

Prolific App Developer Michael Royzen Plans for a Future in College and AI Innovation

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On June 10 Michael Royzen, 18, will don his cap and gown and graduate from The Bush School in Seattle, Washington. Like many of his classmates, the soon-to-be high school grad has been busy finishing up projects and finals, celebrating, and preparing for the big day. He admits, however, that he has been slightly distracted by the recent launch of his seventh app for iOS, Apple's mobile operating system. SmartLens, designed to turn your phone into a search box, is Royzen's most sophisticated app yet, and is fittingly launching at a time when the teen software developer is considering future prospects and the shape of his life after high school. That will definitely involve entrepreneurship, but not before he first heads to college.

KWHS caught up with Royzen to discuss his latest fascination with artificial intelligence (human intelligence exhibited by machines) and find out what's in store for a kid who has caught the eye of media outlets like GeekWire (he was the featured 'Geek of the Week' in February 2017) and companies like Apple and Microsoft.

An edited version of our interview appears below.

Knowledge@Wharton High School: How does your SmartLens app operate?

Michael Royzen: I think of it as a Shazam [an app that identifies the music and other media playing around you] for the visual world. It's a way for you to quickly understand the world around you. You can point your phone at anything and the app will quickly identify it. The app segments the world into three categories: products, general objects, like flora and fauna, and businesses. As soon as it recognizes something, it then determines what you want to do next. Let's say you point your phone at a product, like something in a package or a book, it will identify the product and then let you buy it. That doesn't make sense for flora and fauna. If you point your phone at a dog, it will identify the dog and then show you a Wikipedia description, something relevant for the object that it recognizes. My goal is to not only tell users what they're looking at, but to also take that second step and bridge the gap between what they see and what they want to do by showing them relevant information based on the type of object they recognize.

Another important thing to me was to have the app be able to work offline. You can put your phone in airplane mode or can go off the grid and SmartLens will still be able to recognize more than 17,000 objects — animals, flora, fauna — totally offline. You can go into the forest and it will still work. That is the first of its kind. No other visual search solution can do that as of now.

It was my goal from the beginning to have the app work offline. I love nature, to hike and to explore the outdoors. The world around us is incredibly beautiful, and it also raises a lot of questions. One day it hit me that there wasn't a solution that could tell you what you're looking at, whether it's nature, a product or anything you encounter. My idea was to have an app that could give you that information whether you were on or off the grid. I built the whole app on the technical side from that foundation. The way the app works is even if you do have an Internet connection, the app always runs a neural network on the device. So, no matter what, when you open the app it will run a neural network on the device using the GPU (graphics processing unit) and it will give a primary result. Based on that result, it will do multiple different things. It will either run other neural networks on the device to give you a more specific answer or it will invoke other neural networks working in the cloud to recognize products and other things. The reason why I have so many neural networks running on the device is because it's much better for the user. You get a result much quicker than if you have to send the request to a server somewhere in the cloud and then wait for it to come back.

KWHS: An artificial neural network (often shortened to neural network) has been described as a “strange new breed of artificial intelligence.” What exactly are neural networks and how do they work?

Royzen: Ultimately, what the neural network portion of SmartLens does is a task known as image classification, where it sees an image and it assigns a label for what that image is. My app has other stuff on top of that, like the Wikipedia information and Amazon products. But that isn’t related to the machine-learning portion. The machine-learning portion takes that initial image and determines what it is. That is fundamentally the heart of the app.

The most intuitive way to think about image classification is, say you take an image of your cat and you compare it to an image of a cat from Google Images. If you simply write an algorithm that would take all the pixels from the photo you took of your cat and compare it to a professional picture of the same breed of cat and you compare how many pixels match [to identify it], maybe that would work and maybe it wouldn’t. What if the lighting was very different between those photos or the conditions weren’t the same or the cat has slight variations that confuse its direct equivalent? Neural networks stem out as a solution to that problem. Instead of trying to classify images by a direct equivalent to something we know is the real thing you’re trying to identify, neural networks embody an empirical presentation of what that object is. Neural networks essentially embody real-world examples. There are many, many different kinds of neural networks each designed to solve specific tasks.

As far as the way the app works, you start with your input image. As soon as the user takes the photo, you convert it to a matrix of pixel values. You can think about having several different matrices, one for each color that segments the picture into three color channels of red, green or blue. The neural network is trained to recognize a certain number of objects. For each thing it can recognize, it learns features. It could be a dog’s ear, its face, tail or a specific shape. You take the feature matrix, which is much smaller than your input-image matrix, and you simply multiply all of those matrices together, the input and the feature, to determine if an input image contains a particular feature. Every single input image and every single feature and every object that the neural network can recognize are multiplied together, so it’s a massive computational undertaking. That’s how the neural network narrows down what it identifies, by multiplying the features together for every single object. And depending on the type of architecture you use – I have my own proprietary architecture that I designed for SmartLens – you continue these steps and feature convolutions.

The last step is to give an output. There is something called a fully connected layer, where it connects all of the neurons from the previous steps to all the types of objects that the neural network can recognize; all the trained categories. If SmartLens can recognize 17,000 objects offline, then that very last step would be connected to each one of those possibilities. The fully connected layer generates a probability distribution, and eventually, the category with the largest value is the object that the neural network is most confident in saying that is what the photo is identifying.

KWHS: You have now developed seven apps, everything from a game to a recipe reader to one that tells people when they need to leave for their commute. SmartLens is quite different. Have you evolved toward artificial intelligence and machine learning? If so, why?

Royzen: Yes, I have. My interest in AI stems from the fact that there are so many things that can be done. In the 70s, we saw the personal computer revolution. In the late 90s, we saw the internet revolution. Starting now and in the next five to 10 years, we’re going to see another artificial intelligence revolution. I predict that as devices get more and more powerful, they will get more intelligent. Your devices will be able to communicate with you. All sorts of really incredible stuff is possible from this form of artificial intelligence. I find the pursuit of a general AI that can pass the Turing Test fascinating. The Turing Test is basically a test for when a human interacts with a machine. If the human can’t tell that they’re interacting with a machine, then the machine is considered a true form of AI. It’s the benchmark that several people are going for. We’re not super close to that, but I find the pursuit of that inspiring. Humans are essentially mortal. At some point we’re going to die and possibly go extinct. But we can create a new life form that can continue existing for perpetuity if we do the right things. In the shorter term, there are all sorts of incredible benefits that

can come about from having a truly intelligent assistant for people to use.

You hear all these dystopian stories about the things that can go wrong [with AI and robots taking over]. That's very possible. I completely agree with Elon Musk's determination about AI. [Elon Musk is a well-known entrepreneur who co-founded Tesla and founded SpaceX]. We should not be scared of researching it, but we should try to figure out an ethical framework for how to deal with an intelligent AI now, rather than later when it could be too late. I find all of that inspiring. I feel like that's my calling. I want to make something cool that people can enjoy and benefit from.

KWHS: How do you move on from one project to the next without clinging to your last success?

Royzen: My previous apps were simpler ideas and simpler to make. My goal was to push myself with every new app. When I came up with the idea for SmartLens and began to get into AI, I realized that it was so much cooler than what I had done in the past. That alone was enough to move on. I try not to gloat mentally or otherwise about what I've done in the past. The future strategy part of my brain turns on. In the present, I try not to care what I've done in the past. I focus on what I'm doing now and what my plans are for the future. If you're too inclined to gloat without moving forward, that's an opportunity for people to catch up to you. It's a loss for you because you're not moving forward as much as you could have.

KWHS: You are graduating from high school in a few days. Where do you go from here? Will you take a job at a top software developer or go to college?

Royzen: Ultimately, I see SmartLens as a stepping stone rather than a final destination. It became really important to me when I started working on SmartLens more than a year ago to go to college and enter a program where I can do some intensive computer science research. I'll be going to the University of Texas at Austin this fall into the Turing Scholars program, which is a research-oriented honors program where students have to engage in research and can gradually write a thesis that they have to defend in front of a panel.

I've thought a lot about my path in the past year. Initially, I wasn't as keen on going to college until I got into AI. I realized that the state-of-the-art in AI research is moving so quickly that the only way to allow me to get there and to have the opportunity to push it forward is to first get my feet in academia. Last summer, I interned at Microsoft Research, where I worked on some AI tools. The corporate research landscape is also very interesting, but it's to a degree different. It's still more applied than results-oriented compared to academia research in AI. I see my path as first going into academia to understand all of the theoretical aspects, and then to dip my feet in the corporate research landscape once again to understand the applied landscape, and then go off and start my own company.

KWHS: Do you consider yourself an entrepreneur?

Royzen: Yes, I see starting my own company as the end goal. I do want to go off on my own. That will only happen once my co-founders and I have some idea that we feel can be game changing. The pursuit of that idea is my biggest driving force to go to college. And also to find a specific solution to that idea. Sergey [Brin] and Larry [Page], the founders of Google, came up with the idea for PageRank, Google's initial algorithm that assigned different relevances to web pages from a user search, while they were doing state-of-the-art research at Stanford University. That's the path that I want to stay on until I have the chance to break off. If an idea and a solution happen earlier, then I will go ahead and pursue it.

KWHS: You have made great strides in software development for someone your age. What are some of your personal success strategies?

Royzen: It's initially hard to be confident in your wildest ideas because you don't have a roadmap. You have a cool

idea and you want to work on it, but you don't know if you can get it done or how you can get it done. I have been really inspired by Elon Musk in this area. I do my best to let my ideas flow and not worry too much about the technical side. It can always be figured out. To get to that point, I have had to get comfortable trusting my gut intuition and I have had to persevere. Once you get those two aspects down, then you can start to not be afraid of your wildest ideas.

My previous experience building apps helped me get up to that point. I began to trust my intuition enough to pursue this idea of making the most accurate digital search app in the world, which is a crazy idea. When I came up with the idea, I sat down at my computer and I simply began to research. I had a gut instinct and I trusted that with enough perseverance I could get it done. There were several pitfalls while working on the project. There were also several pivotal decisions that I made, some of which I didn't know the impact of at the time, that resulted in the project turning out the way it did. It's really about trusting your intuition and continuing to try and try again when it doesn't work. I tried no fewer than 150 different neural network architectures and training techniques before I finally came upon something that worked the way I wanted it to. You've just got to keep trying.

Running three to five miles every single day at the same time helps me keep that self-discipline. It helps me persevere and push through those difficult technical moments. It's hard. I can't say enough about how difficult those moments are when you're in that pit where you need to solve a specific problem to get to where you want to be, but it's not a clear deal. Entrepreneurship is a story of high highs and low lows. I've come to enjoy the process in general. Pushing myself to the limit, trying different ideas, persevering when it doesn't work the way I want it to.

KWHS: Do you believe that your age helps or hinders your success?

Royzen: I've been co-president of a club called TeenTech that is part of a larger worldwide network that hosts events to help bring kids into technology and encourages them to create solutions to various issues using technology. I consider being young to be an advantage. When you're a high schooler in tech and doing something cool, people are more likely to pay attention to you than if you're older. In addition to putting on events through TeenTech, I've been helping other high school students see that. Their age is an advantage, not a disadvantage.

KWHS: What has been your greatest lesson through all of this?

Royzen: When I was working on SmartLens, there were periods of time where that was all I did. I put everything else on the back burner. I consider SmartLens to be my first software startup. It requires everything. I thought I understood that after doing six other apps, but it turns out I was way off. That was the one thing that I really got wrong. How difficult it would be physically and mentally at the same time as school, college applications and all of it. There were days for several months where I would get home from school, work on SmartLens for six or seven hours until it was time to go to bed and then wake up early and do my homework. On the weekends, all I would do is work on SmartLens. I had no idea it would be that hard. But it turns out that level of commitment was what it would take to get the app done. I overestimated myself, which is a common thing that younger entrepreneurs need to understand. You need to find your own limits and not be overly optimistic in what you can achieve in a certain period of time.

KWHS: Are you continuing to improve SmartLens?

Royzen: There's a point where every project reaches maturity. SmartLens is getting there quickly. I'm working on several small updates. Over the summer, my goal is to continue adding features and improving the app. I have a decent number of competitors from companies like Google who have a lot more money and resources than I do. I want to retain my lead over them. I need to continue to improve my technology and make it better.