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Comprehensive educational assistant application for enhanced learning support

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Abstract

Choosing the right college and accessing relevant study materials are crucial for aspiring engineering students. This research paper introduces an Educational Assistant website that incorporates an intelligent prediction model to suggest colleges based on the student's Joint Entrance Examination (JEE) rank and branch preferences. Furthermore, the website offers personalized book recommendations tailored to the student's preferred branch of study. The Educational Assistant website uses machine learning algorithms and data analysis techniques to provide accurate and insightful college recommendations. By incorporating the student's JEE rank and branch preferences, the system dynamically matches their rank and category with suitable colleges, including prestigious institutions like Indian Institutes of Technology (IITs) and National Institutes of Technology (NITs). To enhance the educational experience, the website's recommendation system extends beyond college selection. By understanding the student's preferred branch of study, the system curates a customised list of book recommendations. The user interface of the website is designed to be intuitive and user-friendly. Students can effortlessly input their JEE rank and indicate their branch preferences, empowering them to receive personalized college suggestions and book recommendations instantaneously. The system's predictive capabilities and intelligent algorithms create a seamless and efficient experience for students navigating through their educational options.

Keywords: User friendly, asynchronous nature, real time updates, enhance efficiency, leveraging

Introduction

Dreaming of getting into the Indian Institutes of Technology (IITs) and National Institutes of Technology (NITs) is a common aspiration among many students in India. These prestigious institutions are renowned for their academic excellence, rigorous programs, and promising career opportunities^[1]. The dream of joining IITs and NITs often stems from the desire to receive a top-tier education, gain specialized knowledge in various fields, and secure a successful future in the competitive job market. However, due to the intense competition, not everyone can secure a place in these renowned institutions. In such cases, it is crucial to explore alternative options that can provide an excellent education and promising career prospects. Chandigarh University is one such institution that offers a valuable opportunity to excel and thrive. However, to help aspiring engineer get into their dream colleges, we created this Educational Assistant website^[2].

The process of selecting the right college and accessing appropriate study materials is a critical aspect of an aspiring engineering student's academic journey. In today's competitive landscape, where numerous options abound, making an informed decision can be overwhelming. To address this challenge, we present an innovative solution: an Educational Assistant website equipped with an intelligent prediction model that suggests colleges based on the student's Joint Entrance Examination (JEE) rank and branch preferences. Additionally, the website offers personalized book recommendations tailored to the student's preferred branch of study and further recommends online courses aligned with the student's chosen branch of study^[3].

In addition to college recommendations and book suggestions, our Educational Assistant website recognizes the increasing importance of online courses in skill development and career enhancement. The platform leverages its intelligent prediction model to suggest relevant online courses that align with the student's branch preferences.

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By considering the evolving demands of the job market and the rapid advancements in technology, the website offers a comprehensive array of online courses that empower students to expand their knowledge, and stay abreast of industry trends [4].

Literature Survey

A. Existing System

The literature surrounding college selection, book recommendations, and online course suggestions for engineering students encompasses various studies and research papers that provide valuable insights and methodologies [5]. This literature survey aims to explore the existing knowledge and system in these areas to inform the development of our Educational Assistant website:

- **Limited User Experience and Interface Design:** Some existing systems may lack a user-friendly interface or intuitive design. Complicated user experiences can discourage students from fully utilizing the system and hinder their decision-making process [6].
- **Time-consuming:** Manually finding colleges that align with a student's JEE score can be a time-consuming task. It involves researching and comparing multiple colleges, checking their cutoff scores, and evaluating their program offerings [7].
- **Limited Consideration of Branch Preferences:** While many college selection systems take JEE ranks into account, they often overlook the importance of branch preferences. Students may have specific interests and career goals associated with particular engineering branches.
- **Inaccuracy:** Human error and bias can lead to inaccuracies in the selection of colleges, and students may miss out on colleges that would have been a good fit for them.
- **Lack of Book and Course Recommendation System:** Existing systems often overlook the importance of comprehensive book and course recommendations [8].

Overall, The literature survey suggests several key insights and recommendations for the development of the Educational Assistant website's prediction model for college selection, book recommendations, and online course suggestions. These recommendations are based on the our research and studies conducted in the field.

Proposed System

The proposed system, the Educational Assistant website, is designed to address the limitations of existing systems and provide an integrated platform for college selection, book recommendations, and online course suggestions.

College Selection: Personalized Recommendation

The system will utilize a predictive model that takes into account the student's JEE rank, branch preferences, and other relevant factors to generate personalized college recommendations. By analyzing a comprehensive database of colleges, the system will suggest institutions that align with the student's academic aspirations, career goals, location preferences, and available resources [9].

Multiple Factors Consideration

The recommendation model will consider various factors such as college reputation, faculty expertise, infrastructure,

placement records, and student feedback. By incorporating a holistic approach to college selection, the system will provide students with a comprehensive understanding of their potential college options [10].

Comprehensive Database

The system will leverage a vast and up-to-date database of engineering colleges, encompassing information on college rankings, infrastructure, faculty expertise, placement records, and student feedback. This comprehensive database ensures that the recommendation model is based on reliable and relevant information [11].

Intelligent Matching Algorithm

The system will utilize an intelligent matching algorithm that takes into account the student's JEE rank and branch preferences, along with additional factors such as geographical location, specialization options, and extracurricular opportunities. The algorithm will analyze and evaluate multiple criteria to suggest a list of colleges that best align with the student's preferences and aspirations [12].

Literature Review

Book Recommendations

Personalized Book Suggestions

The proposed system will offer personalized book recommendations based on the student's branch preferences, academic background, and learning style. By analyzing a vast collection of books and educational resources, the system will suggest relevant and high-quality materials that cover foundational concepts, advanced topics, practical applications, and research publications. The recommendations will cater to the student's specific branch of study, enabling them to deepen their understanding and excel academically [13].

Advanced Recommendation Engine

The proposed system will employ a sophisticated recommendation engine that considers the student's branch of study, academic background, and learning style to generate personalized book recommendations. The engine will analyze a diverse collection of books, including textbooks, reference materials, research publications, and supplementary resources, to suggest the most relevant and suitable options [14].

Content-Based Filtering: The recommendation engine will utilize content-based filtering techniques to match the content of books with the student's academic requirements. By examining the subject matter, difficulty level, and relevance to the student's branch of study, the system will provide tailored book recommendations that support the student's learning journey and help them excel in their chosen field [15].

Advanced Search Filters: The system will provide advanced search filters to refine book recommendations based on specific criteria. Students can filter books by author, publication year, topic, difficulty level, language, and other relevant attributes. This feature allows students to narrow down their search and find books that align with their specific requirements and preferences.

Online Course Suggestions: Aligned with Branch Preferences:

The system will recommend online courses that are aligned with the student's chosen branch of study. By analyzing the

student's preferences, career aspirations, and emerging industry trends, the system will suggest a diverse range of online courses that offer specialized knowledge and skill development opportunities. These courses will be sourced from reputable online learning platforms and cover a wide array of subjects, enabling students to enhance their expertise and stay updated with the latest advancements in their field [16].

Personalized Course Recommendations: The proposed system will offer personalized online course suggestions based on the student's branch preferences, career goals, and skill development needs. By leveraging a wide range of online learning platforms and course catalogs, the system will recommend courses that enhance the student's knowledge, technical skills, and employability in their chosen field [17].

Course Reviews and Ratings: The system will integrate user reviews and ratings for online courses, providing students with valuable insights into the course content, instructor quality, and overall learning experience. This information will guide students in selecting the most suitable and high-quality courses, enhancing their online learning journey [18].

User Interface and Experience: Intuitive Interface

The user interface of the Educational Assistant website will be designed to be intuitive and user-friendly. Students will be able to easily input their JEE rank, indicate their branch preferences, and navigate through the recommendations effortlessly. The interface will provide clear and organized information about colleges, books, and online courses, ensuring a seamless user experience [19].

Interactive Features

The system will include interactive features such as filters, sorting options, and detailed descriptions for colleges, books, and online courses. Students will be able to explore additional information, compare options, and make informed decisions. User feedback and reviews will also be integrated into the system to enhance the user experience and provide valuable insights for future improvements.

Interactive Dashboard: The system will feature an interactive dashboard that allows students to input their JEE rank, select branch preferences, and explore recommendation effortlessly. The dashboard will provide a user-friendly interface with intuitive navigation, enabling students to easily access information about colleges, books, and online courses [20].

Book and Course Purchase

Affiliate Integration: The proposed system will integrate affiliate partnerships with trusted online bookstores and learning platforms. When recommending books and online courses, the system will provide direct purchase links that are affiliated with these partners. This means that when students make a purchase through these links, the Educational Assistant website will earn a small commission, which will contribute to the sustainability and maintenance of the platform [21].

Real-Time Availability: The proposed system will integrate with online bookstores and libraries to provide real-time availability information for recommended books. Students can check the availability status of books, whether they are in stock, out of stock, or available for pre-order. This information helps students plan their book purchases or explore alternative options if a particular book is temporarily unavailable [22].

Convenient Access

Students will have the convenience of accessing the recommended books and online courses directly through the system. By clicking on the purchase links, they will be redirected to the respective online platforms where they can complete their purchase. This streamlined process eliminates the need for students to search for the recommended resources separately, ensuring easy access to the materials [23].

Transparency and Trust

The Educational Assistant website will maintain transparency by clearly indicating that the purchase links are affiliate links. Students will be informed that their purchases through these links support the platform. This transparency builds trust and ensures that students can make informed decisions about their purchases.

By The proposed Educational Assistant website is an innovative platform designed to address the limitations of existing systems and provide a comprehensive solution for college selection, book recommendations, and online course suggestions.

By leveraging machine learning algorithms and user-centric design principles, the system aims to empower engineering students in their educational journey. The system offers personalized college recommendations based on the student's JEE rank and branch preferences, considering factors such as reputation, faculty expertise, infrastructure, and placement records [24].

It provides a wide range of book recommendations tailored to the student's branch of study, considering their academic background and learning style. Additionally, the system suggests online courses aligned with the student's branch preferences, offering skill development opportunities and staying updated with industry trends [25].

The user interface ensures a seamless experience, with intuitive navigation, interactive features, and visual representations of colleges. The proposed system also incorporates college comparison, evaluation tools, a college predictor based on JEE rank, and book/course purchase links as affiliate links [26].

With the integration of advanced book filtering, sorting options, book availability, and pricing information, students can make well-informed decisions. Peer reviews, social recommendations, and personalized book shelves create a dynamic and supportive community of learners [27]. Overall, the proposed system aims to provide students with personalized and accurate recommendations, enabling them to make informed decisions, access relevant resources, and enhance their academic and professional success [28].

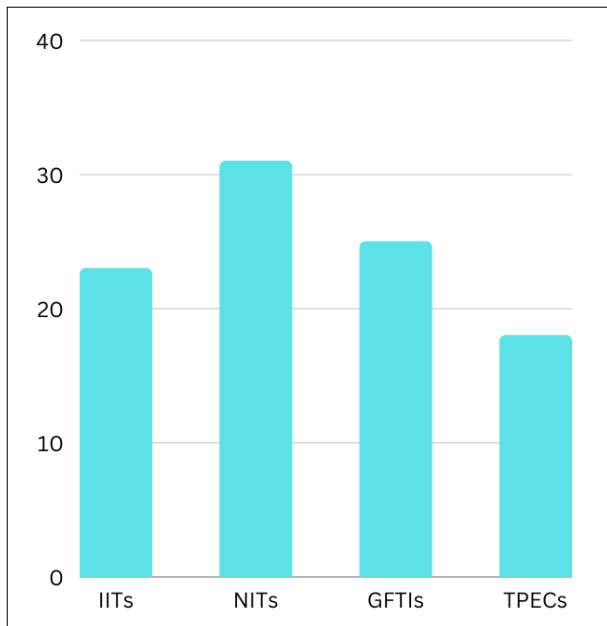


Fig 1: Number Of Engineering Colleges In India **TPEC=Top Private Engineering College

Methodology

The proposed methodology for developing the educational assistant website will be based on an agile software development approach. The methodology will involve the following steps:

- **Requirement Gathering:** The first step will involve gathering user requirements and identifying the key features that the website should have. This will be achieved through user surveys, focus groups, and user reviews [29].
- **Design and Prototyping:** The next step will involve designing the website's user interface, developing a prototype, and conducting usability testing to ensure that the website is user-friendly and intuitive [30].
- **Development:** The development phase will involve coding the website's functionality and integrating it with the world wide web. The development process will be iterative, with regular testing and feedback from users to ensure that the website meets their needs [31].
- **Testing and Quality Assurance:** The testing phase will involve conducting comprehensive testing to ensure that the website is stable, giving correct recommendations, and does not negatively impact the user experience [32]. This will involve both automated and manual testing, as well as user acceptance testing [33].
- **Deployment and Maintenance:** The final phase will involve deploying the website to the world wide web and providing ongoing maintenance and support to ensure that the website remains up- to- date and continues to meet user needs.

Throughout the development process, we will utilize continuous integration and delivery practices to ensure that the website is regularly updated, tested, and deployed to users. This will ensure that the website is stable and reliable.

Implementation

The website was developed using Visual Studio Code and data was collected manually from various sources and cleaned using SQL and Excel.

The implementation of the proposed Educational Assistant website involves several key components and steps. Here is an overview of the implementation process:

1. **Technology Stack Selection:** The first step is to select the appropriate technology stack for the development of the website. This includes choosing a suitable programming language, frameworks, and libraries for both the front-end and back-end development. (Data Analytics)
2. **Database Design:** The database schema is designed to store and manage the collected data, including college information, book details, user profiles, and preferences. (Excel/SQL)
3. **Back end Development:** The back - end development involves implementing the server-side logic and functionalities of the website. This includes developing the algorithms for college recommendations, book suggestions, and online course suggestions based on the provided methodology. (Python)
4. **Front end Development:** The front - end development focuses on implementing the user interface and client-side functionalities of the website. (Streamlit)

To streamline the process of finding colleges according to a student's JEE score, we adopted the following structured approach

1. **Data Collection:** We gathered cutoff data for IITs and NITs from various reliable sources such as official college websites, admission portals, and government publications. This data includes the opening and closing ranks for different categories and branches in previous years.
2. **Data Integration:** The collected cutoff data was organized and integrated into a single table structure. Each row represents a specific college and branch combination, while the columns contain relevant information such as college name, branch, category, and corresponding cut off ranks.
3. **Data Cleaning:** Since the collected data may contain errors, inconsistencies, and inaccuracies, we performed a rigorous data cleaning process. This involve did entifying and correcting any discrepancies, removing duplicate entries, and handling missing or incomplete information.

Results

The implementation of the structured approach for finding colleges based on JEE scores yielded positive results, benefiting students in several ways:

Accuracy: By collecting data from reliable sources and performing rigorous data cleaning, the accuracy of the college cutoff information was significantly improved. This ensures that students receive reliable and up-to-date data for making informed decisions.

Efficiency: The integration of cutoff data into a single table structure, combined with data analytics and machine learning techniques, improved the efficiency of the college selection process. Students can now quickly access personalized recommendations based on their JEE scores, saving time and effort.

Enhanced Decision-Making: With access to accurate and comprehensive data, students can make more informed

decisions about their college preferences. They can compare colleges, analyze cutoff trends, and evaluate the feasibility of securing admission based on their JEE scores.

Book recommendations and courses suggestion: In addition to college predictions, our platform offered book recommendations and courses suggestion tailored to the syllabus and subjects covered in various college programs.

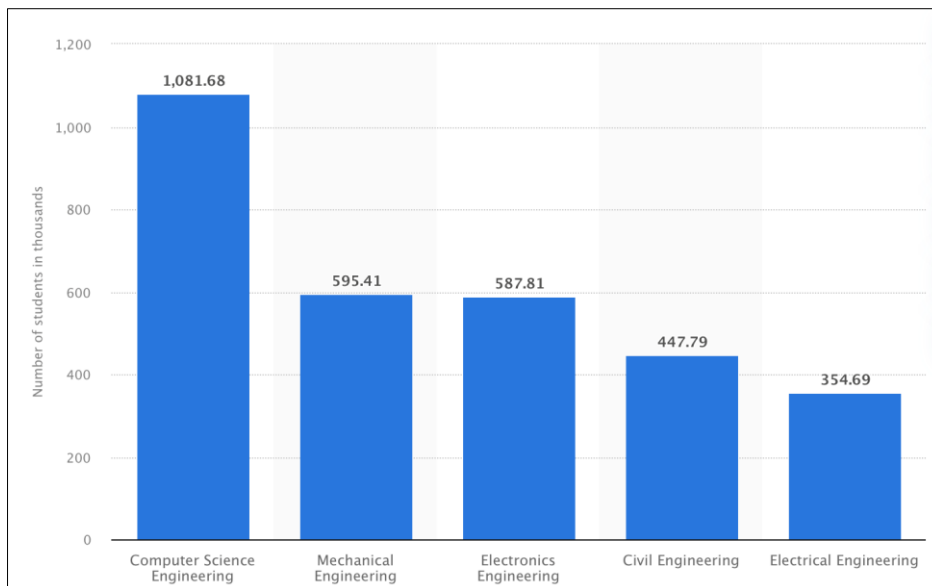


Fig 2

While manually finding colleges according to a student's JEE score can be challenging and time-consuming, the development of educational assistant websites that leverage data analytics and machine learning can simplify the process. These platforms integrate and analyze cutoff data, provide personalized college predictions, book recommendations, and course suggestions, aiding students in making informed decisions about their educational journey.

Additionally, an educational assistant platform goes beyond college predictions and offers valuable book recommendations and course suggestions to support students in their academic journey. The platform considers the syllabus and subjects covered in various college programs, providing

book recommendations that are highly relevant to the curriculum.

By considering these aspects, the platform recommends courses that align with students' interests, career goals, and future prospects.

By streamlining the college selection process and offering personalized recommendations, these platforms empower students to explore suitable alternatives and pursue their dreams beyond IITs and NITs. Ultimately, the focus should be on finding an institution that offers a quality education, state-of-the-art infrastructure, experienced faculty, industry connections, and opportunities for holistic development.

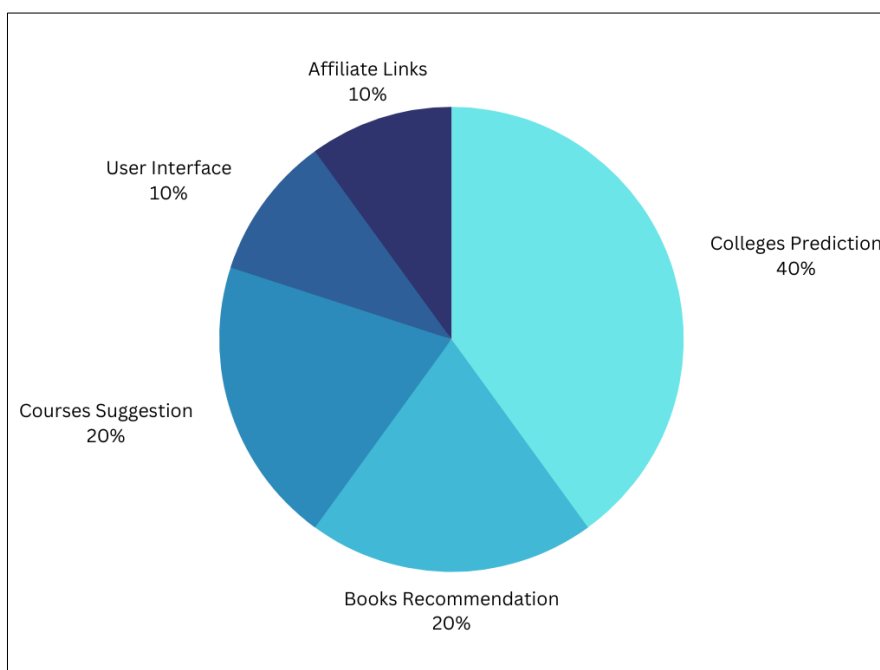


Fig 3

Conclusion

In conclusion, the dream of getting into prestigious institutions like IITs and NITs is common among students in India. However, due to the intense competition, not everyone can secure admission to these institutions. In such cases, alternative options like Chandigarh University can provide an excellent education and promising career prospects.

Future Scope

The proposed Educational Assistant website lays a strong foundation for assisting students in their college selection, book recommendations, and online course suggestions. However, there are several potential areas for future expansion and improvement:

1. **Expansion to Other Fields:** While the current system focuses on engineering colleges and related resources, there is potential for expansion to other fields of study. Including recommendations for other disciplines such as medicine, business, humanities, and sciences would cater to a broader range of students and their specific needs..
2. **Integration of User Feedback:** Continuous user feedback plays a vital role in refining and enhancing the system. Incorporating mechanisms for users to provide feedback on college recommendations, book suggestions, and course recommendations would enable the system to adapt and improve based on the preferences and experiences of its users.
3. **Personalized Profiles:** Student will have personalized profiles where they can save their preferences, track their progress, and view their recommended colleges.
4. **Customized Bookshelf:** The system will allow students to create personalized bookshelves within their profiles. Students can save their favorite books, mark books as "read," or create reading lists for future reference. This feature enhances organization and enables students to easily access and manage their book recommendations.
5. **Price Comparison:** The system will include a price comparison feature for recommended books. Students can compare prices from different online bookstores to find the most cost-effective options. This feature allows students to make informed decisions and potentially save money when purchasing their recommended books.
6. **Enhanced Personalization:** The system can further enhance its personalization capabilities by incorporating machine learning and artificial intelligence techniques. By analyzing user behavior, learning patterns, and academic performance, the system can offer even more accurate and tailored recommendations to students, continually improving their educational journey.
7. **Collaboration and Social Learning:** Introducing features that facilitate collaboration among students, such as study groups, discussion forums, and peer mentoring, would promote social learning and knowledge sharing. Enabling students to connect with others who have similar interests and goals will create a vibrant learning community within the platform.
8. **Integration with E-Learning Platforms:** Collaborating with established e-learning platforms and integrating their course catalogs directly into the system would expand the range of available online courses and ensure access to a diverse set of learning resources. This integration would provide students with a seamless experience in discovering, enrolling in, and tracking their progress within online courses.

9. Career guidance and alumni networking:

Incorporating career guidance features, including internship opportunities, resume building, and networking with alumni, would provide students with comprehensive support in their career development. Connecting students with successful alumni from various colleges would help them gain insights and mentorship in their chosen fields.

10. Adaptive learning and personalized study plans:

Implementing adaptive learning algorithms that assess students' strengths, weaknesses, and learning progress can generate personalized study plans. The system can dynamically adjust the difficulty level and content delivery to optimize learning outcomes for each individual student.

11. Integration with Learning Analytics:

Leveraging learning analytics techniques to track and analyze student performance, engagement, and progress can provide valuable insights to both students and educators. This data can be used to identify areas of improvement, optimize learning strategies, and provide personalized feedback to students.

12. Multilingual Support:

Expanding language options within the system to support multiple languages would enable students from diverse backgrounds to access and benefit from the platform. This inclusivity would cater to a wider audience and promote equal educational opportunities.

13. Mentorship and expert guidance:

Introducing a mentorship program where students can connect with experienced professionals and industry experts would provide valuable guidance and support. The system can facilitate mentor-student interactions, career counselling sessions, and networking opportunities to foster professional development.

14. International College Recommendations:

Expanding the system to include recommendations for international colleges and universities would benefit students interested in pursuing higher education abroad. Including information on admission requirements, scholarships, and visa processes would provide comprehensive guidance for students seeking international opportunities.

15. Mobile Application:

Developing a mobile application for the Educational Assistant website would provide students with convenient access to recommendations, resources, and updates on-the-go. A mobile app would enhance the user experience, ensuring that students can benefit from the system's features anytime, anywhere.

References

1. Sharma NT, Sharma AK. Predictive modeling for JEE counseling using machine learning algorithms. 2016.
2. Altaf U, *et al.* Auto-scaling a defence application across the cloud using Docker and Kubernetes. In: Proc. IEEE/ACM Int. Conf. Utility Cloud Comput. Companion. 2018. p. 327–334.
3. He S, Guo L, Guo Y, Wu C, Ghanem M, Han R. Elastic application container: A lightweight approach for cloud resource provisioning. In: Proc. IEEE 26th Int. Conf. Adv. Inf. Netw. Appl. 2012. p. 15–22.
4. Jiang J, Lu J, Zhang G, Long G. Optimal cloud resource auto-scaling for web applications. In: Proc. 13th IEEE/ACM Int. Symp. Cluster Cloud Grid Comput. 2013. p. 58–65.
5. Huang G, *et al.* Auto scaling virtual machines for web

- applications with queueing theory. In: Proc. 3rd Int. Conf. Syst. Informat. 2016. p. 433–438.
6. Tesauro G, Jong NK, Das R, Bennani MN. A hybrid reinforcement learning approach to autonomic resource allocation. In: Proc. IEEE Int. Conf. Autonomic Comput. 2006. p. 65–73.
 7. Vilaplana J, Solsona F, Teixido I, Mateo J, Abella F, Rius J. A queueing theory model for cloud computing. J Supercomput. 2014;69(1):492–507.
 8. Lu C, Lu Y, Abdelzaher TF, Stankovic JA, Son SH. Feedback control architecture and design methodology for service delay guarantees in web servers. IEEE Trans. Parallel Distrib. Syst. 2006;17(9):1014–1027.
 9. Pan W, Mu D, Wu H, Yao L. Feedback control-based QoS guarantees in web application servers. In: Proc. 10th IEEE Int. Conf. High Perform. Compute. Common. 2008. p. 328–334.
 10. Hu Y, Dai G, Gao A, Pan W. A self-tuning control for web QoS. In: Proc. Int. Conf. Inf. Eng. Comput. Sci. 2009. p. 1–4.
 11. Sha L, Liu X, Lu Y, Abdelzaher T. Queueing model based network server performance control. In: Proc. 23rd IEEE Real-Time Syst. Symp. 2002. p. 81–90.
 12. Xu C, Liu B, Wei J. Model predictive feedback control for QoS assurance in webservers. Computer. 2008;41(3):66–72.
 13. Baresi L, Guinea S, Leva A, Quattrocchi G. Adiscrete-time in Proc.24th ACM SIGSOFT Int. Symp. Found. Softw. Eng. 2016. p. 217–228.
 14. Chung, J. W. Park, G. R. Ganger. Stratus: Cost-aware container scheduling in the public cloud. In: Proc. ACM Symp. Cloud Comput. 2018. p. 121–134.
 15. Kaur K, Dhand T, Kumar N, Zeadally S. Container-as-a-service at the edge: Trade-off between energy efficiency and service availability at fog nano data centers. IEEE Wireless Commun. 2017;24(3):48–56.
 16. Liu C, *et al.* Authorized public auditing of dynamic big data storage on cloud with efficient verifiable fine-grained updates. IEEE Trans. Parallel Distrib. Syst. 2014;25(9):2234–2244.
 17. Guerrero C, Lera I, Juiz C. Genetic algorithm for multi-objective optimization of container allocation in cloud architecture. J. Grid Comput. 2018;16(1):113–135.
 18. Abdullah M, Iqbal W, Bukhari F. Containers vs virtual machines for auto-scaling multi-tier applications under dynamically increasing workloads. In: Proc. Int. Conf. Intell. Technol. Appl. 2018. p. 153–167.
 19. Wang X, *et al.* An autonomic provisioning framework for outsourcing data center based on virtual appliances. Cluster Comput. 2008;11(3):229–245.
 20. Patikirikoral T, Colman A, Han J, Wang L. A multi-model framework to implement self-managing control systems for QoS management. In: Proc. 6th Int. Symp. Softw. Eng. Adaptive Self-Manag. Syst. 2011. p. 218–227.
 21. Hellerstein JL, Diao Y, Parekh S, Tilbury DM. Feedback Control of Computing Systems. Hoboken, NJ, USA: Wiley, 2004.
 22. Li H, Venugopal S. Using reinforcement learning for controlling an elastic web application hosting platform. In: Proc. 8th ACM Int. Conf. Autonomic Compute. 2011. p. 205–208.
 23. Barrett E, Howley E, Duggan J. Applying reinforcement learning towards automating resource allocation and application scalability in the cloud. Concurrency Comput.: Practice Experience. 2013;25(12):1656–1674.
 24. Dutreilh X, Moreau A, Malenfant J, Rivierre N, Truck I. From data center resource allocation to control theory and back. In: Proc. IEEE 3rd Int. Conf. Cloud Compute. 2010. p. 410–417.
 25. Litoiu M, Mihaescu M, Ionescu D, Solomon B. Scalable adaptive web services. In: Proc. 2nd Int. Workshop Syst. Develop. SOA Environ. 2008. p. 47–52.
 26. Kumar R, Tomar P. A hybrid collaborative filtering approach for online course recommendation system. 2015.
 27. Panda A, Rath S. An intelligent recommendation system for online courses using data mining techniques. 2017.
 28. Ojha VK, Kundra H, Sibal R. An intelligent approach for online course recommendation using association rule mining. 2019.
 29. Mani D, De R. Big Data Collection and Analysis in India: Challenges and Opportunities. 2017.
 30. Soundarajan N, Singh SD. Data Collection Challenges in Indian Higher Education: A Case Study of Private Colleges. 2016.
 31. Kaur A, Singh S. Challenges and Opportunities of Data Mining in Indian Education Sector. 2018.
 32. Witten IH, Frank E, Hall MA, Pal CJ. Data Mining: Practical Machine Learning Tools and Techniques. 2016.