SCISPACE Enhances Research Work-flows

SCISPACE realza los flujos de investigación

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KEYWORDS:

Research work-flow, Semantic Search, large language Models, SciSpace, Gemini

ABSTRACT:

This work analyzes the characteristics of SciSpace as a tool to assist in while writing a research. The work explores other software-tools for this purpose. This work presents the historical and the corporate development of Scispace. Also, it describes the main features as compared with classic texts-books for scientific research. Then two cases of research are presented: one concerned with heat-transfer technology, and the other with cognitive aspects of category theory. The first case was repeated 18 months later, and the characteristics of both searches were compared. The last case illustrates how Scispace serves to review a wide background of the development of a specific subject. The conclusion is that Scispace can serve to different types of users; and that it is advantageous to use this type of tool while endeavoring a written research.

PALABRAS CLAVE:

Flujo de investigación, búsqueda semántica, modelos de lenguaje de gran tamaño, SciSpace, Gemini.

RESUMEN:

Este trabajo analiza las características de SciSpace como herramienta de apoyo para la redacción de investigaciones. Explora otras herramientas de software para este propósito. Presenta el desarrollo histórico y corporativo de Scispace. Además, describe sus principales características en comparación con los libros de texto clásicos para la investigación científica. A continuación, se presentan dos casos de investigación: uno relacionado con la tecnología de transferencia de calor, y el otro con los aspectos cognitivos de la teoría de categorías. El primer caso se repitió 18 meses después y se compararon las características de ambas búsquedas. El último caso ilustra cómo Scispace permite revisar un amplio historial del desarrollo de un tema específico. La conclusión es que Scispace puede ser útil para diferentes tipos de usuarios y que resulta ventajoso utilizar esta herramienta al realizar una investigación escrita.

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1. INTRODUCTION

Language has been a fundamental element in the establishment of human civilizations, such as the Sumerian, Egyptian, Greek, and Mayan civilizations, among others, each with different forms of written and spoken language. Language can be considered an instrument of the human mind for the creation and development of science, technology, philosophy, and arts in every civilization. In each of these civilizations, humans invented graphic and sound symbols that gave rise to different languages with their own syntax and semantics through the organization of symbols in words, sentences, and phrases. Language is a key element for the formation of societies in communicated human networks. But it was not always like this.

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The biblical story of the Tower of Babel shows that humanity, after the flood, spoke only one language when it decided to build the tower with the purpose of reaching heaven; God, seeing human pride, confused their language in such a way that they could not understand each other. Semantics had been disturbed.

In modern times, mankind has at its disposal different languages, each with elaborate syntax and semantics, not only for communication between human beings but also with their environment. With only two symbols,0 and 1, words can be formed to communicate with a computer; in biology, four symbols are used (A–adenine, C–cytosine, G–guanine, T–thymine) that make up DNA (deoxyribonucleic acid) and with which the biological software called Genome is written to create and maintain a human body; in the study of the kinematics of robotic mechanisms, four symbols are also used to communicate with the mechanics of a physical robot (a – link length, α – link twist, d – link offset, θ – joint angle), known as DH (Denavit-Hartenberg) parameters. Mathematics, physics, biology, computer science, and other sciences have their own languages with their own syntax and semantics. The mechanics of natural language can help us understand its impact on society. The mind is a cognitive entity of a being to process and interpret thoughts that are treated in their transit through a linguistic process called Semiosis, which is made up of three branches, pragmatics, syntax and semantics as shown in Fig. 1. Language as a system of symbols establishes a relationship between mind and reality. A human being creates the symbols. One part of the symbol is in the physical space (in graphic or sound form, for example) and the other in the abstract space (the meaning provided by semantics). During Semiosis, thought is not only processed but also interpreted. As a result of processing and interpretation, abstract space produces decisions that will affect or modify the physical space, which in turn will respond with another system of symbols.

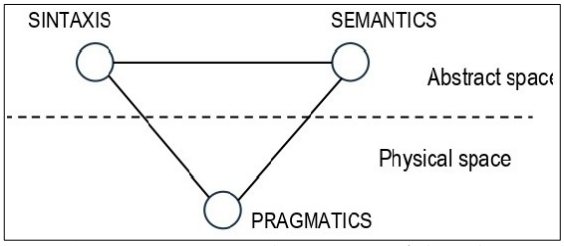

Figure 1. Semiosis, the process of thought.

Since language links mind and reality, we notice that natural language has been very compelling in transforming human civilization. Let us review some episodes in history. Mao Zedong dictated the re-education of the population in the People's Republic of China (1954-1976). The Soviet Union under the leadership of Joseph Stalin (1924-1953) was marked by profound transformations. The Fu¨rer's Germany (1933-1945) was a period of totalitarian dictatorship under the leadership of Adolf Hitler and the National Socialist German Workers' Party. To complete, Harari [1] believes that language is the operating system of human civilization, it is the basis of everything we are as a society, and it dominates our minds and beliefs. On the other hand, Harari also claims that artificial language may have the power to dismantle our mental objectivity, and our social reality compared to the atomic bomb that destroys physical things. In these times, human civilization faces the threat of giving power to artificial language in contrast to the power of natural language discussed above. Artificial intelligence is being applied in different areas of human activity such as medicine, autonomous cars, virtual assistance, and the military industry, among other applications. In virtual assistance there are two popular chatbots, ChatGPT developed by OpenAI and Copilot developed by Microsoft, which can write essays, solve math problems and generate code. This paper will discuss a virtual assistant called SciSpace, a platform focused

on scientific research. In the use of language, there will always be the opportunity for mind control and the modification of beliefs, both through natural and artificial language. The risk of artificial language is its power. -which, as useful as the power of SciSpace is-, always exists the possibility of misuse, although this is a matter of education, regulatory laws and ethics.

2. SCISPACE PRESENTATION

The analysis of the state of art of a particular topic is a fundamental step in the research. It prevents the research from repeating a research path during his/her proposal. Especially when we explore a new research topic one faces obscure concepts, intriguing methodologies, results with difficult interpretation, and uncertainty about how to assess the claims of the consulted research references. The possibility of automating some of the research stages by computer increases now due to some of the affine developments:

1. A large language model (LLM) is a deep-learning algorithm that uses massive amounts of parameters and training data to understand and predict text. This generative artificial intelligence-based model can perform a variety of natural language processing tasks outside of simple text generation, including revising and translating content. “computer programmers use LLMs to generate code in response to specific prompts. Additionally, if this code snippet inspires more questions, a programmer can easily inquire about the LLM’s reasoning. Much in the same way, LLMs are useful for generating content on a nontechnical level as well. LLMs may help to improve productivity on both individual and organizational levels, and their ability to generate large amounts of information is a part of their appeal.”
2. Converters Between different document formats with tools like **Pandoc** [2].
3. Managers of references like **Zotero** help t o collect, organize, annotate, cite, and share research developed at Roy Rosenzweig Center for History and New Media.

2.1. Description

SciSpace is a platform to access scientific literature and discover research content. Scispace was constructed to assist a researcher to carry out the standard works of documenting research. This platform came from the recognition that to do innovative research a lot of effort is required for a substantial literature review.

SciSpace has these capabilities:

- **Finder:** Scispace uses semantic search to find documents with related topics.
- **Formatter:** Scispace formats according to the type of the journal where the manuscript will be submitted
- **Integrator:** Scispace integrates -with the semantic synthesis-, the available sources of information with a common specialized use of concepts. Here, is important to review the selection of concepts (especially those with different meanings) to avoid misleading propositions.
- **Filter:** Customization of the type of search o topic.
- **Exporter:** Construct as comparison table in Excel format.
- **Reviewer:** Reviews the progress of a specific topic *Deep Review*.
- **Extractor of data**: Extract data from a document in a standard format: word, pdf.
- **Phraser and Paraphraser.** Can analyze a sentence, or can modify a paragraph with a particular emphasis

2.2. History

With the wide expansion of available research sources, the need of selective tools is evident.

A similar condition came during the development of search engines, like Altavista, Mosaic, Explorer, and Yahoo. The developers of google search engine recognized that an efficient search was carried in a similar form as consulting bibliographic reference: Author, title, and abstract. A selective search reduced the user time [3].

The search engine of SciSpace focuses on the parts of a research work: ideas, judgement, reason, method [4].

3. CORPORATION

3.1. Research team

The authors are scholars. Saikiran Chandha studied Software Engineering at Vellore Institute of Technology (VIT). Shanu Kumar is a Product and Engineering fellow of Stanford University.

S. Chandha comments that he was exposed to Access of technology GPT-1, GPT-2. He argues that language models can read and evaluate more research, evidence, and reasoning steps than humanly possible.

3.2. Origin

Vellore Institute of Technology

3.3. Research Base

SciSpace is based in Bangalore. This is one of the strongest sites for software development in India.

4. COMPONENTS

4.1. Intercommunication

SciSpace can communicate with: Google Scholar, and Zotero.

4.2. Selection Criteria

The number of citations as good criterion to characterize the quality of a paper.

Also, it is possible to obtain the citation profile of the authors working overtime. Other criteria is the date of the publication. And finally, to recognize that research is given as a cluster, or academy group of colleagues.

4.3. Decision tables

The semantic analysis helps to unify language during the comparison and group attributes like:

who?, when?, how?, what?, where?	Data set	Results	Insights	Limitations

The emphasis is to make a selective search of relevant information of a research topic.

4.4 Stages of work-flow

The identified stages are displayed in the table 1

Table 1. Stages of research work.

Stage	[5]	[6]	[7]
s1. Identify the research topic	•	•	•
s2. Review literature.		•	•
s2.5 Planning and assessing experiments	•	•	
S3. Making a good argument. Hypothesis formulation	•	•	•
s4. Observation and Data analysis	•	•	•
s4.5 Imagination and reasoning	•	•	
s5. Organized the emphasis of research and publication.	•	•	•
s5.5. Strategy to present the evidence	•	•	
s6. Distribute	•	•	•

Each stage can be automatized by a computer program and is also supported now

with bibliographic resources (thesis repositories, grammar-checker, style-checker)

- s2. With the literature review, the user gets a selected number of articles to continue his/her research work.
- s3. Making a good argument. Hypothesis formulation. It is possible to integrate and rephrase the text to be easier to understand. Also, it is possible to extract data to improve the quantitative evidence. Also to identify gaps in the available knowledge.
- s4. Analogy and examples are used to support an argument. SciSpace can be used for this purpose. s4.5 Analysis of cause and deductive techniques are complementary techniques to support an argument [8].

With these stages, it is expected to narrow the feasible research window. The Scispace resembles an automotive Navigation system, see fig. 2.

Mathematically, automotive navigation is based on the shortest path problem, within graph theory, which examines how to identify the path that best meets some criteria (shortest, cheapest, fastest, etc.) between two points in a large network.

5. USER PERSPECTIVE

How to use SciSpace? go to the https://scispace.com SSciSpace website.

- Enter a keyword, question, or article title into the search bar to find relevant papers.
- Review the insights on the literature review list to assess the most relevant papers.
- Select papers to read in detail based on: relevance, date or number of citations.
- Read a paper in SciSpace's reader. Use Copilot to get explanations by highlighting text or cropping equations and tables.
- Make notes and highlights as you read.
- Ask Copilot follow-up questions if you need clarification on concepts, results, or conclusions.
- Export the literature review table as CSV (comma separated values) to share insights with colleagues.
- Save the literature review work-space to continue your analysis seamlessly later.
- Access your notes and highlights from the integrated notebook to review critical concepts learned.

6. TWO CASES OF STUDY

6.1. Coefficient for Two-Phase heat transfer

In this section we are concerned with the characteristics of an adequate search for heat transfer coefficients for two-phase film-heat transfer see fig. 3 In this case, it is important:

- To show the difference between a paper and a published Book.
- To show the difference between analytic and approximated solution.
- To show the difference between an accurate and a noisy measurement.
- To show the difference between a prototype and a full implementation.

6.2. Comparison of Cognitive theories

This search came as a result of the study of [9]. Category theory has evolved as a bridge between mathematical theories because it applies regular syntax to describe relation between the elements of a group of elements (See Fig. 4).

Q1a: Give me a perspective of category theory from Aristole in during the Greek era to Bartosz Milewski in Poland. (consulted 2025-04).

Aristotlle's Categories

Aristotle's categories were a foundational aspect of his ontology, aiming to classify all possible kinds of things that can be the subject

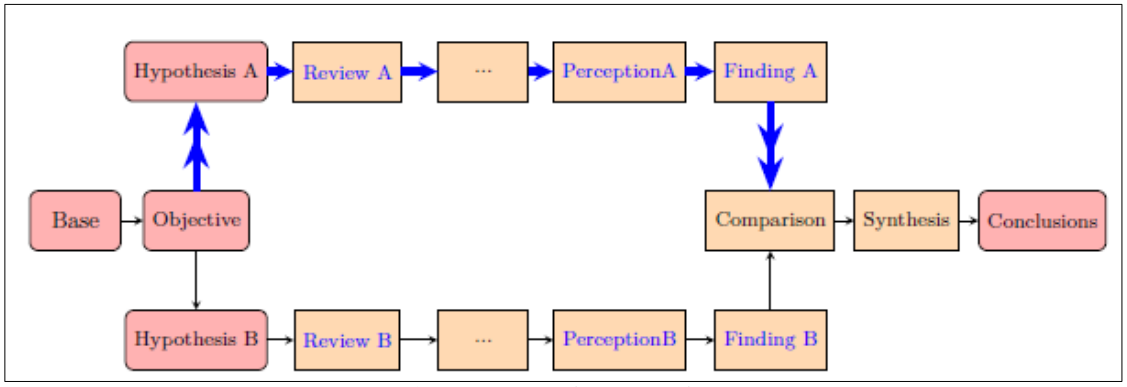

Figure 2. Research Process Flow.

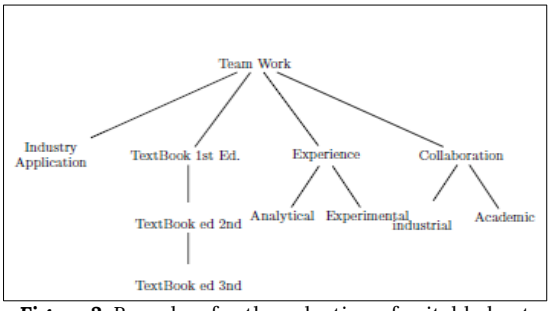

Figure 3. Branches for the selection of suitable heat transfer.

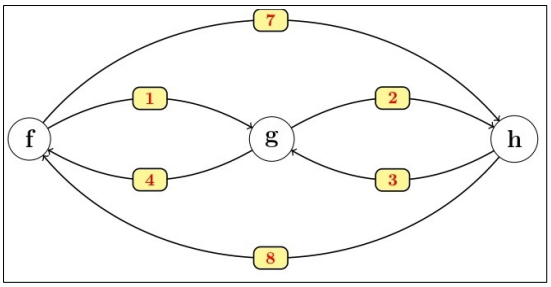

Figure 4. Composition of Functions.

or predicate of a proposition. His list included. His list included ten categories such as substance, quantity, quality, and relation, which were intended to capture the different ways in which a thing can be described or exist (Moravcsik, 1966) (Brentano, 1981). The categories were not merely linguistic but were deeply tied to Aristotle's metaphysical views, where substance was considered the primary category, underpinning all others (Bar-On, 1987). Aristotle's influence extended into early Christian thought, where his categories were adapted and interpreted by figures such as Alexander of Aphrodisias and Origen, demonstrating their lasting impact on philosophical and theological discourse(Lautner, 2022).

Development of Category

Theory The modern mathematical theory of categories, developed in the 20th century, diverges significantly from Aristotle's original conception. It focuses on the relationships between objects rather than the objects themselves, emphasizing morphisms (arrows) and functors as primary Development of Category Theory The modern mathematical theory of categories, developed in the 20th century, diverges significantly from Aristotle's original conception. It focuses on the relationships between objects rather than the objects themselves, emphasizing morphisms (arrows) and functors as primary elements (Heller, 2016) (Heller, 2016). This shift reflects a broader philosophical movement away from substance ontology towards relational ontology, where the identity and existence of objects are defined by their relationships and interactions (Kro´l, 2019). Category theory has been described as a "philosophy of arrows," highlighting its focus on the connections and transformations between structures rather than the structures themselves (Heller, 2016).

Bartosz Milewski's Perspective.

Bartosz Milewski, a contemporary advocate of category theory, emphasizes its utility in computer science and programming, where it

provides a powerful framework for understanding and organizing complex systems (Kr´ol, 2017). Milewski's work illustrates how category theory can be applied beyond pure mathematics, offering insights into the nature of computation and the structure of software, thus bridging the gap between abstract mathematical concepts and practical applications. While Aristotle's categories were deeply rooted in his metaphysical and linguistic framework, modern category theory represents a significant departure, focusing on abstract relationships and structures. This evolution reflects broader philosophical trends and highlights the adaptability of foundational concepts to new contexts and disciplines. The transition from Aristotle's substance-focused categories to the relational focus of modern category theory underscores the dynamic nature of philosophical and mathematical inquiry, illustrating how ancient ideas can be reinterpreted and expanded to address contemporary challenges and questions.

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Q1b: Give me a perspective of category theory from Aristole in during the Greek era to Bartosz Milewski in Poland (consulted 2026-09).

Aristotle defined categories as conceptual classifications, while modern category theory formalizes relationships between mathematical structures. This evolution shifts from static ontological labels to dynamic, functorial mappings, enabling applications in computation, logic, and programming through abstract reasoning.

<u>From Aristotelian concepts to modern theory</u>
Aristotle's original categories, numbering ten in total, were designed to represent the most general conceptual classifications or "Categories of Concepts" [1][2]

This ancient project sought to make explicit the principles of thought [1]

In contrast, mathematical category theory, invented 60 years ago by Eilenberg and Mac Lane, represents a shift from static conceptual labels to the study of the "naturality" of transformations between spaces [1]

While Aristotle initiated the project of making these principles explicit, modern category theory provides the common formal structure that unites logic and geometry [2].

The evolution between these eras is marked by a fundamental change in the meaning of "category." For Aristotle, the term denoted a classification of entities or concepts [2] In modern mathematics, a category is a formal framework for representing abstract objects and the relationships—or transformations—between them [1][3].

This transition represents a move from defining elements by their properties to a more abstract approach where mathematical objects are defined by their relationships within a system [3]

<u>Continuity and mathematical formalization</u>
Despite the shift in definition, a thread of continuity remains: both frameworks aim to establish foundational, explicit principles for reliable reasoning [1]

Category theory is viewed by some as a superior foundational system to set theory, as

it can describe set theory itself and encompass all mathematics, whereas set-theoretic constructions are seen as inadequate for modern mathematical practices [3]

Philosophical excavations into this history reveal that "category" carries different meanings depending on the foundational context [4]

While Aristotle's categories were foundational to his logic [2], modern category theory provides a "Platonic Heaven" of mathematics, allowing for the precise modeling of concrete universals [5].

This allows for the modeling of properties in a way that avoids "bad Platonic metaphysics," instead utilizing the mathematical structure of categories to represent how concrete instances participate in universals [5]

Computation and applied reasoning

Bartosz Milewski's modern exposition contributes to the application of these abstract principles to the fields of programming and computation. Modern category theory facilitates the translation of abstract diagrams into concrete computation, as seen in toolkits like DisCoPy, which utilize string diagrams to reason about quantum circuits, logical formulae, and arbitrary code [6].

This application connects to programming through several key mechanisms:

- *Functorial learning: Generalizing machine learning from simple functions to functors by processing diagrammatic data [6].*
- *Abstract reasoning: Using category theory to interface between high-level grammatical structures and low-level computational architectures [6].*
- *Logical integration: Providing a unified language that bridges the gap between the grammatical structure of human language and the entanglement structure of quantum systems [6].*

The literature notes that while these modern tools are powerful, they often rely on analogies —such as the comparison between grammar and quantum entanglement—to translate abstract category-theoretic concepts into applied, data-driven tasks [6].

Limitations and historical distinctions

It is essential to distinguish between direct historical influence and contemporary reinterpretation. While Lawvere suggests that category theory finally solved a problem opened by Aristotle 2,300 years prior [1], other scholars emphasize that the reception and interpretation of Aristotle's categories have been the subject of extensive, ongoing debate throughout the 19th century and beyond [7][8].

Limitations in the current literature include:

- *Interpretive gaps: Much of the connection between ancient categories and modern theory remains a subject of philosophical excavation rather than historical continuity [4].*
- *Conceptual divergence: The jump from "Categories of Concepts" to "Category Theory" is often treated as a formal reinterpretation rather than a linear evolution [1].*

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Observation from the consults 2025 and 2026

- The format is different. The most recent search is more modular, in the fashion of a generated programming code in Gemini.
- The sources of information are different. The 2025 version refers to books; thus, it presents better historical development. The 2026 version refers to more recent open sources.
- Also, the more recent consult clearly presents the different between the Greek and the present use of 'category theory' (see emphasized text).
- The 2025 version emphasizes people; the 2026 version emphasizes concepts.
- The 2026 version has the last reference repeated.

Q2. How to relate the following theories regarding human memory: Constructive theory, memory-Trace theory, Exemplar theory, Group Theory, and Prototype theory?

The theories of human memory—Constructive theory, Memory-Trace theory, Exemplar theory, Group Theory, and Prototype theory—each offer unique perspectives on how memories are formed, stored, and recalled. These theories can be interrelated by understanding how they address the processes of memory construction, storage, and retrieval. Constructive theory emphasizes the dynamic and reconstructive nature of memory, while Memory-Trace theory focuses on the physical traces left in the brain. Exemplar and Prototype theories deal with categorization and the representation of concepts, and Group Theory explores the social dimensions of memory. Together, these theories provide a comprehensive framework for understanding the multifaceted nature of human memory.

Constructive Theory
Constructive Theory posits that memory is not a static repository but a dynamic process where past experiences are reconstructed rather than retrieved verbatim. This theory highlights the future-oriented nature of memory, allowing individuals to simulate and plan for future events by reconstructing past experiences (Hani, 2025) (Wagoner et al., 2017). The constructive nature of memory is supported by the idea that memories are influenced by prior knowledge and schemas, which help in reconstructing events based on typical patterns and experiences (Zacks et al., 2021). Constructive memory is also seen as a social and cultural process, where memories are shaped by cultural traditions and social interactions (Wagoner et al., 2017) (Wagoner, 2017).

Memory-Trace Theory
Memory-Trace theory suggests that memories leave physical traces or engrams in the brain, which can be reactivated during recall. This theory contrasts with the constructive view by emphasizing the physical and stable aspects of memory storage (Conway & Howe, 2021). While Memory-Trace theory focuses on the biological basis of memory, it can be integrated with Constructive theory by considering how these traces are used in the reconstruction process (Conway & Howe, 2021).

Exemplar and Prototype
Theories Exemplar theory suggests that memories are stored as individual instances or examples, which are used to categorize new experiences based on similarity to these stored examples (Conway & Howe, 2021). Prototype theory, on the other hand, posits that memories are organized around idealized or average representations of categories, known as prototypes. This theory helps explain how people can quickly categorize new information by comparing it to these prototypes (Conway & Howe, 2021). Both theories contribute to understanding how memories are organized and retrieved, providing a basis for the reconstructive processes described in Constructive theory (Conway & Howe, 2021).

Group Theory

Group Theory explores the social dimensions of memory, emphasizing how memories are constructed and shared within social groups. This theory aligns with the Constructive theory by highlighting the role of social interactions and cultural contexts in shaping memory (Wagoner et al., 2018) (Wagoner, 2017). The social aspect of memory construction is evident in how cultural narratives and group dynamics influence individual memories, leading to shared or collective memories within a group (Wagoner et al., 2018). While these theories offer different perspectives, they are not mutually exclusive. Constructive theory provides a framework for understanding the dynamic and reconstructive nature of memory, which can incorporate elements of Memory-Trace theory's focus on physical traces, Exemplar and Prototype theories' insight into categorization, and Group Theory's emphasis on social influences. Together, they offer a comprehensive view of human memory as a complex interplay of biological, cognitive, and social processes.

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Note1: We use underlined text to separate sections.

Note2: In the last query there is no differentiation in the citations of a published work of an author during the same year.

Note3: The accuracy of the description relies on the accuracy of the sources.

7. CONCLUSIONS

SciSpace structures research work-flow. It is convenient to understand the objective of the research, its conditions and constraints. Also, the perspective: Engineering ⇆ Scientific. In some cases, SciSpace obtains a profile of the findings according with the emphasis.. Comparing the consult 2025 and 2026 for the first case the reproducibility of answers to queries was low.

The use depends of the type of task. We identify several types of users of SciSpace:

- Scholar. To apply the Socratic Questioning method, maieutics :How to question to obtain the desired results?. This is an iterative Process. here keywords are important.
- Explorer. To write his/her documents with clear statements, accessible results, with the naming of the concepts according with the academic community
- Reviewer of a research: To use Scispace to find and compare similar research topics.

With this research platform, it is expected that the user obtains a relevant view of this his/her research field.

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ACERCA DE LOS AUTORES

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