Database Management Systems

Module 35: Application Design and Development/5: Application Development and Mobile

Partha Pratim Das

Department of Computer Science and Engineering
Indian Institute of Technology, Kharagpur

ppd@cse.iitkgp.ac.in

Module Recap

- Learnt how to accessing PostgreSQL database from Python
- Learnt to build Python Web Application with PostgreSQL and Flask

Module Objectives

- To explore the Rapid Application Development Process
- To understand the issues in Application Performance and Security
- To understand the similarity and differences between how Mobile Apps and Web Applications

Module Outline

- Rapid Application Development
- Application Performance and Security
- Mobile Apps

Rapid Application Development

Rapid Application Development

- A lot of effort is required to develop Web application interfaces, especially the rich interaction functionality associated with Web 2.0 applications
- Several approaches to speed up application development
  - Function library to generate user-interface elements
  - Drag-and-drop features in an IDE to create user-interface elements
  - Automatically generate code for user interface from a declarative specification
- Used as part of **Rapid Application Development (RAD)** tools even before Web
- RAD Software is an agile model that focuses on fast prototyping and quick feedback in app development to ensure speedier delivery and an efficient result
  - App development has 4 phases: business modeling, data modeling, process modeling, and testing & turnover: Defining the requirements, Prototyping, Receiving feedback and Finalizing the software
  - With RAD, the time between prototypes and iterations is short, and integration occurs since inception.

Rapid Application Development (2)

- Web application development frameworks
  - **Java Server Faces (JSF)**
    - ▷ A set of APIs for representing UI components and managing their state, handling events and input validation, defining page navigation, and supporting internationalization and accessibility
    - ▷ JSP custom tag library for expressing a JSF interface within a JSP page
  - **Ruby on Rails**
    - ▷ Allows easy creation of simple **CRUD** (create, read, update and delete) interfaces by code generation from database schema or object model
- RAD Platforms and Tools
  - G Suite
  - Google App Engine
  - Microsoft Azure
  - Amazon Elastic Compute Cloud (EC2)
  - AWS Elastic Beanstalk
  - ...

ASP.NET and Visual Studio

- ASP.NET provides a variety of controls that are interpreted at server, and generate HTML code
- Visual Studio provides drag-and-drop development using these controls
  - For example, menus and list boxes can be associated with DataSet object
  - Validator controls (constraints) can be added to form input fields
    - JavaScript to enforce constraints at client, and separately enforced at server
  - User actions such as selecting a value from a menu can be associated with actions at server
  - DataGrid provides convenient way of displaying SQL query results in tabular format

Application Performance and Security

Application Performance and Security

Application Performance

- Performance is an issue for popular Web sites
  - May be accessed by millions of users every day, thousands of requests per second at peak time
- Caching techniques used to reduce cost of serving pages by exploiting commonalities between requests
  - At the server site:
    - ▷ Caching of JDBC connections between servlet requests
      - a.k.a. connection pooling
    - ▷ Caching results of database queries
      - Cached results must be updated if underlying database changes
    - ▷ Caching of generated HTML
  - At the client's network
    - ▷ Caching of pages by Web proxy

Application Security: SQL Injection

- Suppose query is constructed using
  - ”select * from instructor where name = ’” + name + ” ’ ”
- Suppose the user, instead of entering a name, enters:
  - X’ or ’Y’ = ’Y
- then the resulting statement becomes:
  - ”select * from instructor where name = ’” + ”X’ or ’Y’ = ’Y” + ” ’ ”
  - which is:
    - select * from instructor where name = ’X’ or ’Y’ = ’Y’
  - User could have even used
    - X’; update instructor set salary = salary + 10000; - -
- Prepared statement internally uses:
  ”select * from instructor where name = ’X \’ or \’Y\’ = \’Y’
- **Always use prepared statements, with user inputs as parameters**
- Is the following prepared statement secure?
  - conn.prepareStatement(”select * from instructor where name = ’” + name + ” ’ “)

Application Security (2): Password Leakage

- Never store passwords, such as database passwords, in clear text in scripts that may be accessible to users
  - ○ For example, in files in a directory accessible to a web server
    - ▷ Normally, web server will execute, but not provide source of script files such as file.jsp or file.php, but source of editor backup files such as file.jsp∼, or .file.jsp.swp may be served
- Restrict access to database server from IPs of machines running application servers
  - ○ Most databases allow restriction of access by source IP address

Application Security (3): Authentication

- Single factor authentication such as passwords too risky for critical applications
  - guessing of passwords, sniffing of packets if passwords are not encrypted
  - passwords reused by user across sites
  - spyware which captures password
- Two-factor authentication
  - For example, password plus one-time password sent by SMS
  - For example, password plus one-time password devices
    - device generates a new pseudo-random number every minute, and displays to user
    - user enters the current number as password
    - application server generates same sequence of pseudo-random numbers to check that the number is correct.

Application Security (4): Application-Level Authorization

- Current SQL standard does not allow fine-grained authorization such as "students can see their own grades, but not other's grades"
  - Problem 1: Database has no idea who are application users
  - Problem 2: SQL authorization is at the level of tables, or columns of tables, but not to specific rows of a table
- One workaround: use views such as

```
create view studentTakes as
select *
from takes
where takes.ID = syscontext.user_id()
```

  - where syscontext.user_id() provides end user identity
    - ▷ end user identity must be provided to the database by the application
  - Having multiple such views is cumbersome

Application Security (5): Application-Level Authorization

- Currently, authorization is done entirely in application
- Entire application code has access to entire database
  - large surface area, making protection harder
- Alternative: **fine-grained (row-level) authorization** schemes
  - extensions to SQL authorization proposed but not currently implemented
  - Oracle Virtual Private Database (VPD) allows predicates to be added transparently to all SQL queries, to enforce fine-grained authorization
    - ▷ For example, add $ID = sys\_context.user\_id()$ to all queries on student relation if user is a student

Application Security (6): Audit Trails

- Applications must log actions to an audit trail, to detect who carried out an update, or accessed some sensitive data
- Audit trails used after-the-fact to
  - detect security breaches
  - repair damage caused by security breach
  - trace who carried out the breach
- Audit trails needed at
  - Database level, and at
  - Application level

Challenges in Web Application Development

Challenges in Web Application Development

Challenges in Web Application Development

- User Interface and User Experience
- Scalability
- Performance
- Knowledge of Framework and Platforms
- Security

Source: 5 Challenges in Web Application Development

Mobile Apps

Mobile Apps

What is a Mobile App?

- A type of application software designed to run on a mobile device, such as a smartphone or tablet computer
- Developed specifically for use on small, wireless computing devices, such as smartphones and tablets
- Designed with consideration for the demands and constraints of the devices and also to take advantage of any specialized capabilities
  - – Form Factor – influences display and navigation
  - – Limited Memory
  - – Limited Computing Power
  - – Limited Power
  - – Limited Bandwidth
  - – . . .
  - + Availability of sensors like accelerometer
  - + Availability of touchscreen – Gesture-based Navigation
  - + . . .

Source: https://www.slideshare.net/hassandar18/architecture-of-mobile-software-applications?from_action=save

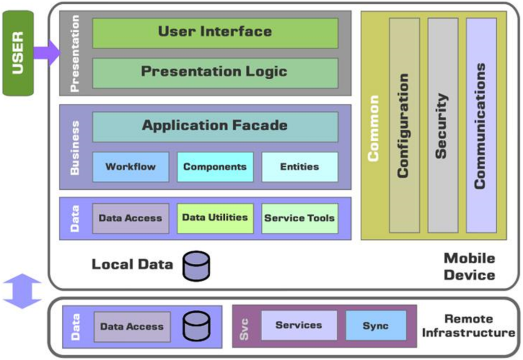
Mobile Website vis-à-vis Mobile App

- **Mobile Website**
  - Similar to any other website in that it consists of browser-based HTML pages
  - Can display text content, data, images and video
  - Typically accessed over WiFi or 3G or 4G networks
  - Designed for the smaller handheld display and touch-screen interface
  - Can also access mobile-specific features such as click-to-call (to dial a phone number) or location-based mapping
- **Mobile Apps**
  - Actual applications that are downloaded and installed on the mobile device
  - Users download apps from device-specific portals such as App Store, Google Play Store
  - The app may
    - ▷ pull content and data from the Internet, in similar fashion to a website, or
    - ▷ download the content so that it can be accessed without an Internet connection

Source: https://www.slideshare.net/hassandar18/architecture-of-mobile-software-applications?from_action=save

Architecture of Mobile App

- Typically 3 tier
  - Presentation
  - Business
  - Data
- Data Layer is often split between:
  - Local Data
  - Remote Data
- Needs customization for platform
  - Android
  - iOS
  - Windows



Source: https://www.slideshare.net/hassandar18/architecture-of-mobile-software-applications?from_action=save

Types of Mobile Apps

- **Native Apps:** Completely written in the native language of a platform
  - iOS → Objective-C; Android → Java or C/C++
  - Platform specific (heavily dependent on OS)
- **Web Apps:** Run completely inside of a Web browser.
  - Features interfaces built with HTML or CSS
  - Powered via Web programming languages → Ruby on Rails, JavaScript, PHP, or Python
  - Portable across any phone, tablet, or computer
- **Hybrid Apps:** Combines attributes of both native and Web apps.
  - Attempts to use redundant, common code that can be used across platforms, and
  - Tailors required attributes to the native system

Source: https://www.slideshare.net/hassandar18/architecture-of-mobile-software-applications?from_action=save

Design Issues

- Determine Device
- Note Device Resources – memory, power, speed
- Consider Bandwidth
- Decide on Architecture Layers
- Select Technology
- Define User Interface
- Select Navigation
- Maintain Flow

Source: https://www.slideshare.net/hassandar18/architecture-of-mobile-software-applications?from_action=save

Module Summary

- Understood the steps in the Rapid Application Development Process
- Exposed to the issues in Application Performance and Application Security
- Learnt the distinctive features of Mobile Apps

Slides used in this presentation are borrowed from http://db-book.com/ with kind permission of the authors.
Edited and new slides are marked with "PPD".