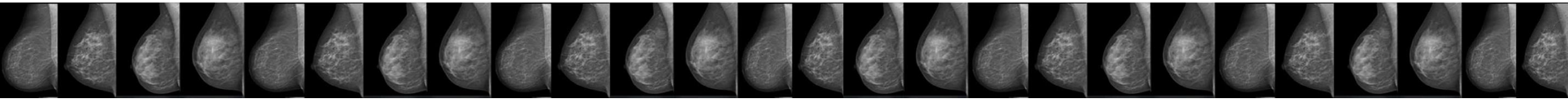

Automatic classification of mammographic breast density

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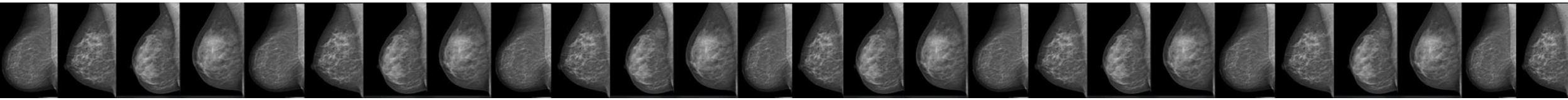

Automatic classification of mammographic breast density

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Contents

- Machine Learning on Medical Imaging Data - Radiologists' Perspective
- Automatic classification of mammographic breast density
- Can we apply this science?

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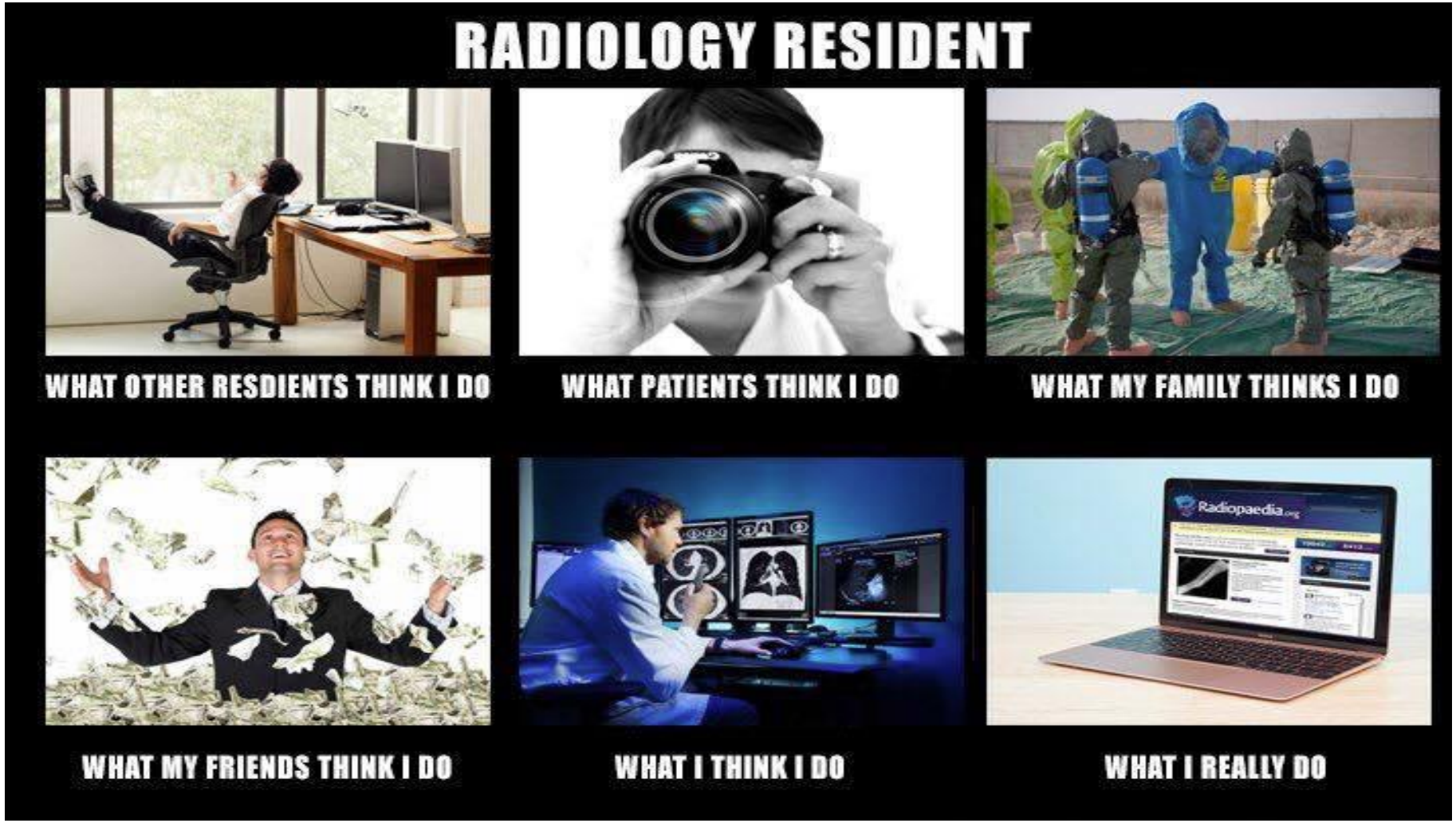
Machine Learning on Medical Imaging Data - Radiologists' Perspective



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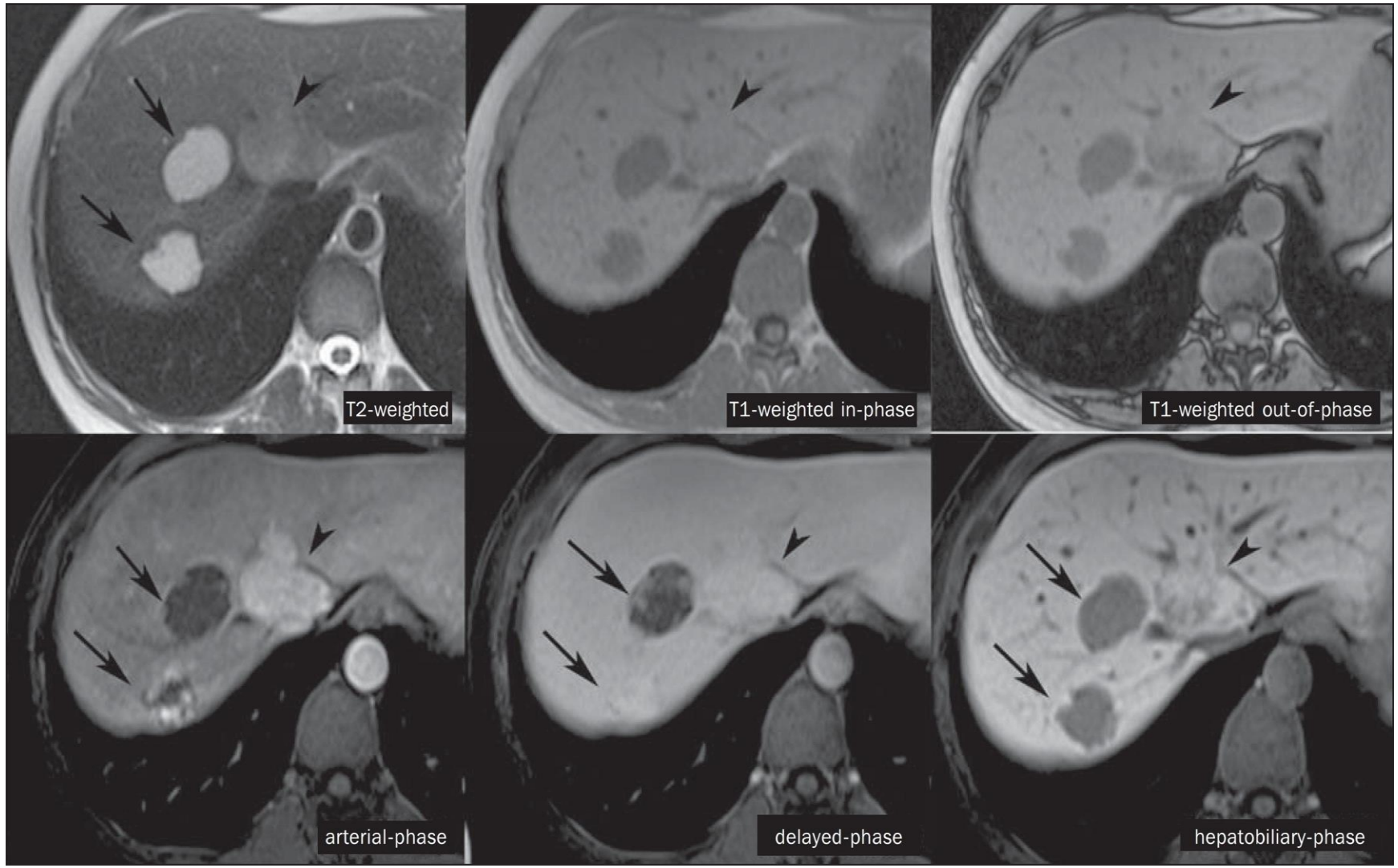
Courtesy of Christian Blüthgen, MD MSc

Machine Learning on Medical Imaging Data - Radiologists' Perspective

- Acquire Patient Information
- Select Adequate Modality
- Acquire Images
- **Describe Findings**
- **Integrate Knowledge**
- **Classify**
- **Act/Recommend**



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Courtesy of Christian Blüthgen, MD MSc

Machine Learning on Medical Imaging Data - Radiologists' Perspective

- Understand the clinical problem
- Target those tasks that
  - profit from standardization
  - are tedious (but still require a long training period)
- Provide transparent solutions that
  - mimic the human decision making process
  - are adaptable to the clinical workflow

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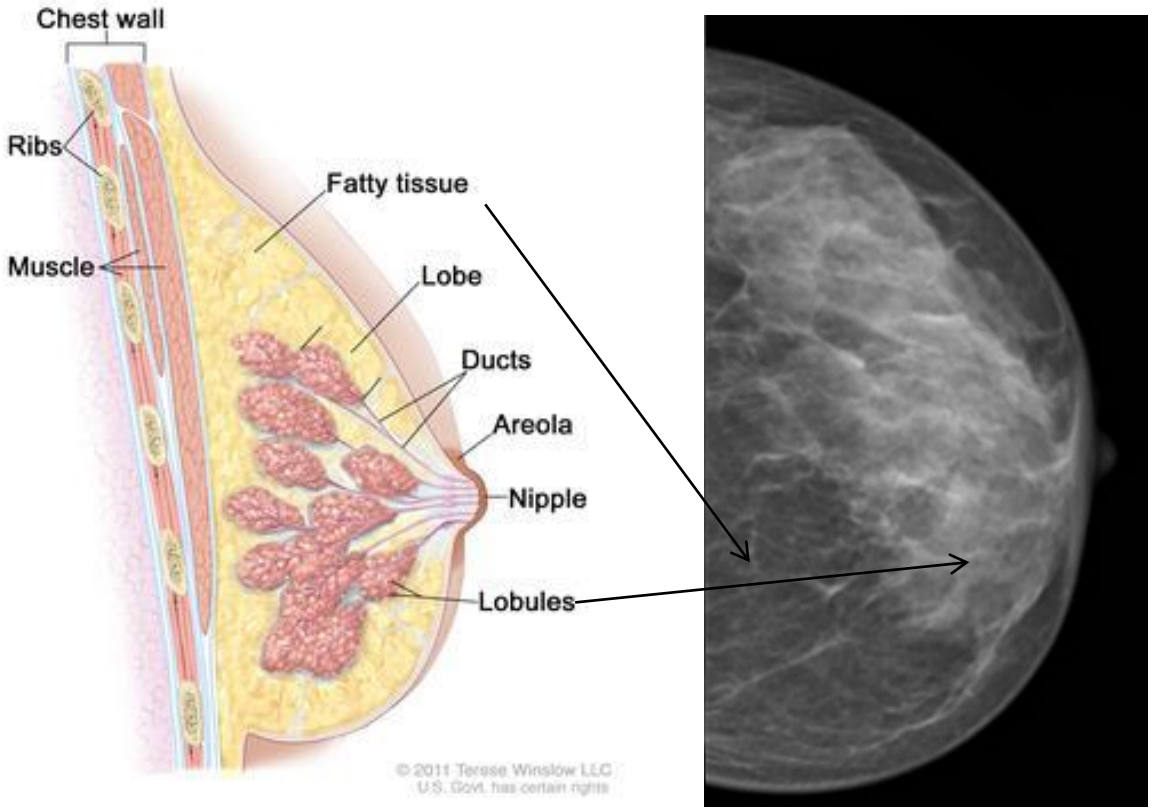
Contents

- Machine Learning on Medical Imaging Data - Radiologists' Perspective
- Automatic classification of mammographic breast density
- Can we apply this science?

UniversitätsSpital Zürich

Automatic classification of mammographic breast density (BD)



www.ncbi.nlm.nih.gov/pubmedhealth

- Women with high BD have a 2- to 6-fold increased risk of developing breast cancer[1]
- For dense breast the sensitivity of the screening mammography drops from 87% to 63%[2]
- Patients with high BD require additional imaging, such as tomosynthesis, ultrasound or breast MR to increase the cancer detection chances[3]

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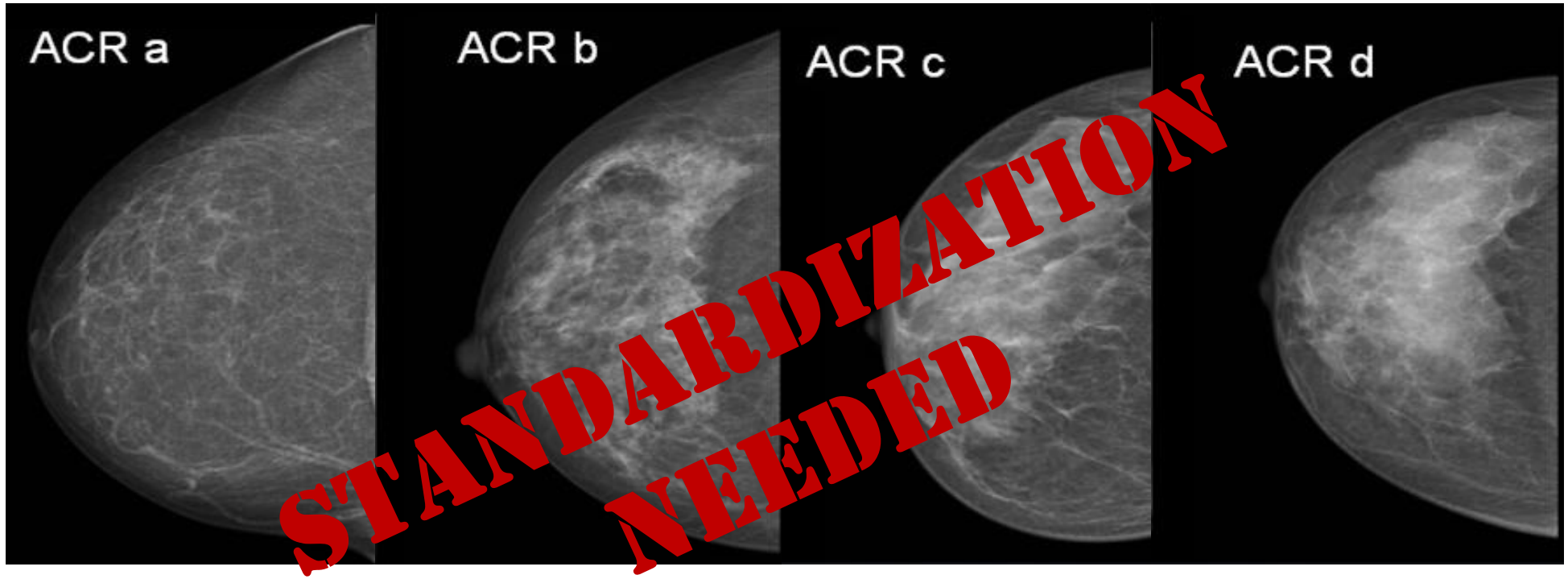
[1]Boyd et al. Mammographic density and the risk and detection of breast cancer. N Engl J Med. 2007;356(3):227-36
[2]Boyd NF. Mammographic density and risk of breast cancer. Am Soc Clin Oncol Educ Book. 2013.
[3]Berg et al. Combined screening with ultrasound and mammography vs mammography alone in women at elevated risk of breast cancer. JAMA. 2008;299(18):2151-63

Automatic classification of mammographic breast density (BD)



Mammographic Breast density ACR a-d. American College of Radiology BIRADS catalogue, 5th edition

- ACR-BD classification is observer-dependent (inter-reader agreement ranging between 0.43 and 0.89)[1]
- Radiologists routinely reading mammographies perform better[2]

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[1]Ekpo et al. Assessment of Interradiologist Agreement Regarding Mammographic Breast Density Classification Using the Fifth Edition of the BI-RADS Atlas. AJR Am J Roentgenol. 2016;206(5):1119-23.

[2]Berg et al. Breast Imaging Reporting and Data System: inter- and intraobserver variability in feature analysis and final assessment. AJR Am J Roentgenol. 2000;174(6):1769-77

Automatic classification of mammographic breast density (BD)

- Data: 20,578 diagnostic mammography views from 5,221unique patients (age = 58±12 years) acquired between 2012 and 2013

- Labeling: views of the single patient were linked to the ACR BI-RADS density from the corresponding radiological report using a home-written text searching MATLAB script (Release 2013b, MathWorks, Natick, MA, USA).

- Balanced dataset: 12, 932 labeled mammography views were successfully linked to the ACR BI-RADS density from the corresponding radiological report. After data augmentation (ImageDataGenerator Keras) a balanced training and validation dataset subdivided into 4 classes composed of n = 22,414 MLO projections and n = 22,439 CC projections was available.

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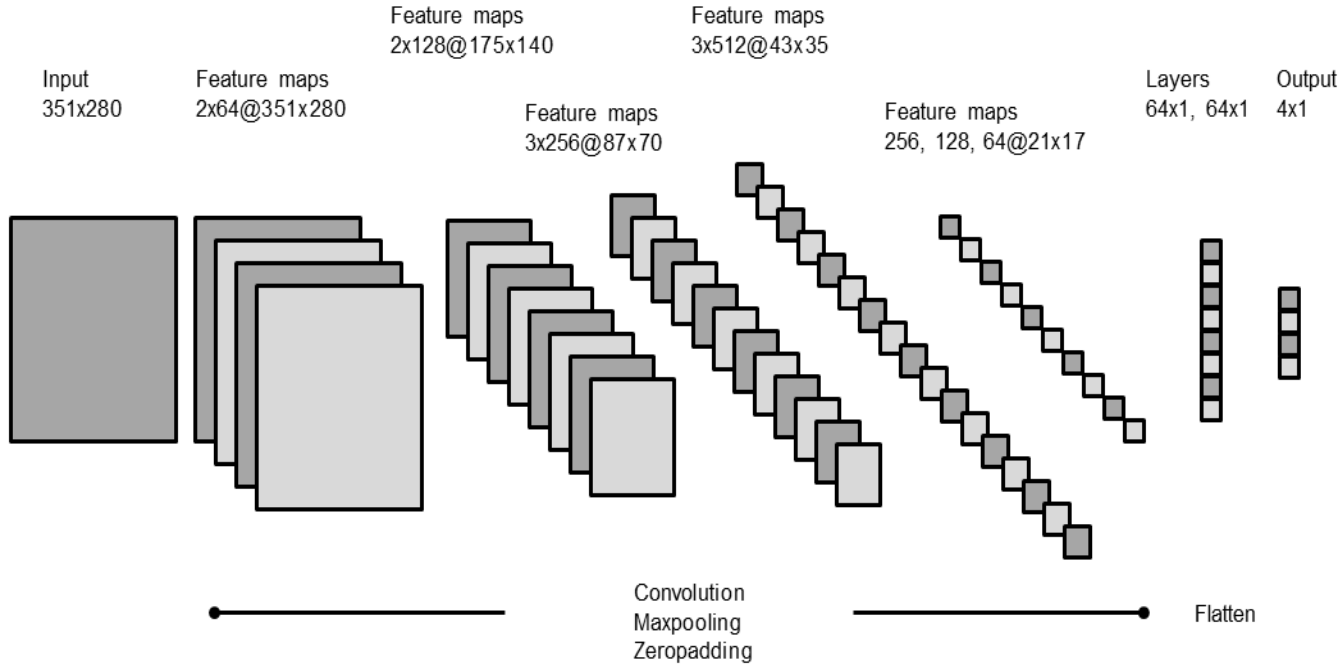
Automatic classification of mammographic breast density (BD)

Hardware and software: consumer-grade desktop computer equipped with an Intel i7-7700 CPU with 16 GB RAM and an NVIDIA 1080 GTX graphics processing unit with 8 GB graphics RAM. The computer was running Ubuntu Linux 16.04 with Tensorflow 1.0.1.



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Automatic classification of mammographic breast density (BD)

Performance over the validation dataset

View	Accuracy	Number of epochs	Computation time
Mediolateral Oblique	90.9 %	91	20.3 hours
Cranio-Caudal	90.1 %	94	21.6 hours

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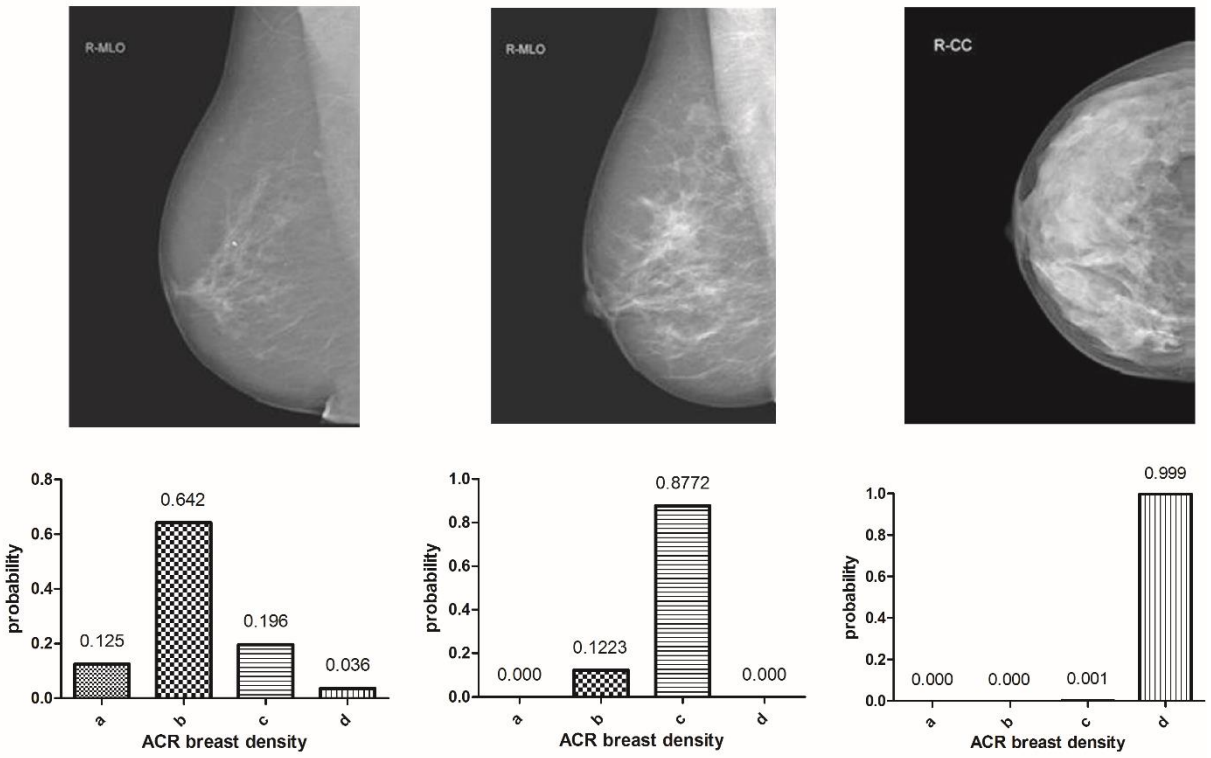
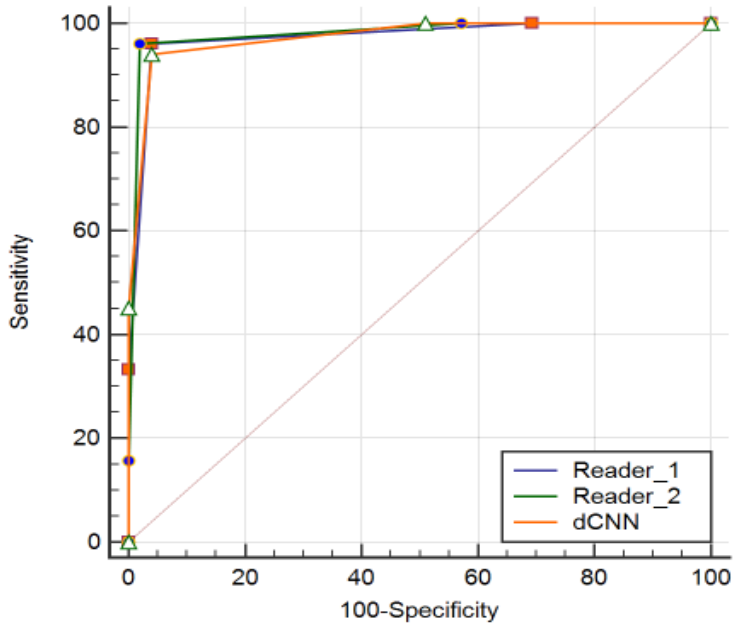


Automatic classification of mammographic breast density (BD)

Test against the expert readers´consensus: CC view

ROC space



Cohen´s kappa

Confusion Matrix

	A	B	C	D
A	94.7%	5.3%	0.0%	0.0%
B	20.7%	79.3%	0.0%	0.0%
C	0.0%	2.7%	75.7%	21.6%
D	0.0%	0.0%	0.0%	100.0%

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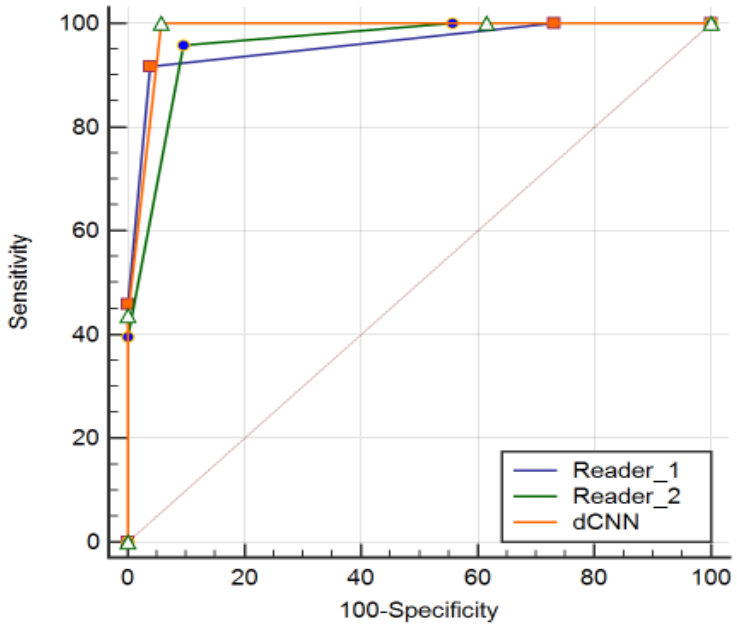
Automatic classification of mammographic breast density (BD)

Test against the expert readers´consensus: MLO view

ROC space



Cohen´s kappa

Confusion Matrix

	A	B	C	D
A	89.5%	10.5%	0.0%	0.0%
B	9.1%	87.9%	3.0%	0.0%
C	0.0%	0.0%	100.0%	0.0%
D	0.0%	0.0%	8.7%	91.3%

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Automatic classification of mammographic breast density (BD)

- The dCNN allows for accurate classification of breast density based on the ACR BI-RADS system.
- The performance of the dCNN are comparable to those of experienced radiologists
- The proposed technique may allow accurate, standardized, and observer independent breast density evaluation of mammographies.

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Contents

- Machine Learning on Medical Imaging Data - Radiologists' Perspective
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- Can we apply this science?

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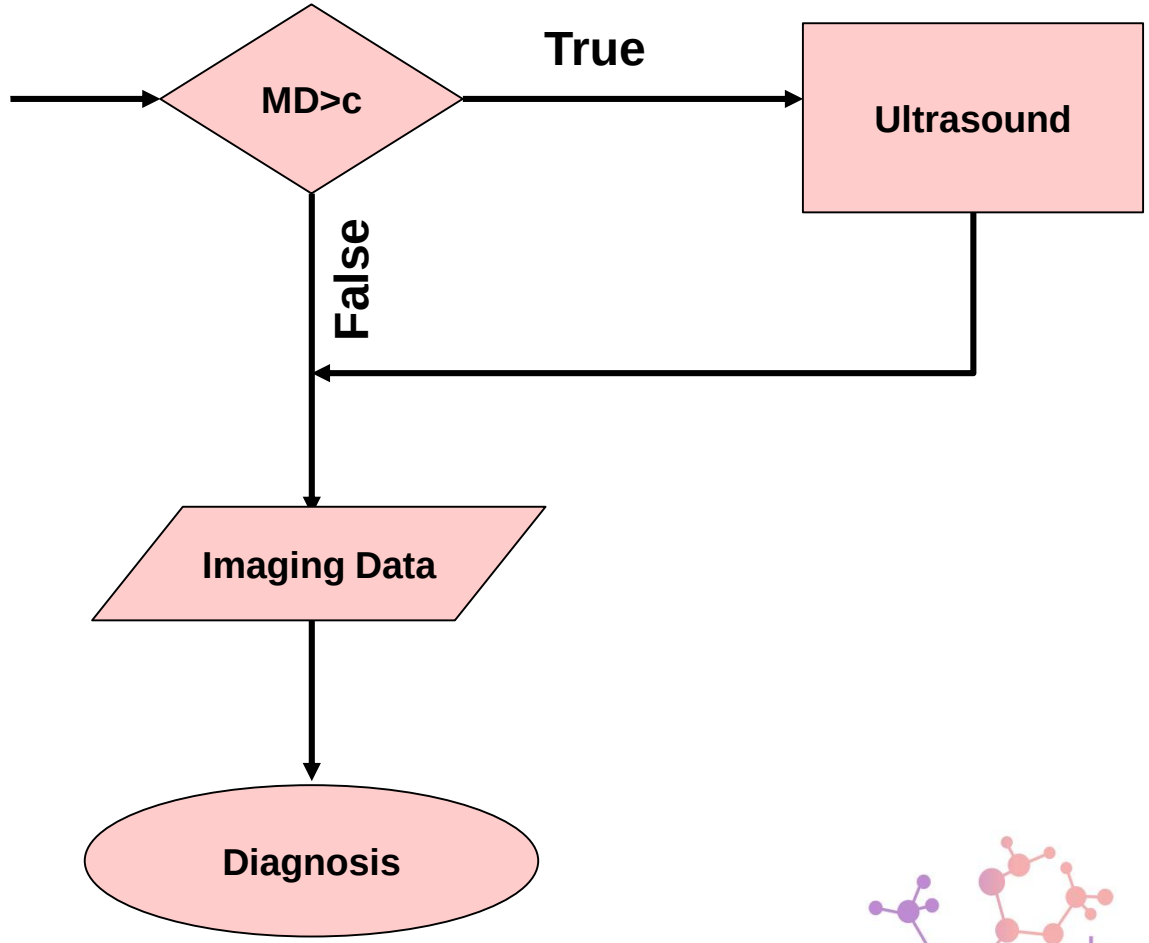
Can we apply this science?

http://www.diagnosticimaging.com/radiology-comics/



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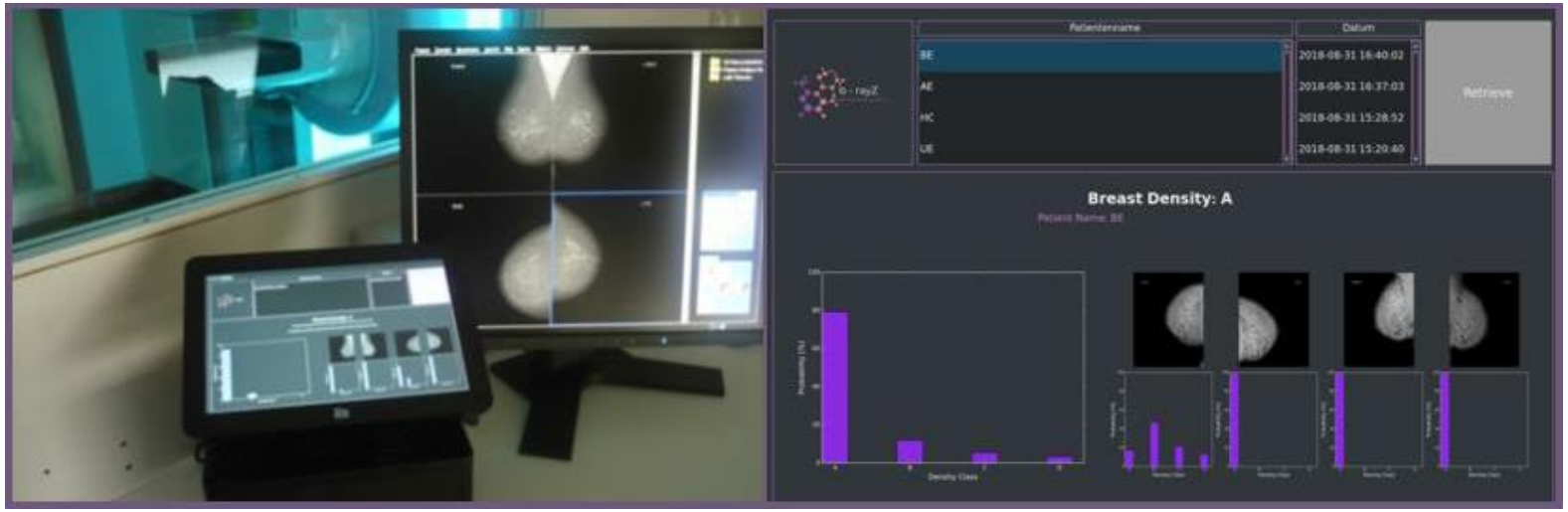
Can we apply this science?

Applied sciences: sciences that are put to practical use. (Collins)



Standardized assessment of high BD allows the prompt schedule of the US

Efficiency radiographer´s workflow

Number of recall examinations

The reduction of recall examinations is cost saving and relives the psychological burden on patient

Efficient workflow improves patient´s perception of the safety and efficiency of the provided care

Patient satisfaction

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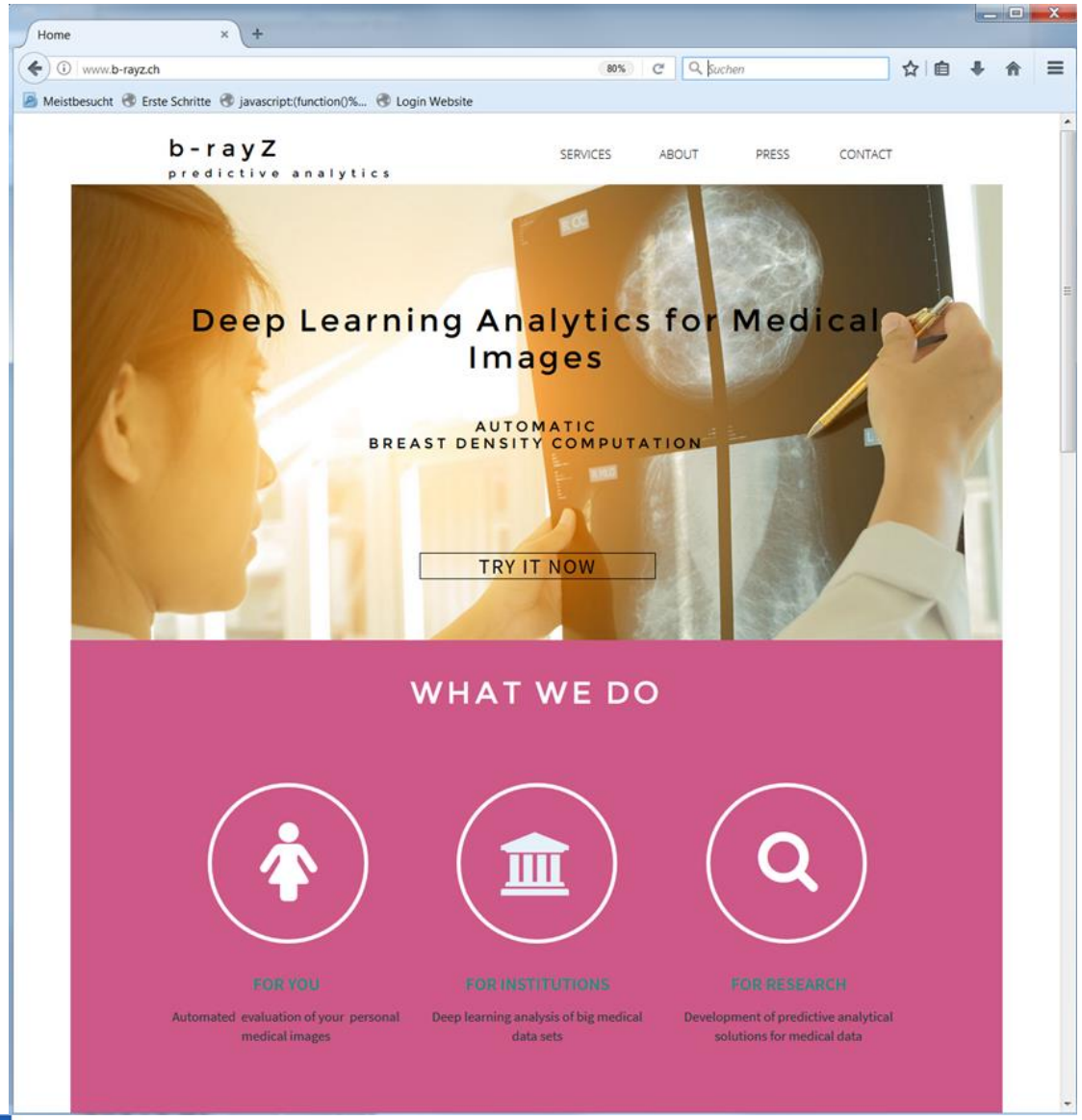

Project name

Artificial Intelligence in oncological Imaging Network

Thank you
Grazie mille

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