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MEDICAL COMPUTING: ANOTHER BASIC SCIENCE?

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Abstract

Medical computing is frequently viewed as the application of established computer science techniques in medical domains. However, it is the thesis of this paper that many clinical computing tasks demand techniques that are as yet undeveloped. As a result, medical computing research should logically be closely tied to basic research in computer science. Failure to recognize that this developing discipline often requires fundamental investigation has tended to foster unrealistic expectations of the field.

1 Introduction

In 1977 Allan Levy cited the need for increased recognition that informatics is a basic medical science [3]. He supported his argument by outlining both the field's scope of relevance and the basic subdisciplines of which it is comprised (computer science, systems analysis, health care organization, and biology/physiology). He then noted:

> "We have commented that the accomplishments of informatics have not been at a level of stability and maturity as might have been expected. We now suggest that among the reasons for this has been the lack of a valid perception of informatics as a basic medical science. Physicians and other senior health professionals have tended to ignore the substantive aspects of the discipline, relegating it to the 'computer expert.' ... The alternate we propose is the common solution to the more effective utilization of any scientific discipline: teach it."

I support Levy's proposal, but would like to carry it a few steps farther. Increased exposure to formal medical computing training is clearly important for both physicians and medical students, but the key issues are the content and purposes of that training. Advanced degrees in medical information sciences are one important aspect of the field's educational effort [6]; we obviously need more individuals who can bridge the diverse fields of medicine and computer science. Many observers have noted that poor communication among workers from the two areas of expertise has tended to limit the design (and ultimately the utility) of some of the medical computing systems developed over the last two decades.

However, most physicians and health professionals will never be involved in the development of computer systems; they will, rather, be offered computer-based tools to assist them in their jobs. The educational needs of these individuals are very different from those of the future medical computing researcher. They can be largely summarized by noting that the emphasis should be on building realistic expectations and informed attitudes towards computers rather than formal expertise. Several studies [4],[5],[7] have analyzed the opinions of health personnel regarding computers, but they have generally not studied the underlying reasons for negative attitudes. It is my contention that one cause for opposition or doubts regarding medical computing efforts is the failure to recognize the basic science components of the field. The remainder of this paper will focus on this issue.

2 Key Problems Resulting From Mistaken Perceptions

I shall not dwell on the psychological barriers to computer implementation which have plagued applications research, both in medicine and in other fields. Issues of ego threat, fears of job security, and human engineering of the terminal interface have all been discussed widely in the medical computing literature [1],[2]. I do believe, however, that improved user education could have a beneficial impact on physician attitudes by encouraging appreciation of the state-of-the-art and of the motives of medical computing researchers.

There are at least two key problems that result from mistaken perceptions regarding the scientific content of medical computing research:

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(1) The field of medical computing has been a victim of overly optimistic predictions and unrealistic expectations. For example, estimation of the time required to complete a project is often based on oversimplified assumptions. Medical environments are typically complex, and constrained by the diversity of personnel involved as well as by the unpredictability of patient care patterns; innovation seldom proceeds quickly or smoothly in such settings. Similarly, medical collaborators involved in a system's development may anticipate a level of performance that is not realistic in light of currently available computing techniques. It is not uncommon for system builders to be asked "Can't you just program the computer to handle that?", only to recognize that the effort would warrant a computer science Ph.D. if it were accomplished.

(2) There is a tendency to fail to distinguish state-of-the-art applications from ones that are fundamental research efforts. We are becoming increasingly aware that medicine provides a fertile arena for pushing the frontiers of computer science; many problems that could be avoided in other domains are forced to the forefront when large-scale systems and reliable dependable performance are required (as is the case when issues of patient well-being, privacy, and the varied demands of busy health care providers are involved). The potential payoffs are great, but the solutions often far from obvious. However, regardless of the basic medical computing insights that may develop in the setting of a research project, there is at present a tendency to assess the work on the basis of its short-term clinical utility. This viewpoint may fail to recognize creative foundations for the science of medical computing as it grows over the years ahead. It may also limit the availability of support for fundamental research efforts that are aimed at long-term performance goals. If there is improved recognition that clinical computing is a basic medical science, on the other hand, research efforts will more consistently be assessed by examining their scientific merits rather than simply noting whether the work has produced a "finished product."

3 Medical Computing In Perspective

Observers of medical computing sometimes forget the relative youth of the field. Research in this area is less than a quarter century old, and indeed Computer Science itself has only recently joined the faculties at many of our universities. It is folly to attempt to predict what the field will produce in the future, particularly at a time when hardware advances are revolutionizing many of the basic assumptions that have constrained software design during the last two decades. Imagine if early radiologists in 1920, 25 years after Roentgen's discovery of x-rays, had tried to predict the technological advances in their field over the next 60 years -- the clarity of images that would one day be achieved, computerized tomography, or the rise of ultrasound and nuclear medicine techniques. Similarly, basic computing research, some of it specifically arising from work in medical domains, will change many of our approaches to clinical systems development. It is logical to recognize the need for ongoing basic medical computing research, and to encourage its support, in the conviction that the field will in time produce tools that can effectively be applied to clinical tasks that are currently resistant to computing innovation.

4 A Perspective On The 80's

As we look ahead to the next decade of medical computer science, it is clear that the field is maturing into an established discipline. The evidence for this assumption is abundant: (1) schools of medical information sciences are growing in number and reputation, (2) increasing numbers of researchers with formal training in both medicine and computer science are participating in investigative work, (3) the formal degree programs are resulting in innovative high quality research on the part of PhD candidates, (4) the federal government, particularly the National Library of Medicine, is supporting education in the field through training grants, and (5) there is a growing interest in computing among practitioners, as witnessed by the recent flurry of courses offered regarding office computing. Similarly, the continued growth of this annual Symposium on Computer Applications in Medical Care over its four year history is a tribute both to the quality of the meeting and to the groundswell of interest in the field of medical computer science.

In order to meet the challenges of the decade ahead, however, we must look for ways to improve the general understanding of the field's diversity along the lines I have discussed in the previous sections. The following points may provide some useful guidelines:

(1) There should be more specific recognition and open identification of the basic research components of ongoing research projects. This means a solid analysis of the task domain when research is proposed and a thoughtful assessment of which components of the task, if any, cannot be easily handled by state-of-the-art techniques. Research proposals must make it clear which parts of a project will require innovative techniques and are therefore potential stumbling blocks in the smooth progression of a project.

(2) As a corollary to the first point,

applications work requires scrupulous attention to task selection and interface specification if finished, accepted products are desired in the short-term. Certainly there are many clinical applications for which currently available techniques are adequate, but these tasks may require modulation of short-term performance expectations.

(3) We need to be cautious in our predictions of the future. Reasoned estimates will always be necessary in research work, but it is generally better to surprise people than to fail to fulfill highly touted expectations.

(4) There is a need for well designed continuing education courses for health personnel. Such courses must provide realistic appraisals of the field, including frank characterization of the current limitations, specification of the research problems currently under attack, and cautious optimism about the future of medical computing and its considerable promise for solving many of the serious problems in modern health care delivery and organization. Wasserman has provided a pertinent list of important problems for medical computer science [6]; many of these can be conveyed to any health professional and need not be saved for degree candidates in formal medical information science programs.

(5) Finally, we must encourage a heightened awareness (perhaps through simple repetition of the point) that there is a major basic research component to medical computing and that the promise of the field largely rests on support for fundamental research and realistic expectations regarding the rate at which progress can be anticipated.

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