Optimizing Convolutional Neural Networks (CNNs) for Image Classification through Advanced Gradient Descent Techniques

By
Srivatsa Tenneti (1230683872) & Ravi Tej Chaparala (1230035172)

Abstract

This project aims to explore and implement advanced gradient descent techniques to optimize the training of Convolutional Neural Networks (CNNs) for the task of image classification. Given the extensive coverage of machine learning and optimization methods in the course, this project will focus on applying concepts such as Stochastic Gradient Descent (SGD), ADAM, Momentum Methods and Regularisation Techniques from the curriculum to improve the efficiency and accuracy of CNNs. The project will involve comparing these optimization techniques on a standard image dataset to evaluate their performance in terms of training time, convergence rate, and classification accuracy. This comparison will not only demonstrate the practical implications of different optimization strategies but also contribute to a deeper understanding of their strengths and weaknesses in the context of deep learning.

Significance of the Project:

The significance of this project lies in its potential to enhance the performance of CNNs, which are widely used in various applications, including facial recognition, autonomous driving, and medical imaging. By optimizing the training process, this project could lead to faster model development cycles and more accurate models, thereby improving the effectiveness of CNNs in real-world applications. Additionally, this project will provide practical insights into the application of optimization techniques covered in this course, bridging the gap between theoretical concepts and their implementation in machine learning.

Timeline:

1. **Week 1-2 (Feb 20 - Mar 5):** Literature review on optimization techniques and their application in machine learning, particularly in image classification. Selection of datasets and preliminary setup for experimentation.
2. **Week 3-4 (Mar 6 - Mar 19):** Implementation of a basic CNN model for image classification. Experimentation with traditional optimization techniques such as gradient descent and SGD.
3. **Week 5-6 (Mar 20 - Apr 2):** Application of advanced optimization algorithms like ADAM and momentum methods to the CNN model. Analysis of their effects on training efficiency and model accuracy.

4. **Week 7 (Apr 3 - Apr 9):** Exploration of regularization techniques and their impact on model overfitting and generalization. Fine-tuning model parameters based on experimental results.
5. **Week 8 (Apr 10 - Apr 16):** Compilation of results, analysis of findings, and comparison of the performance of different optimization strategies.
6. **Week 9 (Apr 17 - Apr 23):** Finalization of the project report. Preparation for the project presentation.
7. **Final Week (Apr 24 - Apr 30):** Submission of the final project report and presentation of findings to the class.

This timeline allocates sufficient time for each phase of the project, from literature review and model implementation to experimentation and analysis, ensuring a comprehensive exploration of optimization strategies for image classification.

Conclusion:

This project proposal outlines a focused study on the application of advanced optimization techniques to improve CNN performance in image classification tasks. By leveraging the concepts taught in this course, this project not only aims to achieve practical outcomes in machine learning but also enriches the learning experience by applying theoretical knowledge to solve real-world problems.