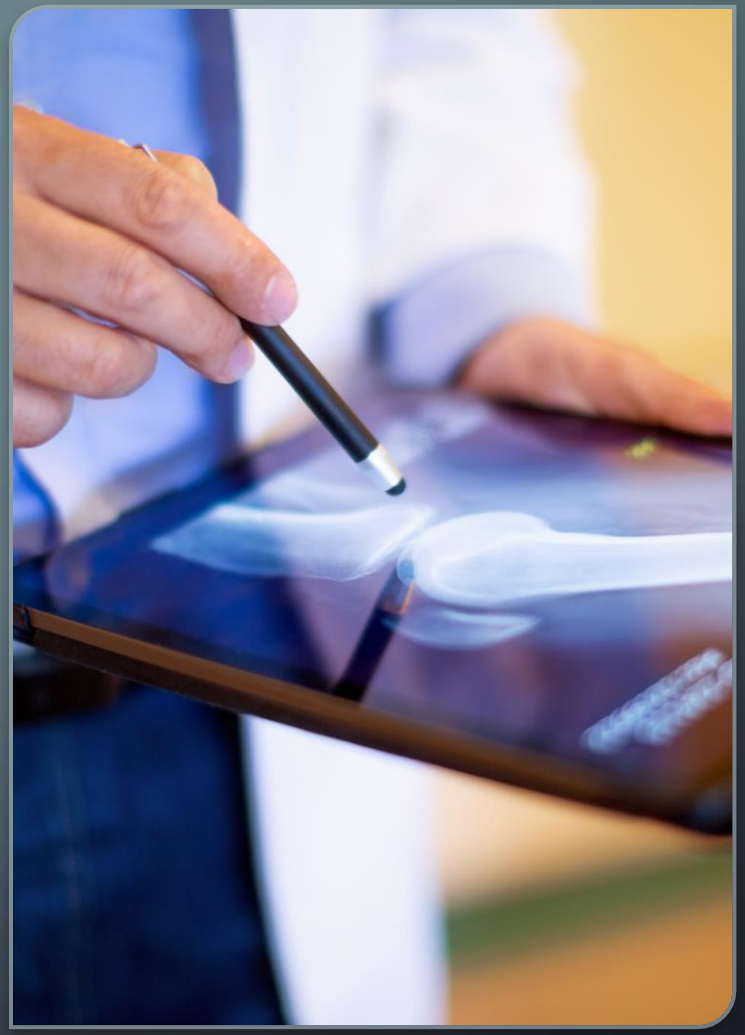
CLASSIFYING KNEE X-RAYS

IDENTIFYING THE SEVERITY OF KNEE OSTEOARTHRITIS IN X-RAY IMAGES

FAST FACTS ABOUT KNEE OSTEOARTHRITIS (OA)

- Most common type of arthritis
- Impacts quality of life, can be debilitating
- Affects over 32.5 million adults in the USA
- 240 cases per 100,000 adults each year
- Symptoms in 1 in 3 obese adults
- No cure
- Early identification is key to slowing the progression of OA



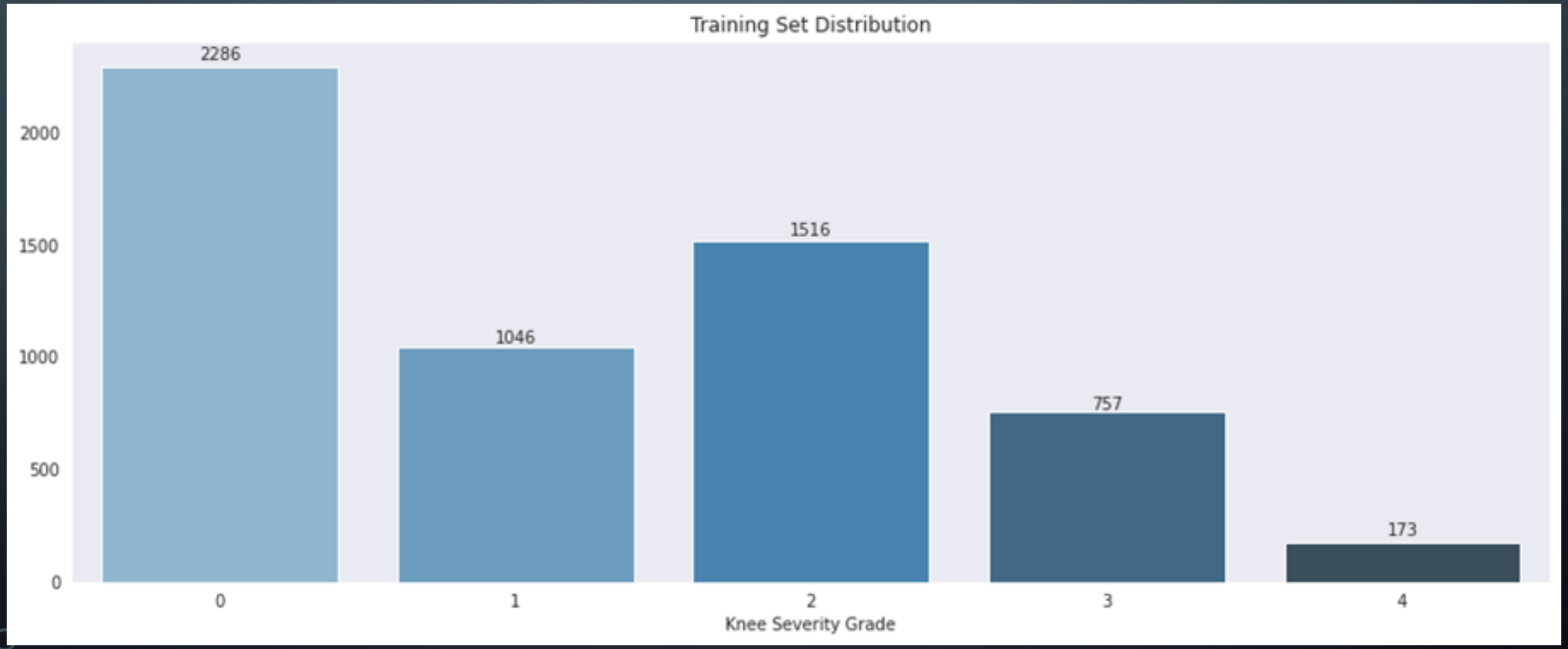
DATA SOURCE

- Kaggle: Knee Osteoarthritis Dataset with Severity Grading
- Mendeley Data (Chen, Pingjun (2018), “Knee Osteoarthritis Severity Grading Dataset”, Mendeley Data, V1, doi: 10.17632/56rmx5bjcr.1)

KELLGREN-LAWRENCE (KL) SCALE

- **Grade 0 (None):** No pathological features, i.e. a healthy knee image
- **Grade 1 (Doubtful):** Doubtful joint narrowing with possible osteophytic lipping
- **Grade 2 (Minimal):** Definite presence of osteophytes and possible joint space narrowing
- **Grade 3 (Moderate):** Multiple osteophytes, definite joint space narrowing, with mild sclerosis.
- **Grade 4 (Severe):** Large osteophytes, significant joint narrowing, and severe sclerosis.

IMBALANCED DATA



MODELING

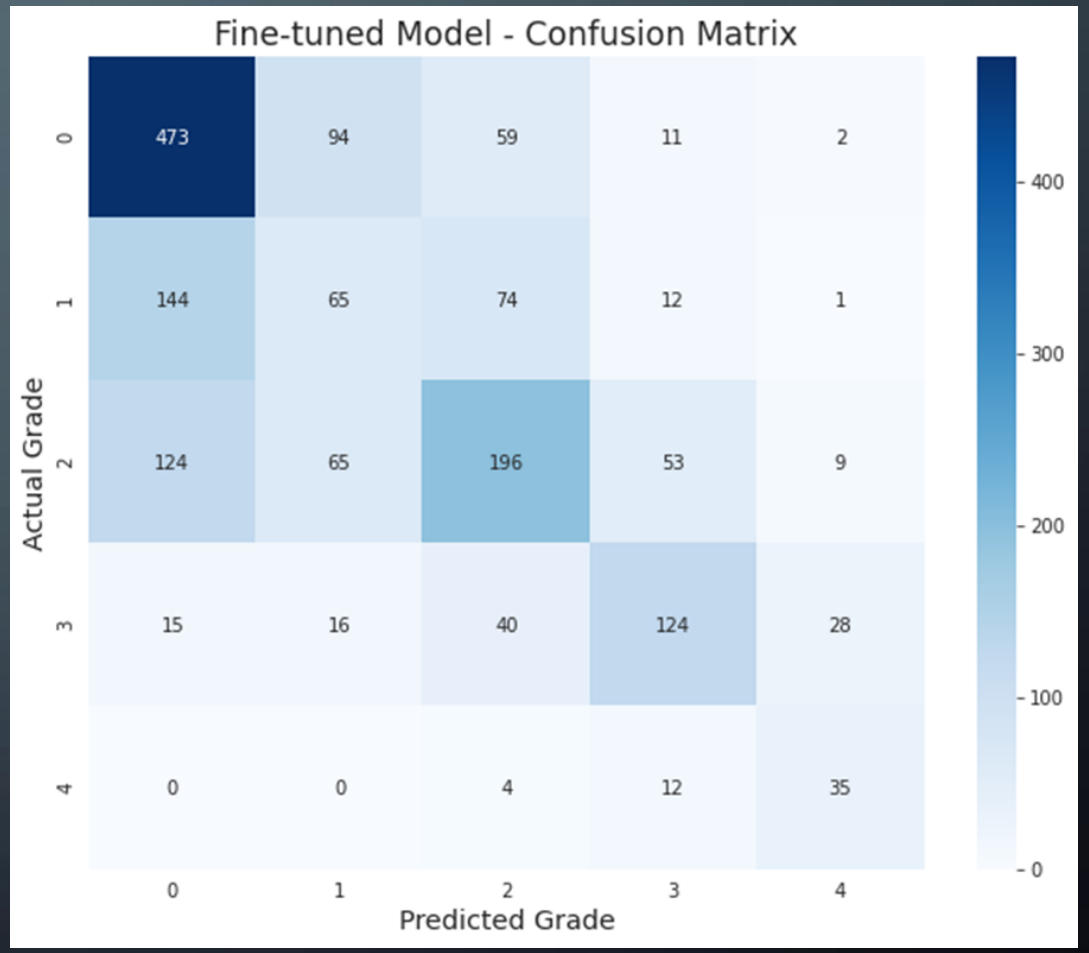
- Keras Image Classification
- Transfer Learning : DenseNet201 initialized with ImageNet weights
- Fine-tuning

MODELING – 5 GRADES ON THE KL-SCALE

ACCURACY = 54%

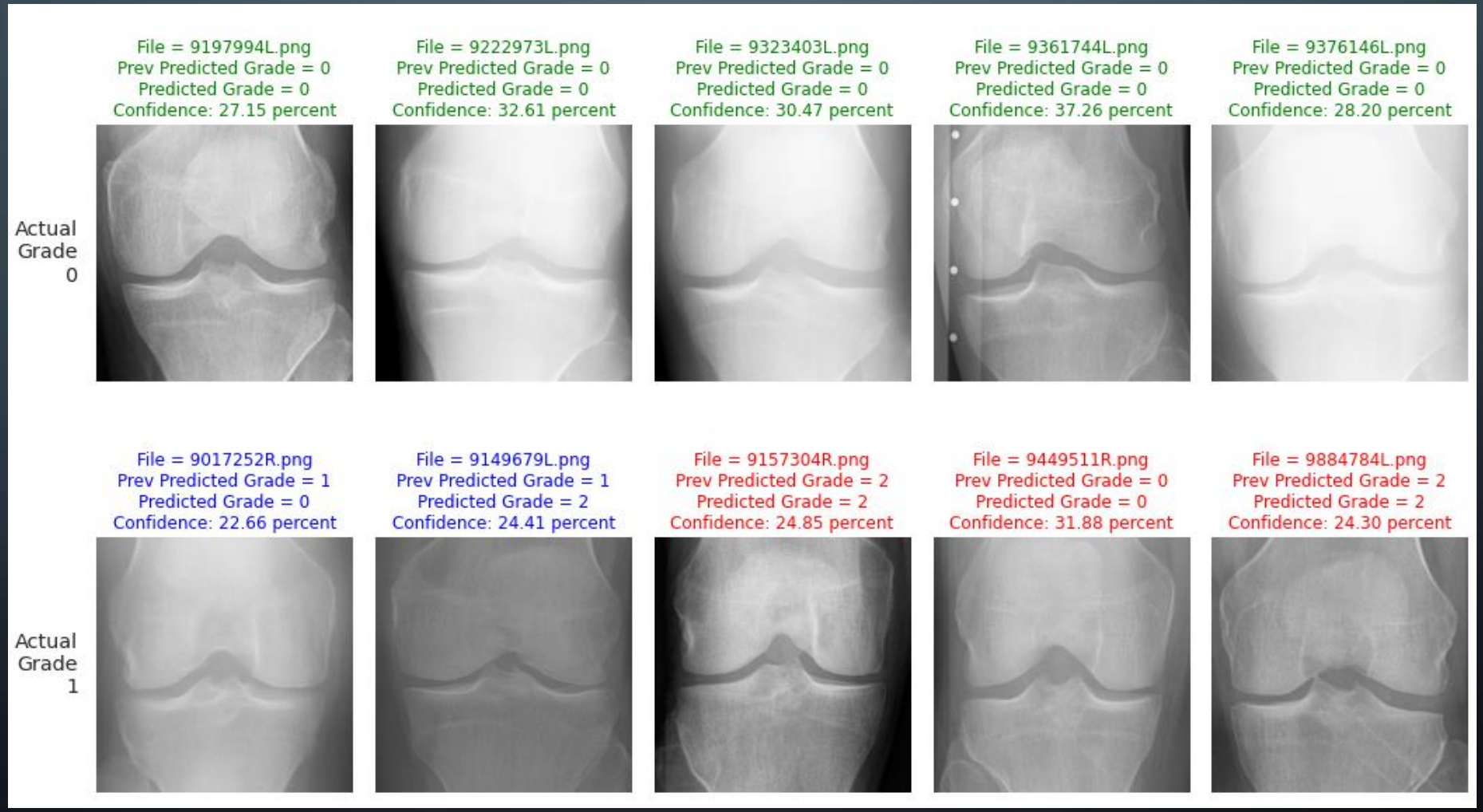
Fine-tuned model - Classification Report:

	precision	recall	f1-score	support
0	0.63	0.74	0.68	639
1	0.27	0.22	0.24	296
2	0.53	0.44	0.48	447
3	0.58	0.56	0.57	223
4	0.47	0.69	0.56	51
accuracy			0.54	1656
macro avg	0.49	0.53	0.50	1656
weighted avg	0.52	0.54	0.53	1656



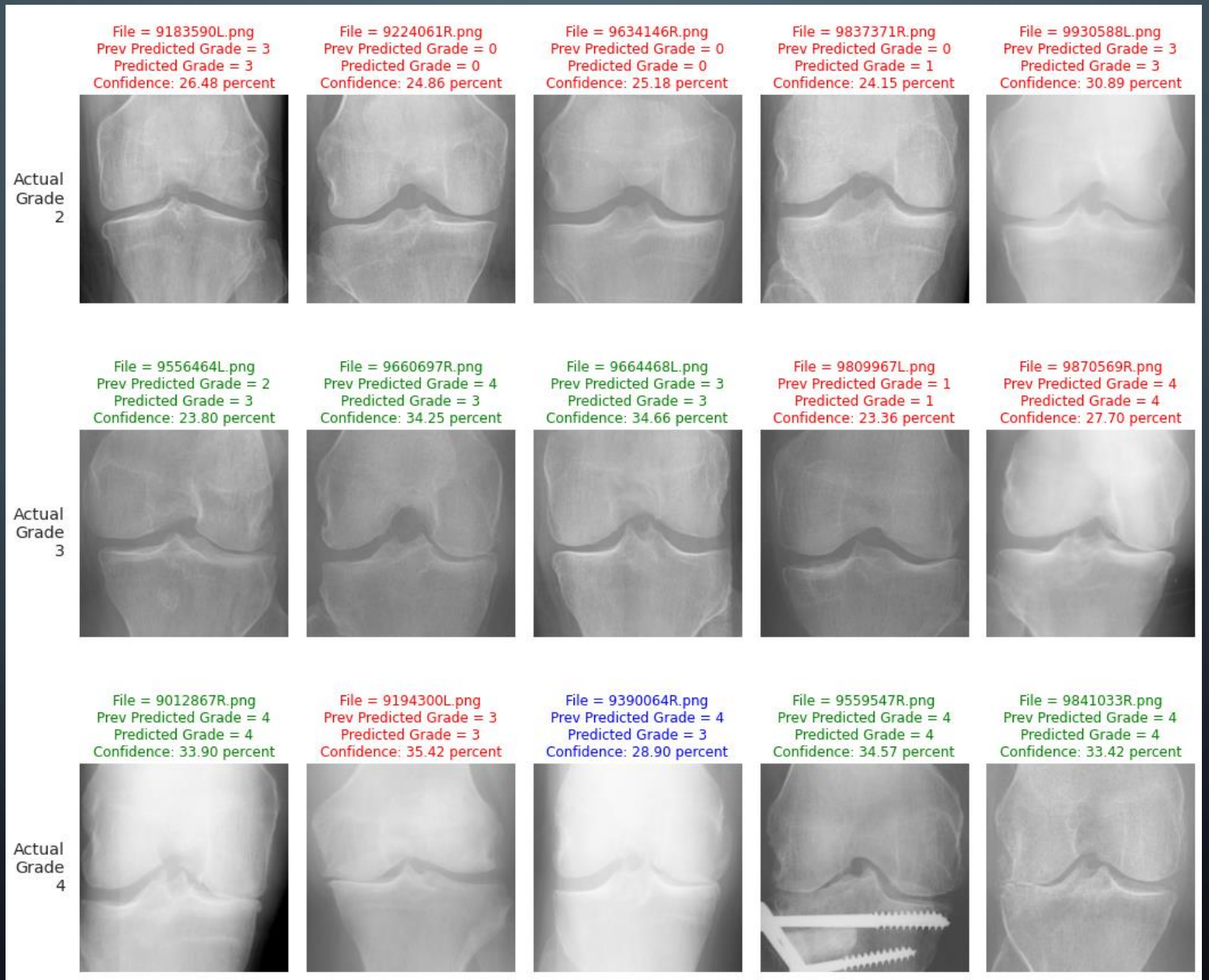
SAMPLE KNEE IMAGES FROM TEST SET (GRADE 0-1)

PREDICTION ACCURACY = 44%



SAMPLE KNEE IMAGES FROM TEST SET (GRADE 2-4)

PREDICTION ACCURACY = 44%



SIMPLIFYING INTO 3 CLASSES

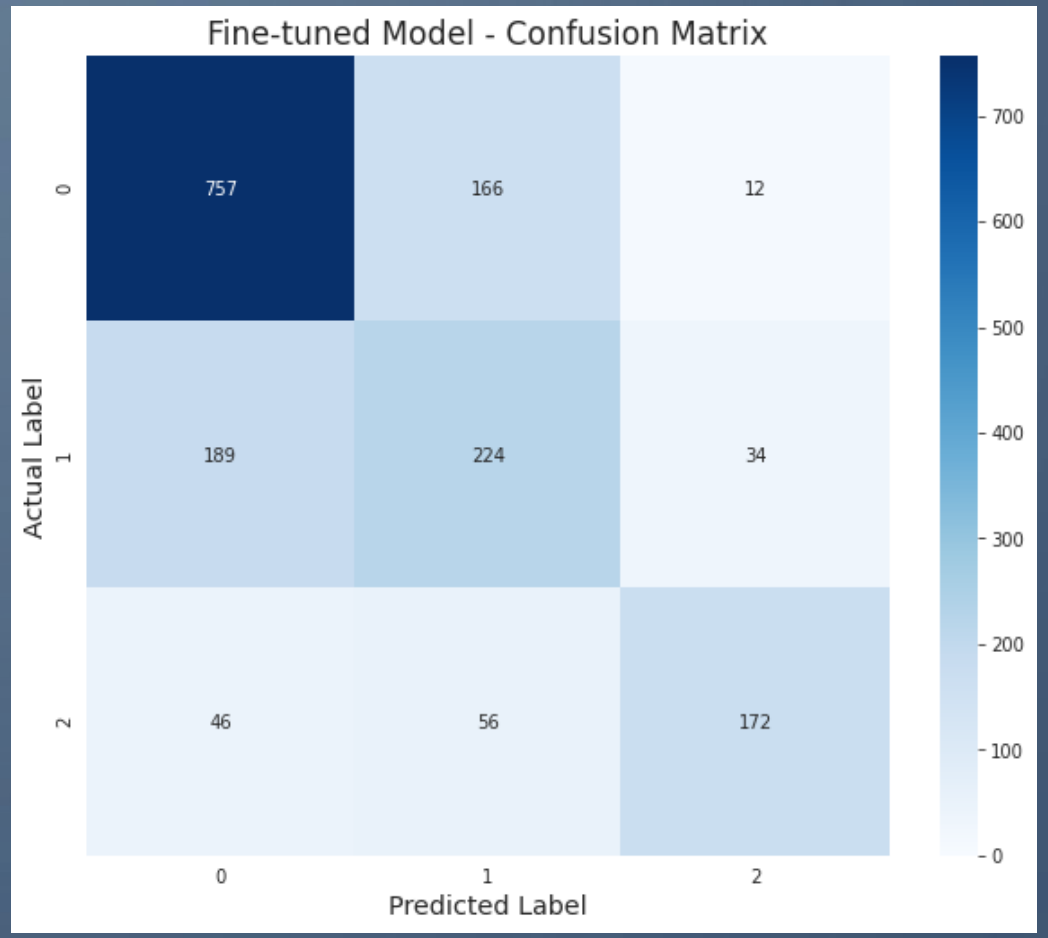
- **A :** Grades **0 (None)** and **1 (Doubtful)** : a reasonably healthy knee, patient with knee pain may wish to explore other causes
- **B :** Grade **2 (Minimal)** : patient has minimal OA and should consider lifestyle changes, and possibly medication
- **C :** Grades **3 (Moderate)** and **4 (Severe)** : knee replacement and other procedures and/or surgeries may be an option

MODELING – SIMPLIFIED 3 CLASSES

ACCURACY = 70%

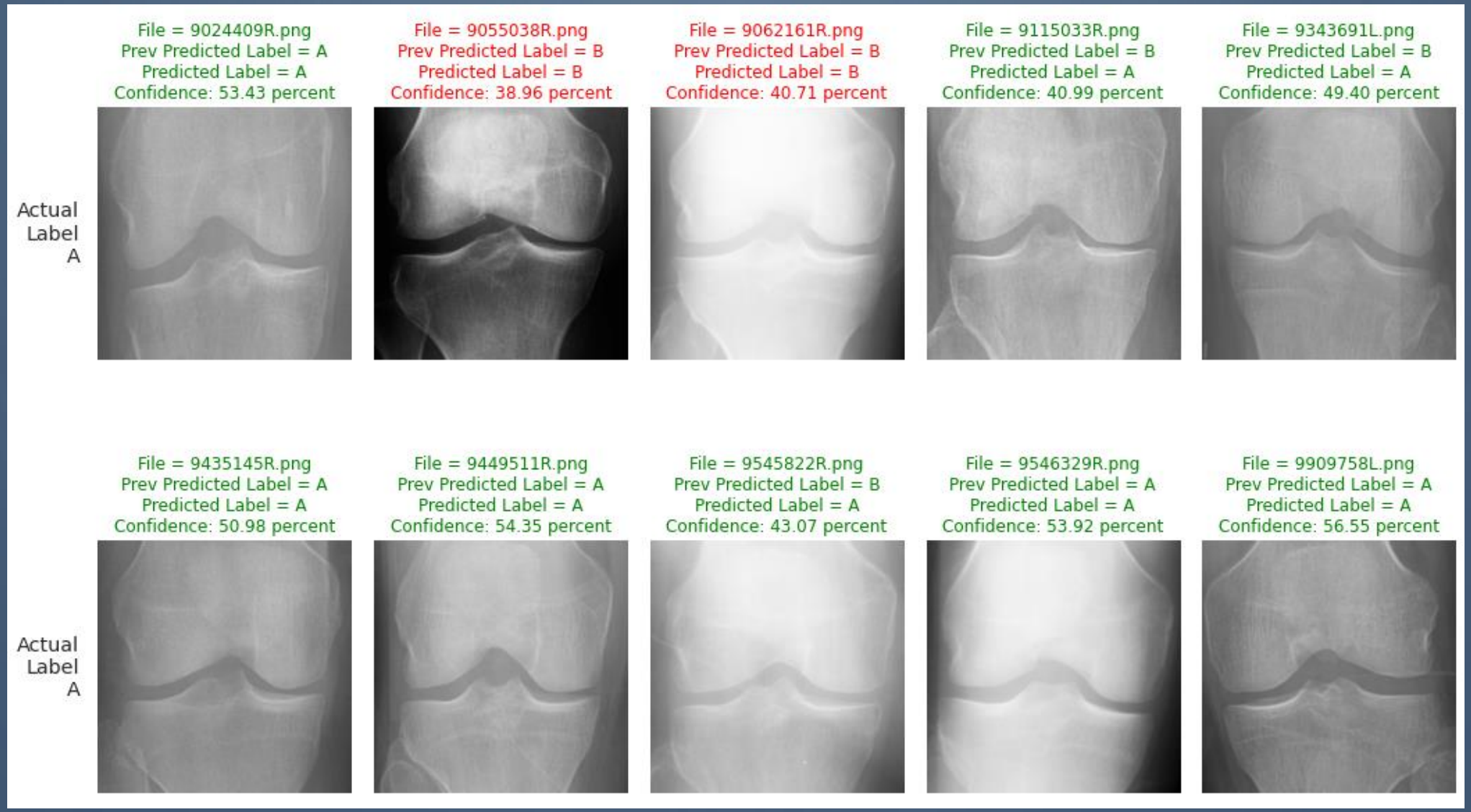
Fine-tuned model - Classification Report:

	precision	recall	f1-score	support
0	0.76	0.81	0.79	935
1	0.50	0.50	0.50	447
2	0.79	0.63	0.70	274
accuracy			0.70	1656
macro avg	0.68	0.65	0.66	1656
weighted avg	0.70	0.70	0.69	1656



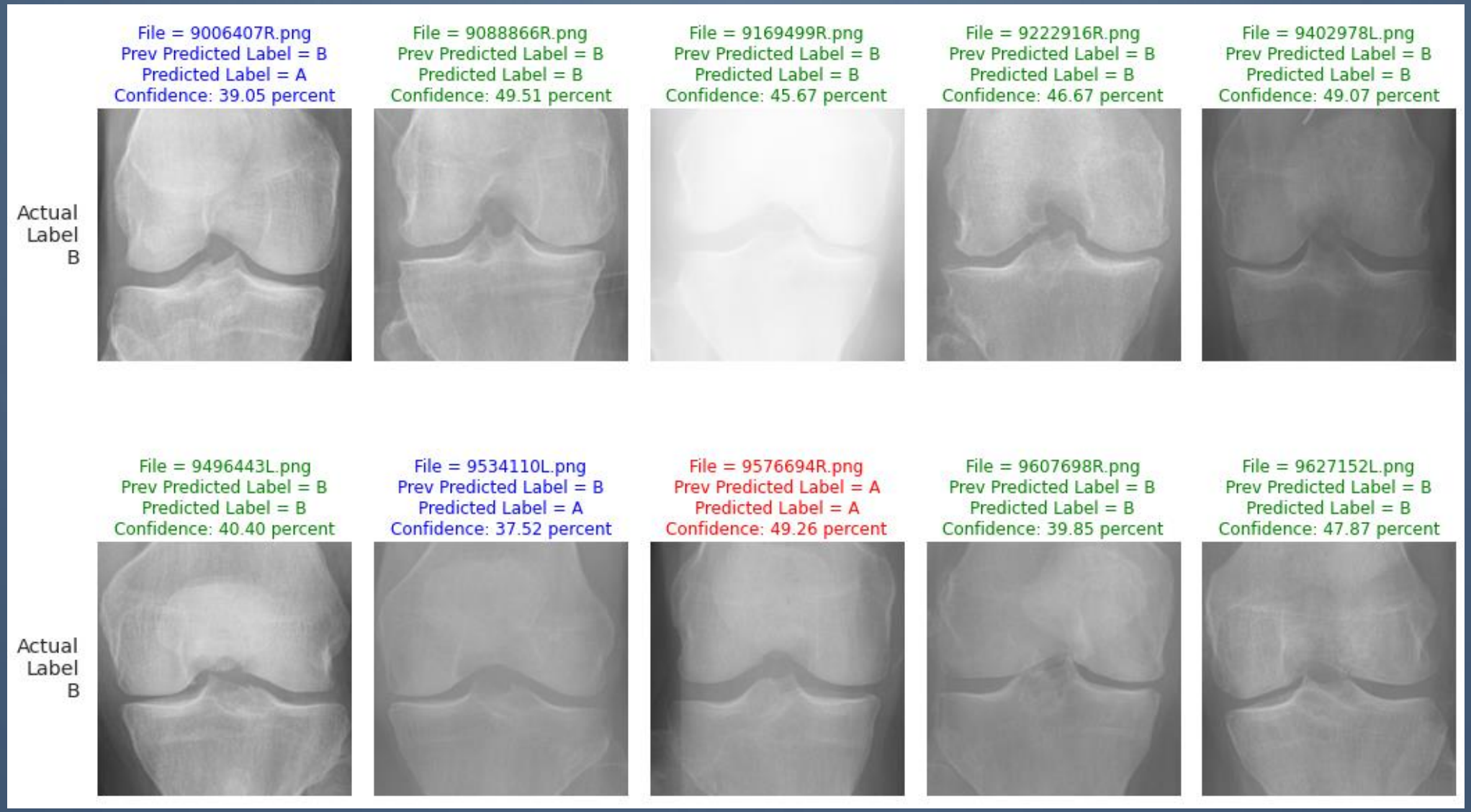
SAMPLE KNEE IMAGES FROM TEST SET (CLASS A)

PREDICTION ACCURACY = 73.33 %



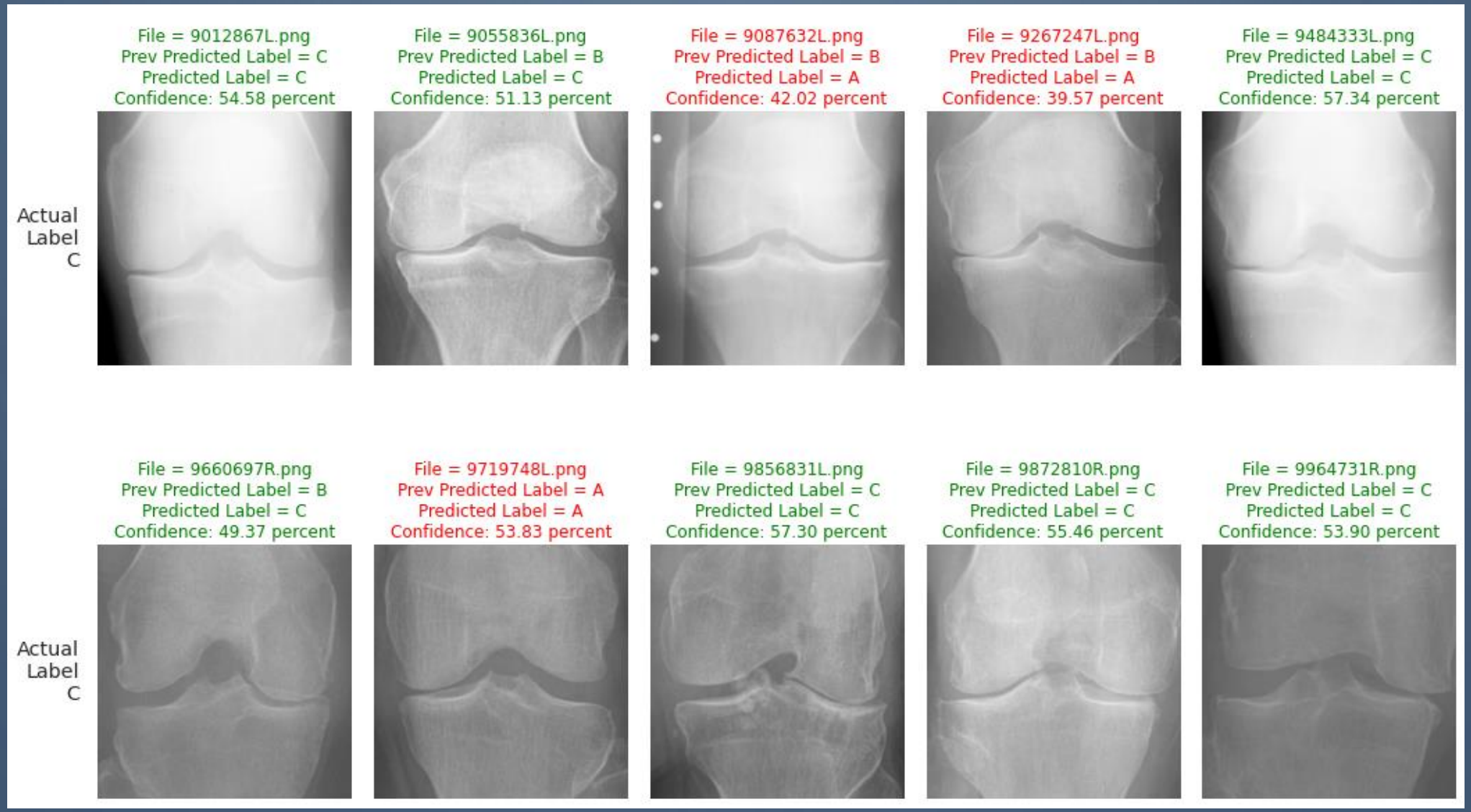
SAMPLE KNEE IMAGES FROM TEST SET (CLASS B)

PREDICTION ACCURACY = 73.33 %



SAMPLE KNEE IMAGES FROM TEST SET (CLASS C)

PREDICTION ACCURACY = 73.33 %



FURTHER RESEARCH

1

Explore other methods of identifying knee OA from X-rays

2

Improve model – add more labeled images to training set

3

Additional fine-tuning, targeting grade 2 / class B classification