DoodleIt: A Beginner's Tool for Understanding Image Recognition

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ABSTRACT

In this poster we present "DoodleIt," an interactive web application that performs sketch recognition and an afterschool curriculum that teaches students the key concepts of convolutional neural network (CNN). With DoodleIt, students make simple line drawings on a canvas area and a previously-trained CNN identifies the object drawn. The application visualizes the different layers that are involved in the process of CNN, including a display of kernels, the resulting feature maps, and the percentage of match at output neurons. We used DoodleIt as a part of 18-hour curriculum to introduce students to artificial intelligence, machine learning, and data science. Our findings indicate that students were able to understand the functionality of the kernels and feature maps involved in the CNN to perform rudimentary image recognition.

1 INTRODUCTION

Children today live in an AI-dominated environment where algorithms choose the videos they watch, filter the information they see, and influence how they learn to speak. Children could become critical consumers of technology if they understood how these algorithms are created [2]. Thus, teaching AI should be a part of K-12 education [4]. The underlying processes of machine learning are rarely exposed to children and it is important to unpack the "black boxes" of how these algorithms works [1].

2 DOODLEIT

DoodleIt is a web-based application that recognizes the drawings of different objects made on a canvas. As the user draws on the canvas, the tool interactively displays the matching percentage for each object, color-coded based on the level of accuracy. It displays the filters/kernels that were trained in the CNN model. It visualizes their application to the source image, producing feature maps in real time which helps users gain insight into how a computer interprets their drawing. DoodleIt was trained to recognize six different objects: cat, sheep, door, cake, apple, and triangle. These images were chosen based on their ease of drawing from the 345 categories in Google's Quick, Draw! dataset. A screenshot is captured each time the user clicks on the clear button, a code name field records the anonymous unique identifier of research participants. Through this tool, we have unveiled some of the functionalities hidden behind the black box of neural networks [3].

3 THE CURRICULUM

We created a two-hour image recognition curriculum which was embedded in an 18-hour afterschool program on AI and data science. It included: (a) a slide presentation to introduce the students to basic concepts of image recognition and CNN (how computer reads an image in the form of numbers, importance of training and testing data); (b) student interactions with the DoodleIt application; and (c) a pen-and-paper activity to illustrate how kernels work (how a filter captures some particular features in an image).

4 PILOT STUDY, RESULTS AND CONCLUSION

A pilot study was conducted with four fifth and sixth grade students who had little prior knowledge of AI. Student performance was evaluated through the data collected from the activities, post-survey questionnaires and interviews. This study suggests that the combination of tutorial presentations, activities with the DoodleIt app, and kernel exercises was a meaningful introduction to CNNs for the students. It helped them understand the concepts of CNNs and also generated curiosity about AI among them.

ACKNOWLEDGMENTS

This material is based upon work supported by the National Science Foundation under Grant No. 2112633.

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SIGCSE 2023, March 15–18, 2023, Toronto, ON, Canada

ACM ISBN 978-1-4503-9433-8/23/03.
https://doi.org/10.1145/3545947.3576275