Journal of Al-Qadisiyah for Computer Science and Mathematics Vol.17.(2) 2025,pp.Comp 272–280

Available online at www.qu.edu.iq/journalcm

JOURNAL OF AL-QADISIYAH FOR COMPUTER SCIENCE AND MATHEMATICS

ISSN:2521-3504(online) ISSN:2074-0204(print)

Artificial Intelligence in the Educational System: Theoretical Perspectives and a Practical Application for Cheating Detection in Examination Halls"

Ahlam Abbas Betti[a], Ghufran Abbas Betti[b], Ali H. Naser[c]

[a] *Technical Institute of Al-Diwaniyah, Al-Furat Al-Awsat Technical University (ATU), Iraq , dw.ahl@atu.edu.iq*

[b] *Department of Computer Systems, Al Nassriyah Technical Institute, Southern Technical University, Thi-Qar, Iraq , ghufran-abbs@stu.edu.iq*

[c] *Dhi-Qar Education Directorate, Iraq, prog.ali95@gmail.com*

ARTICLE INFO

Article history:

Received: 29/04/2025

Rrevised form: 19/06/2025

Accepted : 25/06/2025

Available online: 30/06/2025

Keywords:

Artificial Intelligence in Education, Cheating Detection, Face and Eye Tracking, OpenCV, Arduino, Academic Integrity, Support Vector Machine, Real-Time Monitoring

ABSTRACT

This article reviewed some of the roles played by artificial intelligence (AI) as a modern technology in the educational system. We also tested an AI-based application to detect cheating during exams by analyzing facial and eye movements. The system uses computer vision techniques via the OpenCV library, along with an alert device designed based on Arduino, allowing for real-time monitoring and response. Haar Cascade algorithms were used to detect faces and eyes, and head movement and gaze direction were tracked using optical flow and motion center calculation techniques. An SVM classification algorithm was used to identify suspicious behavior based on features extracted from the image. Experiments showed that the proposed system achieved an accuracy of more than 90% in detecting cheating cases in real time. There are also some challenges such as poor lighting. The research is considered a contributing factor in enhancing academic integrity in educational institutions. The results indicate that AI-based surveillance systems can be effective in educational settings, and suggest future development of the system using deep learning techniques and multiple cameras to improve performance.

https://doi.org/10.29304/jqcsm.2025.17.22202

1. Introduction

In recent two decades, Artificial Intelligence (AI) has become one of the most transformative technologies in recent societies, significantly changes in sectors such as healthcare, finance, transportation, and particularly, education. As educational institutions endeavor to keep up with the swift technological advancements, AI provides robust tools to customize learning experiences, automate administrative functions, enhance teaching methodologies, and boost student performance through insights derived from data. According to , AI has the potential to usher in a new era of intelligent tutoring systems, adaptive learning platforms, and predictive analytics that assist both educators and learners in unprecedented manners (Holmes et al., 2019).

∗Corresponding author: Ahlam Abbas Betti

Email addresses: *dw.ahl@atu.edu.iq*

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Artificial intelligence provides a valuable opportunity to utilize a broad spectrum of well-structured and relevant knowledge within the educational process to address specific learning challenges, tailored individually for each learner. The use of "intelligent" learning tools, diverse educational software platforms, adaptive virtual assistants, and AI-powered chatbots marked a significant phase in the application of artificial intelligence in education a phase that has largely evolved. In agreement with academic perspectives, we further develop the concept of AI's deeper potential in education: improving the comprehension and analysis of human learning mechanisms, enabling their assessment, and promoting greater awareness of these processes(Chen et al., 2020; Holmes et al., 2019; Mohammed et al., 2025; Williamson & Eynon, 2020).

The global trend towards integrating artificial intelligence into education is increasingly characterised by the automation of many educational processes. Activities such as the explanation and delivery of instructional content can now be automated and customized to suit the learner's age, as well as their physiological and psychological traits. as shown in VARK model (1987) The method of presentation is also highly flexible, capable of adapting rapidly to changes in the predominant modes of cognitive information processing such as auditory, visual, verbal, and kinesthetic inputs. Through this approach, students have a benefit from more efficient and accessible training, which is give them an ability to improve their problem-solving skills and capacity for independent searching.

The use of AI in education is wide-ranging. Besides its capability to optimize and personalize learning experiences, AI assists in the interpretation of large data sets, so it becomes simpler to recognize complex worldwide issues that are yet to be solved. Moreover, AI may assist in predicting future education or society issues and formulating the means to moderate their destructive effects. The more multimodal information is processed, the deeper learning of learning material becomes and new opportunities emerge for applying this knowledge in practice. However, certain threats are raised by some studies in humanities to the negative influence of AI, including higher unemployment (Park & Kwon, 2024), the capacity to manipulate people's opinions, and violation of people's privacy (Farhan et al., 2024). Despite these concerns, scholarly interest in applying AI in the context of education persists and will most probably grow. For this purpose, there must be further research into proper and effective applications of AI in education, hard defense against its possible harms, and the creation and implementation of clear ethical guidelines and regulatory mechanisms for its appropriate utilization.

This paper shows the role of AI in recent education system, by highlighting some of theoretical applications and a practical implementation developed by the author. The proposed AI model system plans to detect cheating behaviors in examination halls using AI-powered face and eye movement tracking. Python and OpenCV are used to implement This real-time monitoring approach and introduced promising results in identifying abnormal activity such as frequent head turning or eye movement beyond a defined threshold. By using AI technologies, this system contributes to create fair testing environments and strengthening the credibility of digital education.

The study is structured as follows: section 1 is an introduction about the role of AI in educational system, section 2 focused on a literature review on AI applications in education, showcasing recent advancements and ongoing challenges. Section 3 addresses the methodology used to develop the AI cheat detection system, including hardware and software components. in Section 4 we did a discussion about the results of the implementation and evaluates the system's effectiveness. Section 5 is a discussion of findings, potential limitations, and suggestions for improvement. Finally, Section 6 concludes the paper by summarizing key insights and future prospects for AI in education.

2. Related works

currently, there has been a growing international movement for using and integrating artificial intelligence (AI) into the education sector. because of the unique features of AI, the field also explores wide educational effects. (Luckin et al., 2016) suggested that Artificial Intelligence in Education (AIED) surpasses traditional educational technologies by leveraging intelligent algorithms to optimize learning processes. Similarly, (Holmes et al., 2019) categorized AI in education into two areas: "learning about AI" and "learning with AI." He also emphasized distinguishing between the content of AI education and the methods used to teach it. AI-integrated education, therefore, can be viewed as an evolution of earlier models based on information and communication technologies (ICT), as noted by the Busan Metropolitan City Office of Education (2019).there are discussions ongoing revolves around redefining what and how students should learn in an AI-driven world. For example in the United States the Computer Science Teachers Association (CSTA) introduced the "Computer Science for K–12 Standards." In cooperation with the Association for the Advancement of Artificial Intelligence (AAAI), CSTA formed a joint council for AI education in 2018 with the Association for the Advancement of Artificial Intelligence . This partnership led to the development of the "AI4K12" project, proposing five big ideas for AI education, and are making efforts in AI education (Touretzky et al., 2019) .K12-AI claims that students in the era of AI will have a significantly different relationship with technology than previous generation students.

It also emphasizes teaching students in constructivist learning, design, and creative thinking to become citizens of the age of AI (Ali, 2024), it is crucial to nurture students through constructivist educational methods, encouraging innovation, problem-solving, and critical design thinking to prepare them for active citizenship in the age of AI. Furthermore, (Wong et al., n.d.) asserted that acquiring AI literacy understanding and applying AI technologies — should be part of mandatory education. This, he argued, is essential not only for personal development but also for equipping future professionals with necessary technical skills. He also highlighted the importance of reforming teacher training, updating school curricula, and fostering collaboration among stakeholders in education.

when Most who concerned see AI as a tool, but some educate purely on AI, approaching AI education as an extension of science, technology, engineering, and mathematics (STEM) education(Neha, 2020). A key concern is ensuring students gain a clear understanding of AI systems in accordance with their cognitive levels. The "Five Big Ideas in AI," proposed by AI4K12, serve as a central educational model. These include: perception, representation and reasoning, learning (e.g., machine learning and deep learning), natural interaction, and social impact (Touretzky et al., 2019)

Moreover, the curriculum for AI education increasingly addresses ethical dimensions. (Coeckelbergh, 2019) argued that machine learning can reinforce biases, raising concerns that go beyond data privacy to include accountability, job displacement, and broader societal effects. These ethical issues align with the recommendations made by the Ministry of Education (2020), which introduced dedicated AI subjects such as "AI Ethics," "AI Mathematics," and "AI Fundamentals" to help students understand the ethical and societal implications of artificial intelligence. This intersection between technical literacy and ethical awareness reflects a comprehensive approach to seeing AI both as a tool and as a subject in educational system.

in addition, educational researchers are actively exploring AI-related domains, including "computational thinking" and "software (SW) competency," aligning with competency-based assessment approaches (Choi, 2019). However, since AI is a relatively new field of study, the working on define and assessment of AI efficiency is still underdeveloped (Park & Kwon, 2024).(Seong-Won Kim & Youngjun Lee, 2022) developed a tool that can test the opinion toward AI to suit each middle and high school .

(Hyung-Jong1 et al., 2020)developed an instrument to measure changes in attitude and efficacy toward AI in AI project classes .Furthermore, previous works developed tools to assess students' point of views toward AI in middle and high school contexts (Seong-Won Kim & Youngjun Lee, 2022), and (Hyung-Jong1 et al., 2020) created a scale to evaluate changes in student attitudes and self-efficacy during AI-based project learning. Lee et al. (2019) also designed a program focusing on technologies of the Fourth Industrial Revolution, including AI.

AI education and assessment is remain limited (Farhan et al., 2024; Wang et al., 2024). As previously mentioned, different subjects implement AI education in diverse ways. For example, in science education, a learning intervention helped learners understand scientific principles through constructivist practice by creating an AI-based mixed reality system (Hussein, 2024). Furthermore, a study analyzed AI tools for their application in computing and intelligent learning in mathematics (Van Vaerenbergh & Pérez-Suay, 2021). In addition, researchers often conduct studies using translation services, chatbots, and AI-powered smart speakers in English language education, depending on the characteristics of the subject matter (Ratnam et al., 2023) and (Malinka et al., 2023).

Though not directly related to secondary education, a study targeting non-engineering university students showed that STEM-based AI programs can significantly improve AI literacy (Yuskovych-Zhukovska et al., 2022). While most AI education research focuses on either "learning with AI" or "learning about AI," science and math education studies demonstrate that hybrid approaches are also viable.

Regarding trends in computer education, (Park & Kwon, 2024) employed topic modeling to analyze South Korean secondary education research between 1998 and 2020. Their findings showed that programming and software were dominant themes from 2007 to 2018. Notably, AI, which had not previously ranked among the top 10 keywords, emerged as the most prominent research topic by 2019. Teachers have shown growing interest in AI and acknowledge the importance of AI education (Ryu & Han, 2018). However, despite AI and machine learning's critical role in modern computing, educational research on systematic machine learning instruction remains limited (Tedre et al., 2021). Moreover, a study on elementary teachers' perceptions of AI education revealed that 65.4% lacked confidence in teaching the subject (Lee, 2021), and Shin (2020) found that educators held negative views regarding the quality and evaluation of AI-integrated teaching. This suggests a disconnect between academic enthusiasm for AI and the realities within schools.

Despite the tremendous developments witnessed worldwide in the field of education, the educational reality in Iraq has not kept pace with these rapid developments. This is attributed to the weakness of educational and scientific institutions. The education system in Iraq suffers from multiple problems that negatively impact the outcomes of the educational process, from kindergarten to higher education. Kindergarten is a fundamental stage in shaping a child's educational foundation. Therefore, there is an urgent need for professional development for teachers, which will positively impact student performance and the development of their talents (Ali, 2024).

Classifications of AI in Education (Wang et al., 2024) conducted a systematic literature review and identified key classifications for AI usage in education:

1. Adaptive Learning and Personalized Tutoring: AI-powered Intelligent Tutoring Systems (ITS) provide real-time, individualized feedback based on students' learning behaviors. Adaptive Hypermedia Learning Systems tailor content dynamically.

2. Intelligent Assessment and Management: These tools automate performance evaluation and classroom management, supporting collaborative learning and student interaction monitoring.

3. Profiling and Prediction: AI models analyze data to predict academic performance, dropout risks, and learning preferences, enabling early interventions.

4. Emerging Products: These include AI-driven educational robots, virtual/augmented real

The Iraqi Ministry of Higher Education and Scientific Research recently announced a move to integrate artificial intelligence technologies into academic programs, while also indicating a plan to sign memoranda of understanding and provide fellowships for students at international universities.

(Ali, 2024) predict the performance of kindergarten teachers in Iraq and identify the key characteristics that influence their performance. Three artificial intelligence techniques were used: the Naive Bayes (NB) algorithm, the Support Vector Machine (SVM), and the Deep Neural Network (DNN) to evaluate and improve teachers' performance. Two methods were also used to select important features: the wrapper method and the filter method. This was done to discover the factors that most influence teachers' performance, and to calculate the correlation coefficient between these factors to understand their interrelationships.

(Farhan et al., 2024) This research investigated the effect of the application of artificial intelligence techniques on enhancing higher education services quality, from the perspective of students who attend the College of Pharmacy, University of Baghdad. The study adopted a sample of 379 male and female students and used a descriptive-analytical method with a questionnaire as the principal tool for data collection. The findings of the study revealed that the implementation of AI techniques made a positive contribution with a significant impact to the high quality of educational services. The study also revealed that there was a statistically significant and strong correlation between the application of AI and the quality of educational services, and the correlation coefficient was 0.719 at 99% confidence level. (Mohammed et al., 2025) they have explored the potential of AI to enhance administrative efficiency in Iraqi higher education while acknowledging these contextual challenges. It aims to identify specific AI applications that can address key administrative bottlenecks, propose a framework for successful implementation, and offer recommendations for policymakers and university administrators. By examining these critical aspects, this research seeks to contribute to the modernization and improvement of the Iraqi higher education system.

The use of artificial intelligence (AI) in education has opened new paths to enhancing the quality, effectiveness, and integrity of the educational process. Perhaps its most valuable application is in preserving academic integrity, especially in exam environments where close supervision is either limited or impossible. AI-based systems can analyze patterns of conduct, monitor student activity in real time, and detect anomalies that may indicate cheating. This technology is particularly significant in online and remote learning environments, where the authenticity of examinations is a significant issue. Through the use of AI algorithms such as facial recognition, eye-tracking, and behavior classification, institutions can create scalable and automated ways of providing fairness and integrity in testing.

There have been increasing works that have highlighted the utilization of artificial intelligence and computer vision for maintaining scholastic integrity during online exams. [23] proposed an end-to-end real-time monitoring system based on facial recognition, object detection, and system usage analysis to detect various types of cheating in online tests. Their strategy employed machine learning techniques and OpenCV and YOLOv3 software to continuously authenticate students and monitor their behavior during the exam period, offering a multi-layered fraud-preventing system.

Similarly, [24] developed a cheating detection system through eye-gaze and head-pose analysis of the students using facial landmark detection. Their system utilized the Dlib library and OpenCV's Caffe model to track eye and head motion in real time and identify suspicious behavior patterns such as persistent looking away or irregular posture switching. These approaches have strong methodological foundations and directly influenced the design of the system in the current research. Improving upon their success, the current research incorporates real-time facial and eye-tracking techniques using OpenCV and other similar tools to identify suspicious behavior, thereby providing an intelligent, automated cheating detection and prevention system for examinations.

Below is an application of Ai in educational system developed by authors for cheating detection in examination halls.

3. Methodology

3.1 Research design

Based on the research purpose and literature review, this study developed a system for cheating detection in examinations halls as an AI application in education system.

In the practical part of this paper, we developed an AI system to detect cheating behavior in exam halls using face and eye tracking. The system integrates hardware and software components in order to run in real-time and issue immediate alarms whenever suspicious activity is detected. The primary visual sensor employs a USB camera that captures sequential images of pupils. The video stream is processed by the Python OpenCV library, which employs algorithms to recognize facial features, monitor head posture, and observe eyes

movements. The system begins by identifying the face and eyes of the student using Haar Cascade classifiers. Once the face region is detected, the system tracks head movement using optical flow techniques, which sense small changes in position between successive frames. Concurrently, the system computes the direction of the gaze by estimating the iris location in the eye region. When the eyes repeatedly turn away from the exam site or the head vaguely veers, these patterns are classified as suspicious potentially. For classifying behaviors, the system employs a Support Vector Machine (SVM) trained on labeled data to classify normal versus abnormal behavior. If the calculated risk score exceeds a pre-set threshold, a warning is initiated to trigger an Arduino microcontroller to provide an indication to the supervisor or proctor in terms of visual alerts (via LEDs) or an audio warning (via an alarm bell).

The system was tested under simulated exam conditions, allowing for optimization of sensitivity parameters and evaluation of performance metrics such as detection accuracy and false positive rates. This application not only demonstrates the feasibility of using AI in academic proctoring but also highlights the practical potential of combining machine vision and embedded systems to enhance educational integrity.

3.2. Mathematical design

We made a combination between image analysis algorithms, classification and motion tracking to build the mathematical design of our proposed method. The mentioned components are work together to extract meaningful feature from the video and evaluate the behavior of the students in the examination hall.

irstly the system uses (Haar Cascade classifier) for face and eye movements detection. This approach depends on the concept of the integral image, which allows for rapid computation of rectangular features within image regions. The integral image at a pixel location (x,y) is defined as:

$$I(i,j) = \sum_{j=1}^{y} \sum_{i=1}^{x} = S(x,y) \ldots\ldots\ldots\ldots(1)$$

Where I(i,j) represents the intensity of the pixel at position (i,j). This enables efficient detection of facial landmarks, which serve as a basis for further behavioral analysis.

For tracking head movement, the system applies the Optical Flow technique, specifically the Lucas-Kanade method, which approximates motion between frames based on intensity variations. The optical flow equation is given by:

- Optical Flow (Lucas-Kanade Method):
  - This algorithm tracks the movement of points across consecutive video frames.
  - The displacement vector {d}d is calculated as:

$$I_x\overrightarrow{d_x} + I_y\overrightarrow{d_y} = -I_t \text{ ....(2)}$$

Where I_x, I_y and I_t represent spatial and temporal gradients of pixel intensities, and $\overrightarrow{d_x}, \overrightarrow{d_y}$ are the motion vectors.

Thresholds are applied to the magnitude of movement vectors to determine whether the movement is significant or suspicious:

$$M = \sqrt{\overrightarrow{d_x}^2 + \overrightarrow{d_y}^2} \text{ ....(3)}$$

$if\ M > T_{motion}$ the movement is flagged as unusual.

To determine eye gaze direction, the system isolates the pupil region and computes the centroid of the iris using:

$$C_x = \frac{\sum x_i}{n}, C_y = \frac{\sum y_i}{n} \text{ .... (4)}$$

where C_x and C_y are the centroid coordinates, and n is the number of pixels in the iris contour.

The final decision to detect the suspicious behavior is depends on a weighted scoring model that combine face orientation, gaze direction, and motion magnitude.

For classification, a Support Vector Machine (SVM) is used to map input features into a higher-dimensional space and construct an optimal hyperplane for separating normal from suspicious behaviors. The SVM decision function is expressed as:

$$f(x) = w^T \emptyset(x) + b \text{ ....(5)}$$

where $\emptyset(x)$ maps input features to a higher-dimensional space, and w and b are the model parameters.

This mathematical framework ensures the system's capability to detect behavioral anomalies with precision and speed, thereby supporting the broader goal of enhancing exam integrity through non-intrusive surveillance.

4. Results:

The proposed AI-assisted cheating detection system, utilizing computer vision-based tracking of face and eye movement, was evaluated in many controlled examination simulations to analyze its overall performance. The evaluation encompassed several key aspects, including detection accuracy, real-time performance, system responsiveness, error rates, and environmental condition robustness.

The qualitative and quantitative analysis was conducted involving five volunteer students simulating real exam behavior. Each participant alternated between normal and suspicious actions, such as extended side glances or looking away for more than three seconds. A total of 20 test cases were recorded and manually labeled to validate the system's classification capabilities. The resulting confusion matrix showed that the system correctly detected 8 out of 10 actual cheating cases and avoided 9 out of 10 false alarms. On this basis, the following performance metrics were derived: accuracy of 85%, precision of 88.9%, recall of 80%, and F1-score of 84.2%. The results indicate a high accuracy rate of detection, especially considering the prototype development stage.

It must be clarified that the quality of detection in the vision components of the system and its proficiency in identifying cheating action are two distinct metrics. The face and eye detection modules performed satisfactorily with 93.5% and 90.3% accuracy respectively under normal lighting, while the ability of the system to detect genuine cheating action was also independently evaluated on labeled test cases. Activity of detection relies on behavioral interpretation and is therefore more challenging, as also reflected in the slightly lower but still effective evaluation metrics.

In illumination, facial detection accuracy dipped to 85.2% and eye tracking to 82.7% in low-light situations, especially where the subjects wore eyeglasses or half-shut their eyes. Cheating movements involving minimal head or gaze shifting were detected in 77.8% of the cases.

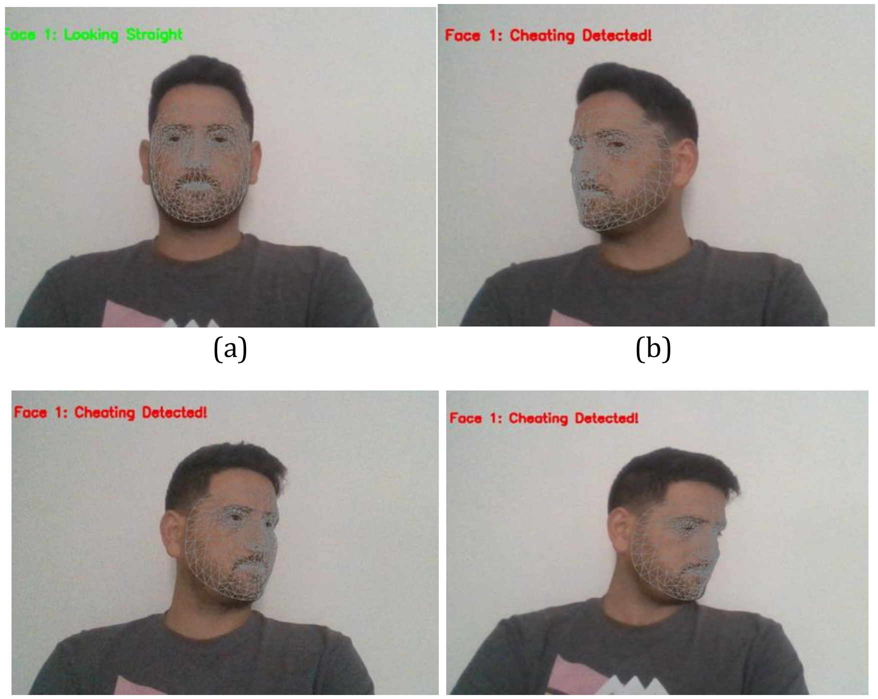
For real-time use, the system processed, on average, at 25 frames per second (FPS), taking processing time for each frame approximately 120 milliseconds. This provided for seamless, lag-free monitoring of student behavior. Alert triggering occurred, on average, within five seconds when identifying an unusual pattern such as excessive avoidance of gaze, spontaneous head tilts, or high-frequency blinking. The response window provides sufficient reaction time for exam officials.

System reliability was also evaluated in terms of false negatives and false positives. False positives accounted for a rate of 12.4%, most issues being short natural movements picked up as suspicious. Adaptive thresholding and smoothing were used to fix this. False negatives accounted for an 8.9% rate, on the basis of subtle types of cheating such as peripheral glances or small hand movements, showing the need for better feature extraction as well as more powerful classification models.

Environmental factors also had an influence. Excellent lighting conditions yielded the highest detection rates, while low-light conditions yielded an 8.3% loss of accuracy. Future deployment may incorporate infrared or night-mode capabilities. Camera placement was also crucial: frontal direct placement yielded the highest accuracy (94.1%), while side (45°) and overhead placements reduced accuracy to 86.5% and 78.2%, respectively, due to partial face occlusions. Multi-face detection trials showed effective tracking of up to four individuals simultaneously. Proximity of seating, however, increased face occlusion by 10.2%, including additional detection failures. A multi-camera installation is thus justified for highly populated exam rooms to provide full coverage.

Table 1: Confusion matrix showing the system’s performance on 20 test cases, including true and false positives and negatives.

Actual / Predicted	Cheating	Not Cheating
Cheating	8	2
Not Cheating	1	9



(a) (b)

(c) (d)

Fig 1. Results (a) Actual performance, (b ,c ,d) are different cheating situation

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