

**A DEVELOPMENT OF RECOMMENDER SYSTEMS TO FIND
APPROPRIATE CANDIDATES FOR RECRUITMENT WITH
COLLABORATIVE FILTERING**

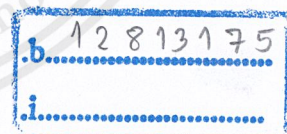
**CHANAWEE CHAVALTADA
PANPAPORN LIKITPANITKUL**



E078016

**ADVISOR
DR. MANOP PHANKOKKRUAD**

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เลขทะเบียน.....
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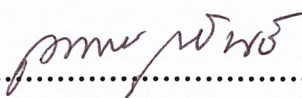
TITLE : A DEVELOPMENT OF RECOMMENDER SYSTEM TO

FIND APPROPRIATE CANDIDATE FOR RECRUITMENT

WITH COLLABORATIVE FILTERING

BY

- 1. MR. CHANAWEE CHAVALTADA STUDENT ID 54070014**
- 2. MS. PANPAPORN LIKITPHANITKUL STUDENT ID 54070057**

.......... **ADVISOR**

(DR. MANOP PHANKOKKRUD)

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หัวข้อโครงการ	การพัฒนาระบบแนะนำบุคคลเพื่อหาบุคลากรที่เหมาะสมสำหรับองค์กร โดยใช้เทคนิคการกรองข้อมูลแบบพึ่งพาผู้เข้าร่วม
นักศึกษา	นายชนวีร์ ขวาลธาดา รหัสประจำตัว 54070014 นางสาวพรรณปพร ลิขิตพาณิชย์กุล รหัสประจำตัว 54070057
ปริญญา	วิทยาศาสตรบัณฑิต
สาขาวิชา	เทคโนโลยีสารสนเทศ
ปีการศึกษา	2557
อาจารย์ที่ปรึกษา	ดร. มานพ พันธุ์โคกกรวด

บทคัดย่อ

กระบวนการการจัดหาบุคลากรขององค์กร ภายใต้ฝ่ายทรัพยากรบุคคล เป็นกระบวนการที่สำคัญในการสรรหา และคัดกรองคนที่มีความรู้ ความสามารถ และคุณลักษณะต่างๆ ที่ตรงกับตำแหน่งงานที่กำหนด โดยปัจจุบันมีการใช้ระบบอิเล็กทรอนิกส์ในการสรรหาบุคคลมากขึ้น ปริญญานิพนธ์ฉบับนี้จึงมีวัตถุประสงค์เพื่อพัฒนาระบบแนะนำบุคคล เพื่อหาบุคลากรที่เหมาะสมกับองค์กร โดยเทคนิคการกรองข้อมูลแบบพึ่งพาผู้เข้าร่วม โดยใช้ข้อมูลบุคคลที่สร้างขึ้นมาในรูปแบบของประวัติส่วนบุคคลจำนวนประมาณ 2,000 คน เพื่อใช้ในการวิเคราะห์ และสร้างระบบแนะนำให้กับฝ่ายบุคคลที่เป็นผู้ใช้ระบบ โดยผู้ใช้งานสามารถกำหนดความต้องการหรือคุณสมบัติของผู้สมัครได้ และระบบสามารถแนะนำผู้สมัครให้กับผู้ใช้ โดยเรียงลำดับตามคะแนนความเหมาะสม โดยวัดจาก ความตรงกันระหว่างคุณสมบัติที่ฝ่ายบุคคลกำหนด กับประวัติของผู้สมัคร และแนวโน้มในการเลือกผู้สมัครของฝ่ายบุคคลจากลักษณะงานที่คล้ายกัน

Project Title	A development of recommender systems to find appropriate candidates for recruitment with collaborative filtering	
Student	Mr. Chanawee Chavaltada	Student ID 54070014
	Ms. Panpaporn Likitphanitkul	Student ID 54070057
Degree	Bachelor of Science	
Program	Information Technology	
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Advisor	Dr. Manop Phankokkrud	

ABSTRACT

Recruitment is the process of finding and hiring candidates in the organization within the human resources management. It is an important process to find appropriate candidates who are match with the job qualification. Nowadays, e-recruitment is an important tool to use in recruitment process. This project presents a development of Recommender Systems that is used to recommend appropriate candidates to recruiter for recruitment in the organization. We match personal characteristic of candidates with qualifications requirement from recruiter. Then, weight and assign score to each candidate and use Collaborative Filtering to improve scoring and analyzing trend of user's choosing candidates. Personal characteristic data was generated as curriculum vitae about 2,000 different forms for matching with requirement. This project develops Web Application for user to specify their requirement. The system will rank candidates for user by giving score of matching between requirement and candidate profile data. Then, system will recommend candidates for recruiter. Recruiter can select interesting candidates into list and can grant Head of department to access list to choose candidates.

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Chanawee Chavaltada

Panpaporn Likitphanitkul

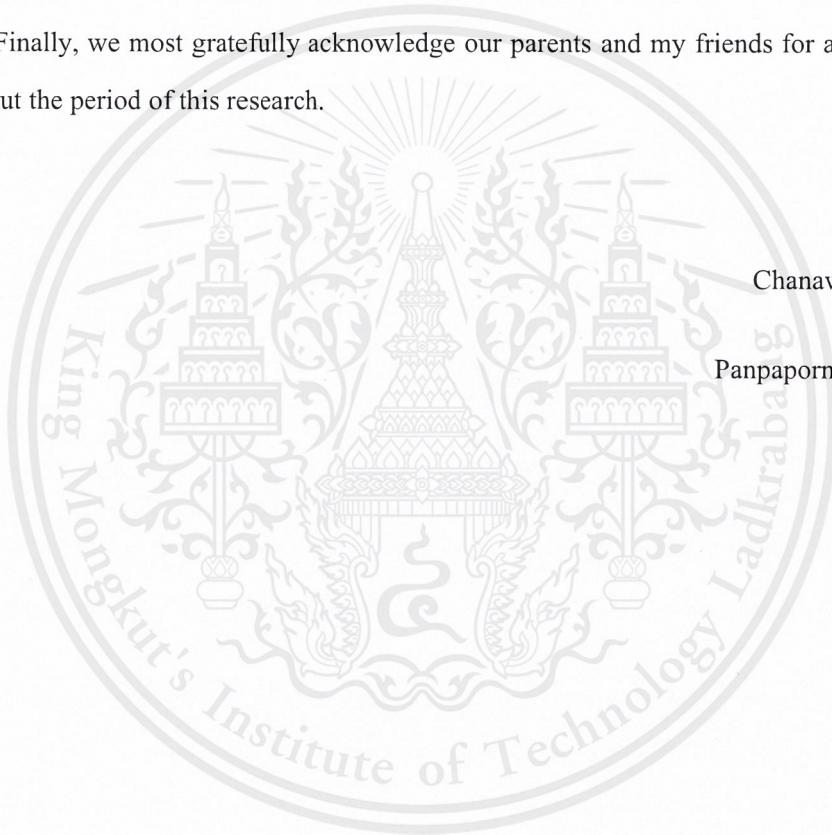


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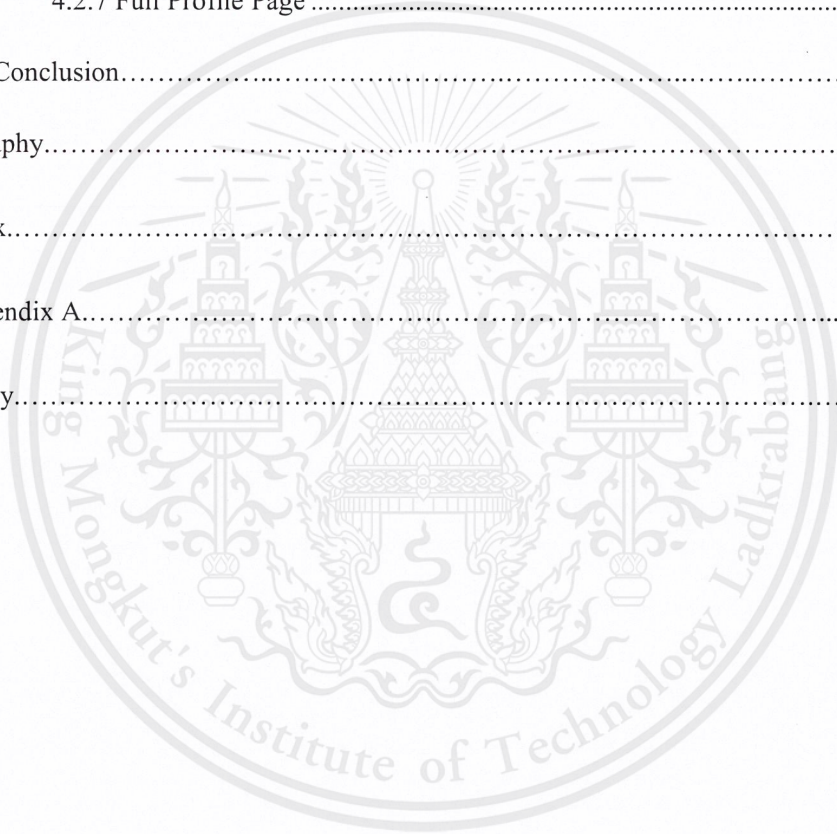
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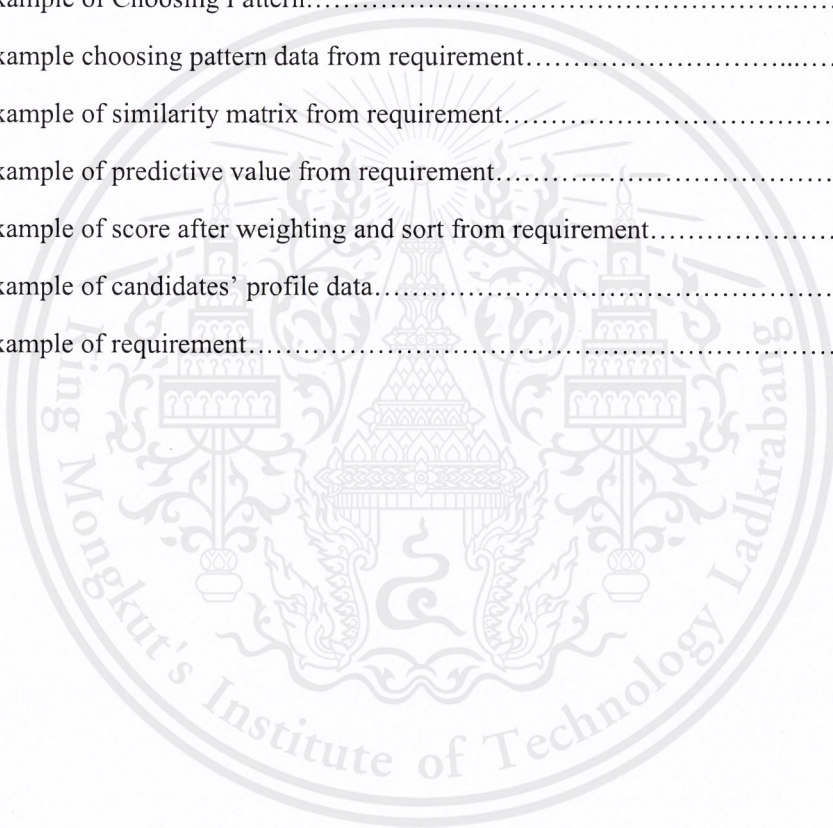


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Chapter I

Introduction

1.1 Background

The recruiting process varies by industry, company, specific work. Many employers are finding appropriate employees by using a team of recruiters or human-resources. There are too many of applicants in one organization. There are many candidates who are correctly matched to the job and the organization, and candidates who are not. The appropriate is talents of the person match with required work and the values of the person are in sync with the values of the organization. Nowadays, technology has influence and important for organization. Many organization recruit candidates by using electronic media as databases to find candidate data and information. The growth of social media sites is now providing to the large number of individuals who have posted their profile, career experience and other relevant information that recruiters need. When the organization looking for hiring employees, social media has made it easier for recruiters to find employees but the data are not sufficiently appropriate to work for different needs. The organization expect that workers to be able to fill vacancies right away, without any training. Information technology is applied to basic performance evaluate such as applicant filtering form introduction in order to matching characteristics and qualifications appropriately by candidate profile and qualification of company. This study aims to develop the system that can match qualification of candidate and requirements of recruiter to find appropriate candidate by recommender system.

1.2 Objectives

1. To study process of recommender systems.
2. To study collaborative filtering process.
3. To study recruitment process.
4. To design personal profile pattern.
5. To generate personal profile data in a curriculum vitae form.
6. To develop recommender system to recommends candidates for recruiter.

1.3 Scope

Recommender systems with collaborative filtering and the web application are developed with following methods:

1. Study recruitment process and hiring process in the organization.
2. Study pattern of personal profile such as resume and curriculum vitae of applicant.
3. Study process and advantages of recommender system.
4. Study the algorithm and procedure of Collaborative filtering.
5. Design database system to store profile data by using noSQL database.
6. Generate a large number of different personal profiles.
7. Develop a recommender systems with matching attribute and collaborative filtering.

1.4 Procedures and operations

1. Define the scope of this work.
2. Explore and collect related knowledge base.
 - 2.1 Study recruitment process
 - 2.2 Study recommender systems process.
 - 2.3 Literature review
 - 2.4 Study computer language and syntaxes that are used for developing applications.
3. Design data structure for using in system and collect data in the format.
4. Generate profile data
5. Design application for implementation and build mock up.
6. Develop application and system within the scope.
7. Test and improve the system for desired results.
8. Evaluate accuracy and complete of result.

1.5 Benefits

1. The system can recommends candidate for recruiter by using personal profile information.
2. System can analyze correctly and the result according as required qualifications.
3. Convenient for recruiters to find required employees.
4. Recruiter comfortable to work without a lot of document.
5. The organization can get appropriate employees.

Chapter II

Background

This chapter presents relevant information and background theoretical framework and review of the literature necessary for a recommender systems and recruitment.

2.1 Recruitment

Recruitment is the overall process of hiring candidates for job position in the organization and its processes are within the Human Resources Management (HRM) [1]. Recruitment is a significant process that effect to organizational performance, not just about human resources department but also for other department that involved in the selection process. It makes the organization to select the most appropriate candidate to fill job vacancies. Recruitment process should be managed with good tools and method. The main propose of this process is to find source of candidates to provide the best opportunity to select the best candidate for the organization.

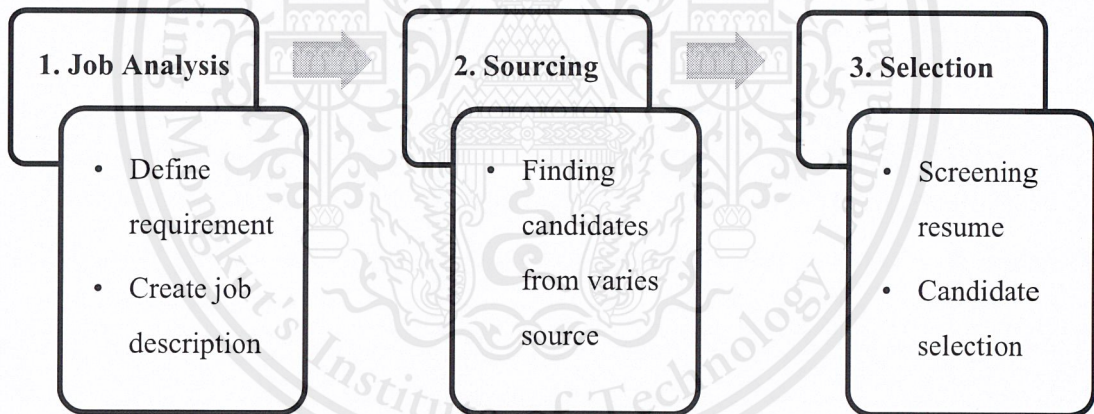


Figure 2.1 Recruitment Process

In general, there are three core process of recruitment: job analysis, sourcing, screening and selection [1] as shown in Figure 2.1. Job analysis is the first step that involves creating and defining the requirement. In this step, human resource will contact the manager or head of department to discussion and specify detail about job position such as skills education background, required qualification, and other. Then, create documents as job descriptions. Second step is sourcing. This is the step of finding candidates to fill job vacancies in many ways by human resource such as advertising, outsourcing, and searching on the internet. Third step is

screening and selection. This is the step of screening resume or curriculum vitae that shown in Figure 2.2. After screening candidates, human resources will identify and select appropriate candidates and they will send information of candidates to head of each department and head of department will select candidates again for interviewing. The interview is a conversation between candidates and representative of organization that concerning about candidates will fit into the job and the organization.

	Blake Zolfo		Height: 5'11" Weight: 150 lbs. Vocal Range: High Baritone (Low F to High G#)
	www.blakezolfo.com blake@blakezolfo.com		400 West Goldsborough Street Crown Point, IN 46307 Tel: 219.218.6873
PROFESSIONAL THEATRE			
<i>Pickle Chiffon Pie*</i>	Prince(s)	Towle Education Department	Shelley Crosby, dir.
<i>Fabulous 50's Christmas*</i>	Featured Soloist	Towle Theater	Jeff Casey, dir.
PROFESSIONAL CABARETS/CONCERTS			
<i>NW Indiana Symphony Orchestra</i>	Guest Artist	Star Plaza Theatre	Kirk Muspratt, Dr. Nancy Menk, cond.
<i>Portable, Portentous Porter</i>	Self	Radisson Hotel	Joyee Lin, dir.
<i>An Evening with Blake Zolfo</i>	Self	Towle Theatre	Joyee Lin, dir.
EDUCATIONAL/OTHER THEATRE			
<i>The Last Days of Judas Iscariot</i>	Simon the Zealot	Boston Conservatory	Kelsey Heres, dir.
<i>God</i>	Bursitis, <i>et al.</i>	Boston Conservatory	Greg Pike, dir.
<i>RENT</i>	Mark Cohen	Towle Theater	Jeff Casey, dir.
<i>Anatomy of Gray</i>	Galen P. Gray	Encore Theatre Company	Kit Degenhart, dir.
<i>Wizard of Oz</i>	Hunk/Scarecrow	Crown Point Theatre Group	Nick Thomas, dir.
<i>Joseph ... Dreamcoat</i>	Simeon	L'arc en Ciel Theatre Guild	Angie Lowe, dir.
<i>* Indicates original piece</i>			
WORKSHOPS/READINGS			
<i>Something for the Boys</i>	Rocky Fulton	Boston Conservatory	Chris Caggiano, dir.
<i>Robot Mike</i>	Various	Towle Theatre	Jeff Casey, dir.
FILM/COMMERCIAL**			
<i>Body of Christ()</i>	Supporting	Family Name	Derek Kowal, dir.
<i>Eos</i>	Featured Actor	Flashpoint Academy	Kyle Witvoet, dir.
<i>... Call Security</i>	Supporting	K-12 Teacher's Alliance	Nicole Dizon, dir.
**Commercial list available upon request.			
SPECIAL SKILLS			
Tap dance, IPA proficient, excellent sight reading, sneezing on command, mooing			
Dialects: French, Irish, Indian, Welsh, others (quick study with dialects)			
Voices: Stewie, Gollum, Baby Rudy			
TRAINING - The Boston Conservatory BFA Musical Theatre Candidate 2015			
Acting:	Doug Lockwood, Deb Cooney, Marjorie Morgan		
Voice:	Bill Casey, Peter Mansfield		
Private Voice:	Robert Honeysucker		
Dance:	Drika Overton, Stephen Erwin, Tommy Neblett		
Additional Training/Masterclasses:	Adam Belcure, Kurt Naebig, Adrienne Cury, Randy Skinner, Drew Gasparini, Jonathan Reid Gealt		
OTHER RELEVANT EXPERIENCE			
Choreographer	Salsa, Ballroom, Hip-Hop	Quinceaneras - Indiana	
Choreographer	"Block Stars" Variety Show	East Chicago, Indiana	
Musical Choreographer	<i>Mulan, Jr.</i>	Towle Education Department	
	<i>Les Miserables (School Edition)</i>	Crown Point High School	
	<i>Anything Goes</i>	Crown Point High School	

Figure 2.2 An example of resume

E-Recruitment is the process of recruitment that using electronic resources such as the internet and employment website. E-Recruitment provides an online database to use online job advertising and search engines. The surveys from employment website focus on three major of web sites are LinkedIn, jobsDB.com, and Indeed.com. Each site has advantages and disadvantages from other.

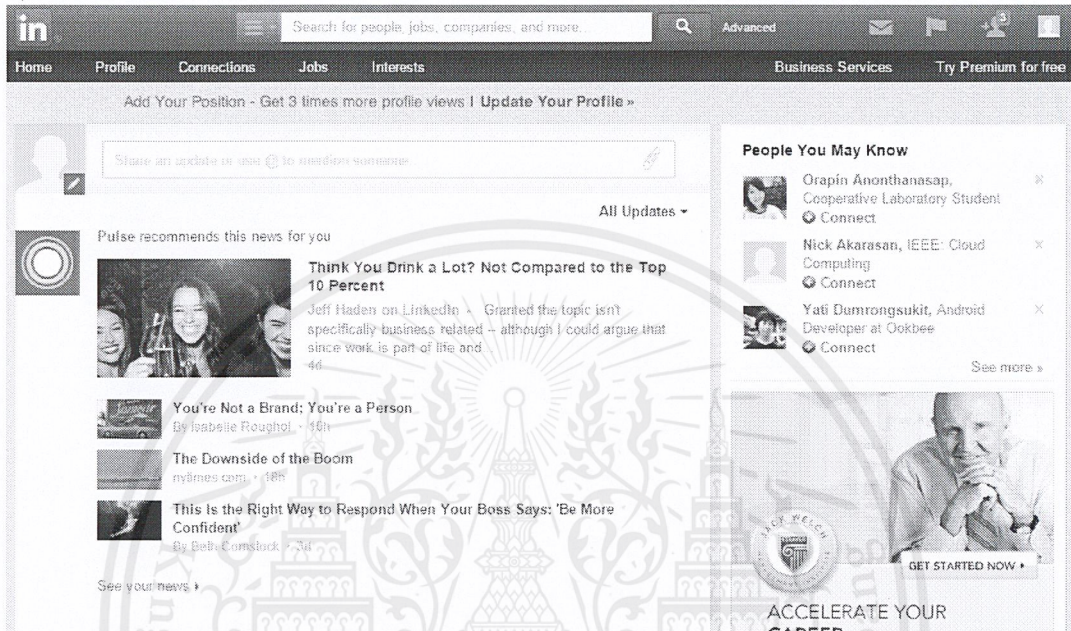


Figure 2.3 An Example of Employment Website (www.Linkedin.com)

LinkedIn is the largest professional network that has 300 million members in over many countries that is shown in Figure 2.3. A main advantage of using LinkedIn is getting connected with professionals who are in the similar industry. People who use LinkedIn can get involved in forums, join groups and meet like-minded individuals. The platform is designed to connect people and companies same interests. User can make a target list of who they want to meet such as companies and people. LinkedIn allows user to make their profile available for search engines to index such as Google. Job searching in LinkedIn has two types are normal search and advance search. Disadvantages of LinkedIn are a lot of data entry, not a suitable and handy for people who don't have a lot of time to spend on it.

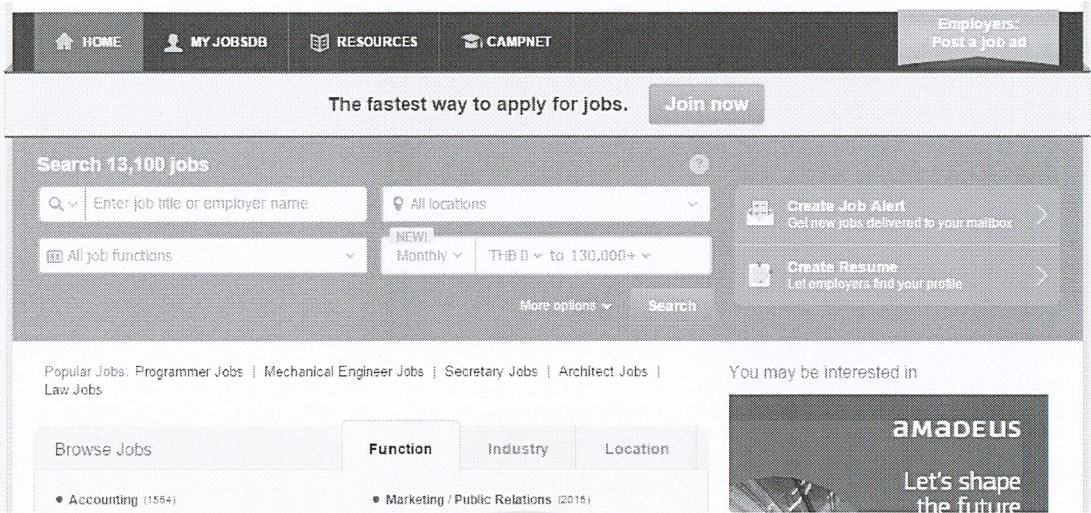


Figure 2.4 An Example of Employment Website (www.JobsDB.com)

JobsDB website is shown in Figure 2.4. It is a website that focuses on Asian user. It has substantial positions across Hong Kong, Indonesia, Malaysia, Philippines, Singapore and Thailand and supports only these seven languages. Job seeker can create multiple resumes up to ten resumes in each job. These resumes can be uploaded from user's local files, or created online. This provides a better flexibility and conveniently for job seekers to apply for positions of job. Job seekers can specify keywords for searching by matching all of the words and can set up to ten Job Alert with different job search criteria. This websites focusses on job seeker user not on the connection like LinkedIn and convenient for some countries in Asian user not for over the world.



Figure 2.5 An Example of Employment Website (www.indeed.com)

Indeed is one of employment website that is shown in Figure 2.5. It is an employment-related metasearch engine for job listings [10]. Indeed is available in over 50 countries and 28 languages. User can search with normal search and advance search. Moreover, Indeed websites can show a job trend. Indeed’s job trend provided top 10 of the fastest growing keyword found in online job postings to show the growing employer demand in each year.

2.2 Recommender Systems

Recommender systems are a part of information system filtering system that predict and suggestion for users [2]. The suggestions are about decision-making process and they are used with each different users or user groups with various suggestions. The suggestions aimed to support decision making process [3]. It is used to recommend information, product, or service such as what movie to watch, what music to listen, or what product to buy. The simplest form of recommendations is suggested as ranked lists. The ranked list show predicted result that are what the most appropriate product or service based on the user’s preferences and constraints by collecting user preferences and action. There are four main task of recommendation process [4] as Figure 2.2: Generation, Queueing, Delivery, and Optimization. Generation task is determination of derived source and determination of filtered attributes. Queueing task is determination of storing data and queue of each task. Delivery task is determination of delivery data to user interface. Optimization task is about system learning from data and improving recommendations.

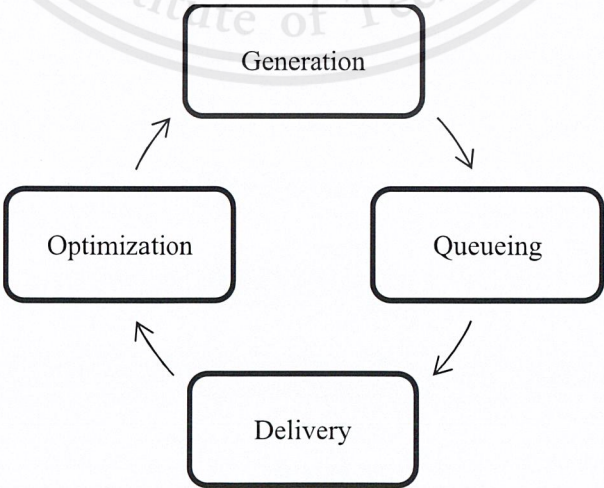


Figure 2.6 Task of recommendation process

There are three recommendation approaches: content-based filtering, collaborative filtering, and hybrid recommender systems.

2.2.1 Collaborative Filtering

Collaborative filtering based on predictions on the rating of other user in the system by selecting and aggregation of other users' opinions to provide a prediction of active user's preference [4]. Assume that, if users agree about the quality of some items, they will agree about other items. The algorithm of Collaborative filtering is about generating of first prediction of user's preference and create their recommendations by ranking items by previous predicted preferences.

Baseline predictors or Baseline algorithm is the pre-processing and normalizing data before use true collaborative filtering algorithm. It is used to predict average rating of all ratings in the system: $b_{u,i} = \mu$, u is user and i is item (where μ is the overall average rating). This can be improved something by predicting the average rating by that user or for that item.

$$b_{u,i} = \mu + b_u + b_i \quad (2.1)$$

b_u and b_i are respective user and item baseline predictors. They can be defined simply by using average offsets. The baseline predictors can also be learned as more parameter estimation techniques. Item-Item or Item-based collaborative filtering is one of the most popular collaborative filtering today. It uses similarities between the rating patterns of items. If two items tend to have the same users like, they are similar.

Today, collaborative filtering is a popular algorithm used in service and other. This project use recommender systems to recommend candidates for recruiter and use Collaborative filtering to improve scoring of each candidate.

2.2.2 Content-based Filtering

Content-based filtering (Cognitive filtering) is a recommendation approach that compares the content of item with a profile of user. Items are selected from a large data that user likely and used to find useful item. The sources or description of item that content-based filtering uses in the process called text document. This recommendation approach analyzes a set of document previously rated by a user. It recommends homologous items that a user likes in the past by comparison of the item and profile of user's preference and various items are compared with previous items that user rate in the past. Items are ranked by the most matches and they will be recommended to user.

2.2.3 Hybrid Recommender Systems

Hybrid recommender systems are combine collaborative filtering and content-based filtering. There are several ways to implement hybrid approaches such as making content-based and collaborative-based predictions one by one and then combining. Hybrid approaches can be implemented in various techniques: content-based, collaborative, demographic, and knowledge-based techniques. Knowledge-based recommender system recommends product based on user's preferences and needs by exploiting explicit user's requirement. Knowledge-based recommenders has two basic specifics: case-based and constraint-based recommenders.

Recommender knowledge-based with constraint-based recommender system is defined by two sets of variables (V_C, V_{PROD}) and tree sets of constraints (C_R, C_F, C_{PROD}). These variables and constraints are parts of a constraint satisfaction problem. V_C is description of the requirement of customer. Where V_{PROD} is description of the properties of classified product such as product name and product types, where C_R are the systems that restrict the possible instantiations of customer properties, where C_F is the relationship between customer requirement and the given classified product, and C_{PROD} are instantiations of product properties [5].

Today, recommendation systems assist user on the internet to find products, information, and even other people based on past behavior. So this research uses recommender systems to

suggest the appropriate candidate for recruitment process by recommender knowledge-based with constraint-based.

2.3 Database

Database is an organized set of data that used for storing, managing, and retrieving. It can be classified in many types such as full-text, numeric, bibliographic, and images. Database is stored as a set of file. It can be stored information about product, people, or anything else. There are six parts in database: tables, forms, reports, queries, macros, and modules. Tables are a set of data with rows and columns. Forms are the interface that user work with data. It is used for viewing, entering, and editing data in the tables of database. Reports are summarized data that are used to present data in the tables. Queries are works in database. It comes in two varieties: select queries and action queries. Macros are a simplified programming language which user can add functionality in the database. Modules are the same with Macros. They are objects that use to add functionality to the database [6]. There are two models of database: relational model and model-less (NoSQL) approach.

2.3.1 Relational model

The relational data model was developed for databases. It is managing of data into two dimensional tables (relations) and each table includes rows and columns. It is the most popular model that used in the database system. The major characteristic of relational model is using keys. There are two keys in relational database: primary key and foreign keys. Primary key is used to identify each row of data. Foreign keys relate data in one relation to the primary key of another relation [6].

2.3.2 NoSQL

NoSQL or Not Only SQL is a type of database which is non-relational or model-less. NoSQL database provides data storage that is modeled in means other than the tabular relations used in relational databases [7]. The main benefit of NoSQL is provides flexibility. NoSQL uses schema-less solutions data models meaning that the database can be allow an

unlimited form, structured, semi-structured, or unstructured: flexible data models that can be modified easily. This allows for developers to do quick iterations and frequent code pushes. NoSQL is efficient and can be horizontally scaled (scaled-out). With its distributed architecture, NoSQL provides continuous data availability with no single-point-of-failure. Zero-downtime maintenance is then made possible. NoSQL also allows for powerful queries and data-mining. It is possible to classify data in same group with NoSQL databases such as the MongoDB.

MongoDB is a database management that is designed for web application infrastructure. Data in MongoDB are called documents. It can provide good performance and intuitive data model because it is a document-oriented database. The document-oriented approach can represent complex hierarchical relationships with a single record and allows it to automatically split up data between multiple servers. There are many feature of MongoDB such as ad-hoc queries, secondary indexes, replication, speed and durability, and scaling. Unlike relational databases, MongoDB has a flexible schema. It can embed related data in a single structure and allow application to store related data in the same database that make applications use fewer queries to complete the same operations. MongoDB uses a binary wire protocol to interact with server. Given all the advantages, MongoDB is a definitely solution and very useful to develop application [8].

From the study of database found that the data structure of relational database and NoSQL database are different. NoSQL make some operation faster and more flexible than relational database. Therefore, this project uses NoSQL as a database of the system.

2.4 Developing tools

The web application of this project is developed by using four major tools and technology: HTML, CSS, jQuery, and UIKit.

2.4.1 HTML

Hyper Text Markup Language (HTML) is the standard markup language used to create web pages. It is widely used and every browser supports HTML language. HTML allows images and objects to be embedded. HTML tags element is component of HTML document. Each

element include specific HTML attribute. Most elements are written by many tags such as html tag, head tag, title tag, and body tag. The <html> tag is written to make the browser know that this is HTML document and use for start and end of page. HTML allows images and objects to be embedded and can be used to create interactive forms. It can embed computer language such as Javascript. It provides a means to create structured documents by denoting structural semantics for text such as headings, paragraphs, lists, links, and quotes. It is recommended by the World Wide Web Consortium (W3C). Today, HTML5 is the latest standard for HTML. It has many changing in new element and provides new input type and it can integrate font size, font style, page background, and etc. [9].

2.4.2 CSS

Cascading Style Sheets (CSS) is a feature being added in HTML for efficient using, looks managing, and formatting on website. CSS define elements of HTML. It allows developer more display page controlling and more function. CSS is used by most websites to user interfaces for web applications and mobile application. Developer can do with CSS in three ways: inline style, internal style, and external style. External style is the most popular way. It was designed to enable the separation of document content from document presentation such as the layout, colors, font size, font style, page background, and etc. The style can saved in external “.CSS” file so, every page that use the in style sheet file will appear in same style. It can reduce complexity in the structural content [9].

2.4.3 jQuery

jQuery is a cross-platform JavaScript library. It contains functions and commands that used to manipulate a page of HTML. It was designed to simplify the client-side HTML scripting. jQuery's syntax is designed to handle events, select DOM element, navigate a document, and develop Ajax applications. It also provides capabilities for developers to create plug-ins on top of the JavaScript library. The core of jQuery is a DOM manipulation library. Document Object Model (DOM) is a mechanism for representing and interacting with HTML.

The advantages of using jQuery are short and simple code, it will be displayed even if JavaScript is disabled, it work well with HTML, JavaScript, and AJAX [10].

2.4.4 UIkit

UIkit is a front-end framework providing many common classes for user interface design. It is fast and powerful web interfaces. Its feature is collection of HTML, CSS, and JS components. It can normalize HTML elements to add some styling and offer typography by the default colors, font-sizes, margins and more for each HTML element. UIkit provides a responsive consistent from phones and tablets to desktops and support many web browser such as Google chrome, Mozilla firefox, Internet explorer, Safari, and Opera browser [11].

2.5 Literature Review

2.5.1 Recommender Systems

Farber et al. [11] presented a gap between requirements of jobs matching and e-recruitment procedures and used a survey data with 1,000 companies in Germany. They used probabilistic automated recommendation approach to matching and present results from applying the algorithm to synthetic data. In order to match people with job, recruitment is separated by two phases. First phase is attraction and second is selection. Attraction phase is managed for attracting qualified people to apply their resume. Selection phase was managed for choosing appropriate person. Each phase include two activities: planning and execution. This literature review will focus on selection method. Normally, matching based on certain criteria on the basis of the information is used for decision that calls predictor data and the method is used to predict is called predictor. An assessment criterion was taken to predictor based on the predictor data and a combination method for handling different information by combining predictor data in two types. Mechanical combination is rule-based that can combine data without human, it need to use large data and proper combination rules. Clinical combination is a human assessor combination with experiences and perception. The method or predictor that often used for recommendation is content-based filtering and collaborative filtering.

Malinowski et al. [12] presented a recommendation approach to improve the matching between people and jobs based on bilateral selection decisions. They surveyed companies in Germany and got the result that today the internet has replaced printed document and replaced former recruitment process. 78% of vacancies was published on the corporate website and 49% of open jobs was posted on Internet job-portals. Over the years, the hiring through job advertisement on the internet rise reaching 58% in 2004. Many company adapted information system support in candidates selection step for applications efficiently. A good fit of candidate and job are hard to measure. Information system technology is used to pre-select candidates by define skill requirements for specific job to match with the criteria. They consider that matching of person's work history will increase and decision support of partner will occur. They begin to develop a system for the individual personalized search. The requirements of a person-recommender when apply in recruitment process is requirements for recommending persons and matching people and jobs. In the first step, they focus on fitness of candidate in relation to the job and then they implement a CV-recommender and a Job recommender separately. They implement a CV-recommender by recommend CVs that are similar to previous resumes that was selected by the same recruiter by using hybrid recommendation approach. They implement a Job recommender by recommend jobs for candidates based on their preference profiles and previous rating. They evaluate the quality of recommendation system. In finally, they used the Mean Absolute Error (MAE) to evaluate the prediction quality of the recommendation system.

Hong et al. [13] provided a research of four online job recommender systems from different aspects and develop a job recommender systems for selecting the appropriate recommendation approaches based on users' characteristic called iHR. iHR categorized the user into groups by using each user information and user historical behaviors. Four different online job recommender systems are profile of user, recommendation strategies, output of recommendation and feedback of user. Profile of user or user profiling step is about creating a job recommender systems to increasing the recommendation experience. In a content of the user profile use the

historical behaviors and individual information such as education background, working experience and skill. Recommendation strategies are the choice of recommendation approaches. The architectures of online job recommender systems have the information flow: data collection, data processing, recommendation, and result. Output of recommendation is the form of listed jobs that recommend in the form of “You Maybe Also Like” and “What Others Looking” and the last part is user feedback. After summarizing them, they found some problem and develop a new job recommender systems based on clustering. They group the job applicant into three types by using the clustering and choose the appropriate recommendation approach for each group of job applicants. They use Content-based recommendation with the proactive group, Collaborative filtering recommendation with the passive group, and Hybrid recommendation with the moderate group. Their job recommender system becomes more personalized and intelligent.

Perugini et al. [16] presented four main dimensions of studying recommender system: style and model of recommender system, target of recommender system, building of recommender system, and maintaining of it. The most popular modeling of recommender system is content-based filtering and collaborative filtering. Content-based filtering is about suggestion of item that similar to those the user liked in the past. Collaborative filtering is about suggestion of item that are liked by similar user.

Sarwar et al. [17] presented the analyzing item-based recommendation generation algorithms. Their first challenge was improving the scalability of the collaborative filtering and their second challenge was improving quality of the recommendations for users. Item-based approach is about examining how similar of set of item that user has rated and how these items similar to the target item. They used item-based collaborative filtering algorithm to found the similarity between items and to select the most similar items. In finally, they found that the item-based recommendation provides greater quality of predicted result than use-based (k-nearest neighbor) scheme and they also found that the item neighborhood is fairly static.

2.5.2 Recruitment

Ishrat [14] presented the process of recruiting, training, and collected data through the survey by distributing questionnaires to the employees (manager). He collected data from company employees, research paper, and journal. He presented that each step of recruitment process are various from the organization and job. For example, some organization focuses on interview while other organization focuses on testing. There are seven core steps that the most organization use to recruit: (1) Reception is the step of defining the requirement and attract candidates with skills, talents, and experience. (2) Screening interview is a selection step that select by the department. This step allows eligible candidates to go through the next selection step. (3) Application blank is a form that used to collect information on various aspects of applicant. (4) Selection testing or employment test is the testing about work sampling, performance, intelligence, and aptitude. (5) (6) Reference checks and (7) Hiring decision. There are questions in the he questionnaires. Question number one is “What are the sources for recruitment and selection?” and about 75% of the managers say that they prefer both internal as well as external source for recruitment and selection. Question number two is “Which method do you mostly prefer for recruitment and selection?” and about 65% of the mangers go for direct recruitment and selection and 32% go for indirect and only 3% go for third party recruitment way. Question number three is “What are the sources for external recruitment?” and the result show that 34% of manager go for campus interviews, 33% go for data bank, 25% from the casual application that are received.

Holm [15] presented that e-recruitment impact on the process of requirement. E-recruitment is the process of recruitment that use electronic data such as internet and web-based recruiting. She focuses on e-recruitment that effect on the traditional recruitment process. If the result of introduction of electronic recruitment had changed, it would have meant significant changes in the overall process of recruitment. She select multinational corporations (MNCs) originating from Denmark to study. Three different selected companies are banking and investment called Scandifin, alcoholic and non-alcoholic beverages called Danadrinco, design,

production, and installation of energy systems called Energowing. Each organizations used different technological solutions in the recruitment process. Scandifin use websites and Internet job advertising as a source of recruitment and use e-recruitment system from a Scandinavian application service provider (ASP). Danadrinco use both internal and external recruitment such as a third party and employment agencies. Energowing use internal recruitment by HR team. The three company's recruitment processes have different task, step, and activities. Each process has advantages and disadvantages.



Chapter III

System Analysis and Design

This chapter describe about requirement of Human resource, the studying of job searching websites, state of problem, data structure of requirement, data structure of candidates' profile, matching of candidates' profile with the requirement, scoring criterion, and system design.

3.1 Human Resource Requirements

The appropriate person for the job is crucial to the success of an organization. The survey from job searching and e-recruitment website found that when the organization looking for hiring employees, there are four main required qualification: Firstly, employers are often looking for skills that go beyond qualifications; for example, programmer who can writes computer software with many computer languages such as JAVA, .NET and so on. Second, employers emphasize academic degree that appropriate with work and duties of position. Third, employers specify duration of work experience including related experience in working fields because person with work experience tend to be resourceful and good to solve problems and the organization don't need to waste time to train new employees. Finally, attitude and personality of employees are important part of looking for a suitable candidate for each organization because the attitudes of employees in the workplace can have a significant effect on the whole business.

Not only consider main required qualifications are described above but also there are more additional feature such as age, sex, race, related certification, computer literacy, capable of written and verbal communication in English or other languages, location to work, contact phone number and email that show in Table 3.1.

Table 3.1 Requirement Fields

Required fields	Description
Skills	Skills needed to use for working.
Education	University degree base on work experience and also faculty or major relate to work.
Work experiences	Duration of work experience appropriate work or position.
Attitude and personality	Attitude and personality suited to the task.
Age	Range of age can do proper job.
Sex	Some job have to do it by only male or female.
Certifications	Relate certifications is necessary in job.
Language	Many work need to use other native language such as English.
Location	Some company want employee who live near office.
Common skills	Skills use in general work such as computer literacy, capable of written and verbal etc.

3.2 State of the Problem

The study from human resource department and recruitment process found the problem in traditional process that is shown in Table 3.2. There are problem from human resource department and resume data. The solving in new system is also shown in Table 3.2.

Table 3.2 State of Problem

Problem	Solving
1. Human Resource	1. Human Resource
1.1 Recruiter required each different qualification for each work.	1.1 Recruiter can create multiple specific qualifications.
1.2 Recruiters must read candidate’s profile data one by one.	1.2 Recruiter can input required qualification
1.3 Recruiter wasted time for arranging	1.3 System can show ranking of

Table 3.2 (Cont.) State of Problem

Problem	Solving
documents and selecting process.	appropriate candidates that are matching with recruiter qualifications in sequent.
2. Resume Data 2.1 It has a lot of resume and the data are not sufficiently appropriate to work for different needs. 2.2 It has a lot of different attribute in each resume	2. Resume data 2.1 Matching, ranking, and use Recommender systems. 2.2 System select only useful and interesting attributes

3.3 Data Structure

From the studying and selecting in pattern of requirement, resume and CV from many sources such as employment websites as Figure 3.1 and Figure 3.2, this project design data structure of requirement in the system that is shown in Table 3.3. Data structure of requirement has a lot of attribute such as name, description, experience, industry, skills, languages, and etc. Each attribute has value and rating that are rated when recruiter create requirement.

Qualifications

REQUIRED:

- Minimum of 5-10+ years' programming experience in Microsoft Office framework using VBA for Excel and Access
- Minimum of 5-10+ years' experience working in a software development and/or support capacity in a time critical financial markets environment, must have full Software Lifecycle experience.
- Advanced proficiency in Oracle development
- Advanced proficiency in Sybase development
- Ability to multi-task in a complex production environment and quickly acquire broad knowledge of applications in LRI RAD space
- Ability to work independently as well as a part of a small team in fast-paced environment to drive issues through to completion
- Strong problem management and problem investigation skills with ability to learn new skills quickly to value add in problem focus areas
- Excellent communication skills and ability to talk directly with business users
- Excellent written language skills and ability to produce business specifications, functional requirements etc.

HIGHLY DESIRED:

- Sybase IQ development experience
- Java development experience
- Proficiency in MS SharePoint

Figure 3.1 Examples of Job Requirement

Karyn Anjali Glubis

Marketing Executive | Consumer Engagement | Strategic Positioning



// SUMMARY

A highly motivated, results-producing Marketing Professional with a proven record for accomplishments in planning and leading comprehensive marketing strategies in support of business goals and objectives. Expertise in directing the creation of marketing tools and steering the execution of marketing programs to impact revenue and brand recognition. Demonstrated success driving growth of target markets through implementation of market leading projects. Recognized as a leader with strengths in project management, administration and business development. Excellent communication skills proven by the ability to successfully manage large events and campaigns while working with people from very diverse backgrounds. Promoted to roles of increasing responsibility and profile due to the success of marketing efforts.

// Experience

// Profile

Name
Karyn Anjali Glubis

Phone
813-610-2810

Email
kglubis@hotmail.com

Vice President, Business Development 1st Quality Insurance Group	APR 2013 - MAY 2013
Public Relations and Marketing Specialist Karyn Anjali Productions, LLC	NOV 2006 - FEB 2013
Columnist and Buzz Stop Event Representative Panache Vue Magazine, Tampa, FL	SEP 2011 - DEC 2012
Market Editor and Columnist Tampa Style Magazine, Orlando, FL	JUL 2011 - SEP 2012
Marketing and Communications Director KVOS TV, Bellingham, WA	DEC 1999 - NOV 2002

// CORE COMPETENCIES

Strategic Market Planning
New Market Penetration
Market Research/Analysis
Marketing Collateral
Development
Web Development
Team Building
Consumer Direct Marketing
Programs
Budget
Preparation/Administration
Global Product Launches
Media & Advertising
Campaigns
Project Management
Business Development
Planning
Digital Advertising
Social Media
Brand Management

// Education & Licenses

University of Phoenix, Vancouver, BC, Canada
Master of Business Administration, Major in Marketing and Finance

St Thomas University, Miami, FL
Bachelor of Arts, Major in Communication Arts

International Fine Arts College, Miami, FL
Associate of Arts, Fashion Merchandising

Florida Department of Professional Regulation
Licensed Real Estate Broker

// PUBLICITY — THE NAKED TRUTH — AN EVENT FOR INTERNATIONAL WOMEN'S DAY 2012

The Naked Truth (Concept/Producer) was the only International Women's Day event recognized in Tampa Bay. for more information, visit:
<http://www2.daytimeonline.tv/content/2012/mar/09/karyn-anjali-glubis-and-gina-marie-naked-truth/daytime-weblinks/>
http://www.abcactionnews.com/dpp/news/region_tampa/the-naked-truth-focuses-on-issues-more-th-an-skin-deep

// OTHER

- "Book of the Year" Author, Trinidad Transcending Time (Non-Fiction)
- Author, Trinidad Treasure Hunt (Children's)
- Created, wrote and produced Inspired (Television Pilot) as well as other television commercials
- "Vision Award" for Excellence in Television Production – Producer, December 2000

Figure 3.2 Example of CV

There are many elements and qualifications in the personal CV such as work experiences or employment history, competencies or skills, certification, education background, and personal detail. From the study of job requirement and CV pattern from many sources, we create data structure of requirement in Table 3.3.

Table 3.3 Data Structure of requirement

Data Structure	Description	
	Value	Rate
Name	Requirement name Requirement description	
Description	Requirement description	
NumberOfCandidate	Number of candidate that are required	
Experience	Range of years' experience	Attribute rate for weighting score
Industry	Group of related industries	Attribute rate for weighting score
Education-degree	Requisite education degree of requirement	Attribute rate for weighting score
Skills	Group of required skills	Attribute rate for weighting score
Languages	Group of required languages	Attribute rate for weighting score
Gender	Required gender	Attribute rate for weighting score
Age	Minimum age, Maximum age	Attribute rate for weighting score
Marital	Required marital status	Attribute rate for weighting score
Driving	Required driving license	Attribute rate for weighting score
Education-detail	Required field of study, Minimum required grade, Maximum required grade	Attribute rate for weighting score
Experience-detail	Company and position that related the job	Attribute rate for weighting score
Selected	List of chosen candidate by recruiter	
Confirm	List of chosen candidate by head of department	
Key	List of related keyword use for collaborative filtering	

3.4 Recommendation Approach

This project use recommender systems to recommends candidates for recruiter. In the recommendation approach that is shown in Figure 3.3, it is separated into two parts, matching by using recently created or edited requirement data and candidate profile data from database and collaborative filtering to find an appropriate score for each candidate by using same tag requirements from database.

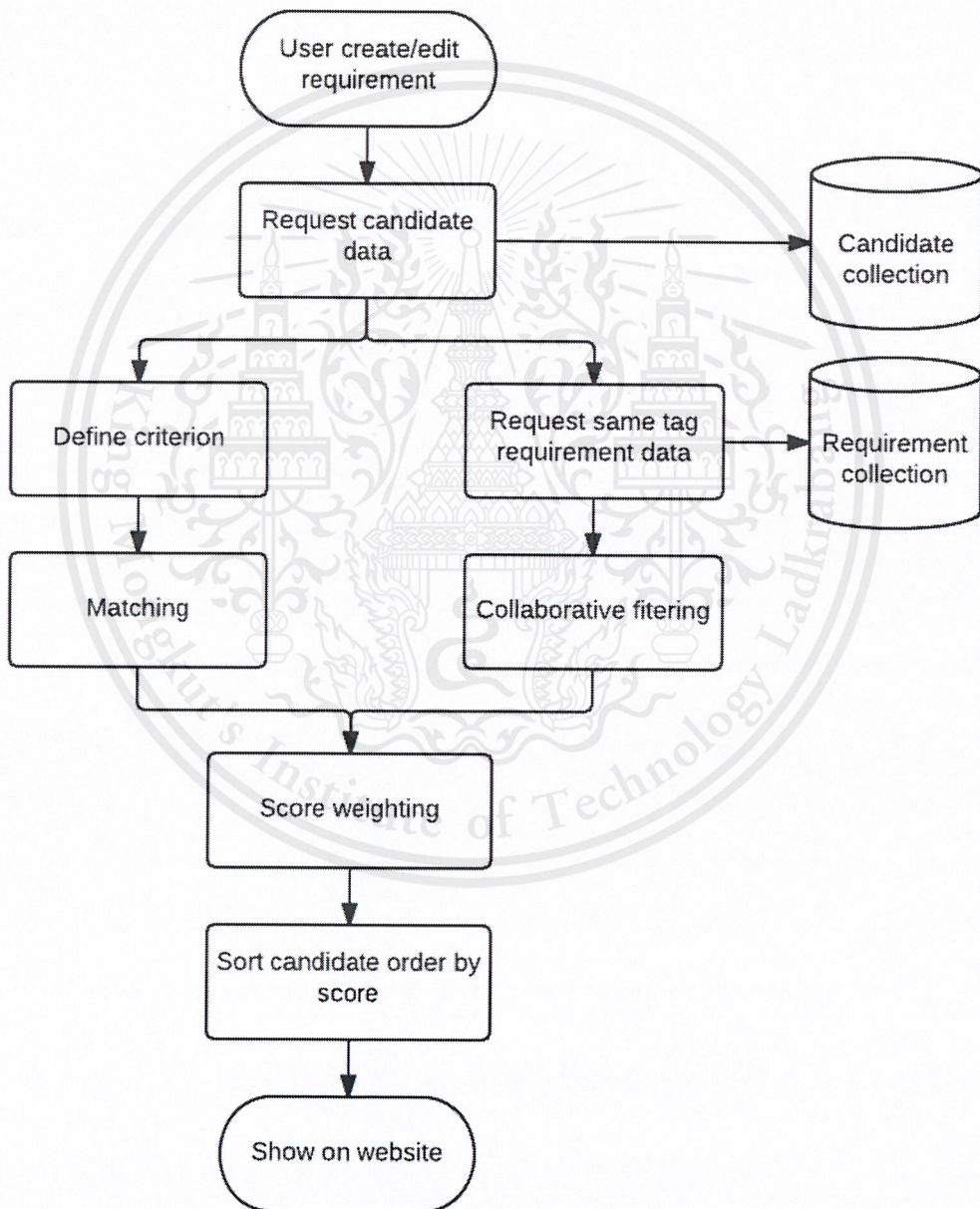


Figure 3.3 Recommendation Approach

Matching is mapping same values between requirement and each resume and assign score for each resume by scoring criterion that is defined by requirement but the scores still has a problem that the scores group likewise so recruiter would make more decision from that problem. In order to solve the problem, the technique that can adjust and improve score ranking is used. Collaborative filtering is a technique that analyze user choosing pattern extract each similar requirements and candidates for recommending item or candidate who other similar requirements have chosen. After collaborative filtering analysis acquired result, the result values can use as score weight and adjust it. This technique makes more difference of scores and improves score quality. Finally, all of candidate who acquires score more than zero are sorted and show on website as result for recommending user.

3.4.1 Scoring Criterion

This project create scoring criterion to assign score for each candidate and create matching process to match attribute in candidate’s profile with attribute in requirement. Scoring criterion process, matching process, and the equation that is used in these processes are shown in Figure 3.4.

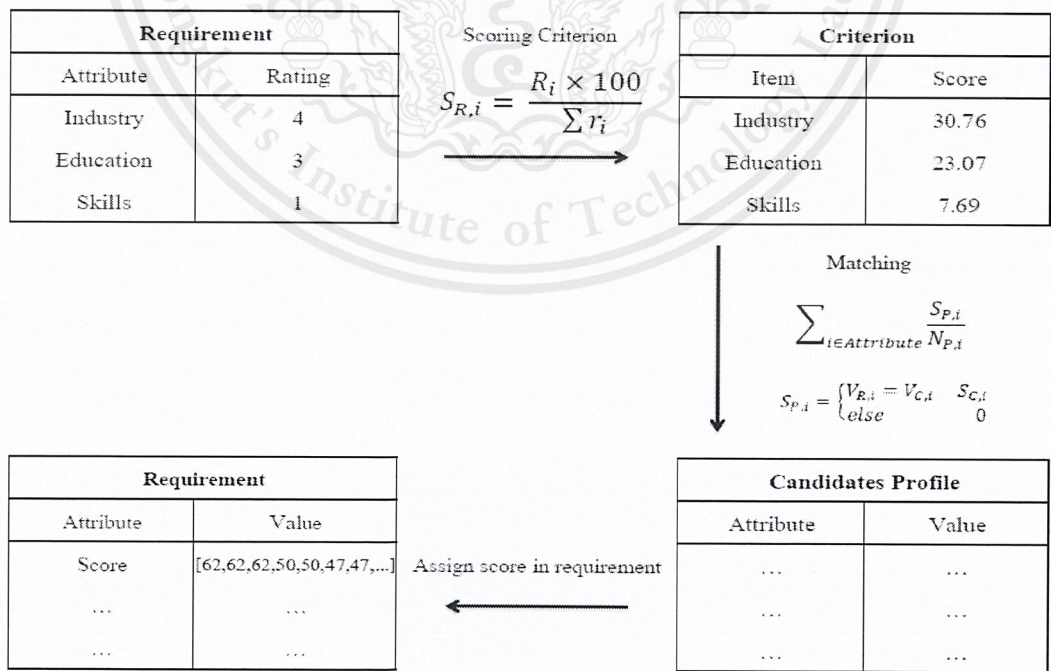


Figure 3.4 Scoring Criterion

Where S_i is a score for matching criterion, R_i is rating of attribute rating in requirement that are rated by recruiter, $S_{i,j}$ is score of each attribute. After matching criterion has created, the resume is assigned scores with comparing between value of each attribute of itself and the requirement. If the attributes of resume and requirement has same value, the score of attribute from criterion is sum for total score of the resume and then add total score to resume as score of the resume. In case the value is multiple value or sub-value such as list, each value in multiple value is compared and the score of comparing is divided by number of value in sub-value. Scoring define as: where $S_{R,i}$ is score of attribute i in requirement. Matching condition define as: where S_p is Total score of candidate profile, $S_{p,i}$ is score of attribute i acquire by condition, $S_{C,i}$ is score of attribute i in criterion, and $N_{p,i}$ is number of value in attribute i of candidate profile.

Resume ID	Score
5066	62.02
8881	62.02
6900	50.08
5688	50.08
3485	47.52
4587	47.52
...	...

Figure 3.5 Example of Result of Scoring Criterion

The result of scoring criterion process is shown in Figure 3.5. It show acquired score for each candidate in order to present to the website for support decision of recruiter but these scores still have some issue. The score is same a lot as a result of recruiter has to make more determine in choosing from candidates who have same score.

3.4.2 Matching

Matching qualification of candidate from each candidate profile with requirement of recruiter by many conditions that show in Table 3.4

Table 3.4 Matching Attribute Description

Requirement	Candidate	Condition
Industry	Industry	Industry attribute is same
Experience	All of experience years in position attribute	Marked when candidate's experience years greater than or equal experience years of requirement
Education-degree	Latest od education degree	Marked when candidate's degree higher than or equal education degree of requirement
Skills	skills	Mark each skill that is same with full attribute's score divide by number of requirement's skill
Languages	languages	Mark each language that is same with full attribute's score divide by number of requirement's language
Gender	gender	Gender is same
Age.start, age.end (age range)	Age is calculated by dateOfBirth	Age that is calculated within the requirement age range
Marital	marital	Marital is same
Driving	driving	Driving is same
Education-detail.faculty	All fieldOfStudy in educations	Educations have one fieldOfStudy value is same
Education-detail.gpa.start / end (gpa range)	Gpa	Gpa is within the requirement gpa range
Experience-detail	Positions.company.na me and positions.title	Compairs of company name and position name like one of company name and position title in positions attribute

3.4.3 Collaborative Filtering

Because of scoring acquired values that are rather congested and same a lot, this project Collaborative filtering technique to solve this problem. Collaborative filtering is a technique that predicts user interesting with similar testes. The process of Collaborative filtering is shown in Figure 3.6. After getting candidate profile data and requirement data that has same tag, is extracting requirement and candidate choosing pattern. Then, calculate similarity matrix and finding predict value. Accordingly, this technique can be used to improve scoring for more accuracy and spread congested values. The example of result of Collaborative filtering is shown in Figure 3.7

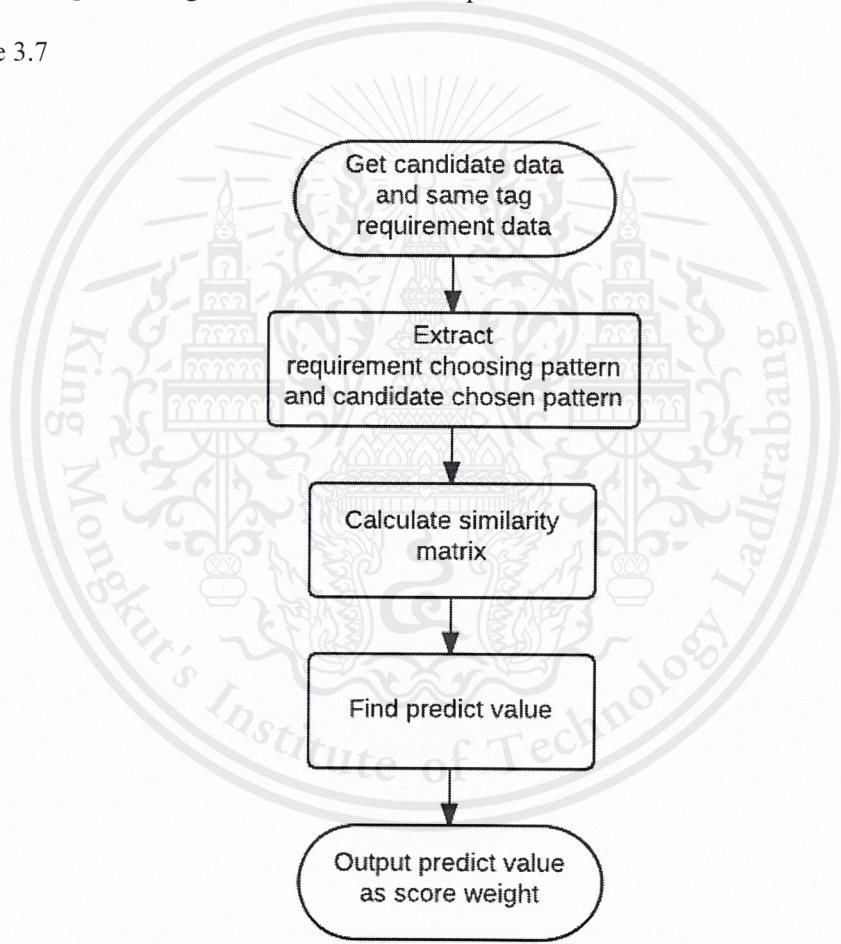


Figure 3.6 Collaborative Filtering Process

3.4.3.1 Extracting requirement and candidate choosing pattern

Collaborative filtering is used in choosing pattern analysis. Raw data cannot use in process directly so pattern of choosing must be extracted for using. The example of choosing pattern is shown in Table 3.5

Table 3.5 Example of Choosing Pattern

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_i
R_1	0	1	0	1	0	1	0	...
R_2	1	0	1	1	0	0	0	...
R_3	0	1	0	1	0	0	0	...
R_4	0	1	0	0	0	1	1	...
R_5	0	0	1	0	0	0	0	...
R_6	1	0	0	0	1	1	1	...
R_u	...	...	...	...	...	...	...	...

Choosing of requirement can be arranged into table from selected list that choose by recruiter and confirmed list that choose by head of department of each requirement that has same tag of target requirement for R_u and R_{u+1} by given candidate C_i who is chosen assign 1 and who is not chosen assign 0. After assigning value in pattern table, R_u can use as list of requirement choosing pattern and C_i use as list of candidate chosen pattern for analysis in next process.

Table 3.6 A part of choosing pattern data from requirement

	c3275	c9834	c6209	c2728	c0624	cBc4s	cmT2v	c7Vch	...
hr8091	1	1	1	1	1	1	1	0	...
mg8091	0	1	0	0	0	0	0	0	...
hr5589	0	0	0	0	1	1	0	1	...
mg5589	0	0	0	0	0	0	0	0	...
hr0711	0	0	0	0	0	0	0	0	...
mg0711	0	0	0	0	0	0	0	0	...
hr2737	0	1	0	0	0	0	0	0	...
mg2737	0	0	0	0	0	0	0	0	...
hr7384	0	0	0	0	0	0	0	0	...
mg7384	0	0	0	0	0	0	0	0	...
hr1154	0	0	0	0	0	0	0	0	...
mg1154	0	0	0	0	0	0	0	0	...

Table 3.6 (Cont.) A part of choosing pattern data from requirement

	c3275	c9834	c6209	c2728	c0624	cBc4s	cmT2v	c7Vch	...
hr5583	0	0	0	0	0	0	0	0	...
mg5583	0	0	0	0	0	0	0	0	...
...	...	...	...	...	...	...	...	...	...

Table 3.6 display example choosing pattern data from requirement in the system that is created for testing after arranging data into table in order to use in next process.

3.4.3.2 Similarity matrix

Similarity testes can find with similarity of candidate choosing and similarity equation in case we use adjusted cosine similarity to compare with candidate choosing list as vector by user and adjust value by mean of requirement choosing for similarity matrix. The candidate choosing list is choosing or added from requirement that has same tags to chosen list and transform to list of binary 0 or 1, 0 refers to not choose and 1 refers to be chosen for example $c_i=[1, 1, 0]$ means candidate $C_{u,i}$ is added to first and second same tag requirement. The adjusted cosine similarity equation becomes:

$$s(i, j) = \frac{\sum_{u \in U} (C_{u,i} - \overline{R_u})(C_{u,j} - \overline{R_u})}{\sqrt{\sum_{u \in U} (C_{u,i} - \overline{R_u})^2} \sqrt{\sum_{u \in U} (C_{u,j} - \overline{R_u})^2}} \quad , \tag{3.1}$$

Where $S(i,j)$ is similarity value by compare candidate i and j , U is set of same tag requirement, $C_{u,i}$ and $C_{u,j}$ is choosing candidate i and j of requirement u , $\overline{R_u}$ is mean of requirement choosing u , i and j is pair of candidates is compared. The value obtained from the equation is similarity value of candidate and the value would be decimal number as value in Table 3.7. The similarity matrix is in the form where $N \times N$ matrix, that N is number of candidates which same tag requirement added in for using in prediction.

Table 3.7 Example of similarity matrix from requirement

	c3275	c9834	c6209	c2728	c0624	cBc4s	cmT2v	c7Vch	...
c3275	1	0.58	1	1	0.71	0.71	1	0	...
c9834	0.58	1	0.58	0.58	0.41	0.41	0.58	0	...
c6209	1	0.58	1	1	0.71	0.71	1	0	...
c2728	1	0.58	1	1	0.71	0.71	1	0	...
c0624	0.71	0.41	0.71	0.71	1	1	0.71	0.5	...
cBc4s	0.71	0.41	0.71	0.71	1	1	0.71	0.5	...
cmT2v	1	0.58	1	1	0.71	0.71	1	0	...
c7Vch	0	0	0	0	0.5	0.5	0	1	...
...	...	...	...	...	...	...	...	...	...

The similarity matrix is in the form where N×N matrix, that N is number of candidates which same tag requirement added in for using in prediction.

3.4.3.3 Prediction

Prediction user interest can predict by similarity matrix for using acquired values to weight score in order to spread score values and increasing ranking performance from interesting of similar user so calculation use a weight average method as follows the equation:

$$p_{u,t} = \frac{\sum_{i \in S} s(t,i) c_{u,i}}{\sum_{i \in S} |s(t,i)|}$$

(3.2)

Table 3.8 Example of predictive value from requirement

ID	$p_{u,t}$	ID	$p_{u,t}$	ID	$p_{u,t}$	ID	$p_{u,t}$
c3275	0.72	c...1468	1	c...9834	0.52	c...8320	0
c8773	0	c...nM5J	1	c...1792	1	c...6654	0.08
c8590	0.08	c...adNl	0	c...9941	0.04	c...2993	0.08
c8907	0	c...0076	0.08	c...0624	0.73	c...8842	0.04
c3288	0	c...5223	0.2	c...5688	0.22	c...ZTM5	1
c6209	1	c...3302	0	c...8544	0.22	c...9enN	0.73
c3252	0.22	c...BnDd	0.11	c...9645	0	c...ZiBr	0

Table 3.8 (Cont.) Example of predictive value from requirement

ID	$p_{u,t}$	ID	$p_{u,t}$	ID	$p_{u,t}$	ID	$p_{u,t}$
c4542	0.08	c...6926	0.08	c...0785	0	c...9602	0.71
c4732	0.17	c...7938	0.04	c...9432	1	c...2477	0.08
cBc4s	0.73	c...2047	0.02	c...6581	0	...	...

A predicted equation predict target candidate t with set of similar values $s(t, i)$, that C is set of candidate in the target requirement, and choosing of requirement u for $R_{u,i}$ so as to find predictive value $p_{u,t}$ and use to weight score for spreading value. If negative value is used to weight score, the score will decrease that is not correct as candidate who are already chosen. For this reason, it can be solved by thresholding similarities for nonnegative value as follows:

$$p_{u,t} = \frac{\sum_{i \in C} s(t,i)(R_{u,i} - b_{u,i})}{\sum_{i \in C} |s(t,i)|} + b_{u,i} \tag{3.3}$$

Thresholding is used as a baseline predictors for solving negative problem using sum of average all choosing, average requirement choosing b_u and average candidate choosing b_i by the following:

$$b_{u,i} = \mu + b_u + b_i \tag{3.4}$$

Predictive value is used as weight of score and increasing score of candidates who are in list of same tag requirements follow predictive value as increasing percent. After weighting, all candidate of requirement is sorted for ranking and show it to recruiter for recommending appropriate candidate of the requirement.

$$new\ score = old\ score \times weight \tag{3.5}$$

Table 3.9 Example of score after weighting and sort from requirement

ID	Score	ID	Score
cBc4s	47.06	c...6KNU	41.18
cmT2v	47.06	c...0624	41.18

Table 3.9 (Cont.) Example of score after weighting and sort from requirement

ID	Score	ID	Score
cbBMB	41.18	c...zNqp	41.18
cnM5J	41.18	c...9enN	41.18
cBnDd	41.18	c...1409	41.18
ctPby	41.18	c...NfZi	41.18
c2043	41.18	c...5770	38.24
cZTM5	41.18	c...0221	38.24

Comparing of the result between before using collaborative filtering and after collaborative filtering is shown in Figure 3.7. The scores after collaborative filtering method have more difference than scores before collaborative filtering.

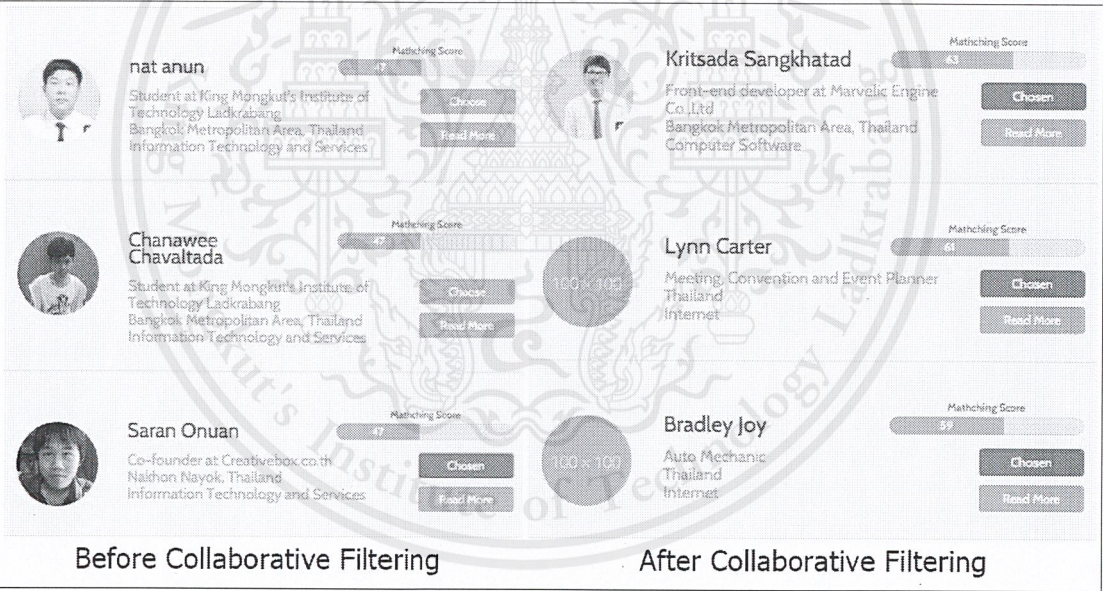


Figure 3.7 Example of result of Collaborative Filtering

3.5 System design

3.5.1 Requirement Schema

The example of requirement schema is show in Figure 3.8. There are attribute that are created when recruiter create requirement. For example, name is a string attribute that used to

store specific name of each requirement, and numberOfCandidate attribute is the number of candidates that are required.

```
{
  name: "String",
  skills: {
    value: [
      "string1","string2","string3","..."
    ],
    care: 0
  },
  industry: {
    value: "String",
    care: 0
  },
  selected: [
    "string1","string2","string3","..."
  ],
  numberOfCandidate: "String",
  experience: {
    value: "String",
    care: 0
  },
  languages: {
    value: [
      "string1","string2","string3","..."
    ],
    care: 0
  },
  education: {
    value: "String",
    care: 0
  },
  id: "String",
  description: "String"
}
```

Figure 3.8 Example of Requirement Schema

3.5.2 Candidates’ Profile Schema

This project collects profile data from many sources such as job searching website, and resume, in order to find the appropriate pattern that use to generate a large number of different personal profiles. The example of candidate profile schema is show in Figure 3.9. For

example, firstName attribute is first name of candidate, education attribute is candidates' education background, and position attribute is the experience under company of candidate.

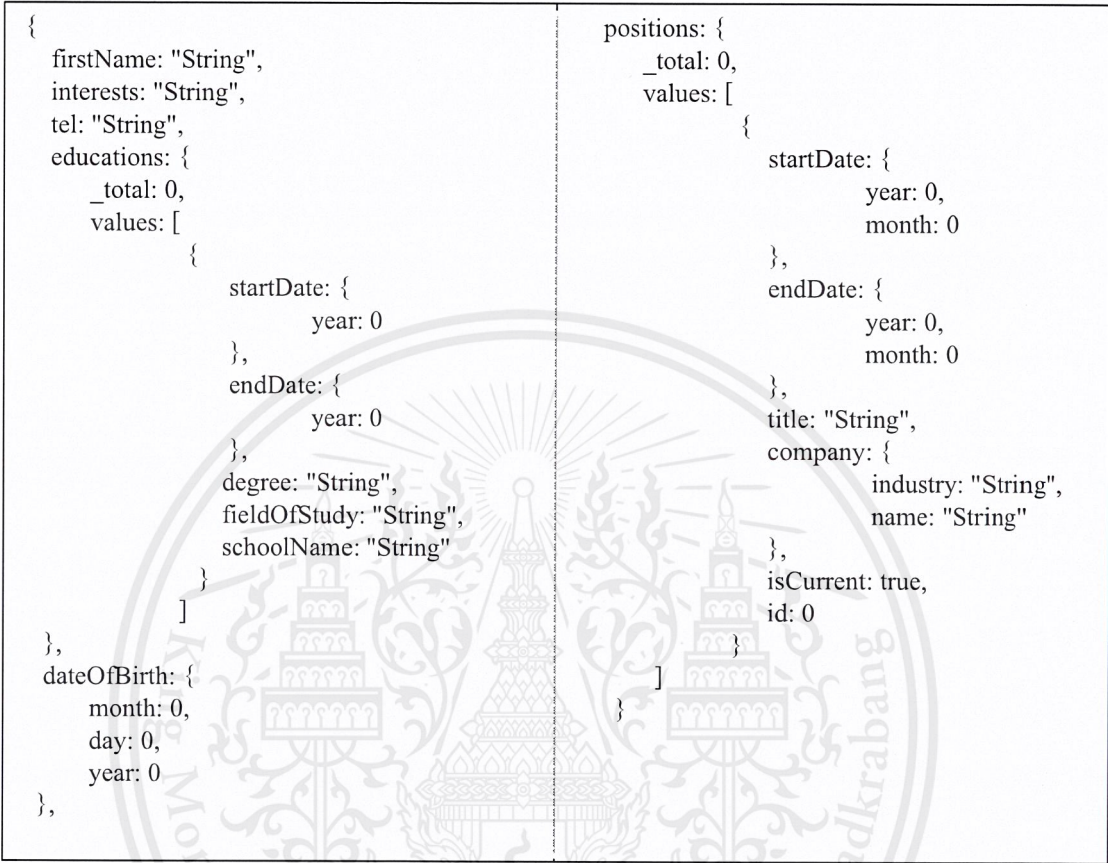


Figure 3.9 Candidate Profile Generated Schema

3.5.3 Use Case Diagram

Use case diagram of the application show in Figure 3.10. This application has two users: Recruiter and Head of department. There are ten major activities for Recruiter: login, logout, register, create requirement, edit requirement, delete requirement, find candidate, show full profile, add candidate to list, and delete candidate. There are seven use cases for Head of department: login, logout, register, show full profile, un-grant, and choose candidate.

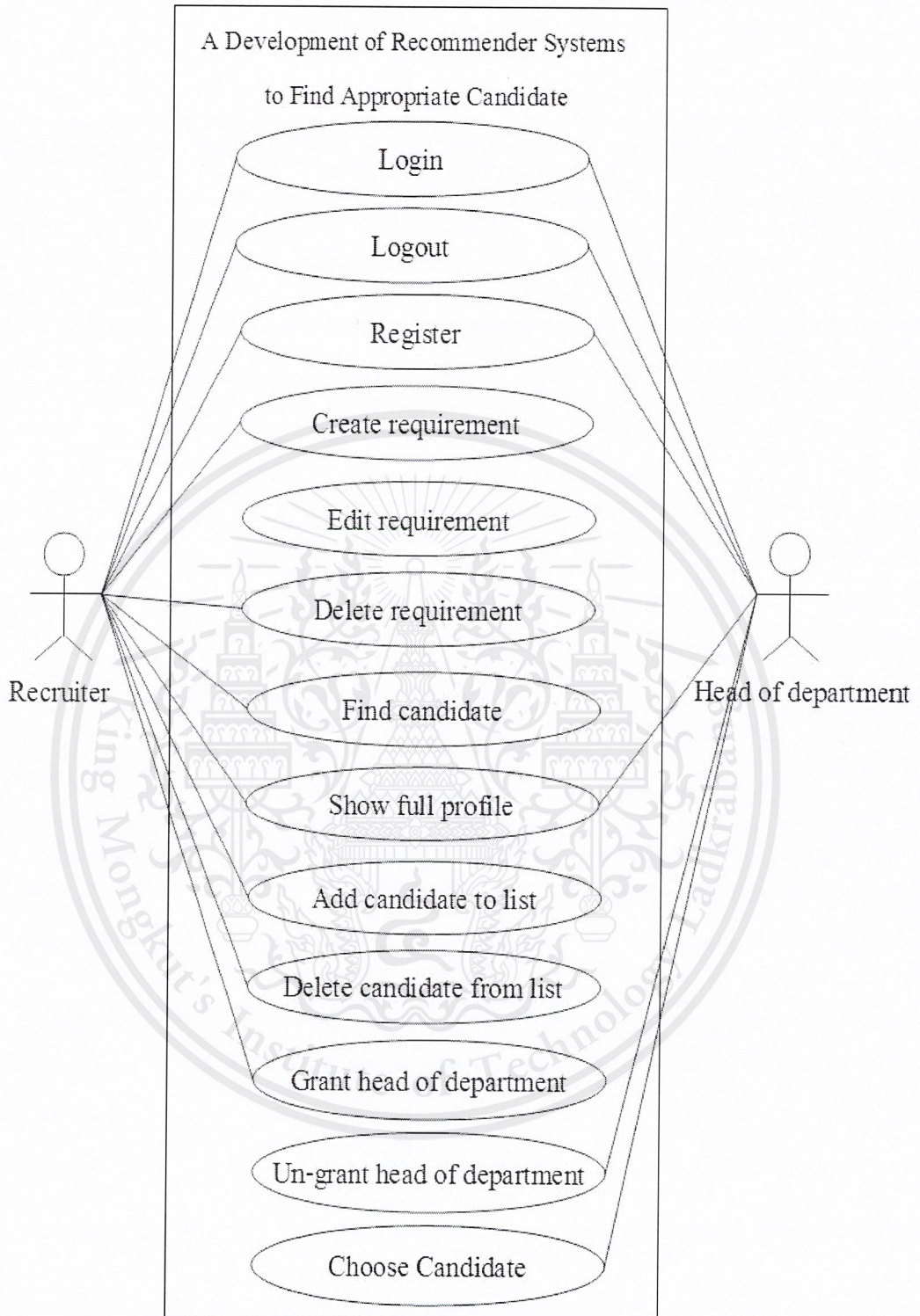


Figure 3.10 Use Case Diagram

3.5.4 Activity Diagram

3.5.4.1 Registration Activity

A registration activity is shown in Figure 3.11. When user does not login in the system and user use this application on the first time, user must create account by using email and password. User can set their display-name that is will be shown in the user interface. User can use the unregistered email to register this system. If the email is already existing or wrong format, the system will show alert and user must re-enter data.

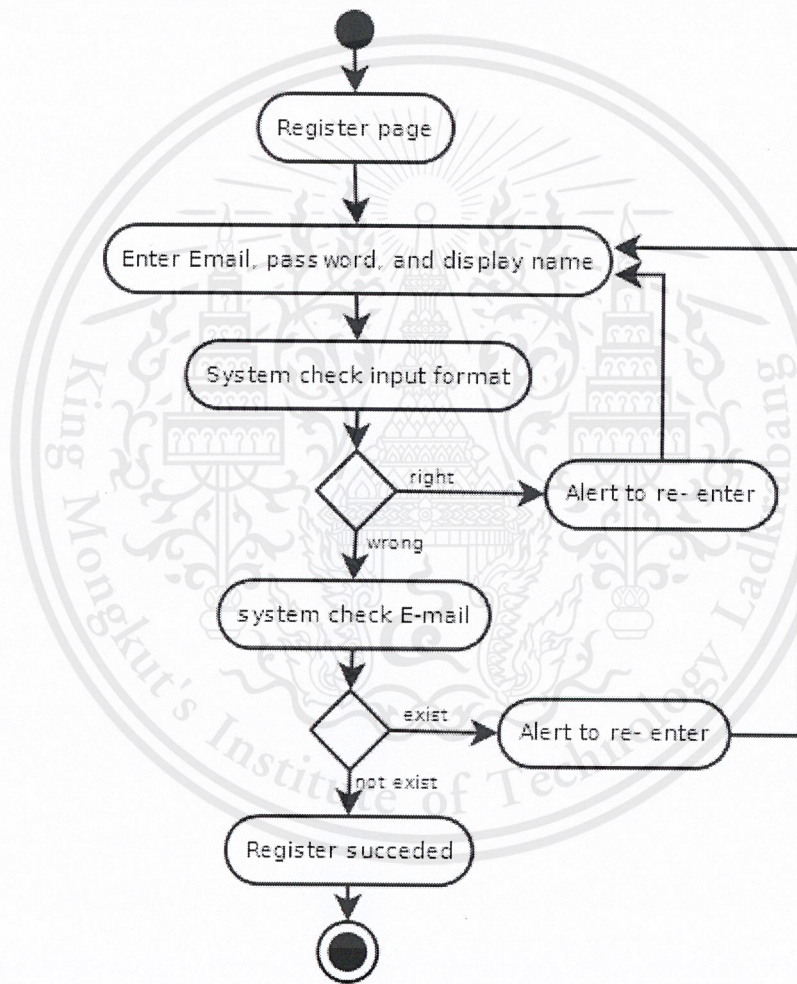


Figure 3.11 Register Activity

3.5.4.2 Login Activity

A login activity is shown in Figure 3.12. When user has already existing account and does not login in the system, user must fill the email and password to login. System will check correctness of user input. If input is incorrect, system will alert user to re-enter.

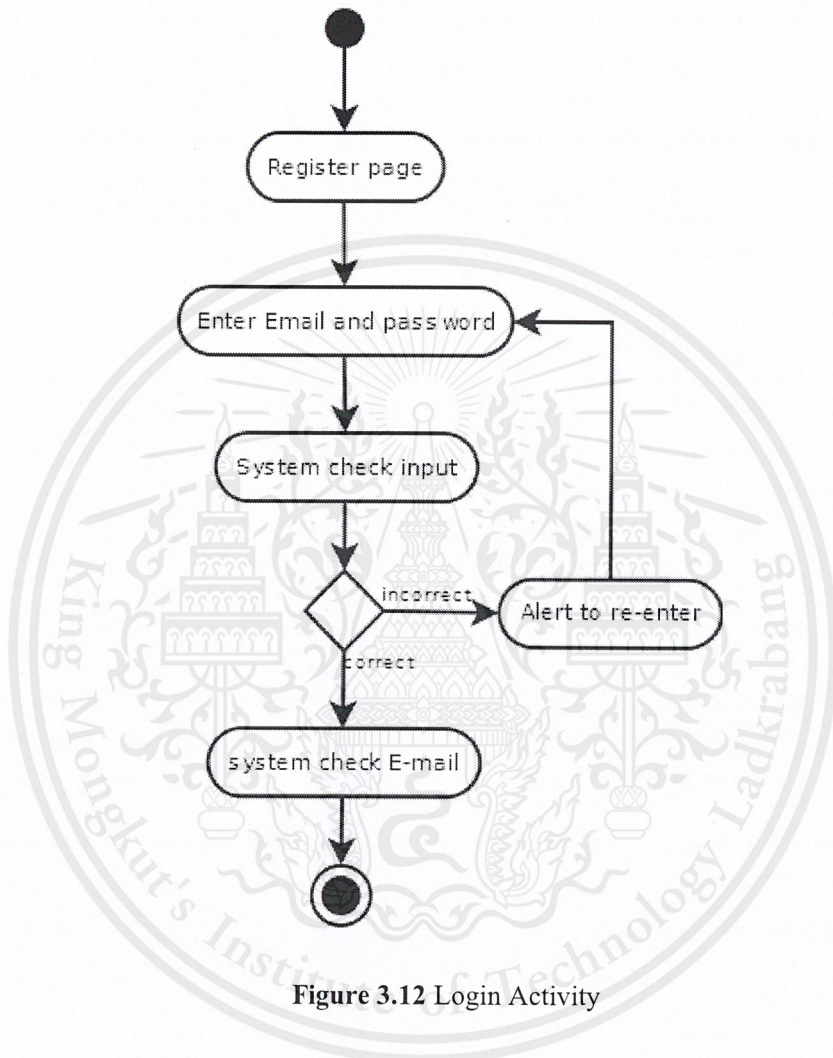


Figure 3.12 Login Activity

3.5.4.3 Requirement Page Activity for HR

Figure 3.13 is the activity in requirement page. This requirement page is the main page for HR or recruiter. If user uses system in the first time, user must create requirement first. If user has existing requirement, user can edit requirement, view listed requirement, delete requirement, and find candidates that will show in ranked candidates list.

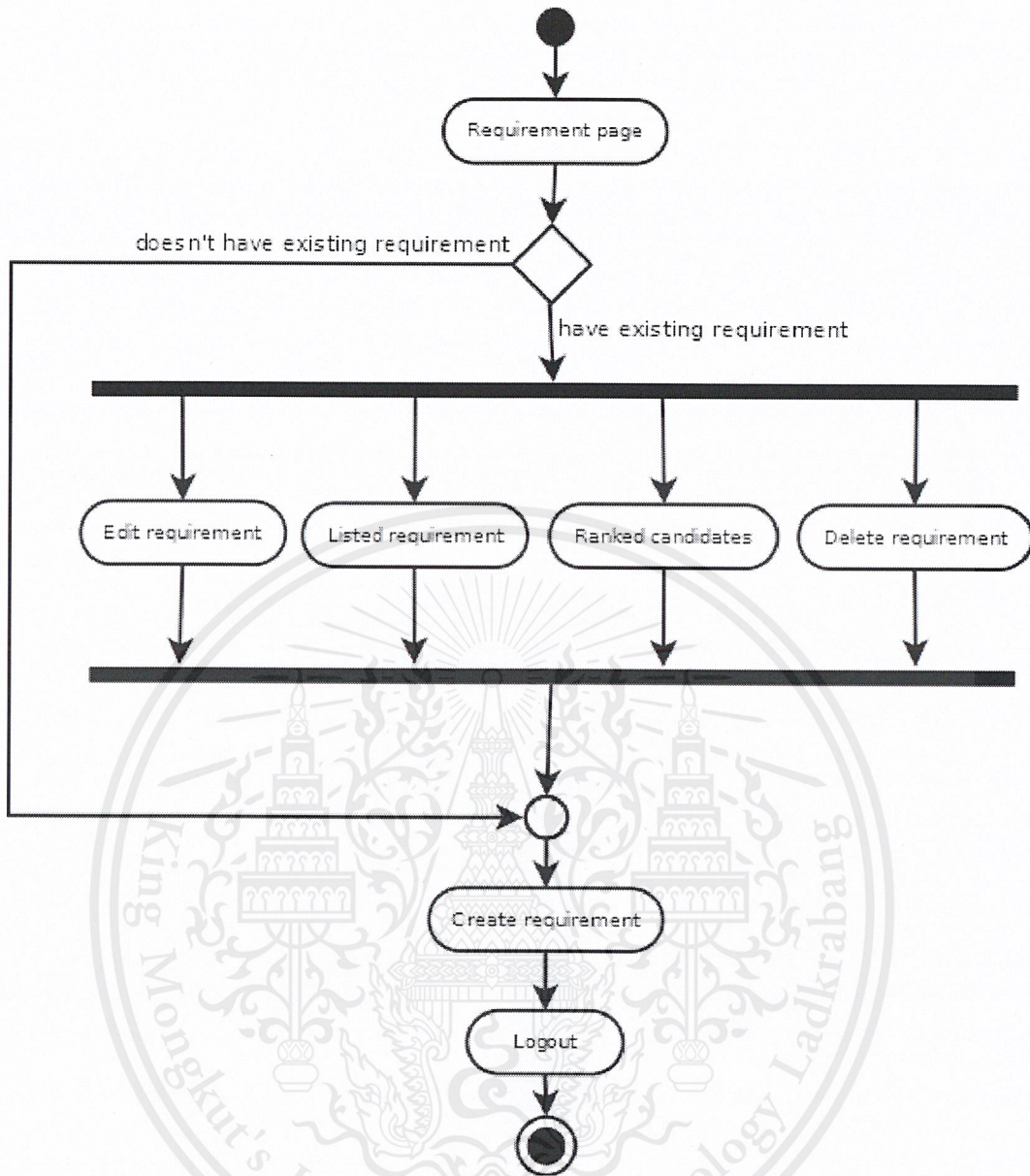


Figure 3.13 Requirement Page Activity for HR

3.5.4.4 Requirement Page Activity for Head of Department

Head of department that was granted by HR can login in the system and after that system will show Requirement page for head of department. The activity of this page is shown in Figure 3.14. In Requirement page for head of department, user can view listed candidate that was selected by HR and user can un-grant them self.

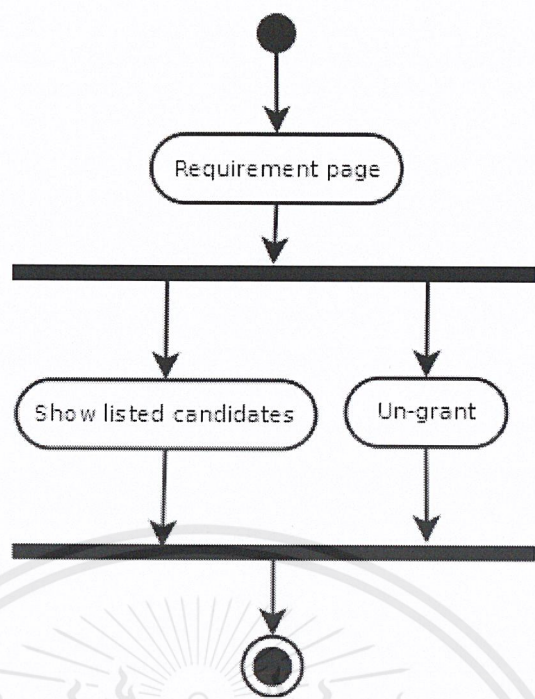


Figure 3.14 Requirement Page Activity for Head of Department

3.5.4.5 Create Requirement Activity

A create requirement activity is shown in Figure 3.15. In this activity, HR is user. When user create requirement, user must fill the requirement form such as requirement name, requirement description, and required skills. User can grant head of department by head of department’s email to authorize head of depart to view selected candidates in the requirement and user can also un-grant head of department too. When user finish filling form and click create requirement button, system will show succeeded and then run the ranking algorithm. When this activity finished, system will link user to the main requirement page.

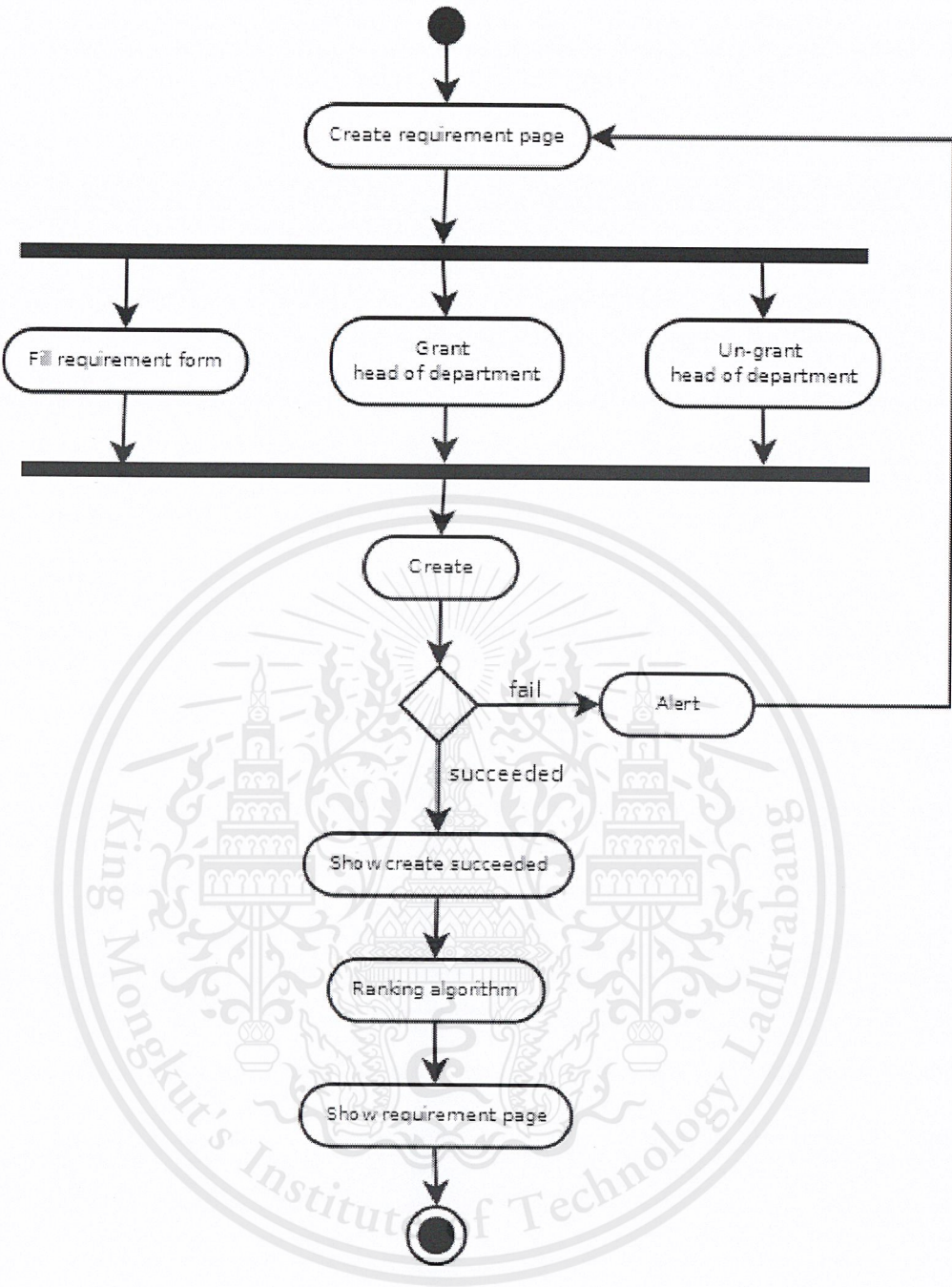


Figure 3.15 Create Requirement Activity

3.5.4.6 Edit Requirement Activity

Edit requirement activity happens when user has existing requirement and want to edit it that is shown in Figure 3.16. User can edit the required qualification of the requirement and can also grant and un-grant head of department in this activity.

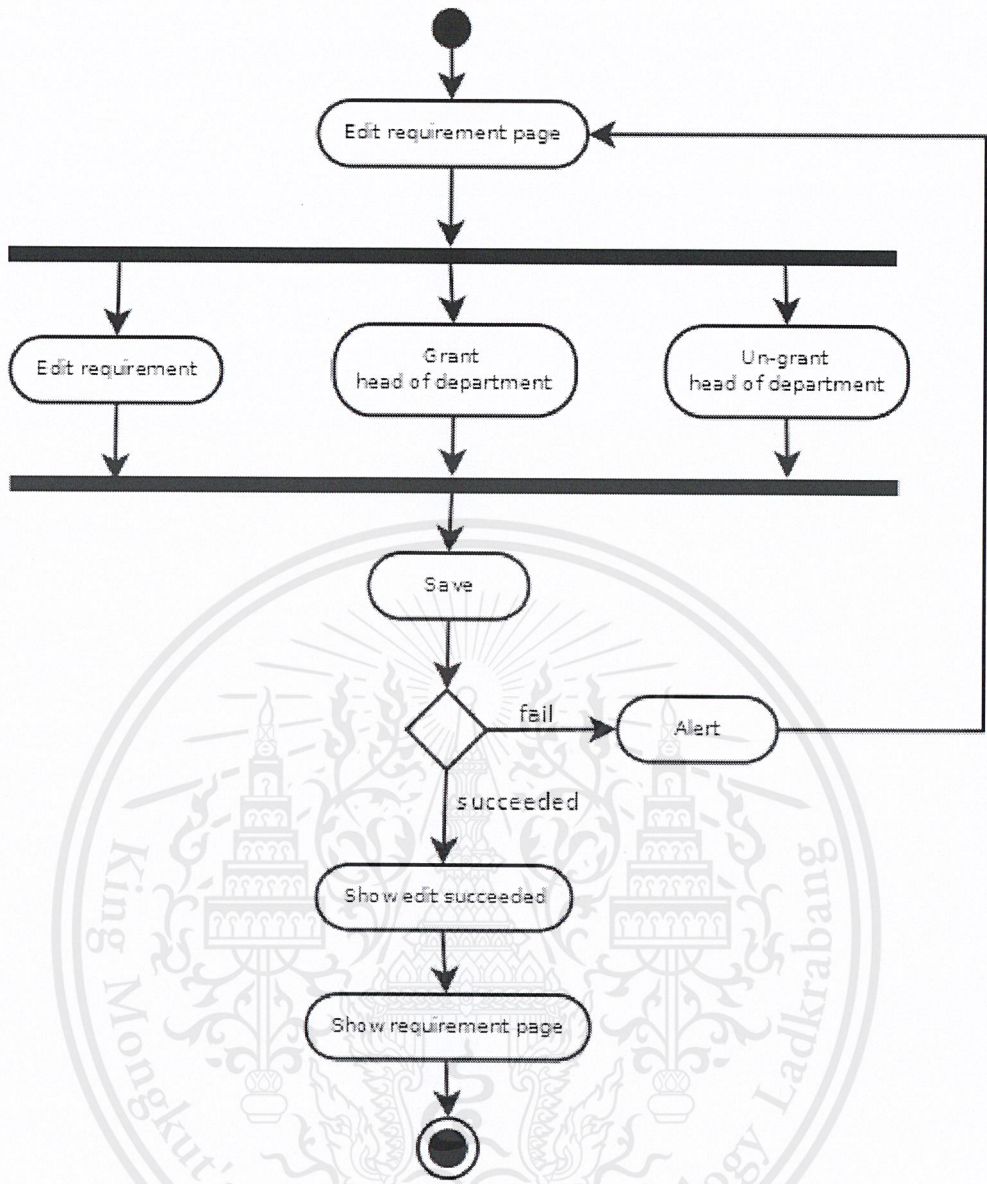


Figure 3.16 Edit Requirement Activity

3.5.4.7 Candidate List Activity for HR

After user adds interesting candidates in to list of each requirement, user can view the list any time. This activity is shown in Figure 3.17. User can delete candidates from list, read full-profile of each candidate in the list and back to requirement page.

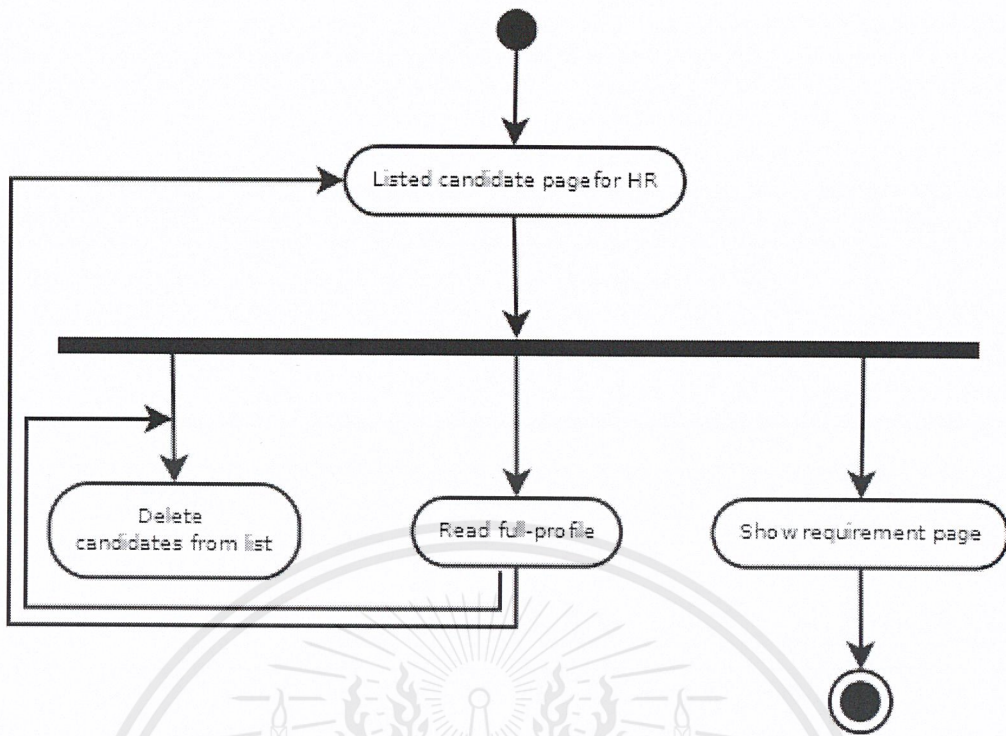


Figure 3.17 Candidate List Activity for HR

3.5.4.8 Requirement List Activity for Head of Department

Requirement List Activity for Head of Department is shown in Figure 3.18. In this activity, Head of department is user. This activity happens when user view listed candidates that were selected by HR. Head of department can read full-profile of candidates, choose desired candidates in to the list, and un-choose them

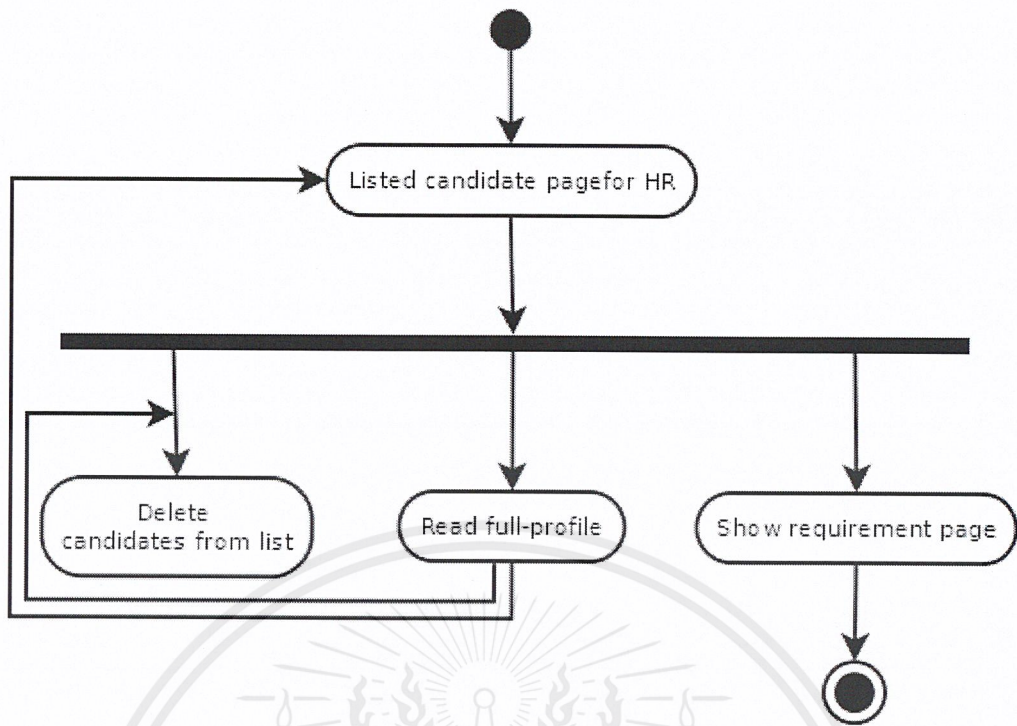


Figure 3.18 Requirement List Activity for Head of Department

Chapter IV

Results and Discussion

This chapter describes about requirement of recruiter, personal profile, main function, and user interface of the system includes: register for candidate, login for candidates, login for recruiters, create requirement, ranked candidate, and candidate description.

4.1 Data

4.1.1 Candidates' Profile Data

The example of candidates' profile data that was generated is shown in Table 4.1. There are five main attributes: personal profile, education, experience, skill, and qualification.

Table 4.1 Example of candidates' profile data

Attribute	Value
First name	Harry
Last name	Cooper
Gender	Male
Birthdate	1-2-1964
Tel.	0954458773
Marital status	Married
Driving Licensed	Yes
Current living location	Thailand
Industry	Information Technology and Services
Educations	Bachelor's Degree, Database and Intelligent Systems
Skills	Networking, Server administration, Microsoft Office,
Languages	English, Thai, Spanish
Positions	Computer Systems Analyst Computer Union Co., Ltd. Computer Hardware 5/1997 – Current Computer Support Specialist Tatung (Thailand) Co., Ltd. Research 5/1995 - 4/1997

4.1.2 Requirement Data

The pattern of requirement was created and requirement will be specified by recruiter. The example of requirement is shown in Table 4.2. Each requirement has many attributes and values. It also has rates or important 1 to 5.

Table 4.2 Example of requirement

Attribute	Value	Important
Requirement Name	Programmer (C#, JAVA)	
Department	Information Technology	
Requirement Description	Develop and design software systems. For IT department at ABC company.	
Tag, Related keyword	Programmer, Developer, Software	
Least Year Experience	2-5	3
Industry Experience	Information Technology and Service, Computer-Software	2
Education Level	Bachelor's Degrees	5
Skills	Java-Developer, C#, SQL, PL/SQL, Teamwork, Communication, SAP-ERP Systems, Oracle, Java	4
Languages	English, Thai	5
Gender	Male, Female	1
Age	22-45	4
Marital Status	Not specified	1
Driving License	Not specified	1

4.2 User Interface

4.2.1 Login and Register Page

Login page is shown in Figure 4.1. Recruiter can sign in with registered account by entering email and password. Register page is shown in Figure 4.2. User can register with their email.



Figure 4.1 Login Page

In register page that is shown in Figure 4.2, user must fill their Email, display-name, password, re-password, and user must choose recruiter or manager.

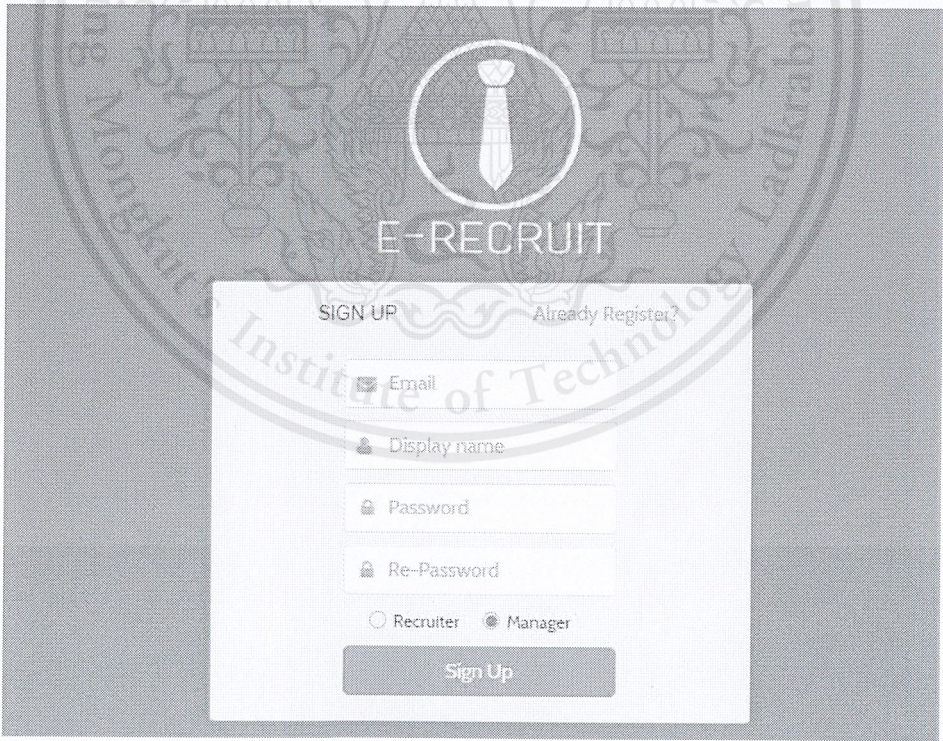


Figure 4.2 Register Page

4.2.2 Requirement Page

Requirement page is shown in Figure 4.3 below. After user log in, Requirement page was show. This page is a main page of this system. In this page user can link to Create requirement page, Find candidate page, Edit requirement page, and Requirement list page.

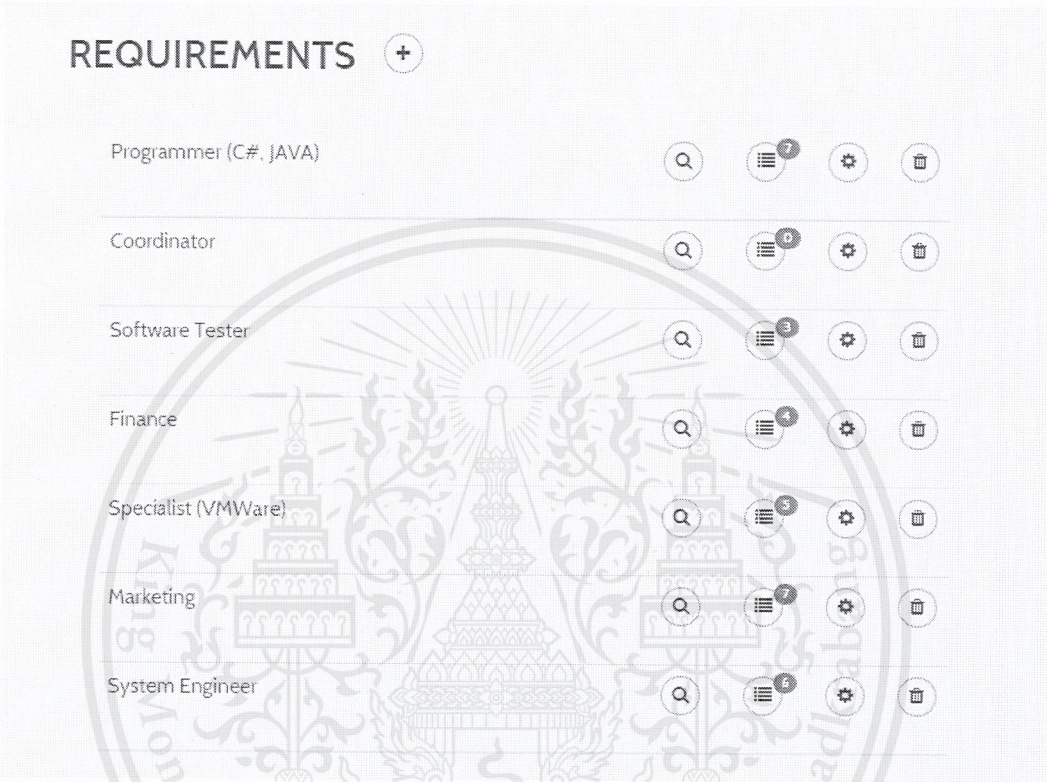


Figure 4.3 Requirement Page

4.2.3 Create Requirement Page

When user click “Create Requirement” button the system will link to create requirement page that is shown in Figure 4.4. In this page user can specific there requirement by entering requirement name, requirement description, required number of candidate, main requirement, and optional requirement. Moreover, user can rate their specific requirement by choose the star.

CREATE REQUIREMENT

Add Manager

+

Requirement Name

Requirement Name

Number of Candidate

1

Department

Department

Requirement Description

Description

Tag : Related keyword

Add a tag

Least Year Experience

0-1

2-5

6-10

10+

Not specified

Industry Experience

Add an industry

Education Level

Not Specified

Skills

Add a skill

Languages

English

Chinese(Mandarin)

Optional Requirement

CREATE

Figure 4.4 Create Requirement Page

4.2.4 Edit Requirement Page

Edit requirement page is shown in Figure 4.5. When user click Edit Requirement button in the Requirement page, the system will link to this page. In this page, user can edit their existing requirement, grant head of department, and save it.

EDIT Programmer (C#, JAVA)

Add Manager

+

itone_it_dep@gmail.com : IT Manager

itone_mngr@gmail.com : Panpaporn_manager

Requirement Name

Programmer (C#.JAVA)

Number of Candidate

1

Department

Information Technology

Requirement Description

Design, develop, and configure software systems to meet market and/or client requirements either end-to-end from analysis, design, implementation, quality assurance

Tag: Related keyword

Programmer

Developer

Software

Information-Technology

java

Add a tag

Figure 4.5 Edit Requirement Page

4.2.5 Candidate List Page

Candidate list page is shown in Figure 4.5. When user click “Candidate List” button in the Requirement page the system will link to this page. This page show the already added candidates in each requirement list. In this page User can read full profile of candidates and delete candidates from their requirement list.

List of Programmer (C#, JAVA)

Manager Selected

100 x 100

Thanachart Vivattanaputi

Microsoft Student Partner at Microsoft
Bangkok Metropolitan Area, Thailand
Computer Software

Mathching Score
71

Delete

Read More

Manager Selected



Saksit Sawang

Programmer at Computer Systems
Integration Co.,Ltd.
Nakhon Ratchasima, Thailand
Computer Software

Mathching Score
68

Delete

Read More

Manager Selected



nat anun

Student at King Mongkut's Institute of
Technology Ladkrabang
Bangkok Metropolitan Area, Thailand
Information Technology and Services

Mathching Score
68

Delete

Read More

Manager Selected

100 x 100

Saran Onuan

Co-founder at Creativebox.co.th
Nakhon Nayok, Thailand
Information Technology and Services

Mathching Score
67

Delete

Read More

Figure 4.6 Candidate List Page

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4.2.6 Raked Candidate Page

Ranked candidates page is shown in Figure 4.6. When user choose requirement to find candidate system will match the requirement with candidates and show in ranked list by giving score. In this page User can read full profile of candidates and add interested candidates in requirement list.

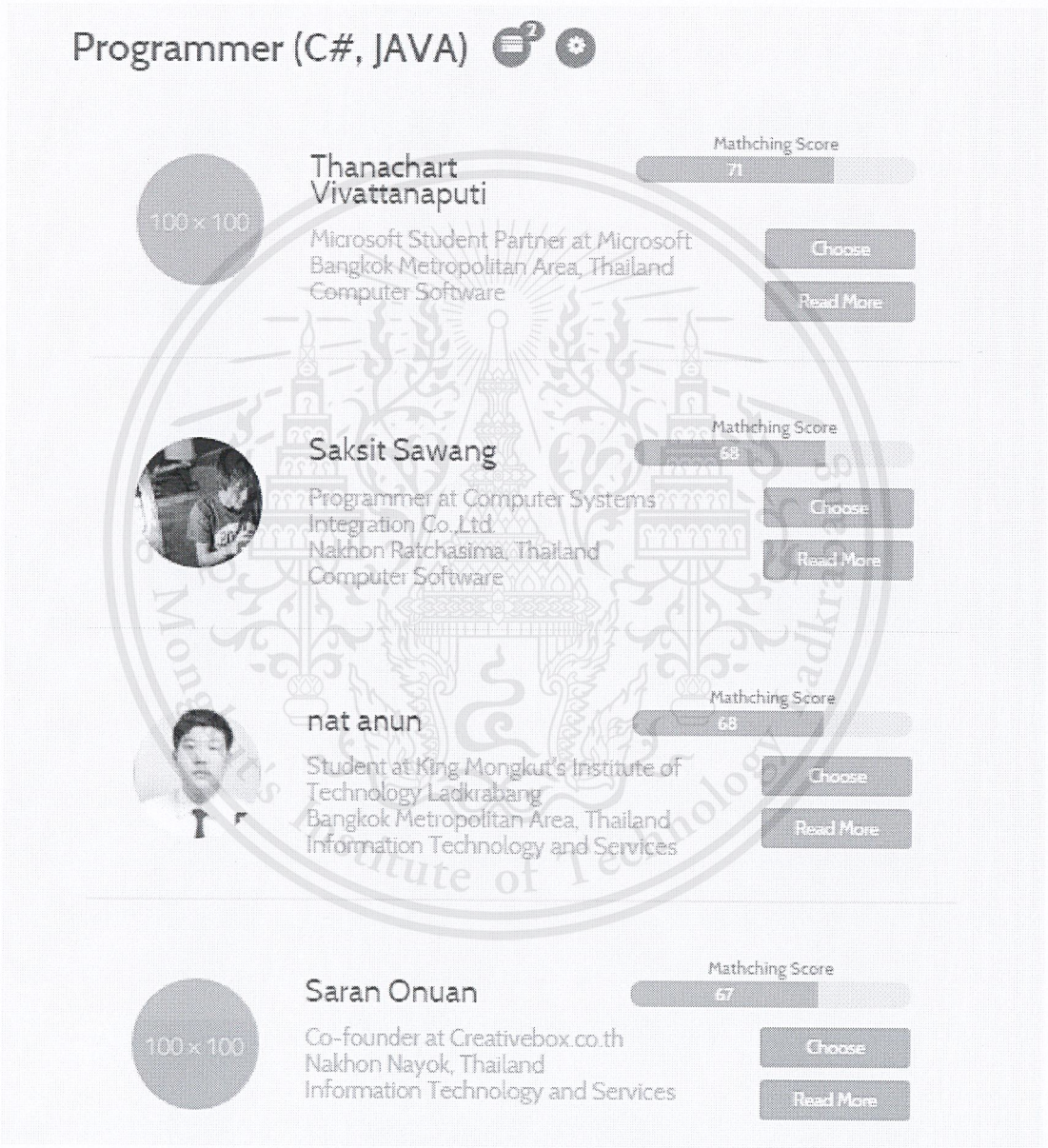


Figure 4.7 Ranked Candidate Page

4.2.7 Full Profile Page

Full profile page is shown in Figure 4.5. When user click “Read More” button in each candidate profile in Ranked candidate page and Requirement list page the system will show full profile of candidate such as personal profile, education, and experience.



Figure 4.8 Full Profile Page

Chapter V

Conclusion

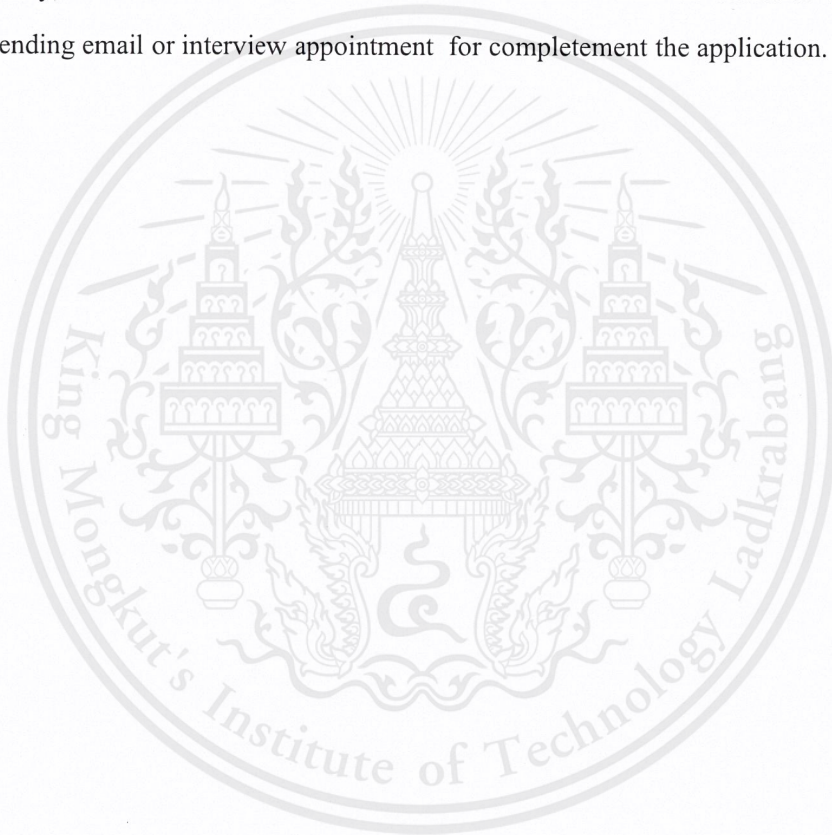
The main objective of this project is to develop a Recommender systems to find appropriate candidates for recruitment in organization with Collaborative filtering technique. We started from studying the process of recruitment in the organization and define recruiter's problem that recruiters had to filter a number of candidates. Then, we define scopes and objective of this project and start to develop recommender systems to find appropriate candidates for recruitment as web application.

After studying of recruitment process, we collected profile data from many sources such as JobsDB.com, Linkedin.com, resume, and curriculum vitae in order to find the appropriate pattern that use to generate a large number of different personal profiles and store the data into database in NoSQL format with MongoDB. However, data have many attribute but not all attribute can match to the requirement of organization, so we collect only necessary data. Then, we start Recommendation approach by matching value of each attribute in requirement and candidate profile. Then, rank candidates by scoring. In the scoring system or ranking process, we found problems about correlation between requirements and candidate profile data that some attribute can match but the score of candidate will be same a lot, in consequence of this problem, we use collaborative filtering to improve comparing with similar user choosing and the result is used as a weight of automatic adjusted values for spreading score that same a lot. Finally, we develop Web Application for recruiter and head of department. The application has two of user: recruiter and head of department. Recruiter type can create a requirement and select candidates after comparing and ranking with the requirement, then head of department can choose candidates from candidates list that was selected by the recruiter. Hence, recruitment can be reduced processes time by filtering from requirement that recruiter created. In addition, recruiter can use the application everywhere by web browser, so it more comfortable to work without a lot of document.

Because of generated profile data, it is not enough accurate. Moreover, the Result of ranking has high tolerance, many recommended profiles have matched qualified attributes but overall of the profiles is not according to those matched attributes. For example, when a recruiter finds a programmer who has website developing skill, the system will recommend candidates having the skill but those recommended candidates may have other skills that are not related to

website developing such as networking skill, system administration skill or other programming languages. Therefore, overall of candidates who are recommended may be the unexpected candidates. In addition, this project still lacks functions for all recruitment process. At this point, the project cannot be used for all process but it can recommend candidates only.

In the future, the other method that can be able to compare characteristic of data is use to matching. Classification is a method that can find characteristic of data and find another that same or similar so it will be used to match between attributes of candidates and requirement for more accurately matching. In addition, this project cannot use for all recruitment processes yet. Consequently, functions or features that relate recruitment will be added to the application, such as sending email or interview appointment for complete the application.

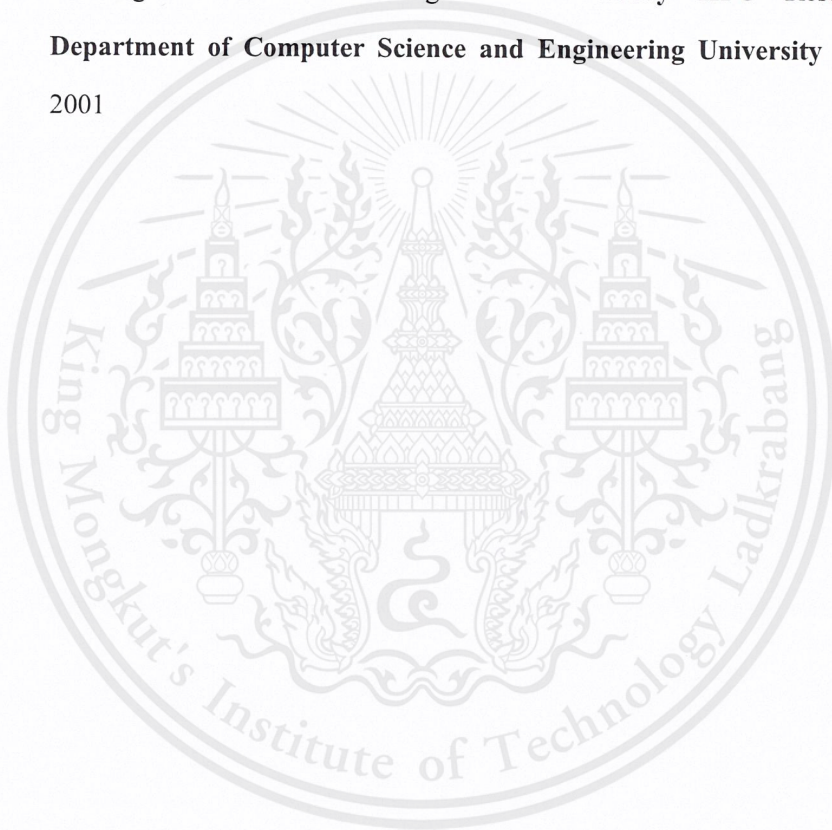


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Appendix A

Manual Installation

This section describe about the steps to open the application by installation Ubuntu server with virtual box, login to server, and using IP address to link to the web application.

- 1. Open Ubuntu server with virtual-box by clicking “Ubuntu-server.ova” file
- 2. Login to the server with:

Username: itkmitl
Password: itkmitl

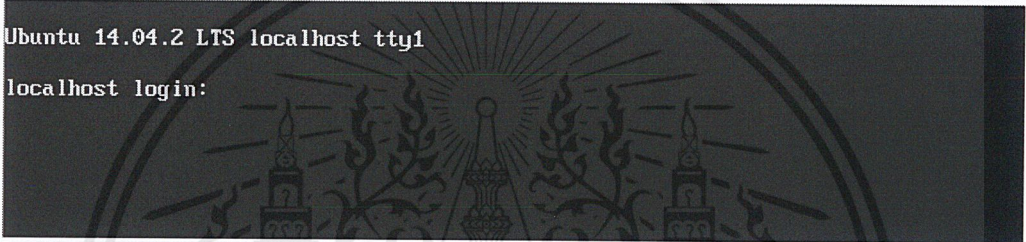


Figure A-1 Login to Server

- 3. If the Internet need authentication, you have to type “lynx” and wait for login.

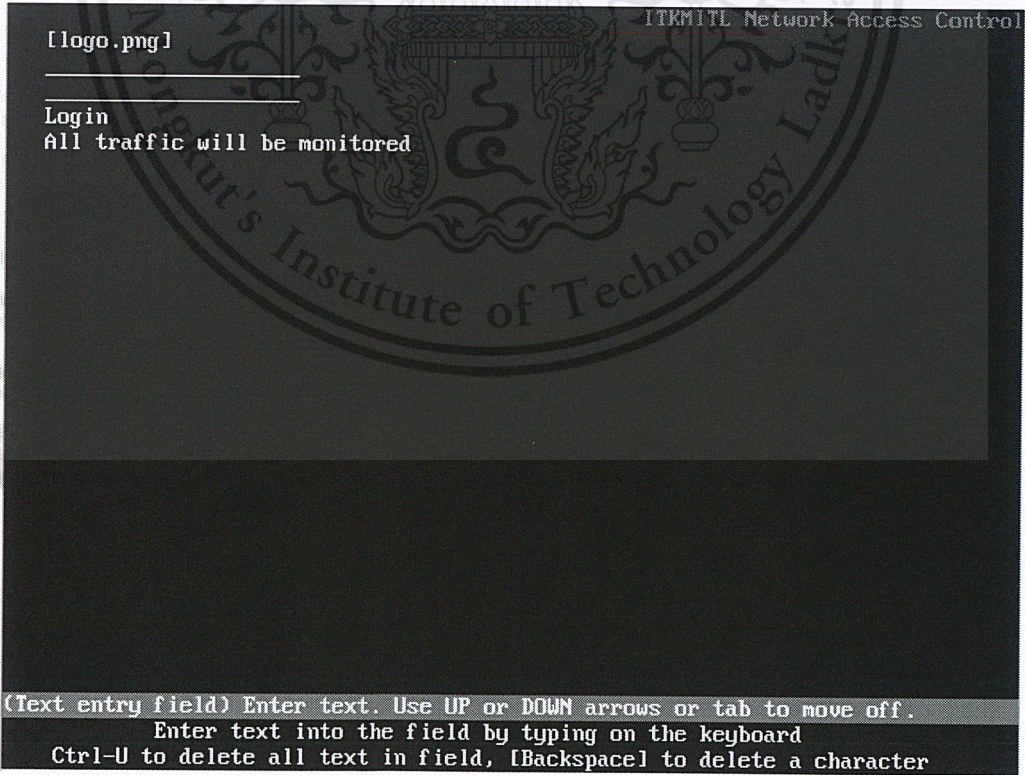


Figure A-2 Authentication

4. Type “ifconfig” and look for IP address

```
itkmitl@localhost:~$ ifconfig
eth0      Link encap:Ethernet  HWaddr 08:00:27:38:de:20
          inet addr:10.0.2.15  Bcast:10.0.2.255  Mask:255.255.255.0
          inet6 addr: fe80::a00:27ff:fe38:de20/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:48 errors:0 dropped:0 overruns:0 frame:0
          TX packets:63 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:10144 (10.1 KB)  TX bytes:5787 (5.7 KB)
```

Figure A-3 Looking for IP Address

5. Use this IP address to put it in browser on desktop



Figure A-4 Putting IP on browser

BIOGRAPHY

Name Mr. Chanawee Chavaltada

Birth Date June 30, 1993

Permanent Address 251/334 Ramkamhaeng Rd. Sapansoong, Bangkok 10240

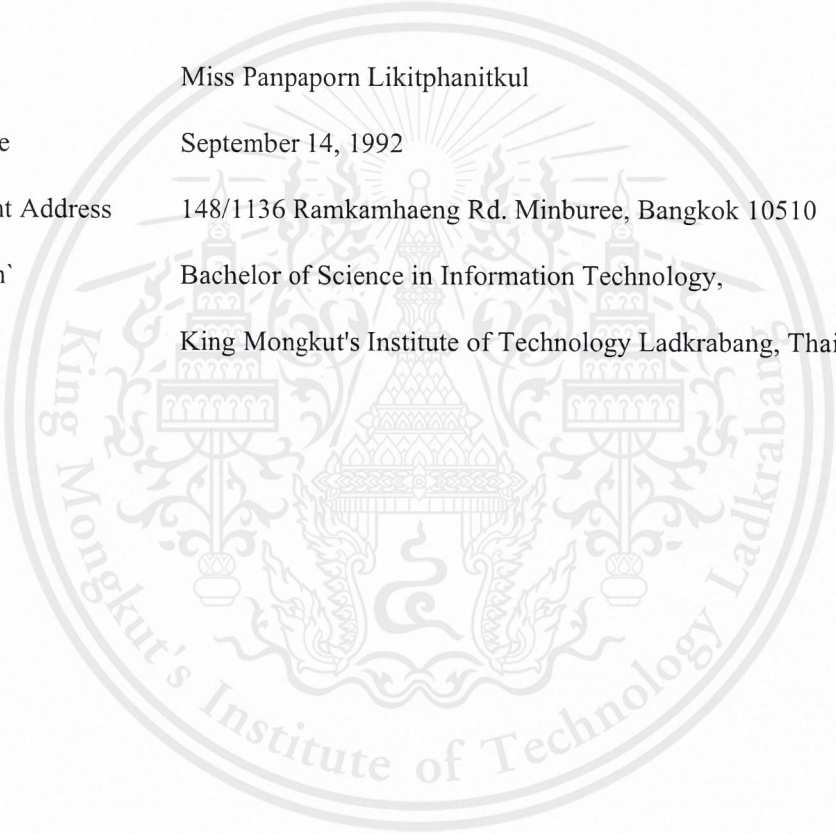
Education Bachelor of Science in Information Technology,
King Mongkut's Institute of Technology Ladkrabang, Thailand

Name Miss Panpaporn Likitphanitkul

Birth Date September 14, 1992

Permanent Address 148/1136 Ramkamhaeng Rd. Minburee, Bangkok 10510

Education Bachelor of Science in Information Technology,
King Mongkut's Institute of Technology Ladkrabang, Thailand



A DEVELOPMENT OF RECOMMENDER SYSTEMS TO FIND APPROPRIATE CANDIDATES FOR RECRUITMENT WITH COLLABORATIVE FILTERING

Chanawee Chavaltada¹ and Panpaporn Likitphanitkul¹

¹*Faculty of Information Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok*

Emails: itoonnn@gmail.com, ffernnn@gmail.com

ABSTRACT

This project aims to develop a personal characteristic analysis system to find appropriate candidate by matching personal characteristic of candidate with qualifications requirement from recruiter and recommend candidates to recruiter by Recommender systems. Personal characteristic data was generated as curriculum vitae form about 2,000 different forms for analyzing and matching with requirement of candidate. This project develops Web Application for user to specify their requirement. The system will rank candidates for user by giving score of matching between requirement and candidate profile data. Then, system will recommend candidates for recruiter.

Index Terms – Recruitment; Recommender Systems; Collaborative Filtering

1. INTRODUCTION

The recruiting process varies by industry, company, specific work. Many employers are finding appropriate employees by using a team of recruiters or human-resources. There are too many of applicants in one organization. There are many candidates who are correctly matched to the job and the organization, and candidates who are not. The appropriate is talents of the person match with required work and the values of the person are in sync with the values of the organization. Nowadays, technology has influence and important for organization. Many organization recruit candidates by using electronic media as databases to find candidate data and information. The growth of social media sites is now providing to the large number of individuals who have posted their profile, career experience and other relevant information that recruiters need. When the organization looking for hiring employees, social media has made it easier

for recruiters to find employees but the data are not sufficiently appropriate to work for different needs. The organization expect that workers to be able to fill vacancies right away, without any training. Information technology is applied to basic performance evaluate such as applicant filtering form introduction in order to analyze characteristics and qualifications appropriately by candidate profile and qualification of company. This study aims to develop the system that can match qualification of candidate and requirements of recruiter to find appropriate candidate by recommender system.

2. THEORETICAL FRAMEWORKS

This section presents relevant information, background theoretical framework.

2.1. Recruitment

Recruitment is the overall process of hiring candidates for job position in the organization and its processes are within the Human Resources

Management (HRM) [1]. Recruitment is a significant process that effect to organizational performance, not just about human resources department but also for other department that involved in the selection process. It makes the organization to select the most appropriate candidate to fill job vacancies. Recruitment process should be managed with good tools and method. The main propose of this process is to find source of candidates to provide the best opportunity to select the best candidate for the organization. E-Recruitment is the process of recruitment that using electronic resources such as the internet. E-Recruitment provides an online database to use online job advertising and search engines.

2.2. Recommender Systems

Recommender systems are a part of information system filtering system that predict and suggestion for users [2]. The suggestions are about decision-making process and they are used with each different users or user groups with various suggestions. The suggestions aimed to support decision making process [3]. It is used to recommend information, product, or service such as what movie to watch, what music to listen, or what product to buy. The simplest form of recommendations is suggested as ranked lists. The ranked list show predicted result that are what the most appropriate product or service based on the user's preferences and constraints by collecting user preferences and action. There are four main task of recommendation process: Generation, Queueing, Delivery, and Optimization. Generation task is determination of derived source and determination of filtered attributes. Queueing task is determination of storing data and queue of each task. Delivery task is determination of delivery data to user interface. Optimization task is about system learning from data and improving recommendations. There are three recommendation approaches: content-based

filtering, collaborative filtering, and hybrid recommender systems.

2.2.1. Collaborative Filtering

Collaborative filtering based on predictions on the rating of other user in the system by selecting and aggregation of other users' opinions to provide a prediction of active user's preference [4]. Assume that, if users agree about the quality of some items, they will agree about other items. The algorithm of Collaborative filtering is about generating of first prediction of user's preference and create their recommendations by ranking items by previous predicted preferences. Baseline predictors or Baseline algorithm is the pre-processing and normalizing data before use true collaborative filtering algorithm.

2.2.2. Hybrid Recommender Systems

Hybrid recommender systems are combine collaborative filtering and content-based filtering. There are several ways to implement hybrid approaches such as making content-based and collaborative-based predictions one by one and then combining. Hybrid approaches can be implemented in various techniques: content-based, collaborative, demographic, and knowledge-based techniques. Knowledge-based recommender system recommends product based on user's preferences and needs by exploiting explicit user's requirement. Knowledge-based recommenders has two basic specifics: case-based and constraint-based recommenders [5].

2.3. DATABASE

2.3.1. NoSQL

NoSQL or Not Only SQL is a type of database which is non-relational or model-less. NoSQL database provides data storage that is modeled in means other than the tabular relations used in relational databases [6]. The main benefit of NoSQL is provides flexibility. NoSQL uses schema-less solutions data models meaning that the database can be allow an

unlimited form, structured, semi-structured, or unstructured: flexible data models that can be modified easily.

2.3.2. MongoDB

MongoDB is a database management that is designed for web application infrastructure. Data in MongoDB are called documents. It can provide good performance and intuitive data model because it is a document-oriented database [8].

3. SYSTEM ANALYSIS AND DESIGN

This section describes about the problem of traditional recruiting process, the architecture of the system, data structure of candidates' profile that was created, data structure of requirement that recruiter will create, and recommendation approach.

3.1. PROBLEM DEFINITION

The organization has a Human Resource Management (HRM) function. One part of HRM is employee recruitment. The organization has a lot of CV, resume, applicants, and online personal profile. These different formats of data are hard to manage and select. When recruiter wants to recruit new employees, they must read resume one by one to find candidates. Recruiter required each different qualification for each work. It has a lot of data and the data are not sufficiently appropriate to work for different needs.

3.2. DATA STRUCTURE

3.1.1. Requirement Data Structure

Requirement was created for recruiter to specific their requirement descriptions. Requirement data structure was separated into 2 parts: main requirement and optional requirement. There are 8 attributes in main requirement part as follows: (1) Name attribute is specific name of each requirement. (2) Description attribute is requirement description. (3) NumberOfCandidate attribute is the number of candidates that are

required. (4) Experience attribute is a required minimum of years' experience. (5) Industry is the experienced industry that candidates belong to such as accounting, computer software, and networking. (6) Education-degree attribute is candidates' education background such as Undergraduate Degrees, Associate's Degrees, Bachelor's Degrees, Master's Degrees, and Doctoral Degrees. (7) Skills attribute is the skills that candidate holds such as Business Intelligence, Mobile Development, and Marketing Management. (8) Languages attribute is the languages that candidate knows such as English, Chinese, and Thai. There are 6 attributes in optional requirement part as follows: (1) Gender attribute is a required gender of candidate such as male and female. (2) Age attribute is the required range of age of candidate. (3) Marital attribute is the marital status of candidate. (4) Driving attribute is a required driving license of candidate. (5) Education-detail attribute is field of study, minimum required grade, and maximum require grade (6) Experience-detail attribute is the experience under company and position of candidate.

3.1.2. Candidates' Profile Data Structure

A large number of different personal profiles or candidate profiles are created as curriculum vitae form. There are 14 main attributes in candidates' profile data structure: (1) firstName attribute is first name of candidate, (2) lastname attribute is last name of candidate, (3) interests attribute is interests of candidate, (4) tel attribute is a telephone number of candidates, (5) educations attribute is education background of candidate that has four sub-value: start date, end date, degree, field of study, and school name, (6) dateOfBirth attribute is date of birth of candidate that has sub-value: day, month, and year, (7) position attribute that has five sub-value: start date, end date, company, and current status, (8) industry attribute is the experienced industry that candidates belong to, (9) languages

attribute is the languages that candidate knows, (10)skills attribute is the skills that candidate holds, (11) location attribute is the address of candidate, (12) interest attribute, (13) gender attribute, and (14) position attribute is the past position of candidate.

3.3. RECOMMENDATION APPROACH

In the recommendation approach that is shown in Figure 1, it can separate into two part, matching and collaborative filtering, in order to acquire appropriate score. Matching is mapping values between requirement and each resume that is same and assign score to each resume by scoring criterion that is defined by requirement but the scores still has a problem that the scores group likewise so recruiter would make more decision from that problem. In order to solve the problem, the technique that can adjust and improve score ranking is used. Collaborative filtering is a technique that analyze user choosing pattern extract each similar requirements and candidates for recommending item or candidate who other similar requirements have chosen. After collaborative filtering analysis acquired result, the result values can use as score weight and adjust it. This technique makes more difference of scores and improves score quality.

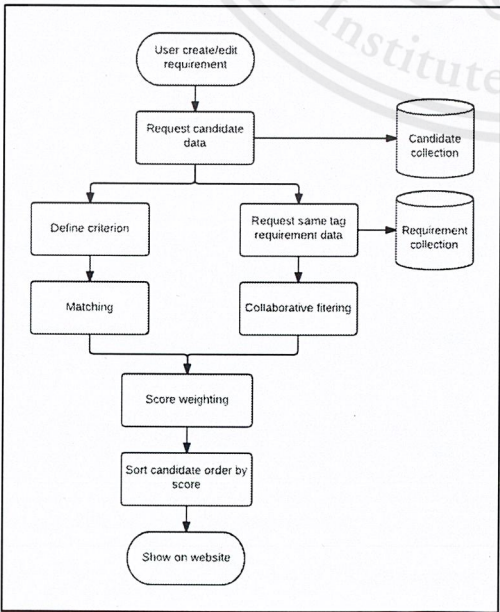


Figure 3.1. A Recommendation Approach

3.3.1. Scoring Criterion

This project create scoring criterion to assign score for each candidate by equitation shown in Figure 3.2, given S_i is a score for matching criterion, R_i is rating of attribute in requirement that are rated by recruiter, S_{ij} is score of each attribute. After matching criterion has created, the resume is assigned scores with comparing between value of each attribute of it and the requirement. In case, the value is multiple value or sub-value such as list, each value in multiple value is compared and the score of comparing is divided by number of value in sub-value.

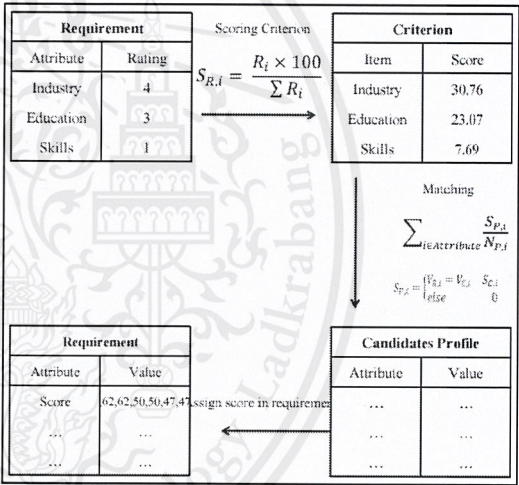


Figure 3.2. A Scoring Criterion

In case, the value is multiple value or sub-value such as list, each value in multiple value is compared and the score of comparing is divided by number of value in sub-value.

3.3.2. Machine Attribute

Matching qualification of candidate from each candidate profile with requirement of recruiter by many conditions. The example of conditions are shown in Table 3.1.

Table 3.1 The Example of Matching Conditions

Requirement	Candidate	Condition
Industry	Industry	Industry attribute

		are same
Skills	Skills	All value in Skills attribute are same
Experience	Experience	candidate's experience years greater than or equal experience years in requirement

3.3.3. Collaborative Filtering

Because of scoring acquired values that are rather congested and same a lot, this project Collaborative filtering technique to solve this problem. Collaborative filtering is a technique that predicts user interesting with similar testes. The process of Collaborative filtering is shown in Figure 3.3.

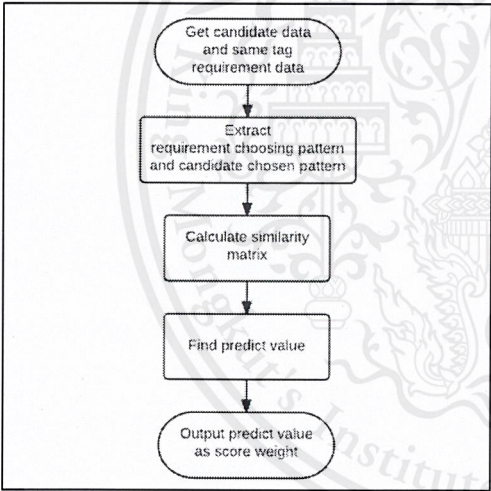


Figure 3.3. Collaborative Filtering Process

After getting candidate profile data and requirement data that has same tag, is extracting requirement and candidate choosing pattern. Then, calculate similarity matrix and finding predict value. Collaborative filtering is used in choosing pattern analysis. Raw data cannot use in process directly so pattern of choosing must be extracted for using. Similarity testes can find with similarity of candidate choosing and similarity equation in case we use adjusted cosine similarity to compare with candidate choosing list as vector by user and adjust value by

mean of requirement choosing for similarity matrix. Prediction user interest can predict by similarity matrix for using acquired values to weight score in order to spread score values and increasing ranking performance from interesting of similar user. Accordingly, this technique can be used to improve scoring for more accuracy and spread congested values.

4. RESULT

This section discusses about the main function and present the example of user interface of the system includes: main requirement page, create requirement, ranked candidate page, and candidate full profile page.

4.1. USER INTERFACE

4.1.1. Requirement Page

Requirement page is shown in Figure 4.3 below. After user log in, Requirement page was show. This page is a main page of this system. In this page user can link to Create requirement page, Find candidate page, Edit requirement page, and Requirement list page.

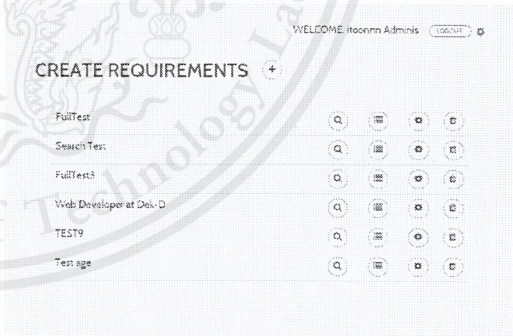


Figure 4.1. Requirement Page

4.1.2. Create Requirement

When user click "Create Requirement" button the system will link to create requirement page that is shown in Figure 4.2 below. In this page user can specific there requirement by entering requirement name, requirement description, required number of candidate, main requirement, and optional

requirement. Moreover, user can rate their specific requirement by choose the star.

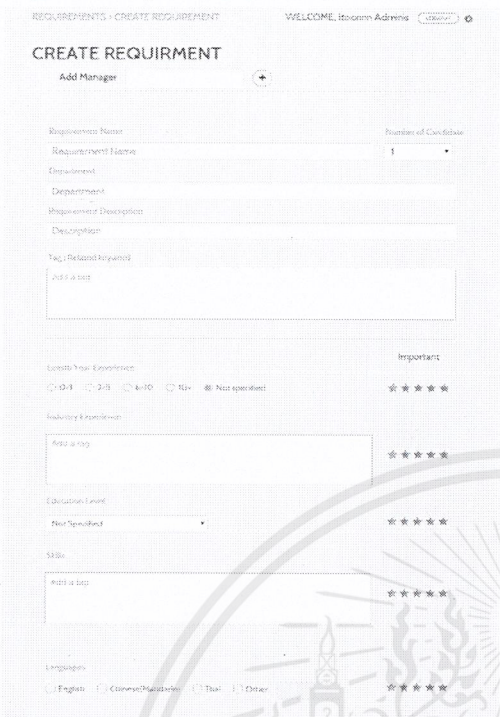


Figure 4.2. Create Requirement Page

4.1.3. Ranked Candidates Page

Ranked candidates page is shown in Figure 4.3.

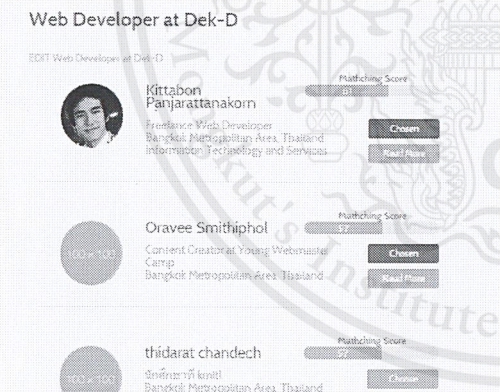


Figure 4.3. Ranked Candidates Page

When user choose requirement to find candidate, The system will match the requirement with candidates and show in ranked list by giving score. In this page User can read full profile of candidates and add interested candidates in requirement list.

4.1.4. Full Profile Page

Full profile page is shown in Figure 4.4. When user click "Read More" button in each candidate profile,

in Ranked candidate page and Requirement list page the system will show full profile of candidate such as personal profile, education, and experiences.



Figure 4.4. Ranked Candidates Page

5. CONCLUSION

Under the development of Recommender systems to find appropriate candidates for recruitment in organization with Collaborative filtering, we started from define recruiter's problem that recruiters had to filter a large number of candidates. Consequently, we found something can use instead resume file. We collected profile data from many sources such as JobsDB.com, LinkedIn.com, resume, and curriculum vitae in order to find the appropriate pattern that use to generate a large number of different personal profiles and store the data into database in NoSQL format with MongoDB. However data have many attribute but not all attribute can match to the requirement of organization, we collect data only necessary. Then, we start Recommendation approach by matching value of each attribute in requirement and candidate profile Then, rank candidates by scoring. In the scoring system or ranking process, we found problems about correlation between requirements and candidate characteristics that some attribute can match but the score of candidate will be same a lot, in consequence of this problem, we use collaborative

filtering to improve comparing with similar user choosing and the result is used as a weight of automatic adjusted values for spreading score that same a lot. Finally, we develop Web Application for recruiter and head of department. The application has two of user: recruiter and head of department. Recruiter type can create a requirement and select candidates after comparing and ranking with the requirement, then head of department can choose candidates from candidates list that was selected by the recruiter. Hence, recruitment can be reduced processes time by filtering from requirement that recruiter created. In addition, recruiter can use the application everywhere by web browser, so it more comfortable to work without a lot of document.

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