

## 2016 Commencement Address

By Peter Norvig

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They say we're in the Information Age, and you're graduating from an Information School. You have chosen ... *wisely*. But by now we must be in the *middle* of the Information Age, and this is a *commencement* ceremony — a beginning — so we must ask: what age is commencing?

Back when I was at Berkeley in the 1980s, we had a framework for Artificial Intelligence Planning called the *Belief-Desire-Intention* framework, which said that Information by itself was impotent — information only serves to better inform what you desire, which then leads to an intention, and finally, an action that makes some change to the world. Knowing leads to doing, and it is the Doing that matters. So remember that. Sure, you've got a great education at a prestigious school — but don't let that go to your head. It's what you do that counts.

Are we entering the age of Doing? Well, Google's CEO, Sundar Pichai, in this year's letter to the stockholders, said that "Over time, the computer itself — whatever its form factor — will be an intelligent assistant helping you through your day. We will move from mobile first to an AI first world." So, for Google, a company that started out with the goal of making information universally accessible, it is now the *doing*, the *assisting*, that matters. The doing could be making reservations or appointments, it could be automatically curating and captioning a photo montage, or it could be driving your car. It is a real challenge to get these actions right. When you're just offering up information, you have less skin in the game — "Hey, I'm just telling you the facts, it's up to you to decide what to do with them!" But when you're assisting,

you can be right or wrong, and there are consequences. I should say that also key to this vision is the universal part: it is not good enough to assist the million or even billion richest, most privileged users; it is crucial to reach out to the rest of the world, equally.

So that's the doing. What about the desiring? 48 years ago, two venerable scribes by the names of Jagger and Richards, wrote "You can't always get what you want but ... you get what you need." (Students, you can ask your parents about it.) But Mick and Keith actually got it exactly backwards. In today's market-driven economy, you can't always get what you need, but you get what you want. We *need* better health care, clean water, food security for all, climate change mitigation, and social equality. But what do we get from the best and brightest of our generation? Angry Birds, Plants vs Zombies, cat videos, and photos of your food that self-destruct in 5 seconds ... these are the things we *get* because they are the things we *want*. We consume them over and over, thereby telling the market that this is what we want, and the market makes sure you *can* always get what we want.

Of course the breakdown is that this is not what we *really* want. After you played that silly game for 100 hours, you emerge from the stupor and think, "I wish I had that 100 hours back." But it is too late, by repeatedly clicking you have repeatedly voted that that's what you want, and some sophisticated data-mining collaborative-filtering algorithm has cleverly recommended the game to 100 other unsuspecting people.

So one of our challenges for the future is to better describe to our markets and to our high-tech products, what it is we really want. In economics, game theory, and artificial intelligence, there is a common goal of maximizing expected utility. We've spent decades on the "expected" part — that's statistics, probability theory, and machine learning. And more decades on the "maximizing" parts — that's the theory of algorithms as it applies to these fields. But mostly, we leave the "utility" part — the "what you really want" part — unspecified. Theorists always assume a utility

function, and then prove results about how to optimize it. But we haven't developed the tools to let the public say what they really want.

So, when you think of what you'll be writing about in your next academic paper, or what project you'll be doing in your next job, don't just think about data science, information visualization, statistical inference and probabilistic reasoning. Think also about utility science, desire visualization, and ethical calculus. Build systems that protect the desires of the few as well as the many. Design algorithms with payoffs that ensure a sustainable future as well as a near-term return on investment. We have the power to do many things, but until the public has a better way to say what it really wants, the market will always choose ... poorly.

One more complication for you to deal with: the Information Age is also called the Digital Age, which by definition means zero or one, on or off, true or false. But most of the World's Information is uncertain: partly true, incomplete, partly contradictory. A large part of the software engineering industry is devoted to eliminating this uncertainty, but you have the tools and the outlook to instead embrace it, to aggregate and reason from uncertainty rather than destroy it.

So it is time for you to commence, to go help make sense of the Information out there, but not just the quantitative *how much*, but also the *why* and the uncertain *what if* and the utility-based *what for*. So go out there and bend the long arc of the moral universe towards justice. By all means use your skills to do optimization, but be aware that unless you make explicit choices, optimization can lead to homogeneity, not diversity, to concentration of wealth, not empowerment for all.

You have been granted the powers to manipulate the magic powers of our age, and in the words of philosopher-economist Spike Lee, it is up to you to Do the Right Thing.