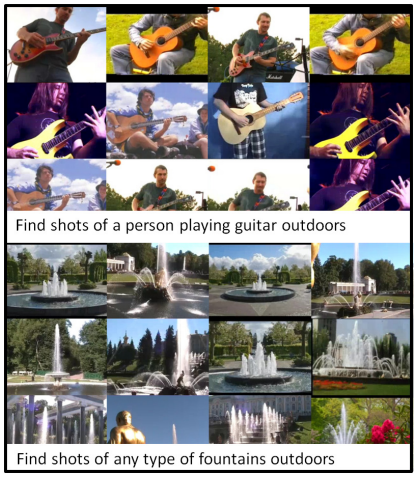
Query and Keyframe Representations for Ad-hoc Video Search

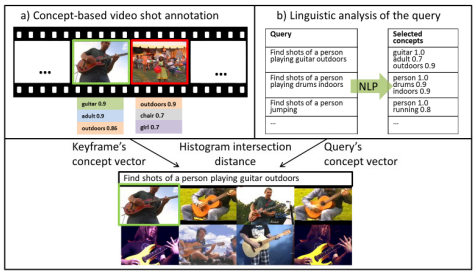
Foteini Markatopoulou[1,2], Damianos Galanopoulos[1], Vasileios Mezaris[1], Ioannis Patras[2]
[1]Information Technologies Institute (ITI), CERTH, Thessaloniki, Greece [2]Queen Mary University of London, London, UK

Problem and motivation

- **Ad-hoc video search**: retrieving, from a large video collection, video fragments (keyframes) that are related to a given query
- **Typical solution:** treat the query as a set of simple terms
- **Motivation:**
  - Detecting the most useful parts of the query, e.g., subsequences that contain the main content that the user asks for retrieval
  - Combining two different measures for the distance between the video shots and the target query, calculated on concept-based and semantic embedding representations



Background

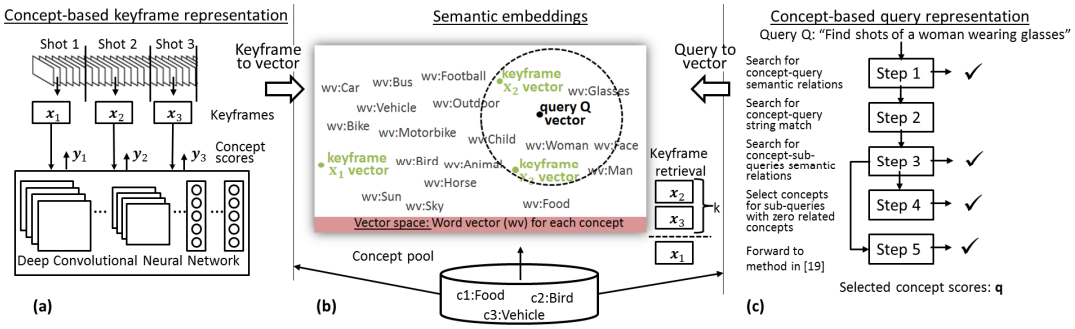


- Each concept is enriched with additional information captured by Google or Wikipedia [20]
- An inverted index structure is used in order to associate the query with the concepts [4]
- A semi-automatic system [21], where the user is asked to choose keywords given a test query

Proposed Method

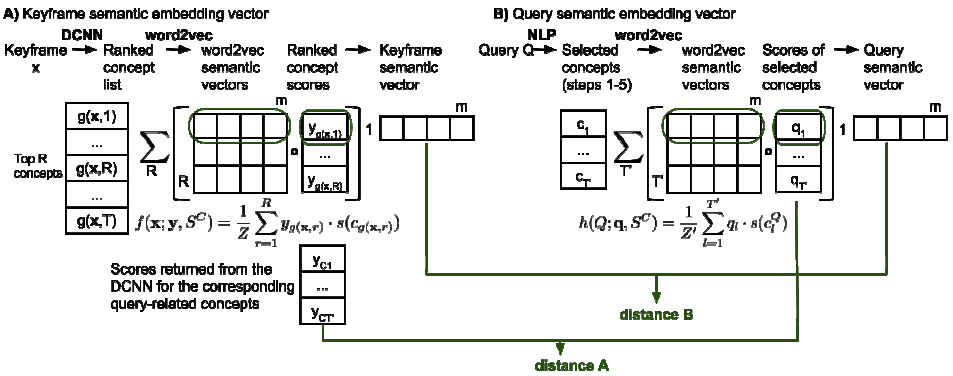
Method outline

- **(a) Concept-based keyframe representation**: apply a DCNN in every keyframe
- **(c) Concept-based query representation:** translate the query in a set of related concepts using NLP
- **(b) Semantic embeddings for concept-based query and keyframe representations:** project both into a given semantic embedding space



Proposed solution

•Two different distances are combined in terms of arithmetic mean



Query: *Find shots of three people or more walking or bicycling on a bridge during daytime*			
	Sub-queries	C^Q ($\theta = 0.8$)	q
Step 1	*Find shots of...daytime*	$\emptyset$	-
Step 2	***three people or more*** *walking or bicycling on a bridge during daytime*	three or more people	1.0
Step 3	people walking	walking	1.0
		bicycle-built-for-two	1.0
	bicycling	bicycles	0.85
		bicycling	0.84
	bridge	suspension bridge	1.0
		bridges	0.84
	Sub-query *daytime* also found but without corresponding concepts with ESA distance > θ		
Step 4	daytime	daytime outdoor	0.74

Experimental results

- **Datasets**: TRECVID AVS 2016, TRECVID Video Search 2008
  - Test set: 600 and 100 hours, respectively
- **Evaluated queries:** 30 and 48, respectively
- **Evaluation measure:** MXInfAP (%)
- **Semantic embeddings:** pre-trained Google News Corpus word2vec model
- **Keyframe representation:** 1346 concepts
  - 1000 Imagenet concepts extracted using 5 pre-trained ImageNet DCNNs; fused in terms of arithmetic mean
  - 346 TRECVID SIN concepts extracted using 2 fine-tuned DCNNs, again fused

A) Parameter selection: MXInfAP (%) on the AVS16 dataset to investigate the parameters of the proposed method; (a) The transformation to the semantic embedding space is ignored; (b) The final distance from the query is calculated solely in the semantic embedding space; (c) The complete process is used, i.e., the final distance is the mean of the distances calculated in (a) and (b)

Steps	All	Excluding one step				
		step 1	step 2	step 3	step 4	step 5
(a) Concept-based representation	5.94	5.92	5.74	3.96	5.95	4.53
(b) Semantic embeddings	3.77	3.86	2.98	3.22	3.75	2.80
(c) Combination	6.35	**6.51**	5.77	4.37	6.27	4.99

B) Comparisons: MXInfAP (%) for different compared AVS methods

Methods	AVS16		VS08	
(a) Literature methods				
Tzelepis et al. [20]	4.16		8.27	
Ueki et al. [21]	5.65		7.24	
Norouzi et al. [15]	3.14		7.30	
(b) Top-4 TRECVID finalists				
Top-1	Le et al. [4]	5.4	Tang et al.	6.7
Top-2	Markat. et al. [13]	5.1	Snoek al.	5.4
Top-3	Liang et al. [6]	4.0	Ngo et al.	4.2
Top-4	Zhangy et al. [23]	3.8	Mei et al.	4.1
Proposed	**6.35**		**9.11**	

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