



Career Prediction through Cognitive Models using Sudoku Game – The Assessment of Applicability

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ABSTRACT

Every student possesses a certain level of psychology. The psychological factor has a bearing on various attributes of a student, such as Motivation, skills, academic and research excellence, preferences, group behavior, etc. For accomplishing a specific job, a student must possess characteristics that match the workmen's particular requirements of a given job. When a match is found right men for the right job can be found. The accomplishment of a professional career is dependent on the kind of path and job chose by the students in the initial stages of their careers. The recruitment of any student is generally done based on some assessment-related Verbal-Nonverbal communication, Ability to quickly solve quantitative problems, Group discussions, Interviews, ability to communicate effectively, and to certain extent, basic knowledge related to the branch of their study. The recruitment process, as such is not scientific, and at times there is a mismatch between the Job requirements and the personnel characteristics of the students. No focus is made on the psychological aspects of the students that include learning ability, perseverance, intelligence, patience, logical thinking, memory power, etc. of the students.

Selecting the students based on the psychological factors possessed by the student that match the job requirement is instrumental to the workforce development, retention, and high-quality delivery of the skills expected of by the students in the Job front. Many methods exist in the literature for assessing the psychology of the students based on game playing. The motto is to determine the psychology of the students through game playing and then use those factors for assessing their suitability to a specific job that has a particular set of psychological requirements.

In this paper, an analysis of the suitability of the Sudoku game for assessing the psychological factors of the students presented. In this paper, the extent of the mental level possessed by an e student through a Sudoku game presented. An expert system is presented in this paper that assesses the psychology of the student through a cognitive model, and a prediction model that predicts the suitable careers to the student's based cognition of the students.

Key words: Psychology, expert system, cognitive model, predictive model, career forecasting

1.INTRODUCTION

One of the most crucial decision that a student should take and the end of graduating a program is to select a career that best suits them so that they excel in delivering the Job responsibility

Only 10% of the students succeed in selecting a job of their suitability. This set of students are considered to be lucky. 40% of the students are semi-lucky as they can only meet partial requirements of a Job. Rest 50% considered as unlucky as their personnel traits do not match the job requirements, their career and future are entirely lost.

Employers these days select the student's based tests conducted to assess the speed at which qualitative problems solved, the way they can reason, and the way they conduct themselves in the Groups. At times they also check on their problem-solving ability and how effectively they communicate. This process does not really reveal the psychological behavior of the students, and therefore wrong people get selected for the right jobs or right people are chosen for illegal employment. This kind of process leads to the development of an unlearned and underdeveloped workforce for the country. High level and high-quality workforce is the real asset of any state. The methods used for selection of the students completely ignore the psychological behavior of a student and the actual characteristics that a student must possess to work on a job of individual characteristics.

Every student has a built-in cognition centered on several psychological factors. Some of the Physiological factors that are worth mentioning include memory power, logical reasoning, perseverance, persistence, intelligence, learning ability, etc. Similarly, the jobs existing in the market need certain psychological traits within the students. Therefore there is a need to select students matching to the needs of the employment and psychological behavior of the students.

Many jobs exist in the world, and the Job requirements are generally spelled out verbally, referencing various abilities required in person who is seeking to pursue the Job. There should be a scientific method of codifying the Job requirements and map the same to a specific job. Sometimes it is also necessary to evaluate the level of psychological

factor that is sufficient to handle a job. Most of the time, the requirements of psychological factor that suits the needs of a job is judgmental, subjective and sometimes objective. No scientific methods are available that find the suitability of psychological factors for a specific Job.

In literature, many methods proposed for assessing the Psychology of the students. Most of the methods do not reveal the realistic easements of the factors. Again the existing techniques do not asses all kinds of psychological factors that are needed to predict suitable careers to the students. Game playing has been proven to be one of these scientific methods used for assessing the psychology of the students. Again there are many games in vogue, and only a few psychological factors sometimes can be measured using certain games. Sometimes it comes necessary to select a few games that together will help in assessing the quality factors of the students based on which suitable careers to the students predicted.

Many have used the Sudoku game for different purposes. In this paper, the suitability of the Sudoku game to assess various psychological factors presented.

2.OVERVIEW ON SUDOKU GAME, PSYCHOLOGICAL FACTORS, COGNITIVE MODEL AND CAREER ASSESSMENT

2.1 The game form and Nature

2.1.1 The game

The Game Sudoku described by many authors differently. The Sudoku game described by Bahare Fatemi et al. [1] is a popular puzzle and is logic-based. The game was described as a paper-pencil game by Kedarnath et al. [2]. The game described as a combinatorial optimization method.

The game played with numbers from 1to 9. The game is designed using a square matrix of any size. The empty squares filled such a way that no row or column will have duplicate numbers. A sample problem matrix square and its related solution matrix are as shown in Figure 1.

	7	5	9			6		1	7	5	2	9	4	8	3	6
	2	3	8		4			6	2	3	1	8	7	9	4	5
8				3		1		8	9	4	5	6	3	2	7	1
5			7	2				5	1	9	7	3	2	4	6	8
	4	8		6	2			3	4	7	8	5	6	1	2	9
		9		1		3		2	8	6	9	4	1	7	5	3
9		4				7		9	3	8	4	2	5	6	1	7
	6			7	5	8		4	6	1	3	7	9	5	8	2
7			1		3	9		7	5	2	6	1	8	3	9	4

Figure 1: Sudoku Game and its Solution.

Sudoku game is simple. Mathematical Knowledge is not required. One needs to have a logical sense to play the game [3]. The main rule of the game is to place digits from 1 to 9

in a 9 by 9 matrix such that no row or a column will have the same number more than once and each 3 by 3 submatrix of a 9 by 9 model will have only one number once considering either the column or row.

2.1.2 Sudoku Game – The levels of difficulty

The Sudoku game played at three difficulty levels, categorized as Hard, medium, and natural [2], [3]. Initially, the matrix filled with certain random numbers that do not give any indication to the difficulty of the game. The actual challenge of the game is dependent on where the initial numbers provided within the sub-matrix of the total matrices [4]. A complete digit provided in sub-matrices is nothing to do with the difficulty of the game. The complexity of the game is dependent on total number and distribution of the cells, the kind of method used for the logic deduction, and the type of search method employed for enumerating the cells and digits to be placed [5].

2.1.3 Generating and solving a Sudoku game

Sudoku games initially are generated with some cells filled with some initial digits into the grid. The way the digits filled depends on the complexity with which the game played. The Sudoku generator should be able to generate the games, considering the complexity of the game performed. A generate game played yielding several possible solutions. A game can, however, be caused by yielding only one solution using different kinds of search algorithms [6]. Similar to the software that can create Sudoku games with varying complexity, software developed that is capable of finding solutions, An SAT-based Sudoku game solution provider was presented in the literature [7].

2.2 Developing Cognitive model through Psychological Factors

Psychology of students can be measured considering psychological factors such as Logical thinking, speed of solving the problems, patience, perseverance, intelligence, etc. A cognitive model described as a form of the model used for validation [8]. A cognitive model is built using different measuring techniques for assessing different levels of psychological actors. The correctness of the cognitive model evaluated by tallying with the results produced through the model. Real-time systems generally developed using cognitive Cognitive models that involve human interaction with computer systems and also for modeling complex systems that are not that easy to simulate using social interaction [9]

2.3 Models for assessing Careers

Sastry et al., [31] [32] [33] [34][35]have defined that career assessment is predicting suitable jobs that a student can pursue the requirements of which are quite matching the psychological factors of the students

3. RELATED WORK

3.1 Generating Sudoku games and finding solutions to the games

An algorithm developed by Yuan-hai XUE *et al.* [5] is capable of generating Puzzles based on the Sudoku game, which are at different complexity levels. The Sudoku puzzles become non-deterministic at times leading to no solution. Shanchen *et al.* [10] have developed a model that leads to a metric that can be used to measure the complexity level of the Sudoku game. The model is developed using information theory. They have also developed another model that can be used to generate a Sudoku game at different complexity.

Bahare Fatemi *et al.* [1] proposed the generation of a Sudoku game based on the satisfaction of constraints that can be pre-determined. They developed a method based hill-climbing algorithm using which the difficulty involved in solving the Sudoku game evaluated.

Tjark *et al.*, [11] have presented an algorithm that satisfies a set of conditions, and a heuristic for assessing different psychological factors. They have also proved that a search based on limited discrepancy is a better alternative to the algorithm based on forwarding checking.

A different solution proposed which is unusual for computing the difficulty level of a given Sudoku game by Christopher Chang *et al.* [12]. They have developed a metric for calculating the difficulty level of a Sudoku game. The authors have developed a game generator that is capable of producing easy to medium difficulty based on the proposed metric.

Genetic Algorithms are used for generating, solving, and computing the complexity of the Sudoku games using genetic algorithms by Timo Mantere *et al.* [4]. The problem formulated as a problem that involves satisfying constraints. They have converted the problem as an optimization problem that requires multi-objective restrictions.

Genetic Algorithms that are retrievable are used by Kedar *et al.* [2] for solving Sudoku related problems. They have proved that genetic algorithms that are retrievable are better than regular genetic algorithms. In advance to these algorithms A genetic algorithms that can be used in Multi-stages used by Haradhan *et al.* [3].

3.2 Developing Cognitive model

Career Management, Career Exploration, and decision-making processes are modeled by Lent *et al.* [13] using Sudoku games. The Psychological disorders of different people formalized using a model of cognitive nature by Aaron *et al.*, [14]. They have developed principles that can be applied to assess different kinds of Psychological disorders.

Sasi *et al.* [31] have developed an expert system used for assessing the Psychology of the students through the TIC-

TAC-TOE game. They have determined decision making power and the intelligence of the students through the game. A cognitive model built by them using the psychological factors of the students while they play the game [31].

3.3 Choosing careers

Every student must select a proper and suitable career, which is quite vital for once own development. The choice of career decides the wellbeing of the people in the long term. It explained [15] that Junior students follow the careers opted by senior students, and this generally leads to the choice of inappropriate careers due to mismatch of the psychological factors of the students with the actual Job requirements. The need for a proper Expert system emphasized.

Manisha *et al.* [16] [17] presented a rule-based expert system that is used by the students for the selection of a suitable career. They have introduced a framework used for the design, development, and implementation of the method used for the variety of career paths. They have considered different parameters for assessing the strength and weaknesses of the students — frameworks designed by them based on the inputs that they collected from domain experts — the structure built around the machine and deep learning algorithms used for mining suitable career streams.

The students having high memory power do perform quite well in academics and also help students to choose the most suitable career. An expert system built on memory power is the most important psychological factor presented by Sastry *et al.*, [32]. A cognitive model built into an expert system developed and the same used for predicting suitable careers to the students. The models are developed using textual, graphical, image, and video presentations.

3.3 Contributions to career Guidance

A system built on game playing helps the students to choose careers most suitable to them [18]. Learners can interact with a career guidance system using a game called 'MeTycoon' [19]. The system seeks inputs from professionals and uses the same to build interactive systems. The system seeks data from learners through questioners based on which the interactive systems modeled. On similar lines, an expert system developed [20], which is used by the students for assessing their psychological factors and also get to know about the careers that are most suitable to them.

A case-based reasoning approach is used [21] for the development of expert systems built on a knowledge base. The approach developed by them focuses on the academic performance of the students who are not in a position to complete the academic studies. The expert system built by them was useful for predicting the best careers for the students.

A web-based system is developed by Kasem et al. [22] for career guidance and suitable employment. The system is used by students who are seeking inputs related to suitable careers. The WEB based system is used to conduct quizzes that are designed focusing on some jobs. The psychology and personality of the students are assessed based on the performance of the students while doing quizzes through a web interface.

Generally, academic counselors of instructions analyze the performance of the students and accordingly recommend the students the kind of career that they choose. But academic performance is not the sole factor for choosing a career. In addition to the academic performance other psychological factors such as the speed with which the problems solved, perseverance, patience, and intelligence must also be considered to provide the most appropriate guidance. An expert system is designed based on the TIC-TOC-TOE game by Sastry et al. [33]. By making the students play the game, psychological factors assessed, and a cognitive model developed and the same is used for predicting suitable careers.

3.4 Career assessment, Planning, Mentoring, Supporting and Counselling

A study is conducted [23] to find various barriers for progressing careers of individuals, and the study revealed the real barriers include lack of training, guidance, and opportunities. A model developed which advises the engineers, the way to overcome the obstacles.

The link between the ability to effectively communicate and the advancement to careers has been modeled and experimented on high school graduates and found that the ability to effectively communicate is the key to career advancement [24].

The issues related to career advancement differ, considering the male and the female. A study conducted by Ying et al. [25] to find the extent to which females are advancing in their careers revealed that the progressed achieved by them is not satisfactory. Their study revealed the barriers that come in the way of career advancements.

A mentoring system designed [26] for understanding the needs of the college students about the excellent job opportunities prevailing in the market. An online system developed and implemented, which is used by the authors for online mentoring of the students.

A process skill model is proposed by Mohammed et al. [27] that aims at matching the attributes of the science discipline students with various career pathways

A psychometric test is used [28] for assessing various personality traits of the students that suit different work-related requirements. An expert system developed using advanced statistical and mathematical models to evaluate the personality traits and report the same.

3.5 Implementing Expert Systems

Expert systems play a great role in helping individuals in making proper decisions. The expert system is like a tool used for making decisions about many scenarios. Much complex system solved through expert systems. An extensive knowledgebase derived through consultations with domain experts for building the expert systems. Many recommendations were presented in the literature [18], [24], [16], [17], [21], [22], [28], [33] which are focused on the career guidance.

4.SCOPE OF USAGE OF SUDOKU GAME FOR CAREER PREDICTION

Many factors considered for assessing suitable careers to the students do not only include academic progression and also on the kind of psychology possessed by the students. Academics alone do not help in pursuing a proper career, which is the case most of the time. Recruiters generally check on the speed of solving problems, the ability to work in groups, the ability to talk correctly in English, and the extent of base technical knowledge that the students possess. It is proved time and again that these criteria proved to be wrong as many students after recruiting failed to succeed in the jobs assigned to them by the recruiters. Many psychological factors of the students play a significant role in the development of a career that predominantly includes Memory power, ability to solve problems, logical thinking, persistence, learning ability, perseverance, and the like.

A cognitive model that considers different psychological factors needed for assessing the levels of psychology and prediction model is required to help to predict suitable careers based on the Psychological standards of the student.

Game playing is proved to be the best method to assess the Psychological strength of the students. In this paper, a thorough investigation is presented to show the extent to which the Sudoku game is suitable for evaluating the psychological behavior of the students and thereby build a cognitive model used for determining suitable careers to the students

4.1 Assessing the Suitability of the Sudoku game

Many IQ tests exist in the literature for assessing the intelligence of the students, which is the most critical primary factor required to evaluate the suitability of the student to a specific career. There are many games introduced in the literature that aims to assess the intelligence of the students, but most of them lack decision-making ability. Sudoku game has been evaluated to find the extent to which the game will suffice the requirements of determining the Psychological factors of the students

Sudoku Game tried by many in the world, contributing to 1000 IEEE, 25 ACM, and 1500 other articles published on using the Sudoku game for different purposes. It is clear from these counts that the game is popular as it has been a challenging game that helps in assessing various distinct aspects. The game is quite suitable for accurately evaluating different levels of Psychology that a student possesses. The game can be used to test the decision making capability of the students. One can check the psychological levels of the students considering perseverance, intelligence learning ability, memory power, logical thinking, and the like.

Through the ability provided in-game playing any number of times, the student's perseverance and patience tested. As the student keep playing the game, the improvements gained by the students can be measured, which reflect the learning ability of the students. The amount of time taken by the student to solve the problems indicate the speed. A cognitive model can be developed using the psychological factors assessed through Sudoku Game and the model used in association with a prediction model for finding suitable careers for the students. Several kinds of Psychological factors can be evaluated using the Sudoku game, the details provided in the following sections.

4.2 Psychological factors

Emotions, thoughts, and other cognitive attributes of a person influence human behavior due to the establishment of the conceived mindset and notions. The Mindset of the students directly impacts their performance of the job assigned to them. The cognitive factors will directly influence the way persons think, especially during decision making at the time of choosing a career. Many types of psychological factors have an impact on the choice of career. Some of the most critical factors include intelligence, problem solving, memory, perception, persistence, perseverance, patient, speed, learning ability, decision making, etc. These factors can be combined with other factors related to academics and research to get overall picture of the suitability of the students for specific jobs. The scope and tenor of each psychological element detailed in the following sections.

4.2.1 Ability to solve Problem

The ability to solve complex problems of different severity within a certain amount of time, generally termed as problem-solving ability. A person is said to have the ability when they have the skill of solving the issues. The strength of a person to solve the problem depends on the way a person understands, interprets, relates, analyzes, reads through the specification of the problem, and then provides solutions that address the problem. Sometimes an expert system is built based on the understating of the problem, and then the expert system issued to solve the problem. Sudoku games provide all the foundation required to create a cognitive model. The ability to solve

the problem computed through Sudoku games based on the highest level of complexity of the problem that the student is capable of solving

4.2.2 Speed of Problem-Solving

The speed of solving the problem is related to the time within which a problem solved or number of the issues resolved within a specified period. The rate or the time during which the problem addressed depends on the complexity of the problem. More than the complexity of the problem, more time is taken to solve the problem. Sudoku game played any number of times with different levels of complexity, and therefore it can be employed effectively for addressing the issues. Sudoku game can be programmed through which the start and end time can be computed. The number of games played within a specific period counted.

Sastry et al. [34] have presented in their paper related to playing the TIC-TOC-TOE game that the average time is taken to solve a certain number of problems is the speed of the student to address the issues.

4.2.3 Logical thinking

The ability to move from one thought to others, step by step with an interlink between the steps through some connectivity or relationship, is called logical thinking. The solve through Sudoku games, one has to think step by step with proper interlink between the actions and thoughts and therefore considered as good game using which one can measure logical thinking power of the students. A person is said to be having good logical thinking power when problems of different complexity could be solved. A student can be made to solve problems with varying complexity and then compute the level of logical thinking power that the student has based on the level of the complexity handled by the student.

4.2.4 Decision-making ability

Effective decision making means, among several alternatives available, the ability to choose the best one. Decision-making ability also requires the ability to evaluate all the other options quickly and then decide to select an option that is the best one. There are many solutions for selecting for solving a problem initiated through a Sudoku game. Generally, this ability can be computed based on the kind of solution that the student has opted. If the solution selected is the easiest one, then it can be concluded that the student has best decision making power.

4.2.5 Intelligence

Intelligence defined as the ability to understand and find a solution to a problem quite quickly. Intelligence defined as the ability to use knowledge and skills to solve the problem. Application of knowledge in relatively lesser time to solve a given problem termed as intelligence. More and detailed knowledge required for solving complex problems.

When it comes to the Sudoku game, knowledge imparted to the students about rules, regulation, possible patterns, and what-if analysis, etc. quite ahead of playing the games and then make the students play the game. The intelligence of the students can then be computed based on the complexity level of the problems solved by the students. Sastry *et al.* [34] stated that intelligence alone is not the guiding factor for the selection of a suitable career. The intelligence-related psychological factor must be combined and evaluated to find the suitability of a student for a particular profession.

4.2.6 Patience - Perseverance

The ability of the students to keep trying till the time the solution to a given problem achieved is called patience. While trying out for the solution, the ability to suppress annoyance and restlessness also defined as patience. Sudoku game played any number of times. There is no limit on playing the Sudoku game. Through a computerized Sudoku game, one can count the number of times a game played before obtaining the actual solution. The kind of patience employed by the student measured by making the student play different complex problems at different levels. While patience only reveals the constant effort, Perseverance, to solve the problem, perseverance implies ongoing effort put-in by a student until the desired solution to the problem achieved. Sastry *et al.* [32] stated in their paper that the number of games played by the student reflects the student's patience and the number of games played till the time desired solution obtained are called perseverance.

4.2.7 Learning ability

If one can comprehend for the trails or experiments made and then use the comprehension to solve the problem when next time attempted is called the learning ability. One can assess the learning ability of the students based on the number of steps taken or the amount of time taken to solve the problem. A student can be said to be learning fast when the number of actions or time taken to solve the problem gradually decreases between every successive attempt.

Sudoku game played any number of times. The number of steps taken and time is taken to solve the problem counted once the game automated for every attempt made by the student. The counts can be accumulated between successive attempts and compared. The lesser the steps or time taken, the more the learning ability of the student.

Sastry *et al.* [32] stated that when a student plays the TIC-TOC-TOE game several times if the scores obtained by the student are in increasing order, then we can say that the student has good learning ability.

4.2.8 Building the cognitive model

Using Sudoku game playing, an Expert system can assess the levels of various psychological factors of a student both quantitatively and qualitatively and build a cognitive model. Based on the cognitive model, a human or an

Expert system can guess or predict what a student can do and what a student cannot do.

5 DISCUSSION AND PROPOSED SYSTEM

5.1 Discussion

During job recruitment, nowadays, a student is assessed based on his/her academic record, performance in aptitude tests, reasoning tests, technical tests, etc., but the student is not evaluated based on his/her other psychological factors. The outcome of this analytical study is the conclusion that Sudoku is the best game for assessing the psychological elements of a student. A designed Expert system will help in evaluating the psychological levels of the student.

A human expert/Expert System evaluates student's academic record and psychological levels as scores obtained in different tests to predict suitable careers for the student. Apart from the career assessment of the student, this research work can be extended to provide support for career counseling by counselors

5.2 Proposed system

The authors propose an Expert System for assessing the psychological factors of a student, build a cognitive model, and provide career assessment. It is to be developed on a Java platform to run in a Client-Server environment. It should have the necessary security features.

5.3 Game playing and score display

The student will interact with the system and plays the Sudoku game at different levels. A Sudoku game played at three different levels, which include natural, medium, and hard levels indicate the complexity of the game played. A student can perform several games at each complexity level. After playing the game, the score obtained by the student displayed and used for computing psychological level of the student.

5.4 Cognitive model and Career Assessment

Psychological levels of a student are assessed based on the scores computed after students complete playing the game. An expert model used to fix the Psychological level of the student based on the ratings obtained by the student. A cognitive model is used to build a combination of psychological factors that suit a particular job. The cognitive model includes nonpsychological elements that belong to either the academic or research in addition to the psychological factors. The pattern of psychological and nonpsychological factors mapped to different careers, and the mapping is used to predict the jobs suitable to the students. A number of expert and cognitive models presented in the literatures are worth considering and analysing the suitability of the same to fit into the models related to career assessment [31][32][33][34][35][36][37][38][39][40].

6. CONCLUSION

Psychological assessment of the students is required and also must be combined with other factors and evaluate to find the suitability of a person for a specific career or job. There are many games employed in determining the psychological level of the students. Not all games will be able to evaluate all Psychological factors of the students. One needs to find a suite of games that, together when used, will help assess the whole psychological levels of the students.

The survey is conducted to find the extent to which the Sudoku game can be employed and it is found that the game is extensive that it can be applied to evaluate majority of the psychological factors of the students, and therefore the game can be used further to develop a cognitive model for assessing the Psychological level of the students and then use it within a predictive model for finding suitable careers that can be pursued by the students.

An initiative is also required to combine the Sudoku game with another type of games so that all possible psychological factors can also be measured

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