LEARNING AND USING IMAGE CLASSIFIERS BY CREATING REAL MOBILE APPLICATIONS

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Abstract

MIT App Inventor is an open-source web platform that uses an intuitive block-based programming environment, allowing anyone to create original mobile applications for Android phones, iPhones, and tablets. We seek to empower people of many backgrounds and degrees of programming ability to participate in app creation and to move from technology consumption to technology creation.

Recently, machine learning has emerged as a core technology with potential applications in our daily lives. For example, machine learning could be used to improve the accuracy of weather forecasts, automatically translate documents, or generate new recipes based on a set of ingredients. As a result, computer science educators are starting to look for ways to deploy machine learning models in the classroom and design curricula that scaffold students in applying these models in design-engineering assignments that solve real-world problems in their daily lives or community.

Our study focused on teaching image classification, a method of categorizing and labeling objects within an image. To do so, we created an intuitive learning platform using MIT App Inventor and a simplified image classification tool, Personal Image Classifier (PIC). PIC is a web interface that allows students to train and test an image classification model based on pictures they snap with their webcams or upload. Once students have created the model, they can deploy it in a mobile application to classify everyday objects. Our goal is to make learning about and using image classification models easier and more enjoyable for students.

Three university computer science students (two from Hong Kong Polytechnic University and one from Worcester Polytechnic Institute) participated in a work shop using our learning platform. All three already had decent experience using MIT App Inventor and spent part of one day learning how to use PIC by going through the tutorials “Introduction to Machine learning: Image Classification” and “Personal Image Classifier: PICaboo.” The students then spent the rest of the day designing their own PIC projects for mobile use. The learning goal was to put their conceptual understanding into practice by making a simple PIC app that could solve a real-world problem in their daily lives or community.

Our research shows that students learned concepts around image classification and implemented them in practical software prototypes using the learning platform. In a college classroom intervention of three students (2 girls, 1 boys), students went through the tutorial and designed divergent working prototypes incorporating machine learning. For example, one student created an app that classifies dinosaur images by species, and that could potentially be used in the Hong Kong Science Museum. In post-intervention surveys, students noted that the work enhanced their interest in Artificial Intelligence, making them want to delve deeper into the details and mechanics of machine learning.

PIC is currently used by more than 100 primary schools in Hong Kong and we are continuously monitoring the progress.

Keywords: image classification, technology, mobile applications, etc.

1 INTRODUCTION

Artificial Intelligence (AI) is a rapidly growing field that has the potential to revolutionize many aspects of our lives. It is changing the way we work and the types of jobs that are available [1] and understanding AI can help people prepare for the future and explore new career opportunities. In addition, AI involves using computers to solve complex problems and create innovative products, services, and solutions. By learning about AI, people can develop problem-solving skills and tap into

their creativity to come up with new ideas. Overall, AI education is an important way for people to gain valuable skills that will benefit them. For this reason, it is essential for people to be introduced to AI and have the opportunity to learn about it.

There are some platforms that are designed specifically for teaching AI, but it is possible that these platforms may not be as effective as they could be. Here are a few reasons why this might be the case:

1. Lack of accessibility: Some AI education platforms may not be accessible to all kids, due to factors such as cost or geographic location.
2. Complexity: Some AI concepts can be difficult to understand, even for adults. It may be challenging for kids to learn about AI if the material is too complex or technical.
3. Lack of engagement: Kids are often more interested in learning when the material is presented in a way that is interactive and engaging. Some AI education platforms may not be as effective at holding kids' attention as others.

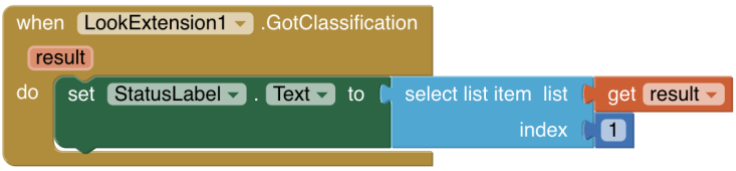

Figure 1. Block Coding

MIT App Inventor is a free, web-based platform for building mobile applications. It was developed by the Massachusetts Institute of Technology (MIT) and is designed to be used by people of all ages, including kids [2]. With MIT App Inventor, users can create their own mobile apps by dragging and dropping various “blocks” of code. The platform includes a wide range of pre-built blocks that can be used to add functionality to an app, such as text input, buttons, and image display [3]. Users can also customize their apps by adding their own blocks of code. MIT App Inventor is a good way for kids to learn about computer science and programming, as it provides a simple and intuitive interface for building apps [4]. It can be used to teach kids about concepts such as algorithms, data structures, and logic. Overall, MIT App Inventor is a useful tool for introducing kids to the world of mobile app development and helping them develop skills in computer science and programming.

Recently, we are aiming to integrate a new platform to teach students about AI using MIT App Inventor [5]. We do so by incorporating AI algorithms into a range of pre-built blocks that can be used to add AI functionality to an app. For example, users can add blocks for natural language processing or image recognition. Using such a platform, students can use MIT App Inventor to build apps that use AI to solve real-world problems. For example, they could create an app that uses image recognition to identify objects in a photo, or a chatbot that uses natural language processing to answer questions. By doing such, students will be able to learn about the underlying concepts of AI [6].

Our study focuses on teaching students about image classification [7]. Image classification is a type of artificial intelligence that involves training a computer to recognize and classify different objects or categories within an image. It is an important technology that carries key components of AI and has many practical applications, such as image search, object detection, and self-driving cars. Here we present a web application Personal Image Classifier (PIC) that allows users to train a custom image classifier within MIT App Inventor [8]. We hope that our new platform will help students develop problem-solving skills and learn about the technology of image classification. Also, we want to provide a fun and engaging experience for students. Students enjoy learning about new technologies, and image classification is an interesting and engaging topic that can spark their curiosity and creativity.

1.1 Personal Image Classification

Personal Image Classifier (PIC) is a platform to create machine learning models for App Inventor. It is powered by MobileNets. The goal of PIC is to give users hands-on practice in image classification.

Users will train image classification models using PIC and then import them in App Inventor to create machine learning-enabled mobile apps [8].

PIC features a training page and testing page. Users can add different category labels and use the webcam to add image data for each label. At least 50 images should be added for each category. Once the data has been added, users can click “Train” to start training.

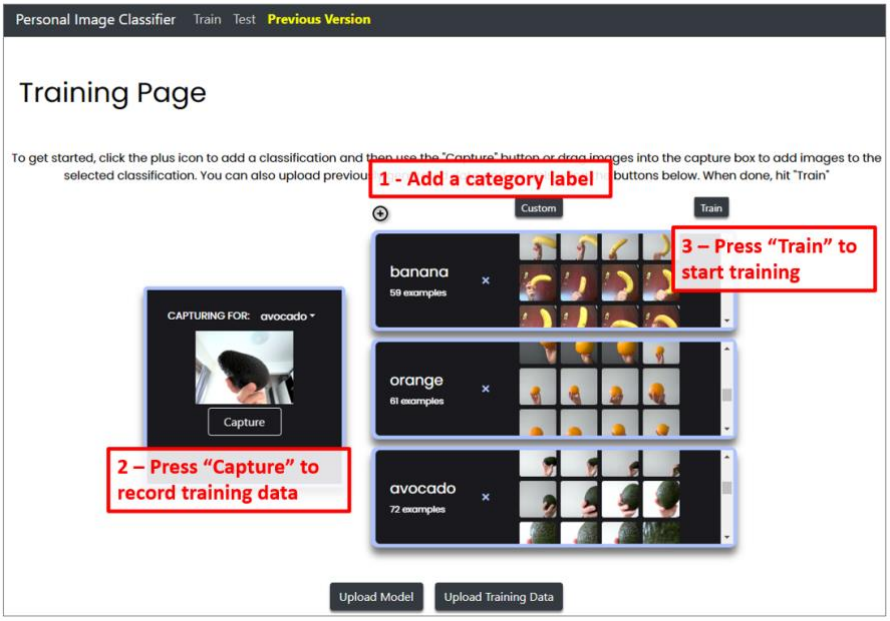

Figure 2. PIC training page

Once training is done, PIC will take the user to the testing page. The user can take a testing image and see its classification result by the model. All the test results are recorded in the “Test Results” section, with confidence level for the resulting label. The model can then be exported as a .mdl file to be used in App Inventor.

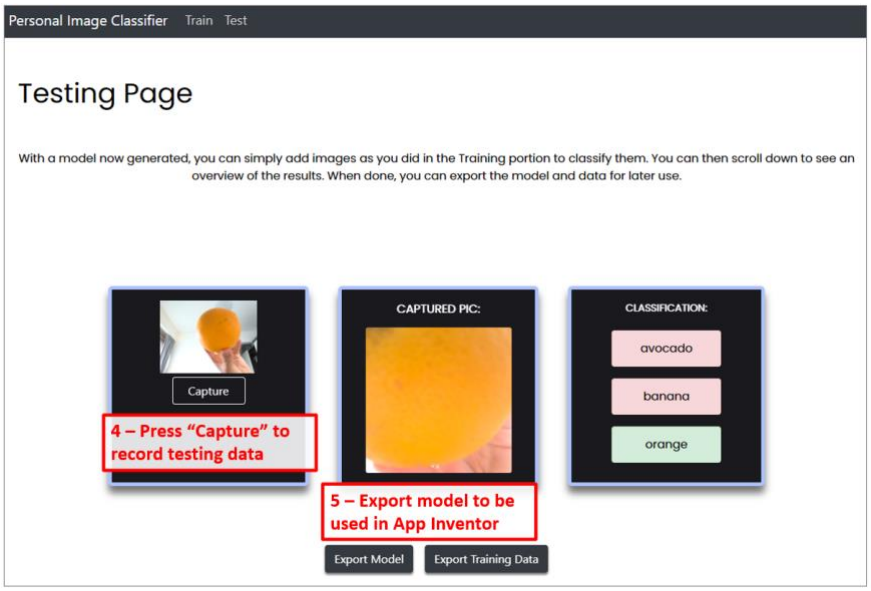

Figure 3. PIC training page 2

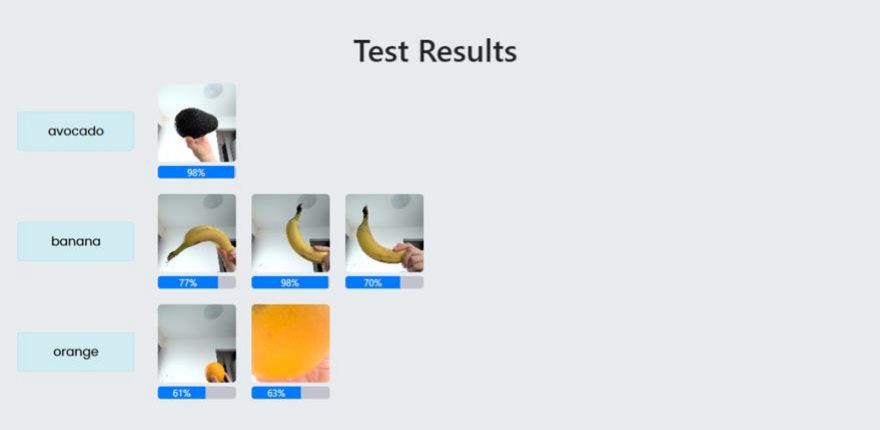

Figure 4. Recorded testing results showing confidence levels

App Inventor has a Designer interface, where users design the user interface for their mobile applications and upload relevant assets, including the trained model. Users can then program using pre-built image classification blocks to obtain the confidence level for each label. The result is a dictionary of classification results, where the keys are the labels and the values are confidence levels ranging from 0 to 1, summing to 1.

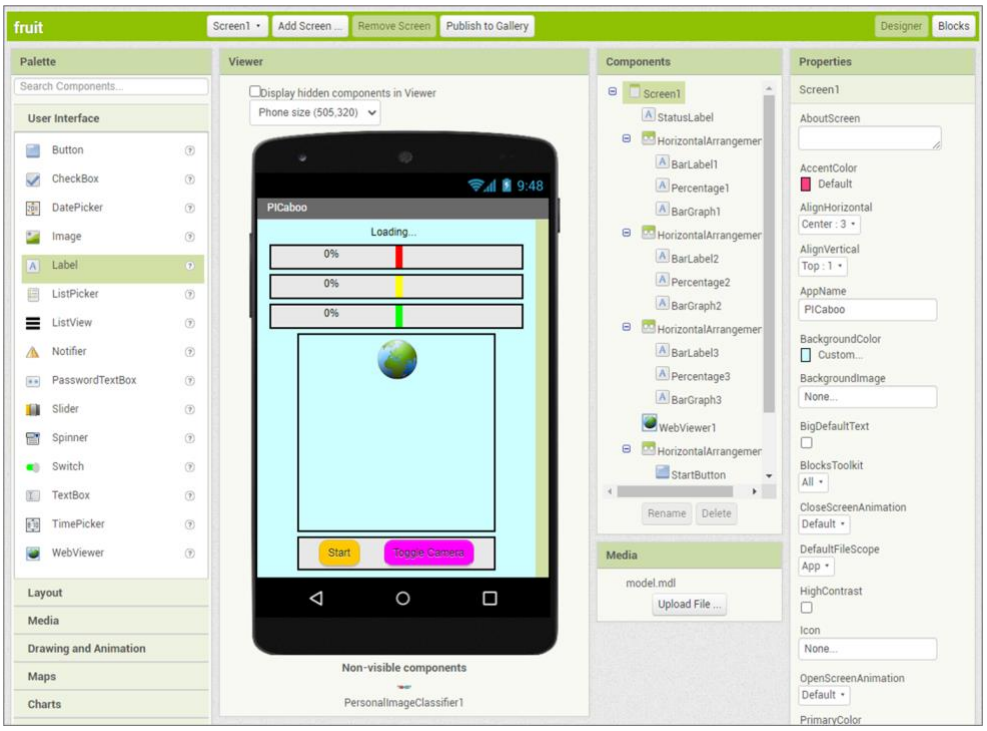

Figure 5. App Inventor Designer screen where users design how their application looks

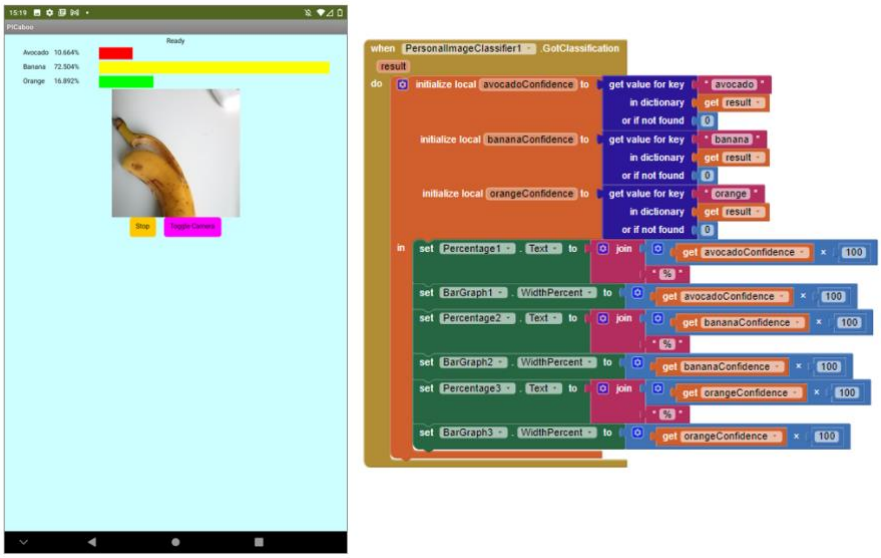

Figure 6. Using App Inventor's pre-built classification blocks to code an app to display confidence levels

2 METHODOLOGY

We conducted a workshop with three university Computer Science students. The students all had at least one year of higher education completed and 100 hours of Computer Science education, with one student having additional hours of prior Artificial Intelligence learning experience while others having none. They were all experienced with using App Inventor. The goal of the workshop was to learn Personal Image Classifier (PIC) and create their own mobile application that utilized PIC and to subsequently create a tutorial to teach secondary school students. Each student spent 4-5 hours learning how to use PIC by completing the tutorial provided by the MIT App Inventor team, including "Introduction to Machine Learning: image Classification" and "Personal Image Classifier: PICaboo" Afterwards, they spent an additional 10-15 hours working on their own mobile application that utilized PIC. The end result for each participant was a PIC-enabled mobile application and a tutorial that could be used to teach secondary school students about these technologies.

3 RESULTS

3.1 Mobile application the student created

Here we present the mobile application created by the three Computer Science students, two female students and one male student, referred to as Student A, Student B, and Student C.

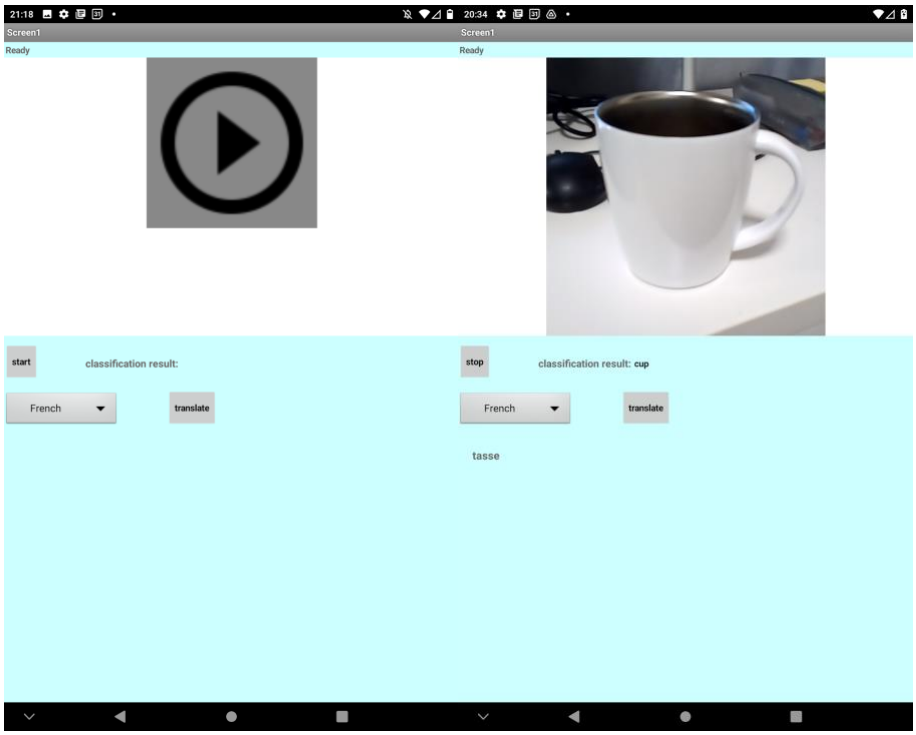

Figure 7. Student A's app, a camera translation app, that translate a recognized object to a language of your choice

Student A developed a Camera Translation application, which allows users to take a picture of the object they want to translate with their smartphone's camera. The app will automatically detect the object and provide a translation. This app is a useful tool for communication and understanding in different languages.

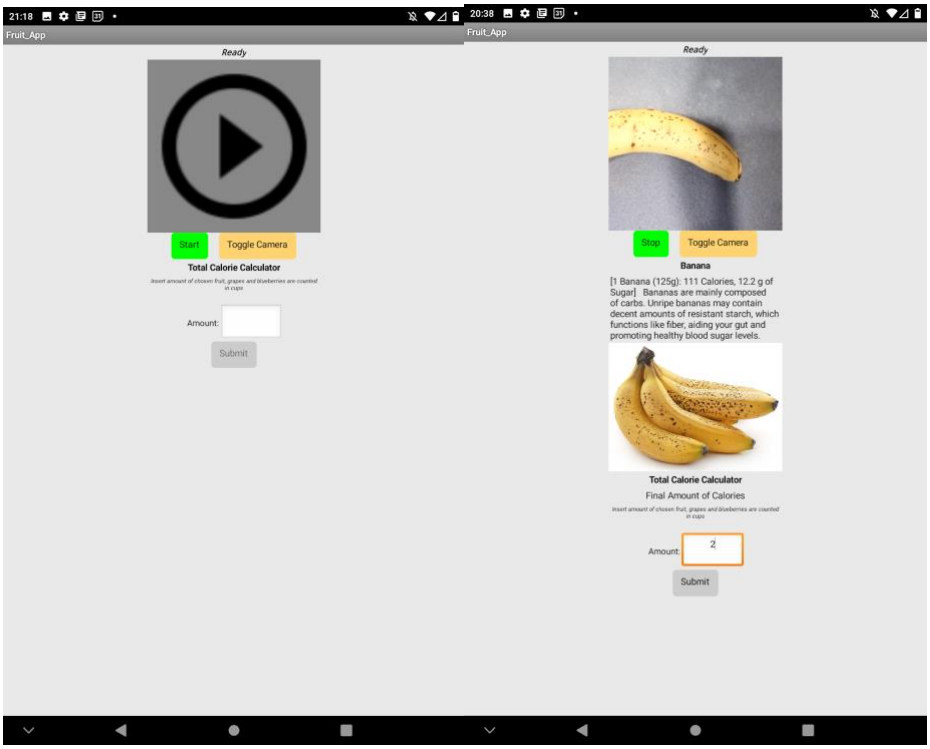

Figure 8. Student B's app, an app that recognize a fruit and shows nutrition information

Student B created an app that can recognize different types of fruit and provide information about their nutritional value. Once the app recognizes the fruit, it will provide information about the calorie and

nutrient content of the fruit. You can also use the app to track your daily intake of calories and other nutrients to help you reach your health and fitness goals.

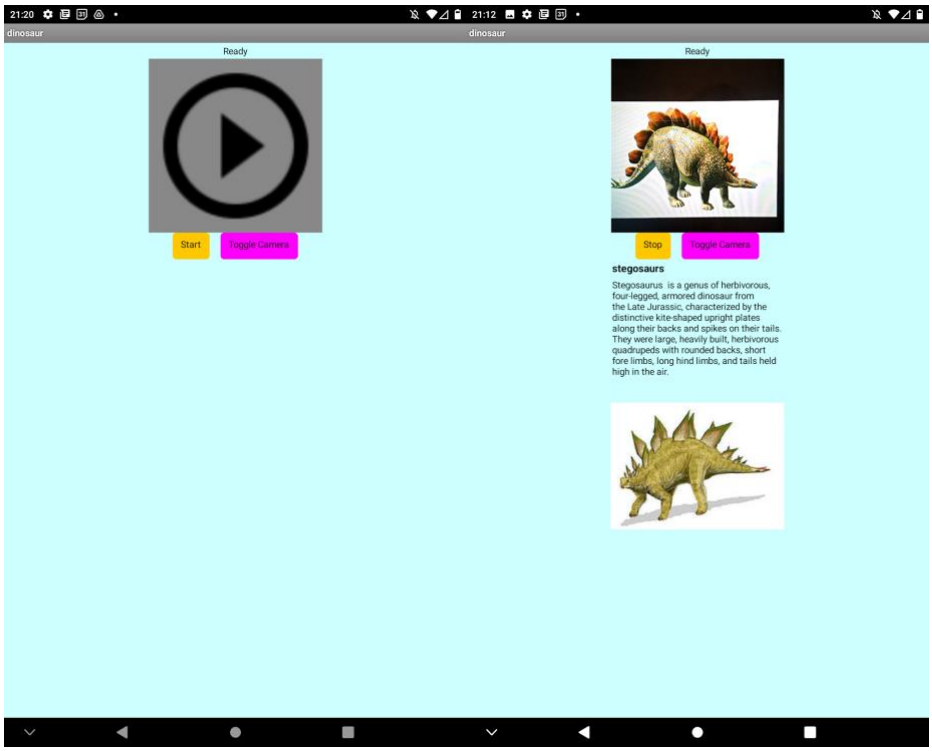

Figure 9. Student C's app, an app that recognize a dinosaur and shows interesting facts about the dinosaur

Student C decided to train an image classification model to recognize dinosaurs, using the Personal Image Classifier (PIC) tool. She discovered that PIC requires dinosaurs with very distinct features in order to be accurately classified. To gather sufficient training data, she used Python web crawlers to download pictures of dinosaurs. However, she had a concern about whether we could use copyrighted pictures for training, so she decided to visit the dinosaur exhibition at the Hong Kong Science Museum to collect her own samples of the exhibiting dinosaurs. The training results were much better than expected, but we suspected that this was due to the different colored lighting on each dinosaur rather than the model accurately recognizing the features of dinosaurs themselves. As a result, she considered turning the pictures into grayscale and retraining the model to see if this improved the classification accuracy.

3.2 Post-intervention surveys

There are a few areas where we hope to improve and expand upon our work with the Personal Image Classifier (PIC). Students A and C hope to increase the amount of training data available in order to improve the model's accuracy. Student A also wants to have an indication of the approximate amount of time needed to train a certain number of images, so that teachers and students can plan their work more effectively.

Student B has encountered difficulties in finding data for images, and all three students believe it would be helpful to have the option to choose different models and play with different parameters. It would also be useful to have more information and explanations about the models and their parameters. Student A mentioned the desire for .pt or .pth files, and Student B expressed a need for more tutorials on PIC.

Finally, Student C suggested adding a method to evaluate how the model performed, such as by providing statistics or allowing for testing in large batches rather than just one image at a time. Currently, we test the trained model by using a single picture and seeing if it is recognized correctly.

4 CONCLUSIONS

In this study, the focus was on teaching image classification, a method of categorizing and labeling objects in images. To do this, we developed a learning platform using MIT App Inventor and a simplified image classification tool called Personal Image Classifier (PIC). PIC is a web interface that allows students to train and test image classification models using pictures taken with a webcam or uploaded to the platform. Once the model is created, it can be deployed in a mobile device to classify everyday objects. The goal was to make learning about and using image classification models more accessible and enjoyable for students, bringing image classification from textbooks to real life.

Three university computer science students participated in the study. They had prior experience with MIT App Inventor and spent part of one day learning how to use PIC through the provided tutorials. They then spent the rest of the day designing their own PIC projects for mobile use, with the goal of creating a simple app that could solve a real-world problem. The results showed that the students were able to learn about image classification and implement their understanding in practical software prototypes using the learning platform. In post-intervention surveys, the students expressed increased interest in Artificial Intelligence and a desire to learn more about the mechanics of machine learning.

This study targeted university students. PIC is currently used by more than 100 primary schools in Hong Kong, and we are closely following how primary school students react to learning it and whether they can learn and create their own AI-enabled apps to solve real problems.

All three participants in this study wished to know more about the model and the parameters behind the training process. We believe this is due to their technical backgrounds. We speculate that younger students and students with less technical knowledge would benefit from a simpler layout as is. We think that the PIC platform could further develop to cater towards different needs by hiding and unhiding model and parameter choices as toolbars.

A key area for further work on education related to machine learning is the data we use for image classification. PIC is designed so that users are encouraged to take pictures using webcams. However, the small sample taken using the webcam limits the effectiveness of the model. The current setup illustrates to students how image classification works in a simplified way. More questions could be explored with students. For instance, how big should the training set be? How does the size of a training set affect the training time? We hypothesized that student C's model ended up recognizing the varied color lighting on dinosaurs rather than the dinosaur features. This example could provide great educational value and insight into how image classification works. If users want a large and more diverse training set, how should they obtain them?

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