



**Vilnius  
University**

# **Enhancing Breast Cancer Recognition using Vision Transformer and Explainable AI**

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Academic year: 2025/2026  
Doctoral study period: 2024-2028**



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# Study plan and summary of their implementation:

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Year of study	Exams	
	Plan	Completed
I (2024/2025)	2	2
II (2025/2026)	2	1
III (2026/2027)	0	
IV (2027/2028)	0	
Total:	4	3

Year of study	Participation in Conferences				Publications					
	International		National		With citation indicator			Without citation indicator		
	Plan	Completed	Plan	Completed	Plan	Completed	Condition	Plan	Completed	Condition
I (2024/2025)			2	2				0	1	Published
II (2025/2026)	1							2		
III (2026/2027)	1				1					
IV (2027/2028)	1				1					
Total:	3		2	2	2			2	1	

# The plan for the reporting half-year and its implementation:

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Exams 2025/2026 (3 <sup>rd</sup> semester)		
Plan	Completion Date	Condition
Fundamental methods of informatics and informatics engineering science	2026 Q1	Pass
Deep Neural Networks		Continuing

General skills 2025/2026 (3 <sup>rd</sup> semester)		
Plan	Completion Date	Condition
The FAIR data principles	2025 Q4	Complete
Lithuanian Academic Electronic Library (eLABa): Author Interface	2025 Q4	Complete

# The plan for the reporting half-year and its implementation:

Conference participation 2025/2026 (3 <sup>rd</sup> semester)		
Plan	Completed	Conference type

Publications 2025/2026 (3 <sup>rd</sup> semester)			
Plan	Completed	Condition	Publication Type

# Information about international events and publications presenting the main results of the dissertation (articles with citation index only)

Participation in international conferences	
	Description

Publications (with citation rate only)	
	Bibliographic description

## Research object & Aim:

**Research object:** Vision Transformer and Large Language Model with Explainable Artificial Intelligence for breast cancer detection to improve diagnostic accuracy with interpretability.

**Aim:** To develop and evaluate techniques used to improve Breast cancer detection using Vision Transformer and Large Language model with Explainable Artificial Intelligence.

## **Research Tasks:**

- Conduct a literature review to examine critical challenges and emerging advancements in breast cancer detection.
- Investigate and Implement current methods used for breast cancer detection using Vision transformer.
- Propose a method based on a vision transformer-based approach to improve breast cancer diagnostic accuracy with interpretability using XAI.
- Evaluate the proposed technique using different datasets and compare the obtained results with existing methods used for breast cancer detection.

# Stages of research and dissertation preparation:

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Title of the work		Deadlines	Notes
1	<b>Review and analysis of scientific research on the topic of the dissertation (in Lithuania and abroad):</b>		An initial review and analysis of scientific research was conducted.
	1.1. Specification of the research object of the dissertation.	October 2024 - March 2025	Studies on Explainable AI techniques and vision transformers used for breast cancer detection began. The significance of the topic was presented at the conference.
	1.2. An overview of Explainable AI techniques in Breast Cancer recognition.	October 2024	The overview of the study has been completed. The review paper has been published in a peer reviewed journal related to LLMs and XAI for Breast Cancer Transparency.
	1.3. Summarizing and presenting the overview in the description of the analytical part of the dissertation.	- September 2025	

Title of the work		Deadlines	Notes
2	<b>Conducting of scientific research</b>	April 2025 - December 2025	
2.1	Development of research methodology:		
2.1.1	The relevance of the topic is justified, the work problem is indicated and the goal is formulated.		The poster was presented at a national conference, highlighting the problem and presenting the expected proposed solution.
2.1.2	Tasks are selected and the problem to be solved is formulated.		The aim and objectives were clarified. Some publicly available datasets of breast cancer were reviewed and applied different data augmentation techniques to the selected dataset to handle the dataset imbalance.
2.1.3	Presentation and description of the applied methodology or research method.		The poster was presented at a national conference, highlighting the advancements in transparent breast cancer diagnostics using XAI and LLMs. The poster presented critical challenges and emerging advancements, shaping the development of trustworthy AI in medical diagnostics.

Title of the work		Deadlines	Notes
2.2	<b>Theoretical study:</b>	December 2025 - September 2026	
2.2.1	Analysis and systematization of scientific and other information		A comprehensive review and systematization of scientific literature related to breast cancer detection using artificial intelligence, deep learning models, vision transformers, and explainable AI techniques is completed, and findings are published in a review article.
2.2.2	Exploring Breast Cancer Detection Techniques using Explainable AI		Study in depth knowledge of Explainable Artificial Intelligence techniques (Grad-CAM, Grad-CAM++, integrated gradients, SHAP) used in medical imaging to explain the black-box model decision and improve interpretability in breast cancer detection.
2.2.3	Parameterization of Breast Cancer Detection Using Vision Transformers and Explainable AI Techniques.		The parameterization and optimization of vision transformer-based models are studied to improve model performance and reduce computational power. Additionally, Hyperparameter optimization is performed using Optuna, which provides an efficient and computationally effective alternative to traditional grid or random search methods for complex deep neural

Title of the work		Deadlines	Notes
2.3	<b>Empirical study:</b>	January 2026 - June 2027	
2.3.1	Description of the experimental part		The implementation and evaluation of the vision transformer-based model are in progress. Some initial steps, data preprocessing, data augmentation, training, and parameter selection. To assess the performance of the proposed model, we examined it in terms of evaluation metrics.
2.3.2	Realization of the existing method for comparison of the developed method.		To evaluate the performance of the proposed model, the same strategy will be applied to another dataset or existing methods for comparison in terms of evaluation metrics and computational cost used for breast cancer detection.

Title of the work		Deadlines	Notes
2.3	<b>Empirical study:</b>	January 2026 - June 2027	
2.3.3	Creating a method modification.		Based on the initial results from the proposed method, the proposed model will be modified to improve some evaluation metrics and achieve better performance used for breast cancer detection.
2.3.4	Experimental study of the developed modifications and comparison of the modifications with published existing methods.		The proposed model will be compared with an existing method used for breast cancer detection based on evaluation metrics and computational cost. After obtaining all results from the proposed method, the results will be published in a research article, and part of the results will be presented at the international conference.

## Description of scientific results obtained during the six-month period:

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- Review some publicly available mammography datasets for model development (MIAS, INbreast dataset, CBIS-DDSM, DMID) used for breast cancer detection.
- Study different data augmentation techniques and implement the Gaussian-based Synthetic Minority Oversampling Technique (SMOTE) to balance the BreakHis dataset and generate synthetic images.
- To enhance the accuracy and interpretability of proposed method used for breast cancer detection. A TokenLearner combined with multi-layer perceptron is used to develop an efficient model that requires less computational power compared to Vision Transformer for breast cancer detection.

## Description of scientific results obtained during the six-month period:

- To make the proposed model interpretable, Gradient-weighted Class Activation Mapping (Grad-CAM) is used for breast cancer classification. With the integration of Grad-CAM, the proposed model highlights the specific regions within an image that highly contributes to model outcome, providing interpretable insights that support medical professionals to strengthen clinical evaluation.

## Work Plan for the next half year 2025/2026

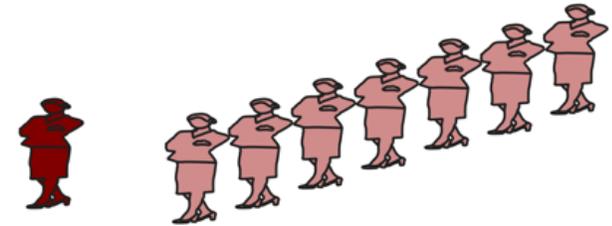
- The elective course: “Deep Neural Networks” will be completed in the second quarter of 2026.
- To participate in an international conference and present research findings on Enhancing Breast Cancer Detection using Vision transformer and Large Language Model with Explainable AI.
- Prepare and publish a scientific article in a peer reviewed journal.
- I started internship (Erasmus) at a foreign research institute on 16 February 2026 , and it will be completed on 15 May 2026.

# Study Results

**The core contribution of the study are following:**

- An analysis of the role of XAI, with a focus on healthcare domain particularly in breast cancer detection.
- Emerging trends and tools in XAI and LLMs for enhancing interpretability in AI.
- An exploration of how LLMs enhance the explanation by translating them into more understandable format.
- Different data augmentation techniques are used to balance the dataset for training the deep neural networks.

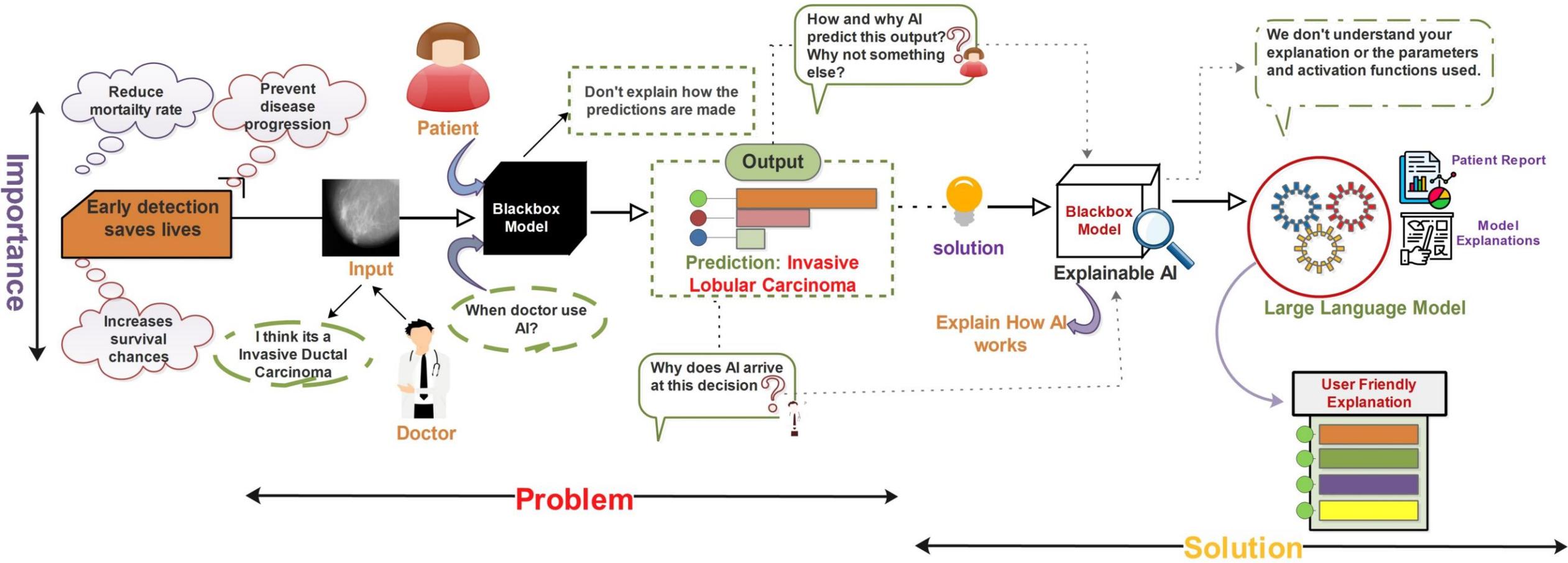
According to World Health Organization (WHO) Breast Cancer (BC) is the most prevalent disease worldwide, with over 2.3 million new cases annually. The most significant risk factor for breast cancer is being a woman. Women are affected by breast cancer in about 99% of cases, whereas men are affected in 0.5–1% of cases. Women with breast cancer who live in high-income nations have a 60% higher chance of surviving than those who live in low and middle-income countries [1].



**Breast cancer affects 1 in 8  
women**

# Methodology

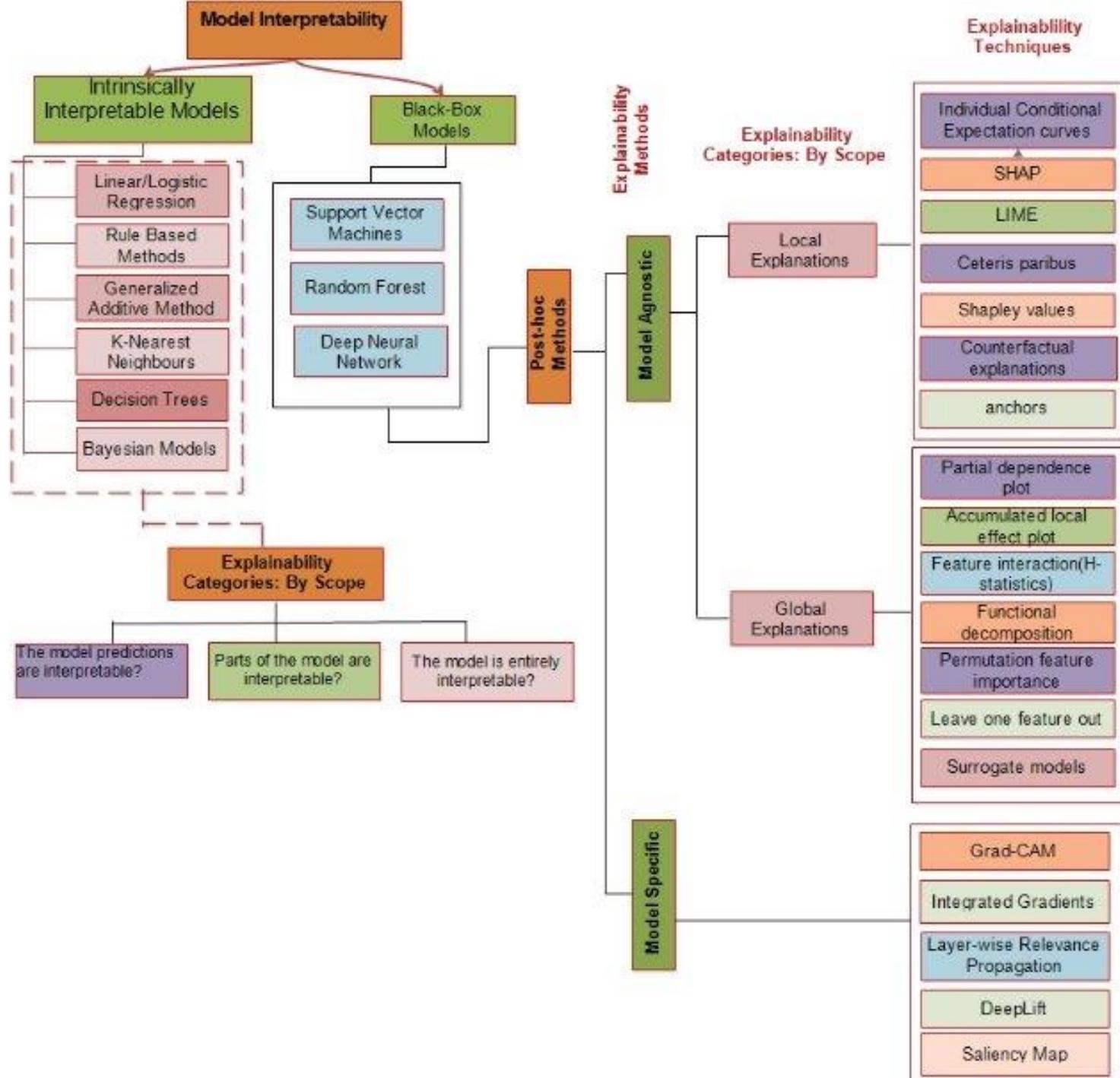
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# Datasets:

Ref	Modality	Dataset name	Dataset availability link
(Spanhol et al., 2015)	Histopathology	BreakHis	<a href="https://web.inf.ufpr.br/vri/databases/breast-cancer-histopathological-database-breakhis/">https://web.inf.ufpr.br/vri/databases/breast-cancer-histopathological-database-breakhis/</a>
(Mangasarian et al., 1995)	cytology	Breast Cancer Wisconsin(Diagnostic)	<a href="https://archive.ics.uci.edu/dataset/17/breast+cancer+wisconsin+diagnostic">https://archive.ics.uci.edu/dataset/17/breast+cancer+wisconsin+diagnostic</a>
(Araújo et al., 2017)	Histopathology	Breast Histology Dataset	<a href="https://rdm.inesctec.pt/dataset/nis-2017-003">https://rdm.inesctec.pt/dataset/nis-2017-003</a>
(Suckling, 1994)	Mammography	Mini-MIAS	<a href="http://peipa.essex.ac.uk/info/mias.html">http://peipa.essex.ac.uk/info/mias.html</a>
(Rose et al., 2006)	Mammography	DDSM	<a href="http://www.eng.usf.edu/cvprg/mammography/database.html">http://www.eng.usf.edu/cvprg/mammography/database.html</a>
(Moreira et al., 2012)	Mammography	INBreast	<a href="https://biokeanos.com/source/INBreast">https://biokeanos.com/source/INBreast</a>
(Ramos-Pollán et al., 2012)	Mammography	BCDR	<a href="https://bcdr.eu/information/about">https://bcdr.eu/information/about</a>
(Halling-Brown et al., 2020)	Mammography	RSNA	<a href="https://www.england.nhs.uk/statistics/statistical-work-areas/diagnostics-waiting-times-and-activity/imaging-and-radiodiagnostics-annual-data/">https://www.england.nhs.uk/statistics/statistical-work-areas/diagnostics-waiting-times-and-activity/imaging-and-radiodiagnostics-annual-data/</a>
(Saha et al., 2021)	Radiology	Duke-Breast-Cancer-MRI	<a href="https://www.cancerimagingarchive.net/collection/duke-breast-cancer-mri/">https://www.cancerimagingarchive.net/collection/duke-breast-cancer-mri/</a>
(Rodrigues, 2017)	Radiology	Breast ultrasound image	<a href="https://data.mendeley.com/datasets/wmy84gzngw/1">https://data.mendeley.com/datasets/wmy84gzngw/1</a>
(Institute, 2025)	Radiology	The Cancer Genome Atlas Program (TCGA)	<a href="https://portal.gdc.cancer.gov/">https://portal.gdc.cancer.gov/</a>

# Taxonomy of AI Models and Explainability Approaches:



# Conclusion

- A comprehensive analysis of Explainable AI (XAI), with a focus on its applications in healthcare and breast cancer diagnostics was carried out.
- The inherent interpretability challenges of Deep Learning models were examined, clarifying why they are often described as 'black boxes'.
- The limitations and challenges associated with current XAI methods, particularly in providing clear and meaningful explanations to end users were analyzed.
- The critical need for trust between humans and AI was highlighted, particularly in medical contexts, where even small errors in model predictions can have severe consequences.



**Thank you.**

