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Chapter IV

Representing Symbolic Pictures Using Iconic Indexing

Chin-Chen Chang and Yung-Kuan Chan
National Chung Chen University, Taiwan

Annie Y. H. Chou and Wei-Pang Yang
National Chiao Tung University, Taiwan

2D-string and 2D H-string are commonly used to describe the spatial relationships among the objects of a picture. This chapter introduces a new data structure, called N-string, to characterize the spatial information of the objects on a picture. The N-string is isomorphic to the 2D H-string in postfix notation. Algorithms for transformations between symbolic pictures and N-strings are developed as well. In addition, this chapter also provides an efficient method for image matching based on the N-string representation. This chapter shows that in most cases the storage space needed by N-strings is less than that by 2D-strings, too. Besides, the experimental results show that N-strings are superior to 2D-strings. Hence both N-string and 2D H-string in postfix notation are good for representing symbolic pictures. That is, both N-string and 2D H-string in postfix notation are good for iconic indexing of pictures.

INTRODUCTION

Much attention has been paid to the design of picture database over the past few years. Similar picture retrieval is an important task in many picture database applications, such as office automation, multimedia, computer-aided design and medical picture archiving. Spatial similarity retrieval is to seek the pictures satisfying a certain picture query based on the spatial relationships among the objects of a picture. An object represents an entity on a physical picture, which is recognized by some pattern recognition techniques. A symbolic picture consists of a set of objects, each of which is attached with a symbolic name. The centroid coordinates of the objects with reference to the picture frame are extracted as well. The symbolic picture offers an efficient and compact way to construct a physical picture and also an ideal one to describe a picture query. By searching for the logical pictures, the corresponding physical pictures then can be retrieved and displayed. Therefore, similar picture retrieval can be simplified to the search of symbolic pictures.

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Techniques of iconic indexing by spatial constraints originated from the 2D string representation (Chang et al., 1987). In the representation, objects and their spatial relationships in a picture are characterized by a spatial data structure, that is a 2D string. A picture query can be specified as a 2D string too. The problem of similar picture retrieval then turns out to be the matching of 2D strings. This representation allows an efficient and natural way to construct iconic indices for pictures. Subsequently, a great number of other picture representations popped out derived from the 2D string, such as 2D G-string (Chang et al., 1989), 2D B-string (Lee et al., 1992), 2D C-string (Hsu et al., 1998a) and 2D H-string (Chang et al., 1988a), etc.

This chapter will review two data structures, 2D-string and 2D H-string, which are often discussed by many researchers. In addition, this chapter will present a new representation, N-string, which is obtained by scanning the symbolic picture according to an N-order. This chapter also develops some algorithms to support iconic indexing by N-strings. In most cases, the storage space required by the N-strings is less than that by 2D-strings. The experimental results show that the N-strings are superior to 2D-strings, too. This chapter is organized as follows. We briefly reviews the 2D-string and 2D H-sting. Then we introduce the N-string representation. Picture reconstructions from the N-strings are illustrated in the next section. We then devote the next section to some picture matching problems. Following that, the storage of N-string is analyzed. In the next section we then show the experimental results and compare N-strings with 2D-strings. The conclusions are given in the last section.

THE 2D-STRING AND 2D H-STRING

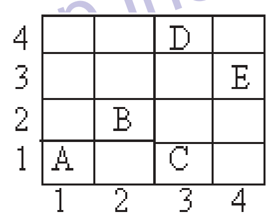
An $m_1 \infty m_2$ symbolic picture f, such as the picture in Figure 1, can be regarded as a mapping $X \infty Y \varnothing 2^V$, where (x, y) denotes a two-dimentional spatial location for x X, y Y, X={1, 2, ..., m_1}, and Y={1, 2, ..., m_2}. Here, V is a set of symbols each of which is specified as follows:

f(1, 1) = {A},	f(2, 1) = { },	f(3, 1) = {C},	f(4, 1) = { }
f(1, 2) = { },	f(2, 2) = {B},	f(3, 2) = { },	f(4, 2) = { }
f(1, 3) = { },	f(2, 3) = { },	f(3, 3) = { },	f(4, 3) = {E}
f(1, 4) = { },	f(2, 4) = { },	f(3, 4) = {D},	f(4, 4) = { },

where the empty set {} denotes a null object. With such a representation, one can derive the spatial relationships among the objects on the symbolic picture f. For instance, the object D is at the north of the object C, and the object E is at the northeast of object A.

Chang et al. (1987) proposed a data structure, called 2D-string, to represent a symbolic picture. Let R be the relation set {=, <, :}, where each element in R is a special symbol not in V that is used to specify the spatial relationship between two objects. Here, "=" represents the spatial relation "at the same location as," "<" denotes the spatial relation "to the west of or the south of" and ':' indicates the relation "in the same set as." A 2D-string over $V \approx R$ is represented as ($O_1 x_1 O_2$ ... $x_{n-1} O_n$, $O_{p(l)} y_1 O_{p(2)}$ ... $y_{n-1} O_{p(n)}$), where O_1, O_2, ..., O_n are the symbols over V, p is a permutation from {1, 2, ... , n} to itself, and x_1, x_2, ..., x_{n-1}, y_1, y_2, ... ,y_{n-1} are the relations

Figure 1: A symbolic picture



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