ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

BALZANO
ARTIFICIAL INTELLIGENCE ENGINEERS

Der Balgrist
University of Zurich[UZH]

Francesco Civardi, Chiara Civardi, Ender Konukoglu, Christian Baumgartner, Christian Pfirrmann, Benjamin Fritz, Rene Balzano

Machine Learning in the Interpretation of Meniscal Tear in Knee MRI

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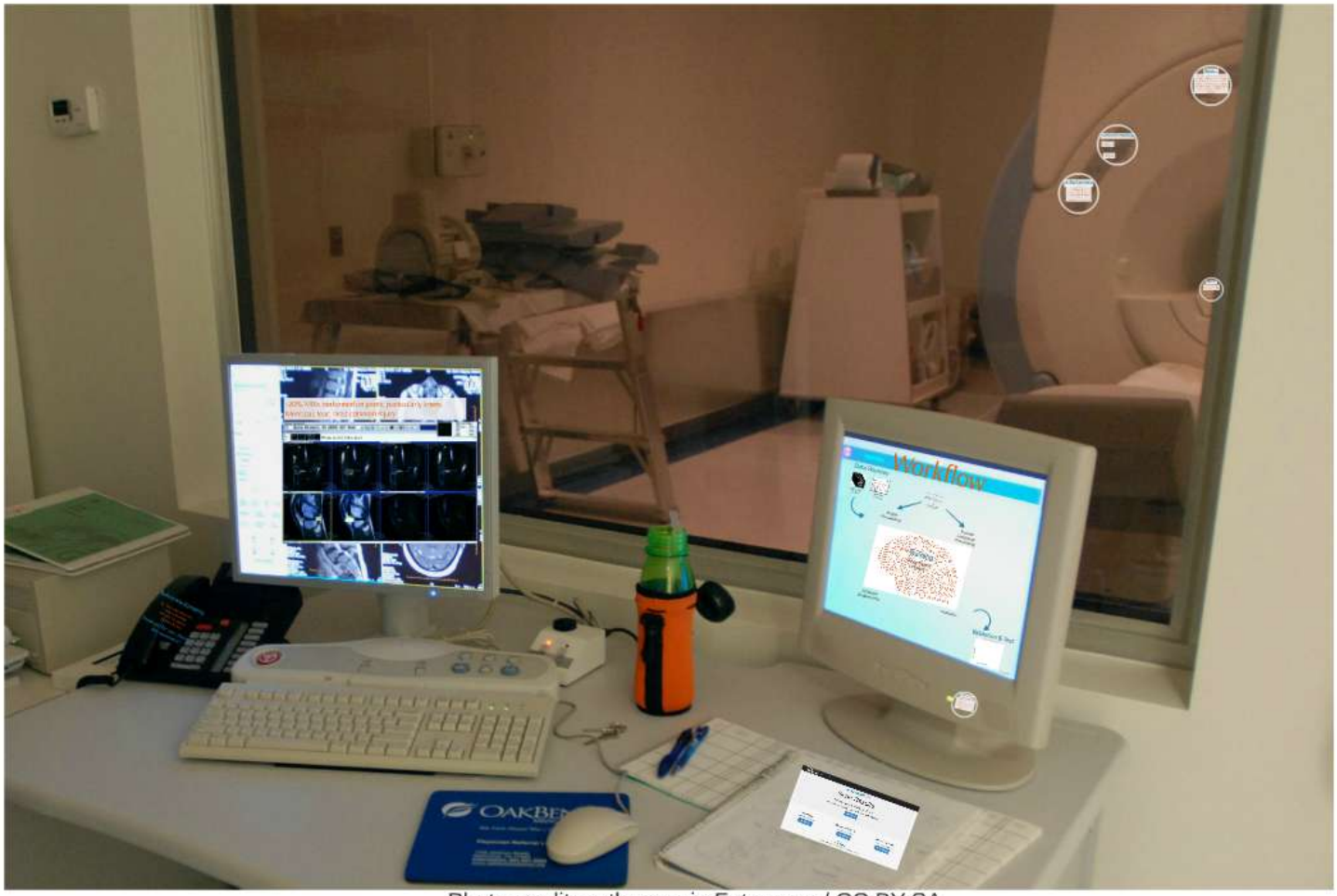

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>20% MRIs performed on joints, particularly knees
Meniscus tear: most common injury
Workflow
Data Sources
Image Processing
Natural Language Processing
Training
Software Engineering
Analytics
Validation & Test
Scan Results

1 MRI Exam...

Contains 570 images
Takes at least 30 MB

McDonald et al., 2015

In Switzerland

183 MRI Units

825 Radiologists

<30 new Radiologists/Year

~37,000 more MRI Exams/Year

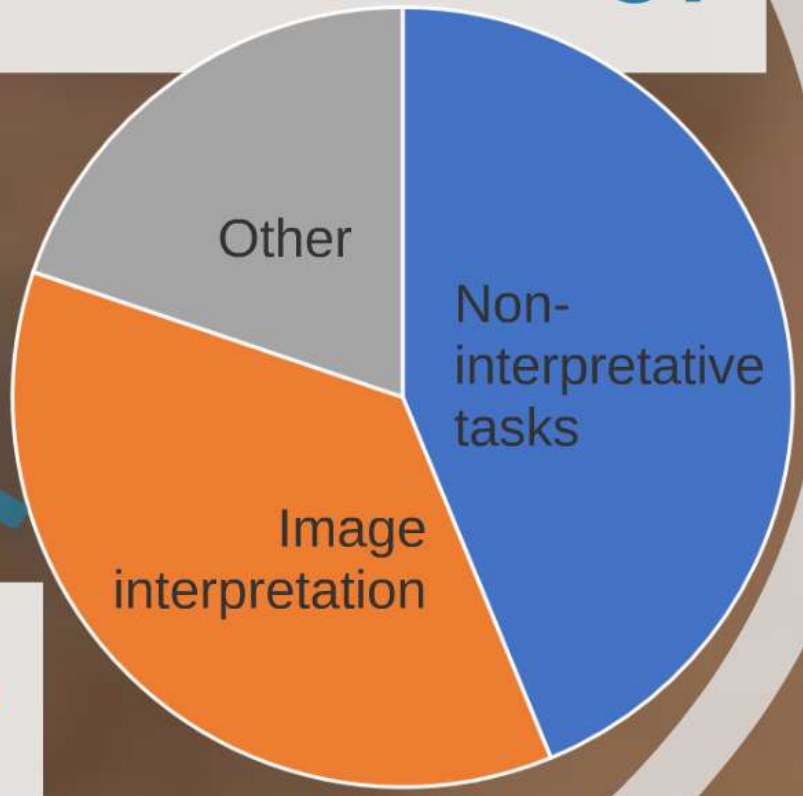
>574,000 MRI Exams/Year

BFS, 2017

FMH, 2016

Workload in Radiology

<4 Hours
~2.7 MRI Exams/Day
>6 Images/Minute



1 out of 2 radiologists burn out!

Dhanoa et al., 2013
Harolds et al., 2016

Oops...

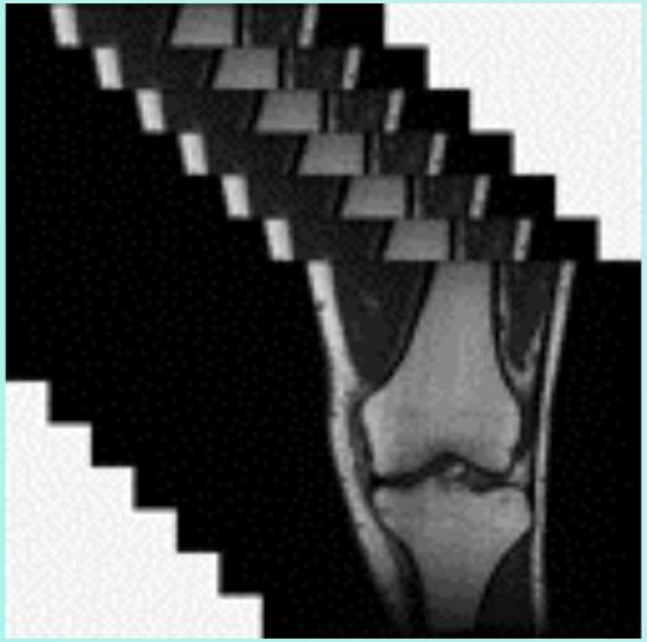
Error rate in the interpretation of medical images remain unchanged since 1949. The interpretive error rate in positive film is 33%, i.e. 4% real-time errors in daily radiology practice, in a mix of positive and negative analyses

Waite et al., 2016
Garland, 1949
Berlin, 2007
Sabih et al., 2011
Lee et al., 2013

Automate to:

- Save time and resources
- Reduce error rates, retrospective analysis

Data Sources



MRI Exam Images

Untersuchungen
MRI Knie links

SCAN DIAGS

Befund

85%	Diskreter Kniegelenkserguss.
87%	Keine Bakercyste.
Medial:	
78%	Schräg zur Unterfläche hinreichender, basisnaher, partieller Einriss am Hinterhorn des Meniskus.
85%	Übrige Meniskusanteile normal. Knorpel normal. Kollateralband intakt. Etwas Ödem entlang des Kollateralbandes
Lateral:	
95%	Meniskus normal.
95%	Knorpel normal.
95%	Kollateralband normal.
95%	Proximales Tibiofibulargelenk normal.
Interocondylär:	
92%	Die Kreuzbänder sind unauffällig.
91%	Hoffa unauffällig.
Femoropatellar:	
45%	Mässige retropatelläre Knorpelschäden vor allem an der medialen Facette mit subchondraler Reaktion.
76%	Fissur im retropatellären Knorpel.
91%	Insertionstendinose der Quadricepssehne.
95%	Patellarsehne normal.

Medical Reports


Training
Deep Neural
Networks

Why Deep Learning?

- No programming, but teaching
- It continuously learns
- The older, the smarter

Intelligent Pre-Processing

MRI Images: identify ROI
Medical Reports: extract labels

Train, Validate, Test
the Neural Networks

Image Processing

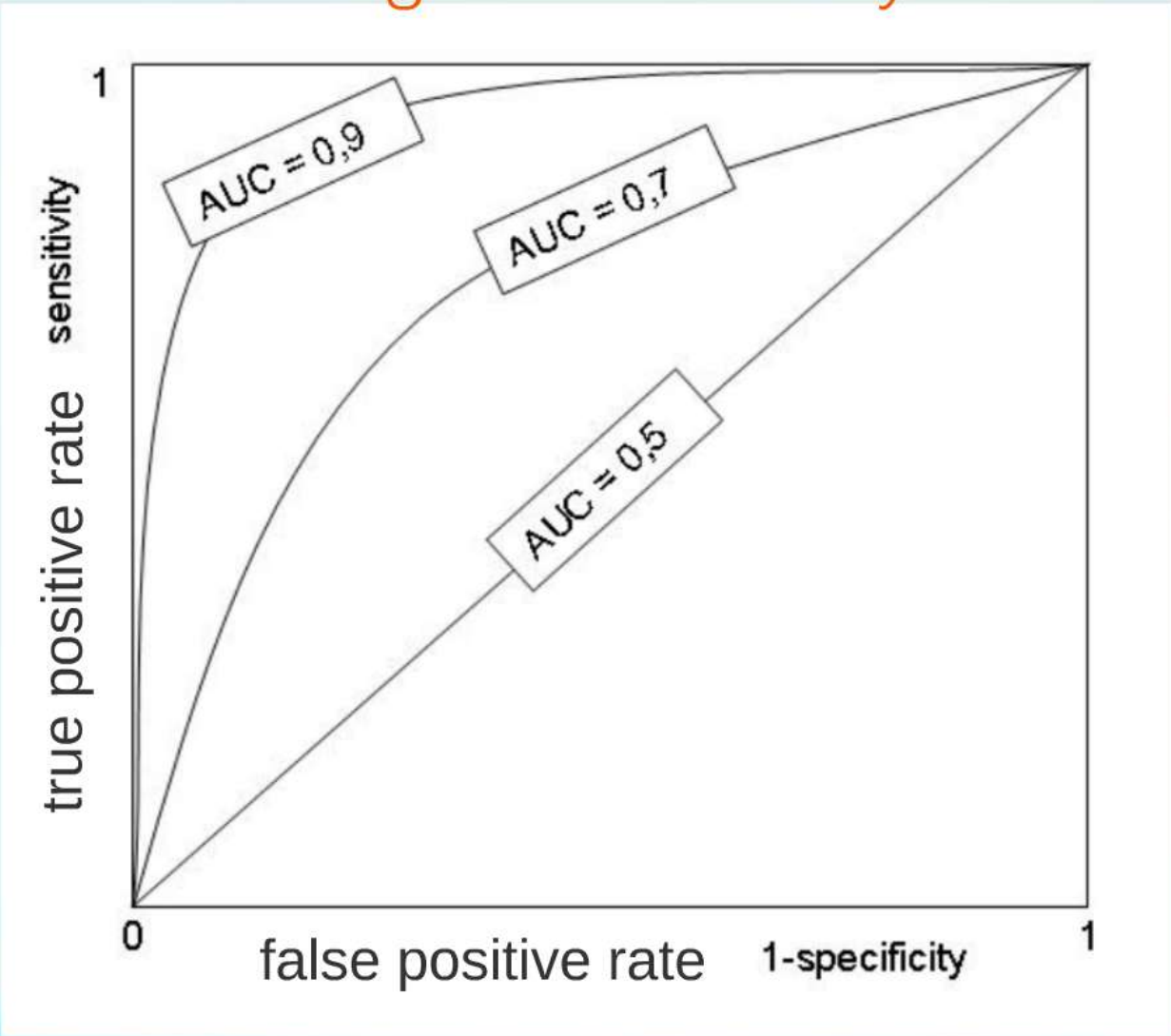
Natural Language Processing

Software Engineering

Statistics

Validation & Test

Diagnostic accuracy



Šimundić, 2008

Workflow

Data Sources

MRI Exam Images

Medical Reports

Intelligent Pre-Processing

MRI images: identify ROI
Medical Reports: extract labels

Train, Validate, Test the Neural Networks

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Šimundić, 2008

>20% MRIs performed on joints, particularly knees
Meniscus tear: most common injury

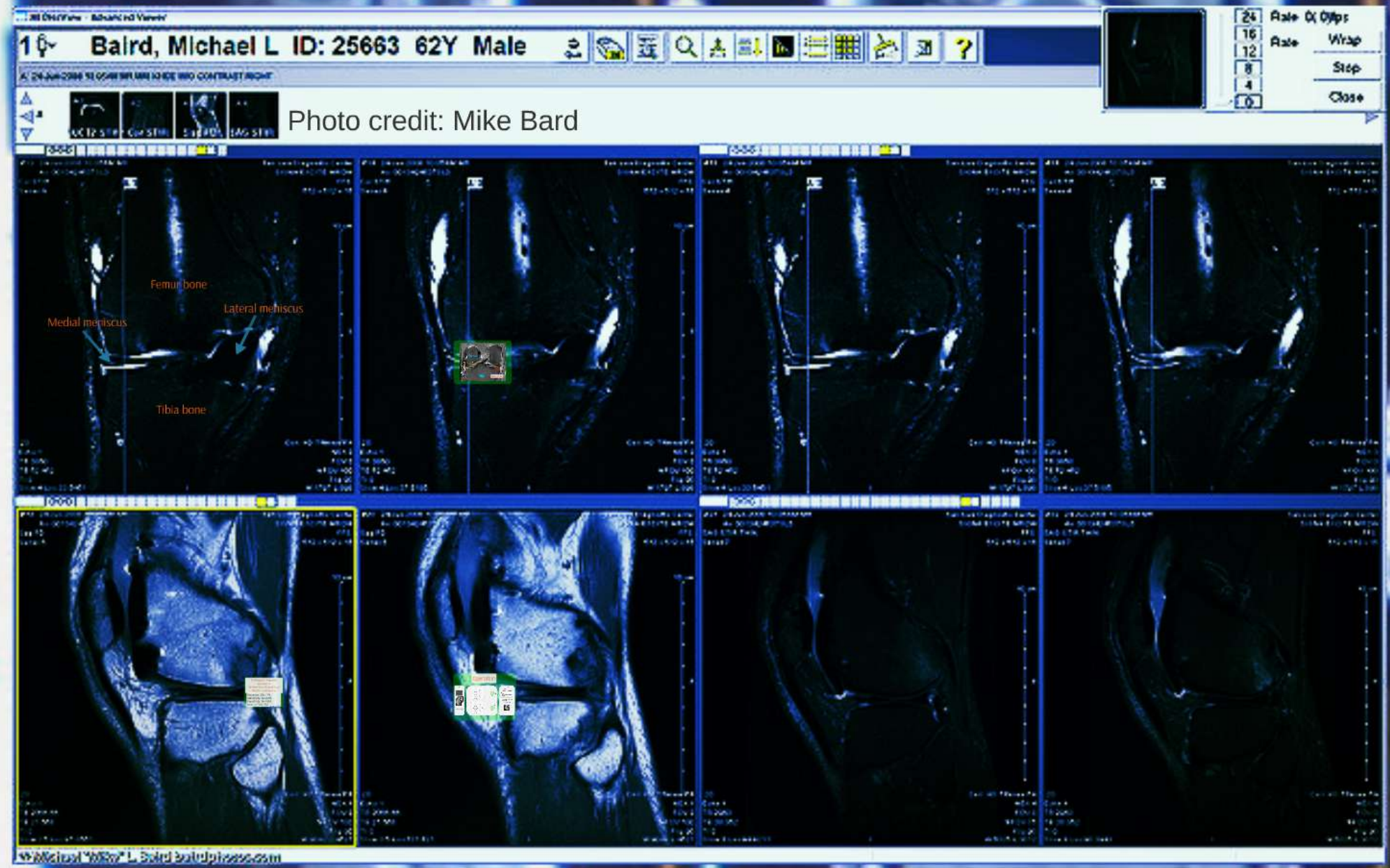
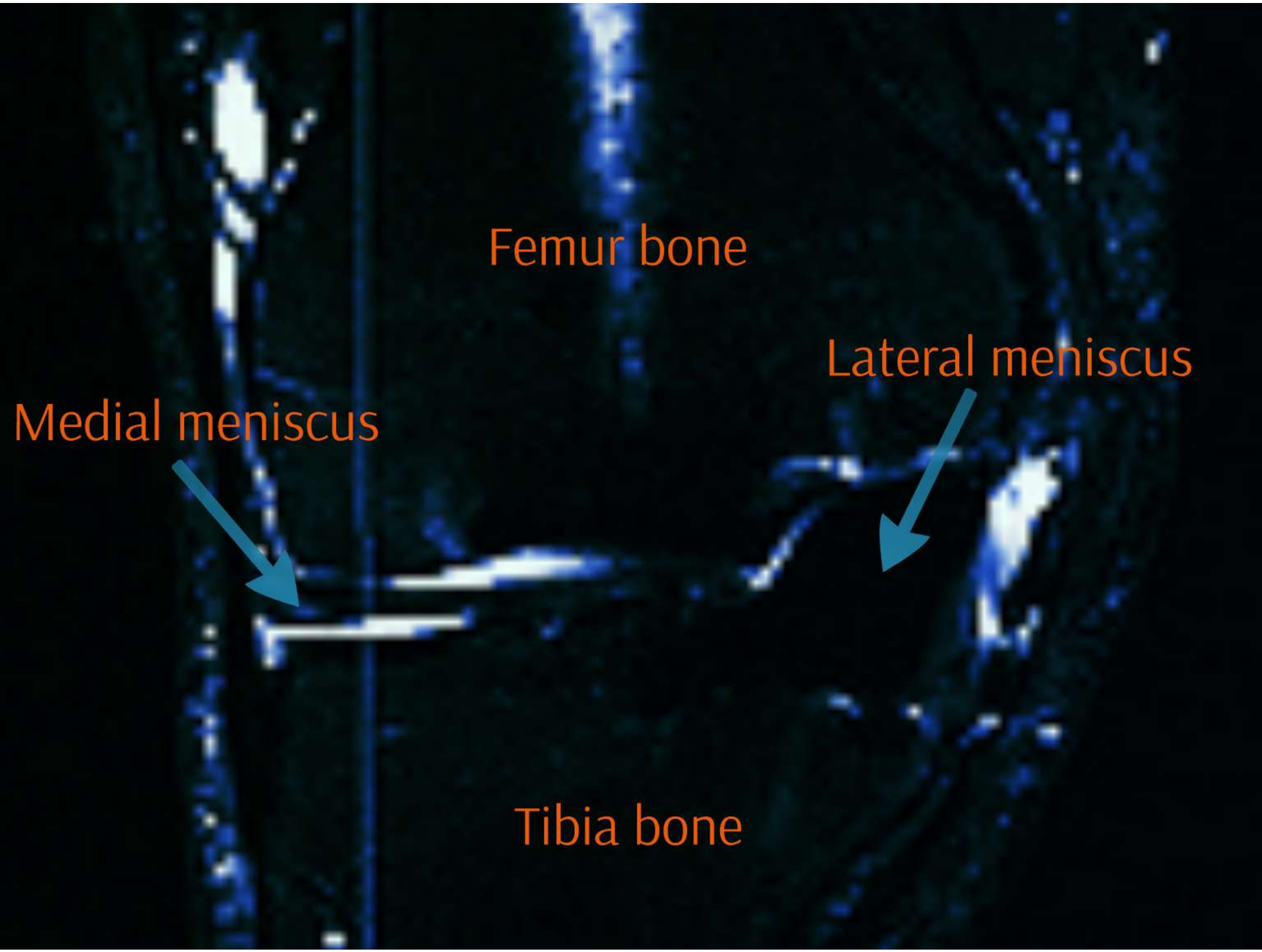
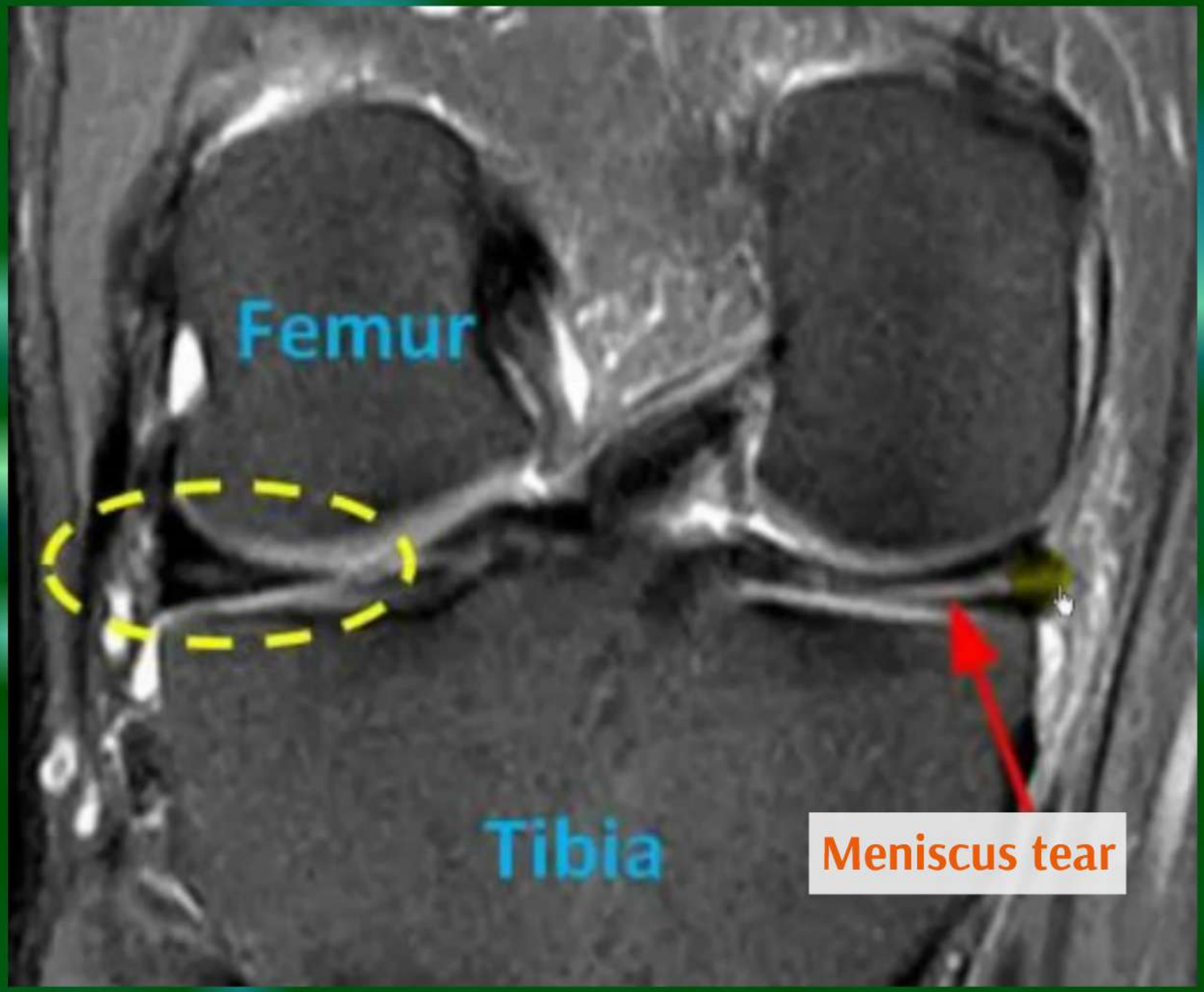


Photo credit: Mike Bard


Femur bone
Lateral meniscus
Medial meniscus
Tibia bone



Centeno, 2014

Radiologists' diagnostic accuracy in the detection of (medial and lateral) meniscus tear

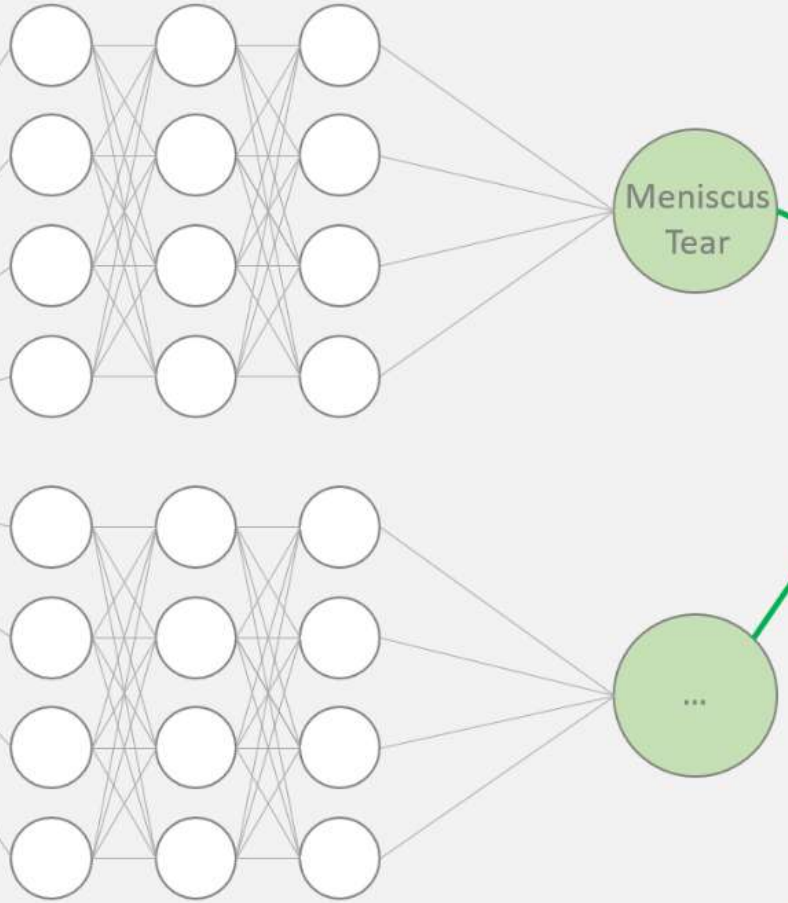
Accuracy: 81-77%
Sensitivity: 83-62%
Specificity: 69-88%
AUC: 0.75-0.752

Nikolau et al., 2008

Operation

Input

Neural Network



Output

Automatically Generated Report

Untersuchungen
MRI Knie links

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Meniscus Tear Localization

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Scans About

SCANDIAGS

Scan Results

Meniscus tears probability: 87.006 %

Batch Process 0496f727-abc0-4976-81cc-a469f1607849

View Report

Input Images

View Original Input Images

View details »

Meniscus Detection

Highlight Meniscus images

View details »

Meniscus Images

View Meniscus Images

View details »

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Acknowledgments

Dr. Giuseppe Marbach
Stefan Odermatt
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Simone Zwicky

Thank you for your attention!

Any questions?

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