OSTEO-VISION

Enhancing Knee Osteoporosis Diagnosis through X-ray Imaging and Explainable AI Techniques

Presented by

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AGENDA

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- Research Gap
- Aim of the Research
- System Design
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Problem Background

- Osteoporosis is a "**silent disease**", often **undetected until fractures occur**. Diagnosis of knee osteoporosis relies heavily on **subjective interpretation of X-ray images**, leading to late detection

(Yen et al. 2024).

- **DEXA scans**, the **gold standard** for diagnosis, are **expensive and less accessible** for early screening.

(Yen et al. 2024).

- Existing AI models often act as a **black boxes**, lacking **interpretable visualization methods**, limiting **clinical trust and adoption.**

(Chaddad et al. 2023, Liu et al. 2024)

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Research Gap

- **Lack of interpretability** in current AI models for knee osteoporosis diagnosis, which operate as "black boxes" and fail to provide clinicians with transparent decision-making insights

(Liu et al. 2024, Chaddad et al. 2023)

- **Limited exploration of advanced models like EfficientNetB4**, which could improve diagnostic accuracy compared to older architectures (e.g., VGG16, ResNet50) but remain understudied.

(Talukder et al. 2024)

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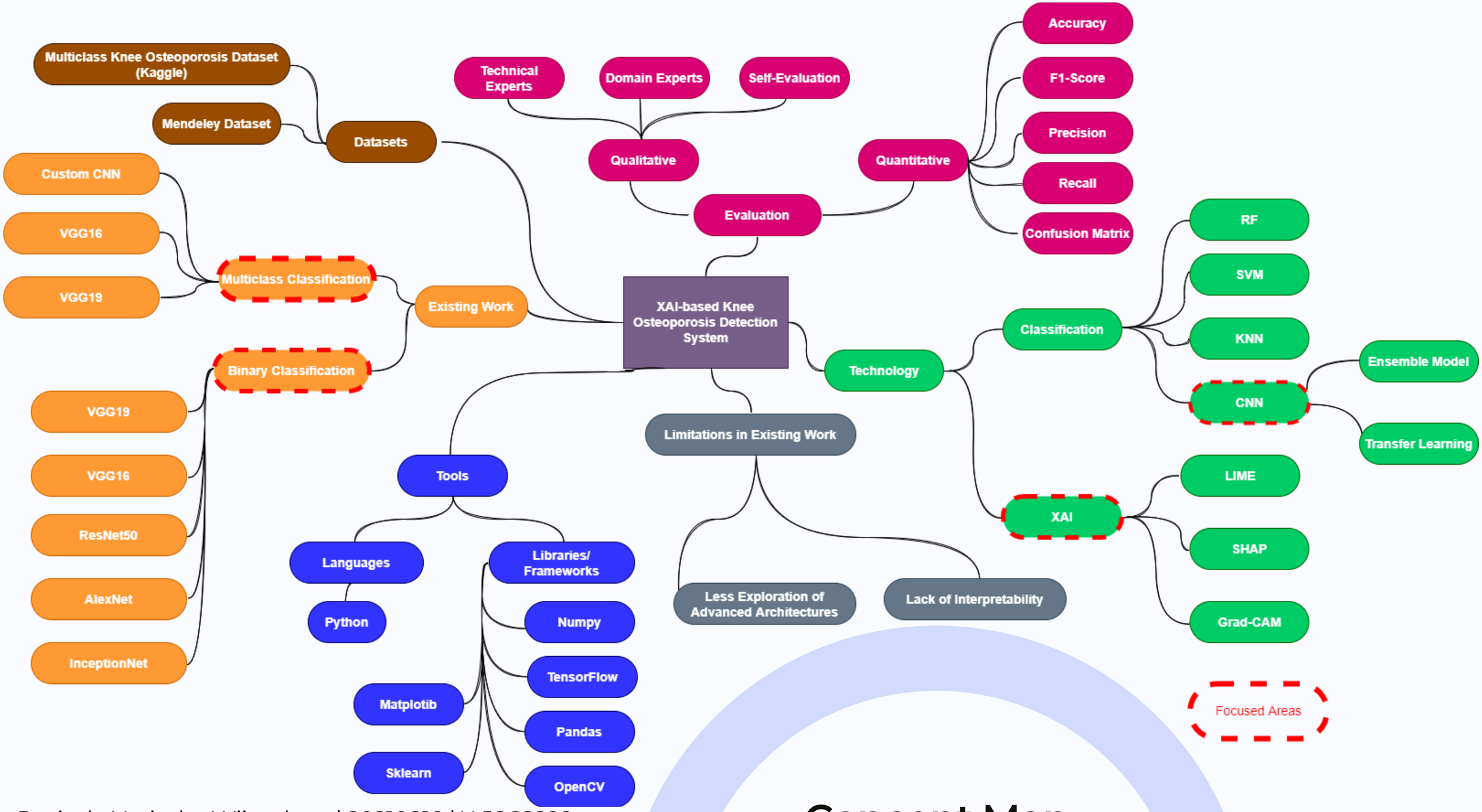

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Concept Map

Aim of the Research

This research aims to design, develop a higher accurate knee osteoporosis diagnosis system that takes advantage of the **X-ray images** and **latest deep learning approaches** based on **XAI**, hence **making the diagnosis precise and interpretable**.

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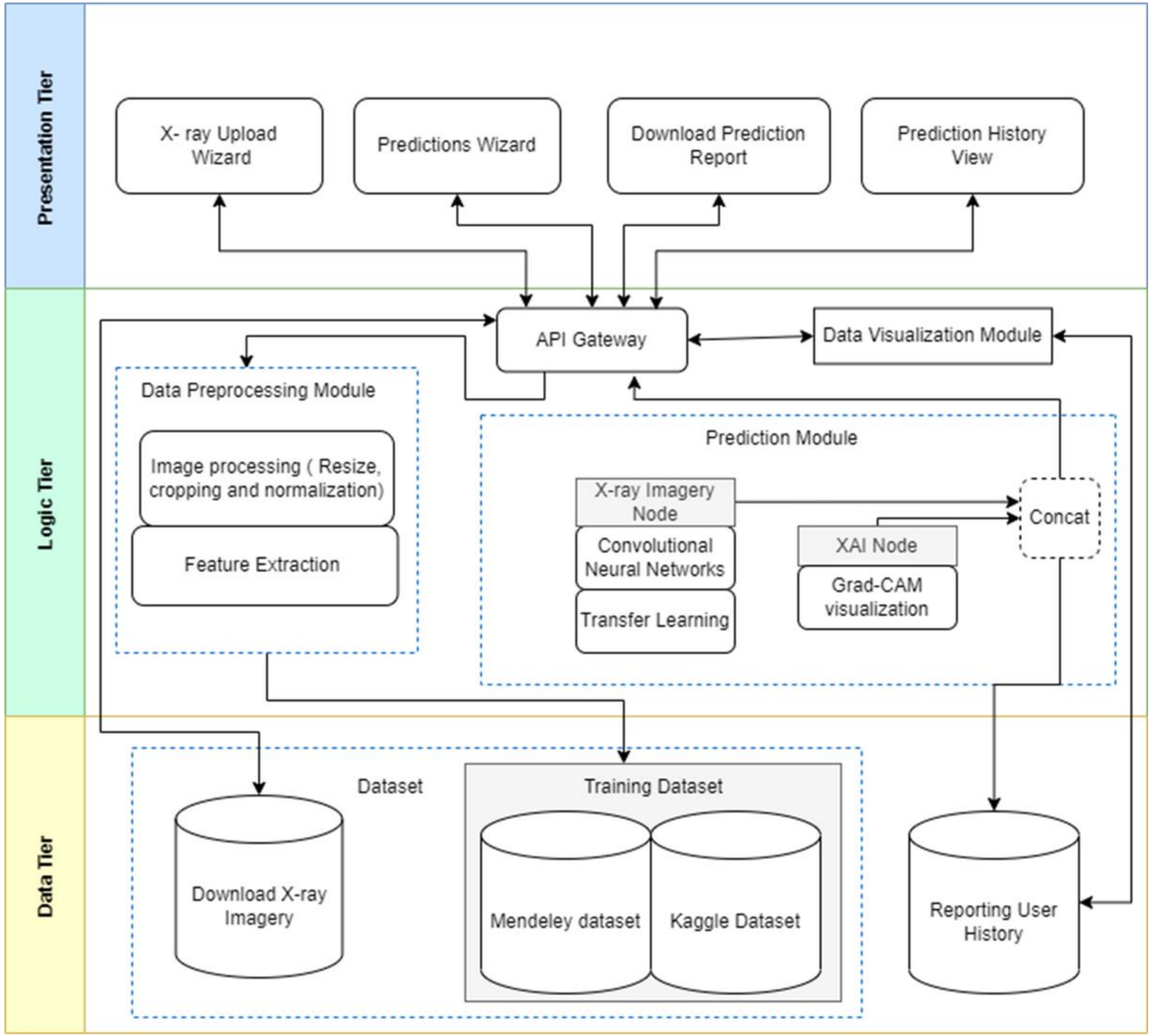
System Design



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Technology Stack

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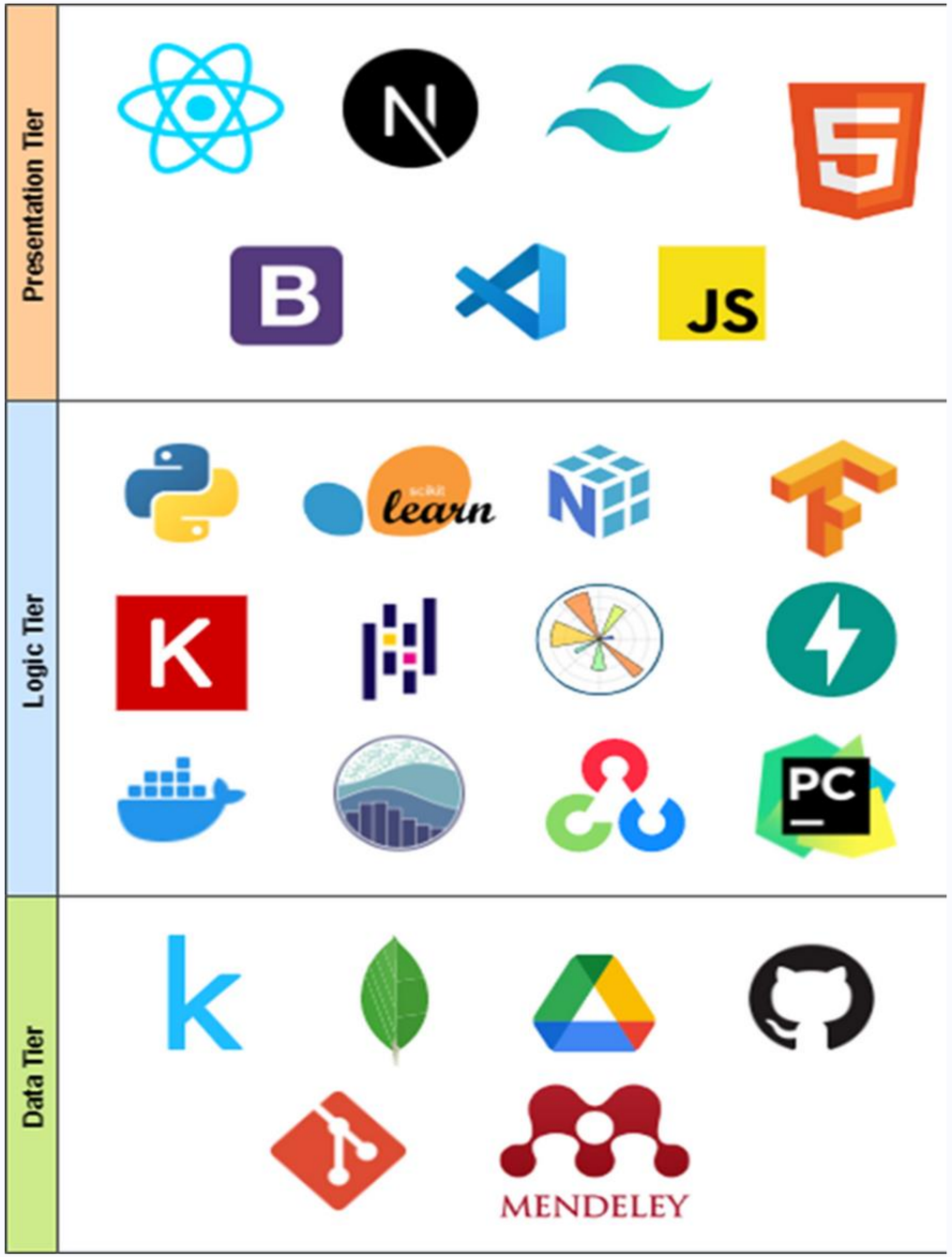

Demonstration

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Benchmarking

Research	Architecture	Accuracy %
Proposed Osteo-vision system	**Ensemble (VGG19 + EfficientNetB4)**	**98.52**
Gobara et. al 2024	VGG-19	97.5
Kumar et al.,2023	ResNet	91.4
Wani & Arora, 2022	AlexNet	91.0
Abubakar et al., 2022	GoogLeNet	90

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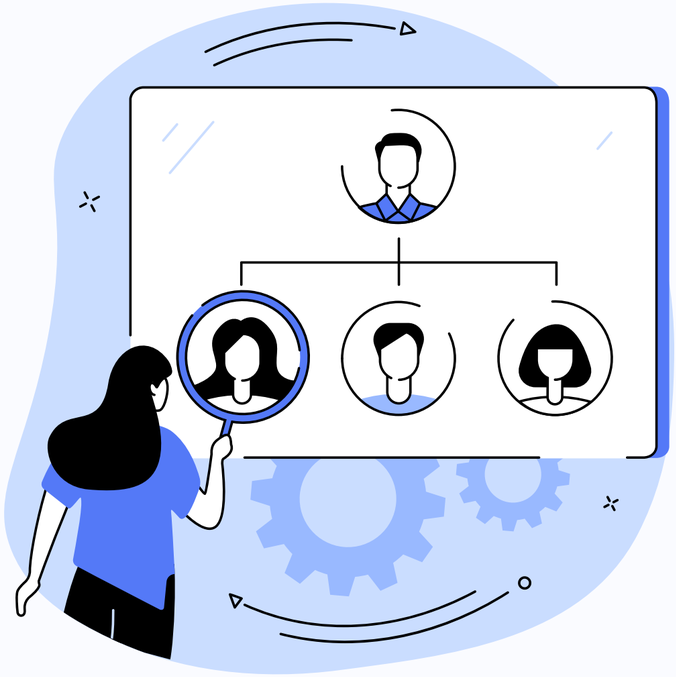
Evaluations - Domain Experts

Name	Professional Background
Dr. Nidhan Perera	Consultant Orthopedic Surgeon @ National Hospital Colombo
Anonymous	General Physician @ National Hospital Colombo
Dr. K.T.K.G Peiris	Medical Officer OPD @ Balapitiya Base Hospital
Dr. Yumndhee Godakanda Arachchi	Medical Officer Cardiology @ Durdans Hospital Colombo
Mr Sadeepa Sandaruwan	4th year Medical Student @ Medical Faculty Colombo
Ms Hiruni Lokuge	4th year Medical Student @ Medical Faculty Colombo



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Evaluations - Technical Experts

Name	Professional Background
Mr Rashan Peris	CTO @ iTelaSoft - Australia
Mr Chamara Herath	SSE specialized in ML and Deep Learning @ iTelaSoft - Sri Lanka
Ms Senuri Gunaratne	Research Assistant and Lecturer @ University of West-Michigan
Mr Harshan Rajan	TL @ iTelaSoft - Sri Lanka
Mr Isuru Nanayakkara	ATL @ iTelaSoft - Sri Lanka
Mr Aditha Pinsara	ASE @ H2Compute - Sri Lanka

Key Highlights from Evaluations

"... the research clearly addresses a real clinical gap. **Manual X-ray interpretation is subjective**. By **automating detection** and adding **explainability**, the project **bridges the gap between technology and real-world clinical practice quite effectively**... "

"...medical imaging diagnosis with AI, and the timing is excellent. Many models **focus only on performance** without considering **clinical applicability** but this project try to address both... "

"... **ensemble model's ability to push accuracy even further** than the individual models shows **solid experimentation and tuning**. This iterative improvement is crucial... "

"...**Grad-CAM integration** is highly appropriate for this kind of application. It **transforms the black-box model** into something **visually understandable**..."

"...Exploring model ensembling with **more diverse CNN architectures** could be a good next step..."

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Contributions & Novelty

Research Domain Contributions :

- Introduced a **novel ensemble model** combining EfficientNetB4 and VGG19 for knee osteoporosis diagnosis.
- First application of this ensemble approach in the domain, achieving superior performance over existing models.
- Integrated **XAI techniques** (Grad-CAM & LIME) to address the black-box issue, enhancing model transparency

Problem Domain Contributions :

- Enabled visual interpretation of predictions for clinicians, improving trust and adoption in real-world settings.
- Bridged the gap between high-accuracy AI models and clinical usability through explainability-focused design.

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Limitations & Future Enhancements

Limitations:

- **Interpretability Limitations**: Grad-CAM and LIME offer visual insights but lack pixel-level precision and quantitative validation, limiting clinical reliability.
- **Dataset and Environment Constraints**: The model was trained and tested on a limited, non-diverse dataset using a single hardware setup, affecting generalizability and real-world testing.

Future Enhancements:

- **Dataset & Model Expansion**: Incorporate more diverse datasets and explore advanced XAI methods for improved anatomical alignment and clearer visual explanations.
- **Clinical & Multimodal Integration**: Integrate DEXA scans for multimodal diagnosis and conduct supervised clinical trials for real-world feedback and validation.

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Conclusion

Existing Skills Applied

Full Stack Development using Python and Next.Js

Machine Learning

UI and UX design

New Skills Gained

Deep learning and Transfer Learning

XAI techniques (Grad-CAM, LIME)

FastAPI, TensorFlow, Docker

Problems & Challenges Faced

Hardware Resources

Package Version Issues

Lack of Experts

Longer Model Training Time

FYP 2024/25

Thank you So Much!

Presentation By Ravindu Yasintha

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