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Chapter XVIII

Temporal Models and Their Applications in Multimedia Information Retrieval

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Temporal models associated with a multimedia presentation describe the ordering of presentation of various objects in the time domain. In multimedia presentations, this ordering of presentation is explicitly formulated and stored along with the multimedia objects. Temporal models specify parameters such as time instant, duration, and synchronization of an object presentation with those of others. The above parameters can be specified either in a hard or a exible manner. In the case of hard temporal specification, the parameters such as time instants and durations of presentation of objects are fixed. In the case of exible specification, these parameters are allowed to vary within a specified range. In this chapter, we present both hard and exible temporal models for multimedia presentations. We describe how these models can be used for understanding the resource requirements (in terms of disk bandwidth, buffers, and network bandwidth) of a multimedia presentation. We present some approaches for deriving retrieval schedules based on temporal models.

INTRODUCTION

Multimedia information comprises objects from different media streams such as text, image, audio, and video. The presentation of multimedia objects to the user involves spatial organization, temporal organization, delivery of the components composing the multimedia objects, and allowing the user to interact with the presentation sequence. The presentation of multimedia objects can be either live or orchestrated. In live presentation, multimedia objects are acquired in real-time from devices such as video camera and microphone. In orchestrated presentation, the multimedia objects are typically acquired from stored databases. In orchestrated presentation, the multimedia objects are typically acquired from stored databases. The presentation of objects in the various media streams have to be ordered

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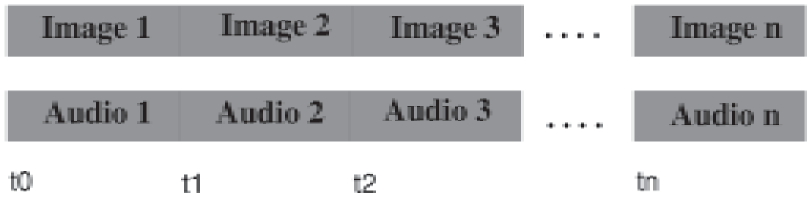
Figure 1. Synchronization in Multimedia Presentation



in time. Temporal model describe this ordering of presentation of various objects in the time domain. Consider the concurrent presentation of audio and images shown in Figure 1. Presentation of the objects in the individual media streams, audio and image, is sequential.

The points of synchronization of the presentation corresponds to the change of an image and the beginning of a new audio clipping. Temporal models should describe these points of synchronization in a multimedia presentation. In a live multimedia presentation, the ordering of objects in the time domain are implied and are dynamically formulated. In an orchestrated presentation, this ordering is explicitly formulated and stored along with the multimedia objects.

The points of synchronization in a multimedia presentation can be modified by the user going through the presentation. In a multimedia presentation, for example, a user may interact by giving inputs such as skip event(s), reverse presentation, navigate in time, scale the speed of presentation, scale the spatial requirements, handle spatial clash, freeze and restart of a presentation. User inputs such as skip, reverse presentation and navigate time modify the sequence of objects that are being presented. User inputs such as scaling the speed of presentation modify the presentation duration of the objects. User inputs such as handling spatial clash on the display screen make the corresponding media stream active or passive depending on whether the window is in the foreground or background. Similarly, while the freeze user input suspends the activities on all streams, restart input resumes the activities on all streams. In the presence of non-sequential storage of multimedia objects, data compression, data distribution, and random communication delays, supporting these user operations can be very difficult.

Modeling Temporal Relations

Temporal information can be represented by time points or time instants and time intervals. Time instants are characterized by specifications such as AT 9.00 AM and time intervals by specifications such as 1 hour or 9.00 AM to 5.00 PM. Time interval is defined by two time instants: the start and the end. A time instant is a zero-length moment in time whereas a time interval has a duration associated with it. A time interval can be defined as an ordered pair of instants with the first instant less than the second (Allen, 1983). Time intervals can be formally defined as follows. Let [S,-] be a partially ordered set, and let a, b be any two elements of S such that a - b. The set {x|a - x - b} is called an interval of S denoted by [a,b]. Temporal relations can then be defined based on the start and end time instants of the involved intervals. Given any two time intervals, there are thirteen ways in which they can relate in time (Allen, 1983), depending on whether they overlap, meet, precede, etc. Figure 2 shows a timeline representation of the temporal relations. Six of the thirteen relations are inverse of the seven relations that are shown in Figure 2.

Multimedia presentation can be modeled by temporal intervals with the time and duration of presentation of the multimedia objects being represented by individual time

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