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Development of a career-guidance expert system

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Abstract

This paper deals with designing and developing a rule-based expert system for career selection. A student's career choice is complicated and depends on various elements, including their interests, abilities, personalities, and social circle, as well as their family, friends, and school. This system interacts with users with the simple English language and psychosomatic tests used to assess students' vocational interest, general mental ability, problem-solving ability, and records. The present system is designed to provide resultsbased on if/then rules, which are extracted from experts in career counseling. Tools such as Angular JS, Node.js, express.js, and MySQL were used to develop the expert system usingthe languagesHTML, CSS, JavaScript, and typescript. The front end of the ES was developed using AngularJS, and the backend and serverside wascreated using Node.js, MySQL, and Express.js. The expert system's inference engine and knowledge base were developed using json-rules-engine, the node package manager available on GitHub.As a pilot study, the system was used by 50 participants to determine its efficiency in accessibility, ease of use, and user experience about the system. Results show that more than 80 percentage participants were highly satisfied with the system.The developed system aims to enhance user experience and accessibility and is simple.

Introduction

Career selection is one of the most significant decisions in a student's life. The decision of career selection is affected significantly by the family members and society in which an individual lives. In developing countries like India, a student's high school and intermediate percentage affect her career choice to a large extent. In addition, financial affluence, societal respect for the profession, and career progress trajectory also play a vital role in deciding a student's career choice**[Frensch etal.]**. On the other hand, parents consider factors viz. return on

investment, the risk attached, economic and social standing, and self-esteem as more influential. Due to the prejudices, an individual's career choices may result in a mismatch between parents' and students' expectations. Wrong career choices may lead to under (or over) utilization of an individual's potential. For the best outcome, a student's career choice must be aligned with her passion**[Akosah-Twumasiet al., 2018]**.In today's fast-paced world, it becomes imperative for a student to make the best career choice to have a fulfilling life**[Marcenaro-Gutierrez et al., 2017]**. Students residing in remote areas have lesser opportunities as far as expert career guidance is concerned. Career selection expert systems have emerged as a prodigious tool for aiding students in making logical career choices.

An expert system is a computer program created to address issues in a domainwhere only humans have expertise. Subject-matter experts compile the system's knowledge base. Based on this information, an expert system may simulate human experts' thought processes and draw logical conclusions. Building an expert system to address issues relating to career selection is advantageous for a variety of reasons. Human specialists can be absent from an area or not always to be available. Due to the knowledge gathered from multiple experts, an expert system may outperform a single human expert without fatigue. However, makinga simple, easy-to-use expert system is still a challenge. Such an expert system can provide career guidance to rural students hesitant to usecomplicated computer-based systems. In the last two decades, tools such as Node.js and AngularJS have emerged as runtime environments and frameworks, respectively.

Node.js provides features such as opening network sockets, spawning child processes, and accessing file systems **[Chaniotiset al., 2015]**. In addition, it can pack diversified functionalities into smaller number coding lines. AngularJS is a component of the MEAN stack consisting of the MongoDB database and functions as a server runtime environment. It permits the user to extend the HTML vocabulary to develop an extraordinarily readable, developable, and expressive setting**[AngularJS]**.It is an open-source framework for creating single-page applications(SPAs). AngularJS analyzes the HTML pages using the extended tag employing directives for binding input and output components of the variables through JavaScript variables. The directive-based functionality facilitates minimal coding for achieving the assigned task.

This article presents an approach for developing a simple, easy-to-use career selection rule-based expert system using AngularJS, Node.js, MySQL, Express.js, and JavaScript.The ES

allows step-by-step career selection based on a student's strengths and weaknesses without expert guidance.The system's availability through the Internet is one of the features of this system. The system is simple to use, and the user experience is satisfying, according to the survey conducted at the end of the development of the expert system.

Related work

Amin & Zaman presented an expert system for career guidance that provides personalized advice to students and job seekers based on their skills, interests, and career aspirations**[Amin& Zaman, 2010]**.An intelligent expert system that uses fuzzy logic to provide career guidance to students and job seekers has been presented by **[Al-Turjman&Alsmadi, 2011]**. The system considers multiple factors, such as aptitude, interests, and personality traits, to make personalized recommendations.A career guidance expert system that uses multimedia technologies, such as videos and animations, to provide interactive and engaging career advice to users has been presented by **[Chiong& Tsai 2011]**. The system also includes a database of job descriptions and salary information.Huang& Chenpresented an expert system for career guidance and counseling in higher education that uses a hybrid approach, combining decision trees and fuzzy logic, to provide personalized career advice to students**[Huang & Chen, 2012]**.A career guidance ES that uses a rule-based approach to provide personalized career advice to students and job seekers was developed by **[Zhang & Zhu, 2012]**.An expert system for career guidance in Taiwan using a rule-based approach to provide personalized career advice to engineering students was developed by **[Lin & Chen, 2013]**.The ES could providecareer guidance to the students based on their skills, interests, and personality traits. The system uses a rule-based approach to provide personalized recommendations for career paths and job roles.[**Singh & Bhattacharjee, 2013**proposed an expert system to provide career guidance to engineering students. Using a rule-based approach, the system offers personalized recommendations based on student skills, interests, and personality traits. The system aims to assist students in choosing the right career path and job roles in engineering.An ES that combines the analytic hierarchy process (AHP) and rule-based approach to provide career guidance to students has been proposed by **[Kurniawan & Kurniawan, 2014]**. The system analyzes students' academic, personal, and professional attributes using AHP and provides personalized career recommendations based on

their strengths and interests. The article was published in the Journal of Intelligent and Fuzzy Systems and aims to assist students in making informed decisions about their careers.

Problem description and motivation

Availability, accessibility to the career counselor, and timely solution to career-related problems is the primary motivation behinddeveloping an expert system for career selection. The available career guidance EShas limited scope due to the absence of various career choices. The ES presented in the present article covers several professions, such as 'executive,' 'literary,'and 'household,' broadening its scope. From the point of view of technology, it is easier to add or remove components or modules to this system because of the flexibility provided by AngularJS. Similarly, the implementation of Node.js permits the management of significant traffic on the server side.

Development of an expert system:general methodology

The first stage of developing an expert system is knowledge acquisition. This stage involvesgathering relevant information from domain experts or existing resources such as books, articles, and databases.Once the knowledge has been acquired, the next stage is to represent it in a format that the expert system can use. This stage involves structuring the knowledge into rules, facts, and concepts that the system can easily understand and is known as the knowledge representation stage.After completing these two phases, the developer enters the inference design phase. This phase isresponsible for processing the knowledge and providing recommendations. In this stage, the inference engine is designed and developed based on the knowledge representation.The inference engine provides recommendations and uses the knowledge base (where the acquired knowledge is stored). This stage, known as the knowledge base implementation,consists of entering the rules, facts, and concepts into the system. This stage is followed by user interface designing, which consists of developing a user interface to allow the user to communicate with the system. The user interface is designed and developed based on the system's requirements and the users' needs.The next stage in the expert system design procedure includes the testing and evaluation phase. Once developed, the system is tested and evaluated to ensure accurate functioning. In this stage, functional and non-functional testing is conducted to verify the performance and behavior of the system. In the last stage, the system is finally deployed, involving its installation in a production environment and making it available to the

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enduser. After deployment, the system is maintained and regularly updated to cater to the user's evolving needs.The overall developmental procedure can be summarized by a linear flow chart in Figure 1.

Figure 1. Linear flow chart depicting expert system development process

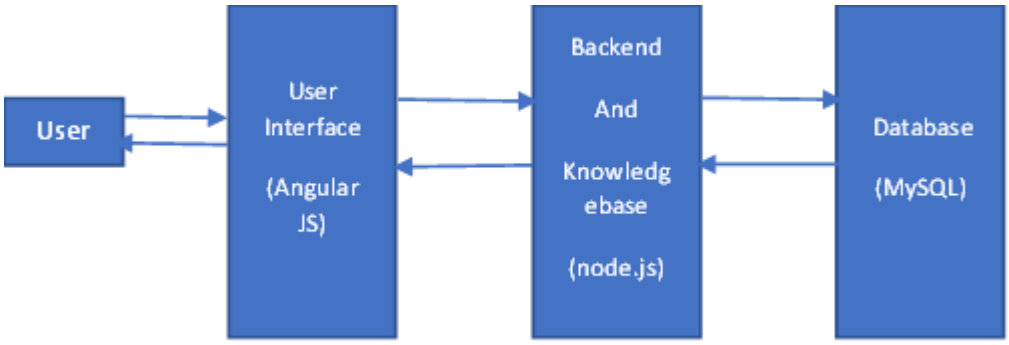

Figure 2. Linear flow chart depicting expert system development process

Development of the career guidance expert system: methodology

Knowledge Acquisition: In this phase, theknowledge collected from different resources,viz. books, articles, and other secondary databases, was employed for knowledge acquisition.In addition, twelve career counselors and experts with experience between 10 to 15 years were consulted to acquire knowledge about the careerguidance process. Structured and unstructured interviews were conducted to acquire the knowledge.The experts were from various fields ranging from engineering, veterinary, agricultural, and social science, and research. Based on the interaction with the domain experts,it was concluded that multiple psychometric tests must be conducted on the students to know their interests, ability, IQ, and personality.

Table 1: Description of various psychometric tests used in developing the expert system

S.No.	Psychometric Test	Description
1	General Mental Ability Test (Dr. Roma Pal & Dr. (Mrs.) Rama Tiwari)	○ Higher Secondary(13 to 18 years) ○ 70 questions/90 minutes ○ This test is highly correlated with IQ

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2	Problem-Solving Ability Test (Dr. (Km.) Roop Rekha Garg)	○ Higher Secondary(12 to 19 years) ○ 22 questions/45 minutes ○ This test correlates with Creative thinking, intelligence, reasoning, and mathematical ability.
3	Vocational Interest Record (Prof. V.P. Bansal & Prof. D. N. Srivastava)	○ High School, Intermediate, Undergraduate(above 12) ○ 128 statements/30 minutes ○ Finds vocational interest in Agriculture, Artistic, Commercial, Executive, House Hold, Literacy, Scientific, Social Science
4	Holland Personality Test (John Holland)	○ Higher Secondary(13 years) ○ 108 statements/20 minutes ○ Finds six different types of personality

Knowledge Representation: Once the knowledge has been acquired, the next stage is to represent it in a format that the expert system can use. In the present investigation, the structuring of knowledge into rules, facts, and concepts was conducted as per Table 2.First, all the rules were developed in the form of rules and facts using simple English to make them easy to comprehend.Further, more than seventy different rules were designed to represent the knowledge base.

Table 2: Knowledge representation using rules, facts, and concepts used in the present expert system

VIR: Vocational interest record test, GMAT: General Mental Ability Test, PSA: Problem-Solving Ability, P: Percentage in 12th, and PT: Personality test			
Rule 1	**Rule 2**	**Rule 3**	**Rule 4**
If VIR is Science and GMAT is high and	If VIR is Agriculture and GMAT is Average and	If VIR is Social Science and	If VIR is Science and GMAT is low and

PSA is high and P is also high Then suggested is a higher level in medical or engineering or research in a related field.	PSA is Average and P is also an Average Thensuggested is a degree in agriculture or related fields.	GMAT is high and PSA is high and P is high Then suggested is a higher level in social science or research in a related field.	PSA is low and P is also low Thensuggested is diploma in medical or engineering-related fields

Inference Engine and Knowledge-Base

JSON Rule Editor, as a tool, enables users to create, edit, and organize the rules within the knowledge base using a JSON-based syntax. The rules defined in the editor represent the logical statements or conditions the inference engine evaluates.The rules in jsonrule Editor typically consist of two main components: conditions and actions. The conditions specify the criteria or patterns that must be matched in the input data or facts for the rule to be triggered. These conditions can be defined using JSON structures representing comparisons, logical operators, or other relevant information. The actions, on the other hand, limit the tasks or operations that are performed when the rule is triggered. These actions can be specified using JSON structures that represent updates to the knowledge base, computations, or any other relevant activities that need to be executed.Once the rules are defined in JSON Rule Editor, they can be exported and used by the inference engine. The inference engine takes the knowledge base, which includes the exported rules, and processes the input data to apply the rules and make inferences or decisions accordingly.

The inference engine evaluates the conditions of the rules against the available facts or input data, matching the patterns specified in the rules. When a rule's conditions are satisfied, the associated actions are executed, which may result in updates to the knowledge base or other relevant operations.

Overall, JSON Rule Editor plays a crucial role in developing and managing the rules that drive the behavior of an inference engine. It allows users to define rules in a structured format, organize them within the knowledge base, and export them for use by the inference engine. This

enables the inference engine to effectively reason and make decisions based on the defined rules and the input data provided.

User Interface

The front end of the ES was developed using 'AngularJS'. The back-end and serverside were created using 'Node.js', 'MySQL', and 'Express.js'. The inference engine and knowledge base of the ES were developed using json-rule-engine. The modules such as 'Admin', 'Home' and 'User module'were created for the UI. Various components, viz. 'dashboard', 'userlist', 'test', and 'result' were created within the 'Admin' module. The' user' module made other components like the dashboard, login, profile, registration, test, and result components. Four files were created within each element to work the related member properly. Table 3 presents the description and the file type with the extensions used in developing the UI.

Table 3: Description and the file type with their extensions used in developing the UI

Description of file	File type extension
Html part	.html file
Style sheets	.css file
Properties and modules	.ts file
Unit testing	.spec.ts

For example, when the login component is created, the page's look will be defined in login.component.html. Similarly, the CSS part and properties are described in the login.component.css and 'login.component.ts' files, respectively. Finally, the testing part is defined by the file 'login.component.spec.ts.' All the other components were developed identically.

The architecture of the application depicting the interaction between different layers along with the related technology is presented in Figure 3.Next, the request generated by the client is forwarded to the server and the database as per the requirement. Finally, the client receives the request's response, completing the procedure.

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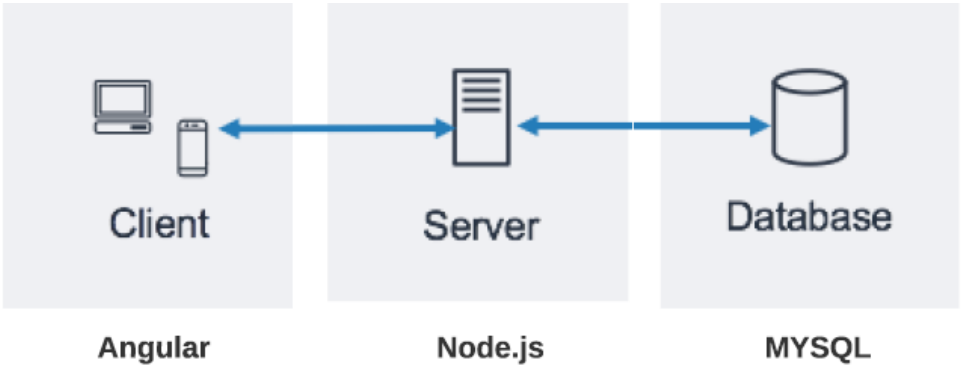

Figure 3. The architecture of the application

Node.js works as a middle layer between UI and the database.Data entered by the user through different components are stored in the database with the help of Node.js. Server.js is one of the most important files created when Node.js is loaded. It consists of several modules, packages, and setting for local hosts.Different controller profiles, tests, test-result, and users are created to perform the logic part.

For example, test-result.controller.js contains the code for calculating the test result.Different modules containing table codes to store the data in the database are created. The router file defines the routes clients can access and maps these routes to specific functions that will handle the incoming requests.The router file is usually used with the server file, responsible for creating an instance of the server and managing the incoming requests.Various fields such as HOST, USER, PASSWORD, and DB_name weredefined inthe db.config.js file to connect with the database.

Working of the System

The general workflow of the designed system is explained in Figure 4. Registration, user login, dashboard, tests, and the results are the components within the user module. The user is allowed to register via a login webpage. Following this, the dashboard page will appear, allowing the user to input her credentials and general information. The user will then perform the tests embedded in the system. Once the test is completed, the user will be navigated to the results page. The user has limited access; she can only log in, fill in the general information, perform the tests, and view results.

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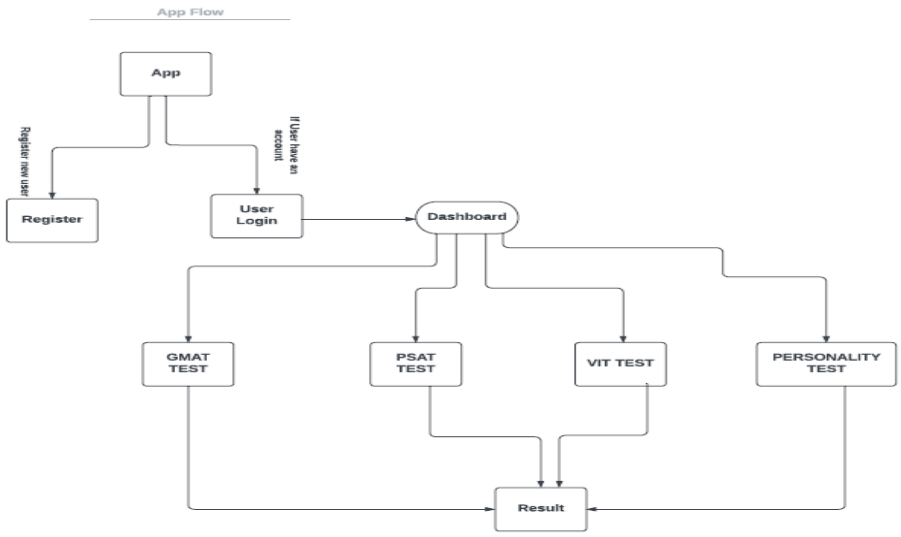

Figure 4. General workflow of the designed system

Admin work includes adding, removing, and updating test data, result analysis, and user list editing. The admin module includes tests, a dashboard, results, and user list components. Figure 5 depicts the general workflow for the admin module.

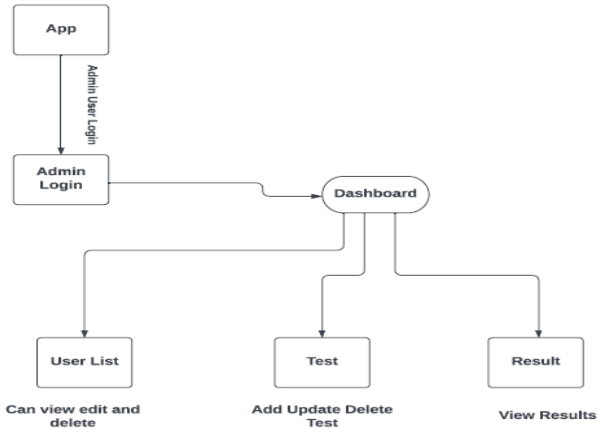

Figure 5. General workflow for the admin module

System Pages:

The developed system has different pages, such as a registration page, login page, admin dashboard, user dashboard, general information page, tests page, and result page. The working of the pages and screen shorts are explained in this section.

Login and Registration Page:

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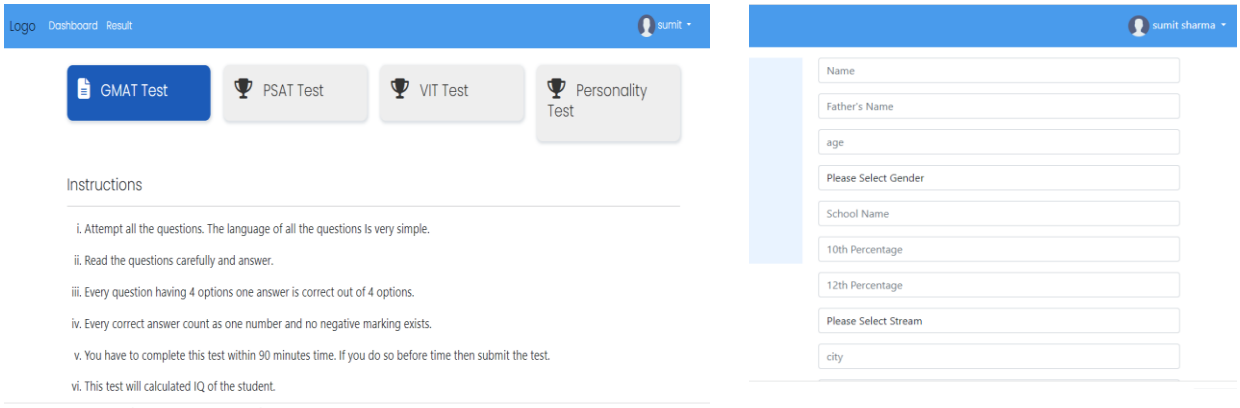
Figure 6 presents the screenshots of the login and registration pages of the developed ES. The registration page is used to register a new user/student into the system, and through the login page, a registered user can login to the system for career guidance.

(a) Login Page (b) Registration Page

Figure 6. Screenshots of the login and registration pages

User Dashboard Page:

The user dashboard will be shown when a user successfully logs in to the system.Before performing the tests, usersmust fill in their general information on the‘general information’ page. Following that, the users willbe allowed to perform the tests.



(a) User Dashboard (b) General Information

Figure 7. Screenshots of the user dashboard and general information pages

Admin Dashboard Page:

Figure 8 presents the screenshot of the admin dashboard. The admin dashboard provides different facilities to the admin. First, the admin can see the user list andcan makedesired

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changes to the list. The addition and editing of the questions by the admin are allowed in different tests.Finally, the admin can see the user results through the dashboard.

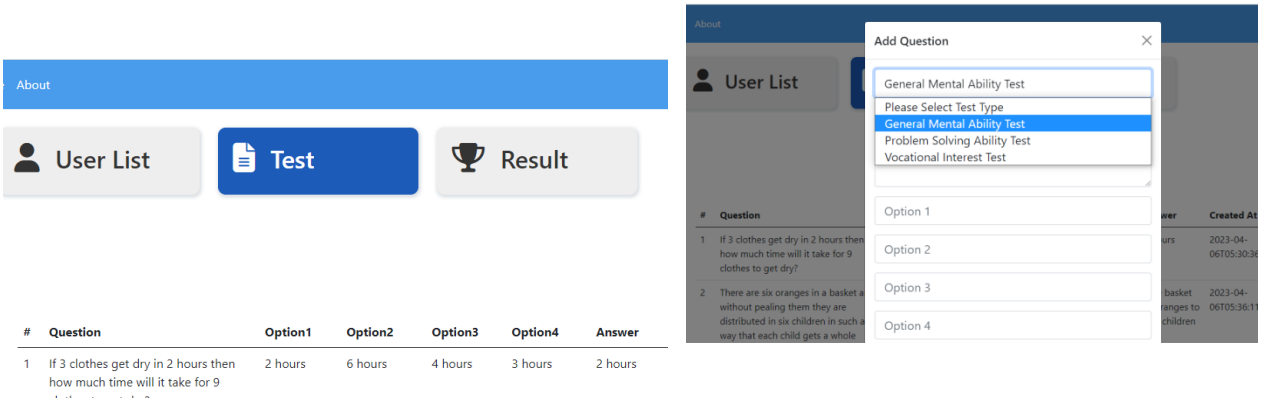

Figure 8. Screenshots of the admin dashboard

Result Page:

Figure 9 presents thescreenshots of the results page. The result page summarizes all test results and career suggestions to the user. In addition, the result page also provides the detail of the positive qualities of that particular personality.

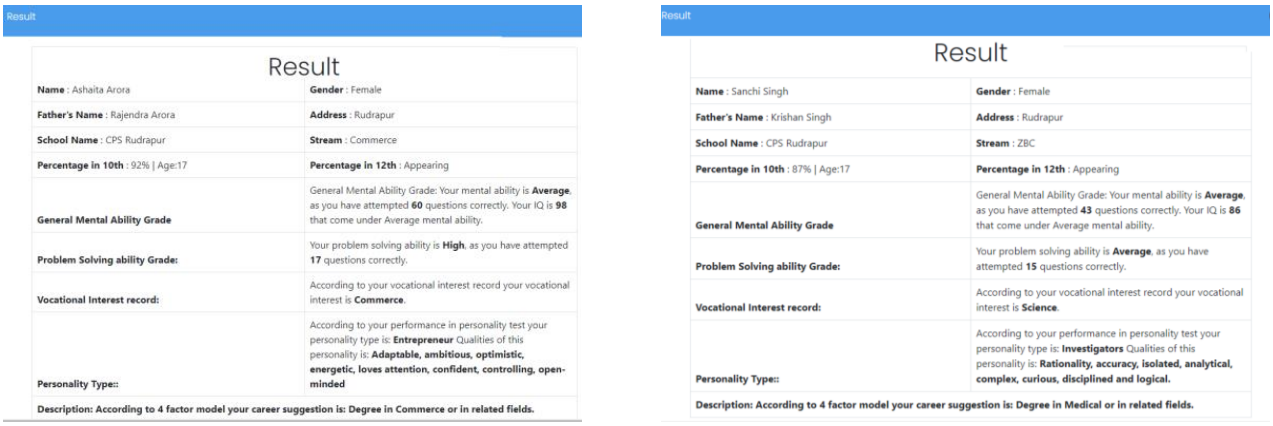

Figure 9. Screenshots of the results page

Conclusion:

This article deals with an ES developed to provide career guidance based on theuser test results. Firstly, a general methodology for the development of ES was discussed briefly. Subsequently, a method was proposed to develop an ES for career guidance using AngularJS, node.js, json-rule-engine, and MySQL. The web-based ES consisted of ten webpages allowing

users to log in, register and take psychometric tests. These psychometric tests are established tools for evaluating vocational interest, mental ability, intelligence quotient, problem-solving ability, and the student's personality. The developed ES was tested on fifty volunteers between the prescribed age group to determine its efficiency per predefined results provided by counselors. These volunteers were asked about the accessibility, ease of use, user experience, and overall satisfaction levels regarding the ES. Out of these, forty-two individuals were confident as far as accessibility and user experience are concerned. Additionally, forty individuals were satisfied with the ease of use and the suggestions provided by the system.

References:

1. Akosah-Twumasi, P., Emeto, T. I., Lindsay, D., Tsey, K., &Malau-Aduli, B. S. (2018, July). A systematic review of factors that influence youths career choices—the role of culture. In Frontiers in Education (Vol. 3, p. 58). Frontiers Media SA.
2. Marcenaro-Gutierrez, O. D., & Lopez-Agudo, L. A. (2017). The influence of the gap between parental and their children's expectations on children's academic attainment. *Child Indicators Research*, *10*, 57-80.
3. Alshahrani, A., Ross, I., & Wood, M. I. (2018, August). Using social cognitive career theory to understand why students choose to study computer science. In *Proceedings of the 2018 ACM Conference on international computing education research* (pp. 205-214).
4. Frensch, P. A., & Sternberg, R. J. (2014). Expertise and intelligent thinking: When is it worse to know better? In *Advances in the Psychology of human intelligence* (pp. 157-188). Psychology Press.
5. Amin, H., & Zaman, R. U. (2010). An expert system for career guidance. Expert Systems with Applications, 37(5), 3771-3779. doi: 10.1016/j.eswa.2009.11.042.
6. Al-Turjman, F. M., &Alsmadi, M. (2011). An intelligent expert system for career guidance. Journal of Emerging Trends in Computing and Information Sciences, 2(6), 277-284.
7. Chiong, R., & Tsai, W. (2011). A career guidance expert system based on multimedia technologies. Expert Systems with Applications, 38(6), 7213-7223. doi: 10.1016/j.eswa.2010.12.021
8. Huang, Y. C., & Chen, Y. Y. (2012). An expert system for career guidance and counseling in higher education. Expert Systems with Applications, 39(9), 7792-7803. doi: 10.1016/j.eswa.2012.01.162
9. Zhang, Y., & Zhu, Q. (2012). Design and implementation of a career guidance expert system. Journal of Software Engineering and Applications, 5(11), 749-754. doi: 10.4236/jsea.2012.511086
10. Lin, C. H., & Chen, M. C. (2013). Developing an expert system for career guidance in Taiwan. International Journal of Information and Education Technology, 3(6), 641-645. doi: 10.7763/IJIET.2013.V3.337
11. Singh, S., & Bhattacharjee, D. (2013). An expert system for career guidance in engineering. International Journal of Engineering Research and Development, 7(5), 64-72.

12. Kurniawan, Y., & Kurniawan, T. (2014). Expert system for career guidance using analytic hierarchy process (AHP) and rule-based approach. Procedia Computer Science, 42, 346-352. doi: 10.1016/j.procs.2014.11.036