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Why LaTeX?

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"The ideal situation occurs when the things that we regard as beautiful are also regarded by other people as useful."

- Donald Knuth



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Why LaTeX?

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1. Introduction

Very few of us (counting those familiar with LaTex) know it is an abbreviation for Lamport Tex, named after its conceptualizer, Leslie Lamport, in the '80s. It is not a wake-up call, but the point here is that even though we are using it as a tool to develop our "precious" manuscript, we are very interested to know about its origin. To define it formally, LaTeX is a typesetting tool for professional-quality scientific and technical writing. It is widely used in academia and research communities for writing academic papers, theses, dissertations, technical reports, and books. It is a document preparation system predominantly used for technical or scientific writing and publishing.

This handout encourages readers to use LaTeX for technical document writing and formatting. Syntax highlighting, autocompletion, and error checking are just a few features of modern LaTeX editors that make it easier to create documents. In addition, they include resources for handling a document's structural elements, like indexes, bibliographies, and tables of contents. To that purpose, this handout describes several latex editors and how even the smallest of documents, like "snippet," can be generated in LaTeX.

Why LaTeX?

1.1 The Big Questions?



Figure 1. LaTeX vs. other document editors

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1.1 The Big Questions?

Do formatting and the look and feel of a document play a role in accepting or rejecting a research article?

Unfortunately, preparing sloppy documents in text editors is easy, but in LaTeX, it is hard to be unprofessional. Canadian research concluded that the researchers spent a median of 84 hours formatting each manuscript using MS Word. Scientists lose 208 hours of the year to formatting, for $1,908, if they work using MS Word [1]. LaTeX automates the structure and format of a document so that the author can focus on the content. It uses excellent optimization algorithms to keep the article's text, sections, figures, and other components well-spaced.

In 2014, 18% of researchers used LaTeX to write their papers:
Mathematics and Statistics: 151,085 (92% LaTeX = 138,998)
Physics and Astronomy: 274,287 (60% LaTeX = 164,572)
Computer Science: 255,916 (45% LaTeX = 115,162) [2]

Why LaTeX?

1.1 The Big Questions?

Why not use other document editors, which are direct and easy to learn?

LaTeX and Microsoft Word are two different types of software with different strengths and weaknesses, and it is not fair to compare them. The choice of which one to use depends on the situation and the user's needs. However, when preparing complex documents with precise formatting, mathematical formulas, and references, LaTeX is recommended [3].

Why LaTeX?

1.1 The Big Questions?

We can benchmark by comparing LaTeX with another document editor in terms of producing scientific documents on the below parameters:

· Professional typesetting: LaTeX was explicitly designed to create technical and scientific documents, producing high-quality output. LaTeX allows precise control over typography, including mathematical symbols and equations, and generates aesthetically pleasing and professional-looking documents.

· Efficiency: LaTeX uses plain text files with simple markup, which can be easily version-controlled and edited with any text editor. This makes it much easier to collaborate on large documents with multiple authors and to maintain a consistent formatting style. On the other hand, Microsoft Word files can become bloated with formatting codes, which can make them challenging to manage.

· Cross-platform compatibility: LaTeX files can compile on any operating system, including Windows, macOS, and Linux, making it easier to collaborate with colleagues using different systems. In contrast, Word files can sometimes have compatibility issues when opened on various operating systems or versions of the software.

· Stability: Because of its widespread popularity and the dedication of its user base, LaTeX has remained unchanged for decades and continues to thrive. In contrast, Microsoft Word can be prone to crashes and errors, mainly when working with large or complex documents.

Why LaTeX?

1.2 Advantages of using LaTeX Editors

We must accept that developers did not create the standard word processing tools for research writing. They are still adapting to the challenges of this type of writing. LaTeX, on the other hand, is the new favorite way of writing for the modern generation of academicians, especially in physics, mathematics, and computer science, due to its unique features (see Figure 2) [4].



Figure 2. Unique features of LaTeX

¿Por qué LaTeX?

1.2 Ventajas de usar Editores LaTeX

- Automated structure: In LaTeX, the formatting segregates the content. Users can define customized styles for each manuscript element, which remain consistent across the document.

- Platform-independent: LaTeX files are plain text files saved as .tex files. These files can be easily opened and edited in any text editor. The only thing required is a compiler that can compile the .tex file and produce a result in.pdf format.

- Quality and beautification of documents: The quality and beauty of papers produced by LaTeX are far better than any other word processing software. The texts with complex equations, formulas, and graphs look very professional in LaTeX. Since the content is coded with commands, decisions about margins, justifications, hyphenation, etc., are only defined once.

¿Por qué LaTeX?

1.2 Ventajas de usar Editores LaTeX

- Cost: LaTeX is free! While MS Word costs around 8 to 10 dollars monthly, other versions, like OpenOffice, do not provide many formatting options.

- Forget the syntax: Nowadays, journals and conference proceedings explicitly provide LaTeX templates already encoded with their preferred formats and settings. Even with basic LaTeX familiarity, users can create manuscripts using these templates.

- Bibliography: This is the primary reason users choose LaTeX over other tools. LaTeX can automatically generate or update the bibliography for a manuscript in several ways, depending on the user's convenience and understanding. By changing a keyword, users can easily switch between various bibliography styles, like IEEEtr for IEEE style, apalike for APA style, etc.

2. How does LaTeX work?

We understand that LaTeX is a markup language used to create documents, particularly scientific and technical documents with complex formatting requirements. LaTeX documents are written in plain text but embedded with commands that describe their structure and meaning [5]. The latex compiler processes this text with these commands and produces a beautifully formatted document, as shown in Figure 3.

Before addressing how a LaTeX editor works, let us see technically what TeX and LaTeX are.

TeX is an advanced typesetting system primarily developed by Donald Knuth. It is mainly famous because of its ability to handle complex technical text and display mathematical formulas.

What is LaTeX, then? Explained simply, LaTeX is a set of macros (or macro packages) built on top of TeX. Whatever LaTeX command we use rests on a set of TeX commands compiled underneath.

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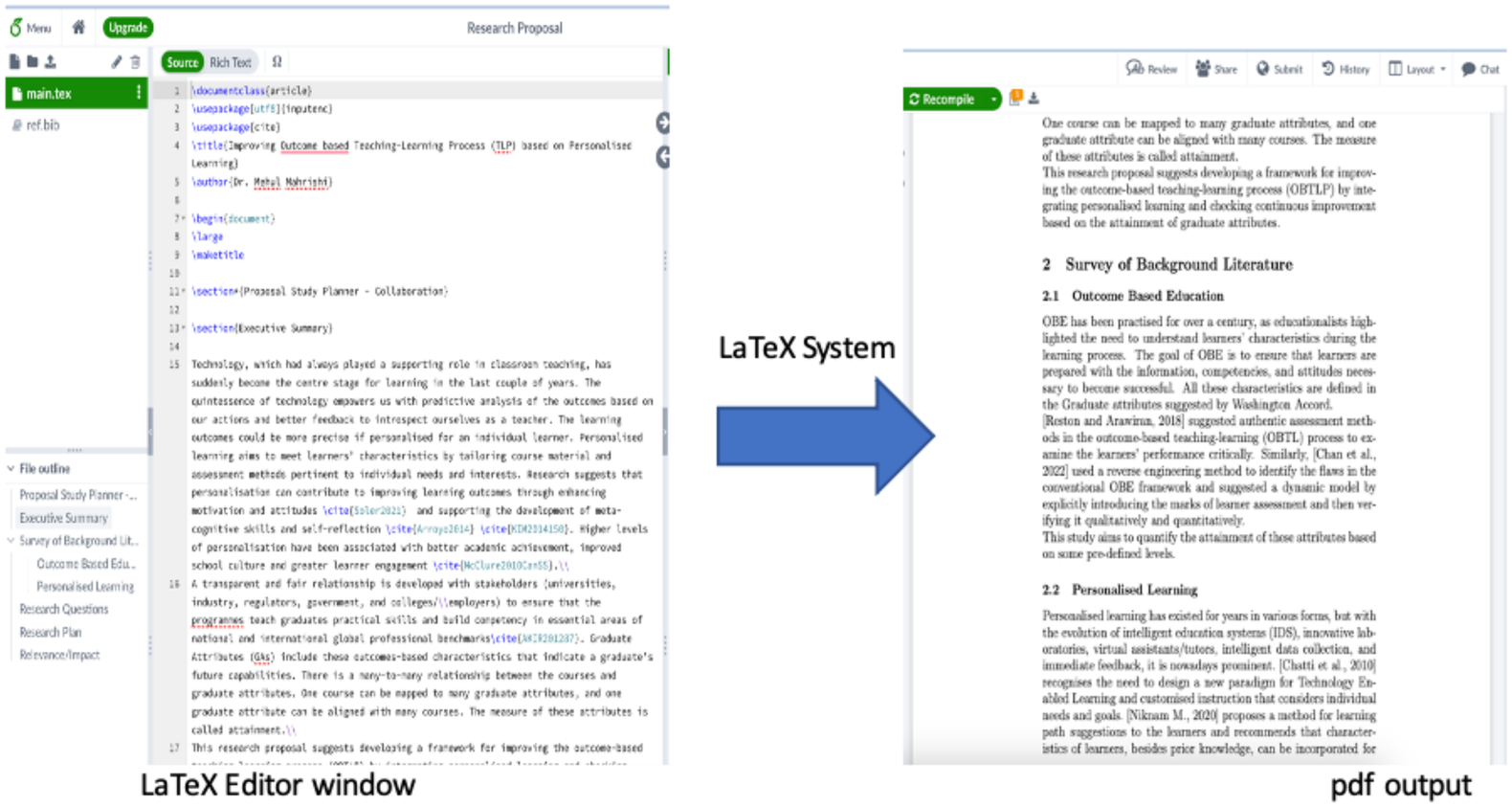


Figure 3: Input plain text to output pdf by LaTeX system. (Material provided using Overleaf)

Why LaTeX?

2.1 Available LaTeX Editors

With LaTeX becoming popular among the research community, more and more editors are available to control the content. We call these editors "text editors." A LaTeX editor is a handy online or offline app that enables us to write, edit, and publish papers in LaTeX.

LaTeX editors empower users to define the formatting of the text in advance through markup-level directions. After entering the content, the user can export the document in multiple formats, such as DOCX, PDF, and LaTeX. Editing mathematical equations is extraordinarily handled by these editors, which is one of the primary reasons they became popular [6].

However, a text editor alone is not sufficient. We also need a compiler to process the commands. These compilers, such as pdfLaTeX, read the LaTeX source code, interpret the orders, and generate the corresponding output in pdf format. The collection of these editors, compilers, packages, and classes is called a LaTeX distribution. The commonly known distributions are TeX Live and MikTeX.

2.1 Available LaTeX Editors

This handout discusses three major editors (Figure 4): Overleaf (an online editor), TeX Maker, and TEXstudio. Users can navigate other editors whose syntax and writing style are like those discussed here.



Figure 4: Various LaTeX Editors

Why LaTeX?

2.1 Available LaTeX Editors

- Overleaf: Previously known as ShareLatex, Overleaf is now a popular cloud-based LaTeX editor. It has a lot of subscriptions and in-built templates from top journals, conferences, and universities. The website claims 11,000,000 users worldwide, including researchers, students, and teachers in institutions, labs, and industries who have created over 100 million documents [overleaf]. Overleaf also provides real-time sharing and collaboration for a research paper. Figure 5 shows the gallery of document templates provided by Tecnologico de Monterrey.

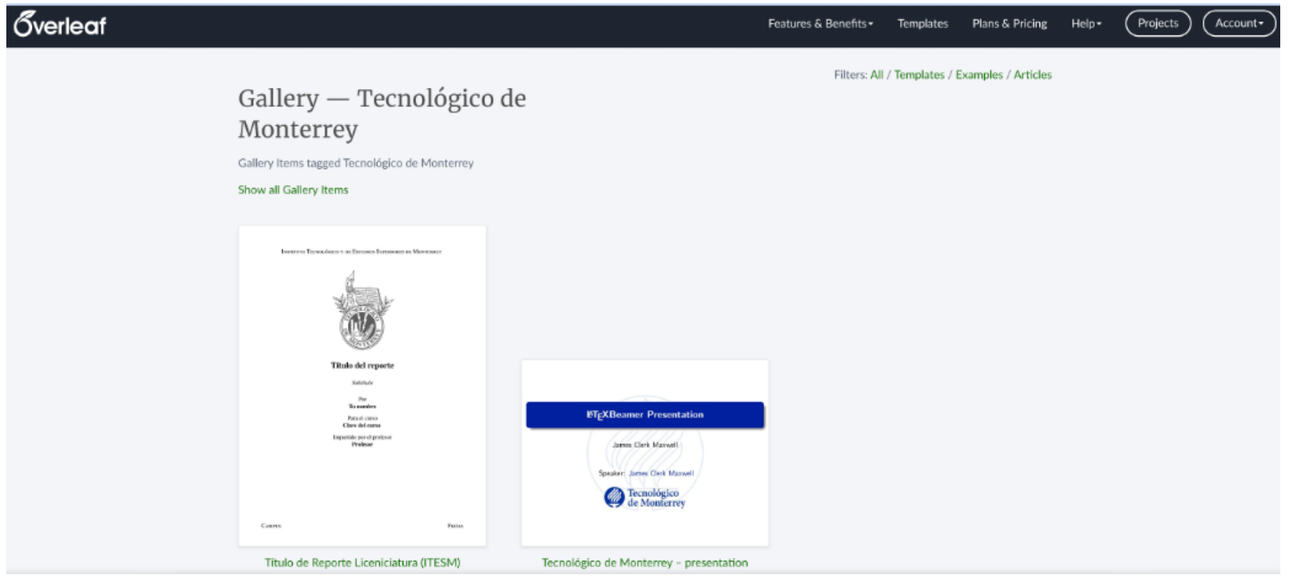


Figure 5: Gallery of LaTeX document templates by Tecnologico de Monterrey Material/tutorial/class provided using Overleaf

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2.1 Available LaTeX Editors

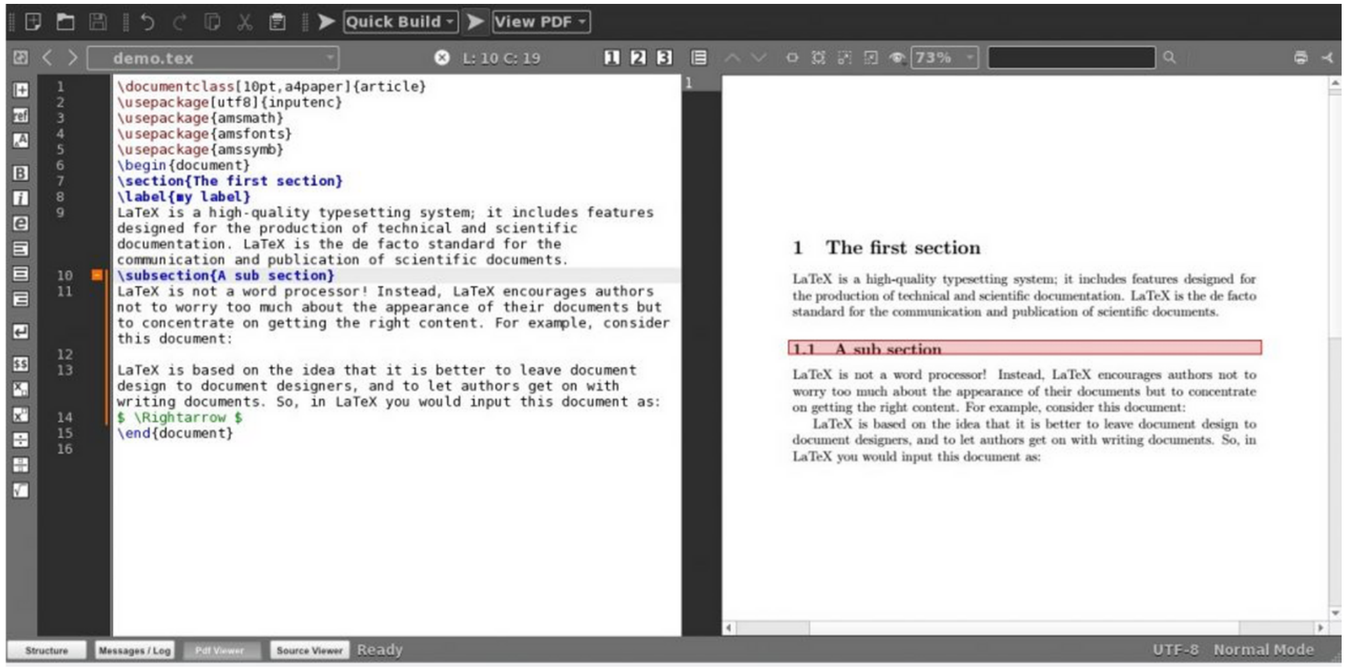


Figure 6: TexMaker software package interface

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- TeXMaker: Another free LaTeX software package that is platform-independent, supports auto-compilation, and may have other features. It is one of the most widely used and powerful LaTeX editors. Figure 6 shows a sample document execution in TeXMaker.

Why LaTeX?

2.1 Available LaTeX Editors

- TEX Studio: Among the best LaTeX editors is TEX Studio, which provides easy-to-use and platform-independent features. The tools come with all the standard features, like built-in mathematical symbols, auto-compilation, bibliography, etc. TeXstudio is free software with an open-source license. Figure 7 shows the editor interface with various sections for TexStudio.

We will use Overleaf to create and compile the LaTeX documents throughout the handout and the coming handouts. The reason for this is apparent: no installation, built-in compiler, and free cloud-based storage.

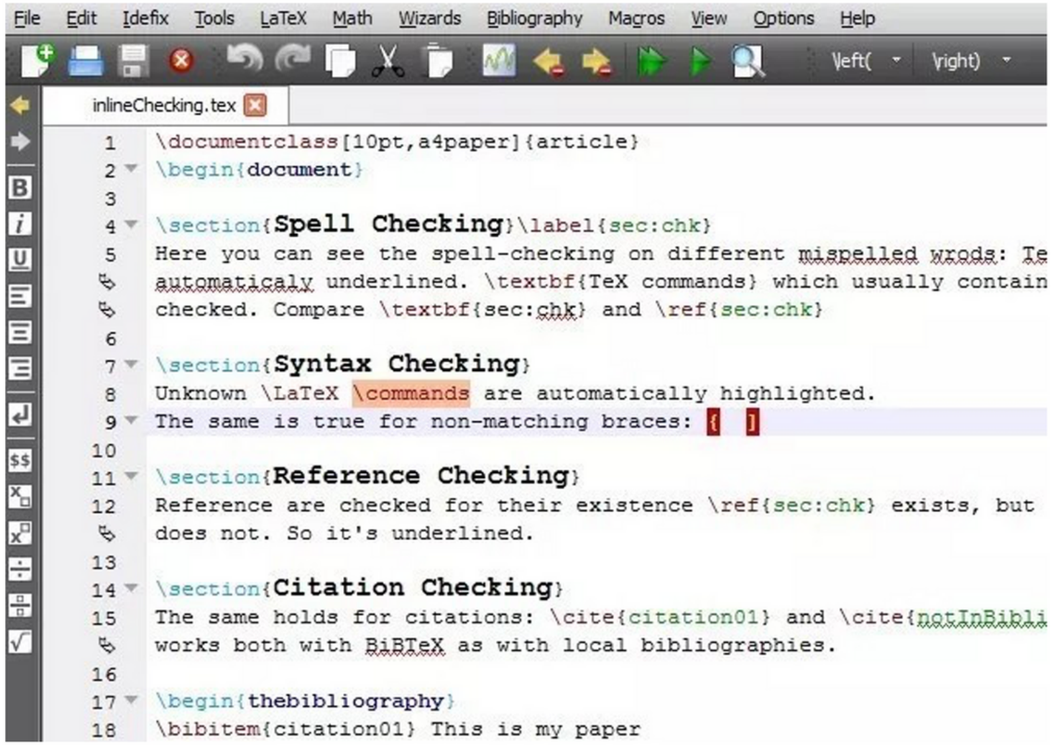


Figure 7: TexStudio software package interface

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3. Create your first LaTeX document using Overleaf!

To start using LaTeX, we must have three things!

1. A LaTeX distribution that compiles the LaTeX code (MiKTeX (https://miktex.org/download)) or TeXLive (https://www.tug.org/texlive/).
2. A LaTeX text editor can be an online editor like Overleaf (https://www.overleaf.com/) or an offline editor like TEXMAKER (https://www.xm1math.net/texmaker/).
3. A PDF viewer to generate the output of the LaTeX code. Adobe Reader and Foxit Reader are familiar pdf viewers [3].

NOTR: Overleaf does not require a different distribution or text editor. It is already embedded with the latest TeX distribution, an editor, and a PDF viewer. Nevertheless, the proficiencies of Overleaf apply to all other platforms and editors. Let us get started with a quick tour of the tool and compile the first latex document.

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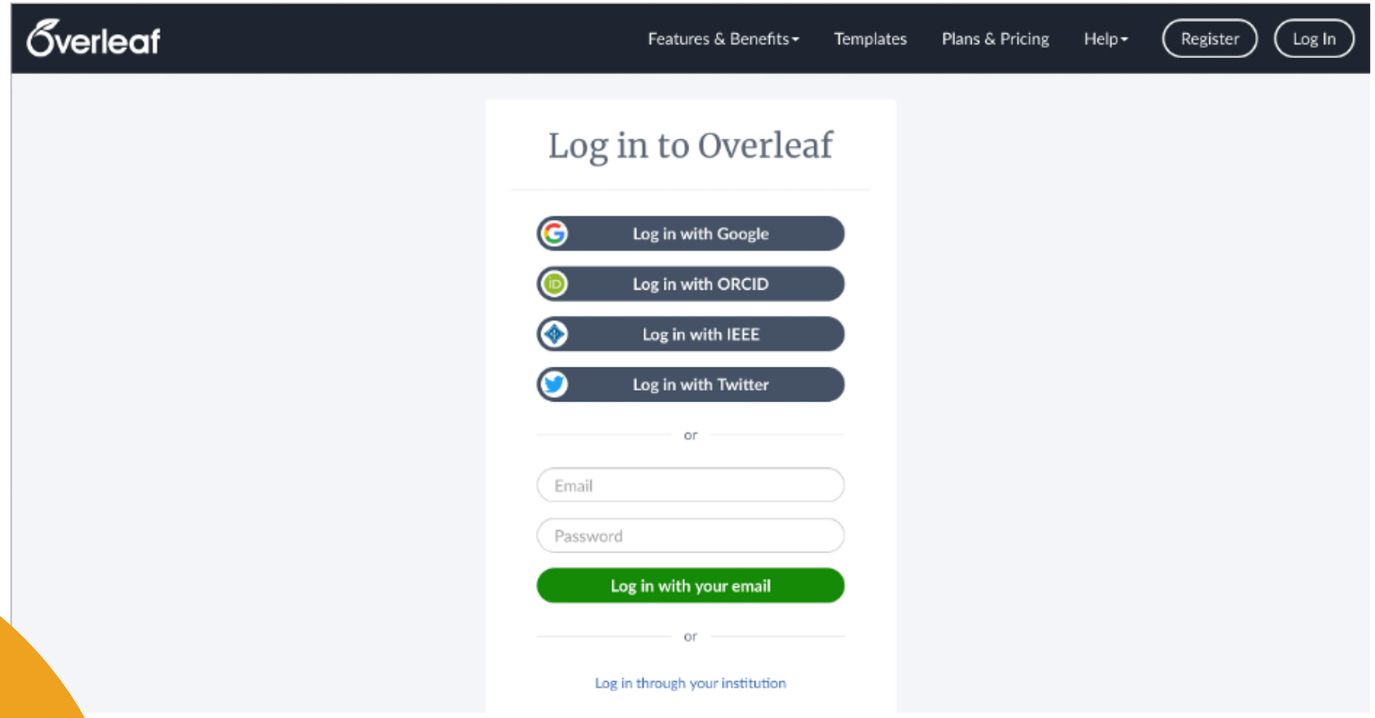


Figure 8: Log-in window for Overleaf

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- Registration to Overleaf is like any other platform where users can register through their personal mail accounts, Google accounts, IEEE accounts, or Twitter accounts or sign up using their ORCID account, as shown in Figure 8.

Why LaTeX?

- The green "New Project" button (Figure 9) indicates a new LaTeX document creation. Apart from creating a new blank document, various other options are available: uploading projects, importing from GitHub, and selecting many templates. Figure 9 depicts the project explorer options when the user clicks on the new project icon.

- The uploaded project allows uploading an already-existing latex template specific to a journal or a conference. This option generally works for a .zip file containing a zipped package consisting of a .tex file, various class files, a basic formatting file, and a bibliography file.

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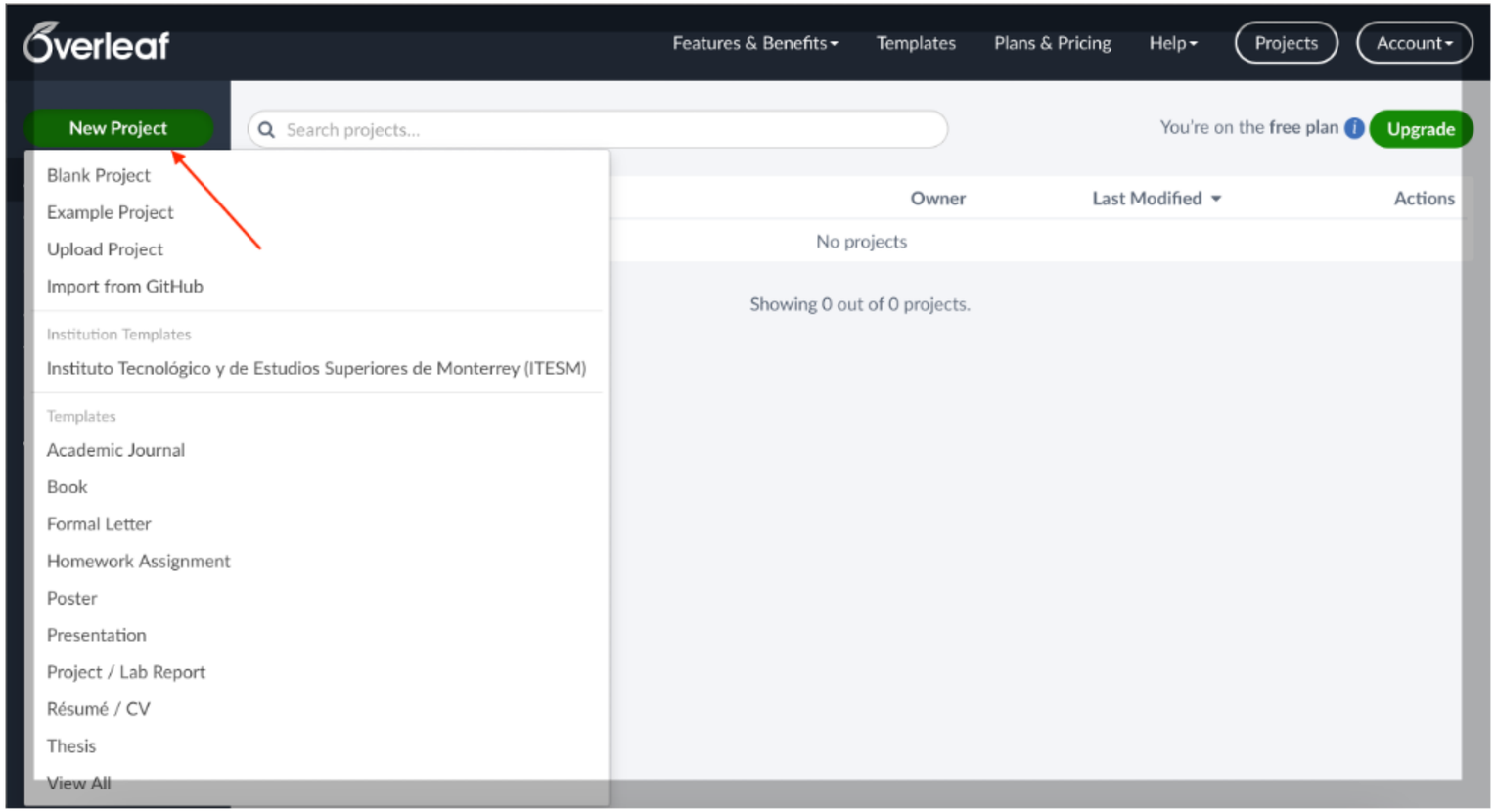


Figure 9: Creating a new project in Overleaf.

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Why LaTeX?

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- Let us select the blank project and name it first. As soon as we create a latex project, a three-window interface appears.
  - The leftmost window is the project file explorer.
  - The middle window is the editor window where the latex commands and the actual content is written.
  - The rightmost window is the window that generates the output in PDF format if the code in the middle window compiles without errors.

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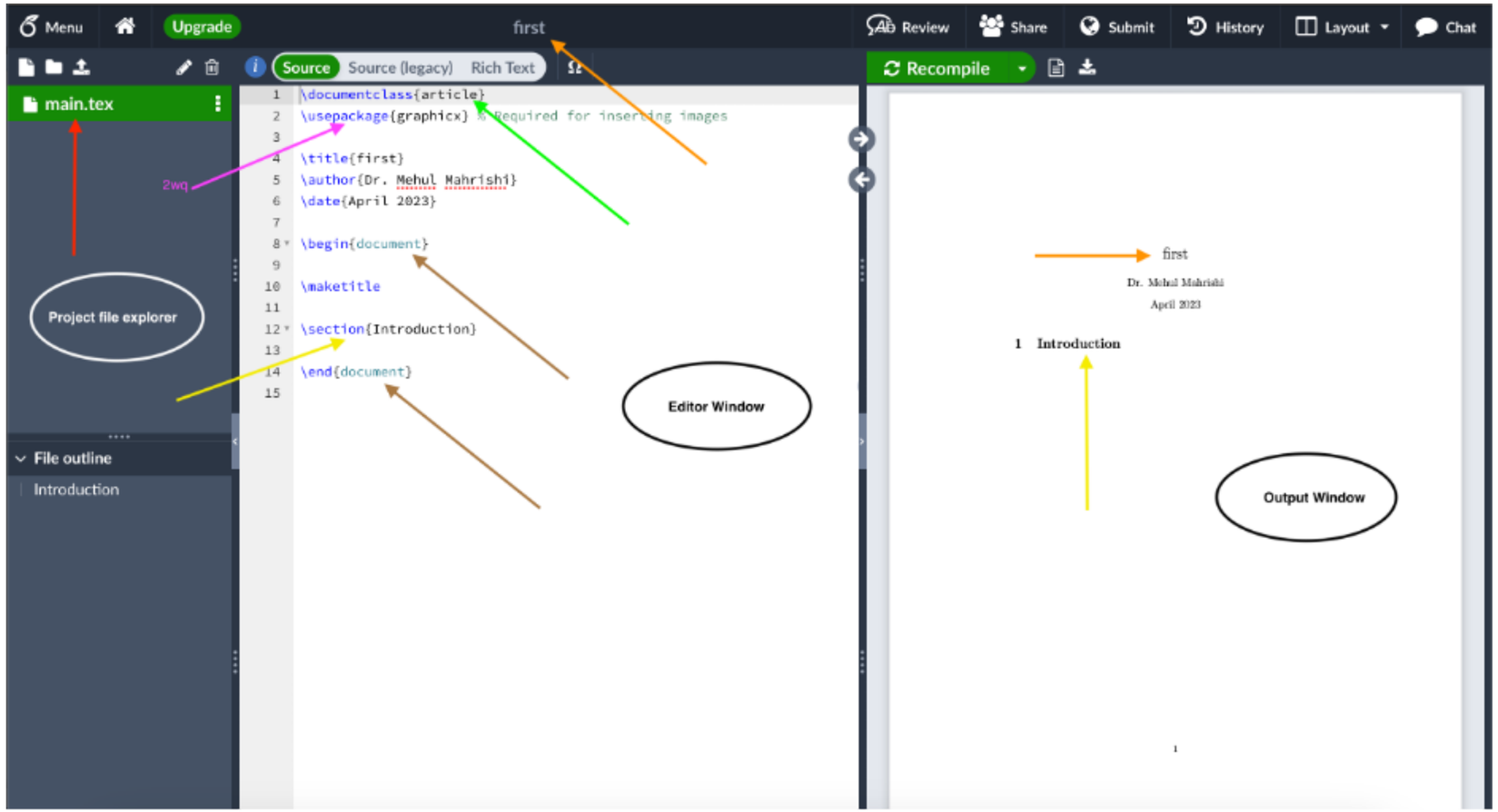


Figure 10: Various components of a LaTeX document

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Why LaTeX?

- For ease of understanding, different color codes represent various constructs of the three-window interface in Figure 10.
  - The elliptical figures show the project file explorer, editor, and output window.
  - The red arrow represents the main.tex file. This primary file contains all the packages and the document's main content.
  - We can see that Overleaf, being the editor, has already given some code by default in the editor window.
  - Each statement that starts with a backslash (\) is a latex command.
  - Every document created in LaTeX falls into one of several document classes. The above example is formatted as an article document marked by a green arrow. Other document classes include books, letters, reports, etc.
  - The following line (pink color) represents the packages to use for various components in a document. For example, the ¨graphicx¨ package would include document images.
  - The title command, represented by the orange arrow, tells the latex compiler about the document's title. The next set of commands, i.e., the author command and date command, are optional and self-understood. This completes what is called the ¨Preamble¨ of a latex document.

Why LaTeX?

- The "begin" command on line 8, represented by a brown arrow, tells the latex compiler that we want to start a document.
- The "maketitle" command on line 10 puts the title in the document using the information in the preamble.
- The section command represented by yellow arrows partitions a document into multiple sections. The Introduction is an example of the first section created in the paper.
- Line 14 is the "end" command that indicates to the compiler that the document is finished.
- Whenever we issue a "begin" command, we must have an "end" command to avoid LaTex giving an error.
- The output of the editor window can be seen in the output window.
- We must follow every change in the editor window by clicking the "recompile" button, which shows the updated, generated pdf.
- Hovering the mouse near the recompile button explores many other options like zoom-in, zoom-out, error log, download pdf, etc.

- Apart from these three partitions, Overleaf has some additional features in the interface, including sharing documents with collaborators, viewing the document's history, creating templates, submitting a manuscript to a journal, etc.
- If everything goes fine, you will produce your first latex document!

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4. Conclusion

LaTeX is a markup language that embeds commands with the manuscript content and generates beautiful scientific documents. (It appears complicated, but I trust now you understand that it is not!) The tool can create all types of documents, even a restaurant menu, and it is very productive for researchers, particularly those working in STEM.

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