Projet 1 :
Microsoft Office – Word

Partie 1 : Mise en page

Computer science is a dynamic and multifaceted field that underpins nearly every aspect of our modern world. It is the study of algorithms, data structures, and the processes of computation, with a focus on the design, development, and analysis of software and **hardware**[1] systems. Computer science encompasses a vast array of topics, from programming languages and artificial intelligence to network security and database management. At its core, computer science is about problem-solving, utilizing logical and algorithmic thinking to address a wide range of challenges, from developing cutting-edge software applications to *optimizing* complex business processes[2]. This discipline has revolutionized the way we live, work, and communicate, shaping the very fabric of our digital age.

It has enabled remarkable innovations, such as the Internet, mobile computing, and machine learning, that have transformed industries, enriched our daily lives, and expanded the horizons of human knowledge. Computer science is not just a scientific and technological endeavor; it is a creative and ever-evolving journey that continues to push the boundaries of what is possible in our increasingly interconnected and data-driven world.

As the foundation of the information age, computer science holds the key to unlocking countless opportunities for innovation, problem-solving, and progress in the years to come.

Here are six important features of computer science:

- Algorithmic Thinking
  - Organigramme,
  - Structures,
- Abstraction
  - Example, high-level programming,
- Data Structures
  - Table,
  - Files,
- Programming
  - C,
  - Python
- Hardware and Software
- Interdisciplinary Nature

[1] HW
[2] Also called BI

Partie 2 : Tables.

Table 1

Matricule	Nom	Prénom	Date de naissance
222331706307	AHMED	Sofiane	23/04/2002
222331706307	KAMEL	Salim	11/05/2004
222331706307	SAIDA	Soltana	03/07/2003

Table 2

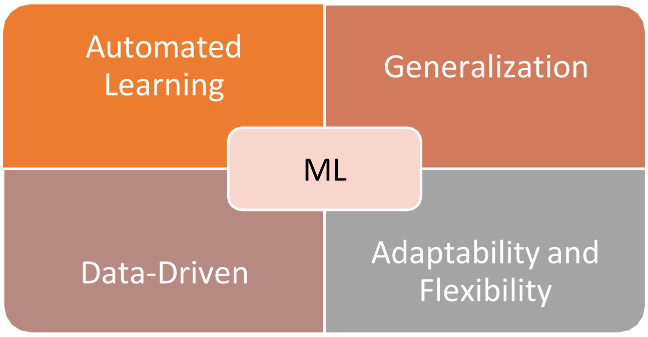
<table>
<tr><th rowspan="3">Dataset</th><th rowspan="3">Data split</th><th colspan="6">Evaluation Metrics in %</th></tr>
<tr><th colspan="2">mAP</th><th colspan="2">Recall</th><th colspan="2">Precision</th></tr>
<tr><th>Before</th><th>After</th><th>Before</th><th>After</th><th>Before</th><th>After</th></tr>
<tr><td rowspan="2">DS1</td><td>Test Data</td><td>61.12</td><td>67.67 +</td><td>34.56</td><td>27.89</td><td>34.56 *</td><td>34.56</td></tr>
<tr><td>Vali. Data</td><td>34.56</td><td>27.89</td><td>67.67 -</td><td>34.56</td><td>27.89</td><td>67.67</td></tr>
<tr><td rowspan="2">DS2</td><td>Test Data</td><td>67.67</td><td>34.56 +</td><td>27.89</td><td>67.67</td><td>34.56</td><td>27.89</td></tr>
<tr><td>Vali. Data</td><td>27.89</td><td>22.56</td><td>34.56</td><td>27.89</td><td>27.89</td><td>34.56</td></tr>
<tr><td rowspan="2">DS3</td><td>Test Data</td><td>34.56</td><td>27.89 +</td><td>22.56 -</td><td>34.56</td><td>34.56 *</td><td>22.56</td></tr>
<tr><td>Vali. Data</td><td>22.56</td><td>34.56</td><td>34.56</td><td>22.56</td><td>34.56</td><td>34.56 *</td></tr>
</table>

Table 3

<table>
<tr><th>Sys.</th><th>Technique</th><th>Complexité</th><th colspan="2">Valeur</th></tr>
<tr><td rowspan="4">Système A</td><td rowspan="3">Technique 1
Description de la première technique</td><td rowspan="3">O(n)</td><td>22</td><td>23</td></tr>
<tr><td>45</td><td>67</td></tr>
<tr><td>45</td><td>78</td></tr>
<tr><td colspan="4">Conclusion 1.</td></tr>
<tr><td rowspan="5">Système B</td><td rowspan="4">Technique 2
Description de la deuxième technique</td><td rowspan="4">O(n*n)</td><td>11</td><td>13</td></tr>
<tr><td>15</td><td>56</td></tr>
<tr><td>34</td><td>45</td></tr>
<tr><td>12</td><td>16</td></tr>
<tr><td colspan="4">Conclusion 2.</td></tr>
</table>

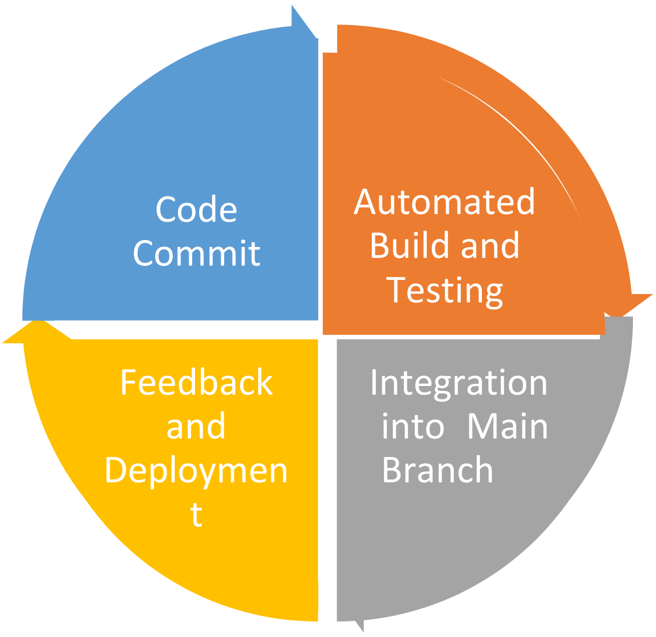
Partie 3: Smart Art

Four key features of machine learning:



Machine learning stages:

Continuous Integration (CI) is a software development practice that involves regularly integrating code changes from multiple contributors into a shared repository.



Partie 4 : Forms

Input

Neural Network Model - NN

Step1.
Encoding the behavior of NN in term of linear arithmetic constraints

Use of BigM Method / MIP optimization problem

- Encoding ReLU function,
- Encoding Max-Pooling,
- Encoding Softmax function,

-1

Step2.
Perturbation Bounds

Compute maximum resilience of NN by solving MIP/MIQCP Problem :

- Define the Maximum Perturbation Bounds for m-th classifier
- Define the Perturbation Bounds for NN
- Encode the problem of finding bounds for NN as optimizitionproblem

Partie 5 : Equations

Fonction	Encoding
ReLU $x_i^{(l)} = \max\ (0, im_i^{(l)})$	Big-M Method $x_i^{(l)} = \max(0, im_i^{(l)})$ iff the constaints below holds. $x^{(l)} \geq 0$ (1) $x_i^{(l)} \geq im_i^{(l)}$ (2) $im_i^{(l)} - b_i^{(l)} M_i^{(l)} \leq 0$ (3) $x_i^{(l)} \leq im_i^{(l)} + (1 - b_i^{(l)})\, M_i^{(l)}$ (4) $x_i^{(l)} \leq b_i^{(l)} M_i^{(l)}$ (5)
Max-Pooling $x_i^{(l)} = \max(im_1, im_2)$, *where* $im_1 = \max\ (x_{j1}^{(l-1)}, x_{j2}^{(l-1)})$ $im_2 = \max\ (x_{j3}^{(l-1)}, x_{j4}^{(l-1)})$ Please note that in this work, they used amax pool with 2*2 filters	Using Big-M Method -if/else statement - they encode the Max-Pooling using the same process as for ReLU encoding. Thus, they introduced three binary integer variables to encode. $x_i^{(l)} = \max(im_1, im_2), im_1 = \max\ (x_{j1}^{(l-1)}, x_{j2}^{(l-1)})$ *and* $im_2 = \max(x_{j3}^{(l-1)}, x_{j4}^{(l-1)})$. Following the same process of encoding $y = \max\ (x_1, x_2)$
Max-Pooling $f\ (x_i^{(l)}) = \frac{e^{x_i^{(L-1)}}}{\sum_{j=1,\dots,L} e^{x_j^{(L-1)}}}$	Since the e cannot be encoded into linear MIP, they propose to omit the output layer (L) and rewrite the property by replacing each x_i^l by $x_i^{(l-1)}$ The ide is : If : $x_{i1}^{(l)} \geq\ \alpha x_{i2}^{(l)}$ *where* α *is a constant* $\alpha\ > 0$ - $\frac{e^{x_{i1}^{(L-1)}}}{\sum_{j=1,\dots,L} e^{x_j^{(L-1)}}} \geq \alpha \frac{e^{x_{i2}^{(L-1)}}}{\sum_{j=1,\dots,d\ L} e^{x_j^{(L-1)}}}$ - $x_{i1}^{(l-1)} \geq \ln(\alpha)\, x_{i2}^{(l-1)}$
ArcTanh $f(x) = tan^{-1}(x)$	To encode tan^{-1} they used a digital signal processing for piece-wise approximating tan^{-1} with quadratic constants and error bounds – basedon the work of [1] [1]. $tan^{-1}\ (im) \approx \frac{\pi}{4}\ im + 0.273\ im(1 - \lvert im \rvert)$ To remove $\lvert im \rvert$ they encode case splits between $im \geq 0$ and $im < 0$ To handle the encoding of tan^{-1}, the authors used $\boldsymbol{MIQCP}$ *mixed integer quadratic constaint problem.*

Partie 6 : Vos Informations

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