

# Artificial Intelligence

## Applications on Musculoskeletal Imaging

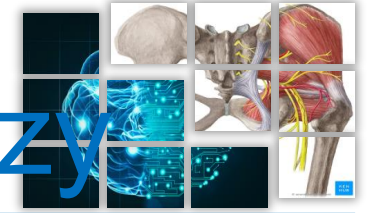


# Lecture outline

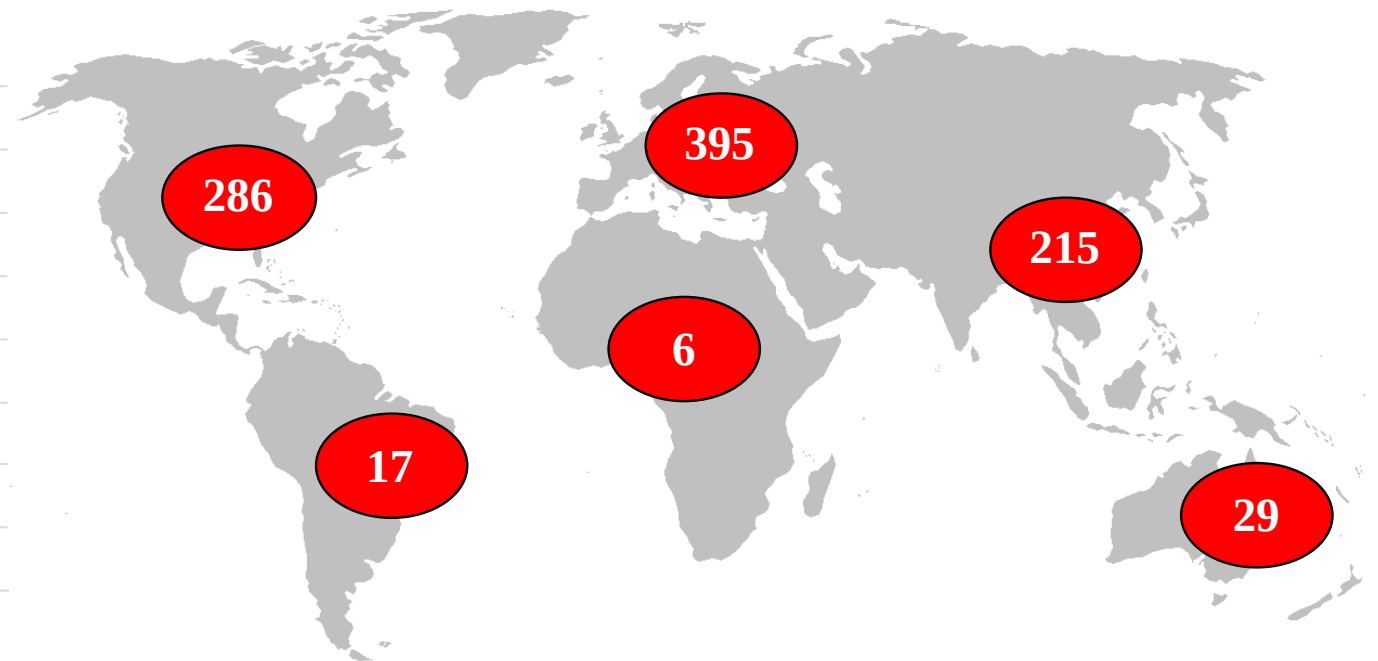
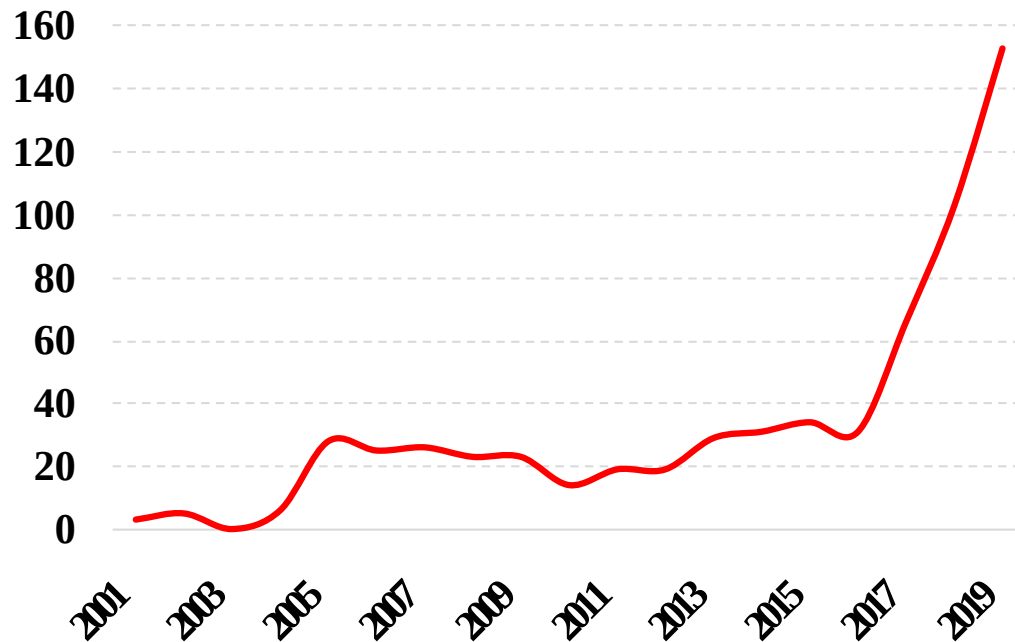
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- Background – the advent of AI
- AI basics for radiologists
- Applications on MSK imaging
- Conclusions – future prospects

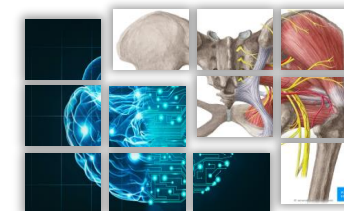
# AI in MSK imaging: publication frenzy



AI publications on MSK imaging

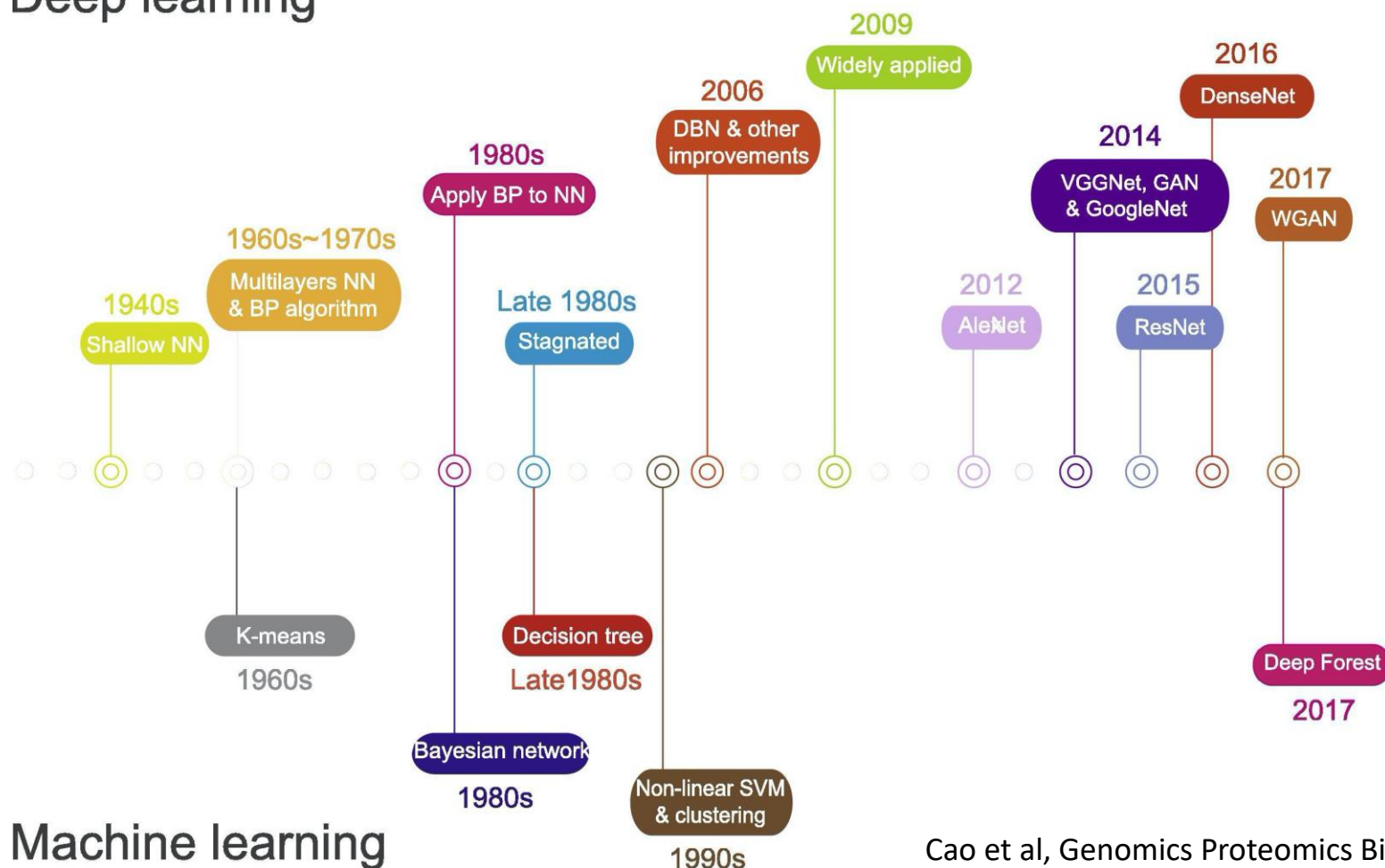


Klontzas, Papadakis, Marias, Karantanas, Injury 2020



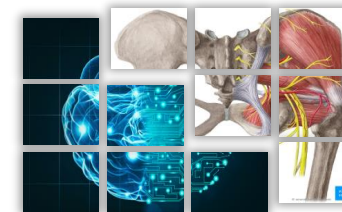
# Is AI new?

## Deep learning

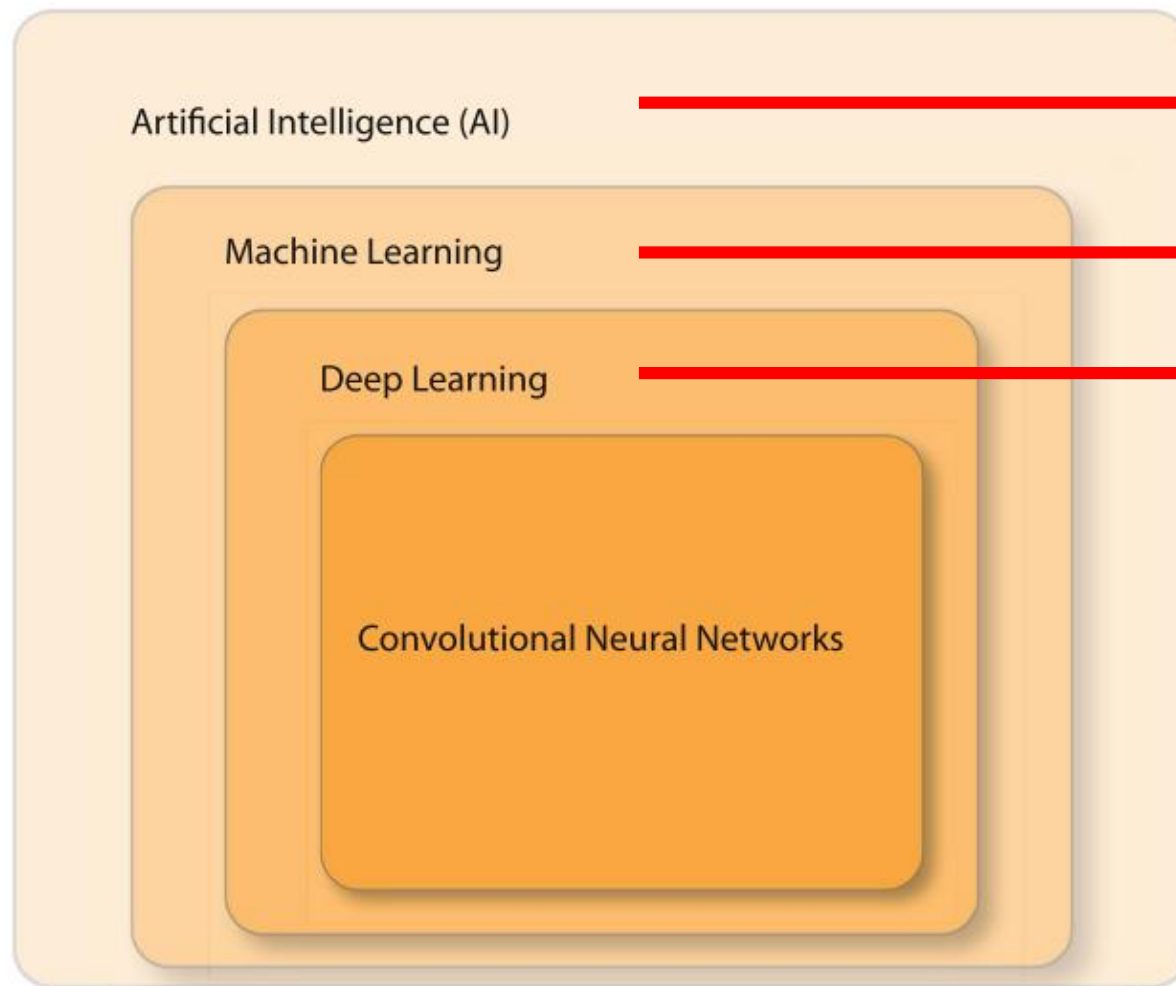


## Machine learning

Cao et al, Genomics Proteomics Bioinformatics 2018



# Nomenclature



Artificial Intelligence (AI)

Any technique that enables computers to imitate humans

Machine Learning

Computers "learn" without being programmed  
Arthur Samuel 1959

Deep Learning

Subset of machine learning studying neural networks

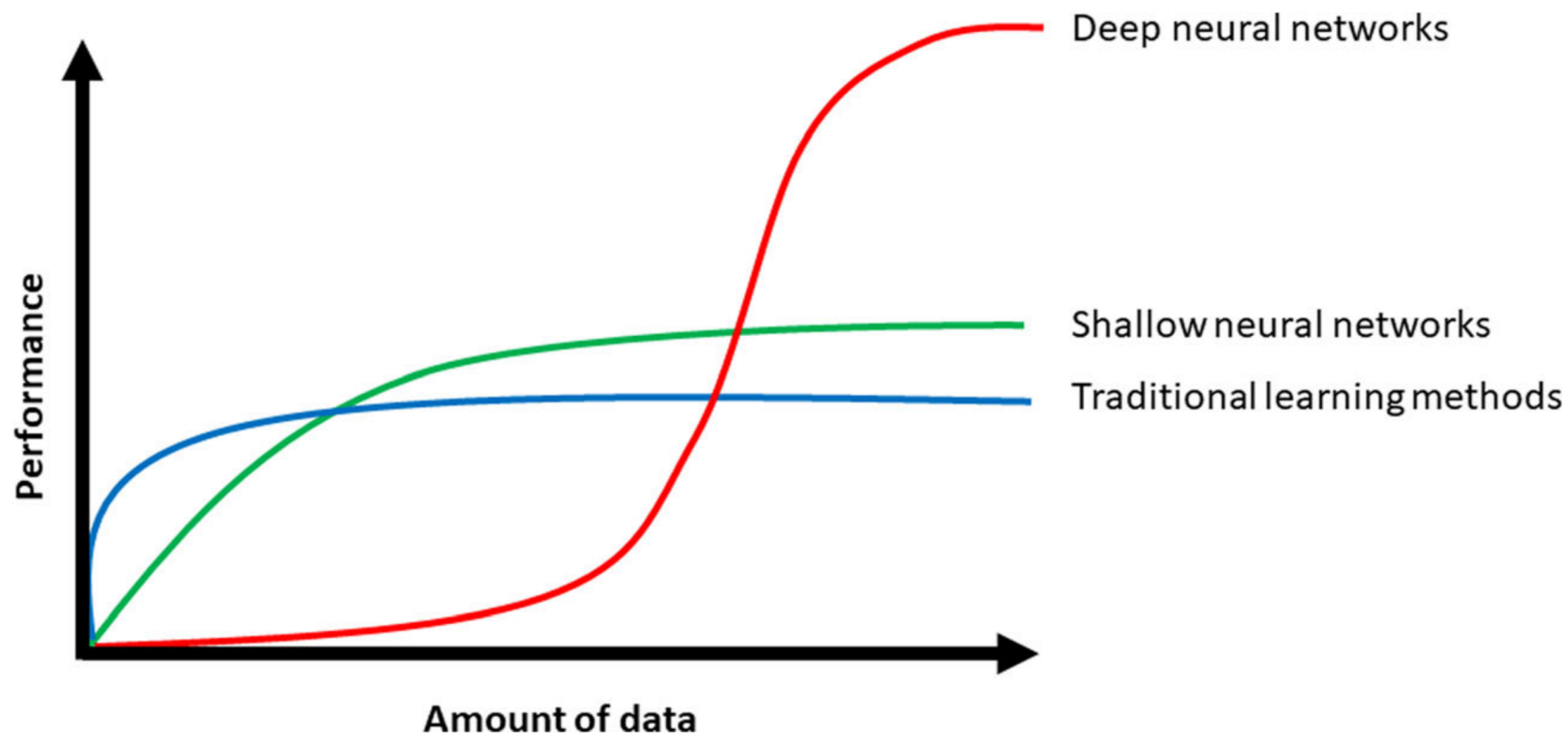
Convolutional Neural Networks



Chea & Mandell, Skeletal Radiol 2020



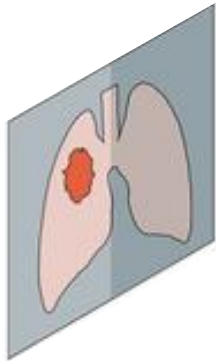
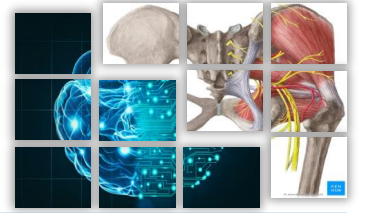
# Do we need data?



Savadjiev Eur Radiol 2019 - adapted from Easy Solutions Inc.  
[<http://blog.easysol.net/building-ai-applications/>]

# AI in medical imaging

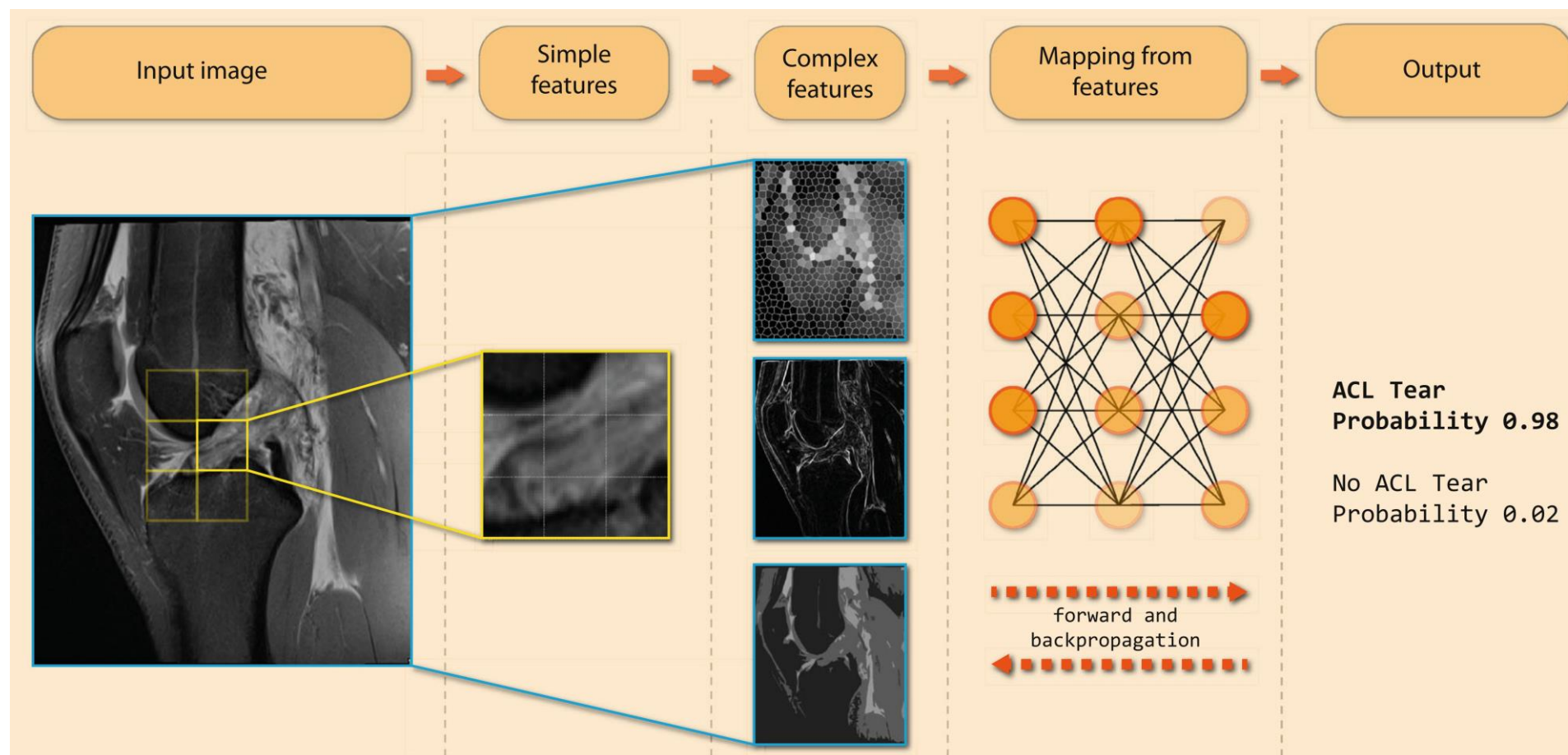
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# Deep learning applications



Chea & Mandell, Skeletal Radiol 2020





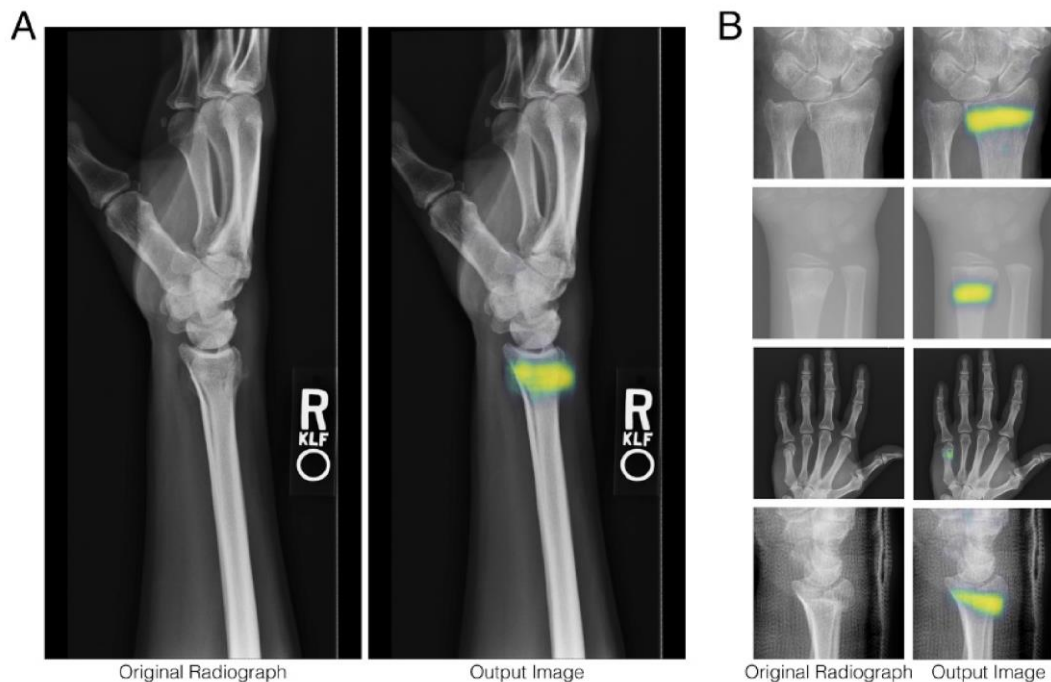
# Fracture detection: appendiceal

PNAS

## Deep neural network improves fracture detection by clinicians

Robert Lindsey<sup>a,b,1</sup>, Aaron Daluiski<sup>a,c</sup>, Sumit Chopra<sup>a</sup>, Alexander Lachapelle<sup>a,d</sup>, Michael Mozer<sup>a,b</sup>, Serge Siclar<sup>a,e</sup>, Douglas Hanel<sup>a,f</sup>, Michael Gardner<sup>a,g</sup>, Anurag Gupta<sup>a,h</sup>, Robert Hotchkiss<sup>a,c</sup>, and Hollis Potter<sup>a,i</sup>

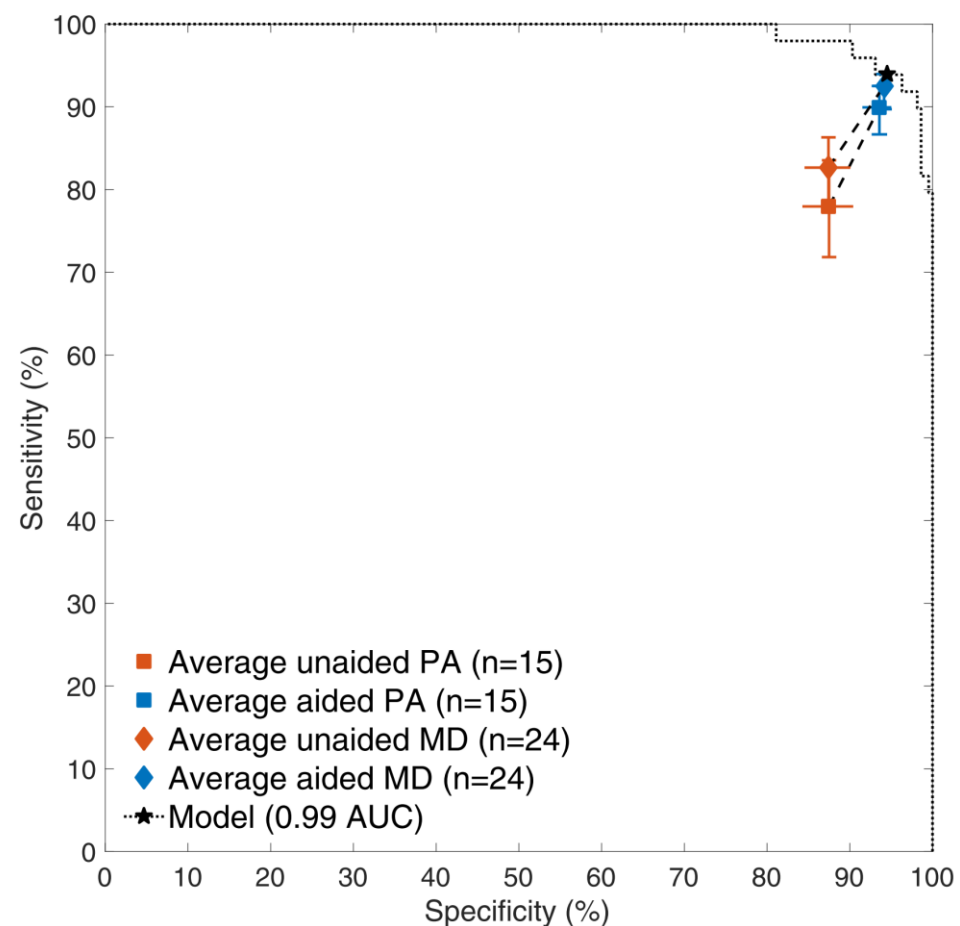
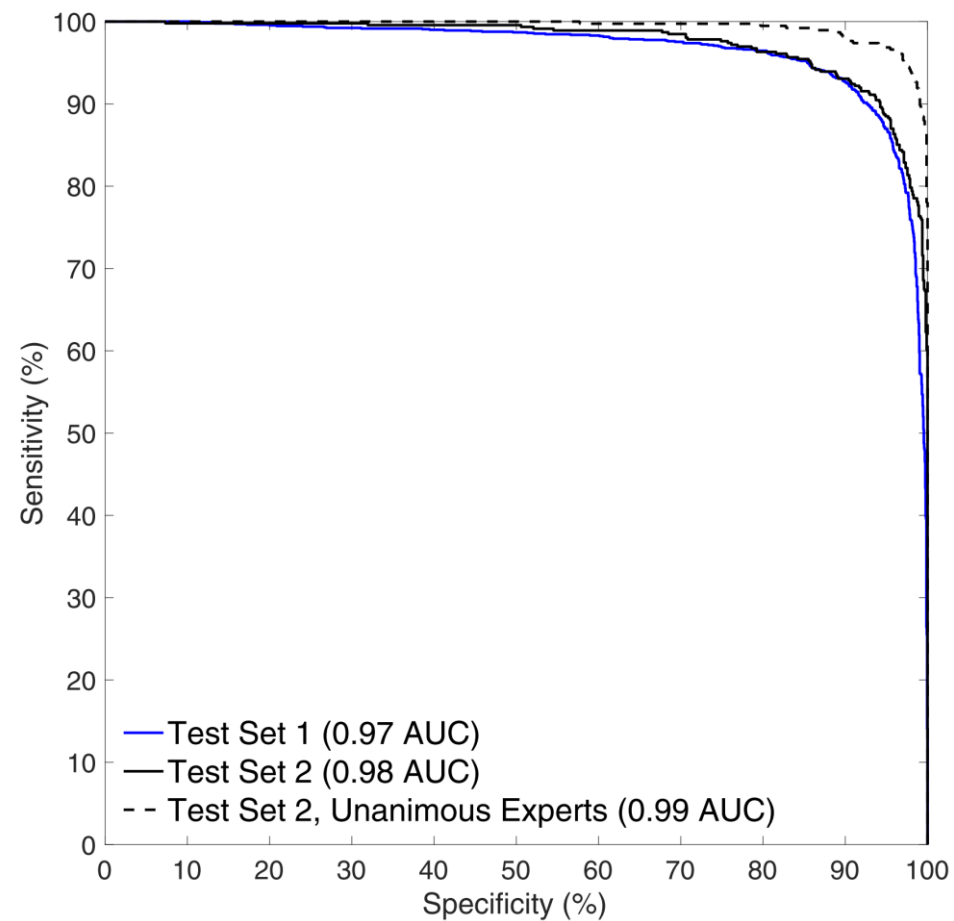
<sup>a</sup>Imagen Technologies, New York, NY 10012; <sup>b</sup>Department of Computer Science, University of Colorado, Boulder, CO 80309; <sup>c</sup>Department of Orthopaedic Surgery, Hospital for Special Surgery, New York, NY 10021; <sup>d</sup>Faculty of Medicine, McGill University, Montreal, QC, Canada, H3A 2R7; <sup>e</sup>Department of Radiology, Mount Sinai Health System, New York, NY 10029; <sup>f</sup>Department of Orthopaedics and Sports Medicine, Harborview Medical Center, University of Washington, Seattle, WA 98104; <sup>g</sup>Department of Orthopaedic Surgery, Stanford University School of Medicine, Stanford, CA 94305; <sup>h</sup>Department of Emergency Medicine, New York, NY 10021



- 132,345 x-rays
- CNN
- 16 physician assistants
- 24 MDs

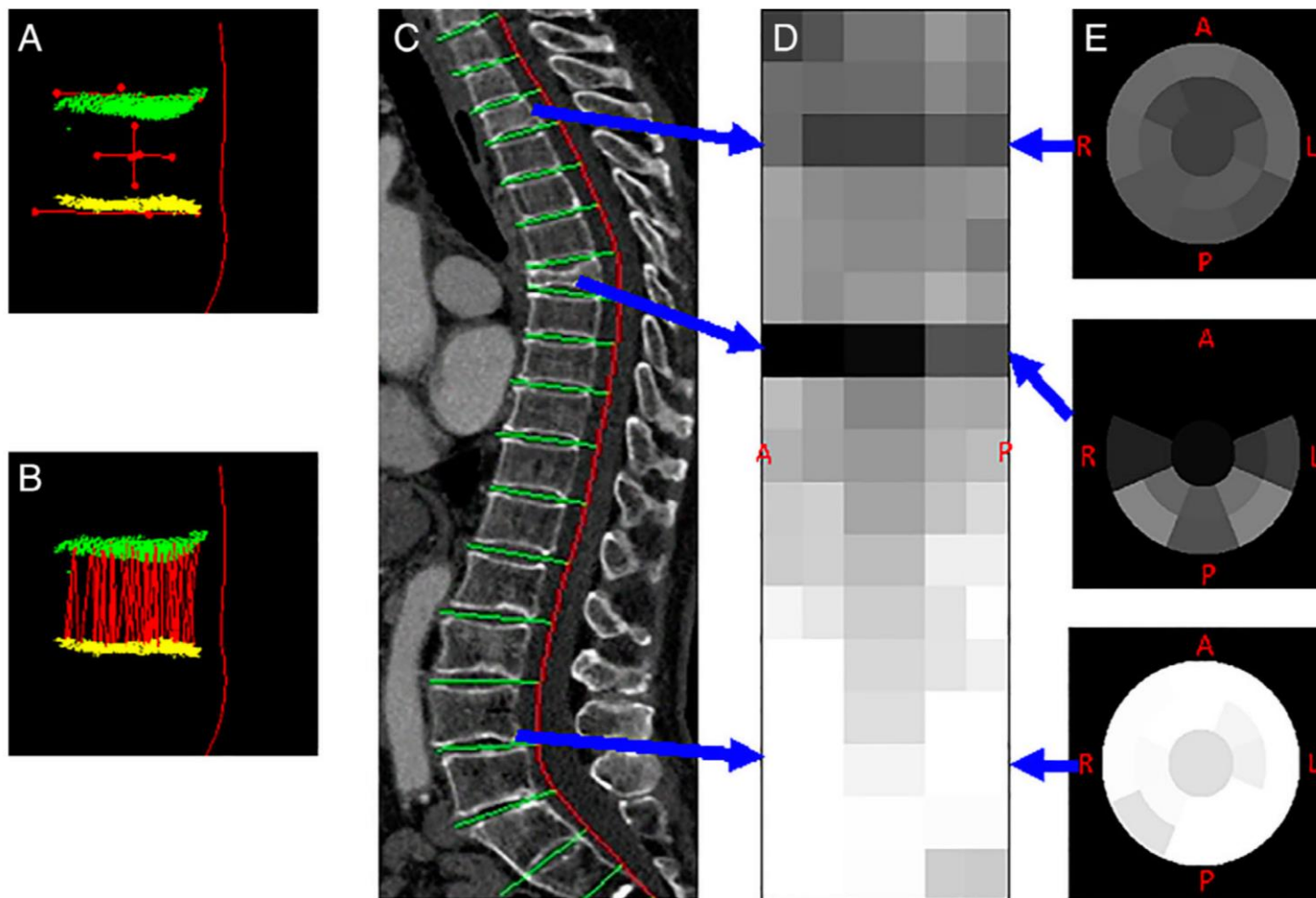


# Results





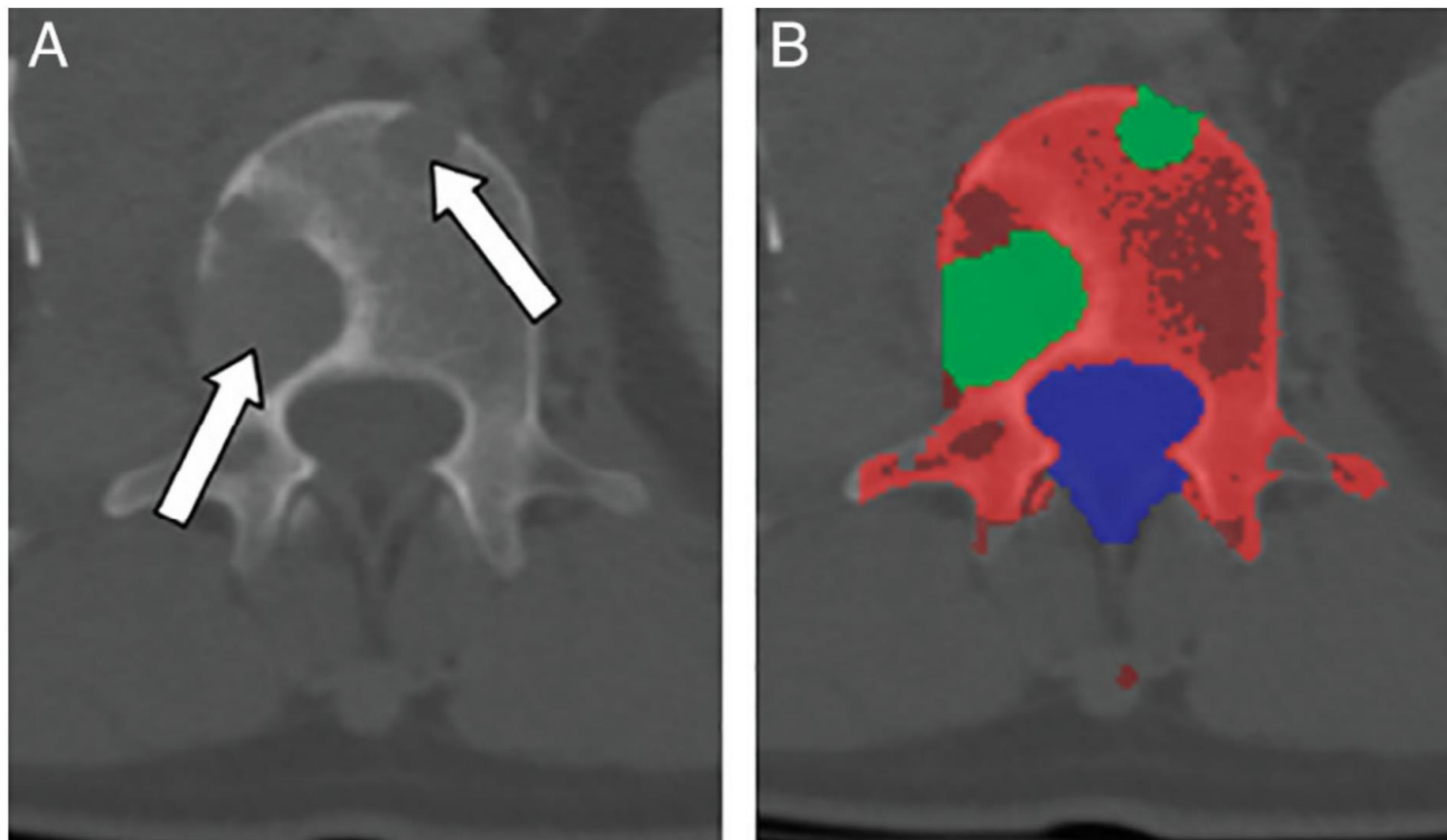
# Fracture detection: spinal



Burns et al, Radiology 2017



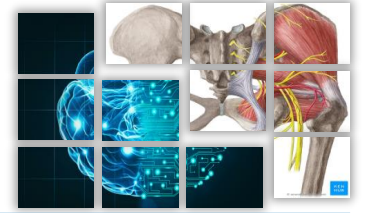
# Bone lytic lesion detection



O'Connor et al, Radiology  
2007

# Miscellaneous applications

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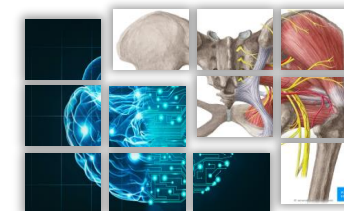


- Machine learning has been used to automate everyday tasks in MSK imaging
  - Necessity of IV contrast enhancement in MRI protocols
  - Reconstructing high quality images from fast acquisition protocols
  - Prediction of follow-up no-shows
  - Automatic reporting of common findings

Trivedi et al. J Digit Imaging 2018

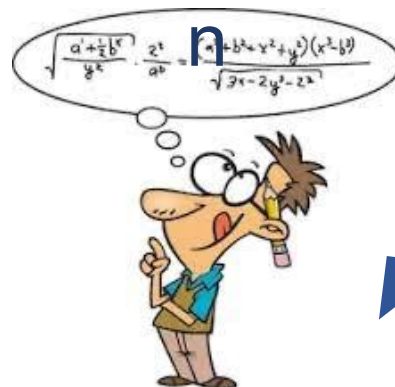
Hammernik et al. Magn Reson Med  
2018

Harvey et al. J Am Coll Radiol 2017



# Interdisciplinary approach

Mathematicia



Business analyst-  
commercialization  
expert



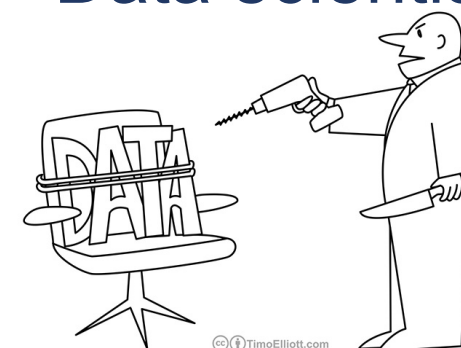
Computer  
scientist



Radiologist



Data scientist



*"If you don't reveal some insights soon, I'm going to be forced to slice, dice, and drill!"*



# Lecture outline

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- Background – the advent of AI ✓
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- Applications on MSK imaging ✓
- Conclusions ✓



# Thank you!!!

