An Expert System for Academic Staff Evaluation

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ABSTRACT
Academic staff evaluation is vital for faculty growth, enhancing education quality, and ensuring accountability. Regular evaluations contribute to faculty retention, career progression, institutional planning, and external accreditation processes, promoting transparency and stakeholder confidence. Validity and reliability are two crucial factors to take into account when evaluating a questionnaire's quality. An expert system for academic staff evaluation can provide valuable assessment and evaluation by utilizing a rule-based system, gathered data from sources like student evaluations, peer reviews, and self-assessments, and providing a comprehensive report with feedback and recommendations. This paper proposes an expert system for academic staff evaluation utilizing data warehouse and data mining technologies.

General Terms
Academic Staff Evaluation, Expert System, Data Mining, Data warehouse.

Keywords
Academic Staff Evaluation, Expert System, Data Mining, Data warehouse.

1. INTRODUCTION
Academic staff evaluation is vital for faculty growth, enhancing education quality, and ensuring accountability [1]. It provides feedback for professional development, impacts student learning outcomes, and holds staff accountable. Regular evaluations contribute to faculty retention, career progression, institutional planning, and external accreditation, promoting transparency and stakeholder confidence [2].

Reliability and validity are crucial when evaluating the quality of a questionnaire [3]. Reliability measures the consistency and stability of the questionnaire's measurements, ensuring consistent results when administered multiple times under similar conditions. Test-retest reliability is assessed through correlation between responses and internal consistency. Validity ensures the questionnaire accurately captures the constructs or variables being assessed. Content validity involves consulting experts to confirm the questionnaire covers relevant aspects of academic staff experiences, attitudes, or behaviors. Construct validity evaluates if the items align with established theories or concepts related to academic staff. Criterion validity compares the results with an external criterion or gold standard measurement. Reliability and validity should be evaluated during the questionnaire's development phase [4].

An expert system for academic staff evaluation can be a valuable tool for assessment and evaluation. It would have a comprehensive knowledge base, utilizing a rule-based system to apply evaluation criteria to data. The system would gather data from various sources, such as student evaluations, peer reviews, and self-assessments. The system would apply predefined rules to the data, calculate scores, and provide a comprehensive evaluation report. Feedback and recommendations would be generated based on the evaluation results.

The rest of the paper reviews the terms then provides an expert system for academic staff evaluation before concluding the paper at the end.

2. REVIEWING THE TERMS
Expert systems (ES) are AI branches that transfer task-specific knowledge from humans to computers, enabling them to make inferences and provide specific advice, a concept developed by the AI community in the mid-1960s [5]. An expert system consists of a knowledge base, an inference engine, a user interface, and an explanation facility [6]. The knowledge base is a repository of domain-specific information, maintained by experts. The inference engine uses this knowledge to draw conclusions, make inferences, and solve problems. The user interface allows users to interact with the system, input queries, and receive responses. The explanation facility provides explanations of the system's reasoning and decision-making process.

Data Warehouse (DW) can be utilized as an expert system for applying machine learning [7]. A data warehouse is a centralized repository of integrated data from various sources within an organization, designed to support business intelligence and decision-making processes. Key characteristics include integrated data, subject-oriented organization, time-variant storage of historical data, and non-volatile data, which ensures consistency and reliability for long-term analysis and reporting. Data warehouses focus on specific subject areas, allowing for comprehensive view of the organization's data for analysis and decision-making [8].

Data mining (DM) is the process of extracting and analyzing datasets from various sources to uncover patterns, correlations, and useful information. Techniques like statistical analysis, machine learning algorithms, and artificial intelligence are used to identify patterns and relationships in structured and unstructured data [9]. Data mining in education uses techniques to analyze data to uncover hidden patterns, and relationships, enhancing educational processes and decision-making [10].

Extract, Transform, and Load (ETL) is a process used in data integration and warehousing to extract data from various sources, transform it into a consistent format, and load it into a target system like a data warehouse [11]. The process involves three steps: extraction, transformation, and loading. The extraction phase involves gathering data from various sources, such as databases, and spreadsheets. The transformation phase involves cleaning, validating, and reshaping the data to ensure consistency and compatibility with the target system. The final step is loading the transformed data into the target system, allowing for querying, analysis, and reporting.

3. PROPOSED SYSTEM

Fig 1 shows the architecture of the proposed system. The ETL process extracts and stores questionnaire data in a data warehouse.

To obtain task-relevant data from a data warehouse, define selection criteria based on specific analysis requirements, such as time periods, subject areas, dimensions, attributes, or variables. This ensures that the vast amount of data is relevant to the task at hand.

Data mining techniques, such as association rules, clustering, and classification, can uncover hidden patterns, trends, correlations, or anomalies. These techniques help organizations make data-driven decisions, identify customer preferences, market trends, user behavior patterns, and factors influencing outcomes. By analyzing the data, organizations can make informed decisions and improve their overall performance.

Fig 2 shows the class diagram of the expert system, with Knowledgebase, Staff, and Rule classes.

As shown in Fig 3, the data warehouse can indeed consist of various tables related to faculty members, students, subjects, and questionnaires. Here is a brief explanation of each table:

- **Faculty Members**: This table stores information about the faculty members, such as their names, employee IDs, contact details, academic qualifications, areas of expertise, teaching assignments, research activities, and other relevant attributes. It helps track faculty-related data for analysis and reporting purposes.
- **Students**: The students table contains data related to enrolled students. It includes information such as student IDs, names, contact details, enrollment dates, academic programs, majors, minors, academic performance records, and other relevant details. This table enables tracking and analysis of student-related information.
- **Subjects**: The subjects table stores information about the subjects or courses offered by the university. It includes details such as subject codes, names, descriptions, credit hours, prerequisites, faculty members assigned to teach the subjects, and other relevant attributes. This table facilitates analysis of course offerings, curriculum planning, and student enrollment patterns.
- **Questionnaires**: The questionnaires table holds data related to survey questionnaires administered to faculty members, students, or other stakeholders within the university. It includes questionnaire IDs, respondent IDs, survey questions, responses, timestamps, and any additional metadata associated with the questionnaires. This table allows for the storage and analysis of survey data for various purposes, such as feedback evaluation, research studies, or institutional assessments.
- **Sections**: The sections table stores information about the specific sections or class offerings within each subject. It includes details such as section IDs, associated subject IDs, faculty members assigned to teach each section, meeting times, locations, enrollment capacities, and other relevant attributes. This table facilitates the management and analysis of class scheduling, enrollment, and resource allocation.
- **Departments**: The departments table contains information about the academic departments within the university. It includes details such as department IDs, department names, department heads, faculty members associated with each department, and other relevant attributes. This table helps in analyzing department performance, faculty distribution, and resource allocation across different departments.
- **Colleges**: The colleges table stores information about the colleges or schools within the university. It includes details such as college IDs, college names, college deans, departments associated with each college, and other relevant attributes. This table facilitates analysis and reporting at the college level, allowing for insights into college-wide metrics, resource allocation, and performance.

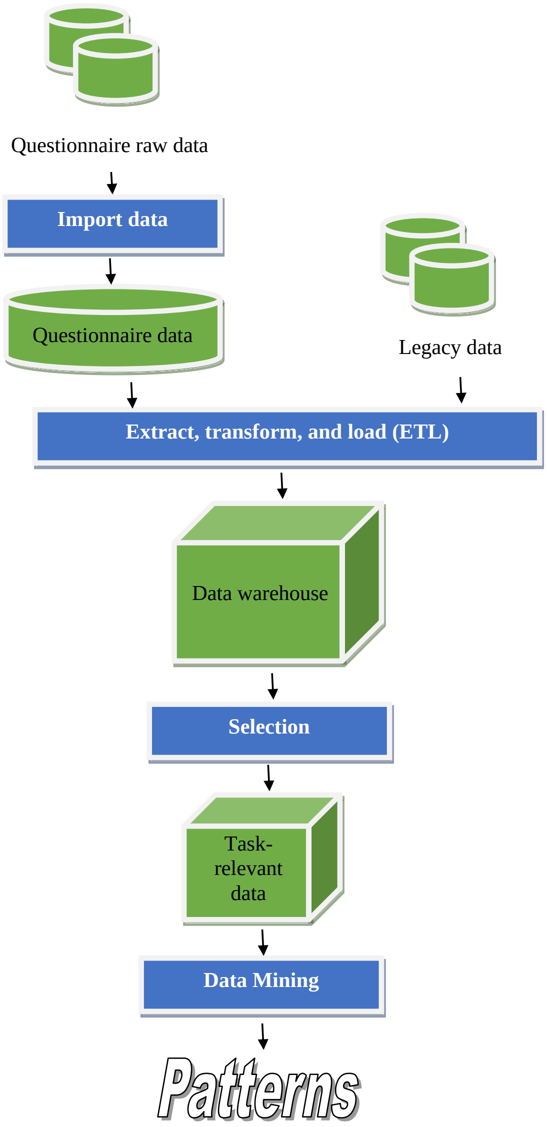

Fig 1: Architecture of the Proposed System

4. PYTHON IMPLEMENTATION

The following code snippet implements the main functionality of the expert system, i.e., the knowledge base and inference engine. This example uses a knowledge base to store three conditions for academic staff evaluation, and a Rule class to store the conditions, ratings, and recommendations. The infer method iterates through the rules, checking if each condition matches the staff member's condition. If a match is found, the corresponding rating and recommendation are returned, otherwise, a 0 rating and recommendation are returned.

```
class Rule:
    def __init__(self, condition, rating, recommendation):
        self.condition = condition
        self.rating = rating
        self.recommendation = recommendation

class KnowledgeBase:
    def __init__(self):
        self.rules = []

    def add_rule(self, condition, rating, recommendation):
        rule = Rule(condition, rating, recommendation)
        self.rules.append(rule)

    def infer(self, staff):
        for rule in self.rules:
            if rule.condition(staff):
                return rule.rating, rule.recommendation
        return 0, "Unknown"

def condition1(staff):
    return staff["teaching_skill"] >= 4
            and staff["research_output"] >= 3

def condition2(staff):
    return staff["teaching_skill"] >= 3
            and staff["communication_skill"] >= 4

def condition3(staff):
    return staff["punctuality"] >= 4
```

Now let us use the python code by initializing the knowledgebase with some actual data as show in in the following code snippet.

```
knowledge_base = KnowledgeBase()
knowledge_base.add_rule(condition1, 5, "Excellent performance. Highly recommended!")
knowledge_base.add_rule(condition2, 4, "Good performance. Recommended.")
knowledge_base.add_rule(condition3, 3, "Average performance. Improvement needed.")

staff1 = {"teaching_skill": 4.5, "research_output": 3.2, "communication_skill": 4.5, "punctuality": 4.5}
staff2 = {"teaching_skill": 3.5, "research_output": 2.8, "communication_skill": 4.0, "punctuality": 3.8}
staff3 = {"teaching_skill": 4.0, "research_output": 3.0, "communication_skill": 3.5, "punctuality": 3.0}

rating1, rec1 = knowledge_base.infer(staff1)
rating2, rec2 = knowledge_base.infer(staff2)
rating3, rec3 = knowledge_base.infer(staff3)

print("Staff 1 Rating:", rating1)
print("Staff 1 Recommendation:", rec1)
print("Staff 2 Rating:", rating2)
print("Staff 2 Recommendation:", rec2)
print("Staff 3 Rating:", rating3)
print("Staff 3 Recommendation:", rec3)
```

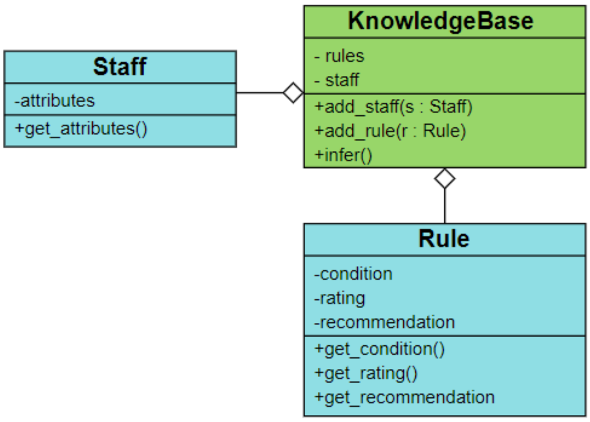

Fig 2: Class Diagram of the Expert System

5. CONCLUSION

The proposed system uses an ETL process to extract and store questionnaire data in a data warehouse, using data mining techniques to make data-driven decisions. The warehouse includes tables for faculty members, students, departments, and colleges, providing insights into metrics, resource allocation, and performance, ensuring relevance to the task at hand. The Python code snippet demonstrates the expert system's main functionality, including a knowledge base and inference engine for academic staff evaluation, storing conditions, ratings, and recommendations.

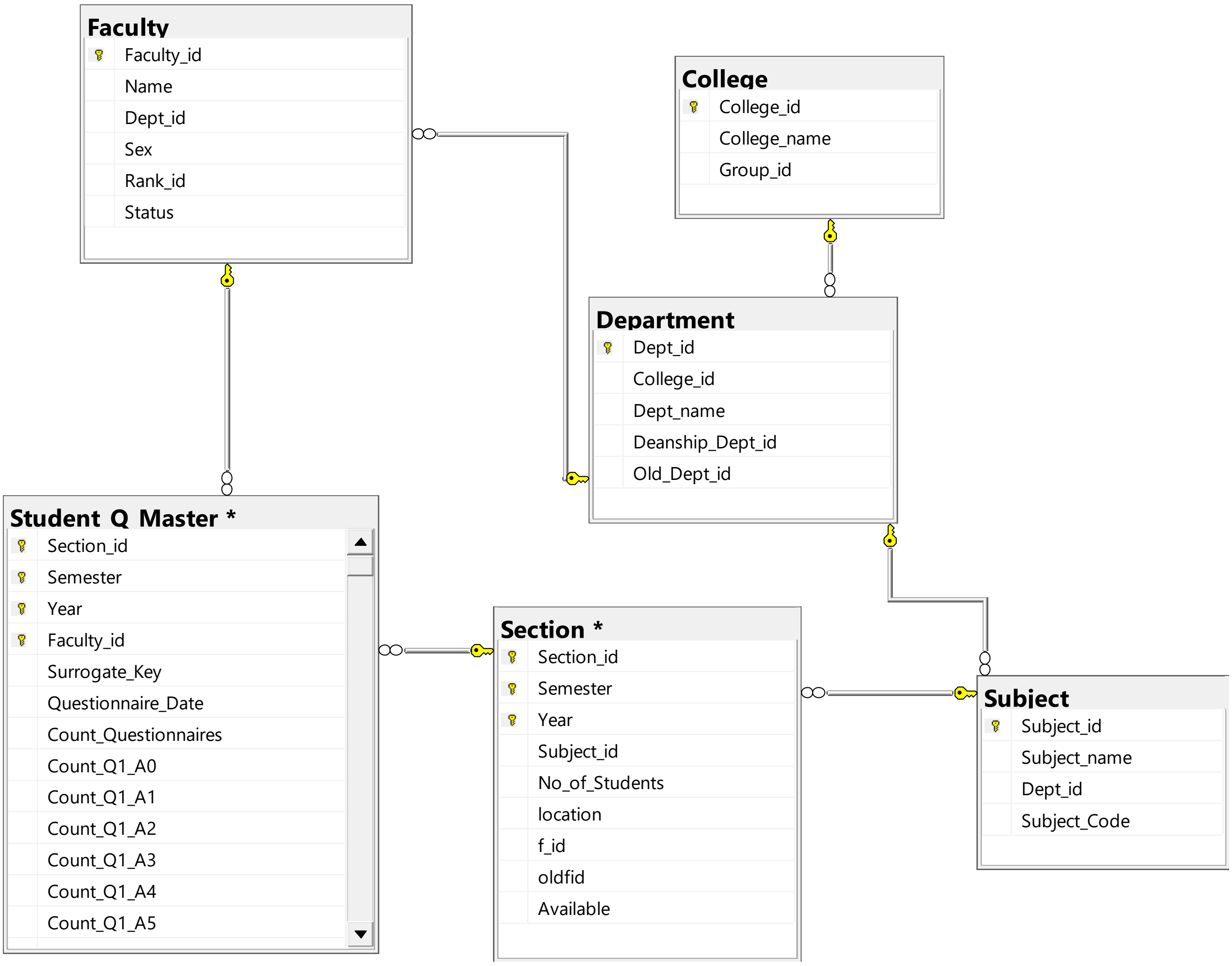

Fig 3: The data warehouse schema

6. REFERENCES

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