# Personal Analytics:

## Making meaning from the measured life

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# Contents



# Definition

## *A brief history of ideas underlying personal analytics*

There is an old and important belief given voice by the physicist Lord Kelvin (b. 1824, d. 1907): **"to measure is to know".** This belief is part of empiricism—the foundation of the Western scientific method [1].

In the early 1900s, the scientific appetite for measurement and quantification spread to the field of management, chiefly through the work of Frederick Winslow Taylor (b. 1856, d. 1915). Under the name of **scientific management,** Taylor used practices like timing workers' motions with a stopwatch in order to identify the "one best way" to perform a task [2]. His approach and convictions persist today under the banner of management science theory—for example, in the work of management guru H. James Harrington (b. 1929) — although management theorists in general turned much of their attention towards human factors and the complex influence of organizational context starting in the 1960s [3].

Some early champions of scientific management in the workplace were also deeply enthusiastic about measuring, quantifying and improving their personal lives—as portrayed in the book *Cheaper by the Dozen* (published in 1948, later adapted by two movies). In this, they exhibited an ethic of perpetual striving for **self-improvement** closely linked to the Protestant religion [4]. Another famous example of this ethic is the businessman, politician, and inventor Benjamin Franklin (b. 1706, d. 1790), who used a daily journal for tracking his performance of thirteen "virtues" [5]. The idea that people have a duty to improve themselves and that measurement is a major tool towards this end also endures today, perhaps even as the dominant ethos [6].

> "If you can't measure something, you can't understand it.
> If you can't understand it, you can't control it.
> If you can't control it, you can't improve it."
>
> —H. James Harrington

# Definition

## *Modern capabilities and frontiers*

Early practitioners of self-quantification for the sake of self-improvement were true believers, willing to sacrifice their personal time for a goal they believed was important. The effort required for manual data collection with primitive tools was considerable—far beyond a casual hobby. This, of course, has changed. Advances in technology (discussed in the following section) have made these sorts of measuring activities easier, more affordable, and more accessible, as well as enabling previously impossible forms of self-quantification.

Now, most people—even those who make no special effort—leave a previously unfathomable **digital footprint** as they go through life purchasing products, using social media, navigating the web, sending email, and so on [7]. From the user side, it is easy to purchase the necessary tools and apps for "lifelogging"; from the organizational side, it is possible—and highly profitable—to record a user's actions as they browse a website or otherwise transact with the company.

"If a measurement matters at all, it is because it must have some conceivable effect on decisions and behaviour."

If we can't identify a decision that could be affected by a proposed measurement and how it could change those decisions, then the measurement simply has no value."

—Douglas W. Hubbard

It is this surge of personal data collection that leads to the need for **personal analytics.** Now that behaviors, interactions, and biometric data are captured widescale, the challenge has largely shifted from *obtaining* data to *using it* well (though, as discussed in a later section, issues with data capture remain) [8].

Both the scale of personal data capture and the unit of measurement raise serious analytic challenges. Traditional statistics evolved in a data-scarce environment where the need was to make inferences about a larger population based on a small sample from that population. The challenge today is different: how to extract insights from a stunningly large data set, perhaps covering the entire population of interest [9]. Moreover, personal analytics, like genomics, is faced with the question of how to connect extremely granular personal data to meaningful benchmarks, advice, and actions [10]. Finally, like the field of library science, it faces the problem of increasing information literacy: training users to interpret and assess the validity of complex information [11].

# History of the Technology

***With illustrations from health informatics***

**The timeline focuses on core technologies that enabled the field of personal analytics by fundamentally changing the types of data collected, the types of analysis that were possible, and the relevance of personal analytics in day to day life.**

## 100 B.C. — Paper

***Writing was invented in China sometime around 100 B.C.*** [12]. Writing was an early technological advance in our ability to capture and preserve data, including personal data. Analysis of this data could only be done by those who were literate and had advanced mathematical knowledge. Everything has to be done manually, from the input to the calculations themselves.

Pen and paper has a very limited ability to track health. It also relies on other technologies like stopwatches to manually track time spent; is nearly impossible to capture other metrics of interest, like calories burned.

## 1971 — World Wide Web

***The worldwide web was born in 1971*** [13]. The web profoundly affected how information is spread, and now provides the primary platform where users look up information. Networking, meanwhile, enabled the interconnection of all the devices users own, making it easier to obtain a complete look into their lives.

The World Wide Web allowed users access to databases with information on calorie content and nutrition, as well as various online apps that can be used to save and track this information. Early databases were very limited and the interfaces were often difficult to navigate.

## 1975 — PC

***The MITS Altair 8800 was released*** [14]**.** The Altair was the first personal computer to gain widespread acceptance; initial projections of consumer demand for computing power were extremely low. Personal information can now be stored digitally and analytics capabilities increase dramatically.

## 1996 — Personal Digital Assistant

***The Palm Pilot was released*** [15]. Personal digital assistants (PDAs) and mobile devices was popular around the same time with similar capabilities. It made personal analytics easier since it allowed users to manually track information wherever they went and helped to organize the data.

# History of the Technology

***With illustrations from health informatics***


***MySpace went public in 2004*** [16]. Social Media sites like Twitter, Facebook, and Instagram provide a platform to connect to others. Much of our daily communication and digital lives are stored on these sites: who we know, what we like to purchase, what we like to read, and so on. These examples are just the tip of the iceberg in terms of the information that can be extracted from the data.

By connecting to social media platforms, users can compete with their friends on fitness goals. It helps create a social support mechanism that motivates people to better obtain individual goals.

***The iPhone was released in 2007*** [17]. Smartphones profoundly increased the popularity and accessibility of personal analytics. Mobile hardware uses accelerometers and GPS technology to track our movement from place to place, and our phones are always nearby and available for data input. The smartphone also provides a plethora of apps from personal finance to simple to-do lists. These apps help users with structured data creation, analysis, social media connections, and simple suggestions.

Apps like MapMyRun [18] helped users track their exercise while others like MyFitnessPal help with calorie counting. Both of these help users organize their health and fitness data and share with others. In the case of MapMyRun, it helps create data with help of the GPS on smartphones. My Fitness Pal has an large database of food so users can quickly enter in what they ate. The app will store this data and use it to identify trends in overall intake and macronutrient ratios.

***The first Fitbit device was released in 2009*** [19]. Like the smartphone, wearables brought even more advances to the field of personal analytics—mainly in their ability to track biometric data with greater precision and accuracy than accelerometers and GPS permitted.

With the advent of smaller sensors that directly monitor our physical status, wearables have had a major impact in the field of health informatics. Heart rate and number of steps can be automatically tracked 24/7. With an app to complement the device, users are able to view visualizations that provide an easy way to understand the data. Data is also analyzed automatically in order to calculate, for example, when users are exercising or sleeping, thus reducing the need for manual entry. This technology has such a broad appeal that "60% of US adults are currently tracking their weight, diet, or exercise routine" [20].

# Technology

## *A glimpse of current device capabilities*

***ACTIVITY SENSING & DATA COLLECTION:*** There are two major categories of instruments used to sense activities and collect data: wearable devices and non-wearable devices. Wearables include wristbands and smart garments, while non-wearables range from cameras and mobile phones to IoT devices. Many are equipped with motion sensors, GPS, and network connectivity that links to dedicated software. Some devices—especially diet trackers—require manual data input, perhaps assisted by a barcode scanner.

***DATA ANALYSIS:*** Most devices includes basic analytic capabilities, such as the ability to calculate averages and 'streaks'. A sleep tracking app, for example, may include average sleeping time, average sleep stage (deep or light), sleep duration, sleep quality over time, the correlation between caffeine intake and sleep quality.

***VISUALIZATION:*** Most devices present data to users through attractive interfaces and offer data visualizations with varying degrees of sophistication. Some present the raw data and let users draw connection themselves; some visualize user data against benchmarks (percentile standing within the user population, performance versus that of famous people, performance versus own past performance, etc). A few depict correlations.

***SUPPORT FOR DECISION MAKING:*** Currently, most personal analytics applications support decision making by visualizing data in a way that it could lead to conclusions and behavior changes. While some provide actionable suggestions or plans based on the results of data analysis, many place the onus heavily on the user to interpret data and make the leap from data to insights to action. The incorporation of gamification elements, like personal streaks, help motivate users to pursue healthy behaviors.

# Market

***Where will personal analytics be applied?***

### *HEALTH & WELLNESS METRICS*

- ♥ Heart Rate
- ♥ Sleep Quality
- ♥ Exercise
- ♥ Mood
- ♥ Weight Loss
- ♥ Calorie Intake
- ♥ Pregnancy Progress
- ♥ Period Tracking

### *TECHNOLOGY-USE METRICS*

- ⊠ Phone Use
- ⊠ Mobile Data Use
- ⊠ E-mails
- ⊠ Social Media
- ⊠ Smart Device Use
- ⊠ Mobile Addiction
- ⊠ Ebay Bidding
- ⊠ Music Habits

### *WORK & MONEY MANAGEMENT*

- $ Productivity
- $ Commute
- $ Networking
- $ Personal Finance
- $ Budget and Bills

### *HOUSEHOLD MANAGEMENT*

- ☺ Holiday
- ☺ Driving
- ☺ To-Do List
- ☺ Shopping List
- ☺ Personal Resolutions
- ☺ Energy Consumption
- ☺ Cosmetics Use
- ☺ Leisure

# Market

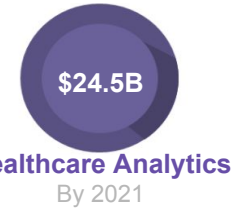
## *How large is the market for personal analytics?*

**Personal Analytics is one of sixteen technologies added to Gartner' Hype Cycle for Emerging Technologies in 2016. According to Gartner, it is currently in its "innovation trigger" phase and will take 5-10 years for mainstream adoption [21]. Since there is no explicit data regarding market size, potential market size will be probed by looking at related markets.**

The **wearable fitness technology** market is expected to reach $12.44 billion by 2022, at a Compound Annual Growth Rate (CAGR) of 13.7% between 2016 and 2022[22]. Fitness technology
is expected to evolve beyond smartwatches and wristbands to include new products such as smart shoes, smart apparel, headbands and more.


The **social media analytics** market is expected to reach $5.40 billion by 2020, at a CAGR of 27.6% from 2015 to 2020 [23]. This rapid growth is projected due to expectations of a massive surge in the number of social media users.


The **healthcare analytics** market [24] is predicted to reach $24.55 billion at a CAGR of 27.1% from 2016 to 2021.



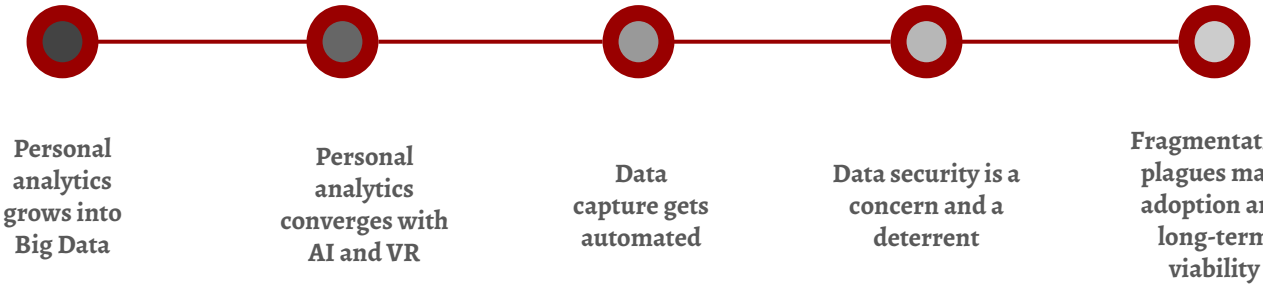

About $46 billion in the mobile apps market; $400 million is health-related [25]


About 1 in 10 American mobile users downloaded a health-related app in 2010 [25]

Over 500,000 apps in the Apple store; about 13,700 are health-related [25]

# Predictions

*The future of personal analytics and information management*



# Predictions

## *Personal analytics grows into Big Data*

At present, personal analytics applications deal with a relatively small volume of fairly predictable data. As the technology matures, we predict that it will cross the threshold and become Big Data: high volume, high velocity, and more varied [26]. This transformation will arise from an increase in lifelong users of personal analytics devices who will seek to capture an increasingly larger part of their daily lives and analyze it with personal analytics technology.

A second facet of this trend is the movement to harness vast amounts of highly granular personal data for research purposes. **Citizen science** initiatives like the Harvard Personal Genome Project and the Open Humans Foundation allow people to volunteer genetic and other data for use by researchers; meanwhile, researchers at Facebook demonstrated the existence of emotional contagion in an experiment involving around 700,000 unwitting Facebook users, and another researcher used a bot to scrape data from around 70,000 OKCupid profiles [27].

This trend will feed growing demand for data scientists who can wrangle and extract insights from large, heterogeneous data sets. Big data engineers will see an average 5 percent pay increase for salaries ranging from $123,000 to $158,000, and data scientists will likely bring home salaries between $99,500 and $132,000—a 3.3 percent increase from 2015 [28]. In addition to general data science roles, we foresee a rise in specialized roles such as “Health Informatics Manager”, “Personal Analytics Analyst”, etc.

To be responsible stewards of this technology, information professionals will need to stay wary of the ethical pitfalls associated with Big Data, the privacy risks of open data [29], and the possibility of unethical behavioural manipulation through interface design. The possible payoffs of ethical violations are high, whether one is motivated by financial gain or by more ‘noble’ goals like the pursuit of knowledge. Despite the temptations, those in information management must be mindful of users’ rights to privacy and control of their own data.

# Predictions

## *Personal analytics converges with AI and VR*

We predict that personal analytics will converge with the emerging and exciting trends of artificial intelligence (AI) and virtual reality (VR). These trends will not just leverage but even propel each other.

VR technologies will make the data outputs and interfaces of personal analytics more interactive and user-friendly, a possibility called **immersive analytics.** Users will be able to enjoy more engaging experiences and seamless work flows for data analysis applications, making personal analytics a more tempting prospect.

AI technology will also contribute to the user experience of personal analytics devices, enabling **virtual personal assistants** and **natural user interfaces** that are intuitive to the point of being invisible. Gartner predicts that, even as early as 2017, "[e]xisting things including IoT devices will become intelligent things delivering the power of AI enabled systems everywhere, including the home, office, factory floor, and medical facility" [26].

Information management professionals will participate in this trend by filling roles in AI research and development, information visualization, and the design of VR or AR environments.

**A virtual heart.**
*Users might be able to explore their own heart function in real time through a combination of IoT sensors, personal analytics, and VR technology.*

# Predictions

## *Data capture gets automated*

Current technology makes use of sensors in smartphones and wearables to gather biometric data, making data capture for movement, sleep quality, and similar biophysical processes automatic. However, tracking personal aspects like weight, mood, food intake and more still require direct user interaction—which is tedious for the user, subject to human forgetfulness, and a source of potential error in the data.

Because the gains in terms of user satisfaction are so great, we predict that companies will invest serious effort into expanding the extent of automatic data capture and will make considerable breakthroughs in this arena, mostly through integration with APIs and IoT devices. Automation data collection will guarantee more continuous and accurate data collection, as well as freeing the user from the onerous responsibility of regularly inputting data.


**Smart dust sensors shown against a penny for scale**

One promising possibility is the use of **smart dust**—extremely miniscule and networked sensors that are capable of detecting many electromechanical and chemical signals. Smart dust can be distributed throughout a user's environment, worn on a user's body, ingested by or even semi permanently embedded inside a user to automatically capture a range of behaviors and phenomena.

By 2030, we are likely to see the emergence of **wearable drones** with the ability to check for pollution, put up a mask or defense mechanism, scout for the best possible route, or identify nearby sites of interest.

Fulfilling this trend will mostly require the skills of engineers, but information management professionals will be needed for project management and the design of user interfaces that aggregate, analyze, and report data from underlying sensors.

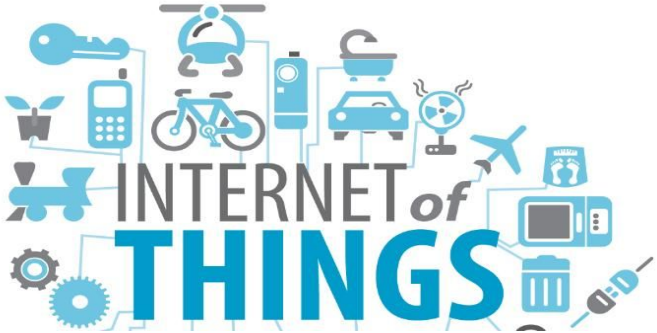
# Predictions

## *Data security is a concern and a deterrent*

While the use of IoT sensors and increased integration with APIs will greatly facilitate data capture, it will simultaneously make sensitive personal data vulnerable to attacks and misuse. We are already seeing the shadow of this threat: hackathon participants at the August 2016 Defcon security conference identified 47 vulnerabilities in 23 devices [31], and in October 2016, a massive DDos attack was waged against major government, corporate, and social media websites by the Mirai IoT botnet [32].

We predict that these kinds of threats will give users pause as they weigh the benefits of tracking their medical data, financial data, location data, and other personal activities. While consumers of the present appear to have a shockingly high tolerance for risks to their personal data [33], it is more likely driven by security illiteracy and the legal opacity of 'terms of service' contracts than by a true acceptance of the risks. It may take only a few high-profile security incidents for consumers to abandon their devices and associated personal analytics apps.

While operating as a deterrent in the market, this trend nonetheless increases demand for information security professionals, leading to many employment opportunities as well as tremendous challenges for people in the information/cyber security sector [34].



# Predictions

## *Fragmentation plagues mass adoption and long-term viability*

There are over five-hundred personal analytics tools ranging from iOS and Android applications for mobile devices, to heart rate and sleep-duration and quality monitors [35]. But there is no service available that exchanges data effortlessly between platforms and applications. This fragmentation poses a major inconvenience for users, who presumably want to gain a comprehensive, integrated picture of their life through apps that 'play well' together.

We predict that this will continue to be a challenge that plagues the mass adoption and long-term viability of personal analytics. Companies are motivated to compete against each other and to develop innovative, differentiated products, not necessarily to develop products that work seamlessly with their competitors' devices and apps.

The onus on information management professionals is to find ways to serve users by increasing data portability and interoperability between platforms. This responsibility to users impacts a myriad of roles including Information Architects, User Experience designers, and Data Engineers.

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