SCIENCE & SOCIETY

What's next for humanity?

With an emphasis on data science and biotechnology, a historian looks to the future

By **Dov Greenbaum**[1,2] *and* **Mark Gerstein**[2]

Historian Yuval Noah Harari's new book is his third in a trilogy that examines the annals of humanity. Divided into five parts and 21 chapters, it discusses the near future, as extrapolated from our current trajectories.

Like his other bestsellers, *21 Lessons for the 21st Century* is meant for a broad audience, and Harari effortlessly jumps between diverse topics, from biology and information science to history, religion, and philosophy. But despite the wide-ranging subject matter, many scientists will also find substantial value in reading this book because it places recent scientific and technological developments within the broader arc of history.

Following a theme from his second work, Harari focuses on how current innovations in information science and biotechnology will affect humanity in the not-too-distant future. "When the biotech revolution merges with the infotech revolution, it will produce Big Data algorithms that can monitor and understand my feelings much better than I can," he predicts, adding, worryingly: "and then authority will probably shift from humans to computers." Harari claims that this phenomenon will eventually be so pervasive that we will be stripped of free will by machine-learning algorithms that will "analyze the biometric data streaming from sensors on and inside your body, determine your personality type and your changing moods, and calculate the emotional impact that a particular song—even a particular musical key—is likely to have on you."

To reinforce just how important data already is in our lives, Harari explains how societal institutions such as government, education, and advertising can be conceptualized in terms of information processing. He describes how many autocratic regimes of the past century failed because their top-heavy, overly centralized structures were unable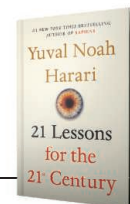 to handle the vast amounts of information from their populace. By contrast, he notes, many democratic regimes found success by using a more distributed structure and associated information-processing ability.

But Harari reminds the reader that advances in information science can change this balance: Large-scale data mining now favors highly centralized collection and processing of data, leveraging social structures typical of autocratic states and data monopolies. In an extreme example, he sketches out a futuristic autocracy in which pervasive sensors intimately monitor the population, giving both despots and entrenched corporate data platforms an unparalleled grip on power.

In this potential future, power is concentrated in the hands of a few elites, who use centralized data collection, artificial intelli-

As biometric data collection becomes more pervasive, machine-learning algorithms are beginning to play a greater role in society.

gence (AI) algorithms, and biometrics. This "data collective" will know us better than we do. And within a small amount of time, it will make arguably better decisions than we can individually. This need not be wholly nefarious, however; the benefits of data-driven decisions will be particularly evident in areas such as disease diagnosis, transportation, and personalized product recommendations.

Of course, the hyperefficiency of the collective will also leave the bulk of the population irrelevant as classical labor. But even this may not be all bad: In perhaps an unintentional nod to the gentlemen scientists of old, Harari argues that under the right circumstances, the future might allow displaced laborers to pursue scholarly and

21 Lessons for the 21st Century
Yuval Noah Harari
Spiegel & Grau, 2018.
395 pp.

philosophical understanding rather than toiling in the pursuit of a livelihood.

One wonders whether individuals will still be necessary for producing data. Harari is unclear on this point. In some passages, he seems to think so. At other times, he seems unconvinced, such as when he asserts that AI chess masters no longer need external data to vanquish their opponents.

There is more good news for the digital future in the book: Modern technology will continue to enmesh us in an ever-bigger collective in which data shared will be immediately and thoroughly used to optimize everything from networked cars to AI doctors, which will be able to immediately use the entirety of all medical knowledge, as it becomes available in real time, to better treat our illnesses.

The scientific readership no doubt already appreciates the value of aggregating data because much of modern scientific research is effectively impossible to achieve by individuals alone. As we accumulate more scientific knowledge, the gap between the expansive knowledge of collective humanity and the knowledge of each individual grows larger.

In his eyes, only science can save us from an unpleasant outcome: "...the mark of science is the willingness to admit failure and try a different tack. That's why scientists gradually learn how to grow better crops and make better medicines."

But how do we use science to steer society toward the better future? Harari concludes with a call to action: Scientists need to learn to communicate better. We need to discard the notion that we can win over the public with tedious data. Rather, he argues, we must use narrative. "Humans think in stories rather than in facts, numbers, or equations, and the simpler the story, the better." ■

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