Building smarter wearables for healthcare, Part 1: Examining how healthcare can benefit from wearables and cognitive computing

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In this article, I examine the current trends in wearable computing in healthcare. Also, I explore the gaps between what can be done with current hardware offerings and their analytic capabilities. You’ll learn how cognitive computing platforms like Watson can accelerate time to market for wearable device makers and also how Watson can fill the gap between the potential of wearables and their current rather weak offerings.

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Wearables and healthcare

One of the hottest trends among hardware developers is the development of small wearable sensors, or wearables, specifically for collecting health and lifestyle data. This trend includes everything from simple devices such as the Fitbit to more sophisticated Lab-on-a-Chip devices that measure everything from blood sugar and hormone levels to complex proteins.

Unfortunately, most of these devices generate data that is underutilized. Either the user cannot derive anything but simple metrics from the devices, such as step count, or the data to is just not accessible to users. This underutilization often occurs because many hardware developers cannot afford to develop either the big data capabilities that are needed to manage all that data or the analytic capabilities that are needed to derive useful information from the wearables.

Services like the IBM Watson API, however, provide developers with the ability to offer valuable information to their users who use wearables, without having to build their own PaaS offerings. With the help of Watson, developers can create solutions that combine and compare data, find patterns and look for trends in that data, and even learn about the patients who are using the wearables.

For this article, I define wearables as a device with central processing capability and sensors that are designed to provide services to the user with the least amount of user interaction as possible.
for a specific task or need. So, while a smartphone can be worn on your arm as a wearable fitness sensor, it's not designed to do that. So it requires a lot of interaction to do tasks such as downloading an application, enabling the application, and then strapping the setup to your arm in an often cumbersome manner. As such, a smartphone can be worn, but it is not a wearable. A good example is something like a Fitbit device, which is designed to help a user track their steps or activity with the idea of promoting healthy behaviors. Keeping this definition in mind, wearables offer a plethora of potential capabilities within healthcare if the information and data created by these devices can be turned into actionable intelligence and insights.

The analytics gap

The Mi Band, Fitbit, and other wearables can collect a lot of data on a user. However, data such as how many steps you take in a day, no matter the frequency or accuracy, has little actual correlation between fitness and health without being able to contextualize that data. By contextualizing we mean comparing your activity to your age, sex, weight, and overall health. For example, if you're 20 years old and in good health, taking 700 steps a day is not particularly active for your demographic. But, if you're 80 and recovering from knee surgery, it's an impressive amount of activity. Most activity sensors in wearables are not useful: the accelerometers and magnetometers are not accurate, they can't differentiate between activity like walking or strength training, and they are often terrible at counting calories. Yet, with enough computational power and data, you can make data from something like these wearables far more relevant as a personal health and fitness monitoring tool.

Taking advantage of Watson APIs

IBM's Watson offers developers of wearables a sophisticated super computer and cognitive computational system as a service. This service allows savvy developers to rapidly design and develop applications that can fuse data that a user provides on weight, diet, health, and much more. For example, data can be collected from your activity sensors and potentially from other data sources, such as sleep monitors, glucose monitors, an Internet connected scale, and even your electronic medical records. Watson APIs can even help intelligently fuse this data together, but more importantly, they can derive meaningful information from your data. For example, a Fitbit offers data visualization like that shown in Figure 1, which isn't that useful.

Figure 1. Example of the sort of visual analytics from Fitbit
Fusing data from wearables with personal health data

To make data from wearables more useful, you need to not only analyze a user's data from their wearable, but also fuse it with their personal health data. You can contextualize this fused data further with similar data from other individuals with similar metrics, thus providing you with a meaningful statistical analysis.

For example, in Figure 2 you can see an example of Watson combining a patient's wearable data with their electronic medical records and then comparing it to patients with similar criteria. In this case, the goal is to get a sense of the patient's risk of heart disease by following the Framingham Criteria, which is a methodology that is used by physicians to evaluate the risk of cardiac failure. Read the full paper, "Interactive Intervention Analysis," presented by David Gotz and Krist Wongsuphasawat at the American Medical Informatics Association Annual Symposium in 2012. (See Resources for more information.)

Figure 2. An example of Watson-generated visualization of patient data compared to similar patients. This image is excerpted from this report: "Interactive Intervention Analysis." by David Gotz and Krist Wongsuphasawat. American Medical Informatics Association Annual Symposium (AMIA), Chicago, IL (2012).

Because Watson has an open design as a platform with simple RESTful APIs, developers can pull data from popular sensors and from sites that store a user's DNA analysis. They can access sites...
where the user enters their diet information, or their medical records, and even get data from the National Institute of Health’s updated data sets. Comparing that data based on what times users are active, the type of their activity, where they live, and changes in their weight, opens the door to more advanced statistical analysis beyond simple regression.

Developers can create applications that help users understand their basic wellness and diagnose medical problems. These apps can also potentially predict future medical problems based on early indicators of illness. The apps might even recommend that they see a specialist and have specific tests done based on the analysis. Policy makers and public health officials might also benefit from apps like this, since the apps might recognize disease outbreaks and even potential spikes in illness, before a major problem arises. Cognitive computing platforms, like Watson, can help developers bridge the analytic gap and allow wearables to move from simple devices that collect simple data, to potentially revolutionary platforms for understanding fitness and overall wellness.

The "Quantified Self" movement and cognitive computing

Wearables have in large part been driven by the Quantified Self movement, which focuses on individuals who use technology to monitor their own self to have a greater understanding of their personal health and well-being. Unfortunately, few users have been able to truly benefit from current hardware tools and software offerings due to the previously mentioned analytical gap. This gap caused the Quantified Self movement to be almost completely dominated by a small group of highly technical individuals who have the resources and abilities to extract useful personal information from their wearables. Tools need to be able to help users who are not trained data scientists or physicians to find outliers and trends that are specific to their individual health. Users also need tools that can understand or “learn” about themselves, and guide them to their health and fitness goals.

Currently, a platform like this isn't available to users, partly because it requires a level of intelligence that is hard to develop into software tools. However, IBM Watson is a cognitive computing platform that offers the foundations to help create this new breed of tools. For example, the Question and Answer service coupled with the Text to Speech and Natural Language services can enable individuals to manage, explore, and better understand their own well-being without having to have a sophisticated understanding of statistics, biology, physiology, and technology. With Watson, you can create cognitive applications for wearables that would truly transform the Quantified Self movement into something from a domain of the technology elite to a major fitness and health movement for the masses.

Wearables and cognitive computing applications will help deliver on two key benefits of the Quantified Self movement: patient-centered care and a more efficient and effective healthcare system.

Patient-centered care

Information about your health and wellness from even the most sophisticated of computer platforms cannot replace dedicated physicians or healthcare specialists anytime soon. Wearable developers need to consider how their devices and associated software platforms can help
individuals engage with their healthcare providers to develop a more open and collaborative form of healthcare, which is commonly referred to as patient-centered care.

In patient-centered care, healthcare providers collaborate with patients to help them make not just informed choices, but choices that are best for their particular circumstance and situation. With this new model of collaborative care, developers of healthcare wearables can provide a critical role by making their devices and tools securely accessible to a patient's healthcare providers in formats that healthcare providers regularly use. Furthermore, wearable developers can create interfaces and services that are specifically designed to allow both patient and physician to explore the patient's data, and drill down into it. These services might provide the main user an important tool for monitoring their health. Also, they might provide their caregivers a method to more efficiently monitor their patients' health and collaborate with their patients and other caregivers.

In this patient-centered environment, patients might come in and sit down with their healthcare providers and talk to them about their issues. Then, along with their physician, they might review their medical records alongside of their wearable's data. The system might summarize the patients' medical records along with recent data, pointing out potential outliers to the physician that might require greater analysis. The physician might then walk through those outliers with their patient, calling up past medical tests or records. The physician might even compare recent wearable data to past data to help patients understand the physician's analysis or prognosis.

Even more exciting, wearable platform developers might add predictive modeling capabilities for the physician to show their patient likely outcomes of various treatments, therapies, or regimens. For example, a physician might have the system show a patient the outcome of what a modest exercise and diet change would have on their health, based on their specific medical case and aggregates of other medical cases like them. Wearable devices might help healthcare providers make better decisions faster, allowing them to provide better service for more patients.

**A more efficient and effective healthcare system**

Currently, the medical community is overwhelmed by both patients and data. Many physicians are spending only 15-30 minutes with new patients, where they must rapidly assess their medical history, often provided orally, and make a diagnosis. The result, according to some studies, is 12 million misdiagnoses a year just in the United States. This issue is exacerbated by poor medical records and often low fidelity and low frequency lab tests that are often not even digitized, resulting in physicians often making informed guesses. Wearable devices and cognitive applications might fundamentally change how physicians diagnose patients, by providing better quality analytics, by helping recommend treatments, and also by providing higher quality and very high frequency data.

With this cognitive computing solution, physicians might review patient records, tapping into sensor data streams to get clearer views of what’s really going on with a patient. And, the physician would benefit greatly from the analytic and decision support capabilities from a cognitive computing platform like Watson.

The next generation of wearable device providers might even create notifications for healthcare providers that can allow physicians to create rules to notify them when certain conditions are met.
The physicians can follow up remotely by looking directly at a patient's data without having to meet with the patient at all. This enhancement would be extremely powerful, allowing healthcare providers to test various hypotheses and validate them in real time outside of a lab. This scenario is something that is currently only possible and practical under medical or scientific studies. But with wearables and cognitive computing, physicians might manage larger numbers of patients, with clearer visibility into their health, while using better data, and while reducing the potential for tragic mistakes and misdiagnosis.

Conclusion

In this article, we briefly looked at how cognitive computing platforms like IBM Watson can help usher in a new generation of wearables that allow developers to enable better analysis, user interaction, and patient-centered care. We have also looked at how taking advantage of wearables to mix big data, historical user data, and sensor data can be used to more accurately diagnose illness and also predict illness. Finally, we looked at how cognitive applications combined with wearable sensors can help physicians in managing their workloads, reducing misdiagnoses, and providing them with an important tool in understanding their patients' health in real time.

In the next article in this series, "Designing cognitive applications that take advantage of the Watson services," I look at how you might design a cognitive application that uses IBM Watson for wearable sensors.
Resources

- Read the Guardian review of Fitbit. *Fitbit Charge HR review: a heart-rate tracker that's skipped a beat.*
- Read a paper (David Gotz and Krist Wongsuphasawat. "Interactive Intervention Analysis." *American Medical Informatics Association Annual Symposium (AMIA), Chicago, IL (2012).* ) that describes an interactive visualization-based system for intervention analysis and applies it to patients at risk of developing congestive heart failure (CHF).
- The *Quantified Self-Movement* focuses on individuals using technology to monitor their own self to have a greater understanding of their personal health and well-being.
- Read *Advancing the science of measurement of diagnostic errors in healthcare: the Safer Dx framework* by Hardeep Singh and Dean F. Sitting in *BMJ Quality & Safety*, issue 24, no. 2.
About the author

Robi Sen

Robi Sen, CSO at Department 13, is an experienced inventor, serial entrepreneur, and futurist. His dynamic 20-plus year career in technology, engineering, and research had him working on cutting edge projects for DARPA, TSWG, SOCOM, RRTO, NASA, DOE, and the DOD. Robi also has extensive experience in the commercial space, including the co-creation of several successful startup companies. He has worked with companies such as UnderArmour, Sony, CISCO, IBM, and many others to help build out new products and services. Robi specializes in bringing his unique vision and thought process to difficult and complex problems, which allows companies and organizations to find innovative solutions that they can rapidly go to market with.

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