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ONTOLOGY BASED JOB-CANDIDATE MATCHING USING SKILL SETS

BY

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A THESIS

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Abstract

Adopting an efficient skills matching approach is necessary for discovering right skills needed in the labour market. Hence, skills management has been recently acknowledged as one of the key factors to adequately face the increasing competitiveness among different companies. In fact, suitable knowledge representation and matching of skills and other competences in the job and individual profiles—if properly chosen—could support human resources management automation through suitable matching and ranking services. This thesis work presents an approach for matchmaking between skills demand and supply through the implementation of methodology for skill profiles enrichment and matching supply and demand profiles over multiple criteria. In this respect, this work brings together research from different fields – profile modelling, information enrichment and multi-criteria matching. Methodology for harmonization and enrichment of heterogeneous profile models and skill set description by making use of standard ontology is the first contribution of this work. Secondly the formulated solution utilizes algorithm for similarity matching across multi-criteria for discovering set of profiles that best fits the job description criteria. The system developed in the scope of this thesis work can provide a foundation for realization of a sustainable virtual marketplace for employees and employers to discover the best fitting job or resource respectively.

Keywords:

HR Management, Ontology, Job Matching, similarity matching.

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1. Introduction

In order to meet user's needs and maximize outcomes, it is necessary to develop processes and methodology that focus on the quality of the learning and assessment experience. It is well established in research that effective strategies involve:

- Making sense of new knowledge and skills and developing understanding to be reproduced when required;
- Looking for what is significant such as key concepts, principles; and relating new ideas to previous knowledge experiences;
- Finding the link between conceptual knowledge and real-world applications;
- Utilize semantic concepts through examining issues, clarifying problems and producing new knowledgebase.

1.1 Background

Due to the information overload on a given topic, the user has to filter out the proper results satisfying his information needs. In complex scenarios with multiple criteria and fuzziness of selection criteria, the information retrieval strategy based only on relational database is not sufficient. This problem is further deepened by the unstructured and heterogeneous nature of web data. This problem is strongly prevailed in the domain of human resource management because human resource management is highly dependent on user profiles being created by different internet based recruitment solutions.

Nowadays human resource managers rated the internet as an important recruitment channel and over half of all personnel recruitment is the result of online job postings. Although job portals are an increasingly important source for job applicants and recruitment managers, they still exhibit shortcomings in retrieval and precision as the stored job offers are in syntactic formats, i.e. searches are subject to the ambiguities of natural language and job descriptions and characteristics lack relations to similar or interdependent concepts. Particularly, queries which are over-specified or inconsistent return no matches while relevant job offers could actually still be found if the consistency or specificity problem were to be resolved. Moreover, if exact matches are lacking, worse alternatives must be often accepted or the original requirements have to be negotiated for compromises. [1]

No matter what the need might be, the job provider has certain requirements when it comes to the skill set, experience, education and expected salary of the people they are hiring. The goal of proper decision-making is to optimize one or more criteria in order to achieve the desired result. In human resource scenario there is a need of optimizing several criteria simultaneously. These specific problems are handled using the matching technique with the help of ontology and similarity based strategy is used in order to compute the degree of similarity between each of the job seekers and a job description and to rank the seekers according to their similarity score.[2]

This thesis work is focused on the modelling a solution for information enrichment by utilizing human resource ontology and development of a matching approach for comparisons of applicant profiles and job openings with focus on skills, occupations, and experience as well as industry sector descriptions.

1.2 Problem Definition

Job recruitment often involves processing a big number of applications for an open position. It is not efficient and effective to shortlist candidates manually. Therefore Web has become more and more important platform for job recruitment for both job providers and job seekers. There are many job portals and big organizations who set up online application systems, where basic data of job profiles and application profiles are entered so that the data can be used for automated selection of candidates who have satisfied the competencies and other requirement in the job profiles. On the other hand job seekers prefer to use web portals to search for jobs that fits their competencies and other preferences. In both cases, it is a matter of matching between job demands and job offers.

In determining relative suitability of applicants with different skill sets with regards to a specific job offer, number of questions arises as:

- How does one select people from the database with the sought after skills?
- If no exact match is found, can a selection be done where people with similar skills to the sought ones can be recommended?
- How can CV be ranked with regards to their skills, and as such, compared to each other with regards to suitability to given job offer?

In order to understand the problem let's take sample tables of candidate profile and the job offer criteria containing following data

Table 1-1 Example of candidate profile

Name	Skills	Designation	Experience
Paolo	Web Programming, C, SQL, MVC, jQuery, Python, Java	Analyst Programmer	11
John	Architect, Technical Lead, Development Lead, .Net, Asp.Net, C#, VB, JQuery, MVC	Senior Programmer	6
Dominic	JavaScript, Ajax, Asp.Net, HTML, Oracle, MySQL, C, C#, C++, Ruby on Rails, SmallTalk, web Programming	Programmer	3

Table 1-2 Example of job offer criteria

Job Title	Skill Required	Experience	Qualification
Senior web programmer in .Net	Asp.Net, C#	>5	Bachelor in computer engineering or equivalent
Ruby on Rails Developer	Ruby on Rails, MongoDB	>2	Bachelor in computer engineering or equivalent
System analyst	Architect, .Net , AWS	>8	Bachelor in computer engineering or equivalent

If a simple piece of information from candidate data in Table 1-1 is needed for satisfying the job offer having job title “Senior web programmer in .Net” which is described as in Table 1-2 above. Let us suppose that three candidates John, Paolo, Dominic skilled as presented in Table 1-1 and that the three of them have a bachelor degree fulfilling the strict constraint of the user request. Looking at the three profile descriptions and at the original request, the three candidates are ranked as (1) John (2) Paolo (3) Dominic w.r.t. the preference expressed by the user. In fact, reasonably, the candidate Paolo has higher ranking than Dominic because of eleven years of experience in web programming and java even if he does not fully satisfy the criteria Asp.Net, c#. On the other side, Paolo has experience in MVC, JQuery so skills seems to be more useful than Dominic ones. To get this type of ranking the normal relational database query is not sufficient.

It's clear from this scenario that the attention need to be given to multiple criteria the candidates have in their CV with some semantic matchmaking for getting proper desired result.

1.3 Objective

The main objectives of this thesis work are:

1. To develop a system for matching candidate CVs and jobs requirement based on skill and experience
2. To enrich Jobs and CVs meta data using standard domain knowledge base i.e ESCO ontology and metric similarity method.

1.4 Scope of Work

The public and private employment agencies, companies, talent management agencies need efficient approach for resource acquisition that can be quickly adapted to volatile environments. This thesis work provide the ranked candidate according to their skillset and experience taking the skillset and experience of job specification as input. The ranked list deals efficiently with the cases where the exact match of given requirement does not met by the candidate profile.

1.5 Structure of report

The thesis is organized as follows.

- Chapter 1 gives the brief introduction of the job requirement scenario in current world and the problem human resource management currently facing.
- Chapter 2 is all about the basic information of the terms and technology used in the system with related work and different approaches carried out in the area of job requirement.
- Chapter 3 explains the methodology used in the thesis work. The algorithms, model development, system development, datasets and experimental setup as well as validation methodology for the system are described.
- Chapter 4 covers results, validation data and validation consideration along with the analysis of experimental results and discussion on the results.
- Chapter 5 provides the conclusion, limitation and recommendation of the thesis work.

2. Literature Review

This section provides the study on current knowledge, as well as theoretical, methodological and technical contributions in particular topics that have been followed in the scope of this thesis work. This section is particularly important to see the big picture of the research problem and understand some of the existing research results and activities that have acted as the starting point of this thesis. Following three sub—sections provide a discussion on two important aspects of this research work viz. similarity matching and skills representation ontology along with brief discussion on some technical implementations. This section ends with a comparative analysis of previous research works for gaps that have been identified and addressed by this research work.

2.1 ESCO Ontology

ESCO (European Skills, Competence and Occupation) is the multilingual classification of European Skills, Competences, Qualifications and Occupations. It identifies and categorizes skills, competences, qualifications and occupations relevant for the EU labor market and education and training, in 25 European languages. The system provides occupational profiles showing the relationships between occupations, skills, competences and qualifications. ESCO has been developed in an open IT format, is available for use free of charge by everyone and can be accessed through an online portal. ESCO is part of the Europe 2020 strategy. [10]

ESCO provide the EU with a set of cross boarder multi-lingual vocabularies to facilitate EU job market transparency by using the ESCO thesauri as a hub for translating and encoding CV and Job Postings.

ESCO is structured on the basis of three pillars representing a searchable database in 25 languages. These pillars are:

- Occupations
- Skills and competences
- Qualifications (certifications)

https://ec.europa.eu/esco/portal/escopedia/ESCO_data_model

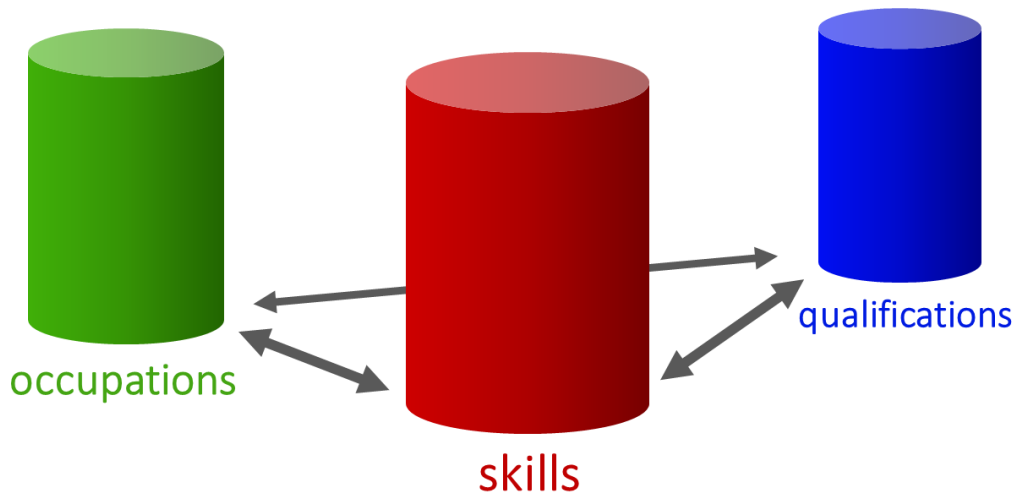


Figure 2-1 Pillar of ESCO Ontology

Source: https://ec.europa.eu/esco/portal/escopedia/ESCO_data_model

More importantly, the pillars are interlinked to show the relationships between them. Occupational profiles show whether skills and competences are essential or optional and what qualifications are relevant for each ESCO Occupation. Alternatively, the user can identify a specific skill and see which occupation or qualification this skill is relevant to. [10]

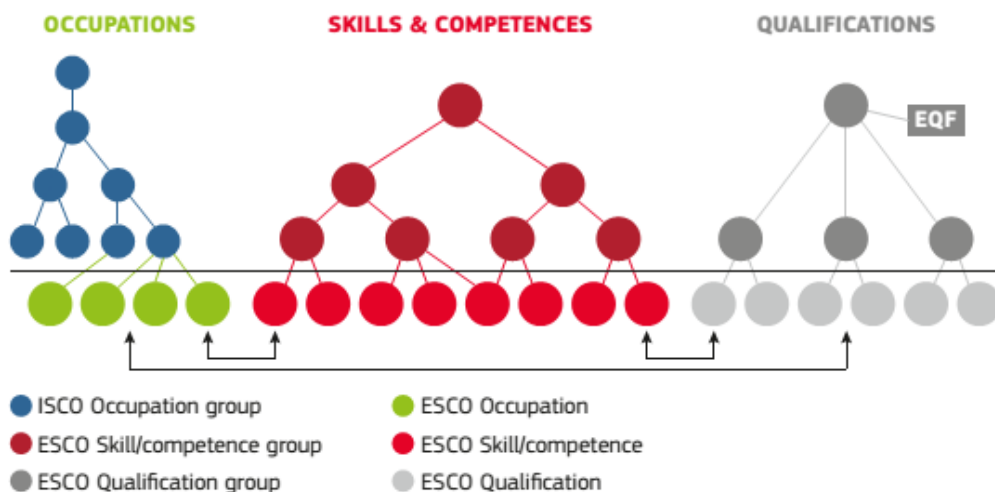


Figure 2-2 ESCO Data Model

Source: https://ec.europa.eu/esco/portal/escopedia/ESCO_data_model

The Semantic relationships between concepts of the three pillars can be written as

- Occupations and Skills/Competences: essential and optional skills for an Occupation
- Occupations and Qualifications: Qualifications required for an Occupation
- Qualifications and Skills/Competences: Skills asserted by a Qualification (certificate)

2.1.1 Occupations

In ESCO v1 the ESCO occupations pillar contains around 3,000 occupation concepts. Since each occupation is mapped to the ISCO-08 it can be used as a hierarchical structure of the occupations pillar.

2.1.2 Knowledge, skills and competences

The skills pillar contains knowledge, skills and competences as well as some group concepts. In ESCO v1 it contains about 13,500 concepts and is not organised in a full hierarchy, but structured through its link to occupations. The transversal knowledge, skills and competences in ESCO v1 are organized hierarchically.

2.1.3 Qualifications

The qualifications pillar allows Member States and awarding bodies to provide data on qualifications which is collected in ESCO. The qualification are structured using the European Qualifications Framework (EQF) and the ISCED Fields of Education and Training 2013.

2.1.4 Relationships between ESCO concepts

- Between the three pillars
The three pillars of ESCO are interlinked to make visible; which knowledge, skills and competences terms are useful to describe jobs in a specific occupation and learning outcomes of a qualification. Also they provide insight of which qualifications Member States consider relevant in the context of a specific occupation.
- Between knowledge, skills and competences and occupations

The relationship between knowledge, skills and competences and occupations is defined as "essential" or "optional". "Essential" are those knowledge, skills and competences that are usually required when working in an occupation, independent of the work context or the employer. "Optional" refers to knowledge, skills and competences that may be required or occur when working in an occupation depending on the employer, on the working context or on the country.

- Between knowledge, skills and competences and qualifications

In addition to the full learning outcome description, Member States or awarding bodies that provide data on qualifications can indicate which ESCO knowledge, skills and competence concepts are relevant in this context. This semantic annotation creates relationships between the qualifications and the skills pillar.

- Between qualifications and occupations

The relationship between qualifications and occupations describes how Member States considered particular qualification or certificate relevant for occupations. It merely reproduces information that is managed and kept on a national level, in case the Member State transmits this information together with data on qualifications. In the course of the ESCO project such relationships are not being created actively.

ESCO is being gradually developed and will be continuously updated to reflect changes on the European labour market and in education and training. These changes are reflected in different ESCO versions. Version numbers starting with 0 (zero) are used for early ESCO versions that are used for piloting and testing only. The first fully-fledged ESCO version is ESCO v1. As of this version, a versioning mechanism will keep track of changes in ESCO. ESCO v0, ESCO v0.1, ESCO v0.2, ESCO v0.8, ESCO v0.9, ESCO V1 are the version available for ESCO. [11]

ESCO can enhance recruitment by contributing to better competence-based job matching. It does so, by:

- Offering people the possibility of compiling CVs and vacancies using ESCO's vocabulary in all ESCO languages, enabling them to exchange information across borders.

- Providing a tool for the automated analysis and interpretation of semi-structured and unstructured data (CVs and vacancies).
- Supporting competence-based job matching on the grounds of an individual's work experience and qualifications, e.g. in EURES.
- Showing how skills and competences developed in one occupation are applicable and transferable to another one, i.e. cross-sectoral skills and competences. [11]

2.2 Similarity Matching

Match is a critical operator in many well-known metadata intensive applications, such as schema/ontology integration, data warehouses, data integration, e-commerce, etc. The match operator takes two graph-like structures and produces a mapping between the nodes of the graphs that correspond semantically to each other.[3]

Similarity is the measure, which quantifies the relation between two objects and portrays how much they reflect each other. Similarity is of diffuse character, since comparing two objects is abstract. They might be similar to each other in one regard and different in another. Thus determining similarity is not always a precise science. Edit distance and Vector space model are examples of calculating similarity between texts where the main focus for similarity versus dissimilarity is thought to be in the sense of either similar or not similar. The algorithms Hamming Distance, Jaro-Winkler Distance, Levenshtein Distance, Longest Common Subsequence (LCS) etc. are the examples of edit distance model. Examples of different vector space models are; Cosine Similarity, Term Frequency Inverse Document Frequency (TF-IDF), Jaccard Index and Dice's Coefficient, N-gram etc.

2.3 Related Works

Some state of the art in the field of recruitment by matching the candidate skills and competencies with job description using ontological technique, similarity matching technique and logic base technique can be summarize as below.

In the paper "Improving the recruitment process through ontology-based querying" [1], the authors present the query relaxation technique which is able to return results even in

the cases of inconsistent or overly specific queries which would return no results is presented. Subsymbolic methods estimate the (quantitative) similarity between job or applicant descriptions. Symbolic approaches allow a more intuitive way to formulate and handle preferences and domain knowledge. But due to their partial preference order they cannot rank all results in practice like subsymbolic approaches. In this paper author propose a query relaxation method which combines both methods. This method demonstrates that by having data based on formal ontologies, one can improve the retrieval.

Bird Mating Optimization method for one-to-n skill matching is proposed in “Bird Mating Optimization method for one-to-n skill matching” [2]. The method finds the optimal combination of skills from two or more CVs that best satisfies a job description. In this approach the CV sets as well as the job description are described semantically by using a skill taxonomy. To evaluate the quality of a solution (i.e. a set of CVs that satisfies the job description considered) a fitness function is defined that evaluates the degree of semantic matching of the combination of skills part of the considered solution to the set of skills of the job description.

The authors propose an ontology based method that matches a job seeker to job offers in "Semantic Matchmaking for Job Recruitment: An Ontology-Based Hybrid Approach," [4]. In this approach, the job seeker and the job offers are described semantically by using a skill ontology, and the type of match between a job seeker and a job offer is determined by using a description logic based classification. Additionally, a similarity based strategy is used in order to compute the degree of similarity between each of the job seekers and a job description and to rank the seekers according to their similarity score.

The author explains Logic-based techniques and technologies permit to make more efficient and flexible the recruitment process in “A system for retrieving top-k candidates to job positions” [5]. And the system they propose automatically performs a matchmaking process between available candidate profiles and vacant job positions according to mandatory requirements and preferences provided by a recruiter. In order to perform it, a language suitable for data intensive applications with a good compromise between expressiveness and computational complexity is needed. The system performs non-exact match through top-k retrieval techniques: it uses a match

engine which performs top-k queries over a DLR-lite Knowledge Base providing a ranked list of candidates.

The hybrid Ant Colony Optimization based method for solving the multi-skill resource-constrained project scheduling problem is proposed in “Hybrid ant colony optimization in solving multi-skill resource-constrained project scheduling problem,”[6]. In this approach, an ant is mapped to an artificial ant, every edge in a path (i.e. solution) that the ant tries to build is represented as a given task together with the resources that are capable of performing the task, the pheromone value is a value that specifies the probability of assigning a given resource to given task, the path (i.e. a solution) is a set of tasks and their associated resources, while the surface is represented by the set of all feasible solutions. Moreover, there is a special ant that leaves much more pheromone than any other ant in the colony. This ant is selected by using a Tabu-Search strategy.

The illustration of a method for matching jobs to workers, which is able to deal with incomplete and inaccurate information is done in “Expansion Methods for Job-Candidate Matching Amidst Unreliable and Sparse Data,”[7]. This approach is based on a probabilistic weighted ontology model that assigns weights to different attributes (i.e. location, skills, and qualification) and is able to perform a probabilistic conversion of audio content to text. In the case of location as attribute, the Euclidean distance is used to compute the distance between two points, while in the case of skills as attributes, a WordNet based strategy is applied to establish the distance between two skills. In the case of qualification as attribute, a lattice based approach is used. The quality of the method proposed has been evaluated by using a set of metrics from information retrieval.

In “A survey of text similarity approaches”[8], the various survey of text similarity approaches are described. These survey basically describes the most popular string similarity measures which were implemented in SimMetrics package. The string similarity measures are divided into character based algorithm and term based algorithm described in “SimMetrics: a java & c# .net library of similarity metrics” by Chapman,S., 2006 (<http://sourceforge.net/projects/simmetrics/>). Character Based algorithms: Longest common sequence, Levenshtein, Jaro Jaro-Winnkler, N gram and Term based algorithms: Block distance, cosine similarity, Dice’s Coefficient, Euclidean Distance, Jaccard Similarity are explained on this paper.

The different string similarity approach on ontology alignment are discussed in “String similarity metrics for ontology alignment,” [9] . Here the string similarity measured are classified as global versus local, set versus whole string, and perfect-sequence versus imperfect-sequence. Global versus local refers to the amount of information the metric needs in order to classify a pair of strings as a match or a non-match. Global metrics must compute some information over all of the strings in one or both ontologies before it can match any strings whereas for local metrics the pair of strings currently being considered is all the input that is required. A set-based string metric works by finding the degree of overlap between the words contained in two strings. The set-based metric must still use a basic string metric to establish if the individual tokens are equal. Word-based set metrics are generally thought to perform well on long strings. Perfect-sequence metrics require characters to occur in the same position in both strings in order to be considered a match. Imperfect sequence metrics equate matching characters as long as their positions in the strings differ by less than some threshold. In some metrics, this threshold is the entire length of the string. Imperfect-sequence metrics are thought to perform better when the word ordering of labels might differ but may result in more false positives.

2.4 Comparative analysis of the related research work

The following table shows the comparative analysis of the related research work and the idea put forward for this research work.

Table 2-1 Comparative table of related work of this thesis work

Study	Purpose	Approach	Dataset and Validation Approach	Outcome
M.Mochol, H.Wache and L.Nixon,2007	Improving the recruitment process through ontology-based querying	Query relaxation with the use of ontology(KEWIN)	Some Sample data of job portal in German; Prototype only no validation	Ontology with prototype for validation of that ontology in e-recruitment domain
S. Corde, V. R. Chifu, I. Salomie, E. S. Chifu and A.	Bird mating optimization method for one-to-n skill	One-to-n skill matching using bird mating algorithm with skill taxonomy	Self-generated data according to their taxonomy and model; Validation	Best fit multiple candidate having different skillset satisfy the job criteria

Iepure,2016	matching	(self-generated)	for choosing the parameter of algorithm but not for the result	
M. Fazel-Zarandi and M. S. Fox,2009	Semantic matchmaking for job recruitment with ontology based approach	Use of ontology (SkillOnt generated by themselves) And logic deductive similarity measure	German government job data; Prototype only no validation	Ranked candidate list
U. Straccia, E. Tinelli, S. Colucci, T. D. Noia and E. D. Sciascio,2006	Retrieving top-k candidates to Job Positions	Logic based system managing skill and experience of the candidate with ontology mapping (self-generated)	Self-generated data according to their model; Prototype only no validation	Ranked candidate list
J. WHITE, K. KUMMAMU RU and N. RAJPUT,2012	Expansion methods for job-candidate matching of unreliable and sparse data	Probabilistic weighted model with Wordnet based string similarity. Euclidean distance is considered	Some Sample data collected over a phone for job; Prototype only no validation	Detection of sparse data and using wordnet based string similarity matching of the job and candidate
This Thesis	Matching CVs and jobs based on skill and experience using standard ontology	Use of standard ontology (ESCO) with metric similarity	Real Candidate and job data from job portal Hirefire; Validation using Human expert	Ranked candidate list according to job description even if the exact match of the skill is not in the CV the suitable candidates would found

In summary, the work presented in this thesis work builds on concepts and methodologies presented in previous research results to formulate solution for metric similarity in the domain of human resource management. Most of the previous work is focused on – development of standard ontology for human resource management and utilization of logical reasoning techniques for inferring new relationships from existing knowledge. Some of them have also explored in the direction of match generation in the case of sparse and highly distributed data. And most important common aspect is these works are developed by utilizing a proprietary data model for skills description. In, the scope of this thesis work, the aim is to strengthen the research domain by considering

semi-structured data as input for the system. Also, the information enrichment methodology that has been formulated in this thesis work provides comparatively correct result in the case of incomplete skill set in both the job and CV profiles. Even though the metric similarity approach followed in this research is not a novel approach, the implementation and experimentation of such techniques in the domain that has been selected for this work has not been performed by previous researches. On the whole, this thesis work presents a different perspective for supply and demand match between employees and employers that can lead towards the formulation of automated solution of human resource management. Furthermore, the experimentation and validation of the result with the help of domain experts has provided good results on system performance, thus fulfilling the object of the thesis work.

3. Methodology

3.1 Overview

For the successful research work, it is necessary to formulate a research methodology. Planning, Design, Implementation, Experimentation, validation and documentation will be carried out for this research work which is Traditional and well adopted methodology in research and software engineering.

The methodology for development of technical solution is as shown as in figure 3-1 below.

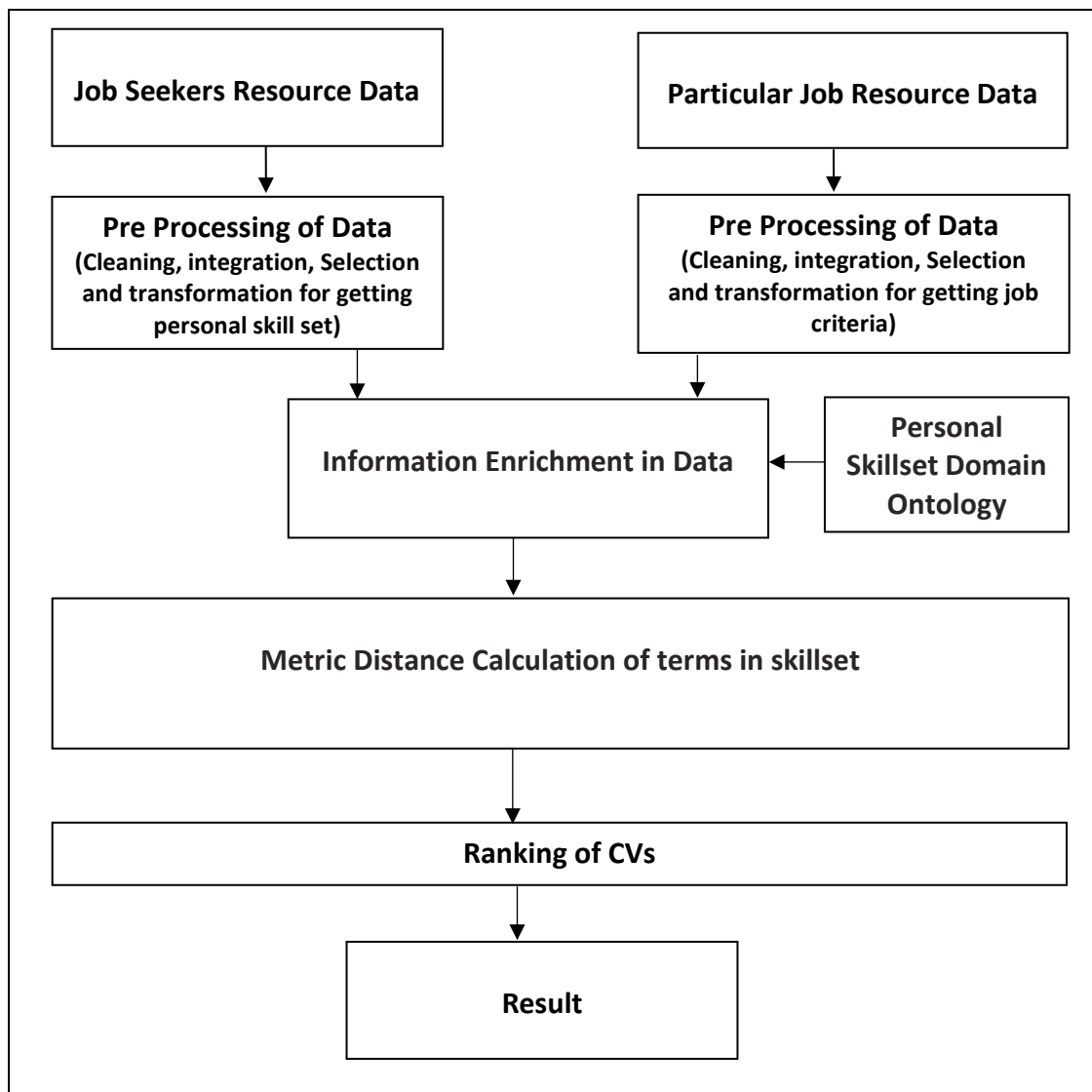


Figure 3-1 Model for the System

The first step is data collection which includes data set for both the job seekers and recruiters. The base data type for the job seekers is collection of CVs while for the recruiters is job description and necessary requirements. In order to harmonize such types of data that can be collected from different sources, the first step is cleaning, integration, selection and transformation which basically address the need to model heterogeneous data into one uniform data model. The data after pre-processing contains the personal skillsets, experience, education and expected salary data which are the factors that this thesis work will consider for further analysis. These pre-processed data of CV sets as well as the job description can be semantically linked by using domain ontology of skillset. The main purpose of this semantic linking is to find semantic distance between different terms that are used for defining skillset. So, until this step uniform representation of both the CV and job description with necessary semantic linking with skillset domain ontology will have acquired.

The next step is generation of suitable matching CVs in correspondence to the job description. In doing so, the first step is to filter out widely dissimilar CVs, which is done by computing semantic distance between skill sets in the CV and job description. Next, as stated in the problem definition section, the matching problem is finding best fit between the CV and job description by considering multiple criteria that define the job description. At this step the end users will have two main advantages for making decision for selecting the best candidate and or job, which are

- The end user (Recruiter) now has a good view of the CVs that are closely related to the job description sorted by relevance.
- The end user (Job Seeker) can have the perspective into his missing skills over which (s)he can improve to fit more closely to some hot jobs in the market.

3.2 Model Development

3.2.1 Metric Similarity model

Similarity score is the measure to show how similar two set of data are to each other. The set of data can be about as in this case about two different texts. To find the similarity is to find the comparison between the two texts and grade it after a score system.

For case of similarity measure the method of rewarding common substrings and a common ordering of those substrings is used. In addition, the algorithm consider not only the single longest common substring, but other common substrings too. This algorithm answer the question Find out how many adjacent character pairs are contained in both strings. The intention is that by considering adjacent characters, the algorithm take account not only of the characters, but also of the character ordering in the original string, since each character pair contains a little information about the original ordering.

This metric similarity measures similarity over strings by splitting them up into their character pairs and using the following relation [12]

$$\text{Similarity}(S1, S2) = \frac{2 * |\text{pairs}(s1) \cap \text{pairs}(s2)|}{|\text{pairs}(s1)| + |\text{pairs}(s2)|}$$

The similarity between two strings s1 and s2 is twice the number of character pairs that are common to both strings divided by the sum of the number of character pairs in the two strings. The vertical bars in the formula mean the size of and the formula rates completely dissimilar strings with a similarity value of 0, since the size of the letter-pair intersection in the numerator of the fraction will be zero. On the other hand, if a (non-empty) string to itself is compared, then the similarity is 1.

For example let's take the two strings 'France' and 'French'. First split them up into their character pairs:

FRANCE: {FR, RA, AN, NC, CE}

FRENCH: {FR, RE, EN, NC, CH}

Then the metric is computed as follows:

$$\begin{aligned} \text{similarity}(\text{FRANCE}, \text{FRENCH}) &= \frac{2 * |\text{FR}, \text{NC}|}{|\text{FR}, \text{RA}, \text{AN}, \text{NC}, \text{CE}| + |\text{FR}, \text{RE}, \text{EN}, \text{NC}, \text{CH}|} \\ &= \frac{2 * 2}{5 + 5} \\ &= 0.4 \end{aligned}$$

3.2.2 Object Model

In the scenario of matching between employee and employers, it is necessary to identify the different types of actors and the respective models to describe them. The process of finding a match is defined from the distribution of vacancies posted by the employers with certain requirement and skills possesses by the available candidate. The objective will be to maximize the fit between the requirements and offers between the employers and employee.

The basic model for representing different entities that will be part of the match making process are:

Job seekers

Job seekers represent the group of people who are looking for jobs in the domain of their skills. The number of job seekers in the market is $I \in \{1, 2, \dots, N\}$. Each job seeker owns a set of non-transferable endowments: they cannot be exchanged among job seekers. The set of endowments for individual is termed as CV and is characterized by skill vector and experience.

Skill vector for individual i is characterized by $s_i = s(1,i) , \dots, s(K,i) ,$ where K is the number of skills.

Experience for individual i is characterized by $e_i = \{x \in \mathbb{R} : x \geq 0\}$

Skills are heterogeneously distributed among the job seekers, so the vectors is a multivariate random variable $s \sim F_s(s_1, \dots, s_K)$ and represents the set of skills available in the specified domain.

Employers (Companies or Firms)

This represents the companies that have various businesses in different domains. The number of firms in the given business domain is represented as $F \in \{1, 2, \dots, N\}$ and have different hiring requirements which is represented as job description.

Job Description

This represents the way a firm opens vacancies for different positions that are available at the firm. The job description is represented as skill vector exactly as used for the job seeker.

Mapping to ESCO model

ESCO is the multilingual classification of European Skills, Competences, Qualifications and Occupations. For a given skillset s_i in Job/CV the skillset is expanded by mapping with skills defined in the ESCO ontologies by considering the similarity between the skill $s(j,i)$ and $s(m,esco)$ where $s(j,i)$ is a skill in CV and $s(m,esco)$ is the skill from the ESCO ontology. If $w(j,m)$ is the similarity between the skills then the skill is added in the skillset s_i by adding the weight to the skill in the skillset vector. In the next iteration similar mapping is done with the similar skills that are related to the occupations that correspond to the skills in the skillset s_i . After this mapping the skillset vector is enriched with necessary similarity weight, which is represented as:

$$s_i = (s(1,i), w(1,i)), \dots, (s(M,i), w(M,i))$$

s.t. $M > K$ i.e. the original count of skills in the skillset from the CV.

This expansion of skillset will give us more detailed association with various skillsets that have been defined for different domains of works from the ESCO ontology, thus helping to build model that can lead towards better match between skillsets in demand (job descriptions) and offer (CVs)

Mapping of Jobs and CVs

Matching between skills of individuals and job description is by a number of factors. The choice of how to manage these factors and/or different factors that are considered or discarded can lead to different solutions. Other factors are typical of the matching of skills and can be neglected in other contexts. The outline in the following some of the factors are given which characterize skill matching scenarios and then focus on our particular setting.

Negative Information treatment:

This factor affects the choice of the language in which descriptions have to be expressed and is fundamental in the matching process of any kind of description. The possibilities can be itemized as follows:

Absent: all information allowed in profile descriptions are positive and all others are considered unknown.

Implicit: lacking information in a description are implicitly managed as negative.

Explicit: negative information can be elicited in descriptions together with positive ones, but all not elicited information are considered unknown.

Notice that considering negative information as absent or implicit in a CV can lead to having limited match results. Instead the absence of a characteristic in the description of a profile should not be interpreted as a constraint of absence but as an item that can be either refined later, or left unknown if irrelevant for a user.

Multiplicity of Relationship between Individuals and Jobs:

This issue is typical of the skill matching process, because in the matching of other kinds of good the multiplicity is always one to one. For example if there is a demand describing one particular good and need to search for one supply fulfilling the demand. When turning to skill matching, instead, one offered profile may be assigned more than one task and vice versa. Match relationship between Individuals and Jobs may be characterized by a multiplicity:

One to one: There is a one job profile to match with one individual; offered and requested profile descriptions may be relative to more than one skill. The scenario is typical of temporary work agencies or counseling companies, in which one person is employed if s/he is able to attend one task.

Many to one: There is a one job to assign to several people. This happens for example in the selection of a working team for a project, representing in this case the task to assign. For this case, each person is assigned no more than one task.

One to many: If there is a search for one individual attending to many simple tasks. The scenario is similar to time-sharing in Operating Systems, in which one resource need to be shared between several users. In this context many tasks share the same human resource and several constraints may ensue.

Many to many: If there are many tasks to assign and many individuals available, the search is for the best scheduling of human resources on the different tasks. In this work the concentration is only on one-to-one skill matching and highlight some intuitive properties that a semantic approach should take into account. First of all notice that open-world assumption is made in this thesis work.

Within the scope of this thesis work the considered scenario is only limited to Negative Information treatment – absent and Multiplicity of Relationship between Individuals and Jobs – one to one. The Negative Information treatment – explicit is partially handled during the skills expansion by utilizing the ESCO taxonomy as explained in the sub-section mapping to ESCO ontology.

3.2.3 Algorithms

Algorithm 1: Enrich metadata of Jobs/CVs

Step 1: START

Step 2: Take Skillset (array of skill) of Jobs or CVs and ontology as input.

Step 3: Find the metric similarity between the skill from skillset and each skills from the ontology

Step 4: Case I

If the skill is from the ontology, make a skill object using the similarity weight, URI of the skill from ontology and name of skill from the ontology.

Case II

If the skill is from the skillset, make a skill object using the similarity weight, URI of the skill from skillset and name of skill from the skillset.

Step 5: Repeat from Step 3 for each skill in skillset to get the array of skill object

Step 6: Choose the skill object array having similarity weight greater than ' α '

Step 7: For each skill object find the corresponding occupation using ontology

Step 8: For each occupation from step 7 find corresponding skill object array as in step 5 using Ontology. Multiply the similarity weight by factor ‘ β ’ for this skill object Array.

Step 9: Choose the skill object array having similarity weight greater than ‘ α ’

Step 10: Merge the skill object array from step 6 and step 9 then final skill object array is generated as output

Step 11: STOP

Algorithm 2: Rank the CVs

Step 1: START

Step 2: Take CVs object array (arrCVObj), Job object array (arrJobObj), Job Input, Experience Criteria (EC) as input

Step 3: For Job Input find the corresponding job object (JobObj) from Job object array (arrJobObj)

Step 4: Take CV object (CVObj) from CVs Object array (arrCVObj)

IF CVObj.experience satisfy EC

$$SumofSkillWeight = \frac{Find\ Metric\ similarity\ of\ CVObj.\ skill\ and\ JobObj.\ skill}{1000 * (1 + CVObj.\ experience)}$$

$$SkillCompareWeight = \frac{Find\ Metric\ similarity\ of\ job.\ jobInput.\ skill\ and\ CV.\ CVInput.\ skill}{skillWeigh}$$

$$skillWeigh =$$

$$SumofSkillWeight + SkillCompareWeight * \gamma + CV.\ experience * \lambda$$

Using skillweight create new CV object CVObjRank

END IF

Step 5: Repeat step 4 for each CVObj in arrCVObj and create the array of CVObjRank

Step 6: Rank the CVObjRank array according to the skillweight and select no of ranked CV as needed.

Step 7: STOP

3.3 System Development

3.3.1 System architecture

The approach for this thesis work is gathering the raw data of candidate CV and Jobs from the job sites and creating the skill object of jobs and CVs using ESCO ontology. The matching is done on this created object to get the ranked CVs for the Job. The system's architecture diagram is presented in Fig below.

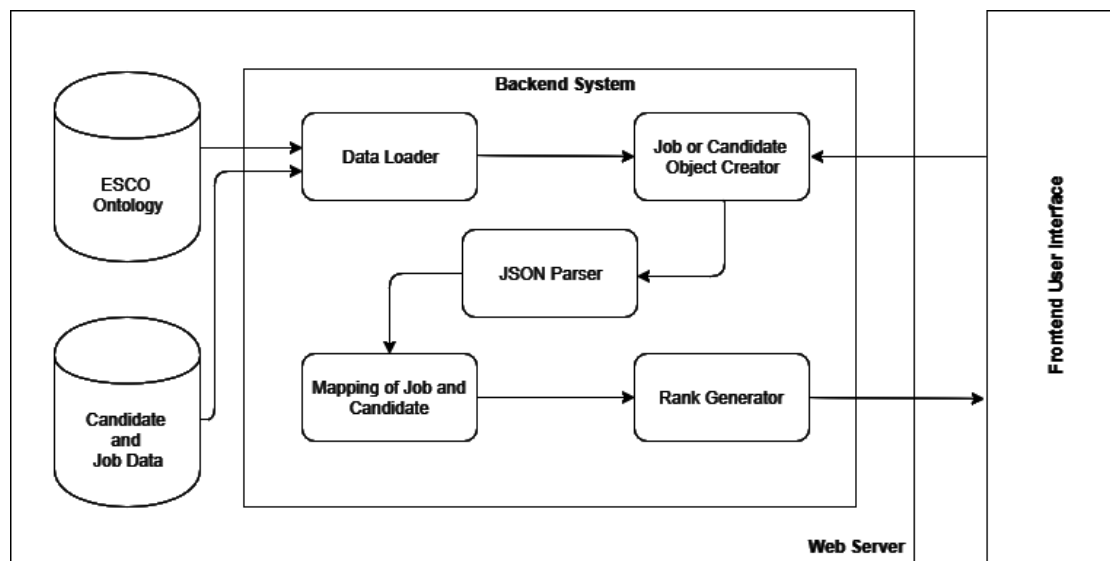


Figure 3-2 System architecture

ESCO Ontology and the raw data of candidate and jobs from the job sites are the main data for this thesis work. The raw data are preprocessed specially skills of the jobs and CVs. In preprocessing, the skills are presented in comma separated form and the specific skills are only considered as the skills. Backend system consist of Data loader, job or Candidate Object Creator, JSON Parser, Mapping of Job and Candidate and Rank Generator. In Data Loader the ESCO ontology and the Candidate and Job Data are loaded. The array of skills i.e. Skillset of the Candidate or Jobs are generated consisting of skills which are in the form of comma separated. For every skills in the skillset the Job or Candidate Object Creator performs the metric matching operation with the ESCO ontology skills. The weight calculated in metric matching for each skill of the skillset is used to filter the skills with threshold value. The Skills and Occupation relation of the ontology is used to generate the final object. The object created is in the form of JSON object. Using JSON parser the object is read and write in the file where all the created

object array for Job and CVs are placed. Then Mapping of particular job object which user selected or entered with array of CV object is done. The CV and Job object are matrix like structure and the mapping on these two matrix like structure is done and the weight is assigned to each CV object. The top ranked CVs are arranged to show to the user. The frontend user system is mainly for the two type of users; employers and employee. The employer can add jobs with their specific requirement and employee can add his/her profile with his/her skillset and description. The employer can find the suitable candidate among the candidate present in the system giving the required criteria on the system. The score obtained by each candidate from the system also shown from which it is easy to find how relevant the result is.

3.3.2 Tools and IDE

- .Net Framework
- C#
- Visual Studio
- JSON Parser

3.3.3 Datasets and Experimental Setup

Jobs and CVs raw data for this thesis work are taken from the job advertisement site www.hirefire.co.uk for the period of 5 years. These data are in the form of SQL tables so they can be easily processed. The CVs taken initially for the experiment are 1060 and the jobs taken are 110. The new CVs and Jobs can be added from the system manually as well. The following table gives the no of data used for testing the system.

Table 3-1: Data for Experimental purpose

No of Jobs	No of CVs
110	1060

The ontology used in this thesis work is ESCO ontology. The ESCO ontology identifies and categorises skills, competences, qualifications and occupations relevant for the EU labour market and education and training. It systematically shows the relationships between the different concepts. In this thesis work the focus is only on the skill, competence, qualifications and occupations of computing and information technology of ESCO ontology.

4. Results and Discussion

This section provides the overall system output, validation of system output using expert evaluator and the details of the results for various experimentations that have been performed in the scope of this research work along with the analytic study of the various results that have been obtained during experimentation.

4.1 Outputs

When the skillset of the job description as well as experience criteria is given to the system the outputs are the list of ranked CVs with similarity score matching the particular job. The following figure is the basic output for matching the candidate with similarity score to the given job description. The CVs having higher matching score is ranked higher and the CVs having lower match score are ranked lower.

job: 2BOW4RN:Android, IOS, .NET, Xamarin,Android, IOS

Matching Candidate List

Copy CSV Excel Print Show 10 rows Search:

Rank	CVEmail	CVSkills	Experience	Score
1	asifnpatel@gmail.com	Android,ASP.NET,Java,J2EE,Java JSP, AJAX,VB.NET,C#,	12 Years 1 Months	10.00
2	bhairu.cse@gmail.com	HTML,HTML5,CSS,CSS3,JavaScript,JQuery,ajax,PHP Programming,Front End Web Developer,magento,phonegap,jquery, mobile application,android ,ios	2 Years 0 Months	09.40
3	nwosu.uj@gmail.com	Android Developer,Android,Java, Java Developer,SQL,JSON,PHP, PHP Developer,Dreamweaver, jQuery,Database,	8 Years 1 Months	08.29
4	rahul.kotak@ymail.com	.net, sql, java, android, c, c++	0 Years 4 Months	06.54
5	urvipathak1090@gmail.com	Java,C++,.NET,Java,C++,.NET,Java,C++,.NET,	0 Years 3 Months	06.53
6	satishghone@gmail.com	java,sql,PL/SQL, .net,android sdk,testing	0 Years 7 Months	06.00
7	pawan.iitroorkee@gmail.com	Core Java, C++, Android, jQuery, Nosql	5 Years 1 Months	05.92
8	chitransh141@yahoo.in	Java, Mutithreading ,Android	6 Years 8 Months	05.89
9	rajarun16@gmail.com	.net,c#.net,Asp.net,Ado.net, sql server 2008	3 Years 5 Months	05.65
10	yogiponn2@gmail.com	c#, vb,net, C/C++, VC++, C, Java, MVC, .Net, MFC, com/dcom,WCF, WPF,	15 Years 1 Months	05.56

Showing 1 to 10 of 15 entries

Previous 1 2 Next

Figure 4-1: System Output

4.2 Validation

In the scope of this thesis Validation is process of checking whether or not the system output is appropriate for ranking the candidate based on the job description. The similarity score is given to each candidate in correspondence to the job description to find suitable matching CVs, which is used to rank them. In this process it is assumed that the most relevant CV get highest score and least relative CVs are given lowest mark. Since, there were not available any standard dataset that could be used validation in the domain of skill matching, the experts in the field of job recruitment are chosen to evaluate the system with certain score on the system generated output described in chapter 4.1. The highest score normalization technique is used to find the average score from different experts for particular job description. Then the comparison has been made between the system evaluation and human evaluation. This gives how close the system evaluation to the expert evaluation. The main propose of comparing human evaluation verses system evaluation is to analyze the correlation between ranking of CVs generated by the System and the ranking given by human for the corresponding CV.

The following table shows the information about the number of jobs, CVs and experts used for the validation purpose in this thesis work.

Table 4-1: Number of data used for validation purpose

No of Jobs	No of CVs	No of experts
14	1060	7

The following sub-section provide the discussion on the validation data that has been used in this methodology and various considerations that have been enforced.

4.2.1 Validation data

The validation data given to the individual evaluator is as shown below. It included the criteria- job description and list of CVs. Each CV has an identifier, skillset and experience which are generated from the system. The score generated by the system is not given to evaluator because they can freely evaluate and give their score to results.

Job Skills : c#,.net, asp.net,sql server,c++

ID	CVEmail	CVSkills	Experience
CV 1	yogiponn1@gmail.com	c++, C#, Java, .Net, asp.net, Javascript, VC++,	15.1
CV 2	sreejayanravindran@yahoo.co.uk	asp.net,c#,sql server,vb.net,mvc,tridion	10
CV 3	yogiponn2@gmail.com	c#, vb.net, C/C++, VC++, C, Java, MVC, .Net, MFC, com/dcom,WCF, WPF,	15.1
CV 4	suneel.vanka@gmail.com	.Net ,ASP.NET, MVC, jQuery,angular js, C#, Web Developer,WCF,web API, Microsoft SQL Server,SQL Server 2008, HTML5, CSS,CSS3,ASP.Net Programming,jquery asp net, Web services,	6
CV 5	nabeelcp@gmail.com	.Net, C#,ASP.NET,ASP.NET MVC, jQuery,JavaScript,WCF,WPF,Enterprise Software,UML, Microsoft SQL Server,Oracle,SSRS,Software Programming,	8.1
CV 6	urvipathak1090@gmail.com	Java,C++,.NET,Java,C++,.NET,Java,C++,.NET,	0.3
CV 7	ptirtha@hotmail.com	Maths, Quant, C++, VC++, GMAT, CAT, Programmer, Technical Architect, C#, .Net, SDET	14.2
CV 8	rajarun16@gmail.com	.net,c#.net,Asp.net,Ado.net, sql server 2008	3.5
CV 9	zeeshandbg260@gmail.com	Engineer,.net,sql server,c#,c++,dbms,javascript,networking.	1.8
CV 10	navin.goradara@gmail.com	c,c++,C#,vb,SQL Server 2008,asp.net,	3.1
CV 11	coreyschristian@gmail.com	SQL,C#,.NET,LINQ, ASP.NET,Microsoft Office,HTML,SCRUM,Database Design,Microsoft SQL Server,ASP.NET MVC,MySQL,Java,XML,SSRS,Software Development,Database Administration,CSS, Java,C#,PHP, JavaScript, ASP .NET, .NET	2

Figure 4-2 Validation data format to evaluators

4.2.2 Validation consideration

For the given job description the generated CVs are given to the people who are IT professionals having experience at least 5 years. This allowed us to simulate the candidate selection as it happens in professional companies.

4.3 Experimental Results

For case of experiment the input is the skillset of the job description as well as experience criteria is given and the outputs will be the ranked CVs with score matching the skillset and the experience criteria of the job description. The average validation score given by the evaluators for the particular job also shown in the output. The three

experiments carried out are presented here with output of the system. For the details of all the experiment refer to Annex 7.2

Experiment 1:

Input: c#,.net, asp.net,sql server,c++, Experince criteria:all

Output:

Rank	CVEmail	CVSkills	Experience	Score	ValidationScore
1	yogiponn1@gmail.com	c++, C#, Java, .Net, asp.net, Javascript, VC++,	15 Years 1 Months	10.00	9.876
2	sreejayanravindran@yahoo.co.uk	asp.net,c#,sql server,vb.net,mvc,tridion	10 Years 0 Months	08.18	7.77
3	yogiponn2@gmail.com	c#, vb.net, C/C++, VC++, C, Java, MVC, .Net, MFC, com/dcom,WCF, WPF,	15 Years 1 Months	07.11	8.5
4	suneel.vanka@gmail.com	.Net ,ASP.NET, MVC, jQuery,angular js, C#, Web Developer,WCF,web API, Microsoft SQL Server,SQL Server 2008, HTML5, CSS,CSS3,ASP.Net Programming,jquery asp net, Web services,	6 Years 0 Months	05.54	6.394
5	nabeelcp@gmail.com	.Net, C#,ASP.NET,ASP.NET MVC, jQuery,JavaScript,WCF,WPF,Enterprise Software,UML, Microsoft SQL Server,Oracle,SSRS,Software Programming,	8 Years 1 Months	05.47	7.172
6	urvipathak1090@gmail.com	Java,C++,.NET,Java,C++,.NET,Java,C++,.NET,	0 Years 3 Months	05.30	4.202
7	ptirtha@hotmail.com	Maths, Quant, C++, VC++, GMAT, CAT, Programmer, Technical Architect, C#, .Net, SDET	14 Years 2 Months	04.90	8.056
8	rajarun16@gmail.com	.net,c#.net,Asp.net,Ado.net, sql server 2008	3 Years 5 Months	04.84	4.286
9	zeeshandbg260@gmail.com	Engineer,.net,sql server,c#,c++,dbms,javascript,networking.	1 Years 8 Months	04.55	5.148
10	navin.goradara@gmail.com	c,c++,C#,vb,SQL Server 2008,asp.net,	3 Years 1 Months	04.49	4.958
11	coreyschristian@gmail.com	SQL,C#, .NET,LINQ, ASP.NET,Microsoft Office,HTML,SCRUM,Database Design,Microsoft SQL Server,ASP.NET MVC,MySQL,Java,XML,SSRS,Software Development,Database Administration,CSS,	2 Years 0 Months	04.41	4.426
12	munashe@xnine.us	Java, C#, J2EE, PHP, VB, C++, ASP .NET, .NET, HTML, JavaScript, SQL	5 Years 0 Months	04.40	6.066
13	vipinkm89j@gmail.com	Programmer, C++,C#,Asp.Net,Vb.Net,Sql,.Net	0 Years 6 Months	04.24	5.038
14	vasanth.net@live.com	E-commerce,SEO,ASP.Net,Programming,C#, .Net, Software Developer,SQL Server,HTML,	4 Years 0 Months	04.18	5.454
15	megha.dave@gmail.com	ASP.NET, C#, VB.NET, SQL Server, Software engineer, web developer, speech server	4 Years 5 Months	04.04	5.15

Showing 1 to 15 of 15 entries

Figure 4-3 Output for the experiment 1

Experiment 2:

Inupt: PHP, MySql, CodeIgniter, Wordpress, Drupal, Cake PHP, Zend Framework,
Experience Criteria: all

Output:

Rank	CVEmail	CVSkills	Experience	Score	ValidationScore
1	fanus@pinsoftstudios.com	Wordpress, Wordpress Multi User + Administration - Network, PHP, CSS3, HTML5, Web design, Web development, Photoshop, MySQL, Social Network Integration	14 Years 1 Months	10.00	9.178
2	saravananmalikaraj@gmail.com	PHP, Cake PHP, MySQL, Ajax, jQuery, Javascript, MySQL, HTML5, CSS3, XML,WordPress, Joomla	2 Years 7 Months	08.25	6.09
3	binolala@gmail.com	JAVA, PHP,HTML, DHTML, CSS, C++,C,VB,JOOMLA, DRUPAL, WORDPRESS, AJAX, JAVASCRIPT, JQUERY, SQL, PL/SQL, MYSQL, SQL-SERVER	5 Years 0 Months	07.61	6.956
4	sindhuphp515@gmail.com	PHP,MySQL,Codeigniter,MVC,Wordpress,CMS,Jquery,JavaScript,Ajax,HTML,CSS	5 Years 5 Months	07.21	6.886
5	im.mohammadali@gmail.com	HTML, CSS, PHP, MySQL, Wordpress, Codeigniter ,(MVC), JavaScript, JQuery, Ajax	2 Years 2 Months	06.53	5.344
6	adaan.smit@gmail.com	C#,Software Engineer,SQL Server 2008,Java,MySQL, PHP,	15 Years 11 Months	06.42	7.838
7	aryakrishnan172@gmail.com	Code Igniter, PHP, JAVA, .Net, Mysql,SQL Server, AJAX, JSON,JS,CSS,HTML, C, C++	7 Years 0 Months	05.99	6.308
8	ron@villageinternet.ca	Drupal,Linux server,CSS, Hands-on Training,Training,MySQL,E-commerce, Mobile Web Design, Web Designer, Web Developer, Web Design, Web services,Website Development,	15 Years 1 Months	05.98	8.756
9	raamkumar.m23@gmail.com	HTML,JQuery, PHP, Css, Mysql, Joomla, Wordpress, Photoshop	3 Years 0 Months	05.54	4.888
10	raheelwp@gmail.com	php, javascript, mysql, mongodb, linux, laravel, codeigniter, wordpress	2 Years 0 Months	05.46	5.288
11	nizam.taha@gmail.com	PHP, HTML, DHTML, JavaScript, AJAX, CSS, ASP, JAVA, C, C++, VBScript, MS Visual Basic 6.0, MySQL, MS Access, SQL Server, Flash,	10 Years 0 Months	05.38	6.966
12	noorsyamimi_ismailbasha@yahoo.com	C++, PHP,css, Wordpress, Drupal, Photoshop, Dreamweaver,Flash,	2 Years 5 Months	05.24	4.96
13	amarnath.qa.5555@gmail.com	Java,PHP, HTML + CSS, Software Testing,Test Automation, Quality Assurance,MySQL,Windows7,Windows XP, Wordpress,	3 Years 0 Months	05.16	5.194
14	bacani_fie04@yahoo.com	HTML5, CSS3, JavaScript,JQuery, JSON,XML, PHP,ASP, Wordpress, Web Development, Front-End, Back-End,Bootstrap,Responsive Web Design,	5 Years 0 Months	04.93	5.572
15	vikram_rke10@yahoo.com	JAVA,VB,ASP,PHP,HTML, SEO,JAVA,VB,ASP,PHP,Digital marketing	6 Years 0 Months	04.86	5.72

Showing 1 to 15 of 15 entries

Figure 4-4 Output for the experiment 2

Experiment 3:

Input: ASP.net, C#, XML, Ajax, SQL Server, Oracle, SDLC, ASP.net, C#, XML,
Experience Criteria: all

Output:

Rank	CVEmail	CVSkills	Experience	Score	ValidationScore
1	nabeelcp@gmail.com	.Net, C#,ASP.NET,ASP.NET MVC, jQuery,JavaScript,WCF,WPF,Enterprise Software,UML, Microsoft SQL Server,Oracle,SSRS,Software Programming,	8 Years 1 Months	10.00	9.258
2	balavsts@gmail.com	VSTS automation testing,C#,ASAP.NET,XML,SqlServer,WCF	9 Years 9 Months	09.85	7.98
3	yogiponn1@gmail.com	c++, C#, Java, .Net, asp.net, Javascript, VC++,	15 Years 1 Months	09.27	9.384
4	asifnpatel@gmail.com	Android,ASP.NET,Java,J2EE,Java JSP, AJAX,VB.NET,C#,	12 Years 1 Months	09.12	8.932
5	vidyadanam100@gmail.com	ASP.NET,C#,VB6,VB.NET,SQL SERVER,JQUERY,XML,HTML	3 Years 9 Months	08.88	6.144
6	chowdhury_mainak@rediffmail.com	ASP.NET, MVC, C#, SQL Server, Project Lead, Team Lead	9 Years 2 Months	08.51	7.626
7	coreyschristian@gmail.com	SQL,C#,.NET,LINQ, ASP.NET,Microsoft Office,HTML,SCRUM,Database Design,Microsoft SQL Server,ASP.NET MVC,MySQL,Java,XML,SSRS,Software Development,Database Administration,CSS,	2 Years 0 Months	08.45	5.09
8	suneel.vanka@gmail.com	.Net ,ASP.NET, MVC, jQuery,angular js, C#, Web Developer,WCF,web API, Microsoft SQL Server,SQL Server 2008, HTML5, CSS,CSS3,ASP.Net Programming,Jquery asp net, Web services,	6 Years 0 Months	08.30	6.606
9	kiran_kjp@yahoo.co.in	Asp.net,C#,Sql server,Crystal Reports,Mvc,SSRS,Ajax,Javascript,jquery	5 Years 3 Months	07.65	6.412
10	sreejayanravindran@yahoo.co.uk	asp.net,c#,sql server,vb.net,mvc,tridion	10 Years 0 Months	07.59	7.852
11	isuhel.a@gmail.com	Asp.Net, C#, MS SQL Server, Ajax, XML,	0 Years 8 Months	07.42	4.67
12	danny@danznet.co.uk	C#,Angular.Js,VB.Net, Microsoft SQL Server,Oracle,MVC,ASP.Net,Javascript,Crystal Reports,Programmer, .Net Programming,Web Api,	8 Years 1 Months	07.37	8.41
13	pinakin2in@gmail.com	ASP.Net, C#, SQL, Oracle, AJAX, LINQ, HTML, Javascript,	4 Years 4 Months	07.33	6.27
14	megha.dave@gmail.com	ASP.NET, C#, VB.NET, SQL Server, Software engineer, web developer, speech server	4 Years 5 Months	07.14	5.488
15	sunil.net61@gmail.com	ASP.Net, MVC Framework,WCF, Microsoft SQL Server,JavaScript, IIS,WEBAPI,TFS,VB.NET,C#,	8 Years 1 Months	07.09	7.324

Showing 1 to 15 of 15 entries

Figure 4-5 Output for the experiment 3

4.4 Parameter Tuning

The algorithms that have been developed in the scope of this work utilized a number of coefficients for skill set matches at different steps. For the development of tested and well performing system, it is necessary to perform series of experiments to find the most suited values for such coefficients. In order to define such values, a number of experiments are performed to observe the impact of such coefficients in the system output. This sub-section provides the results that have been obtained for different values of the coefficient. Provided, experimental results in the following sections is thus obtained after adjusting the values of coefficients in the algorithms., which are the final results obtained in this research work.

The coefficient that effect the algorithms are α , β , γ and λ which represent:

- α : Threshold match score between skills in CVs or Jobs to ontology skills. The purpose is to filter out highly unrelated skills having score lower than α .
- β : The factor which is used to evaluate skill weight during enrichment of skills from the second layer ontology.
- γ : The factor which is used to evaluate skill which matches the skills of CV and Jobs without any enrichment.
- λ : The factor that is used to evaluate the impact of experience.

The value of α is dependent on the number of skills considered for the further processing. The higher the value of α lower the number of skills to be selected. If lower value of α is choosen, the system resource requirement will be higher. For the experimentation the value of α used is 0.3. The value γ gives the importance to the skills that are usually written in unstructured Job and CV skills. In order to use data coming from unstructured sources it is advised to use the lower value for this coefficient. If the data is obtained from standard CVs and Jobs description higher value of γ can give good results. For this thesis the value chosen is to be 2. The value of λ can be freely chosen based on the importance of experience. This value is 0.1 on the basis of different experiment on the data.

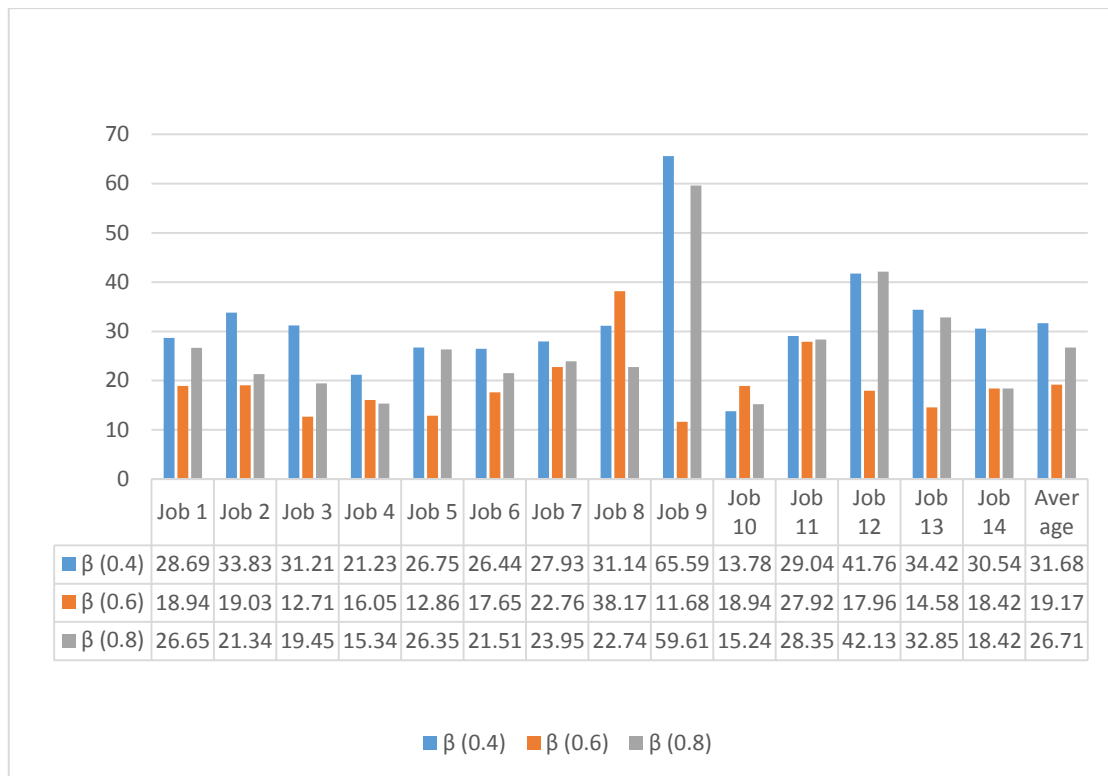


Figure 4-6: Error comparison for different values of β

From the experiment on changing the value of β it is bserve that the data are more close to the expert score for $\beta =0.6$. So for this work the value chosen is 0.6.

Note that the implementation provide the configuration to change the values of these coefficients to allow for the further experimentation.

4.5 Analysis and Comparisons

For the analysis purpose the difference between the score by the system and evaluator average score is calculated and in the table it is marked as error. In the output the CVs that are matching to the job description can be observed. The column Score_Actual provides the score for each CV calculated by the system, while the column Score_Avg provides the average score given by all the evaluators. Error column gives the absolute value of difference between the score by system and evaluator average score and Error% column shows the percentage of the value in Error column. Following section provides the analysis of the three experiments which are discussed in chapter 4.3.

Experiment 1:

Input: c#,.net, asp.net,sql server,c++, Experince criteria:all

Output:

Table 4-2 The overall evaluation result of the evaluators for Experiment 1

ID	CVEmail	CVSkills	Exp erie nce	Score _ Actua l	Sco re_ Avg	Err or	Error %
CV 1	yogiponn1@gmail.com	c++, C#, Java, .Net, asp.net, Javascript, VC++,	15.1	10.00	9.87	0.13	1.26
CV 2	sreejayanravindran@yahoo.co.uk	asp.net,c#,sql server,vb.net,mvc,tridion	10	8.18	8.12	0.06	0.73
CV 3	yogiponn2@gmail.com	c#, vb.net, C/C++, VC++, C, Java, MVC, .Net, MFC, com/dcom,WCF, WPF,	15.1	7.11	9.50	2.39	25.16
CV 4	suneel.vanka@gmail.com	.Net ,ASP.NET, MVC, jQuery,angular js, C#, Web Developer,WCF,web API, Microsoft SQL Server,SQL Server 2008, HTML5, CSS,CSS3,ASP.Net Programming, jquery asp net, Web services,	6	5.54	6.62	1.08	16.37
CV 5	nabeelcp@gmail.com	.Net, C#,ASP.NET,ASP.NET MVC, jQuery,JavaScript,WCF,WPF,Enterprise Software,UML,Microsoft SQL Server, Oracle,SSRS,Software Programming,	8.1	5.47	7.68	2.21	28.75
CV 6	urvipathak1090@gmail.com	Java,C++,.NET,Java,C++,.NET,Java,C++,.NET,	0.3	5.30	5.80	0.50	8.57
CV 7	ptirtha@hotmail.com	Maths, Quant, C++, VC++, GMAT, CAT, Programmer,Technical Architect, C#, .Net, SDET	14.2	4.90	7.45	2.55	34.26
CV 8	rajarun16@gmail.com	.net,c#.net,Asp.net,Ado.net, sql server 2008	3.5	4.84	4.79	0.05	1.05
CV 9	zeeshandbg260@gmail.com	Engineer,.net,sql server, c#,c++, dbms, javaScript,networking.	1.8	4.55	5.39	0.84	15.62
CV 10	navin.goradara@gmail.com	c,c++,C#,vb,SQL Server 2008,asp.net,	3.1	4.49	5.21	0.72	13.81
CV 11	coreyschristian@gmail.com	SQL,C#,.NET,LINQ, ASP.NET,Microsoft Office,HTML,SCRUM,Database Design, Microsoft SQL Server,ASP.NET MVC,MySQL,Java,XML,SSRS,Software Development,Database Administration,CSS,	2	4.41	5.07	0.66	13.03
CV 12	munashe@xnine.us	Java, C#, J2EE, PHP, VB, C++, ASP .NET, .NET, HTML,JavaScript, SQL	5	4.40	6.43	2.03	31.55
CV 13	vipinkm89j@gmail.com	Programmer, C++,C#,Asp.Net, Vb.Net, Sql,.Net	0.6	4.24	6.63	2.39	36.03
CV 14	vasanth.net@live.com	E-commerce, SEO,ASP.Net,Programming, C#, .Net,Software Developer,SQL Server,HTML,	4	4.18	5.45	1.27	23.34
CV 15	megha.dave@gmail.com	ASP.NET, C#, VB.NET, SQL Server, Software engineer, web developer, speech server	4.5	4.04	5.51	1.47	26.73

Analysis:

The comparison of system score and the evaluator average score is presented in the graph below.

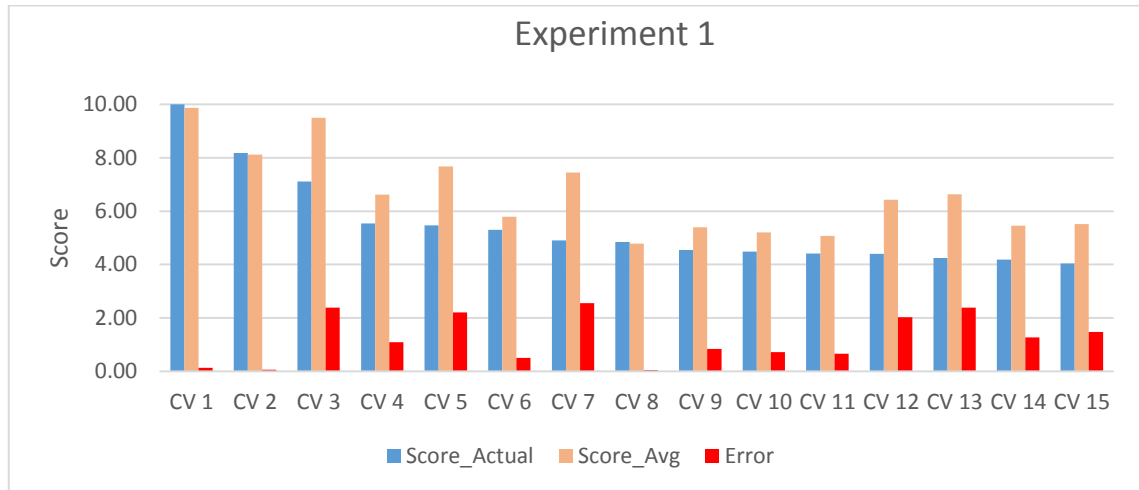


Figure 4-7 The comparison of system and evaluator score of Experiment 1

Some errors observed in the scoring by the system and evaluator which is approximately 18.94%. But the CVs which have been ranked highest have smaller error to the CVs which have been ranked lowest. Also the profiles having different skillset described in the job also profited and ranked higher because of their skillset association with the job description.

Experiment 2:

Input: Job Skills :PHP, MySql, CodeIgniter, Wordpress, Drupal, Cake PHP, Zend Framework, Experince criteria:all

Output:

Table 4-3 The overall evaluation result of the evaluators for Experiment 2

ID	CVEmail	CVSkills	Expe rienc e	Score _ Actu al	Scor e_A vg	Erro r	Erro r %
CV 1	fanus@pinsoftstudios.com	Wordpress, Wordpress Multi User + Administration - Network,PHP, CSS3, HTML5, Web design, Web development, Photoshop, MySQL, Social Network Integration	14.1	10.00	9.18	0.82	8.22
CV 2	saravananmalikara	PHP, Cake PHP, MySQL, Ajax, jQuery,	2.7	8.25	6.09	2.16	26.1

	j@gmail .com	Javascript, MySQL, HTML5, CSS3, XML,WordPress, Joomla						9
CV 3	binolala@gmail.com	JAVA, PHP,HTML, DHTML, CSS, C++,C, VB,JOOMLA, DRUPAL,WORDPRESS, AJAX, JAVASCRIPT, JQUERY, SQL, PL/SQL, MYSQL, SQL-SERVER	5	7.61	6.96	0.65		8.61
CV 4	sindhuphp515@gmail.com	PHP,MySQL,Codeigniter,MVC,Word press, CMS,Jquery,JavaScript,Ajax,HTML,CSS	5.5	7.21	6.89	0.32		4.48
CV 5	im.mohammadali@gmail.com	HTML, CSS, PHP, MySQL, Wordpress, Codeigniter ,(MVC),JavaScript, JQuery, Ajax	2.2	6.53	5.34	1.19		18.19
CV 6	adaan.smit@gmail.com	C#,Software Engineer,SQL Server 2008,Java,MySQL, PHP,	15.11	6.42	7.84	1.42		18.10
CV 7	aryakrishnan172@gmail.com	Code Igniter, PHP, JAVA, .Net, Mysql,SQL Serveer, AJAX,JSON,JS,CSS,HTML, C, C++	7	5.99	6.31	0.32		5.01
CV 8	ron@villageinternet.ca	Drupal,Linux server,CSS, Hands-on Training,Training,MySQL,Ecommerce, Mobile Web Design, Web Designer, Web Developer, Web Design, Web services,Website Development,	15.1	5.98	8.75	2.77		31.69
CV 9	raamkumar.m23@gmail.com	HTML,JQuery, PHP, Css, Mysql, Joomla, Wordpress, Photoshop	3	5.54	4.89	0.65		11.78
CV 10	raheelwp@gmail.com	php, javascript, mysql, mongodb, linux, laravel, codeigniter, wordpress	2	5.46	5.29	0.17		3.14
CV 11	nizam.taha@gmail.com	PHP, HTML, DHTML, JavaScript, AJAX, CSS, ASP, JAVA, C, C++,VBScript, MS Visual Basic 6.0, MySQL, MS Access, SQL Server, Flash,	10	5.38	6.96	1.58		22.75
CV 12	noorsyamimi_ismailbasha@yahoo.com	C++, PHP,css, Wordpress, Drupal, Photoshop, Dreamweaver,Flash,	2.5	5.24	4.96	0.28		5.34
CV 13	amarnath.qa.5555@gmail.com	Java,PHP, HTML + CSS, Software Testing,Test Automation,Quality Assurance, MySQL, Windows7,Windows XP, Wordpress,	3	5.16	5.20	0.04		0.67
CV 14	bacani_fie04@yahoo.com	HTML5, CSS3, JavaScript,JQuery, JSON,XML, PHP,ASP,Wordpress, Web Development, Front-End,Back-End,Bootstrap,Responsive Web Design,	5	4.93	5.57	0.64		11.50
CV 15	vikram_rke10@yahoo.com	JAVA,VB,ASP,PHP,HTML, SEO,JAVA,VB,ASP,PHP,Digital marketing	6	4.86	5.72	0.86		15.06

Analysis:

The comparison of system score and the evaluator average score is presented in the graph below.

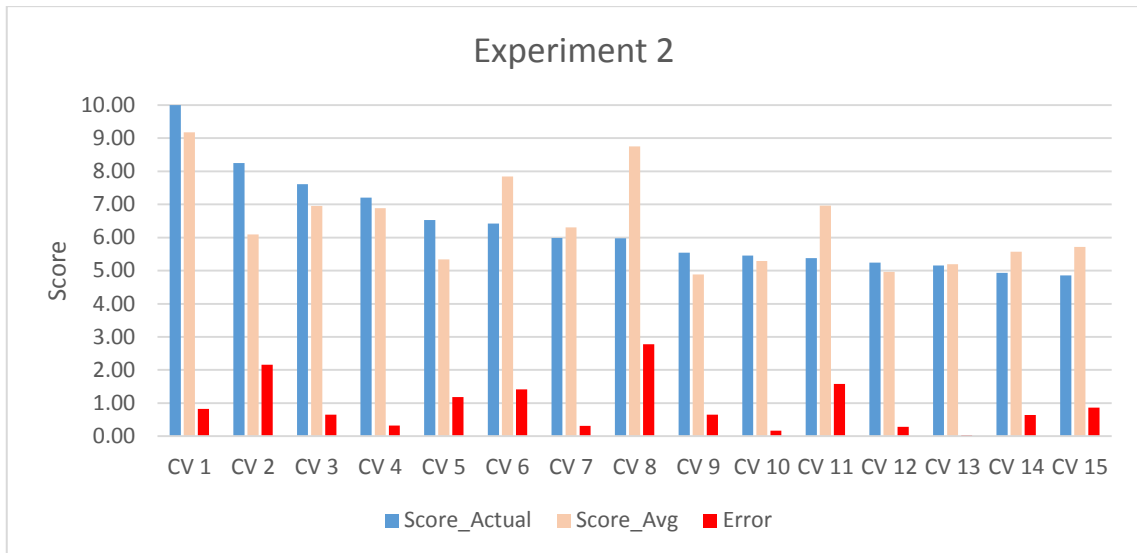


Figure 4-8 The comparison of system and evaluator score of Experiment 2

The deviation of score in scoring by the system and evaluator which is approximately 12.71%. But the system score has higher value than the evaluator score for the CVs which have been ranked highest and evaluator score has greater value than system score for the CVs which have been ranked lowest.

Experiment 3:

Input:ASP.net, C#, XML, Ajax, SQL Server, Oracle, SDLC,ASP.net, C#, XML,

Experience criteria: all

Output:

Table 4-4 The overall evaluation result of the evaluators for Experiment 3

ID	CVEmail	CVSkills	Experience	Score_Actual	Score_Avg	Error	Error %
CV 1	nabeelcp@gmail.com	.Net, C#,ASP.NET,ASP.NET MVC, jQuery,JavaScript,WCF,WPF,Enterprise Software,UML,Microsoft SQL Server, Oracle,SSRS,Software Programming	8.1	10.00	9.26	0.74	7.40
CV 2	balavsts@gmail.com	VSTS automation testing,C#, ASAP.NET,XML,SqlServer,WCF	9.9	9.85	7.98	1.87	18.98
CV 3	yogiponn1@gmail.com	c++, C#, Java, .Net, asp.net, Javascript, VC++,	15.1	9.27	9.38	0.11	1.22
CV 4	asifnpatel@gmail.com	Android,ASP.NET,Java,J2EE,Java JSP, AJAX,VB.NET,C#,	12.1	9.12	8.93	0.19	2.06
CV 5	vidyadanam100@gmail.com	ASP.NET,C#,VB6,VB.NET,SQL SERVER,JQUERY,XML,HTML	3.9	8.88	6.14	2.74	30.80

CV 6	chowdhury_mainak@rediffmail.com	ASP.NET, MVC, C#, SQL Server, Project Lead, Team Lead	9.2	8.51	7.63	0.88	10.37
CV 7	coreyschristian@gmail.com	SQL,C#,.NET,LINQ,ASP.NET,Microsoft Office,HTML,SCRUM,Database Design,Microsoft SQL Server, ASP.NET MVC, MySQL, Java, XML, SSRS,Software Development,Database Administration,CSS,	2	8.45	5.09	3.36	39.74
CV 8	suneel.vanka@gmail.com	.Net ,ASP.NET, MVC, jQuery,angular js, C#, Web Developer,WCF,web API, Microsoft SQL Server,SQLServer 2008, HTML5, CSS,CSS3,ASP.Net,jquery asp net, Web services,	6	8.30	6.60	1.70	20.42
CV 9	kiran_kjp@yahoo.co.in	Asp.net,C#,Sql server,Crystal Reports, Mvc,SSRS,Ajax,Javascript,jquery	5.3	7.65	6.41	1.24	16.17
CV 10	sreejayanravindran@yahoo.co.uk	asp.net,c#,sql server,vb.net,mvc,tridion	10	7.59	7.85	0.26	3.33
CV 11	isuhel.a@gmail.com	Asp.Net,C#,MS SQL Server,Ajax, XML	0.8	7.42	4.67	2.75	37.10
CV 12	danny@danznet.co.uk	C#,AngularJs,VB.Net, Microsoft SQL Server,Oracle,MVC,ASP.Net,Javascript ,Crystal Reports,Programmer, .Net Programming,Web Api,	8.1	7.37	8.41	1.04	12.39
CV 13	pinakin2in@gmail.com	ASP.Net, C#, SQL, Oracle, AJAX, LINQ, HTML,Javascript,	4.4	7.33	6.27	1.06	14.46
CV 14	megha.dave@gmail.com	ASP.NET, C#, VB.NET, SQL Server, Software engineer, web developer, speech server	4.5	7.14	5.49	1.65	23.13
CV 15	sunil.net61@gmail.com	ASP.Net, MVC Framework,WCF, Microsoft SQL Server,JavaScript, IIS,WEBAPI,TFS,VB.NET,C#,	8.1	7.09	7.33	0.24	3.22

Analysis: The comparison of system score and the evaluator average score is presented in the graph below.

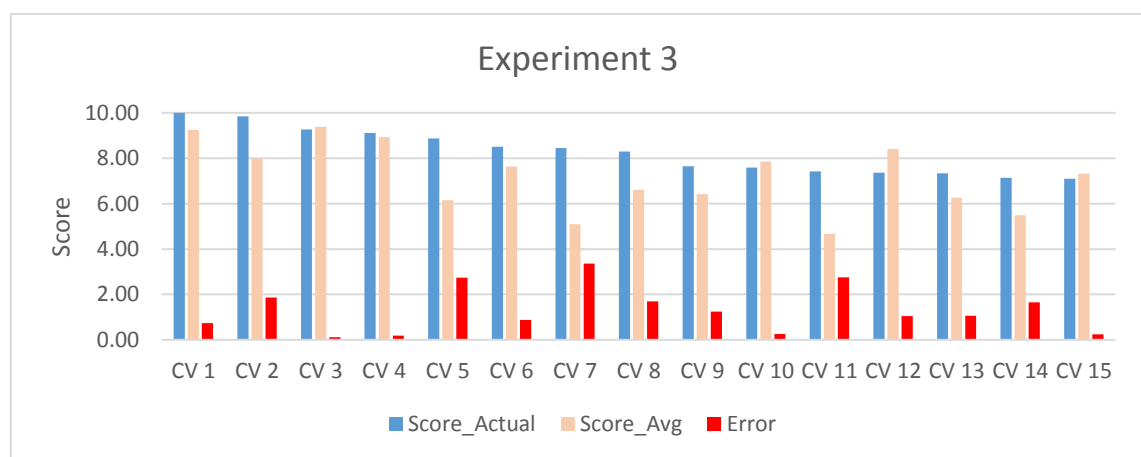


Figure 4-9 The comparison of system and evaluator score of Experiment 3

The error observed in the scoring by the system and evaluator which is approximately 16.05% for this experiment.

Overall Experiment Summary

The experiments were performed for 14 job descriptions. The table below provides the summary of all the experiments. The standard deviation presented in the table is calculated as

$$\sqrt{\sum_{i=0}^n (x - \bar{x})^2 / (n - 1)}$$

And the standard error is given by:

Standard Error = Standard Deviation / Square Root of n

The value of n is 13.

Table 4-5 The standard error for each job

JobId	Score Type	Average Score	Standard Deviation	Standard Error
Job1	Expert Score	6.40	1.35	0.35
	System Score	6.30	1.43	0.37
Job2	Expert Score	7.11	1.22	0.32
	System Score	7.48	1.38	0.36
Job3	Expert Score	6.81	1.40	0.36
	System Score	8.07	1.08	0.28
Job4	Expert Score	6.74	1.31	0.34
	System Score	8.07	1.08	0.28
Job5	Expert Score	6.27	1.56	0.40
	System Score	4.89	2.09	0.54
Job6	Expert Score	6.87	1.51	0.39
	System Score	5.89	1.59	0.41
Job7	Expert Score	7.16	1.50	0.39
	System Score	8.26	0.99	0.25
Job8	Expert Score	6.89	1.08	0.28
	System Score	5.85	1.63	0.42
Job9	Expert Score	6.61	1.62	0.42
	System Score	4.22	2.08	0.54
Job10	Expert Score	6.61	1.62	0.42
	System Score	4.22	2.08	0.54
Job11	Expert Score	7.39	1.35	0.35
	System Score	7.63	1.53	0.40
Job12	Expert Score	7.05	1.33	0.34
	System Score	8.57	0.77	0.20
Job13	Expert Score	6.64	1.59	0.41
	System Score	5.44	1.70	0.44
Job14	Expert Score	6.78	1.48	0.38
	System Score	6.13	1.59	0.41

The following graph shows the standard error plot for both system and evaluator score for the 14 jobs which are evaluated using the expert in this work.

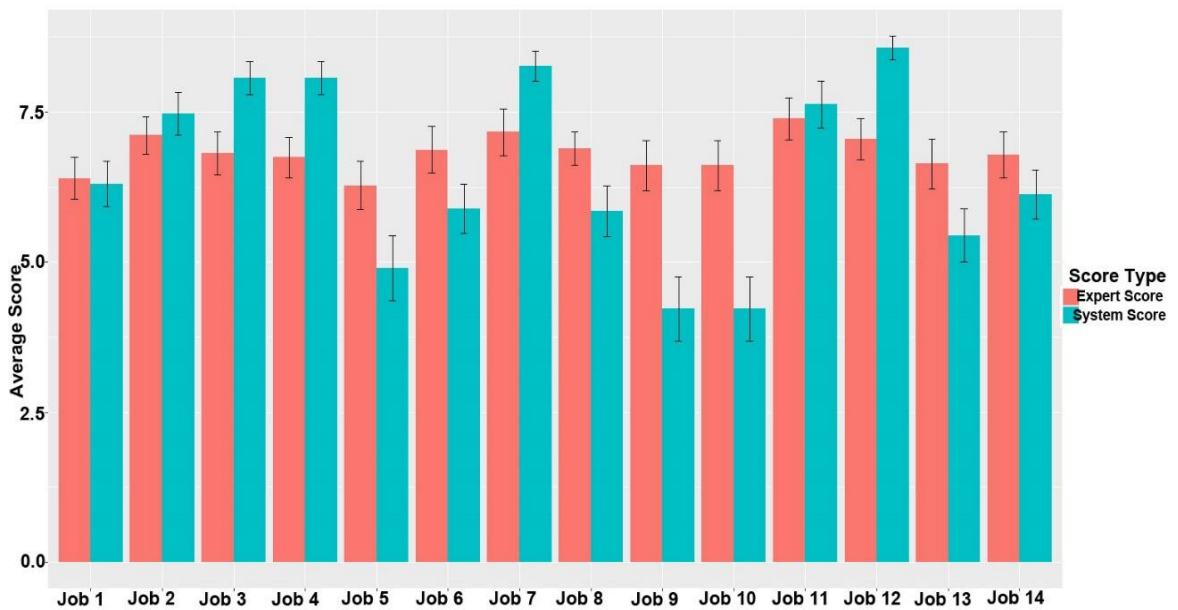


Figure 4-10 The graph for the standard error

And the table given below provides the average error for all the job descriptions i.e. the 14 jobs which are used for the evaluation purpose. The detail of experiment can be found in Annex II.

Table 4-6 The overall error for each evaluated jobs

ID	Job 1	Job 2	Job 3	Job 4	Job 5	Job 6	Job 7	Job 8	Job 9	Job 10	Job 11	Job 12	Job 13	Job 14	Average
Error (%)	18.94	19.03	12.71	16.05	12.86	17.65	22.76	38.17	11.68	18.94	27.92	17.96	14.58	18.42	19.12

From the observation the most important point to note is the even distribution of error across all job description. This implies that the performance for matching by the system is consistent. Even though the average error percent is 19.12% the performance of the system can be consistently improved by tuning the various coefficient α , β , γ and λ in matching algorithm.

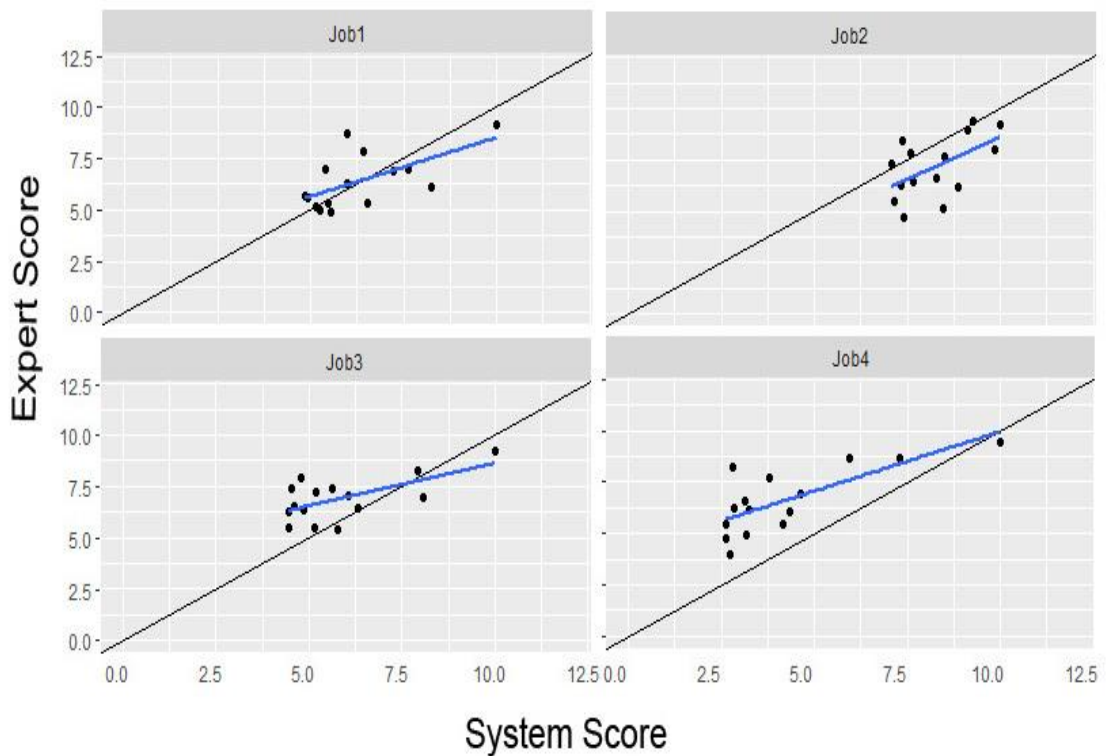
4.6 Discussion

The evaluation of the system output is carried out by the IT professionals who have at least 5 years of experience. They all have managerial positions on their respective

working area and have a strong hand on selecting the employees on their companies. So it can be said that the validation presented in this thesis work closely related to the way of recruitment in the companies. The total number of the experts to which the validation data given are 7.

The results in the system shows the even distribution of deviation of score from system and evaluator score across all job description which shows the system is consistent. If the other criteria are considered which are not included in this thesis work, the system can perform efficiently. From the observation of the result of the system, the ranked list deals efficiently with the cases where the exact match of given requirement does not met by the candidate profile.

The scatter plot for all the CVs for all the job descriptions is shown in the figure below. The line having slope 45 degree represent the median line for both the axes (x-axis-System Score, y-axis-Evaluator Score). The regression line also present in the graph which can be used to predict the values of a dependent variable based upon the values of an independent variable. From the graph it is obvious that the plot for all job description is evenly distributed.



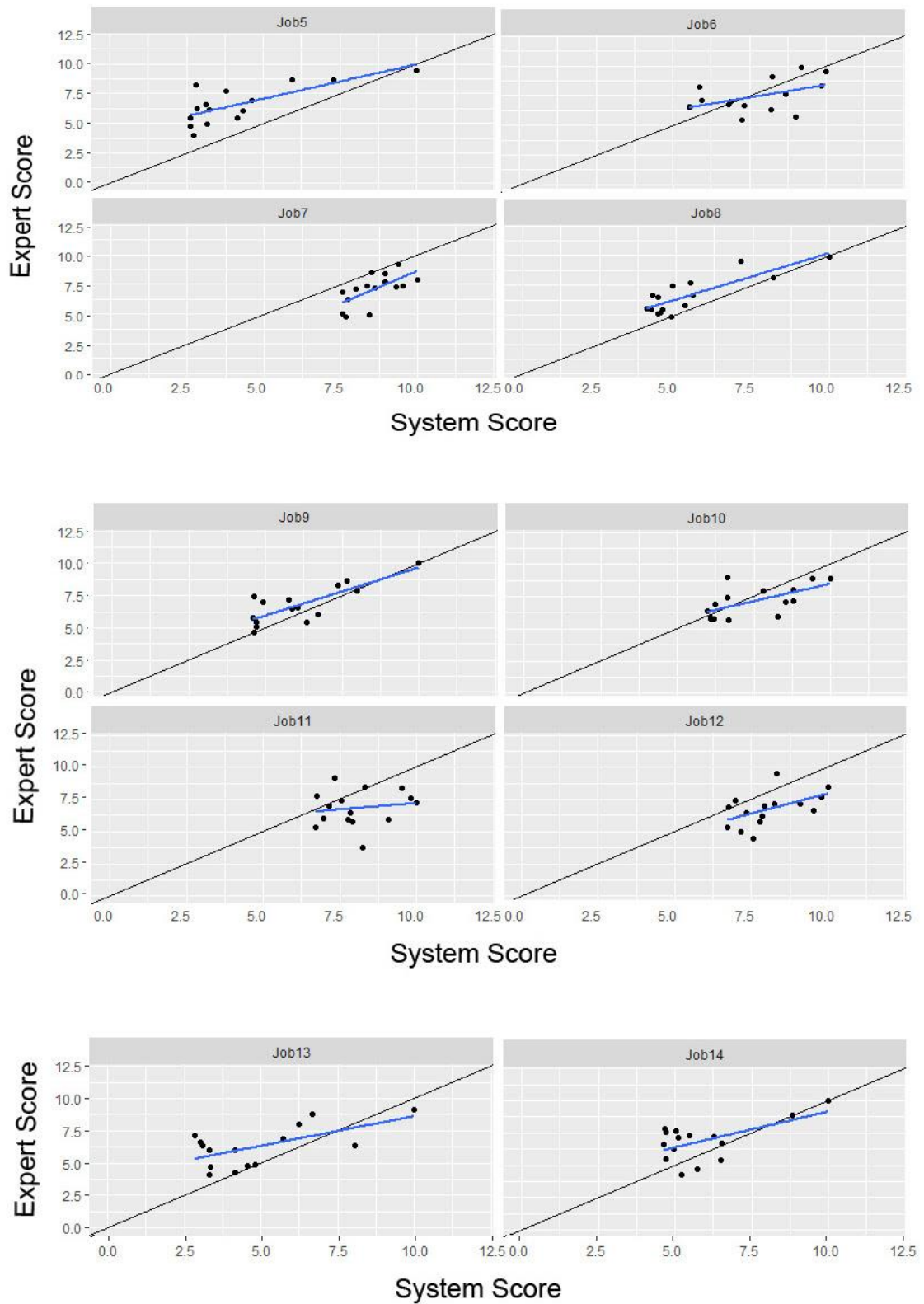


Figure 4-11 the expert score verses system score scatter graph for each job

This graph below shows the scatter plot for all the job description with system score on x axis and expert score on y axis. This figure shows the data are grouped very closely with each other.

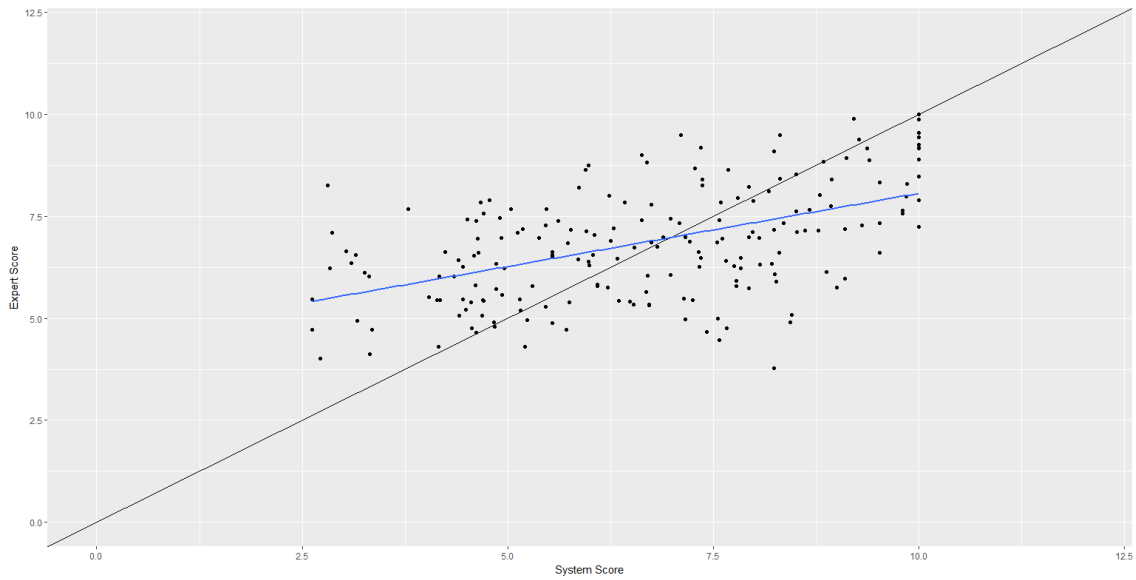


Figure 4-12 the scatter graph of expert score verses system score for all job

5. Conclusions

5.1 Conclusions

In this research work an approach for matchmaking between skills demand and supply through the implementation of methodology for skill profiles enrichment and matching supply and demand profiles over multiple criteria is carried out. This work brings together research from different fields – profile modelling, information enrichment and multi-criteria matching. The Methodology for enrichment of heterogeneous profile models and skill set description of the candidate and jobs by making use of standard ontologies is the first contribution of this thesis work. Secondly the formulated solution utilizes algorithm for similarity matching across multi-criteria for discovering set of profiles that best fits the job description criteria. This thesis work mainly focus on modeling the existing data in the field of job recruitment with standard ontology and similarity matching algorithm.

The result obtained from the system was evaluated by comparing the results collected from experts for same inputs. The observation during the validation have an evenly distributed deviation. This deviation can be corrected by tuning different coefficient defined in the algorithm. On the whole this research work can provide a foundation for realization of a sustainable virtual marketplace for employees and employers to discover the best fitting job or resource respectively.

5.2 Limitations and Recommendations

Some of the limitations of the solution that has been formulated by this research work are:

- The proposed methodology is highly dependent on domain knowledge base. In the scope of our implementation the quality of ESCO ontology determines the quality of matching result.

- Another limitation during experimentation is the consideration of only IT skills, thus ignoring other soft skills which are also very important during candidate matching.

Some very interesting result in the scope of this research work are achieved, which can be extended further in future. Some recommendations for future work are:

- Automatically handle the integration of changed in ESCO ontology which is improving on continuous basis. One of the recommendation is to improve the system by making dynamic enough to automatically link with ESCO ontology.
- Extend the usability of system by by considering all the skills in the ESCO ontology. Also it is highly recommended to use other pillar and relation of these pillars of ESCO for example the information enrichment using qualification (education and certification) is not implemented.
- The matching algorithm can be further improved by including other criteria such as degree, previous projects, expectations, designation, soft skills, location etc.
- And finally, some further work on experimental analysis with more criteria can be important future work for fine tuning the algorithm. Additionally recommendation would be to extend the system with learning algorithm to improve matches over time.

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List of Annexes

Annex I: The pseudo code of the algorithms implemented

Algorithm 1: JobsAndCVMatcher

Input: Job, CVs

Output: Ranked CVs

```
{
<MySkillObject>jobSkillObj ← ObjectCreation(job) // Job Object Creation
<MySkillObject>cvSkillObj ← ObjectCreation(CVs) //CVs Object Creation
MatchCVsAccordingToJob(jobSkillObj,cvSkillObj) // Match CVs according to Job
and return ranked CVs
}
```

Algorithm 2: ObjectCreation

Input:Skills, SkillOntology, OccupationOntology, skillandOccupationRelationOntology

Output: <mySkillObject> //skill object with weight

```
{
<mySkillObject> objSkill
ForEach skill in Skills
{
ForEach ontoSkill in skillOntology
{
mySkillObject objSkillInner
matchScore ← stringMatch(skill,ontoSkill) // matchScore from
stringMatch algorithm

objSkillInner.Skill=ontoSkill
objSkillInner.Weight=matchScore
if(objSkillInner does not exist in objSkill)
objSkill.Add(objSkillInner)
else
objSkill.objSkillInner.weight += matchScore
}
} // returns objSkill (skill object with weight)

<mySkillObject> objOccupation
ForEach skill in objSkill
{
Occupations= select all occupations from skillandOccupationRelationOntology
s.t. :occupations:has:skill
ForEach ontoOccupation in Occupations
{
mySkillObject objOccupationInner
objOccupationInner.Occupation= ontoOccupation
objOccupationInner.Weight= skill.weight * 0.6
if(objOccupationInner doesn't exist in objOccupation )
objOccupation.add(objOccupationInner)
} // Find distinct occupation of objSkill from skillandOccupationRelationOntology
} // returns objOccupation (Occupation object with weight)
```

```

<mySkillObject> objOccupationSkill
Foreach occupaton in objOccupation
{
OccupationsSkills= select all skills from OccupationOntology
    s.t. :skills:has:occupation
Foereach occupatonSkill in OccupationsSkills
{
mySkillObject objOccupationSkillInner
objOccupationSkillInner.Skill= occupatonSkill
objOccupationSkillInner.Weight= occupation.weight
if(objOccupationSkillInner does not exist in objOccupationSkill)
objOccupationSkill.Add(objOccupationSkillInner)
else
objOccupationSkill.objOccupationSkillInner.weight += occupation.weight * 0.2
} // returns objOccupationSkill (skill object from occupation skills with weight)
}
Union objSkill, objOccupationSkill // return MySkillObject with weighted skills
    from both skills and occupations
}

```

Algorithm 3: Stringmatch

Input: string1, string2

Output: matchvalue // percentage match from 0.0 to 1.0 where 1.0 is 100%

```

{
pairs1 ← WordLetterPairs(string1.ToUpper())
pairs2 ← WordLetterPairs(string2.ToUpper())
intersection = 0;
union = pairs1.Count + pairs2.Count
for (i = 0; i < pairs1.Count; i++)
{
for (j = 0; j < pairs2.Count; j++)
{
if (pairs1[i] == pairs2[j])
{
intersection++
pairs2.RemoveAt(j) //Must remove the match to prevent "GGGG"
from appearing to match "GG" with 100% success
break
}
}
}
return (2.0 * intersection) / union
}

```

Algorithm 4: WordLetterPair

Input: string

Output: <string>

```

{
<AllPairs>

```

```

// Tokenize the string and put the tokens/words into an array
Words[] = Regex.Split(str, @"\s")
// For each word
for (w = 0; w < Words.Length; w++)
{
    if (!IsNullOrEmpty(Words[w]))
    {
        // Find the pairs of characters
        PairsInWord[] = LetterPairs(Words[w])
        for (int p = 0; p < PairsInWord.Length; p++)
            AllPairs.Add(PairsInWord[p])
    }
}
return AllPairs
}

```

Algorithm 5: LetterPairs // Generates an array containing every two consecutive letters in the input string

Input: word

Output: pairs[]

```

{
    numPairs = word.Length - 1
    pairs[numPairs]
    for (i = 0; i < numPairs; i++)
    {
        pairs[i] = word.Substring(i, 2)
    }
    return pairs
}

```

Algorithm 6: MatchCVsAccordingToJob

Input: CVsObject, JobObject, JobInput, CVInput , ExperienceCriteria

Output: RankedCVsObject

```

{
    <myCV> cvs
    Foreach job in JobObject
    {
        Foreach CV in CVObject
        {
            If (CV.experience satisfy ExperienceCriteria)
            {
                myCV CVInner
                // CV and Job are from generated object
                SumofSkillWeight ← CompareArraysString(CV.skill,job.skill) /
                    1000 * (1 + CV.experience);
                SkillCompareWeight=CompareArraysString(job.jobInput.skill ,
                    CV.CVInput.skill)
                skillWeight = SumofSkillWeight + SkillCompareWeight * 2;
                CVInner.skills = CV.skills
                CVInner.cumulativeWeight = skillWeight + CV.experience * 0.6;
            }
        }
    }
}

```

```

    cvs.Add(CVInner)
    }
}
}
}

```

Algorithm 7: CompareArraysString //extension of Stringmatch

Inputs: JobSkills, CVSkill

Output: MatrixSimilarity

```

{
    intersection = 0
    union = JobSkills.Count() + CVSkill.Count()
    intersectionSum = 0.0
    totalSum = 0.0;
    foreach (var _JobSkills in JobSkills)
    {
        foreach (var _ CVSkill in CVSkill )
        {
            if (_JobSkills == _ CVSkill)
            {
                intersection++;
                intersectionSum += ((_JobSkills.Weight+_CVSkill.Weight)/ 2.0)
                    * _JobSkills.Weight
                break
            }
            totalSum += ((_JobSkills.Weight + _CVSkill.Weight) / 2.0) * _JobSkills.Weight
        }
    }
    return (2.0 * intersectionSum * intersection) / union * totalSum
}

```

Annex II: Validation Data

Job 1 Skills: c#, .net, asp.net,sql server,c++

CVEmail	CVSkills	Experie nce	Score_ Actual	Score_S G_N	Score_k k_N	Score_Y T_N	Score_N M_N	Score_N J_N	Score_A vg
yogiponn1@gmail.com	c++, C#, Java, .Net, asp.net, Javascript, VC++,	15.1	10.00	9.38	10.00	10.00	9.99	10.00	9.87
sreejayanravindran@yahoo.co.uk	asp.net,c#,sql server,vb.net,mvc,tridion	10	8.18	8.75	8.89	7.06	7.01	8.89	8.12
yogiponn2@gmail.com	c#, vb.net, C/C++, VC++, C, Java, MVC, .Net, MFC, com/dcom,WCF, WPF,	15.1	7.11	10.00	10.00	7.50	10.00	10.00	9.50
suneel.vanka@gmail.com	.Net ,ASP.NET, MVC, jQuery,angular js, C#, Web Developer,WCF,web API, Microsoft SQL Server,SQL Server 2008, HTML5, CSS,CSS3,ASP.Net Programming,jquery asp net, Web services,	6	5.54	8.13	5.56	6.99	4.68	7.78	6.62
nabeelcp@gmail.com	.Net, C#,ASP.NET,ASP.NET MVC, jQuery,JavaScript,WCF,WPF,Enterprise Software,UML, Microsoft SQL Server,Oracle,SSRS,Software Programming,	8.1	5.47	8.75	6.67	7.68	6.95	8.33	7.68
urvpathak1090@gmail.com	Java,C++,.NET	0.3	5.30	7.50	6.11	2.60	9.99	2.78	5.80
ptirtha@hotmail.com	Maths, Quant, C++, VC++, GMAT, CAT, Programmer, Technical Architect, C#, .Net, SDET	14.2	4.90	7.50	7.78	8.45	4.09	9.44	7.45

rajarun16@gmail.com	.net,c#.net,Asp.net,Ado.net, sql server 2008	3.5	4.84	7.50	3.33	3.66	4.12	5.33	4.79
zeeshandbg260@gmail.com	Engineer,.net.sql server,c#.c++,dbms.javaScript,networking.	1.8	4.55	6.25	6.11	5.60	3.45	5.56	5.39
navin.goradara@gmail.com	c,c#.c#,vb,SQL Server 2008,asp.net,	3.1	4.49	6.88	3.33	4.78	3.51	7.56	5.21
coreyschristian@gmail.com	SQL,C#.NET,LINQ, ASP.NET,Microsoft Office,HTML,SCRUM,Database Design,Microsoft SQL Server,ASP.NET MVC,MySQL,Java,XML,SSRS,Software Development,Database Administration.CSS,	2	4.41	7.50	2.78	5.66	4.97	4.44	5.07
munashe@xnine.us	Java, C#, J2EE, PHP, VB, C++, ASP .NET, .NET, HTML, JavaScript, SQL	5	4.40	7.50	4.44	5.41	5.90	8.89	6.43
vipinkm89j@gmail.com	Programmer, C++,C#,Asp.Net,Vb.Net,Sql,.Net	0.6	4.24	6.25	8.89	5.20	9.47	3.33	6.63
vasanth.net@live.com	E-commerce,SEO,ASP.Net,Programming,C#, .Net, Software Developer,SQL Server,HTML,	4	4.18	6.88	3.89	6.32	3.51	6.67	5.45
megha.dave@gmail.com	ASP.NET, C#, VB.NET, SQL Server, Software engineer, web developer, speech server	4.5	4.04	6.88	3.89	5.24	4.68	6.89	5.51

Job 2 Skills: Photoshop, Html, Css, Dreamweaver, Jvascript,

CVEmail	CVSkills	Experience	Score Actual	Score_S G_N	Score_k k_N	Score_Y T_N	Score_N M_N	Score_N J_N	Score_Avg
brucelica@live.com	Dreamweaver, Flash, Photoshop, CSS, HTML, Javascript, PHP ,MySQL, ASP.net ,Access	3	10.00	8.24	7.14	8.67	8.33	10.00	8.48
arunaruchamy@yahoo.com	Html, Html5, CSS, Photoshop, Dreamweaver, wordpress and Javascript.	2	9.80	9.41	5.71	8.00	6.67	8.46	7.65
web@ip-design.ca	Dreamweaver, XHTML, HTML, HTML5, CSS, CSS3, Javascript, Photoshop, Indesign, Illustrator, Flash, Acrobat, Graphic design, Web design, Responsive design, Creativity, Scanning, Photography, Studio setting, Large format photography, Social media, facebook, twitter, Instagram, Pinterest, Tumblr, Microsoft word, Excel, Outlook, Powerpoint, Mac, PC, Leadership, detail oriented, Visual arts, painting,	1.2	9.52	8.24	4.29	7.47	5.33	7.69	6.60
gr.vimala@yahoo.com	Dreamweaver,HTML,CSS,Javascript,Jquery,Php,Ajax,Sql,Photoshop,Flash	2	9.10	10.00	2.86	8.00	6.67	8.46	7.20
nizam.taha@gmail.com	PHP, HTML, DHTML, JavaScript, AJAX, CSS, ASP, JAVA, C, C++, VBScript, MS Visual Basic 6.0, MySQL, MS Access, SQL Server, Flash,	10	8.31	8.24	10.00	10.00	10.00	9.23	9.49
perashantku89@gmail.com	LOGO DESIGN, BANNER DESIGN,Newsletter,slicing, PHOTOSHOP,ILLUSTRATOR,CORAL DRAW,FLASH, DREAMWEAVER, CSS,CSS3 ,HTML,HTML5 , Responsive Website Design, JQUERY, File zilla	2.2	8.24	8.82	3.43	8.13	7.00	8.46	7.17
vongi.fm@gmail.com	Dreamweaver,Adobe Photoshop, Fireworks, Advanced MS Office,Adope PhotoShop,FireWorks,HTML,Advanced Ms Office,A+,N+,MS Installation,Css,Desktop publishing,	3.1	7.93	7.65	4.29	7.07	6.38	9.54	6.98
alisha.bhure@gmail.com	HTM:, CSS, Javascript, ASP/C# Net, MOSS 2007, Sharepoint 2010, Flash, Photoshop, Dreamweaver	2	7.83	8.24	3.71	8.00	5.00	6.15	6.22
ijasmca09@gmail.com	Html,Css,Jquery,Javascript,dreamwaver and photoshop	2	7.78	8.24	4.29	4.67	3.33	8.46	5.80
work.thapa.hims@gmail.com	HTML,HTML5,CSS,CSS3,JavaScript,JQuery,Photoshop ,	0.6	7.57	7.06	2.00	5.40	3.25	4.62	4.46
kulkarniamar18@gmail.com	Photoshop, Corel draw, HTML, CSS, Dreamweaver	1.8	7.35	7.06	3.43	7.87	6.33	7.69	6.48
dipendrajha101@gmail.com	Coral Drow, pagemake, Photoshop, Html, Dhtml, Dreamwear, Flash & Tally 9.0	2	7.16	6.47	4.29	4.67	3.33	6.15	4.98
binolala@gmail.com	JAVA, PHP,HTML, DHTML, CSS, C++,C.VB,JOOMLA, DRUPAL, WORDPRESS, AJAX, JAVASCRIPT, JQUERY, SQL, PL/SQL, MYSQL, SQL-SERVER	5	6.98	7.65	8.57	6.67	5.83	8.46	7.44
ankurjain.756@gmail.com	HTML,css,flash, photoshop,dreamweaver,coreftp,DIV	2.5	6.75	6.47	4.29	8.33	7.50	7.69	6.86
wagleniraj@yahoo.com	photoshop,dreamweaver,html,css, java script etc...	1	6.72	5.88	1.43	7.33	5.00	6.92	5.31

Job 3 Skills: IT Sales, Sales Engineer, Sales Pre Sales Executive, Sales Coordinator, Inside Sales Executive, Marketing Executive, Online Marketing, Lead generation, Cold Calling, Tele Caller, Tele Sales, tele marketing

CVEmail	CVSkills	Experience	Score_Actual	Score_SG_N	Score_k_N	Score_YT_N	Score_NM_N	Score_NJ_N	Score_Avg
diptanu.nit@gmail.com	Sales, territory sales, corporate sales, B2B sales, technology based products sales, Channel management, Channel sales, sales training, sales team leading, customer relationship, customer acquisition, negotiation skills	1	10.00	5.88	7.69	7.82	9.41	9.33	8.03
merisham5@gmail.com	Internal Sales Executive, Relationship Databases, Sales Order Processor, Direct Sales, Sales Co-ordinator, Sales Professionals, IT Sales,	3.1	9.80	6.47	9.23	7.84	6.00	8.27	7.56
mhsq_71@yahoo.com	Marketing, Sales, Channel Development, Retail and Corporate Sales,	14.7	9.52	10.00	8.46	6.48	9.41	7.33	8.34
kobuslab@gmail.com	IT Sales, IT Helpdesk, Marketing, Sales,	2.1	9.10	5.29	4.62	7.40	4.82	7.73	5.97
baldev.sharma88@gmail.com	Digital Marketing, SEO, E-commerce SEO, IT Project Manager, IT Technical Consultant, Online Marketing, Social Media Marketing, Social Media Expert,	6.1	8.31	8.24	6.15	9.16	9.53	9.07	8.43
marnsventer88@gmail.com	Marketing, sales, accounting software	7	8.24	8.24	3.08	4.38	0.00	3.20	3.78
larryj@eim.ae	Adobe Creative Suite, Call Center, Sales & Marketing, Graphic Designer, Data Entry Operator, Production/Operations Management, Advertising, Microsoft Office,	7	7.93	8.82	2.31	4.38	9.41	3.73	5.73
s.riaz.mahmud@gmail.com	Secretary, Admin Clerk, Online Marketing, Telemarketing, Creative Direction, business communication, Computer, Advertising,	2.1	7.83	6.47	1.54	7.40	9.65	7.33	6.48
frederic.bonifassy@gmail.com	marketing, sales, business development, management, international trade	3.6	7.78	6.47	6.92	5.47	8.82	1.87	5.91
shukrisaleh@yahoo.com	Computer Hardware/Software, Marketing, Training and Development, Sales and service.	14	7.57	7.65	7.69	6.17	8.82	6.67	7.40
mrdejagerm@gmail.com	A+, N+, Store Manager, Support, Call Centre, IT Sales	8	7.35	5.88	10.00	10.00	10.00	10.00	9.18
krishnawillb@gmail.com	Web Research, Market Research, Lead Generation, SEO, Digital marketing	4.9	7.16	6.47	3.08	8.63	8.12	8.67	6.99
Niven_chellan@hotmail.com	HTML Programming, java script, vb script, visual basics, pastel accounting, juniper sales, networking products, it sales, help desk, audio codes	2	6.98	6.47	4.62	7.36	4.71	7.20	6.07
dsochang@hotmail.com	Regional Sales, Business Development, Channel Sales, Account Management, Contract Negotiation, Customer/Supplier Relations, People Management, Cross-Culture Communication, Operation Start-Up, Global Procurement, Strategic Sourcing, Cost Savings	14	6.75	9.41	8.46	6.17	8.24	6.67	7.79
0727800679@vodamail.co.za	Networking, Linux, Installation, PC Repairs, Redhat, Windows 7, exchange, sales, services	4.11	6.72	6.47	3.08	5.70	9.41	2.00	5.33

Job 4 Skills: PHP, MySQL, CodeIgniter, Wordpress, Drupal, Cake PHP, Zend Framework

CVEmail	CVSkills	Experience	Score_Actual	Score_SG_N	Score_k_N	Score_YT_N	Score_NM_N	Score_NJ_N	Score_Avg
fanus@pinsoftstudios.com	Wordpress, Wordpress Multi User + Administration - Network, PHP, CSS3, HTML5, Web design, Web development, Photoshop, MySQL, Social Network Integration	14.1	10.00	10.00	6.67	9.22	10.00	10.00	9.18
saravananmalikaraj@gmail.com	PHP, Cake PHP, MySQL, Ajax, jQuery, Javascript, MySQL, HTML5, CSS3, XML, WordPress, Joomla	2.7	8.25	8.24	3.33	7.86	4.87	6.15	6.09
binolala@gmail.com	JAVA, PHP, HTML, DHTML, CSS, C++, C, VB, JOOMLA, DRUPAL, WORDPRESS, AJAX, JAVASCRIPT, JQUERY, SQL, PL/SQL, MYSQL, SQL-SERVER	5	7.61	8.82	4.67	8.87	5.80	6.62	6.96
sindhuphp515@gmail.com	PHP, MySQL, Codeigniter, MVC, Wordpress, CMS, JQuery, JavaScript, Ajax, HTML, CSS	5.5	7.21	9.41	6.00	7.43	6.21	5.38	6.89
im.mohammadali@gmail.com	HTML, CSS, PHP, MySQL, Wordpress, Codeigniter (MVC), JavaScript, JQuery, Ajax	2.2	6.53	7.65	3.33	7.64	3.48	4.62	5.34
adaan.smit@gmail.com	C#, Software Engineer, SQL Server 2008, Java, MySQL, PHP,	15.11	6.42	7.65	6.00	10.00	7.08	8.46	7.84

aryakrishnan172@gmail.com	Code Igniter, PHP, JAVA, .Net, Mysql,SQL Server, AJAX, JSON,JS,CSS,HTML, C, C++	7	5.99	8.24	6.67	6.42	5.59	4.62	6.31
ron@villageinternet.ca	Drupal, Linux server, CSS, Hands-on Training, Training, MySQL, Ecommerce, Mobile Web Design, Web Designer, Web Developer, Web Design, Web services, Website Development,	15.1	5.98	8.24	10.00	10.00	7.08	8.46	8.75
raamkumar.m23@gmail.com	HTML, JQuery, PHP, CSS, Mysql, Joomla, Wordpress, Photoshop	3	5.54	7.06	3.33	6.32	3.11	4.62	4.89
raheelwp@gmail.com	php, javascript, mysql, mongodb, linux, laravel, codeigniter, wordpress	2	5.46	7.06	3.60	7.55	3.31	4.92	5.29
nizam.taha@gmail.com	PHP, HTML, DHTML, JavaScript, AJAX, CSS, ASP, JAVA, C, C++, VBScript, MS Visual Basic 6.0, MySQL, MS Access, SQL Server, Flash,	10	5.38	8.82	6.67	7.75	4.97	6.62	6.96
noorsyamimi_ismailbasha@yahoo.com	C++, PHP, CSS, Wordpress, Drupal, Photoshop, Dreamweaver, Flash,	2.5	5.24	7.65	3.33	6.10	2.80	4.92	4.96
amarnath.qa.5555@gmail.com	Java, PHP, HTML + CSS, Software Testing, Test Automation, Quality Assurance, MySQL, Windows 7, Windows XP, Wordpress,	3	5.16	7.06	3.33	6.32	3.11	6.15	5.20
bacani_fie04@yahoo.com	HTML5, CSS3, JavaScript, JQuery, JSON, XML, PHP, ASP, Wordpress, Web Development, Front-End, Back-End, Bootstrap, Responsive Web Design,	5	4.93	8.24	5.33	5.54	2.90	5.85	5.57
vikram_rke10@yahoo.com	JAVA, VB, ASP, PHP, HTML, SEO, JAVA, VB, ASP, PHP, Digital marketing	6	4.86	7.65	5.33	8.31	3.31	4.00	5.72

Job 5 Skills: ASP.net, C#, XML, Ajax, SQL Server, Oracle, SDLC, ASP.net, C#, XML,

CVEmail	CVSkills	Experience	Score Actual	Score_S G_N	Score_k k_N	Score_Y T_N	Score_N M_N	Score_N J_N	Score_Avg
nabeelcp@gmail.com	.Net, C#, ASP.NET, ASP.NET MVC, jQuery, JavaScript, WCF, WPF, Enterprise Software, UML, Microsoft SQL Server, Oracle, SSRS, Software Programming,	8.1	10.00	10.00	9.23	9.90	7.16	10.00	9.26
balavsts@gmail.com	VSTS automation testing, C#, ASP.NET, XML, SQL Server, WCF	9.9	9.85	8.89	7.69	7.45	8.44	7.43	7.98
yogiponn1@gmail.com	C++, C#, Java, .Net, asp.net, Javascript, VC++,	15.1	9.27	9.44	10.00	9.67	9.70	8.11	9.38
asifnpatel@gmail.com	Android, ASP.NET, Java, J2EE, Java JSP, AJAX, VB.NET, C#,	12.1	9.12	9.44	8.46	10.00	10.00	6.76	8.93
vidyadanam100@gmail.com	ASP.NET, C#, VB6, VB.NET, SQL SERVER, JQUERY, XML, HTML	3.9	8.88	7.22	6.15	8.11	5.86	3.38	6.14
chowdhury_mainak@rediffmail.com	ASP.NET, MVC, C#, SQL Server, Project Lead, Team Lead	9.2	8.51	8.33	7.69	8.76	7.94	5.41	7.63
coreyschristian@gmail.com	SQL, C#, .NET, LINQ, ASP.NET, Microsoft Office, HTML, SCRUM, Database Design, Microsoft SQL Server, ASP.NET MVC, MySQL, Java, XML, SSRS, Software Development, Database Administration, CSS,	2	8.45	6.67	5.38	7.30	3.40	2.70	5.09
suneel.vanka@gmail.com	.Net, ASP.NET, MVC, jQuery, angular js, C#, Web Developer, WCF, web API, Microsoft SQL Server, SQL Server 2008, HTML5, CSS, CSS3, ASP.Net Programming, jquery asp net, Web services,	6	8.30	7.22	8.46	7.40	4.54	5.41	6.60
kiran_kjp@yahoo.co.in	ASP.net, C#, SQL server, Crystal Reports, Mvc, SSRS, Ajax, Javascript, jquery	5.3	7.65	6.67	6.15	8.71	6.21	4.32	6.41
sreejayanravindran@yahoo.co.uk	asp.net, c#, sql server, vb.net, mvc, tridion	10	7.59	7.78	8.46	9.10	8.51	5.41	7.85
isuhela@gmail.com	ASP.Net, C#, MS SQL Server, Ajax, XML,	0.8	7.42	5.56	3.08	6.79	2.78	5.14	4.67
danny@danznet.co.uk	C#, AngularJs, VB.Net, Microsoft SQL Server, Oracle, MVC, ASP.Net, Javascript, Crystal Reports, Programmer, .Net Programming, Web Api,	8.1	7.37	8.33	9.23	9.90	7.16	7.43	8.41
pinakin2in@gmail.com	ASP.Net, C#, SQL, Oracle, AJAX, LINQ, HTML, Javascript,	4.4	7.33	7.78	6.15	8.32	5.45	3.65	6.27
megha.dave@gmail.com	ASP.NET, C#, VB.NET, SQL Server, Software engineer, web developer, speech server	4.5	7.14	7.22	6.15	6.76	4.61	2.70	5.49
sunil.net61@gmail.com	ASP.Net, MVC Framework, WCF, Microsoft SQL Server, JavaScript, IIS, WEB API, TFS, VB.NET, C#,	8.1	7.09	8.33	8.46	8.29	5.73	5.81	7.33

Job 6 Skills: Web Designer,Flash, flash MX, adobe , 3D, Macromedia Flash, Photoshop , Corel Draw, Illustrator

CVEmail	CVSkills	Experience	Score_Actual	Score_S G_N	Score_k k_N	Score_Y T_N	Score_N M_N	Score_N J_N	Score_Avg
annam.gangadhar@gmail.com	DESIGNING ,ANIMATION ,Photoshop, Flash , Sound Forge	11.3	10.00	10.00	10.00	10.00	10.00	10.00	10.00
ehp@local.cl	3DStudio Max. Acad. Photoshop, Illustrator, Flash, Premier, sketchUP, Maya	7	7.99	9.33	6.00	8.37	6.77	8.89	7.87
srinivaballa2k@yahoo.com	ui designer. ux designer. front end developer.photoshop, illustrator, web designer, jquery, bootstrap ,responsive web design	8.2	7.68	10.00	6.67	8.83	7.67	10.00	8.63
kishoresridhar.s@gmail.com	flash,photoshop,illustrator, coreldraw.soundforge(basic)	5	7.37	9.33	8.67	7.61	7.89	7.78	8.26
web@ip-design.ca	Dreamweaver, XHTML, HTML, HTML5, CSS, CSS3, Javascript, Photoshop, Indesign, Illustrator, Flash, Acrobat, Graphic design, Web design, Responsive design, Creativity, Scanning, Photography, Studio setting, Large format photography, Social media, facebook, twitter, Instagram, Pinterest, Tumblr, Microsoft word, Excel, Outlook, Powerpoint, Mac, PC, Leadership, detail oriented, Visual arts, painting,	1.2	6.70	8.00	5.33	6.17	2.41	8.33	6.05
perashanku89@gmail.com	LOGO DESIGN, BANNER DESIGN,Newsletter,slicing, PHOTOSHOP,ILLUSTRATOR,CORAL DRAW,FLASH, DREAMWEAVER, CSS,CSS3 ,HTML,HTML5 , Responsive Website Design, JQUERY, File zilla	2.2	6.35	6.67	8.00	6.55	3.16	2.78	5.43
sayantikadas.kol@gmail.com	Photoshp designer, CorelDraw, Flash	5	6.04	9.33	4.00	4.75	5.26	9.44	6.56
chanaka_su@yahoo.com	MS Office,Photoshop, Illustrator, Indesign, Pagemaker, CorelDraw.	7	5.86	10.00	8.00	5.51	3.38	5.33	6.45
ron@villageinternet.ca	Drupal,Linux server,CSS, Hands-on Training,Training,MySQL,E-commerce, Mobile Web Design, Web Designer, Web Developer, Web Design, Web services,Website Development,	15.1	5.77	9.33	6.00	8.58	6.43	5.56	7.18
brucelica@live.com	Dreamweaver, Flash, Photoshop, CSS, HTML, Javascript, PHP ,MySQL, ASP.net ,Access	3	4.92	8.00	8.67	6.86	3.76	7.56	6.97
noorsyamimi_ismailbasha@yahoo.com	C++, PHP,css, Wordpress, Drupal, Photoshop, Dreamweaver,Flash,	2.5	4.71	7.33	5.33	6.67	3.38	4.44	5.43
heinhettmyat@gmail.com	Adobe Photoshop, Illustrator, Java Script, CSS, HTML, Dreamwaver, Flash, PHP	2	4.69	6.67	4.67	3.62	1.50	8.89	5.07
rakesh.shingare17@gmail.com	html, css, flash, photoshop, illustrator, jquery	0.6	4.62	6.00	6.00	5.95	1.95	3.33	4.65
hjls_hx@yahoo.com	SAP ABAP, Cobol, C++, Axapta, Flash,Revelation, Dbase, AS/400	15	4.62	8.67	6.67	8.54	6.39	6.67	7.39
alisha.bhure@gmail.com	HTM:, CSS, Javascript, ASP/C#. Net, MOSS 2007, Sharepoint 2010, Flash, Photoshop, Dreamweaver	2	4.61	8.00	4.67	6.48	3.01	6.89	5.81

Job 7 Skills : Software Testing,Test Analyst,test plan,test cases,Software QA, QA Analyst

CVEmail	CVSkills	Experience	Score_Actual	Score_S G_N	Score_k k_N	Score_Y T_N	Score_N M_N	Score_N J_N	Score_Avg
alumav43@ymail.com	Test Analyst,manual testing.quality center,	11.2	10.00	10.00	10.00	10.00	10.00	10.00	10.00
yogebhatt@gmail.com	Test Analyst,Cisco Networking,Cisco CCNA,IT Technical Consultant,automation,TCL,QTP VB,protocol testing,manual testing,functional testing.	7.7	8.84	9.29	8.18	8.66	9.19	8.89	8.84
akayalvizhieze@gmail.com	software Testing,Functionality Testing,Quality Assurance,Web Testing,Black Box Testing,Regression Testing,Manual Testing,Validate Bug Fixing,Defect Reporting	0.6	6.54	7.86	3.64	5.95	6.21	10.00	6.73
shafwatur@hotmail.com	Support analyst, Network engineering, software, hardware, SQL, Oracle, CCNA, Technical analyst, Business presentation, People management, Sales support Management	2.2	6.49	6.43	4.55	5.42	7.50	7.78	6.33
mohitsaxena255@gmail.com	automation testing, software testing, automation testing, selenium testing, qtp , regression testing, database testing, web tester, white box testing	2.1	6.29	10.00	7.27	6.53	3.88	8.33	7.20
muthukumarca21@gmail.com	C++,Software Engineer,PHP Programming,Test Analyst,	0.4	5.71	7.14	1.82	5.88	6.02	2.78	4.73
bisson@webmail.co.za	SAP ISU,Test Analyst,IT Helpdesk,IT Support Engineer, Customer Service,Desktop support Technician,Microsoft Office,PC Support,Microsoft Word,	5.1	5.46	7.14	5.45	7.67	6.72	9.44	7.29

baankomo@gmail.com	HTML,systems analysis,Programmer,HTML,systems analysis,Programmer,HTML,systems analysis,Programmer,Apprentice IT Administrator,	1.1	5.21	6.43	1.82	5.00	7.50	5.33	5.22
chris_davies_2013@yahoo.com	Test Analyst,Quality Assurance,Linux,Linux Engineer,IT Project Manager,	4.2	5.12	8.57	8.18	7.33	5.87	5.56	7.10
john@johnnince.co.uk	Consultant, Senior Software Engineer, Architect, Technical Lead, Development Lead, Senior Analyst	15	5.04	10.00	6.36	5.73	8.75	7.56	7.68
karen.johnson@arobusops.co.uk	Business Transformation,Change Management, Business Analyst,Analysis, Program Management,Program Director,	10	4.96	9.29	5.45	3.82	8.13	4.44	6.23
gbungay@hotmail.com	C++, Python, SQL, C#, VB .NET, Time Series, Excel, programmer, analyst,manager	10	4.71	10.00	6.36	3.82	8.75	8.89	7.56
franco.arteseros@gmail.com	Virtualization, System Analyst, VMware, Citrix,Analytics,Performance Managemnt,Capacity Planning,	10.1	4.70	9.29	4.55	3.85	6.25	3.33	5.45
abdulrahmandahalan@gmail.com	Software Testing, Team Management, Project Management	6	4.67	7.86	9.09	8.02	7.58	6.67	7.84
jacobus.burger@gmail.com	a+ computer certificate,data recovery,repairing computers,software update,installation of any software	15	4.64	7.86	6.36	5.73	6.25	6.89	6.62

Job 8 Skills : Android developer,Java, core Java,J2EEAndroid developer,Java, core Java,J2EE

CVEmail	CVSkills	Experience	Score_Actual	Score_SG_N	Score_k_N	Score_YT_N	Score_NM_N	Score_NJ_N	Score_Avg
asfinpatel@gmail.com	Android,ASP.NET,Java,J2EE,Java JSP, AJAX,VB.NET,C#,	12.1	10.00	7.37	10.00	10.00	9.98	8.89	9.25
hassan.ashmawy@gmail.com	Programmer, Developer, Java, J2EE, GWT, EJB, Hibernate, Spring, Struts, Oracle Application Server 10g, Oracle WebLogic Server, OBIEE	10.4	7.74	7.37	5.00	9.38	8.77	8.89	7.88
nwosu.uj@gmail.com	Android Developer,Android,Java, Java Developer,SQL,JSON,PHP, PHP Developer,Dreamweaver, jQuery,Database,	8.1	6.52	10.00	6.88	8.53	7.15	10.00	8.51
shadeepti@gmail.com	Java,Java J2EE,Java Software Engineer,JDBC,JSP,JDK,Spring Framework,Java Spring, Java Developer,Ajax,J2EE Technologies,XML,Database,	8.1	6.37	9.47	5.63	5.75	4.76	7.78	6.68
nischaltanna@gmail.com	Java, J2EE, Spring, Hibernate, JPA, JSF, Coherence,	10.5	6.26	8.95	6.25	9.41	8.84	8.33	8.36
rajatsrivastava92@gmail.com	Java, C++, Programmer, Engineer,Java, C++, Programmer, Engineer,Java, C++, Programmer, Engineer,Java, C++, Programmer, Engineer,	1.5	6.04	4.74	5.63	4.44	6.60	2.78	4.84
mr_venkat26@yahoo.com	C, C++, Java, SQL, PL/SQL, Perl, Siebel, siebel CRM,Siebel 7.7 Certified,Siebel EIM , Informatica, Java, UNIX,	8.6	5.31	6.32	5.00	5.94	10.00	9.44	7.34
yogiponn1@gmail.com	c++, C#, Java, .Net, asp.net, Javascript, VC++,	15.1	5.25	7.89	7.50	8.33	8.07	7.56	7.87
anup.sarkar151854@gmail.com	Telecom Engineer,Java, HTML + CSS,JavaScript,Web Services,	12.6	5.10	6.84	6.88	7.41	6.89	5.56	6.71
swamyks@yahoo.com	Java, C++ , C , Unix , Shell scripting, Perl , telecommunication,	15	5.05	7.37	7.50	8.29	8.02	7.56	7.75
munashe@xnine.us	Java, C#, J2EE, PHP, VB, C++, ASP .NET, .NET, HTML, JavaScript, SQL	5	4.97	6.84	3.13	7.39	4.95	5.56	5.57
sxv6633@louisiana.edu	C, C++ ,PHP, Java,J2EE, JSP, Servlets , JDBC, SQL, VRML, X3D, OpenGL, GLUT, GLSL (Shaders), OpenSG,Python, Java Script	4	4.80	7.37	3.75	7.02	4.25	8.89	6.26
adaan.smit@gmail.com	C#,Software Engineer,SQL Server 2008,Java,MySQL, PHP,	15.11	4.68	7.89	7.50	8.33	8.07	6.67	7.69
vikram_rke10@yahoo.com	JAVA,VB,ASP,PHP,HTML, SEO,JAVA,VB,ASP,PHP,Digital marketing	6	4.30	5.26	5.63	4.98	7.55	6.67	6.02
erickson71@yahoo.com	Java Developer,C++ ,JAVA,JDBC,ODBC,REST, Web services, TCP/IP,Linux,RHCE,SiteMinder,Access Management,LDAP,	10.1	4.22	8.42	6.25	6.49	5.71	6.89	6.75

Job 9 Skills: CCNA, MCSE, Network Administrator, System Administrator

CVEmail	CVSkills	Experience	Score_Actual	Score_SG_N	Score_k_N	Score_YT_N	Score_NM_N	Score_NJ_N	Score_Avg
anil.kumar.dutta@gmail.com	Project Management, System Administrator, Network Administrator, DBA	15	10.00	8.82	9.41	10.00	8.95	10.00	9.44
binumulangil@gmail.com	MCP,MCSE,CCNA,MCP,MCSE,CCNA,MCP,MCSE,CCNA,	7.4	7.28	9.41	7.65	7.47	10.00	8.89	8.68
peter.abulencia@gmail.com	Server 2003/2008, IT Support Engineer,MS Access ,Active Directory,VMWare,Networking,System Administrator,Network Administrator,Desktop Support Technician,	10.1	5.95	8.24	7.06	8.37	9.54	10.00	8.64
Khizar@in.com	System Administrator,Network Administrator,Technical Support	5.1	4.63	8.82	5.88	6.70	5.59	7.78	6.96
kaviarassu@gmail.com	Cisco CCNA,Network Administrator,System Administrator,	3.1	4.35	7.06	4.71	6.03	4.02	8.33	6.03
manju.maligi@gmail.com	System Administrator, Network Administrator, System Engineer, Windows Server 2008 / 2003, AD, DNS, DHCP, IIS, Firewall, Router	3.9	4.14	8.24	5.29	6.30	4.65	2.78	5.45
alexander.butkovsky@gmail.com	Network Support Engineer, Network Admin, System Admin, CCNA,	11	3.79	10.00	7.65	6.17	5.12	9.44	7.68
jeff.stone47@gmail.com	Network Administrator, IT support Specialist	10	3.26	7.65	7.06	5.83	4.73	5.33	6.12

joes89@webmail.co.za	A+.2nd Line Service Desk, System Administrator, Network Administrator, Microsoft Word, Microsoft Exchange Server, Information Technology,	2.3	3.17	6.47	3.53	5.77	3.39	5.56	4.94
mare.vijay@outlook.com	ASP.NET, C# Programming, WCF, WPF, MVC, MCSE, CCNA, CCNP,	5.1	3.15	7.65	5.29	6.70	5.59	7.56	6.56
mustafakamal.1981@gmail.com	Microsoft Exchange Server, System Administrator,	11.1	2.84	8.24	7.06	6.20	5.16	4.44	6.22
darrenbrown626@hotmail.com	Systems, Infrastructure, MCSE, IT Management, Server, Networking, Enterprise, Microsoft	15	2.81	8.24	10.00	7.50	6.70	8.89	8.26
sushilg5ss@gmail.com	Windows Server 2008, SAN Administrator, Data centre Implementation, System Administrator,	3.1	2.72	6.47	4.71	3.53	2.01	3.33	4.01
viju.net@rediffmail.com	CCNA, CWNA, MCSE, Routing protocols, RIP, IGRP, EIGRP, OSPF, IS-IS, BGP Network services: DNS, DHCP, IIS, FTP. Operating systems: Windows 98, XP, 7, UNIX Server operating systems: Windows 2003, 2008, WAN technologies: Frame relay, ATM, ISDN, DSL	3.1	2.62	5.88	4.71	6.03	4.02	6.67	5.46
pijadi@gmail.com	C++ Software Developer, Networking, Network Engineer, Network Administrator, Oracle 11g Database Administrator, Systems Engineering, Software Engineer, IT Support Engineer, Support Engineer, Desktop support Technician,	3.1	2.62	7.06	4.12	3.53	2.01	6.89	4.72

Job 10 Skills: MAT LAB, Digital image processing, Communication, Digital signal processing

CVEmail	CVSkills	Experience	Score_Actual	Score_S_G_N	Score_k_k_N	Score_Y_T_N	Score_N_M_N	Score_N_J_N	Score_Avg
eileenhughes1.lh@gmail.com	Honest, Reliable, Data Capturing, Administration, Accuracy, Customer Focused, SAP, Microsoft Office, Telecommunications,	15.4	10.00	10.00	7.78	8.70	8.00	10.00	8.90
swamyks@yahoo.com	Java, C++ , C , Unix , Shell scripting, Perl , telecommunication,	15	9.40	9.17	8.89	8.47	9.00	8.89	8.88
mellowwilpro@gmail.com	Web Designer, Graphic Designer, Marketing Communications, Telecommunications,	2.4	8.80	10.00	3.33	8.32	8.50	10.00	8.03
masedikwelethabo@yahoo.com	admin, Communication, Customer Service, Microsoft Word, Microsoft Office, excel, power point, outlook, internet, Marketing and Sales,	2.3	8.78	7.50	3.33	10.00	7.17	7.78	7.16
salampop@gmail.com	Sharepoint, Systems Administrator, IT Project Manager, ITIL, TELECOMMUNICATION, RFID, AUTOMATION, SYSTEMS DESIGN, IMPLEMENTATION	3.8	8.52	7.50	4.44	7.37	7.90	8.33	7.11
liewjinyean@gmail.com	Marketing, Management, Project Planning, Leadership, Microsoft Word, Microsoft Excel, PowerPoint, Communication,	2.1	8.27	6.67	3.33	9.89	6.83	2.78	5.90
misssto@yahoo.com	Telecommunications, Customer Support, Computer Technician, Time management, Training, Leadership abilities,	10.3	7.80	10.00	6.67	5.82	7.80	9.44	7.95
cooty9979@yahoo.com	Draughting, 3D isometric drawings, Telecommunications, construction drawings, Telecom Engineer, design,	4.1	6.68	6.67	2.22	7.54	6.50	5.33	5.65
ausafislam@yahoo.com	MS OFFICE, IT HELPDESK, IT SUPPORT, SAP BASIS, COMMUNICATION SKILLS	5.7	6.63	8.33	6.67	8.44	8.00	5.56	7.40
mohamedbecha@yahoo.fr	MATLAB, PHP, JAVASCRIPT, HTML, CSS, SQL, VBSCRIPT, VRML	4	6.63	10.00	10.00	7.48	10.00	7.56	9.01
tsshinde9@gmail.com	GT Power, Matlab, Simulink, INCA, Six Sigma, C/C++, MS Office,	2.7	6.25	8.33	8.89	5.01	7.83	4.44	6.90
zeeshan1348m@gmail.com	Core java, J2ee, JDBC, servlets, JSP, C++, MATLAB, ANDROID application	0.6	6.22	6.67	3.33	5.56	4.33	8.89	5.76
chandankumargaba@gmail.com	Networking, CCNA, CCNP, Telecommunications, SS7, GSM,	3.7	6.09	10.00	3.33	7.31	5.20	3.33	5.84
subashni.1985@gmail.com	C, Java, SQL, AS400, PIC, Embedded C, Matlab	2.1	6.09	7.50	3.33	4.67	6.83	6.67	5.80
kps.shelva@gmail.com	MATLAB ,simulink, Visual studio, Electronics engineer	1.7	5.98	6.67	7.78	4.44	6.17	6.89	6.39

Job 11 Skills: Android, IOS, .NET , Xamarin

CVEmail	CVSkills	Experience	Score_Actual	Score_S_G_N	Score_k_k_N	Score_Y_T_N	Score_N_M_N	Score_N_J_N	Score_Avg
asifnpatel@gmail.com	Android, ASP.NET, Java, J2EE, Java JSP, AJAX, VB.NET, C#,	12.1	10.00	9.38	10.00	8.68	8.25	10.00	9.26
bhairu.cse@gmail.com	HTML, HTML5, CSS, CSS3, JavaScript, JQuery, ajax, PHP Programming, Front End Web Developer, magento, phonegap, jquery, mobile application, android, ios	2	8.06	8.75	5.00	7.55	4.68	8.89	6.97
nwsu.uj@gmail.com	Android Developer, Android, Java, Java Developer, SQL, JSON, PHP, PHP Developer, Dreamweaver, JQuery, Database,	8.1	7.93	10.00	8.33	6.91	5.91	10.00	8.23
pawan.litroorkee@gmail.com	Core Java, C++, Android, JQuery, Nosql	5.1	6.33	8.13	6.67	5.58	4.15	7.78	6.46
chitransh141@yahoo.in	Java, Multithreading ,Android	6.8	6.05	8.75	6.67	6.34	5.15	8.33	7.05
urvipathak1090@gmail.com	Java, C++, .NET Java, C++, .NET Java, C++, .NET,	0.3	5.75	7.50	9.17	3.47	4.04	2.78	5.39
rahul.kotak@ymail.com	.net, sql, java, android, c, c++	0.4	5.61	7.50	8.33	6.84	4.81	9.44	7.39
dauren@gmail.com	Python, Java, .NET, C#, Objective-C, Linux	10	5.18	7.50	8.33	7.75	7.02	5.33	7.19
satishghone@gmail.com	java, sql, PL/SQL, .net, android sdk, testing	0.7	5.15	6.25	8.33	3.64	3.58	5.56	5.47

rajarun16@gmail.com	.net,c#.net,Asp.net,Ado.net, sql server 2008	3.5	4.86	6.88	9.17	4.88	3.22	7.56	6.34
yogiponn2@gmail.com	c#, vb.net, C/C++, VC++, C, Java, MVC, .Net, MFC, com/dcom,WCF, WPF,	15.1	4.78	7.50	7.50	10.00	10.00	4.44	7.89
salientsachin308@gmail.com	java,c++,dot net,programmer,android,html,css,c#	1.4	4.59	7.50	8.33	3.95	3.99	8.89	6.53
yogiponn1@gmail.com	c++, C#, Java, .Net, asp.net, Javascript, VC++,	15.1	4.51	6.25	7.50	10.00	10.00	3.33	7.42
nabeelcp@gmail.com	.Net, C#,ASP.NET,ASP.NET MVC, jQuery,JavaScript,WCF,WPF,Enterprise Software,UML, Microsoft SQL Server,Oracle,SSRS,Software Programming,	8.1	4.45	6.88	5.00	6.91	5.91	6.67	6.27
sreenu.malladi@gmail.com	Android ,J2me , Java , Html , Xml	2	4.45	6.88	5.00	4.22	4.34	6.89	5.46

Job 12 Skills: SEO Executive, Internet Marketing, Ecommerce Manager, Search Engine Ranking Optimization, PPC, Affiliating marketing, link building, search engine marketing, social media optimization, pay per click

CVEmail	CVSkills	Experience	Score_Actual	Score_SG_N	Score_k_N	Score_YT_N	Score_NM_N	Score_NJ_N	Score_Avg
baldev.sharma88@gmail.com	Digital Marketing,SEO,E-commerce SEO,IT Project Manager,IT Technical Consultant, Online Marketing,Social Media Marketing,Social Media Expert,	6.1	10.00	10.00	10.00	10.00	8.75	7.06	9.16
hiteshmakwana15@yahoo.com	Onpage Optimization, SEO, Off page Optimization, SEO Analyticities, Link Exchange, Social Bookmarking,Wordpress,Blogger, Article Submissions, Digital marketing, Directory Submission, Key Word Research, Google analytics, Google webmaster tools, Social Media Optimization	1.4	8.07	5.88	6.15	7.81	5.45	9.41	6.94
shamim9026@gmail.com	Social Media,SEO,PPC,Onpage ,Off Page,Affiliate Marketing,	5.8	6.69	8.24	7.69	9.90	10.00	8.24	8.81
krishnawillb@gmail.com	Web Research, Market Research, Lead Generation,SEO,Digital marketing	4.9	6.23	7.65	6.15	9.29	8.75	8.24	8.01
ankit07sharma@gmail.com	Content Writer,Search Engine Optimization,Sub Editor,Copy Writer,SEO,	1.8	5.73	6.47	2.31	7.86	8.75	8.82	6.84
manish143al@gmail.com	SEO,SMO,PPC, Reputation Mgt., HTML, Digital Marketing	1	4.83	5.29	3.85	7.62	4.81	2.94	4.90
s_amjad_amir@yahoo.com	web designer,desktop support engineer ,seo,web designer,desktop support engineer ,seo,web designer,desktop support engineer ,seo,	0.1	4.56	4.71	1.54	4.71	7.50	10.00	5.69
vikram_rke10@yahoo.com	JAVA,VB,ASP,PHP,HTML, SEO,JAVA,VB,ASP,PHP,Digital marketing	6	4.17	8.24	3.85	2.86	8.75	6.47	6.03
s.riaz.mahmud@gmail.com	Secretary, Admin Clerk, Online Marketing, Telemarketing,Creative Direction, business communication, Computer,Advertising,	2.1	4.16	5.29	3.08	3.86	6.25	5.88	4.87
akshaymangla786@gmail.com	blogging, online marketing, seo	0.1	3.35	4.12	2.31	2.86	7.88	8.00	5.03
ljay_1801@yahoo.com	SQL,UNIX,Engineering,IT Service Management,IT Technical Consultant,System Engineer,Telecom Engineer,Network Engineer,Support Engineer,IT Project System Engineer,	2.4	3.32	4.71	1.54	4.00	8.50	4.71	4.69
dionne@evione-connect.co.za	IT Support Engineer,Linux server, Web Design,Cloud Computing,Windows Server,Windows,Linux Engineer,Linux Networking, Networking, TCP/IP, Computer Technician,	15	3.31	7.06	3.85	2.86	7.00	9.41	6.03
bsamy2003@gmail.com	Web Designer, Web Developer, Database Solutions, SEO,Web Security,Responsive Web Design,E Commerce ,	5.4	3.10	7.06	3.08	6.43	8.13	7.06	6.35
shukrisaleh@yahoo.com	Computer Hardware/Software, Marketing, Training and Development, Sales and service.	14	3.03	7.65	5.38	5.00	8.13	7.06	6.64
mhsq_71@yahoo.com	Marketing, Sales,Channel Development,Retails and Corporate Sales,	14.7	2.86	8.82	3.08	3.57	8.13	7.29	6.18

Job 13 Skills: UI, User Interface, User Interface Design,User Interface Design, HTML, CSS, HTML5, Javascript libraries, jQuery

CVEmail	CVSkills	Experience	Score_Actual	Score_SG_N	Score_k_N	Score_YT_N	Score_NM_N	Score_NJ_N	Score_Avg
islavath.nagaraju@gmail.com	HTML, css,html5,css3,java script, jquery,Responsive Web Design,android, ui,	2.8	10.00	6.00	6.67	9.14	8.79	8.89	7.90
bhairu.cse@gmail.com	HTML,HTML5,CSS,CSS3,JavaScript,JQuery,ajax,PHP Programming,Front End Web Developer,magento,phonegap,jquery, mobile application,android ,ios	2	9.52	6.67	6.67	7.14	7.33	8.89	7.34
nizam.taha@gmail.com	PHP, HTML, DHTML, JavaScript, AJAX, CSS, ASP, JAVA, C, C++, VBScript, MS Visual Basic 6.0, MySQL, MS Access, SQL Server, Flash,	10	9.37	8.67	8.33	10.00	8.79	10.00	9.16
perashantku89@gmail.com	LOGO DESIGN, BANNER DESIGN,Newsletter,slicing, PHOTOSHOP,ILLUSTRATOR,CORAL DRAW,FLASH, DREAMWEAVER, CSS,CSS3 ,HTML,HTML5 , Responsive Website Design, JQUERY, File zilla	2.2	9.31	9.33	5.83	7.29	6.15	7.78	7.28

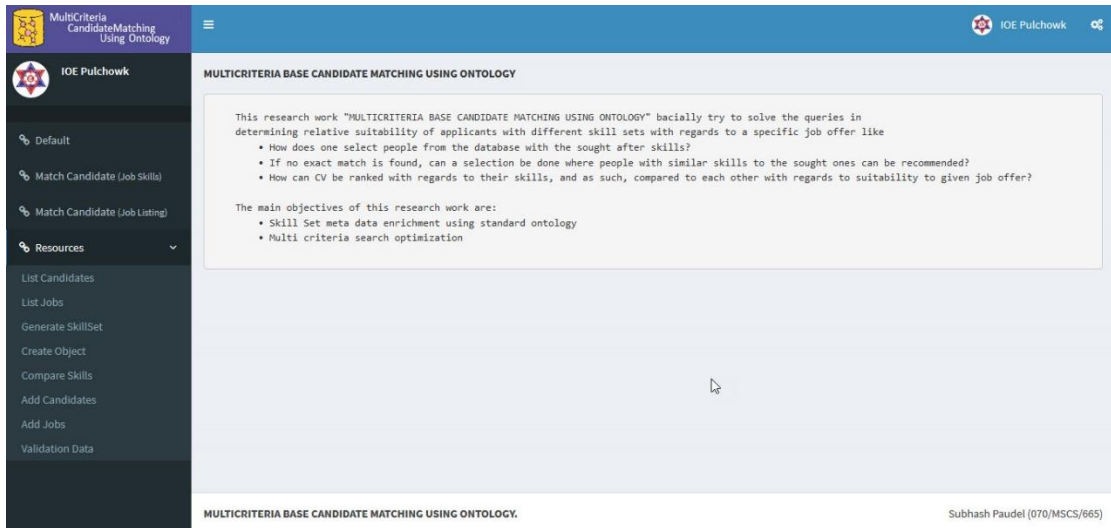
suneel.vanka@gmail.com	.Net ,ASP.NET, MVC, jQuery,angular js, C#, Web Developer,WCF,web API, Microsoft SQL Server,SQL Server 2008, HTML5, CSS,CSS3,ASP.Net Programming,jquery asp net, Web services,	6	8.94	8.00	8.33	8.57	8.79	8.33	8.41
vimala.supriya87@gmail.com	C,C++, HTML ,Software,	7.1	8.93	8.67	4.17	6.50	10.00	9.44	7.76
engr_nadeem786@yahoo.com	HTML, HTML5, CSS, JavaScript, jQuery, Java, OOP, Servlet, AJAX,	3	8.62	5.33	5.83	7.86	7.33	9.44	7.16
alwar.shankar@gmail.com	HTML, Css, Responsive Design, Bootstrap, jQuery, Javascript	6	8.51	10.00	10.00	8.57	8.79	5.33	8.54
web@ip-design.ca	Dreamweaver, XHTML, HTML, HTML5, CSS, CSS3, Javascript, Photoshop, Indesign, Illustrator, Flash, Acrobat, Graphic design, Web design, Responsive design, Creativity, Scanning, Photography, Studio setting, Large format photography, Social media, facebook, twitter, Instagram, Pinterest, Tumblr, Microsoft word, Excel, Outlook, Powerpoint, Mac, PC, Leadership, detail oriented, Visual arts, painting,	1.2	8.44	8.67	1.67	5.14	3.52	5.56	4.91
binolala@gmail.com	JAVA, PHP,HTML, DHTML, CSS, C++,C.VB,JOOMLA, DRUPAL, WORDPRESS, AJAX, JAVASCRIPT, JQUERY, SQL, PL/SQL, MYSQL, SQLSERVER	5	8.36	8.00	6.67	7.86	7.69	6.44	7.33
sindhup515@gmail.com	PHP,MySQL,Codeigniter,MVC,Word press,CMS,Jsquery,JavaScript,Ajax,HTML,CSS	5.5	7.98	8.00	6.67	8.21	8.24	4.44	7.11
saleemcse@gmail.com	ASP.Net, Ado.Net, AJAX, JavaScript, WCF,Web Services, XML, HTML,XHTML, CSS, JQuery, Crystal Report	2.3	7.75	6.00	5.83	5.93	4.73	8.89	6.28
appmaker82@gmail.com	C# .Net Software Developer, C#, User Interface Design, User Interface,User Experience,JavaScript, Microsoft SQL Server,	1.5	7.66	6.00	3.33	3.93	3.85	6.67	4.75
work.thapa.hims@gmail.com	HTML,HTML5,CSS,CSS3,JavaScript,JQuery,Photoshop,	0.6	7.56	6.67	1.67	6.14	3.81	6.67	4.99
gayatri.akki@gmail.com	Sql server .net , MVC, JQuery , CSS, HTML,MS ACcess	5	7.55	6.00	5.00	7.86	7.69	7.78	6.87

Job 14 Skills : C#, .NET, Mysql, XML, AWS,

CVEmail	CVSkills	Expe rience	Score Actual	Score_S G_N	Score_k k_N	Score_Y T_N	Score_N M_N	Score_N J_N	Score_A vg
yogiponn1@gmail.com	c++, C#, Java, .Net, asp.net, Javascript, VC++,	15.1	10.00	8.82	10.00	10.00	9.99	8.89	9.54
dauren@gmail.com	Python, Java, .NET, C#, Objective-C, Linux	10	9.86	8.24	8.46	7.75	7.01	10.00	8.29
adaan.smit@gmail.com	C#,Software Engineer,SQL Server 2008,Java,MySQL, PHP,	15.11	9.21	10.00	10.00	10.00	10.00	9.44	9.89
coreyschristian@gmail.com	SQL,C#, .NET,LINQ, ASP.NET,Microsoft Office,HTML,SCRUM,Database Design,Microsoft SQL Server,ASP.NET MVC,MySQL,Java,XML,SSRS,Software Development,Database Administration,CSS,	2	9	6.47	2.31	7.55	4.68	7.78	5.76
balavsts@gmail.com	VSTS automation testing,C#,ASAP.NET,XML,SqlServer,WCF	9.9	8.67	7.65	7.69	7.70	6.95	8.33	7.67
yogiponn2@gmail.com	c#, vb.net, C/C++, VC++, C, Java, MVC, .Net, MFC, com/dcom,WCF, WPF,	15.1	8.24	8.24	10.00	10.00	9.99	7.22	9.09
munashe@xnine.us	Java, C#, J2EE, PHP, VB, C++, ASP .NET, .NET, HTML, JavaScript, SQL	5	8.21	6.47	6.15	5.54	4.09	9.44	6.34
asifnpatel@gmail.com	Android,ASP.NET,Java,J2EE,Java JSP, AJAX,VB.NET,C#,	12.1	7.32	8.24	7.69	7.01	4.12	6.11	6.63
vidyadanam100@gmail.com	ASP.NET,C#,VB6,VB.NET,SQL SERVER,JQUERY,XML,HTML	3.9	7.25	7.06	6.15	5.05	3.45	5.56	5.45
gbungay@hotmail.com	C++, Python, SQL, C#, VB .NET, Time Series, Excel, programmer, analyst,manager	10	6.89	8.24	7.69	6.08	3.51	9.44	6.99
linux.admin@rjbutler.com	Linux Administration,Red Hat Linux, VMware,KVM,Docker,OpenStack,AWS,Google Cloud,DevOps, System Engineer,Attention to Detail,Well Organized,Self Motivated,Strong Analytical Skills,Excellent Relationship Skills,	15	6.82	7.65	8.46	8.28	4.97	4.44	6.76
nabeelcp@gmail.com	.Net, C#,ASP.NET,ASP.NET MVC, jQuery,JavaScript,WCF,WPF,Enterprise Software,UML, Microsoft SQL Server,Oracle,SSRS,Software Programming,	8.1	5.96	7.06	6.92	6.91	5.90	8.89	7.14
ptirtha@hotmail.com	Maths, Quant, C++, VC++, GMAT, CAT, Programmer, Technical Architect, C#, .Net, SDET	14.2	5.87	8.82	5.38	9.60	9.47	7.78	8.21
sreejayanravindran@yahoo.co.uk	asp.net,c#,sql server,vb.net,mvc,tridion	10	5.54	8.82	7.69	6.08	3.51	6.67	6.55
suneel.vanka@gmail.com	.Net ,ASP.NET, MVC, jQuery,angular js, C#, Web Developer,WCF,web API, Microsoft SQL Server,SQL Server 2008, HTML5, CSS,CSS3,ASP.Net Programming,jquery asp net, Web services,	6	5.54	8.24	6.92	5.98	4.68	6.67	6.50

Annex III: Screenshots

The initial user interface of the system



The following figures shows the user interface where the candidate can provide some initial personal information and add skills to be added and the employer can provide their basic information and job description with required skills.

Add Job Add New Job

Enter the Job Data

Company Name	<input type="text" value="Enter Company Name"/>	
Company Email	<input type="text" value="Enter email"/>	
Company Address	<input type="text" value="Jwagal-10,Lalitpur"/>	
Company Phone	<input type="text" value="Enter Phone No"/>	Minimum 7 Numbers
Company Website	<input type="text" value="Enter Website"/>	
Job URL	<input type="text" value="Your Job Uri"/>	
Job Title	<input type="text" value="Job Title"/>	
Salary	<input type="text" value="Salary"/>	
Key Skills Required	<input type="text" value="eg. Java"/> <input type="button" value="+ Add Skill"/>	
Job Skills	<input type="text"/>	
Job Description	<p>If you copy paste from Microsoft Word bullet point changed to ?(Replace ? to •)</p> <div style="border: 1px solid #ccc; height: 100px; width: 100%;"></div>	
<input type="button" value="Submit"/>		

Add CV Add New CV

Enter the CV Data

Candidate Name

Candidate Email

Candidate Address

Candidate Phone

Minimum 7 Numbers

Candidate Designation

Candidate Experience

Gender

Key Skills

+ Add Skill

Skills

CV Description

If you copy paste from Microsoft Word bullet point changed to ?(Replace ? to •)

Submit

The skill object creation is done using the following user interface where the skill object of jobs or CVs by selecting from the SQL database or excel file can be generated.

Create skill Object create candidate or job object from skillset of the candidates or jobs

Select Excel File or Database

Select Excel or Database

No file selected.

Display Data Only

JSON Object

```
{
  "marunbhatia@gmail.com": [
    {
      "uri": "Main Term Siebel Administrator",
      "NameVal": "Siebel Administrator",
      "Weight": 100.0
    },
    {
      "uri": "Main Term siebel",
      "NameVal": "siebel",
      "Weight": 100.0
    },
    {
      "uri": "Main Term CRM",
      "NameVal": "CRM",
      "Weight": 100.0
    },
    {
      "uri": "Main Term OBIEE",
      "NameVal": "OBIEE",
      "Weight": 100.0
    },
    {
      "uri": "Main Term AIX",
      "NameVal": "AIX",
      "Weight": 100.0
    },
    {
      "uri": "Main Term Oracle",
      "NameVal": "Oracle",
      "Weight": 100.0
    },
    {
      "uri": "http://data.europa.eu/esco/skill/22360",
      "NameVal": "Siebel CRM Desktop"
    }
  ]
}
```

The results are generated using the following user interface where the jobs which are already in the database can be chosen or the job criteria and search for the suitable candidate can be entered. The generated result gives the ranked list of candidates and the similarity score calculated by the system.

Matching matching skillsets of the candidate according to job skillsets

Enter Job Skills And Experience

Enter Skills:

Enter Experience:

[Proceed](#) [Basic Information](#)

1F3A8JQ:ASP.net, C#, XML, Ajax, SQL Server, Oracle, SDLC,ASP.net, C#, XML,

Matching Candidate List

Rank	CVEmail	CVskills	Experiences	Score	ValidationScore
1	nabeelcp@gmail.com	.Net, C#,ASP.NET,ASP.NET MVC, jQuery,JavaScript,WCF,WPF,Enterprise Software,UML, Microsoft SQL Server,Oracle,SSRS,Software Programming,	8 Years 1 Months	10.00	9.258
2	balavsts@gmail.com	VSTS automation testing,C#,ASAP.NET,XML,SqlServer,WCF	9 Years 9 Months	09.85	7.98
3	yogiponn1@gmail.com	c++, C#, Java, .Net, asp.net, Javascript, VC++,	15 Years 1 Months	09.27	9.384
4	asifpatel@gmail.com	Android,ASP.NET,Java,J2EE,Java JSP, AJAX,VB.NET,C#,	12 Years 1 Months	09.12	8.932
5	vidyadanam100@gmail.com	ASP.NET,C#,VB6,VB.NET,SQL SERVER,JQUERY,XML,HTML	3 Years 9 Months	08.88	6.144
6	chowdhury_mainak@rediffmail.com	ASP.NET, MVC, C#, SQL Server, Project Lead, Team Lead	9 Years 2 Months	08.51	7.626
7	suneel.vanka@gmail.com	.Net ,ASP.NET, MVC, jQuery,angular js, C#, Web Developer,WCF,web API, Microsoft SQL Server,SQL Server 2008, HTML5, CSS,CSS3,ASP.Net Programming,jquery asp net, Web services,	6 Years 0 Months	08.30	6.606
8	kiran_kjp@yahoo.co.in	Asp.net,C#,Sql server,Crystal Reports,Mvc,SSRS,Ajax,Javascript,jquery	5 Years 3 Months	07.65	6.412
9	sreejayanravindran@yahoo.co.uk	asp.net,c#,sql server,vb.net,mvc,tridion	10 Years 0 Months	07.59	7.852
10	danny@danznet.co.uk	C#,AngularJs,VB.Net, Microsoft SQL Server,Oracle,MVC,ASP.Net,Javascript,Crystal Reports,Programmer, .Net Programming,Web Api,	8 Years 1 Months	07.37	8.41

Showing 1 to 10 of 15 entries

Matching matching skillsets of the candidate according to job skillsets

Enter Job Skills

Enter Skills:

asp.net,c#,sql server

Enter Experience:

Any

Proceed

Basic Information

Matching Candidate List

Show 10 entries

Search:

Rank	CVEmail	CVSkills	Experience	Score
1	sreejayanravindran@yahoo.co.uk	asp.net,c#,sql server,vb.net,mvc,tridion	10 Years 0 Months	10.00
2	yogiponn1@gmail.com	c++, C#, Java, .Net, asp.net, Javascript, VC++,	15 Years 1 Months	05.76
3	suneel.vanka@gmail.com	.Net ,ASP.NET, MVC, JQuery,angular js, C#, Web Developer,WCF,web API, Microsoft SQL Server,SQL Server 2008, HTML5, CSS,CSS3,ASP.Net Programming,jquery asp net, Web services,	6 Years 0 Months	04.84
4	nabeelcp@gmail.com	.Net, C#,ASP.NET,ASP.NET MVC, JQuery,JavaScript,WCF,WPF,Enterprise Software,UML, Microsoft SQL Server,Oracle,SSRS,Software Programming,	8 Years 1 Months	04.40
5	yogiponn2@gmail.com	c#, vb.net, C/C++, VC++, C, Java, MVC, .Net, MFC, com/dcom,WCF, WPF,	15 Years 1 Months	04.13
6	ashok.bhardwaj82@gmail.com	asp.net,c#,sqlserver2008,Linq,Crystal Report	3 Years 0 Months	04.00
7	kanchansingh1123@gmail.com	asp.net, c#, vb.net, ajax tool , html , sql server 2005,2008	1 Years 5 Months	03.92
8	megha.dave@gmail.com	ASP.NET, C#, VB.NET, SQL Server, Software engineer, web developer, speech server	4 Years 5 Months	03.88
9	navin.goradara@gmail.com	c,c++,C#,vb,SQL Server 2008,asp.net,	3 Years 1 Months	03.84
10	chowdhury_mainak@rediffmail.com	ASP.NET, MVC, C#, SQL Server, Project Lead, Team Lead	9 Years 2 Months	03.79

Showing 1 to 10 of 15 entries

Previous 1 2 Next

The following figure gives the candidate list of the system

Candidate List Total Candidates

Candidate List

Show 10 entries Search:

Candidate Id	Email	Designation	Skills	Experience	Name	Gender
lclQbiEK3t	roearthur@gmail.com	Infrastructure Manager/ IT Manager	IT Management, Desktop Support, Risk Management, Project Management, Oracle, Unix, JD Edwards, Windows Server Support 2000/2003	15 years 0 months	Arthur Roe	
OccVTxmuki	oksnkwane@yahoo.com	Networks	Networks, C++, Java,VB,Project Management, Database, Web Development	1 years 6 months	Ofentse Koos Samuel Nkwane	Male
MXVzEXwNDS	rohit.patel50@gmail.com		MS-Office, Pagemaker, Photoshop, Tally, Internet, HTML	8 years 0 months	Rohit Patel	
dedpEaEiTh	amandeep.cheema05@gmail.com	senior software engineer	java,HTML, XML, JavaScript, JSP 2.0, Struts 2.0, Spring 2.5, JDBC, IBatis 2.3, EJB 2.0, MDB, JMS 1.1, IBM MQ 6.0	3 years 4 months	Aman Sidhu	
lO8lC8wnOX	tag.mofokeng@yahoo.com	Web Developer	IT Technician, Photoshop, Html, C#, ASP.net	3 years 2 months	Thabo Mofokeng	
q0TE6zNQLc	makhudu.isaiah@webmail.co.za	IT Support	IT Support, Hardware and Software, SQL,pl/sql,ORACLE 9i, vb.net, Business analyst	0 years 7 months	makhudu isaiah	
P8jhxFO05W	isuhel.a@gmail.com		Asp.Net, C#, MS SQL Server, Ajax, XML,	0 years 8 months	Suhel Akhtar	
lOHBfsgNS	lekshmysangi@gmail.com	System Engineer	System Engineer, Networking, MCITP, JAVA, ORACLE, SQL, HTML	1 years 0 months	Lekshmy Sangeeth	
5kUK7z1o3q	shravanthumula@gmail.com	Software Developer	C#.Net, ASP.NET, SQL Server, HTML, Javascript, MS-Office.	1 years 2 months	Shravan Thumula	
KWfrA8mGVT	john@johnince.co.uk	Software Development	Consultant, Senior Software Engineer, Architect, Technical Lead, Development Lead, Senior Analyst	15 years 0 months	John Ince	

Showing 1 to 10 of 1,064 entries

Previous 1 2 3 4 5 ... 107 Next

The following figure gives the job list of the system

Job List Total Jobs

Job List

Show entries Search:

Job ID	Job Title	Skills	Employer ID	Salary	Town	Country	Address
5ROVLWE	Network Administrator	CCNA, MCSE, Network Administrator, System Administrator,	pGqqbpfRMu	60000 TO 300000	CHANDIGARH	Intersoft Professional	
BB0X67S	OPENING FOR PHP PROGRAMMERS	PHP, MY SQL, JOOMLA , OSCOMMERCE, OPENSOURCE, CMS, DRUPAL , MAGENTO , CAKE PHP, ZEND, DEVELOPER, PHP PROGRAMMER, WEBSITE DEVELOPER, SOFTWARE ENGINEER	l6le0JKzYl	As per company norms	OKHLA	MJS Communications LLP	CUG-1E & 1F, First Floor , Jumbo House, 15 Ishwar Nagar, Dr. Jha Marg, Okhla, New Delhi-110020
CE1EBZ3	PHP	core php,html,jquery,cake php, c++,open cart,	cAsv2FgKvx	10k to 12k	mohali	Euclide software solutions	
0YGZFCG	PHP Developer	PHP, Wordpress, HTML, CSS, Javascript	Mr7EXcE7J0		Ahmedabad	Inventive Softech Pvt Ltd	
BPH0KIC	PHP Developer	Codeigniter, HTML, Bootstrap, Photoshop, PHP CNC, Coding ,	2kSNV1RWel		Trivandrum	Hindustan HR Solutions	
EPIGSCZ	PHP Developer	Core PHP, E-commerce Expert, Joomla	5SkXVqUxmR	7k-25k	Noida	NSG System Pvt. Ltd.	Noida Sector 7, D12
8HGXF6W	PHP Developer - 0 to 1 year Experience	PHP, MySQL, Ajax, JQuery, Javascript, HTML, CSS,	RkT7JKBvbr		Adambakkam	Victory Visions Software Development Pvt Limited	
EP6VG6U	PHP Developer at Surya Web Solutions	PHP Developer ,MySQL JavaScript, HTML + CSS,WordPress, Joomla,PHP,	fHplCpf7zz		Mumbai	Surya Web Solutions	
DEADE8R	PHP Software Developer Job In Delhi/NCR	Advance, Java, Testing, CSS, JQuery, HTML,DHTML, C, VB.net, Oracle, Flash, Photoshop,Web Development	OmRGhqGb2v		Delhi	Today Life Style	Delhi
E0FUNJY	Platform Architect	MCSE Server Infrastructure,Cloud Computing,ProLiant,CompTIA Server,Virtualization, VMware,Hyper-V,Cisco Datacenter, Windows,Solaris, Linux,Disaster Recovery,Oracle,MCSE SQL, Microsoft SQL Server,	57bQkKmxYX		Doha	GTS Corporate	

Showing 41 to 50 of 118 entries

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[...](#)
[4](#)
[5](#)
[6](#)
[...](#)
[12](#)
[Next](#)

This figure shows the entry for validation data from the evaluators

Validation Data Validation Data for cv ranking

Select Excel File No file selected.

Validated By

Validation Data

Show 10 entries
Search:

JobID	CandidateEmail	Kumar	Narendra	Nish	Sudeep	Yogendra
0WJ36TQ	fanus@pinsoftstudios.com	6.67	10	10	10	9.22
0WJ36TQ	saravananmalikaraj@gmail.com	3.33	4.87	6.15	8.24	7.86
0WJ36TQ	binolala@gmail.com	4.67	5.8	6.62	8.82	8.87
0WJ36TQ	sindhuphp515@gmail.com	6	6.21	5.38	9.41	7.43
0WJ36TQ	im.mohammadali@gmail.com	3.33	3.48	4.62	7.65	7.64
0WJ36TQ	adaan.smit@gmail.com	6	7.08	8.46	7.65	10
0WJ36TQ	aryakrishnan172@gmail.com	6.67	5.59	4.62	8.24	6.42
0WJ36TQ	ron@villageinternet.ca	10	7.08	8.46	8.24	10
0WJ36TQ	raamkumar.m23@gmail.com	3.33	3.11	4.62	7.06	6.32
0WJ36TQ	raheelwp@gmail.com	3.6	3.31	4.92	7.06	7.55

Showing 1 to 10 of 210 entries