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JUNE 20-23, 1990

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STRUCTURAL INFORMATICS: THE REPRESENTATION OF ANATOMICAL KNOWLEDGE IN COMPUTER READABLE FORM.

C. Rosse, J Brinkley, and J Prothero

The explanation of many biological phenomena becomes intelligible only if presented in structural terms. Therefore, it is reasonable to argue that any causal knowledge base in the biomedical sciences should be built around a framework of biological structure; that is, the anatomy of biological objects, ranging in size from molecules to the entire organism. Anatomical knowledge can be classified into two components: spatial and symbolic. Spatial knowledge deals with the geometrical attributes of biological objects, such as their shape, size, volume, and the 3-D relationships of clusters of objects and their component parts; symbolic knowledge deals with the nonspatial attributes and relationships of biological objects, such as their functional, developmental, hierarchical, and taxonomic relationships. Spatial knowledge has been conventionally represented by images and symbolic knowledge by text. Spatial and symbolic knowledge of anatomy is integrated in the mind of anatomists, physicians, and scientists. Structural Informatics deals with the computer representation and integration of the spatial and symbolic components of anatomical knowledge; its purpose is to apply such knowledge to solve problems in biomedical research, education, and patient management.

Activities in The Digital Anatomist Program at the University of Washington center around developing databases and knowledge bases in both spatial and symbolic knowledge domains of anatomy. The spatial database is made up of 3-D x-, y-, z-coordinate tables describing reconstructions of a steadily growing number of anatomical objects, augmented with higher level geometric information (surfaces, volumes). The purpose of the symbolic database is to keep track of the spatial data sets, the ultimate aim being an object-oriented visual database. Knowledge of the generic shape of different classes of objects and their range of variation will be represented in the spatial knowledge base through geometric constraint networks, a method for representing spatial attributes of physical objects. Although the representation of taxonomies, hierarchies, and rules of inference will give useful capabilities to the symbolic knowledge base, much of the symbolic information will be accessed for the time being through hypercard or supercard. We intend to approach the large and complex issue of symbolic knowledge representation through multimedia systems with AI programs such as KEE or BB1 in the background as a knowledge navigator.

We have defined a number of knowledge-driven modules that will rely on the knowledge bases: increasing degrees of automation will be introduced into our existing low level graphics and image processing protocols by accessing knowledge of generic shape of object classes represented in the knowledge base. Long range plans include intelligent tutoring modules in anatomy and embryology, as well as treatment planning modules for radiation therapy.

We have adopted a design framework based on a distributed system in which individual modules running on different machines best suited for their purpose communicate with each other. Such a flexible design for anatomical knowledge representation allows for incremental improvement in individual modules from which other modules can in turn benefit. Supported by Grant LMO4925 from the National Institutes of Health and grants from the National Fund for Medical Education and the MG Murdock Charitable Trust.