



## Deep Learning in Depth: The Future of Deep Learning

featuring Ritwik Gupta and Carson Sestili as Interviewed by Will Hayes

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**Will Hayes:** You guys kind of add a focal point of some really interesting advancements here. What is about to come out? What is about to break? What should our audience be looking for?

**Carson Sestili:** Can we tell them anything?

**Ritwik Gupta:** I would say this again. We make this point again. If anyone says, *Here is what is next*, they are probably not going to tell you. I will tell you what I believe is next in specific things that I am interested in. This is a disclaimer to anyone who is watching out there. These are the things that I am interested in, and what I think are big. My personal focus has always been how can we use machine learning, deep learning, and statistical techniques to better improve the human condition. That usually turns to health, medicine, and healthcare systems. I believe that there are going to be revolutions in using, and there already have been, in using deep learning and machine learning to automatically detect cancer from CT scans, from radiology scans.

There are going to be revolutions in automatically discovering drugs to cure a certain specific disease and automatically detecting and discovering again mechanisms of drug behavior or disease behavior that are not intuitive to humans, but a machine can discover with data that will change the way that we look at treating diseases or curing things. There will be massive changes in electronic health record processing and continuity of care.

**Will:** I heard somebody say that they can detect with some percentage of confidence opioid addiction looking at the eye of a person walking by a camera.



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**Ritwik:** Correct, and Google just made a claim recently. [Jeff Dean](#), he is the chief scientist, he is the guy for machine learning at Google, just tweeted out some great work that his team did, which is they make a claim (they are still exploring this) that by looking at retinal images, which Google has a good history of doing work with, they can detect cardiovascular disease. There is an insane amount of work and disruption to be done in the field of health, medicine, healthcare. I think it is a great way to apply machine learning. There is tons of research being done here, not only at CMU, but also at SEI, in fields that are not only computational biology and health, but also related fields.

**Will:** That is a pretty awesome vision for the future. Are you going to try to top it?

**Carson:** Actually, instead of good cop/bad cop, what I am going to do is exciting cop/boring cop. I am such a wet blanket here, but I spend a lot of time talking to my team who has an extensive background in statistics. We are frequently talking about—not only we, but a lot of the community at large—is focusing on, *How can we quantify the uncertainty that comes out of these models, and what do we do with that uncertainty?*

It is common to just interpret the output of machine learning models as probabilities. They say, *Oh, my model says 70 percent. I guess that is pretty confident.* But that is just a number. And it is a number with a super sketchy statistical and mathematical underpinning. So I think now, there has actually been a paper—I think it's the one you referenced earlier saying, *Hang on a second. It has been five years. We have had a great success. Let's take a step back and think about how we do be responsible with the results of these machine learning techniques. How do we be socially responsible in making sure that they are deployed in ways that are trustworthy, that are investigatable, that you can ask them why they made such a decision?* Also how do you be mathematically responsible? How do you report uncertainty? How do you make sure that your audience knows... Again, it is about how much they can trust you. I don't think that people need to be worried yet about *Are the robots going to kill me or take my job?* I do think people need to worry about *Are the policymakers going to make a decision based on a bad statistics paper or something or a bad machine learning paper?*

**Ritwik:** One thing, again so tying this back to the health point, one thing that Carson said here, is that one of the biggest things holding deep learning back in the field of medicine and health is, everything a doctor does has to be backed by his decision. He has to say, *I am doing this because.* The reason they can't do that with deep learning models yet, is because a deep learning model cannot tell you why it did that. So if a doctor says, *Oh I performed the surgery because a deep learning model told me to,* that is when they get sued for medical malpractice.

**Will:** You cannot audit the deep learning models the same way you can audit...



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**Ritwik:** And there again, there is amazing research being done all over the world on how we make what is called explainable AI. How do we explain what the deep learning is trying to do? This is a problem across all fields. We have kind of approached this point where we have gone so much in deep learning that we have kind of gone away from solid statistical underpinning. Not to say that there isn't, but there's just some things that are being done without saying like, *Here is all the statistical proof behind it.* I think it is very important to step back a bit and just look at just deep learning itself and say, *Hold up. How do we make you better and not apply any of it to any other field, just how do we make the field itself better?*

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