الجمهورية الجزائرية الديمقراطية الشعبية
République Algérienne Démocratique et Populaire
وزارة التعليم العالي و البحث العلمي
Ministère de L'Enseignement Supérieur et de la Recherche Scientifique
المدرسة العليا للاعلام الآلي بسيدي بلعباس
École Supérieure en Informatique - 08 Mai 1945 - Sidi Bel Abbès

Mémoire de Fin d'étude
Présenté pour l'obtention du **diplôme** d'**ingénieur d'état**
Filière : Informatique
Spécialité : Système d'Information et Web (SIW)

Dans le cadre d'un diplôme - une startup

Thème

MammaRate: An Ai Assistant Tool For Mammography Reading And Decision Helping

---

Présenté par :

- Boudinar Mohamed El Amine
- Abdelali Mohamed Amine

Soutenue le 04/07/2023, devant le jury composé de :

-	Mr	Khaldi Miloud	Président
-	Mme	Dif Nassima B	Encadrante
-	Mme	Bousmaha Rabab	Examinateur
-	Mr	Kechar Mohamed	Représentant de l'incubateur

Année Universitaire : 2022 - 2023

Acknowledgements

First of all, thank you Allah for giving us the courage and strength to complete this thesis.

We would also like to thank our supervisor Dr. Dif Nassima for her valuable advice, corrections, and suggestions that greatly contributed to the completion of this work. Also, we would like to express our sincere gratitude to Dr. Djazia Benchuk for her valuable support throughout this research, especially in the medical field. Her continuous encouragement contributed to this work.

In addition, we would like to thank the president of the jury as well as the members of the jury who agreed to review and evaluate our research. Their expertise and feedback improve the quality of our work.

We commend the (ESI-SBA) School and its dedicated mentors for their academic support in providing us with a solid foundation to overcome the challenges posed by this research. We also thank all the staff members for providing us with a comfortable environment for our research.

Dedication

To my dearest father, Ben Mhamed, my beloved mother, Zouaia Mama, and my wonderful little brother, Khaled. The three most important people in my life. Today, I want to express my deepest gratitude and appreciation for your support and relentless hard work. It is through your love and guidance, alongside the blessings of God, that I stand in the position I am today. Words cannot fully capture the extent of your encouragement and affection toward me. From every corner and at all times, I am honored to convey my heartfelt thanks to each of you. I particularly mention my mother, who is battling a grave illness. Despite this, she has never faltered in her love and care for our family. Her strength, patience, and resilience inspire me every time. I pray with all my heart that Allah will grant her healing. This work is dedicated to all of you as a symbolic gift, representing my immense gratitude.

I also extend my gratitude to my beloved family, who played an active role in my achievements, never failing to support me.

Additionally, I want to express my sincere thanks to my dear friends, with whom I shared countless moments and joyous days: Nadjib, Adel, Yannis, Seddik, Mukhtar, Aymen, and all my friends. Your support during these times means the world to me.

Last but not least, I cannot overlook the contributions of my friend and business partner, Amine, whose role was instrumental in the success of this work.

Standing here, I say to all of you: Thank you, and may God grant us success and contentment in all that we pursue.

Boudinar.

Dedication

I would like to start my thanks expressions with my parents, The great dad Abdelali said, my dear mom Hallas Fatiha, whose immeasurable impact cannot be adequately expressed in mere words. They never give up on me throughout my academic journey, showering me with endless love, care, and affection. Their unwavering presence has been a constant source of strength in my life. They have consistently uplifted me with their prayers and never once made me feel inadequate or incapable of pursuing my studies.

I would like to express my gratitude to my brothers, Chemssedine, Zoubir, Yahia, and Youcef, who have always been the essence of my existence. Their unwavering support and encouragement have given me a profound sense of purpose, motivating me to persevere tirelessly in pursuit of our common goals and transform our aspirations into concrete accomplishments. I particularly pray for my brother Yahia's swift recovery, may Allah heal him soon.

I would also like to express my appreciation and thankfulness to my extended family for their unwavering support and love, who have stood by my side and provided unwavering support and motivation in my entire life. Their constant pride in my accomplishments has been a driving force in my journey.

Additionally, I would like to sincerely convey my heartfelt gratitude to my friends, coaches, my basketball team, and all the people I have come to know in my close-knit village, Theniet El Had. Their presence and guidance have played a significant role in my life, and I am truly grateful for their impact.

Then, I would like to give a special thanks to my two friends, Yaniss and Amine, who have accompanied me throughout the best five years of our college journey. Together, we have shared unforgettable moments and I have truly cherished their friendship in every sense of the word. I hope our bond remains strong throughout my entire life.

Furthermore, I cannot conclude this speech without appreciating the immense contribution and unwavering support of my partner, Boudinar Mohamed Amine. Without him, the creation of MammaRate would not have been possible, as he played a crucial role in every aspect of this project.

I am very proud to be a part of the ESI Sba family for five years, thanks to everyone in this university. Thank you all for everything.

Abdelali.

Abstract

The integration of deep learning and artificial intelligence holds extremely significant in many fields, particularly in contexts where machine assistance can improve decision-making. In the medical domain, the importance of this subject becomes even more apparent as disease prevalence and mortality rates increase over time.

One of the most dangerous diseases affecting women, especially those 40 years of age and older, is breast cancer. Although biennial mammography and regular early screening by a professional are recommended, diagnosing breast cancer can still be difficult. The interpretation of mammograms, which primarily aims to evaluate breast density through image analysis, is still challenging when using current techniques and tools, creating significant time pressures. The patient's increased anxiety makes these difficulties worse. Additionally, medical professionals' varying perspectives exacerbate the issue.

This memoir aims to investigate risk factors for breast cancer, focusing on breast density from a medical standpoint. We explore how machine learning and deep learning experts have advanced in combining the expertise of medical professionals with these techniques where they faced many obstacles in their studies. In the end, we make a contribution to this field by carrying out extensive research, consulting prior literature, and running many experiments. Our study supports the use of particular methods, and we incorporate the developed models into a platform that helps radiologists classify and explain breast density in mammogram images.

KeyWords: Breast Cancer, Breast Density, Risk Factors, Deep Learning, BI-RADS, CNN, Mammogram Images.

Résumé

L'intégration de l'apprentissage profond et de l'intelligence artificielle dans de plusieurs domaines de notre société est essentielle, en particulier là où les machines peuvent soutenir la prise de décision. Dans le domaine médical,Plus la prévalence des maladies et les taux de mortalité augmentent avec le temps, plus l'importance du sujet devient prépondérante.

Parmi ces maladies, le cancer du sein est l'une des plus dangereuses pour les femmes, en particulier celles âgées de 40 ans et plus. Malgré les recommandations des spécialistes en faveur d'examens précoces réguliers et de mammographies tous les deux ans, le diagnostic du cancer du sein peut s'avérer difficile. L'interprétation des mammographies, qui vise principalement à évaluer la densité mammaire par l'analyse d'images, reste une tâche complexe avec les méthodes et les outils actuels, créant d'importantes contraintes de temps. L'anxiété accrue des patients aggrave ces difficultés. De plus, les divergences de points de vue entre les professionnels de la santé exacerbent le problème.

Ce mémoire se propose d'explorer les facteurs de risque associés au cancer du sein, en accordant une attention particulière à la densité mammaire dans une perspective médicale. Nous examinons la manière dont les experts en apprentissage automatique et en apprentissage profond ont progressé en intégrant les connaissances des professionnels de la santé aux techniques d'intelligence artificielle. Ils ont dû surmonter diverses difficultés et obstacles tout au long de leurs études. En définitive, notre contribution à ce domaine repose sur des recherches approfondies, une analyse de la littérature existante et la réalisation de nombreuses expériences. Notre étude soutient l'utilisation de méthodes spécifiques, et nous intégrons les modèles développés dans une plateforme qui aide les radiologues à classifier et à interpréter la densité mammaire à partir des images de mammographie du chaque patient.

Mots clés: Cancer du sein, Densité mammaire, Facteurs de risque, Apprentissage en profondeur, BI-RADS, CNN.

الملخص

إن دمج التعلم العميق والذكاء الاصطناعي في العديد من الجوانب أمر ضروري، خاصة في تلك الجوانب التي يمكن أن تساعد الآلات في اتخاذ القرارات. في المجال الطبي، يزداد أهمية هذا الموضوع تأكيدًا مع زيادة انتشار الأمراض ومعدلات الوفيات مع مرور الوقت.

واحدة من أخطر الأمراض التي تؤثر على النساء، خاصة تلك اللاتي تبلغن من العمر ٤٠ عامًا وأكثر، هي سرطان الثدي. في حين ينصح بإجراء فحوصات الثدي كل عامين والفحوص المبكرة المنتظمة من قبل الأخصائيين، قد يكون من الصعب لتشخيص سرطان الثدي. تعتبر تفسير صورة الثدي بواسطة الأشعة ، التي تهدف في المقام الأول إلى تقييم كثافة الثدي من خلال تحليل الماموغرام، مهمة صعبة لا تزال تواجه تحديات عند استخدام التقنيات والأدوات الحالية، مما يخلق ضغوطًا زمنية كبيرة. وتزيد القلق المتزايد للمريض . بالإضافة إلى ذلك، تزيد وجهات نظر الأطباء المختلفة من تفاقم المشكلة.

تهدف هذه المذكرة إلى دراسة عوامل الخطر لسرطان الثدي، مع التركيز على كثافة الثدي من منظور طبي. نستكشف كيف تقدم خبراء التعلم الآلي والتعلم العميق في دمج خبرات الأطباء مع تقنيات الذكاء الاصطناعي. وقد واجهوا مجموعة من الصعوبات والعقبات في دراستهم. في النهاية، نساهم في هذا المجال من خلال إجراء بحوث شاملة، والاستشارة من الدراسات السابقة، وإجراء العديد من التجارب. تدعم دراستنا استخدام طرق محددة، وندمج النماذج المطورة في منصة تساعد الأطباء في تصنيف وتفسير كثافة الثدي في صور الماموغرام.

الكلمات المفتاحية: سرطان الثدي ، كثافة الثدي ، عوامل الخطر ، التعلم العميق ، الشبكات العصبة التلافيفية ، نظام بيانات ، تقارير تصوير الثدي

Acronyms

ACA	*American College of Radiology*
ACR	*American College of Radiology*
AI	*Artificial intelligence*
AJHS	*Algerian Journal of Health Sciences*
AUC	*Area Under Curve*
BI-RADS	*Breast Imaging-Reporting and Data System*
BRCA	*Breast Cancer Gene*
CA	*Channel Wise Attention*
CBIS-DDSM	*Curated Breast Imaging Subset of DDSM*
CC	*Cranio Caudal*
CNN	*Convolutional neural network*
DCC	*Dilated Convolution*
DCN	*Deep Convolution Network*
DDD	*Domain Driven Design*
DDSM	*Digital Database for Screening Mammography*
DL	*Deep Learning*
DICOM	*Digital Imaging and Communications in Medicine*
FC	*Fully Connected*
FFDM	*Full Field Digital Mammography*

FN	*False Negative*
FP	*False Positive*
FH	*Flip Horizontally*
FLEF	*Feature Late Evidential Fusion*
GAP	*Global Average Pooling*
ICA	*Individual Classification Accuracy*
IRMA	*Image Retrieval in Medical AppliCation*
JWT	*Json Web Token*
LEF	*Late Evidential Fusion*
MLO	*Mediolateral Oblique*
MIAS	*Mammographic Image Analysis Society*
MRI	*Magnetic resonance imaging*
NAG	*Nesterov Accelerated Gradient*
OCA	*Overall Classification Accuracy*
PGM	*Portable Gray Map*
PNG	*Portable Network Graphics*
PR	*Precision*
RC	*Recall*
RBG	*Red Green Blue*
SFM	*Screen Film Mammography*
SGD	*Stochastic Gradient Descent*
SSE	*The Sum of Squared Errors*
SP	*Specifity*
TN	*True Negative*

TP	*True Positive*
VS-FLEF	*View Specific Future Late Evidential Fusion*
VS-LEF	*View Specific Late Evidential Fusion*
WHO	*World Health Organization*