An Automatic System to Enhance Videos for a Learning Experience, Using an Interlinking Technique

Olfa Ben Said[1, 2*], Ali Wali[2], Adel M. Alimi[2]

[1] Department of Computer Science, King Khalid University (KKU), Abha, Kingdom of Saudi Arabia.
[2] REGIM: Research Groups on Intelligent Machines, University of Sfax, National Engineering School of Sfax (ENIS), BP 1173, Sfax, 3038, Tunisia.

* Corresponding author. Tel.: 00966558101768 ; email: omessai@kku.edu.sa
Manuscript submitted January 10, 2022; accepted April 8, 2022.
doi: 10.17706/jsw.17.192-206

Abstract: Basing on the emergent evolution of web technologies and the increasing number of video consumers on the one hand, and the immense role of this multimedia data in the information diffusion in the other hand, we have thought of designing a new system which makes connection between videos and Knowledge base connected to the semantic web technologies, in order to enhance videos. We aim by this work to enhance information received by the video's viewer with extra-data. The added data must be related to the video topics and explains more the content of the video. In this paper, we present the proposed system with the different components and used techniques.

Keywords: Enhancing video system, interlinking, entercation, open linked data, semantic web, dbpedia, disambiguation, summarization.

1. Introduction

Since, Knowledge bases appeared in the field of computational linguistics and artificial intelligence. They become key assets and with their applications within natural language processing, information retrieval, question answering, data enhancement and many other fields. The actual knowledge bases usually satisfy the information need of the user without resorting to other source documents. At the same time of the appearance and development of knowledge bases, Videos and Photos becomes an integral part of the online social experience. A huge increase of added media content is noticed. Each minute, Hours and Hours of videos are uploaded for sharing.

Hence, one of the areas that need to be researched more is creating an efficient method and technique to deliver connectivity and interaction to the semantic web technologies and videos. In this paper, we will discuss how to combine the mentioned applications by creating a Mashup system that make connection between videos and knowledge bases, in order to tag videos with extra data connected to the Linked datasets.

To realize this idea we propose a new architecture of interlinking videos with extra-data. The system includes a series of steps. Based on different technologies and methods, the mentioned system can enhance a videos with a data that is related to the context of the video, to make the viewer in an intellectual context. In addition to that, the extra data is presented in a concise and comprehensive way to produce a user-friendly interface to the user.

This paper is organized as follows: Related work section contains analysis of models and theoretical

frameworks that have been previously introduced to the research area. Section III presents the proposed architecture of our system. Section IV presents the interlinking sub-system and its different components. In section V, we dealt with the adopted Entity summarization service and its adaptation to the proposed system. Finally, section VI revealed the paper conclusion and the potential future perspectives.

2. Related Work

In the age of Big Data we notice a huge increase in the amount of added videos. Hours of videos are uploaded for sharing each minute. This important increase requires specific treatment regarding these multimedia resources.

Due to the large number of data sources within BBC, [1] use Semantic Web technology to integrate data and ensure a better interlinking of existing systems and connections across BBC domains. They work on two BBC services: BBC programs and BBC music, and they describe a content categorization system called CIS which aims to interlink data items of both services with an extra Linked Open Data, in order to make richer relationships between concepts. Then they interlinked concepts from CIS with Dbpedia as the controlled vocabulary. The core idea of their approach is described by a similarity clustering based on the "context" of concepts. After classification step with CIS, they use the information classification to build similarity clusters (clusters on the same category) which help them to disambiguate the given term. Then, they calculate a similarity metric for the set of meanings based on distances of nodes in the DBpedia categorization and classification graph. All these steps describe how BBC system have published and interlinked existing structured data and concepts. This step will build the structure on which they will base to construct their linked data ecosystem, which is constructed from several services, such as program support sites, Radio Station Sites, TV channels. Otherwise, it supports the branding of all the BBC services; at the same time it ensures to users the ability to traverse the graph of BBC data though to other data sources.

In [2], the team develops a system for automatically interlinking of speech radio BBC archives and automatically assigning tags to programs. This process is used to help navigation and topic-based search of BBC programs. The system begin by transcribing the audio and identifying terms within the transcripts which correspond to the potential tags. Transcription pass through several steps. First a multiple speaker automated speech recognition is described. Then, the system try to reduce the noisiness of those transcriptions to get a list of tags to be applied to the program. In the next, the system proceed to a term disambiguation step using an Enhanced topic-based disambiguation algorithm (eTVSM). They are based on DBpedia as a knowledge database, which is linked to different ontologies. Finally, the system generate the list of linked DBpedia entities with a time-stamp.

In an ulterior study [3], another attempt was proposed to automate the annotation process among the BBC audio and text archive and interlink it to Linked Open Data. BBC World service proceed on a digitization of the radio program's contents. Due to the limited quantity and quality of meta-data, team bootstrap the annotation process using a set of automated interlinking tools basing on preexisting meta-data and audio content. First, they propose an automated tagging from preexisting meta-data. Meta-data is processed using Wikipedia Miner's instances, which proposes a set of Wikipedia identifiers for all the topics detected in the meta-data text. Then identifiers are mapped to DBpedia Lite service and then stored in a shared RDF store with a confidence score. In a next step, they enrich their topics identification with audio content. An identification and transcription of the speech parts was proposed. Basing on the proposed transcripts, a list of DBpedia URI was proposed to tag BBC content. The disambiguation algorithm uses DBpedia's structure to rank the candidate terms basing on a similarity measure. Speaker identification is proposed as a third service, basing on a set of tools. As a result, a unique identifier is created for each

speaker, and linked to all program detecting with the same voice. As a result for the previous cited three services, each program has a set of links identifying topics and speakers. These links help to bootstrap navigation and search in the online web archive.

The objective of the three BBC cited projects was to create a linked data Eco-system that is constructing from several services and to make semantic navigation among all videos or videos and other sources. To realize such an Eco-system, a Knowledge base connected to LOD noting DBpedia, was adopted as a controlled vocabulary.

Another form of video enhancement was proposed in [4]. This experience takes into account two aspects: edutainment (education that entertains) which is based on learning elements; and entercation (entertainment that educates) which focuses on TV programs enriched with learning elements. This experience aims to combining TV programs with learning modules in a personalized way, for the purpose of making learning more attractive and engaging TV viewers in learning experience. The team has developed an architecture for T-learning interactive services called ATLAS. The framework ATLAS (Architecture for T-Learning interactive Services) was born in this experience, to give two fundamental entities: T-MAESTRO is an intelligent Tutoring system, which applies semantic knowledge about the learners to build the T-learning experience; and A-SCORM (Adaptive-SCORM) is an authoring tool, which facilitates to teacher to create adaptive courses with a minimal technical background. In order to relate educational and entertainment contents, both of them should be labeled and modeled. Course creator's agent is responsible for the modelization of Learning contents, which are based on SCORM ontology. As to TV contents, it is marked with metadata in the TV-Anytime specification, where contents are organized in an ontological structure (an ontology for TV contents).

In the same context, [5] proposes a system which offers additional contents linked to the segments of TV programs to create semantic relations, using MPEG-7 segmentation information. The system looks for establishing relationships not only with entire contents but also with some parts of them such as segments of videos, some learning objects or some pages of a web site. Two different fields are proposed as a practical use of this approach: First, to provide the user with educational contents in relation to the program he is watching, and the second field is for personalized advertising, which aims to offer advertisements to the viewer, related to the program's content.

The objective of the two last T-learning projects, was to enhance the videos in order to create an entercation context in this last. As additional data that enhance videos, these systems use learning objects, which are created manually, or pages from external web sites.

In the same context but using different tools, [6] produces innovation-based research towards the e-learning based application. This will be more effective than the existing methods. a MeLing application called "MeL application" was proposed in this paper. MeL supports mixed and cooperative learning with various capacities that benefit the learners to collaborate, and the system prove that learning with various capacities benefit the learners to collaborate with content effectively, adequately, and productively. [7] also present a proposal for a smart edutainment application for young children which allow automatic identification of the child and adaptation of the interaction flow based on the child's emotions. the idea and the need of this applications comes from the reality that, this tools has been rapidly transformed into a mandatory requirement due to the current COVID-19 pandemic. In [8]Authors present a new tool called Powtoon that it was used to support the teaching and learning process in the experimental class based on an edutainment approach. The experience showed positive effect on the students' comprehension and gained positive responses from the students.

In our proposed system, we base on the idea of making a system interlinking videos with additional content aiming at matching educational and entertaining elements. In the other hand, similarly to BBC

projects, we use a knowledge base connected to LOD, noting DBpedia, as the controlled vocabulary, that will also play the role of the data provider of the extra-content to enhance videos.

3. Proposed System

Large amounts of videos are published every day into the web taking different topics. Our idea consists of enriching the main topics of a video with extra information from DBpedia. Fig. 1 illustrates our idea. We aim, by this work, to engage videos viewers in an intellectual context, therefore making video an entercation [1] (entertainment+ education) environment. Moreover, we aim to interlink videos specifically with a Knowledge base connected to Linked Data in order to enrich videos and make them connected to a variety of sources and data. Starting from an input video, we must ensure connection from the video towards the knowledge base DBpedia.

Fig. 2 presents the proposed architecture. The first part represents the video data source (left top side of the figure). A pre-treatment step is required in order to extract information from the input multimedia content (video in our case). First of all, the video must be segmented into several parts. Then, each segment have to be semantically annotated. Video description can be extracted from different sources. It can be described with metadata (such as title, video descriptions, keywords, context, etc), it can be also taken from audio/visual modality and other data. In our case, we adopt TRCVID2 database as input videos, where videos are accompanied with metadata represented as keywords. Thus, we based on these metadata to make linking with the extra-resources.

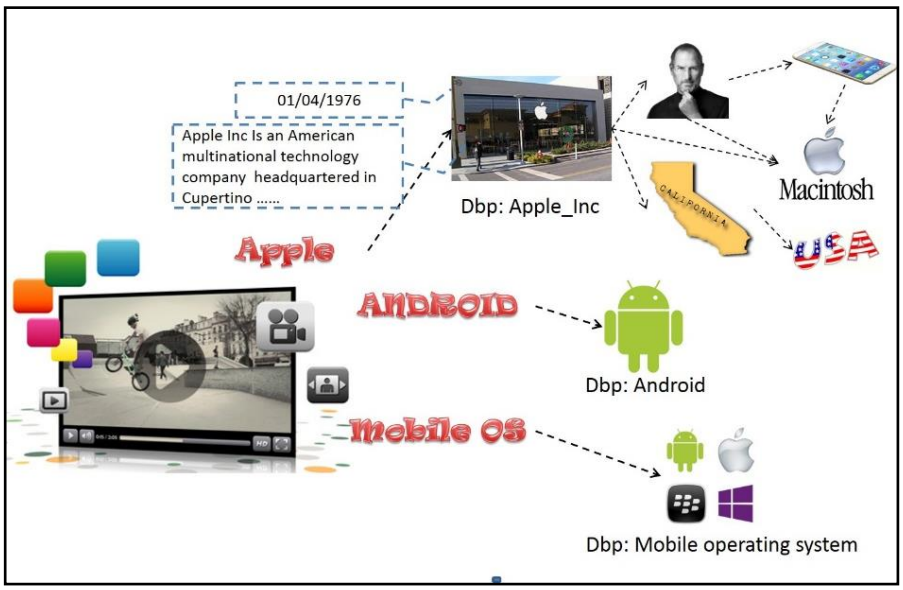

Fig. 1. Proposed system.

The second bloc (middle side) concerns the interlinking between the two resources, Videos and Knowledge base. The objective of this task is to interlink videos basing on their description with extra data within the W3C3 Linking Open Data community project. Actually, the interlinking step consists of assigning, to each segment of video, an external resource that resembles to it semantically. This step is illustrated in

[1] This term is used in [4] also in the web, having the mean of entertainment that educates

[2] The main goal of the TREC Video Retrieval Evaluation (TRECVID) is to promote progress in content-based analysis of and etrieval from digital video via open, metrics-based evaluation. TRECVID is a laboratory-style evaluation that attempts to model real world situations or significant component tasks involved in such situations.

[3] The World Wide Web Consortium (W3C) is an international community where Member organizations, a full-time staff, and the public work together to develop Web standards. Led by Web inventor Tim Berners-Lee and CEO Jeffrey Jaffe, W3C's mission is to lead the Web to its full potential.

the middle side of the architecture in Fig. 2. The extra content is extracted from the knowledge base DBpedia resource. This step requires semantic reasoning techniques, as well as techniques for searching the semantic correspondence between the two contents (video description and DBpedia). We adopt DBpedia as the encyclopedic resource, since it is considered as the largest dataset in the Linked Open Data Cloud and it is extracted from Wikipedia, the biggest multilingual free encyclopedia. The process and the architecture of our system was described in [9]and [10].

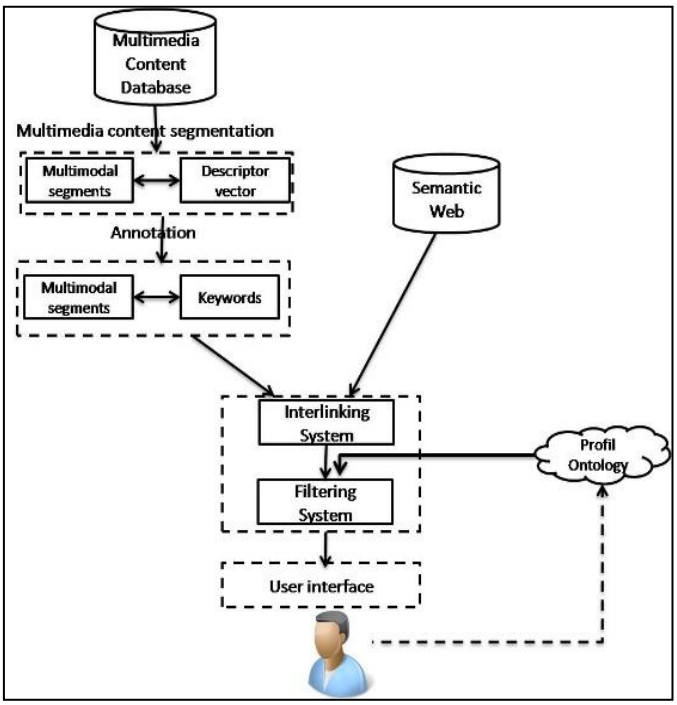

Fig. 2. Video interlinking system architecture [12] [13].

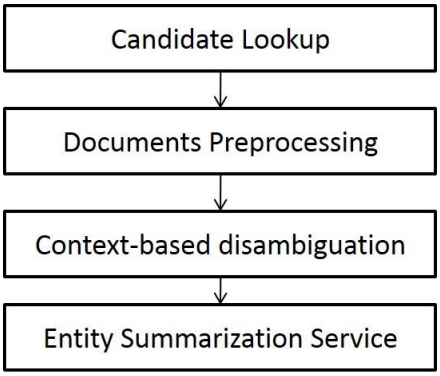

Fig. 3. System components [13].

4. Interliniking Sub-system

In this section, we focus on the interlinking process, which aims to link videos description with DBpedia Dataset. As presented in Fig。 3, the interlinking sub-system is composed from four main steps: Candidate Lookup service, Documents Preprocessing, context-based disambiguation and Entity summarization Service.

In the Lookup step, the system builds his space candidate resources according to the searched keyword. Document preprocessing consists of modeling the list of candidates and applying a list of pretreatment

steps. The disambiguation consists of applying ranking function to choose the most relevant candidate according to query's vector and candidates' vectors. In the summarization service, we aim to filter only the main proprieties for the selected entity. Otherwise, this service aims to summarize selected entities and presents main information in a concise form. The interlinking process is described in Fig. 4.

4.1. Candidate Lookup

In the first step, we describe the possible candidates for the ambiguous word by querying DBpedia with a label matching the keyword. In fact, the DBpedia endpoint service, will Query the database about all resources which their label contains the keyword in question. The outputs of this query describe our DBpedia resource candidates, which represent possible senses of the keyword. The example of Fig. 5 describes a query, which seek to find all English entities where label contains the word "Apple", from DBpedia dataset.

The request looks for the label, the DBpedia URI and the corresponding Wikipedia URI. All redirect and disambiguation pages are excluded. Redirect pages occur, if it exists an accepted different spelling or a common misspelling for the resource. In fact, redirect is a page that sends a reader to another page. This feature is shown in DBpedia in the RDF propriety dbpedia-owl:wikiPageRedirects. For example the DBpedia page of Bob Marley (dbpedia:Bob_Marley.) cites in its redirect pages the BDpedia page dbpedia:Bob_Marly. It means, if a user send the browser to http://en.wikipedia.org/wiki/Bob_Marly, he will end up on http://en.wikipedia.org/wiki/Bob_Marley. On the other hand, disambiguation pages on DBpedia and Wikipedia are used to resolve conflicts in some article titles, when a term can occur with more than one topic. This propriety is defined in a DBpedia page with dbpedia-owl:wikiPageDisambiguates. Thus, from the query result we can construct the DBpedia candidates and consequently we can get the textual description of each entity from the corresponding Wikipedia article.

```
PREFIX dbpedia-owl:<http://www.dbpedial.org/>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX dbo:  <http://dbpedia.org/ontology/>
SELECT DISTINCT  ?Name ?Dbp ?Wikiurl   WHERE
{
    ?Dbp  rdfs:label  ?Name.
    ?Dbp  foaf:isPrimaryTopicOf ?Wikiurl  .
    ?Name <bif:contains>  "Apple".
    FILTER (langMatches( lang(?Name),"EN")).
    MINUS
      {?Dbp
       dbo:wikiPageRedirects|dbo:wikiPageDisambiguates
       ?dis }
}
```

Fig. 5. DBpedia SPARQL query [13].

4.2. Document Preprocessing

We choose Wikipedia articles to obtain the textual descriptions corresponding to each DBpedia candidate. The choice of Wikipedia instead of DBpedia is due to the quality of textual information contained in Wikipedia. Whereas DBpedia contains only a small abstract, which will not being useful to build the vectors and therfore will not give relevant ranking result. The document corresponding to each entity, coming from Wikipedia articles pass into a pre-processing step. In the first step, the system exclude stop words, which often have a high frequency and isn't useful to distinguish between documents. Then, a Stemming Algorithm is applied. Stemming is the process of reducing inflected or derived words to their stem or base form. In this

context, we apply Porter Stemmer Algorithm [11]. Finally, the system extracts the most frequent words and its frequencies, to construct vectors representing each entity. The output result of this step is a vector of the most frequent words of each DBpedia entity and its frequencies.

4.3. Context-Based Disambiguation

In the current step, we have to select the proper sense among all candidates according to the context of the keyword. In order to disambiguate the possible matches, the system ranks all candidate resources by using a similarity score for each candidate. To do so, the system compute the similarity between the keywords context and the resource description. We adopt the Vector Space Model (VSM) to represent our system. The algorithm deal on vectors already prepared, representing the document and the query. After that, the similarity is calculated between those vectors, using as measure the cosine of the angle they form.

The objective of the disambiguation process is to choose among all interpretation associated to a keyword, the most appropriate one, according to the context of the ambiguous word. In previous publications [12] and [13] , we test two disambiguation algorithms VSM and TVSM and we showed in [13] that the Topic-based Vector Space Model (TVSM) is characterized by its flexibility in definition of term similarities and has given good results in our system.

Figure 6 illustrates the generated XML file containing Meta-data concerning the selected video (video Title, duration) and information about each segment (keywords, Ranked DBpedia list with the similarity value for each entity).

```
<?XML version="1.0"?>
<Ranked_DBpedia_List>

<Video_Name>Storyboard for www.hypedbingo.com </Video_Name>
<Duration>00:03:36</Duration>
<Segment>
<id> 1 </id>
<Keywords>storyboard;illustration;animation;bingo;online bingo;editorjackie</Keywords>
<Time begin="00:00:00" end="00:03:36" />
<DBpedia_List>
<Entity URI="http://dbpedia.org/resource/Storyboard" Value="0.677" />
<Entity URI="http://dbpedia.org/resource/Storyboard_artist" Value="0.461" />
<Entity URI="http://dbpedia.org/resource/Bryan_Andrews_(storyboard_artist)" Value="0.380" />
<Entity URI="http://dbpedia.org/page/StoryBoard_Quick" Value="0.358" />
<Entity URI="http://dbpedia.org/resource/Crank_Storyboard_Suite" Value="0.339" />
</DBpedia_List>
</Segment>

</Ranked_DBpedia_List>
```

Fig. 6. Generated XML file [13].

4.4. Entity Summarization Service

The disambiguation process results a DBpedia entity, which refers to the main topic of the video's segment. The selected entity contains different information in the form of RDF triplet or even a literal value. Resource's information (facts) varies from one resource to other, depending to the entity membership and the popularity of the resource. For example the entity DBp:BobMarley, which belongs to Artist's class, contains birthDate, birthName, BirthPlace, Religion, musicalBand of, producer of, etc. Whereas, the entity dbp:Apple_Inc, which belongs to Company class, contains different facts, such as foundedBy, foundingDate, locationCity, service, product, industry, etc. In addition, two sources having the same class can differ in representing its facts, if one resource is connected to several external links due to its popularity. Most of Entity Summarization work focuses on some criteria in the selection of facts, such as popularity, relatedness, informativeness, etc.

The aim of this task is to present the entity selected for the video in a concise form instead of presenting all the entity. Due to the specificity of our system, this task is primordial and will improve the visualization of our application.

In this task we have adopted the SUMMA API. After a literature overview, SUMMA seems the most suitable to our needs. It includes different criteria such as relevance, popularity, conciseness. With SUMMA we can also define the summarize with the chosen languages. Likewise, SUMMA is adopted to DBpedia entity and provides an open-source reference implementation. In the next, we present the details of the adopted method and how we adapt it to our system.

5. Entity Summarization Adapted to Interlinking System

5. 1. Background

Knowledge bases field has known a huge development these last years. Indeed, Knowledge bases are increasingly developed and highly used by intelligent systems, search engines and several other applications. With the wealth of these data, comes the problem of the navigation into this last and the extraction of important facts and information. That's when appeared the entity summarization methods. The big challenges in this field of search, is to decide which information is important and according to which criteria we have to extract these information. Figure7 presents the DBpedia entity's interface of "dbp:Apple_Inc.". According to the figure, we notice the huge information's quantity that could contain a Knowledge base entity.

In some cases and for some applications, this large amount of information becomes embarrassing. That is why; it would be very valuable to have systems that extract only limited information from such a graph. This problem is called Graphical Entity Summarization (GES). As regards GES problem, an entity is specified by a user or generated by a system (e.g.following an interlinking stage, as it is in our case), in order to give to the system the ability to summaries facts of the entity.

In the last years, entity summarization's field has gained particular attention by both industry and research. On one hand, the commercial approaches have the propriety of being very specific to their individual settings and rely on large amounts of background information. As such, these approaches can neither be generally applied nor reproduced. As to approaches from scientific field, they are more generic and generally applicable. In the next, a list of criteria is extracted that can make a good entity summarization.

Conciseness

A good summary should have a concise form and not very long representation. Conciseness can be declared in two forms, with a given percentage of the facts that will be presented or with an upper limit fixed either by the developer or by the user. The second method is better than the first one, due to the fact that the amount of facts contained in an entity varies from one entity to another. For example 20% can represent 1000 facts for an entity while only 10 for other entity.

Relevance

Relevance is the topological proximity of an arc to the query-entity in the semantic knowledge graph. I.e. the arcs that are less number of hops from the summarized node represent facts that are more "relevant" to this node.

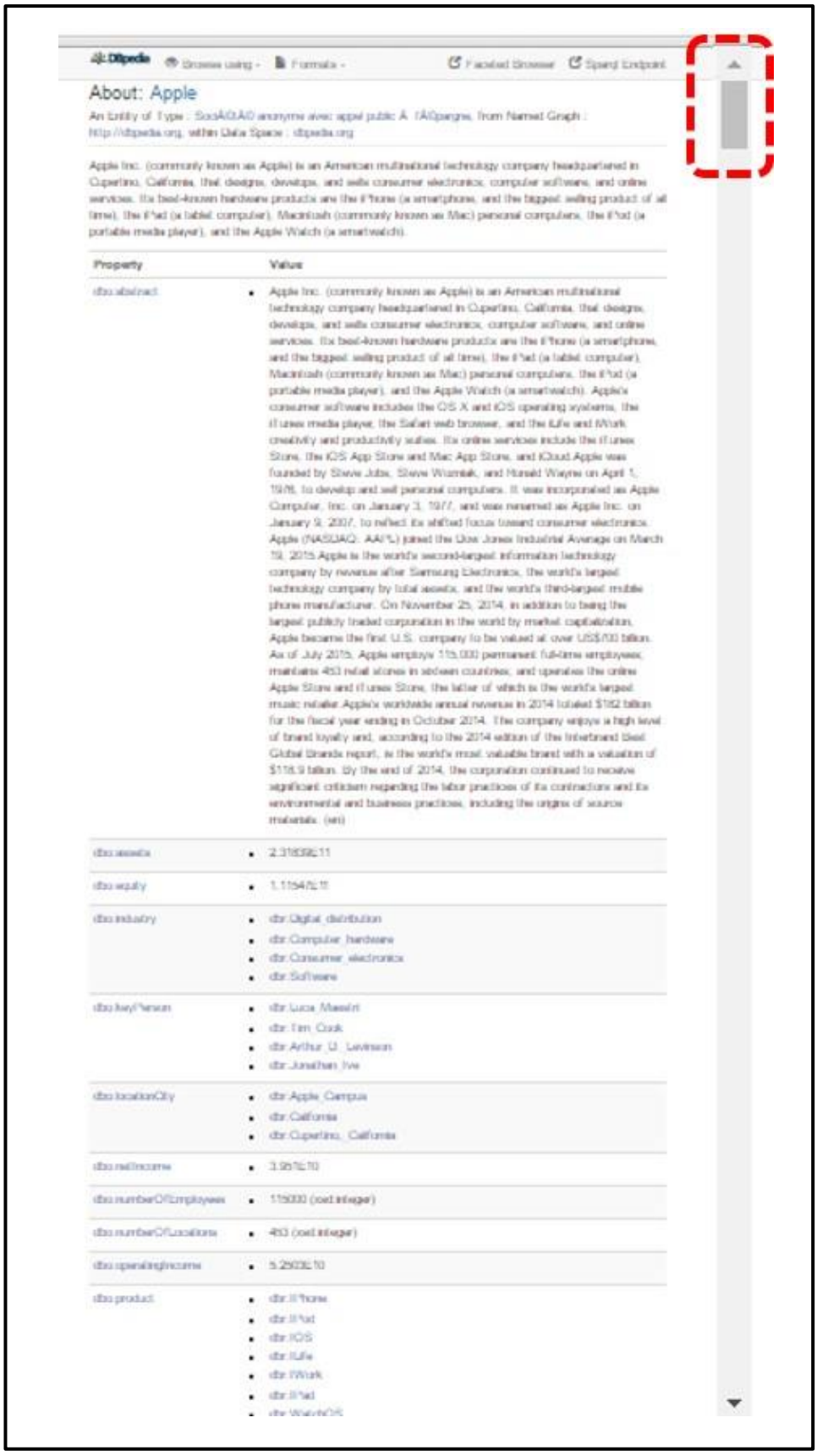

Fig. 7. Related information of the dbpedia entity "Apple_Inc."

Diversity

It is more convenient if the summary presents a diverse choice of predicates (type of relation). It becomes

boring if we get a repetitive list of the same relation. For example for the example of William Shakespeare, for the property "author of " we can get "First Faulio", "Mac Haumor ", "Shakespear: The animated Tales", etc. Diversification aims to avoid this problem to provide a more complete entity's overview.

Importance/ Informativeness

Importance is based on the arcs' weights that represent importance of the fact. Different methods are proposed for this metric, the most used one is the PageRank algorithm and other variants such a Random surfer.

Popularity

For each entity, there are some types that convey valuable information. Popularity is based on the statistical frequency of arc label in the topological neighbourhood of the summarised node in the graph. Example the type English Poet is very important if we talk about William Shakespeare, while it is less important if we talk about People of the Tudor period.

5. 2. Entity Summarization Overview

The Entity Summarization field, that has recently been studied, aims at summarising information around a single node in a graph or an entity. The first proposition was presented by [14] , who proposes an algorithm called PRECIS. PRECIS is a diversity-oblivious approach, which try to simply selects the K edges closest to the entity. An experiment presented in [15], shows that for the query 'Tom cruise', the summarization algorithm extract only edges 'actedIn'. This result is clearly not optimal.

A similar proposition called RELIN [16], uses a random surfer model on a graph to rank features that characterize the entity. The both proposed algorithm aims at quickly identifying the entity. In fact, it focuses on distinctive information and it does not consider important information, also it does not look at diversity [17] discuss a number of heuristics to rank proprieties of DBpedia entities in order to identify proprieties connected to related entities.

DIVERSUM [15] is a diversity-aware approach. Unlike to PRECIS and RELIN, DIVERSUM doesn't suffer from the redundancy problem. It tries to produce a diversified output by avoiding arc label redundancy. DIVERSUM summary is constructed by adding the edge having the shortest distance to the entity and the most frequently used property in the data. Especially, in order to improve its diversity, DIVERSUM does not generate features sharing a common propriety. [18] also considers that the importance of entity's feature is related to the number of relation with nearest neighbours. So, it exploits usage data (such as ratings) to identify the most shared proprieties with the k neighbours. Like PRECIS and RELIN, this method does not consider diversity.

A recent work to Thalhamer called SUMMA was proposed in [19]. It consists of an API definition that presents an entity summarisation service with DBpedia, which combines diverse summarisation approaches. To develop this API, Thalhamer proposes The SUMMA vocabulary, which offers different parameters that represent a summary and a RESTful Web Service. We adopt this method in our enhancement video application and adapt it to the needs of our system. The method adopted by SUMMARUM ranks objects (ongoing links) based on the number of Wikipedia's incoming links and makes it available with vRank vocabulary. In an ulterior version [20], vRank was updated by combining two measures: one that accounts for the importance of the connected resource (PageRank) and one that accounts for the strength of the connection (Backlink). Also, this research work in [21] represent resent the first comprehensive survey of entity summarization research. Table 1 outlines some summarization propositions presented above and the different criteria respected by each technique. All methods present already summaries of entities in a top-K manner to ensure Conciseness criteria.

Table 1. Overview of Summarization Systems [22]

	Relevance	Importance	Pupularity	Diversity
PRECIS	✔	✔		
RELIN	✔	✔		
DIVERSUM	✔	✔	✔	✔
SUMMA	✔	✔	✔	

The entity summarization is also a part of some search engines, such as Google (GKG) [23], yahoo Knowledge [24] and Microsoft Bing Satori/Snapshots [25]. Google Knowledge graph (GKG) aims at enriching results of the user query with summarized information about disambiguated entities. Google bases in its summarization on contexts about data items (e.g abstract from Wikipedia, birthdate, population, etc) for some facts. In addition, some proprieties are always present, such as abstract, pictures, entity names. GKG supports RDF to enable the adaptation of summarisation according to the preferred language. Bing extracts features similar to GKG (grouping, special property, context and multi-languages). As to Yahoo Knowledge, it displays his service only for persons and movies. Summarisation in Yahoo is not available for all languages.

5. 3. Adopted Method

After a literature overview, we conclude that SUMMA API [19] is the most suitable to our needs. It includes different criteria. SUMMA ensure relevance by including the property maxHops; In fact, relevance is ensured when setting maxHops to 1. A popularity-based approach is also proposed, which compute the Rank Scores for each statement, using the vRank4 vocabulary (Vocabulary for Ranking). As to conciseness, SUMMA defines a property called topK, which define the number of statements that will be returned.

Fig. 8. Result of SUMMA summarization system of the entity dbp:Apple_Inc., with a topK=5 and topK=10 [22]

Other property presented in SUMMA is the possibility of defining summarize with the chosen languages. Likewise, SUMMA is adopted to DBpedia entity and provides an open-source reference implementation. After configuring all the cited parameters; that will be defined later with others; it will be the most adequate service that could be passed. Therefore, we adopt this service and adapt it to our system after making the appropriate changes.

This approach consists of two main components: SUMMA Vocabulary and the RESTful web service. SUMMA API server adopt these notions to make a uniform interface for entity summarization that meet the

[4] vRank aims to model ranking information within datasets.
vRank: http://purl.org/voc/vrank#-

standard of the Linked Data model. Figure 8 represents the result of SUMMA summarization system of the entity dbp:Apple_Inc., presented in English language with a topK=5 and topK=10.

Our proposition consists of adapting the SUMMA API to our interlinking system. In other word, this integration aims to present the selected entity in a concise and comprehensive form and to send the information in a light way that suits to the application's need. As we presented above, the SUMMA service presents a good summarization system, which responds to different criteria. Nevertheless, there is still a lack of some information. As Goggle or Yahoo summarization system, we catch up the idea of specific properties. We make the necessary changes to the existing service, and we add the abstract and a picture that describes the entity to the old SUMMA interface. We get the examples present in Fig. 9.

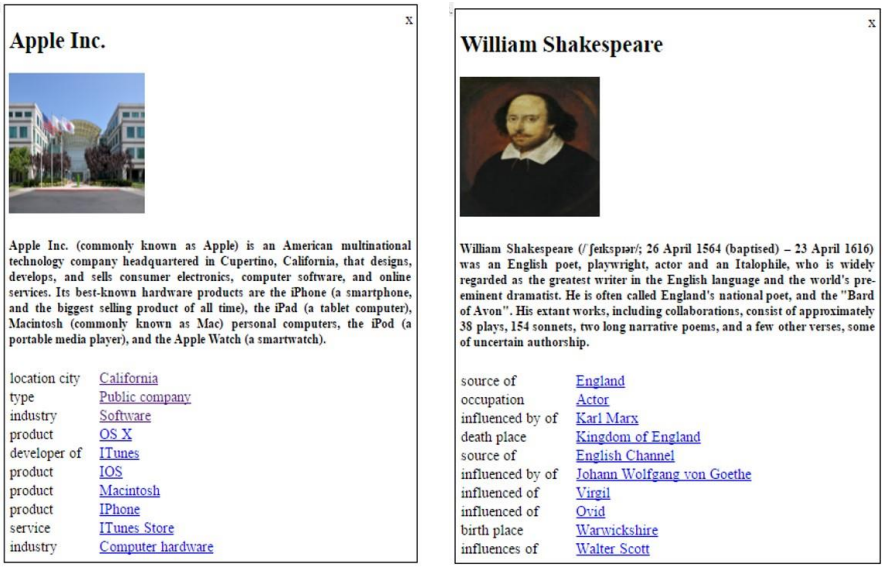

Fig. 9. A screen-shot of the SUMMA Summarization system after modification with dbp: Apple_Inc. and dbp: William_Shakespeare [22].

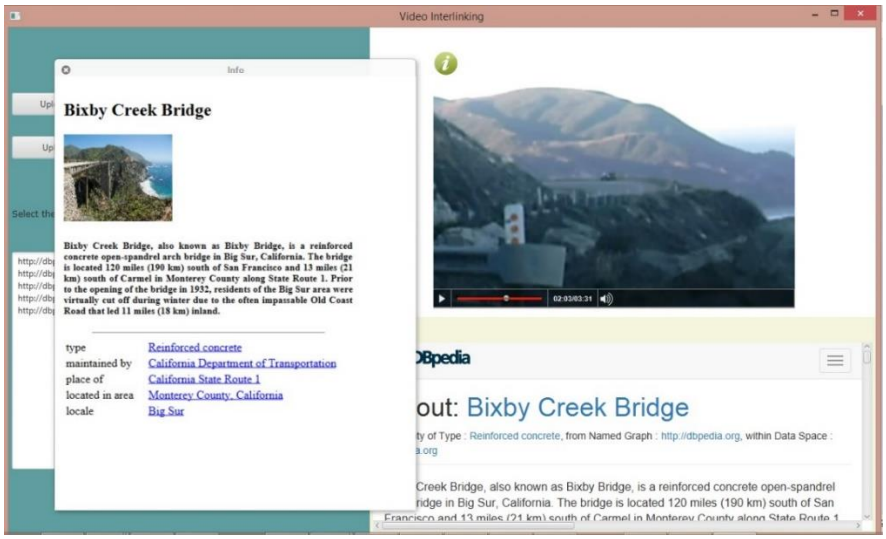

Fig. 10. Screen-shot of a video about "Bixby Bridge" enhanced with DBpedia entity and presented with Summarization system.

6. Conclusions and Future Work

Multimedia content such as videos become, an integral part of the online social experience and in the all

internet traffic services. This important increase requires specific treatments regarding these multimedia resources and specific intelligent systems for enrichment and adaptation with the new trend of the digital technologies. This fact was the basis of our idea. Indeed, the explosive increase of videos gave us the idea to enhance videos with extra-content. Moreover, it has also widely spread among end users, students, researchers, which can help them to enhance their learning experiences.

In this paper, we proposed the integration of a knowledge base connected to LOD, for the enhancement of a video. Our system is a mashup between videos and Semantic web, which aim to automatic interlink videos with a knowledge base connected to LOD. The aim of this system is the enhancement of the main topics contained into a video, to make the viewer in an intellectual context while he is in an entertaining environment. The enhancement process is assured using a knowledge base, which will be then summarized to be presented in a concise form to the user. As DBpedia reflects the largest Knowledge Base in the Linked Open Data cloud, we use it for our interlinking system in regard of enhancing videos with structured information coming from the biggest Knowledge base.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Author1: Olfa Ben Said: Conducted the research, implemented the sub-system, wrote the paper.

Author2: Ali Wali: Analyzed the data of interlinking sub-system, helped in the organization and reviewed the paper.

Author3:Adel M. Alimi: Analyzed the data of Entity summarization sub-system , helped in the organization and reviewed the paper.

all authors had approved the final version.

References

[1] Kobilarov, G., Scott, T., Raimond, Y., Oliver, S., & Kobilarov, B. C. A. L. (2009). Media meets semantic web-how the BBC uses dbpedia and linked data to make connections. *Proceedings of the 6th European Semantic Web Conference (ESWC)*, Heraklin, Crete, Greece.

[2] Raimond, Y., & Lowis, C. (2012). Automated interlinking of speech radio archives. *Proceedings of the Word Wide Wibe* Conference, Lyon, France, 2012.

[3] Raimond, Y., Ferne, T., Smethurst M., & Adams, G. (2014). The BBC world service archive prototype. *Web* Semantics*: Science, Services and Agents on the World Wide Web*, North America,.

[4] Marta, R. L., Rebeca, P. D. R., Ana, F. V., José, J. P. A., Martín, L. N., Jorge, G. D., Alberto, G. S., & Manuel, R. C. (2008). T-MAESTRO and its authoring tool: using adaptation to integrate entertainment into personalized t-learning, *Multimedia Tools Appl,* 409-451.

[5] Marta, R. L., Ana, F. V., Rebeca, P. D. R., Martín, L. N., José, J. P. A., Alberto, G. S., Manuel, R. C., & Jorge, G. D., Enhancing TV programmes with additional contents using MPEG-7 segmentation information. *Expert Syst. Appl.,* 37(2), 1124-1133.

[6] Saidani, O. *et al*. An educational tool for enhanced mobile e-Learning for technical higher, microprocessors and microsystems.

[7] Guran, A. M., Cojocar, G. S., & Dioşan, L. S. (2021). Towards smart edutainment applications for young children. *International Conference on Intelligent Tutoring Systems,* 439–443, 2021.

[8] Adnyani, L. D. S., Suprianti, G., Marsakawati, N. P. E., & Narotama, P. D. A. (2020). Powtoon as the

implementation of edutainment for young learners (ICTES 2020). *Proceedings of the 2nd International Conference on Technology and Educational Science*.

[9] Said, O. B., Karray, H., Haqiq, A., & Alimi, A. M. (2013). T-learning and interactive television for edutainment. *Proceedings of the International Conference on Engineering Education and Research.*

[10] Olfa., B. S., Ali, W., & Alimi, A. M. (2013). A new system for TV program contents improvement using a semantic matching technique. *Proceedings of the 13th International Conference on Hybrid Intelligent System*.

[11] Porter., M. F. (1997). Readings in information retrieval. *An Algorithm for Suffix Stripping,* 313-316.

[12] Olfa., B. S., Ali, W., & Alimi, A. M. (2015). Interlinking video programs with linked open data. *Proceedings of the 15th International Conference on Intelligent Systems Design and Applications (ISDA)*.

[13] Olfa., B. S., Ali, W., & Alimi, A. M. (2016). Interlinking video with DBpedia using knowledge-based Word sense disambiguation algorithms. *Journal of Information Assurance and Security, 6(11)*, 322-330.

[14] Sydow, M., Pikuta, M., & Schenkel, R. (2010). Entity summarisation with limited edge budget on knowledge graphs. *Computer Science and Information Technology.*

[15] Sydow, M., Pikuta, M., & Schenkel, R. (2013). The notion of diversity in graphical entity summarisation on semantic knowledge graphs. *Journal of Intelligent Information Systems, 41(2)*, 109-149.

[16] Cheng, G., Tran, T., & Qu, Y. (2011). RELIN: Relatedness and Informativeness-based centrality for entity summarization. *Proceedings of the The Semantic Web - Iswc 2011: 10th International Semantic Web Conference*.

[17] Waitelonis, J., & Sack, H. (2012). Towards exploratory video search using linked data. *Multimedia Tools and* Applications*, 59(2)*, 645-672.

[18] Thalhammer, A., Toma, I., RoaValverde, A. J., & Fensel, D. (2012). Leveraging usage data for linked data movie entity summarization. *Proceedings of the 21st International World Wide Web Conference*.

[19] Thalhammer, A., & Stadtmüller, S. (2015). SUMMA: A common API for linked data entity summaries. *Engineering the Web in the Big Data Era,* 430-446.

[20] Thalhammer, A., Lasierra, N., & Rettinger, A. (2016). LinkSUM: Using link analysis to summarize entity data. *Proceedings of the Web Engineering: 16th International Conference*.

[21] Liu, Q., Cheng, G., Gunaratna, K., & Qu, Y. (2021). Entity summarization: State of the art and future challenges. *Journal of Web Semantics, 69*.

[22] Olfa., B. S., Ali, W., & Alimi, A. M. (2016). An adapted entity summarization service for an enhancement video system. *Proceedings of the 16th International Conference on Hybrid Intelligent Systems*.

[23] Singhal, A. (2012). Introducing the Knowledge Graph: Things, not strings.

[24] Torzec, N. (2014). Yahoo's Knowledge Graph.

[25] Qian, R. (2013). Understand your world with bing.

[26] Hu, W., Jia, C., Wan, L., He, L., Zhou, L., & Qu, Y. (2014). CAMO: Intégration of linked open data for multimedia metadata enrichment. *Proceedings of the Semantic Web Conference*.

Olfa Ben Said received her PhD on computer sciences since 2017 from ENIS, University of Sfax, Tunisia. Currently working in King Khalid University Abha, Saudi Arabia as assistant professor in Department of Computer Sciences for more than 4 years. Initially She received her bachelor's degrees in computer sciences in FSS, Sfax Tunisia. Then she obtained the master from ENIS, University of Sfax, Tunisia. She published 2 papers in international journals, 4 international conferences. Her research interest includes semantic web, information retrieval, e-learning, m-learning, and Internet of Things (IoT).

Ali Wali is an associate professor in signal and images processing at ISIM, University of Sfax. He got his Ph.D. in engineering computer systems at National school of Engineers of Sfax, in 2013. He is member of the REsearch Groups on Intelligent Machines (REGIM). His research interests include computer vision and image and video analysis. These research activities are centered around video events detection and pattern recognition. He is a senior member of IEEE. He was the member of the organization committee of the International Conference on Machine Intelligence ACIDCA-ICMI2005, Third IEEE International Conference on Next Generation Networks and Services NGNS2011 and 4th International Conference on Logistics LOGISTIQUA2011, International Conference on Advanced Logistics and Transport (ICALT'2013, ICALT'2014,ICALT'2015), 13th International Conference on Document Analysis and Recognition (ICDAR 2015), International Conference on Hybrid Intelligent Systems (HIS'2013), International Conference on Information Assurance and Security (IAS'2013).

Adel M. Alimi was graduated in electrical engineering in 1990. He obtained a PhD (from Ecole Polytechnique of Montreal, Canada) and then an HDR both in electrical & computer engineering in 1995 and 2000 respectively. He is full professor in electrical engineering at the University of Sfax, ENIS (National Engineering School of Sfax), since 2006. He is founder and director of the research REGIM Lab in intelligent Machines. He was Director of the Tunisia Erasmus+ Office (2018-2020). He also was director of the National Engineering School of Sfax, University of Sfax, Tunisia (2005-2011). His research interests include are smart brain, smart services, smart citizen, smart life and smart health. He volunteered for several academic, research, and scientific structures and associations. His scientific production is: h index=28 (Web of Science), 36 (Scopus), 45 (Google Scholar), Citations=3.9+k (Web of Science), 6+k (Scopus), 10.6+k (Google Scholar), 100+ Journal Papers, 600+Conference Papers, 100+ PhD Thesis defended, 20+ Tunisian patents, 20+ chapters in edited scientific books and 6 special issues editions of international scientific journals.