Emerging Opportunities for Text Retrieval and Analysis in Online Education

This review considers six papers focused on online learning. One paper [4] is a survey while the remaining five are focused on specific scenarios. A high-level summary of each paper will be provided followed by a focus look at common emerging themes. The review will finish by suggesting emerging opportunities based on the findings of the papers.

Summaries

[1] Tutorons [1]

Tutorons is a system to find segments of web pages which can be augmented by mico-explanations. The explanations are on-demand and "context-relevant, describing only the syntactic elements that are present and important within a snippet, using domain-specific terms". The segments of the web page which have available explanations are augmented with a color coding.

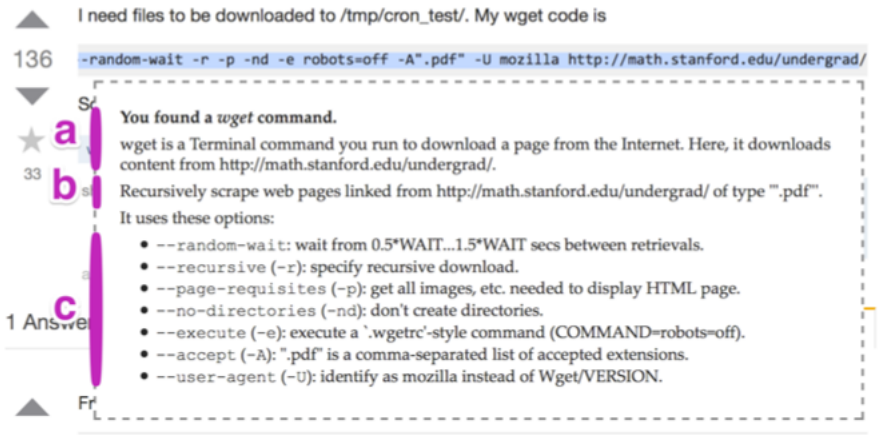

Fig. 8. A multi-level explanation of wget comprises three parts. *(a)* An introduction to the command. *(b)* A meaningful description of what this combination of options does at a high level. *(c)* A review of the meaning and values of each of the options.

[2] DynamicSlide

The DynamicSlide study outlines a "video processing system that automatically extracts references from slide-based lecture videos". It also describes a reviews workshops conducted

[1] References throughout the remained of this review will use the summary heading to highlight specific papers.

to uncover 37 ideas for interacting with lecture videos. Finally, it investigates in depth how to emphasize the current item being discussed, navigate and take notes by items on lecture slides.

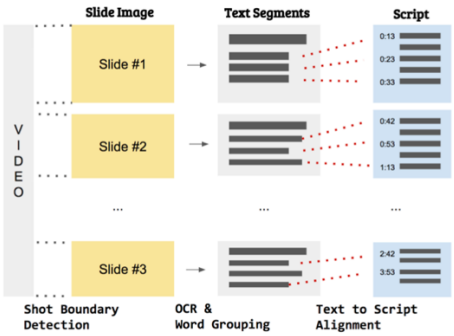

Figure 3: An overview of our automatic pipeline for finding references from slide-based lecture videos. Given an input video, Stage 1 detects unique slides with a shot boundary detection algorithm, Stage 2 finds text segments in each slide by grouping words together, and Stage 3 finds references by aligning text segments and sentences in the script.

[3] ConceptScape

ConceptScape investigates how to improve upon passive watching of videos in online learning and details a method to facilitate generation of concept maps by crowd learners which then can be used while interacting with the videos. “The result shows that crowd workers collaboratively generated concept maps that match the quality of those generated by experts.”

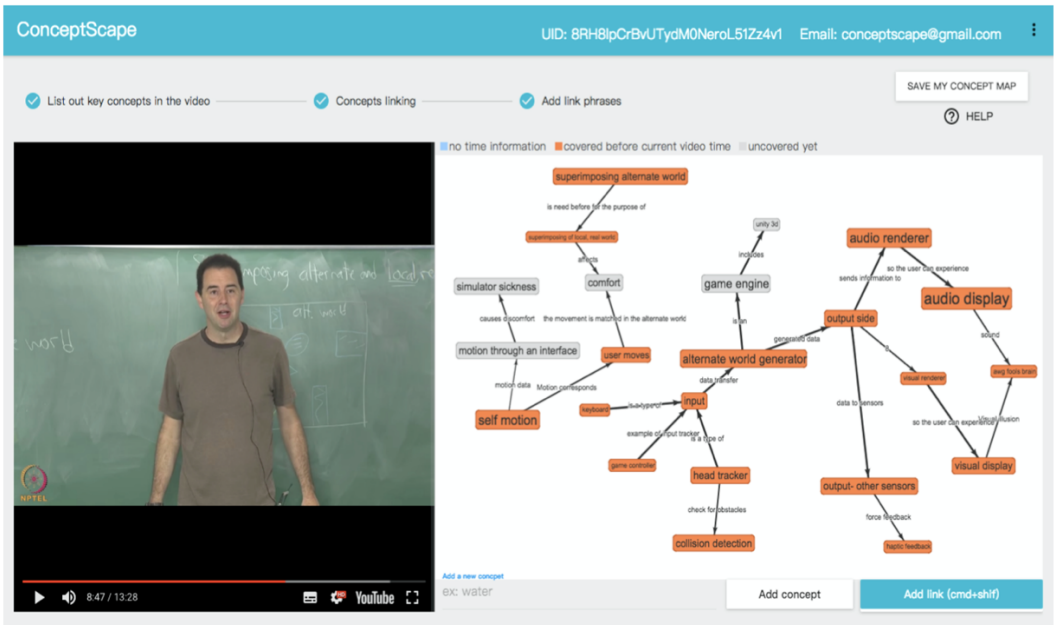

Figure 1. ConceptScape integrates an interactive concept map into a video player. Each concept in the concept map has a time anchor linking to a specific time point in the video, which intends to capture the moment a concept is introduced or explained in the video. The time information is used to visualize lecture progress (by color) and navigate the video (by double-clicking the concept). The size and relative proportion of the video player and the concept map is adjustable, and the space is evenly distributed by default.

[4] Learning Path Personalization

In this review Learning Path Personalization is unique as it is a survey that considered 160 studies up until May 2020. Furthermore, its focus was on personalized learning and had a higher-level focus then the other papers which were primarily focused of a specific learning objective.

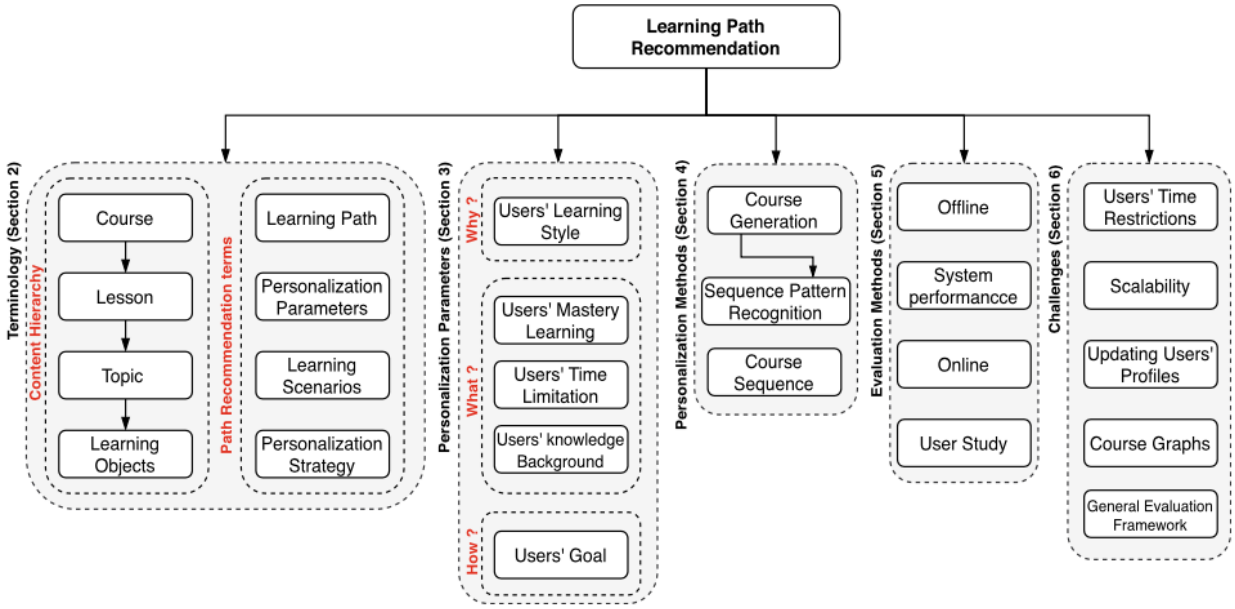

Fig. 1. Literature map.

[5] Video Recommendation

Video Recommendation articulates a system which recommends appropriate videos for a complex software program that has over 1000 unique commands. The study uses natural usage logs from 20000 users which accounts for 255643 sessions and 20 million commands. In the study a hierarchical approach to topic modeling in recommended when there is a specific group of topics which are part of common usage scenario.

[6] AXIS

AXIS details a model to generate explanations for math problems using learners. The explanations generated were deemed to be high quality and an effective alternative to requiring instructors to generate the explanations.

	Explanation	Explanation Rating
Learner Explanation AXIS Discarded via Filtering Rule	It is three over seven because after the chocolate cookie has been removed there are 7 cookies in the jar, leaving 3 oatmeal cookies remaining.	5.2
Early Stage AXIS	go based on the amount of cookies that are available and run a trial until the chocolate cookie is picked out, then do the same for oatmeal	4.2
Later Stage AXIS	When you have 8 cookies in the jar and 5 are chocolate you have a 5/8 chance of the cookie you draw being chocolate. When there are 7 cookies in the jar and 3 are oatmeal you have a 3/7 chance of drawing the oatmeal cookie. To get the overall probability you need to multiply 5/8 by 3/7 which results in overall probability of 15/56	6.8
Written by Instructional Designer	The total number of cookies in the jar is 8. Since there are 5 chocolate cookies the probability that Chris gets an chocolate cookie is 5/8 Since Chris removed 1 cookie from the jar and did not replace it or put it back there are now 7 cookies in the jar. So, the probability that Chris gets an oatmeal cookie from the jar is 3/7 5/8 x 3/7 = 15/56 So, the probability of Chris getting a chocolate cookie on the first draw, and an oatmeal cookie on the second draw is 15/56 Type in 15/56	7.7

Figure 4. Examples of explanations for one of the problems that AXIS was deployed for. After deployment, we conducted an independent evaluation study with new users to evaluate explanations from AXIS and other sources. The explanations were included in the evaluation study, and the mean helpfulness ratings are shown in the second row.

Select Emerging Themes

While reviewing the selected literature multiple common theme emerged even though the specific objectives for each article were unique. Below the themes for emerging opportunities are highlighted.

Learning Objective Mining

"[Learning objects] are the small units of learning content that are reusable and constructed regarding a certain learning objective" [4]. Video Recommendation mine command logs to discern which community generated video to recommend. In ConceptScape time indexes for learning objectives are discovered and combined with their representation in a concept map. Tutorons adds context appropriate explanations to learning objectives detected within a web page.

Enabling Learning at Scale

For AXIS it was recognized that instructors "have limited time and resources to generate quality explanations for all the problems they create" [6]. Beyond this there are limits to what a learning object can effectively communicate by itself which is further exasperated by the fact that a common learning object is the video lecture which naturally leads to passive student engagement. To overcome these challenges a variety of crowdsourcing methodologies are engaged. ConceptScape articulates a three stage process.

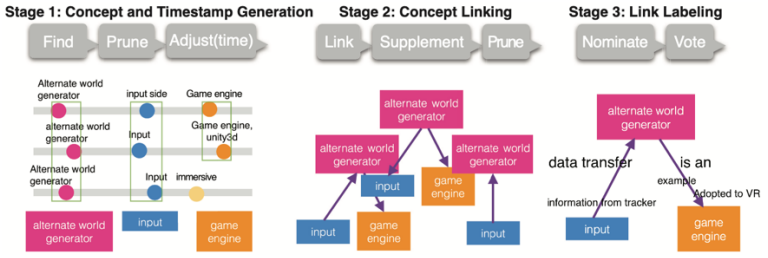

Figure 2. ConceptScape's crowdsourcing workflow includes three stages with eight detailed steps. Workers perform micro concept mapping tasks parallel in each step and our system automatically aggregates collected contributions within a step and propagate the result to the next step. Steps are divided for quality control, guiding workers to focus on certain task but not restricted to. We allow workers to work on different tasks within a stage to make the task more natural for learning and also help us gather extra contributions. [3]

AXIS also uses learners by "adding explanations to the system pool when: the explanation is above a minimum character length, the explainer displays above average knowledge about how to solve this type of problem, and the explainer rates her explanation as likely to be helpful to other learners" [6].

Augmenting Passive Learning Objects to Promote Engagement

ConceptScape augmented an instructional video with a mind map. Learners were involved in the process of creating the mind map and once created the mind map was useful for navigating the video as well highlighting the concept currently being covered by the instructor. In DynamicSlide navigation was also investigated and found that users preferred a pointer or blurring to indicate the current point being explained on a slide. In the user study it was found that highlighting "lessens the cognitive demand of watching lecture videos" [2]. Tutorons augmented web pages with context specific information applicable to the learner's current focus. AXIS described a method to augment questions with explanations. Video Recommendation detailed how a recommendation system could be used to support learns of complex software.

Emerging Opportunities

When pulling together the individual works considered in this review a number of opportunities present themselves. Specifically, if all the information required for the system were pooled there are multiple areas of cohesion. For instance, the information required for personalized learning plans could be used as input to a Tutorons style AXIS explanations in a ConceptScape mind map and an augmented DynamicSlide. Alternatively, AXIS explanations could be teamed with a Video Recommendation system where learn ratings of explanations are used to select future learning objects for the explanation generator.

Conclusion

In this review select emerging opportunities to improve online learning were sketched out. These opportunities emerge when from combining the findings of six papers which were summarized above.

References

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