NVIDIA Testimony
February 14, 2018

## Subcommittee on Information Technology of the Committee on Oversight and Government Reform

Thank you, Chairman Hurd, Ranking Member Kelly, and distinguished members of the Committee. I appreciate your invitation to give testimony today on the important subject of A.I.

My name is Ian Buck. I am vice president and general manager of accelerated computing at NVIDIA. Headquartered in Silicon Valley, NVIDIA is one of the world's leading computer technology companies, with more than 11,000 employees.

NVIDIA invented a new type of processor in 1999 called the graphics processing unit, or GPU. It was designed to accelerate computer graphics for games by processing millions of calculations at the same time. Today, GPUs are used for a variety of applications including virtual reality, self-driving cars, AI and high performance computing. America's fastest supercomputer, at Oak Ridge National Laboratories, uses 18,000 NVIDIA GPUs for scientific research.

Our involvement with AI began about 7 years ago when researchers started using our processors to simulate human intelligence.

Before AI, programmers had to write complex software by hand. Those traditional computer vision systems took years to develop and were not highly accurate.

In 2012 a brilliant graduate student named Alex Krizhevsky, at the University of Toronto, trained his computer to automatically recognize and classify objects. He did that by processing one million images on two NVIDIA processors. Training his A.I. model took about a week; without our processors, it would have taken nearly a year. His results were so accurate, he won a competition against researchers who had devoted their careers to hand-coding systems. That moment was the Big Bang of modern AI.

AI systems require enormous computation. To teach a computer how to accurately recognize vehicles, for example, you'll need about 100 million example images of cars, trucks, buses, emergency vehicles, etc. Without GPUs, training a system to recognize those images would take months. Today's state-of-the-art systems can reduce this to within a day.

The world's leading technology companies have aggressively adopted A.I. Google and Microsoft algorithms can now recognize images better than humans, and can automatically tag and search photos. Facebook translates over two billion language queries a day. Twitter understands the live video content in social media and can learn to detect harmful videos. Netflix uses AI to personalize your movie and TV show recommendations. All those systems rely on thousands of GPUs. My job is to help companies like Amazon, Google, Facebook, Microsoft, IBM and others bring intelligent features to billions of people.

But AI's impact isn't just limited to tech companies. Self-driving cars. Surgical robotics. Smart cities that can detect harmful activities. Solving fusion power. AI holds the best promise to solve these previously unsolvable problems.

To solve a big problem with A.I., you basically need 3 things: massive amounts of data, massive amounts of computing, and talented data scientists.

Here's a short list of problems for which AI could help:

1. **Cyber defense.** We need to protect government data centers, our institutions and our citizens from cyberattack. The scale of the problem is mind-boggling. The CEO of Juniper Networks said, "It's a challenge that is ultimately beyond human capability. No human can keep up with the pace of software changes today." We're working with Booz Allen Hamilton to develop faster cybersecurity systems and train federal employees in AI.

2. **Healthcare**. Nearly two million Americans die each year from disease. We should diagnose them earlier, and develop more personalized treatments. The National Cancer Institute and Department of Energy are using AI to accelerate cancer research.

3. **Transportation.** Congestion cost U.S. drivers over $300 billion last year, according to a recent transportation study. We're working with more than 300 companies to develop autonomous vehicles to make our roads safer and more efficient. The technology exists to make road, rail and air travel much more efficient.

4. **Waste, fraud, and abuse**. The GAO reported that agencies made $144 billion in improper payments in fiscal 2016. The commercial sector is using AI to reduce such costs. PayPal used AI to cut their fraud rate in half, saving billions. Google used A.I. to lower the cost of cooling its data centers by about 40%.

5. **Defense platform sustainment costs.** Maintenance costs are a huge challenge for the DoD, typically equaling 50% or more of the cost of a major platform. Sustainment costs

for the Army, Air Force, and Navy are about $150 billion, according to a report from the office of the Undersecretary of Defense. AI could help lower these costs by identifying maintenance issues earlier. G.E. is doing just that: using AI to detect anomalies and perform predictive maintenance on gas turbines, saving $5 million per plant each year. The Air Force is working on an experimental program to gather and analyze mission data so that technicians can address issues before they become serious.

These are complex problems that require innovative solutions. A.I. can help us achieve better results in less time and at lower cost.

**Role of the Government**

I have 3 recommendations for how the federal government can help.

**1) Fund AI research**

The reason we have neural networks today is because our government funded research for the first neural network, in the 1950s. America leads the world in autonomous vehicle technology because DARPA funded self-driving car competitions over a decade ago.

While other governments are aggressively raising their research funding, U.S. government research has been relatively flat. We should boost research funding through agencies like the NSF, NIH, and DARPA. We also need faster supercomputers, which are essential for AI research.

**2) Drive agency adoption of A.I.**

Every major federal agency -- just like every major technology company -- needs to invest in A.I. Each agency should consult with policy advisors who have domain expertise and understand the benefits of AI, and each agency needs to recruit data scientists and AI experts.

**3) Open access to data**

Data is the fuel that drives the AI engine. The federal government has access to vast sources of information. Opening access to that data will help us get insights that will transform the U.S. economy. It would help American workers in the public and private sector by eliminating mundane tasks and enabling them to focus on problem-solving and applying creative solutions.

The OPEN Government Data Act, which the House passed in November 2017, is a great start. Government data is available, but much of it needs to be curated before it can be useful. These activities need funding for researchers to carefully analyze and curate datasets.

**Closing**

A.I. is the biggest economic and technological revolution to take place in our lifetime. By some estimates, A.I. will add eight trillion dollars to the U.S. economy by 2035. The bottom line is, we can't afford to allow other countries to overtake us.

Thank you for your time and consideration. I look forward to answering any questions.

**Committee on Oversight and Government Reform**
**Witness Disclosure Requirement — "Truth in Testimony"**

Pursuant to House Rule XI, clause 2(g)(5) and Committee Rule 16(a), non-governmental witnesses are required to provide the Committee with the information requested below in advance of testifying before the Committee. You may attach additional sheets if you need more space.

Name: Ian Buck

1. Please list any entity you are representing in your testimony before the Committee and briefly describe your relationship with each entity.

| Name of Entity | Your relationship with the entity |
|---|---|
| NVIDIA Corporation | VP / GM Tesla Data Center Business |
| | |

2. Please list any federal grants or contracts (including subgrants or subcontracts) you or the entity or entities listed above have received since January 1, 2015, that are related to the subject of the hearing.

| Recipient of the grant or contact (you or entity above) | Grant or Contract Name | Agency | Program | Source | Amount |
|---|---|---|---|---|---|
| NVIDIA Corporation | Standard Navy Cooperative Research and Development Agreer | Naval Undersea Warfare Center Division, Newport | | | N/A |
| NVIDIA Corporation | Cooperative Research and Development Agreement | National Geospatial-Intelligence Agency | | | N/A |
| NVIDIA Corporation | Cooperative Research and Development Agreement | National Security Agency/Central Security Service | | | N/A |

3. Please list any payments or contracts (including subcontracts) you or the entity or entities listed above have received since January 1, 2015 from a foreign government, that are related to the subject of the hearing.

| Recipient of the grant or contact (you or entity above) | Grant or Contract Name | Agency | Program | Source | Amount |
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I certify that the information above and attached is true and correct to the best of my knowledge.

Signature _____ Date: 2/11/2018

## Ian Buck, Ph.D.

Ian Buck is vice president and general manager of NVIDIA's Accelerated Computing business, which generates over $2 billion in revenue annually and includes hardware and software for data centers and artificial intelligence applications. Buck’s team works closely with other AI leaders, including Amazon, Facebook, G.E. Healthcare, Google, IBM and Microsoft, to bring intelligent services to billions of people.

Buck joined NVIDIA in 2004 and created CUDA, the world’s leading platform for accelerated computing. Before joining NVIDIA, he was the development lead on Brook, the forerunner to generalized computing on GPUs.

He holds a Ph.D. in computer science from Stanford University and a Bachelor of Science degree in computer science from Princeton University.