



AI spots broken bones on x-rays

Agenda:-

- Overview
- Understanding the problems
- Human bones
- Magic in AI
- Fraction Detection using Deep Learning
- Applications of AI in fracture detection



Overview

- Bone fractures are one of the most common injuries nowadays. Every year, 2.7 million fractures occur across the EU6 nations, France, Germany, Italy, Spain, Sweden, and the UK.
- An incredible number of people suffers from this disorder and the implications of an untreated fracture may lead to permanent damage or even death.
- A great responsibility for this lies with the doctors, who have to evaluate tens of X-ray images a day.



Overview

- The technology utilized for first diagnosis is mostly X-ray, which is a modality that has been used for more than one hundred years and is still frequently used.
- About 44 million Americans - mostly women - are at risk of the bone-weakening disease osteoporosis and have an increased risk of fractures because of low bone mass, according to the Hormone Health Network. Only 2 in 10 older women in the United States who sustain a fracture receive testing or treatment for osteoporosis.



Understanding the problems

Challenging faces doctors to evaluate X-ray images :-

- **X-ray could hide certain particularities of the bone.**
- **a lot of experience is needed to correctly classify different types of fractures.**
- **doctors have often to act in emergency situations and may be constrained by fatigue. Actually, it has been shown that the performance of radiologists in the interpretation of musculoskeletal radiographs decrease in fracture detection by the end of the work day compared to the beginning of the work day.**



Understanding the problems

- There is a shortage of radiologists due to a lag in recruitment and the large number of radiologists approaching retirement.
- Analyzing medical images can often be a difficult and time-consuming process.

Artificial intelligence (AI) has the potential to address these issues



Human bones

Bones are the solid organs in the human body protecting many vital organs such as brain, heart, lungs, etc. The human body contains **206** bones with various shapes and structures.

The largest bones are the **femur bones**, and the smallest bones are the **auditory ossicles**. There are five types of bones: long, short, irregular, sesamoid and flat.

Bone fractures can occur due to a simple accident or any other scenario in which a high pressure is applied on the bones. There are many types of bone fractures: simple, oblique, compound, comminuted, spiral, greenstick and transverse.



Magic in AI

AI is a general term that implies the use of a computer to model intelligent behavior with minimal human intervention. Furthermore, AI, particularly deep learning, has recently made substantial strides in the perception of imaging data allowing machines to better represent and interpret complex data.

Computer aided diagnosis is a hot research field. Systems with the ability to provide a highly accurate diagnosis using little resources are highly desirable. One type of such systems depend on medical images to provide instantaneous diagnosis based on some discriminative features extracted from the images after processing them for noise removal and enhancement.



Magic in AI

Diagnostic medical imaging tools are invaluable. Computed Tomography **CT**, Magnetic Resonance Imaging **MRI**, and **x-rays** are examples of such tools which help physicians in detecting different types of abnormalities.

Quick and accurate diagnosis can be crucial to the success of any prescribed treatment. Depending on human experts alone for such a critical matter have caused intolerable errors. Hence, the idea of automating the diagnosis procedure has always been an appealing one.



Magic in AI : Deep learning

Deep learning is a subset of AI represented by the combination of artificial neuron layers. Each layer contains a number of units, where every unit is a simplified representation of a neuron cell, inspired by its structure in the human brain.

Today, deep learning algorithms are able to match and even surpass humans in task-specific applications.

Deep learning has transformed the field of information technology by unlocking large-scale, data-driven solutions to what once were time-intensive problems.



Deep Learning in classification and detection of fractures

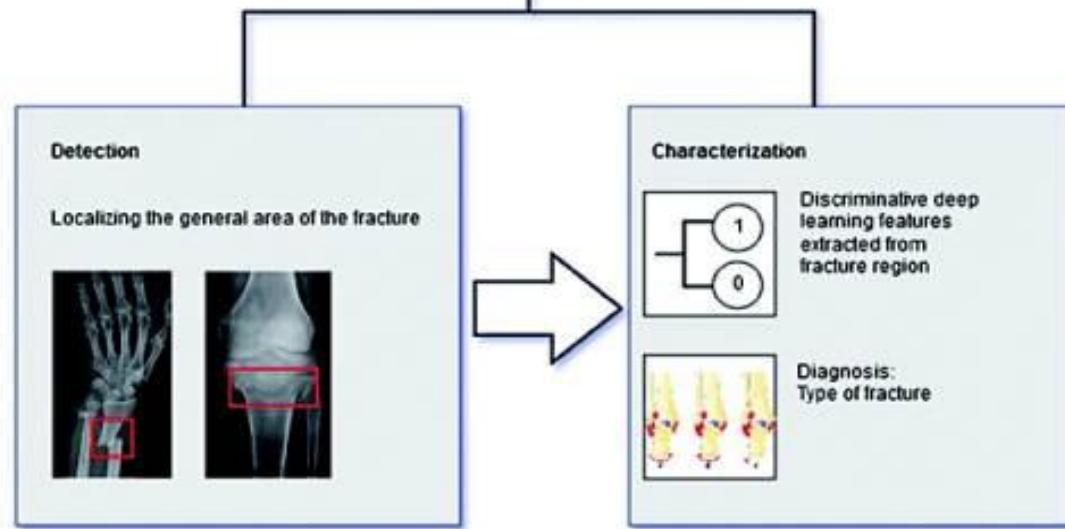
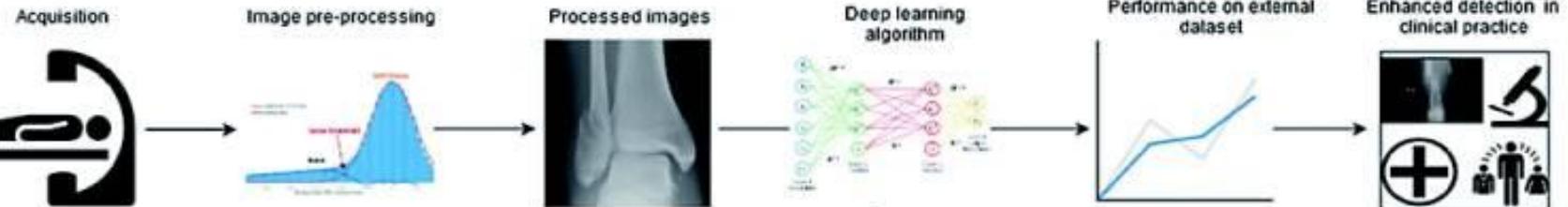
- **Detection and classification** of fractures on radiographs x-rays and CT images with high sensitivity and specificity can be assisted or even replaced by the automated DL system with high accuracy.
- Given a few thousand images we can address several problems with DL.



Deep Learning in classification and detection of fractures

- Using such models as VGG16, Inception V3 , and Xception, we can classify and detect the images.
for example to detect whether there is a fracture, or even differentiate between fracture types. Given the bounding box annotations or labels for the regions of interest, we can train such models as ResNet, U-net, Mask-RCNN , Faster-RCNN, YOLO for the fracture detection and segmentation problem.

Workflow of deep learning-aided clinical radiology



Deep learning aided workflow in fracture detection



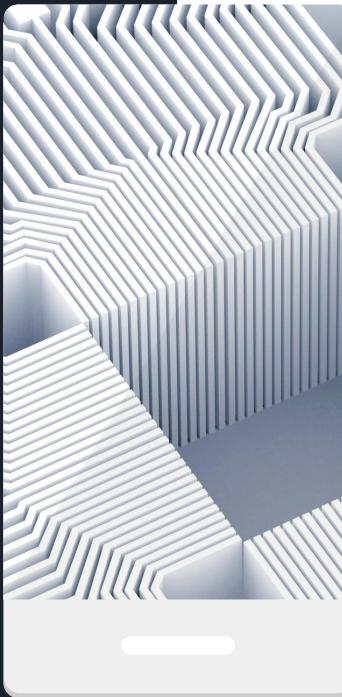
Applications of AI in fracture detection

X-ray Artificial Intelligence Tool (XRAIT)

- A new artificial intelligence tool topped manual methods for flagging broken bones on x-rays, weeding-out patients who are more at risk of osteoporosis.

XRAIT

Australian researchers trained their natural language processing approach on thousands of radiology reports and detected nearly a five-fold higher number of fractures or breaks than manual-based techniques.



By improving identification of patients needing osteoporosis treatment or prevention, XRAIT may help reduce the risk of a second fracture and the overall burden of illness and death from osteoporosis.



Resources

- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7144272/>
- <https://link.springer.com/article/10.1007/s00330-019-06167-y>
- <https://www.sciencedirect.com/science/article/pii/S1877050917324493>
- https://www.researchgate.net/publication/321898396_Artificial_intelligence_in_fracture_detection_Transfer_learning_from_deep_convolutional_neural_networks
- https://www.researchgate.net/figure/Accuracy-measures-for-the-base-classifiers-using-the-combined-feature-set_tbl4_279963895
- <https://www.healthimaging.com/topics/artificial-intelligence/ai-broke-n-bones-x-rays-osteoporosis>

Thank you!

