








**THÈSE DE DOCTORAT**

**DE L'ÉTABLISSEMENT UNIVERSITÉ DE TECHNOLOGIE DE BELFORT-MONTBÉLIARD**

École doctorale n°37

Sciences Physiques pour l'Ingénieur et Microtechniques

Doctorat d'Intelligence Artificielle

par

FIRSTNAME LASTNAME

# Titre en francais

## Subtitle

Thèse présentée et soutenue à Belfort, le 20 avril 2025

Composition du Jury :

| | | |
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| HULK INCROYABLE | Professeur à l'Université de Gotham City<br>Commentaire secondaire | Président |
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| MAN SUPER | Professeur à l'Université de Gotham City | Examinateur |
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| M. VOLWERINE THE | Professeur à l'Université de Gotham City | Co-Directeur |
| Mme MAN PAC | Professeure quelque part | Invité |

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**DOCTORAL THESIS**

**OF BELFORT-MONTBÉLIARD UNIVERSITY OF TECHNOLOGY**

Doctoral School #37

Physical Sciences for Engineering and Microtechnologies

Doctor in Artificial Intelligence

by

FIRSTNAME LASTNAME

# Title in English

## Subtitle

Thesis defended the April 20, 2025 at Belfort

Doctoral Committee Members:

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| HULK INCROYABLE | Professor at Gotham City University | President |
| | Additional comment | |
| AMERICA CAPTAIN | Professor at USA University | Reviewer |
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| M. MAN BAT | Professor at Gotham City University | Director |
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| Mme MAN PAC | Professor somewhere | Invitee |

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# ACKNOWLEDGEMENTS

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# RÉSUMÉ LONG



You must write here a long summary of your PhD thesis in French language. According to the SPIM rules, the length of this long summary must be of minimum 3 pages for people who is not native-french speaker, and of minimum 20 pages for who is native-french speaker.

# ACRONYMS

- **MAS:** Multi-Agent System

# I

# Context and Issues

# 1

# INTRODUCTION

This is an acronym: Multi-Agent System (MAS). This is the same acronym: MAS.

**Research Question 1 (RQ1) – a name**

Description of the research question.

**Objective 1 (O1) – a name**

Description of the objective.

**Contribution 1 (C1) – a name**

Description of the contribution.

## 1.1 Context

This template describes some elements that can help you write your thesis. A typical outline for a scientific thesis is also proposed.

## 1.2 Thesis Objectives

The main objective of your thesis can be highlighted using the environment below:

Propose a model that does something!

## 1.3 Thesis Outline

# 2

# State of the Art

## 2.0 Contents


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To help you write your thesis, several tools are described below. Many other macros are available in the LaTeX package set `tex-upmethodology` on which the style of this thesis is based. Examples include environments for automatically creating subfigures and macros for defining unnumbered sections that appear in the table of contents.

## 2.1 Propose a Definition

Definition 1 illustrates the proposal of a definition.

**Definition 1: A Thesis**

Document presented to a university jury for obtaining a doctorate.

## 2.2 Include a Figure

Including a figure is done using standard LaTeX tools (environment `figure`, `\includegraphics`, etc.).

We propose a macro to simplify the inclusion of a figure.

```
\mfigure[position]{options}{filename}{title}{labelid}
```

This is equivalent to (note the addition of `fig:` as a prefix to the label):

```
\begin{figure}[position]
 \begin{center}
  \includegraphics[options]{filename}
  \label{fig:labelid}
  \caption{title}
 \end{center}
\end{figure}
```

Referencing the figure can be done using the macros:

```
\figref{labelid}
\figpageref{labelid}
```

## 2.3 Include a Table

Including a table is done using standard LaTeX tools (environment `table`, environment `tabularx`, etc.).

We propose a macro to simplify the inclusion of a table.

```
\begin{mtable}[options]{width}{numberofcolumns}{columnspec}{title}{labelid}
 content
\end{mtable}
```

This is equivalent to (note the addition of `tab:` as a prefix to the label):

```
\begin{table}[options]
 \begin{center}
  \begin{tabularx}{width}{columnspec}
   content
  \end{tabularx}
  \label{tab:labelid}
  \caption{title}
 \end{center}
\end{table}
```

Referencing the table can be done using the macros:

```
\tabref{labelid}
\tabpageref{labelid}
```

### 2.3.1 Example 1

Table 2.2 is an example of a table with 4 columns, with a title added at the top.

| *Col1* | *Col2* | *Col3* | *Col4* |
|---|---|---|---|
| a | b | c | d |
| e | f | g | h |

Table 2.2: Table Title

### 2.3.2 Example 2

Table 2.4 is an example of a table with 5 columns, with the table title also added at the top.

| *Col1* | *Col2* | *Col3* | *Col4* | *Col5* |
|---|---|---|---|---|
| a | b | c | d | x |
| e | f | g | h | z |

Table 2.4: Table Title
*Source:This is a source*

## 2.4 Inline Enumeration

You can enumerate elements in a paragraph: *(i)* element 1, *(ii)* element 2, *(iii)* element 3;and continue your text.

## 2.5 Description

The `description` environment provided by LaTeX has been extended:

- **Element 1:** Text 1
- **Element 2:** Text 2
- **Element 3:** Text 3

Omitting an item header is not a problem:

- **Element 1:** Text 1
- Text 2
- **Element 3:** Text 3

## 2.6 Enumeration

The `enumerate` environment provided by LaTeX has been extended to combine the advantages of the `enumerate` and `description` environments in a single LaTeX environment:

1. **Element 1:** Text 1
2. **Element 2:** Text 2

3. **Element 3:** Text 3

You can specify the type of enumeration by switching to Arabic numerals:

1**Element 1:** Text 1

2**Element 2:** Text 2

3**Element 3:** Text 3

Or in Roman numerals:

i**Element 1:** Text 1

ii**Element 2:** Text 2

iii**Element 3:** Text 3

Or in alphabetical numerals:

a**Element 1:** Text 1

b**Element 2:** Text 2

c**Element 3:** Text 3

Omitting an item header is not a problem:

1. **Element 1:** Text 1
2. Text 2
3. **Element 3:** Text 3

## 2.7 Format Text

You can place text $^{\text{as a superscript}}$. You can place text $_{\text{as a subscript}}$.

You can highlight text, or highlight it **even more**.

You can format people's names uniformly, for example STÉPHANE GALLAND (other macros are available).

## 2.8 Mathematical Symbols

- $\mathbb{R}$
- $\mathbb{N}$
- $\mathbb{Z}$
- $\mathbb{Q}$
- $\mathbb{C}$
- $\mathcal{P}a$
- $\operatorname{sgn}(a)$
- $\min(a, b)$
- $\max(a, b)$

## 2.9 Theorems

You can define your own environment to describe a theorem, lemma, etc. This type of environment must be declared in the preamble of your document with the macro `\declareupmtheorem` (see the example in the preamble of this template).

**My Theorem 1: Some Theorem**

This is the description of this theorem.

*This is my optional source*

At the end of your document, you can then add a chapter listing the theorems present in your document: `\listofmytheorems`

## 2.10 Conclusion

# II

# CONTRIBUTION

# 3

# CONTRIBUTION


3.1 Introduction

3.2 Details of the Contribution

3.3 Conclusion

# 4

# IMPLEMENTATION


4.1 Introduction

4.2 Presentation of the Implementation

4.3 Experimental Results

4.4 Conclusion

# III

# CONCLUSION

# 5

# General Conclusion

5.1 Summary

5.2 Perspectives

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# List of Tables

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# IV

# APPENDICES

# A

# First Appendix Chapter

# B

# Second Appendix Chapter

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Replace by your logo

**Title:** Title in English

**Keywords:** Keyword 1, Keyword 2

**Abstract:**

This is the abstract in English. This is the abstract in English. This is the abstract in English. This is the abstract in English. This is the abstract in English. This is the abstract in English. This is the abstract in English. This is the abstract in English. This is the abstract in English. This is the abstract in English. This is the abstract in English. This is the abstract in English. This is the abstract in English. This is the abstract in English. This is the abstract in English. This is the abstract in English.

**Titre :** Titre en francais

**Mots-clés :** Mot-clé 1, Mot-clé 2

**Résumé :**

Ceci est un résumé en français. Ceci est un résumé en français. Ceci est un résumé en français. Ceci est un résumé en français. Ceci est un résumé en français. Ceci est un résumé en français. Ceci est un résumé en français. Ceci est un résumé en français. Ceci est un résumé en français. Ceci est un résumé en français. Ceci est un résumé en français. Ceci est un résumé en français. Ceci est un résumé en français. Ceci est un résumé en français. Ceci est un résumé en français. Ceci est un résumé en français.

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