# Web Development Frameworks

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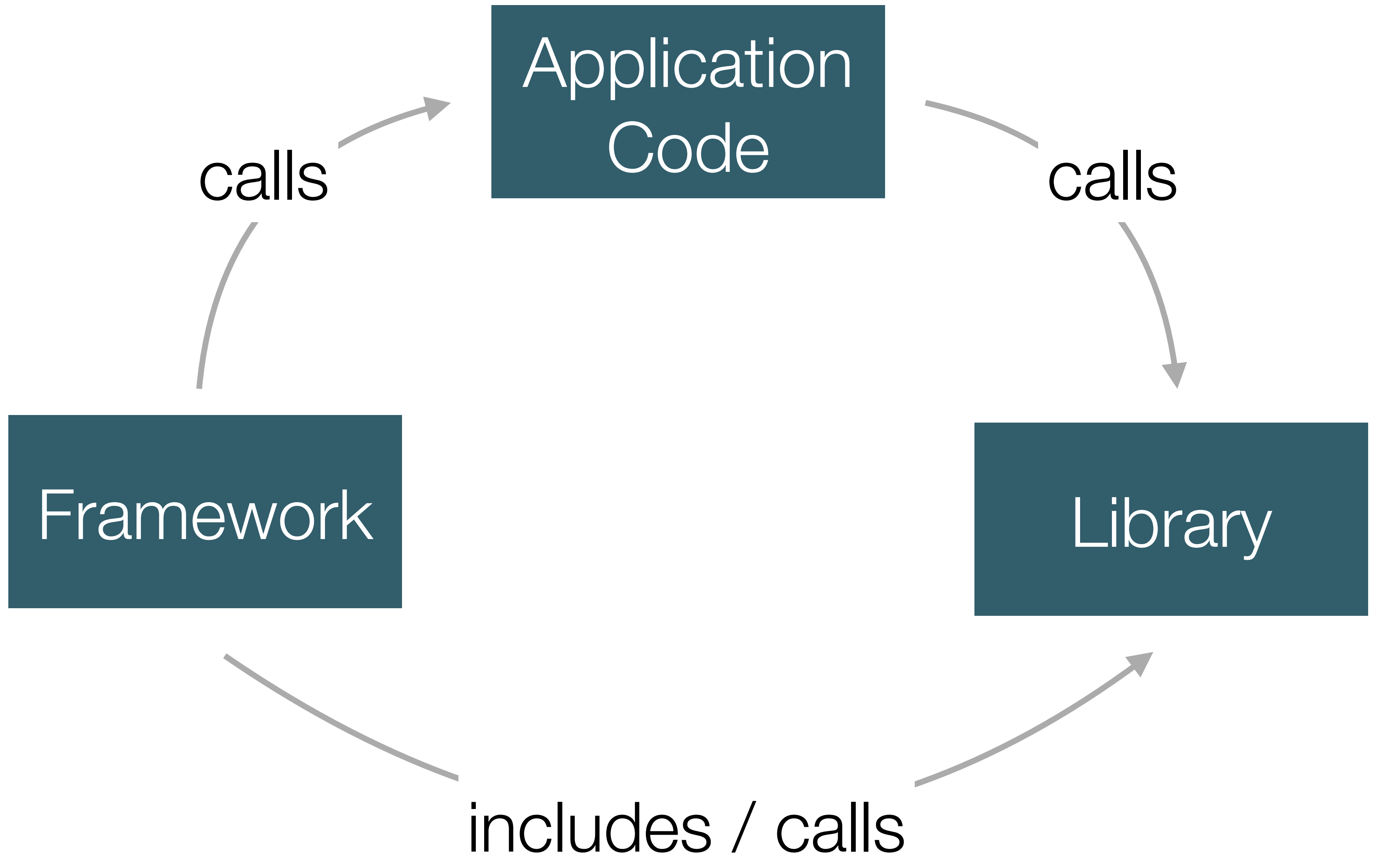
## Software Frameworks

- Software frameworks provide a generic software foundation over which custom application-specific code can be written.
- Software frameworks often include multiple libraries, in addition to tools and rules on how to structure and use these components.
- Libraries are used by the application-specific code to support specific features.
- Frameworks control the application flow and call application-specific code.

## Frameworks and Libraries



## Why Frameworks

- **Advantages?**
  - Implementation speed
  - Tested, proven solutions
  - Access to expertise and off-the-shelf solutions
  - Maintenance (i.e. updates, patches)
- **Disadvantages?**
  - Reduced independence
  - Lower performance
  - Dependence on external entities
  - Technological lock-in

## Choosing Frameworks

- **What to consider?**
  - Team expertise on language, libraries and framework
  - Existing code base
  - Licensing model
  - Maturity
  - Community support
  - …

## Web Development Frameworks

- Web development frameworks are designed to support the development of web applications, providing generic and integrated solutions to common use cases.

- These frameworks provide tools, libraries, and rules to address common tasks. Integration is central in contrast to the use of individual libraries.

- Currently, there is a big and diverse ecosystem of libraries and frameworks to support both backend and frontend development.

- Examples of libraries: jQuery, Bootstrap, Twig, PEAR DB.

- Examples of frameworks: ReactJS, Vue.js, Ruby on Rails, Django, Laravel.

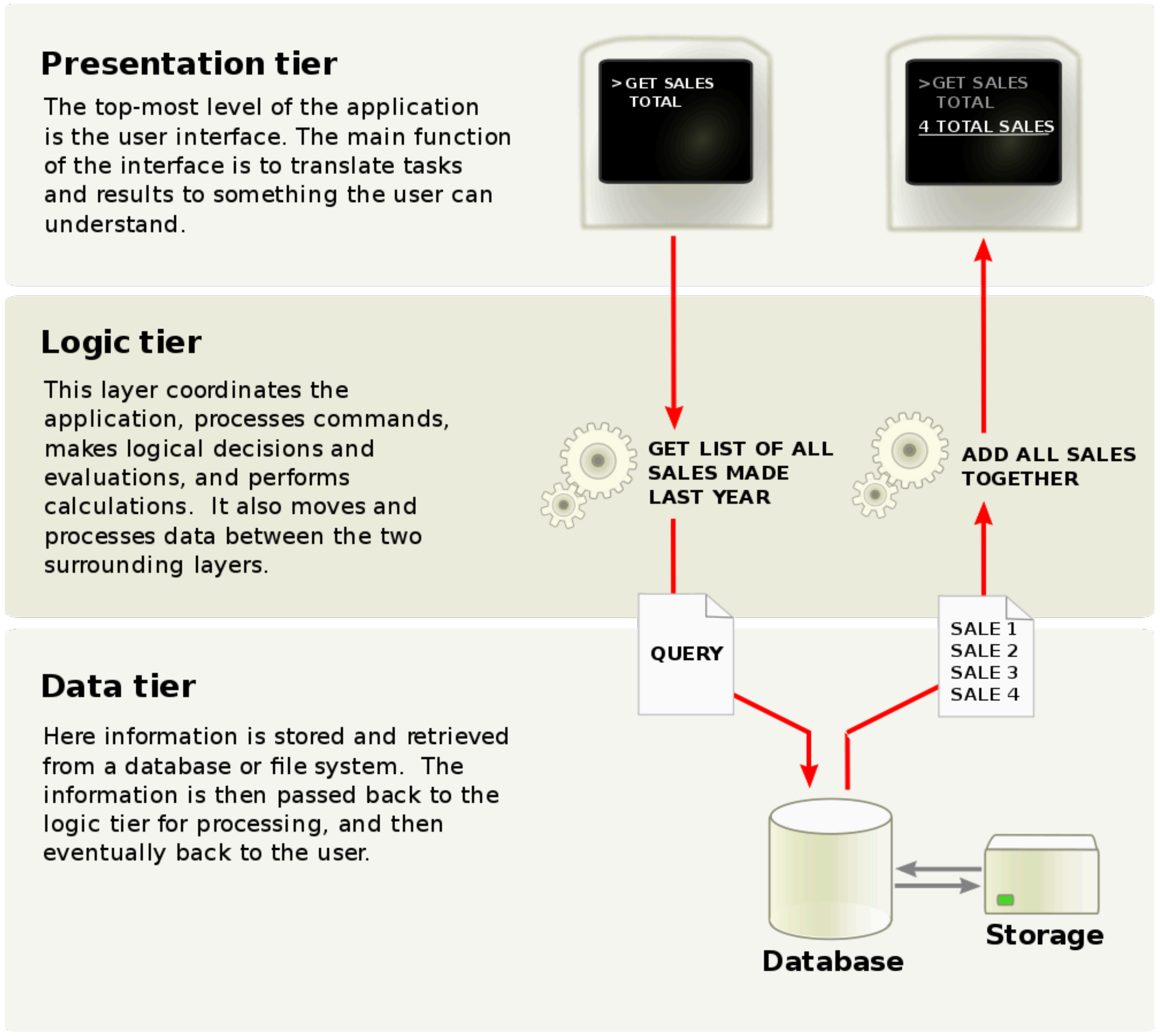
## History

- In 1993, the Common Gateway Interface (CGI) was designed to enable the communication between browsers and applications, i.e. "programs as web pages". First popular web development libraries were designed to support CGI.
- During the 90s there was a strong development of libraries targeted at common use cases, e.g. outputting HTML (templating), accessing data, interface with mail, managing user input, etc.
- In the early 2000s, the first modern full-stack server-side frameworks for web development started to appear, e.g. Drupal, Ruby on Rails, Symfony, Django.
- The growth of client-side supported web applications led to the development of multiple frontend libraries, e.g. jQuery, Mustache.
- More recently, full-stack client-side frameworks for web development emerged, e.g. ReactJS, AngularJS, Vue.js.

## Three-tier Architectures

- The Three-tier Architecture is a software architecture pattern commonly adopted in web applications.
  - Presentation tier — interface with the user; process user interactions; present views to the user.
  - Logic tier — coordinate the application; decide on the application flow; process data; move data between the two other layers.
  - Data tier — manage information; persist information; handle consistency; translate between physical models and conceptual model.

## Three-tier Architecture



**Presentation tier**

The top-most level of the application is the user interface. The main function of the interface is to translate tasks and results to something the user can understand.

**Logic tier**

This layer coordinates the application, processes commands, makes logical decisions and evaluations, and performs calculations. It also moves and processes data between the two surrounding layers.

**Data tier**

Here information is stored and retrieved from a database or file system. The information is then passed back to the logic tier for processing, and then eventually back to the user.

Source: https://en.wikipedia.org/wiki/Multitier_architecture

## Common Problems in Web Development

- **Common problems in web applications development?**
  - Handle access requests.
  - Manage interface components.
  - Access and manipulate data.

  - Session and authentication management.
  - Access control management.
  - Validating inputs.
  - Error handling.
  - Interacting with email systems.
  - …

## Server-side Frameworks

- Frameworks can be grouped in three types:
    - **Micro Frameworks** —focused on routing HTTP request to a callback, commonly used to implement HTTP APIs.
    - **Full-Stack Frameworks** — feature-full frameworks that includes routing, templating, data access and mapping, plus many more packages.
    - **Component Frameworks** — collections of specialized and single-purpose libraries that can be used together to make a a micro- of full-stack framework.

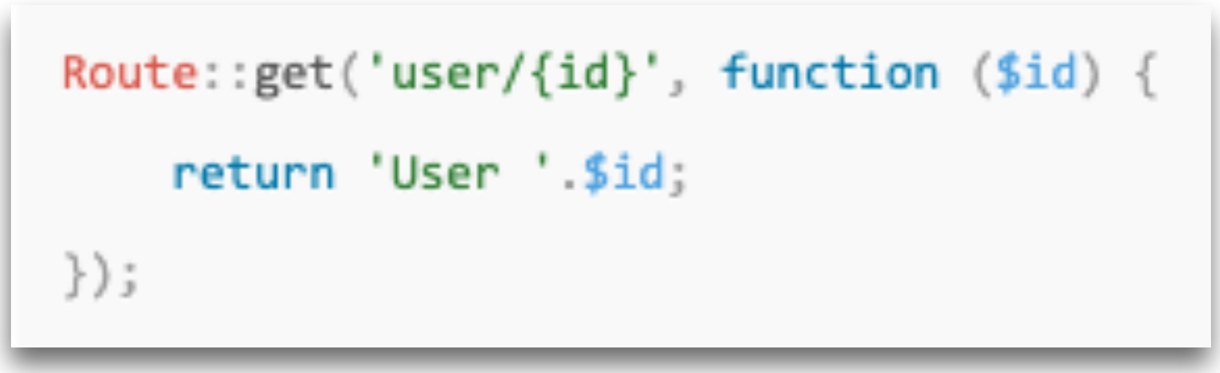
## Framework Components

- Core components
  - Request Routing — Match incoming HTTP requests to code.
  - Template Engine — Structure and separate presentation from logic.
  - Data Access — Uniform data access, mapping and configuration.
- Common components
  - Security — Protection agains common web security attacks.
  - Sessions — Session management and configuration.
  - Error Handling — Capture and manage application-level errors.
  - Scaffolding — Quickly generate CRUD interfaces based on data model.
  - …

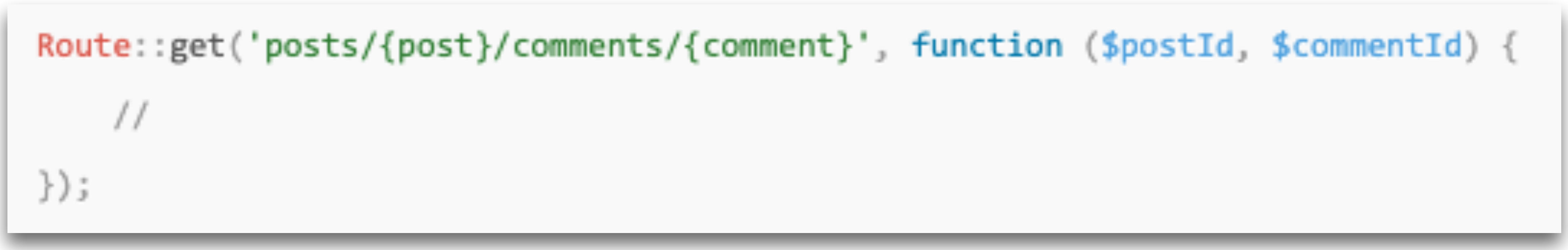
## Request Routing

- Request routing maps HTTP access requests to specific functions.
- URL design is handled independently from application code using request routing.
- Clean URLs (aka "friendly URLs") are an important part of a web application: usability, seo, technology independence, etc.
- https://sigarra.up.pt/feup/pt/cur_geral.cur_view?pv_curso_id=742
- https://sigarra.up.pt/feup/pt/curso/mieic

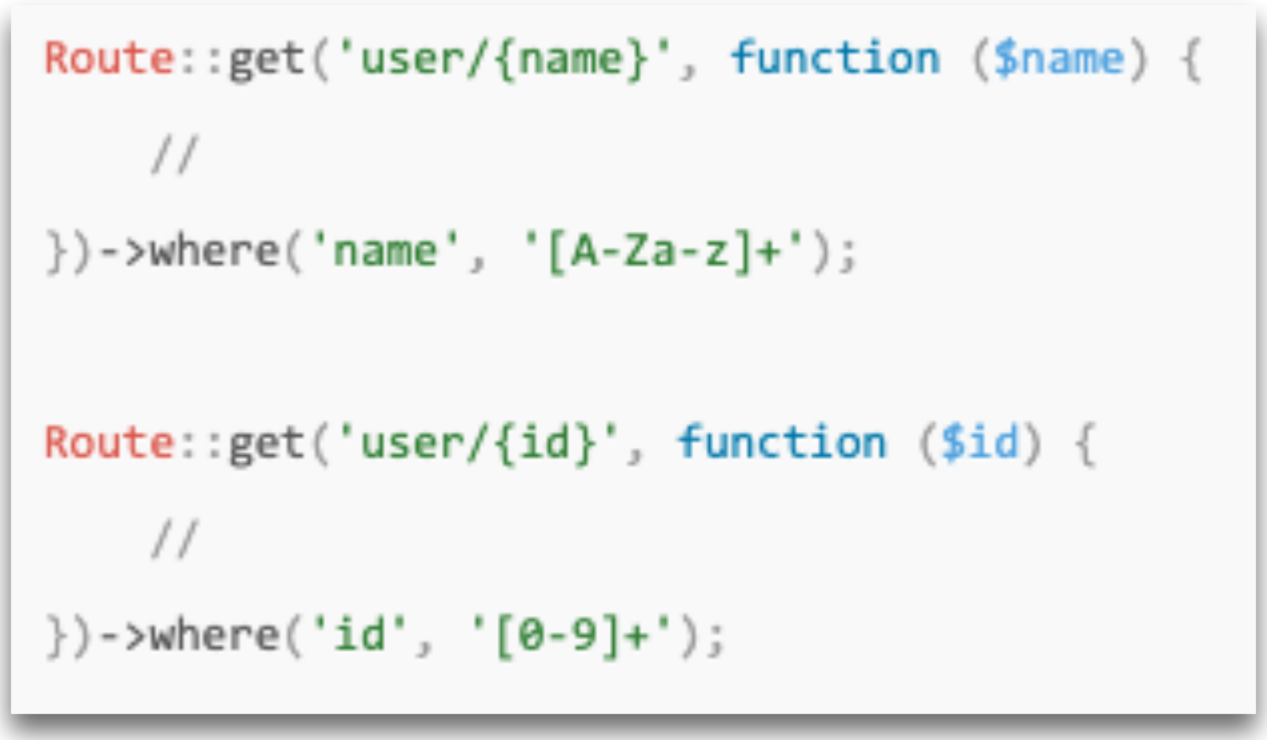
## Laravel Example



```php
Route::get('user/{id}', function ($id) {
    return 'User '.$id;
});
```



```php
Route::get('posts/{post}/comments/{comment}', function ($postId, $commentId) {
    //
});
```



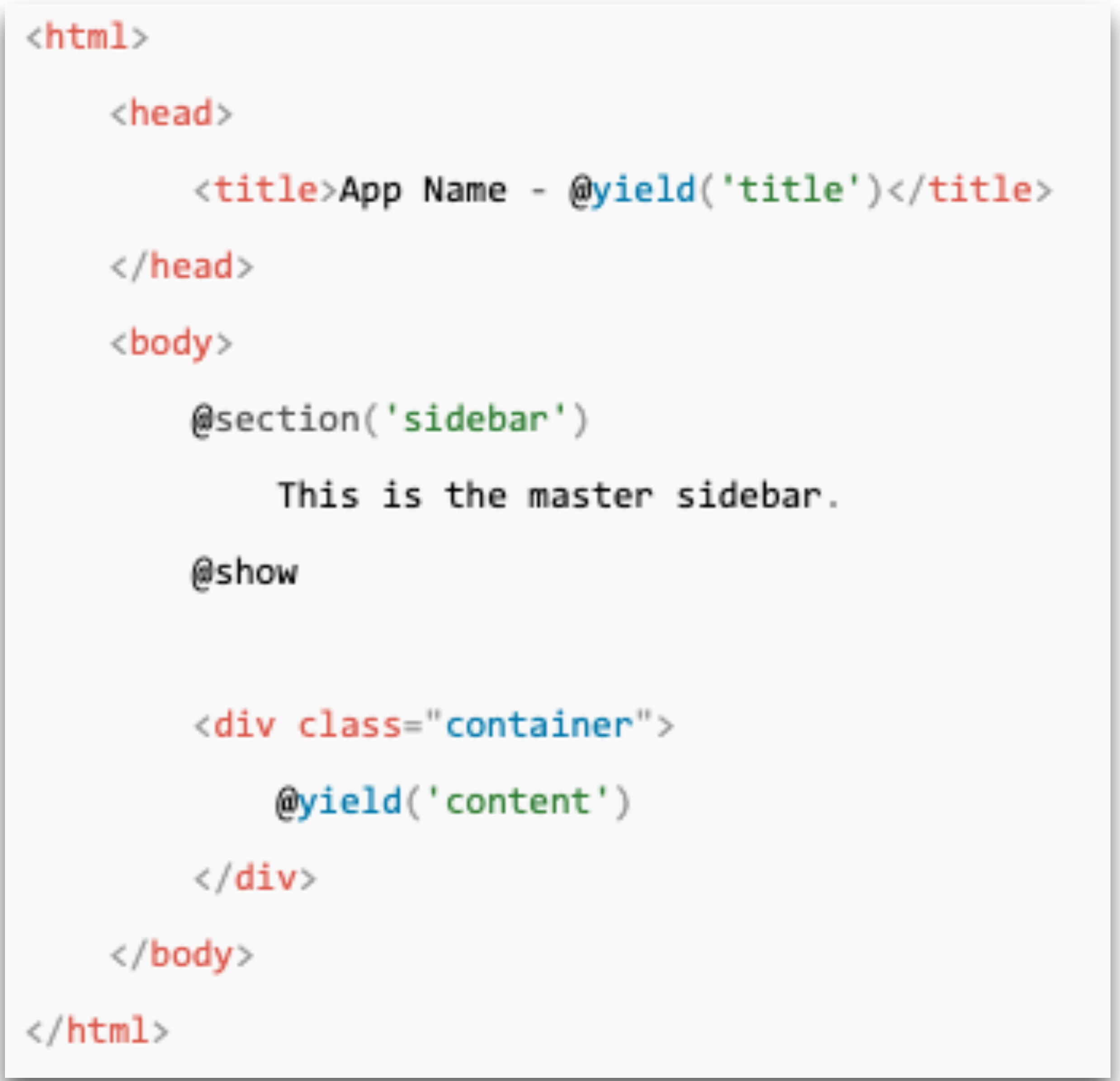
```php
Route::get('user/{name}', function ($name) {
    //
})->where('name', '[A-Za-z]+');

Route::get('user/{id}', function ($id) {
    //
})->where('id', '[0-9]+');
```

## Template Engines

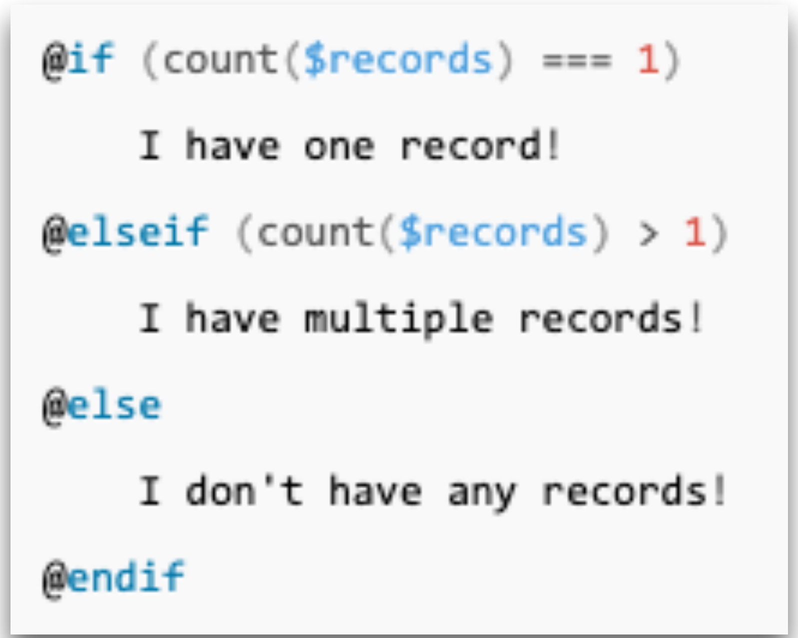
- Many of the first libraries for web development were template engines.
- Focused on the separation between presentation code and logic code.
- There are many independent libraries. Frameworks either use existing libraries or develop their own system.
- Notable solutions: Smarty (PHP), Blade (PHP), Jinja (Python), Mustache (*).

# Laravel Example (Blade)

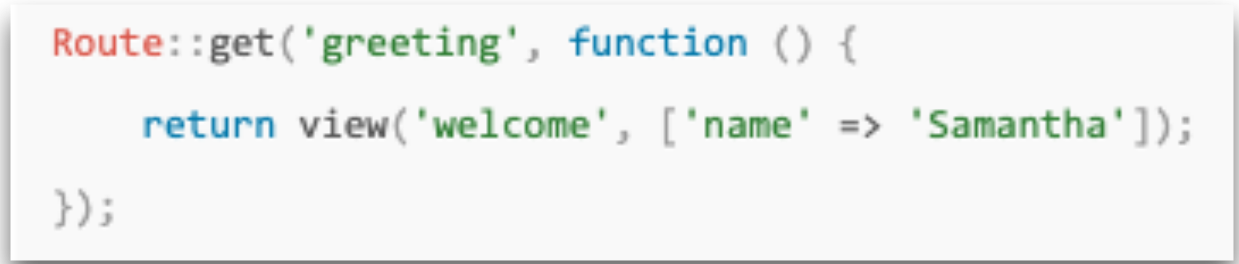


```
<html>
    <head>
        <title>App Name - @yield('title')</title>
    </head>
    <body>
        @section('sidebar')
            This is the master sidebar.
        @show

        <div class="container">
            @yield('content')
        </div>
    </body>
</html>
```



```
@if (count($records) === 1)
    I have one record!
@elseif (count($records) > 1)
    I have multiple records!
@else
    I don't have any records!
@endif
```



```
Route::get('greeting', function () {
    return view('welcome', ['name' => 'Samantha']);
});
```

## Data Access

- The data access layer can be managed with different levels of automatism and control.
- Data layer independence can be achieved using libraries that provide a uniform access to different technologies. Example: PHP PDO.
- A higher level of coupling can be achieved by providing access to data through a mapping between the underlying data structures and an object layer (ORM). Example: ActiveRecord (Laravel, RoR).
- This coupling between the data layer and the application’s data model can imply database migrations.

## Laravel Example (Eloquent)

```php
$user = DB::table('users')->where('name', 'John')->first();

echo $user->name;
```

```php
$users = DB::table('users')->count();

$price = DB::table('orders')->max('price');
```

```php
$users = DB::table('users')
                     ->select(DB::raw('count(*) as user_count, status'))
                     ->where('status', '<>', 1)
                     ->groupBy('status')
                     ->get();
```

## Notable Web Frameworks

RAILS

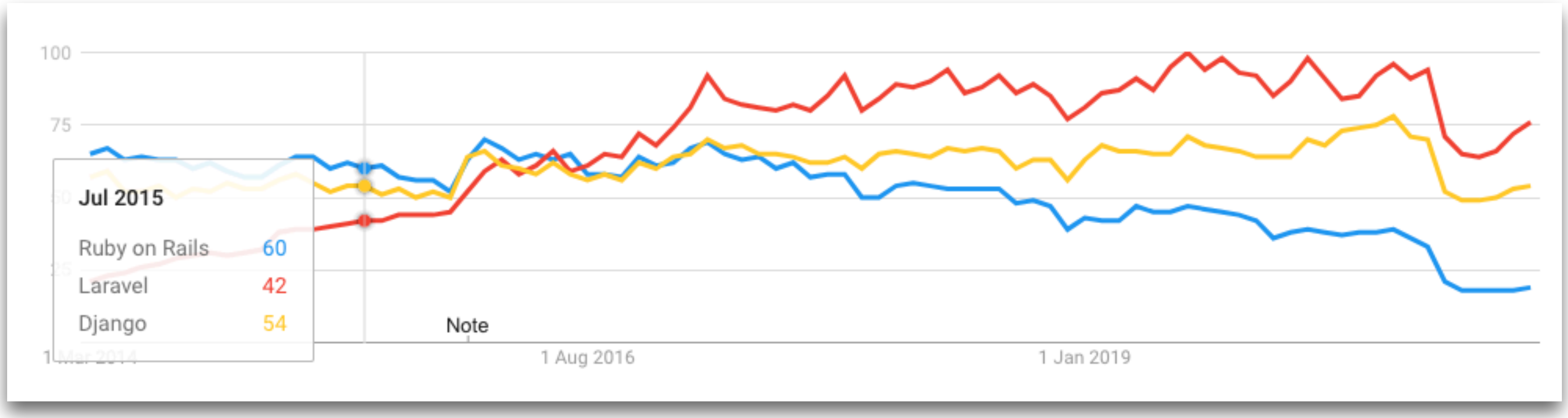
django

catalyst
Web Framework

spring®

https://en.wikipedia.org/wiki/Comparison_of_web_frameworks

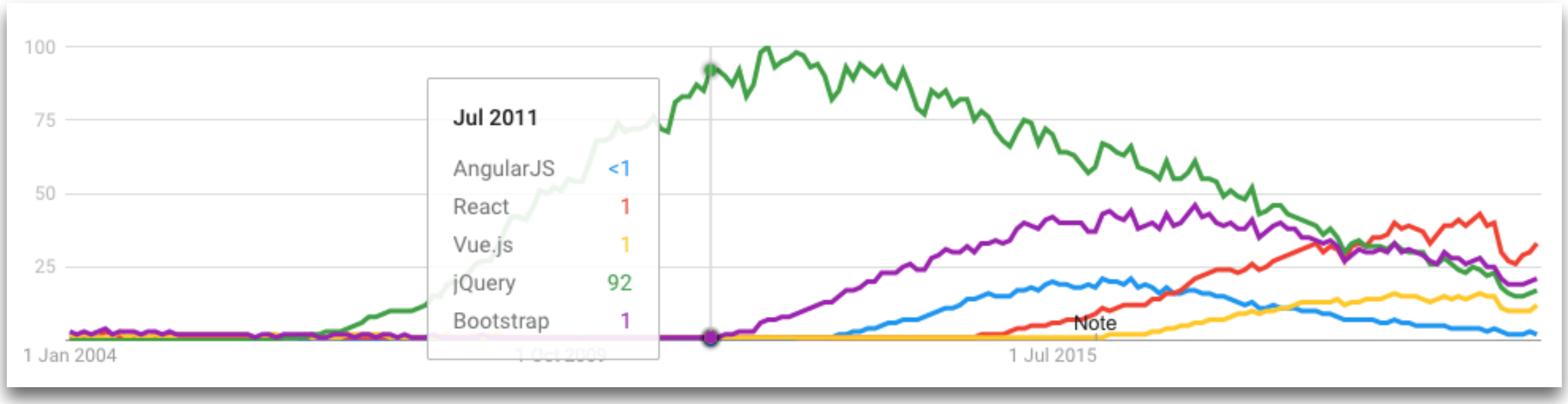
# Trends


100
75
Jul 2015
Ruby on Rails 60
Laravel 42
Django 54
Note
1 Mar 2014
1 Aug 2016
1 Jan 2019

## Client-side Frameworks

- Client-based web applications, rely on frontend technologies to manage both the Presentation and the Logic layers. In a nutshell, the current web page is dynamically manipulated instead of loading a new page.
- Single-page web applications (SPA) are an extreme example of this architecture. All application views are mapped to a single document.
- Frontend web frameworks typically adopt an MVC pattern (or variants) to support this architectural style, including: data-bindings, templates, routing.
- Most notable solutions: AngularJS (Google), React (Facebook), Vue.js.

## Trends



100
75
50
25
1 Jan 2004
1 Oct 2009
1 Jul 2015
Note
Jul 2011
AngularJS <1
React 1
Vue.js 1
jQuery 92
Bootstrap 1