

Ethical and social implications of biometric identification technology

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Summary. This paper discusses the social and ethical aspects of biometrics, using mainly a historical approach. A description is provided as regards the origins and development of the word. Reference is made to the various ways in which it has been interpreted, sometimes very different one from another, and finally to the meaning currently attached to it. The most relevant ethical and social implications are highlighted by giving a brief overview of the contents of the main institutional documents produced both on an international and domestic level in the various countries. The analyses contained in these reports also bring to the fore the main challenges which society shall have to deal with, in the near future and on a long-term basis, as a consequence of the extremely rapid diffusion of those technologies which use biometric data request.

Key words: biometrics, ethics, social sciences, historical aspects.

Riassunto (*Implicazioni etiche e sociali delle tecnologie per le identificazioni biometriche*). L'articolo introduce gli aspetti sociali e di etica della biometria in una prospettiva prevalentemente storica. Sono descritte le origini e l'evoluzione del termine. Si individuano le varie accezioni, talvolta assai differenti tra loro, ad esso attribuite fino al significato attuale. Le principali implicazioni etiche e sociali vengono evidenziate presentando sinteticamente i contenuti dei principali documenti istituzionali prodotti a livello sia internazionale, sia nazionale in vari paesi. Le analisi contenute in tali rapporti evidenziano anche le principali sfide che la società dovrà affrontare nel futuro immediato e a lungo termine, a fronte di una molto rapida diffusione delle tecnologie che utilizzano dati biometrici.

Parole chiave: biometria, etica, scienze sociali, aspetti storici.

INTRODUCTION

Biometric technologies can be defined as automated methods of recognizing or verifying the identity of a living person based on a physiological or behavioural characteristic. "Hal" in 1968 Kubrick's *Odissey 2001*, Bladerunner's "Voight Kampff Machine" in 1982, eyes transplants in 2002 *Minority Report*: no longer a science fiction solution, biometric technologies are the most important innovation in the information technology (IT) industry for the next few years and the biometric industry is projected to grow from \$ 600 million in 2002 to \$ 4 billion by 2007. Biometric systems are being developed in many countries for such purposes as social security entitlement, payments, immigration control and election management. Even technical surveillance-related responses to September 11th have been largely based on biometrics.

Biometrics defined broadly is the scientific discipline of observing and measuring relevant attributes of living individuals or populations to identify active properties or unique characteristics. Biometrics looks

for patterns of change by measuring attributes over time or look for consistency by measuring attributes of identity or unique differentiation. When looking for patterns of change, biometrics can be considered a tool for research, diagnosis, or medical monitoring. When looking for consistency, biometrics becomes a useful vehicle for security [1].

Biometrics can be used in two ways. The first is identification ("who is this person?"), in which a subject's identity is determined by comparing a measured biometric against a database of stored records: a one-to-many comparison. The second is verification ("is this person who he claims to be?"), which involves a one-to-one comparison between a measured biometric and one known to come from a particular person. All biometrics can be used for verification, but different kinds of biometric vary in the extent to which they can be used for identification. Identification mode is more challenging, time-consuming, and costly than the authentication mode. Biometric "identification" systems vary in

cost, complexity and intrusiveness. Early biometric identification technology was considered extremely expensive. However, due to constant developments in computer technology and reduction in prices, along with improvements in accuracy, biometrics have begun to see widespread deployment. For example, a fingerprint scanner that cost \$ 3000 five years ago, with software included, and \$ 500 two years ago, costs \$ 100 today. As a result, biometric systems are being developed in many countries for such purposes as social security entitlement, payments, immigration control and election management.

Biometric identifications systems consist of a reader or scanning device, a software that converts the scanned information into digital form (template), and, wherever the data is to be analyzed, a database that stores the biometric data for comparison with entered biometric data. The incredible variety of human forms and attributes might seem to reveal a large number of potential attributes for biometric identification. Good biometric identifiers, however, must be:

- universal: the biometric element exists in all persons;
- unique: the biometric element must be distinctive to each person;
- permanent: the property of the biometric element remains permanent over time for each person.

Existing biometrical methods of identification include fingerprints, ultrasound fingerprinting, retinal and iris scans, hand geometry, facial feature recognition, ear shape, body odor, signature dynamics, voice verification, computer keystroke dynamics, skin patterns, foot dynamics. Future biometrics will include DNA analysis, neural wave analysis and skin luminescence. Multimodal systems, which cross different methods, are the current trend.

BIOMETRICS: HISTORY OF THE WORD

The origin of the word “biometrics” is straightforward (βίος “life” and μέτρος “measure”). The concept of “measure” in Greek thought is related to ideal geometrical properties which remain constant over time: from these it is possible to organise a deductive system based on principles and postulates guaranteed by their evidence.

According to the *Grande enciclopedia De Agostini* the compound word was created in the 18th century and can be defined as follows: “Science which uses mathematical means, especially statistics, to analyse biological questions which can be expressed quantitatively, i.e. through measures. Biometrics is still being developed: for the moment it has been successfully applied to population analyses and to the study of species associations, genetics, epidemiology, drug dosage, chemical experimentation controlled by means of sequential analysis, taxometry. The use of computers also allows for automated disease diagnosis and for the study of a wide range of biological phenomena” [2].

Dictionaries and encyclopaedias give shorter and often more limited definitions. According to *Webster's dictionary* the nouns “biometry” and “biometrics” are synonyms. They belong to the “statistical” area and are defined as follows: “The statistical study of biological observations and phenomena” [3].

Also the *Academic press dictionary of science and technology* considers “biometry” and “biometrics” as equivalent nouns pertaining to “statistics” with the following two meanings: “1) the statistical study of biological phenomena and events; 2) the calculation of life expectancy” [4].

According to the *Vocabolario della lingua italiana Zingarelli*, the term dates back to 1930 and its meaning is twofold: “1) science which applies statistics to analyse biological and medical phenomena; 2) in life insurance, the calculation of life expectancy” [5]. The first of the two definitions given by Zingarelli is also included in the Italian edition of the *Medicine and biology encyclopaedic dictionary* by the same publisher (with only one difference: the verb “employ” is used instead of “apply”) [6].

In the *Enciclopedia italiana di scienze, lettere ed arti* Treccani, published in 1930, biometrics is defined as “a generic word which relates to the systematic presentation of quantitative studies concerning life phenomena. It is sometimes used as a synonym for the other one with a specific meaning, biometrics, or science dealing with the statistical study of inheritance and development in individual species. Alongside many naturalistic disciplines, biometrics was established in the 17th century as a consequence of the study trend encouraged by great induction and programme theoreticians, whose staunchest supporter and representative was Galileo, with the aim of measuring all that could be measured and make measurable what cannot be immediately measured. It appears, however, to have two fairly distinct sources. One consisted in introducing the measure criteria to the study of the individual organism and began, under the name static medicine, in 1614 with the famous research on exchange phenomena by Santorio Santorio from Capodistria, a colleague of Galileo's in Padua (1620-1674); the other focuses on the totally new need for collectively studying the biological phenomena of human populations using the enumeration method, started in 1662 by the London captain G. Graunt (1620-1674) and soon called political arithmetic, the precursor of modern demography (...)” [7].

Thirty-nine years later the *Lessico universale italiano*, also published by the Istituto Treccani, used the same definition (except for small variations, for example the date 1666 instead of 1662 for G. Graunt's enumeration method), indicating, however, “statistics” rather than “demography” as the discipline which “developed” from “political arithmetics” [8].

In the *Enciclopedia del Novecento*, published in 1975 also by the Istituto Treccani, biometrics no longer occupies only a couple of pages (as in the two works mentioned above), but as many as nineteen,

divided into “history of biometrics” and “biometrics concepts”. In the first part, after a reference to the scientific method, we read: “Having thus clarified the concept of quantitative biology as meeting the essential requirement of a rigorous scientific character, we can say that it coincides with the term “biometrics”, as stated, among others by W. G. Cochran. In 1900, during a meeting of the Royal Society, the suggestion was put forward that scientific quantitative biology should be called “biometrics” and that its organ should be the publication “biometrika”. The first issue of this journal stated, in a rather vague manner, that “the main task of biometrics was to provide sufficiently exact material as to allow for the discovery of the initial variations which are too small to become apparent in a different way”. Also, the journal was intended to be the starting point for the mathematical-statistical study of evolution. At that time, the phrase “statistical method” basically implied the use of the correlation coefficient. This statement as to the meaning of the word biometrics confirmed the decision taken in 1947 on the occasion of the biometric society foundation (...)” [9]. The second part covers mathematical aspects and provides an overview of specifically statistical concepts (variability, probability, binomial distribution, normal distribution, population and samples, estimate of parameters and degrees of freedom, etc.) [10].

Biometrics is once again identified with aspects pertaining to statistics in most of the literature. For example the book *Biométrie. Modélisation de phénomènes biologiques* [11] deals exclusively with biostatistics. In the first chapter we read that biometrics “is not a subject matter: it is a job which involves the use of mathematical concepts and symbols”. In the same pages the expressions “biomathematics”, “bio-statistics”, “theoretical biology” are presented as synonyms for biometrics.

A substantial part of biometrics therefore overlaps with bio-statistics; it would be inappropriate, however, to confine biometrics within the boundaries of this subject area: biometrics covers, in fact, a vast range of subjects and topics, as is confirmed by other examples. In the great work *Storia della scienza moderna e contemporanea* the topic of biometrics is dealt with in volume three, solely with reference to evolutionism. In the paragraph “Mendel’s theory and biometrics” we read that “the theoretical roots of the conflict between Mendel’s approach and biometrics seem to lie in different evolution concepts. According to the biometric school (...) evolution was based, as in Darwin’s theory, on inheriting small variations which accumulate (continuous variation), whereas Mendel’s theory suggested evolution by leaps” [12].

Also in the *The growth of biological thought* reference is made to biometrics only as regards the controversy between supporters of Mendel’s approach (especially Bateson) and of biometrics (Weldon, Pearson) [13].

It is just a short step from evolutionism to genetics: in the *Dictionnaire de la pensée médicale* there is no entry for “biometrics”, but in the analytical index we find “statistical biometrics”, which refers back to a single item: “dwarfism” [14]. Genetics then leads on to eugenics: also in the *Dictionnaire d’histoire et philosophie des sciences* there is no “biometrics” entry; the word appears, however, in the analytical index with a reference to “eugenism” [15].

Statistics, genetics and other evolution theories are also mentioned by the *Encyclopedia Britannica*, which reminds us that in the nineteenth century there were applications of “the statistical concept of normal probability curve to human beings”. The same encyclopaedia also describes the disputes against “mutationism” started “by many naturalists, and in particular by the so-called biometricians, led by Karl Pearson, who defended Darwinian natural selection as the major cause of evolution through the cumulative effects of small, continuous, individual variations (which the biometricians assumed passed from one generation to the next without being limited by Mendel’s laws of inheritance)” [16].

ETHICS AND BIOMETRICS

Biometrics has passed through its pioneering period, the time when it seemed science fictional. Biometrics are now increasingly used for user identification and/or authentication in information systems, in border controls, in health systems. Rapid decreases in price and better performance have made biometric technology practical for consumer applications and for governmental purposes. Yet any innovative technology program needs a continuous investigation of its possible ethical implications. The relevance of ethical implications of biometrics is self-evident: it is not only a consequence of the scale of the phenomenon and of the current historical period where security is the centre of attention in many countries. Its relevance is mainly a consequence of the deeply-rooted ethical significance of some issues raised by biometrics. Many of the problems are related to individual rights such as the protection of personal data, confidentiality, personal liberty, the relationship between individual and collective rights. Biometrics is one of the most significant examples of how complex it is to match individual and collective needs. It inevitably leads to questions related to personal, social and collective identity which according to some authors are essential study domains for contemporary sociology [17].

Although some of these subjects have been studied from an ethical viewpoint for a long time, there is no overall and detailed analysis on an international level of the ethical aspects of biometrics as such. In the new edition of the *Encyclopaedia of bioethics*, for example, the word “biometrics” does not feature either as an entry or in the analytical index, even though references to the topic are scattered through many subject areas [18]. The same can be said of the

Encyclopaedia of human biology by the Academic Press [19] and of smaller-sized works such as the *Encyclopaedia of science and technology* [20] and the *Nouvelle encyclopedie de bioéthique* [21].

Till 2006 only a few reports have been issued (or commissioned) by official bodies on ethical and wider social implications of biometrics:

- 2001, *RAND Report: Army biometric applications: identifying and addressing sociocultural concerns* [22];
- 2003, Working Paper of the data protection working party of the European Commission: biometrics [23];
- 2004, BIOVISION Report: *BIOVISION – Roadmap to successful deployments from the user and system integrator perspective* [24];
- 2004, Organisation for Economic Co-operation and Development (OECD) Report: *Biometric-based technologies* [25];
- 2005, Report of the Institute for Prospective Technological Studies – European Commission Joint Research Centre: *Biometrics at the frontiers: assessing the impact on society* [26];
- 2006, National Biometrics Challenge Report (and other Reports) of the National Science and Technology Council (NSTC) of the United States [27].

RAND Report (2001)

In 1999 the RAND Institute was asked by the US Army to examine the legal, ethical and sociological issues raised by biometrics. In 2001 a comprehensive report was published. According to this report there are three areas of ethical and social concern raised by biometric technology:

- 1) informational privacy;
- 2) physical privacy;
- 3) religious objections.

With “informational privacy” the report refers to i) function Creep, ii) tracking and iii) data misuse. We have already mentioned function creep. Tracking, which may be thought of as a particular type of function creep, refers to the ability to monitor in real time an individual’s actions or to search databases that contain information about these actions as in Spielberg’s movie “Minority Report”, where ubiquitous wireless network and biometrics were omnipresent. Misuse of data, *e.g.*, the stealing of identities (identity theft), is another unavoidable risk of the information society. Biometrics promises to improve security, although one should always remember that biometric identification is probabilistic, it means that biometric systems operate by comparing templates and establishing the probability that two templates belong to the same person.

According to the RAND report the use of biometrics may also raise physical privacy concerns. The report distinguishes three kinds of risk: i) the stigma associated with some biometrics, ii) the possibility of actual harm to the participants by the technology itself; and iii) the concern that the de-

vices used to obtain or “read” the biometric may be unhygienic. Stigmatisation can be an important issue when biometrics is mandatory (*e.g.*, border control for migrants, in the Army, etc.). Fingerprinting is associated in many culture with criminal law and, generally speaking, biometrics can be perceived as abusive by minority groups. The report states that the possibility of harm and the concern about hygiene are both unmotivated but it is however important to address properly the public concern raised by these two issues.

Finally the RAND Report discusses religious objections to biometrics. This is an important issue in US where some Christian groups consider biometrics to be the brand of the Evil on the basis of a (very questionable) interpretation of the Revelation.

Working Paper of Data Protection Working Party of the European Commission (2003)

In August 2003 the EU Commission Advisory Body on Data Protection and Privacy issued a working paper on biometrics, which specifically addressed the issue of privacy. The document enlightens some reasons for concern and sets some basic principles.

First of all the working paper emphasizes that biometrics identification technology must respect the so called “purpose principle” according to which no personal data can be collected without explicit and legitimate purposes. The respect of this principle implies firstly a clear determination of the purpose for which the biometric data are collected and processed. “For instance when biometric data are processed for access control purposes, the use of such data to assess the emotional state of the data subject or for surveillance in the workplace would not be compatible with the original purpose of collection. All measures must be taken to prevent such incompatible re-use”.

A second principle is the respect for proportionality. Biometric data may only be used if adequate, relevant and not excessive. “A respect for the principle of proportionality – concludes the working party – imposes a clear preference towards biometric applications that do not process data obtained from the physical traces unknowingly left by individuals or that are not kept in a centralized system”.

The working party finally considers the risk that biometric data may contain more information than that which is necessary for identification or authentication/verification functions. “Some biometric data could be considered as sensitive [...]. It is more likely to be the case if biometric data in the form of images are processed, since in principle the raw data may not be reconstructed from the template [...]. Unnecessary data, states the advisory board, should be destroyed as soon as possible.” The working paper concludes by making an appeal to construct biometric systems in such a way that they could be considered as privacy enhancing technology which may reduce the need of processing of other personal data like name, address, residence etc.

BIOVISION REPORT (2003)

“Biovision: Roadmap to successful deployments from the user and system integrator perspective” was a project funded by the European Commission in the scope of the fifth framework programme. The project, which aimed to develop a Roadmap for the development of biometrics in Europe, was completed in July 2003 and its final report was published in October. The project identified some human and social elements relevant to biometrics. “Initially, it appears that people have a spontaneously positive attitude towards biometrics” – notes the report – “At a second glance there is a tendency to be skeptical, especially with regard to the privacy issues when using biometrics. The way that users are given assistance during their first contact with a biometric system is key to its acceptance and their willingness to use it in future.”

The report focuses medical implications: “One of the issues that causes concern in the application of biometrics is that there may be a direct or indirect medical risk. As biometrics gains prominence, we anticipate that curiosity or speculation could make potential users question the direct or indirect effects of biometric techniques on their health.” While concerns for direct medical implications (i.e., the impact of biometric systems on users’ health) are largely irrational according to the BIOVISION consortium, concerns for indirect medical implications (the possibility to deduct physical or mental characteristics or conditions from biometrics) deserve to be discussed more in depth. “The scientific basis for the elucidation of certain behavioural traits or physical conditions from biometric signals has begun to be analysed – states the report – with some initial results available on the assessment of anxiety states. Of course, the possible future use of DNA analysis as a biometric (not a feasible option currently) raises potential issues of privacy and indirect medical implication, whilst other proposed techniques that are not strictly biometrics could add to the confusion in the mind of the public at large.”

OECD: Biometric-based technologies (2004)

In 2004 the Organisation for Economic Co-operation and Development (OECD) issued a report on biometric-based technologies, with the aim to discuss security and privacy concerns raised by biometrics. The report enlightens three areas of privacy concern “i) the potential of “function creep” in biometric systems; ii) the risk that these systems may become an infrastructure of surveillance; and iii) that consent and transparency may be optional in certain biometric implementations. The report points also to some weaknesses of biometric systems, which are, however, today partly outdated. The relevance of this document lies indeed in the application of the OECD privacy guidelines and principles, which were formulated in 1980, to biometric technologies. Such an application leads to two main policy points that have durably influenced the international debate:

- 1) the first point regards biometric template physical location. On the basis of privacy and security considerations the OECD document argues that it is (almost) never acceptable to store biometric template in a centralised databank;
- 2) the second point regards the very nature of biometric data. Though in this document there is no explicit statement about the status of biometric data, they are treated as though they were sensitive data and the sole two legislations attached to the OECD document (Ontario Privacy Act, and New Jersey Biometric Privacy Act) both consider biometric data as sensitive.

Report of the Institute for Prospective Technological Studies (2005)

In June 2004, the Committee on Citizens’ Freedoms and Rights, Justice and Home Affairs of the European Parliament (the LIBE Committee) asked the Institute for Prospective Technological Studies to carry out a study on the future impact of biometric technologies (EC-DG JRC-IPTS, 2005). The report considers five areas of possible public concern:

- 1) *privacy* – “One could argue – states the report – that the use of a part of oneself (the biometric feature that is being digitised, stored and compared) as one’s identity is eliminating the space that we traditionally place between our physical selves and our identity. Currently, any individual has the option of changing identity if the need arises (e.g. witness protection programme). This becomes harder or even impossible when identity is tied up with the physical self”;
- 2) *social aspects* – they concern the need to prevent function creep and to address factors such as age, ethnicity, gender, diseases or disabilities (including natural ageing), which could impair usability in certain categories of people. The document point out also the risk that Government control perceived as “too efficient” may lead to an erosion of trust;
- 3) *economic aspects* – under this general heading the IPTS report addresses the issue of “optimal identity”. “The strongest identity protection is not necessarily the optimal one – argues the report – identity errors and abuse may become less frequent, but when they happen, they could potentially be more dangerous”;
- 4) *legal aspects* – they include data protection rules, transparency and privacy. The report warn against risks carried by wider implementation and “about the failure to protect individuals from their inclination to trade their own privacy with what seems to be very low cost convenience”;
- 5) *medical aspects* – also the IPTS report distinguishes between direct and indirect medical implications. Its conclusions do not differ from the conclusions of the BIOVISION report.

National Science and Technology Council Reports (2006)

The NSTC's Subcommittee on Biometrics developed introductory material in the *Biometrics foundation documents* report [28]. In August 2006 the Subcommittee released the Report "Privacy and Biometrics: Building a Conceptual Foundation" [30]. In September the NSTC released the "National Biometrics Challenge Report" [27] and launched the website www.biometrics.gov.

The report *Biometrics foundation documents* [28] gathers introductory documents developed by the NSTC in order to better communicate with all the interested parties. It states facts and discusses related issues in a consistent, understandable manner. The report is a useful tool for the public, the press and the Congress.

The report *Privacy and biometrics: building a conceptual framework* [29] provides a general overview of both privacy and biometrics and offers a perspective through which to view the convergence of both. The paper is organized into three primary sections. The first section presents a general introduction of biometrics and explains the dual use of the term "biometrics", as referring to both physical characteristics and information processing. The second section presents a review of privacy, points to multiple definition of the term "privacy" and highlights the conceptual foundations underlying privacy. The third section brings the two earlier discussion together.

The *national biometrics challenge* report [27] describes the major challenges that must be addressed by the biometrics community. According to the report the use of biometrics is one of the most promising identity management tool. The report serves as a guiding document in the pursuit of technological innovation. The NSTC's subcommittee on biometrics has developed the report taking into account the unique attributes of biometrics, the societal aspects, the advances required for next-generation capabilities and the market forces. The NSTC underlines the need of a synergic work to overcome the challenges: such a work will lead the community to meet evolving operational requirements while being supported by a robust biometrics industry.

The website www.biometrics.gov provides official documents and reference material on biometric technologies.

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GENERAL REMARKS

A sharp debate is emerging over whether biometric technology offers society any significant advantages over conventional forms of identification, and whether it constitutes a threat to privacy and a potential weapon in the hands of authoritarian governments. Given the limitations of current biometric technology, the concerns raised by privacy advocates are probably misplaced, at least for the time being. Other technologies, such as the ability to track the location of mobile phones, will arguably make much more substantial intrusion on privacy over the next few years.

However, in the long term, biometrics, by their very nature, will compromise privacy in a deep fashion. No doubt there will be some benefits but privacy advocates argue that such benefits are not worth the risk. As biometric identification devices become more pervasive, they may compromise privacy in a deep and thorough fashion: they can reveal more about a person than only his identity. Are we ready for this form of being digital? Are we ready to have parts of our body (fingers, eyes, and speech) stored in central databases and traded like commodities by direct marketers, insurance companies, and government agencies?

Many of the ethical and social questions raised by biometrics can be summarised under a main heading: biometrics and human dignity. Ever since the Magna Charta to the Charter of Fundamental rights of the EU, the respect for the body and for dignity have been basic components of the human being and have been fundamental conditions for freedom and equality. Researchers and engineers should base their work on the effort to respect human dignity in any situation. Biometric technology chiefly needs democratic accountability and ethical scrutiny. Democratic accountability starts with a willingness to listen to the voice of the other. Ethical scrutiny begins with care for the other, to relieve and to prevent suffering. This is the lesson taught by traditional bioethics. One should now apply such a lesson to biometric technology. Calm, public discussion of benefits and drawbacks of biometric technology has been lamentably lacking. Such discussion is now mandatory.

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