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FRAMEWORK DESIGN OF AN INTEGRATED MULTIAGENT EXPERT SYSTEM FOR SAUDI EMPLOYMENT

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Abstract

This study schemes an expert system framework for a very large scale integrated Saudi employment system. It aims to discover, evaluate, develop and match the skills of Saudi youth with the labor market prerequisite. The proposed design comprises one system integration unit (SIU) and four major agents. The SIU guarantees system integrity, monitors and adjusts its operation. The skill discovery agent determines the academic and behavioral skills of individuals. The skill evaluation agent assesses the skills based on custom and standard tests then proposes a custom training program. The skill development agent upgrades the skills based on the suggested training program. Finally, the matching agent nominates and follows up the optimum job for certified individuals. The detailed design of the full system concerning input, tasks and outputs as well as a comparison with the existing related systems are presented. Recommendations to implement the proposed system are also discussed.

Introduction

The vision of this study emerged from the recent priorities of Saudi Arabia's developmental programs that include youth issues and development, particularly the "unemployment" problem. According to labor force survey bulletin, Saudi unemployment reached an average of 11.7%, according. Despite of governmental and civil efforts, solutions still partial, fragmented and temporary. Hence, they suffer a gap in the integration and compatibility. Furthermore, because of the wide domain of the problem, there is no single integrated system to measure the quality and continuity of such solutions.

This study is motivated to design a framework for an integrated Saudi employment system. It employs the capabilities of computer systems (speed, accuracy and storage) as well as artificial intelligent expert systems. The significant goal is to design a framework for an information expert system to: discover, evaluate, develop and match the skills of Saudi youth with the labor market requirements.

This work flow proceeds with five stages:

1. Review and configure the issue of unemployment from a technical and informational point of view. The reports of the Saudi ministry of labor as the competent authority are considered. The contributions of traditional studies in this field including: governmental, academic and private sector studies are supportive
2. Characterize the elements of proposed expert system by studying and comparing the dynamics of available corresponding sub-systems concerned with: diagnosis, evaluation and development of human skills. In addition to those systems related to human resources and operational management
3. System analysis to adopt the best design method(s) considering the consistency of social and cultural dimensions of the Saudi labor market
4. Design the proposed system major components: skills evaluation, employment counselor, and skill development agents as well as databases and knowledgebase
5. Discuss and compare the final proposed design to assess the results.

Background

The nature of this study requires coupled backgrounds. In the following subsections, the unemployment problem and the application of the proposed expert system design as a solution framework are declared.

A. Review of unemployment in Saudi Arabia

As defined by the international labor organization, unemployed people are those without work and actively seeking work [1]. The major four types of unemployment are [2]: **involuntary** unemployment occurs when workers are prepared to work at the going wage rate but cannot find jobs; **voluntary** unemployment is a situation when a person is unemployed because of not being able to find employment of his/her own choice; **seasonal** unemployment occurs when there is limited need for a specific type of work to be performed during certain times of the year; and **covered** unemployment is the unemployment of potential workers that is not reflected in official unemployment statistics, due to the way the statistics are collected.

Causes of unemployment in SA can be briefed as: **state intervention** in the normal functioning of the free market

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especially to ensure a minimum wage; **reluctance of investors** from investing if production do not lead to enough profit that meets their aspirations; **population growth**, although in most cases, it is a national treasure that should be exploited and utilized; and **continued increase in machining**, which usually leads to downsize.

According to official statistical studies it is clear that the main causes of unemployment in the Saudi society relate to: the lack of central labor market information; the mismatch between educational outcomes and market needs; and high productivity and quality rates of expats with low payment in contrary with locals. While most relevant traditional solutions proposed: train Saudi youth to raise their productivity; improve education curricula and training programs; consult the private sector in "Saudization" programs; raising awareness to correct the incorrect perception of some jobs via public media; and create joint committees between the ministry of labor, the private sector, and higher education institutions to address the labor market. Furthermore, according to the Saudi 49th statistical yearbook [3], unemployment rate for Saudis reached 11.7% higher than the globally accepted rate (~5%). This reinforces the need for studies and solutions to reach the global average or less. While, most of the unemployed belong to age group 20 to 24 years which is an ideal category that has sufficient time to develop their skills. The highest unemployment rate (48.2%) is among those with higher education which is the ideal category to accommodate technology and able to learn new skills. About one-third of workers are employed in service activities. However, important activities such as: information and communication, financial and insurance activities, and administrative and support services rates about 5% which can be increased through high-quality training programs.

The present proposed system design includes these significant statistics to frame a part of its criteria.

B. Review of expert systems concerned with this study

Emerging information technologies allow us to build transformative cyber-infrastructures [4]. Characterized by broadband networks, high performance processors, multi-user computation facilities, and super-large databases, these novel technologies have facilitated expansive collaboration among users scattered across many physical and institutional locations. As such, unemployment solutions, in which dispersed users (government, job seekers, training centers, and recruitment companies) cooperatively work towards a common goal should significantly be benefited from the new development of these technologies.

Computer-based expert systems solve real problems which normally would require a human expert [5]. The human expertise may be in short supply, expensive, and hard to get hold, while an expert system may be made easily available on demand. Expert systems are designed to mimic what a human expert knows. A classical expert system represents its knowledge in the form of production rules. A production rule is a small executable program segment that consists of a set of conditions and a set of actions. For a rule to be considered applicable in a given situation, all of its conditions must be satisfied If the rule is applicable, then its set of actions may be executed. Thus a production rule is basically similar to an IF-THEN statement in a typical programming language.

This knowledge is used by the program's inference and control structure. Such structure determines which rules are appropriate in a given situation, resolves conflicts among rules, and executes the action portion of the appropriate rule. Conflict arises when the conditions of several different rules and/or constraints has to be satisfied. Such conflicts can be handled by defining two types of constraints hard and soft. The first must be satisfied (i.e. they cannot be violated) while the second are preferably satisfied, but may be relaxed if necessary.

This subsection focuses on revising and selecting innovative methodologies that would lead to an efficient design of the present proposed system. It concerns with four categories of previous related literature directed to discover, evaluate, develop and match the skills of a person with the labor market requirements.

An expert system for diagnosing intuitive skills was modeled by Jedrzejczyk et. al. [6]. The study started by a quick survey managed to get information on the general skills. Then it is followed by a more specific survey. Next, it constructed a knowledge base in a principle of graphic representation decision tree. The conclusion is reached by answering the questions successively asked by the system according to the paths on the decision tree. Such method would be applied to survey other skills. In a related study, Labate et. al. [7] integrated neural networks and expert systems to analyze corporate databases. In this application, a neural network is trained to discover patterns of information in an employee database, and an expert system component combines those results with a rule-based analysis to recommend staffing for projects. The study concluded to connect the employee's name and the symbol of skill in the database. This hybrid technique creates the potential for systems that are more powerful than ones using either of the techniques alone.

Concerning skill evaluation, Breakey et. al. [8] adopted a dynamic evaluation system (DAS). In DAS the expert system presents many questions for the user based on his/her responses to previous questions in the evaluation session. The fundamental idea is that the individual responses to previous questions are often a good indicator to formulate and ask the following question. This evaluation approach leads to explore deeper than the user knowledge. Thus,

determines the level of accuracy skills in a particular area and the potential of the individual to learn within the scope of the problem related to training needs. The study also concluded that DAS would reduce users' failure rate down to 5%, compared with fixed-content pencil-and-paper evaluation. Otero [9] developed a layered structure of a fuzzy logic scheme that models personnel capabilities as imprecise parameters. The layered structure is adaptable with the sub-context of other layers and sub-components can be customized for each layer without significant changes in the structure of the system. This approach provides decision makers the flexibility to add/delete/edit any layer when needed. This present work modifies these results to include an adaptive evaluation as well as modulation of each unit of the proposed system.

Regarding skill development, Aggarwal [10] confirmed that intelligent systems offer personalized training taking into account the circumstances, capabilities and reediness of the trainee. Meaning that, the learner can adjust the educational material in accordance with his/her responses within a diversity of teaching methods, exercises and examples. This technique provides a unlimited experience of interactions between the learner and the skill under development. Other studies [11,12,13,14] indicate the need to use intelligent systems environments for low and middle-capability trainees. Three ways to use such expert systems were illustrated in a book by Grabinger et. al. [15]. These are: gain training support, training decision-making, and supporting training purposes. Every chapter of this book lists training activities to facilitate and standardize their practice as much as possible.

Finally, the selection process of recruitment and/or job rotation was interesting to Mehrabad [16]. He followed three goals: selection, appointment, and salary determination. His expert system model was able to provide flexibility in the knowledge base as well as to explain the reasons for the decisions of appointing an employee. In a related context, Hajiha et. al. [17] contributed that the outputs of the hiring expert system agent would lead to modify the job requirements itself and design systems for performance evaluation. Also, the behavioral characteristics have been identified in the model.

Proposed System Architecture

Based on the previous reviews, this section sketches a clear vision of the most important characteristics that must be met by the proposed expert system design of this study, Figure 1. First, the structural layers of the expert sub-system (agents) need to be flexibly characterized without affecting other layers. Second, the skill discovery agent should include mental and behavioral capabilities. It has to be able to connect employee's identity with the symbol(s) of the skill(s) in the "skills list" database. Third, determines the individual's susceptibility to learn within the scope of the problem related to its training needs, through good assessment of the real skill level. Fourth, the design of the training agent should consider that it will be extensively used by low and medium capability trainees. Additionally, the outputs should assist to gain training support, training decision-making, and supporting training purposes. Finally, the skill matching agent should provide flexibility in the knowledge base and ability to explain the reasons for matching certain individual to a specific job. Besides, the agent ought to use its outputs to modify the jobs' requirements.

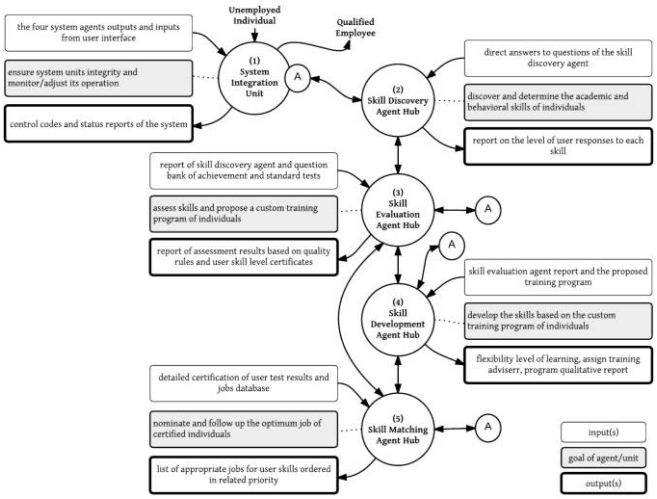

Figure 1 Proposed integrated system framework to discover, evaluate, develop, and match the skills of Saudi youth to labor market requirements

Taking into account the above considerations, this work proposes an expert system to discover, evaluate, develop and match the skills of Saudi youth with the labor market requirements. It consists of five major units: system integration, skill discovery, skill evaluation, skill development, and skill matching. Each of these units and/or agents is briefed in Table 1.

Table 1 Summary of goals, inputs, outputs of system units and agents

no.	unit/agent name	goal(s)	input(s)	output(s)
1	**System integration**	ensure system units integrity and monitor/adjust its operation	the four system agents outputs and inputs from user interface	control codes and status reports of the system
2	**Skill discovery**	discover and determine the academic and behavioral skills of individuals	direct answers to questions of the skill discovery agent	report on the level of user responses to each skill
3	**Skill evaluation**	assess skills and propose a custom training program of individuals	report of skill discovery agent and question bank of achievement and standard tests	report of assessment results based on quality rules and user skill level certificates
4	**Skill development**	develop the skills based on the custom training program of individuals	a report of the user skill level, and his/her proposed training program	flexibility level of learning skills, assign training adviser to user, and a qualitative report on the training program
5	**Skill matching**	nominate and follow up the optimum job of certified individuals	detailed certification of user test results and jobs database	list of appropriate jobs for user skills ordered in related priority

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The present work proposes multiagent system for each individual major unit to provide modular architecture and flexibility for future extensions. Figure 2 shows an agent hub of unit x that consists of n number of subagents. Consequently, a lower level of related subagents x_{ij} performs and communicates with the upper level. For example, if x=3 then it represents the skill development agent hub. Hence, agents 31, 32 and 33 might represent the development of soft, behavioral and technical skills, respectively. Therefore, subagents 331, 332 and 333 might represent the development of computer, management and accounting skills, respectively. Using such architecture promises an open-ended design to add new agents at any level.

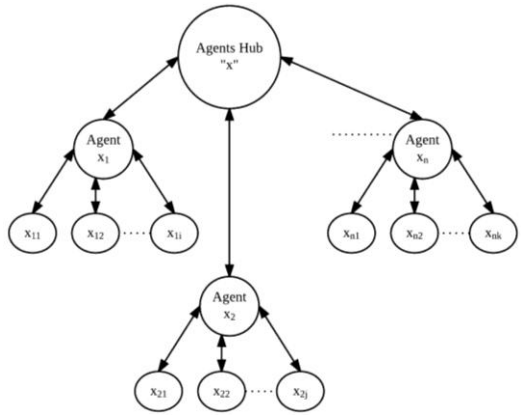

Figure 2 An agent hub architecture (x) communicates with subagents (x_1, x_2, …x_n) which are consequently communicating with subagents (x_{11}, x_{12}, …x_{1i}) to provide modular architecture and flexibility for future extensions.

The **system integration unit** consists of eight subunits. They are quality, costs, time management, content development, communication, purchasing, human resources, risk subunits. It is responsible for basic procedures that ensure the integration of the different system units. Also, it is the only knowledge area which focuses on the development and implementation of the system procedures. It aims at the consistency and integration of system objectives as well as alternatives between competing units. It directs the whole and monitors and controls its operation. The inputs are the outputs of the other four system units (agents) in addition to inputs from user interface. The outputs are control codes for the system and reports on its status.

Lowest-Level Agent Design

In this section, the design of the lowest-level agent belongs to a specific major unit is described. First, the **skill discovery agent**, Figure 3, includes skills database and the skills' discover subsystem. It aims to discover the skills of the user, whether academic or mental. It determines the level of each skill based on the direct answers of user questions generated by the recruitment consultant subsystem. Such subsystem consists of diagnostic tests according based on the skills' matrix, interview subsystem, knowledge base, inference engine, and user interface. The output is a comprehensive report, according to user responses determines the level of each tested skill chosen by user or suggested by the system.

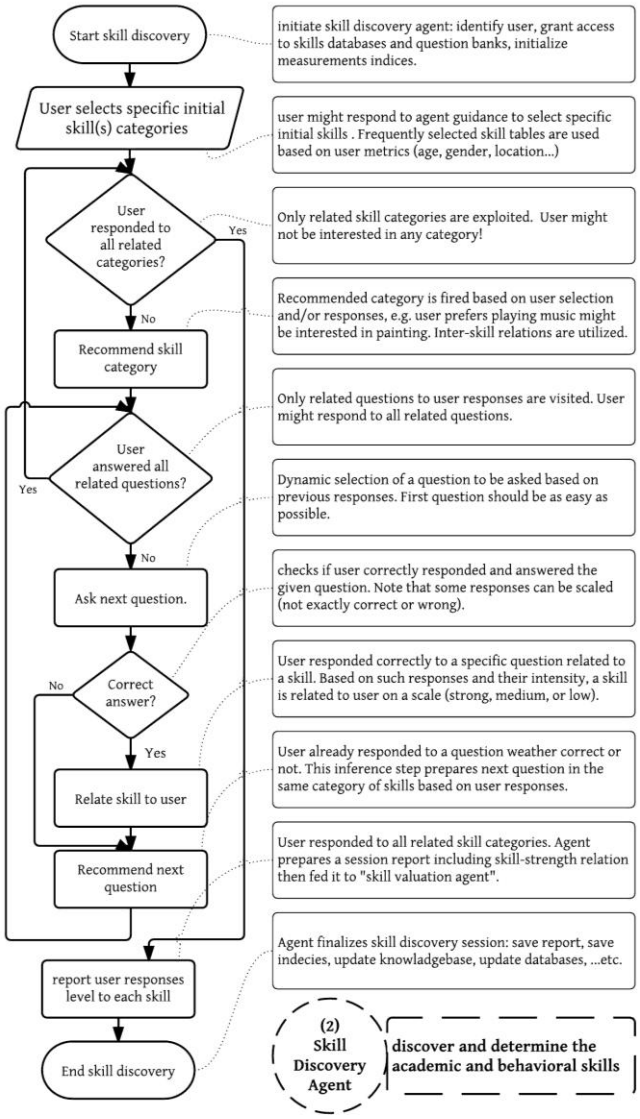

Figure 3 Inference diagram of proposed skill discovery agent

Second, the **skill evaluation agent**, Figure 4, includes five subsystems: achievement tests, standard tests, evaluation of tests, test reports, and certification. It aims on detailed user skills assessment and proposes a custom training program to develop the skills of each user separately. The inputs are the report of skill's discovery unit, and achievement and

standard test banks for each skill. The outputs are: a report on the assessment of the tests based on quality rules, and a certification of the user skills level.

Third, the **skill development agent**, Figure 5, agent includes: training packages database, trainers' database, partial tests system, and the training expert system. It aims to develop the selected skills of the user according to his/her own training program. The unit inputs are: a report of the user skill level, and his/her proposed training program. The outputs are: the flexibility level report to learn each skill based on user responses, recommend a human training adviser to the user if the needed, and a statistical report about the training process (e.g. most qualitative skills development, least frequently used programs, …etc.).

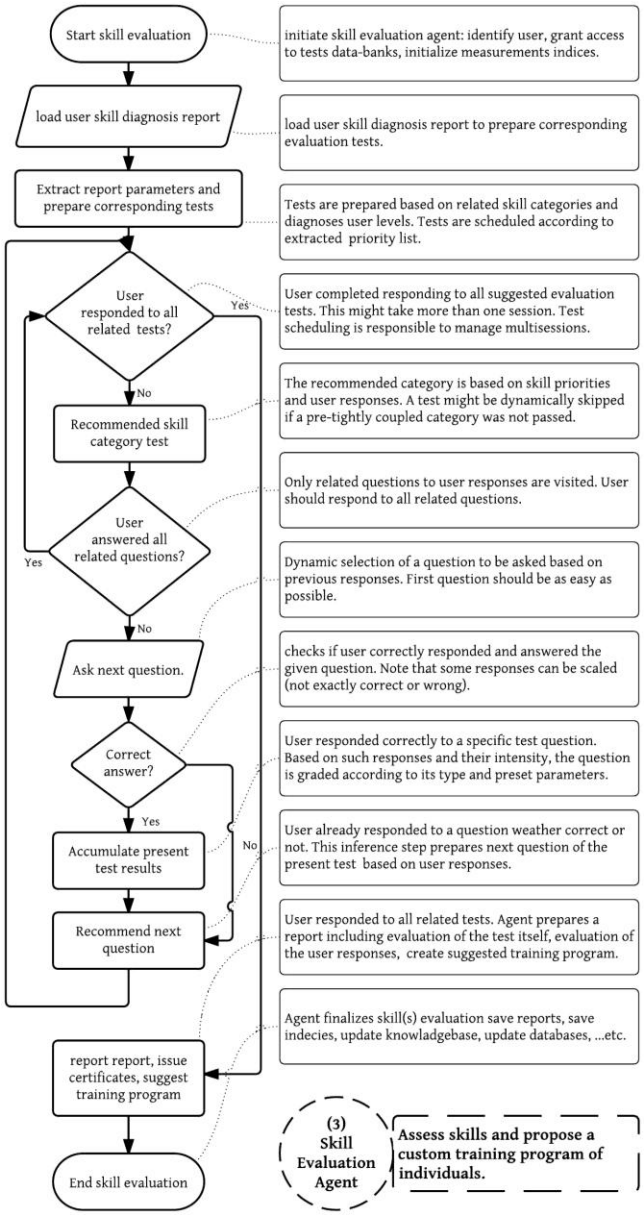

Figure 4 Inference diagram of proposed skill evaluation agent

Fourth, the **skill matching agent**, **Figure 6**, agent consists of: activities database approved by the ministry of labor, jobs database approved by the ministry of labor, vacant and occupied jobs database, skills' matching expert system, and recruitment expert system. It aims to nominate an individual to the optimum job after skills development and follow up his/her employment. The inputs are the user certificate(s) and jobs database. The outputs are a determined list of jobs appropriate to user skills ordered in priorities. Such priorities include: skills level, user desires, wage, geographic location, availability of vacancies. This unit also follow-up user employment for quality measures purposes.

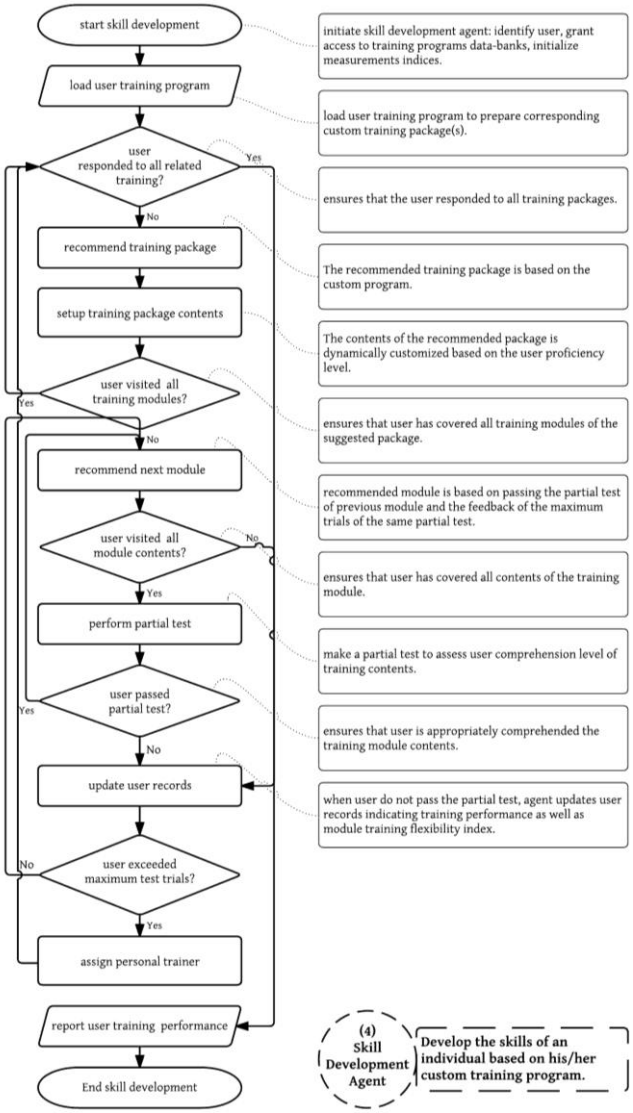

Figure 5 Inference diagram of proposed skill development agent

The proposed research project aims at developing an intelligent environment based on intelligent agents to act as an academic advisor that suggests courses to be registered for students, and modify the faculty timetables to satisfy as much registration requests as possible. This will reduce the cases where students are not able to register courses due to contradictions in timetables.

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Comparison study and implementation aspects

There are a few implementations of similar partially integrated systems, e.g. www.{freelancer, elance, guru. odesk}.com. However, they are fragmented and target international users without culture localization flexibility. They commonly match a person to a job according to his/her responses with minor identity confirmation, skill diagnosis, evaluation, and/or training. They differ from the present proposed design as given in Table 2.

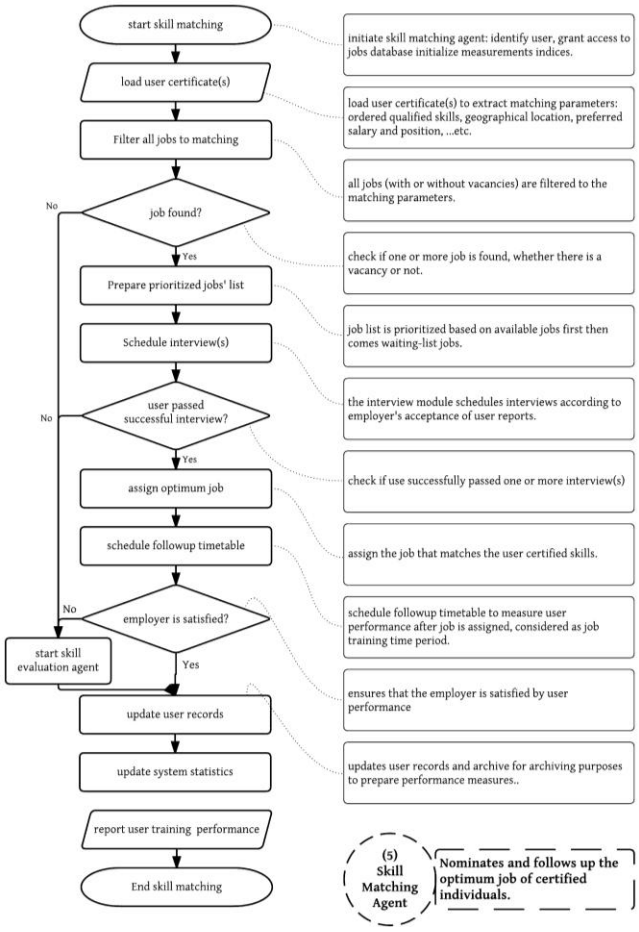

Figure 6 Inference diagram of proposed skill matching agent

To realize the implementation of the proposed design, some considerations would be useful to be considered:

- a protocol should be initiated to grant access to the national identity database for user identification and authentication purposes
- build a standard database of classified human skills
- a protocol should be initiated to grant access to both local and/or global "virtual universities".
- a protocol should be initiated to grant access to standard tests' providers

Table 2 Comparison between the present proposed design and commercial systems

no.	unit/agent name	Commercial systems	Present proposed design
1	**System integration**	Provide user registration, service fees payment, and other specific tasks.	Guarantees the quality of the system outputs and measures the performance and ensures system flexibility and effectiveness.
2	**Skill discovery**	Concerns only with academic skills regardless of other skills.	Supports academic and non-academic skills (e.g. personal communication, motor, social, and creativity skills).
3	**Skill evaluation**	General evaluation without a offering standard tests	Objectively evaluates skills through custom and globally standard tests (e.g. TOEFL, GRE, MPA, CCN, …etc.).
4	**Skill development**	Offers general online training packages, if exist.	Trains individuals based on customized program, assigns a human trainer, if necessary, and issue certificates.
5	**Skill matching**	Connects a person to an available job without a development program to get a better job or to provide a feedback to modify a present job description.	Provides a composite index of several weighted sub-indices to measure the convenience of an individual skill(s) to a profession or job of his/her choice, or those suggested by the system in consistent with Saudi ministry of labor jobs.

It is highly recommended to consider these agent types: simple reactive, reactive planning, collaborative and learning for implementation. Furthermore, blackboard architecture would facilitate storing the common knowledge. It is beyond the scope of this work to recommend the communication protocols between agents at the present framework sketching phase.

Conclusion

As indicated by the Saudi 49th statistical yearbook, unemployment rate is about 11.7% in Saudi Arabia which is higher than the internationally accepted rate (~5%). This fortifies the need for studies and solutions to attain the worldwide normal or less. Most classical solutions suggest matching a skilled individual to an available job. However, computer based expert systems can possibly offer more to cooperate with governmental efforts towards solving or at least diminishing the unemployment problem. This study represented a large scale expert system framework design that targets to discover, evaluate, develop and match the skills of highly educated Saudi youth (representing 48.2% of unemployment) with the labor market requirements. Focusing to develop skills related to important activities such as: information and communication, financial and insurance activities, and administrative and support services

which are covered by only 5% of all workers. The proposed framework outlines in details how a job seeking individual with limited skills would evaluate them and discover new ones. Then, alleviate such skills to match an optimum available job.

While the present design extends the state of the art techniques and models for each of its agents, it does not mean to be a fully embedded standalone system. However, it is flexible to embrace other stable outsourced databases and systems. For example, the ministry of interiors database to authenticate users, standard tests for skill evaluation and standard training programs. In addition, the present modular design facilitates parallel implementation of its modules and agents. Optimistically, the present design would support a limited skill unemployed individual to enhance his/her qualifications and match an optimum job which is subsequently reduces the unemployment rate in Saudi Arabia.

Acknowledgments

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Biography

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