AI-driven Insights for Learning Difficulties in Engineering Education: Predictive Approaches and Solutions

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ABSTRACT

Student Performance Analysis Tool for monitoring early engineering subjects in both students' and faculty members' roles. The tool keeps and uses test scores, offering education that meets the topics needed for the tests. The level of coursework expected is determined by the test result for each student. Depending on student achievement, teachers place them into the three categories Good, Average, or Needs Improvement. The system after that gives test-related review questions, video links from YouTube for more in-depth learning, and book concepts that are consistent with the course curriculum. It also states possible difficulties that can slow down a student's learning. With Python being its language, Pasta uses the tabulate library to show feedback in a well-structured way. There are six important subjects offered now: Engineering Mathematics-I, Engineering Physics, Engineering Chemistry, Basic Electrical Engineering, Programming in C, and Engineering Graphics. The subjects are split into separate modules to focus the student's answer. When analytics meet handpicked learning contents, the tool transforms the learning atmosphere into something useful for students.

Keywords: Student performance monitoring, Test-wise analysis, Subject-wise module tracking, Educational resource recommendations

I.INTRODUCTION

Evaluating student performance is an essential aspect of engineering education, serving not just to assign grades but also to identify areas where students may be struggling. Looking at how students perform in their assignments is very important, since this helps assign marks and also spot any struggles. In many cases, conventional tests mainly focus on numbers, which may not consider personal issues that could slow down a student's education. Therefore, we need other tools that look at different aspects than just the basic ones. Therefore, the Student Performance Analyzer has been developed to help assess first-year engineering students by using a personal approach. By going over the test scores and the syllabus topics tested in each exam, the tool helps to assess what the student understands about the subject. It is meant to go further than checking marks and provide feedback based on every student's journey in school.

The system identifies how well the performance is by classifying it as either Good, Average, or Improvement Needed. Moreover, the tool has a list of questions for review, links to videos on YouTube for better understanding, and it recommends textbooks relevant to the topics mentioned. One important thing about the analyzer is that it pays special attention to making sure no signs of potential learning problems are overlooked and that the environment supports each student in the right way. At the moment, the app helps you study six of the main subjects taught in the first year of engineering: Engineering Mathematics-I, Engineering Physics, Engineering Chemistry, Basic Electrical Engineering, Programming in C, and Engineering Graphics. Each topic is divided into parts so that the feedback is correct and helps improve the focus area in the test. Since the tool is written in Python and relies on the tabulate library, it brings users a clear and convenient way to use the app.

This study helps to improve learning results and the quality of academic life for engineering students through detailed evaluation and the adding of related resources and assistance.

II. LITERATURE REVIEW

[1] Gómez (2025) describes many of the aspects in which AI could improve engineering education. AI is able to facilitate learning when methods fit the strengths and weaknesses of the students, thus, the process becomes less daunting for students who struggle with different subject. It adjusts the learning experience to the student's performance and progress. For an instructor, AI can help complete time-consuming tasks such as grading and maintaining oversight. AI also facilitates maintaining clarity on how well the students are learning with very little effort. In general, this viewpoint is about how to enhance teaching and learning with AI in education. However, it does not dive into how AI enhances our ability to prevent learning issues or to predict students who may be struggling to learn. It does not talk about specifications of tools and solutions to deal with students who may struggle to learn, or predictably run into learning problems. In the end, the viewpoints of AI supporting education effectively are useful.

[2] Tlili et al. (2025) studied how AI helps improve learning in education. They combined results from many studies using a method called meta-analysis.
The research found that AI has a strong impact on student achievement (g = 1.10). Chatbots were found to be the most effective among all AI tools. Other systems like intelligent tutors and personalized learning tools also worked well. The study covered various subjects and levels, not just engineering. It focused on how AI improves learning but did not explore learning difficulties. No details were given about predictive tools or solutions for weak students. The findings show that AI is useful in general learning improvement. Overall, AI can support better results across different educational settings.

[3] Babu, M., Virgin, A., Edwin, M. R., Priya, G., & Ravichandran, K. (n.d.). Identifying Learning Difficulties at an Early Stage in Education with the Help of Artificial Intelligence Models and Predictive Analytics. INTERNATIONAL RESEARCH JOURNAL OF MULTIDISCIPLINARY SCOPE. The research looks into ways that predictive analytics can help detect difficulties and weaknesses in students' education. It shows that, if a problem is discovered late, a student may start to do poorly in school and face consequences to their well-being. Data-driven actions are recommended at the starting point to enhance achievements in education. The research investigates the use of intelligent tools in helping students learn personally and lightening the workload of teachers. It also pays attention to making decisions that are right, secure, and respect the privacy of everyone involved. Different types of data are put to use in machine learning to ensure students at risk are correctly found. Making updates to the models enables them to handle any changes in education. Imbalance caused by algorithmic bias and lack of equal tech resources is accepted as a major issue for fairness. For people to trust AI apps, they need to rely on ethical actions and open data. In the end, the study considers early detection to be essential for creating education systems that are better for all.

[4] Adeyeye, O. J., & Akanbi, I. (2024). The future of engineering education: a data analytics approach. This paper studies the ways in which machine learning and data analytics are impacting engineering professions by means of personalized learning. It relies on using recent data to help predict a student's achievements and design lessons to suit each student. Unique

learning behaviors are spotted by adaptive systems, helping to increase how interested students are and how well they do. Identifying at-risk students early is possible with such tools, so teachers can help as soon as possible. Using these technologies enables teachers to make better plans for their curriculum with the help of data. The paper draws attention to the ethical problems related to data and points out how key privacy, consent, and trust are required. It tries to overcome the problem that some regions do not have enough technology to take advantage of AI. It is very important to focus on equal access to benefit from new educational technologies. Key stakeholders working together is considered necessary to use AI responsibly and include everyone. All in all, the study seeks to create an education system that makes use of technology, is ethical, and better fits the expectations of work environments.

[5] Alam, A. (2023). Improving Learning Outcomes through Predictive Analytics: Enhancing Teaching and Learning with Educational Data Mining. International Conference Intelligent Computing and Control Systems. In this study, Educational Data Mining (EDM) is explored as a helpful method for improving how students learn using academic data. Using EDM helps expose useful trends that can inform how teachers instruct and choose learning theories that explain students' actions. Educators can find out about students' learning habits by examining their performance and the way they use tools in the classroom. By working with EDM, research gathers insights from lots of data for better guidance in education. It allows teachers to spot specific strengths and issues of each student, so they can modify the materials on the spot. The paper points out that EDM has the ability to determine academic performance, spot tough topics, and suggest helpful interventions. They improve teachers' responsiveness and encourage fast learning for students. Encouraging students' engagement is noticeable when their teaching is adapted to them individually. The research considers EDM as a way to bring positive changes to education. Overall, it proves that EDM helps shape choices that lead to greater success in schools.

[6] Harsha et al. (2024) Investigated how machine learning could enhance personalised learning. They developed predictive models using student data including previous marks and engagement, and used the models to help teachers understand each student's strengths and weaknesses. Regression methods were used which allowed students to be grouped more accurately for effective teaching. Predictive tools support early identification of students who may need additional support. The approach confirmed that predictive tools could provide focus in learning, reinforcing learning where the focus would be more effective.

[7] Vladova and Borchyk (2024) created a model to evaluate student performance, using several machine learning techniques. They used three methods: logistic regression, linear regression, and k-means clustering, for better accuracy. The model itself uses normalized scores, rankings, and comparisons of performance trends to improve accuracy. It predicts pass/fail outcomes with 90% accuracy and can estimate scores with 70% accuracy. Students are grouped based on similar behavior and/or learning patterns to provide better instructional support. This model is a helpful way to identify students who may not succeed early in the semester, and intervene in a timely way to improve student learning outcomes.

[8] Besbes (2016) created a learning environment enhancement plan (LEEP model) to assist with teaching and learning and educational improvement through data mining. It obtains data from classrooms, surveys and STEM exam scores to identify patterns of potential utility in learning. The framework incorporates aspects of cognitive science and education theory in order to create better ways to teach. Both numerical and descriptive data are examined to analyse how students are engaging with learning in classrooms. Ultimately, this allows the development of learner and educator profiles in order to create better teaching approaches. All in all, the LEEP initiative

champions students in a personalized learning experience and promotes educator improvements based on actual data from education and educational research.

[9] Boda and Svihla (2020) theorize about inequitable access to technology in STEM education. They articulate how technology can support and enlarge differences across students from different backgrounds. The chapter considers the importance of engaging with technological tools that are cognizant of students' cultural and social contexts. The chapter reflects on the importance of training teachers to be able to contextualize lessons that are more diversified and engage students more appropriately. Limited access to digital tools may limit certain students while providing more benefit to others with less need which provides additional complexity. The authors cast a vision for an equitable, tech-driven STEM education model that gives all students a fair chance to succeed.

[10] Ravikumar and Sasikala (2024) explore how predictive models can help improve engineering education. They link falling student numbers to job market concerns and stress the need to boost employability. The study uses student data to group learners based on academic background and personal skills. Teachers can use this grouping to adjust their teaching methods for different student needs. A linear regression model was used to predict CGPA, and clustering helped spot students needing extra help. While effective, the study doesn't discuss data bias or how well the findings apply to larger groups.

III. PROPOSED METHODOLOGY

The proposed methodology used for evaluating student performance across a variety of subjects and assessments, while offering suggestions to improve their performance using rule-based approach, includes the following actions:

- Data Structuring: It creates a dictionary that organizes specific data relevant to each subject which include: modules, important questions, main topics, textbook references, linked YouTube videos for help, and suggestions that vary according to each learning disability.

- Collecting User Input: The system prompts the user for the total number of students. For each student, it collects basic information (name and University Serial Number; USN). The user selects which assessment test the student took; Test 1, Test 2 or Test 3.

- Setting up Test Parameters: After selecting an assessment test, the program isolates the appropriate modules and identifies the maximum total marks:

- **Test 1:** Covers Module 1 with a maximum of 15 marks per subject.
- **Test 2:** Covers Modules 2 and 3 and has a maximum of 30 marks per subject.
- **Test 3:** Covers Modules 4 and 5 and has a maximum of 30 marks per subject.

- Record the Performance Data: The user enters the student scores for each subject on the selected test.

- Analyze the Performance: Each subject score for the student is analyzed into performance categories**:**

- **Needs Improvement:** Scores below a defined threshold.
- **Average:** Scores within a middle range.
- **Good:** Scores exceeding a higher threshold.

Generation of Personalized Feedback: For each subject, the program compiles: **Educational Records**

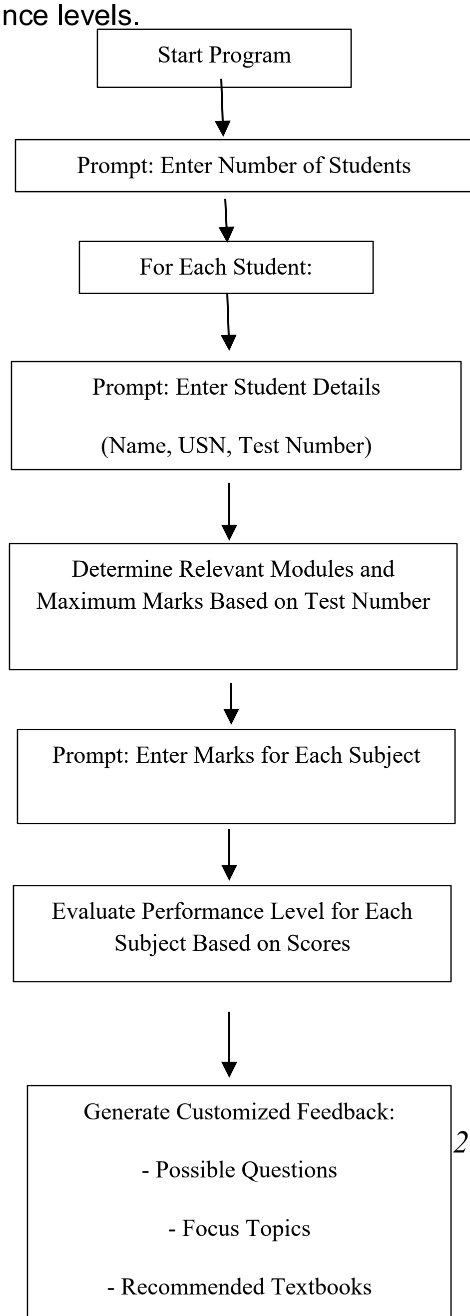
i) A selection of potential questions from the pertinent modules to guide targeted study.
ii) Primary topics that warrant attention based on the student's performance.
iii) Recommended textbooks for comprehensive understanding.
iv) Curated YouTube links for visual and auditory learning support.
v) Information on any learning disabilities relevant to the subject, providing insights into potential challenges and accommodations.

Compilation and Presentation of Reports:

i) The program organizes the collected data into a tabular format, delivering a detailed report for each student.
ii) This report encompasses the student's scores, performance level, suggested study materials, and additional resources.

Visual Representation of Performance:

A pie chart is generated to visually represent the student's overall performance in the test. The below Fig.1 illustrate the proportion of total marks obtained relative to the maximum possible, categorized by performance levels.



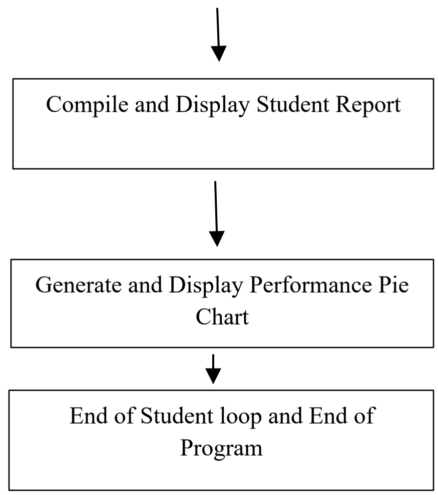


Fig 1: Flow Diagram of Proposed Methodology

Assessing student performance across various subjects and tests requires a structured approach to provide personalized improvement suggestions. Initially, it's essential to organize detailed information for each subject, including modules, potential questions, key topics, textbook references, supplementary YouTube links, and considerations for specific learning disabilities.

IV. RESULTS AND DISCUSSION

The process begins by collecting user input: determining the number of students and gathering each student's personal details, such as name and University Serial Number (USN). Additionally, identifying which test—Test 1, Test 2, or Test 3—the student has taken is crucial. Based on the selected test, the relevant modules and maximum possible marks are established:

Test 1: Covers Module 1 with a maximum of 15 marks per subject.

Test 2: Encompasses Modules 2 and 3, totaling a maximum of 30 marks per subject.

Test 3: Includes Modules 4 and 5, also with a combined maximum of 30 marks per subject.

During performance data entry, the user provides the marks obtained by each student in their respective subjects and selected test. Based on these scores, the system assesses and classifies the performance into three distinct categories.: **Need Improvement**, **Average**, **Good**

Subsequently, customized feedback is generated for each subject, compiling:

- A list of potential questions from the relevant modules to guide focused study.

- Key topics that require attention based on the student's performance.
- Recommended textbooks for in-depth understanding.
- Curated YouTube links for visual and auditory learning support.
- Information on any pertinent learning disabilities, offering insights into potential challenges and accommodations.

The information is organized in a logical table layout, and provides a comprehensive report for each student. The report includes their marks, category performance levels, recommended learning materials, and other resources. In addition, each student has a pie chart that summarizes the marks received and total possible, broken down by category. This is done for each student individually so that they receive an assessment and the recommendations are directed toward them.

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STUDENT PERFORMANCE IN TEST AND SUGGESTIONS

Enter total number of students: 1

Enter Student Details:
Name: Sharu
USN: 4vv23scs05
Enter Test (Test 1 / Test 2 / Test 3): Test 2

Enter marks out of 30 for each subject:
Engineering Mathematics - I: 25
Engineering Physics: 21
Engineering Chemistry: 19
Basic Electrical Engineering: 28
Programming in C: 29
Engineering Graphics: 30
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Fig 2: Student Input Interface for Generating Personalized

Report for Sharu (4vv23scs05) - Test 2

Subject	Marks	Suggestion	Possible Questions	Focus Topic
Engineering Mathematics - I	25	Good	Evaluate ∫x^2 dx. Explain integration by parts. Find ∂z/∂x for z = x^2 + y^2. Chain rule in partials?	Definite/indefinite integrals, Partial differentiat
Engineering Physics	21	Average	Explain double slit experiment. Interference patterns? Working of He-Ne laser? Population inversion?	Interference, Stimulated emission
Engineering Chemistry	19	Average	Nernst equation? Conductivity of electrolyte? Types of corrosion? Galvanic cell?	Cell potential, Prevention of corrosion
Basic Electrical Engineering	28	Good	RMS value? Impedance of RLC circuit? EMF equation? Types of transformers?	AC analysis, Working principle
Programming in C	29	Good	If-else usage? Switch case example? Recursive factorial? Function parameters?	Decision structures, Modular code
Engineering Graphics	30	Good	Top/front view of object? Third angle projection? Draw isometric cube. Isometric of cone?	Projections, 3D Representation

Textbook	YouTube	Learning Disabilities
Higher Engineering Mathematics by B.S. Grewal	https://www.youtube.com/results?search_query=module+2+engineering+maths+1st+sem https://www.youtube.com/results?search_query=module+3+engineering+mathematics	Dyscalculia (difficulty with numbers and calculations)
Engineering Physics by M.N. Avadhanulu	https://www.youtube.com/results?search_query=physics+module+2+engineering+1st+sem https://www.youtube.com/results?search_query=physics+module+3+engineering+1st+sem	Difficulty with abstract concepts and visualization
Engineering Chemistry by Jain & Jain	https://www.youtube.com/results?search_query=Engineering+Chemistry+module+2+engineering+1st+sem https://www.youtube.com/results?search_query=Engineering+Chemistry+module+3+engineering+1st+sem	Trouble with memory retention of chemical names and reactions
Basic Electrical Engineering by V.K. Mehta	https://www.youtube.com/results?search_query=Basic+Electrical+Engineering+module+2+engineering+1st+sem https://www.youtube.com/results?search_query=Basic+Electrical+Engineering+module+3+engineering+1st+sem	Difficulties in understanding complex circuit diagrams
Let Us C by Yashavant Kanetkar	https://www.youtube.com/results?search_query=Programming+in+C+Engineering+module+2+engineering+1st+sem https://www.youtube.com/results?search_query=Programming+in+C+Engineering+module+3+engineering+1st+sem	Difficulty with logic building and abstract syntax
Engineering Drawing by N.D. Bhatt	https://www.youtube.com/results?search_query=Engineering+Graphics+module+2+engineering+1st+sem https://www.youtube.com/results?search_query=Engineering+Graphics+module+3+engineering+1st+sem	Difficulty with spatial reasoning and 3D visualization

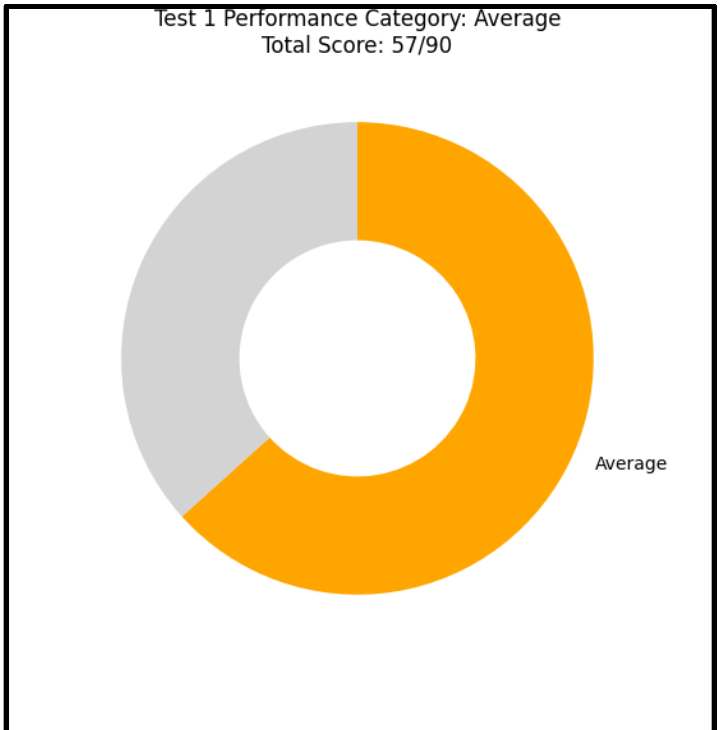
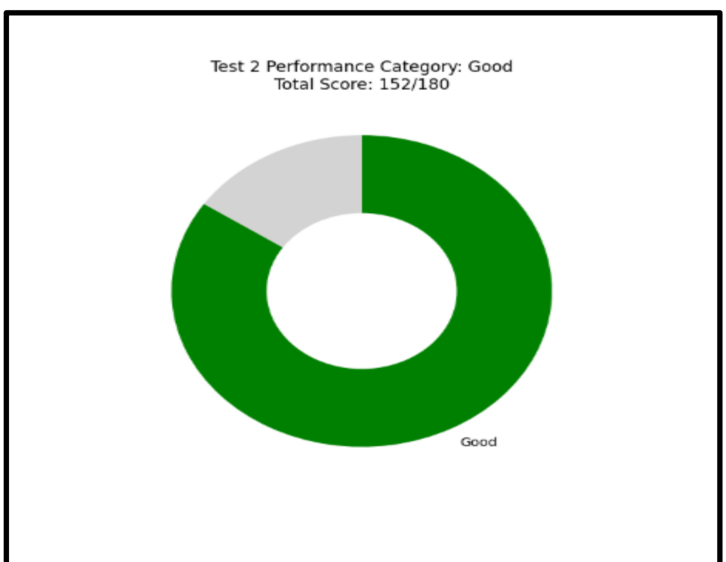


Fig 4: Donut Chart Representing Test 1 Performance Category and Total

Fig 5: Donut Chart Representing Test 2 Performance Category and Total Score



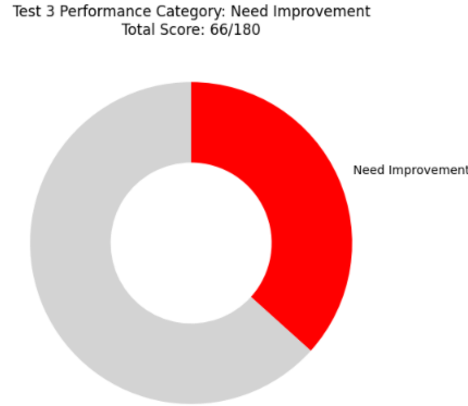


Fig 6: Donut Chart Representing Test 3 Performance Category and Total Score

The Fig 2 to Fig 6 show a system that collects student test data and provides feedback on each subject area. The system originally provides detailed 'reports' containing marks, learning resources, and subject-specific focus areas. It also makes 'donut' charts to help visually represent level of overall performance in terms of Test 1, Test 2, and Test 3, and these visualizations help quickly identify whether the student's performance is Good, Average or Needs Improvement. Overall, the system enables personalized learning by linking scores to specific resources and suggestions.

V. CONCLUSION

The assessment of student performance across subjects and tests is a structured process designed to recommend individual student pathways toward learning growth. Academic or content-based information is the first step in organizing subject content (which content is sequenced into modules, along with guides for open learning five of the top ten questions being asked, highlighted content within modules, recommended textbooks, free Youtube video explanations, gained insight into recommended supports for any learning challenges). The program starts with the request for the number of students were to be analyzed entered and recorded essential information for students, name and University Serial Number (USN), and indication of which one of the three test modules Test 1, Test 2, or Test 3 was attempted. Each test had specific modules and specific marks distributions attached to them:

- Test 1 assesses Module 1, with a maximum of 15 marks per subject.
- Test 2 covers Modules 2 and 3, with a combined total of 30 marks per subject.
- Test 3 focuses on Modules 4 and 5, also carrying a maximum of 30 marks per subject.

Upon selecting the test, the user enters the scores for each subject. Then, those scores are examined and placed into one of 3 categories: Need Improvement, Average, Good

The evaluation standards can vary depending on the test format so that it reflects the correct score value ranges. Based on those classifications, the system will provide individualized feedback per subject that will include:

- A bank of recommended questions based on the test modules the students received
- Topics to note for further practice

- Relevant textbooks for further study
- Curated videos for additional help
- Notes on relevant learning disabilities and supports

All the feedback will be presented in a clear table format and will provide a complete overview of each student that is individualized. The process will also produce a pie chart for each student that demonstrates their score and the distribution of scores and level of performance. This process will repeat this process for all the students to ensure that the reports are personalized and detailed.

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