Submitted to

**The University of Roehampton**

In partial fulfilment of the requirements

for the degree of

**Master of Science**

**in**

**Computing /Data Science /Web Development**

By

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Predictive Modeling for Early COPD Detection: Leveraging Artificial Intelligence in Pulmonary HealthcareSubtitle if required

Declaration

I hereby certify that this report constitutes my own work, that where the language of others is used, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of others.

I declare that this report describes the original work that has not been previously presented for the award of any other degree of any other institution.

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Acknowledgements

Here, it is customary to thank the people who have supported this work and your studies in general. It is up to you who you thank!

Abstract

GUIDANCE: Up to 500 words

A short summary of your project to include the problem, the main literature reviewed, your implementation and your findings.

Write this after you have finished the entire report!

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# Introduction

Chronic Obstructive Pulmonary Disease (COPD) represents a significant global health challenge, with increasing prevalence and mortality rates. The condition, characterized by chronic airflow limitation and persistent respiratory symptoms, often remains undiagnosed until it reaches an advanced stage [1]. It was observed that COPD accounts for a substantial burden on healthcare systems, particularly in low- and middle-income countries, where early detection and access to proper treatment remain limited [2]. The evidence supports that early diagnosis is vital, as it enables timely therapeutic interventions that can slow disease progression, improve quality of life, and reduce healthcare expenditures [3]. The World Health Organization (WHO) classifies COPD as the third leading cause of death globally, attributing over 3 million deaths annually to the disease [2]. Despite its prevalence, many cases go undetected in their early stages due to non-specific symptoms, under-reporting, and lack of routine diagnostic tools in primary care. An analysis of the data from WHO and other health registries reveals that more than 70% of COPD cases are diagnosed late, often after significant lung function has been lost [4]. This underlines the critical need for effective predictive systems that can aid in identifying the disease earlier. The researcher identifies Artificial Intelligence (AI) and Machine Learning (ML) as transformative technologies that offer significant potential in the domain of healthcare diagnostics. It was observed that AI-powered algorithms can process and analyze vast volumes of clinical data including spirometry tests, patient histories, imaging data, and symptom reports to detect early signs of COPD with greater accuracy and speed than traditional methods [5], [6]. The study indicates that such intelligent systems can augment clinical decision-making, reduce diagnostic delays, and extend screening capabilities to underserved populations. The predictive modeling process involves using historical and real-time patient data to train AI algorithms to recognize patterns associated with the early onset of COPD. The observer noted that various ML models, including Support Vector Machines (SVM), Random Forests (RF), Gradient Boosting Machines (GBM), and Deep Neural Networks (DNN), have been implemented to classify COPD patients from non-COPD individuals [7]. The procedure was executed as follows: data collection from relevant repositories, preprocessing through normalization and feature selection, training of models on labeled datasets, and performance evaluation using statistical metrics like accuracy, precision, recall, and AUC-ROC curves. The test conditions were controlled to ensure unbiased training and validation, and hyperparameter tuning was performed using cross-validation techniques. The results show that ML models, particularly ensemble methods and deep learning frameworks like Convolutional Neural Networks (CNNs), can achieve diagnostic accuracy above 90% when trained on clean and comprehensive datasets [8], [9]. The findings imply that integrating ML into routine screening workflows may significantly reduce misdiagnosis and optimize treatment strategies. One can infer that AI-based approaches are well-suited to handling the multidimensional and heterogeneous data typically involved in COPD diagnosis. For instance, electronic health records (EHRs) include demographic information, comorbidities, medication history, lab test results, and imaging data all of which can be analyzed to detect subtle indicators of early-stage COPD [10]. The observer highlighted that traditional rule-based systems lack the flexibility and learning capacity of ML models, which continuously improve as more data become available. Furthermore, the process was documented to ensure transparency and reproducibility in model training and validation. The phenomenon was recorded in real-world healthcare settings where AI-assisted tools were deployed for COPD screening. These tools demonstrated improved sensitivity and specificity compared to standard spirometry alone, especially in patients with mild symptoms who would otherwise go unnoticed [11]. The data suggest that combining imaging analysis (e.g., chest X-rays, CT scans) with clinical indicators enhances the robustness of prediction models. This multimodal approach also opens avenues for creating personalized risk profiles for patients. A statistical analysis was conducted on performance metrics of different models tested in existing literature. The study conducted by Chen et al. [8] using deep CNNs on CT scans achieved an AUC of 0.94, suggesting strong predictive performance. In contrast, Ruiz and Gomez [7] utilized RF classifiers trained on spirometry and patient-reported symptoms, reaching an overall accuracy of 87%. These comparisons indicate that model performance is contingent upon both the algorithm type and the quality of input data. The observer also noted ethical and practical considerations when implementing AI in clinical practice. Concerns related to data privacy, model interpretability, and algorithmic bias must be addressed. The findings imply that black-box models, while accurate, may lack transparency, which can hinder their adoption in clinical decision-making. Therefore, explainable AI (XAI) techniques are increasingly being explored to make predictions more interpretable and trustworthy for medical professionals [12]. Additionally, the study indicates that wearable sensors and mobile health technologies are being integrated into COPD monitoring and prediction. Real-time data from devices measuring oxygen saturation, heart rate, and respiratory patterns can be fed into ML models to predict exacerbations and support early interventions [13]. The measurements were taken continuously, enabling a dynamic understanding of patient conditions rather than relying solely on episodic clinical visits. The subjects in multiple studies behaved in a manner consistent with early COPD signs—such as breathlessness, chronic cough, and reduced exercise tolerance but often did not seek medical help until the disease had progressed [14]. This highlights the role of AI-driven alert systems in flagging at-risk individuals based on behavioral or physiological trends. The trends in the data emphasize that early intervention yields better patient outcomes and reduces long-term healthcare costs.

## Legal, Social, Ethical and Professional Considerations

Chronic Obstructive Pulmonary Disease (COPD) remains a major global health challenge, ranking among the leading causes of death worldwide. The researcher observed that early detection of COPD can significantly improve patient outcomes and reduce healthcare costs [15]. The data suggest that traditional diagnostic methods often fail to identify the disease in its initial stages, leading to delayed treatment [16]. The study indicates that Artificial Intelligence (AI) and Machine Learning (ML) techniques can enhance early detection by analyzing clinical data, imaging, and patient histories to identify subtle patterns indicative of COPD [17]. The experiment revealed that models such as Random Forests and Convolutional Neural Networks deliver promising diagnostic accuracy and robustness [18]. The process was documented to comply with legal standards including GDPR, ensuring patient data privacy and informed consent [19]. The observations were made regarding potential biases in datasets, highlighting the need for fairness and transparency in AI models to prevent discriminatory outcomes [20]. Socially, the findings imply that AI applications must promote equitable access to healthcare and support, rather than replace, clinicians [21]. The evidence supports the professional responsibility of healthcare providers to interpret AI outputs judiciously, maintaining accountability in patient care [22]. Overall, the study reveals that integrating AI for early COPD detection requires a balanced approach, addressing technical efficacy alongside ethical, legal, and social considerations.

## Background

Chronic Obstructive Pulmonary Disease (COPD) represents a significant and growing challenge within the field of respiratory medicine, affecting millions globally and imposing a substantial burden on healthcare systems [23]. The researcher observed that COPD’s insidious onset and nonspecific symptoms often result in late diagnosis, limiting the effectiveness of treatment and management strategies. The data suggest that early detection is critical for preventing disease progression, improving patient quality of life, and reducing hospital admissions [24]. Despite advances in clinical diagnostics, many patients remain undiagnosed until the disease reaches an advanced stage, underscoring an urgent need for improved screening methods. This work is situated within the broader context of digital health and medical informatics, where Artificial Intelligence (AI) and Machine Learning (ML) offer promising tools to enhance diagnostic accuracy and efficiency [25]. The findings imply that predictive modeling, leveraging large datasets including spirometry, imaging, and electronic health records (EHR), can identify early COPD patterns that traditional methods might miss. The experiment revealed that ML algorithms have the capacity to analyze complex, multidimensional data, enabling the classification of COPD at earlier stages than conventional clinical assessments [26]. The phenomenon of integrating AI into healthcare is particularly relevant in respiratory medicine, where the variability in symptom presentation complicates diagnosis. The researcher’s personal motivation arises from the recognition of COPD’s underdiagnosis and the potential life-saving benefits of timely intervention. The observations were made that existing COPD screening tools are often limited by accessibility and reliance on subjective symptom reporting, which can introduce bias [27]. The process was documented through review of studies demonstrating how AI models can mitigate these limitations by providing objective, data-driven insights. Furthermore, COPD disproportionately affects populations with limited access to specialist care, including those in rural or under-resourced settings. The study indicates that AI-enabled early detection tools could democratize healthcare delivery by facilitating remote monitoring and decision support, thereby addressing social inequities [28]. The evidence supports that predictive models, when integrated into primary care workflows, may empower general practitioners to identify at-risk patients earlier, improving referral rates and clinical outcomes [29]. This work also addresses known challenges related to data heterogeneity, privacy, and the interpretability of AI decisions. The researcher notes that to be clinically useful, predictive models must be transparent and explainable to healthcare providers. The data were analyzed with an emphasis on model interpretability to ensure that the AI outputs can be trusted and effectively incorporated into patient management [30]. Additionally, adherence to legal and ethical frameworks for data handling ensures the protection of patient rights and supports public confidence in AI applications [31]. In summary, this research contributes to the growing field of AI-assisted medical diagnostics by focusing on early COPD detection. It bridges gaps in current diagnostic pathways and responds to an urgent clinical need with innovative computational approaches. The study not only holds potential to improve individual patient outcomes but also to alleviate systemic healthcare pressures by enabling proactive disease management.

## Structure of Report

Insert your text here

Describe the upcoming sections in order -- this provides your reader with a roadmap of the report.

You may find this [link](https://online.york.ac.uk/masters-research-projects-what-to-expect-and-how-to-prepare/) useful

# Literature – Technology Review

Insert text here

GUIDANCE: Up to 1500 words

Note: All projects will require a technology review. However, not all projects will require a literature review. Please speak to your supervisor to confirm what is required for your project.

## Literature Review

Insert text here

The literature review is a key part of your project and has specific marking criteria attached. The purpose of the literature review is to show that you have researched, understood, and critically evaluated all aspects of your problem statement. This is your ‘investigation’.

You should describe the problem in detail, mentioning any literature, organisations, institutions or individuals who are important in the context or the solution.

You should correctly reference using IEEE style key articles, books, or papers you have read that are relevant to the problem.

It is not enough to list relevant points. You also need to show the ability to:

• Summarise the main points.

• Discuss (e.g., point out strengths, weaknesses, differences of approach etc).

• Describe how the literature you have found relates to the problem you are addressing.

• Apply your own critical thinking to the material you include.

• Draw your own conclusions from your investigation and show how these will guide your methodology and implementation.

Everything that you write in your literature review must be clearly relevant to your problem statement and aims and objectives, and you must clearly state this.

## Technology Review

Insert text here

The technology review focuses on technology that will be and could be used for the project. Firstly, you should review and summarise different technology options you could apply to your project. Then, you should write down the rationale for your own choice.

## Summary

Insert text here

Provide a critical summary of the section, including the literature and technologies' benefits and limitations and identify how your critical analysis outcomes will influence your methodology and your project overall.

# Implementation

Insert your text here

GUIDANCE: Up to 3000 words

Discuss how did you apply the methodologies you have described in the section above to your actual problem.

Some strategies that can help you write this part:

• Start this section with any design work you might have done e.g., experimentations, system design/architecture, UX design artefacts etc.

• If you divided your work into sprints, that can be a good structure for this section.

• Only include code snippets for particularly challenging parts of your implementation.

• Pick out a few difficult problems you had to solve and tell us in detail how you solved them. This brings your experience to life.

# Evaluation and Results

Insert text here

GUIDANCE: Up to 2000 words

This is an important section where you weigh up the strengths and weaknesses of your artefact/experimentation.

Guidance: If your project has a user-facing element, we expect to see some kind of evaluation of this with representative intended users, for example a ‘think aloud’ usability test.

You can also apply standard metrics for the domain you are working in and see how you have done against them. Your project does not have to be perfect -- indeed the outcomes might have been bad. The point is you must evaluate the outcome and discuss its strengths and weaknesses.

This section should include the following subheadings:

• Related Works

## Related Works

Insert text here

# Conclusion

Insert text here

GUIDANCE: Up to 1500 words

The conclusion summarises the project. Start by summarising the overall outcome of your project and to what extent the aims and objectives have been met. You need to highlight your key outputs and/or discoveries.

The following subsections that must appear in your conclusion.

## Future Work

Insert text here

Answer the question -- What next?

You've completed a significant piece of work -- perhaps the largest piece of work you have ever done. But no project is ever 100% complete, and you will have found new ideas along the way. If someone were to pick up your project, what avenues should be explored next?

This is an important section, and it helps us understand what you have learned by doing the project and allows you to show you understand what a more ideal solution might look like, outside the constraints of the MSc Project timeframe.

## Reflection

Insert text here

You must critically reflect on the entire project process and how well you have worked on the project. What particular things have you learned during the project? Why were you able and unable to meet project goals? What would you have done differently in hindsight?

Insert text here

Additional chapters can be added using the *Heading 1* style.

References

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You should include your reference list at the end of your report but before the appendices. You must ensure you use the appropriate IEEE format for your subject area.

Your referencing must use the [IEEE referencing style IEEE Citation Guidelines](https://ieee-dataport.org/sites/default/files/analysis/27/IEEE%20Citation%20Guidelines.pdf).

It is highly recommended that you use reference management software such as RefWorks that is provided by the university. Your project should have as many references as is required. However, having few references indicates that no thorough investigation has occurred.

It is your responsibility to ensure that you have actually read all the material you reference, and that the references provided in your report are legitimate and NOT AI-generated.

A Note about EndNote

If you are using EndNote for your references, your reference list will initially appear below the appendix. You can cut and paste it to this page and it will stay here after that.

Below this line is a hidden Section Break (Next Page). DO NOT DELETE THIS!  
You can see hidden elements by using the Show/Hide option () on the home ribbon.

Appendices

Appendices appear after references. Your appendices depend on the nature of your project. If you direct them to do so in your main text, appendices are considered additional information and should not be relied upon to understand your main body of work. Refer readers to an appendix using a phrase such as see Appendix A for further details.

The following documents must be included as references:

• Your Project Proposal.

• Evidence of your use of a project management tool.

• A description of accessing (link) any technical output, such as the developed dataset and coding. It is strongly recommended you use GitHub or something similar to do this.

• Provide a link to the video recording for demonstrating your artefact

For any important communications between you and external stakeholders, please remove private data and anonymise communications.

Use Heading back matter style for the headings of appendices.

You can delete these guidelines but you need to leave the rest of page black with “Appendices” on the top.

Appendix A: Project Proposal

Insert text here

Appendix B: Project Management

Insert text here

Appendix C: Artefact/Dataset

Insert text here

Provide a link and on how to access any technical output such as the developed/used dataset and coding. It is strongly recommended you use GitHub or something similar to do this.

Appendix D: Screencast

Insert text here

Provide a link to your video file here. You can share your screencast using Microsoft Stream, OneDrive or any other method which gives full access to your supervisor and second marker.

A PowerPoint is not required.