

# THE HUMAN FACE OF **BIG DATA**

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## **Pulse of the Planet by Esther Dyson**

After more than 50 years, the Computer Age as we've known it is ending. And what will replace it—perhaps we'll call it the Informatics Age—will be a kind of Copernican Revolution in knowledge. That is, humans will no longer be the center of the data solar system, with all of the billions of devices orbiting around us, but will rather become just another player, another node, in an increasingly autonomous data universe.

From that perspective, the half-century of computing that we know so well, with its evolution from mainframe computers to minicomputers to personal computers to servers, laptops, and iPhones, now looks to be more monolithic than we thought, with each of those product leaps (which at the time seemed so revolutionary) merely an incremental improvement on what came before. Ultimately, they all approached problems the same way: we loaded all of the data in and told the computer, big or small, about the physical world.

But all of that has changed, almost without our noticing it. Three things have made possible this change. The first is the Internet and the web. Every newly added node on the Internet produces uncounted numbers of new interconnections, so that the web has increasingly taken on a life of its own.

The second is the rise of devices. In just the last decade we've gone from personal computers and cell phones owned and managed by individuals to a world of billions of intelligent, or intelligence-added, devices that are self-aware in some sense and can communicate among themselves as well as with computers and, ultimately, with people. Each of them has an address (though not necessarily visible to all), a status, and an autonomous identity. They now share the digital world with us.

And third, in what has been a largely overlooked technological breakout, analog measurement, the forgotten also-ran of electronics, has undergone a comeback—in particular because there has been a breakout in the sensor technology for which analog-to-digital chips and devices serve as brains and translators. Put sensors and processors together, and then add Moore's Law—the principle that computing power generally doubles every 18 months—and for the first time it is possible to make a very small, smart, and cheap sensor that can be embedded by the billions into the natural world.

Suddenly, the conversation goes far beyond what humans can comprehend, to a ubiquitous decentralized communication, as all of these devices begin to talk to one another without our intercession. This is where the really "Big" comes from in Big Data: self-organization through agent interaction. It's much closer to an immune system than to a nervous system—let alone a brain-centered hierarchy.

Billions of objects operate and interact with their own virtual presence and virtual identity, mostly following human-given rules but without (much) human intervention, announcing themselves and their current states, sending the data they're recording not just to us but to other devices to coordinate their common activity—be it tracking changes in microclimates, patient vital signs, the migration of fish in the South Pacific, traffic in São Paulo, or millions of other phenomena. When we talk about Big Data, we often focus on the tracking and mining of vast mountains of static results, but the *dynamic* interaction among complex agents in real time ultimately will be more valuable. It is this latter form of Big Data, because it duplicates nature itself, that has the greatest potential for revolutionary change.

This is what it means to take the pulse of the Earth: the dream, as old as humanity, to *observe*—not just experience—the world around us. But that does not yet mean to understand it. As with the human genome, we can find and even predict correlations, but we cannot yet understand or model the behaviors and interactions that produce them.

Yet we are getting closer by the year. Soon we will salt the oceans, the land, and the sky with uncounted numbers of sensors invisible to the eyes but visible to one another and to a variety of data collection devices. The vast, increasingly accurate data streams will combine and interact (like the combination of ocean records with sea captain logs illustrated on the pages in this chapter) to produce more and more meaningful caches of knowledge.

Yet there's more to come ... that is, more to be done. Today's Big Data tools, stunning as they are, are only the beginning. We have learned over the last century just how difficult it is to model the natural world. We make models using only the data we have collected; what are we missing? Just as the ancients missed microbes, so did we miss solar flares until more recently. Once we included them, we got a little bit better at weather prediction.

Of course, one purpose of prediction is not to know the future, but to be able to change it. That's fine—but incomplete data or sloppy models inevitably lead to unintended consequences. There's a human irony in the fact that a natural disaster is somehow less painful than one we cause inadvertently: once you mess with something, you are responsible for the outcome. For better or worse, Big Data is taking the concept of "messing with something" to a level that humanity has never experienced before.

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