3.1 Philosophy of Bioinformatics

Logic is the foundation of philosophy. It's also the foundation of Computer Science.

Computer Science

Computer science (or computing science) is the study of the theoretical foundations of information and computation and their implementation and application in computer systems. (http://en.wikipedia.org/wiki/Computer_science)

Philosophy is the discipline concerned with the questions of how one should live (ethics); what sorts of things exist and what are their essential natures (metaphysics); what counts as genuine knowledge and what are the correct principles of reasoning (logic). (http://en.wikipedia.org/wiki/Philosophy)

3.1.1 Computer Science and Philosophy inter dependent

Philosophy is engaged in answering frequently asked questions concerning human existence and the order of being generally.

- Computational philosophy is Application of computational (i.e., algorithmic) solutions to philosophical problems
- Philosophical computation is Application of philosophy to Computer Science
The strategies for making mathematical models for observed phenomena have been evolving since ancient times for e.g., an organism—physical, biological, psychological and social, is observed in different states. A biological organism is a naturally-occurring, self-reproducing device that effects controlled manipulations of matter, energy and information. This observed system is the target of the modeling activity which we call computer.

Figure 3.1: Solution Steps for Techies
Solution for Techies or salvation for Philosophers is the ultimate reality. Reaching this ultimate reality is the final goal for all humans. Salvation for Philosophers may take life time; solution for Bioinformatician will take years.

Computers which were evolved from the logic of philosophy and from the existing science have now become the basic step to reach philosophy of all sciences in the fast and accurate process.

**Solution Steps for Techies**

**Psychology in Computers Science**

The mind is what the brain does; specifically, the brain processes information, and thinking is a kind of computation, is now called the computational theory of mind. Human-computer interaction (HCI) is the area of intersection between psychology and the social sciences, on the one hand, and computer science and technology, on the other. HCI researchers analyse and design-specific user-interface technologies (e.g. three-dimensional pointing devices, interactive video). They study and improve the processes of technology development (e.g. usability evaluation, design rationale). They develop and evaluate new applications of technology (e.g. computer conferencing, software design environments). Through the past two decades, HCI has progressively integrated (Carroll, J.M., et al, 1997). Connect the ethereal world of meaning and intention, the stuff of our mental lives, with a physical hunk of matter like the brain, which is similar to processing of bits of information which have no physical existence but logical. It is argued that the continuing technological improvements being made on computers and their increasingly widespread use in
society is likely to affect behavioral scientists in two ways. First, they themselves will become users of computers. Second, they will be called upon to evaluate and help control how computers impact human behavior (Elwork, A., Gutkin, T.B., et al, 1985)

Physics in Computer Science

Physics is the science of measurement or calculation of events, which is very much required in field of computer science. This science talks about the capacity of a computer or computing speed, at different stress and loads. Mips is one of the metrics which talks about computing speed of the computer. Phase transitions, ubiquitous in condensed matter physics, are encountered in computer science too. The existence of critical phenomena has deep consequences on computational complexity, that is the resolution times of various optimization or decision problems. Concepts and methods borrowed from the statistical physics of disordered and out-of-equilibrium systems shed new light on the dynamical operation of solving algorithms (Biroli, G, et al, 2002). \(O(t)\) is metric which deals with the complexity of the computation of the algorithms, which tells the efficiency of the algorithms or approach of solving the problem, which is the decision factor of the computer scientist in solving the critical problem. It's like light speed calculation for the astronaut

Sociology in Computer Science

Much of computer science is concerned with the design and construction of artifacts like practitioners of many engineering disciplines, computer scientists are always on the look out for new ideas to borrow from other areas. The notion of roles is
common to sociology, organizational management and computer science. Although these disciplines partially converge in the field of computer-supported cooperative work (Jahnke, I. et al, 2005). For practical and commercial reasons, systems need to have a high degree of usability. But it is generally accepted that interfaces should be easy to learn, quick to operate, give rise to low rates of error and be pleasant to use. This is one of the principles of Object Oriented Analysis and design for designing the software interface.

**Mathematics in Computer Science:**

First, the traditional relationship between a science, the mathematics it uses, and the engineering for which it is the basis. Second, the role of mathematics in the practice of software engineering, which is sometimes called "formal methods." And finally, the role of theory in computer science (Hamlet, D. et al, 2001)Computer science has a significant role in the meta-activity associated with programming such as with the design and development of tools and methodologies that facilitate and aid the specification, development, implementation, and analysis of computing systems. The three caricaturing paradigms for computer science include the mathematical, the engineering, and the scientific. The first paradigm takes computer science to be a branch of mathematics, the second takes it to be a scientific discipline, and the last largely as an engineering endeavor that is stripped from any scientific and mathematical underpinnings(Turner, R., Eden, A.H. et al, 2007)
Where is bioinformatics?

Bioinformatics is the meeting point of algorithms and information technology with the biological science, in particular, with the study of gene sequences and related information. Biology in computer science now calling it as Bioinformatics, which can be called as Interdisciplinary science. We argue that large-scale engineering principles can be successfully adapted from disciplines such as software engineering and data management, and that having an in-the-large perspective will be a key advantage in the next phase of bioinformatics development (Parker, D.S et al, 2003). Introduction to bioinformatics must be a joint effort between biologists and computer scientists called as bioinformatics. The ultimate goal of bioinformatics is to develop in silico models that will complement in vitro and in vivo biological experiments (Cohen, J., 2004). The role of the biologist is to identify the processes of replication, transcription, and translation and the relationships among DNA, RNA, and proteins. For world wide biologists to easily implement enormous, complex processes, and effectively share and access computing resources and data, regardless of how heterogeneous the format of the data is and how decentralized and distributed these resources are around the world (Yuan, T., Juan, L., 2005) The initial role of the computer scientist(s) is to explain about the storage of data and the efficient and rapid transfer of these data. Biology is being transformed from a purely lab- or field-based science to a field that includes the use of computers to store and analyze large amounts of information.
Bioinformatics is the application of computer technology to the management of biological information. Computers are used to gather, store, analyze and integrate biological and genetic information which can then be applied to gene-based drug discovery and development. (http://www.bioplanet.com/whatis.html). Bioinformatics applies principles of information sciences and technologies to accomplish a set of practical tasks.

3.2 Ethical concerns of Bioinformatics

The international efforts to determine the human DNA sequence and assess its ethical, legal, and social implications started in 1990. Since then, the data from the project has been available in public databases for researchers and scientists around the world (Abbas, A.E., Holmes, S.P, et al, 2004). Ethical issues affecting Bioinformatics are not as easily recognizable as others. Ethical issues typically arise because of a range of concerns that ultimately have to do with notions such as fairness, autonomy, dignity, and respect for persons. However, identifying other, more specific, ethical issues in this area is not always easy because the computational tools and methods used make it difficult to anticipate the kinds of problems that can arise for research subjects. Unification of ...ethics and [computing/information technology] and genomics awaits sustained discussion, rigorous analysis and clear identification of issues Goodman (1996, p. 223). This hypothesis could be broken down into three sub-hypotheses: (1) Research in biology is undergoing a complete transformation; (2) Research in biology is a cultural practice, which cannot be reduced to a simple
cognitive action; (3) Research in biology is a techno-scientific practice. As for the method, the aim of our research at the Medical Ethics Centre is to elucidate the philosophical and ethical range of biomedical practices. On the one hand, from the revelation of ethical tensions present in these practices, we have to think about what is at stake in these practices, and more broadly in society. On the other hand, we have to analyse the conditions enabling the actors to assume the significance of ethical reflection in their practices (de Bouvet, A., et al., 2006).

In January 1989, the Program Advisory Committee of the Human Genome Project established a working group on ethics to develop plans for an (establishment of an ethical, legal, and social implications) ELSI component. Human Genome Project (HGP), the National Institutes of Health (NIH) and the U.S. Department of Energy (DOE) jointly proposed the ELSI program to guide genomics researchers. The Ethical, Legal, and Social Implications (ELSI) program is an in-house evaluation program for the United States Human Genome Project. Understanding the ethical and moral implications of genetic information and technology is crucial towards ensuring the proper use of genetic data. The ELSI programs have had a positive influence in understanding problematic areas surrounding the HGP by acting as a center for discussion for many bioethicists and scientists (Jin, J., et al., 2000). Organizers of the Human Genome Project (HGP) understood from the beginning that the scientific activities of mapping and sequencing the human genome would raise ethical, legal, and social issues that would require careful attention by scientists, health care professionals, government officials, and the public (Meslin, E.M et al, 1997).
The initial ELSI report, issued jointly by NIH and DOE in 1990, described ELSI function; it also identified objectives for the ELSI Program, some of them are:

1. Anticipate and address social and ethical implications of mapping and sequencing the human genome,
2. Develop policy options to ensure that the information would be used to benefit individuals and society.

The ELSI Research Program has different goals like

1. Privacy and fairness: Examines questions concerning who should have access to genetic information and also focus on ways to prevent the misinterpretation or misuse of genetic information.
2. Clinical issues: Examines on concerns relating to the impact of genetic testing on individuals, families, and society, and ethical issues relating to this.
3. Commercialization: Who should have legal rights to genes and DNA segments? If patented, do DNA sequences limit their accessibility and development into useful products?

The ELSI program plays a major role in Bioinformatics ethics because of its importance role in feature fate of genetics information, unlike other personal, including medical, data because that data provides information not only about an individual from whom a sample is taken, but also about related individuals.


3.2.1 Human Genome Project

The Human Genome Project has become a reality. Building on a debate that dates back to 1985, several genome projects are now in full stride around the world, and more are likely to form in the next several years. Italy began its genome program in 1987, and the United Kingdom and U.S.S.R in 1988. The European communities mounted several genome projects on yeast, bacteria, Drosophila, and Arabidopsis thaliana (a rapidly growing plant with a small genome) in 1988, and in 1990 commenced a new 2-year program on the human genome (Watson, J.D., Cook-Deegan, R.M., et al, 1991). The application of genetic understanding to practical applications raises ethical, medical and legal issues central to the Genome Project. Unfortunately, emotion and sensationalism sometimes dominate and prevent a constructive discussion of ethical and social issues pertaining to genetics. To answer public concerns about human gene transfer experiments, the medical and biotechnology communities must constructively discuss the medical realities, the benefits to human health and the adequacy of the current governmental oversights (Mackler, B.F., Barach, M., et al, 1991). Any useful attempt to resolve the moral problems that may arise because of the new information that is generated by the Human Genome Project requires an explicit, clear, and comprehensive account of morality. Since some of the problems that will be generated by the Human Genome Project seem to be so different from the kinds of moral problems we normally
confront, it is likely that many people will find it difficult to apply their intuitive understanding of morality to these problems. The Human Genome Diversity Project raises political, economic and ethical issues. These intersect clearly when the genomes under study are those of indigenous peoples who are already subject to serious economic, legal and/or social disadvantage and discrimination. The fact that some individuals associated with the project have made dismissive comments about indigenous peoples has confused rather than illuminated the deeper issues involved, as well as causing much antagonism among indigenous peoples (Dodson, M., Williamson, R., et al, 1999) Human Genome Project does not provide a unique solution to every moral problem, but it always provides a way of distinguishing between morally acceptable answers and morally unacceptable answers.

The electronic storage of Human Genome Project information replicates a tension already familiar in health informatics: the tension between

(1) The need for authorized access to personal information.

(2) The need to prevent inappropriate or unauthorized access.

3.2.2 Genetics and Computer Science

Computer science is important for the new genetics on two levels: (1) from a theoretical perspective, and (2) from the point of view of geneticists practice (Marturano, A., Chadwick, R., et al, 2004). Moor (p. 257) remarks: "Watson and Crick described a simple arrangement of simple components following simple rules that captured a mechanism, a biological computer, which can generate incredible diversity
and complexity." Also tells that the "sequence of nucleotides can be regarded as a kind of computer program for constructing an organism.

Our claim is that there is no new genetics without computer science. Marturano and Chadwick (p. 43) note that "information" is a "fundamental concept" that is shared both by computer science and genetics. And Manuel Castells (2001, p. 164) points out that geneticists focus on "decoding" and eventually "reprogramming". Without computer science there is no new genetics (Marturano and Chadwick (p. 43)).

3.3 Ethical values, Legal, and Social Challenges

Researchers face 3 challenges in writing about race and ethnicity: accounting for the limitations of race/ethnicity data; distinguishing between race/ethnicity as a risk. Use of race and ethnicity terms in genetic research continues to generate controversy. Despite differing opinions about their basis or relevance, there is some agreement that investigators using these terms should: explain why the terms or categories were used, define them carefully, and apply them consistently (Sankar, P et al, 2007). Significant race and ethnic disparities exist in diabetes-related health care. Using a nationally representative database, we sought to determine if use of thiazolidinediones (TZDs) differs by race and ethnicity (Aquilante, C.L et al., 2007). The challenges of meeting this request included the sociological and ethical issues associated with research in First Nations communities, as well as the pragmatic issues of conducting complex research in remote communities. Three separate visits were undertaken to respect the cultural dynamics and capacity of the community to
accommodate a project of this magnitude. The process began with dialogue, listening and presentations to the community. Only then began the planning of logistics and application for funding. Next, the team visited the communities to ensure understanding of exactly what was involved for the community, each child and family, and to be certain that consent was fully informed. For the diabetes screening visit, special arrangements including chartering a Beaver float plane were needed for the transport of the five-member team with all the necessary equipment, including a -20°C freezer to safeguard the integrity of blood samples. (Panagiotopoulos, C, et al, 2007)

The use of an individual's race and ethnicity has been a very controversial issue as a result of the inappropriate use of genetic information to discriminate against individuals in the past. Today, we have challenge to explore the relationship between race and genetics in a socially unequal environment. These risks present themselves not only to individuals with known risk-conferring polymorphisms, but also to broader ethnic groups. All members of an ethnic group may suffer discrimination, stigmatization, or self-stigmatization because of an association between that group and a genetic pre-disposition to a disease. A crucial issue for health researchers is how to measure health and health-related behaviors across racial/ethnic groups. This commentary outlines an approach that involves the deconstruction of race/ethnicity, which clarifies the independent influences of acculturation, quality of education, socioeconomic class, and racial socialization on outcomes of interest (Manly, J.J., et al, 2006). There are unique bioethical challenges and dilemmas. New treatment
strategies should be regulated appropriately to minimize risks to patients, their relatives and the wider community (Ellison, T., et al, 2006).

Although nineteenth-century classifications of the major "races" are not biologically accurate, there is some basis for epidemiologic stratification by ethnicity because we live in social communities with ethnic identifiers. Recently, studies on large diverse populations have described important ethnic/racial differences in venous thromboembolism incidence, and sex has been reported as an important predictor of recurrence. (Keenan, C.R., White, R.H., et al, 2007) However, given the legacy of oppression and the ongoing social injustices encountered by some members of historically disadvantaged groups, there remains the potential for hardening of social categories and discrimination on the basis of socially constructed racial groupings.

3.4 The right to privacy

The right to privacy contains different dimensions. Best known are the possibility to restrict the flow of personal information to others (limited access by others) and the right not to know certain information gathered about oneself. Since the privacy right is mean to protect the identity, self-image and personal life of the person, he should also have the right to know certain facts about himself (Pennings, G., et al, 2001). The right to privacy is a normative claim about protection from the intrusion of others. Privacy, then, is a concern that arises from social interactions. The right to privacy contains different dimensions. Best known are the possibility to restrict the flow of personal information to others (limited access by others) and the right not to
know certain information gathered about oneself. Since the privacy right is mean to protect the identity, self-image and personal life of the person, he should also have the right to know certain facts about himself (Pennings G., et al, 2001). When we seek a right to privacy we seek protection from the intrusion of others. Privacy is a kind of shield that protects individuals from the harmful demands and idiosyncrasies of other members of society and in some cases protects other members of society from individuals. The concept of privacy as a basic human right which has to be protected by law is a recently adopted concept in Thailand, as the protection of human rights was only legally recognized by the National Human Rights Act in 1999 (Kitiyadisai K., et al, 2005). Hence, privacy is a concept whose content may evolve over time and will be determined in part by the details of the structure of that society including political and technological features of the society's environment.

The concept of privacy has become informationally enriched by the explosive growth and use of computer technology (Moor., et al, 1998). Flexible access rights allow a customer to choose a subset of items or groups of items from the repository, obtain access to and be charged only for the items selected. And portability of access rights means that the rights themselves can be stored on small devices of limited storage space and computational capabilities such as smartcards or sensors, and therefore the rights must be enforced using the limited resources available.( Blanton, M., Atallah, M., et al, 2006)

The theory of privacy I wish to advocate is the control/restricted access theory (Moor, 1997). Recent advances in computer technology permit the accumulation,
analysis, and storage of an unlimited quantity of medical record information, thereby seriously compounding existing controversies surrounding patient confidentiality and privacy (Hiller, M.D., Beyda, V., et al, 1981). Computers can help medical researchers who use bots (agent programs) that can search out and compare data from medical records without revealing identities of patients to anyone (Moor, et al, 1989).

3.5 Strong Protection for Genetic Privacy

While the proliferation of human genetic information promises to achieve many public benefits, the acquisition, use, retention, and disclosure of genetic data threatens individual liberties. States (and to a lesser degree, the federal government) have responded to the anticipated and actual threats of privacy invasion and discrimination by enacting several types of genetic-specific legislation (Gostin, L.O., Hodge, J.G., et al, 1999). Genetic information provides insights into who we are, where we came from, and where we are going. Obviously, genetics does not provide the whole story but it does lay out some significant features of the story of each of our lives. Beliefs in genetic determinacy explain some of the heightened concern about genetic privacy. Discussion of the debate over genetic testing within families illustrates the most recent response to genetic privacy concerns (Sankar P. et al, 2003). Thus, genetic information is particularly sensitive information and potentially damaging. Using computers to protect privacy would also give us the power to elevate the security of genetic records if it were so desired. Suggest three alternative public policy approaches to the problem of protecting individual privacy and also preserving
databases for genetic research: (1) governmental guidelines and centralized databases, (2) corporate self-regulation, and (3) my hybrid approach (DeCew J.W et al, 2004).

Legislation and other policy-making should target the needs of persons with all conditions and not focus exclusively on genetic discrimination, given that experiences and concerns generally do not differ based on the genetic etiology of the condition (Kass, N.E., et al, 2004). A patient shows symptoms of some disease and genetic testing is done on the patient to confirm or disconfirm the genetic basis for the disease in that patient. But, some genetic testing is predictive. An example of such a predictive test is the genetic test for Alzheimer’s disease. Alzheimer’s disease appears later in life, usually in middle age, and produces devastating neural degeneration. The illness is inexorably progressive. Patients lose the mental abilities to care for themselves and eventually severe dementia occurs. There is no known treatment and the suffering of the patient and the patient's family and friends can be traumatic. The advent of genetics and genetic testing has given rise to unique problems for the family. The discovery of a predisposition to a genetic condition in one individual also reveals information about the genetic make-up and potential risks of family members. There is, therefore, potential for conflict over access to and control of such information (Laurie, G.T., et al, 1996) The new knowledge (and predictions) created by DNA tests and the family nature of genetic information has already led to a new problem: the intra-familiar communication of genetic data. This raises questions such as the following. Is there a duty to inform in cases when treatment is possible and the patient does not permit disclosure of genetic results to relatives? Is there an obligation to warn
or merely an authorization (that could be used or not)? Could privacy protection be maintained as an individual interest but with some justified violations? A balance needs to be established between the interest of privacy and the need to disclose secret information (Moniz, H., et al, 2004).

In the context of medical information, the possibilities of exploiting, aggregating, or misusing genetic testing results, prescription records, drug test data, mental health records, information on pregnancy, and results from tests for sexually transmitted diseases and HIV status, to name just a few, make it obvious how important it is to preserve the protection that privacy affords individuals. If they fail to provide additional protections against discrimination for most people, their most significant impact may be in their ability to either diminish or enhance the power of genetic information and to influence the way individuals view themselves and others (Everett, M., et al, 2004).

Strong genetic privacy laws are needed to counterbalance this, not to stop the research, but to keep it within ethical boundaries.

3.6 Genetic Information Proprietary Rights

Rights, autonomy, privacy, and confidentiality are concepts commonly used in discussions concerning genetic information. When these concepts are thought of as denoting absolute norms and values which cannot be overridden by other considerations, conflicts among them naturally occur (Häyry, M., Takala, T, et al, 2001). This issue has new salience thanks to the Human Genome Project and "bio-
prospecting" initiatives based on the aggregation of genetic information, such as the one being managed by deCODE Genetics in Iceland. The rationale for ownership is twofold: ownership will protect the basic human rights of privacy and autonomy and it will enable the data subjects to share in the tangible benefits of the genetic research (Spinello, R.A., et al, 2004). The mapping of the genome and the advent of genetic testing have triggered a plethora of perplexing ethical conundrums. The most prominent of these involve the interconnected issues of privacy and the ownership of one's "genetic information." That information is broadly defined as information about genes, but the information contained in the DNA molecule itself is more sensitive because it contains an individual's probabilistic 'future diary,' is written in a code that has only partially been broken, and contains information about an individual's parents, siblings, and children (Annas, G.J, et al, 1993). A DNA sample refers to any human biological specimen such as human tissue or blood from which DNA can be extracted. Genetic information includes information about any individual's genetic test results or genetically linked diseases.

Genetic screening has opened up new paths for progress in preventive and curative medicine, and will probably progressively increase its positive contribution in the future. Rules and regulations have been established attempting to protect the donors' rights and to avoid damage to the donor and to others. Present day regulations seem unable to prevent the occurrence of serious problems and possible dangers as per Bruns, G., Wolman, M., et al, 2000.
These are:

1. Ownership of genetic information and right to determine to whom it is divulged.
2. Direct emotional damage to individuals (mainly young persons expecting late-onset catastrophes) by having the information.
3. Damage caused by unsought for findings.
4. Restriction of transfer of information to the stated aim.
5. Right to release information important for public safety

The expansive version of the property argument is that ownership rights should be conferred on genetic source material including the human tissue sample and any information about the genes derived there from. There are narrower versions of this argument but in general what we are talking about is the proprietary "rights of sources."

The major rationale for providing these rights is the protection of privacy. Obviously, if this information becomes too widely available or falls into the wrong hands, one's privacy rights are put in the gravest peril. While some maintain that genetic information (in the form of test results) is just an additional component of a person's overall medical record, others support the position of "genetic exceptionalism," that is, "genetic information is sufficiently different from other kinds of health-related information that it needs special protection. Currently, there are no specific federal laws regulating the dissemination of this information, despite the fact that genetic testing (that is, testing of DNA to ascertain an individual's predisposition
to a genetic illness or impairment) is becoming more widespread. Genetic information is unique in that it doesn't just reveal one's present condition but also future probabilities and predispositions to certain ailments. One's DNA is analogous to a "diary" of a person's future medical conditions. Therefore, unlike other forms of data, it is subject to broad and subjective interpretation, opening up considerable room for bias and manipulation.

Clearly, an individual's private genetic information when combined with other data or the genetic information of other people can be an extremely valuable research tool. There is well-founded apprehension that an overemphasis on privacy and data protection might preclude or interfere with such research.

Patenting is used for a type of industrial property, which is protected primarily to stimulate the innovation, design and creation of the technology. The social purpose is to provide protection for the results of investment in the development of new technology, thus giving the incentive and means to finance research and development activities. The main social purpose of protection of copyright and related rights is to encourage and reward creative work. The NIH to patent the human genome to prevent private entrepreneurs, and especially foreign capital, from controlling what has been created with American funding (Lewontin, et al, 1991: p. 75). The most appealing feature of the Open Source philosophy for Bioinformatics is the fact that it is possible to create a research network based on the model that the source code can be given away and other researchers can fix and improve that software. Open Source projects also tend to have much stronger communities. The entire premise is one based on
sharing and the enjoyment of creation for the good of the community (Torvalds, et al, 2001).

3.7 Utilizing Genetic Information @ Valuing the Privacy

In the last half of the twentieth century two technologies that potentially threaten privacy have developed dramatically—genetics and computing. These informational technologies are closely connected. When combined with medical information, large electronic databases of information that identify individuals provide superlative resources for genetic, epidemiology and other biomedical research. Such research resources increasingly need to balance the protection of privacy and confidentiality with the promotion of research. Models that do not allow the use of such individual-identifying information constrain research; models that involve commercial interests raise concerns about what type of access is acceptable. Researchers, individuals representing the public interest and those developing regulatory guidelines must be involved in an ongoing dialogue to identify practical models (Wylie, J.E., Mineau, G.P., et al, 2003). It is, for example, only through the "eyes" of computers that we can hope to map and sequence the human genome in a practical period of time. Our understanding of the details of genetics is becoming increasingly important when providing the best medical recommendations and treatment. And yet, this genetic information, which is so helpful to the medical practitioner and to the epidemiological researcher, is a significant threat to the privacy and security of individuals. The rapid advance of technology has permitted the
creation of vast amounts of information, both on and off the Internet. The public is only just beginning to realize how this information, especially personal information, may be used in ways that may not be acceptable. Laws across different countries are often conflicting, making it difficult to control how personal information is being used and how individual privacy is being violated. The solution to this problem lies somewhere between government, industry, and the individual (Kruck, S.E et al, 2002).

Computing plays an important role in genetics (and vice versa). Theoretically, computing provides a conceptual model for the function and malfunction of our genetic machinery. Practically, contemporary computers and robots equipped with advanced algorithms make the revelation of the complete human genome imminent—computers are about to reveal our genetic souls for the first time. Ethically, computers help protect privacy by restricting access in sophisticated ways to genetic information (Moor, J.H., et al, 1999). Not all personal information is equally sensitive and some personal information should be treated with more care and protection than the rest. Genetic information concerning particular individuals demands special protection.

All of us, especially those involved in medical information gathering, have an obligation to act quickly to place enforceable safeguards around genetic information so that, as the store of genetic information and understanding of it grows, individuals are not placed in harm’s way. Electronic medical record keeping can be designed and adjusted to enhance individual privacy. Ensuring that our society continues to protect both patient privacy and individual rights in the pursuit of the computer-based patient...
record requires that we also recognize the potential threats of the emerging systems and technology (Patrikas E.O., 1996).

3.8. Responding to the Challenges

Recent ethical and legal challenges have arisen concerning the rights of individuals over their IVF embryos, leading to questions about how, when the wishes of parents regarding their embryos conflict, such situations ought to be resolved. A notion commonly invoked in relation to frozen embryo disputes is that of reproductive rights: a right to have (or not to have) children. This has sometimes been interpreted to mean a right to have, or not to have, one's own genetic children (Chan, S., Quigley, M., et al, 2007).

In the same way, the number of older people using emergency care is increasing steadily and older people account for over half of all emergency admissions. In the emergency setting, nurses caring for older people with Alzheimer's disease can be faced with many complex ethical and legal challenges. Moreover, challenges such as the use of physical restraint can precipitate conflict when the nurse is placed in the precarious position of doing good, respecting autonomy and avoiding paternalism (McBrien, B., et al, 2007). Cancer also falls under this category, as a result of the increasing effectiveness of cancer screening and preventive interventions, ethical issues, as well as legal liabilities, are increasingly associated with cancer genetic testing. These issues include the possible "duty to warn" relatives of inherited cancer risk, the appropriateness of testing of children and embryos, equity of access to genetics services, and potential harms of testing including the risk of genetic
discrimination. An approach to these and other ethical challenges will be presented, drawing not only on recent case law but also on a broader bioethical framework (Offit, K., Thom, P.et al, 2007). Caring for dying patients appears to be one of the most difficult challenges in modern medicine. Apart from respective medical standards, such care is influenced by legal stipulations, economic resources, societal values, and ethical principles (Michalsen, A., et al, 2007).

Anton Vedder (2004) introduced a conceptual scheme that explicitly addresses the problem of group confidentiality, proposes a new level of privacy protection that he calls categorial privacy.

<table>
<thead>
<tr>
<th>Individual Privacy</th>
<th>Categorical Privacy</th>
<th>Collective Privacy</th>
</tr>
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<tbody>
<tr>
<td>Applies to personal data, but not after that data has been aggregated</td>
<td>Applies to personal data in the aggregate, even after it has been abstracted and processed</td>
<td>Applies to data about the group (of individuals, but not to personal data perse).</td>
</tr>
<tr>
<td>Protects individuals as personally identifiable individuals, but cannot be extended to protect individuals as members of groups</td>
<td>Protects individuals in groups, even when individuals do not know that they have been assigned to a certain group—e.g., a group generated from nondistributional profiles</td>
<td>Protects groups per se, but only groups that are already known to exist.</td>
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Table 3.1 illustrates some essential characteristics that differentiate Vedder's three categories of privacy.
**Appropriate Uses and Users**

Ubiquitous computing environments embedding a wide range of pervasive computing technologies provide a challenging and exciting new domain for information access. Individuals working in these environments are increasingly permanently connected to rich information resources (Jones, G.J.F., 2005). Questions concerning who should use clinical information systems and in what contexts have been shown to raise interesting and important ethical issues and, indeed, many of these have been recognized for decades (Miller, Schaffner and Meisel., et al, 1985); For instance, suppose a physician or nurse begins including genetic data in patient charts, uses those data to predict the likelihood of clinical manifestations and correlations, and then employs those analyses to refer patients to genetic counselors. Or suppose that individuals' genetic data were being collected by governments, managed care organizations or other third-party payers with the goal of shaping or adjusting risk pools or coverage eligibility.

**3.9 Opportunities and Challenges – Information Access and Retrieval**

Electronic publishing is considered as the systematic open communication of information and ideas through recognized channels in such a way as to permit retention and archiving for future use. An attempt is made to assess the challenges and opportunities provided by electronic publishing and its possible impact on the various members of the information community, ranging from authors to end-users (Anon, et
As the volume of data and knowledge grows it is becoming critical to biologists that they be able to access and retrieve the relevant pieces when they need it. The electronic publication of research reports and books has facilitated both the dissemination and the retrieval of scientific information. Electronic archives of speech and language corpora, too, stimulate research efforts. Although technology provides many opportunities, there remain significant challenges. Establishment and maintenance of scientific archives is largely dependent upon volunteer efforts, and there are few standards to ensure long-term access. Coordinated efforts and peer review are necessary to ensure utility and quality (Powell, T.W et al, 2003). Questions concerning ethics and how an individual can act ethically when confronted with issues related to libraries, archives, and, more broadly, information have ever been present in our professional lives whenever individuals considered their own principles and actions as related to creating, organizing, managing, using, disseminating, preserving, and providing access to information and documents in all forms (Carbo, T., Almagno, S., et al, 2001).

Current developments on Service-oriented Architectures, Peer-to-Peer and Grid computing promise more open and flexible architectures for digital libraries. They will open the Digital Library (DL) technology to a wider clientele, allow faster adaptability and enable the usage of federative models on content and service provision. These technologies raise new challenges for the realization of DL functionalities, which are rooted in the increased heterogeneity of content, services and metadata, in the higher degree of distribution and dynamics, as well as in the omission of a central control instance (Knežević, P, et al, 2005). There are different
factors that bother, The first factor is that the sheer volume of new information is such that systematically keeping up is no longer a viable option. The second and related factor is that with the growth in new information has come a growth in the number of places in which information is published. The third factor is that information is becoming more and more available in electronic form and no longer just in condensed form in journals, resulting in a proliferation of biological databases, knowledge bases, and tools. New emerging technologies like GIS based on Internet as a promising research field brings new opportunities and challenges to geographic information accessing, sharing and disseminating. However, the inherent limitation of current Internet GIS architecture based on connection makes it incompetent to fulfill various requirements of GIS applications under dynamic, complicated and distributed computing environment such as the Mobile Internet (An, Y., Guan, J., Zhao, B. et al, 2004). Simply trying to find the right resource for a particular task from among hundreds is a challenge to say nothing of finding the right information within that resource. Given the volume of data and the fact that it exists as a combination of data in databases and free text, an important part of information access and retrieval has been both data integration and data mining. Intelligent parsing of queries, frequently involving natural language processing of both queries and sources, is becoming a key component of information access and retrieval.
3.9 Ethical Issues challenging Science and Technology

They can be classified into almost 30 different areas, ranging from the use of gene therapy for human beings, enzyme engineering, stem cells and cloning, to marine biotechnology, bioinformatics, nanotechnology and biological warfare among many others. Many of them have major sociopolitico-economic, moral, ethical and legal implications. They include genetic engineering, gene therapy, tissue culture, stem cell work, the new DNA technologies, commercialization of traditional plant-based drug formulations, assisted reproduction techniques, cloning technologies, organ transplantation, bioinformatics, and biological weapons (Bhargava, P.M., et al, 2003).

As science and technology in genetics continue to expand, complex ethical questions arise that require difficult decisions for all concerned. Rather than having ready-made answers, there may be only more challenging questions for patients, families, and healthcare professionals. These complicated questions may have no straightforward, correct answers, thus creating an ethical quandary (Erlen, J.A., et al, 2006). Considering the ethical and legal implications of one of the newest and most controversial medical breakthroughs. Stem cell research has been performed on mice for many years, but human embryonic stem cells are believed by scientists to be the basis for possible treatments and/or cures to many diseases affecting millions of people around the world. In order to perform research on human embryonic stem cells, numerous ethical issues must be addressed. Guidelines and protocols can be established in order to allow scientists to pursue new medical advances while maintaining the highest ethical
standards in the use of human embryos. An alternative to using embryos is adult stem cells which have recently proven to be more versatile than previously believed. Opposing views will always be encountered when facing new science technologies. Where should the ethical line be drawn? (Trepagnier, D.M., et al, 2000). Recent advances in the fields of genomics and bioinformatics are making accurate and precise screening for these conditions a reality. Government policymakers will soon be faced with decisions regarding whether or not to sanction the use of these newly-developed genetic tests in the immigration application procedure. The terror threat currently facing the United States may ultimately bolster the argument in favor of genetic testing and/or DNA collection of applicants. However, the possibility of a government mandate requiring genetic testing raises a host of ethical issues; including the threat of eugenics and privacy concerns. Genetic testing has the ability to uncover a wealth of sensitive medical information about an individual and currently there are no medical information privacy protections afforded to immigration applicants (Burroughs, A.M., et al, 2005). The ongoing evolution of genomics and bioinformatics has an overwhelming impact on medical and clinical research, albeit this development is often marked by genuine controversies as well as lack of scientific clarities and acumen. The search for disease genes and the gene-environment interaction has drawn considerable interdisciplinary scientific attention: environmental health, clinical and medical sciences, biological as well as computational and statistical sciences are most noteworthy. Statistical reasoning (quantitative modeling and analysis perspectives) has a focal stand in this respect while data mining resolutions are far from being
scientifically fully understood or interpretable. (Sen, P.K., et al, 2008). Scientific societies can have a powerful influence on the professional lives of scientists. Using this influence, they have a responsibility to make long-term commitments and investments in promoting integrity in publication, just as in other areas of research ethic (Caelleigh, A.S. et al, 2003). Scientists should have the responsibility of judging what is best for the society. All should ensure that research they participate in is ethically conducted. Scientific misconduct is defined as any practice that deviates from those accepted by the scientific community and ultimately damages the integrity of the society where science may end without serving the humanity.
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