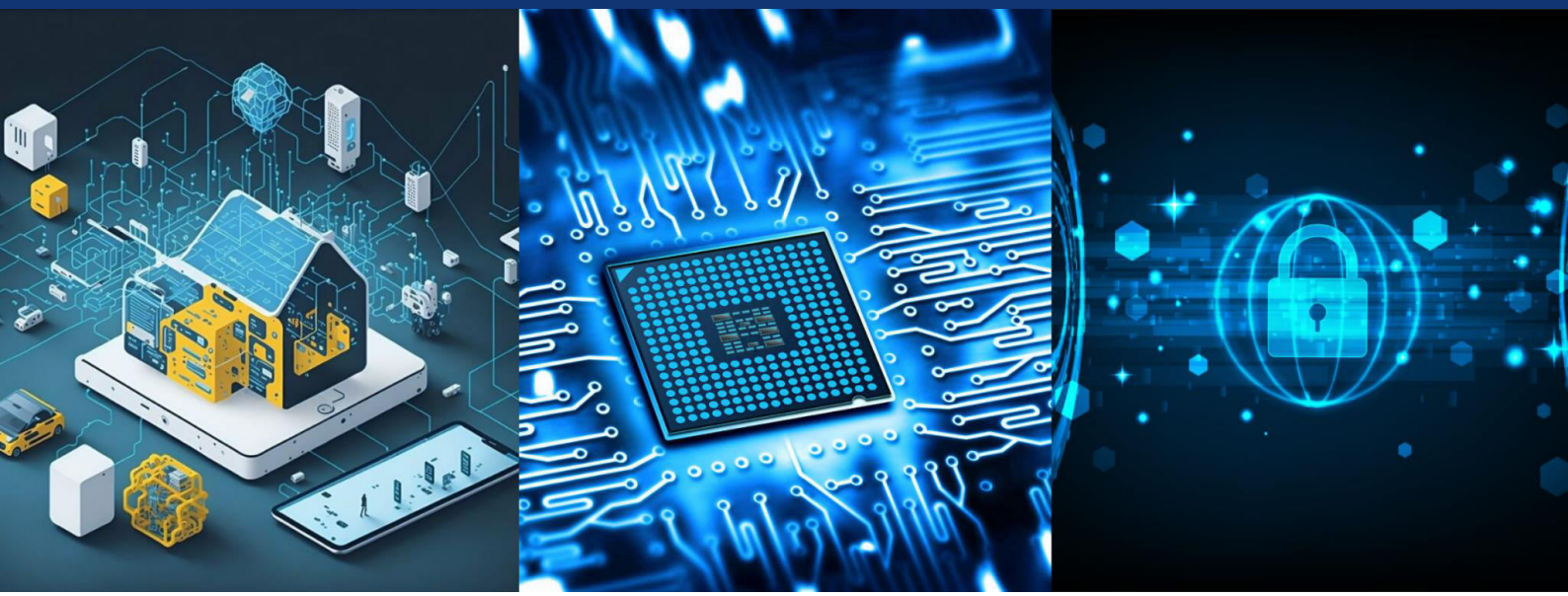
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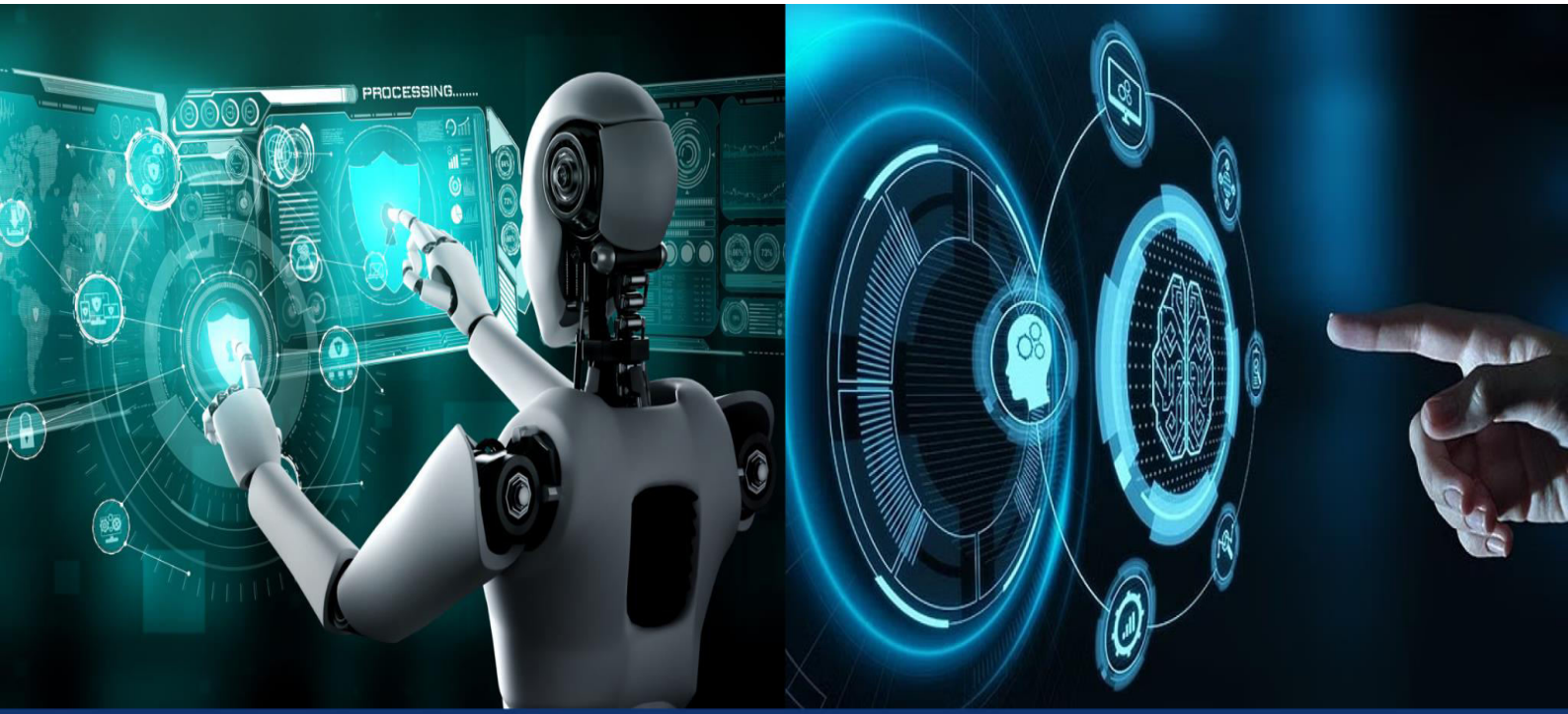
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Elderly Knee and Leg Pain Diagnosis System

Prof. Usha K[1], Mala P[2], Mohammed Malik Rehan Darwesh[2], Mohammed Maqsood Ali[2], Mohammed Yaseer[2]

Assistant Professor, Dept. of Computer Science and Engineering, Jain Institute of Technology, Davanagere, Karnataka, India[1]

UG Students, Department of Computer Science and Engineering, Jain Institute of Technology, Davanagere, Karnataka, India[2]

ABSTRACT: Knee and leg pain can limit mobility, independence, and quality of life among older adults. This paper presents the Elderly Knee and Leg Pain Diagnosis System, a web-based prototype intended to organize user-reported symptoms and provide preliminary decision-support information. The system combines a weighted rule-based symptom assessment with a deep-learning module that estimates radiographic knee osteoarthritis severity using the Kellgren–Lawrence (KL) grading scale. The symptom module considers inputs such as pain severity, onset, swelling, fever, ability to bear weight, crepitus, locking, numbness, weakness, injury history, morning stiffness, age, and selected medical history. Safety rules identify selected symptom combinations that warrant urgent medical assessment. For X-ray analysis, the system preprocesses uploaded images to 224 × 224 pixels and applies a MobileNetV2-based model with an ordinal output design to estimate KL grades 0–4. The application includes a web interface, FastAPI backend, downloadable PDF assessment reports, and a recent-assessment history feature. In the stored test evaluation of 1,656 images, exact-grade accuracy was 47.83%, while accuracy within one grade was 72.71%. Class-wise recall was uneven, including 0% recall for grade 1, indicating that the model requires substantial improvement and further validation. The prototype is therefore intended for educational and preliminary decision support only, not for independent clinical diagnosis. Further work includes model refinement, external validation, clinician review, accessibility testing, and privacy-focused deployment.

KEYWORDS: Esophageal Cancer Detection, Deep Learning, Medical Image Analysis, Convolutional Neural Network, Adenocarcinoma, Endoscopy AI, Clinical Decision Support

I. INTRODUCTION

Knee and leg pain are common concerns in older adults and may interfere with walking, standing, climbing stairs, and everyday activities. Osteoarthritis is one important cause of joint pain and disability, but symptoms can also arise from inflammatory arthritis, injuries, muscle or tendon conditions, nerve disorders, fractures, infection, or vascular problems. As the population ages, accessible ways to organize symptoms and support timely consultation are increasingly valuable. However, an online tool cannot replace a clinical history, physical examination, or investigations selected by a qualified healthcare professional.

Conventional assessment of knee pain relies on information from the patient, clinical examination, and imaging when appropriate. These steps can be difficult for people who have limited access to healthcare or who struggle to describe their symptoms. Digital decision-support applications can provide a structured process for collecting information and communicating possible next steps. Rule-based methods are useful when the reasons behind each output should be visible, while machine-learning methods can identify image patterns that are difficult to define using manual rules.

The Elderly Knee and Leg Pain Diagnosis System, referred to in this paper as the proposed system, combines two separate pathways. The first uses a weighted rule engine to rank possible explanations for user-reported symptoms and to display selected safety warnings. The second uses a MobileNetV2-based image model to estimate knee osteoarthritis severity from an uploaded X-ray. The two outputs address different aspects of assessment and are not combined into a confirmed medical diagnosis. The goal is to support understanding and encourage appropriate consultation, not to replace professional care.

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II. RELATED WORK

Sl. No.	Author & Year	Research Work	Methodology	Findings/ Relevance
1	Kellgren and Lawrence (1957)	Radiological Assessment of Osteo-Arthrosis	X-ray-based grading	Introduced the standard grading system for knee osteoarthritis severity.
2	Lutjens et al. (2017)	Deep Learning in Medical Image Analysis	CNN and deep learning	Demonstrated AI applications in medical image classification and detection.
3	Tajbakhsh et al. (2016)	CNNs for Medical Image Analysis	Transfer learning	Demonstrated the effectiveness models medical image classification.
4	Sandler et al. (2018)	MobileNetV2	Lightweight CNN	Introduced an efficient architecture for image feature extraction with reduced cost.
5	Chen and Or (2023)	Knee Pain and Osteoarthritis Prediction	Automated Machine Learning (AutoML)	Predicts knee pain progression and supporting early of possible conditions.

III. PROPOSED ALGORITHM

The proposed Elderly Knee and Leg Pain Diagnosis System uses symptom analysis and MobileNetV2-based deep learning to assess knee and leg pain and estimate osteoarthritis severity from X-ray images.

The system integrates symptom assessment, red-flag detection, X-ray classification, clinical guidance, and PDF report generation to support healthcare decision-making.

3.1 Symptom acquisition and validation

The user enters structured information about the symptoms and relevant history. The request schema validates the expected fields before the assessment engine processes them. The quality of the output depends on the completeness and accuracy of user-provided answers. The system does not independently verify the user's symptoms or medical history.

3.2 Weighted rule-based symptom assessment

The engine calculates a score for each candidate condition when the associated symptom rules are satisfied. For example, crepitus, gradual onset, age above 55, and prior arthritis can add points to the osteoarthritis candidate. Prolonged morning stiffness and swelling can contribute to the rheumatoid arthritis candidate. Sudden severe pain with swelling and a history of gout can contribute to the gout candidate. Locking or recent injury can contribute to the meniscus or ligament injury candidate, while numbness, weakness, or a history of diabetes can contribute to the peripheral neuropathy or nerve-compression candidate.

After scoring, the engine ranks the candidates and returns up to three possibilities with plain-language explanations. This distinction should be clearly stated in the user interface and any report.

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3.3 Red-flag rules and urgency

Safety-oriented rules are evaluated before the ordinary weighted scoring. For example, fever with swelling and inability to bear weight triggers a message to seek immediate care. Sudden onset, inability to bear weight, and recent injury also trigger urgent assessment advice. Other conditions can be serious even when these exact combinations are absent; therefore, the rules cannot be used to rule out emergencies.

3.4 Knee X-ray preprocessing

The X-ray service accepts JPEG or PNG image data. The uploaded image is decoded and converted to RGB, resized to 224 × 224 pixels, converted to a floating-point array, and scaled to the range [-1, 1]. This preprocessing is consistent with the MobileNetV2 preprocessing used by the model pipeline. The preprocessed image is then supplied to the trained Keras model.

I_p = Normalize (Resize (RGB(I), 224 × 224))

Where I is the uploaded image and I_p is the preprocessed image.

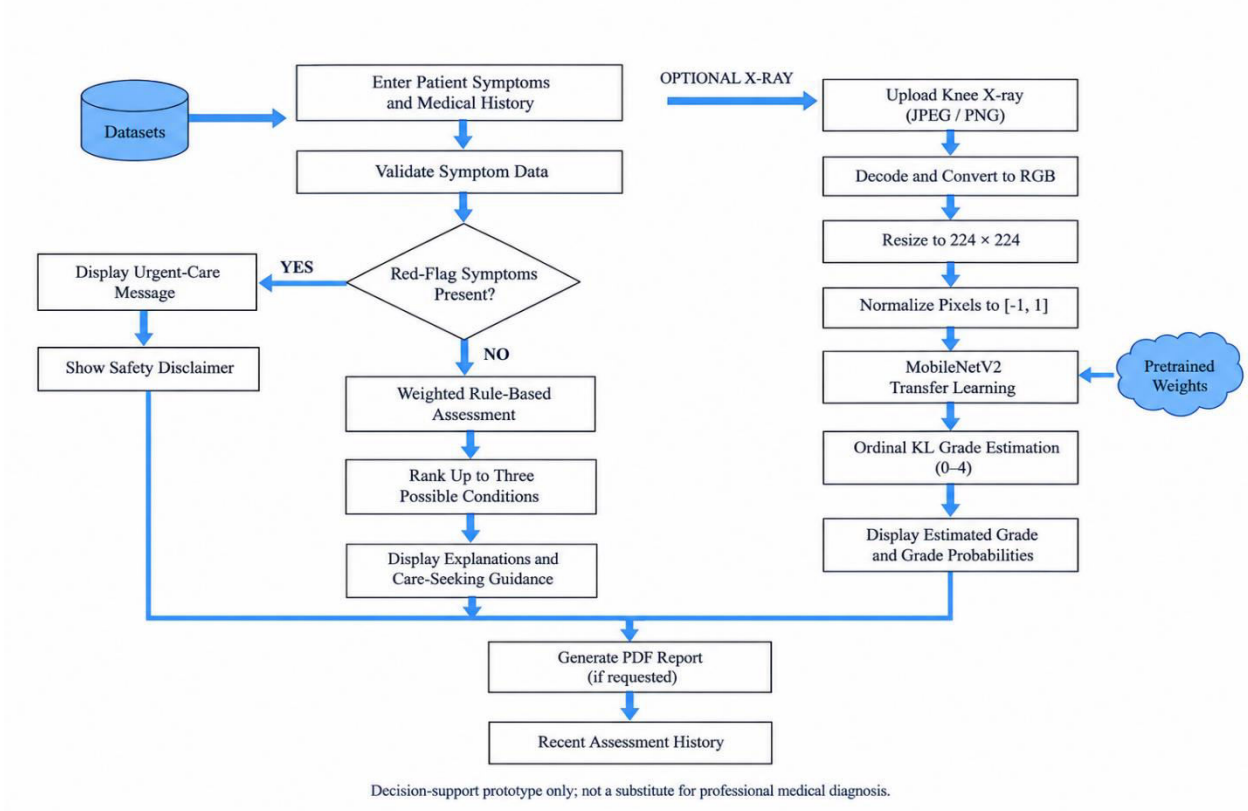


Fig.3.4.1 Methodology of Elderly Knee and Leg Pain System

3.5 MobileNetV2-based KL grade estimation

The image model uses MobileNetV2 transfer learning and an ordinal output structure. Four sigmoid outputs represent cumulative thresholds corresponding to P(grade ≥ k), for k = 1, 2, 3, and 4. Training occurs in two stages: first, the classification head is trained while the pretrained backbone is frozen; second, the upper portion of the backbone is fine-tuned. The training pipeline uses image augmentation and class weighting to address variation and class imbalance.

The KL grades are interpreted as follows: grade 0, no radiographic osteoarthritis; grade 1, doubtful changes; grade 2, mild changes; grade 3, moderate changes; and grade 4, severe changes. These labels describe radiographic appearance and must not be presented as a direct measurement of pain or a treatment recommendation.

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3.6 Report generation and history

The Clinical Report Generation module analyzes patient details, symptoms, and X-ray images using the MobileNetV2 model to predict possible knee conditions. It generates a downloadable PDF report containing diagnosis results, confidence score, and personalized recommendations, including exercises, precautions, and lifestyle suggestions.

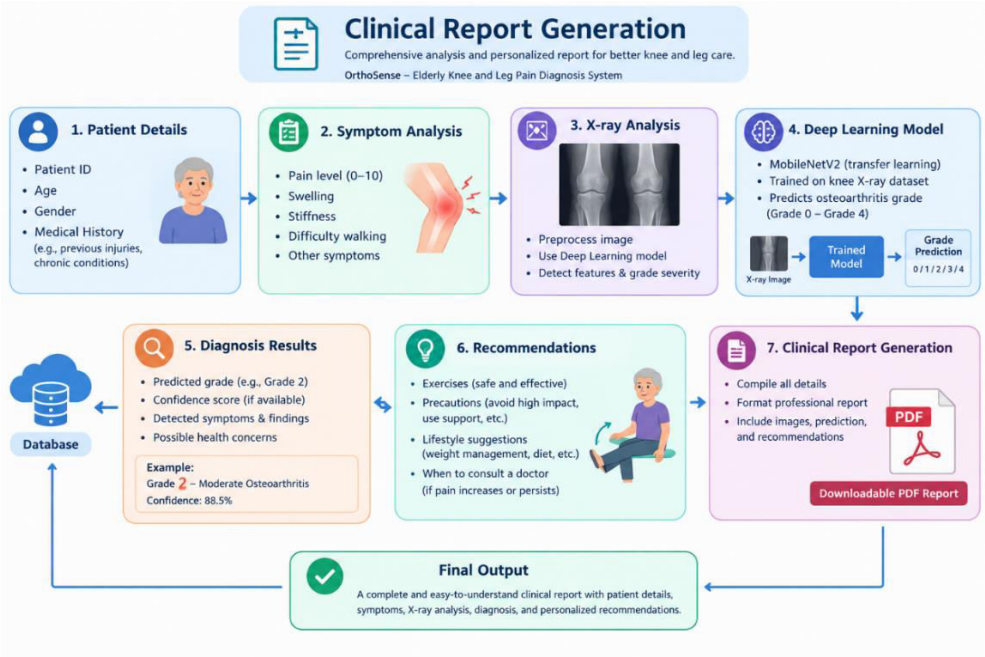


Fig. 3.6.1. Clinical Report Generation

3.7 Pseudocode

1. Step 1: Start the web application and backend services.
2. Step 2: Receive symptom answers from the user.
3. Step 3: Validate the submitted symptom data.
4. Step 4: Check selected red-flag combinations.
5. Step 5: If a red flag is present, return the corresponding urgency message.
6. Step 6: Otherwise, apply weighted rules and rank possible conditions.
7. Step 7: Display candidate explanations, care-seeking guidance, and disclaimer.
8. Step 8: If an X-ray is submitted, convert it to RGB and resize to 224 × 224.
9. Step 9: Scale pixel values to [-1, 1] and run the KL grading model.
10. Step 10: Return the estimated KL grade and model probability information.
11. Step 11: Generate a PDF report if requested and expose recent history.
12. Step 12: End the request.

IV. SIMULATION RESULTS

The project includes a frontend and Fast API backend with symptom assessment, X-ray grading, PDF report generation, assessment history, and model status APIs. The frontend also supports symptom assessment using a TypeScript fallback when the backend is unavailable.

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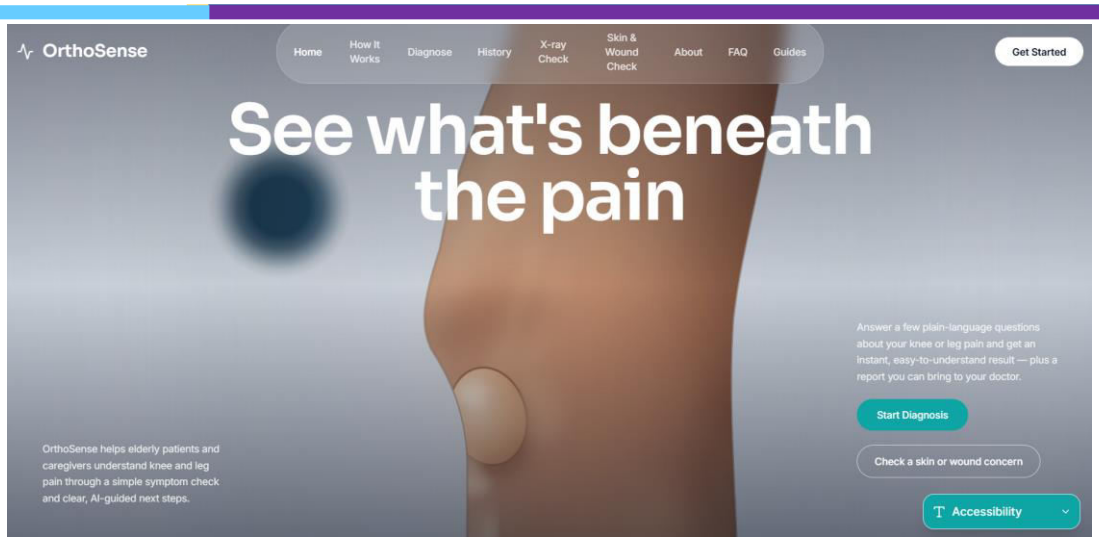


Fig. 4.1. Homepage for Orthosense

The OrthoSense Home Page provides a user-friendly interface for elderly patients and caregivers to understand knee and leg pain. It features a simple navigation menu with options such as Home, How It Works, Diagnose, History, X-ray Check, Skin & Wound Check, About, FAQ, and Guides. The page allows ions and receiving an easy-to-understand assessment with a report to share with a doctor. It also provides a separate option for checking skin or wound concerns and includes accessibility features to improve usability.

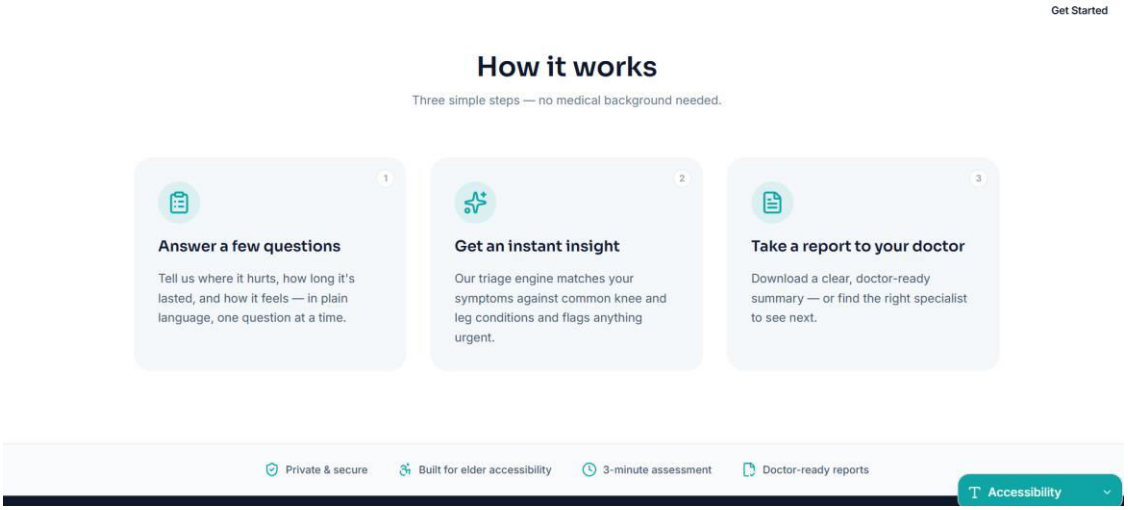


Fig. 4.2. How it Works Page

The How It Works Page explains the steps involved in using the OrthoSense system. It guides users through entering their symptoms, completing the assessment, reviewing the results, and understanding the suggested next steps. This page helps users understand the system's workflow.

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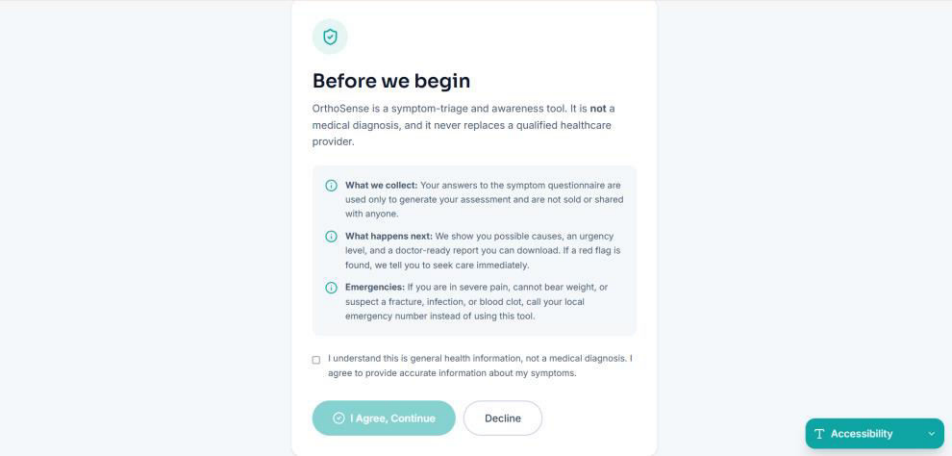


Fig. 4.3. Diagnosis Page

The Diagnose Page allows users to enter information about their knee or leg pain, including pain severity, duration, swelling, stiffness, injury history, and other relevant symptoms. The system evaluates the submitted information using weighted rules and provides possible conditions with explanations and care-seeking guidance.

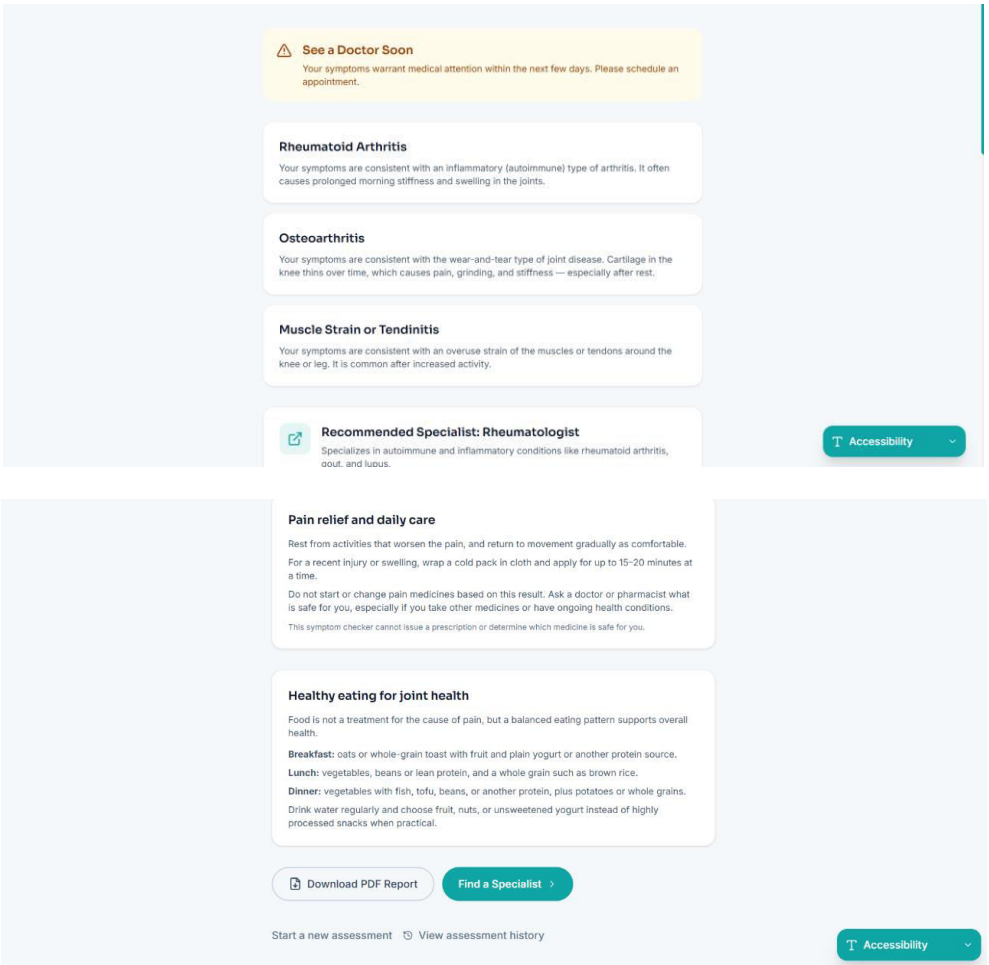


Fig. 4.4. Diagnosis Results and Health Guidance Page

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The Diagnosis Results and Health Guidance Page display possible conditions based on the user's symptoms, along with explanations and recommendations. It provides guidance on when to seek medical attention and suggests a suitable specialist. It helps users understand their assessment results and make informed decisions about seeking medical care.

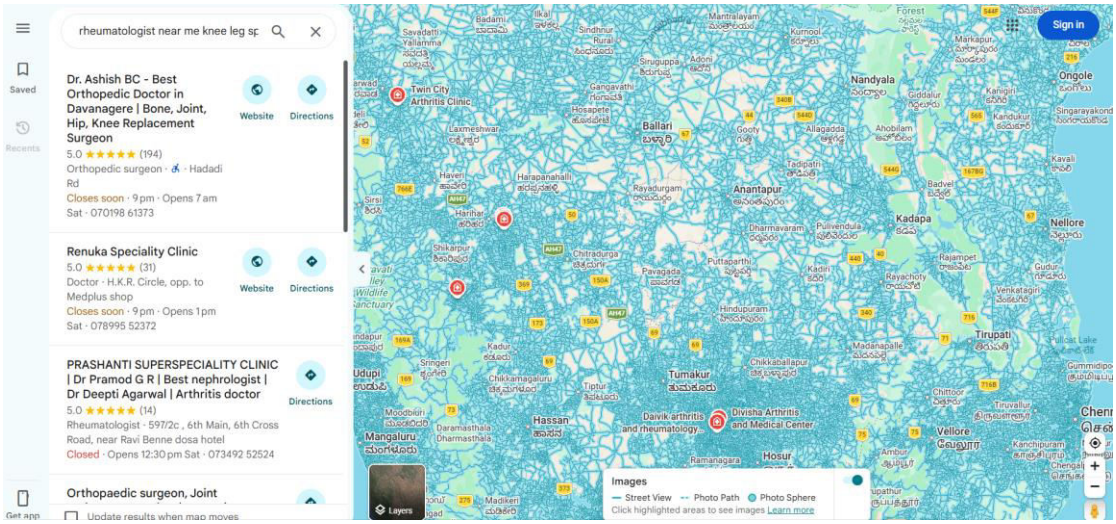


Fig. 4.5. Find a Specialist Page

The Find a Specialist Page helps users locate nearby healthcare professionals and clinics for knee and leg pain concerns. When users click the “Find a Specialist” button, the system opens a map-based search displaying relevant doctors, clinics, ratings, contact details, and directions. It helps elderly patients and caregivers identify suitable healthcare providers and find locations for further medical consultation.

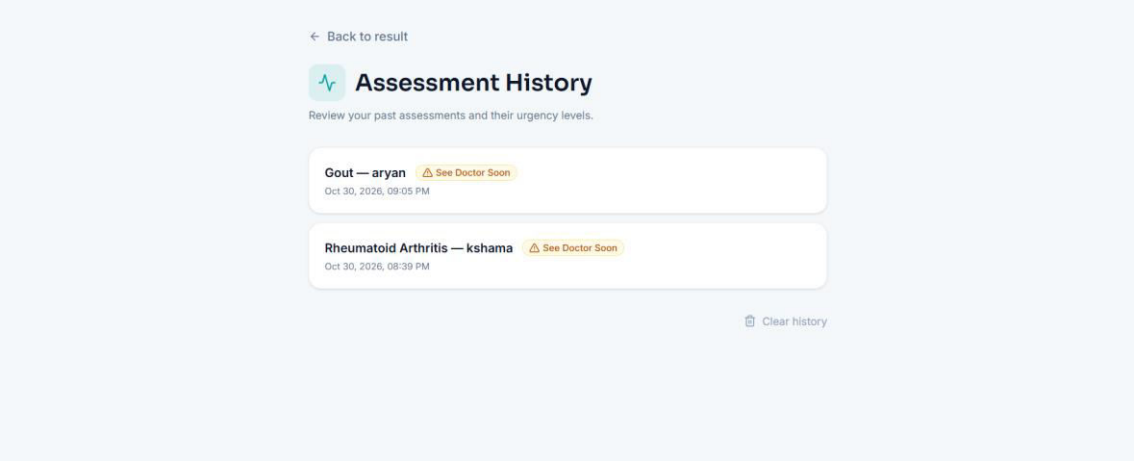


Fig. 4.6. Assessment History Page

The History Page provides access to recent assessments made through the system. It helps users review previous assessment results and refer to the information when discussing their symptoms with a healthcare professional. In the current demonstration, history may be stored temporarily and may not persist after the backend restarts.

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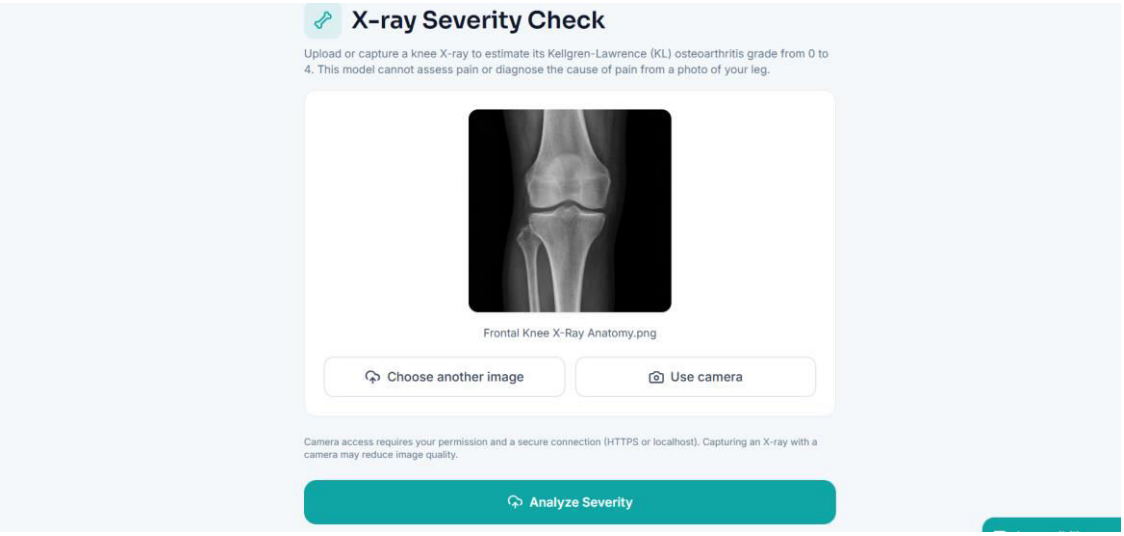


Fig. 4.7. X-ray Severity Check

The X-ray Check Page allows users to upload a knee X-ray image in a supported format, such as JPEG or PNG. The system preprocesses the image and uses a MobileNetV2-based deep-learning model to estimate the Kellgren–Lawrence grade of radiographic osteoarthritis from 0 to 4. The result describes the estimated X-ray grade and should not be treated as a confirmed diagnosis.

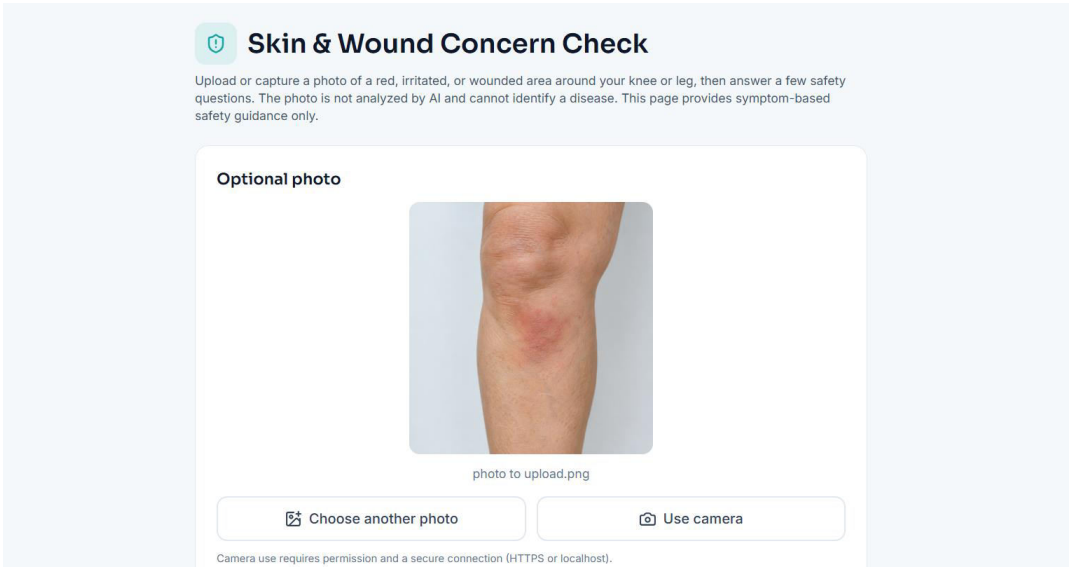


Fig. 4.8. Skin & Wound Concern Check

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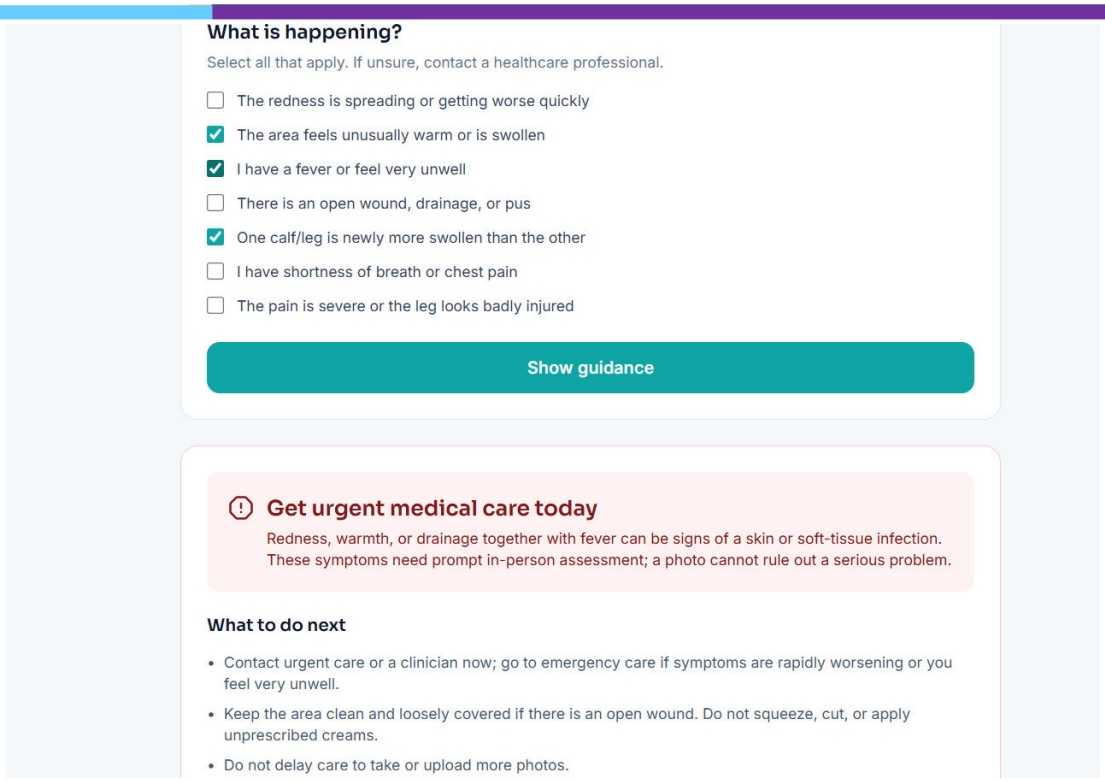


Fig. 4.9. Urgent Medical Guidance for Skin and Wound Concerns

The Skin & Wound Concern Check module helps elderly people identify possible skin-related problems around their knees and legs. It allows users to upload or capture photos of the affected area and select symptoms such as redness, swelling, fever, and wounds. If serious warning signs are detected, it displays an urgent medical alert and advises users to consult a healthcare professional. This module helps users understand potential risks and seek timely medical attention.

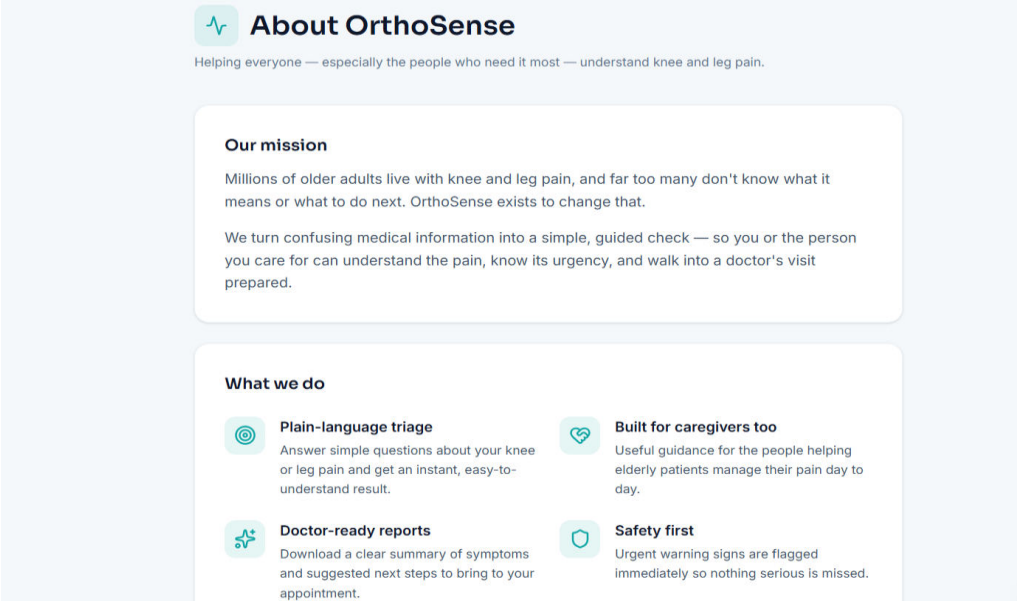


Fig. 5.0. About OrthoSense

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The About OrthoSense section explains the main purpose of our project. It helps elderly people understand their knee and leg pain in simple words. It provides easy symptom checking, guidance for caregivers, and reports that can be shared with doctors. It also highlights serious warning signs and suggests when to seek medical help. The main aim is to make knee and leg pain care easier and safer.

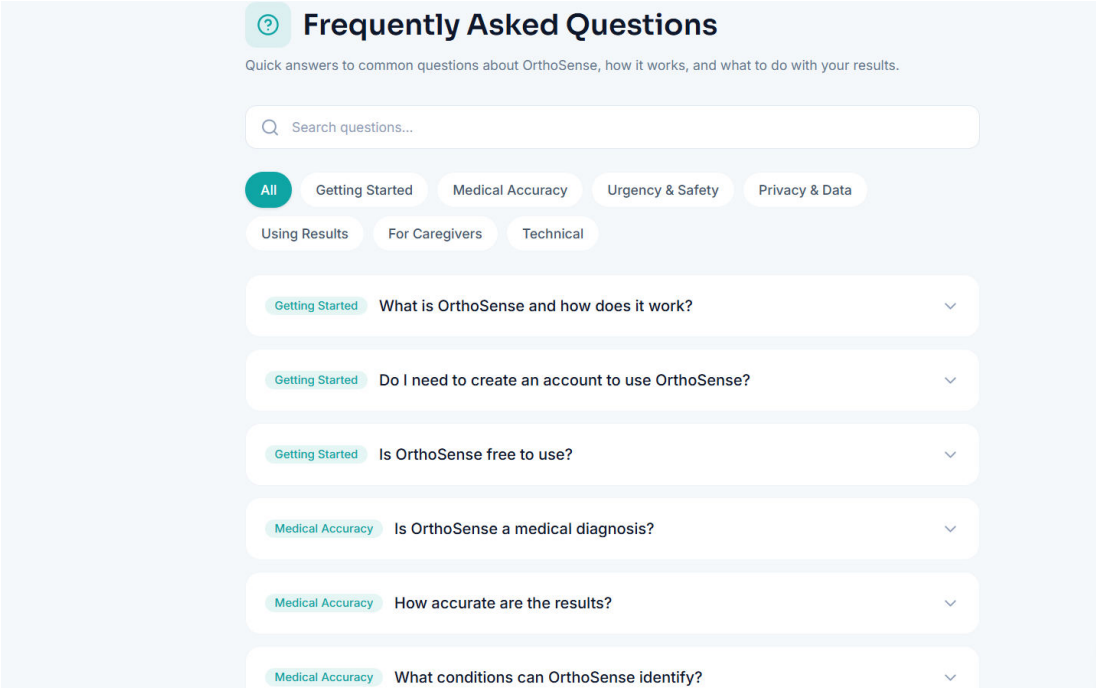


Fig. 5.1.Frequently Asked Questions

The Frequently Asked Questions (FAQ) section provides answers to common questions about the OrthoSense system. It helps users understand how the system works and how to use its features. Users can search for questions and find answers under different categories like medical accuracy, safety, privacy, and technical support.

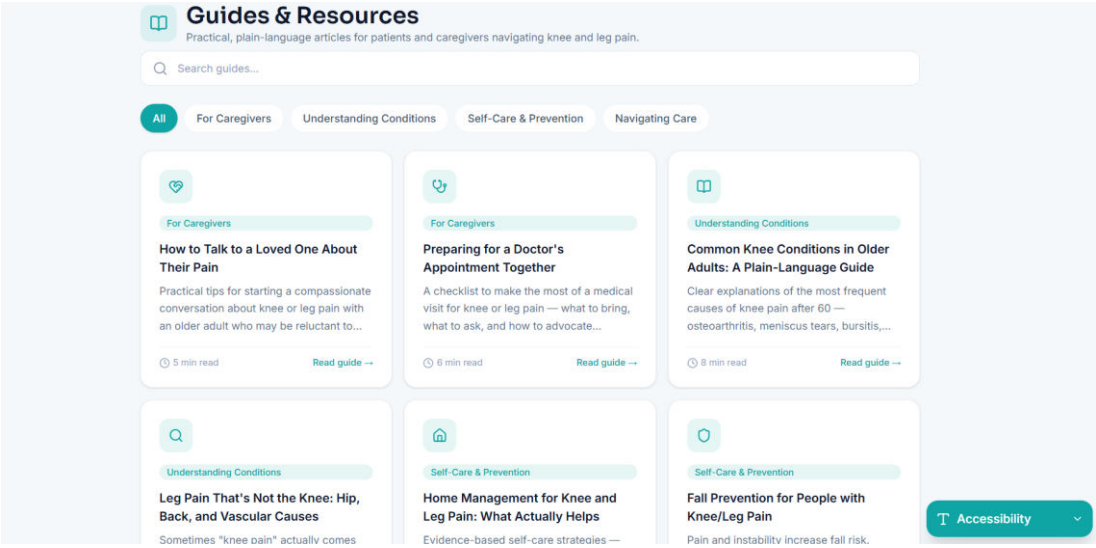


Fig. 5.2. Guides & Resources Page

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The Guides & Resources section provides useful information about knee and leg pain for elderly people and caregivers. It includes articles about common knee problems, doctor appointments, home care, and self-care tips. Users can search for guides and select different categories to find information easily. It helps elderly people understand their health problems and learn how to take better care of their knees and legs.

4.1 Performance Evaluation

The saved metrics file reports a test set of 1,656 images. The model achieved 47.83% exact-grade accuracy and 72.71% accuracy within one KL grade. Class-level results are shown in Table 5.1. These figures describe the stored model evaluation and should be rechecked by running the final training and evaluation pipeline before publication.

Metric / Grade	Precision	Recall	F1-score
Grade 0	48.18%	97.34%	64.46%
Grade 1	0.00%	0.00%	0.00%
Grade 2	46.47%	32.44%	38.21%
Grade 3	45.45%	8.97%	14.98%
Grade 4	71.43%	9.80%	17.24%
Macro average	42.31%	29.71%	26.98%
Overall exact-grade accuracy	—	47.83%	—
Accuracy within one grade	—	72.71%	—

Table 4.1:X-ray model metrics reproduced from the project's saved metrics.json file.

4.2 Recommended evaluation procedure

A publication-ready evaluation should report a confusion matrix, per-class precision/recall/F1, macro-F1, balanced accuracy, an ordinal agreement metric such as quadratic weighted kappa, and confidence intervals where possible. The authors should verify the dataset source and license, document the split procedure, and ensure that related images from the same patient do not appear across training and test sets. External validation on an independent dataset is recommended. Any performance claim should be based on a reproducible run of the exact model submitted with the paper.

V. CONCLUSION AND FUTURE SCOPE

The Elderly Knee and Leg Pain Diagnosis System is a web-based prototype that combines weighted symptom assessment, selected red-flag triage rules, knee X-ray osteoarthritis grading, PDF report generation, and recent assessment history. Its rule-based component provides understandable candidate explanations, while the MobileNetV2-based model estimates radiographic KL grades from uploaded knee X-rays. In the saved evaluation, the X-ray model achieved 47.83% exact-grade accuracy and 72.71% accuracy within one grade across 1,656 test images. However, the class-wise results—particularly the zero recall for grade 1 and low recall for grades 3 and 4—show that the model requires substantial improvement. The system should therefore be considered a preliminary educational and decision-support prototype rather than a tool for independent clinical diagnosis.

Future development should focus on improving class-wise model performance, validating data splits and dataset licensing, adding confusion-matrix and ordinal metrics, and testing the model on independent datasets. The symptom rules should be reviewed by healthcare professionals and evaluated prospectively before any clinical use. Additional

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work should improve accessibility for older adults, strengthen privacy and security, replace temporary history storage with an appropriate secure data store, and ensure that uncertainty and care-seeking guidance are clearly communicated.

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