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Title: MetaDance: The development of a Dance Annotation Tool

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Category	Min	Max	Chosen
Requirement Analysis and Design	0	20	20
Theoretical Analysis	0	25	
Experiment Design and Execution	0	20	
System Development and Implementation	0	20	20
Results, Findings and Conclusions	10	20	10
Aim Formulation and Background Work	10	15	10
Quality of Paper Writing and Presentation	10		10
Quality of Deliverables	10		10
<u>Overall General Project Evaluation</u> ( <i>this section allowed only with motivation letter from supervisor</i> )	0	10	
<b>Total marks</b>		<b>80</b>	80

# MetaDance: The development of a Dance Annotation Tool

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## ABSTRACT

We present the mobile dance annotation tool that has been developed to solve the problem of documenting dance media files. A dance ontology was developed, through web-scraping and natural language processing, using a bottom-up approach. SCRUM was used as the software development methodology. The annotation tool implements the dance ontology by extracting terms to provide users with a dance vocabulary for annotating. Users are able to annotate dance videos by using the pre-defined or self-defined terms. A basic database was designed and implemented. Usability basics were integrated into the tool as well. Evaluations were conducted on the method used for knowledge acquisition of the dance ontology development process, as well as the usability of the tool. The results from evaluating the process of collecting terms indicates that the method can be extended to other dance types. Subsequently, the usability evaluation results indicate that the usability basics were effectively developed into the tool.

## CSS CONCEPTS

• **Human- centered computing** → **Human computer interaction (HCI)** • **Applied computing** → **Annotation**

## KEYWORDS

Annotation Tool, Dance Annotation Tool, Video Annotation, Dance Concepts, Dance Ontology, Ontologies, Database Model, Usability, Usability Testing

## 1 Introduction

At present, technology has the capabilities of documenting various forms of information that people deem as important and useful to have at hand, whether it be for accessing or manipulating. One of these sources of information is dance. Dance is a form of contemporary art and is interpretative at its core. Thus, documenting this source of information in a digital platform seems to be challenging when faced with attempting to store it for access in a wealth of unstructured information. Many attempts have been made in trying to preserve dance using a number of methods. These methods included storing dance in the memories of people, dance notations and digital archives [14].

Therefore, this project aims to solve the problem of documenting dance media in a digital platform. The project will attempt to solve this problem by developing a dance ontology within a mobile platform, so as to allow for easy access within a social dance setting. This project's objective is to develop a mobile application, which dancers will use to store and annotate dance media files, for the purpose of documenting and retrieval (within a social setting). This annotation tool will provide dancers with a method of annotating dance by using the pre-defined dance terms provided to users, or the option of annotating using self-defined dance terms so as not to restrict dancers within the annotation process. Our solution involves developing a dance ontology for two Latin dances from which the dance vocabulary will be extracted for the pre-defined dance terms. The ontology development includes two Latin dances only, i.e. Salsa and Cha-Cha-Cha, to demonstrate the reusability of the process of collecting dance terms, so that it can be used by knowledge and domain experts to further develop the dance ontology. Our motivation for developing the tool on a mobile platform was to increase the accessibility of the tool within a social dance setting, to allow dancers to easily access annotated dance content and to recreate the production/s of the dance content.

Through extensive research, it was noted that when developing a dance annotation tool, it required some form of a dance representational model in order to provide users with a vocabulary for annotating. Our research was, therefore, focused on the implementations of dance annotations tools, specifically relating to how dance ontologies are used to provide a vocabulary for annotating. In addition to this, since we are developing a mobile application with the main functionality being the annotation process; we extended our research into the usability of annotation tools.

This paper has the following structure: related work, requirements analysis, mention of the software development methodologies used within this project, the software design. Followed by the ontology and system development and implementation, evaluation processes, the results thereof and discussion, with the conclusions discussed.

## 2 Related Work

### 2.1 Dance Ontologies

Dance annotation systems are developed for a number of reasons, namely documenting for the purpose of recreating productions or

educational purposes. Through our research it is noted that to provide choreographers and dancers with a dance vocabulary to annotate dance media files, a dance representational model was developed.

The most prevalent dance notations are Labanotation and Benesh Movement notation [17]. These notation systems are used to represent human body movements. However, proves difficult to interpret if you have not studied these notation systems as the movement representations are abstract. To counteract this problem dance annotation tools have implemented dance representational models to provide users with a dance vocabulary to annotate with [5][6][8][10][13][14].

Each annotation tool allows users to annotate using pre-defined dance terms and/or using free-text. The Choreographer's Notebook [16] and ANVIL [9] are annotation tools that make use of free-text annotations only. The lack of a dance representational model implemented within these tools attribute to the reason being that these tools' main purpose was to add metadata to dance media files for educational and research purposes.

On the other hand, a number of annotation tools implemented a dance representational model, specifically dance ontologies, to provide users with a dance vocabulary with pre-defined dance terms, i.e. BalOnSe[6], DanVideo[8], TDAT[10], DMAR[14]. Ontologies were used to represent dance concepts within a hierarchical taxonomy. In each case, dance concepts were represented by the nodes within the ontology, and linked based on their associations with one another. Within BalOnSe, the dance concepts were arranged based on generic movement terminology, which can be understood and utilized by any non-expert, while the specific movement terminology included dance concepts that were more formal and cannot be understood by the average user unless they had some formal exposure to dance [6]. DanVideo [8] organizes annotations using an ontology, where dance concepts are organized into macro and micro features. Macro features include details relating to the context of the dance media content, i.e. dance type, music details, tempo, performance venue, while micro features relate to the dancers and their actions within the media file, i.e. number of dancers, dance move, posture of dancer, role of dancers (lead/follow). This representation of dance focuses on the metadata of the dance. While this is advantageous in the case of attaching metadata to media files for storage and retrieval, it does not fully represent dance concepts to provide an extensive vocabulary for the purpose of annotating dance media. In comparison, the DMAR tool allows for movement descriptors, which are more suitable for providing a dance vocabulary within an annotation process as this allows for users to attach descriptive annotations for the purpose of recreating productions more accurately. Therefore, the approach taken in the DMAR tool, i.e. the comprehensiveness in the detail of the vocabulary provided, is more suited for annotating for recall of dance content within a social setting.

Each annotation tool adopts a varying approach to representing dance concepts, even if they are the same type of model, i.e. an ontology. Some of the dance ontologies reviewed are more suited for providing a dance vocabulary for annotating for the purpose of recreating productions within a social setting, due to its structure and detail, while others are not. Also, each dance ontology was developed while focusing on different aspects of dance, hence each ontology was developed differently for the specificity of its case. The one exception is the TDAT tool [10], which adopts the flexibility of allowing developers to upload and use different

dance ontologies so as not to restrict the tool to specific dance types. The dance vocabulary extracted from the different ontologies would, therefore, vary with each ontology uploaded for use within the system. The flexibility of allowing the upload of different dance annotations can be used to test the comprehensiveness of ontologies in providing vocabularies for dance concepts.

These ontologies will not be able to be integrated with the annotation tool intended to be developed as a lightweight ontology is needed for implementation within a mobile environment.

## 2.2 Usability of Annotation Tools

The following section provides information on the usability of annotation tools, specifically focusing on the dialogue presented to users and how these annotations are visualized.

Burghardt [2] analyses general annotation tools and the problems and recommendations discussed therein by using a Heuristic Walkthrough (HW), which is a task-orientated approach to evaluating. The HW consists of a Cognitive Walkthrough (CW) and a Heuristic Evaluation (HE). The CW involves experts completing a pre-defined list of tasks and uses the system in order to identify any problems within the functionalities of the system. The HE evaluates the system using Nielsen's [11] ten usability heuristics. Therefore, making the HW an evaluation strategy that combines aspects of both CW and HE. Burghardt [2] highlights problems within the development process of annotation tools specifically relating to 1) 'Feedback, user guidance & error messages' and 2) 'User interface elements & design'. These are the general problems that should be taken into consideration when evaluating the usability of the dance annotation tool that would be developed in this project.

It is noted that the annotation process for users are both complex and time consuming [5][14]. Within the evaluation of the usability of the WML [5] and DMAR [14] annotation tools it was noted that the annotation process was complex and required assistance to users, and for users to be trained on the annotation functionality. WML was evaluated by user experience experts and tested the main functionalities of the tool. Experts conclude that while the tool proved to be valuable in the functionalities that it provided, it remained a complicated process and required user instructions. Concejero et al. [3] recommends that users be trained and assisted, as well. Consequently, it is recommended that annotation tools implement a quick and easy annotation method in a minimum number of steps to eradicate any complexities that may arise, as well as to reduce the number of mistakes that could be made when annotating. Since the annotation process is complex and time consuming, Bianco et al. [1] suggests that the implementation of a semi-automatic process be used to assist in reducing the time taken to annotate files. In this case, a vocabulary, which has an accurate and understandable dialogue, would be needed for the process [4]. Furthermore, the accommodation of an edit/remove functionality would be needed to accommodate for the mistakes made within the annotation process.

Burghardt [2] states that each annotation tool has both its advantages and disadvantages as each tool has been developed for a specific purpose. Therefore, the highlighted problems and recommendations concerning the usability of annotation tools

mentioned above can be applied to solving the current project problem and can be used as a guide to what conditions to take into consideration, as well as what problems to overcome during the development of the annotation tool and the incorporation of usability.

### 3 Requirements Analysis

The formulation of the requirements of the application that was developed was based on addressing the problem of providing dancers with a mobile option to recall dance moves that they have learnt, in a quick and easy manner within a social setting, as opposed to skimming through a notebook.

The first step included meeting with the project supervisor to obtain additional information surrounding the problem stated within the project brief, and establish the requirements expected to be included within the final mobile application. From these first meetings we established the expected requirements, which was developing a mobile application in two components, i.e. 1) dance annotation tool and 2) dance archival system. This paper outlines the development of the annotation tool component.

From this process we had established the requirements for the design of the mobile dance annotation tool. The functional requirements of the annotation tool are listed below:

1. Annotation process using pre-defined dance terms from the dance ontology
2. Annotation process using self-defined dance terms
3. Editing /Deletion of annotations
4. Editing/Deletion of videos

#### 3.1 Stakeholders

We had to identify the type of users that would be directly impacted by the tool that was to be developed. The users included dancers that needed to document dance concepts, using a mobile device. Since the tool was to be developed using Android Studio, end users would need to operate within an Android environment only. Other stakeholders to consider are the participants that would be recruited for testing the usability of the annotation tool.

#### 3.2 Usability Requirements

*3.2.1 Ease of Learning.* User should be able to intuitively add a video to the system and annotate it using the pre-define or self-define options available, on opening the tool for the first time.

*3.2.2 Task Efficiency.* User should be able to annotate video within an average of 2-4mins per annotation.

*3.2.3 Ease of Remembering.* The application should be limited to a specific number of main functionalities, which will be indicative of the simplicity of the system and therefore ease of remembering how to utilize the application.

*3.2.4 Understandability.* The application should make use of simple instructional pointers, such as buttons with simple dialogue to understand.

*3.2.5 Feedback.* At each point of the annotation process the tool should provide feedback (success/failure), such as when an annotation is added, edited and/or deleted, as well as adding, editing and/or deleting a video from the system.

### 4 Software Development Methodologies

The mobile application was developed using the SCRUM agile software development methodology [15]. This methodology makes use of iterative development within sprints. Within each sprint each requirement that has been identified within the planning and modelling of the tool will be developed and implemented within the final product. The scrum framework was best suited for development within this project as it allows for each sprint to be allocated to developing, testing and implementing each functionality of the application. The priority of the functionalities to be developed were specified within the product backlog, that was consulted at the beginning of each sprint. The product backlog was compiled within the first phase of planning and system architecture design.

Within the first phase of the project the deliverables were identified as follows:

1. Develop the dance ontology
2. Design database model
3. Design application flow between screens
4. Develop the annotation tool to include the functionalities as listed in section 3.

The above requirements were developed and implemented within each sprint of the project.

#### 4.1 Ontology Design

The specifications of the dance ontology were designed by using the NeOn methodology [12]. This included assessing the requirements of the ontology and what it will be used for, in order to develop an Ontology Requirements Specification Document (ORSD). In order to compile the ORSD, we had to identify the purpose of the ontology. For this project that purpose was developing a dance ontology to use the terminology within it to provide a vocabulary for the dance annotation tool.

Subsequently, it was decided to develop a lightweight ontology, as the extent to which the formality of the ontology will be developed needed to be decided upon within this process. This was based on the fact that the ontology would only be used to provide a dance vocabulary. The intended users were then identified, which were dancers and/or choreographers. Following this, we had to identify the uses of the ontology. For this project, the ontology will be developed purely for the use of providing a dance vocabulary within the annotation process of a mobile annotation tool.

The main task in compiling the ORSD is identifying the requirements of the ontology. These requirements are written in natural language in the form of Competency Questions (CQ) and tools (mind maps, spreadsheets). The purpose of these requirements is to identify the key ideas, concepts or words that

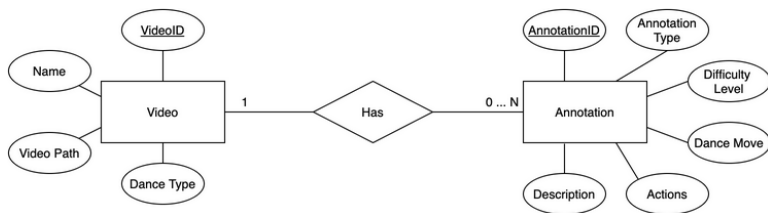
will be included in the ontology. These key concepts were identified by using a bottom-up approach. From here on, the requirements were grouped to identify missing or contradicting CQs, then prioritized and the terminology from these CQs were extracted for the conceptualization of the ontology.

Web-scraping and natural language processing was used to extract dance terminology from dance syllabi to develop a lightweight dance ontology. Only two Latin dances were chosen to develop this ontology to demonstrate the reusability of the knowledge acquisition process and extensibility of the dance ontology.

## 4.2 Database design

Subsequent to the ontology being used to provide a dance vocabulary for annotating, it is used to provide developers with a conceptualization of the types of information that would need to be stored when annotating a dance video.

We had created an entity-relationship (ER) model (figure 1) by identifying the entities, relationships between these entities and attributes of these entities. It is important to note that the design of the database is not the main focus of this project, and it is simply a placeholder for indicating that the implementation of the archival system, which is mentioned in section 3, is planned to be integrated with the annotation tool to be developed. The entities that would be necessary for storage in the annotation tool are the *Video* and *Annotation* objects. It is planned that each video object will have multiple associated annotation objects within the database. The attributes of the *Video* and *Annotation* objects are shown below in figure 2. Since each *Annotation* object will be linked to a specific video, it would need a foreign key identifier, which will be the video's ID. Figure 2, below, will be used to fulfill the requirements of the database that should be implemented within the annotation tool.



**Figure 1: ER diagram conceptualizing the entities that will be implemented in the database within the annotation tool**

## 5 Software Design

### 5.1 Application Flow

The annotation tool will make use of the ontology and database design to aid in the annotation process of dance videos. Before the application was developed the application flow was established. No consideration was given to the user interface design as the focus of the project was to develop a solution of documenting dance media on a mobile platform.

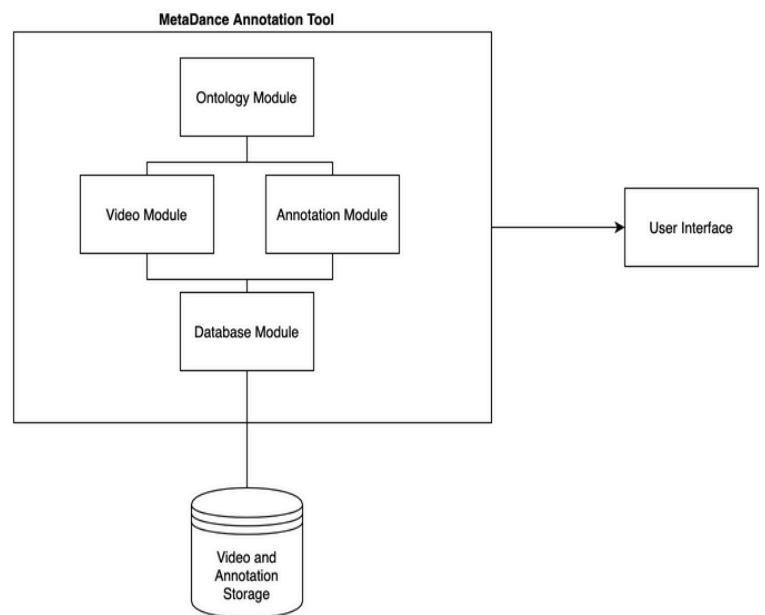
The application flow highlights the main objectives of the user and will help to communicate more clearly what the application flow should be. This design will, in turn, ensure that important steps within the annotation process and navigation of the application is not missed. By mapping out the user flow within the annotation tool it will allow developers to highlight any problems that have not been considered, and therefore make changes at a low fidelity before development has begun.

The main objectives of the user would be to:

1. Upload video for annotating
2. Annotate video
3. View annotated video in system
4. Edit/Delete annotations
5. Edit/Delete videos

For each of the main objectives of the annotation tool, the user's navigation within the tool is illustrated in figure 3 below.

### 5.2 System Architecture



**Figure 2: High-level illustration of how components within the system interact**

The high-level system components are presented in figure 2 to show the different components included in the system. The OWL file contents, containing the dance ontology, will be stored within the Ontology component to ensure that the mobile application can be used for other dance ontologies that have more comprehensive information on dance terminology. This allows for the tool to be adapted to use different dance ontologies. The video module will be used to store information relating to Video files that are being annotated, while the Annotation module stores the annotations that users make relating to a selected dance media file. Lastly, the Database module is used to interact with the database of the system to store, retrieve and change video and/or annotation items within the system storage.

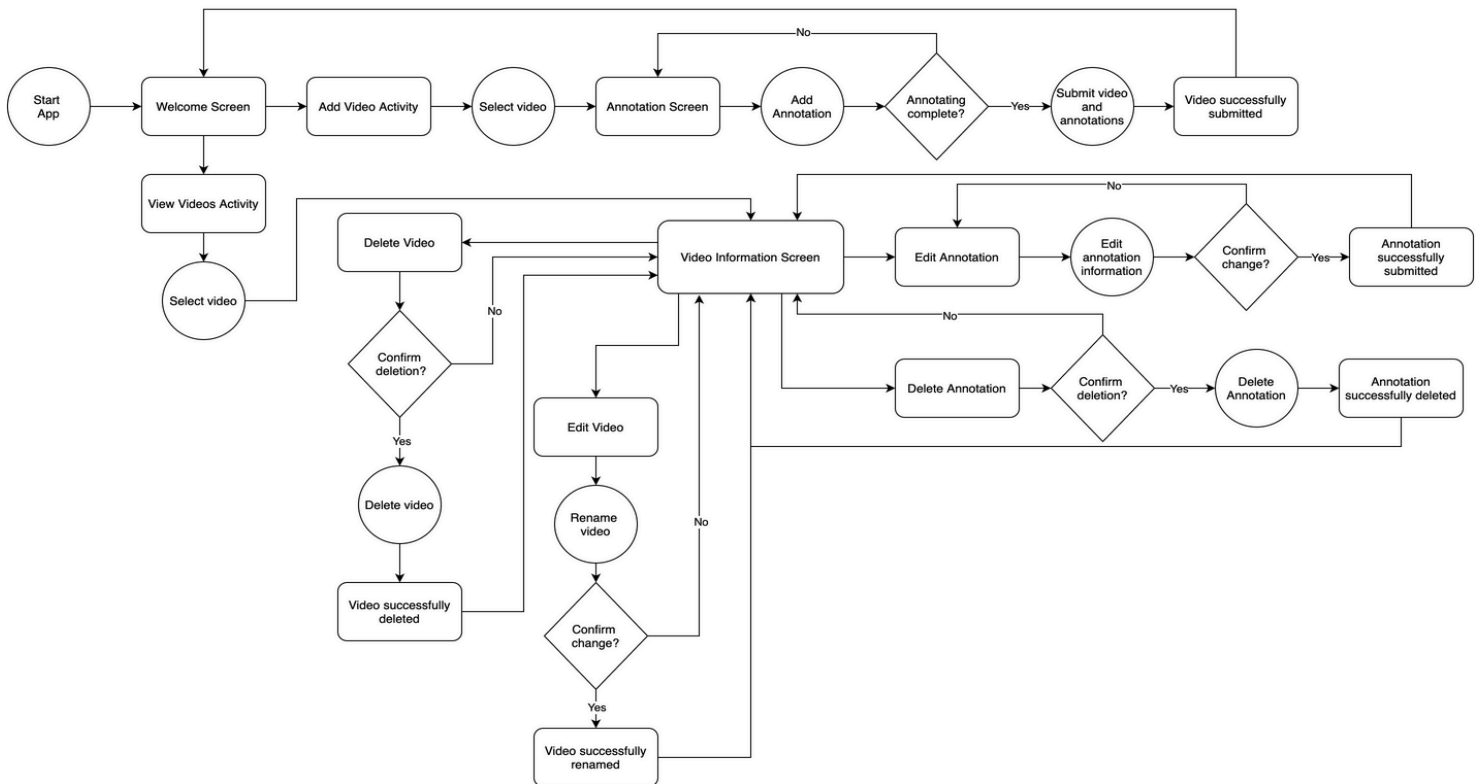
## 6 Ontology Development

The structure of the application is simple at its core, due to the project focus being on developing and implementing a solution to document dance media files for recall within a social setting. The application attempts to solve this problem by developing and implementing an ontology for the dance vocabulary used within the annotation process of the application. For the gathering of dance terminology, we had developed a python program that was used to do web-scraping. Web-scraping is the extraction of data from websites. The python program was used to extract information from websites that are in HTML format, by using the BeautifulSoup Python library. The information extracted from the various websites included dance syllabi, specifically for Salsa and Cha-Cha-Cha. Table 1 lists the websites from which terms were extracted for each dance type.

The program used for the web-scraping process extracted only the necessary information from html tags that contained it. In a number of cases the results extracted were readable and required minimal cleaning of the text. In the other cases, where the results extracted were not immediately readable it was further processed by developing another python program that was used for text cleaning, which removed the extra html tags that were extracted during the web-scraping process. The information was then further processed using a natural language processor (NLTK). Since NLTK does not contain a dance corpus, word and sentence tokenizers were used to extract terms from the web-scraping results and was then further processed to be cleaned and made readable. The dance terminology extracted from these online resources were then used to develop the lightweight dance ontology, using a bottom-up approach.

**Table 1: Table containing the websites that dance terms were extracted from for each dance type**

Dance Type	Websites
Salsa	<ul style="list-style-type: none"> <li>• <a href="https://www.jaephillips.com/beginners-salsa">https://www.jaephillips.com/beginners-salsa</a>.</li> <li>• <a href="https://salsawithsilvia.com/levels-syllabus-videos/">https://salsawithsilvia.com/levels-syllabus-videos/</a></li> <li>• <a href="http://www.salsaisgood.com/dictionary/Salsa_dictionary.htm">http://www.salsaisgood.com/dictionary/Salsa_dictionary.htm</a></li> <li>• <a href="https://www.ballroomdancers.com/Dances/syllabus.asp?dance=SAL">https://www.ballroomdancers.com/Dances/syllabus.asp?dance=SAL</a></li> <li>• <a href="http://estebanconde.com/salsa-syllabus/">http://estebanconde.com/salsa-syllabus/</a></li> <li>• <a href="https://mambodinamico.com/salsa-syllabus/">https://mambodinamico.com/salsa-syllabus/</a></li> <li>• <a href="http://www.dancewithcarolyn.com/salsa-syllabus.html">http://www.dancewithcarolyn.com/salsa-syllabus.html</a></li> <li>• <a href="https://pgh.lossabrosos.org/syllabus/">https://pgh.lossabrosos.org/syllabus/</a></li> <li>• <a href="http://www.tampasalsa.com/TampaSalsa/syllabus.pdf">http://www.tampasalsa.com/TampaSalsa/syllabus.pdf</a></li> </ul>
Cha-Cha-Cha	<ul style="list-style-type: none"> <li>• <a href="https://www.ballroomdancers.com/Dances/syllabus.asp?dance=CHA">https://www.ballroomdancers.com/Dances/syllabus.asp?dance=CHA</a></li> <li>• <a href="http://www.ballroomguide.com/workshop/latin/cha_cha.html">http://www.ballroomguide.com/workshop/latin/cha_cha.html</a></li> <li>• <a href="http://www.dancecentral.info/ballroom/international-style/cha-cha-cha">http://www.dancecentral.info/ballroom/international-style/cha-cha-cha</a></li> <li>• <a href="http://www.wright-house.com/dance/istd-international-latin-syllabus-ballroom-dance.html">http://www.wright-house.com/dance/istd-international-latin-syllabus-ballroom-dance.html</a></li> <li>• <a href="https://www.centralhome.com/ballroomcountry/cha-cha-syll.htm">https://www.centralhome.com/ballroomcountry/cha-cha-syll.htm</a></li> <li>• <a href="https://personal.utdallas.edu/~aria/dance/syllabus_am.html">https://personal.utdallas.edu/~aria/dance/syllabus_am.html</a></li> </ul>



**Figure 3: Application flow diagram of the dance annotation tool**

Firstly, the development started with the dance terms extracted and we started categorizing dance terms according to the difficulty levels that they were specified under, followed by categorizing the dance terms according to which dance type it belonged to. The difficulty levels were, also, categorized into the relevant dance types.

The ontology was developed using Protégé. The classes and their properties/relationships were defined by using the class hierarchy tool to develop the ontology.

## 7 System Development and Implementation

### 7.1 Software Design Considerations

The annotation tool will be developed for Android smartphone use, with an API level 14 or above.

Other considerations would pertain to the software quality characteristics [7]. Functionality should be the main focus of the tool design, as the annotation process is imperative to the operation of the tool. Usability integration with the tool would need to be considered to ensure the ease of use of the functionalities of the tool. The modularity of system components should be ensured to allow for easy testing thereof, as well as allows for the ease of altering modules within the system.

### 7.2 System Implementation

The architecture of the annotation tool was completed using object-orientated principle design and the tool is to be operational on a mobile environment. In this case, we chose Android as the technical environment in which the tool will be able to operate. Hence, we chose the Android Studio 4.0 IDE. This IDE was best suited for the development of the dance annotation tool as it contains a virtual testing environment, which allows developers to program and test features. Additionally, Android Studio can be used to check the compatibility and performance of the annotation tool across multiple devices.

Java was chosen as the programming language due to it being robust and object-orientated, which matches the design of the system architecture, as well as the database design. JDK 14 was used as the software development platform.

#### 7.2.1 Annotation Process.

The system allows users annotate dance media files through the annotation process. From the welcome screen users are able to select the option to add a video for annotating. The user is able to select a video from their mobile device. An annotation screen is then presented. From this screen the user is able to enter the video's name and select the dance type. The user can enter the video's name within a textbox, while the dance types available for annotation is chosen from the ontology that will be uploaded to the system (discussed in section 7.3).

The system is designed to allow users the flexibility to choose between annotating using the pre-defined system dance vocabulary or annotate using their self-defined terms. The annotation information that users are required to enter into the

system includes a difficulty level and a dance move. Optionally the user is able to enter the actions associated with the dance move and other notes.

In the case that a user selects the pre-defined option for annotating, they are urged to select from drop-down lists of options for the difficult level, dance move and action. They are, also, allowed to provide additional notes within the text field provided. The list of options displayed within the drop-down lists are extracted from the ontology, which will be discussed in section 7.3.

Furthermore, if a user selects the self-defined option for annotating, textboxes are provided for the user to enter the dance move and actions associated with the dance move. The difficulty level is automatically selected to 'Uncategorized', as the categorization of the user's self-defined terms may not conform to the difficulty level classifications defined by the system.

The user is able to add multiple annotations to the video from the annotation screen before submitting it to the system. Once the video has been submitted, the user is able to navigate to it from the welcome screen and add additional annotations as well.

To ensure the reliability of the annotation process, the system checks that all necessary information is entered/selected by the user before adding an annotation. Within the pre-defined annotation option, the difficulty level and dance move are required before an annotation can be added. Within the self-defined annotation option, the dance move needs to be entered by the user before an annotation can be added. Likewise, the video's name and dance type need to be selected before the video can be added to the system with its annotations.

#### 7.2.2 Viewing Videos and Annotations.

From the welcome screen, the users are able to view videos that are already within the system and annotated. The videos are presented in a list view for selection. On selecting a video for viewing the user is able to view the video and its annotated information, edit the video and its annotations, and delete the video and/or its annotations. All the information that is displayed within the list view of all the videos within the system is obtained from the local SQLite database connected to the system; likewise, the information displayed when a user selects a video for viewing its information is obtained from the local SQLite database.

When viewing a video and its annotations, the user is able to add more annotations (section 7.2.1), edit annotations or delete annotations. Equally, a video can be deleted. When any change is made to a video and its annotations, the tool adjusts the database information.

### 7.3 Ontology Implementation

Once the ontology had been designed and developed, it was exported to an RDF/XML format for upload to the annotation tool. See appendix A for a snippet of the OWLfile that contains the details of one of the classes within the ontology.

Since the annotation tool requires a dance vocabulary to allow users to annotate dance media, the ontology is an important aspect

of the tool. Due to this reason, it was imperative to develop the ontology at an early stage, i.e. first, before the development of the mobile application.

In order for the ontology to be used within the system, an *Ontology* class was created to extract the relevant information from the OWL file. This class will be able to extract dance terms and actions and organize them based on the dance type to which it needs to be categorized under, as well as the difficulty levels. The dance types and difficulty levels are already pre-defined within the *Ontology* class and is mainly used to extract dance terms from the OWL file and arrange them, accordingly, based on their properties stated within the ontology file. The *Ontology* class can only, at this time, be used to extract dance terms for Salsa and Cha-Cha-Cha and arrange their dance terms according to their corresponding dance difficulty levels. The actions of dance moves are not specified for each dance move, as this would have required collaboration between developers and a domain expert.

## 7.4 Database Implementation

The database design model (figure 1) was used to design the database within the tool. As the annotation tool will be developed using Android Studio, a local SQLite database will be developed to store video and annotation information. Implementation of a local database ensures reliable and easy access to the database when retrieving information from it, as it can be accessed from a device anytime and without having to consider internet access issues. The following illustration is the database design implemented:

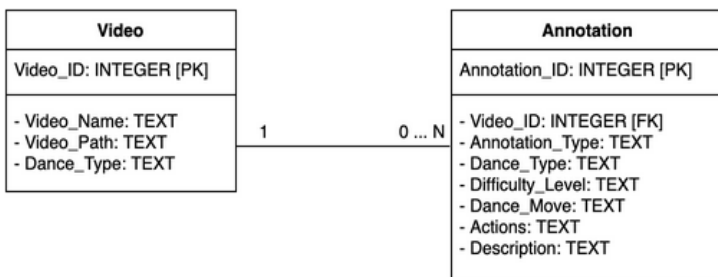


Figure 4: Database design used in annotation tool

The database makes use of two tables, representing the Video and Annotation entities. The video objects that are stored within the Video table include the ID, video name, video path (for access later) and the dance type that the video is categorized under. Similarly, annotation objects are stored within the Annotation table. Each annotation that is created is, however, associated with a specific video object in the Video table. This is done by making use of a foreign key. In this case, the video ID is defined as the foreign key within the Annotation table, in order for each annotation object to be linked to a specific video.

The application will create video and annotation objects (section 7.5) and store them within the database. The user will then be able to access this information for viewing and choose to edit

and/or delete specific annotations of a video or choose to edit/delete a video from the database entirely. If the user chooses to delete a video from the database, the application ensures that the database deletes all information related to this video object as well.

## 7.5 Data Structures and Data Organization

The application utilizes lots of data for access and manipulation, therefore the approach taken in storing this data is important to the flow of the application and its usability. Once developers had deliberated about the types of information that would need to be stored and considering the adherence to the principle of encapsulation when developing it had been decided that an object-orientated approach would be best. We chose to develop four main classes, which will be used to store various information for access and manipulation. These four classes included the *Ontology*, *Video*, *Annotation* and *DatabaseHelper* classes.

The implementation of the *Ontology* is discussed above in section 7.3. The reasoning behind developing this class was to store the vocabulary of the ontology uploaded to the system. By storing the vocabulary of the ontology in one object it could be easily accessed to provide users with the dance terms to annotate videos, therefore speeding up the annotation process.

The *Video* class is used to create objects to store all information relating to videos, such as the title of the video, the path of the video in the device storage and the type of dance it is related to. In conjunction with this, the *Annotation* class was developed. This class is used to create objects to store all information relating to one specific annotation that is associated to a video object. It stores information such as the video it is annotated to, the dance type it is related to, the dance move and its actions and a description or other notes that can be attached to this dance move. The *Video* and *Annotation* objects are used in conjunction with one another as each video object contains one or more annotation objects. This is further used when storing information within the tool's local database.

The database design further propagates the approach of an object-orientated design to storing information. A *DatabaseHelper* class was developed to create, access, update and remove data from the tool's local database. This ensures that only one class is responsible for all methods relating to gaining access to the database. The *DatabaseHelper* class makes use of *Video* and *Annotation* objects when adding new objects to the database or when updating objects already stored within the database.

Furthermore, array lists are used as another predominant data structure within the application. It is mainly used, due to its ability to dynamically adjust to sizing, i.e. it is easy to add and/or remove objects from an array list. Also, array lists within the Java programming language contains many useful methods that can be used to manipulate the objects stored within them. In addition to this, the array lists can be used to store abstract data types, such as *Video* and *Annotation* objects, to be used throughout the annotation tool.



## 8 System Evaluations

### 8.1 Ontology Development Evaluation

The evaluation of the dance ontology was split into three phases. The first phase included evaluating the process of collecting dance terms for the development of the dance ontology and whether it was an effective method. The second phase involved validating the classes, object properties and relationships used within the ontology that had been developed.

#### 8.1.1 Ontology Development Methodology.

This phase of evaluation included testing the method used to extract dance terms from syllabi presented freely on webpages on the internet. The focus of the development of the ontology was on using two types of Latin dances. We chose to collect dance terms using our methodology for two dance types to ensure that the methodology was well constructed to be extended to not only one type of dance, but many others that follow a formal structure, e.g. Ballet, Kizomba, Rumba, etc. We measured the robustness of the methodology for collecting dance terms by counting the number of new terms that were collected at each iteration of the web-scraping and natural language processing procedures.

#### 8.1.2 Validation of Ontology Entities.

Following the extraction of the dance terms using the methodology, as mentioned in section 7.3, the ontology was developed for Salsa and Cha-Cha-Cha dances. The second phase of evaluation was conducted by sending it for review by the project supervisor, who has substantial knowledge relating to ontology development, and has some degree of knowledge relating to dance concepts. Feedback was obtained through this process to further improve the structure of the ontology and validate the dance terms and their arrangement, with regards to object properties and the relationships between classes.

### 8.2 Annotation Tool Evaluation

The evaluation of the tool was focused on the usability of the functionalities to allow users to complete their objectives.

#### 8.2.1 Participant Recruitment.

To analyze the application flow and the usability thereof, we recruited 5 participants to take part in an evaluation testing process. We were limited to the number of participants available for recruiting due to COVID-19 lockdown regulations. However, we attempted to proceed with evaluation procedures in a safe environment. The participants were recruited by using convenience sampling. The type of participants recruited were mainly focused on individuals who are beginner dancers. These types of participants would be advantageous to our evaluation process as they would highlight any navigational feature problems or functionalities that they would like to be included or removed when using the application.

#### 8.2.2 Evaluation Process.

Evaluations took place online where the participants were provided with the software to complete a task-based evaluation. The interview began by explaining the purpose of the project and any other relevant background information. Participants were, also, informed about how their contribution to the project will be used and that they were free to withdraw from the interview at any time, as well as inform us that they would not like their interview results being published in the final results. Once the participant had signed the consent form the interview proceeded.

The interview was semi-structured, as the interview was divided into two parts. The first part of the interview was a set of tasks that the user was expected to complete using the annotation tool developed, testing the functionalities of the tool. The second part of the interview consisted of obtaining feedback from the user about their experience with the use of the tool to complete their tasks. Within this stage of the interview, participants provided feedback on any issues that they had with the usability of the application and any recommendations on improving it. Appendix B includes a list of the tasks asked to be completed by the user and other questions to highlight any issues that the user might have encountered.

## 9 Results Discussion

### 9.1 Dance Ontology

#### 9.1.1 Ontology Development Results.

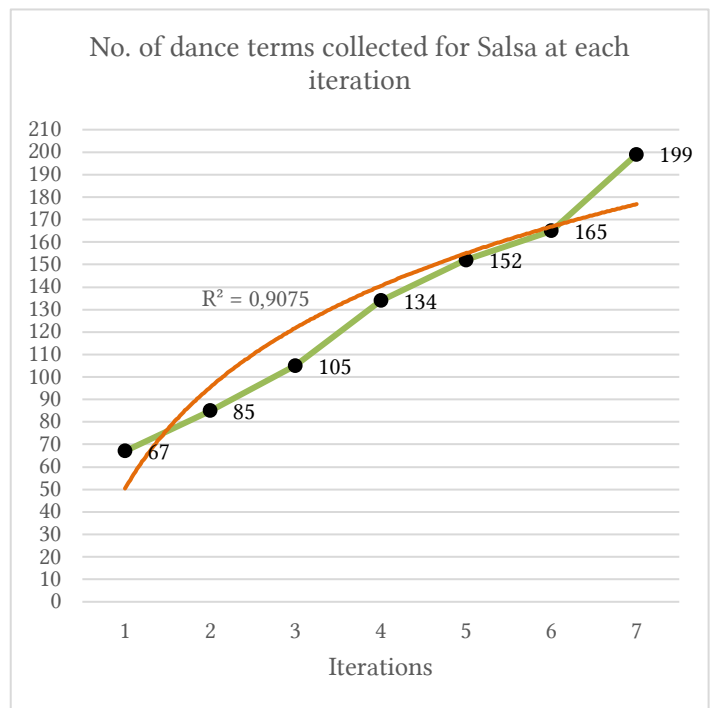
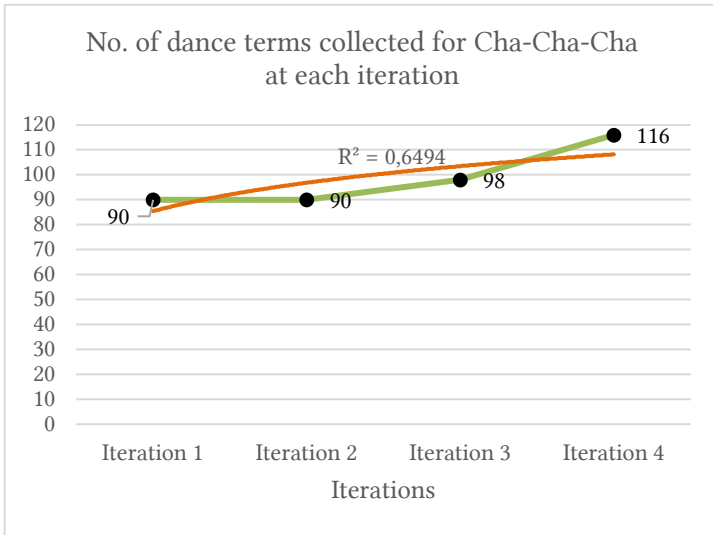


Figure 5: Graph illustrating the number of Salsa dance terms collected at each iteration

The results to test how well constructed the process of extracting terms were divided into two, i.e. Salsa and Cha-Cha-Cha results. Below are the graphs illustrating the number of new dance terms being extracted at each iteration. Salsa included eight iterations of term extraction, while Cha-Cha-Cha included four iterations.

As can be seen from the above graphs (figures 5 and 6), there is a downward logarithmic trend in the number of new terms collected at each iteration of term extraction (orange line). A logarithmic



**Figure 6: Graph illustrating the number of Cha-Cha-Cha dance terms collected at each iteration**

trendline was chosen as it best demonstrates the rate of change of data, and whether it increases, decreases or levels out.

From both the graphs above, the trendline tends to level out towards the end. When comparing the two graphs, it can be seen that the number of new Salsa terms collected overall increased faster than that of Cha-Cha-Cha. However, there were more results collected for Salsa than for Cha-Cha-Cha. This can be further attributed to the fact that the R-squared value of the Salsa term collection is 0,9075, which is classified as a large positive association. This means that there tends to be a large increase in the number of terms collected at each point. On the other hand, the R-squared value of the Cha-Cha-Cha term collection is 0,6494, which is classified as a small positive association. This indicates that there is a slower increase in the number of new terms collected. In comparing the R-squared values of the two graphs, it is clear that after each iteration of Cha-Cha-Cha term collection results in less new terms being collected each time, compared to that of Salsa.

### 9.1.2 Ontology Development Results.

As a result of the previous process, the dance ontology had been developed, as discussed in section 6.

Figure 7 shows a snippet of the dance ontology developed. The general structure of the ontology relates to a dance type. Each dance type can contain some levels, as in the case of Salsa these levels are *Level I*, *Level II*, *Level III*, *Level IV*. Each dance move is then categorized under each dance level, as in the above diagram, the *Side step*, *Backward slide*, *Front step* and *Basic step* are all

categorized under *Level I* difficult level. Cha-Cha-Cha has the similar structure to Salsa displayed above.

The final dance ontology developed resulted in 267 classes. Furthermore, there are 1099 axioms between these classes. As a result of the knowledge acquisition process it can be seen that the ontology is large.

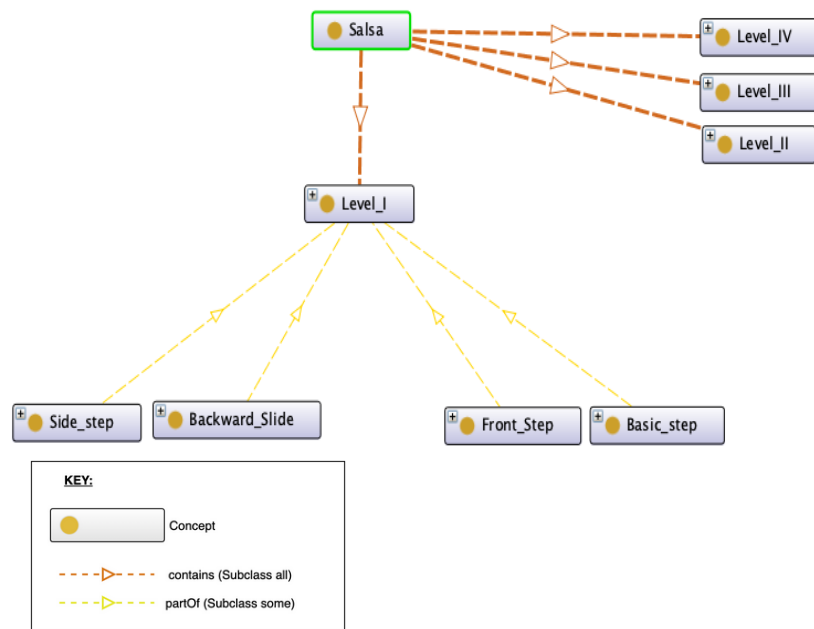
### 9.1.3 Validation of Ontology Entities Results.

After the project supervisor had reviewed the ontology and its entities, she had proposed a number of changes to be made.

The ontology had included an object property called 'isA'. It was highlighted that the 'isA' object property is redundant as objects being subclasses of another indicates this relationship. Subsequently, the names of the object properties had to be reconsidered to fit the context and that would be better suited for use within the dance ontology.

The relationship between specific class that had been set needed to be inverted. In this case, the ontology uses 'SomeLevel' memberOf some 'SomeDanceType'. It was suggested that the relationship be inverted to 'SomeDanceType' contains only 'SomeLevel'.

Also, synonyms for dance moves needed to be dealt with, by adding additional annotations to the dance moves. Furthermore, terms that were added to the ontology that contained the same dance move, but had capitalizations within them or not, plural and/or singular versions of the same dance move had to be put into one class.



**Figure 7: Snippet of the dance ontology developed**

## 9.2 Annotation Tool Evaluation Results

The tool was evaluated to ensure that it meets the usability requirements (section 3.2).

To evaluate the ease of learning the functionalities of the tool was

determined by whether or not participants were able to annotate using both the pre-defined and self-defined annotation options. All participants were able to successfully annotate the videos given to annotate. However, 2/5 participants struggled to select a video from their device for annotating within the tool.

We aimed for the annotation process to be completed within 2 – 4 minutes per annotation. The average annotation process per annotation took participants 1:34 minutes to complete. The average annotation process per pre-defined annotation took participants 1:50 minutes. The average annotation process per self-defined annotation took participants 1:19 minutes.

Every participant, i.e. 5/5, indicated that they would be able to remember how to use the tool after the evaluation process, and that the tool was easy to understand. However, it was suggested that a tutorial be included to understand how the process of annotating works before using the tool. Additionally, it was confirmed by each participant that they had received feedback at each step of the annotation, deletion and editing processes.

Problems that arose during the evaluation process included that the annotations that are added within the annotation process be shown as annotations are being added.

## 10 Discussion

### 10.1 Dance Ontology

From the results discussed above relating to the collecting of dance terms, it can be seen that there is a slow increase in the number of new terms being added to the term collection for Cha-Cha-Cha, while the opposite is true for Salsa. This can be attributed to the fact that Cha-Cha-Cha dance terms are fairly standard and have very little variation in them, compared to Salsa dance terms. The aforementioned can, therefore, be as a result of Salsa having different styles and therefore different dance terms. Overall, the gathering of dance terms using the method stated in section 6 worked well as it resulted in a large ontology and the success of annotating a video using the pre-defined terms classified within the dance ontology.

From the feedback received from our project supervisor evaluating the ontology developed, it highlighted the significance of consultation and involvement with an ontology expert to guide the development of an ontology and ensure that the ontology is developed in accordance with ontological standards. Furthermore, the results of the dance ontology could be better verified by consultation with a domain expert, which we did not have access to.

## 10.2 Usability of Tool

The evaluation of the usability of the tool successfully confirmed the incorporation of usability into the tool, as well as highlighted issues within it.

Firstly, all participants were able to annotate videos using the pre-defined and self-defined annotation options, ensuring that the tool is easy to learn. At the start of the project we aimed for each annotation that would be added to a video to take a participant between 2-4 minutes. However, the average time taken per annotation is faster than what we initially aimed for. Although we would expect the pre-defined annotation process to be faster than the self-defined annotation process, it was the opposite. This could be attributed to the fact that participants had taken some time in finding the relevant dance terms for annotating, as opposed to inserting the dance terms in the self-defined annotation process, which essentially faster. Since all participants agreed that they would be able to remember how to use the tool after the evaluation process, which indicates that the tool ensures ease of remembering. Subsequently, there were participants that had trouble identifying how to add a new video for annotating, which means that the understandability of the tool could be improved. Furthermore, the tool provided feedback at each point of the functionalities' processes.

## 11. Conclusions

A dance ontology, including only Salsa and Cha-Cha-Cha, was developed as a means of providing a dance vocabulary to users for annotating dance videos. The process of knowledge acquisition used to collect dance terms proved to be effective since we were successfully able to annotate dance videos using the ontology terms; thus, indicating that the process of collecting dance terms worked and can be extended to other dance types. Furthermore, it is indicative of the reusability of the method for more than one dance type; in the event that the dance type has some formal structured syllabus.

Overall, the incorporation of usability into the annotation tool was successful as it incorporates the usability evaluation basics of an intuitive design, ease of learning, task efficiency, memorability, user feedback and user satisfaction.

## FUTUREWORK

The method used within this project is a well-constructed approach to collecting terms for dance and can be reused to further develop the ontology from this project. Consequently, the dance ontology vocabulary should be validated by a domain expert. Furthermore, the mobile development aspect of the annotation tool can be taken into consideration for further development and improvement.

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## APPENDIX

### A. DANCE ONTOLOGY OWL FILE SNIPPET

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#### *Dance\_Ontology.owl:*

---

<http://www.semanticweb.org/kouthardollie/ontologies/2020/8/untitled-ontology-7#Action> -->

```
<owl:Class
  rdf:about="http://www.semanticweb.org/kouthardollie/ontologies/2020/8/untitled-ontology-7#Action">
  <rdfs:subClassOf
    rdf:resource="http://www.semanticweb.org/kouthardollie/ontologies/2020/8/untitled-ontology-7#DanceMove"/>
</owl:Class>
```

---

## B. EVALUATION QUESTIONS

### ANNOTATION PROCESS

No	Task	Task completed?	
		Yes	No
1	Select video for annotating		
2	Annotate video with the following information: <ul style="list-style-type: none"> <li>• Video name =Testing Annotation Process</li> <li>• Dance type = Salsa</li> <li>• Annotation type = Pre-defined</li> <li>• Difficulty Level = Level I</li> <li>• Dance Move = Back Rock</li> <li>• Action = Back Step</li> <li>• Notes = Back Rock dance move consists of the Back Step action</li> </ul>		
3	Add annotation		
4	Annotate video with the following information: <ul style="list-style-type: none"> <li>• Video name =Testing Annotation Process</li> <li>• Dance type = Salsa</li> <li>• Annotation type = Self-defined</li> <li>• Difficulty Level = Level I</li> <li>• Dance Move = Basic Step</li> <li>• Action = Basic</li> <li>• Notes = Basic step is the foundation of the back rock</li> </ul>		
5	Add annotation		
6	Add video to the system		
7	Navigate to the video that had been added to the system		

1. Time to annotate (Pre-defined)= x.xx minutes
2. Time to annotate (Self-defined)= x.xx minutes

### EDIT & DELETE FUNCTIONALITIES

No	Task	Task completed?	
		Yes	No
1	Find the video with the title "Cha-Cha-Cha: Beginner routine"		
2	Identify how many annotations and the names of the dance moves associated with the video		
3	Remove the annotation with the dance move "New York"		
4	Select any video from the system and edit an annotation by changing or adding information to the notes section		
5	Delete the video titled "Grapevine (Cha-Cha-Cha)"		

### Evaluation Questions:

1. Would you be able to remember how to use this tool after using it during this evaluation process? (Yes/No)
2. Did you understand what the purpose of the tool is and its functionalities?
3. On a scale from 1 – 5, how easy was the tool to navigate when completing tasks? (1 – extremely difficult and 5 – extremely easy)
4. Were you provided with feedback at each point of the tool when completing tasks?
5. Which functionalities proved to be a problem when attempting to use?
6. What you recommend to be added or removed from the application functionalities?
7. On a scale from 1 – 5 how satisfied were you with the application's functionalities?
8. Are there any other general problems that arose during the completion of the tasks?