iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** IV **Month of publication:** April 2026

DOI: https://doi.org/10.22214/ijraset.2026.81085

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IV Apr 2026- Available at www.ijraset.com

Survey and Design of a Comprehensive Module for a Class Scheduling System using SVM

Supriya Sawwashere[1], Gauri Raju Bhoyar[2], Kalyani Tayade[3], Shifa Abdullah Khan[4], Tanishka Jadhav[5]
Computer Science and Engineering, J D College of Engineering and Management, Nagpur, Maharashtra, India

Abstract: ***An advanced class scheduling system leverages Support Vector Machine (SVM) technology to optimize timetable management in educational institutions. By analyzing factors such as teacher availability, classroom capacity, and student enrolment, the system efficiently allocates resources while preventing scheduling conflicts. The model processes scheduling data to generate well-structured timetables, adapting dynamically to any unforeseen changes. Additionally, automated notifications ensure that teachers and students receive real-time updates regarding their schedules. By reducing manual workload and minimizing errors, this system enhances efficiency, improves communication, and simplifies scheduling.***
Keywords: Machine Learning, Support Vector Machine, Real-Time Scheduling, Timetable Optimisation.

I. INTRODUCTION

Support Vector Machines (SVMs) are a powerful and versatile set of supervised machine learning algorithm that looks at data and sort it into one of two categories used for tasks in classification and regression. SVM is one of the best nonlinear supervised machine learning models. Given a set of labeled training data, SVM will help us to find the optimal hyperplane that categorises margin to differentiate between classes. This approach ensures the closest possible class for achieving the desired outcomes. The data points that are located near the margins are crucial, known as support vectors. In two-dimensional space the hyperplane is a point in two-dimensional space, the hyperplane is a line, and in three-dimensional space, the hyperplane is a surface that divides a space into two parts, where each class lies on either side. A hyperplane to separate the positive samples from the negative samples, but which one is the best? SVM can help us choose the best hyperplane that maximizes the margin, or sometimes we call it a line around the hyperplane to separate the positive ones from the negative ones. That's the reason why sometimes we also call SVM the maximum margin classifier. Support vectors are the data points that lie closest to the hyperplane. They are the data points most difficult to classify, which also decide which hyperplane we should choose. Unlike some other machine learning like linear regression or neural networks, all data points influence the final optimization. For SVM only the difficult points which is the support vectors has an impact on the final decision boundary Moving a support vectors move the decision boundary moving the other vectors has no impact, during the inference time SVM will predict output Y with input X. SVM will help us to find a set of weights W for each feature then through the linear combination of input features and weights we can predict the output Y. The model learns to recognize patterns in the data and make predictions on new, unseen data. SVMs are particularly useful for handling high-dimensional data and can achieve high accuracy in classification tasks. They are also robust to noisy or missing data, making them a reliable choice for real-world applications. By using SVMs in our classroom scheduling system, we can leverage the power of machine learning to optimize schedules, reduce conflicts, and improve resource allocation. In this project, we are dealing with the non-linear type of data, which means it cannot be separated by a straight line or a hyperplane. SVM has a strong advantage on the basis of theory, thus it can guarantee that the solution of the extreme solution is the optimal solution rather than the local minimum.

II. LITERATURE REVIEW

There is significant ongoing research in the application of multiple Machine Learning algorithms, particularly Support Vector Machines (SVMs), in solving real-world optimization problems. In the context of classroom scheduling, SVM can be effectively utilized to classify and optimize scheduling constraints, ensuring efficient allocation of resources and time slots and other necessary features.

To start with, we observed the efficiency of classifiers [1] in classification and pattern recognition tasks. The kernel function plays an important role in SVM, as it maps data into higher dimensional space to enable linear separability of the decision boundary or hyperplane. The article [2] acknowledged the analytical survey done, summarizing the involvement of machine learning in teaching Quality. It mainly focuses on the positive prediction of the SVM algorithm, which is effective in various studies. The aim was to examine the limitations that occurred in the adaptation of the SVM and other ML algorithms.

Various machine-learning algorithms [3] are suggested that can be used in an efficient scheduling of academics. SVM implementation has been referred to as an optimal Machine learning algorithm. Both classification and regression tasks can be performed using it. It classifies the courses based on high and low demand. Furthermore, Ref. [2,3] depicts the performance of the model by using parameters such as recall, accuracy, and precision, and others, depending upon whether it is a classification or regression task. [4] showcased the required improvement in the unsatisfactory classification effect of traditional classification methods, which are adapted for online education resources. [5] discusses the accuracy of the SVM algorithm in recent applications. It deals with nonlinearity and high-dimensional data as compared to other ML algorithms. The superiority of SVM over other algorithms [7] is accompanied by its theoretical foundations and good conceptual capacity. Improvement in processing the large amount of data collected.

III. RESEARCH GAP

The articles published in [1,13] in their studies proposed new kernel functions, which were mainly tested on restricted datasets and generic classification problems. This will not let the kernel to adapt to the real-time scheduling challenges. In this project, we apply kernel functions to real-time class scheduling, focusing on teacher availability, overlapping time slots, instead of just focusing on classification tasks. In the educational domain, SVM has been trained for predicting student performance, retention rate, and placement outcomes from the historical dataset [6, 8, 9, 10]. While these studies successfully demonstrate the predictive capacity of SVM in academic analytics, but not emphasize on the scheduling patterns. The study [14, 15] showcased the primary choices between the kernel function majorly RBF or Linear, based on improving the classification accuracy. However, it lacks to explore the circumstantial preferences like subject ordering, classroom availability. This essential aspect is covered in the proposed real time scheduling system project. The existing studies [1,13, 14] considered SVM as an isolated classifier, focusing only on classification performance without integrating it into larger optimization frameworks which might prove robust. This limits its operational tasks. In our project, we integrate kernel based SVM with Google OR-Tools. Kernels provides feasible scores for candidate assignments, while OR-Tools ensures hard rules like overlapping and slot conflicts are satisfied. This hybrid framework bridges machine learning with constraint optimization. This proposed real-time scheduling system bridges the gap between small-level classification tasks and real-time scheduling for practical utility, which was previously unexplored. Overall, our project contributes to solving complex multiple constraints with a supporting tool, Google OR Tool for better optimization, leading to a scalable system.

IV. RESEARCH METHODOLOGY

Algorithm: Support Vector Machine

Support Vector Machine (SVM) is a supervised learning algorithm capable of handling both classification and regression problems. This project employs the Support Vector Classifier (SVC) variant, which is well-suited for datasets with multiple influencing features and complex, non-linear relationships. By applying an appropriate kernel function, the model can effectively distinguish between optimal and non-optimal scheduling configurations.

A. SVM and SVC working together

In this work, the classification variant of SVM, known as Support Vector Classifier (SVC), is used for classification when the data is multidimensional. It is utilized to distinguish between viable and non-viable scheduling assignments. The model takes multiple input features such as faculty name, course name, course code, faculty availability, time slots, subject, and classroom allocation to evaluate each candidate's schedule. The implementation of the model is carried out using standard machine learning libraries, while the underlying working is based on the mathematical formulation of SVM. The Support vector classifier model is trained on these input feature representations to learn patterns that distinguish between preferred and non-preferred assignments. Based on this learning, the model evaluates each candidate assignment and assigns a valid score indicating how appropriate the assignment is. In this process, SVM acts as the underlying mathematical model that defines how the decision boundary is formed.

B. RBF-SVM Stage

The model is trained using the Radial Basis Function (RBF) kernel, chosen for its ability to capture non-linear patterns inherent in scheduling data — such as faculty time preferences, subject-specific room requirements, and batch lecture sequencing. Once trained, the model evaluates candidate scheduling assignments, each represented as a tuple of faculty, subject, room, day, and time slot. A feasibility score is assigned to every candidate, with higher scores reflecting more suitable assignments and lower scores indicating less favourable ones. These scored candidates are then passed to the next optimization stage.

C. Google OR-Tools

Standard classification metrics: accuracy, precision, recall, and F1-score, are used to assess how well the SVM distinguishes optimal from non-optimal assignments. The model is examined under three behavioural conditions: underfitting (where patterns go unlearned, leading to frequent misclassifications), overfitting (where the decision boundary becomes too rigid to generalize), and normal fitting (where an ideal balance between bias and variance is achieved). Visual plots illustrating misclassification against model complexity guide the selection of suitable hyperparameters.

D. SVM Working with the Google OR-Tools

In the proposed system, SVM and Google OR-Tools work together in a sequential and complementary manner. The SVM model, implemented using SVC, first evaluates different candidate scheduling assignments based on learned patterns and assigns feasibility scores to them. These scores reflect how suitable a particular assignment is based on feature relationships.

However, since SVM focuses on pattern learning and does not enforce strict rules, the generated assignments may still violate certain constraints. To address this, the scored candidate assignments are passed to Google OR-Tools.

At this stage, OR-Tools uses the SVM-generated scores as a guiding factor while selecting assignments, but it ensures that all hard constraints are satisfied. The optimization process aims to select a set of assignments that maximizes overall suitability while maintaining a conflict-free schedule.

Comparative analysis between the existing model and the proposed model.

Ref.	Approach Used in existing Models	Improvement in the Proposed Model
[1]	SVM with the modified kernel is used for classification, but evaluated on generic datasets, not real-time scheduling	Applied RBF kernel to real time class scheduling, not just generic classification. It integrates scheduling constraints which were not included in [1]
[3]	Survey of machine learning algorithm for academic scheduling	Moves beyond survey by implementing a working hybrid system combining SVM and optimization
[4]	Improved SVM for online education resource classification	Extends SVM usage from resource classification to timetable generation with constraint handling
[6]	SVM model was used for analysing for educational performance.	In the proposed model, it shifts from performance prediction to operational scheduling and resource allocation
[11]	Non linearity of SVM kernel function is shown, but isolated kernel evaluation	RBF kernel is used within a real-world scheduling pipeline instead of isolated kernel evaluation

TABLE (I) Comparative Analysis table

V. STATEMENT OF THE PROBLEM

Educational institutions face major challenges in managing a vast amount of workload, real-time class scheduling, and resource allocation, including:

1) Inefficient Timetable Generation: Scheduling systems often depend on manual methods, leading to scheduling conflicts, poor usage of resources, and increasing admin workload as well.
2) Lack of Real-Time Adjustability: Existing systems are unable to respond dynamically to sudden alterations such as faculty unavailability or replacement, classroom assignments, or timetable conflicts.
3) Limited Use of Emerging Technology: Recent solutions do not successfully apply machine learning techniques, especially Support Vector Machine, for accurate classification, resource allocation, and decision-making in scheduling.

The challenge is to develop a comprehensive real-time scheduling system using a support vector machine that enables intelligent and adaptive timetable generation in educational institutions with efficient resource allocation and ease in decision-making in the environment

VI. OBJECTIVE OF THE STUDY

The primary objective of this project is to develop a comprehensive real-time scheduling system using SVM that uses modern technology to generate efficiently and regulate timetable generation. The system objectives are:

1) To replace manual timetable creation with an intelligent system that reduces human effort and errors.
2) To use SVM with a kernel for classifying feasible subject–faculty–room–time combinations based on historical and simulated data.
3) To avoid overlapping lectures, double-booked faculty, and exceeding room capacities.
4) To dynamically revive schedules in case of sudden changes (faculty replacement, room inaccessible, extra sessions).
5) To maximize classroom usage efficiency and fairly distribute workloads among faculty, students and administrators.
6) Finally, this project seeks to create scalable, adapting and effective timetable including intelligent features while ensuring accuracy, efficiency, real-time availability and transparency in timetable management.

VII. SCOPE AND LIMITATIONS

A. Scope

The real-time class scheduling system aims to create an intelligent system that integrates timetable generation and efficient resource allocation to enhance scheduling. This framework will provide:

- To accommodate many departments and branches or plan for the entire university and alter or make changes to the scheme, including auto-notification systems.
- Additionally, include schemes of laboratories based on election preferences and alternative courses.
- Generate a spontaneous mobile or wireless network interface for faculty, admin, or supervisors.

Continuous updates and optimization of schedules using live teaching staff, faculty, and resource availability.
Integrates SVM-based classification methods, achieving accuracy, adaptability, and robustness.

B. Limitations

The SVM model requires a large, high-quality dataset to learn properly. Inconsistent data often leads to learning and training failure.

- When a teacher becomes absent or unavailable, the model simply cannot cope unless additional handling logic is built in.
- The system's performance can eventually become slow and costly when managing the classrooms, labs, and teachers.
- The accuracy of the system model heavily depends on data scaling and how parameter selection is set.
- Any change in scheduling or any managing rules can often lead to poor system performance that can force the system into unnecessary risk.

VIII. CONCLUSION

The conclusion establishes that the proposed SVM-based class scheduling system effectively addresses the challenges associated with manual timetable creation. By automating the allocation of classes, faculty, and resources, the system significantly reduces scheduling conflicts and administrative workload while ensuring optimal utilization of available resources. The integration of machine learning with constraint optimization forms the core strength of the system, as it combines intelligent decision-making with strict viable enforcement.

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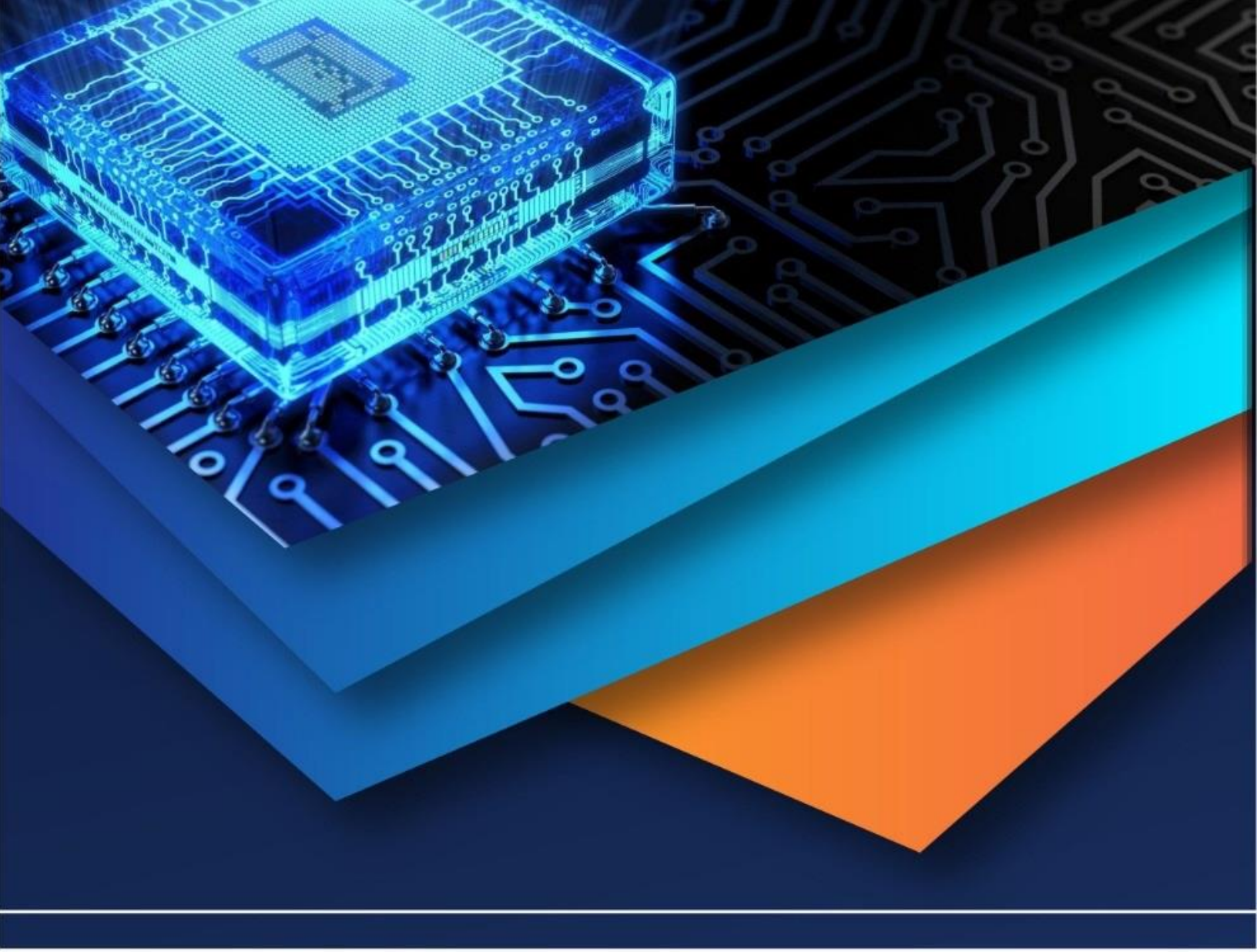

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