**Programming Web Applications in Finance**

## **Description**

This course aims to teach how to build web-based applications for finance. You will learn how to build interactive reports/dashboard/notebook, interactive rich data visualization in browser. You will also learn about how internet works, how to create a website with cloud computing infrastructure like Amazon Web Services. We will also study about the latest technology for internet, the cryptocurrency and payment system, Bitcoin and Blockchain.

The course will advance the knowledge and skills towards building real-world application for the internet. Web-based application is easily accessible worldwide only with a browser and there are powerful libraries to display financial data in browser. This skill is of very high practical value to the students because they can turn their knowledge to applications quickly and more ready for a career in finance. Spreadsheet running on desktop is not the working model for the future due to its “offline” nature and lack of tools; the now and future is all about web-based applications.

**After Taking the Course**

* Students are able to pick up new programming languages quickly, new programming paradigm (reactive, object-oriented) quickly, new functional libraries quickly.
* Students are able to do problem solving in large and small scales, i.e., understanding the structure of web/browser and make use of it.
* Students are able to independently and confidently complete computing projects.

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## **Teaching**

MFE course is fast-paced and intense. To mimic the experience of learning swimming, I approach the topic progressively following the order.

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| --- | --- | --- |
| **Stage** | **Objective** | **Teaching Method** |
| Build the foundations | To bring eloquence to languages and tools | Lecture |
| Challenge for application building | To follow instructors’ steps to build own applications | Guided exercise. Group-based.  Presentation. |
| Extend to thought-provoking topics | To present various novel ideas that make Bitcoin and Blockchain working | Lecture and seminar-based.  Group-based. Discussion. |

The foundation or web programming will be thoroughly covered in the lecture. Students are expected to self-learn from the reading materials.

**Syllabus**

**Lecture 1 and 2**: Foundation

1. What’s Web and what’s Internet?
   1. TCP/IP protocol: where IP address, network protocols, DNS
   2. HTTP(S) protocols
   3. URL
2. Languages
   1. HTML/CSS
   2. JavaScript
   3. Markdown: the language for static and interactive documents.
   4. R refresh
3. Development Tools
4. Amazon Web Services:
   1. How to setup S3 for storage, EC2 for virtual machine, Route 53 for DNS.

Reading: TBC

Assignment:

* Setup a website with AWS.
* Write a markdown document and publish it website.
* Use JavaScript to manipulate web page parts

**Lecture 3 and 4**: Applications (already running on AWS)

1. R Programming
   1. Interactive Web-based R application with Shiny framework
   2. Dashboard with Flexdashboard/htmlwidget in R
2. JavaScript
   1. Node.JS development framework
   2. React.JS application framework
   3. Full-stack Web application development with React.JS framework

Reading and self-study:

* Video lecture on Shiny/React.JS on YouTube.

Assignment:

* Write a new map-based interactive application
* Write a bond pricing program
* Algorithm trading analysis

**Lecture 5 and 6**: Extension Layer: Bitcoin and Blockchain

1. Bitcoin as an invention of many ideas
   1. Mining
   2. Blockchain data structure
   3. Consensus algorithm
2. Case studies
   1. “Genesis” Nakamoto, Satoshi (24 May 2009). "Bitcoin: A Peer-to-Peer Electronic Cash System"
   2. Smart Contract

* <https://medium.com/@ConsenSys/a-101-noob-intro-to-programming-smart-contracts-on-ethereum-695d15c1dab4#.rahuuy8uh>
* <https://bitsonblocks.net/2016/02/01/a-gentle-introduction-to-smart-contracts/>
  1. Practical
     1. Hard fork of Ethereum after a hacker stole tens of millions of dollars worth of digital currency.
     2. Bank of England: Staff Working Paper No. 605: The macroeconomics of central bank issued digital currencies - John Barrdear and Michael Kumhof
     3. Bitcoin Energy Consumption: <http://digiconomist.net/beci>

Reading: the papers listed in case studies.

Assignment:

* Do experiment with etherum for private blockchain
* Write a smart contract

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### **Resource**

1. AWS education grant: student can apply for grant individually from AWS Educate. Or, MFE office can apply for program-wide grant from AWS Educate.
2. Laptop
3. NTU library e-books.

### **Format**

* Six 3.5-hour lecture time
* Self-studying and Assignment: 3-5 hours.

### **Exam**

Session 7: 1.5 hrs. written exam (closed book) + 2 hr. coding (open book).

Coding Test: two questions: one for R and one for JavaScript. Possible questions are:

* Create a risk application
* Create a map-data visualization dashboard
* Generate a private blockchain.
* Building a web application with React.JS for trading/banking/shopping/voting with the private blockchain.