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Dynamic Analysis of an Expert System as A Tool For Improving Students's Academic Learning :(Implementation on Number Base System)

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ABSTRACT: This work aims to revolutionize the conceptual framework stand point of expert knowledge in solving some number bases operations, need for this is to assist student in an optional dimension to understand the rudiment, both in a dynamic operability and hybrid integrated learning system. An Agile methodology was adopted for this research work, java programming language was adopted as a tool for implementation of this system, envisaged objectives were obtained, this was achieved through think tanks that spared most of their precious time in pursuance of this research goal.

Key Words: expert system, knowledge base, e-learning, binary, hexadecimal, program

I. INTRODUCTION

In spite of the Internet and the World Wide Web, which provides abundant educational resources, various computer application packages, e-portfolios and the cropping of open systems, proceeded further to enhanced student work through powerful documentations, presentations, calculations, publications, as well as formalized, integrated and logical storage of student information. All these efforts proved effective but left the tutoring side unabated(Gunwant et al., 2022).

Only human intellectuals are domination the whole scene. Therefore, this gives room for attitudes like biasness, favoritism, negligence, laziness and incompetence, which all deteriorates the quality of professional work delivered to the students in context. In spite of all these human weaknesses, the educational system is currently suffering from the inadequacy of professionally qualified staff to execute the lecturing and examining duties as the existing ones are leaving in search of greener pastures.

Bulks of semi-qualified staff have been inevitably considered to fill the gap by the ministry of higher and tertiary education. The efforts rendered by these staff are definitely below the expected professional level and hence there is absolute need to have expert system in brain drained sections of profession such as medical and information technology so that the systems can assume much of duties of tutors through provision of expert advice and decisions while lecturing.

Expert systems

An expert system is a computer program that uses artificial intelligence (AI) technologies to simulate the judgement and behavior of a human or an organization that has expertise in a particular field (Neha&Sidiq, 2021).

Expert systems involves the study and design of systems or computer systems that represents, behaves and reasons with expert knowledge in some specialist subject with a view to solving problems or giving advice in areas where human expertise is falling short. These systems are centralized on the use of the knowledge base (collection of reliable expertly gathered facts; pertaining to a particular subject, which can be formally represented if form of cases, frames, patterns, rules and semantic networks).

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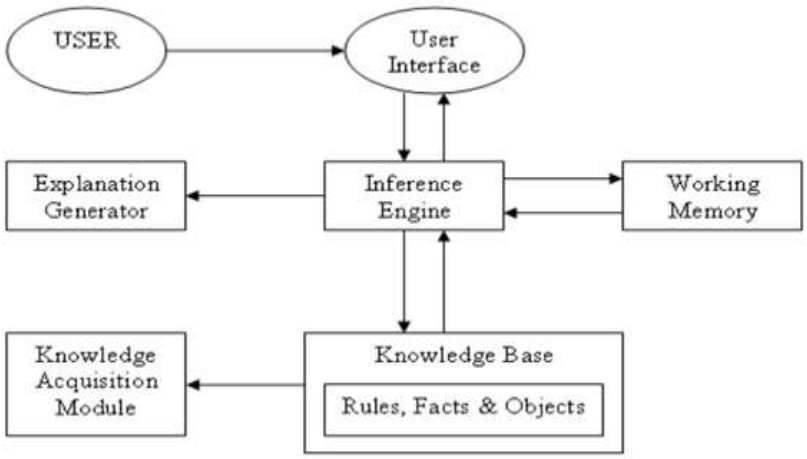
Fig 1. Expert System



(a) User

Expert systems are applicable to various trades, professions and other sections that involve human ideas, deductions and reasoning which implies that any fields that require human expertise can use it to minimize risks associated with doing the business, or improve consistence of solutions, or improve completeness, or improve accuracy or all at once while appropriate documentation of the steps followed is compiled for reference and explanations (Darlington, 2020).In addition, today's weather forecasting is inevitably done by expert systems. These systems do the actual prediction of the weather accurately, quickly and consistently unlike the case of human beings whose reasoning is sometimes unpredictable, slow and inconsistent (Giarratano and Riley, 2021). In spite of these areas, expert systems are an essential useful tool for instructing or training which makes them ideal to aid academic tutors to deliver quality data to their respective students.

(b)User Interface

In academic expert systems, the potential users are the tutors (trainers) and the tutees (students). Both interact with the system via an interactive interface where user queries pertaining to a particular subject are created and the system is then commanded to compute and decide on the solution or advice to the query. It is equipped with the unique features which allow users to ask question on how, why and what format. Student's tutorials and additional materials can be requested and passed on to the student easily over the interface.

In addition, revision and self assessment is expertly conducted between the system and the student and thus better preparation for student examinations. The tutor also uses the interface to the system to create queries on what to expertly deliver to students as well as setting parameters on computer aided student assessments, tests and marking. The actual training or instructing which is supposed to be done by the instructors can easily be conducted by the expert system on the student's pace and thus effective dissemination of data as the student interacts with the system.

(c) Explanation Generator

The explanation generator clearly explains all the procedures that the system used to reach a certain decision or advice which aids the system users to keep track of the strategies being applied to arrive at certain conclusion. During the implementation of forward or backward chaining reasoning strategies, expert systems produce permanent documentation of the decision process.

This enables the students and other users to understand better as the system documents the procedure as in an e-portfolio, unlike human explanations which can be affected by tone, vocabulary and the spellings used. Repeated use of the system by the student helps in better understanding while not bothering with the information source since machines do not get tired or bored from repetitive work human explanations.

(d) Inference Engine

The inference engine is the central processing unit of an expert system whose main role is to infer rules and facts from the knowledge base to draw conclusions, solutions or give advice

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to particular situations as defined by the user with around 100% confidence. It conducts dialogue with the user asking for information and applying it. The sequence of steps taken to reach a conclusion is dynamically synthesized with each new case and in the same time the system can process multiple values for any problem parameter to improve the breadth and depth of the goal(s) archived.In addition, these systems never "forgets" to ask questions as a human might,while providing consistent answers for repetitive decisions, processes and tasks. This makes them useful in learning environment where correct and consistent answers are tolerated.

(e) Knowledge Base

The knowledge base is independent from all other components of an expert system which makes it flexible to accept changes without affecting the whole system. It is the duty of the experts in a particular domain to research and compile data to fill into a knowledge base for use by an expert system to meet demand of expert ideas in areas where they are falling into short supply.

As the system matures, new rules maybe added and existing ones maybe amended or deleted from the knowledge base with the use of the knowledge acquisition module. All these are normally done to take into account inventions, innovations and discoveries as technology improves. In addition, some material may become obsolete and thus there will be need to update to standard material since education system is dynamic. In addition, expert knowledge is formally represented in a knowledge base which means that the system cannot forget unlike what humans do with the increase in time.

EDUCATIONAL EXPERT SYSTEM

Educational systems provide solutions to the challenges of education. Educational ES try to mimic the expertise of the human expert and present in a computerized system to assist the non-expert. Various research works give evidence that supports the efficiency of ES in the management of educational challenges. Student graduates' advisory ES is reviewed by Tawafak et al (2020) to help in knowing the positive effect of the AI approach over manual registration and verifications. This did not only help in improving graduate-advisor efficiency but also minimized the cost. Attempting to find out if AI can improve education and enhance accreditation as indicated in (Chedrawi & Howayeck, 2019) proves that AI can reshape educational processes. This supports the evidence in Radwan et al (2016) which dwells on the evaluation of the Learning Management System (LMS) to support teaching and learning. Using an integrated ES to enhance the teaching of task-based problems, (Rybina et al., 2022) student knowledge is automated in forming a unified ontological space. Also, integrating data mining in ES assist in enhancing effective teaching and learning(Yang, 2021).

In the aspect of educational management, ES has played a major role in the allocation of resources and the economic use of time for the resources (Inusah et al., 2023a). As management is a technical aspect of education and many pedagogies do not have resource managerial skills, a challenge on resource utilization to enhance effective teaching and learning is posed. Specifically, in decision-making, ES has helped domain experts to make informed decisions faster and more accurately (Sayed, 2021).

EDUCATIONAL EXPERT SYSTEMS FOR TEACHING AND LEARNING

The use of ES to enhance effective teaching and learning is a dominant field in ES in education. This aspect has gained much attention from researchers. The cost of hiring instructors to teach demonstratable lessons is unbearable for institutions. The few experts as well as the time and cost make it easier to use ES. Learners from far and near can learn remotely using ES. This is applicable both online and offline (Bradáč et al., 2022). The expertise of the teacher can be incorporated into games and simulations to assist the learner (Chu et al., 2022). Adaptability in LMS is a necessity to assist in achieving the learning process as a whole (Sridharan et al., 2021). Assessment in the form of practical exercises can be incorporated into ES to complete the learning process as suggested by (Sus et al., 2021). The various learning styles of the learners can be considered in the development and adoption of ES (Anwar, 2021). Various contents in the learning process in divergent fields of study can be presented in ES. The use of ES in education has no limitations on time and place. During a pandemic, ES is still more suitable for imparting knowledge (Al-Sanjary et al., 2021). Smart learning is enhanced using ES (Iswan et al., 2021). Learning stress can be eliminated by the use of ES (Rizki&Amalia, 2021). General evaluation of learning is practically applicable to ES (Cahyaningrum et al., 2021). Qualified instructors can be chosen for institutions through ES.

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EDUCATIONAL EXPERT SYSTEMS FOR RESOURCE MANAGEMENT

Management of educational resources for effective teaching and learning is a necessity. Pedagogical tools and content should be effectively utilized to achieve the desired quality of education. Time management and resource allocations can effectively be achieved through ES (Rosa-Rivera et al., 2021). A personalized study plan can be achieved in this (Bradáč et al., 2022). Modern technologies can be utilized in ES for the processes of education (Gabriska&Pribilova, 2021). Several decisions on the effective management of resources can be done with the use of ES (Sayed, 2021). Even in higher education, it can be used for programme accreditation (Chedrawi&Howayeck, 2019). The entire management of basic education is possible (Inusah et al., 2021) and (Inusah et al., 2023a). These resource managements catapult quality education through effective teaching and learning.

EDUCATIONAL EXPERT SYSTEMS FOR BEHAVIOUR MODIFICATION

Guidance and counselling are essential services in education for learners to identify their strengths and weaknesses. Misplacing learners in programmes without considering their backgrounds and abilities affects their growth and development in education(Bila, 2020). Higher institutions prepare learners for jobs and this is the stage ES can be used in identifying career paths (Sayed, 2021). The academic performance of learners can be predicted based on ES to assist in their career path (Neha & Sidiq, 2021). Academic advising systems can be web-based or offline (Supriyanto et al., 2019). The positive implications of online distance learning (ODL) are immeasurable (Gunwant et al., 2022). From basiceducation to the graduate level, ES can be used to advise students (Tawafak et al., 2020). Applying ES will however enhance early career determination when used at the early stages of learning.

II. METHODOLOGY

Although so many expert systems have been developed, some are even being open systems; one candesigned these expert systems for the academic industry. In this case, a knowledge base is developed to capture all the fundamental aspects pertaining to each particular module. Various expert ideas are coaxed out of human experts and encoded for use by expert systems for forward or backward reasoning strategies in problem solving. All the course outlines, lecturing materials and tutorials are expertly formulated by professionals, analyzed and formally represented into rules or frames or cases depending on the method suggested by the knowledge engineer.

An introductory course offered in nearly all the Universities and Colleges named **Introduction to computer science** which is designed to strategically introduce computer science concepts to all students in their first academic year. The course covers computer basics concepts, importance and applications as an aid to student learning, organizational and business operational needs for profit or non-profit reasons.

However, an example of expert system is a Binary Converter that performs number conversion from decimal to binary number system or vice-versa. Under normal circumstances, the conversion of any number from decimal number system to binary is done using the long division mathematical principle, noting down the remainders.

After implementing the binary converter and given to students doing Introduction to Computers, students are expected to use the program for their academic work.

RESEARCH DESIGN

The expert system (Binary Converter) performed number conversion from decimal to binary number system or vice-versa. Under normal circumstances, the conversion of any number from decimal number system to binary is done using the long division mathematical principle, noting down the remainders.

The binary equivalent is the concatenation of the remainders starting with the last calculated as the highest unit as shown by the example below:

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Convert 10_{10} into Binary equivalent.

Answer

2	10	r	0
2	5	r	1
2	2	r	0
2	1	r	1
	0		

Read the answer from bottom to top as indicated by the arrow

$$10_{10} = 1010_2$$

However, the concept of recursive long division while noting the remainder until the dividend is 0 has been considered and embedded in the design of Binary Converter Expert system. This system aids students in understanding the division process and how the actual binary equivalent value can be deduced from the results of the overall computations.

Binary Converter

The system initially prompts the user to enter any valid number from decimal number system into the text area provided on the interface. The interface allow the user to enter any particular number in decimal number system as well as the command options for the computational stages the system uses to arrive at a particular solution which is the binary equivalent by clicking the compute button as shown below:

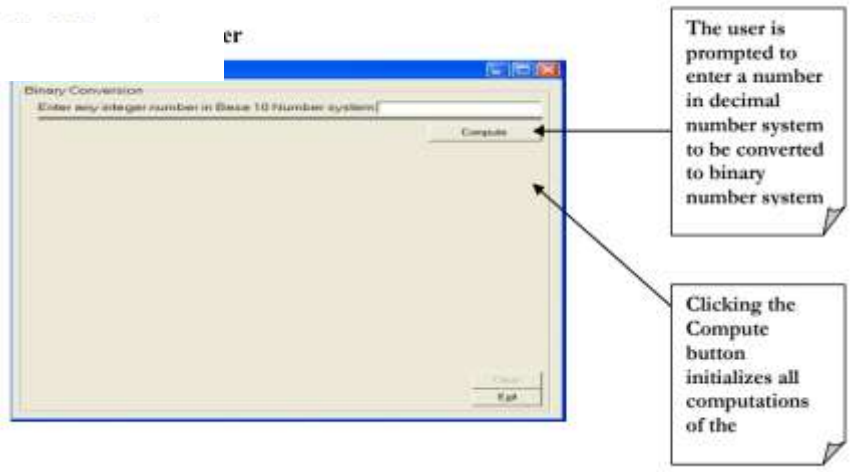

Fig. 2 Binary Converter

Entering a valid digit from decimal number system will be followed by clicking the "Compute" command which begins the conversion process by drawing the long-division horizontal and vertical lines as well as positioning the divisor , dividend, remainder and answer.

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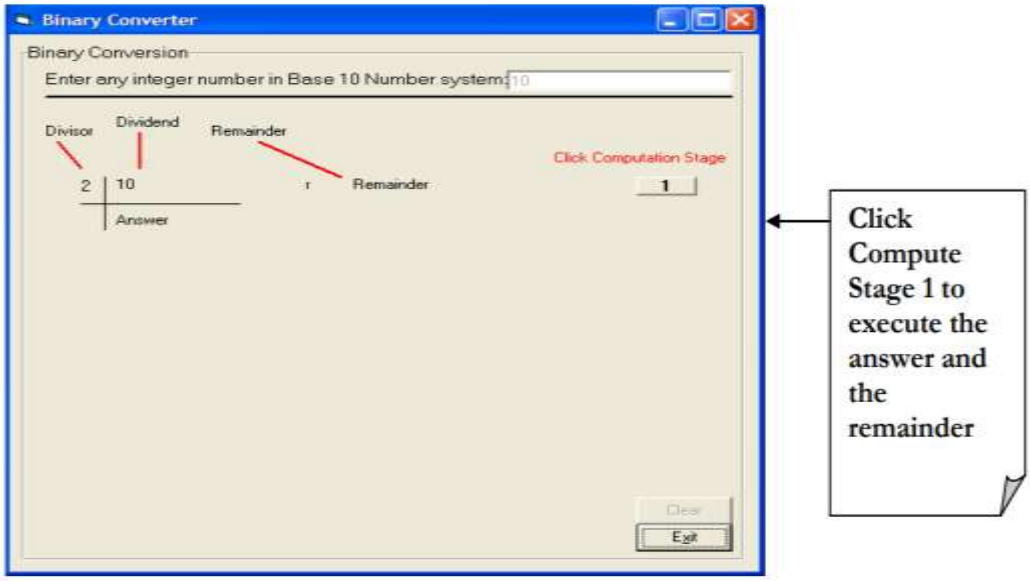

Fig. 3 Binary Converter Computation

By clicking the computational stages, the system performs the long division process until no more computations are required for the computation of the binary equivalent for 1010 as illustrated below:

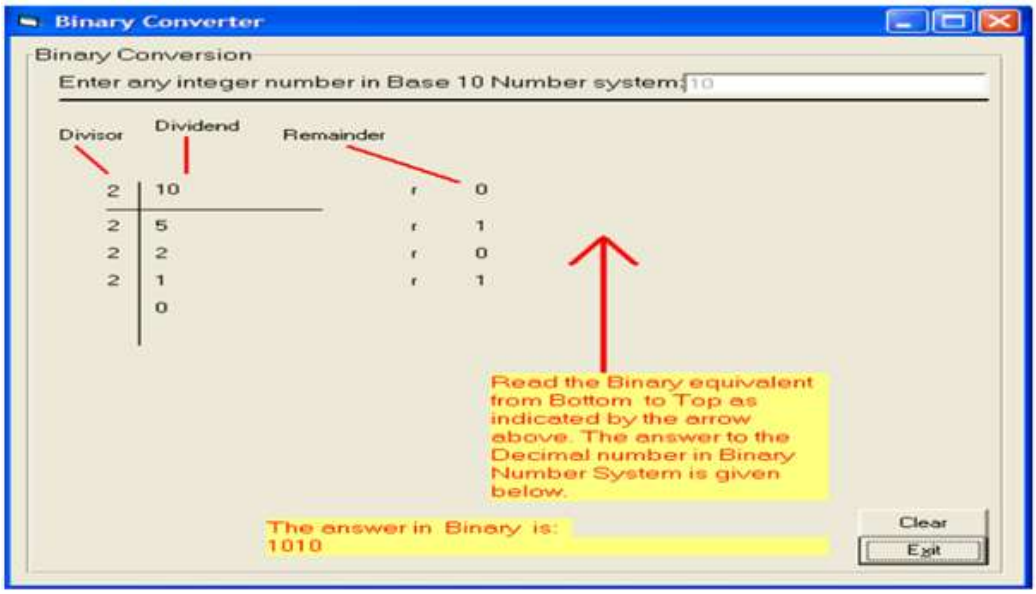

Fig. 4 Binary Converter Solution

PROGRAM CODE

1. Decimal to Binary

```
def decimal_to_binary(n):
    return bin(n).replace("0b", "")
```

2. Decimal to Octal

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```
def decimal_to_octal(n):
    return oct(n).replace("0o", "")
```

3. Decimal to Hexadecimal

```
def decimal_to_hexadecimal(n):
    return hex(n).replace("0x", "").upper()
```

4. Binary to Decimal

```
def binary_to_decimal(b):
    return int(b, 2)
```

5. Octal to Decimal

```
def octal_to_decimal(o):
    return int(o, 8)
```

6. Hexadecimal to Decimal

```
def hexadecimal_to_decimal(h):
    return int(h, 16)
```

e.g

```
number = 42

binary = decimal_to_binary(number)
octal = decimal_to_octal(number)
hexadecimal = decimal_to_hexadecimal(number)

print(f"Decimal: {number}")
print(f"Binary: {binary}")
print(f"Octal: {octal}")
print(f"Hexadecimal: {hexadecimal}")

# Converting back to decimal
print(f"Binary to Decimal: {binary_to_decimal(binary)}")
print(f"Octal to Decimal: {octal_to_decimal(octal)}")
print(f"Hexadecimal to Decimal: {hexadecimal_to_decimal(hexadecimal)}")
```

In another Language:
How to convert from Decimal to Binary

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```java
import java.util.Scanner;

public class DecimalToBinary {
    public static void main(String[] args) {
        Scanner scanner = new Scanner(System.in);

        System.out.print("Enter a decimal number: ");
        int decimalNumber = scanner.nextInt();

        String binaryString = Integer.toBinaryString(decimalNumber);

        System.out.println("Binary representation: " + binaryString);

        scanner.close();
    }
}
```

How It Works:

1. It imports the Scanner class for user input.
2. It prompts the user to enter a decimal number.
3. It uses Integer.toBinaryString() to convert the decimal number to binary.
4. Finally, it prints the binary representation.

How to convert from Decimal to Binary

```java
import java.util.Scanner;

public class BinaryToDecimal {
    public static void main(String[] args) {
        Scanner scanner = new Scanner(System.in);

        System.out.print("Enter a binary number: ");
        String binaryString = scanner.nextLine();

        // Convert binary to decimal
        int decimalNumber = Integer.parseInt(binaryString, 2);

        System.out.println("Decimal representation: " + decimalNumber);

        scanner.close();
    }
}
```

How It Works:

1. It imports the Scanner class for user input.
2. It prompts the user to enter a binary number as a string.
3. It uses Integer.parseInt() with a radix of 2 to convert the binary string to a decimal integer.
4. Finally, it prints the decimal representation.

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III. DISCUSSION

When implemented, the expert systems can utilize their ability to adaptively adjust the training for each particular student on the bases of his/her own pace of learning which in turn allows students to gain deep understanding of the fundamentals of the number systems. In addition, this expert systems will provide an excellent alternative to the private tutorial and individual training. However, in general, expert systems are the best in those situations where there is a structure that is noted as previously existing or can be elicited just like the academic environment. They also work perfectly depending on the technology used and need to be designed suiting the student's background.

Most developing countries are faced with severe brain drain, which leads to loss of knowledgeable experts in various sectors like; education, medical, engineering, mining, agriculture etc. This leaves a country with absolutely minimum resources to support economic, social and manpower development since the remaining professional will definitely fail to meet the requirements. The training of the remaining manpower to meet the necessary knowledge will be inevitable. This means that relying on knowledgeable human experts is unsustainable for economic, social and human development in the country since more and more continue to trickout with the need for greener pastures. This makes it difficult to the meet present needs without compromising the ability for future generations to meet their own needs hence no sustainable development.

Therefore, there is need to put in place a dependable system that sustains development, like an expert system. An expert system has the ability to represent multiple experts, their development and implementation in the developing economies will definitely aid in restoring the lost expertise and probably salvaging ravaging economies. This means that better professionals will be modeled without human professions to mentor but with the aid of expert systems in various fields. In addition, fuzzy expert system(instance of expert systems) also helps in representing the expertise in case where multiple experts participating in design have opposing or conflicting ideas (e.g. in areas, such as business and management), which means that a wealth of ideas are used in expert system development to promote the ultimate output quality.

IV. CONCLUSION

Finally, expert systems in their various forms have the ability to meet current needs and future needs since they cannot be affected by fatigue, death etc like humans and they can be upgraded by adding new rules and facts into the knowledge base, hence it will be cumbersome for human experts to achieve sustainable development without the interconnection with expert systems.

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