Tell us what your idea is.

Describe in 250 words what the feature or service will do and how you'll use Machine Learning to push the bar:

Smartphones are the world's largest Augmented Reality platform. Google's ARCore and Apple's ARKit have made immersive experiences accessible to anyone with a recent smartphone. To create a realistic experience, understanding the user's physical environment is crucial, and these frameworks detect real-world planes, images, and faces. However, the world is a wonderfully chaotic place, and no two environments are the same. EnviARment allows AR to adapt its content to fit any room, park, or store just like it was designed for that space, seamlessly integrating with real objects.

Reimagine a biology classroom. Jumbo cross sections of plant cells rest on each student table. Photons stream through the windows in golden rays as students witness photosynthesis firsthand. Upon closer inspection, a basil plant on the teacher's desk shows the process on the plant level. An overview of the experiment is available on the whiteboard, and attached to the bookshelf are materials that dive deeper into the science behind the concept. Nobody measured the classroom or arranged these virtual objects themselves; in fact, the same experience works in a school halfway around the world with no additional setup.

EnviARment will use machine learning to detect specific physical objects and features to accurately anchor virtual content in appropriate places. This scene understanding applies to many concepts including games like AR soccer or an AR scavenger hunt. With semantic segmentation, EnviARment can identify continuous surfaces like grass, concrete, floors, and walls, enabling AR indoor and outdoor games that adapt to the amount and layout of available space.

Tell us how you plan on bringing it to life.

Describe where your project is, how you could use Google's help in the endeavor, and how you plan on using On-Device ML technology to bring the concept to life. The best submissions have a great idea combined with a concrete path of where you plan on going, which should include:

- *(1) any potential sample code you've already written,*
- *(2) a list of the ways you could use Google's help,*
- *(3) as well as the timeline on how you plan on bringing it to life by May 1, 2020.*

EnviARment has many applications including education, retail, gaming, and utilities. Being able to attach

virtual content to specific real objects makes AR much more useful and easier to integrate. Currently, the only way to anchor content on a specific item is recognizing a unique image or a prescanned 3D object. EnviARment leverages machine learning to ensure, for example, any nightstand can serve as a real world anchor for virtual content.

EnviARment is currently in the beginning prototyping stage. I plan on using the TensorFlow object detection API and transfer learning to train a model that detects objects to use as content anchors. To cover many objects and variations, I could use Google's help gathering a large and diverse dataset of images. DeepLab for semantic segmentation is a perfect architecture to detect the extent and location of surfaces including indoor floors, grass, and concrete. From a past project, I know converting DeepLab models to TFLite can be challenging, and would appreciate assistance running that model through the new model optimization and conversion tools available. While the 2D object bounding boxes and hit test distance information is sufficient to place virtual content on a detected object, I would like to investigate if Google AI's research in depth estimation from video can be applied to EnviARment for more accurate AR placement. Access to computing resources, especially for training the DeepLab model, would be very helpful.

To initially bring the concept to life, I'm choosing an educational experience as the first demo of EnviARment's capabilities. The rough outline of steps include:

Machine Learning

1. Collect and label a dataset of objects in indoor scenes, possibly from existing datasets or new data (2-3 weeks)
2. Retrain an object detection model with this dataset (1 week)
3. Label the dataset of indoor scenes with segmentation masks including the classes: floor, wall, door, window, table (1-2 weeks)
4. Retrain a DeepLab model on this dataset (1 week)
5. Convert the models to TFLite and run inferences with the TFLite GPU delegate in a sample Android app (1 week)
6. Conduct real world tests and collect more data to update the models if necessary (1-2 weeks)

The app (Augmented Reality)

Build a working prototype using existing object detection and segmentation models while the custom dataset and models are developed and training.

1. Use the TFLite GPU Delegate to quickly run inferences on both models (3-5 days)
2. Calculate the 3D locations of objects and surfaces using the predicted bounding boxes and masks, adding depth with hit testing in ARCore (3-5 days)
3. Leverage ARCore and Sceneform to render virtual content at the calculated positions (1-2 weeks)
4. Design the UI and AR interface for the educational experience (3-4 weeks)
5. Solicit feedback and update the UI accordingly (3-4 weeks)

When the custom models are trained, they will replace the pretrained models.

Tell us about you.

A great idea is just one part of the equation; we also want to learn a bit more about you. Share with us some of your other projects so we can get an idea of how we can assist you with your project.

I am a 17 year old self-taught hardware and software developer passionate about merging cutting-edge technology with creative design to create delightful products. From a young age, I have endeavored to build projects with hardware including Raspberry Pi, Arduino, circuit board design, 3D CAD modeling, and 3D printing combined with embedded software in Python and C++, mobile development in iOS and Flutter, and machine learning with TensorFlow.

For the last two years, I have employed augmented reality to solve problems in navigation and education. My first published AR app, Mav World, transforms the campus of my high school into an interactive experience that directs visitors to the right place and explains what each building does. Mav World rounds out the experience with dozens of bright stickers and a couple of hidden easter eggs.

As someone who has worked with the Raspberry Pi Foundation mentoring teachers at Picademy training or engaging with the maker community at events like SxSW, I noticed beginners building circuits had a difficult time translating 2D circuit diagrams into real 3D components. To solve this problem, I tapped into AR's power to transform education by offering users a giant Raspberry Pi and components. My app, Pi AR, walks beginners through the process of setting up their first Pi and building an LED circuit. For the first time, one can walk around a circuit and view it from any angle just as if it were sitting in front of them.

I have built several iterations of small robots since middle school, and last year I decided to take my robot to the next level with machine learning. Project WOMBAT (Working On Machine Based Autonomous Transport) is a state of the art self-driving platform. Based off of a kid's ride-on toy Mini Cooper, Project WOMBAT can detect 90 different classes of objects and avoid them in real time. The brain of the car that enables this functionality is a Google Coral Edge TPU running a converted TFLite object detection model. Currently, I'm working to run a DeepLab segmentation model on the Edge TPU to follow sidewalks and roads. Earlier this year, I was fortunate to attend I/O where I met many TensorFlow engineers to discuss my project.

With EnviARment, I am combining my expertise in designing effective augmented reality apps with my experience in on-device machine learning with TensorFlow from Project WOMBAT. Together, augmented reality and machine learning enhance the way people interact with the real world and their devices.

To learn more about these projects, please see these links:

Augmented Reality - Mav World & Pi AR

Machine Learning - Project WOMBAT

Pi AR on the App Store

Mav World on the App Store