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**题目：基于SPA的电子商务网站设计**

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Modern and Responsive Mobile-enabled Web Applications

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**Abstract**

Rapid web technology improvements in the last few years have powered software developers to quickly write responsive mobilefriendly applications. The innovative web frameworks and libraries make it easy to have same software code base for desktop and mobile devices. Single-page applications oﬀer a more-native-app-like experience to the user. This also means a web application can easily be converted to a native mobile application if desired. This allows software products to be evolved continuously at a much faster pace with features added on daily basis. The software companies who can adopt these technologies will most likely see the beneﬁt in the long run as they can oﬀer new and modiﬁed products faster than their competitors. In this paper, were view some of the state-of-the-art web technologies, third-party libraries, and frame works for quick interactive web development. Finally, we present a simple interactive browser-based, mobile friendly web application which was developed using one of the latest web development frameworks.

**Keywords**: Web-based Applications; JavaScript; Web Framework, Mobile-friendly Application, Single-Page Applications

1. Introduction

In the last few years, several web technology innovations have allowed software designers and engineers to quickly develop responsive mobile-friendly applications. These improvements include web frameworks and libraries which allow quick and user-friendly application development for desktop and mobile devices. In fact, it is quite common to have single code base for an application which functions on the desktop and mobile devices (like smart phones and tablets). The successful software companies will adopt these technologies quickly to stay ahead of their competitors by oﬀering new and modiﬁed products at a much faster rate. The content of a web page are described by HyperText Markup Language (HTML). HTML5 evolves from HTML and includes new attributes and behaviors. Apart from HTML5, the building blocks for most of the modern browserbased applications include JavaScript (JS) and Cascading Style Sheets (CSS3). Single-Page Applications (SPAs) are web-based applications which load a single HTML page and dynamically update the page content as the user interacts with the application through menus and sidebars. These applications oﬀer a more-native-app-like experience to the user. Fluid and responsive web applications are created, without constant. page reloads, using AJAX (Asynchronous JavaScript and XML) technology, which communicate with server-side scripts to receive as well as send information in a variety off or mats(usually from/to a persistent storage like database). The applications that uses basic functions of persistent storage namely Create, Read, Update, Delete (CRUD) are called CRUD applications. CRUD are the basic operations to be done in a data repository. Inoneofourpreviousworks, we re viewed somes tate-of-the-art web technologies, third-party libraries and frameworks that can be utilized to fulﬁll the promise of interactive browser based custom visualization applications. This library uses client-based technologies for appending and manipulating Scalable Vector Graphics (SVG) elements, which is supported in almost all modern browsers, smart phones and tablets. Shaikh et. al.2 presented some state-of-the-art web based tools and libraries for client-side browser-based visualization. They introduced a novel web-based network visualizer and simulator application which utilizes HTML, JavaScript and Bootstrap. Some of the contribution of this work includes brief description of latest tools and frameworks which are backbone of modern web applications and a simple description of the architecture of a modern web application. The rest of this paper is organized as follow. In section 2, we provide some background related to modern web development and list some latest framework and libraries. We provide modern web application architecture insection 3. We present an example application in section 4. The conclusion of our work is provided in the last section.

2. Latest Web Framework and Libraries

In this section, we review some of the JavaScript libraries which are designed for modern browsers and smart devices. These libraries exploited the advancement in HTML5, CSS3 and JavaScript and provide an Application Programming Interface (API) for developer to create web-based mobile-friendly applications. Lightweight frameworks add structure to a web application and oﬀer a way to handle navigation between diﬀerent views, and typically split the application into layers implementing the Model-View-Controller (MVC) design pattern. These libraries and frameworks are developed using pure JavaScript, so users get interactivity without requiring round-trips to servers and without any additional plugins.

• jQuery is a popularJavaScript library3.

jQuery helps in ﬁnding and manipulating the Document Object Model (DOM) elements, processing browser events, and dealing with browser incompatibilities. jQuery is an extensible library, and thousands of plugins have been created by developers from around the world.

•AngularJS is a tool set for building the framework most suited to application development. It is fully extensible and works well with other libraries. Every feature can be modiﬁed or replaced to suit unique development workﬂow and feature needs4. AngularJS is often used for creating single-page applications, where only certain portions of the page (sub-views) are updated as a result of the user‘s actions or data being sent from the server. Other features include tw-way data-binding, reusable components, deep linking, built-in services for backend communication and localization support. Mobile Angular is another User Interface(UI) framework that is built on AngularJS and Bootstrap for mobile-friendly application development.

• Angular Angular 2 (or just Angular) is an open source JavaScript framework maintained by Google. It is an evolution of its popular predecessor, AngularJS. Apart from JavaScript, Angular applications can be developed in Dart, or TypeScript5. The framework makes it simpler to create custom components that can be added to HTML documents and to implement application logic. Angular uses data binding extensively, includes a dependency injection module, supports modularization, and oﬀers a routing mechanism. Whereas AngularJS was MVC-based, Angular is not. This framework doesnt include UI components.

• Bootstrap is the most popular HTML, CSS, and JS framework for developing responsive, mobile ﬁrst projects on the web6. It is an open source library of UI components developed by Twitter. The components are built using the responsive web design principles, which makes this library extremely valuable for web applications that needs to automatically adjust its layout depending on the screen resolution.

• Google‘s Material Design libraries is a new library of UI components called Material Design, which may become an alternative to Bootstrap. Material Design is optimized for cross-device use and comes with a set of nice-looking UI components7. Material Design is a uniﬁed system that combines theory, resources, and tools for crafting digital experiences.

•React is an open source library by Facebook for building user interfaces8. It‘s non-intrusive and can be used with any other library or a framework. React creates its own virtual DOM object, minimizing access to browser‘s DOM, which results in better performance. For content rendering, React introduces the JSX format, which is a JavaScript syntax extension that looks like XML. Using JSX is recommended but optional.

• Node.js (or Node) is a framework or a library, as well as is a runtime environment. This framework can be used to develop JavaScript programs that run outside the browser. The Node.js framework includes an API to work with the ﬁlesystem, access databases, listen to HTTP requests, and more.

• Jasmine is an open source framework for testing JavaScript code. It includes a set of functions that test whether certainparts of your applicationbehave asexpected. Jasmine is oftenused with Karma, which is atest runner that allows you to run tests in diﬀerent browsers.

3. Modern Web application architecture

Fig. 1a depicts modern web application architecture. Ideally, no data is read from the DOM but application outputs HTML and perform element operations as needed. No data is stored in random objects or in the DOM. A set of models represent all the data in the application. Views receive change notiﬁcations (via events) from models and handle redrawing as appropriate. Views utilizes template to render information as per user interface design. Model also reads and writes from/to storage (usually a database) using AJAX and server-sidescripts. These scripts are written in server-side dynamic languages like PHP or ASP.

Fig. 1b shows architecture of a typical AngularJS application. Controllers are written in JavaScript and are the behavior behind the DOM elements.. This makes it easy to test, maintain, and reuse code. Services are also written JavaScript and access data or information from model via AJAX requests (server communication). Views are usually HTML-based (including any CSS) and receives information from model via controller (as is or after some postprocessing). Data-binding is an automatic way of updating the view whenever the modelchanges, as well as updating the model whenever the view changes. Views/template also provides client-side form validation. AngularJS lets developer declare the validation rules of the form without having to write JavaScript code. Models provide reads and writes access to persistent storage, like a database, and written in some server-side scripting language (like PHP).

Single Page Applications (SPA) have more complex state transitions than a server-side applications because there are:

• DOM events that cause small state changes in views,

• model events when model values are changed,

•application state changes that cause views to be swapped,

• global state changes,

• delayed results from backend CRUD operations via AJAX.

One of the advantages of using development frameworks is that the above issues are handled or notiﬁed seamlessly by the framework and software developer stay focus on the actual business logic and user interface design.

4. An Example

We have utilized the technologies and libraries introduced in previous section and developed few custom applications. We will present one of the interactive application which was designed and developed in a week. Family Harmony Maps is an interactive; color-based; diagnostic parenting method which allows Parents and/or a Family to ﬁll out age-appropriate need maps to be used as input for analysis and scoring. The method was converted into anonline tool which analyses the input data, compute saparenting score and provides family-speciﬁc and gender speciﬁc harmony maps to serve as direct indicators of how harmonious the relationship between parents and their children is. The parenting score and family harmony scores are calculated by comparing the the user-entered maps with an ideal parenting map. User/Parent choose a color (Green, yellow, red by repeat clicking on the box) that best describes parenting style (under ﬁve diﬀerent attributes) during each of their child(ren) speciﬁc age periods. The parent entry-map is shown in Fig. 2a and corresponding options are shown as legends (Fig. 2b). Similar entry-maps are availablefor children to ﬁll (a separate map for boys and girls). The maps have six(6) rows corresponding to six age groups and ﬁve(5) columns corresponding to ﬁve attributes describing important parenting aspects. A sample of ﬁnal user-ﬁlled entry-maps for parent and children are shown Fig. 3a. These maps are entered by a parent and their children (separate maps for girls and boys). These maps are compared with an ideal map to compute the parents and children’s harmony scores and corresponding harmony maps are calculated and displayed as output. A sample computed family harmony maps for parent and children are shown Fig. 3b. The corresponding legends are shown in Fig. 2c. The data submitted by diﬀerent families regardless of their country of origin, religion or ethnicity is then collected and stored in a database for further processing and analysis. A number of parameters are evaluated to assess the harmony of a family or a group of families within a community as a function of parents’ and children’s country of residence, age, ethnicity and religion to draw certain parenting themes, trends and styles.

Conclusion

We presented and compared some of the latest framework, web-based tools and libraries available for mobilefriendly responsive browser-based applications. We also introduced an interactive and lightweight web-based singlepage social application. We believe that the successful software companies will adopt these technologies quickly to stay ahead of their competitors. The innovative web frameworks and libraries allow software products to be evolved continuously.

As future work, we will continue building on the presented and other applications to improve user friendliness and performance. The use of presented development framework allow fast turn around time and new features will be easier to implement.

现代响应式兼容移动端的Web应用

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**概要**

在过去几年快速web技术的飞速发展下，软件开发人员能够快速编写响应式的移动应用程序。创新的Web框架和库使得我们编写一套代码就可以适用于个人电脑和移动设备。单页面应用程序为用户提供了更加接近原生手机应用的体验。这意味着，如果需要，可以将Web应用程序可以轻松转换为手机移动应用程序。这种技术使得软件产品能够以更快的速度不断迭代，并且每天都可以增加新的功能。从长远来看，那些采用这些技术的软件公司会具有优势，因为他们可以比竞争对手更快地提供新的和改进的产品。

在本文中，我们将回顾一些最先进的Web技术，第三方库和快速交互式Web开发框架。最后，我们会使用最新的一个Web开发框架去开发一个以浏览器为基础，移动友好的简单交互式Web应用程序。

关键词：基于Web的应用程序;JavaScript; Web框架，适用于移动设备的应用程序，单页面应用程序。

**1.引言**

在过去的几年中，几项技术创新使得软件设计人员和工程师能够快速开发响应式并能适用于移动端的应用程序。这些创建包括Web框架和库，可以为桌面和移动设备进行快速和用户友好的应用程序开发。 实际上，在桌面和移动设备（如智能手机和平板电脑）上运行的应用程序具有相同的底层代码是很正常的。 成功的软件公司将迅速采用这些技术，以更快的速度更新迭代现有的产品，以保持领先于竞争对手的地位。

超文本标记语言（HTML）用来描述网页的内容，HTML5从HTML演变而来增加了许多性的特性。除了HTML，大多数现代基于浏览器的应用程序的构建块包括JavaScript（JS）和层叠样式表（CSS3）。

单页面应用程序（SPA）是基于Web的应用程序，可以加载单个HTML页面，并在用户通过菜单或者侧边栏进行交互时动态更新应用的页面内容。这种应用给用户的体验更加接近于原生的手机APP应用。响应式Web应运而生，使用Ajax（异步JavaScript和XML）技术异步获取服务器的数据，当数据更新时不需要重新加载整个页面。使用持久性存储的基本功能，即创建，读取，更新，删除（CRUD）的应用程序被称为CRUD应用程序。CRUD是在数据存储库中完成的基本操作。

在我们之前的工程中，我们回顾了一些可用于实现基于交互式浏览器的自定义可视化应用程序的最新技术，第三方库和框架。 这些库的使用使得我们在客户端可以操作可缩放矢量图形（SVG）元素，几乎所有的现代浏览器，智能手机和平板电脑都支持这些元素。

Shaikh et.al.2提供了一些基于Web的工具和库，用于基于浏览器的客户端可视化。 他们引入了一个新颖的基于网络的网络可视化器和模拟器应用程序，利用了HTML，JavaScript和Bootstrap。

本文的其余部分组织如下。 在第2节中，我们提供了一些与现代Web开发和一些最新的框架和图书相关的背景。 我们提供了现代应用程序体系结构3.我们在第四部分提供一个示例应用程序。最后一部分提供了我们工作的结论。

2. 最新web框架和库

在本节中，我们将回顾一些为现代浏览器和智能设备设计的JavaScript库。 这些库利用了HTML5，CSS3和JavaScript，并为开发人员提供了一个应用程序编程接口（API），以创建基于Web的移动友好型应用程序。轻量级框架将结构添加到Web应用程序，并提供了处理不同视图之间转换路由的方法，并且通常将应用程序分成实现模型 - 视图 - 控制器（MVC）设计模式的模式。这些库和框架是使用纯JavaScript开发的，没有任何额外的插件。

**•jQuery**是一个流行的JavaScript脚本库。 jQuery用来帮助我们查找和处理文档对象模型（DOM）元素，处理浏览器事件以及处理浏览器不兼容问题。 jQuery是一个可扩展的库，已经有数以千计的jQuery插件被来自世界各地的开发者所创造。

•**AngularJS** 是构建应用程序最适合开发的框架的工具集。它是完全可扩展的，并且可以与其他的库很好地协作。每个功能都可以修改或更换，以适应独特的开发工作流程和功能需求。AngularJS通常用于创建单页面应用程序，其中，由于用户的操作页面或服务器向客户端发送的数据时，只有页面的某些部分（子视图）被更新。其他功能还包括双向数据绑定，可重用组件，深层链接，用于后端通信和本地化支持的内置服务。Mobile Angular是另一种用户界面（UI）框架，构建于AngularJS和Bootstrap之上，用于移动友好应用程序开发

•**Angular** Angular 2（或者Angular）是由Google开源维护的JavaScript框架。 这是它受欢迎的前身AngularJS的演变。除了JavaScript，Angular应用程序可以在Dart或TypeScript5中开发。该框架使创建可添加到HTML文档并实现应用程序逻辑的自定义组件变得更简单。Angular广泛使用数据绑定，包括一个依赖注入模块，支持模块化，并提供一个路由机制。而AngularJS是基于MVC的，Angular不是。这个框架不包括UI组件。

•**Bootstrap**是最流行的响应式框架，它提倡移动端先行的概念，它是由Twitter开发的一个开源的UI组件库。这些组件使用响应式网页设计原则构建，这使得该库对于需要根据屏幕分辨率自动调整其布局的Web应用程序非常有价值。

•**Google**的Material Design库是一个名为Material Design的新组件库，可能成为Bootstrap的替代品。 Material Design针对跨设备使用进行了优化，并附带一组漂亮的UI组件。

•**React**是Facebook的一个开源库，用于构建用户界面。 它是非侵入性的，可以与任何其他库或框架一起使用。 React创建自己的虚拟DOM对象，最大限度地减少对浏览器DOM的访问，从而获得更好的性能。 对于内容呈现，React引入了JSX格式，它是一种类似于XML的JavaScript语法扩展。 推荐使用JSX，但是可选的。

•**Node.js**（或Node）是一个框架或一个库，也是一个运行时环境。这个框架可以用来开发在浏览器之外运行的JavaScript程序。Node.js框架包括一个API来与文件系统一起工作，访问数据库，监听HTTP请求等等。

•**Jasmine**是一个测试JavaScript代码的开源框架。它包含一组函数，用于测试你的应用程序的某些部分是否具有被检查的特征。Jasmine经常与Karma一起使用，它可以让你在不同的浏览器上运行测试。

**3.现代Web应用程序架构** 图1a描述了一个现代的Web应用程序体系结构。理想情况下，不从DOM读取数据，但应用程序输出HTML并根据需要执行元素操作。没有数据存储在随机对象或DOM中。一组模型表示应用程序中的所有数据。视图从模型接收更改通知（通过事件），并根据需要处理重绘。视图利用模板来呈现按照用户界面设计的信息。模型还使用AJAX和服务器端脚本读写存储（通常为数据库）。这些脚本以服务器端动态语言（如PHP或ASP）编写。

图1b显示了一个典型的AngularJS应用程序的架构。控制器是用JavaScript编写的，是DOM元素后面的行为。这使测试，维护和重用代码变得很容易。服务也通过AJAX请求（服务器通信）写入JavaScript并访问来自模型的数据或信息。 视图通常是基于HTML的（包括任何CSS），并通过控制器从模型接收信息。数据绑定是自动更新视图的过程，每当视图更改时更新模型。视图/模板还提供客户端表单验证。AngularJS允许开发者声明表单的验证规则，而不必编写JavaScript代码。模型提供对持久性存储的读写访问，如数据库，并以某种服务器端脚本语言（如PHP）编写。

单页应用程序（SPA）比服务器端应用程序具有更复杂的状态转换，因为有：

•DOM事件会导致细小的视图状态的改变

•模型事件会导致模型的值发生变化

•应用状态的改变导致视图转换

•全局状态改变

••通过AJAX异步更新后端CRUD操作的结果。

使用开发框架的好处之一是，上述问题由框架无缝地在底层处理，软件开发人员将注意力集中在实际的业务逻辑和用户界面设计上。

**结论**

我们介绍和比较了一些最新的第三方框架和库，包括了基于网络的工具的库和可用于基于浏览器的移动应用程序的库。我们还介绍了一个交互式和轻量级的基于Web的单页社交应用程序。我们相信，成功的软件公司将迅速采用这些技术，以保持领先于竞争对手。创新的Web框架和库允许软件产品不断演变和迭代。 作

作为未来的工作，我们将继续在其他的应用上使用这些技术，以提高用户的友好性和性能。所提供的开发框架的使用允许快速交付时间，并且新特征将更容易实现。