Developing a Data-Driven Learning Interest Recommendation System to Promoting Self-Paced Learning on MOOCs

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Abstract

The revolution of Massive Online Open Courses (MOOCs) brings great opportunities for millions of learners worldwide. Meanwhile, student-generated data on MOOCs could be effectively used to improve both the teaching and learning effectiveness. In this study, considering the habit of replay the video, a data-driven learning interest recommendation system called Videomark is proposed to identify the specific concepts that might interest leaners through integrating both the learner's logs and video subtitles in the Chinese-speaking environments. Videomark provide a "keywords cloud" learning interest/difficult reminding system based on learners' video watching logs and subtitles is proposed for promoting self-paced MOOC learning. By identifying the hot video segments (via video seek event counts) and weighting the keywords of hot video segments, we are able to establish the "keywords cloud" of each learning topic. This feature is valuable for learners to quick identify the most important or difficult concepts of each topic. This is also useful for the teacher to more understand which parts of the contents of each topic are most difficult for the learners which can be further improved. We hope that the proposed system help learners to review, consolidate, and clarify specific concepts in the video-based learning environment. The overall idea and steps will be presented in this study

Keywords -MOOCs, self-paced learning, keywords cloud, subtitles.

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Chapter 1

Introduction

Massive Online Open Courses (MOOCs) refer to an open educational resources, which allows learners worldwide to take well-designed online courses of interest free of charge. On MOOCs, learners watch the high-quality instructional videos made by professors from prestigious universities, share their ideas and reflections on the discussion forum, and use the online exercise system to evaluate their learning outcome. Due to the fact that the MOOCs provide with high-quality self-directed learning environment without costing much for online learners, MOOCs have been thought of as a contemporary way of 21-century learning.

There are two type of MOOCs, cMOOCs (connectionism MOOCs) and xMOOCs (instructionism MOOCs). These two types of MOOCs are base on different philosophical positions underpinning, cMOOCs focuses on connections between participants in particular on strong content contributions from the participants themselves [1], xMOOCs, by contrast focus on instructor's design of the course. Many famous MOOCs platform such as Coursera[2], edX[3], and Udacity[4] are belong to xMOOCs.

For current xMOOCs, the instructional videos play a significant role in the online learning process [5, 6]. In essence, the learning focuses in the form of visual and audial presented in the instructional videos. Traditionally, video-based learning follows structured instructor-designed sequences for the better results. Owing to the technological nature of the online stream video, it is found that many students drag the play bar replaying specific concept in the video for consolidating their understanding. Therefore, many studies aim to improve the video-based learning environment by adding additional features in video-watching, such as embedded assessment, caption tool, as so on.

In view of the rapid development of data sciences, more and more studies on educational data mining and learning analytics take the advantages of the learners' data to optimize learning process. For example, [7] develops a step-by-step annotations feature to improve the learning experience of existing how-to videos. Study [8] constructs a system that recommends students videos best on their forum post, making a self-solved confusion system and meanwhile reducing the teaching load. Therefore, considering the learning needs and the authentic learner data, this study develops a data-driven learning interest recommendation system to promote self-paced learning by integrating educational data mining and word segmentation in the Chinese-speaking MOOC environment. Videomark combines both the learning seek event counts and the subtitles of each video to automatically generate learning concepts for learners in friendly user interface. Through the huge amount of video watching/seeking log data, the Videomark helps learners to quickly identify popular video seek events for consolidating their concept of the learning focus in hope of promoting better self-paced video-based learning environment.

This thesis proposes a learning interest recommendation system on xMOOCs which is Videomark, the system generate keywords relatevive to lecture video content base on students' video watch activity records and lecture video transcripts. Moreover, each keyword collects video segment about the specific keyword. We hope this system will help students sketch the course when they first come to the class, and review the whole course after the course.

The remainder of this thesis is organized as follows. In Section 2, we first introduce two kinds of MOOCs and the data driven analysis researches on MOOCs In Section 3, the architecture of the proposed system. This system is composed of two system Share-Course [9] and our data service server. In Section 4, the detail of data service server and the interface we designed. In Section 5, the result experiments we did on two course. In Section 6, the conclusion and the drawback needed to be conquer.

Chapter 2

Related Work

2.1 MOOCs

2.1.1 Overview

MOOCs refers to massive online open courses, which is a online course platform people can access through internet connection regardless of the limit of space and time. MOOCs is normally free, credit-less and is designed for massive people to enroll and learn. Base on different theories, there are two kinds of MOOCs, cMOOCs and xMOOCs, which will mentioned in following section.

2.1.2 cMOOCs v.s. xMOOCs

Since "The year of MOOCs" [10], MOOCs have become increasingly robust and diverse in last few year. There are many websites provide MOOCs for different group in various way. Based on different learning theory, we classify MOOCs into cMOOCs and xMOOCs. cMOOCs are base on the learning theory of Connectivism, this kind of MOOCs focus on network between individuals in course. students may use any digital platform such as Facebook, Google+, blog to make connections with other learners to create and construct knowledge. The participants in cMOOCs act as teacher and learner at the same time as they share knowledge with each other. Instead of being structured as an open online community of learners, xMOOCs are much more like traditional classroom environment. xMOOCs are centered around class instructor, instructor will usually provide series of lecture video, where learners mainly get knowledges. Besides, exercises, quiz, assignments are also used during the course. Most of the popular MOOC websites in recent year are belong to xMOOCs such as Coursera, edX, Udacity, etc.

2.1.3 Coursera

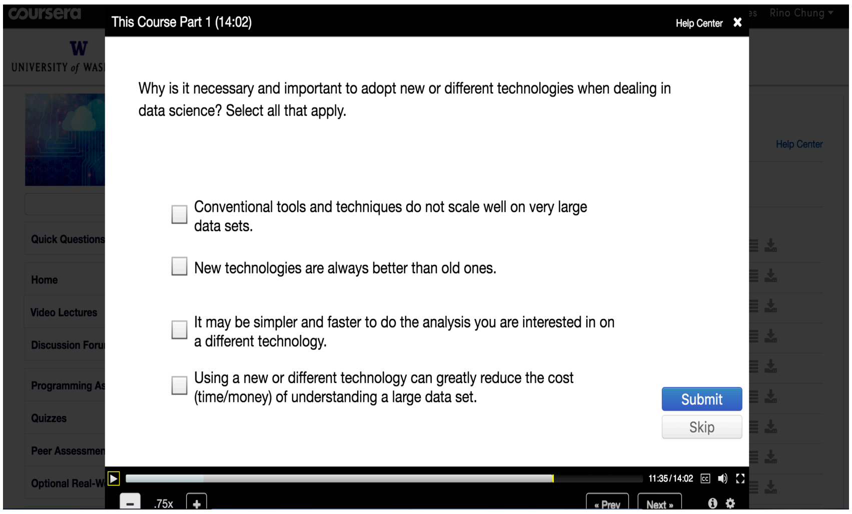

Figure 2.1: Coursera pop-up question in lecture video

Coursera [2] started in 2012 founded by Stanford University. It provides courses from renowned universities like Stanford University, Princeton University, University of Michigan, etc. Taking course on Course is free, learners can enroll courses that interest them at will. Applying for hard copy certification of course, however, will charge for some money. As a xMOOC platform, lecture videos are the major teaching material of courses with transcripts in many different language, usually after every one of two lecture video there will be a exercise for user to check if the had understand previous content of videos; moreover forum, quiz, assignments and other traditional xMOOC functions are also provide on Coursera. To make sure learners focusing on the lecture video, there is a pop-up question about current video in every lecture video see Figure 2.1. The question will let you submit three times, and if all the answers are wrong in three submission system will tell you the answer but learners can chose to continue the video without answering the question. Coursera also has iOS, Android, and Kindle Fire apps.

2.1.4 edX

edX [3] is also a xMOOC platform, which founded by Harard University and MIT at 2012 offering high-quality courses from universities and intuitions to learners. As a xMOOC too, edX and Coursera are pretty alike. Free for taking courses, center on lecture videos whit the supports like forum, exam, and other features most MOOC platform has. Similar to Coursera, edX has a certificate system, which you can apply for hard copy proof when you pass the course; it will charge you certificate fee, however, the price is slightly lower than Coursera. Besides the majority of courses are taught in english, edX also provides some foreign language courses.

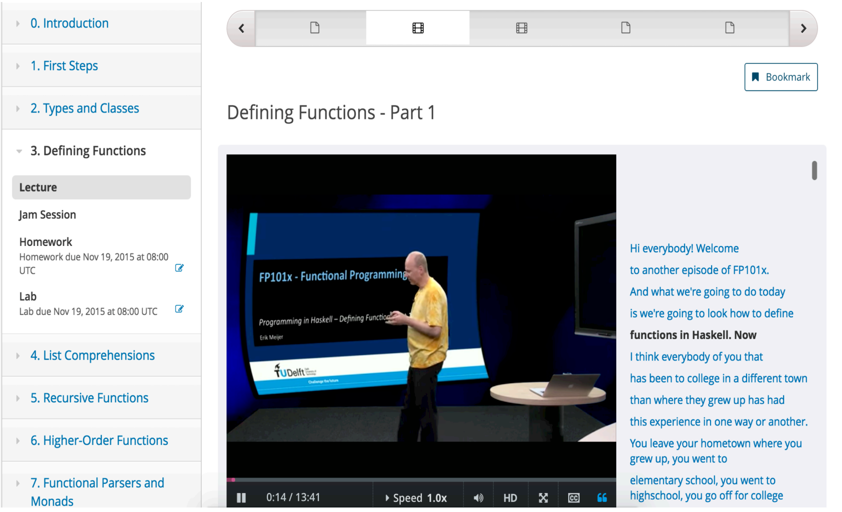

Figure 2.2: edX transcript redirect function: redirect video to specific section by transcript content

edX has transcript redirect function on the right of the player see Figure 2.2. This function is helpful for learners to know what is the video talks about before go through the whole video or help them easier to target the segment they what to replay again.

2.1.5 Open edX

Open edX is a free and open source course management system that was originally developed by edX. Among Open edX, there are many useful tool or model for constructing a course already be done, see Table 2.1. With the help of Open edX, people around the word can build and host their own MOOC, take xuetangx [11] for example, a famous MOOC website in China for Chinese speaking learners that built based on Open edX.

Table 2.1: Open edX features

Feature	Description
Open edX Studio	Studio is the Open edX tool that used to build courses, which provided with a GUI interface make users easily edit courses through a browser. You use Studio to create the course structure and then edit course content, including problems, lecture videos, and other resources for learners. You also use Studio to manage the course schedule and the course team(instructors, tutors), set grading policies, publish each part of your course, and more.
LMS	LMS in the Open edX is a tool that learners use to access course resources and to check their learning progress in the course. The Open edX LMS can also offer a discussion forum and a wiki that both learners and course team members can contribute to.
XBlock	XBlock is the component architecture for the elements of an Open edX course. Platform developers can adjust course components to meet instructors' need. For instance, you can build XBlocks to represent course contents such as problems, text string, or HTML content to implement interactive learning laboratories. The primary advantage of XBlocks is that they are deployable in any edX Platform or other XBlock application, which make the code you write can be used by any course team and vice versa.
Open edX Insights	edX Insights is a course analytics system in Open edX, course team can use collected data to monitor learners' activities, learning patterns, reveal problems might confuse learners, or do researches base on these data to refine courses.

2.1.6 Data-Driven Analysis

Since MOOCs are becoming increasingly popular, thousands of lecture video clickstream data are produced. Many studies do research on applying clickstream data to observe user learning behavior and what's more, the meaning of user learning behavior [12]. The information provided by user clickstream data can help not only instructor to improve but also to optimize the learning experience of lecture video watcher. Paper [13] develops a analytic system is proposed to help analyzing user behavior by using video clickstream data (see Figure 2.3).

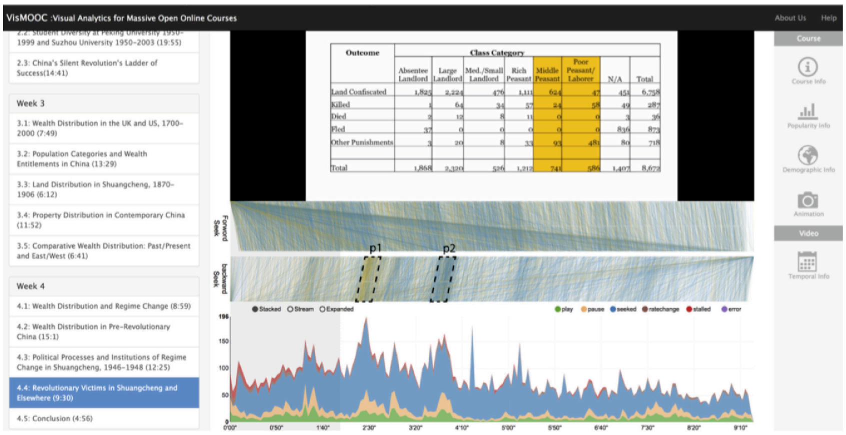

Figure 2.3: Screenshot of visMooc

Seek graphs analysis in visMOOC is a feature to understand leaners proactive information seeking behavior on watching videos. From the seek graph we can observe some video segments of interest with dense seek lines 2.4. In this thesis, we use the similar concept to find the hot segment.

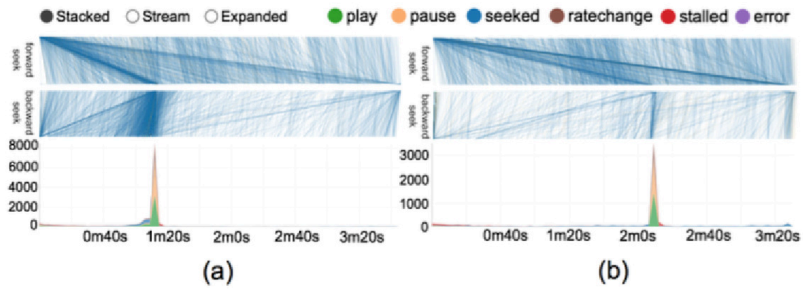

Figure 2.4: visMooc Seek Graph Analysis

Chapter 3

System Architecture

In this thesis, we design and implement a data-driven learning interest recommendation system and integrate with current MOOC platform. In this chapter, we will introduce the system architecture and course data flow in two different course scenario. Moreover, we will also introduce the website MVC design and the user activity modules.

3.1 Layer Structure Overview

This system can be divided into three parts: user interface, web server and data-service server. (see Figure 3.1). User interface is focus on processing user's interaction and contains two parts, website view and data analysis view. Website view is contents provided by web server, which contains all MOOC learning and management features for users to interact with, Data analysis view, on the other hand, is the content of analyzed result based on events triggered by users, which will presented by visualizing the processed data. Web server is mainly handling requests from user interface. Data-service is a API server collects user interface's activity data and analyze it afterward, and furthermore send back the analyzed data result back to user interface whenever user send a specific request to data-service server.

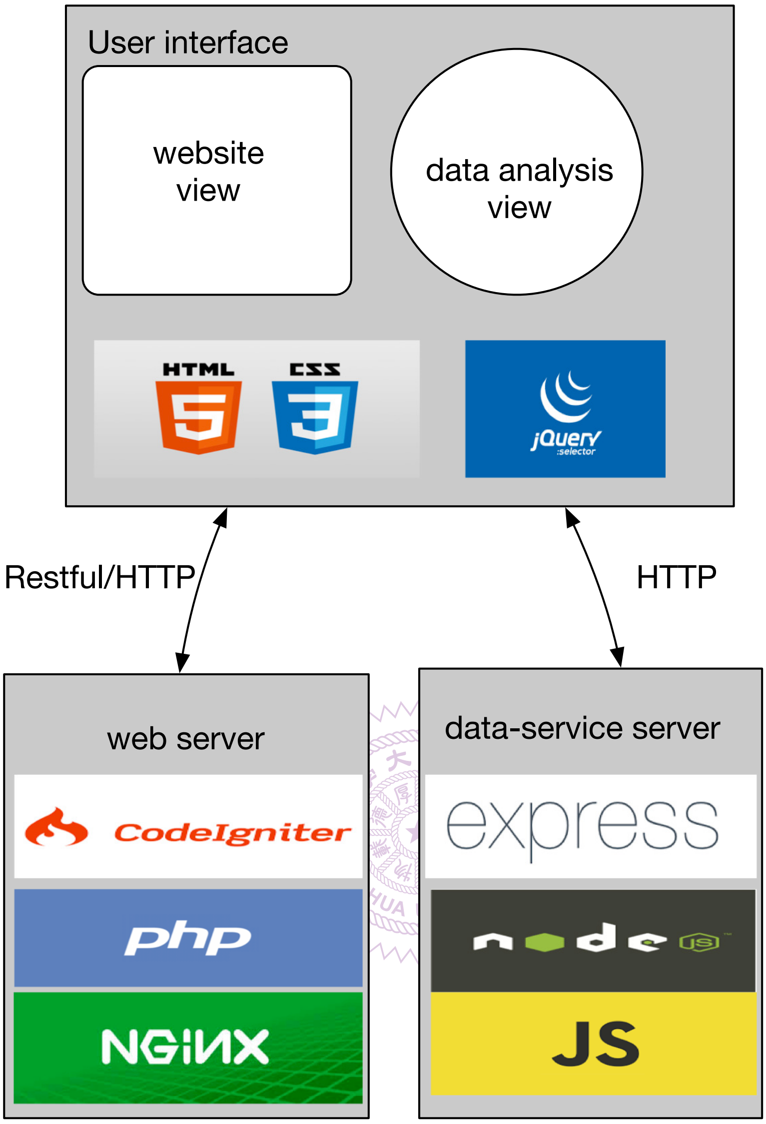

Figure 3.1: layer structure overview

3.2 Website MVC Design Pattern

MVC (Model-View-Controller) is a kind of design patter in software engineering, it separate application into three interconnected parts, model, controller, and view [14] (see Figure 3.2). Controller act as the brain of application, dealing with users' request and converts requests into command for model and view. View provides user a Graphical User Interface (GUI) to display application's state. Model is the only one who can access data base directly, sometimes it represents a schema of table or specification or the data type.

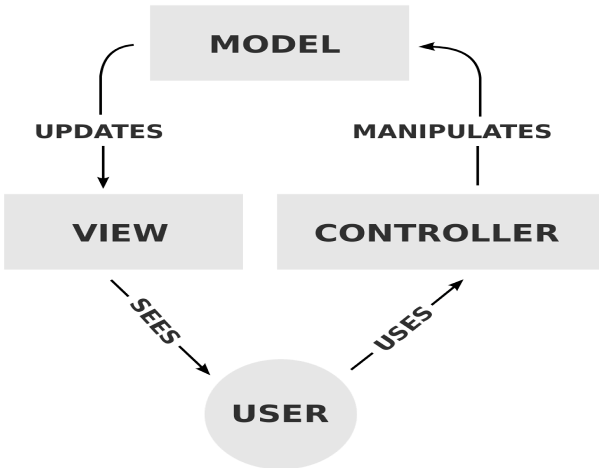

Figure 3.2: Collaboration of MVC elements

3.3 Activity Modules

User activity data play an important role in the proposed system, in order to analyze user's activity pattern when learning on website we designed four activity module for different scenario (see Figure 3.3) each activity module composed of multiple action which maps to user's activity. First, account module records user's log into and logout from the website. Second, page module records user's trail since he/she log in to the website, every record is tagged with "leave" or "access" to note action that triggered the record so that we can monitor user's web page activity. Third, forum module has three action, “post”, will records user’s forum post, “reply” records which user give another poster a reply and “like” records user click like button on specific post and reply. Finally, video module is the most complicated module among activity modules, “play”, “pause”, “seek”, “change rate” are actions that user interacts with player, and “leave when pause”, “leave when play” are actions that user leave the lecture video page.

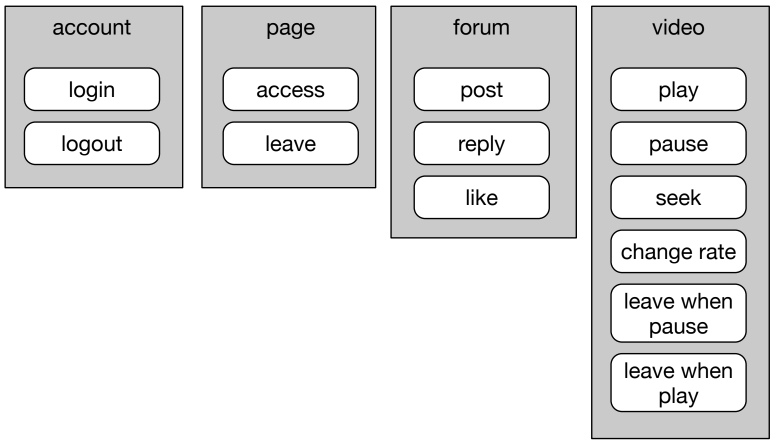

Figure 3.3: User activity modules

3.4 System Architecture

Figure 3.4 illustrates the system architecture, which shows the detail of each parts. The whole system is constructed from two subsystem, web server and data-service system, these two system are run independently. Web server is a entry for user to get access to this system, through the browser user makes requests to web server to get pages they want; moreover it contains the most logic of web application and responsible for front-end presentation to the user. Data-service server is a pure API-server without front-end views, which responsible for collecting user activity data and analyze collected data. Whenever users interact with view element such as click button, click play on website embedded player, leave pages, etc. on the views provided by web servers (website view in Figure 3.1), a data will be sent to data-service server as a record. After every period of time, the data in data-service server will be analyzed by our algorithm and generate refined data. Finally, we send back the refined data back to user interface at the time users call the related api on data-service, the browser will render the result based on refined data (data analysis view in Figure 3.1).

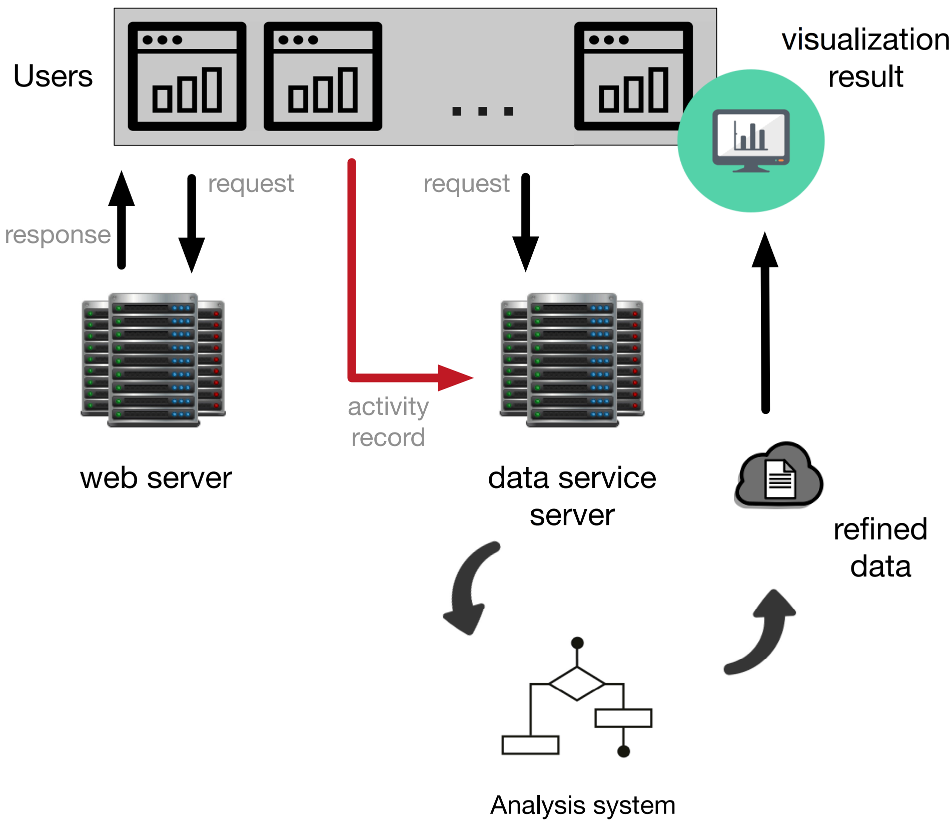

Figure 3.4: system architecture

3.5 Course Data Flow

On MOOCs, there are two course starting models can be seen, one is course that had open before and reopen, which is old course, the other is new course that never opened before. In view of keeping presented data updated, system should store refined data for user to access and simultaneously store new data for future analysis, to do so, we design two data flow for two different starting model. To begin with, data flow of new course (see Figure 3.5) focus on maintaining a schema for system easy to store and be serialized. Moreover, to make system runs as a automation process we setup a worker to send a request to update data to data-service server every period of time.

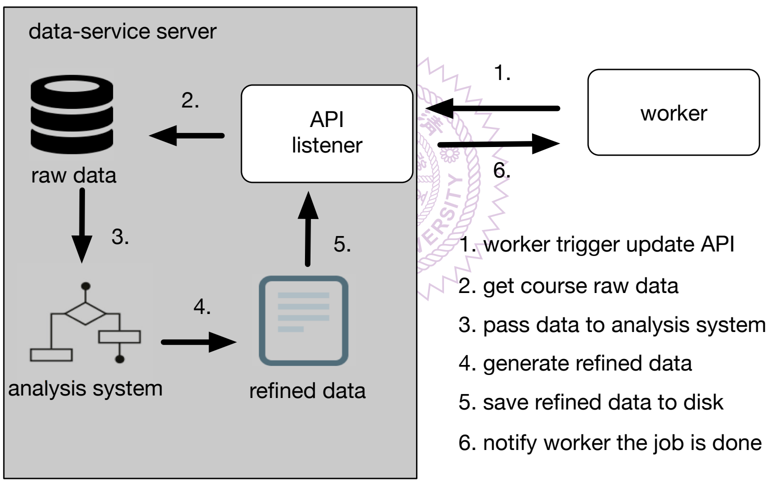

Figure 3.5: new course data work flow

For new course that had never opened before (see Figure 3.5), we simply query the data base and send the return data to analysis system and then generate and store back the new refined data to replace the old one.

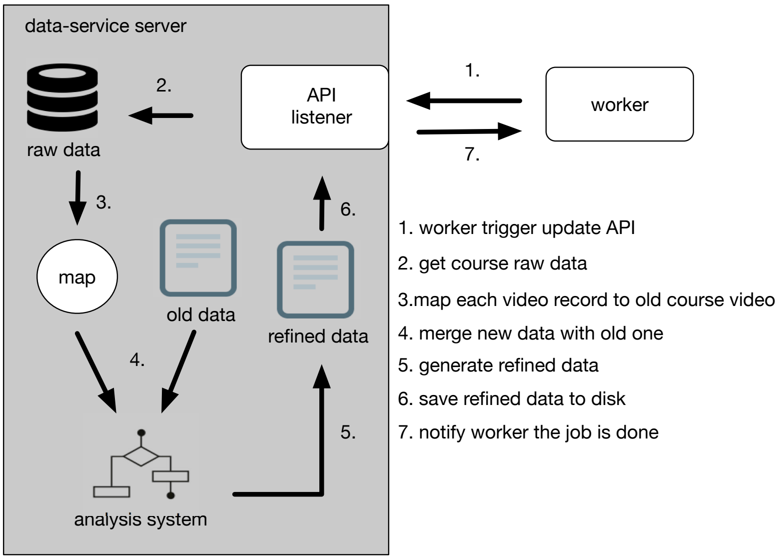

Figure 3.6: old course data work flow

On the other hand, processes to generate refined data for old courses is more complicated (see Figure 3.6), the challenge of the scenario is derive from data structure of MOOC platform, since there is no inherited relationship between courses. To solve this issue, we maintain a map table for classes that have inherited relationship to map each lecture video in the course, so that we can merge the old course data with new one.

Chapter 4

System Implementation

In this chapter, we will talk about the implementation detail of the proposed system and will focus on the function on data service server's environment and techniques.

4.1 Data Service Server Environment

4.1.1 Node.js

Node.js [15] is a open source JavaScript application framework written in C [16], C++ [17] and JavaScript [18] Node.js can run on many operation systems like Microsoft Windows, Linux, Mac and embedded system like Raspberry, Cubieboard. There are many advantages of Node.js. To begin with, it use V8 JavaScript engine to boost performance, which make it much more better than other script language. Second, it's event driven and non-blocking I/O feature is surprisingly appropriate to both front-end and back-end of web application. Third, as a popular programming language like Python and Ruby, there are many third-party module on the word wild web that developers around the world wrote, we can make use of these modules to accelerate time developing apps. What's more, the module is managed properly by Node.js package management (npm), which make it easy to import modules.

4.1.2 Asynchronous Process Control

Since Node.js is JaveScript with extensional function, the event-driven feature in JaveScript is to Node.js, as a result we can often see asynchronous design model in JavaScript code. The idea of event-driven and asynchronous is run the job need long time to finish in the back-end event engine to avoid the job block all the process. After that, we will set a callback function to inform the process when the time consuming job is done. Figure 4.1 shows the idea of asynchronous process control.

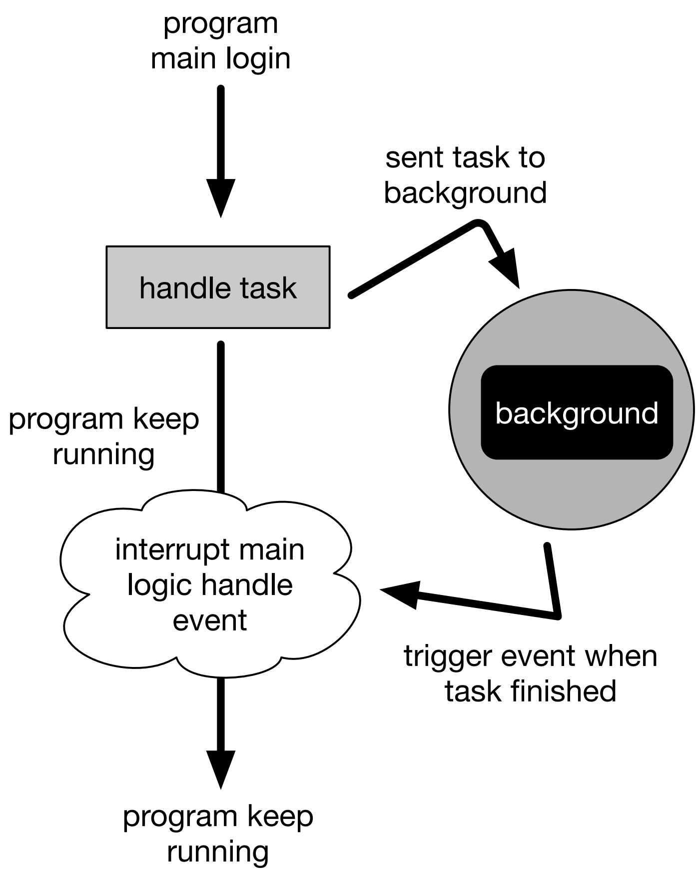

Figure 4.1: Asynchronous process control model

4.1.3 MongoDB

MongoDB [19] is an free and open source no-sql database, data in MongoDB saved as a json-like document with dynamic schemas (BSON). MongoDB can handle big data in scale in Terabytes with its high performance and it's schemaless database structure also make it easy to integrate data in certain type of applications easier and faster.

4.1.4 Google Cloud Platform

Google Cloud Platform [20] is a platform integrates Iaas, Paas and Saas. According to the website, it provides eight categories of service, including basic virtual machine renting, database hosting, big data analysis, machine learning and more.

4.1.5 Iron Worker

Ironworker [21] is a service on Iron.io, which make developer setup a worker on website with flexible scheduling setting. Once developer setup the worker, Ironworker will monitor the worker, and if any thing go wrong, Ironworker will notify you by email with detail information.

4.1.6 Jieba

Jieba [22] is a open source python Chinese text segmentation module which provide friendly API for developers, it is now support python2, python3 and can be installed by pip or other python package management module. Jieba segment the text by it's own dictionary on default, however it allow developers to edit or replace the dictionary which Jieba used to segment text. In our analysis system, we use this flexible tool to segment out subtitle base on our custom dictionary file.

4.2 Server Setup

In order to construct out server, we rent a VM instance machine type:n1-standard-4 (4 vCPUs, 15 GB memory), and on top of that we run a mongoDB on the same machine. After setting up the environment, we execute the Node.js api server connected with the mongoDB to save the data to database and to provide other API for query data. Among APIs the server provide, there is a API will triggered by the worker we set once a day, this API is designed for execute a python script, which is our data analysis system that will update the refine data (see Figure 4.2).

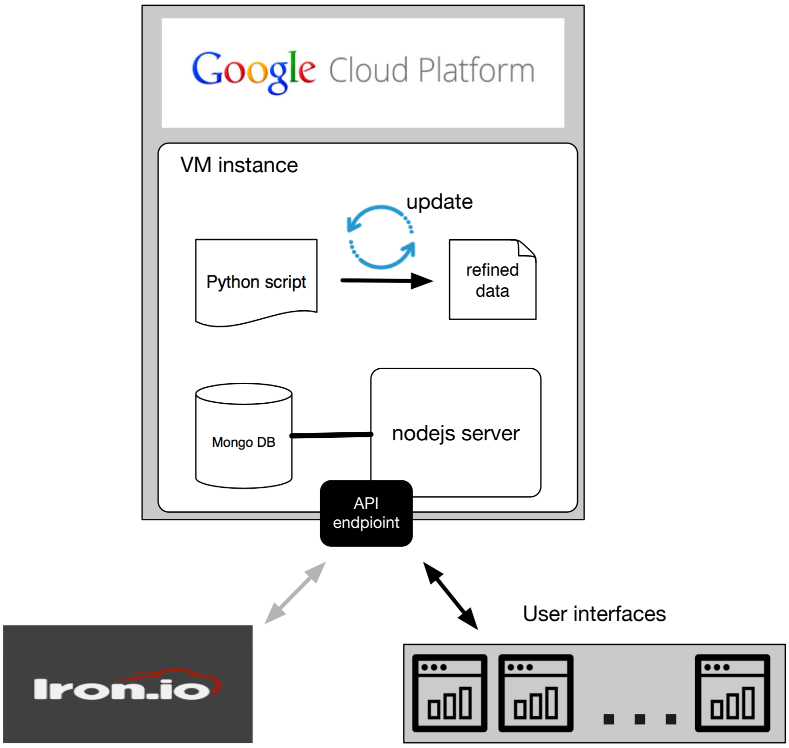

Figure 4.2: server setup

4.3 Data Service API

4.3.1 API's Collects User Activity Records

We discussed activity models in Chapter **??**, in table 4.1 shows the APIs that data service server provided for recording activity records belong to different activity models, and the schema column of table pictures out the data structure stored in mongoDB. Among the schema of all model, action field denote the situation user interacted with the platform object.

Table 4.1: APIs records user activity

method	url	purpose	schema
POST	/login_data	records user's log in/out activity	action: String userId: Number userAccount: String time: ISODate
POST	/page_data	records user's trail on website	action: String userId: Number userAccount: String page: String courseId: Number chapterId: Number time: ISODate
POST	/article_data	records user's forum activity	action: String userName: String userId: Number userAccount: String courseId: Number object_article_info: {article_Object} time: ISODate
POST	/post_data	records user's exercise activity	exerciseId: Number exerciseType: String correctAns: String execOrder: Number courseId: Number getScore: Boolean execTotalCount: String userId: Number studentAns: Array time: ISODate
POST	/video_data	records user's video player activity	action: String userId: Number userAccount: String videoStartTime: Number videoEndTime: Number videoId: Number videoTotalTime: Number courseId: Number chapterId: Number chapterVideoCount: Number chapterVideoOrder: Number playRate: Number time: ISODate

4.3.2 API's Record Usage of Videomark

In order to understand whether the feature Videomark improve student's performance on learning, we recorded the usage data of Videomark by another set of APIs. Table 4.2 shows the detail of these APIs.

Table 4.2: Videomark APIs

method	url	purpose	schema
POST	/cloud/saveLog	record which keyword in keyword cloud been clicked	userId: Number courseId: Number chapterId: Number videoId: Number word: String time: ISODate
POST	/cloud/saveUrlLog	records which hyperlink in hyperlink section been clicked	userId: Number courseId: Number chapterId: Number videoId: Number time: ISODate
POST	/cloud/openCloud	records action that user open keyword cloud	userId: Number courseId: Number chapterId: Number videoId: Number word: String time: ISODate

4.4 Analysis System

Analysis system is a important role of the proposed system, we use users' video watching activity records to observe users' watching patterns and find out video sections that are possibly is the difficult part in lecture video for users, we call these video sections "hot segment". As long as we find out hot segment, we integrate further these hot segments with video subtitles to map out what concepts were mentioned in the video section, which is "Videomark" in this thesis. In this section we will explain how we generate Videomark with combination of difficult lecture videos section and segmented subtitle.

4.4.1 Counting the Video Seek Events

The collected video seek event refer to the event that leaners drag the play bar to relocate the start point of the video while watching a video. In other words, two specific time stamps, the start time and the end time, are collected. The end time is the starting point of the specific part that leaners want to watch again. Considering the continuation of the timeline, the timeline is split into small segments to improve the accuracy of the concept for further analysis. In this study, based on the experiments, the duration of a segment is designed to have 40 seconds. Thus, the 1st segment is from 1 to 40 seconds, the 2nd segment is from 41 to 80 seconds, and son on. Nevertheless, a learner usually didn't drag the play bar to the correct watching position at the first time. It is found that the average number of seeking events before the learner getting the final position is around 2 to 5. These kinds of seeking events should be ignored as they are just for "looking" the right position. To do this, a seek event is ignored if the time interval between this seek event with its previous seek event is less than two seconds. To find out the "hot learning interests or difficult point", the "hot segment" of the video are first identified based on the number of video seeking events and then the "keywords" included in the subtitles of these hot segments were processed, see Figure 4.3.

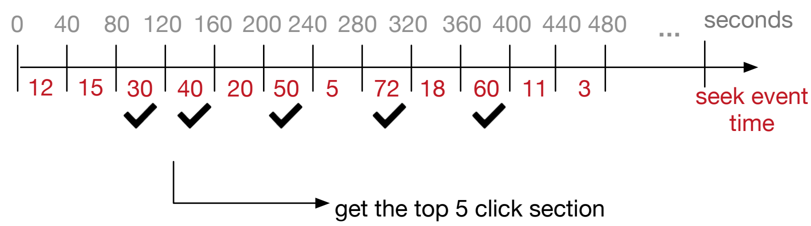

Figure 4.3: counting seek event find hot sections

4.4.2 Subtitle Segmentation

The subtitles of the videos are processing to extract the "keyword" of the learning concept. In this thesis, all the subtitles are provided by Chinese. Jieba is used to split subtitles into several meaningful chunks of word in the sentence level. To improve the accuracy, two extra processing were used. First of all, since the contents of subtitles are colloquial, some stop-words will be mistakenly seen as keywords, such as "this", "that", "because", and "so". Therefore, those stop words are added into the stop-word dictionary to avoid the redundancy. Secondly, the word-frequency dictionary is adjusted for better Jieba results. The keyword-frequency stands for the keyword weight. The higher the weight of a keyword, the more likely the keyword is valued as a meaningful chunk. Finally, if some teacher wants to make keyword more precisely we will ask them provide a concept file, this concept file will act as a filter leave only words in file, Figure 4.4 illustrate the idea of subtitle segmentation. The results of processed subtitles (keywords) are combined with the seek event counts (hot segments) to identify the "hot keywords" of the specific topic.

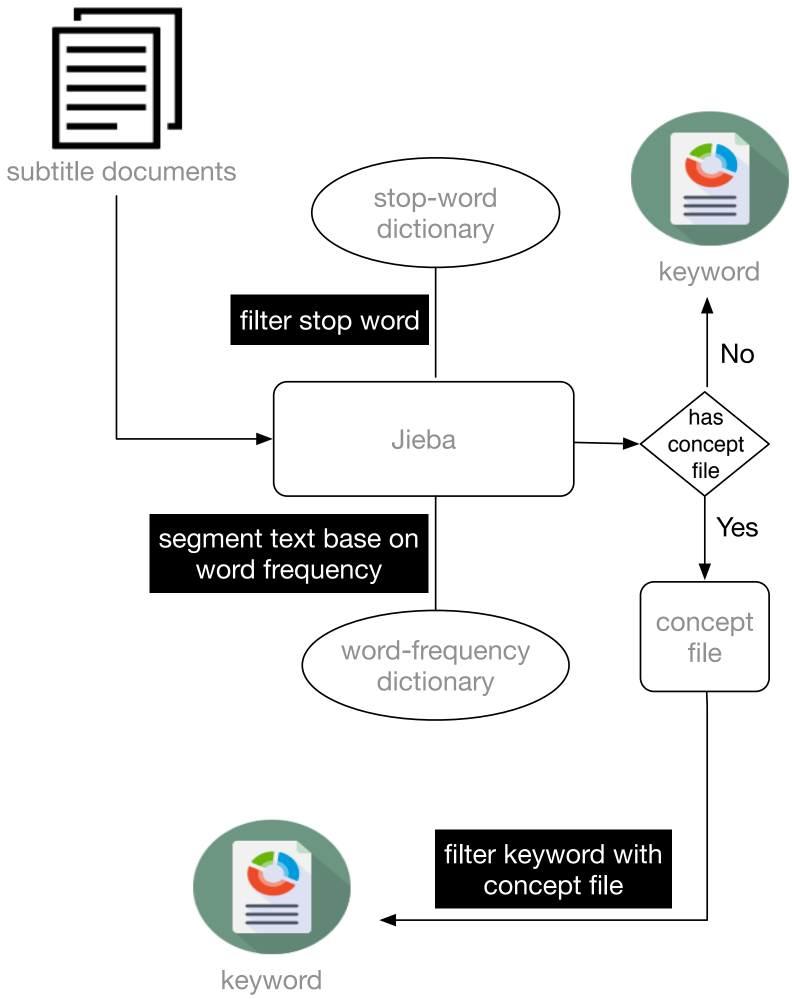

Figure 4.4: subtitle segmentation

4.4.3 Weighting the Keyword

After the preprocessing of the video seek event counts and identified keywords, the third step is to calculate the weight of each of the keywords. In this study, for each video, the top five weighted keywords are collected into the keyword cloud. Figure 4.5

depicts the “keywords cloud” of week 1 of the course 2016 spring Network Security on ShareCourse. The larger size of keyword means that more learners are interested or feel difficulty in that keyword (concept). Thus, the video segments introducing this keyword were watched more frequently. For example, in Figure 4.5, the “SYN”, “DDoS” and “Flooding” are the biggest (hottest) three keywords in the keywords cloud, meaning that those concepts are most interested in or difficult of the learners.

Figure 4.5: keyword cloud example

4.5 User Interface

4.5.1 Environment

4.5.1.1 ShareCourse

ShareCourse [9] is a famous MOOCs platform in Chines speaking countries, which provides both Web and mobile service. Since 2012, ShareCourse has been providing more than 1,000 courses with over 60 cooperative universities in Taiwan. Up to the precent, more than 60000 students have registered on ShareCourse. ShareCourse provide a environment with complete functions for MOOCs learners in terms of instructional videos, peer-grading quiz/assignment, discussion forum, weekly exercise, and certificate.

4.5.1.2 D3-cloud.js

D3-cloud [23] is a JavasCript module which can make texts turn into cloud layout on the web page, we use d3-cloud to present the result of data analysis system to user, providing them a friendlier and fancier data visualization view.

4.5.1.3 Bootstrap

Bootstrap[24] is a open-source and free front-end web framework for design website and web applications, it contains html, css and JavasSirpt-based template for typography. Useful elements such as button, modal, grid system and more are provided which makes developers create beautiful custom website easily.

4.5.1.4 jQuery

jQuery is a [25] cross browser javascript library simplify the manipulation of javascript to control html DOM elements and provides features like event-handle, animation and ajax. Ajax, one of the feature of jQuery, make it possible to perform cross-browser Ajax requests using `$.ajax`, Figure 4.6 shows an code that ajax post a hash variable `data` to url `http://API_endpoint/saveData`. If the request succeed `.done()` in line 8 will be triggered; otherwise `.fail()` in line 10 will be triggered. This kind of usage in example can be linked with elements in web page to create different user interactive scenarios. Ajax also follows the asynchronous mechanism so that any single ajax execution or failure will not cause page crash or been locked.

```
$.ajax({
  type: 'POST',
  url: 'http//:API_endpoint/saveData',
  data: {
    name : 'John',
    location : 'Boston',
  },
}).done(function(msg) {
  alert('Data Saved: ' + msg);
}).fail(function(xmlHttpRequest, statusText, errorThrown) {
  alert(
    'Your form submission failed.\n\n'
      + 'XML Http Request: ' + JSON.stringify(xmlHttpRequest)
      + ',\nStatus Text: ' + statusText
      + ',\nError Thrown: ' + errorThrown);
});

```

Figure 4.6: Ajax post example

4.5.2 Videomark Page

All the Videomark feature are start with the keyword cloud, we add a button at bottom of lecture video page labeled with “keyword cloud” as shown in Figure 4.7.

Figure 4.7: Videomark feature open keyword cloud button

Once the button been clicked, the browser will use ajax to send a post request to data service server to get weighted keyword data. The return data of ajax request will be a json format containing keywords in the chapter that user is now watching at, moreover, each keyword will connect to a bunch of concept-related video information. D3-cloud.js will handle the json data afterward and draw out the keyword cloud see Figure 4.8.

Figure 4.8: keyword cloud shows up

In keyword cloud, size of keyword reveal how important the keyword is, and the information of keyword size will be in the return data of API we mentioned above. In fact, keywords in keyword cloud will be a clickable button, and if the keyword is clicked, another section contains multiple hyperlink, we call it hyperlink section, will show up at the bottom of keyword cloud. Figure 4.9 shows the result we click "DDos" in keyword cloud, and a section contains four hyperlinks shows up.

Figure 4.9: hyperlinks show up on click the keyword in cloud

For each hyperlink, the label is used to tell users the hyperlink will bring them to which video and on which seconds in this chapter. In Figure 4.10 show the result we click the first hyperlink or DDos hyperlink section, a tab of video player poped up and start the video from 10:00(600) seconds which matches the seconds of hyperlink label and the video is talking about DDos as well.

Figure 4.10: open new tab playing start from Video ark

Chapter 5

Experiment

5.1 Overview

Since we are curious about whether Videomerk helps user or not, Videomark had been applied in two courses on ShareCourse. In this chapter we will validate the effects of Videomark by records of user activities and usage of Videomark. We will focus on user learning performance and learning engagement.

5.2 Introduction to Computer Networks (2016-spring)

The first course we applied Videomark in Introduction to Computer Networks (2016-spring), we analyzed the learning performance and learning engagement by comparing users' activity records between users' learned with and learn without Videomark feature. Table 5.1 shows the basic information of the course.

Table 5.1: Base Information of Introduction to Computer Network

course duration	2016/2/15 - 2016/5/18
chapter count	9
video count	97
student number	2577
exam time	2
pass students	113
pass rate	4.28%

5.2.1 Learning Performance

We classify user enrolled this course in two categories, user learn with and learn without the help of keyword cloud. If a user did click the word in keyword cloud, we classify the user into the side that uses keyword cloud, and vice versa. However, user that never applied any exam will not classified into both categories. Table 5.2 compare the average score in two exam, and the final pass rate of the course.

Table 5.2: Comparison User's Learning Performance

	Users learn with keyword cloud	User learn without keyword cloud
persons	12	2080
1st exam average score	91.26	76.55
2ed exam average score	91.19	81.69
pass rate	83.3%	51.04%

5.2.2 Learning Engagement

In addition to learning performance, we also analyzed the frequency of video watch, forum activity records to observe whether Videomark will boost the learning engagement. As same as the way we classify user to compare learning performance, the result of learning engagement comparison is showed in Table 5.3

Table 5.3: Comparison User's Learning Engagement

	Users learn with keyword cloud	User learn without keyword cloud
average watch time per week	124	28.56
average forum post	6.1	2.51
average forum reply	13.25	3.61
average forum like give	6.95	3.13

5.3 Network Security (2016-spring)

The second course we applied Videomark is Network Security (2016-Spring), the course information shows in Table 5.4. We do the same data-driven analysis on users' learning performance and learning engagement. In addition, we observed the video watching pattern after enter the recommended keyword video segment to understand whether the feature is useful for them. At the end of the course, we made a questionnaire to get users' feedback about user interface usage experience and feeling after using the Videomark feature.

Table 5.4: Base Information of Network Security

course duration	2016/4/15 - 2016/6/21
chapter count	7
video count	51
student number	2841
pass students	xxx
pass rate	xx%

5.3.1 Performance of Learning

5.3.2 Engagement of Learning

Table 5.5: Comparison User's Learning Engagement

	Users learn with keyword cloud	User learn without keyword cloud
average watch time per week	124	28.56
average forum post	6.1	2.51
average forum reply	13.25	3.61
average forum like give	6.95	3.13

5.3.3 Questionnaire

Our questionnaire is designed base on three research question.

1. Is Videomark improves users' learning performance.

2. Is Videomark improves users' learning engagement.

3. Is Videomark user interface easy to use or easy to learn.

Table 5.6 show the questions and result about improving learning performance the numbers in table is the percentage of the answer. The result shows that half of user believe Videomark will positively effect their performance.

Table 5.6: Performance of Learning

	學習成效增進程度	非常同意	同意	不確定	不同意	非常不同意
1.	關鍵字雲讓我更容易記住影片中老師講的內容	34.7	48.6	15.3	1.4	0
2.	我對每個章節的關鍵字有深刻的印象	27.8	56.9	0	0	0
3.	我更容易記住與關鍵字相關的內容	30.6	51.4	16.7	1.4	0
4.	關鍵字雲使我在課程開始前能瞭解課程大致內容	29.2	48.6	19.4	0	0
5.	關鍵字雲讓我更容易了解課程的重點	26.4	58.3	12.5	2.8	0
6.	關鍵字雲讓我更容易了解章節內容的架構	27.8	43.1	26.4	2.8	0
7.	關鍵字雲對於我幫助我更快的複習課程	22.2	51.4	25	1.4	0
8.	關鍵字雲讓我更快找到課程中遇到的問題點	16.7	43.1	29.2	11.1	0
9.	關鍵字雲使我在日常生活中網路安全的應用有更多的了解	25	43.1	26.4	5.6	0

Table 5.7 shows the feedback about learning engagement effects of Videomark.

Table 5.7: Engagement of Learning

	學習投入增進程度	非常同意	同意	不確定	不同意	非常不同意
1.	關鍵字雲讓我更想解決我不懂的問題	11.1	62.5	19.4	6.9	0
2.	關鍵字雲的功能讓我更有動力上ShareCourse學習	16.7	30.6	31.9	20.8	0
3.	關鍵字雲讓我在課程的重點更加專注	18.1	54.2	19.4	8.3	0
4.	關鍵字雲增加我在ShareCourse上課的次數	11.1	25	48.6	15.3	0
5.	我會重複觀看關鍵字雲標註的內容片段	19.4	45.8	22.2	12.5	0
6.	我會更常思考關鍵字雲裡面出現的重點	16.7	66.7	13.9	2.8	0
7.	我會特別觀注關鍵字出現的討論串	23.6	44.4	26.4	5.6	0
8.	關鍵字雲使我更想要在討論區發表問題	5.6	23.6	59.7	9.7	1.4
9.	關鍵字雲讓我更積極回應討論區的問題	6.9	25	56.9	11.1	6.9
10.	配合關鍵字雲學習讓我感到心情愉快	13.9	50	30.6	5.6	0
11.	我會期待看到新一週的關鍵字雲	15.3	43.1	30.6	11.1	0
12.	看到新一週的文字雲後我會更想觀看本週課程	18.1	44.4	33.3	4.2	0

Table 5.7 shows the feedback about user interface experience of Videomark.

Table 5.8: Usage of Keyword Cloud

	使用經驗	非常同意	同意	不確定	不同意	非常不同意
1.	我能夠容易地找到展開關鍵字雲的按鈕	22.2	52.4	16.7	6.9	0
2.	展開後的關鍵字雲的位置非常明顯	25	51.4	15.3	6.9	1.4
3.	我能容易的找到在點擊關鍵字後出現的關鍵字連結	13.9	63.9	16.7	2.8	2.8
4.	我能清楚地看出關鍵字雲中字的大小清楚的分別出各個關鍵字的重要性	25	56.9	16.7	1.4	0
5.	關鍵字雲的影片連結能帶領我到正確的影片位置	13.9	63.9	19.4	2.8	0
6.	我認為關鍵字雲放置的地方非常合適	16.7	58.3	20.8	4.2	0
7.	關鍵字雲內的關鍵字是課程真正重要的概念	19.4	50	29.2	0	1.4

Chapter 6

Conclusion and Future Work

In this thesis, a “keywords cloud” learning interest/difficult reminding system (LIDRS) based on learners’ video watching logs and subtitles has been developed for promoting self-paced MOOC learning. By identifying the hot video segments (via video seek event counts) and weighting the keywords of hot video segments, we are able to establish the “keywords cloud” of each learning topic. This feature is valuable for learners to quick identify the most important or difficult concepts of each topic. This is also useful for the teacher to more understand which parts of the contents can be further improved for each topic. To the best of our knowledge, this is the first content based interest analysis and recommendation system supports the Chinese-speaking and Chinese-subtitles environment. Furthermore, our experiments of two course proves the proposed system improves users’ learning performance and their learning engagement, both questionnaire and cloud usage record can match with each other to explain the same result.

Beyond design and implementation result,there is still a lot of improvement we could make to promote the usage or optimize the user perception in the future. Base on our observation, keyword cloud is the feature user like the most but rare of them used Videomark to watch video non-sequentially, the reason of this phenomenon may cause by the user interface design or user’s preference. It still lacks of empirical evidence to explain the low Videomark usage rate.

1. Manually input subtitle

The proposed system analyze keyword in course is heavily rely on lecture video subtitle, our subtitle is manually generated firstly before the course begin and double checked. However not every course has subtitle file for all the video, and regenerate subtitle file for all these course is not a efficient solution. As a result, tools can auto generate Chinese speaking lecture is needs to be developed to break through the limitation.

2. User Interface

Base on the feedback of questionnaire the web page of Videomark will sometimes confuse user. Our design to hide urls of keyword at the beginning of user access to this page will sometimes make user doesn't aware that the url section exist and this may be the reason why our usage rate of keyword url click is so low. We should put more effort to find and use our features easily.

3. Other Category of Activity Record

In the proposed system, we analyze only seek event to find out the learning interest in the video, but actually our system also collected click stream data including play, pause and change play rate. Combining these action, the analysis result may be more accurate.

Currently the "keywords cloud" is constructed for the Chinese-speaking and Chinese-subtitles environment. More specific, innovative, and learner-centered features especially for the video-based learning environment can be further developed in the future.

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