

Title of the thesis

First names Last names

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Abstract

- Maximum length: 300 words per language
- Must include: problem, methodology, main results, conclusion

The abstract includes the purpose of the work and a brief explanation of the methodology used, results, and conclusions. It must clearly and concisely present the essence and importance of the work carried out. It is written in the past tense, does not include bibliographic references, and is usually the last part to be written, once the scope and contributions of the thesis are clear.

Keywords: Keywords (5–7)

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Chapter 1

Introduction

The introduction presents the central problem addressed by this research, situating it within its application context and highlighting the relevance of examining this specific issue. It outlines the proposed solution and situates it within the existing body of literature. This section also provides a concise synthesis of the state of the art, identifying the main approaches previously developed and emphasizing the distinctions between those works and the methodology adopted in this study. It is essential to clearly articulate the innovative aspects of the proposed approach and the contributions and improvements it introduces relative to earlier research (for further guidance on thesis writing, see Katz [1]).

In addition to a brief justification of the academic, social, or practical significance of the study, the introduction presents the general and specific objectives in an integrated and coherent manner, without the use of bullet points or enumerations. This narrative format should enable the reader to grasp the direction and scope of the research from the outset.

Finally, the introduction reviews the fundamental conceptual elements necessary to understand both the research problem and the proposed methodological solution, thereby providing the essential conceptual foundation for following the arguments developed throughout the thesis.

Chapter 2

State of the art

This chapter presents a critical review of the scientific literature relevant to the research problem, highlighting both the main advances reported in previous studies and the gaps that justify the development of the present work. It also establishes the conceptual and methodological framework that guides the study, identifying the theories, models, and approaches most closely related to the topic under investigation.

The literature review offers an analytical perspective on the current state of research concerning the phenomenon under study. Rather than providing a merely descriptive account of previous works, this section evaluates their methodologies, findings, strengths, and limitations. By contrasting different perspectives and results, the review identifies trends in the field, methodological challenges, and unresolved questions that the present research seeks to address.

Based on the critical analysis of existing studies, this section synthesizes the main contributions that have shaped the field, as well as the deficiencies, inconsistencies, or unexplored dimensions that persist in the literature. These gaps provide the rationale for the research questions and objectives introduced in Chapter 1, and define the contribution that this thesis intends to make to the academic and practical understanding of the problem.

This section outlines the theoretical constructs, definitions, and models that underpin the study. The chosen framework establishes the analytical perspective adopted throughout the thesis and supports the interpretation of findings. It also clarifies the relationships among key concepts, ensuring coherence between the literature review, the research design, and the proposed methodology.

Data Description

This section describes in detail the data used to answer the research questions formulated in the introduction. The description includes the structure, format, variables, and conditions under which the data were collected, as well as the procedures applied for cleaning, preprocessing, and transforming the information before the analysis. When applicable,

the origin of the data—such as institutional databases, data repositories, experimental procedures, or fieldwork instruments—is documented clearly and transparently.

Whenever relevant, this section may also present preliminary results derived from exploratory analysis or data treatment. These general findings help illustrate important characteristics of the dataset that are not included in the main results chapter, such as distributional properties, missing-value patterns, outliers, or descriptive statistics.

Data Repository

If the dataset is publicly accessible, this subsection provides the corresponding URL or reference so that the data can be consulted or downloaded. Examples include GitHub repositories, institutional data portals, or scientific data archives. When appropriate, a brief explanation of the repository structure and access instructions is also included.

Chapter 3

Problem Statement

This section presents a clear and precise definition of the research problem addressed in this thesis. It contextualizes the phenomenon of interest, outlines the motivations for studying it, and identifies the specific limitations, challenges, or inconsistencies found in current practices or in the existing literature. The purpose is to establish the necessity of the research and articulate the gap that the proposed work intends to fill.

Research Question(s)

Based on the problem formulation, the research question(s) guide the direction of the study and delimit the scope of the analysis. These questions are formulated to be specific, measurable, and aligned with the objectives introduced in the previous chapters. They provide the analytical foundation for the methodological design and support the rationale behind the proposed approach.

Hypothesis (If Applicable)

If the research adopts a hypothesis-driven framework, this section presents the central hypothesis or set of hypotheses that the study aims to test. The hypotheses should establish an expected relationship between key variables or phenomena, grounded in theoretical foundations and prior empirical findings. When applicable, this section also explains the assumptions underlying the hypothesis and the criteria that will be used to evaluate it through the methodological procedures described later in the thesis.

Chapter 4

Justification

Significance and Contributions of the Study

This section outlines the scientific, academic, social, and industrial relevance of the research. By situating the work within broader disciplinary and practical contexts, it highlights the importance of addressing the identified problem and underscores the potential impact of the study's findings.

Scientific, Academic, Social, and Industrial Importance

The relevance of this study derives from its potential to advance current knowledge, strengthen theoretical understanding, and contribute to ongoing academic debates. From a scientific and academic perspective, the research provides insights that refine existing models, introduce improved methodological approaches, or reveal new relationships within the studied phenomenon. Socially, the work may address needs or challenges that affect communities, institutions, or public policy, thus offering evidence-based guidance for decision-making. From an industrial or technological standpoint, the outcomes of this research may support process optimization, innovation, or the development of practical solutions aligned with current professional demands.

Added Value of the Study

The added value of this thesis lies in the originality and relevance of its contributions. These may include the proposal of a novel methodological framework, the introduction of analytical tools not previously applied in the field, or the generation of empirical results that provide fresh perspectives on the research problem. The study's contributions also encompass improvements over previous approaches, such as enhanced accuracy, efficiency, interpretability, or applicability. Ultimately, the work aims to offer insights or solutions

that meaningfully advance the state of the art and open pathways for future research and practical implementation.

Chapter 5

Objectives

General Objective

The general objective of this thesis is to clearly define the overarching purpose that guides the research. It expresses the main aim of the study and establishes the direction of the methodological and analytical components developed throughout the document. The general objective should be broad in scope yet sufficiently precise to reflect the core contribution that the research intends to accomplish.

Specific Objectives

The specific objectives articulate the concrete steps required to achieve the general objective. They describe the particular goals that structure the research process, including the analytical, methodological, and empirical tasks necessary to address the research questions. Each specific objective should focus on a distinct component of the study while collectively supporting the fulfillment of the general objective. These objectives provide operational clarity, ensuring coherence between the stated problem, the research questions, and the methodological approach adopted in the thesis.

Chapter 6

Background

This chapter introduces the key concepts, constructs, and theoretical perspectives associated with the phenomenon under study. It defines the terminology used throughout the thesis, explains the underlying principles of the relevant theories, and situates them within the broader disciplinary context. The purpose is to ensure conceptual clarity and provide a coherent understanding of the elements that shape the research problem.

Here, the chapter reviews the major models, frameworks, or methodological approaches previously developed to address similar problems. This analysis includes a discussion of their structure, assumptions, strengths, and limitations. By examining these models, the section highlights the theoretical and methodological precedents that inform the current study and identifies the gaps or constraints that justify the development of the proposed approach.

This section explains how the theoretical foundations discussed above connect directly to the research problem outlined in earlier chapters. It demonstrates how specific theoretical constructs guide the formulation of the research questions, shape the methodological choices, and support the interpretation of results. Establishing this connection ensures coherence across the thesis and highlights the relevance of the theoretical framework in addressing the identified problem.

Finally, this section presents the conceptual rationale underpinning the proposed solution or methodological contribution. It explains the principles that justify the approach, the assumptions on which it is built, and the way it integrates or extends existing theories or models. This conceptual foundation is essential for understanding the logic and validity of the solution presented in the following chapters.

Chapter 7

Methodology

This chapter presents the methodological approach adopted to address the research problem described in earlier chapters. It outlines the type of research conducted, the experimental or methodological design, the procedures used for data collection, and the techniques applied for processing and analysis. Additionally, it specifies the tools, materials, algorithms, and software employed throughout the study, as well as the ethical considerations adhered to during the research process.

Type of Research

This section describes the nature of the research, specifying whether it follows a qualitative, quantitative, or mixed-methods approach. It also defines whether the study is exploratory, descriptive, correlational, experimental, or applied. Establishing the type of research clarifies the epistemological and methodological orientation that guides the development of the thesis.

Experimental or Methodological Design

Here, the methodological or experimental structure is presented in detail. This includes the models or algorithms developed, the procedures implemented, and the protocols followed to execute the study. When applicable, diagrams or flowcharts may be incorporated to illustrate the sequence of methodological steps, the system architecture, or the workflow of the proposed solution.

Data Sources and Collection Techniques

This section describes the data used in the study, specifying their origin, format, collection methods, and conditions under which they were obtained. It also explains any instru-

ments, sensors, surveys, or software systems involved in the data acquisition process. The description should be detailed enough to ensure reproducibility and transparency.

Data Processing and Analysis

Here, the steps used to prepare the data for analysis are explained, including preprocessing, cleaning, transformation, normalization, or feature extraction procedures. Additionally, the analytical techniques, statistical tests, machine learning models, or computational tools applied are clearly described. When relevant, the section also explains how the results were validated or evaluated.

Ethical Considerations

This section outlines the ethical principles and guidelines followed during the research process. It includes issues such as informed consent, data privacy, confidentiality, bias mitigation, and compliance with institutional or national ethical standards. When working with sensitive data, a statement regarding anonymization and secure data management is also included.

Chapter 8

Results

This chapter presents the findings obtained from the application of the methodological framework described in Chapter ???. The results are organized and displayed using tables, figures, simulations, and additional visual resources to provide clear evidence of the effectiveness and scientific contribution of the proposed approach. The analysis focuses on identifying patterns, validating the performance of the methods implemented, and contrasting the outcomes with those reported in previous studies.

Presentation of Findings

This section introduces the main results derived from the experiments, analyses, or computational procedures carried out during the research. The findings are presented in a structured manner, highlighting the most relevant observations and their implications in relation to the research questions and objectives. When appropriate, intermediate or derived results are included to support the interpretation of the outcomes.

Use of Tables, Figures, and Simulations

To ensure clarity and precision in the presentation of results, tables, figures, and simulation outputs are included throughout the chapter. These elements provide graphical and tabular representations that enhance the understanding of complex information.

Figures

Figures are incorporated using the `figure` environment, which allows the inclusion of images in formats such as PNG, JPEG, and PDF. Each figure is accompanied by a caption and a label to enable cross-referencing within the text. For example:

Figures can be referenced in the text using the command `\ref{fig:compute-trends}`.

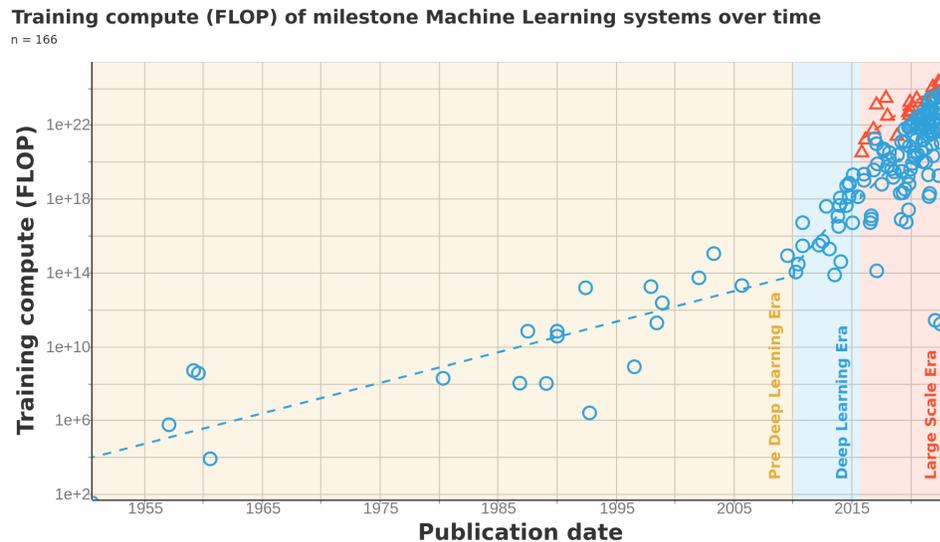


Figure 8.1: Compute trends are slower than previously reported

Tables

Tables are constructed with the `tabular` environment, allowing customization of column alignment, spacing, and formatting. The use of the `table` environment enables captions and labels. For instance:

Table 8.1: Compute trends are slower than previously reported

Col1	Col2	Col3	Col4
1	6	87837	787
2	7	78	5415
3	545	778	7507
4	545	18744	7560
5	88	788	6344

For ease of table creation, online tools such as <https://www.tablesgenerator.com/> can be used to import tables from spreadsheets and automatically generate LaTeX code.

Equations

When necessary, mathematical expressions are presented using the `equation` environment. LaTeX ensures high-quality rendering and supports referencing of equations, as in the following example:

$$E = Mc^2 + \sqrt{\frac{1-\gamma}{\gamma_0}} m_C v^2. \quad (8.1)$$

Scientific Contribution and Evidence

This section discusses how the results obtained constitute an original scientific contribution. The analysis highlights improvements over existing methods, validation of theoretical assumptions, or empirical findings that expand the current understanding of the topic. When applicable, comparisons with previous studies are included to position the contribution within the broader research landscape.

Discussion

The discussion examines the implications of the results, identifying factors that may have influenced the outcomes, such as methodological limitations, sources of error, data constraints, or experimental conditions. The findings are contrasted with related literature to assess the consistency and relevance of the evidence obtained. This section also identifies lines of inquiry for future work, based on the strengths and limitations observed during the research.

Chapter 9

Discussion

This chapter presents a comprehensive interpretation of the results obtained in Chapter 8. The discussion examines the implications of the findings, contrasts them with previous studies, and identifies the limitations that may have influenced the outcomes. The goal is to situate the results within the broader context of existing knowledge and to evaluate the extent to which the research objectives have been achieved.

Interpretation of Results

This section provides an in-depth interpretation of the findings, explaining their significance in relation to the research questions and objectives established in earlier chapters. The analysis seeks to clarify the meaning of the observed patterns, evaluate the performance of the proposed methods, and identify any unexpected behaviors. When relevant, alternative explanations are discussed to ensure a nuanced understanding of the results. The interpretation also highlights the theoretical, methodological, or practical implications derived from the study.

Comparison with Related Studies

To contextualize the contribution of this research, the results are compared with those reported in prior scientific literature. This comparison assesses the consistency and discrepancies among findings, providing insights into the novelty and alignment of the proposed approach. The discussion examines how the results support, refine, or challenge existing theories or models, and clarifies the extent to which the present study advances the state of the art. When appropriate, methodological differences are acknowledged to explain variations in outcomes.

Limitations of the Study

This section identifies the limitations and constraints encountered during the research process. These may include data availability and quality, methodological assumptions, computational constraints, parameter choices, and experimental conditions. A transparent discussion of these limitations provides context for interpreting the results and defines the boundaries of their generalizability. Additionally, the section outlines potential improvements and suggests directions for future research that could overcome the limitations identified.

Chapter 10

Conclusions

This chapter presents the main conclusions derived from the research conducted throughout this thesis. The conclusions synthesize the key findings, provide direct answers to the research questions, and articulate the contribution of the study to the understanding and resolution of the problem addressed. Each conclusion is aligned with the specific objectives established at the beginning of the work, ensuring coherence between the expected goals and the achieved outcomes.

Summary of Main Findings

The study has yielded several significant findings that contribute to the comprehension and analysis of the phenomenon under investigation. This section summarizes the most relevant results, emphasizing how they validate the methodological approach adopted and highlight the effectiveness of the proposed solution. The summary focuses on the central patterns identified, the performance of the implemented methods, and the evidence supporting the scientific and practical value of the research.

Response to the Research Question(s)

Based on the results and their interpretation, this section provides a clear and direct response to the research question(s) posed in the introductory chapter. The answers are grounded in the empirical evidence obtained and reflect the extent to which the research objectives have been fulfilled. When applicable, this section also addresses secondary questions or subcomponents of the main research problem, offering a comprehensive overview of the study's contributions.

Conclusions Derived from the Specific Objectives

In accordance with the recommendation to formulate one conclusion per specific objective, this section articulates the findings and contributions associated with each objective. This structure ensures that the conclusions are systematically connected to the goals that guided the research process, making explicit how each objective was achieved and what insights were generated in the process.

Implications and Contributions

This section discusses the theoretical, methodological, and practical implications of the study. It explains how the findings contribute to advancing the current state of knowledge, refining existing models or approaches, or addressing relevant gaps in the literature. When appropriate, the section also highlights the potential applications of the results in academic, industrial, or social contexts.

Chapter 11

Recommendations

This chapter provides recommendations derived from the findings, conclusions, and limitations identified throughout the research. The purpose of these recommendations is to guide future studies and to highlight potential practical applications of the work. These suggestions aim to extend the contributions of the thesis and to encourage continued exploration of the research topic in both academic and applied contexts.

Recommendations for Future Research

Based on the results obtained and the limitations encountered during the development of this study, several directions for future research can be proposed. These include the refinement or extension of the methodological approach, the exploration of alternative data sources, the incorporation of additional variables or analytical techniques, or the evaluation of the proposed solution in different contexts or environments. Future studies may also investigate broader theoretical implications, validate the findings across larger or more diverse samples, or examine long-term effects that were beyond the scope of the present work. These avenues can contribute to a deeper and more comprehensive understanding of the research problem.

Practical Applications

The findings of this thesis also enable the identification of potential practical applications of the proposed approach. These may involve the implementation of the developed methods or models in real-world systems, the integration of the results into organizational processes, or the use of the insights to inform policy, decision-making, or technological development. Depending on the nature of the research, practical applications may include the design of tools, guidelines, or prototypes that support operational improvement, efficiency enhancement, or innovation. These recommendations aim to bridge the gap between theoretical contributions and real-world impact, offering pathways for the practical use of the knowledge generated in this study.

Chapter 12

Future Work

This chapter outlines potential directions for extending and strengthening the research presented in this thesis. The proposals listed here arise from the limitations identified in the study, the insights gained during the development of the methodology, and the opportunities revealed through the analysis of the results. These suggestions aim to guide future efforts toward enhancing the scope, accuracy, and applicability of the proposed approach.

New Research Directions

Several avenues of research can be pursued to deepen the understanding of the problem and explore complementary perspectives. Future studies may investigate alternative theoretical frameworks, incorporate additional variables or datasets, or apply the methodology to different contexts, environments, or populations. Researchers may also consider expanding the analytical scope by integrating interdisciplinary approaches, examining long-term trends, or conducting experimental validations that were beyond the scope of this thesis. These directions provide opportunities to enrich the theoretical foundation and broaden the applicability of the research findings.

Methodological Improvements

Future work may also focus on refining or extending the methodological components of the study. Potential improvements include enhancing the proposed models or algorithms, optimizing computational procedures, or incorporating more advanced analytical techniques. Additionally, researchers could explore the use of emerging technologies, more sophisticated validation strategies, or hybrid methodologies that combine quantitative and qualitative approaches. Such methodological advancements would contribute to increasing the robustness, efficiency, and generalizability of the results, thereby strengthening the overall impact of the research.

Referencias

- [1] G. T. Abramson, "Writing a dissertation proposal." *Journal of Applied Learning Technology*, vol. 5, no. 1, 2015. [Online]. Available: <https://web.p.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=0&sid=e1e3cc48-8764-4a88-8bdc-b4131869be4c%40redis>

Appendix

Appendix A

This appendix contains supplementary material developed by the author that expands, complements, or provides additional detail to the content presented in the main chapters of the thesis. The purpose of this section is to make available technical information, computational resources, extended results, or any supporting material that contributes to the clarity, reproducibility, and completeness of the research.

Scope of the Appendix

The materials included in this appendix serve to document resources that, due to their length, technical complexity, or supportive nature, were not incorporated directly into the main body of the thesis. These materials may include:

- Source code developed as part of the research (e.g., scripts, algorithms, implementation details).
- Mathematical derivations or extended formulas that support the theoretical development presented in the main chapters.
- Complete tables of results, datasets excerpts, or additional figures that complement the analysis.
- Technical specifications, configurations, or implementation details of software, models, or experimental setups.

Purpose and Use

The additional information provided here is intended to enhance transparency and facilitate replication of the study. Readers may consult this appendix to gain deeper insight into the methodological decisions, computational implementation, or extended findings associated with the research.

When applicable, each subsection of the appendix includes cross-references to the corresponding sections of the main document, ensuring coherence and easy navigation between the core content and the supplementary materials.

Annex

Annex A

This annex includes external material that supports, complements, or provides contextual information to the research presented in this thesis. The content incorporated here has not been produced by the author but is included as reference material that may be useful for understanding regulatory frameworks, technical procedures, or background documentation relevant to the development of the study.

Purpose of the Annex

The material gathered in this annex does not constitute a direct part of the primary analysis but serves as supplementary evidence or contextual support. It provides readers with access to external documents that informed the methodological decisions, theoretical considerations, or practical implementations described throughout the thesis.

Examples of materials typically included in this annex are:

- Official regulations, standards, or policies that frame the study's context.
- Technical manuals, manufacturer specifications, or operational guidelines.
- Normative documents used as reference during the design or validation of the methodology.
- Original survey forms, questionnaires, or administrative documents employed during data collection.

Use and Reference

Readers may consult this annex when additional clarification or documentation is needed to understand procedures, constraints, or external requirements that influenced the research. Cross-references to these materials are provided within the main chapters whenever they are relevant.

All documents included in this annex are cited appropriately and comply with the ethical and academic standards for the inclusion of external material.