



TeXFlow

: Drawing lines between highlighted texts in a PDF to illustrate text flow

Lorem ipsum dolor sit a **“Text”** consectetur adipiscing sed labor dipa

Presenter: Mohammad Hasan Payandeh (محمد حسن پاینده)

Course: Advanced Topics in Electronic Publishing (CS 846 or ۸۴۶)

Instructor: Dr. Daniel Berry (دکتر دانیال بری)

Cheriton School of Computer Science, University of Waterloo



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Background

- Some of text formatters that support drawing lines:
 - LaTeX
 - HTML
 - Troff
 - Word (wysiwyg)



Background

Drawing Lines Using LaTeX:

- **Pros:**
 - Working with PDF documents
 - Easy to use, as it allows for creating a package that everyone can use
 - Consistency in appearance across the document
 - Ability to use lists to store series of data
- **Cons:**
 - Learning curve
 - Complexity and inconsistency in programming with LaTeX
 - High compilation time when there are many lines to draw, each requiring processing
- **A package for drawing lines:**
 - TikZ



What is this project about? (Use cases)

- Drawing lines between highlighted texts, points in figures, or points in tables within a PDF document
- From now on, we will refer to them as **nodes**.



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- Use Cases:
 - Illustrating the flow of text beyond its written sequence
 - To specify what word a pronoun refer to (similarly like a variable in programming)
 - Referencing a text to a specific point in a figure or table
 - Annotations and comments



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ABSTRACT

Human-Computer Interaction (HCI) is a multidisciplinary field that focuses on the design and use of computer technology, emphasizing the interfaces between people (users) and computers. Two fundamental concepts within HCI are usability and [user-centered design](#). Usability, defined as the ease of use and learnability of a human-made object, is critical in ensuring that technology meets users' needs efficiently. User-centered design (UCD), on the other hand, [is a design philosophy](#) that prioritizes the user's needs and experiences throughout the development process. These concepts are essential in creating effective and user-friendly technology solutions.

1 INTRODUCTION

Human-Computer Interaction (HCI) is a dynamic field that integrates principles from computer science, cognitive psychology, design, and other areas to improve the interaction between users and technology. User-centered design (UCD) is a key philosophy in HCI, placing the user's needs at the forefront of the design process to ensure that the final product aligns with user preferences and limitations. This process involves steps such as user research, which gathers data about users to understand their behaviors and needs, and prototyping, which [involves creating visual representations of design ideas to gather feedback early](#).

Usability, another core concept in HCI, refers to the ease of use and learnability of a human-made object. For instance, a highly usable mobile app allows users to navigate and perform tasks intuitively without extensive instructions, reflecting high learnability and efficiency. Usability encompasses several attributes, including learnability, which measures how easy it is for users to accomplish basic tasks the first time they encounter the design, and efficiency, which allows users to perform tasks quickly once they have learned the system.

The UCD approach also includes usability testing, where [tests are conducted with real users to identify usability problems](#) and gather qualitative and quantitative data. Iteration, another step in the UCD process, involves continuous refinement of the design based on user feedback, ensuring that the product evolves to meet user expectations. By focusing on these usability attributes, developers can create technology that meets users' needs effectively and efficiently.

In summary, by [integrating usability and employing a user-centered design approach](#), developers and designers can create technology

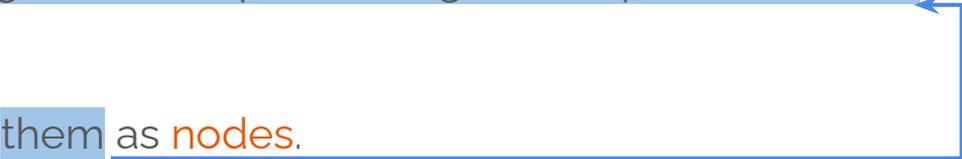


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In summary, by integrating usability and employing a user-centered design approach, developers and designers can create technology that is not only functional but also enjoyable and easy to use. This holistic approach leads to higher user satisfaction and better overall performance of the technology solutions.





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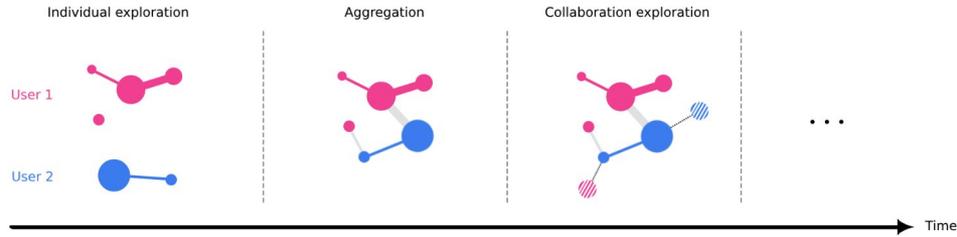


Figure 1: A preliminary version of the teaser

ABSTRACT

KEYWORDS

Collaboration sensemaking, LLMs, Generative AI

ACM Reference Format:

Mohammad Hasan Payandeh and Jian Zhao. 2018. SenseSync: Enabling Collaborative Sensemaking and Exploration of Conversations with LLMs to Achieve a Shared Information-Seeking Goal. In *Proceedings of . ACM*, New York, NY, USA, 5 pages. <https://doi.org/XXXXXXX.XXXXXXX>

1 INTRODUCTION

Information-seeking involves the actions, strategies, and processes individuals perform to find information that meets their needs (Wilson, 1999). Sometimes, the information need can be satisfied by simply finding a single optimal resource, which is called **lookup search** [1]. Conversely, there are times when users are uncertain about what or how to search for information, leading them to engage in **more complex search tasks** (White & Roth, 2009). Nowadays, Large Language Models (LLMs) as a tool for individually or collaboratively searching for information are extensively used

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for these kinds of search tasks. Literature highlights that collaboration is often necessary for activities that are too complex or challenging for a single individual (Shah, 2010), and a good example of this is collaboration in performing complex search tasks using LLMs. While collaboration offers benefits such as incorporating diverse perspectives, it also introduces challenges such as the difficulty in collaborative sensemaking. This involves groups of people with varied perspectives working together to interpret information (Umaphy, 2010). Effective collaborative sensemaking is crucial for collaborators to understand the shared information and explore further collectively.

The existing body of literature on collaborative sensemaking, devoid of LLM usage, showcases the challenges and needs faced by collaborators in such scenarios. However, there remains a gap in understanding whether collaborators utilizing LLMs encounter similar challenges and needs, or if their experiences differ. To address this gap, we conducted a formative study, yielding the following insights:

- (1) Sharing understanding is not as straightforward as sharing conversations; it requires both contextual information and advanced features.
- (2) Organizing and summarizing each individual's conversations, then aggregating (synthesizing) all collaborators' findings, is challenging for effectively identifying overlaps and gaps and enabling further exploration toward the goal.
- (3) Responses generated by LLMs often lack trustworthiness, but a collaborative environment can offer effective solutions. One approach is to leverage response inconsistencies across different LLM

s. need to give one simple example each for each kind of task. It is very abstract.

→ while ends? you mean "complex search tasks"?

still very abstract

what is collaborative sensemaking? The difficulty is not very concrete.

→ it sounds like the gap only motivates the

formative study. You should motivate the entire project.

Too many details for the insights. The info is

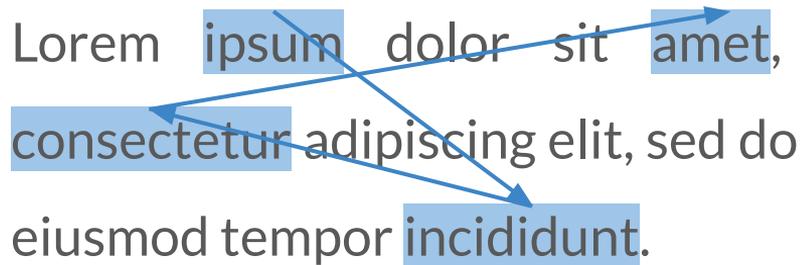
These use cases are not EP problems

(I discussed these use cases to showcase the differences of EP problems vs non-EP problems)

The EP Question/Problem

- What is the best visual way to connect the nodes together?
- Connecting nodes using straight lines is problematic as:
 - Creates a visually unappealing design as the lines cross the text.
 - Make it difficult for readers to effectively and efficiently perceive the connection of nodes.

Lorem ipsum dolor sit amet,
consectetur adipiscing elit, sed do
eiusmod tempor incididunt.

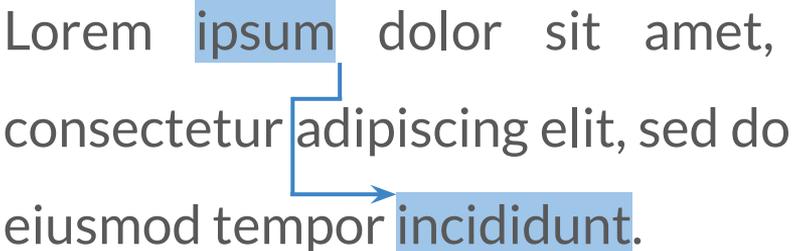
A diagram illustrating the problem of connecting nodes with straight lines. The text "Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt." is shown with several words highlighted in blue boxes: "ipsum", "amet", "consectetur", and "incididunt". Blue arrows connect these highlighted words, showing that straight lines would cross each other, creating a visually cluttered and unappealing design.



The EP Problem

- There are different approaches for this problem:
 - Drawing lines between the words in the text
 - Drawing lines that surrounds the text

Lorem ipsum dolor sit amet,
consectetur adipiscing elit, sed do
eiusmod tempor incididunt.



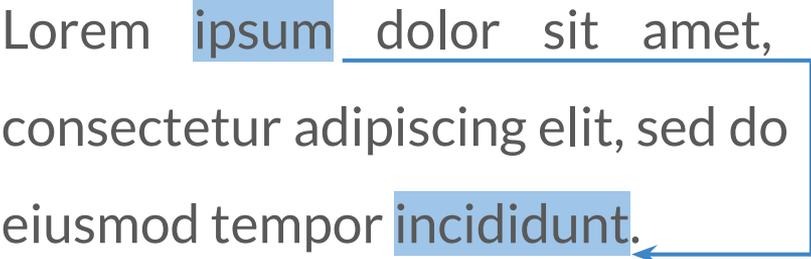
The diagram shows the text "Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt." with the words "ipsum" and "incididunt" highlighted in blue. A blue line connects the bottom of "ipsum" to the top of "adipiscing", and another blue line connects the bottom of "adipiscing" to the top of "incididunt", illustrating the problem of connecting words across lines.



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The diagram shows the text 'Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt.' with 'ipsum' and 'incididunt.' highlighted in blue. A blue line connects the end of 'ipsum' to the start of 'incididunt.', and another blue line connects the end of 'consectetur adipiscing elit, sed do eiusmod tempor' to the start of 'incididunt.', illustrating the problem of connecting words across lines.



The EP Problem

- There are different approaches for this problem:
 - Drawing lines between the words in the text
 - Drawing lines that surrounds the text
- However, each of these methods creates other challenges that need to be addressed.



Solution

- Drawing a surrounding line around the text was selected because:
 - Visually more appealing
 - It does not clutter the text, so:
 - Readers are not distracted by lines within the text.
 - Readers can easily follow the lines connecting nodes.



Challenges

- Two type of challenges:
 - Conceptual
 - Implementation using LaTeX



Where should be the starting/ending point of a line? (Conceptual)

- At the middle of a node
- Right or left side of a node

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt.



Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt.





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How to specify the right/left side of a node in LaTeX? [\(Implementation using LaTeX\)](#)

- To answer this question let's discuss a little bit of the code and the procedure of drawing the lines:
 1. How to highlight the text and specify the right/left side
 2. How we call the marking macro
 3. How we call the drawing line macro
 - When an ending node is marked, we call the drawing macro to draw the macro from previous node to this node



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```
\newcommand{\highlightwithtikzmark}[2]{  
    \tikzmark{w#1-start}  
    \hlcolor{#2}  
    \tikzmark{w#1-end}  
}
```



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```
\newcommand{\highlightwithtikzmark}[2]{  
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  \hlcolor{#2}  
  \tikzmark{w#1-end}  
  
  \connectwords{\the\numexpr\value{highlightcount}\relax}{\the\numexpr\value{highlightcount}+1\relax}{cyan}{\the\numexpr\value{highlightcount}\relax}  
}
```



If we do “Right or left side of a node”, which side should be connected to the previous node and which one to the next node? (Conceptual)

- If a line connected to one side of the node, another line can be connected to the other side of it.

Lorem ipsum dolor sit amet,
consectetur adipiscing elit, sed do
eiusmod tempor incididunt.

Lorem ipsum dolor sit amet,
consectetur adipiscing elit, sed do
eiusmod tempor incididunt.



If we do “If a line connected to one side of the node, another line can be connected to the other side of it.”, what about the first node that there is no connected line to it? (Conceptual)

- Greedy approaches:
 - Pick right/left for the first node.
 - If the position of the node is in the right half of the page, pick right; otherwise, pick left.
- Approaches that pre-calculates the best direction

Lorem ipsum dolor sit amet,
consectetur **adipiscing** elit, sed do
eiusmod tempor incididunt.

Lorem ipsum dolor sit amet,
consectetur **adipiscing** elit, sed do
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Lorem ipsum dolor sit amet, consectetur **adipiscing** elit, sed do eiusmod tempor incididunt.



Consideration of when two nodes are in the same line or not (Conceptual)

- If the nodes are in the same line, one single line should be drawn
- If they are not, 3 distinct lines should be drawn.

Lorem ipsum dolor sit amet, cons.

Lorem ipsum dolor sit amet,
consectetur adipiscing elit, sed do
eiusmod tempor incididunt.



How long should the line extending from the right side? (Conceptual)

- Draw the line all the way to the right margin of the page.
- Draw the line to where the text ends in the line.

Lorem ipsum dolor sit amet, sed do
eiusmod tempor dodod
incididunt.

Lorem ipsum dolor sit amet, sed do
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Lorem ipsum dolor sit amet, sed do eiusmod tempor dodod incididunt.

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Horizontal lines can overlap, making it difficult to identify which line corresponds to which nodes. (Conceptual)

- Maintain **a list of Y-coordinates for all of the drawn lines**. When adding a new horizontal line, create **a gap calculated as the number of lines having the same Y-coordinate as the new line multiplied by the spacing between two lines**.

Lorem ipsum dolor sit amet,
consectetur adipiscing elit, sed do
eiusmod tempor incididunt ut
labore et dolore magna aliqua. Ut
enim ad minim veniam.

Lorem ipsum dolor sit amet,
consectetur adipiscing elit, sed do
eiusmod tempor incididunt ut
labore et dolore magna aliqua. Ut
enim ad minim veniam.



Vertical lines can overlap, making it difficult to identify which line corresponds to which nodes. (Conceptual)

- Track **the count of lines on both the right and left sides**. For each new vertical line added to either side, create a **gap calculated as the number of lines on that side multiplied by the spacing between two lines**.

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consectetur adipiscing elit, sed do
eiusmod tempor incididunt ut
labore et dolore magna aliqua. Ut
enim ad minim veniam.

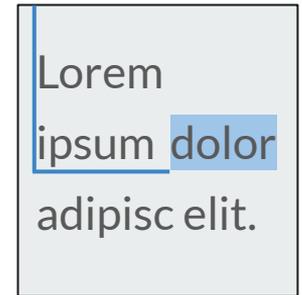
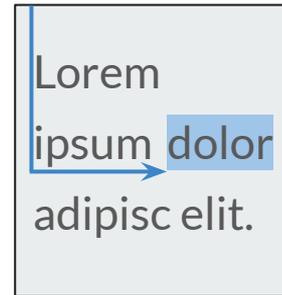
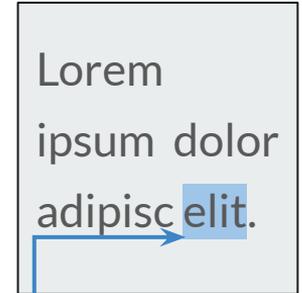
Lorem ipsum dolor sit amet,
consectetur adipiscing elit, sed do
eiusmod tempor incididunt ut
labore et dolore magna aliqua. Ut
enim ad minim veniam.



What if the two nodes that are connecting with a line are in two different pages?

(Conceptual)

- Dividing the line to two lines: one from the starting node to the bottom-left of its page, and one from the top-left of the ending node's page to the ending node.

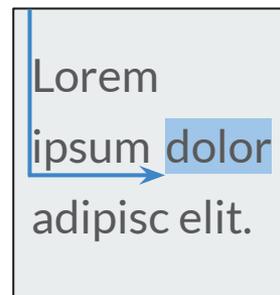
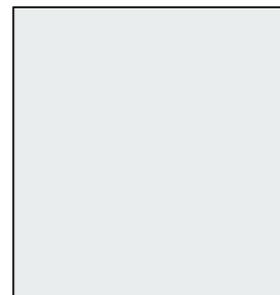
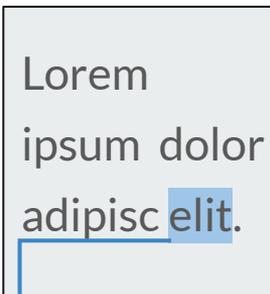




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- If the nodes are not in two page that are next to each other:
 - The pages between them show nothing





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 - The pages between them show a line from the top-left to bottom-left



Diagram of a page containing the text: Lorem ipsum dolor adipisc elit. A blue line starts from the bottom-left corner of the page and extends horizontally to the right, ending under the word "elit".

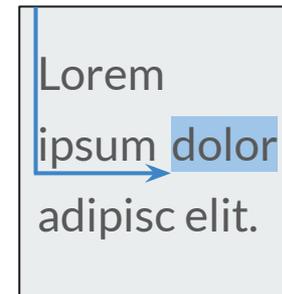


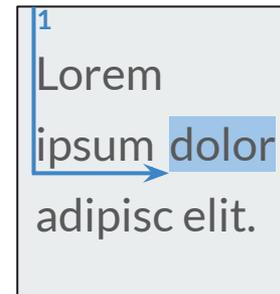
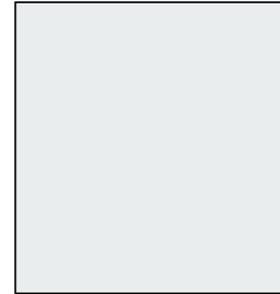
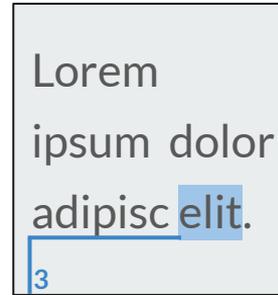
Diagram of a page containing the text: Lorem ipsum dolor adipisc elit. A blue line starts from the top-left corner of the page, runs vertically down to the bottom-left corner, and then extends horizontally to the right, ending under the word "dolor".



What if the two nodes that are connecting with a line are in two different pages?

(Conceptual)

- Dividing the line to two lines: one from the starting node to the bottom-left of its page, and one from the top-left of the ending node's page to the ending node.
- If the nodes are not in two page that are next to each other:
 - The pages between them show nothing
 - The pages between them show a line from the top-left to bottom-left
 - Show a the number of the other page in the bottom-left/top-left



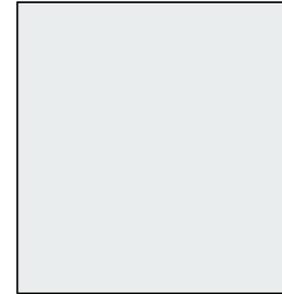
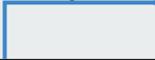


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 - The pages between them show a line from the top-left to bottom-left
 - Show a the number of the other page in the bottom-left/top-left

Lorem
ipsum dolor
adipisc elit.



Lorem
ipsum dolor
adipisc elit.





LaTeX renders the lines based on the order that they are marked in the text; not the order that the users specifies them. [\(Implementation using LaTeX\)](#)

- What are the problems this cause?
 - The lines will be drawing differently.
 - Managing the line drawing from a page to another would be challenging.
- This challenge makes so many difficulties as for the programming part.

Lorem ipsum dolor sit amet,
consectetur adipiscing elit³, sed do
eiusmod tempor incididunt ut
labore et dolore² magna aliqua¹. Ut
enim ad minim veniam.

Lorem ipsum dolor sit amet,
consectetur adipiscing elit³, sed do
eiusmod tempor incididunt ut
labore et dolore² magna aliqua¹. Ut
enim ad minim veniam.



Limitations

- For the places where vertical or horizontal lines overlap, we considered adding space between them to avoid this. Although the solution works, the number of lines is still limited.
- If there are too many lines connecting nodes, it would be hard to follow the flow of the lines.
- If there are multiple sets of lines and we differentiate them with different colors that are not aligned with the document theme, it might hurt the visual appeal of the document itself.



Limitations

- In terms of programming using LaTeX, specifying the highlighted text by calling the macros might be challenging. It would be even more challenging to specify a point in a figure or table, as they need to enter the coordinates of that point.

Future work (Open Questions/Problems)

What if instead of one-series of the nodes to connect, there are multiple series of them?

- Does it makes any problems?
 - Maybe it would be hard to differentiate different series
 - What are other problems?
- How to make it easy for the reader to differentiate the series of lines?
 - Maybe using different colours?

How to manage two column text?

- The problem is that the current approach for one-column text can be applied to a two-column text, but it's probably not the best approach.

Lorem ipsum dolor sit amet,
consectetur adipiscing elit, sed do
eiusmod tempor incididunt ut
labore et dolore magna aliqua.

Lorem ipsum dolor sit amet,
consectetur adipiscing elit, sed do
eiusmod tempor incididunt ut
labore et dolore magna aliqua.

How to manage two column text?

- As a possible better approach we can use the vertical space between the two columns to have a better visuals. However, it makes further implementation challenges.

Lorem ipsum dolor sit amet,
consectetur adipiscing elit, sed do
eiusmod tempor incididunt ut
labore et dolore magna aliqua.

Lorem ipsum dolor sit amet,
consectetur adipiscing elit, sed do
eiusmod tempor incididunt ut
labore et dolore magna aliqua.

What issues may arise if the right and left sides of a point are in different lines?

What if the they are in different pages?

Lorem ipsum dolor sit amet,
consectetur adipiscing elit, sed do
eiusmod tempor incididunt ut
labore et dolore magna aliqua.

How to specify a specific point as a node in a table or picture?

- One possible solution would be that the user identify the X and Y coordinate of that point. However, this approach is hard for the user.
- What other approaches could be a solution for this problem?



Conclusion

- Although it seems it's not very challenging to draw lines between the nodes, there are so many challenges and problems with a variety of solutions that can be applied.
- For each challenge/problem, I considered different solutions that came to my mind and chose the best one. However, there may be better solutions for each.
- Although the code I implemented addresses many of these challenges and performs satisfactorily, as I discussed in the “Future Work” section, there are still many open challenges to solve to improve it further.



Conclusion

- The LaTeX code is implemented as a package, which means that everyone can include it in their code and use it easily.
- Although there are some limitations, the writer of the document has the ability to use the package within the text properly to overcome these limitations based on their decisions.

Thanks!
Any Questions?

