routes can contain parameter parts, as seen in the `show` route in the example above. In this route, the part of the fragment after `show/` will then be based as an argument to the `show` method.

Multiple parameters are possible, as well. For example, a route of `search/:query/p:page` will match a fragment of `search/completed/p2` passing passing `completed` and `2` to the action.

In the routes, `/` is the natural separator. For example, a route of `show/:id` will not match a fragment of `show/1/2`. To match through route, Backbone.js provides the concept of splat parts, identified by `*` instead of `:`. For example, a route of `show/*id` would match the previous fragment, and `1/2` would be passed to the action as the `id` variable.

Routing occurs when the browser's URL changes. This can occur when clicking on a link, entering a URL into the browser's URL bar, or clicking the back button. In all of those cases, Backbone.js will look to see if the new URL matches an existing route. If it does, the specified function will be called with any parameters.

In addition, an event with the name of "route" and the function will be triggered. For example, when the `show` route above is routed, an event of `route:show` will be fired. This is so that other objects can listen to the router, and be notified about certain routes.

6.4.2. Initializing a Router

It is possible to specify an `initialize` function in a Router which will be called when the Router is instantiated. Any arguments passed to the Routes constructor will be passed to this `initialize` function.

Additionally, it is possible to pass the routes for a router via the constructor like `new ExampleRouter({ routes: { "" : "index" }}`. But note that this will override any routes defined in the routes hash on the router itself.

6.5. View helpers (chapter unstarted)

6.6. Form helpers (chapter unstarted)

6.7. Event binding

A big part of writing snappy rich client applications is building models and views that update in real-time with respect to one another. With Backbone.js you accomplish this with events.

TODO: This is probably the first time we dive into events, unless we touch on them earlier in the models/collections sections. Might want to introduce the topic with a basic example that uses `Backbone.Events` without views & models.

There are three primary kinds of events that your views will bind to:

- DOM events within the view's `this.el` element
- Backbone events triggered by the view's model or collection
- Custom view events

TODO: This three-point breakdown is the wrong way to slice this. Instead of "DOM, model/collection, custom" it should be "DOM, events I observe, events I publish". Events that your view observes need to be cleaned up upon disposing the view, regardless of where those events are triggered (models, collections, or other views, or other arbitrary objects). Events that your view publishes need to be handled in a different way.

TODO: Consider promoting events and binding/unbinding to its own top-level section; this isn't view-specific, although the view layer is where you'll be doing most of your binding.

6.7.1. Binding to DOM events within the view element

The primary function of a view class is to provide behavior for its markup's DOM elements. You can attach event listeners by hand if you like:

```
<!-- templates/soundboard.jst -->
<a class="sound">Honk</a>
<a class="sound">Beep</a>
```

```
var SoundBoard = Backbone.View.extend({
  render: function() {
    $(this.el).html(JST['soundboard']());
    this.$("a.sound").bind("click", this.playSound);
  },

  playSound: function() {
    // play sound for this element
  }
});
```

But Backbone provides an easier and more declarative approach with the `events` hash:

```
var SoundBoard = Backbone.View.extend({
  events: {
    "click a.sound": "playSound"
  },

  render: function() {
    $(this.el).html(JST['soundboard']());
  },

  playSound: function() {
    // play sound for this element
  }
});
```

Backbone will bind the events with the Backbone.View.prototype.delegateEvents() [http://documentcloud.github.com/backbone/#View-delegateEvents] function. It binds DOM events with `$.delegate()`, whether you're using the jQuery [http://api.jquery.com/delegate/] or Zepto [https://github.com/madrobby/zepto/blob/v0.7/src/event.js#L96-108] `.delegate()` function.

It also takes care of binding the event handlers' `this` to the view instance using `_.bind()`.

6.7.2. Binding to events triggered by `this.model` or `this.collection`

In almost every view you write, the view will be bound to a `Backbone.Model` or `Backbone.Collection`, most often with the convenience properties `this.model` or `this.collection`.

TODO: Make sure we discussed the convenience properties previously?

Consider a view that displays a collection of `Task` models. It will re-render itself when any model in the collection is changed or removed, or when a new model is added:

```
var TasksIndex = Backbone.View.extend({
  template: JST['tasks/tasks_index'],
  tagName: 'section',
  id: 'tasks',

  initialize: function() {
    _.bindAll(this, "render");
    this.collection.bind("change", this.render);
    this.collection.bind("add",    this.render);
    this.collection.bind("remove", this.render);
  },
```

```
  render: function() {
    $(this.el).html(this.template({tasks: this.collection}));
  }
});
```

6.7.3. Binding to custom events

With sufficiently complex views, you may encounter a situation where you want one view to change in response to another.

TODO: Expound on this situation, discuss that it's unlikely, and you should consider whether you should be binding to models instead. However, sometimes it's useful.

Consider a simple example with a table of users and a toggle control that filters the users to a particular gender:

```
GenderFilter = Backbone.View.extend({
  events: {
    "click .show-male":   "showMale",
    "click .show-female": "showFemale",
    "click .show-both":   "showBoth"
  },

  showMale: function()   { this.trigger("changed", "male");   },
  showFemale: function() { this.trigger("changed", "female"); },
  showBoth: function()   { this.trigger("changed", "both");   }
});

UsersTable = Backbone.View.extend({
  initialize: function() {
    this.filterView = new UserFilter();
    this.filterView.bind("changed", this.filterByGender);
  },

  filterByGender: function(gender) {
    this.filteredCollection = this.collection.byGender(gender);
  }
});
```

`GenderFilter` is responsible for the filter control, and triggers an event with `Backbone.Events.prototype.trigger()` when it changes. `UsersTable` observes this event, and filters its own collection in response.

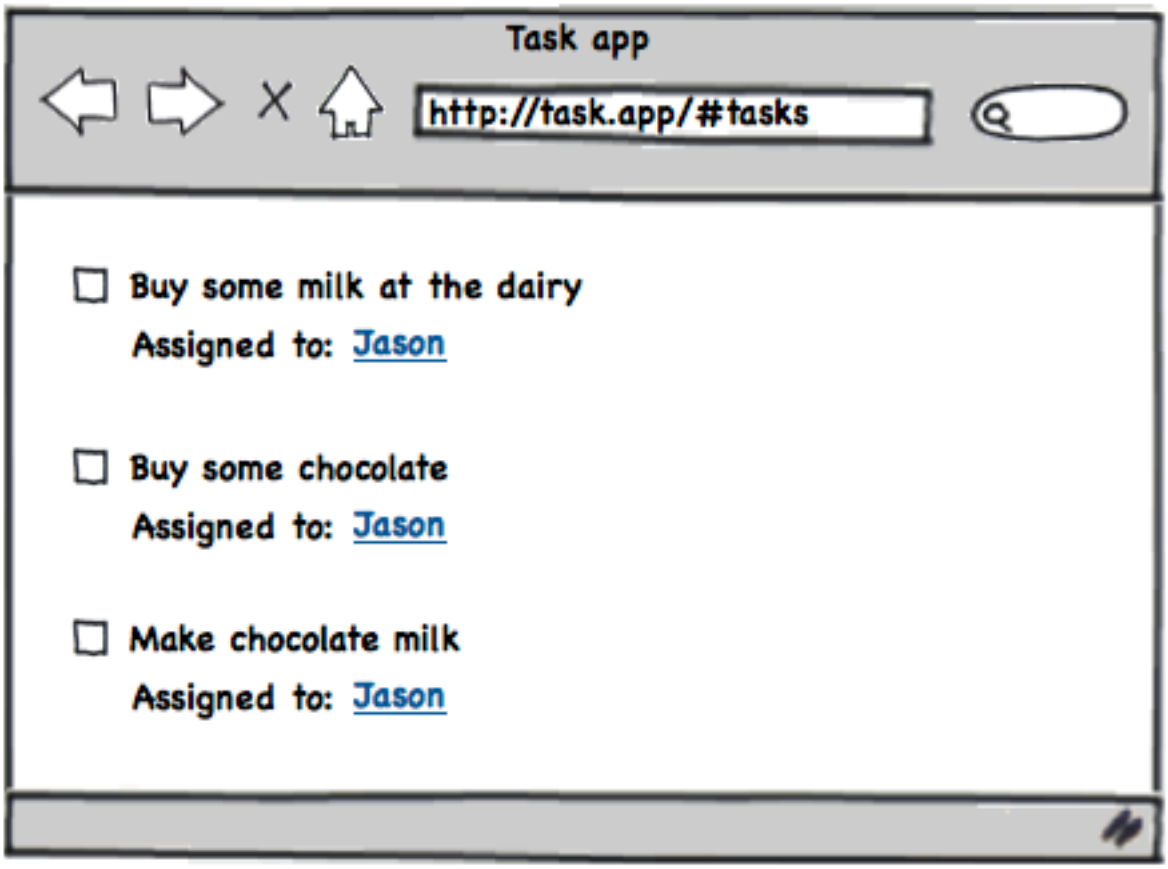
6.8. Cleaning Up: Unbinding

In the last section, we discussed three different kinds of event binding in your `Backbone.Views` classes: DOM events, model/collection events, and custom view events. Next we'll discuss unbinding these events: why it's a good idea, and how to do it.

6.8.1. Why do I have to unbind events?

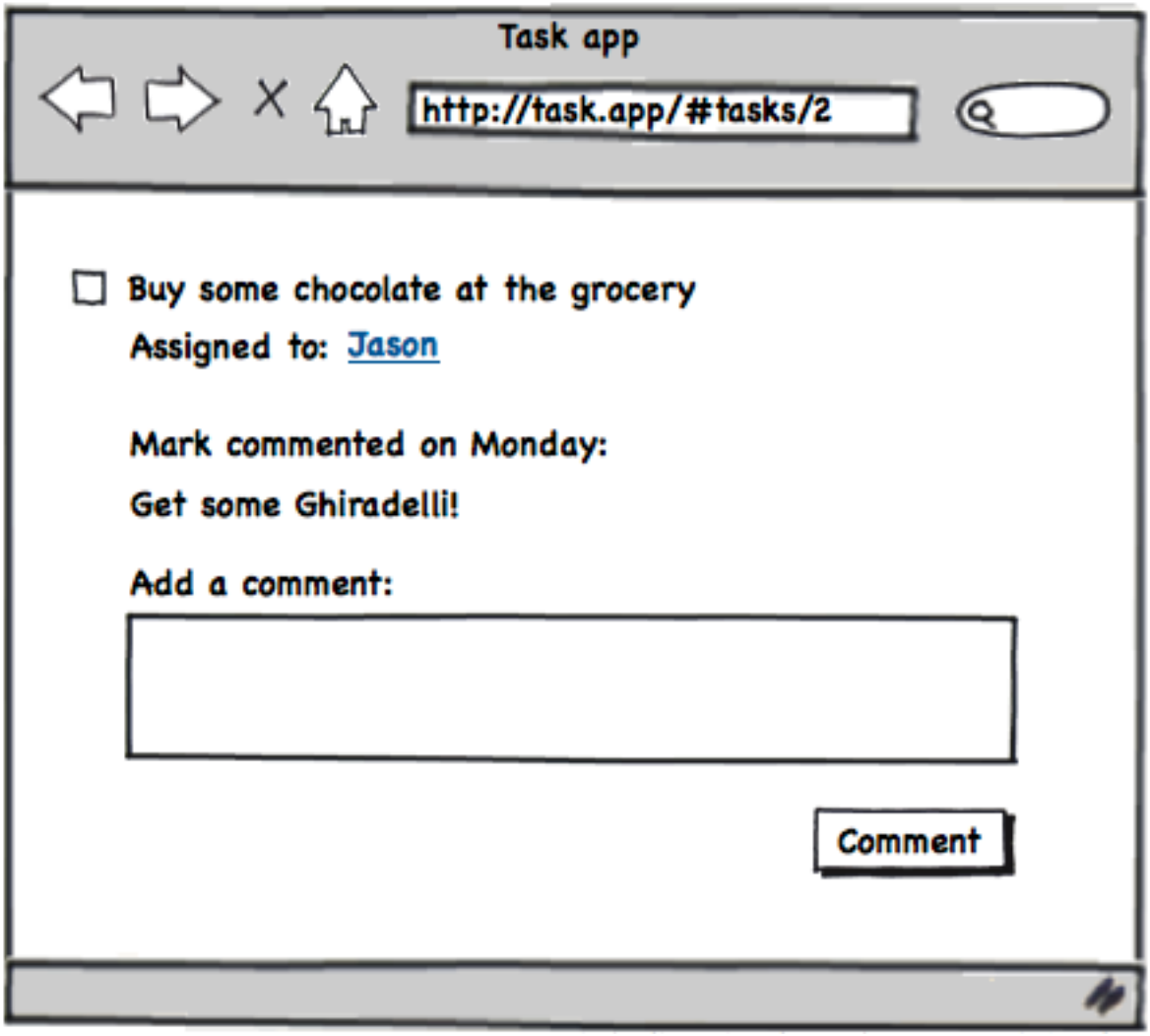
Consider two views in a Todo app: an index view which contains all the tasks that need to be done:

Figure 2. Tasks index view



and a detail view that shows detail on one task:

Figure 3. Tasks detail view



The interface switches between the two views.

Here's the source for the aggregate index view:

```
var TasksIndex = Backbone.View.extend({
  template: JST['tasks/tasks_index'],
  tagName: 'section',
  id: 'tasks',

  initialize: function() {
    _.bindAll(this, "render");
    this.collection.bind("change", this.render);
    this.collection.bind("add",    this.render);
    this.collection.bind("remove", this.render);
  },

  render: function() {
    $(this.el).html(this.template({tasks: this.collection}));
  }
});
```

and the source for the individual task detail view:

```
var TaskDetail = Backbone.View.extend({
  template: JST['tasks/tasks_detail'],
  tagName: 'section',
  id: 'task',

  events: {
    "click .comments .form-inputs button": "createComment"
  },

  initialize: function() {
    _.bindAll(this, "render");

    this.model.bind("change", this.render);
    this.model.comments.bind("change", this.render);
    this.model.comments.bind("add", this.render);
  },

  render: function() {
    $(this.el).html(this.template({task: this.model}));
  },

  createComment: function() {
    var comment = new Comment({ text: this.$('.new-comment-input').val() });
    this.$('.new-comment-input').val('');
    this.model.comments.create(comment);
  }
});
```

Each task on the index page links to the detail view for itself. When a user follows one of these links and navigates from the index page to the detail page, then interacts with the detail view to change a model, the `change` event on the `TaskApp.tasks` collection is fired. One consequence of this is that the index view, which is still bound and observing the `change` event, will re-render itself.

This is both a functional bug and a memory leak: not only will the index view re-render and disrupt the detail display momentarily, but navigating back and forth between the views without disposing of the previous view will keep creating more views and binding more events on the associated models or collections.

These can be extremely tricky to track down on a production application, especially if you are nesting child views. Sadly, there’s no "garbage collection" for views in Backbone, so your application needs to manage this itself.

Let’s take a look at how to unbind various kinds of events.

6.8.2. Unbinding DOM events

When you call `this.remove()` in your view, it delegates to `jQuery.remove()` by invoking `$(this.el).remove()`. This means that jQuery takes care of cleaning up any events bound on DOM elements within your view, regardless of whether you bound them with the Backbone `events` hash or by hand; for example, with `$.bind()`, `$.delegate()`, or `$.live()`.

6.8.3. Unbinding model and collection events

If your view binds to events on a model or collection, you are responsible for unbinding these events. You do this with a simple call to `this.model.unbind()` or `this.collection.unbind()`; the

`Backbone.Events.unbind()` function [http://documentcloud.github.com/backbone/#Events-unbind] removes all callbacks on that object.

When should we unbind these handlers? Whenever the view is going away. This means that any pieces of code that create new instances of this view become responsible for cleaning up after it. That doesn't sound like a very cohesive approach, so let's include the cleanup responsibility on this view.

TODO: Consider just overriding `Backbone.View.prototype.remove()` instead of making a new function, since `remove()` is very simple. What are the pros/cons?

Let's write a `leave()` function on our view that wraps `remove()` and handles any additional event unbinding we need to do. As a convention, when we use this view elsewhere, we'll call `leave()` instead of `remove()` when we're done:

```
var SomeCollectionView = Backbone.View.extend({
  // snip...

  initialize: function() {
    this.collection.bind("change", this.render);
  },

  leave: function() {
    this.collection.unbind("change", this.render);
    this.remove();
  }

  // snip...
});
```

6.8.4. Keep track of `bind()` calls to unbind more easily

In the example above, unbinding the collection change event isn't too much hassle; since we're only observing one thing, we only have to unbind one thing. But even the addition of one line to `leave()` is easy to forget, and if you bind to multiple events then it only gets more verbose.

Let's add a step of indirection in event binding so that we can automatically clean up all the events with one call. We'll add and use a `bindTo()` function that keeps track of all the event handlers we bind, and then issue a single call to `unbindFromAll()` to unbind them:

```
var SomeCollectionView = Backbone.View.extend({
  initialize: function() {
    this.bindings = [];
    this.bindTo(this.collection, "change", this.render);
  },

  leave: function() {
    this.unbindFromAll();
    this.remove();
  },

  bindTo: function(source, event, callback) {
    source.bind(event, callback, this);
    this.bindings.push({ source: source, event: event, callback: callback });
  },

  unbindFromAll: function() {
    _.each(this.bindings, function(binding) {
```

```
      binding.source.unbind(binding.event, binding.callback);
    });
    this.bindings = [];
  }
});
```

These functions, `bindTo()` and `unbindFromAll()`, can be extracted into a reusable mixin or superclass. Then, we just have to use `bindTo()` instead of `model.bind()` and be assured that the handlers will be cleaned up during `leave()`.

TODO: Is it viable to use Function.caller inside Backbone.Events so this functionality is provided by Backbone.Events? https://gist.github.com/158a4172aea28876d0fc

TODO: Wrap `bindTo()` and `unbindFromAll()` into `Observer` which gets mixed into `CompositeView`.

6.8.5. Unbinding custom events

With the first two kinds of event binding that we discussed, DOM and model/collection, the view is the observer. The responsibility to clean up is on the observer, and here the responsibility consists of unbinding the event handler when the view is being removed.

But other times, our view classes will trigger (emit) events of their own. In this case, other objects are the observer, and are responsible for cleaning up the event binding when they are disposed.

However, additionally, when the view itself is disposed of with `leave()`, it should clean up any event handlers bound on **itself** for events that it triggers.

This is handled by invoking `Backbone.Events.unbind()`:

```
var FilteringView = Backbone.View.extend({
  // snip...

  events: {
    "click a.filter": "changeFilter"
  },

  changeFilter: function() {
    if (someLogic()) {
      this.trigger("filtered", { some: options });
    }
  },

  leave: function() {
    this.unbind(); // Clean up any event handlers bound on this view
    this.remove();
  }

  // snip...
});
```

6.8.6. Establish a convention for consistent and correct unbinding

There’s no built-in garbage collection for Backbone’s event bindings, and forgetting to unbind can cause bugs and memory leaks. The solution is to make sure you unbind events and remove views

when you leave them. Our approach to this is two-fold: write a set of reusable functions that manage cleaning up a view's bindings, and use these functions where ever views are instantiated: in `Router` instances, and in composite views. We'll take a look at these concrete, reusable approaches in the next two sections about `SwappingRouter` and `CompositeView`.

6.9. Swapping router

When switching from one view to another, we should clean up the previous view. We discussed previously a convention of writing a `view.leave()` Let's augment our view to include the ability to clean itself up by "leaving" the DOM:

```
var MyView = Backbone.View.extend({
  // ...

  leave: function() {
    this.unbind();
    this.remove();
  },

  // ...
});
```

The `unbind()` and `remove()` functions are provided by `Backbone.Events` and `Backbone.Events.unbind()` will remove all callbacks registered on the view, and `remove()` will remove the view's element from the DOM.

In simple cases, we replace one full page view with another full page (less any shared layout). We introduce a convention that all actions underneath one `Router` share the same root element, and define it as `el` on the router.

Now, a `SwappingRouter` can take advantage of the `leave()` function, and clean up any existing views before swapping to a new one. It swaps into a new view by rendering that view into its own `el`:

```
Support.SwappingRouter = function(options) {
  Backbone.Router.apply(this, [options]);
};

_.extend(Support.SwappingRouter.prototype, Backbone.Router.prototype, {
  swap: function(newView) {
    if (this.currentView && this.currentView.leave) {
      this.currentView.leave();
    }

    this.currentView = newView;
    this.currentView.render();
    $(this.el).empty().append(this.currentView.el);
  }
});

Support.SwappingRouter.extend = Backbone.Router.extend;
```

Now all you need to do in a route function is call `swap()`, passing in the new view that should be rendered. The `swap()` function's job is to call `leave()` on the current view, render the new view and append it to the router's `el`, and finally store who the current view is, so that next time `swap()` is invoked, it can be properly cleaned up as well.

6.9.1. SwappingRouter and Backbone internals

If the code for `SwappingRouter` seems a little confusing, don't fret: it is, thanks to JavaScript's object model! Sadly, it's not as simple to just drop in the `swap` method into `Backbone.Router`, or call `Backbone.Router.extend` to mixin the function we need.

Our goal here is essentially to create a subclass of `Backbone.Router`, and to extend it without modifying the original class. This gives us a few benefits: first, `SwappingRouter` should work with Backbone upgrades. Second, it should be **obvious** and **intention-revealing** when a controller needs to swap views. If we chose to just mix in a `swap` method, and called it from a direct descendant of `Backbone.Router`, an unaware (and unlucky) programmer now needs to go on a deep source dive in an attempt to figure out where that's coming from. At least with a subclass, the hunt should start at the file where it was defined.

The procedure used to create `SwappingRouter` is onerous thanks to a mix of Backbone-isms and just how clunky inheritance is in JavaScript. First off, we need to define the constructor, which delegates to the `Backbone.Router` constructor with the use of `Function#apply`. The next block of code uses Underscore's `Object#extend` to create the set of functions and properties that will become `SwappingRouter`. The `extend` function takes a destination, in this case the empty prototype for `SwappingRouter`, and copies in the properties in the `Backbone.Router` prototype along with our new custom object that includes the `swap` function.

Finally, the subclass cake is topped off with some Backbone frosting: setting `extend`, which is a self-propagating function that all Backbone public classes use. Let's take a quick look at this function, as of Backbone 0.5.3:

```
var extend = function (protoProps, classProps) {
  var child = inherits(this, protoProps, classProps);
  child.extend = this.extend;
  return child;
};

// Helper function to correctly set up the prototype chain, for subclasses.
// Similar to `goog.inherits`, but uses a hash of prototype properties and
// class properties to be extended.
var inherits = function(parent, protoProps, staticProps) {
  // sparing our readers the internals of this function... for a deep dive
  // into the dark realms of JavaScript's prototype system, read the source!
}
```

So, it's a function that calls `inherits` to make a new subclass. The comments reference `goog.inherits` from Google's Closure Library, which contains similar utility functions to allow more class-style inheritance.

The end result here is that whenever you make a custom controller, internally in Backbone, you're making **another** subclass. The inheritance chain for `TasksRouter` would then look like:

Figure 4. Router class inheritance

Phew! Hopefully this adventure into Backbone and JavaScript internals has taught you that although it's more code, it's hopefully going to save time down the road for those maintaining your code.

6.10. Composite views

The `SwappingRouter` above calls `leave()` on the view it currently holds. This function is not part of Backbone itself, and is part of our extension library to help make views more modular and maintainable. This section goes over the Composite View pattern, the `CompositeView` class itself, and some concerns to keep in mind while creating your views.

6.10.1. Refactoring from a large view

One of the first refactorings you find yourself doing in a non-trivial Backbone app is splitting up large views into composable parts. Let's take another look at the `TaskDetail` source code from the beginning of this section:

```
var TaskDetail = Backbone.View.extend({
  template: JST['tasks/tasks_detail'],
  tagName: 'section',
  id: 'task',

  events: {
    "click .comments .form-inputs button": "createComment"
  },

  initialize: function() {
    _.bindAll(this, "render");

    this.model.bind("change", this.render);
    this.model.comments.bind("change", this.render);
    this.model.comments.bind("add", this.render);
  },

  render: function() {
    $(this.el).html(this.template({task: this.model}));
  },

  createComment: function() {
    var comment = new Comment({ text: this.$('.new-comment-input').val() });
    this.$('.new-comment-input').val('');
    this.model.comments.create(comment);
  }
});
```

The view class references a template, which renders out the HTML for this page:

```
<section class="task-details">
  <input type="checkbox"<%= task.isComplete() ? ' checked="checked"' : '' %> />
  <h2><%= task.escape("title") %></h2>
</section>

<section class="comments">
  <ul>
    <% task.comments.each(function(comment) { %>
      <li>
        <h4><%= comment.user.escape('name') %></h4>
```

```
        <p><%= comment.escape('text') %></p>
      </li>
    <% } %>
  </ul>

  <div class="form-inputs">
    <label for="new-comment-input">Add comment</label>
    <textarea id="new-comment-input" cols="30" rows="10"></textarea>
    <button>Add Comment</button>
  </div>
</section>
```

There are clearly several concerns going on here: rendering the task, rendering the comments that folks have left, and rendering the form to create new comments. Let's separate those concerns. A first approach might be to just break up the template files:

```
<!-- tasks/show.jst -->
<section class="task-details">
  <%= JST['tasks/details']({ task: task }) %>
</section>

<section class="comments">
  <%= JST['comments/list']({ task: task }) %>
</section>
```

```
<!-- tasks/details.jst -->
<input type="checkbox"<%= task.isComplete() ? ' checked="checked"' : '' %> />
<h2><%= task.escape("title") %></h2>
```

```
<!-- comments/list.jst -->
<ul>
  <% task.comments.each(function(comment) { %>
    <%= JST['comments/item']({ comment: comment }) %>
  <% } %>
</ul>

<%= JST['comments/new']() %>
```

```
<!-- comments/item.jst -->
<h4><%= comment.user.escape('name') %></h4>
<p><%= comment.escape('text') %></p>
```

```
<!-- comments/new.jst -->
<div class="form-inputs">
  <label for="new-comment-input">Add comment</label>
  <textarea id="new-comment-input" cols="30" rows="10"></textarea>
  <button>Add Comment</button>
</div>
```

But this is really only half the story. The `TaskDetail` view class still handles multiple concerns: displaying the task, and creating comments. Let's split that view class up, using the `CompositeView` base class:

```
Support.CompositeView = function(options) {
  this.children = _([]);
  Backbone.View.apply(this, [options]);
};

_.extend(Support.CompositeView.prototype, Backbone.View.prototype, {
```

```
  leave: function() {
    this.unbind();
    this.remove();
    this._leaveChildren();
    this._removeFromParent();
  },

  renderChild: function(view) {
    view.render();
    this.children.push(view);
    view.parent = this;
  },

  appendChild: function(view) {
    this.renderChild(view);
    $(this.el).append(view.el);
  },

  renderChildInto: function(view, container) {
    this.renderChild(view);
    $(container).empty().append(view.el);
  },

  _leaveChildren: function() {
    this.children.chain().clone().each(function(view) {
      if (view.leave)
        view.leave();
    });
  },

  _removeFromParent: function() {
    if (this.parent)
      this.parent._removeChild(this);
  },

  _removeChild: function(view) {
    var index = this.children.indexOf(view);
    this.children.splice(index, 1);
  }
});

Support.CompositeView.extend = Backbone.View.extend;
```

TODO: Re-link to swapping-internals anchor once https://github.com/schacon/git-scribe/issues/33 is fixed

Similar to the `SwappingRouter`, the `CompositeView` base class solves common housekeeping problems by establishing a convention. See the Swapping Router and Backbone internals section for an in-depth analysis of how this subclassing pattern works.

Now our `CompositeView` maintains an array of its immediate children as `this.children`. With this reference in place, a parent view's `leave()` method can invoke `leave()` on its children, ensuring that an entire tree of composed views is cleaned up properly.

For child views that can dismiss themselves, such as dialog boxes, children maintain a back-reference at `this.parent`. This is used to reach up and call `this.parent.removeChild(this)` for these self-dismissing views.

Making use of `CompositeView`, we split up the `TaskDetail` view class:

```
var TaskDetail = Backbone.View.extend({
  tagName: 'section',
  id: 'task',

  initialize: function() {
    _.bindAll(this, "renderDetails");
    this.model.bind("change", this.renderDetails);
  },

  render: function() {
    this.renderLayout();
    this.renderDetail();
    this.renderCommentsList();
  },

  renderLayout: function() {
    $(this.el).html(JST['tasks/show']());
  },

  renderDetails: function() {
    var detailsMarkup = JST['tasks/details']({ task: this.model });
    this.$('.task-details').html(detailsMarkup);
  },

  renderCommentsList: function() {
    var commentsList = new CommentsList({ model: this.model });
    var commentsContainer = this.$('comments');
    this.renderChildInto(commentsList, commentsContainer);
  }
});
```

```
var CommentsList = CompositeView.extend({
  tagName: 'ul',

  initialize: function() {
    this.model.comments.bind("add", this.renderComments);
  },

  render: function() {
    this.renderLayout();
    this.renderComments();
    this.renderCommentForm();
  },

  renderLayout: function() {
    $(this.el).html(JST['comments/list']());
  },

  renderComments: function() {
    var commentsContainer = this.$('comments-list');
    commentsContainer.html('');

    this.model.comments.each(function(comment) {
      var commentMarkup = JST['comments/item']({ comment: comment });
      commentsContainer.append(commentMarkup);
    });
  },
```

```
  renderCommentForm: function() {
    var commentForm = new CommentForm({ model: this.model });
    var commentFormContainer = this.$('.new-comment-form');
    this.renderChildInto(commentForm, commentFormContainer);
  }
});
```

```
var CommentForm = CompositeView.extend({
  events: {
    "click button": "createComment"
  },

  initialize: function() {
    this.model = this.options.model;
  },

  render: function() {
    $(this.el).html(JST['comments/new']);
  },

  createComment: function() {
    var comment = new Comment({ text: $('.new-comment-input').val() });
    this.$('.new-comment-input').val('');
    this.model.comments.create(comment);
  }
});
```

Along with this, remove the `<%= JST(…) %>` template nestings, allowing the view classes to assemble the templates instead. In this case, each template contains placeholder elements that are used to wrap child views:

```
<!-- tasks/show.jst -->
<section class="task-details">
</section>

<section class="comments">
</section>
```

```
<!-- tasks/details.jst -->
<input type="checkbox"<%= task.isComplete() ? ' checked="checked"' : '' %> />
<h2><%= task.escape("title") %></h2>
```

```
<!-- comments/list.jst -->
<ul class="comments-list">
</ul>

<section class="new-comment-form">
</section>
```

```
<!-- comments/item.jst -->
<h4><%= comment.user.escape('name') %></h4>
<p><%= comment.escape('text') %></p>
```

```
<!-- comments/new.jst -->
<label for="new-comment-input">Add comment</label>
<textarea class="new-comment-input" cols="30" rows="10"></textarea>
<button>Add Comment</button>
```

There are several advantages to this approach:

- Each view class has a smaller and more cohesive set of responsibilities.
- The comments view code, extracted and decoupled from the task view code, can now be reused on other domain objects with comments.
- The task view performs better, since adding new comments or updating the task details will only re-render the pertinent section, instead of re-rendering the entire task + comments composite.

6.10.2. Cleaning up views properly

We now have a full set of tools to clean up views properly.

TODO: Wrap up and re-state the "cleaning up, swappingrouter, compositeview" sections. Mix `Observer` into `CompositeView`.

6.11. How to use multiple views on the same model/collection (chapter unstarted)

6.12. Internationalization (stub)

When you move your application's view logic onto the client, such as with Backbone, you quickly find that the library support for views is not as comprehensive as what you have on the server. The Rails internationalization (i18n) API [http://guides.rubyonrails.org/i18n.html], provided via the i18n gem [https://rubygems.org/gems/i18n], is not automatically available to client-side view rendering. We'd like to take advantage of that framework, as well as any localization work you've done if you are adding Backbone into an existing app.

TODO: Discuss our progress with copycopter_client javascript integration. For most i18n cases, this plugin will suffice: https://github.com/fnando/i18n-js For copycopter, however, we'd like new translations to show up while the app is running. Likely we will provide Rack middleware that products the translations as jsonp. Waiting until we make more progress for copycopter

7. Models and collections

7.1. Naming conventions (chapter unstarted)

7.2. Nested resources (chapter unstarted)

7.3. Model associations

Backbone.js doesn't prescribe a way to define associations between models, so we need to get creative and use the power of JavaScript to set up associations in such a way that its usage is natural.

7.3.1. Belongs to associations

Setting up a `belongs_to` association in Backbone is a two step process. Let's discuss setting up the association that may occur between a task and a user. The end result of the approach is a `Task` instance having a property called `user` where we store the associated `User` object.

To set this up, let's start by telling Rails to augment the task's JSON representation to also send over the associated user attributes:

```
class Task < ActiveRecord::Base
  belongs_to :user

  def as_json(options = {})
    super(options.merge(include: { user: { only: [:name, :email] } }))
  end
end
```

This means that when Backbone calls `fetch()` for a `Task` model, it will include the name and email of the associated user nested within the task JSON representation. Something like this:

```
{
  "title": "Buy more Cheeseburgers",
  "due_date": "2011-03-04",
  "user": {
    "name": "Robert McGraffalon",
    "email": "bobby@themcgraffalons.com"
  }
}
```

Now that we receive user data with the task's JSON representation, let's tell our Backbone User model to store the User object. We do that on the task's initializer. Here's a first cut at that:

```
var Task = Backbone.Model.extend({
  initialize: function() {
    this.user = new User(this.get('user'));
  }
});
```

We can make a couple of improvements to the above. First, you'll soon realize that you might be setting the user outside of the initialize as well. Second, the initializer should check whether there is user data in the first place. To address the first concern, let's create a setter for the object. Backbone provides a handy function called `has` that returns true or false depending on whether the provided attribute is set for the object:

```
var Task = Backbone.Model.extend({
  initialize: function() {
    if (this.has('user')) {
      this.setUser(new User(this.get('user')));
    }
  },

  setUser: function(user) {
    this.user = user;
  }
});
```

The final setup allows for a nice clean interface to a task's user, by accessing the task property of the user instance.

```
var task = Task.fetch(1);
console.log(task.get('title') + ' is being worked on by ' + task.user.get('name'));
```

7.3.2. Has many associations

You can take a similar approach to set up a `has_many` association on the client side models. This time, however, the object's property will be a Backbone collection.

Following the example, say we need access to a user's tasks. Let's set up the JSON representation on the Rails side first:

```
class User < ActiveRecord::Base
  has_many :tasks

  def as_json(options = {})
    super(options.merge(include: { tasks: { only: [:body, :due_date] } }))
  end
end
```

Now, on the Backbone `User` model's initializer, let's call the `setTasks` function:

```
var User = Backbone.Model.extend({
  initialize: function() {
    var tasks = new Tasks.reset(this.get('tasks'));
    this.setTasks(tasks);
  },

  setTasks: function(tasks) {
    this.tasks = tasks;
  }
});
```

Note that we are setting the relation to an instance of the `Tasks` collection.

TODO: Let's exapnd upon this, as it isn't the most flexible solution. (It is a good start.) We are setting the JSON representation of the Rails models to suit the Backbone.js concerns. Additionally, the `Task#as_json` method at the top is concerned with the User JSON representation. It should at least delegate to User#as_json. Going further, the JSON presentation for consumption by Backbone.js should be completely extracted into the JSON API endpoint controller action, or even a separate presenter class.

7.4. Filters and sorting

When using our Backbone models and collections, it's often handy to filter the collections by reusable criteria, or sort them by several different criteria.

7.4.1. Filters

To filter a `Backbone.Collection`, like with Rails named scopes, define functions on your collections that filter by your criteria, using the `select` function from Underscore.js, and return new instances of the collection class. A first implementation might look like this:

```
var Tasks = Backbone.Collection.extend({
  model: Task,
  url: '/tasks',

  complete: function() {
    var filteredTasks = this.select(function(task) {
```

```
      return task.get('completed_at') !== null;
    });
    return new Tasks(filteredTasks);
  }
});
```

Let's refactor this a bit. Ideally, the filter functions will reuse logic already defined in your model class:

```
var Task = Backbone.Model.extend({
  isComplete: function() {
    return this.get('completed_at') !== null;
  }
});

var Tasks = Backbone.Collection.extend({
  model: Task,
  url: '/tasks',

  complete: function() {
    var filteredTasks = this.select(function(task) {
      return task.isComplete();
    });
    return new Tasks(filteredTasks);
  }
});
```

Going further, notice that there are actually two concerns in this function. The first is the notion of filtering the collection, and the other is the specific filtering criteria (`task.isComplete()`).

Let's separate the two concerns here, and extract a `filtered` function:

```
var Task = Backbone.Model.extend({
  isComplete: function() {
    return this.get('completed_at') !== null;
  }
});

var Tasks = Backbone.Collection.extend({
  model: Task,
  url: '/tasks',

  complete: function() {
    return this.filtered(function(task) {
      return task.isComplete();
    });
  },

  filtered: function(criteriaFunction) {
    return new Tasks(this.select(criteriaFunction));
  }
});
```

We can extract this function into a reusable mixin, abstracting the `Tasks` collection class using `this.constructor`:

```
var FilterableCollectionMixin = {
  filtered: function(criteriaFunction) {
    return new this.constructor(this.select(criteriaFunction));
```

```
  }
};

var Task = Backbone.Model.extend({
  isComplete: function() {
    return this.get('completed_at') !== null;
  }
});

var Tasks = Backbone.Collection.extend(_.extend({
  model: Task,
  url: '/tasks',

  complete: function() {
    return this.filtered(function(task) {
      return task.isComplete();
    });
  }
}, FilterableCollectionMixin));
```

7.4.2. Propagating collection changes

The `FilterableCollectionMixin`, as we've written it, will produce a filtered collection that does not update when the original collection is changed. To do so, bind to the change, add, and remove events on the source collection, reapply the filter function, and repopulate the filtered collection:

```
var FilterableCollectionMixin = {
  filtered: function(criteriaFunction) {
    var sourceCollection = this;
    var filteredCollection = new this.constructor;

    var applyFilter = function() {
      filteredCollection.reset(sourceCollection.select(criteriaFunction));
    };

    this.bind("change", applyFilter);
    this.bind("add",    applyFilter);
    this.bind("remove", applyFilter);

    applyFilter();

    return filteredCollection;
  }
};
```

7.4.3. Sorting

The simplest way to sort a `Backbone.Collection` is to define a `comparator` function. This functionality is built in:

```
var Tasks = Backbone.Collection.extend({
  model: Task,
  url: '/tasks',

  comparator: function(task) {
    return task.dueDate;
  }
});
```

If you'd like to provide more than one sort order on your collection, you can use an approach similar to the `filtered` function above, and return a new `Backbone.Collection` whose `comparator` is overridden. Call `sort` to update the ordering on the new collection:

```
var Tasks = Backbone.Collection.extend({
  model: Task,
  url: '/tasks',

  comparator: function(task) {
    return task.dueDate;
  },

  byCreatedAt: function() {
    var sortedCollection = new Tasks(this.models);
    sortedCollection.comparator = function(task) {
      return task.createdAt;
    };
    sortedCollection.sort();
    return sortedCollection;
  }
});
```

Similarly, you can extract the reusable concern to another function:

```
var Tasks = Backbone.Collection.extend({
  model: Task,
  url: '/tasks',

  comparator: function(task) {
    return task.dueDate;
  },

  byCreatedAt: function() {
    return this.sortedBy(function(task) {
      return task.createdAt;
    });
  },

  byCompletedAt: function() {
    return this.sortedBy(function(task) {
      return task.completedAt;
    });
  },

  sortedBy: function(comparator) {
    var sortedCollection = new Tasks(this.models);
    sortedCollection.comparator = comparator;
    sortedCollection.sort();
    return sortedCollection;
  }
});
```

And then into another reusable mixin:

```
var SortableCollectionMixin = {
  sortedBy: function(comparator) {
    var sortedCollection = new this.constructor(this.models);
    sortedCollection.comparator = comparator;
    sortedCollection.sort();
```

```
    return sortedCollection;
  }
};

var Tasks = Backbone.Collection.extend(_.extend({
  model: Task,
  url: '/tasks',

  comparator: function(task) {
    return task.dueDate;
  },

  byCreatedAt: function() {
    return this.sortedBy(function(task) {
      return task.createdAt;
    });
  },

  byCompletedAt: function() {
    return this.sortedBy(function(task) {
      return task.completedAt;
    });
  }
}, SortableCollectionMixin));
```

Just as with the `FilterableCollectionMixin` before, the `SortableCollectionMixin` should observe its source if updates are to propagate from one collection to another:

```
var SortableCollectionMixin = {
  sortedBy: function(comparator) {
    var sourceCollection = this;
    var sortedCollection = new this.constructor;
    sortedCollection.comparator = comparator;

    var applySort = function() {
      sortedCollection.reset(sourceCollection.models);
      sortedCollection.sort();
    };

    this.bind("change", applySort);
    this.bind("add",    applySort);
    this.bind("remove", applySort);

    applySort();

    return sortedCollection;
  }
};
```

7.5. Client/Server duplicated business logic (chapter unstarted)

7.6. Validations

The server is the authoritative place for verifying whether data that is being stored is valid. Even though backbone.js exposes an API [http://documentcloud.github.com/backbone/#Model-validate] for

performing client side validations, when it comes to validating user data in a backbone.js application we want to continue to use the very same mechanisms on the server side that we've used in Rails all along: the ActiveModel validations API.

The challenge is tying the two together: letting your ActiveRecord objects reject invalid user data, and having the errors bubble up all the way to the interface for user feedback - and having it all be seamless to the user and easy for the developer.

Let's wire this up. To get started, we'll add a validation on the task's title attribute on the ActiveRecord model like so:

```
class Task < ActiveRecord::Base
  validates :title, presence: true
end
```

On the backbone side of the world, we have a Backbone task called YourApp.Models.Task:

```
YourApp.Models.Task = Backbone.Model.extend({
  url: '/tasks'
});
```

We also have a place where users enter new tasks - just a form on the task list.

```
<form>
  <ul>
     <li class="task_title_input">
       <label for="title">Title</label>
       <input id="title" maxlength="255" name="title" type="text">
     </li>
     <button class="submit" id="create-task">Create task</button>
  </ul>
</form>
```

On the NewTask backbone view, we bind the button's click event to a new function that we'll call createTask.

```
YourApp.Views.NewTask = Backbone.View.extend({
  events: {
    "click #create-task": "createTask"
  },

  createTask: {
    // grab attribute values from the form
    // storing them on the attributes hash
    var attributes = {};
    _.each(this.$('form input, form select'), function(element) {
      var element = $(element);
      if(element.attr('name') != "commit") {
        attributes[element.attr('name')] = element.val();
      }
    });

    var self = this;
    // create a new task and save it to the server
    new YourApp.Models.Task(attributes).save({
        success: function() { // handle success }
        error:   function() { // validation error occurred, show user }
      });
```

```
    return false;
  }
})
```

When you call save() on a backbone model, Backbone will delegate to .sync() and create a POST request on the model's URL where the payload are the attributes that you've passed onto the save() call.

The easiest way to handle this in Rails is to use respond_to/respond_with available in Rails 3 applciations:

```
class TasksController < ApplicationController
  respond_to :json
  def create
    task = Task.create(params)
    respond_with task
  end
end
```

When the task is created successfully, Rails will render the show action using the object that you've passed to the respond_with call, so make sure the show action is defined in your routes:

```
resources :tasks, only: [:create, :show]
```

When the task cannot be created successfully because some validation constraint is not met, the the Rails responder will render the model's errors as a JSON object, and use an HTTP status code of 422, which will alert backbone that it there was an error in the request and it was not processed.

The response from Rails in that case looks something like this:

```
{ "title": ["can't be blank"] }
```

So that two line action in a Rails controller is all we need to talk to our backbone models and handle error cases.

Back to the backbone model's save() call, Backbone will invoke one of two callbacks when it receives a response from the rails app, so we simply pass in a hash containing a function to run both for the success and the error cases.

In the success case, we may want to add the new model instance to a global collection of tasks. Backbone will trigger the add event on that collection, so there's your chance for some other view to bind to that event and rerender itself so that the new task appears on the page.

In the error case, however, we want to display inline errors on the form. When backbone triggers the error callback, it passes along two parameters: the model being saved and the raw response. We have to parse the JSON response and iterate through it rendering an inline error on the form corresponding to each of the errors. Let's introduce a couple of new classes that will help along the

First off is the ErrorList. An ErrorList encapsulates parsing of the raw JSON that came in from the server and provides an iterator to easily loop through errors:

```
ErrorList = function (response) {
  if (response && response.responseText) {
    this.attributesWithErrors = JSON.parse(response.responseText);
  }
```

```
};

_.extend(ErrorList.prototype, {
  each: function (iterator) {
    _.each(attributesWithErrors, iterator);
  },

  size: function() {
    return _.size(attributesWithErrors);
  }
});
```

Next up is the ErrorView, who's in charge of taking the errorlist, and appending each inline error in the form, providing feedback to the user that their input is invalid.

```
ErrorView = Backbone.View.extend({
  initialize: function() {
    _.bindAll(this, "renderError");
  },

  render: function() {
    this.$(".error").removeClass("error");
    this.$("p.inline-errors").remove();
    this.options.errors.each(this.renderError);
  },

  renderError: function(errors, attribute) {
    var errorString = errors.join(", ");
    var field = this.fieldFor(attribute);
    var errorTag = $('<p>').addClass('inline-errors').text(errorString);
    field.append(errorTag);
    field.addClass("error");
  },

  fieldFor: function(attribute) {
    return $(this.options.el).find('[id*="_' + attribute + '_input"]').first();
  }
});
```

Note the fieldFor function. It expects a field with an id containing a certain format. Therefore, in order for this to work the form's HTML must contain a matching element. In our case, it was the list item with an id of task_title_input.

When a backbone view's el is already on the DOM, we need to pass it into the view's constructor. In the case of the ErrorView class, we want to operate on the view that contains the form that originated the errors.

To use these classes, we take the response from the server and pass that along to the ErrorList constructor, which we then pass to the ErrorView that will do it's fine job in inserting the inline errors when we call render() on it. Putting it all together, our save call's callbacks now look like this:

```
var self = this;
var model = new YourApp.Models.Task(attributes);
model.save({
  error: function(model, response) {
    var errors = new ErrorList(response);
    var view   = new ErrorView( { el: self.el, errors: errors } );
    view.render();
```

```
  }
});
```

There still is a part of this action that doesn't feel quite right, and that's the fact that we are looping through the elements in a form in order to build the attributes hash for the new object, which is an entirely separate concern. Let's extend the Backbone.Model prototype so that it can handle saving from forms and we can reuse it throughout the app.

TODO: Introduce Backbone.Model.saveFromForm function

7.7. Synchronizing between clients

A big driving force behind the move to rich client web apps is to improve the user experience. These applications are more responsive and can support more detailed and stateful interactions.

One such interaction involves multiple concurrent users interacting with the same resource in realtime. We can deliver a more seamless experience by propagating users' changes to one another as they take place: when we edit the same document, I see your changes on my screen as you type them. If you've ever used Google Docs or Google Wave, you've seen this in action.

So, how can we build this functionality into our own applications?

7.7.1. The moving parts

There are a few different pieces that we'll put together for this. The basic parts are:

1. Change events. The fundamental unit of information that we broadcast through our system to keep clients in sync. Delivered as messages, these events contain enough information for any receiving client to update its own data without needing a full re-fetch from the server.

2. An event source. With trusted clients, changes can originate directly from the client. More often, however, we will want the server to arbitrate changes so that it can apply authorization, data filtering, and validations.

3. A transport layer that supports pushing to clients. The WebSocket API [http://www.w3.org/TR/websockets/] is such a transport, and is ideal for its low overhead and latency.

4. Event-driven clients. Clients should be able to react to incoming change events, ideally handling them with incremental UI updates rather than re-drawing themselves entirely. Backbone.js helps out in this department, as your client-side application app is likely already set up to handle such events.

5. A message bus. Separating the concern of message delivery from our main application helps it stay smaller and helps us scale our messaging and application infrastructure separately. There are already several great off-the-shelf tools we can use for this.

7.7.2. Putting it together: a look at the lifecycle of a change

Revisiting our todo application, we'd like to add the ability to collaborate on todo lists. Different users will be able to work on the same todo list concurrently. Several users can look at the same list; adding, changing, and checking off items.

There are a few technical decisions mentioned previously. For this example, we will:

1. Use Rails on the server and Backbone on the client.

2. Use the server as the canonical event source so that clients do not have to trust one another. In particular, we'll employ an `ActiveRecord::Observer` that observes Rails model changes and dispatches a change event.

3. Use Faye [http://faye.jcoglan.com] as the messaging backend, which has Ruby and JavaScript implementations for clients and server. Faye implements the Bayeux protocol [http://svn.cometd.com/trunk/bayeux/bayeux.html], prefers WebSocket for transport (thought it gracefully degrades to long polling, CORS, or JSON-P), and supports a bunch of other goodies like clustering and extensions (inbound- and outbound- message filtering, like Rack middleware).

In our application, there are several connected clients viewing the same todo list, and one user Alice makes a change to an item on the list.

Let's take a look at the lifecycle of one change event.

TODO: System-partitioned sequence diagram

Setup:

1. An instance of JavaScript class `BackboneSync.FayeSubscriber` is instantiated on each client. It is configured with a channel to listen to, and a collection to update.

2. The Faye server is started.

3. The Rails server is started, and several clients are connected and viewing `#todo_lists/1`.

On the Alice's machine, the client responsible for the change:

1. Alice clicks "Save" in her view of the list.

2. The "save" view event is triggered.

3. The event handler invokes `this.model.save(attributes)`.

4. `Backbone.Model.prototype.save` calls `Backbone.sync`.

5. `Backbone.sync` invokes `$.ajax` and issues an HTTP PUT request to the server.

On the server:

1. Rails handles the PUT request and calls `#update_attributes` on an ActiveRecord model instance.

2. An `ActiveRecord::Observer` observing this model gets its `#after_save` method invoked.

3. The observer dispatches a change event message to Faye.

4. Faye broadcasts the change event to all subscribers.

On all clients:

1. `FayeSubscriber` receives the change event message, likely over a WebSocket.

2. The subscriber parses the event message, picking out the event (`update`), the `id` of the model to update, and a new set of attributes to apply.

3. The `FayeSubscriber` fetches the model from the collection, and calls `set` on it to update its attributes.

Now all the clients have received the changeset that Alice made.

7.7.3. Implementation: Step 1, Faye server

We'll need to run Faye to relay messages from publishers to subscribers. For Rails apps that depend on Faye, I like to keep a `faye/` subdirectory under the app root that contains a `Gemfile` and `config.ru`, and maybe a shell script to start Faye:

```
$ cat faye/Gemfile

source 'http://rubygems.org'
gem 'faye'

$ cat faye/config.ru

require 'faye'
bayeux = Faye::RackAdapter.new(:mount => '/faye', :timeout => 25)
bayeux.listen(9292)

$ cat faye/run.sh

#!/usr/bin/env bash
BASEDIR=$(dirname $0)
BUNDLE_GEMFILE=$BASEDIR/Gemfile bundle exec rackup $BASEDIR/config.ru -s thin -E producti

$ ./faye/run.sh

>> Thin web server (v1.2.11 codename Bat-Shit Crazy)
>> Maximum connections set to 1024
>> Listening on 0.0.0.0:9292, CTRL+C to stop
```

7.7.4. Implementing it: Step 2, ActiveRecord observers

Now that the message bus is running, let's walk through the server code. The Rails app's responsibility is this: whenever a Todo model is created, updated, or deleted, publish a change event message.

This is implemented with an ActiveRecord::Observer. We provide the functionality in a module:

```
module BackboneSync
  module Rails
    module Faye
      mattr_accessor :root_address
      self.root_address = 'http://localhost:9292'
```

```
      module Observer
        def after_update(model)
          Event.new(model, :update).publish
        end

        def after_create(model)
          Event.new(model, :create).publish
        end

        def after_destroy(model)
          Event.new(model, :destroy).publish
        end
      end

      class Event
        def initialize(model, event)
          @model = model
          @event = event
        end

        def broadcast
          Net::HTTP.post_form(uri, :message => message)
        end

        private

        def uri
          URI.parse("#{BackboneSync::Rails::Faye.root_address}/faye")
        end

        def message
          { :channel => channel,
            :data => data          }.to_json
        end

        def channel
          "/sync/#{@model.class.table_name}"
        end

        def data
          { @event => { @model.id => @model.as_json } }
        end
      end
    end
  end
end
```

and then mix it into a concrete Observer class in our application. In this case, we name it `TodoObserver`:

```
class TodoObserver < ActiveRecord::Observer
  include BackboneSync::Rails::Faye::Observer
end
```

This observer is triggered each time a Rails `Todo` model is created, updated, or destroyed. When one of these events happen, the Observer sends along a message to our message bus, indicating the change.

Let’s say that a `Todo` was just created:

>> Todo.create(title: "Buy some tasty kale juice") ⇒ #<Todo id: 17, title: "Buy some tasty kale juice", created_at: "2011-09-06 20:49:03", updated_at: "2011-09-07 15:01:09">

The message looks like this:

```
{
  "channel": "/sync/todos",
  "data": {
    "create": {
      "17": {
        "id": 17,
        "title": "Buy some tasty kale juice",
        "created_at": "2011-09-06T20:49:03Z",
        "updated_at": "2011-09-07T15:01:09Z"
      }
    }
  }
}
```

Received by Faye, the message is broadcast to all clients subscribing to the `/sync/todos` channel, including our browser-side `FayeSubscriber` objects.

7.7.5. Implementing it: Step 3, In-browser subscribers

In each browser, we want to connect to the Faye server, subscribe to events on channels that interest us, and update Backbone collections based on those messages.

Faye runs an HTTP server, and serves up its own client library, so that's easy to pull in:

```
<script type="text/javascript" src="http://localhost:9292/faye.js"></script>
```

To subscribe to Faye channels, instantiate a `Faye.Client` and call `subscribe` on it:

```
var client = new Faye.Client('http://localhost:9292/faye');
client.subscribe('/some/channel', function(message) {
  // handle message
});
```

When the browser receives messages from Faye, we want to update a Backbone collection. Let's wrap up those two concerns into a `FayeSubscriber`:

```
this.BackboneSync = this.BackboneSync || {};

BackboneSync.RailsFayeSubscriber = (function() {
  function RailsFayeSubscriber(collection, options) {
    this.collection = collection;
    this.client = new Faye.Client('<%= BackboneSync::Rails::Faye.root_address %>/faye');
    this.channel = options.channel;
    this.subscribe();
  }

  RailsFayeSubscriber.prototype.subscribe = function() {
    return this.client.subscribe("/sync/" + this.channel, _.bind(this.receive, this));
  };

  RailsFayeSubscriber.prototype.receive = function(message) {
    var self = this;
```

```
    return $.each(message, function(event, eventArguments) {
      return self[event](eventArguments);
    });
  };

  RailsFayeSubscriber.prototype.update = function(params) {
    var self = this;
    return $.each(params, function(id, attributes) {
      var model = self.collection.get(id);
      return model.set(attributes);
    });
  };

  RailsFayeSubscriber.prototype.create = function(params) {
    var self = this;
    return $.each(params, function(id, attributes) {
      var model = new self.collection.model(attributes);
      return self.collection.add(model);
    });
  };

  RailsFayeSubscriber.prototype.destroy = function(params) {
    var self = this;
    return $.each(params, function(id, attributes) {
      var model = self.collection.get(id);
      return self.collection.remove(model);
    });
  };

  return RailsFayeSubscriber;
})();
```

Now, for each collection that we'd like to keep in sync, we instantiate a corresponding `FayeSubscriber`. Say, in your application bootstrap code:

```
MyApp.Routers.TodosRouter = Backbone.Router.extend({
  initialize: function(options) {
    this.todos = new Todos.Collections.TodosCollection();
    new BackboneSync.FayeSubscriber(this.todos, { channel: 'todos' });
    this.todos.reset(options.todos);
  },

  // ...
});

Now run the app, and watch browsers receive push updates!

==== Testing synchronization
TODO: Testing client-client sync.  `Capybara.using_session` for multiple concurrent acto

==== More reading
NOTE: Faye implements a messaging protocol called Bayeux: http://svn.cometd.com/trunk/bay

NOTE: Read up on idempotent messages.  Check out this solid, readable article http://devl


== Testing (section unstarted)
=== Full-stack integration testing
=== Isolated unit testing
```

```
== The JavaScript language (section unstarted)
=== Model attribute types and serialization
=== Context binding (JS +this+)
=== CoffeeScript with Backbone.js

== Security (stub)

=== XSS with JSON bootstrapping (stub)

Use +json2.js+ and:

[js]
source~~~~
<script type="text/json" id="something">
  <%= something.to_json %>
</script>

<script type="text/javascript">
  (function () {
    var something = JSON.parse($('#something').text());
    someJavascriptFunction(something);
  })();
</script>
source~~~~

=== XSS in HTML templates (stub)

TODO: Discuss +Backbone.Model.escape+, +_.escape+, defaulting to escape with +<%=+ vs +<%

== Performance (stub)

=== Dependency choice

Backbone.js defines a +$+ variable that defers to jQuery if present.

If you are only targeting mobile platforms, Backbone will handily fall back to
Zepto http://zeptojs.com for a more lightweight dependency.  Zepto is "a
minimalist JavaScript framework for mobile WebKit browsers, with a
jQuery-compatible syntax."  From +backbone.js+:

[javascript]
source~~~~
(function(){

  // Initial Setup
  // -------------

  // Save a reference to the global object.
  var root = this;

  // For Backbone's purposes, jQuery or Zepto owns the `$` variable.
  var $ = root.jQuery || root.Zepto;

  // ...

}).call(this);
source~~~~
```