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Synopsis

Networks: The "Fabric of Life" for Informatics Applications

The power of computer networks is pervasive and the influence they exert on our profession is immense. The seven articles selected for this section of the 1998 Yearbook of Informatics all share the network in some respect, yet are disparate and thus are challenging to coherently introduce to the reader. Perhaps the dissimilarity of these articles is the message that I should emphasize the most, because it reinforces the ubiquitous nature of our networks. Whether we refer to our networks as the Internet, an intranet, or the World Wide Web, the impact they have on the conception and evolution of informatics practice is readily apparent.

Our computer networks are now sufficiently mature that the spectrum of activities we engage in over these networks mirrors the spectrum of activities that comprise informatics practice. I argue that these articles are a representative cross-section of informatics practice which can be broadly categorized into three areas:

1. accumulation of knowledge,
2. delivery of information, and
3. evaluation of benefit.

Although it is possible to accumulate knowledge, deliver information, and evaluate benefit without utilizing networks or computers, it seems foolish to do so. The ubiquity of the network has created such a powerful positive feedback cycle with potential for standards-based synergistic interactions that to do anything other than to base our practice firmly on the network, and make it the "fabric of life" for the evolution of our informatics applications warrants close scrutiny. The articles presented in this section have done so. As the rest of our profession follows their lead, the notion of categorizing articles by the novel idea that they all use the network will vanish, and instead they will be categorized into sections that are some variation of the three broad categories I previously mentioned.

1. Cooperative Accumulation of Knowledge

Winograd and Flores point out the central role that language plays in creating domains in which we act [1]. For informatics, we endeavor to structure these domains into what Winograd and Flores would call *systematic domains*-structured formal representations that provide precise and unambiguous descriptions of tasks and form the basis for tools that aid in communication and the cooperative accumulation of knowledge. The first three articles I summarize have each created systematic domains that use computer networks as their substrate, albeit for different aspects of informatics practice.

1.1 The Digital Anatomist Distributed Framework and its Applications to Knowledge-based Medical Imaging

Brinkley and Rosse recognize the power of using the network as a substrate for evolutionary development of knowledge-based anatomic applications and for the accumulation of anatomic knowledge [2]. As such they have founded their Digital Anatomist distributed framework upon the network. They assume that independently developed applications can evolve to synergistically work together to solve problems larger than the applications could independently solve on their own, and they are seeking to foster interaction with other groups through the internet who have a need for access to structured anatomic information.

The Digital Anatomist project has four information resources that it makes available over the network: A spatial database which consists of one to four dimensional structural information, a spatial knowledge base which consists of spatial models that describe classes of anatomic objects as well as the relationship between those objects, a symbolic database that contains non-spatial data about images and other items that are part of the Digital Anatomist framework, and a symbolic knowledge base that consists of symbolic representations of the physical and conceptual entities that comprise anatomy.

Brinkley and Rosse describe each of these components of the Digital Anatomist framework. Internet-based clients are used to update and access an expanding set of anatomical information resources. The authors describe example applications which have successfully used the Digital Anatomist information resources, present evaluations of the different components, and describe the direction they envision for the ongoing and collaborative work.

1.2 The Biological Toolbox: A Computer Program for Simulating Basic Biological and Pathological Processes

Vawer and Rashbass have created a program they call the "biological toolbox" which enables pathologists and biologists with minimal computer experience to design complex models of cell interactions [3]. They recognized that mathematical approaches have successfully modeled biological processes such as wound healing, but these approaches are limited in that the answers are in the form of equations which are unapproachable by the majority of biologists. To make mathematical modeling approachable, they have created the biological toolbox which serves as a "crane" [4] in the accumulation of knowledge. Just as a crane enables taller buildings to be constructed than would be the case without the help of the crane, the biological toolbox enables complex models of cell interactions to be developed and shared with others which would have been beyond the abilities of pathologists and biologists with minimal computer experience.

The biological toolbox provides a computer simulation approach where the mathematical modeling is preserved, but the answers are presented as a simulation which is easier to interpret. This simulation can be presented in the form of a picture of the final results of the simulation, or as an MPEG video that can allow the modelers to see the dynamic nature of the models they have developed. The biological toolbox provides its own language for creating simulations called the Cell Description Language. This language provides an abstraction layer between the algorithms in the underlying application algorithms. The biological toolbox provides distributed access to centralized resources over the network via standard web browsers, and provides the framework for accumulation of knowledge through exchange of programs written in the Cell Description Language.

1.3 A Generalized Language for Platform-independent Structured Reporting

Many have recognized that the success of clinical informatics applications depends upon efficient methods for capturing accurate and appropriately detailed clinical information. Kahn has brought the power of network friendly standards into a framework to address the data acquisition problem [5]. He has developed a Data-entry and Reporting Markup Language (DRML) using the Standard Generalized Markup Language (SGML). Using DRML he demonstrates how structured-data entry forms can be presented on standard web browsers, and thus do not depend upon interface programming languages such as Visual Basic. He believes that by using open standards some of the barriers that have prevented the diffusion of the technology necessary for structured reporting applications can be overcome, and presents a system named SPIDER (Structured Platform-Independent Data Entry and Reporting) which serves both as a system for specifying reporting applications to be served up as a DRML document, and as a data repository that stores individual reports that were generated from the DRML documents and in an aggregate form.

The data acquisition through structured reporting problem has been refractory for many years. Individual groups have lacked the resources to develop comprehensive systems on their own, and there were no standards upon which collaborative work could be based [6]. Kahn has solved the latter problem by creating a systematic domain for structured reporting (the DRML). DRML creates a structured environment on top of network-friendly standard upon which collaborations could be based.

2. Delivery of Information

Knowledge that has been acquired has no benefit unless it can be distributed to those in need of that knowledge. The next two articles describe successful projects that seek to distribute knowledge to two important groups: the consumers of health care, and the providers of health care.

2.1 Approaching Equity in Consumer Health Information Delivery: NetWellness

Morris and colleagues describe an ambitious project: to deliver an electronic consumer health library service to residents of 29 counties in three states, and to make those resources available to all the residents of these areas regardless of their socioeconomic status [7]. This project has many challenges: deployment of appropriate technology, training people to use that technology, assuring the quality of the content provided through the technology and development of partnerships to support the project with financial and political support.

Morris and colleagues describe the background behind the development of NetWellness, the motivation for using the Internet as the delivery vehicle for NetWellness, their design objectives, the system that was deployed to deliver content including the methods employed for remote access in limited access communities, and they provide a status report of their successes in the project and work yet to be concluded. As a critical feature they describe three key elements that they describe as requirements for success: development of partnership from the local community through the national level, presentation of quality content, and provision of easy access for all users regardless of location or social standing.

2.2 Electronic Clinical Trial Protocol Distribution via the World-Wide Web: A Prototype for Reducing Costs and Errors, Improving Accrual, and Saving Trees

Afrin and colleagues [8] have deployed a system for distributing clinical protocols via the World Wide Web. They developed a system where they were able to eliminate protocol hardcopies with the exception of the master copies from which the electronic protocols were derived, and have reduced distribution errors and delays by providing on-line access to the protocols. Many groups have aspired to develop "paperless" systems. It is gratifying to read about a success story in this regard.

Afrin and colleges describe the hardware and software that they use to run their protocol distribution, the labor costs required to develop and run the system, and evaluation of their system that includes an overview of the system users, and benefits of the system. It is interesting to note a positive feedback loop was created between the system developers and the providers of the protocols. The authors originally were unable to obtain electronic sources for most of the protocols, and therefore had to develop a process for converting the paper documents into electronic format. This process included optical character recognition, scanning and reformatting of graphics, and quality assurance of the protocols that often identified frequent typographical errors in the source hardcopy protocols. At the time of writing, the authors were noting increased cooperation from local protocol authors and are working to establish electronic protocol submission which would streamline the process of making the protocols available electronically.

3. Evaluation of Benefit

Any evolutionary process must have a method of differentiating beneficial change from destructive change. In informatics we seek to develop the applications we develop, and hope to quantify the benefits they provide. Often, we are faced with the problem of evaluation not of the systems we directly create, but with the systems that evolve around us in the interest of the public good. The last two articles in this section address this point specifically. How reliable is the information available on our networks, and what policies should we develop to ensure that information provided is beneficial?

3.1 Reliability of Health Information for the Public on the World Wide Web: Systematic Survey of Advice on Managing Fever in Children at Home

Impicciatore and colleagues performed an evaluation of the reliability of health information for the public on the World Wide Web [9]. They followed a very simple strategy. They picked a typical problem: when should parents seek medical attention if their child has a fever, and they performed a search on the Web using two popular search engines. They then evaluated the articles that were returned by comparing them with published guidelines.

They found that a majority of the web sites provided incomplete and often errant information about how to manage a child with a fever. Given this finding, they suggest the urgent need to check public oriented healthcare information on the internet for accuracy, completeness, and consistency.

3.2 Commentary: Measuring Quality and Impact of the World Wide Web

Wyatt expands upon Impicciatore and colleges recommendations for checking the accuracy of content on the world wide web [10]. He suggests that there are many aspects that should be evaluated: the credibility, and conflicts of interest of the web site owner or sponsor; the structure and content of a web site including its reference to sources of information, coverage, accuracy of content, currency of content, readability of content, and quality of links to other sites; the functions of the web site including accessibility via search engines; the expected users of the site, and means of navigation through the material; and the impact of the site, including its educational impact on users, on clinical practice, and on patient outcome.

4. Conclusion

The network foundation of our informatics applications has formed a positive feedback cycle such that we are in a period of explosive growth in our capabilities, the generality and availability of our applications, and the rate at which we acquire new functionality. The scope of the effects this explosion has on informatics practice is readily apparent in the articles in this section. The network is helping us to develop strategies for cooperatively accumulating knowledge and for disseminating that knowledge to the end user, and lest we forget, we are reminded of the importance of evaluating the benefit our network based technologies provide.

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