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PJAXR - A new technology for stateful single-page applications

Bachelorarbeit

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Contents

1 Introduction

At the beginning of the World Wide Web websites were self-contained. The content which was initially loaded was not changed until a new URL was requested by the user. One big change was the invention of AJAX. It introduced the possibility to change content without the need of requesting a new URL. This approach only loading one website initially and then changing its content interactively is called single-page application. Single-page applications are more user-friendly than the common designs, e.g. due to lower load times in combination with not being able to indicate clearly that a new website is being loaded. A big disadvantage is that users are not able to save their websites as a bookmark, because while surfing on this page, the URL never changes. AJAX is available in nearly every browser which is a reason that a lot of different frameworks gain this functionality, improving and enhancing it.

Single-page applications have a problem in the current time: Search engines and other crawlers trying to examine websites will find nothing more than content which was provided initially. Every further change of content is not easily accessible. As Google is the most used search engine in the World Wide Web they have a design pattern[1] for implementing a crawlable AJAX web application. In this guideline it is recommended to have snapshots available under non-user-friendly URLs, called Hash-Bang URLs.

In this thesis we will evaluate the performance of a new technology called PJAXR. Together with Stephan Groß I developed this technique for using AJAX with it's advantages but trying to avoid the disadvantages explained before. The result of this cooperation is the frontend-side implementation called *jquery-pjaxr*. As PJAXR also needs a backend to be implemented, I developed the first PJAXR backend called *django-pjaxr*. Additionally in this thesis I will introduce a new PJAXR backend for PHP, *php-pjaxr* and *twig-pjaxr* an extension for the twig[2] template-engine.

1.1 Background and motivation

explain

1.2 Goals of this thesis

explain

1.3 Thesis outline

explain

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[1]https://developers.google.com/webmasters/ajax-crawling/docs/getting-started
[2]http://twig.sensiolabs.org/

2 Fundamentals

2.1 HTTP request

The world wide web has one main protocol to let web-browsers and web-servers communicate, the Hypertext Transfer Protocol (HTTP), which is built on top of the Transmission Control Protocol (TCP). TCP and so HTTP requests always start with a handshake to establish a connection before data is transferred. After this handshake, the client sends the request data to the web-server. This recognizes and interprets the request and if the requested resource is available, sends the according data back, otherwise it sends an error. Typically it renders data out of a database into a HTML-Template or to JSON and sends it back as the response. Afterwards the browser receives, interprets and displays the response data, which is most of the time HTML, CSS, images or scripts.

2.2 HTML

explain

2.3 Single-page application

explain

2.4 AJAX

explain

2.5 History API

explain

3 State of the art

AJAX is a widely used technique in the internet to build web applications because of the user experience improvements it brings. In [1] is mentioned that AJAX applications have a better usability than non-AJAX websites. The same conclusion is made in [2], despite of the lack of browser navigation support. Beside the navigation problem another disadvantage is, as presented in [3], crawling AJAX applications is not trivial. One solution of this task is finding clickables and navigating to every page found by this. Nevertheless [3] states also that this only generates a snapshot of the full application. Even search engines are avoiding to crawl websites because of it's difficulty.[4], page 81 Currently the task of building a crawlable single-page application using AJAX is often avoided, instead crawling algorithms are getting improved and in focus of research.

A common way to implement AJAX in websites is to use the pattern of HIJAX. It encourages developers to have AJAX in mind from the start of building the website. But when they start to implement the single-page application they should do not implement AJAX. This should only be done after the website is finished without AJAX. This could then be done by *hijacking* an event like a click to then handle it by an additional script.

3.1 HIJAX

explain

3.2 Hash-Bang URLs

explain

4 PJAXR

4.1 Introduction

explain

4.1.1 Requirements

The idea of PJAXR is to have the advantages of AJAX while trying to avoid it's disadvantages. This means it should have the same UX improvements, and reduced load times as classical AJAX. On the other hand single-page applications using PJAXR should be easily crawlable by the most used crawlers without additional efforts. E.g. it should not be necessary to have several endpoints with the same content for crawlers and normal users. Additionally PJAXR should be a generic solution for single-page applications, not just for one specific.
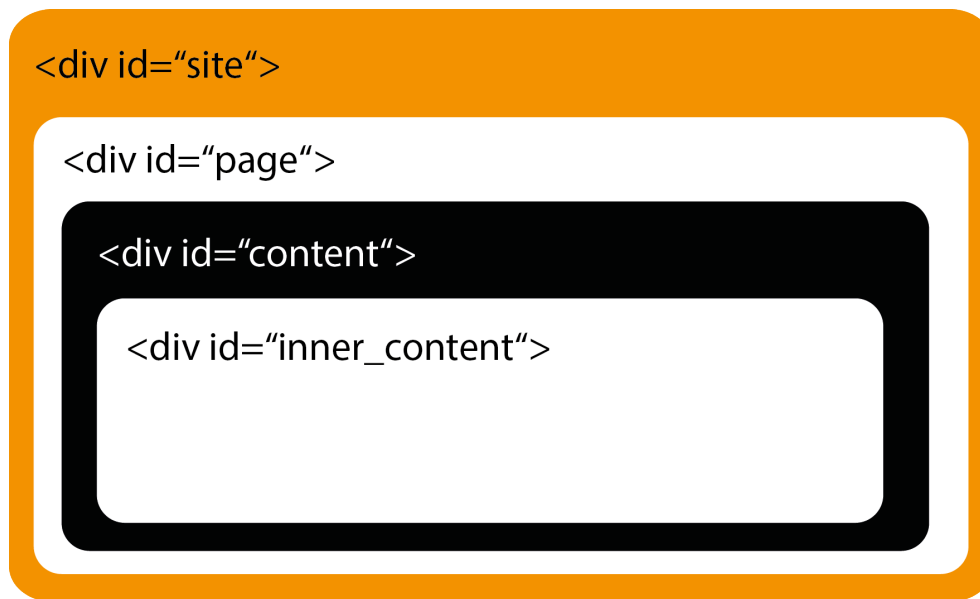
4.2 Concept

Figure 1: Basic HTML structure of a web application using PJAXR

Every single-page application which uses PJAXR has a hierachical namespace structure. Typically the namespace consists of a prefix, a site id, a page id, a content id and an inner-content id. Every level in the hierarchy has it's counterpart on the website as shown in figure 1, a container with an id telling which part of the namespace it belongs to. After the PJAXRfrontend is initialized it hijacks events like clicks on links and enriches the request with the current website's namespace. A PJAXR backend analyzes the namespace of the requested website and the one sent in the request. For every hierarchy level it checks if both namespaces match. If on one level the namespaces don't match the containers according to this level will be responded to the request. An optimized web application only grabs the data necessary for those containers and render them afterwards. The PJAXR frontend retrieves the response, replaces the containers at the website and updates the current namespace.
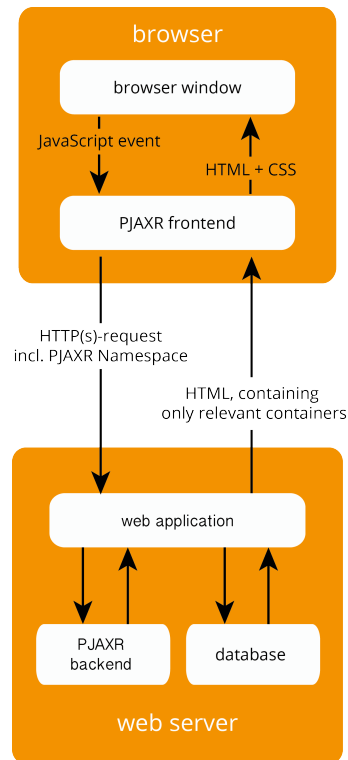
Figure 2: Component and communication diagram of PJAXR

4.3 Realization

To load a page, the first request is a normal HTTP request followed by a JavaScript script initializing the PJAXR frontend module. Further requests to the same host are then initated by this module. The HTTP headers of these requests are extended by the namespace of the current website. The webserver using a PJAXR backend detects the first namespace of the requested resource not matching the namespace of the HTTP header. It then decides which data is needed to be gathered and which template should be used to render those. The content delivered by the PJAXR backend enriched web server is interpreted by the frontend module and replaces the related containers. This replacement is implemented using the ID attribute. Other methods identifying corresponding containers like e.g. XPath are not as generic in it's position on the page as the ID. This is important because single-page applications should be able to include content dynamically in every position on the page. PJAXR in combination with the History API makes it then possible to update the content and change the URL like it would be made by normal requests. This is possible with the use of the pushState method introduced in the History API. Back- and forward-buttons and bookmarks in a browser will work like on a normal request using this function.

4.4 Usage

4.5 PJAXR backends

5 Implementation

5.1 php-pjaxr

PHP-Pjaxr is a general Pjaxr-backend to used in PHP. It builds the base of every other PHP-Pjaxr module, especially for template engines.

Pjaxr is a implemented as a request-scoped Singleton. In PHP a singleton is implemented as a class, which provides only static methods and static attributes.

5.1.1 API

When including the Pjaxr.php automatically a Singleton named Pjaxr will be created.

- Pjaxr::is_enabled()

  Returns true if the current request is a Pjaxr request, otherwise false.

- Pjaxr::set_current_namespace($namespace)

  Sets the namespace of the current request to $namespace.

- Pjaxr::get_current_namespace()

  Returns the namespace of the current request.

- Pjaxr::get_matching($extension_namespace = null)

  $extension_namespace is an optional paramenter, to check the matching to a given namespace. If $extension_namespace is not given, the matching will be done against the namespace of the current request.

  Returns the most specific matching namespace level.

- Pjaxr::matches($extension_namespace = null)

  $extension_namespace is an optional paramenter, to check the matching to a given namespace. If $extension_namespace is not given, the matching will be done against the namespace of the current request.

  Returns true if the whole namespace is matching, otherwise false.

5.2 twig-pjaxr

Twig-Pjaxr brings Pjaxr functionality to the template engine Twig[3]. Twig is used by Symfony, a framework which is used in e.g. Drupal 8, eZPublish, phpBB and Sylius.

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[3]http://twig.sensiolabs.org/

Twig-Pjaxr is a implemented as a Twig extension. It consists of a TwigToken-Parser, a anonymous TwigSimpleFunction and a global variable. The TwigToken-Parser Twig_Pjaxr_TokenParser_PjaxrExtends is the heart of the extension. It provides the possibility to use the tag {% pjaxr_extends %} in the way it may be used in django. To prevent multiple extend tags, including the default twig tag *{% extends %}* it throws a Error if either the default tag or {% pjaxr_extends %} was already used. Additionally we ensure that it is not called inside a block tag.

5.2.1 API

- {% pjaxr_extends $default_template %}

  Extends $default_template like the original {% extends $default_template %}.

- {% pjaxr_extends $default_template $pjaxr_namespace %}

  Extends ::__pjaxr.html if $pjaxr_namespace is matching, otherwise it extends $default_template.

- {% pjaxr_extends $default_template $pjaxr_template $pjaxr_namespace %}

  Extends $pjaxr_template if $pjaxr_namespace is matching, otherwise it extends $default_template.

5.3 jquery-pjaxr adjustments

5.4 concluding remarks

6 Evaluation

I will evaluate PJAXR based on a sample web application. It provides different type of sites which are designed to perform the different aspects of this evaluation.

To evaluate PJAXR we will first test it's functionality. We will check if the desired content is delivered and if PJAXR is actually used. To make the test as realistic as possible I will use selenium. We will test if the webapp delivers the same content using PJAXR as without using it. Selenium additionally makes it possible to use different WebDrivers, in this thesis FireFox and Chrome will be used.

To test the performance, I will use two technologies. First of all curl-based tests will be done. Those tests will focus on the first response, containing the markup. This will show how PJAXR influences the webserver.

Additionially the webapp will be benchmarked by using the Chrome Network Tools. This method provides the possiblity to check whether further requests for scripts, images, etc. are influenced. The Chrome Network Tools will show the actual load time the user has to wait for, until the whole page is loaded.

To make the tests as representative as possible, caching in every dimension will be enabled and disabled to see whether it influences the results or not. As I use Mysql as database I will enable and disable the query caching. Twig, the template engine

allows caching, which will be enabled and disabled as well. Additionally all tests are performed on a local machine and a remote server, to see whether the latency takes effect in the performance of PJAXR.

I will distinguish between static pages without database queries and dynamic pages which have those. Every page relevant for the test will be requested in different modes. First of all every site will be requested with PJAXR disabled. After that it will be requested with PJAXR enabled. As PJAXR should only influence subsequent requests, every page will be tested with PJAXR headers from different sources, imitating those requests.

6.1 test layout

Initial-Requests: Static: - / - /imprint/ Dynamic: - /tags/p/ - /tags/p/2/

Site-to-site Requests: Self - / to / - /tags/p/ to /tags/p/ Static page matching Site-Namespace - / to /imprint/ Dynamic page matching Site-Namespace - / to /tags/p/ Dynamic page matching Page-Namespace - /tags/p/ to /tags/p/2/

6.2 Testing web application

6.3 Selenium

6.4 Curl

6.5 Chrome Network Tools

6.6 Results

6.7 concluding remarks

7 Conclusion and future work

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