

Thinking Books Projects

This document describes 8 projects being offered by a local startup, Thinking Books. Thinking Books is developing software tools for building applications for mobile (such as iPhone, iPad, Android Phones and tablets, Windows, etc.), Web, Internet of Things (IoT) devices, and desk top systems. The tools are built around the next generation programming language, Ankur, that Thinking Books has developed. Ankur is an object-oriented programming language, and is unique in that it has been designed to address the diversity among different platforms. Dr. Raju Pandey who is the founder of Thinking Books and designer of Ankur, will present the details of the language on the first day of the class.

The proposed projects will form key components of Ankur's programming eco-system. These projects are core and foundational in nature in that they involve researching, designing, and implementing key aspects of the programming eco-system. These including building key web-server backend infrastructure, cloud-based backend services, intrinsic support for sql- and non-sql databases, data analytics frameworks, GUI design, and cloud-based programming development environments. These projects will provide great platforms for students to develop much sought after expertise in core areas such as programming language design, system design, Web client and server infrastructure design, backend server design, cloud architectures, mobile system design, data analytics algorithm, GUI design, performance analysis, and cloud-based system design.

Thinking Books will provide guidance to students in completing these projects successfully. The company will also select three best projects and provide monetary prizes, which will be described on the first day of the class. Further, Thinking Books will credit each project team on its web site for the key component that they have developed.

1 Distributed Runtime System

Topics of Interest:

- Distributed Programming, Network Programming
- Web Backend, Web Frameworks, HTTP Servers and Protocol
- Node.js
- Open source HTTP servers

Node.js provides a distributed runtime framework for executing server-based JavaScript code. It supports several modules that make it easier to support server-based programming. It is being used for tooling, building micro-services, creating real-time services, serving as IoT middleware, and providing http server-based services. Node.js exemplifies the need for a light weight, scalable, robust, efficient and configurable server-based framework. While the Node.js framework is extremely appealing, its universal appeal is limited by the underlying language technology (JavaScript) used.

This project will build a Node.js like distributed runtime framework for the Ankur programming language. Specifically this project will involve the following:

- **Research and Design:** Analyze the Node.js framework and programming environment, and propose a programming model/framework for the Ankur programming environment. We will call these nodes Anchor Servers.
- **Module List:** Make a prioritized list of different runtime modules that is currently supported by Node.js.
- **HTTP Server Module Design and Implementation:** HTTP server module is a key module in Node.js, and is used for building Web servers using Node.js. The project will Implement a server module. In addition, develop a programming model for starting, stopping and integrating execution of Ankur programs from the HTTP server. This will require finding an open source efficient HTTP server, integrating it within Ankur source, and building Ankur libraries for managing HTTP servers.
- **Configuration and Installation:** Develop a set of configuration and installation model for easily downloading, installing and running Anchor servers.

2 Cloud Back-ends

Topic of Interest:

- Cloud
- User Management and Social Networking Services
- API, RESTful API
- Backend As a Service
- Amazon, Google, Microsoft, IBM Cloud Services

The notion of cloud provides a scalable and reliable repository for accessing different resources (including storage, computing, and networks as well as higher level abstractions such as databases). They provide a single point of control for acquiring, using and managing these resources. Over the last few years, several startups have provided cloud-based abstract services through the notion of Backend As a Service (BaaS).

This project involves building a cloud-based backend and infrastructure service for Ankur applications. Specifically the project will involve the following:

- **Research and Design:** Research different back end as a service and cloud offerings. From these offerings, develop a service model for such a service for Ankur.
- **API Development:** Develop a set of API and RESTful API for accessing the backend from iOS, Android and desktop devices.
- **User Management:** Develop a platform-interdependent user-management system. In addition, integrate this management system with social networking services.
- **Backend Service Design and Implementation:** Design and implement the backend as a service infrastructure on Amazon, Google and Microsoft cloud services.
- **Configuration and Installation:** Develop a set of configuration and installation model for easily downloading, installing and running backend services.

3 Databases

Topic of Interest:

- SQL- and Non-SQL databases
- Schema design and ORM models
- Query processing

- Database programming

A vast majority of applications involve storing information in either local or remote databases, retrieving information from these databases, manipulating them (transforming, visualizing, etc.) and then storing them back in the database. Much of this is achieved by sending “sql”-like queries to processes that run databases, and then interpreting the set of results sent by the database. Over the last few years, several programming frameworks have evolved that have tried to integrate an easy to use database-programming models with programming models. These include the programming model in C# programming language, the ORM model in Ruby on Rails and several other ORM models for JavaScript.

This project will build a similar programming model for databases in the Ankur Programming language. This model should be broad enough that it can be run on mobile devices that run iOS as well as on backend servers and cloud. The project will involve the following:

- **Research and Design:** Research different ORM models. From these offerings, develop an ORM model and query language for such a service for Ankur. An initial design for such an ORM model already exists, which can be used as a starting point.
- **Implementation:** Implement the ORM model. Implementation will involve modifying the Ankur language to support the ORM schema design, ORM query language, and translation of query language into low level database queries.
- **Configuration and Installation:** Develop a set of configuration and installation model for easily downloading, installing and running databases on a wide variety of platforms.

4 Data Analytics

Topic of Interest:

- R, Python, NumPy, and other data analytics languages
- Data models
- Data storage formats such as JSON, XML and CSV
- Data analytics algorithms

Data analytics is a key components of an intelligent computing infrastructure. Programming language such a R provide a wide variety of features for representing, manipulating and storing different kinds of data components.

This project will develop a R-like capability in the Ankur programming language. Ankur already supports key abstractions (such as Vector, Matrix, and DataFrame) as well as modules for reading from and writing to different data formats (such as JSON, CSV, etc.) This project will build upon the existing features of Ankur, and add any missing components. These will include the following:

- **Research and Design:** Evaluate the designs of data analytics languages such as (R, Julia, and Python). Complete the data analytics model in Ankur.
- **Data Analytics Libraries:** Make a comprehensive list of various libraries that are available on other data analytics platform. Prioritize this list.
- **Implementation:** Find the open source versions of a set of libraries and integrate them within an Ankur data analytics module.
- **Configuration and Installation:** Develop a set of configuration and installation models for easily downloading, installing and using data analytics libraries of different platforms.

5 IoT Platform (Multiple Projects)

Topic of Interest:

- Internet of Things (IoT), Sensors and Gateways
- Distributed Programming, Embedded Programming
- IoT low cost platforms such as Raspberry Pi, Arduino
- IoT Gateways (such as Intel Gateway)

There is significant interest in Internet of Things (IoT) applications that use sensors and actuators to collect data, analyze the data and use the analysis to optimize certain behavior. Companies like CISCO, Intel, GE, MicroSoft, and Google are investing billions of dollars in building IoT infrastructures. IoT applications impose significant challenges because of the diversity in the different components (sensors, gateways, etc.), tools and programming models. This project is aimed at porting Ankur across different IoT sensor and gateways. Each Ankur port will be counted as a project. The effort here will involve the following:

- **Research and Design:** Analyze the IoT platform, its native operating system or bare bone firmware, and its tool chain. Build a platform model along with a build model. Formulate a strategy for porting Ankur platform-specific files to the platform
- **Implementation:** Implement the different files for porting the language.
- **Optimize:** Optimize the implementation for memory footprint, resource efficiency and overall power usage.
- **Configuration and Installation:** Develop a set of configuration and installation tools for easily downloading, installing and updating binaries of platforms.

6 Graphics: User Interface Libraries

Topics of Interest:

- GUI
- Graphical controls
- Web GUI models
- GUI element Layout
- Gestures and touch interfaces

Most platforms provide a set of libraries for building complex user interfaces. These includes libraries for specific graphical objects, controls for interacting with them, an event semantics for dealing with events, and algorithms for laying out graphical objects on screen. The programming abstractions for most libraries are similar; they only differ in minor ways. This project involves building a common GUI library in Ankur. The library should capture both common and platform-specific features of the different platforms. The effort here will involve the following:

- **Research and Design:** Research different platform and GUI models. Develop a GUI programming model that captures both platform-independent and platform-specific aspects.
- **Implementation:** Implement the GUI model.
- **Application:** Develop a simple application that highlights the capabilities of the GUI model.

Team size: 4-6

7 Web Client Programming Frameworks

Topics of Interest:

- Web client programming, Single Page Interactive Applications
- Frameworks such as AngularJS, Ember, React, Meteor
- MVC Design Pattern

Much of the web-client side programming has involved moving a significant amount of functionality into the web client side code. This leads to a more responsive behavior, reduces network communication and can even continue operating if the remote server is down. This behavior also mimics the behavior of native applications on mobile devices. Several frameworks have been designed to overcome the limitations of the HTML declarative programming model and to make it easier to write single page applications.

The Ankur programming language includes intrinsic support for HTML within its programming framework. This makes it easy to write client-side programming. This project will develop similar client-side framework for the Ankur programming environment. It will include the following:

- **Research and Design:** Research different client side programming frameworks. Analyze Ankur's support for client side programming. Develop a platform independent programming model. This model will unify the Web model as well the native application model on devices as well.
- **Implementation:** Implement the framework in Ankur.
- **Application:** Develop a simple application that highlights the capabilities of the framework.

8 Cloud-based IDE and Continuous Integration Tool

Topics of Interest:

- Integrated Development Environment
- Cloud
- Version control
- Automated Build
- DevOps

An Integrated Development Environment (IDE) allow rapid development of application. A continuous integration tool on the other hand allows integration in the version control system, the build system and automated testing process. Currently, no IDE or integration tools exist for Ankur. This project will involve building a cloud-based IDE and continuous integration tool for Ankur. It will include the following:

- **Research and Design:** Develop an understanding of the development, build, deployment and change management work flow. Research open source cloud-based IDE and integration tools that can be modified to support Ankur. Propose a software lifecycle management model for Ankur.
- **Implementation:** Implement the IDE and continuous integration tool.

9 Applications

We will also entertain innovative applications ideas from students. The goal would be to build a single application that can run on at least three platforms: iOS, Android, and Web browsers.



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