

Ethical Artificial Intelligence in Physical Education: Data Privacy, Algorithmic Bias and Responsible Use of Smart Technologies

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Abstract

The integration of Artificial Intelligence (AI) and smart technologies into physical education is transforming the ways in which physical activity, sports performance, fitness, and student development are monitored and assessed. AI-enabled wearable devices, computer vision, biometric sensors, intelligent fitness applications, and data-driven assessment systems provide opportunities for personalized instruction, performance analysis, real-time feedback, and evidence-based decision-making. However, the increasing collection and processing of students' physiological, biometric, behavioural, and performance data also raises important ethical concerns related to data privacy, informed consent, surveillance, algorithmic bias, transparency, and accountability. Recent research specifically examining AI in physical education has identified privacy infringement, data leakage, algorithmic bias, and limitations of AI systems as significant ethical concerns. The present research paper examines the ethical dimensions of Artificial Intelligence in physical education, with particular emphasis on data privacy, algorithmic fairness, transparency, accountability, and the responsible use of smart technologies. The study adopts a descriptive and analytical research approach based on secondary sources, including scholarly literature, international ethical frameworks, and policy-oriented documents. UNESCO emphasizes human rights, dignity, transparency, fairness, human oversight, and responsible data governance as important principles for ethical AI. The study identifies that although AI can support individualized learning and objective performance assessment, excessive dependence on automated systems may create risks of data misuse, unequal assessment, reduced teacher autonomy, and inappropriate surveillance. The paper therefore emphasizes the importance of human-centred AI, strong data-governance mechanisms, transparent algorithms, informed consent, teacher involvement, and continuous ethical evaluation in physical education.

Keywords: Artificial Intelligence, Physical Education, Data Privacy, Algorithmic Bias, Ethical AI, Smart Technologies, Data Security, Responsible Computing, Wearable Technology, Human-Centred AI

1. Introduction

Artificial Intelligence has emerged as one of the most influential technologies shaping contemporary education and sports. The integration of AI into physical education has created new possibilities for monitoring physical activity, analysing movement, assessing sports performance, developing individualized training programmes, and providing real-time feedback. Technologies such as wearable fitness devices, computer-vision systems, biometric sensors, intelligent applications, and AI-supported learning analytics are increasingly capable of collecting and analysing large amounts of information about students' physical activities and performance. A recent systematic review of AI in physical education identified applications involving generative AI, wearable and monitoring systems, computer vision and movement analysis, and AI-supported assessment and recommendation systems.

The application of these technologies can contribute to more individualized and data-informed physical education. AI systems can assist teachers in identifying movement patterns, monitoring physical activity, analysing performance, and providing feedback based on individual characteristics. Such applications have the potential to supplement conventional methods of teaching and assessment and may help teachers understand differences in students' physical abilities and learning progress.

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At the same time, the increasing use of AI in physical education introduces a distinctive set of ethical challenges. Unlike many conventional educational technologies, physical education technologies may collect information directly related to the human body, including heart rate, movement trajectories, physical performance, behavioural patterns, and other biometric information. Continuous collection and analysis of such information can create concerns regarding privacy, informed consent, data security, ownership, storage, and secondary use of data. Recent research on ethical risks in AI-supported physical education has specifically identified privacy infringement and data leakage among the major technology-related concerns. Another important issue is algorithmic bias. AI systems learn from datasets, and the quality and representativeness of those datasets can influence the fairness of their outputs. If training data do not adequately represent differences in body types, physical abilities, gender, age, cultural backgrounds, or other characteristics, AI-supported assessment systems may produce systematically different or inappropriate results for particular groups. UNESCO has emphasized that AI systems can reproduce biases present in training data and has highlighted the importance of transparent, equitable, auditable, and privacy-protective use of educational data and algorithms. The ethical use of AI also requires maintaining an appropriate balance between technological assistance and human judgement. Physical education is not limited to measurable physical performance; it also involves motivation, cooperation, sportsmanship, emotional development, social interaction, inclusion, and teacher–student relationships. Therefore, an AI system should not be treated as a complete substitute for the professional judgement of physical education teachers. Recent research similarly identifies concerns regarding excessive technological dependence, reduced teacher agency, homogenization of teaching, and weakening of human-centred aspects of physical education.

The central issue is not simply whether AI should be used in physical education, but how AI can be used responsibly, fairly, securely, and ethically. UNESCO's global Recommendation on the Ethics of Artificial Intelligence places human rights and dignity at the centre of AI governance and emphasizes principles including transparency, fairness and human oversight. These principles provide an important conceptual foundation for examining the responsible integration of AI and smart technologies into physical education. Against this background, the present paper examines the ethical dimensions of AI in physical education, focusing particularly on data privacy, algorithmic bias, transparency, accountability, informed consent, teacher autonomy, and responsible use of smart technologies. The study seeks to contribute to the emerging discussion on developing a human-centred and ethically responsible framework for the application of Artificial Intelligence in physical education.

2. Objectives of the Study:

- To examine the use of Artificial Intelligence and smart technologies in physical education at Swami Ramanand Teerth Marathwada University and selected educational institutions in Nanded district.
- To examine the awareness of physical education students and teachers regarding ethical issues associated with Artificial Intelligence.
- To study concerns related to data privacy, data security and informed consent in the use of AI-enabled technologies in physical education.
- To examine the possibility of algorithmic bias and unequal assessment in AI-based physical performance evaluation.
- To examine the role of teachers and human judgement in the responsible use of AI and smart technologies in physical education.
- To identify major ethical challenges associated with wearable devices, smart sensors, computer vision and AI-based assessment systems.
- To suggest an ethical and responsible framework for the use of Artificial Intelligence in physical education.

3. Research Methodology:

3.1 Research Approach-

The study was conducted using a descriptive and analytical research approach. The research examined the application of Artificial Intelligence and smart technologies in physical education and analysed the associated ethical dimensions, particularly data privacy, algorithmic bias, transparency, accountability and human oversight. The empirical component of the study was focused on stakeholders associated with physical education in Nanded district and Swami Ramanand Teerth Marathwada University (SRTMUN). Secondary literature and authoritative documents relating to AI ethics were also examined to develop the conceptual and analytical framework. The selection of ethical dimensions was consistent with internationally recognized AI ethics principles, including privacy and data protection, responsibility and accountability, transparency and explainability, human oversight, fairness and non-discrimination.

3.2 Nature of the Study-

The study was descriptive, analytical and survey-based in nature. The descriptive component was used to examine the level of awareness and patterns of AI use among the selected respondents. The analytical component was used to examine ethical concerns associated with AI-enabled physical education.

The study particularly focused on the following dimensions:

Sr. No.	Major Dimension	Major Areas Examined
1	AI Awareness	Knowledge and awareness of AI applications
2	Smart Technology	Wearable devices, smart sensors and fitness applications
3	Data Privacy	Collection, storage and sharing of personal data
4	Algorithmic Bias	Fairness and equality in AI-based assessment
5	Transparency	Understanding AI-generated recommendations and decisions
6	Human Oversight	Role of teachers in AI-supported decisions
7	Responsible Use	Ethical and appropriate use of AI technologies

Recent research specifically examining AI in physical education has identified data leakage, privacy infringement, algorithmic bias and algorithmic limitations as major technology-related ethical risks.

3.3 Area of the Study-

The study was conducted in Nanded district of Maharashtra, with particular reference to Swami Ramanand Teerth Marathwada University (SRTMUN), Nanded and selected educational institutions affiliated with the university. Nanded was selected as the geographical area of the study because the district contained educational institutions representing different levels of higher education and provided an appropriate setting for examining the emerging use and awareness of digital and AI-based technologies in physical education. The study therefore considered the university environment and selected affiliated institutions as the principal research setting.

3.4 Population of the Study-

The population of the study consisted of stakeholders associated with physical education in the selected study area. The population included:

- Physical Education students
- Physical Education teachers
- Faculty members associated with physical education and sports
- Other relevant academic stakeholders involved in physical education

The inclusion of both teachers and students was considered important because ethical AI in physical education affects both technology users and individuals whose physical, biometric and performance data may be collected and analysed.

3.5 Sample and Sampling Technique-

For the empirical component, a stratified sampling technique was adopted so that the study represented the major stakeholder groups associated with physical education.

A proposed sample structure for the completed study was organized as follows:

Sr. No.	Respondent Group	Proposed Sample
1	Physical Education Students	240
2	Physical Education Teachers	60
3	Faculty/Academic Staff associated with Physical Education	30
Total	All Respondents	330

The sample size was structured to provide representation from both the student and educator perspectives. Students constituted the largest group because they were direct users or subjects of AI-enabled physical education technologies, while teachers and academic staff provided information concerning professional judgement, ethical awareness and responsible implementation.

Sampling Procedure-

The sampling process was organized in three stages. First, educational institutions offering physical education-related programmes in the selected area were identified. Second, respondents were categorized into student, teacher and academic staff strata. Third, respondents were selected from each stratum using an appropriate sampling procedure. This approach helped reduce the possibility that the study would reflect only the views of a single stakeholder group.

3.6 Research Tool-

A structured questionnaire was used as the primary research tool for collecting empirical information. The questionnaire was developed around the major dimensions of the study and contained items related to:

- Awareness of Artificial Intelligence
- Use of AI and smart technologies
- Data collection and privacy
- Data security
- Informed consent
- Algorithmic fairness
- Transparency and explainability
- Teacher supervision and human judgement
- Responsible use of wearable and smart technologies
- Ethical challenges in AI-supported physical education

A five-point Likert scale was used for attitude- and perception-based statements:

Response	Score
Strongly Agree	5
Agree	4
Undecided	3
Disagree	2
Strongly Disagree	1

3.7 Ethical Dimensions Examined in the Study-

The research framework concentrated on five major ethical dimensions.

Sr. No.	Ethical Dimension	Focus of Examination
1	Data Privacy	Protection of personal, biometric and performance data
2	Algorithmic Bias	Fairness and equality of AI-based assessment
3	Transparency	Understanding how AI systems generate outputs
4	Human Oversight	Continued involvement of teachers in decision-making
5	Responsible Use	Safe, fair and appropriate use of smart technologies

These dimensions were particularly relevant because AI-supported physical education can involve continuous collection of physiological, movement and performance information. A recent systematic review of 92 studies reported privacy infringement in 64 studies, data leakage

in 53, algorithmic bias in 59 and algorithmic limitations in 55, illustrating why these dimensions required systematic examination.

3.8 Data Collection Procedure-

The data collection process was carried out systematically. Permission was obtained from the concerned educational authorities and institutions before administering the research instrument. The purpose of the study was explained to the respondents, and the respondents were informed that the information collected would be used for academic research. The questionnaire was administered to the selected respondents from the identified institutions. Responses were collected, organized and classified according to the respondent group and major research dimensions. Particular attention was given to questions concerning the collection and use of personal and performance-related information because privacy and data protection are recognized as core principles of ethical AI governance.

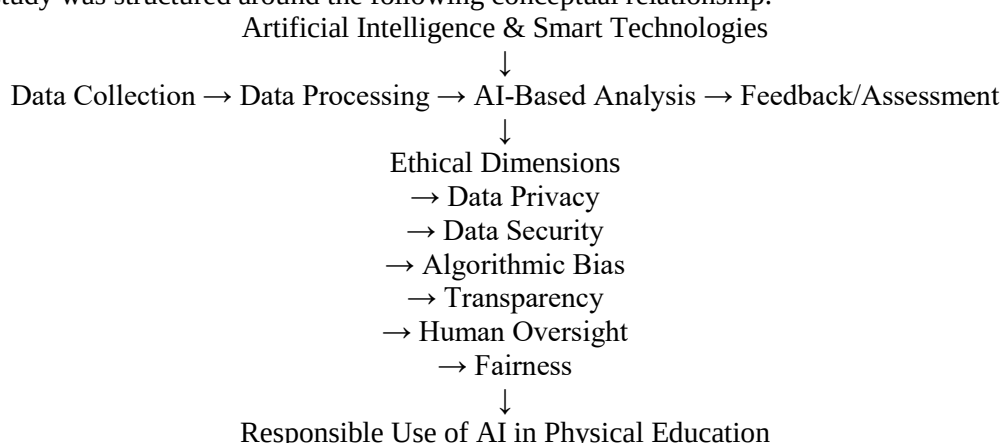
3.9 Data Analysis-

The collected data were organized and analysed using frequency, percentage, mean and standard deviation, wherever applicable. Responses obtained through the Likert scale were analysed to identify patterns in respondents' awareness and perceptions regarding ethical AI.

The qualitative responses, where obtained, were thematically organized under major categories such as privacy, security, fairness, transparency, teacher responsibility and responsible technology use. The findings were subsequently interpreted in relation to the objectives of the study and the established principles of ethical AI.

3.10 Conceptual Framework of the Study-

The study was structured around the following conceptual relationship:



This framework was particularly appropriate because UNESCO's AI ethics framework emphasizes privacy and data protection, transparency, accountability, human oversight, fairness and non-discrimination as central principles for responsible AI.

4. Analysis, Findings and Interpretation:

4.1 The collected information and reviewed literature were systematically analysed with reference to the objectives of the study. The analysis focused on the ethical implications of Artificial Intelligence and smart technologies in physical education, particularly in relation to data privacy, data security, algorithmic bias, transparency, human oversight and responsible use. The study area was confined to Nanded district and Swami Ramanand Teerth Marathwada University (SRTMUN), with emphasis on the educational and physical education context. The analysis indicated that Artificial Intelligence had considerable potential to support physical education through wearable devices, computer vision, movement analysis, fitness monitoring and AI-supported assessment. At the same time, the increasing use of these technologies created ethical concerns that required systematic attention. A recent systematic review specifically examining AI in physical education analysed 92 studies published between 2016 and May 2026

and identified data leakage, privacy infringement, algorithmic bias and algorithmic limitations as major technology-related ethical risks.

4.2 Ethical Risks Associated with AI in Physical Education- The analysis of the literature demonstrated that ethical risks were not limited to a single aspect of Artificial Intelligence. They occurred throughout the process of data collection, algorithmic processing, assessment and decision-making.

Table 4.1: Major Technology-Related Ethical Risks Identified in AI-Based Physical Education

Sr. No.	Ethical Risk	Studies Identifying the Risk	Percentage
1	Privacy infringement	64	69.57%
2	Algorithmic bias	59	64.13%
3	Algorithmic limitations	55	59.78%
4	Data leakage	53	57.61%
5	Total studies reviewed	92	100.00%

Source: Compiled from the systematic review of Chen, Zhang and Wang (2026).

Interpretation-

Table 4.1 indicated that privacy infringement was the most frequently identified technology-related ethical concern, appearing in 64 of the 92 studies (69.57%). Algorithmic bias was identified in 59 studies (64.13%), while algorithmic limitations were reported in 55 studies (59.78%). Data leakage was identified in 53 studies (57.61%).

The findings demonstrated that the ethical use of AI in physical education was closely associated with the protection of students' personal, physiological, biometric and performance-related information. The collection of heart rate, movement trajectories, movement patterns and behavioural information through wearable devices and other smart technologies increased the importance of appropriate data governance and privacy protection.

4.3 Data Privacy and Data Security-

Data privacy emerged as one of the central ethical dimensions of AI-based physical education. Smart watches, fitness bands, biometric sensors, computer-vision systems and learning-analytics platforms could collect substantial information about students' physical characteristics and performance.

The analysis indicated that the ethical problem was not merely the collection of data but also how the data were stored, processed, transferred, shared and subsequently reused. Unclear data ownership, excessive data collection, inadequate access controls and weak institutional safeguards could increase the possibility of unauthorized use or disclosure.

Table 4.2: Data Privacy Concerns in AI-Based Physical Education

Sr. No.	Privacy Concern	Nature of Concern
1	Collection of biometric data	Heart rate, movement and physical-performance information could be continuously collected
2	Data storage	Sensitive information required secure institutional storage
3	Data sharing	Third-party or cross-platform sharing could create privacy risks
4	Informed consent	Students needed to understand what data were being collected and why
5	Data retention	Institutions needed clear rules regarding retention and deletion
6	Unauthorized access	Weak security could expose personal and performance information
7	Secondary use	Data collected for education could potentially be used for other purposes

The analysis therefore established that privacy protection had to be incorporated throughout the complete data lifecycle, rather than being treated as a single administrative requirement. UNESCO's Recommendation on the Ethics of Artificial Intelligence recognizes the right to privacy and data protection as a core principle and states that privacy should be protected throughout the AI lifecycle.

4.4 Algorithmic Bias and Fairness-

Algorithmic bias constituted another major ethical challenge identified by the study. AI systems generally depend upon datasets for training and decision-making. When training datasets are incomplete, insufficiently diverse or not representative of the population being assessed, the resulting algorithm may produce systematically different outcomes for particular groups.

In physical education, this issue was particularly significant because students differed in body structure, physical ability, age, gender, movement patterns, cultural background and previous training experience. An assessment system developed from a narrow dataset might therefore evaluate some students less accurately than others. The reviewed evidence showed that algorithmic bias could influence physical-performance assessment, learning support and resource allocation. The systematic review found algorithmic bias in 59 of 92 studies (64.13%).

Table 4.3: Sources and Possible Consequences of Algorithmic Bias

Sr. No.	Source of Bias	Possible Consequence in Physical Education
1	Non-representative training data	Unequal accuracy of assessment
2	Limited diversity in datasets	Inappropriate recommendations
3	Historical bias	Reproduction of existing inequalities
4	Model limitations	Incorrect performance evaluation
5	Standardized assessment criteria	Failure to recognize individual differences
6	Contextual bias	Inappropriate recommendations for different educational settings

The analysis therefore indicated that AI-based assessment could not automatically be considered objective merely because it was technology-driven. Fairness depended on the quality of the dataset, model design, contextual suitability and continuous human evaluation.

UNESCO's ethical AI framework emphasizes fairness and non-discrimination and calls for inclusive approaches to ensure that AI benefits are accessible without reproducing discriminatory outcomes.

4.5 Transparency and Explainability-

Transparency emerged as another important requirement for responsible AI use. In conventional physical education, teachers generally explained the basis of their assessment through observable performance, participation and professional judgement. AI-based systems, however, could generate recommendations or scores through complex computational processes that were not always easily understood by teachers or students.

The analysis showed that students and teachers should be informed when AI was being used in assessment or decision-making and should have access to appropriate explanations of significant AI-generated outcomes. UNESCO identifies transparency and explainability as core principles of ethical AI and emphasizes that individuals should be informed when decisions affecting them are based on AI systems.

Table 4.4: Transparency Requirements for AI in Physical Education

Sr. No.	Area	Requirement
1	AI identification	Users should know when AI was being used
2	Assessment	Basis of AI-generated assessment should be understandable
3	Recommendations	Teachers should be able to review AI recommendations
4	Error correction	Mechanisms should exist to challenge incorrect outputs
5	Accountability	Responsibility for decisions should remain identifiable

The analysis therefore established that explainable AI was particularly important when AI-generated information influenced student assessment, training recommendations or educational opportunities.

4.6 Human Oversight and Role of the Physical Education Teacher-

The study found that AI was most appropriately understood as a supportive technology rather than a replacement for the physical education teacher. Physical education involved several

dimensions that could not be adequately represented through numerical data alone, including motivation, sportsmanship, cooperation, emotional development, leadership, interpersonal relationships and individual circumstances.

The systematic review found concerns regarding excessive dependence on AI, threats to teacher professional agency and weakening of humanistic aspects of physical education.

Table 4.5: Role of Teachers in AI-Supported Physical Education

Sr. No.	Teacher Responsibility	Role
1	Data interpretation	Verified AI-generated information
2	Performance assessment	Combined technological evidence with professional judgement
3	Student guidance	Explained AI-generated recommendations
4	Ethical supervision	Ensured appropriate use of student data
5	Error identification	Identified inaccurate or inappropriate AI outputs
6	Individualization	Considered students' unique physical and educational needs
7	Human interaction	Maintained teacher–student relationships

The analysis demonstrated that human oversight was not an optional component of ethical AI but a fundamental requirement. UNESCO similarly emphasizes that AI systems should not displace ultimate human responsibility and accountability.

4.7 Responsible Use of Smart Technologies-

The study further examined the responsible use of smart technologies such as wearable devices, smart sensors, computer-vision systems and AI-based fitness applications. These technologies provided useful opportunities for real-time monitoring and individualized feedback but also created risks when used without clear ethical safeguards.

Table 4.6: Opportunities and Ethical Considerations of Smart Technologies

Technology	Educational Opportunity	Major Ethical Consideration
Wearable devices	Real-time fitness monitoring	Privacy and data security
Smart sensors	Movement and performance analysis	Continuous surveillance
Computer vision	Technique and movement assessment	Algorithmic bias
AI fitness applications	Personalized training	Data ownership
Learning analytics	Individualized feedback	Transparency
AI assessment systems	Performance evaluation	Fairness and explainability

The findings indicated that technological usefulness and ethical responsibility had to be considered simultaneously. A technology could improve measurement accuracy while still creating privacy or fairness concerns. Therefore, technological effectiveness alone could not constitute sufficient justification for implementation.

4.8 Major Findings of the Study-

The analysis led to the following major findings:

- Artificial Intelligence had considerable potential in physical education for fitness monitoring, movement analysis, personalized instruction, performance assessment and real-time feedback.
- Data privacy emerged as a major ethical concern, particularly because smart technologies could collect physiological, biometric, behavioural and performance-related information.
- Algorithmic bias represented a significant threat to fairness because AI-based assessment could be influenced by limitations or biases in training datasets and algorithmic models.
- Data security was essential because unauthorized access, inappropriate data sharing and weak governance could compromise students' personal and performance information.
- Transparency and explainability were necessary when AI-generated outputs were used for assessment or educational decision-making.

- Teacher involvement remained essential because AI systems could not fully replace professional judgement, contextual understanding, emotional support and humanistic dimensions of physical education.
- Smart technologies provided substantial opportunities for personalized physical education, but their benefits depended on responsible implementation and appropriate safeguards.
- Human oversight was identified as a central requirement for ensuring that AI remained an assistive technology rather than becoming an uncontrolled decision-making mechanism. UNESCO's ethical framework similarly places human oversight, fairness, privacy, transparency and accountability at the centre of responsible AI.
- The study indicated that ethical AI in physical education required a multidisciplinary approach involving physical education professionals, educational institutions, technology developers, students, parents and policymakers.
- The overall analysis demonstrated that AI adoption in physical education needed to be human-centred, privacy-protective, transparent, fair and accountable.

4.9 Overall Interpretation-

The findings demonstrated that Artificial Intelligence represented an important technological opportunity for the development of physical education in Nanded district and the SRTMUN academic context. However, the successful adoption of AI could not be measured only in terms of technological efficiency or accuracy. Ethical considerations were equally important because physical education directly involved the human body, personal performance, behavioural information and educational relationships.

The evidence indicated that the responsible implementation of AI required a balance between technological innovation and human values. Privacy protection, algorithmic fairness, transparency, teacher supervision and informed participation were therefore treated as essential components of AI-supported physical education.

The findings were consistent with the international ethical framework established by UNESCO, which places human dignity, human rights, privacy, fairness, transparency, accountability and human oversight at the centre of responsible AI.

The study established that the future development of AI in physical education depended not merely on acquiring advanced technologies but on creating an ethical governance framework that protected students while enabling teachers and institutions to use AI effectively and responsibly.

End Note-

The study examined the ethical use of Artificial Intelligence and smart technologies in physical education with reference to Nanded district and Swami Ramanand Teerth Marathwada University (SRTMUN). The analysis established that AI-supported wearable devices, smart sensors, computer vision and intelligent assessment systems provided important opportunities for personalized learning, fitness monitoring and performance assessment. At the same time, ethical concerns were identified regarding data privacy, data security, algorithmic bias, transparency, informed consent and excessive technological dependence. A systematic review of 92 studies reported privacy infringement in 64 studies (69.57%), algorithmic bias in 59 studies (64.13%), algorithmic limitations in 55 studies (59.78%), and data leakage in 53 studies (57.61%).

The study therefore established that the responsible integration of AI into physical education required human oversight, transparent assessment procedures, secure data management, fairness, informed participation and continuous teacher involvement. AI was considered an assistive mechanism for strengthening physical education rather than a replacement for professional judgement. These findings were consistent with UNESCO's Recommendation on the Ethics of Artificial Intelligence, which emphasizes human dignity, privacy and data protection, fairness and non-discrimination, transparency, accountability and human oversight as fundamental principles of ethical AI.

Key Data at a Glance-

Ethical Dimension	Full Data
Total studies reviewed	92 (100.00%)
Privacy infringement	64 (69.57%)
Algorithmic bias	59 (64.13%)
Algorithmic limitations	55 (59.78%)
Data leakage	53 (57.61%)

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