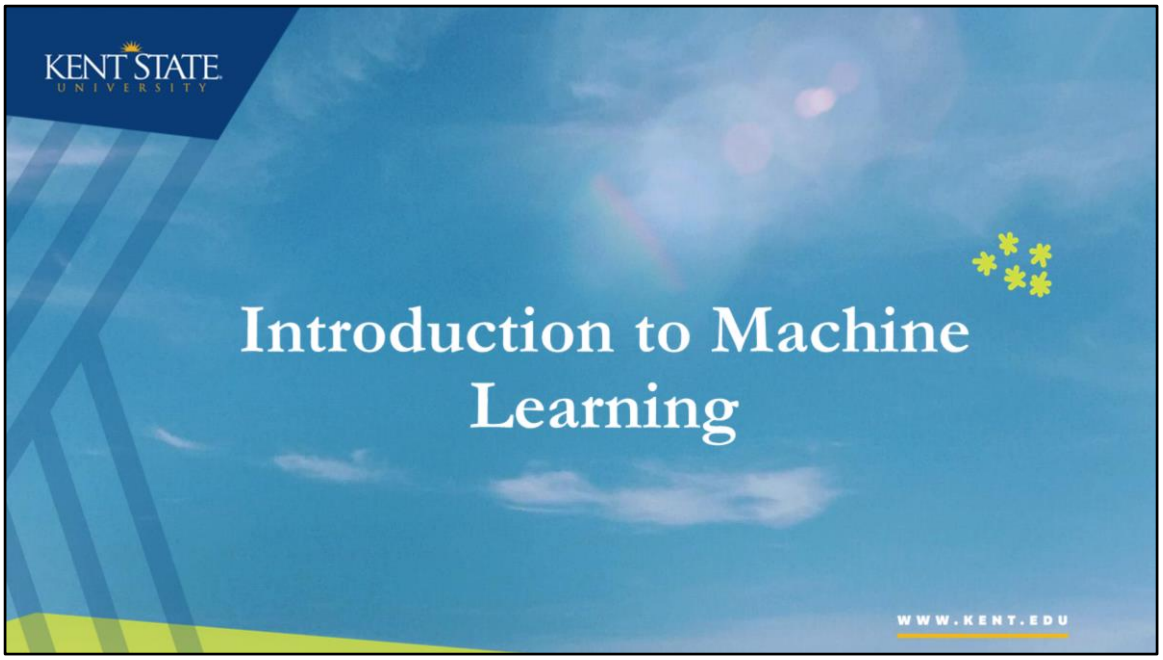
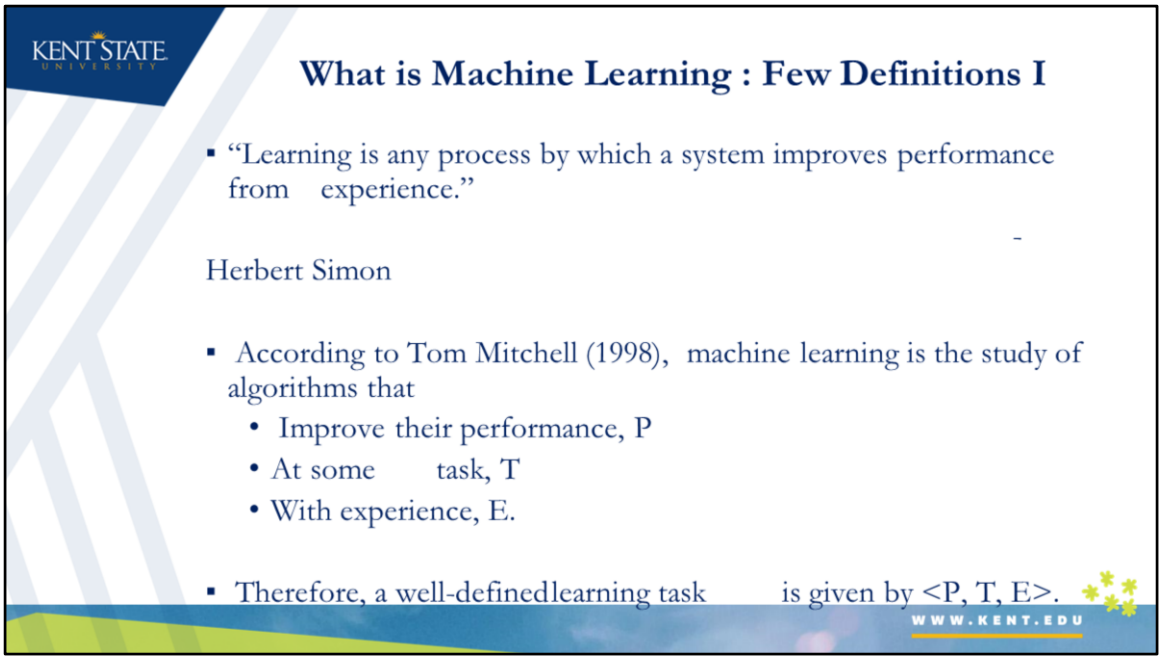


Welcome to your course on Machine Learning.



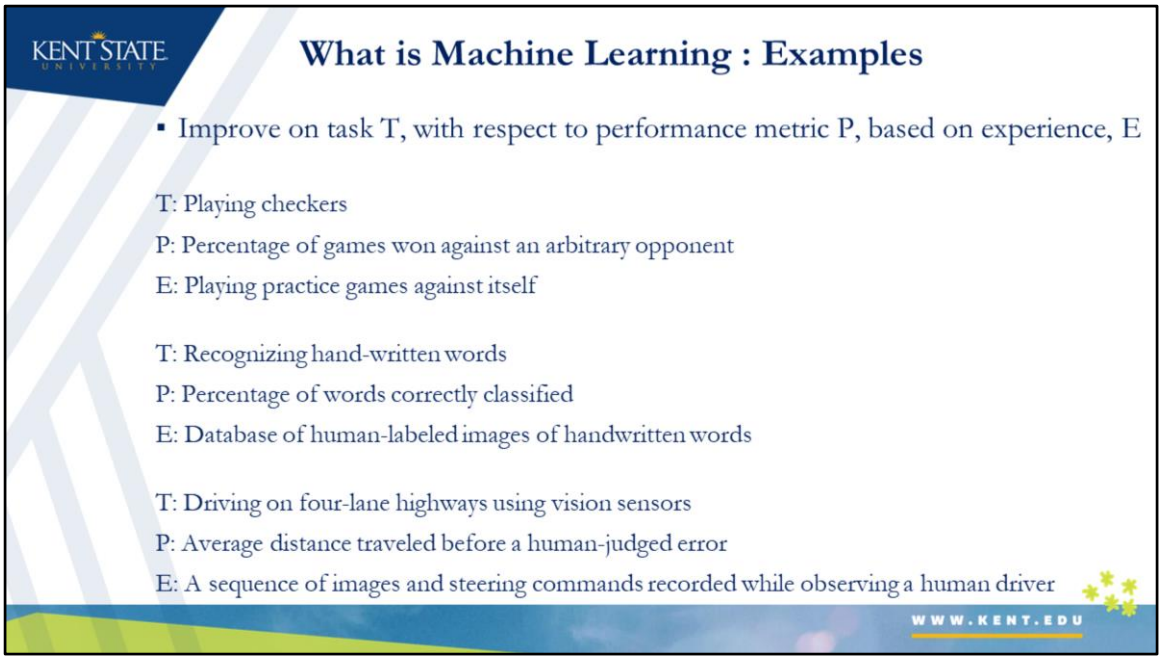
Before we begin, it is important that understand what we mean by machine learning. Machine learning is a part of AI, a branch of science born in the 1950s. AI can be broadly thought of as "the effort to automate intellectual tasks normally performed by humans"

Initially, many experts believed that human-level artificial intelligence could be achieved by having programmers handcraft a sufficiently large set of explicit rules for manipulating knowledge. This approach is known as *symbolic AI,* and while suitable to solve well-defined, logical problems, such as playing chess, it turned out to be intractable to figure out explicit rules for solving more complex, fuzzy problems, such as image classification, speech recognition, and language translation. A new approach arose to take symbolic AI's place: *machine learning*.

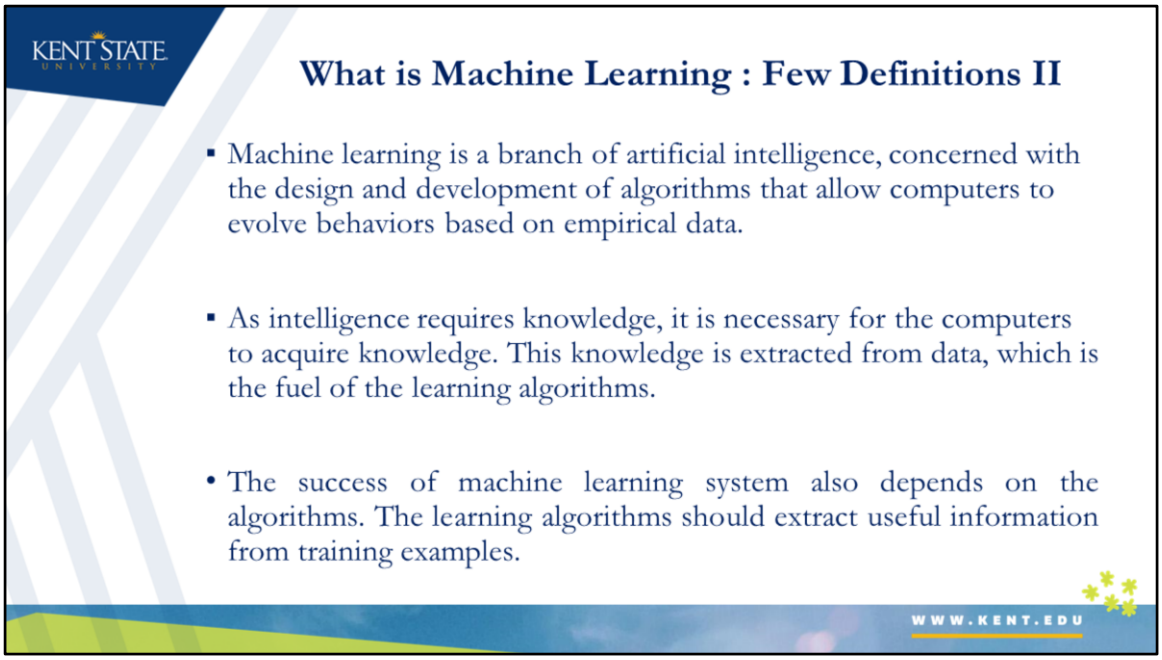
To do ML, requires three things:
- *Input data points (Experience in the above definition)*—For instance, if the task is speech recognition, these data points could be sound files of people speaking.
- *Examples of the expected output*—In a speech-recognition task, these could be human-generated transcripts of sound files.
- *A way to measure whether the algorithm is doing a good job (Performance)*—This is

necessary in order to determine the distance between the algorithm's current output and its expected output. The measurement is used as a feedback signal to adjust the way the algorithm works.

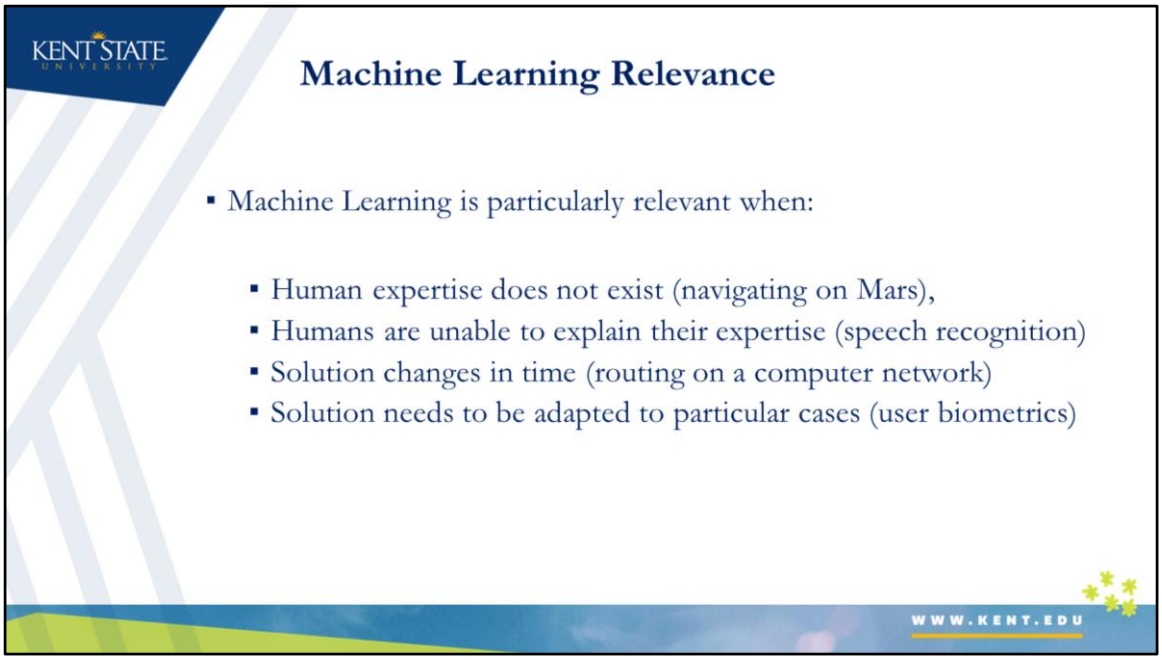
Excerpt From: François Chollet. "Deep Learning with R MEAP V01."



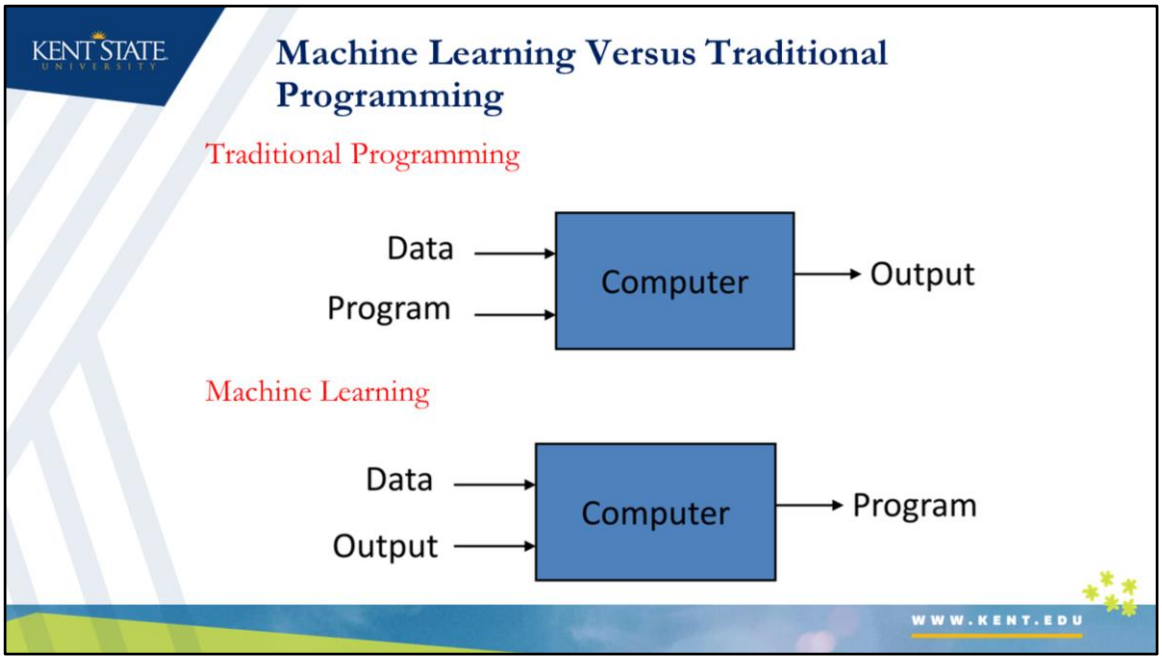
A key characteristic in all ML programs is the need to define performance. This is the objective that we are trying to improve. Defining the proper objective is vital, and it should correspond to the task at hand. Otherwise, the ML algorithm may optimize an objective with unintended consequences. What would you think would happen if a stupid, ML algorithm in a hospital is trained with this poorly chosen objective function: "maximizing the average well-being of all patients." It might decide to kill patients who are not very well, so as to improve the average well-being of those left!



Machine learning arises from a basic question: can a computer go beyond "whatever we know how to order it to perform" and learn on its own how to perform a specified task? Can a computer surprise us? As you will see, this question opens up a new paradigm.

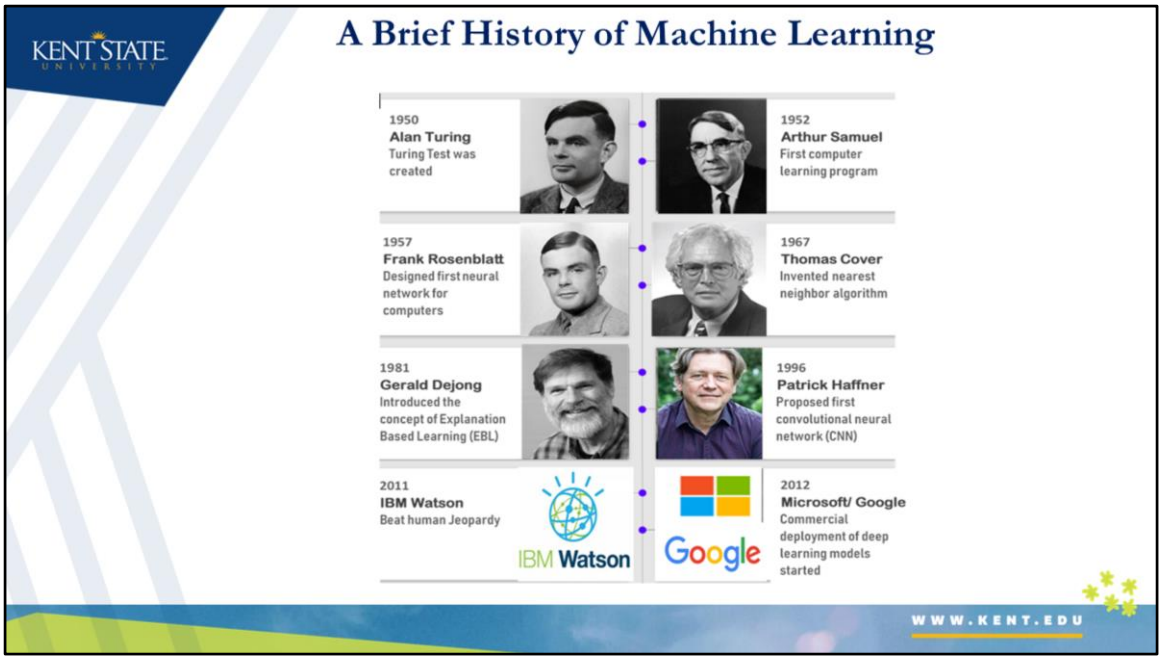


Here are some situations when ML can be useful. Increasingly, we are seeing ML approaches in medicine, image and speech recognition, etc., where results are improving on expert human interpretations. Though, the work on understanding and explaining the parameters used in ML algorithms is still in its infancy. As such, the implementation of these algorithms to critical decision making is slower than the technological advances in prediction.



Now, consider this new paradigm. In traditional programming, we supply the rules (Program) and the data to be processed according to these rules, and out comes the result (Output). With machine learning, we input data as well as the answers expected from the data, and out come the rules. These rules can then be applied to new data to produce original answers. Thus, a ML algorithm is *trained* rather than programmed. It is presented with several representative examples of the task, and the algorithm determines the statistical structure in these tasks, so that rules can be developed to automate the task. For example, notice how Google Photos tags human faces. After a few representative examples, it is able to identify faces in subsequent photos without user input.

One final note. While ML is related to statistics, it differs from statistics. Unlike statistics, machine learning tends to deal with large, complex datasets for which classical statistical analysis would be impractical. As a result, machine learning, exhibits comparatively little mathematical theory, and is engineering oriented. It's a hands-on discipline in which ideas are proven empirically more often than theoretically.



In his landmark 1950 paper "Computing Machinery and Intelligence," Alan Turing introduced the *Turing test* as well as key concepts that would come to shape AI. Turing pondered whether general-purpose computers could be capable of learning and originality, and he came to the conclusion that they could (https://en.wikipedia.org/wiki/Turing_test). His work fundamentally changed the face of AI. You can read his obituary at https://www.nytimes.com/2019/06/05/obituaries/alan-turing-overlooked.html.

In recent years, deep learning algorithms have make significant advances. They not only beat humans at many games like Chess and Go, but also in multiplayer online games. Now, DL algorithms are common for image, and speech recognition, and being used in fields like medicine, and transportation. While DL algorithms fundamentally use neural networks as the basis, it is only through recent advances in algorithms and computation that deep learning has proved successful. Three pioneers in this field, Yann LeCun, Geoffrey Hinton and Yoshua Bengio, recently won the 2018 Turing Award for their work in this area. (https://www.nytimes.com/2019/03/27/technology/turing-award-ai.html).

KENT STATE UNIVERSITY

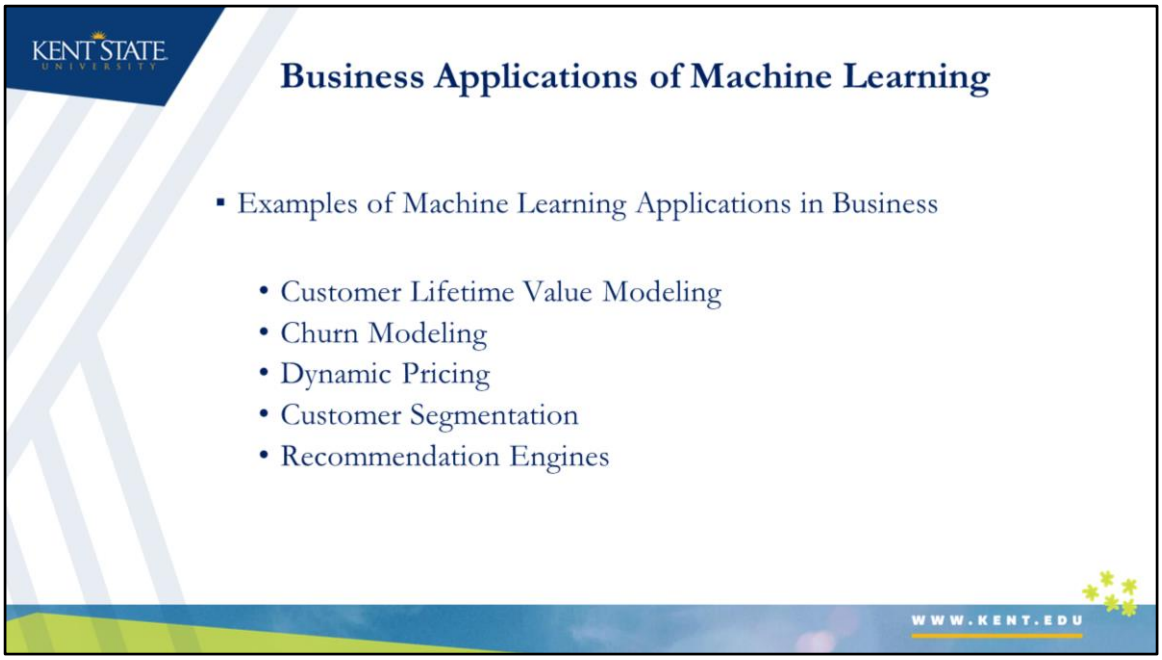
State of the Art in Machine Learning

- Do you know these two people?
- Well, it is normal if you do not; because they do not exist!
- Both images are AI-generated fakes, products of NVIDIA's research* using generative adversarial networks (GANs) !
- AI-based solutions have already outperformed humans in many applications.

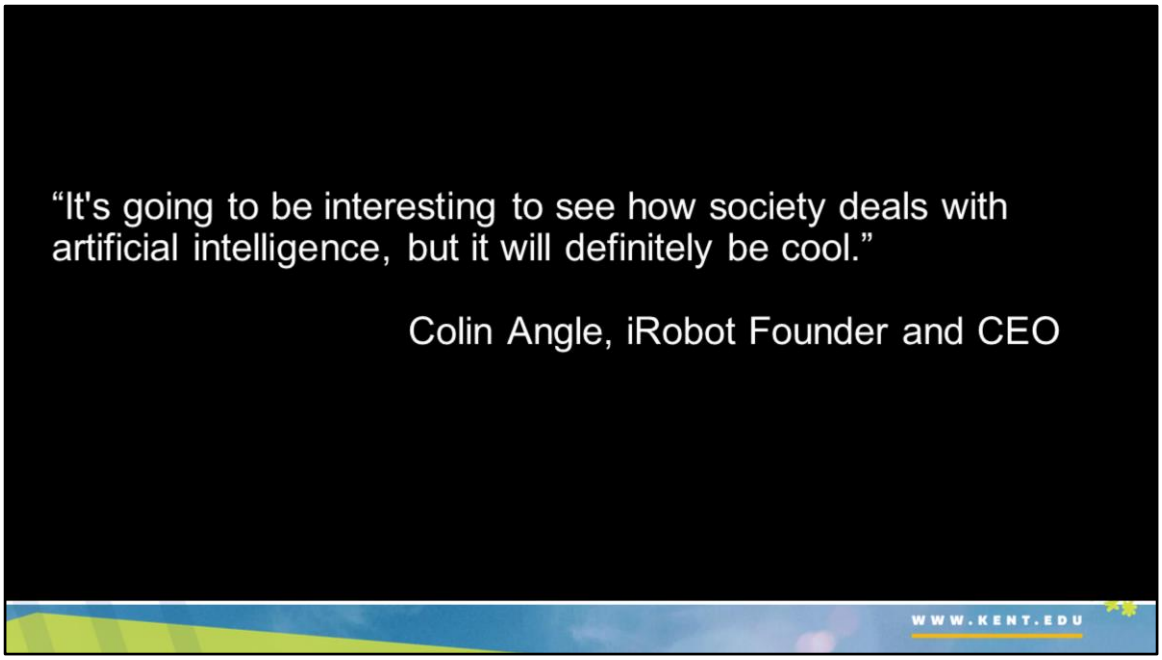
* Karras, Tero, Samuli Laine, and Timo Aila. "A style-based generator architecture for generative adversarial networks." arXiv preprint arXiv:1812.04948 (2018).

WWW.KENT.EDU

The use of AI raises several ethical and moral concerns. Images can now be easily generated that fools humans (a case of turing test?), voice can be duplicated, and even restaurant reservations made with no human interaction (Google duplex). Unfortunately, the ethical framework is well behind the technical advances in AI. If an autonomous vehicle crashes, who is responsible?



We will see several examples of using ML. While business use is still lagging behind, many companies are already benefiting from their limited use of ML. As ML algorithms gets easier to use, domain experts are likely to make increased use of these techniques.



This concludes our introduction.