A Fuzzy Conceptual Model for Multimedia Data with Application to News Video Domain

Dilek Küçük¹, N. Burcu Özgür¹, Adnan Yazıcı¹, and Murat Koyuncu²

¹ Dept. of Computer Eng., METU, Ankara - Turkey
{dkucuk,burcu.ozgur,yazici}@ceng.metu.edu.tr

² Dept. of Computer Eng., Atilim University, Ankara - Turkey
mkoyuncu@atilim.edu.tr
Outline

- Introduction
- A Fuzzy Conceptual Data Model for Multimedia Data
- Application of the Model to News Video Domain
- System Implementation
- Conclusion
- References
Introduction [1]

- To manage multimedia data in an effective way,
  - Its semantics should be modeled appropriately before storing it in a database.
- During modeling, two points should be paid particular attention:
  - Multimedia data is more complex than most other types of data that are stored in conventional relational database systems,
    - An *object-oriented approach* seems a plausible approach.
  - The data has an *inherent fuzzy nature*, for semantics of it may not always be expressed in a precise way;
    - Users of the data may demand information through flexible queries.
Introduction [2]

- **Fuzziness** can be represented in three levels in an object-oriented model (Aygun and Yazici, 2004):
  - Attribute level
    - Attribute values
    - Attributes’ relevance to an object
  - Object/class level
  - Class/superclass level
**Introduction [3]**

- **Sequence - Scene - Shot** are defined as follows:
  - *Shot* is a contiguous sequence of frames representing a contiguous action in time and space.
  - *Scenes* are constructed by shots which are related in time and space.
  - The semantically closer scenes are combined to construct a *sequence* which describes a continuing story.

  (Hjelsvold and Midtstraum, 1994)
Introduction [4]

- **Conceptual model of multimedia data** is an abstract representation of its semantic contents (the semantic **entities** and **relationships** among these entities).

- In this paper, we propose a **generic fuzzy conceptual data model for multimedia data**:  
  
  - We employ an **object oriented approach** and use **extended UML** (Aygun and Yazici, 2004; Yazici et al., 2001) with fuzzy constructs to represent this model.

  - The model also handles
    
    - the hierarchical structure, the **sequence-scene-shot hierarchy** (Hjelsvold and R. Midtstraum, 1994),
    
    - the spatial and temporal relations among the data.
A Fuzzy Conceptual Data Model for Multimedia Data [1]

Abstract Representation of the Video Data Model
A Fuzzy Conceptual Data Model for Multimedia Data [2]
A Fuzzy Conceptual Data Model for Multimedia Data [3]

- **UT_fy**: fuzzy type
- **UT_nu**: null type
- **UT_in**: incomplete type

(Yazici et al, 2001)
A Fuzzy Conceptual Data Model for Multimedia Data [4]

```
Structure
- startingFrame : int
- endingFrame : int
+ getTimeInterval() : int

Sequence
- name : string
- description : string
+ getScenes()

Scene
- name : string
- description : string
+ getShots()
+ getOwnerSequence()

Shot
- name : string
+ getFrames()
+ getEvents()
+ getOwnerScene()
```
A Fuzzy Conceptual Data Model for Multimedia Data [5]

*Direct links denote ‘has’ relationships between corresponding classes and objects.*
A Fuzzy Conceptual Data Model for Multimedia Data [6]

Actor entity idea was introduced in (Ekin et al., 2004)
A Fuzzy Conceptual Data Model for Multimedia Data [7]

The interfaces `SpatialRelation` and `TemporalRelation` are similar to `SpatialObject` and `TemporalObject` classes of VIDE model presented in (Tusch, 2000).

`FuzzyBoolean` is due to (Nepal et al, 1999)
Application of the Model to News Video Domain [1]

<table>
<thead>
<tr>
<th>Video</th>
<th>NewsVideo</th>
</tr>
</thead>
<tbody>
<tr>
<td>-id : int</td>
<td>-broadcaster : string</td>
</tr>
<tr>
<td>-title : string</td>
<td>-broadcastDate : Date</td>
</tr>
<tr>
<td>-description : UT_nu</td>
<td>-country : string</td>
</tr>
<tr>
<td>-author : string</td>
<td>-language : string</td>
</tr>
<tr>
<td>-duration : int</td>
<td></td>
</tr>
<tr>
<td>-dateCreated : Date</td>
<td></td>
</tr>
<tr>
<td>-path : string</td>
<td></td>
</tr>
<tr>
<td>-sizeInBytes : int</td>
<td></td>
</tr>
<tr>
<td>-mimeType : string</td>
<td></td>
</tr>
<tr>
<td>+getSequences()</td>
<td></td>
</tr>
<tr>
<td>+getObjects()</td>
<td></td>
</tr>
</tbody>
</table>
Application of the Model to News Video Domain [2]
Application of the Model to News Video Domain [3]

```
NewsSequence1 : NewsSequence

startingFrame : int = 246
endingFrame : int = 1350
name : string = MinisterOfJusticeSpeakingSequence
description : string = A news sequence on the speaking of the Minister of Justice of Turkish government on a change of a law in the parliament.
topic : string = Speaking of the Minister of Justice in the Parliament
isDomestic : FuzzyBoolean = membershipDegree -> 1.0
isForeign : FuzzyBoolean = membershipDegree -> 0
isPolitical : FuzzyBoolean = membershipDegree -> 1.0
isHealth : FuzzyBoolean = membershipDegree -> 0
isEconomical : FuzzyBoolean = membershipDegree -> 0
isEducational : FuzzyBoolean = membershipDegree -> 0
isCultural : FuzzyBoolean = membershipDegree -> 0
isSports : FuzzyBoolean = membershipDegree -> 0
isWeather : FuzzyBoolean = membershipDegree -> 0
isLive : FuzzyBoolean = membershipDegree -> 0.4

AnchormanScene : Scene

startingFrame : int = 245
endingFrame : int = 594
name : string = AnchormanScene
description : string = Anchorman's telling the details of the news

ReporterScene : Scene

startingFrame : int = 555
endingFrame : int = 809
name : string = ReporterScene
description : string = Reporter's telling her observations in the parliament

ParliamentScene : Scene

startingFrame : int = 810
endingFrame : int = 1350
name : string = ParliamentScene
description : string = Actual parliament scene where the speaking takes place.
```
Application of the Model to News Video Domain [4]
Application of the Model to News Video Domain [5]

SpeakerShot1: Shot

- startingFrame: int = 810
- endingFrame: int = 1140
- name: string = SpeakerShot1

SpeakingEvent1: SpeakingEvent

- objectMembershipDegree: float = 0.9
- classMembershipDegree: float = 1.0
- name: string = SpeakingEvent1
- where: UT_fy = ParliamentBuilding
- when: UT_fy = 12.03.2004
- how: UT_nu = null
- startingFrame: int = 810
- endingFrame: int = 1090

DrinkingEvent1: DrinkingEvent

- objectMembershipDegree: float = 0.6
- classMembershipDegree: float = 1.0
- name: string = DrinkingEvent1
- where: UT_fy = ParliamentBuilding
- when: UT_fy = 12.03.2004
- how: UT_nu = null
- startingFrame: int = 1001
- endingFrame: int = 1140

Speaker1: Actor

- objectMembershipDegree: float = 1.0
- classMembershipDegree: float = 1.0
- id: int = 1
- name: string = Minister
- description: UT_nu = Minister of Justice
- linguisticRole: string = Agent
- semanticRole: string = Speaker

Drinker1: Actor

- objectMembershipDegree: float = 1.0
- classMembershipDegree: float = 1.0
- id: int = 1
- name: string = Minister
- description: UT_nu = Minister of Justice
- linguisticRole: string = Agent
- semanticRole: string = Drinker

Drinkee1: Actor

- objectMembershipDegree: float = 1.0
- classMembershipDegree: float = 1.0
- id: int = 2
- name: string = GlassOfWater
- description: UT_nu = null
- linguisticRole: string = Object
- semanticRole: string = Drinkee
System Implementation [1]
# System Implementation [2]

Table 1: Mapping of the Fuzzy Terms to Their Corresponding Membership Degrees

<table>
<thead>
<tr>
<th>Fuzzy Term</th>
<th>Membership Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exactly/totally</td>
<td>1.0</td>
</tr>
<tr>
<td>Mostly</td>
<td>&gt; 0.7</td>
</tr>
<tr>
<td>Moderately</td>
<td>&gt; 0.4</td>
</tr>
<tr>
<td>Somewhat</td>
<td>&gt; 0</td>
</tr>
</tbody>
</table>

Table 2: Eight Example *NewsSequence* Objects in the Fuzzy Object Oriented Database

<table>
<thead>
<tr>
<th>Object ID</th>
<th>isDomestic</th>
<th>isHealth</th>
<th>isEconomical</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.0</td>
<td>0</td>
<td>0.7</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>1.0</td>
<td>0.3</td>
</tr>
<tr>
<td>3</td>
<td>0.4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>1.0</td>
<td>0.2</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>1.0</td>
<td>0.5</td>
<td>0.8</td>
</tr>
<tr>
<td>6</td>
<td>0.6</td>
<td>0</td>
<td>0.9</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>8</td>
<td>1.0</td>
<td>0.8</td>
<td>0.9</td>
</tr>
</tbody>
</table>
System Implementation [3]

**Q1:** Retrieve the titles of all news videos where the singer ‘Tarkan’ appears.

```sql
select V.title from Video V, Actor A
where V.id = A.getVideo() and
A.name = 'Tarkan' and
A.semanticRole = 'singer';
```

**Q2:** Retrieve news sequences that are somewhat domestic.

```sql
select NS from NewsSequence NS
where NS.isDomestic > 0;
```
Q3: Retrieve all news sequences that are mostly economical, moderately health-related, and totally domestic.

```
select NS from NewsSequence NS
where NS.isEconomical > 0.7 and
    NS.isHealth > 0.4 and
    NS.isDomestic = 1.0;
```
Conclusion [1]

- A fuzzy conceptual data model and its application to news video domain are presented.
  - The proposed model is also generic,
    - it could easily be adapted to any multimedia domain.
  - It takes an *object oriented approach* with the ability to handle fuzziness at the *attribute, object/class* and *class/superclass* levels.
  - The model also handles the *hierarchical structure* of the data and the *spatial and temporal relations* among the data.
Conclusion [2]

- In order to see the effectiveness of the model on news videos,
  - The proposed model is implemented as a fuzzy multimedia database system for news videos.
- As further studies, we are planning to incorporate a fuzzy knowledge base to the implemented system
  - To handle a wider range of queries to the fuzzy database, including spatial, temporal, and trajectory queries.
References


Thank You