What's in it for me?: Augmenting Recommended Learning Resources with Navigable Annotations

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ABSTRACT

(This is the accepted manuscript). This paper introduces an interface that enables the user to quickly identify relevant fragments within multiple long documents. The proposed method relies on a machine-generated layer of annotations that reveals the coverage of topics per fragment and document. To illustrate how the annotations double as a tool for preview as well as navigation, an example application is presented in the form of a personalised learning system that recommends relevant fragments of video lectures according to user's history. Potential implications of this approach for lifelong learning are discussed. We argue that this approach is generally applicable to recommender and information retrieval systems, across multiple knowledge domains and document types.

CCS CONCEPTS

• **Information systems → Users and interactive retrieval**; **Personalization**; **Recommender systems**; *Search interfaces*; Information extraction; • **Applied computing → Interactive learning environments**.

KEYWORDS

Recommender Systems, Information Retrieval, User Modeling, Intelligent Tutoring Systems, Open Education Resources, OER, Future User Interfaces

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1 INTRODUCTION

Long documents, such as ebooks and lecture videos, constitute a substantial fraction among educational resources. While these are of value to learners, research in online learner behaviour has shown that long formats are often considered overwhelming and unwieldy in practice, preventing learners from engaging with these resources [5]. Since engagement has been shown to be a prerequisite for achieving impactful learning outcomes [6], our proposed interface aims to highlight **personalised engaging fragments**, that can serve as effective entry points (or alternatives - depending on the learner's information need at hand) to the use of entire documents. The goal is to increase transparency and put the learner in control of their educational choices.

Keeping in mind that the learner-content interaction plays a key role in providing fruitful learning experiences [7], we design a novel system that combines Artificial Intelligence (AI) and Human Computer Interaction (HCI) to enhance the learner experience and encourage them to engage effectively with learning resources. The benefits of the proposed system go beyond video lectures and apply to a wide range of long document formats including audio and PDF documents, making it a very powerful tool.

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2 SYSTEM OVERVIEW

In order to recommend relevant fragments to learners, our solution leverages **content analytics** to extract characteristics from resources, such as the Knowledge Components (KCs) covered [4]. **Learning analytics** are also designed to capture the user's knowledge state and learning over time.

Content Analytics. In a pre-processing step, the system ingests the text representation of educational resources (e.g. video transcripts) and partitions them into fragments of approximately 5 minutes. Each fragment is then annotated using **Wikifier**[1] to link fragments with Wikipedia concepts [1]. This approach is domain-agnostic, avoids the need for expensive expert labelling and results in human-interpretable annotations that we use as KCs [3].

Learning Analytics. Any recommendation algorithm that provides probabilistic predictions can be incorporated with the proposed user interface. For the purpose of this demonstration, we use TrueLearn [3], a recently proposed probabilistic algorithm that recommends educational resources to lifelong learners using only past engagement signals to build a dynamic learner model. TrueLearn was validated using a large dataset comprising 248,643 video view events from 18,933 users of VideoLectures.Net, showing promising results when compared to appropriate baselines.

2.1 User Interface

The user interface aims to augment and extend how users can engage with detailed content recommendations. A primary goal is to make recommendations transparent, informative, specific and time saving. To make the interface intuitive to use, our design

[1] www.wikifier.org

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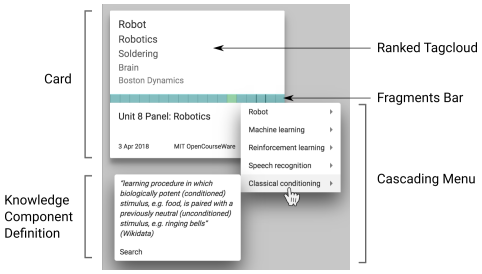

Figure 1: A cascading menu with relevant KCs opens as the user hovers over a fragment in the Fragments Bar. The Ranked Tagcloud (above the Fragments Bar) summarises the main KCs covered in the resource. The information panel (below the Fragments Bar) contains title and metadata.

leverages familiar patterns and techniques, such as cards, popups, and cascading menus. In addition, we introduce two novel elements, a **Ranked Tagcloud** and a **Fragments Bar**, in order to enable the learner to quickly preview KCs, as illustrated in Figure 1.

Selecting a fragment opens a detailed view with the video playing from the corresponding time as shown in Figure 2. The Fragments Bar allows fluid preview, recap and navigation within the resource. Different colour intensities (yellow) indicate the predicted relevance of each fragment to the learner.

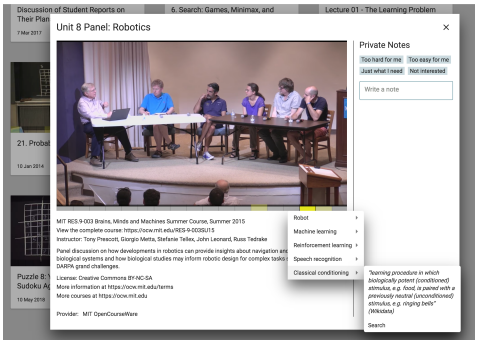

Figure 2: Popup view including the video, the Fragments Bar, description and a panel for note-taking and feedback.

When exploring recommendations, the system ranks the full documents based on their relevance. Furthermore, the Fragments Bar provides fine-grained cues by highlighting relevant fragments in yellow. By hovering over a fragment, the user can explore the topics covered in each fragment, enabling a new and engaging way of looking ahead. It was hypothesised that this method of augmenting the content with AI-based annotation increases the findability and navigability of information in long educational documents.

2.2 Preliminary User Evaluation

Iterative design and evaluation with learners led to insights into their expectations, preferences and behaviours. One key finding was that staying in context is important. Therefore, a popup was used rather than opening a new page when clicking on a video.

A preliminary user study was conducted with 8 participants who were given two versions of an information retrieval task, with and without the Fragments Bar. Qualitative feedback indicated that all participants found the Fragments Bar engaging, intuitive to use and helpful for finding information in videos. The reported benefits were especially pronounced with long videos of unknown content. As one participant stated: "It's very hard if you don't know the video, to know where the content is, where the beginning and the end of one thought are. [..] Without [the Fragments Bar] I had to watch for a long time before it got to the point I was interested in". With the Fragments Bar, the participant found the task easier and more enjoyable "because you can skip to the part you are actually interested in". A large-scale experiment is in planning.

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3 DEMONSTRATION

Visitors are encouraged to explore learning resources using a search field and recommendation features. This is possible because the interface fully generalises to information search tasks. Additionally, visitors are invited to use the public website (www.x5learn.org) on their own devices with the option to sign up for a personal account.

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4 CONCLUSIONS AND FUTURE WORK

There is a need for system designs that can transform how we think about lifelong learning. Our design demonstrates a promising step in this direction by emphasising personalisation and redefining the atomic unit of educational content. It reconceptualises large educational materials as building blocks that can be partitioned, recombined and repurposed. By combining AI and HCI, the learner experience can be improved with added transparency, findability and navigability as demonstrated by this system. New research questions are provoked regarding content representations and user modelling, since more fine-grained content representations enable more specific recommendations and richer engagement signals that can (and should) be incorporated into dynamic user models [2].

Two important challenges for future work are (a) to explore appropriate fragment sizes and segmentation strategies and (b) to investigate the potential for systems to recommend fragment-based learning pathways, i.e. series of fragments from different resources. Finally, it is timely to ask whether the fragment-based approach can extend to social, collaborative and project-based learning. We plan to conduct large-scale experiments to refine our understanding.

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