IBM UK Newsroom

IBM Reveals Five Innovations that will Help Change our Lives within Five Years

IBM Predicts New Scientific Instruments to Make the Invisible Visible

Yorktown Heights, N.Y. - 05 Jan 2017: IBM (NYSE: IBM) unveiled today the annual "IBM 5 in 5" (#ibm5in5) – a list of ground-breaking scientific innovations with the potential to change the way people work, live, and interact during the next five years.

- **With AI, our words will open a window into our mental health**
- **Hyperimaging and AI will give us superhero vision**
- **Macroscopes will help us understand Earth's complexity in infinite detail**
- **Medical labs "on a chip" will serve as health detectives for tracing disease at the nanoscale**
- **Smart sensors will detect environmental pollution at the speed of light**

In 1609, Galileo invented the telescope and saw our cosmos in an entirely new way. He proved the theory that Earth and other planets in our solar system revolve around the Sun, which until then was impossible to observe. IBM Research continues this work through the pursuit of new scientific instruments – whether physical devices or advanced software tools – designed to make what's invisible in our world visible, from the macroscopic level down to the nanoscale.

"The scientific community has a wonderful tradition of creating instruments to help us see the world in entirely new ways. For example, the microscope helped us see objects too small for the naked eye and the thermometer helped us understand the temperature of the Earth and human body," said Dario Gil, vice president of science & solutions at IBM Research. "With advances in artificial intelligence and nanotechnology, we aim to invent a new generation of scientific instruments that will make the complex invisible systems in our world today visible over the next five years."

Innovation in this area could enable us to dramatically improve farming, enhance energy efficiency, spot harmful pollution before it's too late, and prevent premature physical and mental health decline as examples. IBM's global team of scientists and researchers is steadily bringing these inventions from the realm of our labs to the real world.

The IBM 5 in 5 is based on market and societal trends as well as emerging technologies from IBM's Research labs around the world that can make these transformations possible. Here are the five scientific instruments that will make the invisible visible in the next 5 years:

With AI, our words will open a window into our mental health

Brain disorders, including developmental, psychiatric and neurodegenerative diseases, represent an enormous disease burden, in terms of human suffering and economic cost.[1] For example, today, one in five adults in the U.S. experiences a mental health condition such as depression, bipolar disease or schizophrenia, and roughly half of individuals with severe psychiatric disorders receive no treatment. The global cost of

mental health conditions is projected to surge to US$6 trillion by 2030.

If the brain is a black box that we don't fully understand, then speech is a key to unlock it. In five years, what we say and write will be used as indicators of our mental health and physical wellbeing. Patterns in our speech and writing analyzed by new cognitive systems will provide tell-tale signs of early-stage developmental disorders, mental illness and degenerative neurological diseases that can help doctors and patients better predict, monitor and track these conditions.

At IBM, scientists are using transcripts and audio inputs from psychiatric interviews, coupled with machine learning techniques, to find patterns in speech to help clinicians accurately predict and monitor psychosis, schizophrenia, mania and depression. Today, it only takes about 300 words to help clinicians predict the probability of psychosis in a user.2

In the future, similar techniques could be used to help patients with Parkinson's, Alzheimer's, Huntington's disease, PTSD and even neurodevelopmental conditions such as autism and ADHD. Cognitive computers can analyze a patient's speech or written words to look for tell-tale indicators found in language, including meaning, syntax and intonation. Combining the results of these measurements with those from wearable devices and imaging systems and collected in a secure network can paint a more complete picture of the individual for health professionals to better identify, understand and treat the underlying disease.

What were once invisible signs will become clear signals of patients' likelihood of entering a certain mental state or how well their treatment plan is working, complementing regular clinical visits with daily assessments from the comfort of their homes.

Hyperimaging and AI will give us superhero vision

More than 99.9 percent of the electromagnetic spectrum cannot be observed by the naked eye. Over the last 100 years, scientists have built instruments that can emit and sense energy at different wavelengths. Today, we rely on some of these to take medical images of our body, see the cavity inside our tooth, check our bags at the airport, or land a plane in fog. However, these instruments are incredibly specialized and expensive and only see across specific portions of the electromagnetic spectrum.

In five years, new imaging devices using hyperimaging technology and AI will help us see broadly beyond the domain of visible light by combining multiple bands of the electromagnetic spectrum to reveal valuable insights or potential dangers that would otherwise be unknown or hidden from view. Most importantly, these devices will be portable, affordable and accessible, so superhero vision can be part of our everyday experiences.

A view of the invisible or vaguely visible physical phenomena all around us could help make road and traffic conditions clearer for drivers and self-driving cars. For example, using millimeter wave imaging, a camera and other sensors, hyperimaging technology could help a car see through fog or rain, detect hazardous and hard-to-see road conditions such as black ice, or tell us if there is some object up ahead and its distance and size. Cognitive computing technologies will reason about this data and recognize what might be a tipped over garbage can versus a deer crossing the road, or a pot hole that could result in a flat tire.

Embedded in our phones, these same technologies could take images of our food to show its nutritional value or whether it’s safe to eat. A hyperimage of a pharmaceutical drug or a bank check could tell us what’s fraudulent and what’s not. What was once beyond human perception will come into view.

IBM scientists are today building a compact hyperimaging platform that “sees” across separate portions of the electromagnetic spectrum in one platform to potentially enable a host of practical and affordable devices and applications.

Macroscopes will help us understand Earth's complexity in infinite detail

Today, the physical world only gives us a glimpse into our interconnected and complex ecosystem. We collect exabytes of data – but most of it is unorganized. In fact, an estimated 80 percent of a data scientist’s time is spent scrubbing data instead of analyzing and understanding what that data is trying to tell us.

Thanks to the Internet of Things, new sources of data are pouring in from millions of connected objects -- from refrigerators, light bulbs and your heart rate monitor to remote sensors such as drones, cameras, weather stations, satellites and telescope arrays. There are already more than six billion connected devices generating tens of exabytes of data per month, with a growth rate of more than 30 percent per year. After successfully digitizing information, business transactions and social interactions, we are now in the process of digitizing the physical world.

In five years, we will use machine learning algorithms and software to help us organize the information about the physical world to help bring the vast and complex data gathered by billions of devices within the range of our vision and understanding. We call this a "macroscope" – butunlike the microscope to see the very small, or the telescope that can see far away, it is a system of software and algorithms to bring all of Earth's complex data together to analyze it for meaning.

By aggregating, organizing and analyzing data on climate, soil conditions, water levels and their relationship to irrigation practices, for example, a new generation of farmers will have insights that help them determine the right crop choices, where to plant them and how to produce optimal yields while conserving precious water supplies.

In 2012, IBM Research began investigating this concept at Gallo Winery, integrating irrigation, soil and weather data with satellite images and other sensor data to predict the specific irrigation needed to produce an optimal grape yield and quality. In the future, macroscope technologies will help us scale this concept to anywhere in the world.
Beyond our own planet, macroscope technologies could handle, for example, the complicated indexing and correlation of various layers and volumes of data collected by telescopes to predict asteroid collisions with one another and learn more about their composition.

Medical labs “on a chip” will serve as health detectives for tracing disease at the nanoscale

Early detection of disease is crucial. In most cases, the earlier the disease is diagnosed, the more likely it is to be cured or well controlled. However, diseases like cancer can be hard to detect – hiding in our bodies before symptoms appear. Information about the state of our health can be extracted from tiny bioparticles in bodily fluids such as saliva, tears, blood, urine and sweat. Existing scientific techniques face challenges for capturing

and analyzing these bioparticles, which are thousands of times smaller than the diameter of a strand of human hair.

In the next five years, new medical labs “on a chip” will serve as nanotechnology health detectives – tracing invisible clues in our bodily fluids and letting us know immediately if we have reason to see a doctor. The goal is to shrink down to a single silicon chip all of the processes necessary to analyze a disease that would normally be carried out in a full-scale biochemistry lab.

The lab-on-a-chip technology could ultimately be packaged in a convenient handheld device to allow people to quickly and regularly measure the presence of biomarkers found in small amounts of bodily fluids, sending this information securely streaming into the cloud from the convenience of their home. There it could be combined with real-time health data from other IoT-enabled devices, like sleep monitors and smart watches, and analyzed by AI systems for insights. When taken together, this data set will give us an in depth view of our health and alert us to the first signs of trouble, helping to stop disease before it progresses.

At IBM Research, scientists are developing lab-on-a-chip nanotechnology that can separate and isolate bioparticles down to 20 nanometers in diameter, a scale that gives access to DNA, viruses, and exosomes. These particles could be analyzed to potentially reveal the presence of disease even before we have symptoms.

Smart sensors will detect environmental pollution at the speed of light

Most pollutants are invisible to the human eye, until their effects make them impossible to ignore. Methane, for example, is the primary component of natural gas, commonly considered a clean energy source. But if methane leaks into the air before being used, it can warm the Earth’s atmosphere. Methane is estimated to be the second largest contributor to global warming after carbon dioxide (CO_2).

In the United States, emissions from oil and gas systems are the largest industrial source of methane gas in the atmosphere. The U.S. Environmental Protection Agency (EPA) estimates that more than nine million metric tons of methane leaked from natural gas systems in 2014. Measured as CO_2-equivalent over 100 years, that’s more greenhouse gases than were emitted by all U.S. iron and steel, cement and aluminum manufacturing facilities combined.

In five years, new, affordable sensing technologies deployed near natural gas extraction wells, around storage facilities, and along distribution pipelines will enable the industry to pinpoint invisible leaks in real-time. Networks of IoT sensors wirelessly connected to the cloud will provide continuous monitoring of the vast natural gas infrastructure, allowing leaks to be found in a matter of minutes instead of weeks, reducing pollution and waste and the likelihood of catastrophic events.

Scientists at IBM are tackling this vision, working with natural gas producers such as Southwestern Energy to explore the development of an intelligent methane monitoring system and as part of the ARPA-E Methane Observation Networks with Innovative Technology to Obtain Reductions (MONITOR) program.

At the heart of IBM’s research is silicon photonics, an evolving technology that transfers data by light, allowing computing literally at the speed of light. These chips could be embedded in a network of sensors on the ground or within infrastructure, or even fly on autonomous drones; generating insights that, when combined with real-

time wind data, satellite data, and other historical sources, can be used to build complex environmental models to detect the origin and quantity of pollutants as they occur.

For more information about the IBM 5 in 5, please visit: http://ibm.biz/five-in-five

Registered journalists and bloggers *can download b-roll and video about IBM's 5 in 5 at http://ibm.newsmarket.com/Global/ibm-reveals-five-innovations-that-will-help-change-our-lives-within-five-years/s/93df6440-1cb6-47f8-ac5e-ba7a806b7afe?CP=1*

About IBM Research

For more than seven decades, IBM Research has defined the future of information technology with more than 3,000 researchers in 12 labs located across six continents. Scientists from IBM Research have produced six Nobel Laureates, 10 U.S. National Medals of Technology, five U.S. National Medals of Science, six Turing Awards, 19 inductees in the National Academy of Sciences and 20 inductees into the U.S. National Inventors Hall of Fame. For more information about IBM Research, visit www.ibm.com/research.

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[1] https://mcgovern.mit.edu/brain-disorders/by-the-numbers

2 Speech Graphs Provide a Quantitative Measure of Thought Disorder in Psychosis *PLoS One*, 2012

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