AIMindmaps: Enhancing Mind Map Creation Through AI Collaboration and User Input

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Abstract

Mind mapping is a powerful technique for structuring ideas using hierarchies and categories, but users often face limitations in materials and personal abilities. Despite various AI-assisted tools, the problem remains inadequately addressed. This paper introduces AIMindmaps, an AI system designed to help users create mind maps. AIMindmaps leverages large language models, generative image models, and preset prompts to generate mind maps from PDFs, incorporating user input to refine the results. The system explores collaborative methods between humans and AI in mind map creation.

Introduction

Mind mapping is a powerful technique for structuring ideas using hierarchies and categories (Tony and Buzan 1993). Mind maps can be used at any stage of the thinking process, such as generating personal and group ideas, structuring those ideas, and planning how to use them (Bütüner 2006). Mind maps can be used in a wide range of areas, including taking notes, making choices, writing, organizing projects, brainstorming, meetings, making lists, presentations, and self-improvement (Wycoff 1991; Buzan and Buzan 2006). Mind mapping is used as a note-taking tool, which has advantages including recall (Holland, Holland, and Davies 2004; Brinkmann 2003; Buzan and Buzan 2006), structuring and sorting thoughts(Buzan and Buzan 2006), enhancement of conceptual comprehension (Goodnough and Long 2006; Brinkmann 2003; Zhao 2003; Abi-El-Mona and Adb-El-Khalick 2008), and simplifies notes (Buzan and Buzan 2006).

However, it is clear that constructing this kind of mind map is not an easy task (Erdem 2017). Users creating mind maps encounter several challenges related to personal abilities and materials. Some users encounter cognitive difficulties, such as finding the process mentally taxing and forgetting the meanings of symbols (Erdem 2017). Drawing skills are also often lacking (Erdem 2017). Material constraints include the inaccessibility of colored pencils and the difficulty in finding the desired visual content (Erdem 2017). Recently, there have emerged several artificial intelligence-powered mind mapping tools, such as xmind (XMind, Ltd. 2023; Heuristica Inc. 2023; whimsical Inc. 2023), which can solve some material problems to a certain extent, such as the inaccessibility of colored pencils. However, drawing constraints and difficulty in finding desired visual content remain unsolved. These tools utilize AI to enhance the effectiveness of brainstorming on mind maps rather than using AI to enhance note-taking capabilities.

Currently, there is no AI-powered tool that solves all the problems associated with creating mind maps. To overcome the mentioned constraints of current mind maps, we explored a collaborative method between humans and machines. We developed AIMindmap, a web-based application enabling users to create mind maps with AI (see Figure 1). The application takes PDF documents as input and generates a draft mind map as output. It utilizes a large language model to extract information and create content, along with a generative model to generating image of the mind map. Our goal for this project is to design a tool that allows users and AI to design mind maps collaboratively or interactively.

This paper offers three main contributions:

- We designed an AI system that generates personalized mind maps with the guidance of materials and humans.
- Our system uniquely leverages a Generative Image Model to allow users to generate images for mind map nodes through text descriptions.
- Our system innovatively uses LLMs to summarize document information into an interactive structured mind map, facilitating the process of organizing and visualizing complex content.

Background and Related Work

Interaction-centric AI power tools

As artificial intelligence products targeting end-users become increasingly common, understanding the user experience of the system has become an important issue (Shneiderman 2020; Xu et al. 2023). Designing interaction-centered artificial intelligence (by thoroughly understanding how users interact with AI systems) is crucial to creating user-friendly AI-based systems (Shneiderman 2020; Xu et al. 2023). These studies provide insights into how to balance human-AI collaboration through design, improving user control over interactions with AI interfaces. In addition, some studies have made attempts to collaborate and

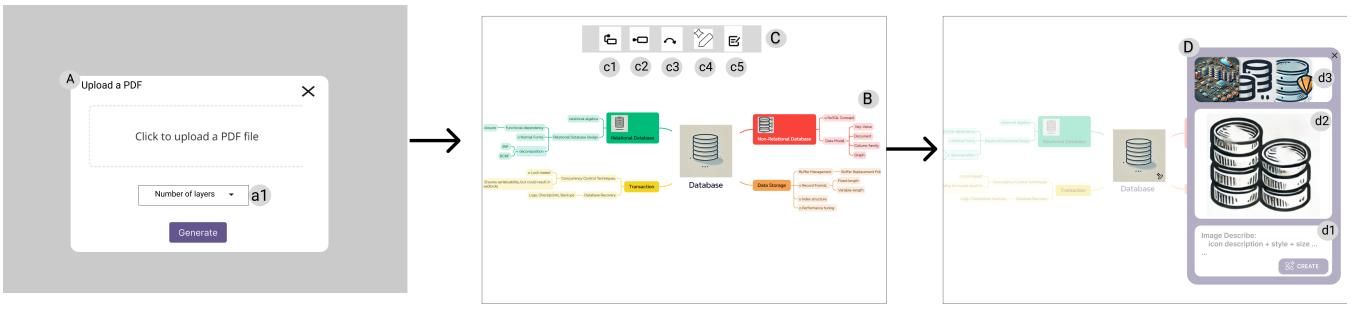

Figure 1: User Interface of AIMindmaps, an AI-assisted mind maps creation system. users can upload a PDF file (a) and configure the number of mind map layers (a1). The generated mind map is presented in (b). The user can modify the mind map with (C) and use (c4) to modify the image with AI. The user can input prompts(d1) to generate a new image(d2), and all the previously generated images are displayed on (d3).

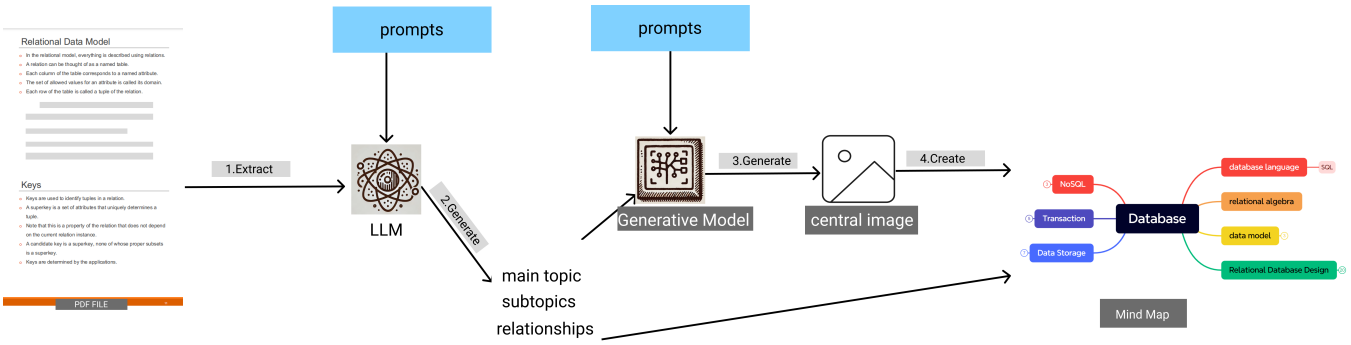

Figure 2: The mind maps generation backend

interact with users and artificial intelligence applications. StoryBuddy (Zhang et al. 2022) is an AI-powered platform that allows parents to craft interactive storytelling experiences with customizable question-and-answer elements. NB2Slides(Zheng et al. 2022) is an AI system that helps data scientists showcase their work more efficiently by generating presentation slides from Computational Notebooks while allowing users to collaborate with AI to optimize slide content. AIStory(Han and Cai 2023) is an AI tool that aids children in visual storytelling and fosters collaboration between humans and artificial intelligence. These previous studies provide meaningful evidence for the collaboration between AI and users in creating mind maps.

Mindmaps tools/design

Various previous works have applied mind maps in learning. A study examined the effectiveness of using mind maps in teaching and found that it not only improves student learning satisfaction but also improves memory retention (Stankovic et al. 2011). Furthermore, mind maps encourage 'Deep' Learning, save valuable revision time, and simplify notes (Buzan and Buzan 2006).

More importantly, the Mind Map book(Buzan and Buzan 2006) provides the steps of Mind Mapping, which include Overview, adding main Mind Map branches, Preview, first and second levels, Inview, filling in the Mind Map details, and Review, completing the Mind Map. These steps guide us in designing applications.

Currently, there are some mind mapping tools, such as Heuristica, Whimsical, and XMind, that attempt to integrate AI technology (Heuristica Inc. 2023; whimsical Inc. 2023; XMind, Ltd. 2023). These tools typically allow users to input a keyword and generate related subnodes of mindmaps for quick brainstorming. These applications rely on LLMs to generate associative nodes from a single keyword, enabling rapid expansion of ideas.

Heuristica(Heuristica Inc. 2023) has made some attempts at document summarization, but all summarized document information is displayed in a single node without expanding the information in a mind map structure. This is likely because Heuristica focuses more on exploring a specific knowledge point and its related content rather than organizing comprehensive document information.

These applications have made preliminary explorations in the integration of AI and mind mapping. However, they do not adequately address the need to summarize document information, nor do they effectively solve the difficulty of finding desired images or symbols related to the subject(Erdem 2017).

In contrast to previous studies, the present application is dedicated to the explicit task of summarizing document information. This application utilizes artificial intelligence to

extract and summarize vital information from documents and present it in a mind map format. This method primarily depends on the document's content, thereby reducing the dependence on large language models (LLMs) and minimizing the risk of producing misleading content in the mind map. This approach also ensures more controllable and accurate information. Furthermore, this application enables users to generate desired images through AI and position them on corresponding mind map nodes, addressing the challenge of finding relevant images that other tools have not adequately resolved.

Design and Implementation

Inspired by previous works (Buzan and Buzan 2006; Erdem 2017; Brand et al. 2023), we designed a prototype of an AI system called AIMindmaps, which has a user-friendly interface that allows users to create mind maps using PDF documents (see Figure 1). The AIMindmaps system receives the user's PDF document along with the specified user configuration and uses LLMs and a generative model to automatically generate mind maps from the PDF document. Users can further refine the generated mind maps. The system consists of a front-end user interface and a server-side back end for processing PDF documents and generating mind maps.

On the front end, we designed the AIMindmaps user interface (see Figure 1). The system comprises a configuration panel (A, which disappears after the user selects), (B) the rendered mind maps panel, (C) the tool panel, and the image generation panel (D) .

The user uploads a PDF document and selects the number of mind map layers in the configuration panel. These configurations are then sent to the back end to guide the generation of the mind map. This is to allow users to participate in the process, allowing users to set their own preferences within a given framework (Brand et al. 2023). The generated mind map contains a central image and related text content. Users can use the tool panel (C) to edit the generated mind map, including modifying subtopics (c1-2), modifying relationships (c3), creating and modifying images (c4), and adding notes (c5). After clicking (c4), the user can use the (D) image generation panel to modify the default generated central image further and can also add AI-generated symbols to other subtopics. This function is to solve the problem that users are unable to achieve desired visual content due to limitations in their capabilities and materials (Erdem 2017). Adding notes (c5) solves the problem of forgetting the meaning of symbols (Erdem 2017).

In the mind maps generation backend, the system architecture is shown in Figure 2. From left to right, the system 1) reads the PDF document and extracts its information; 2) it also calls the large language model (LLM) utilizing a structured prompt to extract its important information and structure; 3) then, the generative model combines the preset prompts and the main topic to generate the central image; and finally 4) it returns the information to the front-end to render mind maps.

Conclusion

In this paper, we introduce AIMindmaps, an AI-assisted system for creating visual mind maps from PDFs. Inspired by the literature, AIMindmaps uses custom configurations to guide the Large Language and Generative Image Models in drafting mind maps. Users can also use AIMindmaps to refine and enhance their mind maps.

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