Hamma Lakhdar University of El-Oued
Faculty of Exact Sciences
Department of Computer Science
2nd Year Master's Program
Course: Introduction to Scientific Research **Duration: 1 hour 30 minutes**

Model Answers for the First Semester Exam

Exercise 1: (05 pts)

You are asked to write the **abstract of a scientific project** that you have already conducted. The abstract must be written in LaTeX and should **respect the standard conventions** of a scientific abstract.

Solution:

```
\documentclass[12pt]{article}
\usepackage[utf8]{inputenc}
\begin{document}
\begin{abstract}
% 1. Research Problem
% 2. Methods
% 3. Results and Findings
% 4. Conclusion and future work
\end{abstract}
\end{document}
```

Exercise 2: (15 pts)

You are provided with **LaTeX source code** corresponding to a **scientific report**. The code contains **errors.** To assist you in **identifying and correcting** these errors, some **screenshots of the compiled output (PDF) are provided**. Your task is to **write the correct LaTeX source code** that reproduces these elements accurately, ensuring proper mathematical notation, footnote formatting, proper formatting of the table and inclusion of the image: **fundus_image.jpg.**

```
\documentclass[12pt]{report}
\usepackage{float}
\newcommand{\dataset}{REFUGE}
\newcommand{\model}{ResNet50}
\begin{document}
\title{Deep Learning for Glaucoma Detection}
\maketitle
\chapter{Introduction}
Glaucoma is a major cause of irreversible blindness worldwide.
Deep learning methods have shown promising results for glaucoma detection
from retinal fundus images \cite{unknown2023glaucoma}.
Figure~\ref{fig:fundus_image} illustrates a sample fundus image.
\begin{figure}[h]
    \centering
    \caption{Example of retinal fundus image used for glaucoma detection.}
    \label{fig:glaucoma_example}
\end{figure}
\chapter{Related Work}
Several studies have explored CNNs and vision transformers
for ocular disease analysis. Table~\ref{tab:results} summarizes
different models.
\begin{table}[h]
\centering
\caption{Performance comparison on glaucoma datasets}
\begin{tabular}{|l|c|c|}
\hline
Model & Accuracy & AUC \\
\hline
```

```latex
CNN & 0.91 & 0.95 \\
\multirow{3}{*}{Transformer} & 0.93 & 0.96 \\
\hline
\label{tab:results}
\end{table}
\chapter{Mathematical Formulation}
The Binary Cross-Entropy loss is defined as:
\begin{equation}
\mathcal{L}_{\mathrm{BCE}} =
-\frac{1}{N} \sum_{i=1}^{N}
\left[
y_i \log(p_i) + (1 - y_i)\log(1 - p_i)
\right]
\label{eq:bce}
\end{equation}
We also define the Dice Loss as:
\begin{equation}
\mathrm{Dice} =
\frac{2\,\mathrm{TP}}{2\,\mathrm{TP} + \mathrm{FP} + \mathrm{FN}}
\end{equation}
Equation~\ref{eq:dice} shows the Dice formulation.
A regularization term is introduced:
\begin{equation}
\Omega(\mathbf{w}) = \lambda \|\mathbf{w}\|_2_2
\label{eq:reg}
\end{equation}
Equations~\eqref{eq:bce}--\eqref{eq:reg} are commonly used in Deep Learning optimization problems defined over \R^n.
\chapter{Methodology}
The dataset \REFUGE consists of retinal fundus images collected from a publicly available repository\footnote{Dataset available online}.
The model \ResNet50 is trained using gradient descent:
\begin{equation}
\mathbf{w}_{t+1} = \mathbf{w}_t - \eta \nabla \mathcal{L}
\label{eq:gd}
\end{equation}
where \eta denotes the learning rate and \mathcal{L} is the loss function.
\chapter{Conclusion}
This report presented deep learning techniques for glaucoma detection.
Future work will focus on multi-modal learning and explainability.
\printbibliography
\bibliography{references}
\end{document}
```

PS: The file references.bib contains the following entries:

```
@article{isensee2021nnunet,
  author  = {Isensee, Fabian and Jaeger, Paul F. and Kohl, Simon A. A. and Petersen, Joachim and Maier-Hein, Klaus H.},
  title   = {nnU-Net: A Self-configuring Method for Deep Learning-Based Biomedical Image Segmentation},
  journal = {Nature Methods},
  volume  = {18},
  number  = {2},
  pages   = {203--211},
  year    = {2021}
}
@article{li2023transformerMRI,
  author  = {Li, Chen and Wang, Yifan and Zhou, Huaqi},
  title   = {Transformer-Based Retinal Image Analysis for Glaucoma Detection},
  journal = {IEEE Transactions on Medical Imaging},
  volume  = {42},
  number  = {6},
  pages   = {1456--1468},
  year    = {2023}
```

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CHAPTER 1

INTRODUCTION

Glaucoma is a major cause of irreversible blindness worldwide. Deep learning methods have shown promising results for glaucoma detection from retinal fundus images [1,2].

Figure 1.1 illustrates a sample fundus image.

Figure 1.1: Example of retinal fundus image used for glaucoma detection.

CHAPTER 2

RELATED WORK

Several studies have explored CNNs and vision transformers for ocular disease analysis. Table 2.1 summarizes different models.

Table 2.1: Performance comparison of deep learning models for glaucoma detection.

Model	Accuracy	AUC	Notes
CNN	0.91	0.95	Baseline model
Transformer	0.93	0.96	Standard training
	0.94	0.97	Fine-tuned version

CHAPTER 3

MATHEMATICAL FORMULATION

The Binary Cross-Entropy loss is defined as:

$$\mathcal{L}_{\mathrm{BCE}} = -\frac{1}{N}\sum_{i=1}^{N}\left[y_i \log(p_i) + (1-y_i)\log(1-p_i)\right] \tag{3.1}$$

We also define the Dice Loss as:

$$\mathrm{Dice} = \frac{2\,\mathrm{TP}}{2\,\mathrm{TP} + \mathrm{FP} + \mathrm{FN}} \tag{3.2}$$

Equation 3.2 shows the Dice formulation.

A regularization term is introduced:

$$\Omega(\mathbf{w}) = \lambda \|\mathbf{w}\|_2^2 \tag{3.3}$$

Equations (3.1)–(3.3) are commonly used in Deep Learning optimization problems defined over R^n.

CHAPTER 4

METHODOLOGY

The dataset REFUGEconsists of retinal fundus images collected from a publicly available repository[1].

The model ResNet50is trained using gradient descent:

$$\mathbf{w}_{t+1} = \mathbf{w}_t - \eta \nabla \mathcal{L} \tag{4.1}$$

where η denotes the learning rate and $\mathcal{L}$ is the loss function.

[1] https://refuge.grand-challenge.org

Solution:

\documentclass[12pt]{report}
\usepackage{graphicx}
\usepackage{amsmath}
\usepackage{hyperref}
\usepackage{cite}
\usepackage{array}
\usepackage{tabulary}
\usepackage{float}
% ERROR: fncychap is required but not included \usepackage[Conny]{fncychap}
% ERROR: \usepackage{multirow}
%\usepackage{graphicx}
%\usepackage{amsmath}
%\usepackage{hyperref}
%\usepackage{cite}
%\usepackage{array}
%\usepackage{tabulary} are not included
\newcommand{\dataset}{REFUGE}
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\begin{document}
\title{Deep Learning for Glaucoma Detection}
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\chapter{Introduction}
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Deep learning methods have shown promising results for glaucoma detection
from retinal fundus images \parencite{unknown2023glaucoma}.
% ERROR: citation key does not exist in references.bib ==> \cite{isensee2021nnunet,li2023transformerMRI}.
Figure~\ref{fig:fundus_image} illustrates a sample fundus image.
% ERROR: ~\ref{fig:glaucoma_example}
\begin{figure}[h]
    \centering
    %\includegraphics{fundus_image.jpg}
    % ERROR: missing \includegraphics{fundus_image.jpg}
    \caption{Example of retinal fundus image used for glaucoma detection.}
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\end{figure}
\chapter{Related Work}
Several studies have explored CNNs and vision transformers
for ocular disease analysis. Table~\ref{tab:results} summarizes
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\begin{table}[h]
\centering
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Model & Accuracy & AUC \\
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CNN & 0.91 & 0.95 \\
\multirow{3}{*}{Transformer} & 0.93 & 0.96 \\
\hline
\label{tab:results}

\end{table}

% ERROR: \multirow{2}{*}{Transformer}
% ERROR: missing second row content for multirow
% ERROR: missing %\end{tabular}
%\begin{table}[H]
%\centering
%\caption{Performance comparison of deep learning models for glaucoma detection.}
%\begin{tabular}{|l|c|c|c|}
%\hline
%\textbf{Model} & \textbf{Accuracy} & \textbf{AUC} & \textbf{Notes} \\
%\hline
%CNN & 0.91 & 0.95 & Baseline model \\
%\hline
%\multirow{2}{*}{Transformer}
 %& 0.93 & 0.96 & Standard training \\
%\cline{2-4}
 %& 0.94 & 0.97 & Fine-tuned version \\
%\hline
%\end{tabular}
%\label{tab:results}
%\end{table}

\chapter{Mathematical Formulation}
The Binary Cross-Entropy loss is defined as:
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\label{eq:bce}
\end{equation}
We also define the Dice Loss as:
\begin{equation}
\mathrm{Dice} =
\frac{2\,\mathrm{TP}}{2\,\mathrm{TP} + \mathrm{FP} + \mathrm{FN}}
\end{equation}
% ERROR: equation is not labeled but referenced later: \label{eq:dice}

Equation~\ref{eq:dice} shows the Dice formulation.
A regularization term is introduced:
\begin{equation}
\Omega(\mathbf{w}) = \lambda \|\mathbf{w}\|_2_2
\label{eq:reg}
\end{equation}

% ERROR: \mathbf{w}\|_2^2

Equations~\eqref{eq:bce}--\eqref{eq:reg} are commonly used in Deep Learning optimization problems defined over \R^n.
%ERROR: $\R^n$

\chapter{Methodology}
The dataset \REFUGE consists of retinal fundus images collected from a publicly available repository\footnote{Dataset available online}.

% ERROR: The dataset \dataset
% ERROR: \footnote{\url{https://refuge.grand-challenge.org}}.
The model \ResNet50 is trained using gradient descent:
% ERROR: The model \model is trained using gradient descent

\begin{equation}
\mathbf{w}_{t+1} = \mathbf{w}_t - \eta \nabla \mathcal{L}
\label{eq:gd}
\end{equation}
where \eta denotes the learning rate and \mathcal{L} is the loss function.
% ERROR: where η denotes the learning rate and $\mathcal{L}$ is the loss function.

\chapter{Conclusion}
This report presented deep learning techniques for glaucoma detection.
Future work will focus on multi-modal learning and explainability.
\printbibliography
\bibliography{references}

% ERROR: missing \bibliographystyle{IEEEtran}
% ERROR: removing \printbibliography
\end{document}