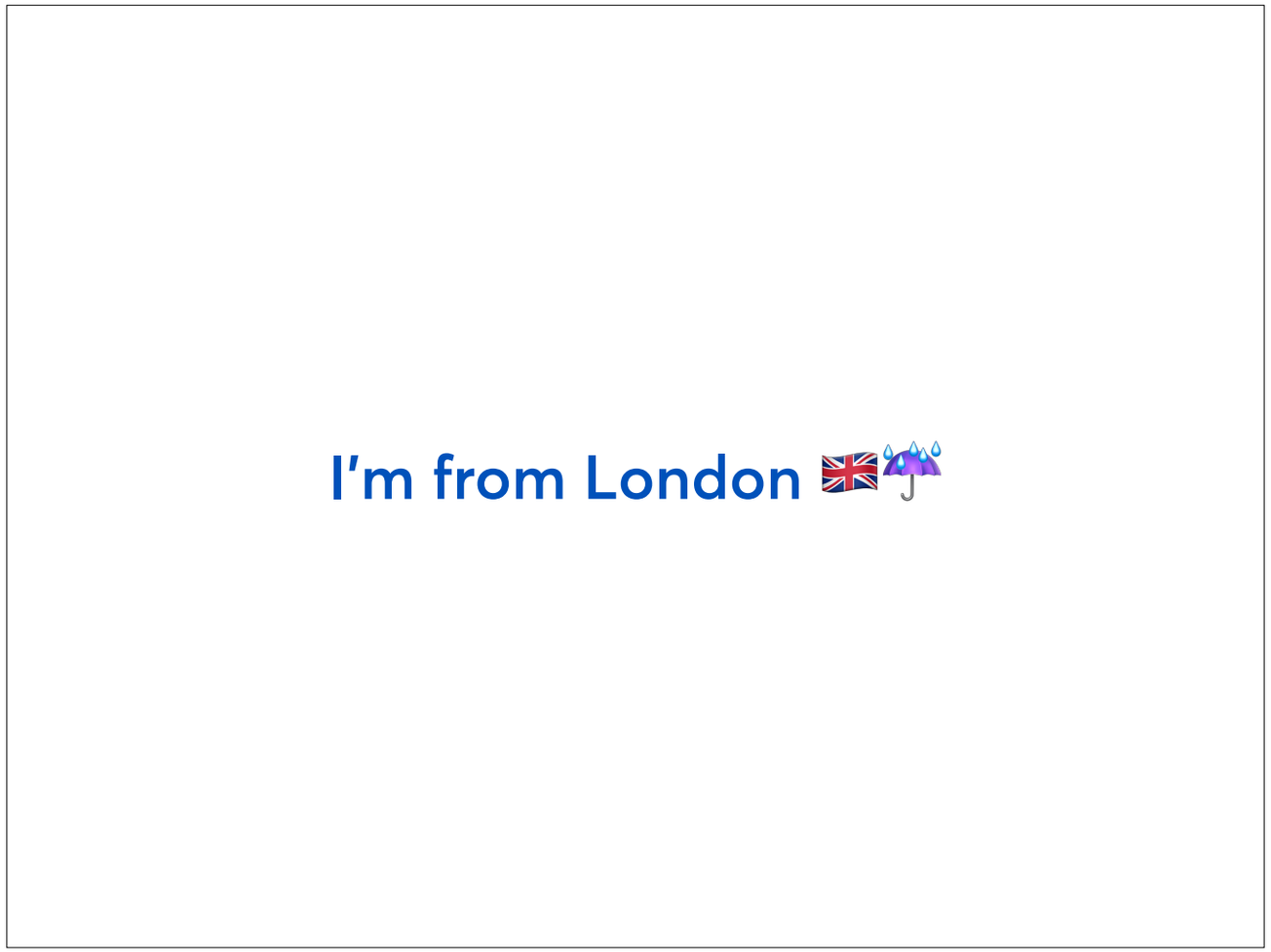
Miles more maintainable: Building APIs with the middleware pattern

I'm @timrogers 🤷🏼‍♂️

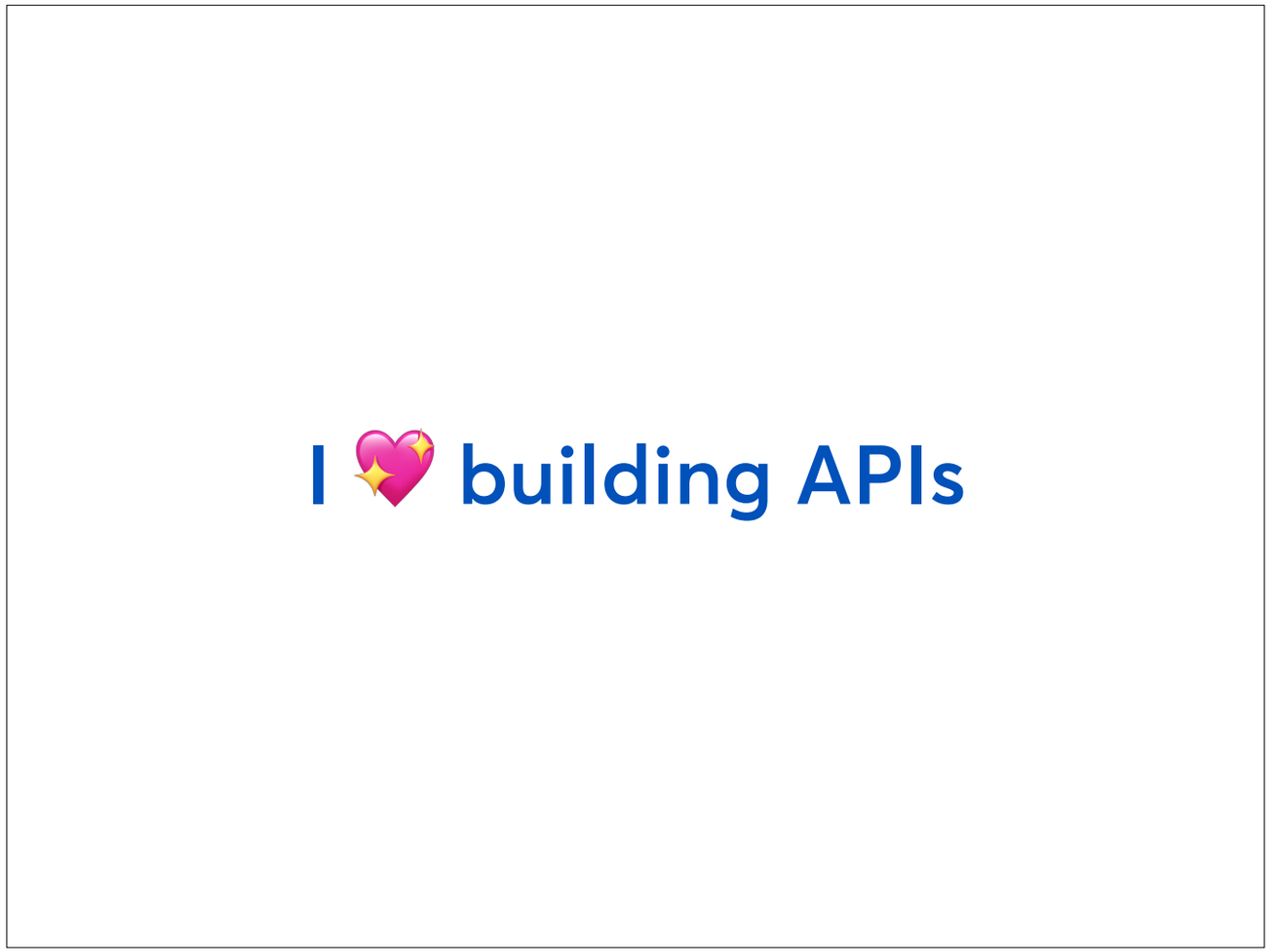
Hey everybody! My name is Tim.



And as you might be able to tell from my accent, I’m from London, in the rainy United Kingdom.

I'm very excited to be here in Kingston 🇯🇲

I'm super excited to be here in Jamaica - it's my first time here and I've had an amazing experience since I landed last night.



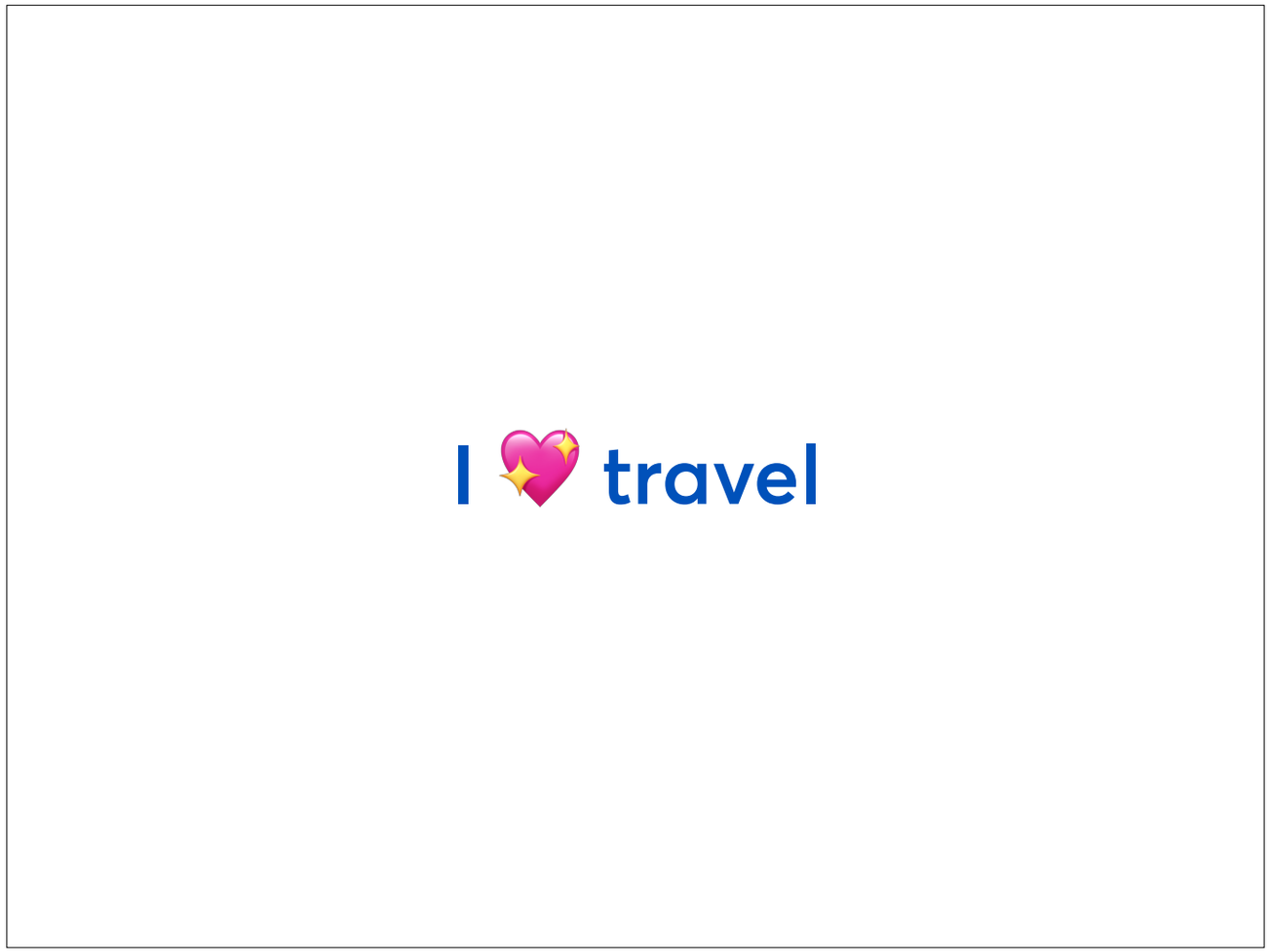
And the reason I'm here today is that I love building APIs.

As a developer myself, there's nothing that excites me more than building fantastic experiences for other developers.

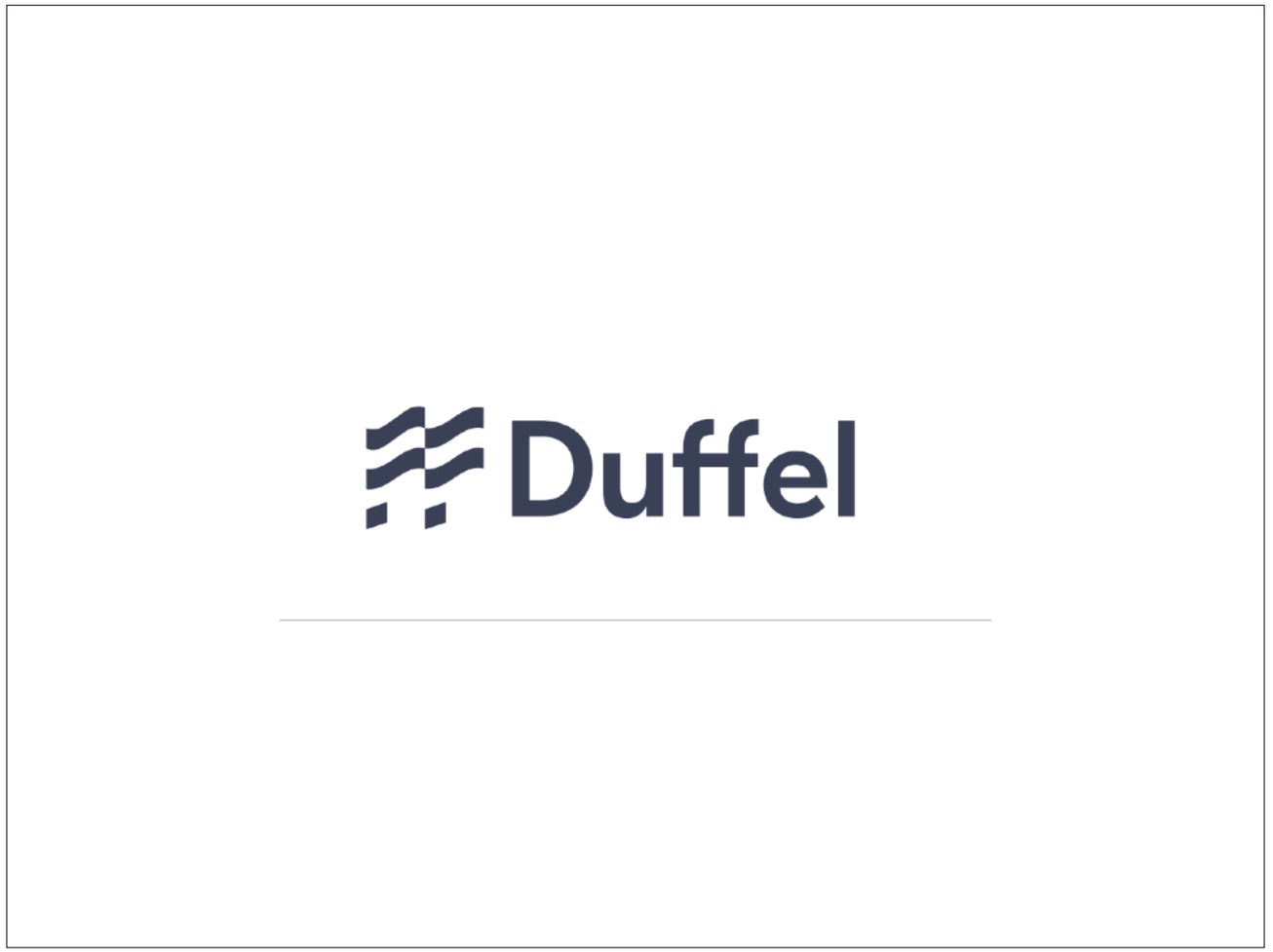
In my talk today, I'm going to share with you a few of the lessons I've learnt designing APIs for world-leading API companies. I want to show you how you can build more maintainable APIs - and more maintainable software more generally!

Until the middle of last year, I worked at GoCardless, building APIs for the world's bank-to-bank payment systems.

Financial technology startups - known as "fintech" - are super hot in London, but let's be honest. They're not the most exciting thing in the world.



What gets me really excited is travel.



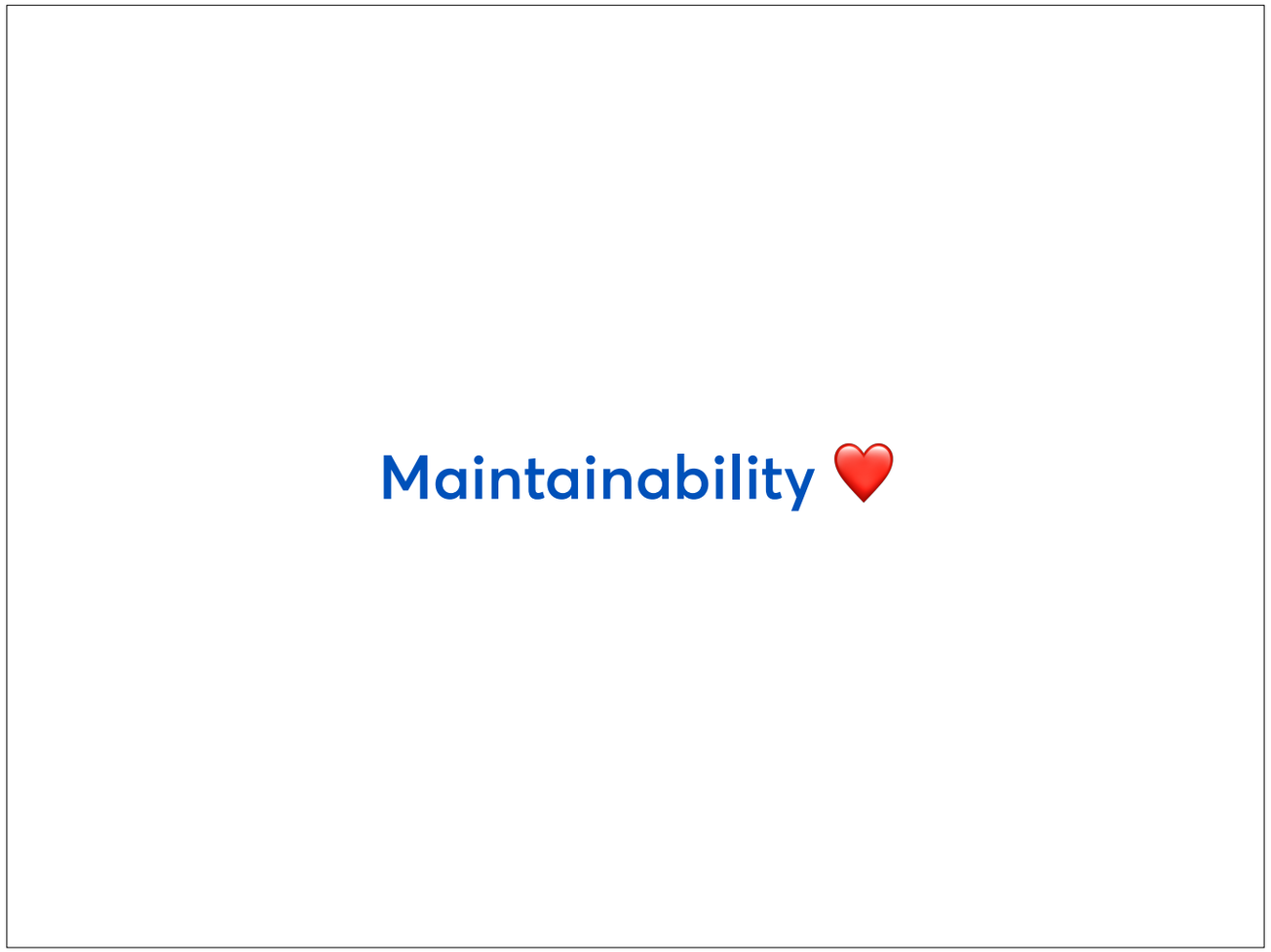
That’s why today, I’m working in an exciting early stage travel API startup called Duffel.

I’d love to tell you more about it, but unfortunately we’re in “stealth mode” at the moment.

In this talk, I'm going to show you what I've learnt from my experiences of building APIs used by tens of thousands of people.

But I'm not going to show you some kind of incredible secret.

I'm just going to show you how you can apply foundational software engineering design principles to build better APIs and make your code more maintainable.



In particular, I’m going to talk about the middleware pattern, which is based on these principles and helps you to write better, more maintainable code behind APIs.

Whilst this is a specific technique for solving a specific problem, the lessons in this presentation are relevant even if you’re not building APIs.

When I say maintainable, what do I mean?

We want our code to be understandable, testable, reusable, and adaptable,

Understandable ✅

Testable ✅

Reusable ✅

Adaptable ✅

We want our code to be understandable. We want code that we - or a member of our team - can come back to in a year’s time and easily understand what it does.

We want our code to be testable. It should be written in such a way that it’s easy to write automated tests for it, so we can be confident that it works and confident to make changes to it.

Understandable ✅

Testable ✅

Reusable ✅

Adaptable ✅

We want code to be reusable, so we can provide a consistent interface across our API - for example, having our authentication work the same everywhere. When we want to make changes to our API, we don’t want to be forced to change code in hundreds of places.

Finally, we want our code to be adaptable.

It should be able to evolve over time, rather than being resistant to change.

Understandable ✅

Testable ✅

Reusable ✅

Adaptable ✅

In this talk, we'll focus on how we can make our APIs more understandable, testable and reusable using the middleware pattern.

Controllers: the standard solution for building APIs

The most common way to build APIs - and in fact, anything that responds to HTTP requests over the internet - is to use the Controller pattern. It’s baked into the frameworks that most of us use, like Django, Ruby on Rails and Laravel.

This talk comes from my experiences of building APIs using controllers, and the challenges me and my team faced.

Patterns are “tried and tested” ways of structuring code, which we can apply in our work

Now, you don’t need to be terrified by the word “pattern”. A “design pattern” in software engineering is just a tried and tested way of structuring code, that we can apply to the specific problem we’re solving

A Controller handles a request, generating a response

So what is a controller?

A Controller is a piece of code that receives a request (for example, you visiting a web page in your browser or someone hitting your API) and is responsible for coordinating all of the hard work needed to generate a response.

We most often talk about controllers in the context of the Model View Controller pattern - also known as MVC. In most applications, the controller will have to talk to a database via what is called a Model, and send back a response, generated using a View.

Let's start by building a simple API using the Controller pattern 🛠️

To make sure we all understand the pattern and see the maintainability challenges we face, let's get started by building a simple payments API together using the Controller pattern.

We'll then think about how we can refactor our code to make it miles more maintainable.

For these examples, we'll use Ruby on Rails 🚂

The examples in this talk are from Ruby on Rails, but don't worry if you're not familiar with it - this talk should still be easy to follow.

You'll see exactly the same ways of working in other frameworks, for example Python's Django and PHP's Laravel.

```
POST /customers HTTP/1.1

Content-Type: application/json
Host: api.gocardless.com

{
  "data": {
    "email": "tim@gocardless.com",
    "iban": "GB60BARC200005577991"
  }
}
```

Let’s start off by imagining a very simple API - it creates a customer based on their email address and bank details.

```ruby
class CustomersController < ApplicationController
 # ...
end
```

To start building that with the Controller pattern, we'd make a "customers controller".

```ruby
class CustomersController < ApplicationController
  def create
    customer = Customer.new(customer_params.merge(user: @user))

    if customer.save
      render json: customer
    else
      render json: { errors: customer.errors.full_messages }, status: 422
    end
  end

  private

  def customer_params
    params.require(:data).permit(:email, :iban)
  end
end
```

And then we'd then add a "create" method.

The "create" method is our first controller action. We point a specific kind of request to it - POST requests to `/customers` - and its job is to handle the requests and generate a response.

This controller might have other methods too, for example an "index" method powering an API to get a list of customers.

```ruby
class CustomersController < ApplicationController
  def create
    customer = Customer.new(customer_params.merge(user: @user))

    if customer.save
      render json: customer
    else
      render json: { errors: customer.errors.full_messages }, status: 422
    end
  end

  private

  def customer_params
    params.require(:data).permit(:email, :iban)
  end
end
```

Now, let’s dig into what that controller might do.

It builds the customer from the incoming parameters

```ruby
class CustomersController < ApplicationController
  def create
    customer = Customer.new(customer_params.merge(user: @user))

    if customer.save
      render json: customer
    else
      render json: { errors: customer.errors.full_messages }, status: 422
    end
  end

  private

  def customer_params
    params.require(:data).permit(:email, :iban)
  end
end
```

And then it tries to save our customer to the database

```ruby
class CustomersController < ApplicationController
  def create
    customer = Customer.new(customer_params.merge(user: @user))

    if customer.save
      render json: customer
    else
      render json: { errors: customer.errors.full_messages }, status: 422
    end
  end

  private

  def customer_params
    params.require(:data).permit(:email, :iban)
  end
end
```

If the customer saves successfully, then we render the created customer back to the user as JSON.

```ruby
class CustomersController < ApplicationController
  def create
    customer = Customer.new(customer_params.merge(user: @user))

    if customer.save
      render json: customer
    else
      render json: { errors: customer.errors.full_messages }, status: 422
    end
  end

  private

  def customer_params
    params.require(:data).permit(:email, :iban)
  end
end
```

And if there are validation errors, so we can’t save the customer to the database, we return the error messages back to the user.

```ruby
class CustomersController < ApplicationController
  def create
    customer = Customer.new(customer_params.merge(user: @user))

    if customer.save
      render json: customer
    else
      render json: { errors: customer.errors.full_messages }, status: 422
    end
  end

  private

  def customer_params
    params.require(:data).permit(:email, :iban)
  end
end
```

This is all very simple so far, right? Obviously, we're missing quite a lot of important things here.

For example, our API would need some kind of authentication. So let's have a think about how we might build that.

```
POST /customers HTTP/1.1

Authorization: Bearer my_access_token
Content-Type: application/json
Host: api.gocardless.com

{
  "data": {
    "email": "tim@gocardless.com",
    "iban": "GB60BARC2000005577991"
  }
}
```

The standard way to authenticate with an API is to send an access token in the Authorization header.

```ruby
class CustomersController < ApplicationController
  def create
    customer = Customer.new(customer_params.merge(user: @user))

    if customer.save
      render json: customer
    else
      render json: { errors: customer.errors.full_messages }, status: 422
    end
  end

  private

  def customer_params
    params.require(:data).permit(:email, :iban)
  end
end
```

We *could* write the code to handle this straight into the create method, but that immediately makes our code less maintainable.

Understandable ❌

Reusable ❌

Testable ❌

Our code is immediately harder to understand - straight away, we'll have a long method doing lots of jobs, with no division of labour.

Understandable ❌

Reusable ❌

Testable ❌

Our code will be hard to reuse, since it isn’t abstracted out, but rather lives in the “create” method.

Understandable ❌

Reusable ❌

Testable ❌

And our code will be hard to test - we can’t exercise it on its own, but rather only in the context of the controller

```ruby
before_action :check_authorization_header

private

def check_authorization_header
  # …
end
```

The most common solution to this problem is to split out the authentication code into separate methods, for example using Rails's filter functionality.

```
before_action
after_action
around_action
```

Filters, sometimes known as callbacks, allow you to run code before, after or around your controller action. You'll find a feature like this not just in Rails, but across web frameworks.

```ruby
before_action :check_authorization_header

private

def check_authorization_header
  # …
end
```

Here, we define a “check authorization header” method, and tell Rails to run it before our controller action with `before_action`.

```ruby
before_action :check_authorization_header

private

def check_authorization_header
  header_value = request.headers["HTTP_AUTHORIZATION"]

  return missing_access_token_error unless header_value.present?
  token_type, token = header_value.split(" ", 2)
  return missing_access_token_error unless token_type == "Bearer"

  @access_token = token
end

def missing_access_token_error
  render json: { errors: [I18n.t("errors.missing_access_token")] },
         status: 401
end
```

This method will be run before our create method for each request.

In our `#check_authorization_header` method, we pull out the value of the Authorization header.

```
before_action :check_authorization_header

private

def check_authorization_header
  header_value = request.headers["HTTP_AUTHORIZATION"]

  return missing_access_token_error unless header_value.present?
  token_type, token = header_value.split(" ", 2)
  return missing_access_token_error unless token_type == "Bearer"

  @access_token = token
end

def missing_access_token_error
  render json: { errors: [I18n.t("errors.missing_access_token")] },
         status: 401
end
```

If the header is missing, then we return an error.

```
POST /customers HTTP/1.1

Authorization: Bearer my_access_token
Content-Type: application/json
Host: api.gocardless.com

{
  "data": {
    “email": "tim@gocardless.com",
     "iban": "GB60BARC20000055779911"
  }
}
```

Once we’ve checked that the header has actually been provided, we need to look at its value. . Which, if you remember, looks like this: “Bearer”, followed by an access token

```ruby
before_action :check_authorization_header

private

def check_authorization_header
  header_value = request.headers["HTTP_AUTHORIZATION"]

  return missing_access_token_error unless header_value.present?
  token_type, token = header_value.split(" ", 2)
  return missing_access_token_error unless token_type == "Bearer"

  @access_token = token
end

def missing_access_token_error
  render json: { errors: [I18n.t("errors.missing_access_token")] },
         status: 401
end
```

We split the header into its two parts: “Bearer”, and the access token itself

```ruby
before_action :check_authorization_header

private

def check_authorization_header
  header_value = request.headers["HTTP_AUTHORIZATION"]

  return missing_access_token_error unless header_value.present?
  token_type, token = header_value.split(" ", 2)
  return missing_access_token_error unless token_type == "Bearer"

  @access_token = token
end

def missing_access_token_error
  render json: { errors: [I18n.t("errors.missing_access_token")] },
         status: 401
end
```

And then we check that it starts with “Bearer”, returning an error if not

```ruby
before_action :check_authorization_header

private

def check_authorization_header
  header_value = request.headers["HTTP_AUTHORIZATION"]

  return missing_access_token_error unless header_value.present?
  token_type, token = header_value.split(" ", 2)
  return missing_access_token_error unless token_type == "Bearer"

  @access_token = token
end

def missing_access_token_error
  render json: { errors: [I18n.t("errors.missing_access_token")] },
         status: 401
end
```

If everything looks good, we save the access token to an instance variable, @access_token.

This instance variable is shared, and can be seen by our controller action once the filter has finished running, as well as by any other filters we have.

If our filter raises an exception or returns an HTTP response as we do here, execution will stop.

Otherwise, Rails will move on to the next filter, and eventually on to the action itself, the “create” method.

```ruby
before_action :check_authorization_header
before_action :check_access_token

private

def check_access_token
  @user = User.find_by(access_token: @access_token)

  return invalid_access_token_error unless @user.present?
end

def invalid_access_token_error
  render json: { errors: [I18n.t("errors.invalid_access_token")] },
         status: 401
end
```

Saving the access token to an instance variable allows us to break down our code into clear, distinct steps.

Now, having extracted the access token, we want to check if it’s valid.

So we add another filter, `#check_access_token`.

```
before_action :check_authorization_header
before_action :check_access_token

private

def check_access_token
  @user = User.find_by(access_token: @access_token)

  return invalid_access_token_error unless @user.present?
end

def invalid_access_token_error
  render json: { errors: [I18n.t("errors.invalid_access_token")] },
         status: 401
end
```

In there, we look up the access token which we've already saved to an instance variable, and store the authenticating user in an instance variable, @user.

```
before_action :check_authorization_header
before_action :check_access_token

private

def check_access_token
  @user = User.find_by(access_token: @access_token)

  return invalid_access_token_error unless @user.present?
end

def invalid_access_token_error
  render json: { errors: [I18n.t("errors.invalid_access_token")] },
         status: 401
end
```

If there’s no match, we return an error.

Otherwise, we’ll reach the end of our filters, and Rails will move on to our controller action.

```ruby
class CustomersController < ApplicationController
  before_action :check_authorization_header
  before_action :check_access_token

  def create
    customer = Customer.new(customer_params.merge(user: @user))

    if customer.save
      render json: customer
    else
      render json: { errors: customer.errors.full_messages }, status: 422
    end
  end

  private

  def customer_params
    params.require(:data).permit(:email, :iban)
  end
end
```

Now, in the controller action, we can make use of the user stored in the @user instance variable.

There are tonnes of other things like this which we might want to do in filters - for example, validating input against our API schema, recording statistics about who is using which API or enforcing users' permissions.

Very quickly, this approach of adding more and more filters gets out of control, leading to a world of pain and unmaintainability.

```
around_action :with_locale, except: [:cancel]
before_action :only_allow_html, only: [:authorize]
before_action :build_oauth_params_from_params, only: [:authorize]
before_action :build_oauth_params_from_session, except: %i[authorize cancel]

# You would shiver to see the number of instance variables set in here...
before_action :set_instance_variables

before_action :check_client_id
before_action :check_redirect_uri
before_action :check_scope
before_action :check_response_type
before_action :redirect_to_cancel, except: %i[authorize cancel]

before_action :persist_oauth_params_to_session, only: [:authorize]
before_action :set_permitted_params
```

Here’s a real example from a controller at GoCardless which used to power our OAuth flow, with no less than 12 filters in the worst case.

```
around_action :with_locale, except: [:cancel]
before_action :only_allow_html, only: [:authorize]
before_action :build_oauth_params_from_params, only: [:authorize]
before_action :build_oauth_params_from_session, except: %i[authorize cancel]

# You would shiver to see the number of instance variables set in here...
before_action :set_instance_variables

before_action :check_client_id
before_action :check_redirect_uri
before_action :check_scope
before_action :check_response_type
before_action :redirect_to_cancel, except: %i[authorize cancel]

before_action :persist_oauth_params_to_session, only: [:authorize]
before_action :set_permitted_params
```

Our code gets really painful, really quickly. Our controller gets bigger and bigger, easily reaching hundreds of lines of codes. Before too long, it becomes very difficult to understand.

Action-specific logic
vs.
Reusable logic

What's happened here? Why does our code get out of control so quickly? Where do all of these filters come from?

The `#create` method in our controller contains the action-specific logic - the code, which you don't need to reuse, to create a customer based on the incoming request.

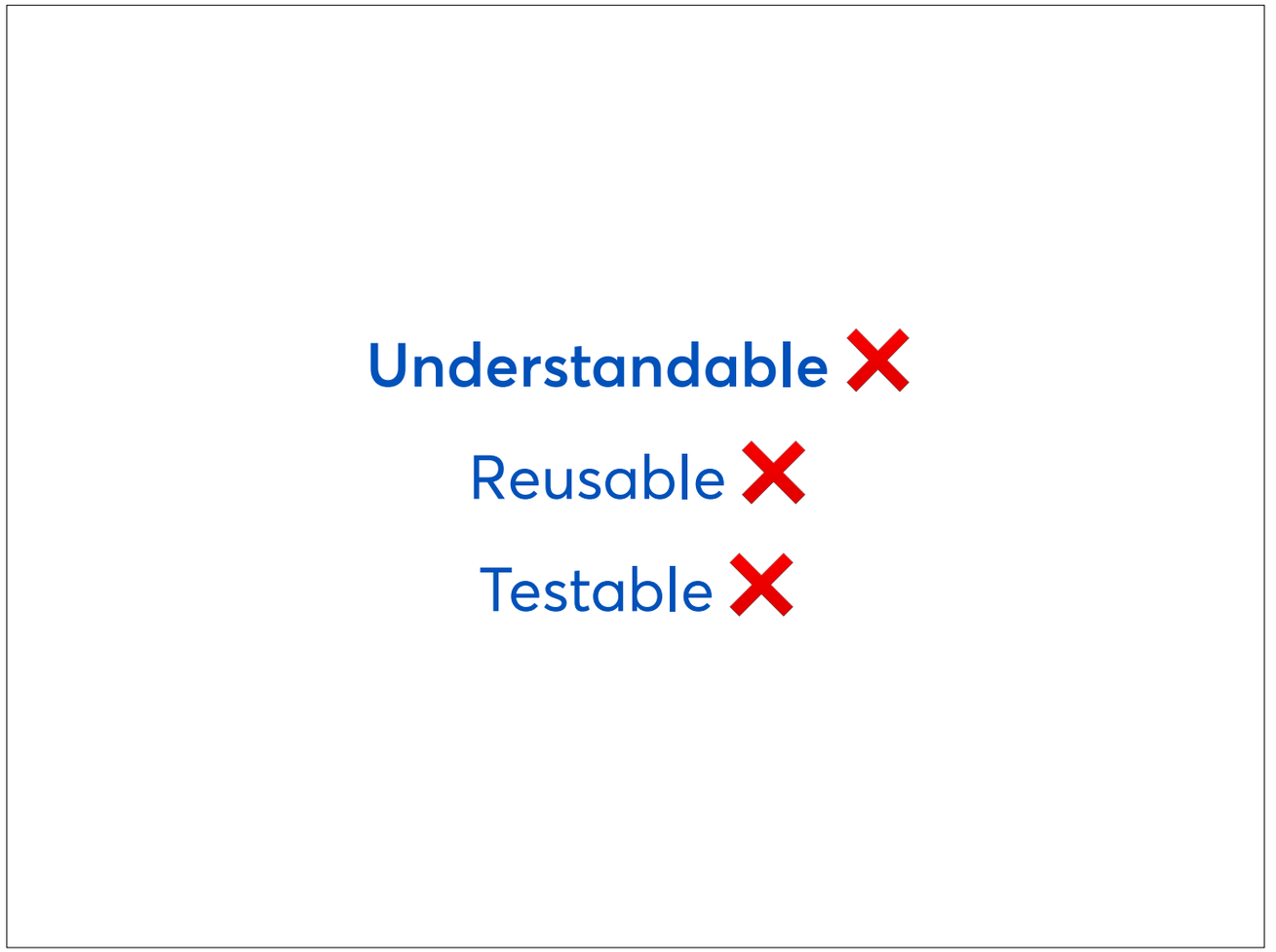
This code tends to stay fairly simple, and there are well-known solutions if it gets more complicated, for example moving complex logic to service objects.

What we've been adding is reusable code which we'd use across our API - things like authentication.

APIs are designed to provide a rigid, consistent interface for users, which means that you're likely to have lots of shared, reusable logic which you use to provide that interface, from authentication to validation.

What's the problem? 🤔

Even just by adding a few of these filters, we've already hit three problems which make our application less maintainable:

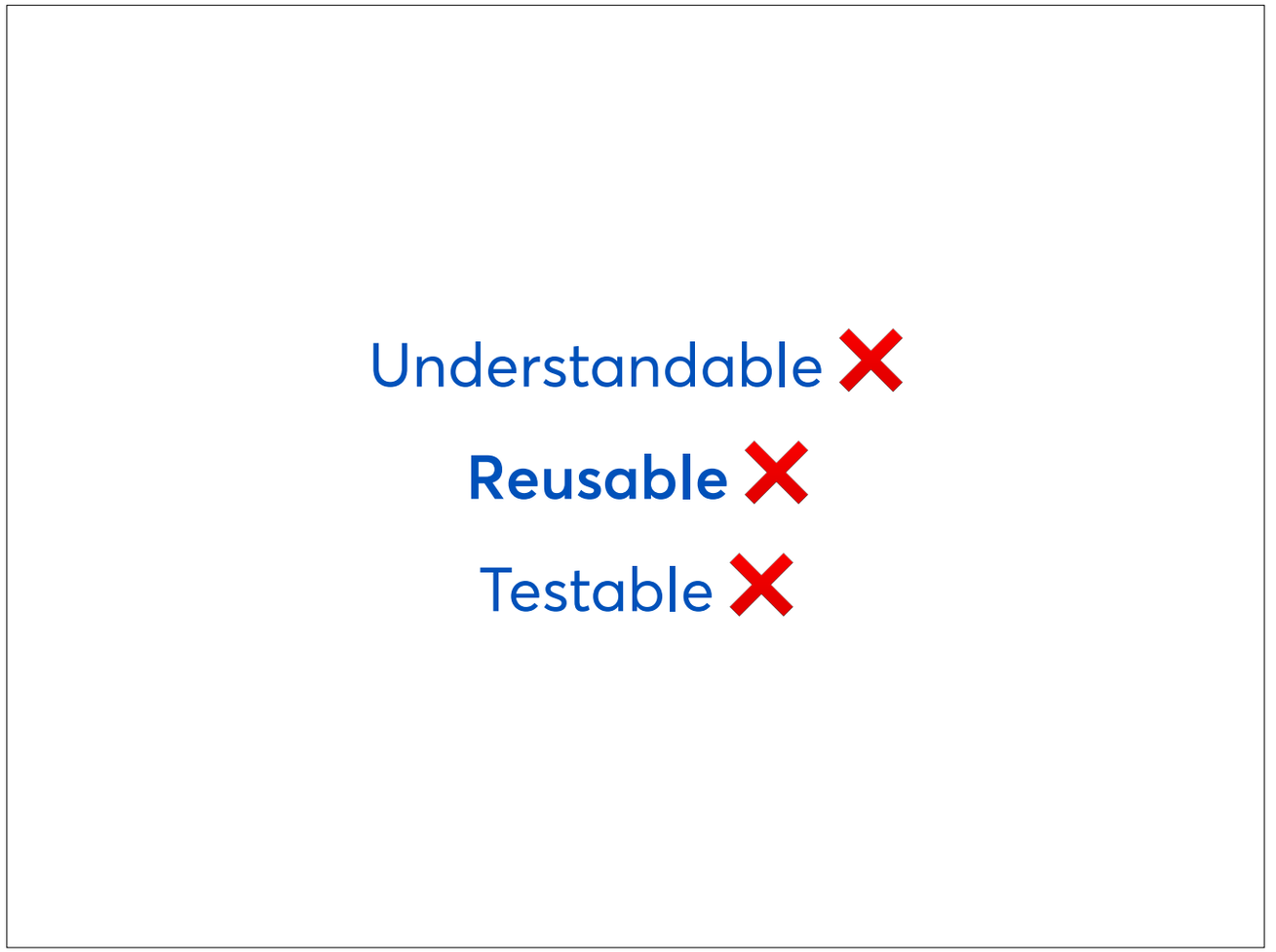


Firstly, our code is hard to understand, particularly in the way it uses state.

We naturally want to split our logic into different methods to make our code as clear as possible. For example, we split getting the access token from checking if it is valid.

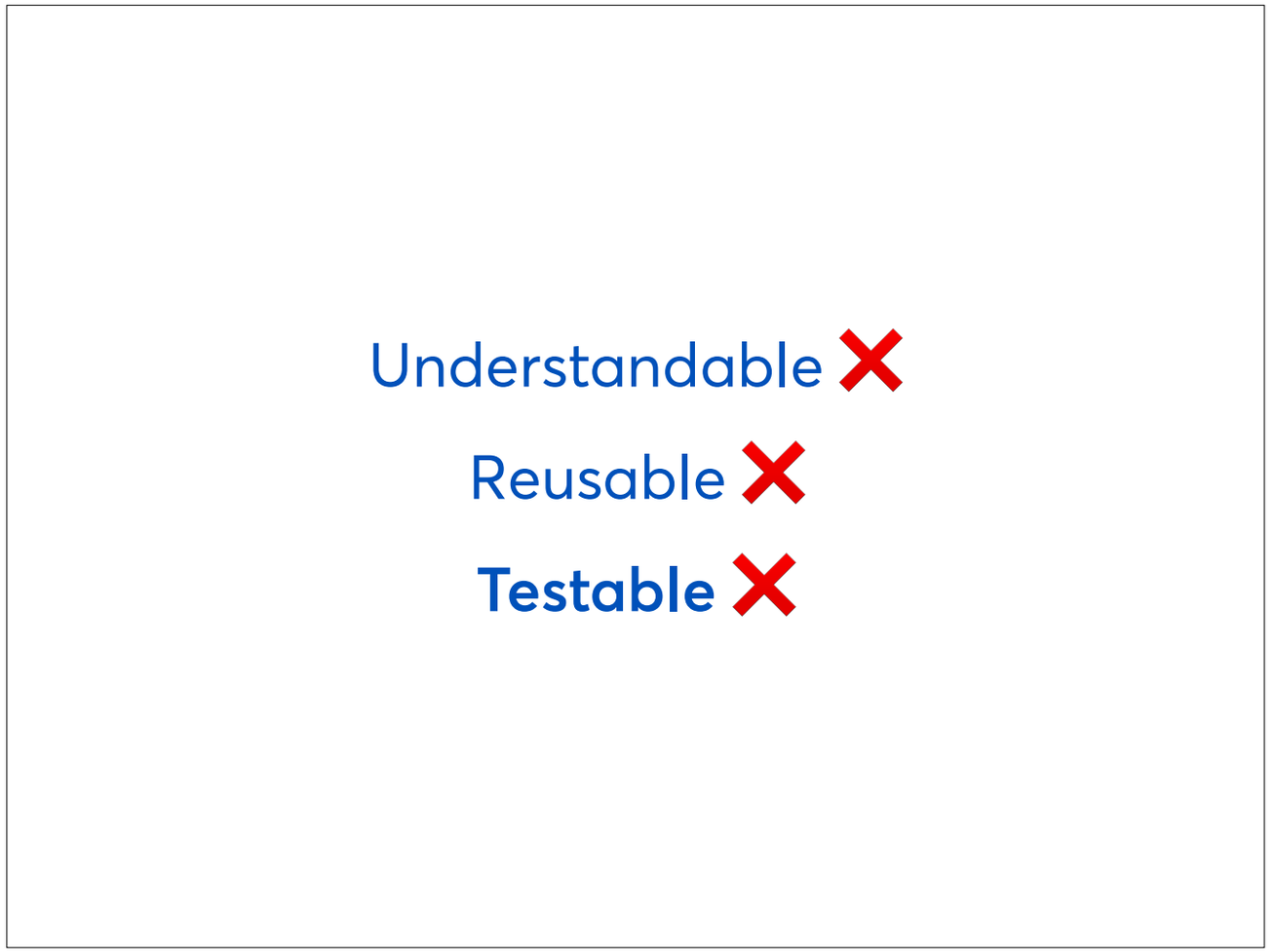
We need to share data between those steps, and make data available from the filters to the controller action itself - in this case, the authenticated user.

We saw an example of doing that using instance variables. But these aren't easy to reason about. The flow of data isn't clear, it isn't defined in one place, and dependencies aren't enforced. Once you have lots of filters, you find yourself scrolling through your code constantly trying to understand where data comes from.



Secondly, this code lives isolated in our controller. It’s difficult to share it, reuse it or adapt it.

We’ll just end up duplicating this code when we want to add another API - for example, an API to collect a payment from a customer.



Thirdly, our code will be hard to test.

We want to be able to test all the edge cases in our logic. For example, what happens if the Authorization header is invalid?

We want to be able to test the state that is constructed (i.e. what data do we fetch and store in instance variables to use later), as well as any response sent to the user.

This approach forces us to test that in the form of an integration test. We can't exercise our authentication or internationalisation logic on its own since it's just part of the controller, tied to an action.

The single responsibility principle

The SOLID principles are a series of software engineering design principles which help to make our code more understandable, more reusable and more testable.

One of these principles is the “single responsibility principle”.

The single responsibility principle helps us to make our code more understandable, more testable and more reusable.

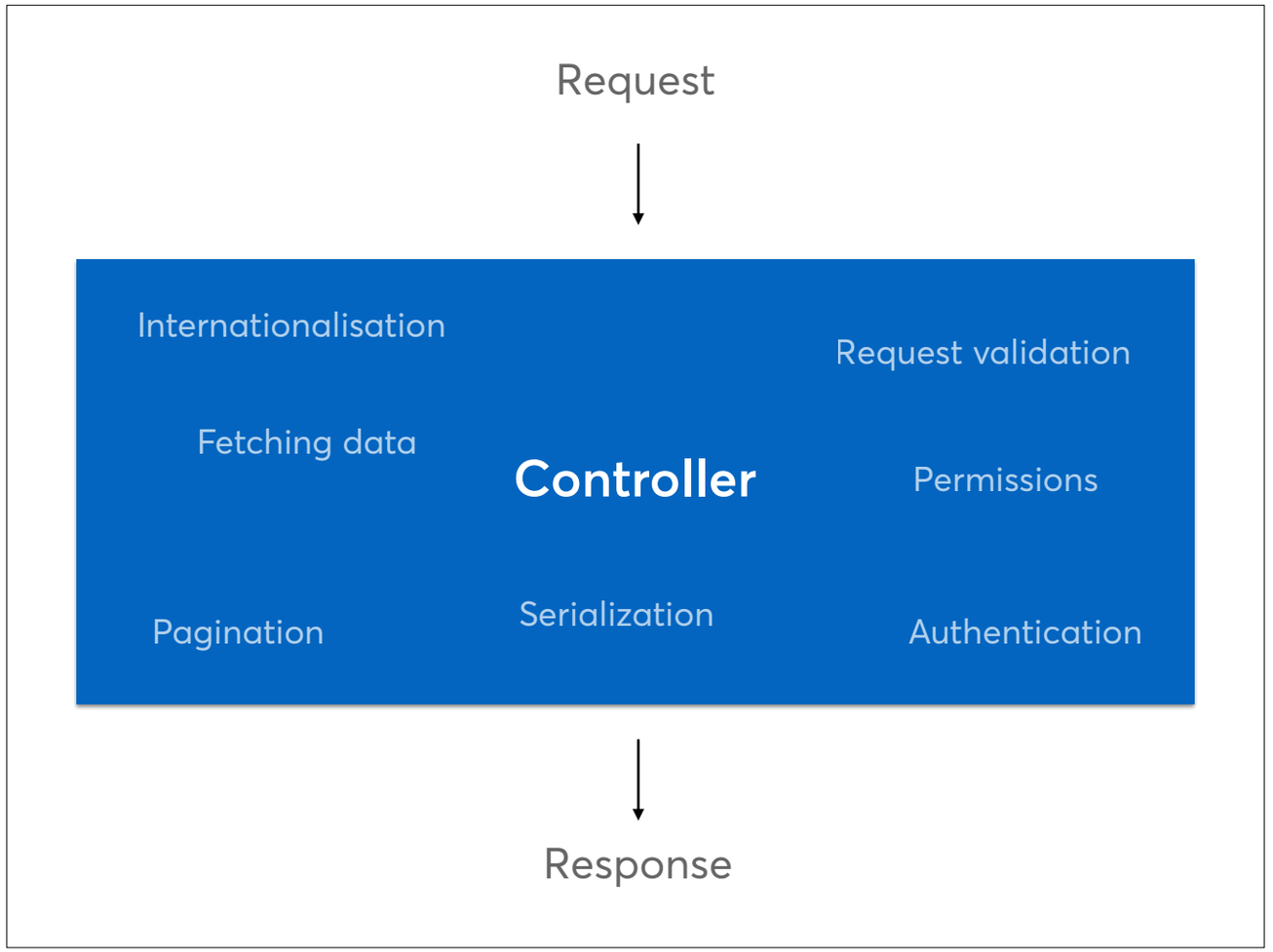
"Every module or class should have responsibility over a single part of the functionality provided by the software, and that responsibility should be entirely encapsulated by the class"

The single responsibility principle says that “every module or class should have responsibility over a single part of the functionality provided by the software, and that responsibility should be entirely encapsulated by the class”.

= small chunks of code
with one job

That’s a pretty complicated way of explaining a simple idea.

At the heart of the single responsibility principle is breaking down big problems into small manageable chunks of code, each of which do one thing.



The problem we have with filters is that controllers become very big and do lots of things, rather than having a small, clear, responsibility.

We want to turn each of our filters into a single class with a single responsibility. This makes our code much easier to test, understand and reuse.

One class, one job

No more fat controllers

We want to put an end to fat controllers, moving towards smaller, more manageable classes with a single responsibility. That way, our code will be more maintainable.

How can we move from “fat controllers” to something more maintainable?

Before we dive into the middleware pattern, let’s look at some other common options for breaking up controllers.

So far, we’ve been using filters defined within our controller. This is certainly better than adding our reusable logic to each controller action, but as we’ve seen, there are still some maintainability challenges.

Object-oriented programming, the paradigm of languages like Ruby, PHP and Python, gives us the option of using *inheritance* to solve this problem

Move our filters from our controller, `CustomersController` to its superclass, `ApplicationController`

First off, we can make our filters more reusable by moving them from our specific controller to its superclass, `ApplicationController`, which is shared by all of our controllers.

This is an option in any object-oriented language, including PHP and Python.

```ruby
class ApplicationController < ActionController::Base
  before_action :check_authorization_header
  before_action :check_access_token

  private

  def check_authorization_header
    # ...
  end

  def check_access_token
    # ...
  end

  def with_locale
    # ...
  end
end

class CustomersController < ApplicationController
  around_action :with_locale
end
```

We can move our filter methods to ApplicationController.

```
class ApplicationController < ActionController::Base
  before_action :check_authorization_header
  before_action :check_access_token

  private

  def check_authorization_header
    # ...
  end

  def check_access_token
    # ...
  end

  def with_locale
    # ...
  end
end

class CustomersController < ApplicationController
  around_action :with_locale
end
```

And then we then have two options for actually using the filters.

We can use `before_action` in ApplicationController if we're really sure we want these filters everywhere. Then, we don't have to declare our `before_action` in every controller.

```ruby
class ApplicationController < ActionController::Base
  before_action :check_authorization_header
  before_action :check_access_token

  private

  def check_authorization_header
    # ...
  end

  def check_access_token
    # ...
  end

  def with_locale
    # ...
  end
end

class CustomersController < ApplicationController
  before_action :check_authorization_header
  before_action :check_access_token
end
```

Or if we want a bit more control, we can add them in CustomersController, referring to our shared method from ApplicationController.

Share methods between classes using a module

Our second option is to move the filter methods to their own modules, and then include those modules into our controller.

This is another standard object-oriented solution to our problem, which you can do in Python and PHP too.

```ruby
module API::AuthorizationHeader
  def check_authorization_header
    # ...
  end
end

class CustomersController < ApplicationController
  include API::AuthorizationHeader

  before_action :check_authorization_header
end
```

This is the standard way in Ruby to share code between classes.

We can create a separate module

```
module API::AuthorizationHeader
  def check_authorization_header
    # ...
  end
end

class CustomersController < ApplicationController
  include API::AuthorizationHeader

  before_action :check_authorization_header
end
```

And define our method there which we want to be shared.

```ruby
module API::AuthorizationHeader
  def check_authorization_header
    # ...
  end
end

class CustomersController < ApplicationController
  include API::AuthorizationHeader

  before_action :check_authorization_header
end
```

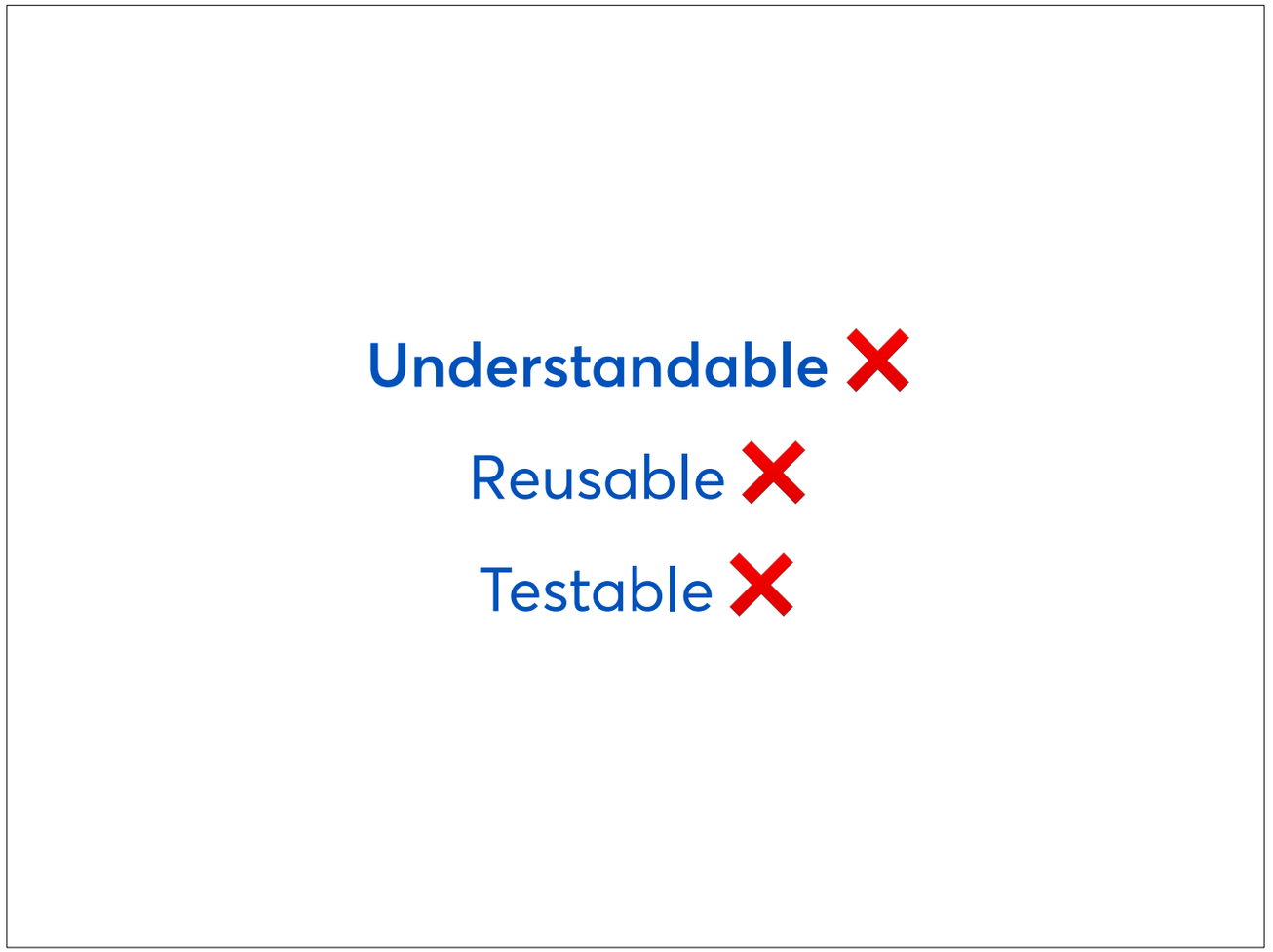
Then, we just include our module in our controller, and it’ll behave just like we define the method in the controller itself — so we can just use `before_action`.

```ruby
module API::AuthorizationHeader
  def check_authorization_header
    # ...
  end
end

class CustomersController < ApplicationController
  include API::AuthorizationHeader

  before_action :check_authorization_header
end
```

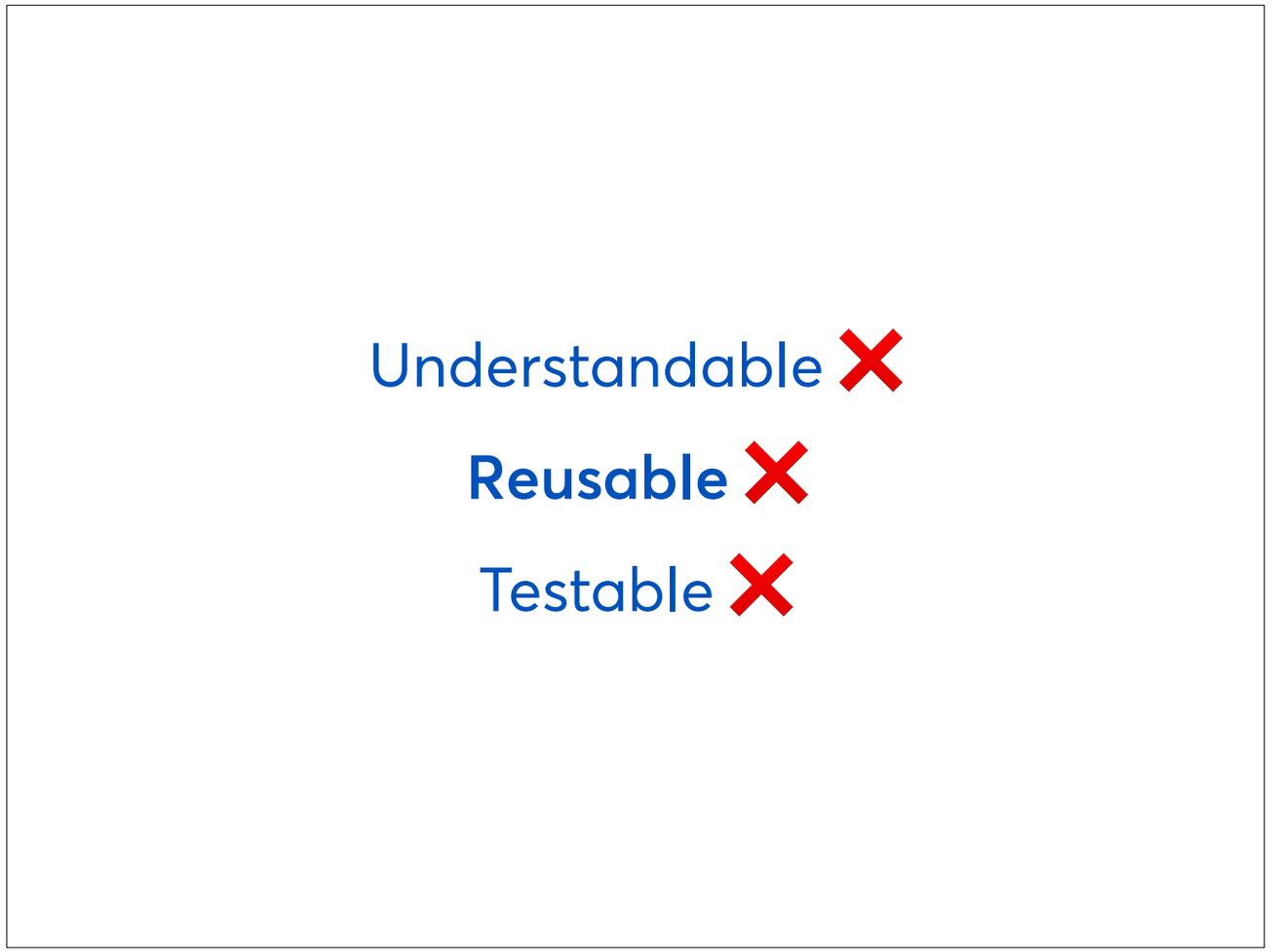
so we can just use `before_action`.

This doesn't get us where we want to be 😪

These solutions don't really work.



Our code is still hard to understand because filters can be declared in lots of different places, and state stored in instance variables is hard to understand and track through our code.



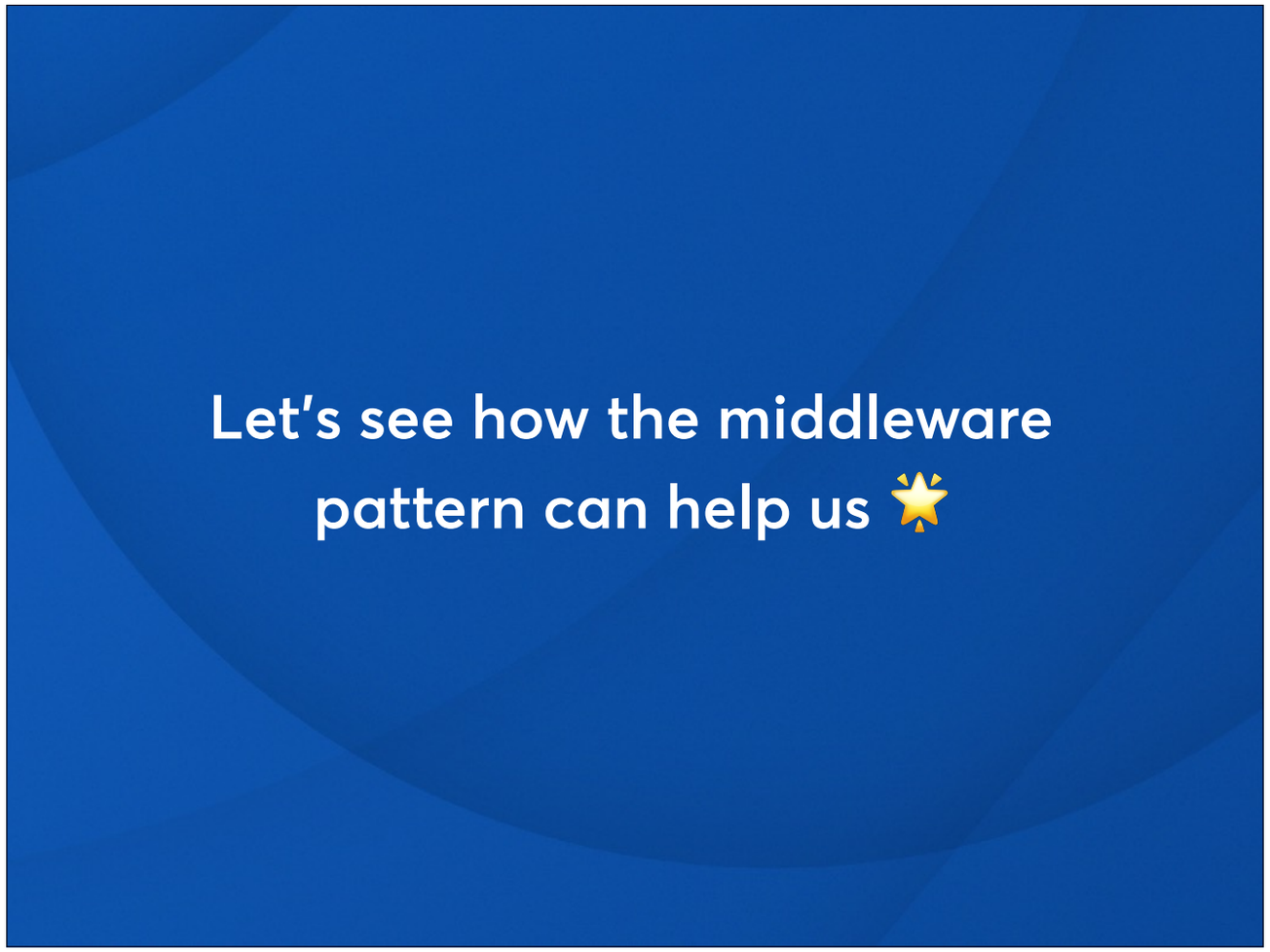
Our code is still hard to reuse, because there is no way to configure our filters. Let’s say, for example, we want to enforce different permissions for different APIs. That will just mean having tonnes of different filter methods.

Understandable ❌

Reusable ❌

Testable ❌

And our code is hard to test. We can’t test these filters independent of the controllers, so it’s difficult to test the edge cases without being stuck using integration tests.



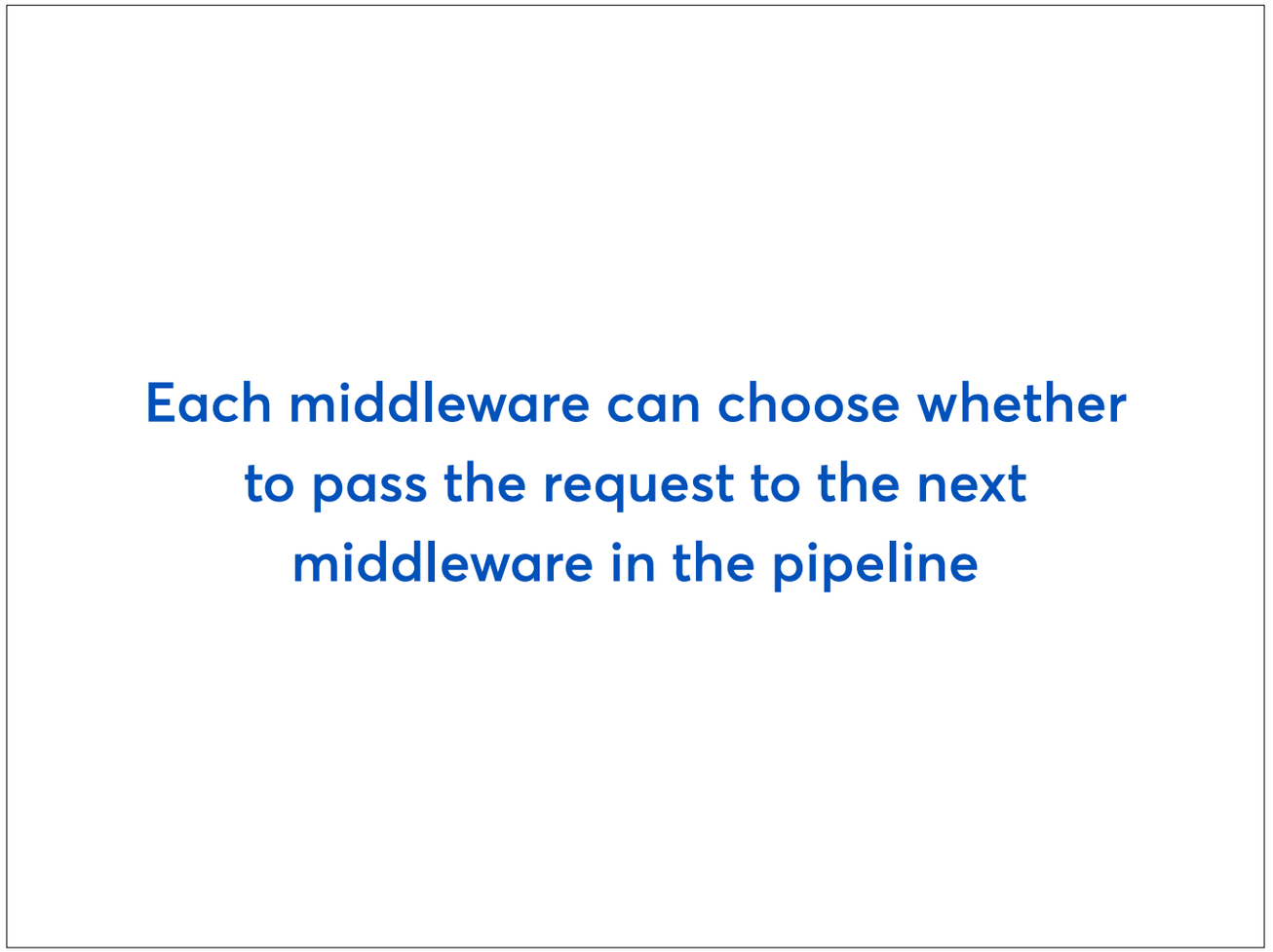
Let’s start talking about the middleware solution. Using the middleware pattern lets us write easy to understand, easy to test, easy to reuse, maintainable code. So what is it?

> “Middleware is software that’s assembled into an application pipeline to handle requests and responses”

Surprisingly, Microsoft’s ASP.NET documentation actually has one of the best descriptions of how middleware work.

Middleware is software that’s assembled into an application pipeline to handle requests and responses.

So what does that mean? We split the job of handling a request into many steps. Each step is a middleware.



Each middleware in the pipeline can choose whether to pass the request to the next middleware in the pipeline

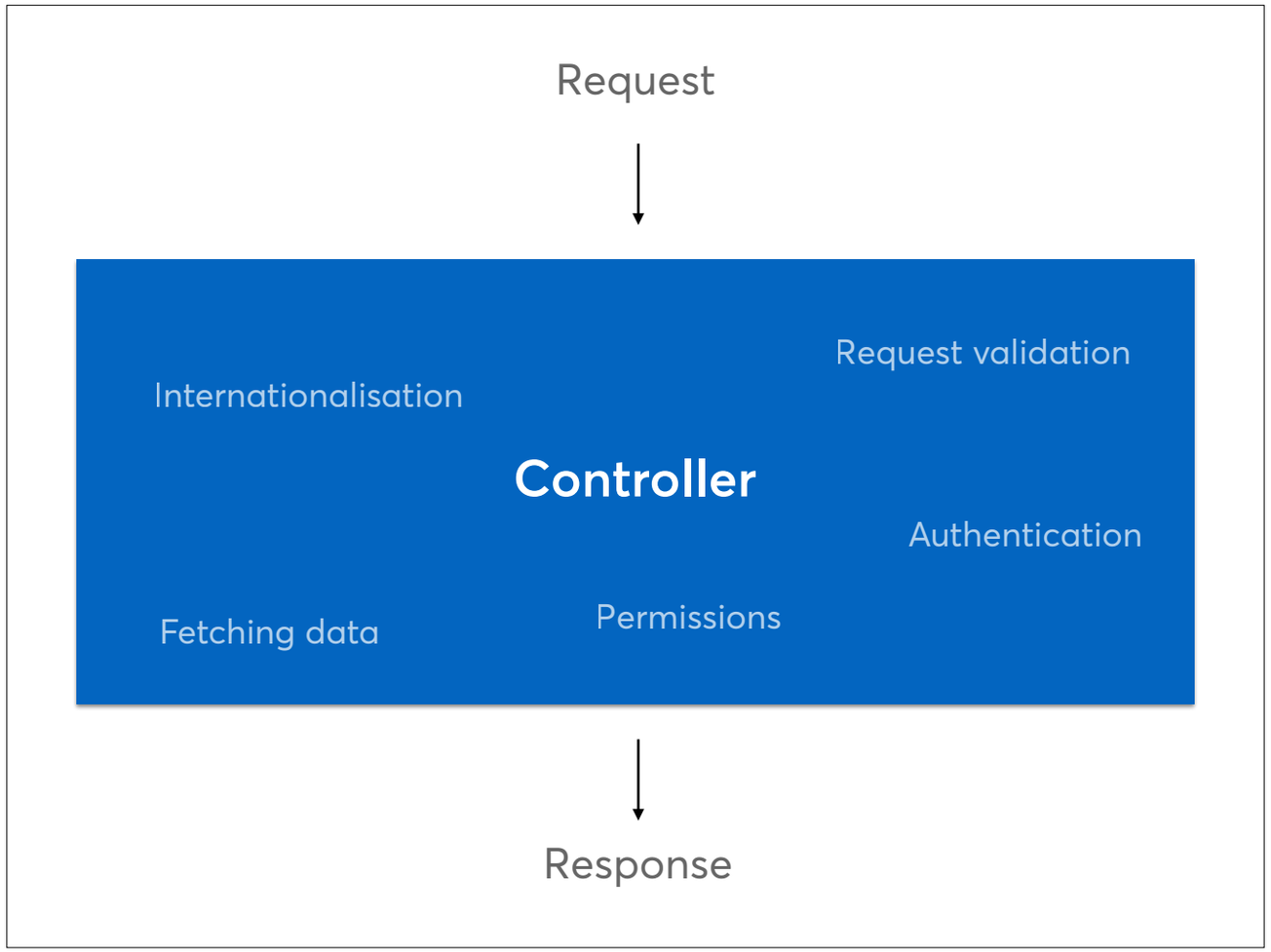
That is, it can either return a result itself (for example, an error response), or it can call on the next middleware in the pipeline to do its job.

So, for example, a middleware which checks a user's access token could return early if the access token isn't valid, or if it is, it can move on to the next middleware in the pipeline.

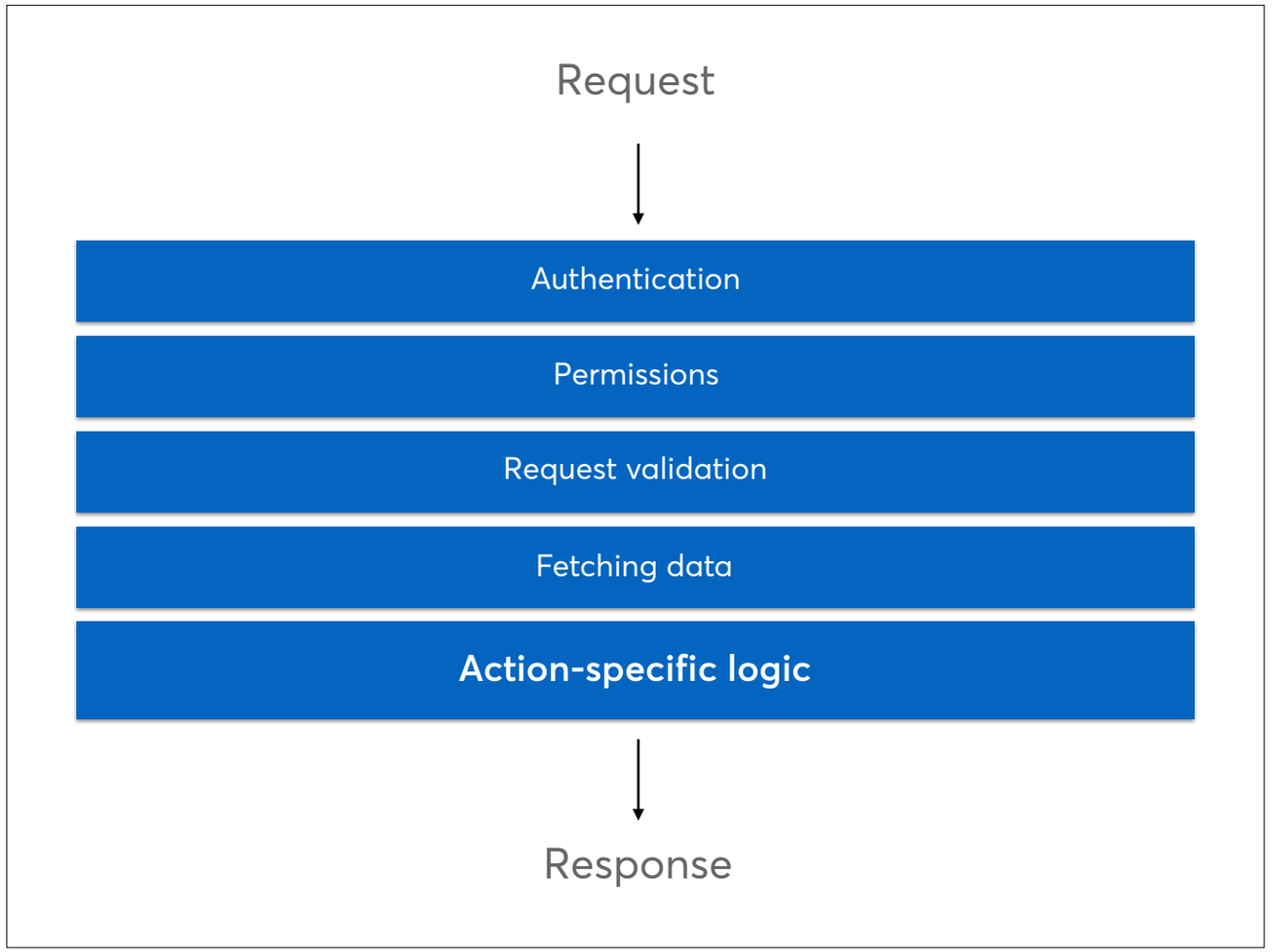
From one fat controller to many skinny middleware

Instead of a fat controller, we can have many skinny middleware, each of which do one job.

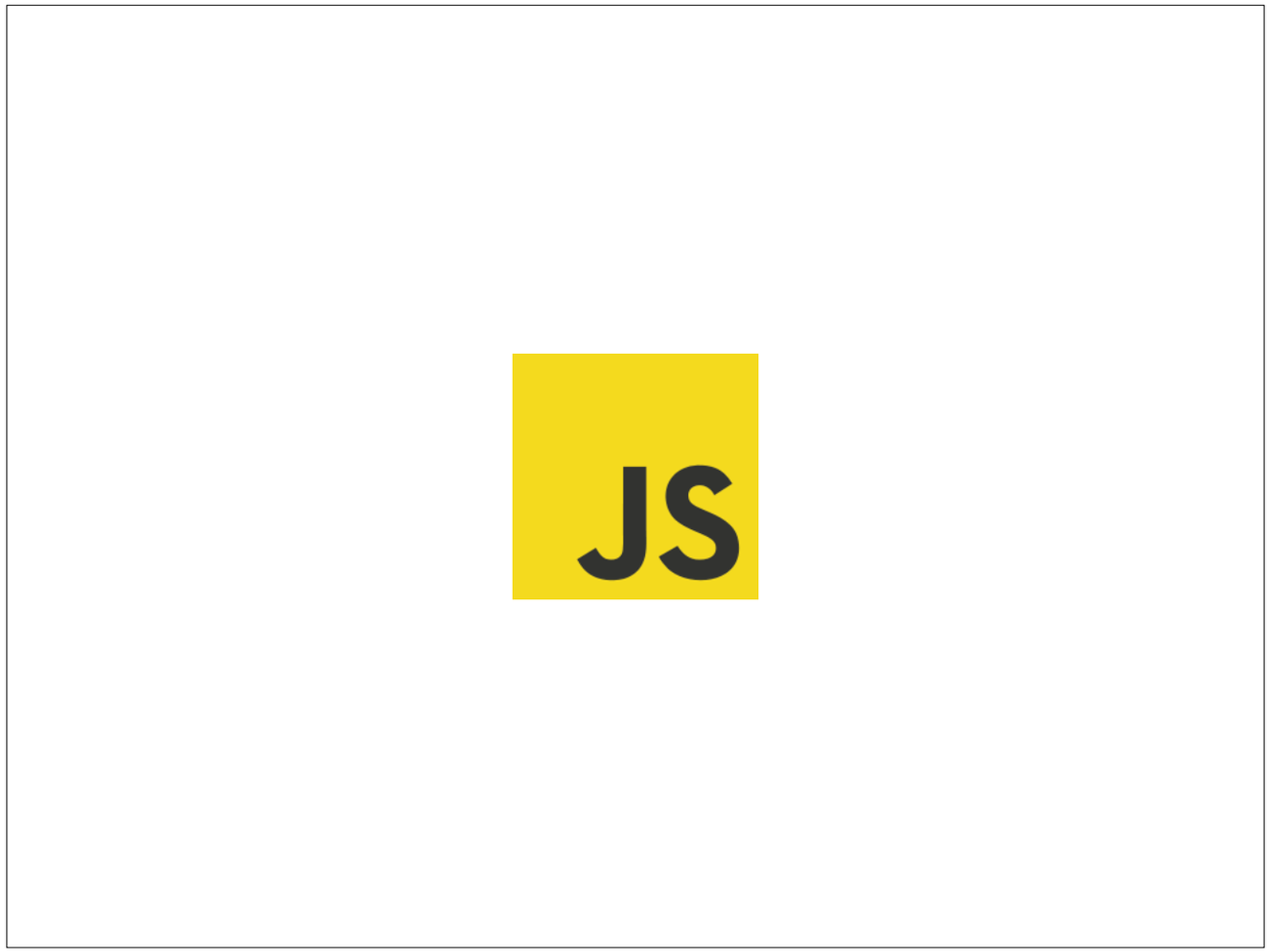
We chain together those middleware into a pipeline, and the middleware in the pipeline work together to handle the request and build a response.



The vision is that with middleware, we can move from fat, confusing controllers…



To reusable, testable and understandable pipelines of middleware



The middleware pattern has been particularly popularised by JavaScript frameworks like Express, as well as in a variety of other frameworks, for example Elixir’s Phoenix.

What's so great about the middleware pattern?

So, what's so great about this pattern? Why does building our application as a pipeline of middleware help us to make our code more maintainable?

The single responsibility principle

At the heart of this is the single responsibility principle: instead of big, unwieldy pieces of code doing many things, we have simple classes with a single job.

Understandable ✅

Reusable ✅

Testable ✅

Our code is easy to understand, because each middleware does one simple thing.

We then assemble lots of simple middleware together into a pipeline, and they work together to produce the final result, which ends up being pretty complex.

This code is easy to reuse, because middleware have one job, and we can easily compose them together to build more complex functionality. We can even make them configurable.

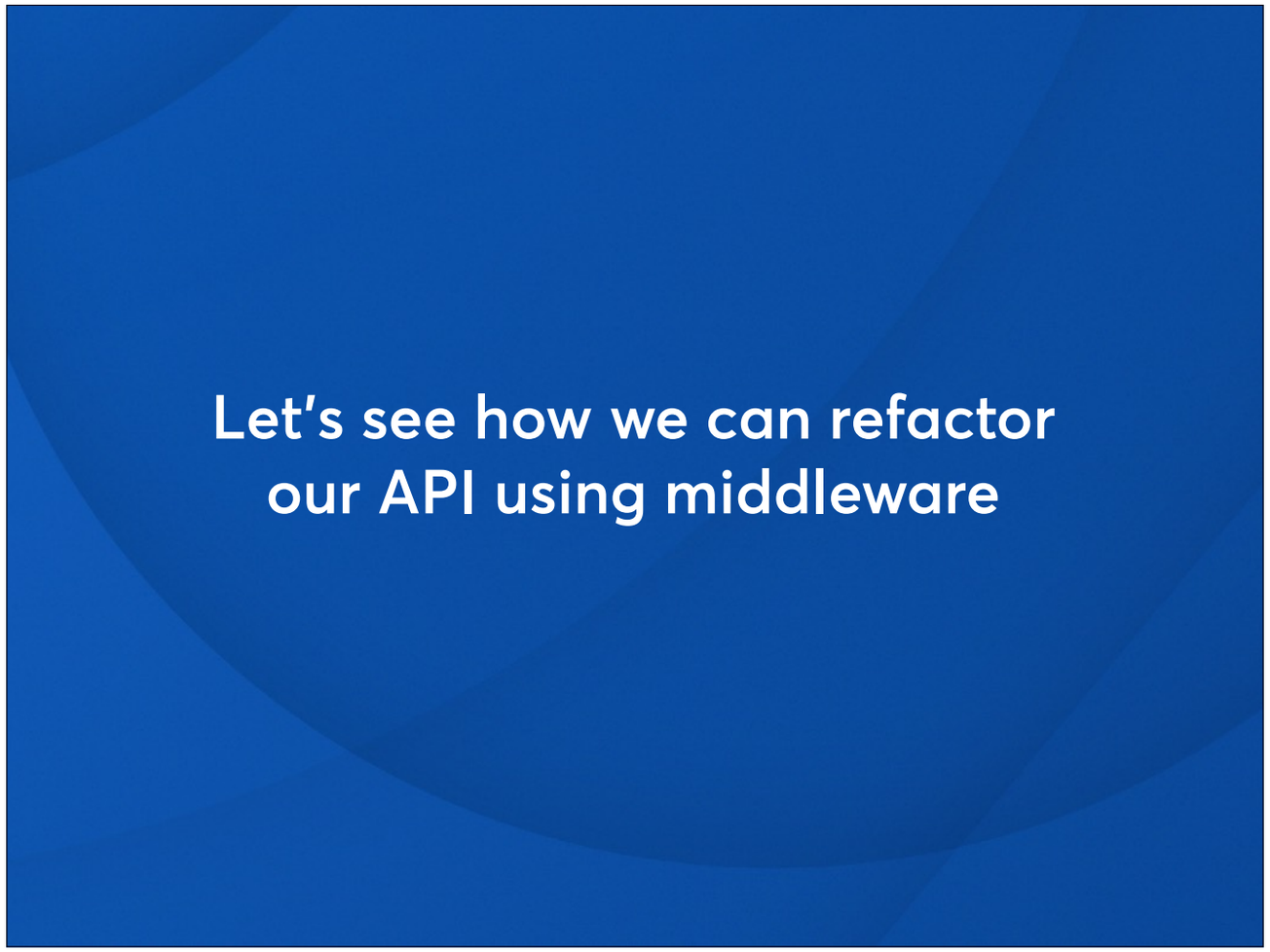
Understandable ✅

Reusable ✅

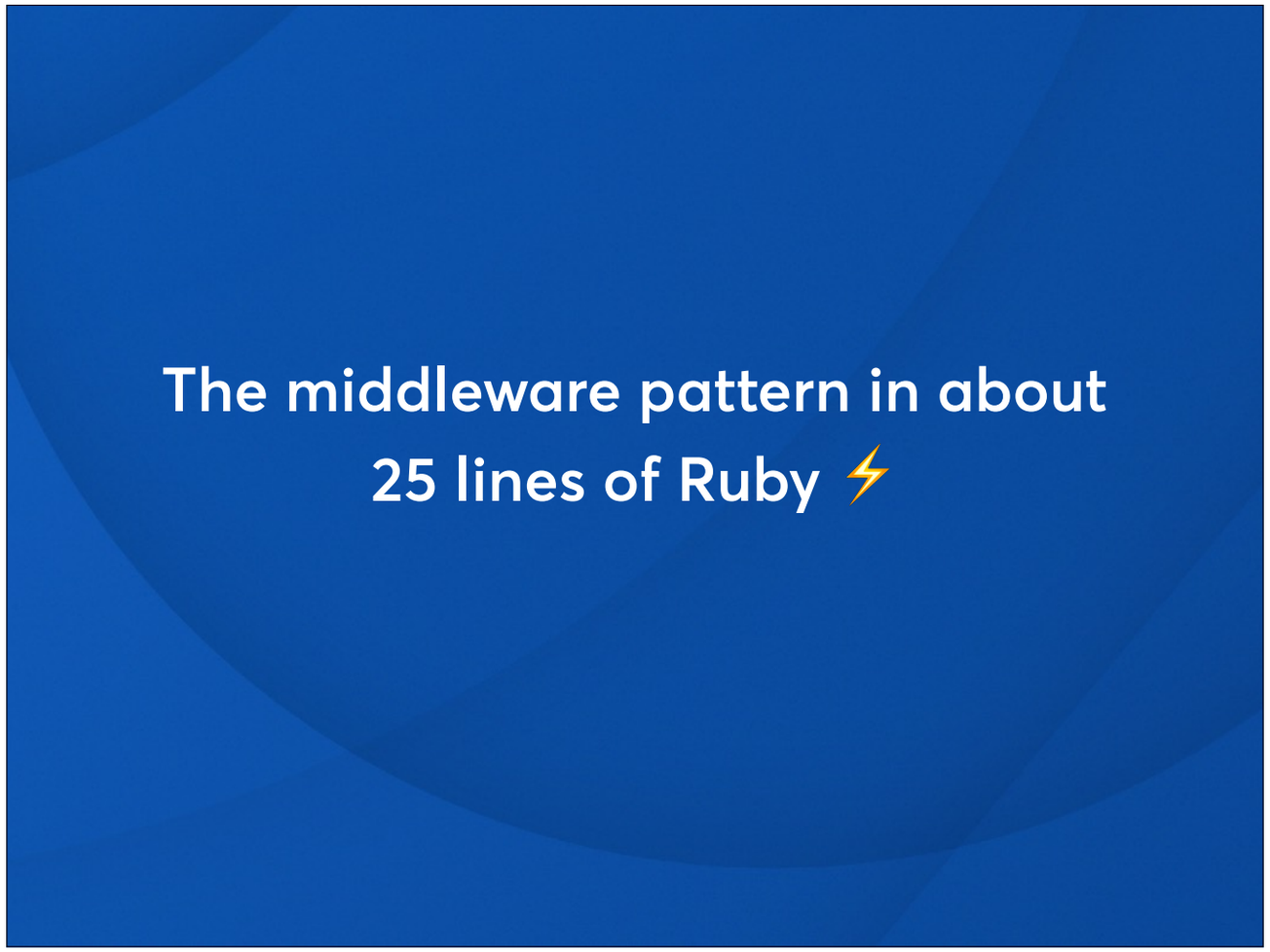
Testable ✅

Our middleware are easy to test. You can call the middleware, passing in some input, and see what happens.

You can see whether a response is returned - and if so, what - or if the next middleware in the chain is called.



Let’s see how we can refactor our API using middleware, making it miles more maintainable.



Your choice of language almost certainly already has a middleware library you can use.

For this talk, I've built a simple implementation of the middleware pattern in about 25 lines of code in Ruby. We're going to look at this so we can understand the pattern better, and get to grips with how it works.

https://github.com/timrogers/simple_middleware

I call it Simple Middleware. Let's go through it together, and then reimplement our API using it.

```ruby
def create
  response = SimpleMiddleware.call(initial_state: { request: request,
                                                    params: params },
                                   middlewares: [Middleware::Locale,
                                                 Middleware::AuthorizationHeader,
                                                 Middleware::AccessToken,
                                                 Create])

  render_rack_response(response)
end
```

To kick off, let’s look at the interface: how we’ll use our middleware.

To avoid re-writing all of Rails’s routing logic, we call our middleware from inside a controller. We don’t have any real logic in the controller itself.

The `#create` method in the CustomersController ends up looking like this.

We call SimpleMiddleware with a list of middleware we want to run through, and specify the data we want to pass in - here, Rails’s request and params objects. These represent the user’s request, and include data like the headers of the request and any JSON they passed it.

We pass those objects in because we want to be able to use them from our middleware, for example to look at the Authorization header.

```
def create
  response = SimpleMiddleware.call(initial_state: { request: request,
                                                    params: params },
                                   middlewares: [Middleware::AuthorizationHeader,
                                                 Middleware::AccessToken,
                                                 Create])

  render_rack_response(response)
end
```

We turn our two filters from earlier into middleware.

```
def create
  response = SimpleMiddleware.call(initial_state: { request: request,
                                                    params: params },
                                   middlewares: [Middleware::AuthorizationHeader,
                                                 Middleware::AccessToken,
                                                 Create])

  render_rack_response(response)
end
```

And we've also defined a final middleware called `Create`. In there, we'll put the action-specific logic that actually creates the customer.

We could do this a bit differently, and keep the action-specific logic that creates the customer in the controller action itself.

But I've chosen to write it as a middleware for consistency, and so we can unit test that part on its own.

```
def create
  response = SimpleMiddleware.call(initial_state: { request: request,
                                                    params: params },
                                   middlewares: [Middleware::Locale,
                                                 Middleware::AuthorizationHeader,
                                                 Middleware::AccessToken,
                                                 Create])

  render_rack_response(response)
end
```

At the end of the middleware chain, we expect to get back a Rack response. This is a special kind of object in Ruby that represents an HTTP response that we want to send back.

At its heart, it’s an array containing an HTTP status code, some response headers and a response body.

We’ll have the same shape of response whether we got an error in an early middleware (e.g. due to a missing access token in the `AuthorizationHeader` middleware), or if the `Create` middleware successfully created a customer and wants to render it back

```ruby
module SimpleMiddleware
  class Middleware
    # @param [#call] the next middleware in the chain, which can be anything
    #   that responds to #call, accepting the current state, an
    #   `Immutable::Hash`, as a parameter
    def initialize(next_middleware)
      @next_middleware = next_middleware
    end

    # Runs the middleware, either returning a result (probably a Rack response)
    # or calling the next middleware in the chain, giving it the opportunity to
    # return a result
    #
    # @param [Immutable::Hash] the current state
    def call(state)
      raise NotImplementedError
    end

    private

    attr_reader :next_middleware

    def render(status:, headers: [], body: nil)
      [status, headers, body]
    end
  end
end
```

So, we've seen what the interface looks like - that is, how we use Simple Middleware.

Now, let's take a look at how the middleware pattern is actually implemented. The base middleware class itself is super simple.

We've talked about how a middleware can do two things - return a response, or call the next middleware and give it a chance to return a response.

A middleware in the pipeline gets initialised with the next middleware in the chain after it, so it knows what the next middleware is, and call it if it wants to.

```ruby
module SimpleMiddleware
  class Middleware
    # @param [#call] the next middleware in the chain, which can be anything
    #   that responds to #call, accepting the current state, an
    #   `Immutable::Hash`, as a parameter
    def initialize(next_middleware)
      @next_middleware = next_middleware
    end

    # Runs the middleware, either returning a result (probably a Rack response)
    # or calling the next middleware in the chain, giving it the opportunity to
    # return a result
    #
    # @param [Immutable::Hash] the current state
    def call(state)
      raise NotImplementedError
    end

    private

    attr_reader :next_middleware

    def render(status:, headers: [], body: nil)
      [status, headers, body]
    end
  end
end
```

It’s up to each middleware class to define a `#call` method.

That method can use the state, and then it has two options. It can either return a response, or call on the next middleware, passing it the state, which it can add something to along the way.

```
def create
  response = SimpleMiddleware.call(initial_state: { request: request,
                                                    params: params },
                                   middlewares: [Middleware::AuthorizationHeader,
                                                 Middleware::AccessToken,
                                                 Create])

  render_rack_response(response)
end
```

Thinking back to our example, we put together a pipeline of three middleware. Each middleware can perform a single job, and they can work together to handle the request.

Our pipeline gets run through in the order we specify. This is important, as some middleware can depend on others. For example, our access token middleware will depend on the access token provided by the authorization header middleware.

We want to parse the Authorization header, then we want to look up the access token, and then finally we want to run the action-specific logic.

```
#<Middleware::AuthorizationHeader @next_middleware=
  #<Middleware::AccessToken @next_middleware=
   #<Create @next_middleware=nil>
  >
>
```

Now we’re thinking in terms of middleware, that means that the authorization header middleware is the outer middleware. Each middleware in the chain knows which middleware is next. It does its work, generates the new state, and then calls the next middleware with it.

They are stacked together a bit like a Russian doll.

```ruby
require "immutable/hash"

module SimpleMiddleware
  # Runs a chain of middlewares with the provided initial state, returning the
  # result of the chain of middlewares
  #
  # @param [Hash, Immutable::Hash] the initial state to be passed into the chain of
  #   middlewares
  # @param [Array<SimpleMiddleware::Middleware>] the middlewares to be run
  def self.call(initial_state: {}, middlewares:)
    middleware_chain = middlewares.reverse.reduce(nil) do |next_middleware, middleware|
      middleware.new(next_middleware)
    end

    middleware_chain.call(Immutable::Hash.new(initial_state))
  end
end
```

The code to put together our pipeline of middleware and run through them is simple too.

It takes the list of middleware passed in, and then stacks them into a pipeline, where each middleware knows the next one in the pipeline.

```ruby
require "immutable/hash"

module SimpleMiddleware
  # Runs a chain of middlewares with the provided initial state, returning the
  # result of the chain of middlewares
  #
  # @param [Hash, Immutable::Hash] the initial state to be passed into the chain of
  #   middlewares
  # @param [Array<SimpleMiddleware::Middleware>] the middlewares to be run
  def self.call(initial_state: {}, middlewares:)
    middleware_chain = middlewares.reverse.reduce(nil) do |next_middleware, middleware|
      middleware.new(next_middleware)
    end

    middleware_chain.call(Immutable::Hash.new(initial_state))
  end
end
```

Once we've built our chain, we can just call the #call method on the first one, passing in our initial state,

```ruby
require "immutable/hash"

module SimpleMiddleware
  # Runs a chain of middlewares with the provided initial state, returning the
  # result of the chain of middlewares
  #
  # @param [Hash, Immutable::Hash] the initial state to be passed into the chain of
  #   middlewares
  # @param [Array<SimpleMiddleware::Middleware>] the middlewares to be run
  def self.call(initial_state: {}, middlewares:)
    middleware_chain = middlewares.reverse.reduce(nil) do |next_middleware, middleware|
      middleware.new(next_middleware)
    end

    middleware_chain.call(Immutable::Hash.new(initial_state))
  end
end
```

Then that state can cascade down through the pipeline.

```ruby
def create
  response = SimpleMiddleware.call(initial_state: { request: request,
                                                    params: params },
                                   middlewares: [Middleware::AuthorizationHeader,
                                                 Middleware::AccessToken,
                                                 Create])

  render_rack_response(response)
end
```

Let’s just go through what happens when we call our pipeline of middleware.

```
#<Middleware::AuthorizationHeader @next_middleware=
  #<Middleware::AccessToken @next_middleware=
   #<Create @next_middleware=nil>
  >
>
```

First, the Authorization header middleware gets called.

It might return an error, for example if there's no Authorization header, in which case our pipeline stops.

Otherwise, we'll call the next middleware, passing on the access token we've just pulled out of the header.

```
#<Middleware::AuthorizationHeader @next_middleware=
  #<Middleware::AccessToken @next_middleware=
   #<Create @next_middleware=nil>
  >
>
```

Now we’re in the access token middleware.

It might return an error if the access token doesn’t exist, in which case our pipeline stops.

Otherwise, we’ll call the next middleware, our endpoint-specific code, passing in the user we’ve just found.

```
#<Middleware::AuthorizationHeader @next_middleware=
  #<Middleware::AccessToken @next_middleware=
   #<Create @next_middleware=nil>
  >
>
```

Finally, we'll try to create the customer attached to the authenticated user, using the request parameters. This middleware will return our final HTTP response.

https://github.com/timrogers/simple_middleware

That’s how simple_middleware works - as you can see, it’s pretty simple and there’s very little code. You’ll find the full source on GitHub.

Now it’s time for what we’ve all been waiting for - let’s refactor our API using middleware.

We’ll write our new middleware, plus unit tests so we can see how testable they are.

https://github.com/timrogers/simple_middleware_example

You'll be able to download the code for this at the end, so don't worry about following along too closely.

```ruby
class CustomersController < ApplicationController
  before_action :check_authorization_header
  before_action :check_access_token

  def create
    customer = Customer.new(customer_params.merge(user: @user))

    if customer.save
      render json: customer
    else
      render json: { errors: customer.errors.full_messages }, status: 422
    end
  end

  private

  def customer_params
    params.require(:data).permit(:email, :iban)
  end
end
```

So, let’s think back to our original controller from the beginning.

We want to refactor our two filters into middleware, using Simple Middleware.

```ruby
class CustomersController < ApplicationController
  before_action :check_authorization_header
  before_action :check_access_token

  def create
    customer = Customer.new(customer_params.merge(user: @user))

    if customer.save
      render json: customer
    else
      render json: { errors: customer.errors.full_messages }, status: 422
    end
  end

  private

  def customer_params
    params.require(:data).permit(:email, :iban)
  end
end
```

We'll then also rewrite the `create` method as a middleware too, to go at the end of the pipeline. We write this as a middleware rather than keeping it in the controller action for consistency.

```ruby
class CustomersController < ApplicationController
  before_action :check_authorization_header
  before_action :check_access_token

  def create
    customer = Customer.new(customer_params.merge(user: @user))

    if customer.save
      render json: customer
    else
      render json: { errors: customer.errors.full_messages }, status: 422
    end
  end

  private

  def customer_params
    params.require(:data).permit(:email, :iban)
  end
end
```

Let’s start by refactoring the “check authorization header” filter.

We’ll turn that to a middleware and add unit tests.

```ruby
class API::AuthorizationHeader < SimpleMiddleware::Middleware
  def call(state)
    # ...
  end
end
```

The fundamentals of a middleware are simple.

We have a class that inherits from `SimpleMiddleware::Middleware`, and defines a `#call` method which expects to be passed the current state.

The `#call` method can access the next middleware in the chain, and can either call it or return a response itself.

```ruby
def create
  response = SimpleMiddleware.call(initial_state: { request: request,
                                                    params: params },
                                   middlewares: [Middleware::Locale,
                                                 Middleware::AuthorizationHeader,
                                                 Middleware::AccessToken,
                                                 Create])

  render_rack_response(response)
end
```

Thinking back to the controller where we build our pipeline, as part of the initial state, we pass in the Rails request object, as well as the request parameters

```ruby
def call(state)
  header_value = state[:request].headers["HTTP_AUTHORIZATION"]

  # ...
end
```

That exposes the HTTP headers, so we can grab the value of the Authorization header as before.

```
def call(state)
  header_value = state[:request].headers["HTTP_AUTHORIZATION"]

  return missing_access_token_error unless header_value.present?
  token_type, token = header_value.split(" ", 2)
  return missing_access_token_error unless token_type == "Bearer"

  # ...
end

private

def missing_access_token_error
  render status: 401,
         headers: { "Content-Type" => "application/json" },
         body: JSON.generate(errors: [I18n.t("errors.missing_access_token")])
end
```

Now we check the header, just as we did before, and return an error if the header doesn’t look right.

```ruby
def call(state)
  header_value = state[:request].headers["HTTP_AUTHORIZATION"]

  return missing_access_token_error unless header_value.present?
  token_type, token = header_value.split(" ", 2)
  return missing_access_token_error unless token_type == "Bearer"

  # ...
end

private

def missing_access_token_error
  render status: 401,
         headers: { "Content-Type" => "application/json" },
         body: JSON.generate(errors: [I18n.t("errors.missing_access_token")])
end
```

SimpleMiddleware defines a `render` method. It’s just a simple helper…

```
[
  401,
  { "Content-Type" => "application/json" },
  "{\"errors\":[\"Missing access token\"]}"
]
```

…that returns a Rack response, which is an array with a status code, response headers and response body.

```
def create
  response = SimpleMiddleware.call(initial_state: { request: request,
                                                    params: params },
                                   middlewares: [Middleware::AuthorizationHeader,
                                                 Middleware::AccessToken,
                                                 Create])

  render_rack_response(response)
end
```

In our controller, we take that and render it back to the user.

```ruby
def call(state)
  header_value = state[:request].headers["HTTP_AUTHORIZATION"]

  return missing_access_token_error unless header_value.present?
  token_type, token = header_value.split(" ", 2)
  return missing_access_token_error unless token_type == "Bearer"

  new_state = state.put(:access_token, token)
  next_middleware.call(new_state)
end
```

What about the case where there's an access token in the header, and we don't need to return an error?

We want to pass the access token we've found on to the next middleware in the chain, so it can check that that token is valid.

We add the access token to the state…

```
Immutable::Hash[
 :access_token => "your_access_token",
 :request => #<ActionDispatch::Request>,
 :params => #<ActionController::Parameters>
]
```

So our new state has three things in it: the initial state from before, so the request and the parameters, plus the access token that we've just added.

```ruby
def call(state)
  header_value = state[:request].headers["HTTP_AUTHORIZATION"]

  return missing_access_token_error unless header_value.present?
  token_type, token = header_value.split(" ", 2)
  return missing_access_token_error unless token_type == "Bearer"

  new_state = state.put(:access_token, token)
  next_middleware.call(new_state)
end
```

…and then we call the next middleware, passing in the new state.

The next middleware will be responsible for checking if the access token exists.

```ruby
require "rails_helper"

RSpec.describe Middleware::AuthorizationHeader do
  # ...
end
```

The beauty of the middleware pattern is what we can write simple unit tests, passing in the initial state and a fake “next middleware”, and then check what is returned, or whether the next middleware gets called.

```ruby
subject(:instance) { described_class.new(next_middleware) }
let(:next_middleware) { double(call: true) }

let(:state) { Immutable::Hash.new(request: request) }
let(:headers) { {} }
let(:request) do
  instance_double(ActionDispatch::Request, headers: headers)
end
```

First, let’s look at the setup we need for our tests.

The subject of our tests is an instance of the middleware. When we instantiate a middleware, we pass in the next middleware in the pipeline.

```ruby
subject(:instance) { described_class.new(next_middleware) }
let(:next_middleware) { double(call: true) }

let(:state) { Immutable::Hash.new(request: request) }
let(:headers) { {} }
let(:request) do
  instance_double(ActionDispatch::Request, headers: headers)
end
```

The next middleware here for our tests is just a “test double".

Basically, it’s just a fake object with a “call” method which does nothing

In our tests, we can check that the middleware passes on to the next middleware in the chain by setting an expectation that that method should be called.

We’ll see that in a couple of seconds.

```
let(:instance) { described_class.new(next_middleware) }
let(:next_middleware) { double(call: true) }

let(:state) { Immutable::Hash.new(request: request) }
let(:headers) { {} }
let(:request) do
  instance_double(ActionDispatch::Request, headers: headers)
end
```

Our initial state is just a fake Rails request. The middleware will refer to this to grab the Authorization header.

You might remember that in our controller, we passed in the request *and* the parameters object. We won't do that here, as this middleware doesn't need the params. We might as well just pass in the bare minimum state required.

```ruby
context "with no Authorization header" do
  let(:headers) { {} }

  it "renders an error" do
    expect(instance.call(state)).to eq([
      401,
      { "Content-Type" => "application/json" },
      "{\"errors\":[\"Missing access token\"]}"
    ])
  end
end
```

Let’s write our first spec: the case when there’s no Authorization header.

We pass in the initial state - a request with no headers - and check what is returned: a 401 error with the correct body and response headers. This return value is a Rack response - an array with a status code, response headers and response body.

```
context "with an invalid Authorization header" do
  let(:headers) { { "HTTP_AUTHORIZATION" => "foo bar" } }

  it "renders an error" do
    expect(instance.call(state)).to eq([
      401,
      { "Content-Type" => "application/json" },
      "{\"errors\":[\"Missing access token\"]}"
    ])
  end
end
```

The case where the header isn’t structured correctly is very similar. We pass in some state - this time, a wrongly-formatted Authorization header - and check that the right error is returned.

```
context "with a correctly-structured Authorization header" do
  let(:headers) { { "HTTP_AUTHORIZATION" => "Bearer your_access_token" } }

  it "calls the next middleware, passing on the access token" do
    expect(next_middleware).to receive(:call).
      with(Immutable::Hash.new(request: request,
                               access_token: "your_access_token"))

    instance.call(state)
  end
end
```

The final case we need to test is where the Authorization header is present and valid.

In that case, we want to make sure that the next middleware in the chain is called, and is passed the original state, plus the access token that has been pulled out from the header.

We set an expectation to say that the next middleware should be called with the correct parameters.

```
context "with a correctly-structured Authorization header" do
  let(:headers) { { "HTTP_AUTHORIZATION" => "Bearer your_access_token" } }

  it "calls the next middleware, passing on the access token" do
    expect(next_middleware).to receive(:call).
      with(Immutable::Hash.new(request: request,
                               access_token: "your_access_token"))

    instance.call(state)
  end
end
```

We don’t expect anything to be returned - that’s the job of the next middleware in the chain.

```ruby
class Middleware::AccessToken < SimpleMiddleware::Middleware
  def call(state)
    user = User.find_by(access_token: state[:access_token])

    return invalid_access_token_error unless user.present?

    next_middleware.call(state.put(:user, user))
  end

  private

  def invalid_access_token_error
    # ...
  end
end
```

Now, let’s go build the access token middleware, the next one in the chain.

We’ll go through this one a bit more quickly, since we’ve already seen an example.

```ruby
class Middleware::AccessToken < SimpleMiddleware::Middleware
  def call(state)
    user = User.find_by(access_token: state[:access_token])

    return invalid_access_token_error unless user.present?

    next_middleware.call(state.put(:user, user))
  end

  private

  def invalid_access_token_error
    # ...
  end
end
```

We pull out the access token from the state, which has been added by the “authorization header” middleware, and we look for a user with a matching access token.

```ruby
class Middleware::AccessToken < SimpleMiddleware::Middleware
  def call(state)
    user = User.find_by(access_token: state[:access_token])

    return invalid_access_token_error unless user.present?

    next_middleware.call(state.put(:user, user))
  end

  private

  def invalid_access_token_error
    # ...
  end
end
```

If there’s a match, we call the next middleware, passing on the authenticated user.

```ruby
class Middleware::AccessToken < SimpleMiddleware::Middleware
  def call(state)
    user = User.find_by(access_token: state[:access_token])

    return invalid_access_token_error unless user.present?

    next_middleware.call(state.put(:user, user))
  end

  private

  def invalid_access_token_error
    # ...
  end
end
```

If there isn’t a match, we return an error.

```ruby
require "rails_helper"

RSpec.describe Middleware::AccessToken do
  let(:instance) { described_class.new(next_middleware) }
  let(:next_middleware) { double(call: true) }

  let(:state) { Immutable::Hash.new(access_token: access_token) }

  # ...
end
```

The specs for our second middleware have pretty much the same setup as the first one.

We set up our middleware instance, passing in a dummy “next middleware”, and build the state. This middleware only needs an access token, so we only pass that in.

So, what cases do we need to test? We want to test when the access token does exist, and when there isn’t a match.

```ruby
context "with a non-existent access token" do
  let(:access_token) { "dummy_access_token" }

  it "renders an error" do
    expect(instance.call(state)).to eq([
      401,
      { "Content-Type" => "application/json" },
      "{\"errors\":[\"Invalid access token\"]}"
    ])
  end
end
```

We’ll start with the sad path, giving a non-existent access token, and checking that the right error is returned.

```
context "with a valid access token" do
  let(:user) { FactoryBot.create(:user) }
  let(:access_token) { user.access_token }

  it "calls the next middleware, passing on the user” do
    expect(next_middleware).to receive(:call).
      with(Immutable::Hash.new(access_token: access_token, user: user))

    instance.call(state)
  end
end
```

And then we’ll test the case where the access token is valid.

We expect to hand off to the next middleware in the chain, passing in the authenticated user.

```
def create
  response = SimpleMiddleware.call(initial_state: { request: request,
                                                    params: params },
                                   middlewares: [Middleware::AuthorizationHeader,
                                                 Middleware::AccessToken,
                                                 Create])

  render_rack_response(response)
end
```

All we have left to re-write is our action-specific code, as our `Create` middleware.

```ruby
class Create < SimpleMiddleware::Middleware
  def call(state)
    customer_params = build_customer_params(state)
    customer = Customer.new(customer_params)

    # ...
  end
end
```

Here, we want to build a customer, try to save it, and then either render back the created customer, or return an error.

We use the state to build the customer attributes. What does that look like?

```ruby
def build_customer_params(state)
  state[:params].
    require(:data).
    permit(:email, :iban).
    merge(user: state[:user])
end
```

In the state, we have the parameters and the authenticated user.

```ruby
def build_customer_params(state)
  state[:params].
    require(:data).
    permit(:email, :iban).
    merge(user: state[:user])
end
```

We pull out the “email” and “IBAN” from the request parameters

```ruby
def build_customer_params(state)
  state[:params].
    require(:data).
    permit(:email, :iban).
    merge(user: state[:user])
end
```

…and then we merge in the authenticated user, so the customer will belong to them.

```
 def call(state)
  customer_params = build_customer_params(state)
  customer = Customer.new(customer_params)

  if customer.save
    render status: 201,
           headers: { "Content-Type" => "application/json" },
           body: customer.to_json
  else
    render status: 422,
           headers: { "Content-Type" => "application/json" },
           body: JSON.generate(errors: customer.errors.full_messages)
  end
end
```

Having built the customer, we try to save it

```ruby
def call(state)
 customer_params = build_customer_params(state)
 customer = Customer.new(customer_params)

 if customer.save
   render status: 201,
          headers: { "Content-Type" => "application/json" },
          body: customer.to_json
 else
   render status: 422,
          headers: { "Content-Type" => "application/json" },
          body: JSON.generate(errors: customer.errors.full_messages)
 end
end
```

If that’s successful, we render the created customer

```ruby
def call(state)
 customer_params = build_customer_params(state)
 customer = Customer.new(customer_params)

 if customer.save
   render status: 201,
          headers: { "Content-Type" => "application/json" },
          body: customer.to_json
 else
   render status: 422,
          headers: { "Content-Type" => "application/json" },
          body: JSON.generate(errors: customer.errors.full_messages)
 end
end
```

If something goes wrong, we render back the validation errors.

```
def create
  response = SimpleMiddleware.call(initial_state: { request: request,
                                                    params: params },
                                   middlewares: [Middleware::AuthorizationHeader,
                                                 Middleware::AccessToken,
                                                 Create])

  render_rack_response(response)
end
```

Hooray! We have refactored our API using the middleware pattern.

https://github.com/timrogers/simple_middleware_example

As a reminder, the sample application we've just built is on GitHub - you'll find it at https://github.com/timrogers/simple_middleware_example

We've learnt to make APIs miles more maintainable with middleware

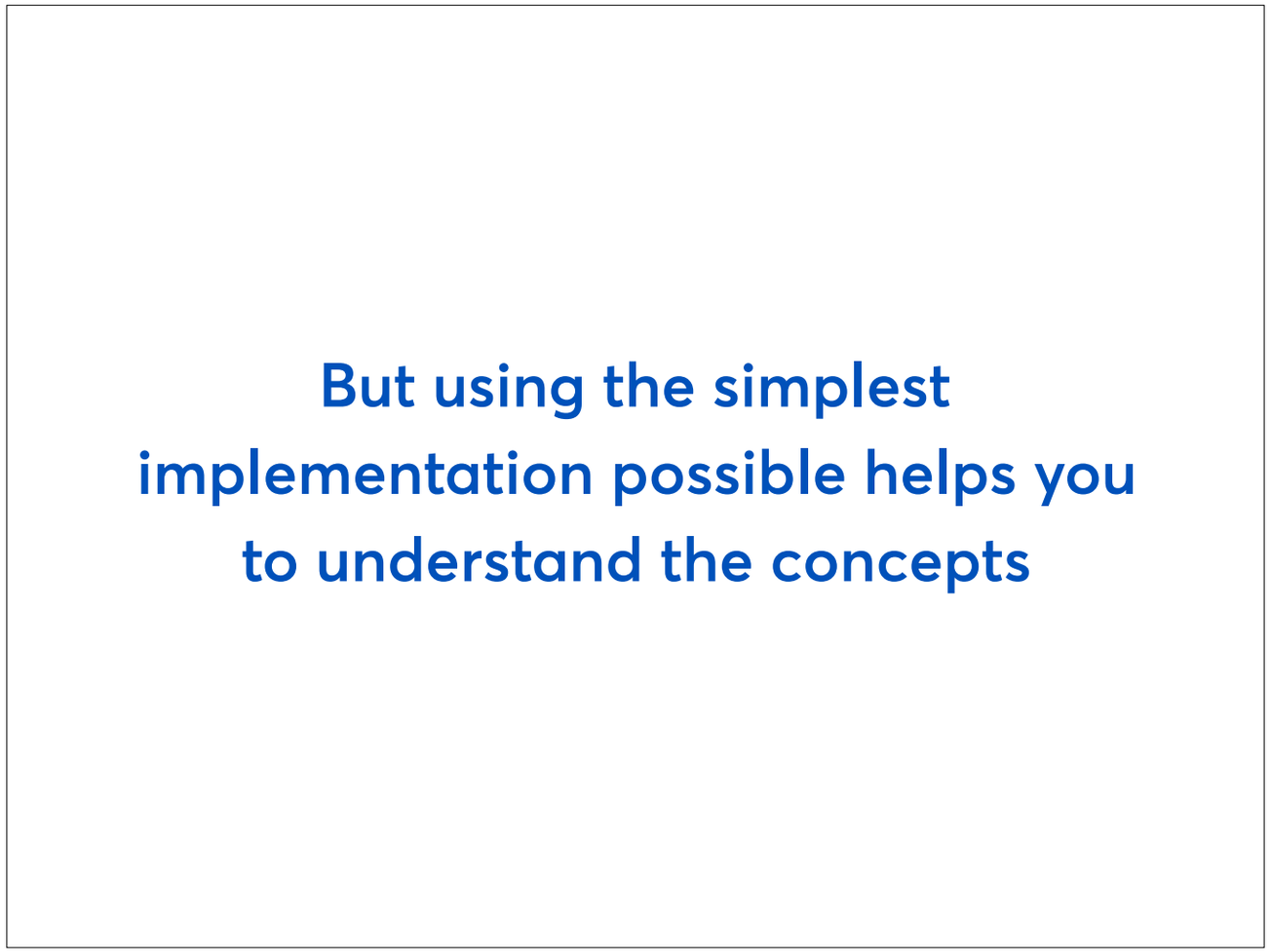
I'm convinced from my experience of using this pattern that it makes your code miles more maintainable

But I wouldn't use Simple Middleware

But I wouldn't actually use Simple Middleware

We can do way better in terms of developer experience

With a more fully-featured middleware library, we can make our APIs even more maintainable. Simple Middleware is missing a lot of sugar which can help to make the developer experience fantastic.



But using a really simple implementation of the middleware pattern helps us to understand the core principles, without getting distracted by more complicated features.

At GoCardless, we built Coach, a Ruby middleware library.

At GoCardless, we built Coach, a more fully-feature implementation of the pattern, with a bunch of extra features. I'll take you through just a few of them so you can see how good this can get.

```ruby
class Routes::Customers::Create < Coach::Middleware
  uses Middleware::AuthorizationHeader
  uses Middleware::AccessToken

  requires :user

  def call
    # ...
  end
end
```

Firstly, with Coach, middleware can *depend on* other middleware. This makes it easier to build your pipeline.

For example, here we define the action-specific code as a middleware, called Routes::Customers::Create

```
class Routes::Customers::Create < Coach::Middleware
  uses Middleware::AuthorizationHeader
  uses Middleware::AccessToken

  requires :user

  def call
    # ...
  end
end
```

and then we make it *depend on* our three other middleware.

```
GoCardless::Application.routes.draw do
  match "/customers",
        to: Coach::Handler.new(Routes::Customers::Create),
        via: :post
end
```

Making it work that way means we can hook our middleware pipeline straight into the Rails router, completely skipping Rails's controllers.

```ruby
class API::Middleware::AccessToken < Coach::Middleware
  requires :access_token
  provides :user

  def call
    user = validate_access_token!(access_token)
    return invalid_permissions_error unless user.scope == config[:scope]

    provide(user: user)
    next_middleware.call
  end
end

class Routes::Customers::Create < Coach::Middleware
  uses API::Middleware::AuthorizationHeader
  uses API::Middleware::AccessToken, required_permissions: "admin"

  requires :user

  def call
    # ...
  end
end
```

Middlewares can even be configured, making them even more adaptable and reusable.

When we depend on the middleware by calling the `uses` method, we can pass in configuration, which we can then refer to in the `#call` method. For example, here, we make the access token middleware configurable. You can now say what permission level the user has to have.

```ruby
class API::Middleware::AccessToken < Coach::Middleware
  requires :access_token
  provides :user

  def call
    user = validate_access_token!(access_token)

    provide(user: user)
    next_middleware.call
  end
end

class Routes::Customers::Create < Coach::Middleware
  uses API::Middleware::AuthorizationHeader
  uses API::Middleware::AccessToken

  requires :user

  def call
    # ...
  end
end
```

A middleware can define what data it passes on, and what data it needs.

This makes your code easier to follow.

Here, for example, we say that the access token middleware is responsible for finding the user, and that the create route *needs* a user.

```ruby
class Routes::Customers::Create < Coach::Middleware
  ~~uses API::Middleware::AuthorizationHeader~~
  ~~uses API::Middleware::AccessToken~~

  requires :user

  def call
    # ...
  end
end
```

This also gives us a really cool feature, which is a bit like static analysis.

When our application boots, it can check all of our middleware, and check that their dependencies are satisfied. For example, if I declared that my route needed to have a user, but I didn't have the middleware that provided it, then the application would error at boot, alerting me to the problem.

```
it { is_expected.to call_next_middleware }

it { is_expected.to respond_with_status(422) }
```

Finally, we have built-in test helpers - this makes it really easy to unit test your middleware in an elegant way, that is declarative rather than long and repetitive

https://github.com/gocardless/coach

If you’re a Ruby developer, or if you just want to take a look, you can find Coach on GitHub at https://github.com/gocardless/coach.

With it, you’ll find an example application and a blog post you can follow to get to grips with it.

So, what have we learned? We want our code to be as maintainable as possible

That is, we want it to be understandable, testable and reusable ✅

That is, we want it to be understandable, testable and reusable

Controllers quickly get out of control 🌪️

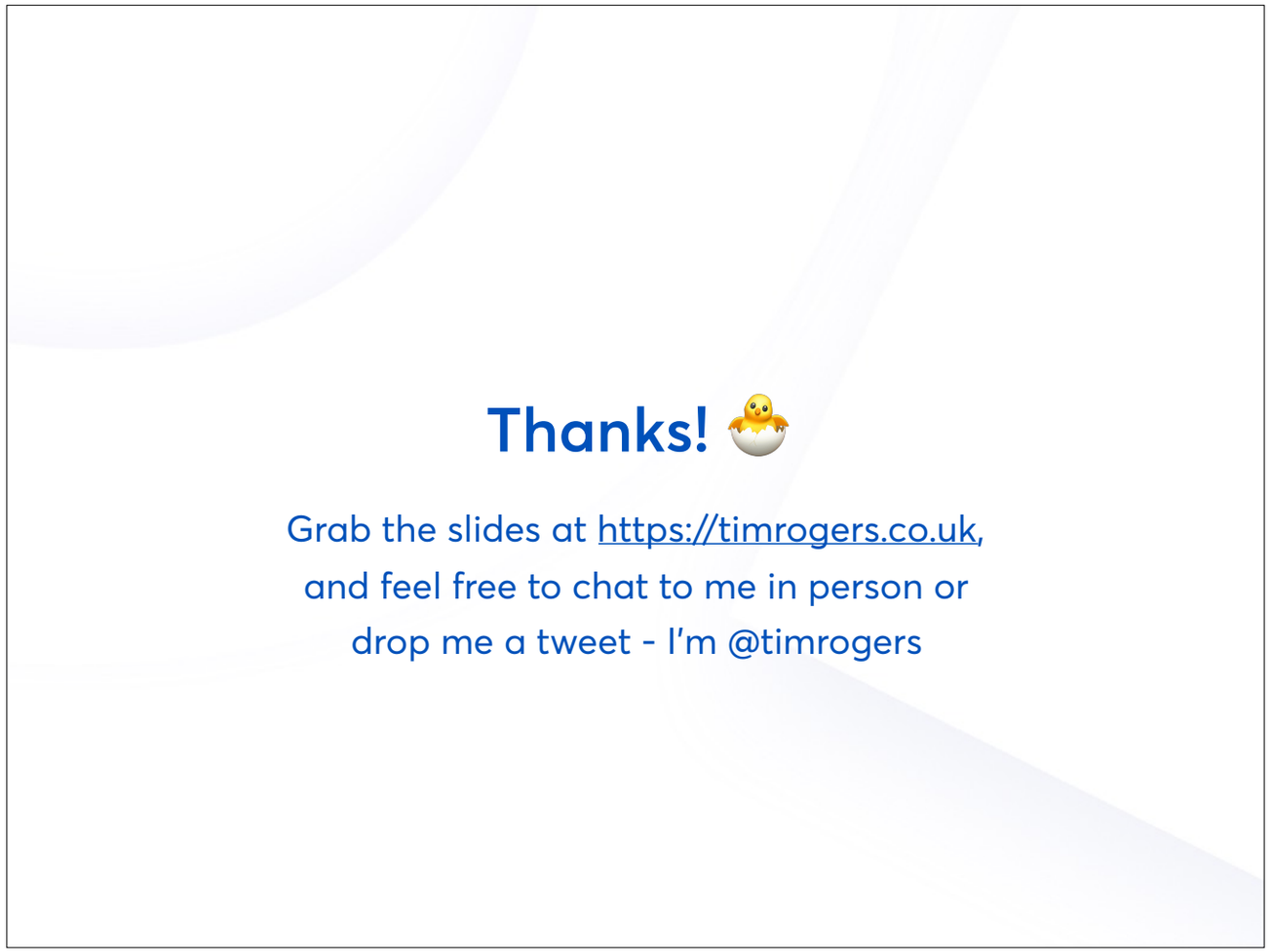
Controller filters quickly get out of control. We've seen with a real example how they lead to unmaintainable code.

The Single Responsibility Principle points us in the right direction, towards simple classes that do one thing

The middleware pattern is an example of the Single Responsibility Principle in action, and it can help us build better APIs.

We can move away from fat controllers to understandable, reusable and testable middleware

Simple Middleware helps us to understand how things work, but with Coach, you can really hit the ground running with the middleware pattern



Thanks so much for your time today, and I hope this talk has been interesting and useful.

You'll be able to find all the slides for this talk on my website. Just go to timrogers.co.uk and click "Speaking".

I'd love to hear what you think and will be hanging around to chat for the rest of the conference or you can tweet me - I'm @timrogers.