Assessing movie similarity using a multilayer network model

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Abstract This work investigates the movie similarity issue. A multilayer network model capturing various aspects of the story is built from movie scripts. Based on this representation, movies are compared not from summary or actors but using their storyboard. We rely on the "Portrait divergence" to quantify distances between graph characteristics. We illustrate the effectiveness of this approach in comparing movie series.

Keywords Multilayer networks, Movies, Network portrait, Network similarity.

1 Introduction

In the computer vision literature similarity is a hot research topic mainly concerned with quality [1,2,3], classification [4,5,6,4] or low-level analysis [7, 8,6,9] issues. Recently, network models have been increasingly used to support movie understanding. Usually, they concentrate on character interactions to bring out a global picture of the story [10,11,12].

In a previous work we proposed a multilayer network model that captures more elements of the movie story including character, dialogues, and locations [13,14]. This model initially focused on the movie script has been extended recently to include visual content [15]. Network extracted from the movie are exploited to compute similarity. Therefore, the visual content similarity issue reduces to computing similarities between network layers. Plenty of methods are proposed in the literature for comparing monolayer networks [16]. Here, we restrict our attention to a method recently introduced by Bagrow *et al.* [17]. The so-called *Network Portrait Divergence* is based on the network portrait [18]. It characterizes a network by its degree distribution at various distances. Experiments performed on the movie series show encouraging results that corroborates user perception.

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2 Multilayer Movie Model

In the context of movie understanding the four Ws are defined as follows: Who? Refers to the characters; Where? Refers to the locations the action takes place; What? Refers to the subjects the characters talk about; When? Refers to the time guiding the succession of actions. We proposed a multilayer graph model that put these entities (characters, locations, and subjects) together in relation to form a story. As shown in Figure 1, this graph has three layers representing characters, locations, and topics (represented by keywords). Two types of relations are modeled: intra-layer relations between nodes of the same category (e.g. two characters conversing, the temporal transition between two locations, two Keywords are in the same conversation); and inter-layer relations (e.g. a character being at a specific location, a keyword is pronounced by a character, a keyword is mentioned in a conversation taking place at a specific location). We Rely mainly on the movie script to extract these entities and their relationships. Indeed, it is usually very well structured, and it contains all the key components to automatically analyze a movie. Investigation of this model have been performed on the whole 6-movie cycle of Star Wars saga. For each movie of the saga, we extract its corresponding multilayer network. Then, for each layer, we compute its corresponding portrait which encodes many structural informations of the graph. The portrait of a network can be computed using the B-matrix which denotes the number of nodes that have exactly k members in their respective l-shells (l-shells: the subsets of nodes at distance l from a given node v_i). Portraits are useful for showing an intuitive picture of a network. They provide a useful visualization and allows for rigorous statistical comparison between networks. Finally to compute the similarity between layers, for each couple of layer we compute their divergence.

3 Results

In the first experiment, we compute for each layer of each movie its corresponding portrait as shown in Figure 2. Due to the lack of space, we only present the result of Episode I, II and III. One can notice that layers of the same category have almost the same portrait. This proves that portrait is a useful property which can characterize networks of the same category. To compute the similarity between network we use the portrait divergence $0 \leq DJS \leq 1$. It quantifies the dissimilarity of the two networks, with smaller DJS for more similar networks and larger DJS for less similar networks. One can notice in Figure 3, that character layers of Episode II and III are the more similar. In the Star Wars story, these three episodes compose the prequel trilogy that contains almost the same characters. We can also observe that Episode IV, V, and VI are much similar compared to other episodes (I, II, III). Indeed, these episodes constitute the story of the original trilogy, which similar co-occurrence of almost all the characters in the three episodes. A little similarity is observed between Episode III and IV. Indeed, episode IV is the bridge of

Saga story between the prequel and the original trilogy. Similar observations can be made with the other layers (locations and keywords).

4 Conclusion

To summarize, extensive investigations with multiple movie series have shown that, computing the similarity between networks, especially for networks which encompass the movie story, the proposed multilayer model, can be a good choice to uncover similar movies. This methodology can be incorporated into recommender systems in order to increase their efficiency.

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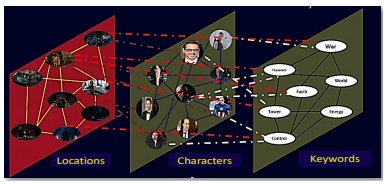

Fig. 1 Movie Multilayer Network

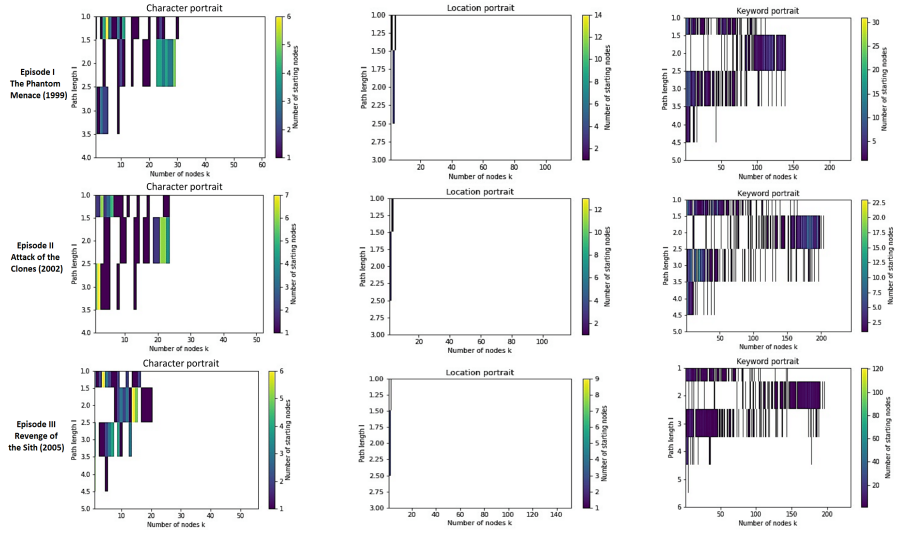

Fig. 2 Portraits of each layer of the movie for the three episodes.

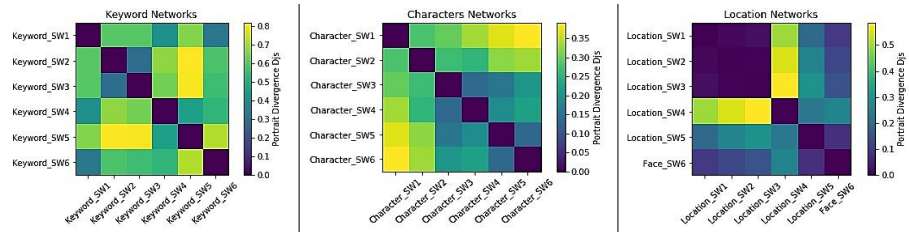

Fig. 3 Divergence between layers for 6-movie episodes of Star Wars saga.