Analyse von Echokardiografie und EKG mit Methoden des maschinellen Lernens

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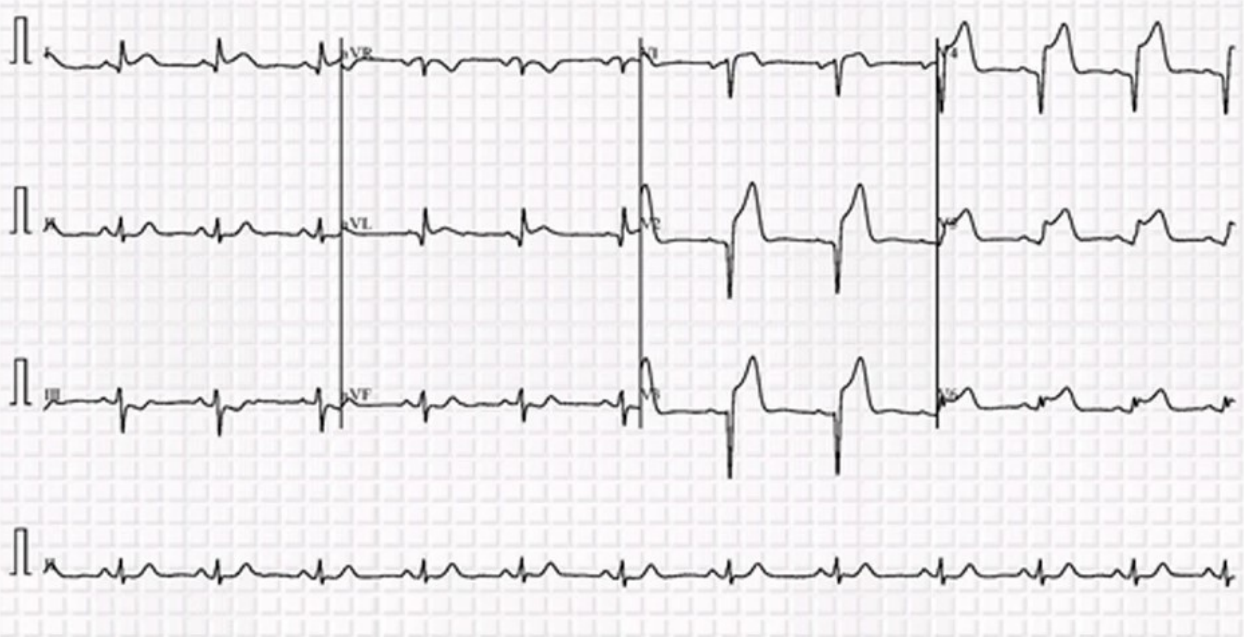
JKU MEDIZINISCHE FAKULTÄT

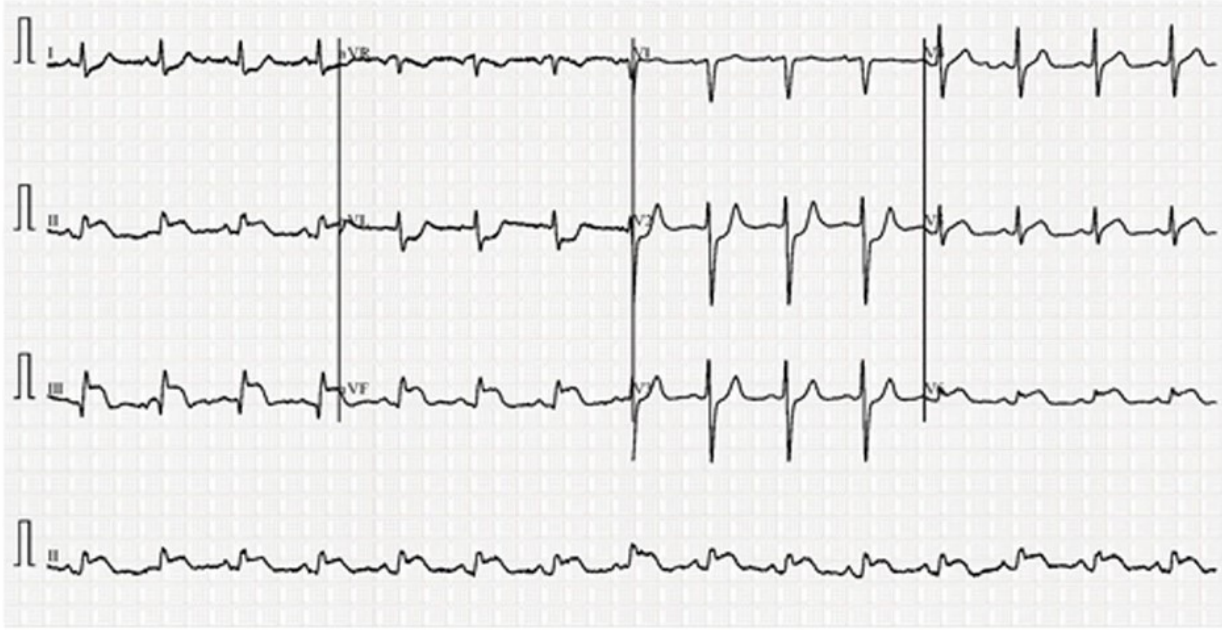
Kepler Universitäts Klinikum

ÖGARI

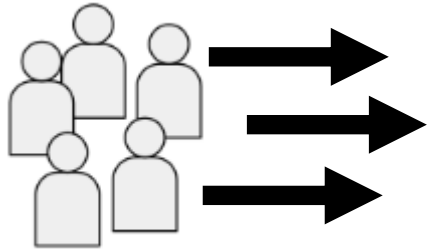
Conflicts of Interest

Welcher dieser Patient*innen hat COVID-19?





Künstliche Intelligenz



Daten

Der Weg durch ein KI-Forschungsprojekt

Vorverarbeitung (Beispiele)
- Imputation
- Feature Extraction & Engineering
- Feature Selection

Architekturen (Beispiele)
- neuronale Netzwerke
- Random Forests
- Support Vector Machines

Training

Test

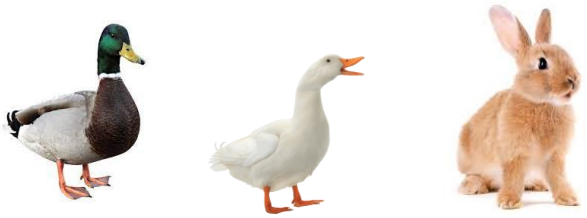
maschinelles Lernen

Modell

Vorhersage

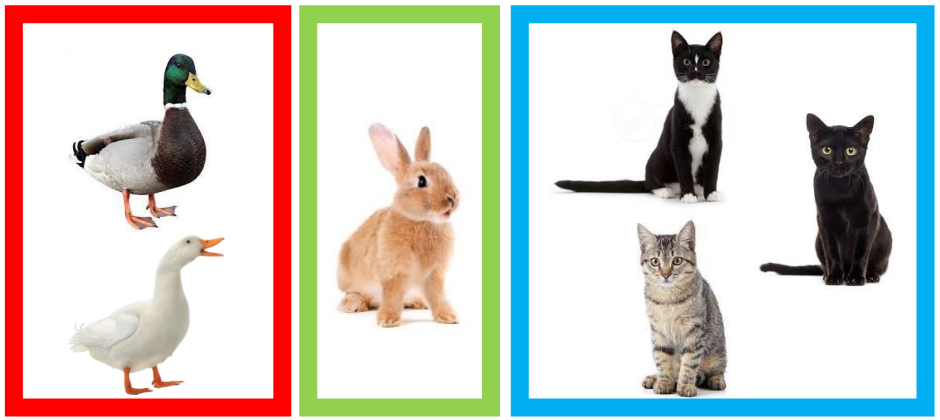
Künstliche Intelligenz
Arten & Umsetzung

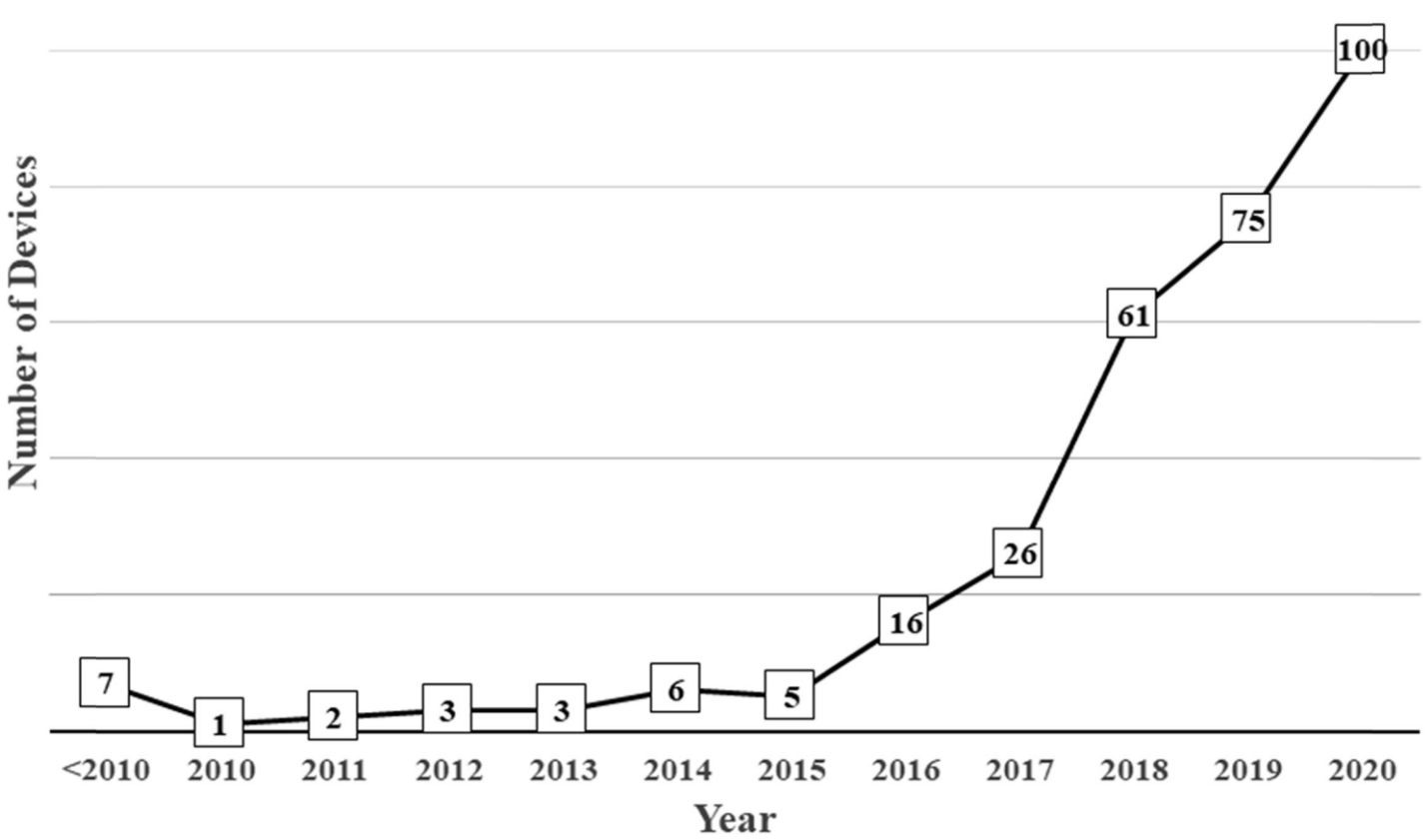
Supervised Learning



Ente Ente keine Ente

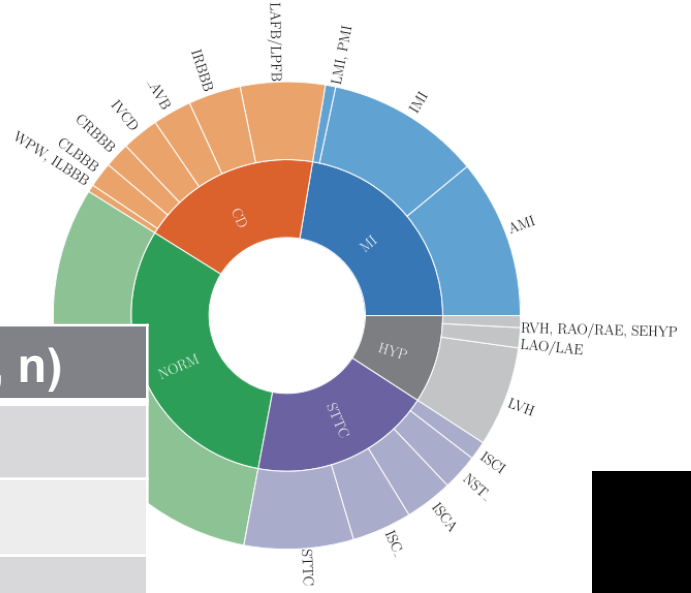
Unsupervised Learning

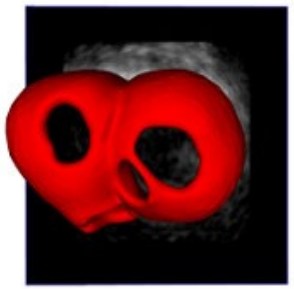


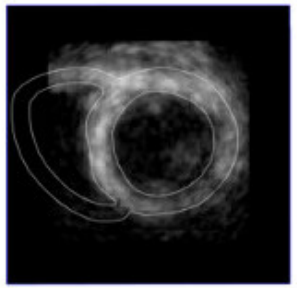


Welche Daten haben wir? öffentliche Datenbanken

Name	Patient*innen, EKGs (n, n)
MIT-BIH	62, 63
AF Classification 2017	8528, 8528
PTB-XL	**18885, 21837**



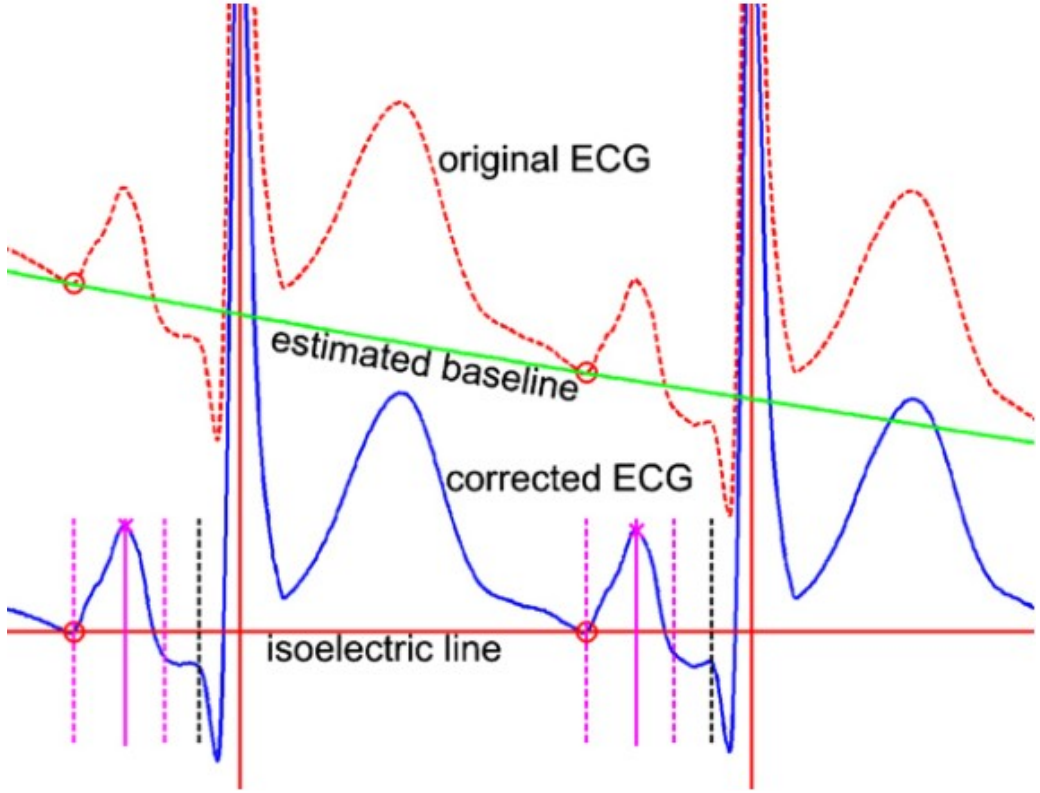


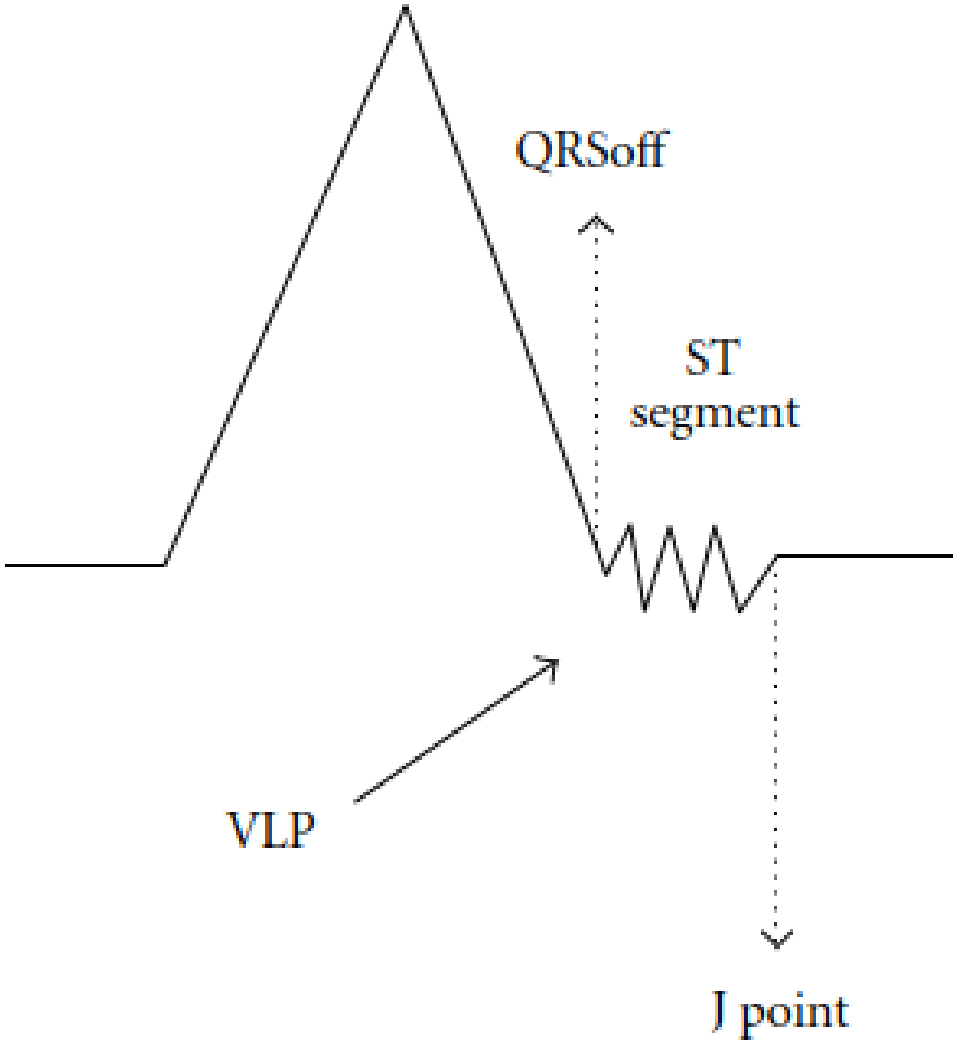


Name	Patient*innen, Echos (n, n)	Art	Annotation
EchoNet Dynamic	**10025, 10025**	2D TTE A4c	EF, LV-Trace, ED/ES-Frame
CETUS	45, 45	3D TTE A4c	LV-Trace, ED/ES-Frame

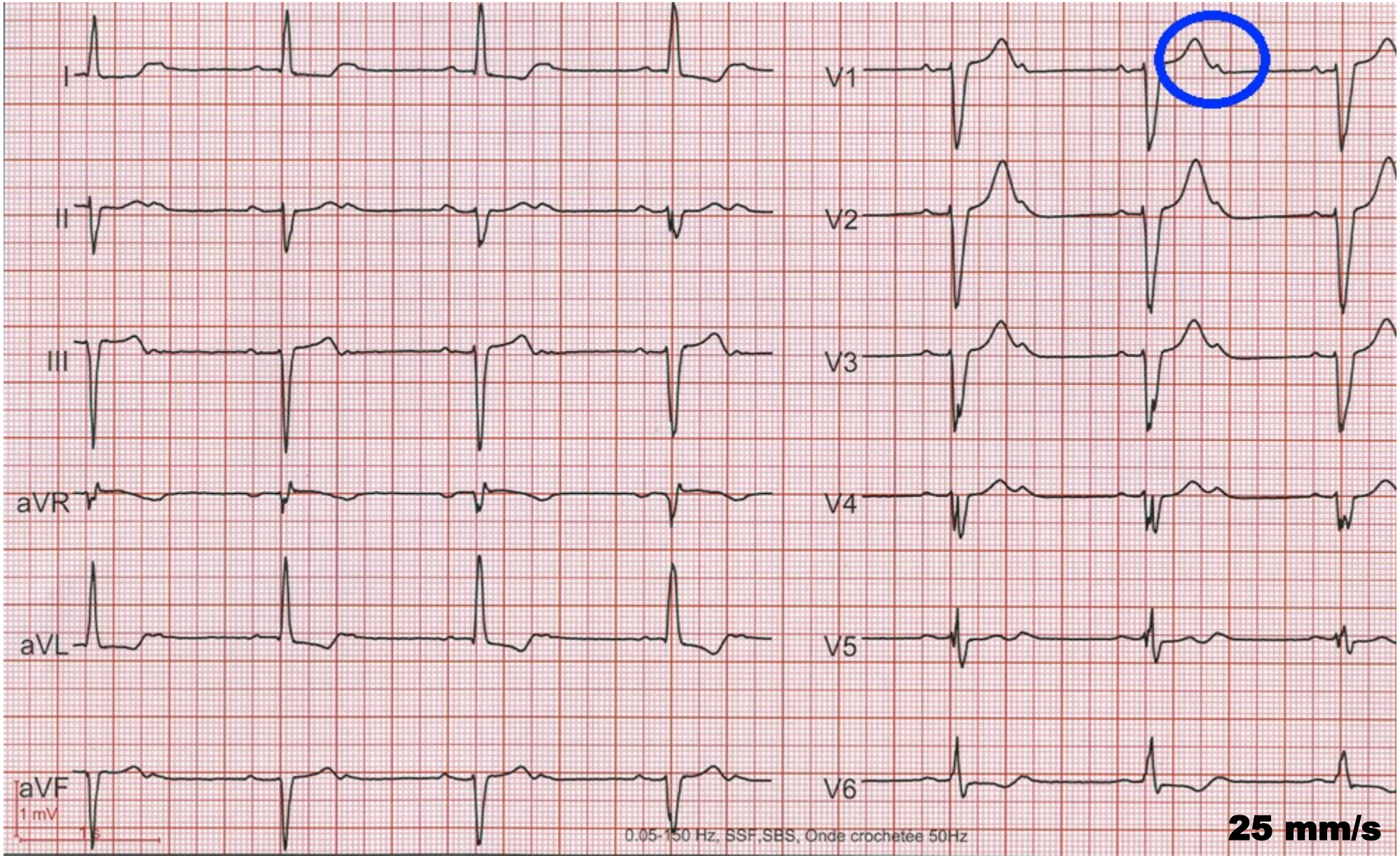
Wagner P, Strodthoff N, Bousseljot RD, Kreiseler D, Lunze FI, Samek W, Schaeffter T. PTB-XL, a large publicly available electrocardiography dataset. Sci Data. 2020 May 25;7(1):154. doi: 10.1038/s41597-020-0495-6. PMID: 32451379; PMCID: PMC7248071.

EKG
Signalverarbeitung





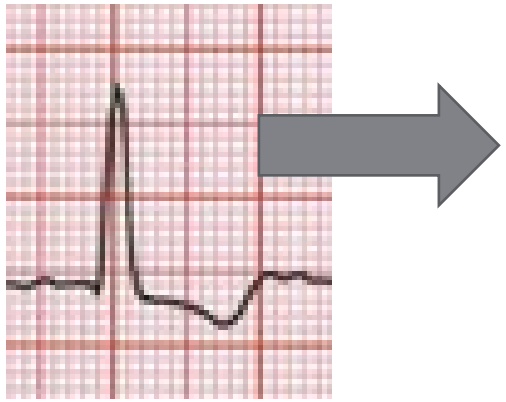
Sovilj S, Van Oosterom A, Rajsman G, Magjarevic R. ECG-based prediction of atrial fibrillation development following coronary artery bypass grafting. Physiol Meas. 2010 May;31(5):663-77. doi: 10.1088/0967-3334/31/5/005. Epub 2010 Mar 22. PMID: 20308773.
Li C, Zheng C, Tai C. Detection of ECG characteristic points using wavelet transforms. IEEE Trans Biomed Eng. 1995 Jan;42(1):21-8. doi: 10.1109/10.362922. PMID: 7851927.
Santangeli P, Infusino F, Sgueglia GA, Sestito A, Lanza GA. Ventricular late potentials: a critical overview and current applications. J Electrocardiol. 2008 Jul-Aug;41(4):318-24. doi: 10.1016/j.jelectrocard.2008.03.001. Epub 2008 May 1. PMID: 18455179.


I
II
III
aVR
aVL
aVF
1 mV
1 s
V1
V2
V3
V4
V5
V6
0.05-150 Hz, SSF,SBS, Onde crochetée 50Hz
25 mm/s

EKG
Künstliche Intelligenz

> Med Eng Phy. 1997 Dec;19(8):738-41. doi: 10.1016/s1350-4533(97)00029-5.

Detection of ECG waveforms by neural networks



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52 70 95 23 04 60 11 42 69 24 68 56 01 32 56 71 37 02 36 91
22 31 16 71 51 67 63 89 41 92 36 54 22 40 40 28 66 33 13 80
24 47 32 60 99 03 45 02 44 75 33 53 78 36 84 20 35 17 12 50
32 98 81 28 64 23 67 10 26 38 40 67 59 54 70 66 18 38 64 70
67 26 20 68 02 62 12 20 95 63 94 39 63 08 40 91 66 49 94 21
24 55 58 05 66 73 99 26 97 17 78 78 96 83 14 88 34 89 63 72
21 36 23 09 75 00 76 44 20 45 35 14 00 61 33 97 34 31 33 95
78 17 53 28 22 75 31 67 15 94 03 80 04 62 16 14 09 53 56 92
16 39 05 42 96 35 31 47 55 58 88 24 00 17 54 24 36 29 85 57
86 56 00 48 35 71 89 07 05 44 44 37 44 60 21 58 51 54 17 58
19 80 81 68 05 94 47 69 28 73 92 13 86 52 17 77 04 89 55 40
04 52 08 83 97 35 99 16 07 97 57 32 16 26 26 79 33 27 98 66
88 36 68 87 57 62 20 72 03 46 33 67 46 55 12 32 63 93 53 69
04 42 16 73 38 25 39 11 24 94 72 18 08 46 29 32 40 62 76 36
20 69 36 41 72 30 23 88 34 62 99 69 82 67 59 85 74 04 36 16
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01 70 54 71 83 51 54 69 16 92 33 48 61 43 52 01 89 19 67 48
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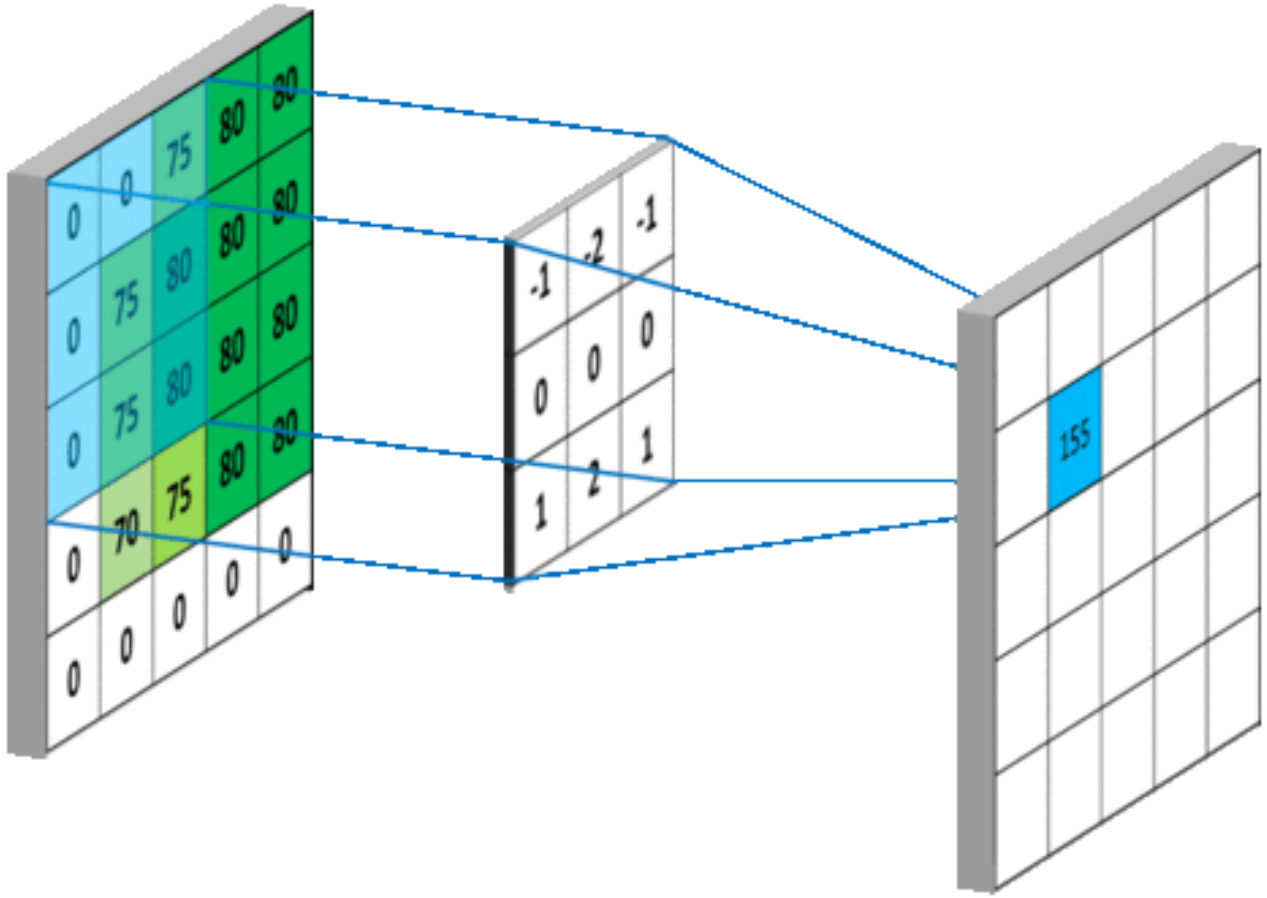
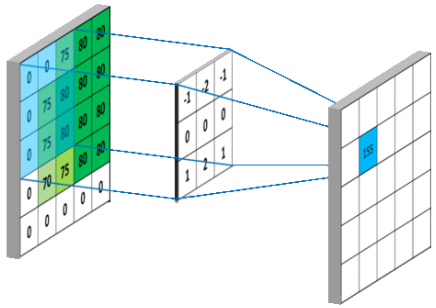
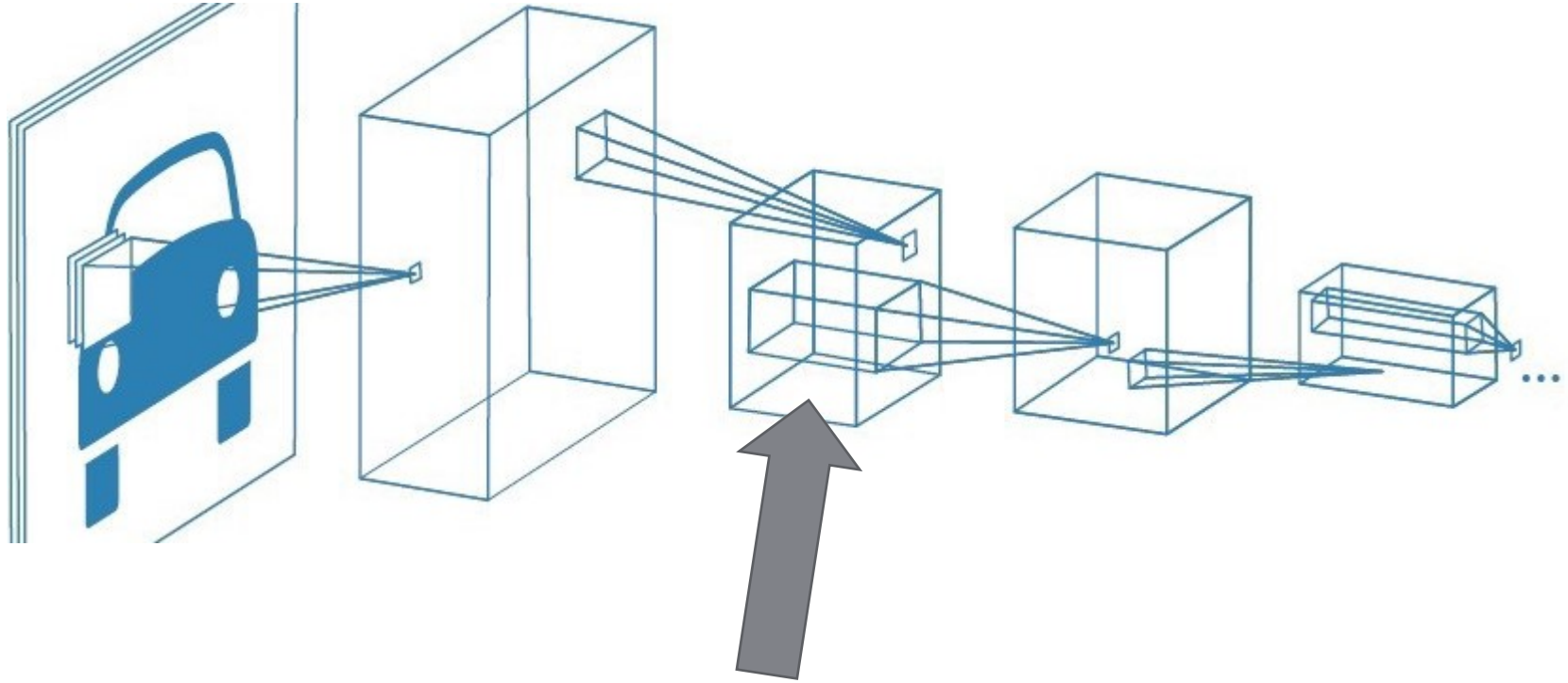
EKG
Künstliche Intelligenz



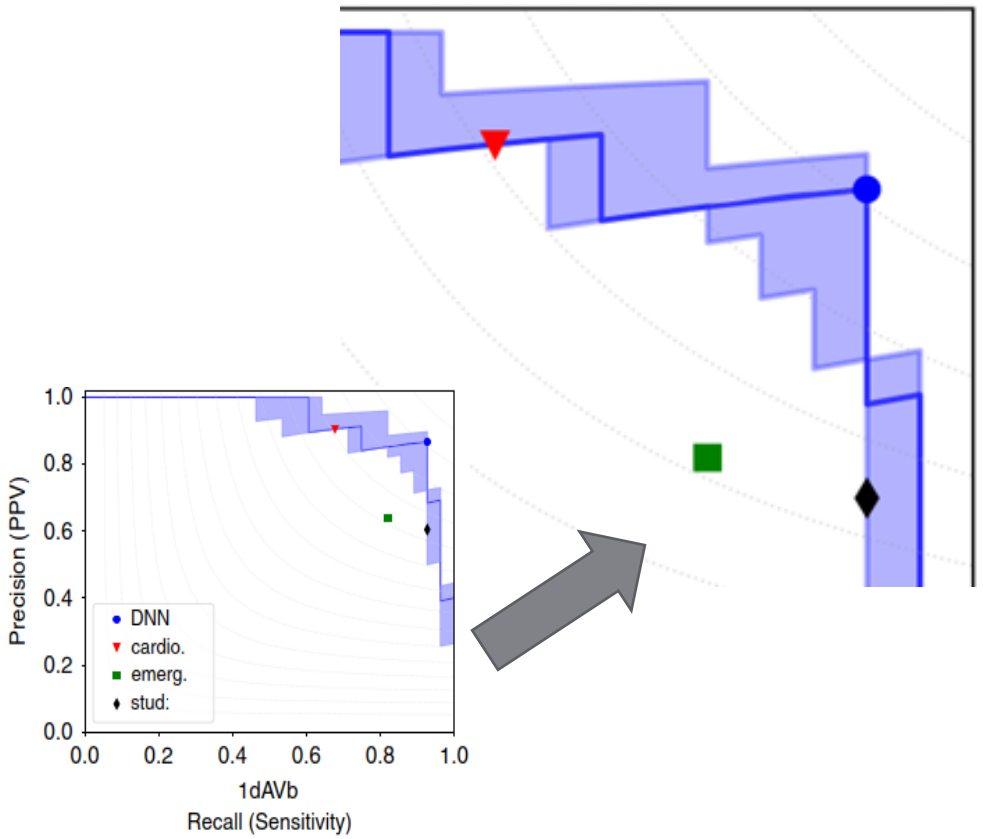
EKG
Künstliche Intelligenz

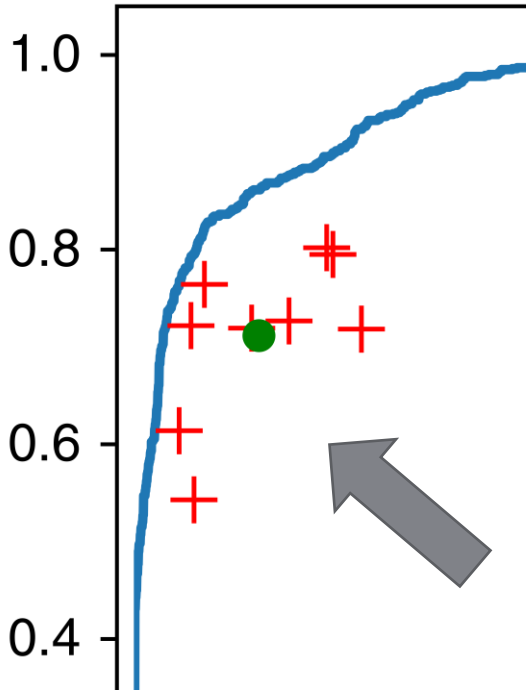


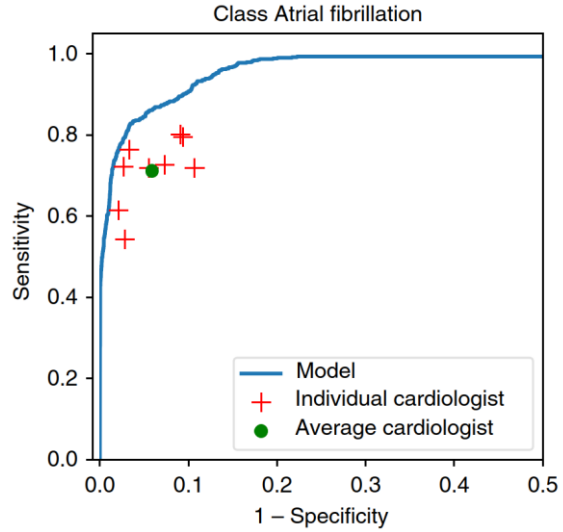


https://towardsdatascience.com/a-comprehensive-guide-to-convolutional-neural-networks-the-eli5-way-3bd2b1164a53

EKG
Detektion kardiale Krankheiten

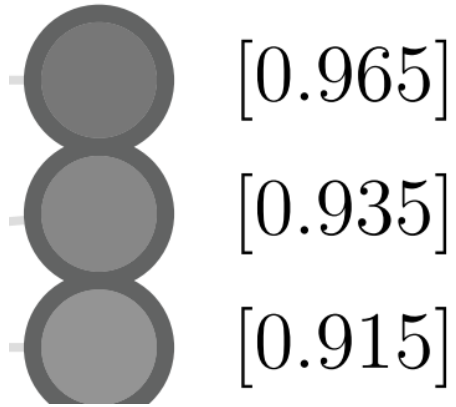




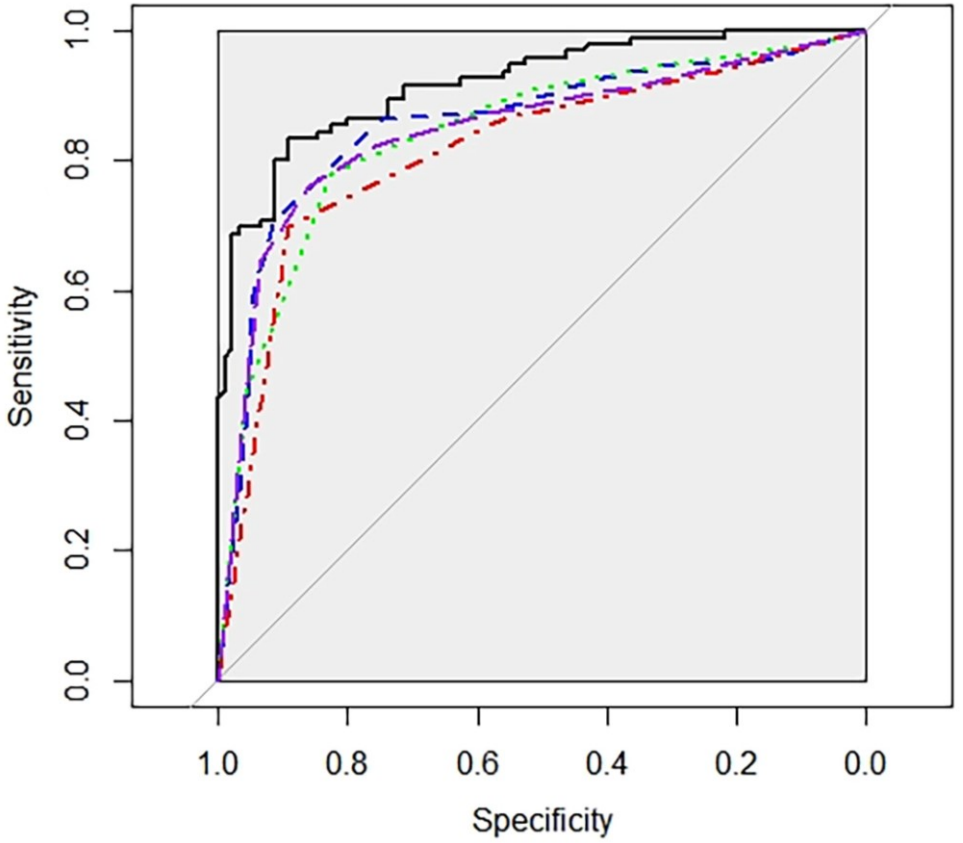


Ribeiro AH, Ribeiro MH, Paixão GMM, Oliveira DM, Gomes PR, Canazart JA, Ferreira MPS, Andersson CR, Macfarlane PW, Meira W Jr, Schön TB, Ribeiro ALP. Automatic diagnosis of the 12-lead ECG using a deep neural network. Nat Commun. 2020 Apr 9;11(1):1760. doi: 10.1038/s41467-020-15432-4. Erratum in: Nat Commun. 2020 May 1;11(1):2227. PMID: 32273514; PMCID: PMC7145824.
Strodthoff N, Wagner P, Schaeffter T, Samek W. Deep Learning for ECG Analysis: Benchmarks and Insights from PTB-XL. IEEE J Biomed Health Inform. 2021 May;25(5):1519-1528. doi: 10.1109/JBHI.2020.3022989. Epub 2021 May 11. PMID: 32903191.

EKG
Detektion kardiale Krankheiten

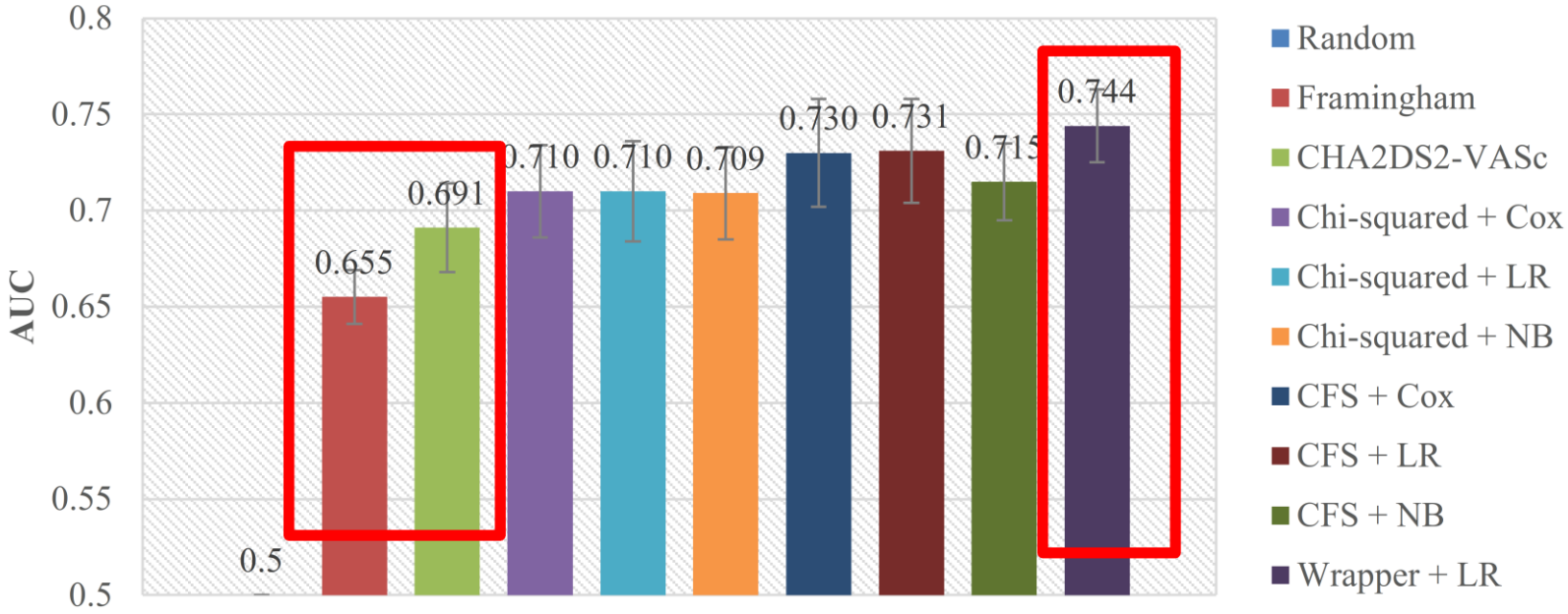


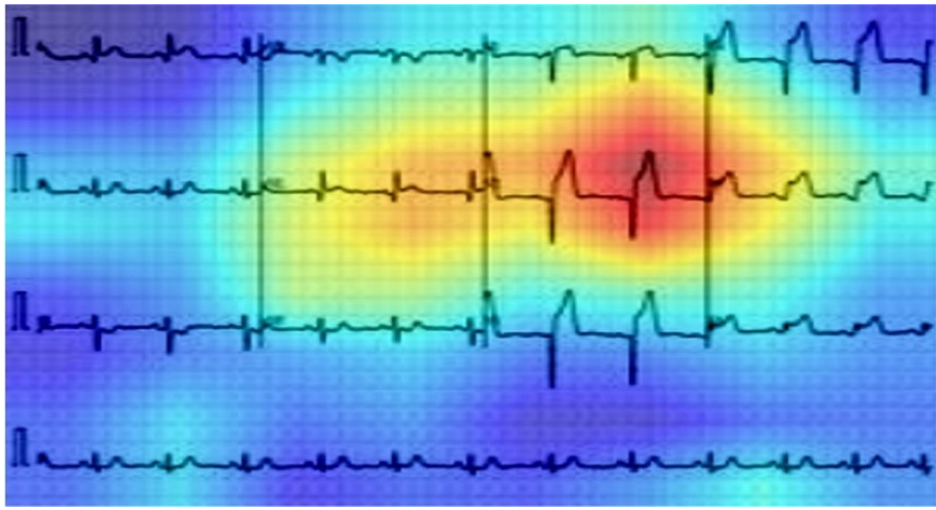
[0.965]
[0.935]
[0.915]



Filos D et al. Beat-to-beat P-wave morphology as a predictor of paroxysmal atrial fibrillation. Comput Methods Programs Biomed. 2017 Nov;151:111-121. doi: 10.1016/j.cmpb.2017.08.016. Epub 2017 Aug 24. PMID: 28946993.
Choi YJ et al. Artificial intelligence versus physicians on interpretation of printed ECG images: Diagnostic performance of ST-elevation myocardial infarction on electrocardiography. Int J Cardiol. 2022 Sep 15;363:6-10. doi: 10.1016/j.ijcard.2022.06.012. Epub 2022 Jun 9. PMID: 35691440.
Hannun AY, Rajpurkar P et al. Cardiologist-level arrhythmia detection and classification in ambulatory electrocardiograms using a deep neural network. Nat Med. 2019 Jan;25(1):65-69. doi: 10.1038/s41591-018-0268-3. Epub 2019 Jan 7.

EKG
extrakardiale Krankheiten





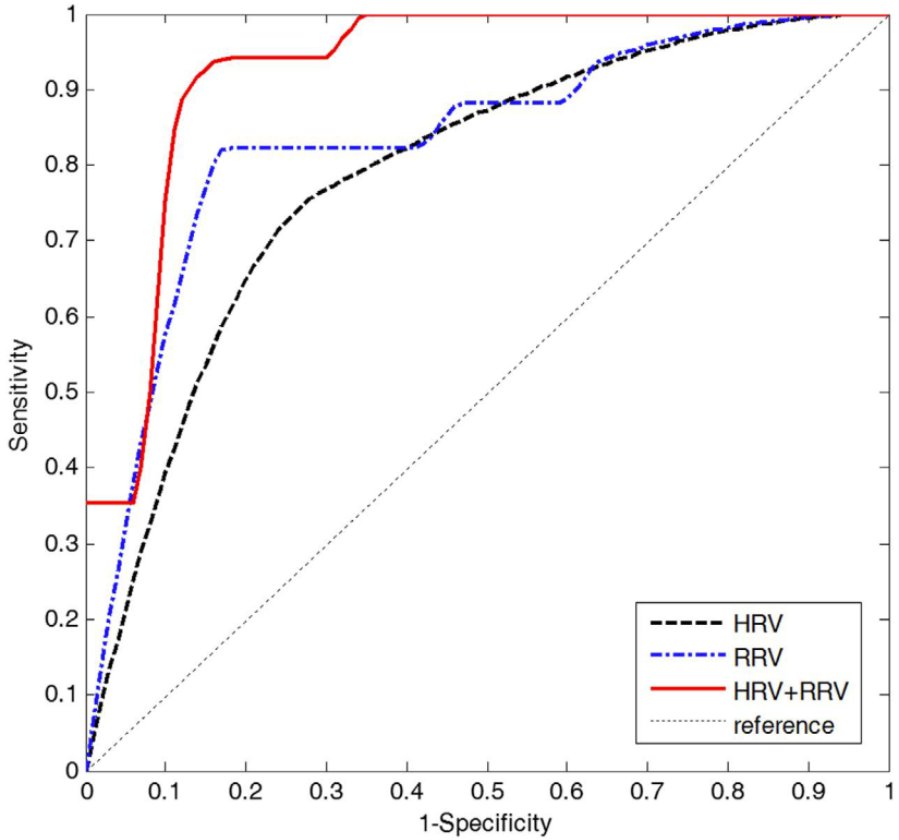
Li X et al. Integrated Machine Learning Approaches for Predicting Ischemic Stroke and Thromboembolism in Atrial Fibrillation. AMIA Annu Symp Proc. 2017 Feb 10;2016:799-807. PMID: 28269876; PMCID: PMC5333223.
Rahman T et al. COV-ECGNET: COVID-19 detection using ECG trace images with deep convolutional neural network. Health Inf Sci Syst. 2022 Jan 19;10(1):1. doi: 10.1007/s13755-021-00169-1. PMID: 35096384; PMCID: PMC8785028.

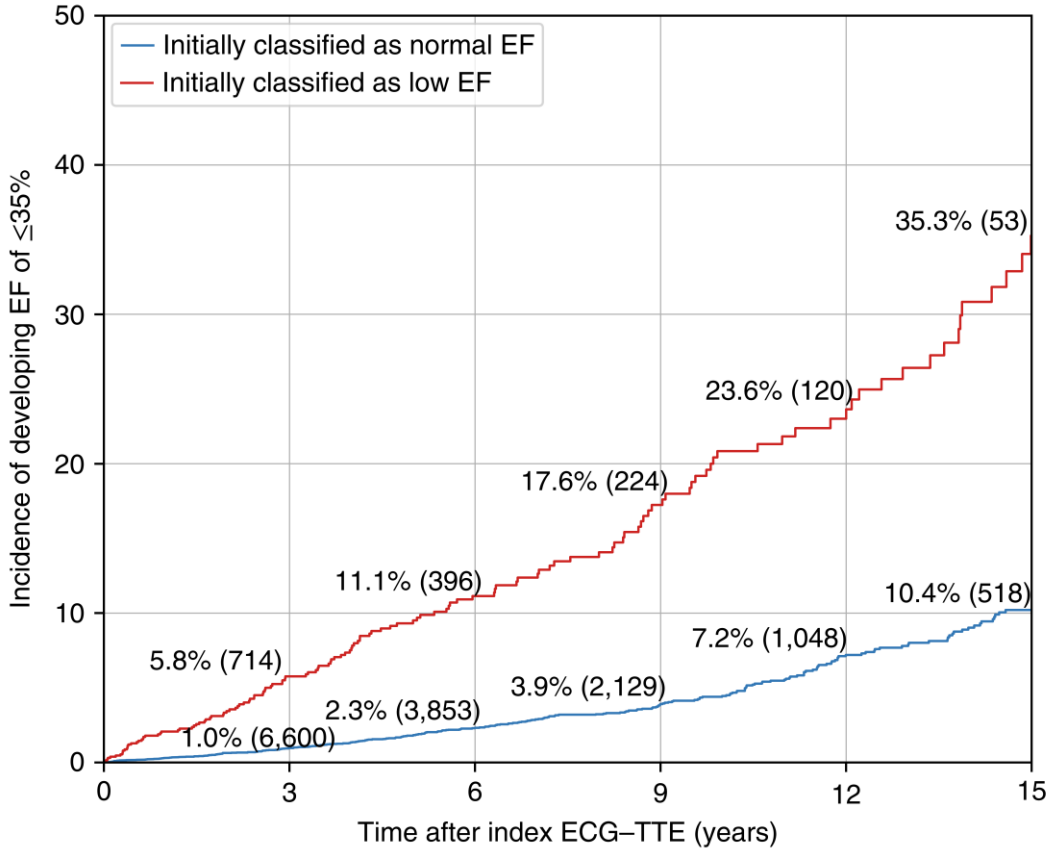
EKG
Prädiktion kardialer Krankheitsbilder

Model	AUROC	PPV	Specificity
Machine Learning	0.827 (**+19%**)	11.5% (**+77%**)	74.9% (+44%)
CHARGE-AF	0.725 (+4%)	7.9% (+22%)	61.0% (+17%)
Logistic Regression	0.695	6.5%	52.0%

Hill NR et al. Predicting atrial fibrillation in primary care using machine learning. PLoS One. 2019 Nov 1;14(11):e0224582. doi: 10.1371/journal.pone.0224582. PMID: 31675367; PMCID: PMC6824570.

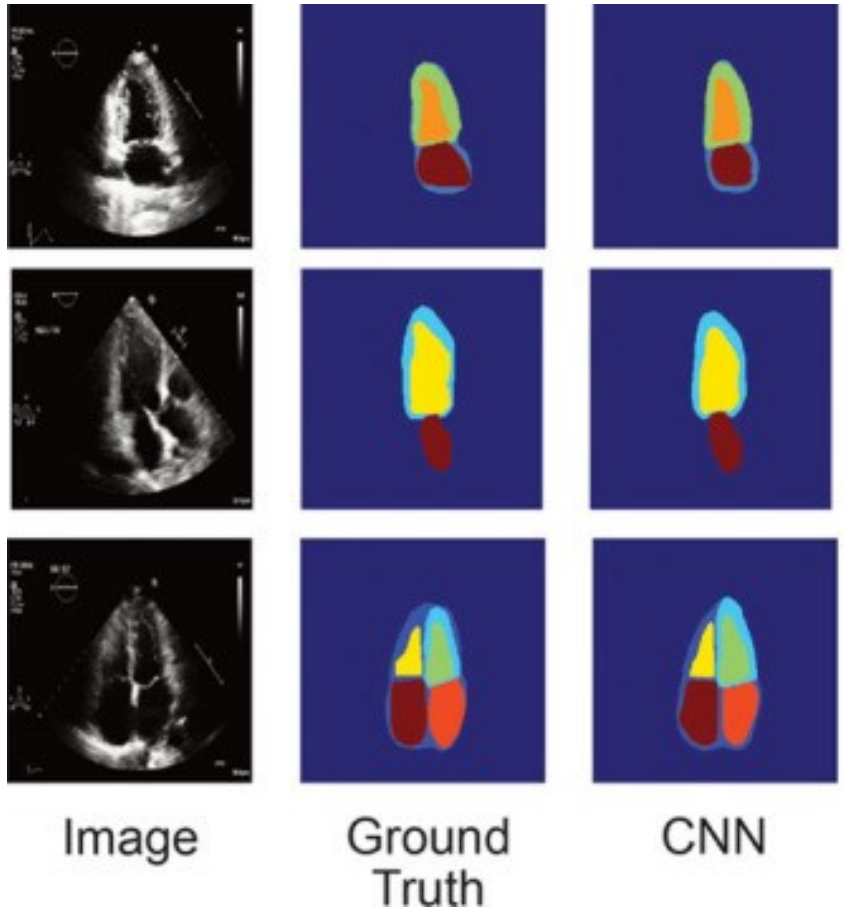
EKG
Prädiktion kardialer Krankheitsbilder

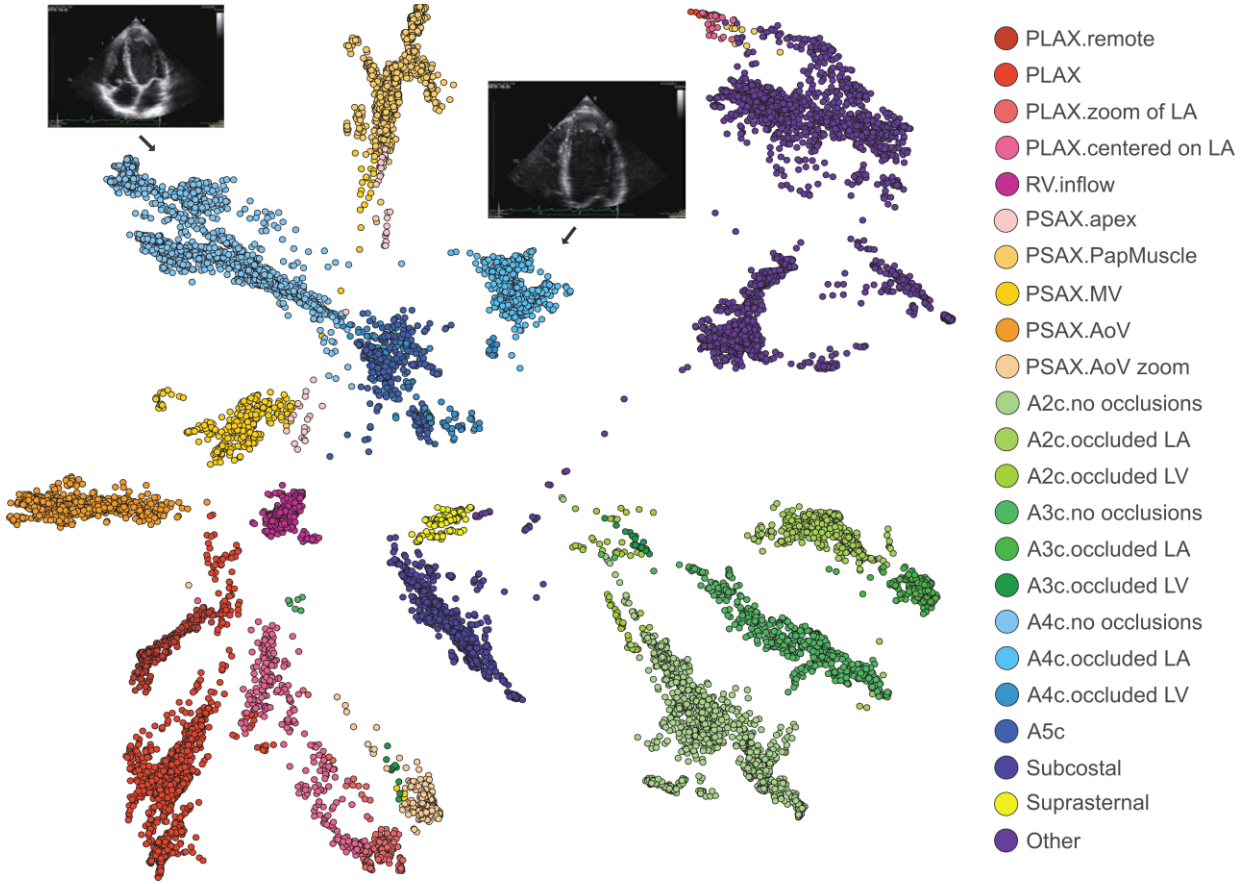




Lee H et al. Prediction of Ventricular Tachycardia One Hour before Occurrence Using Artificial Neural Networks. Sci Rep. 2016 Aug 26;6:32390. doi: 10.1038/srep32390. PMID: 27561321; PMCID: PMC4999952.
Attia ZI et al. Screening for cardiac contractile dysfunction using an artificial intelligence-enabled electrocardiogram. Nat Med. 2019 Jan;25(1):70-74. doi: 10.1038/s41591-018-0240-2. Epub 2019 Jan 7. PMID: 30617318.

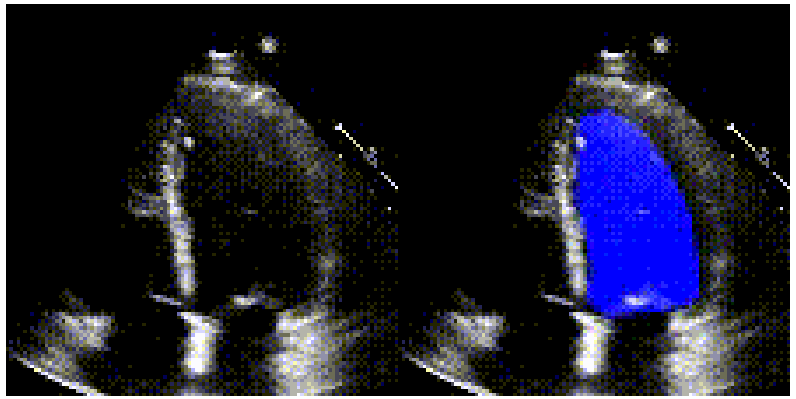
Echokardiografie
Segmentierung & Viewports

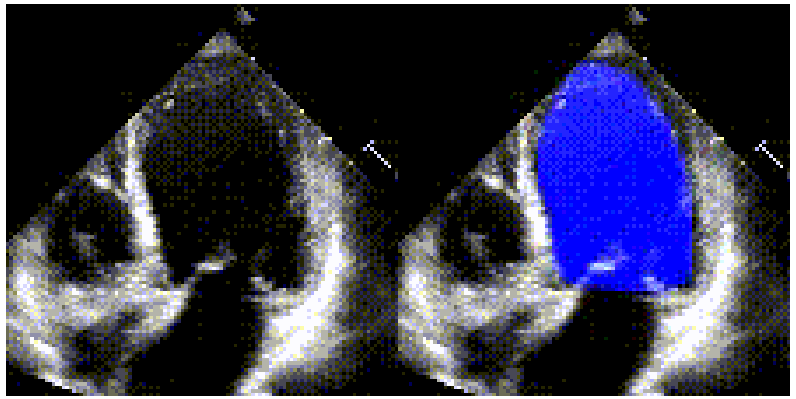


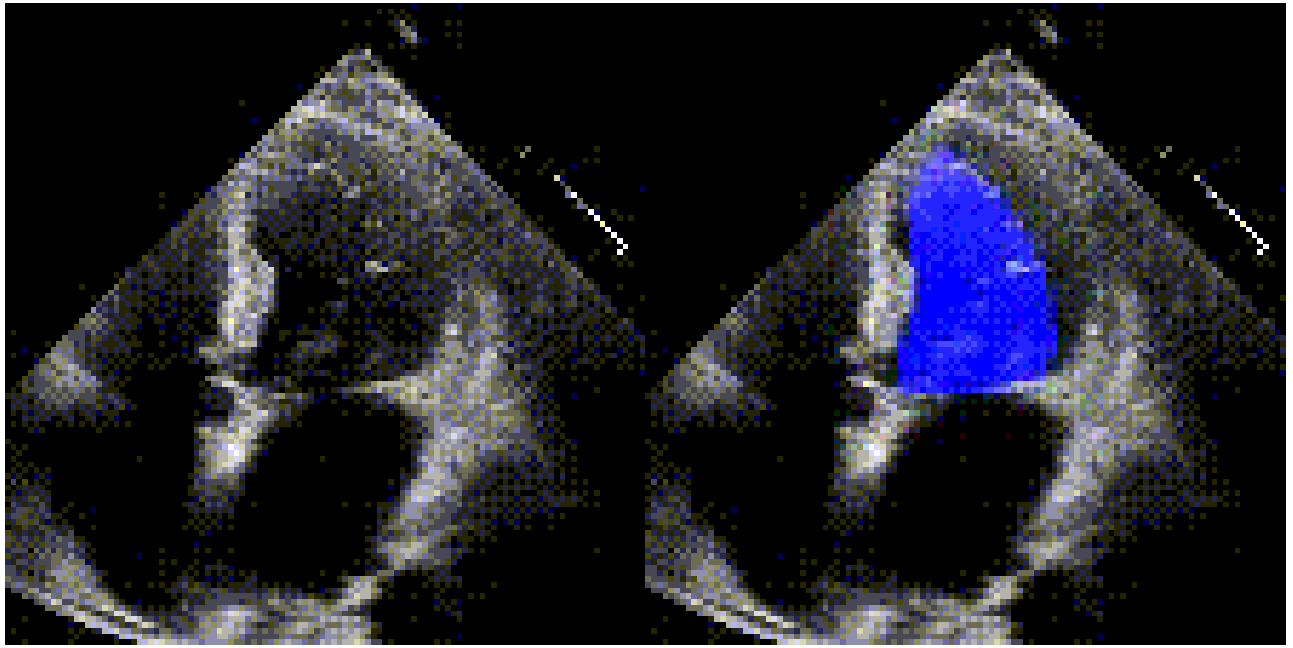


Zhang J et al. Fully Automated Echocardiogram Interpretation in Clinical Practice. Circulation. 2018 Oct 16;138(16):1623-1635. doi: 10.1161/CIRCULATIONAHA.118.034338. PMID: 30354459; PMCID: PMC6200386.

Echokardiografie
Ejektionsfraktion & Arrhythmie

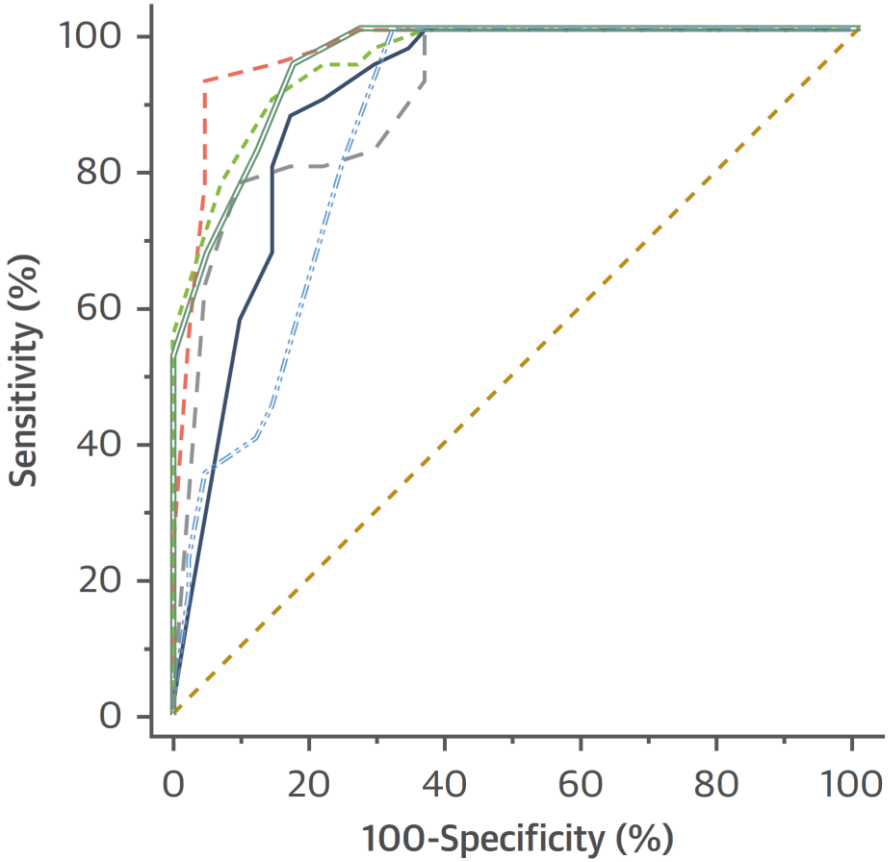


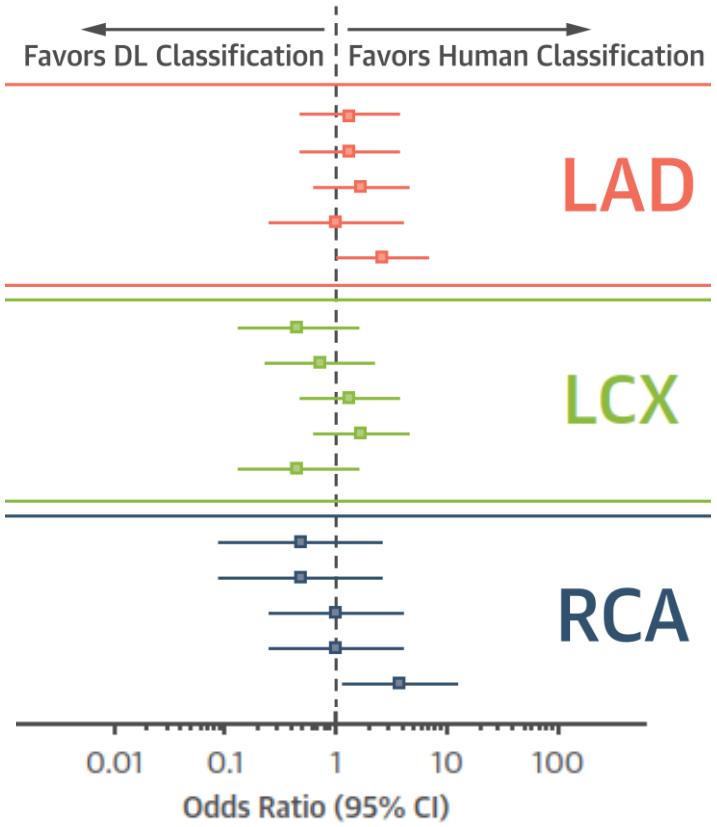


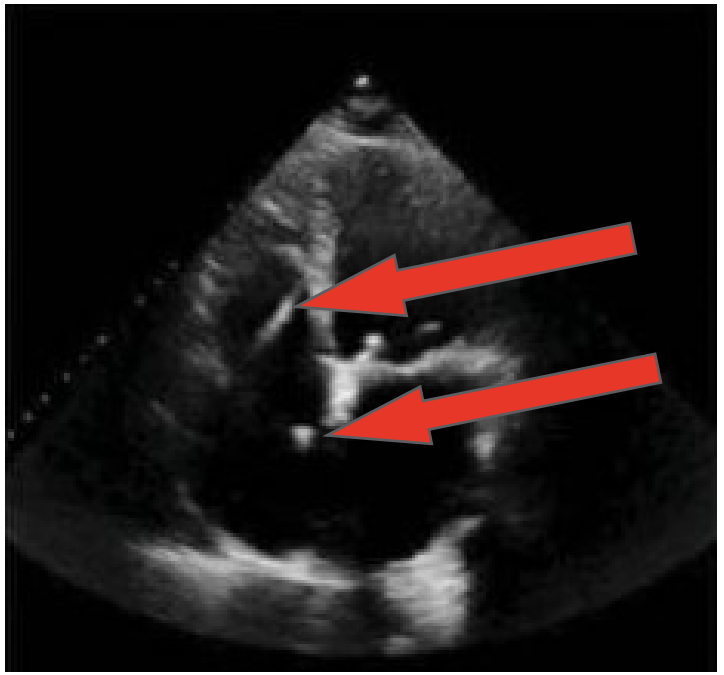


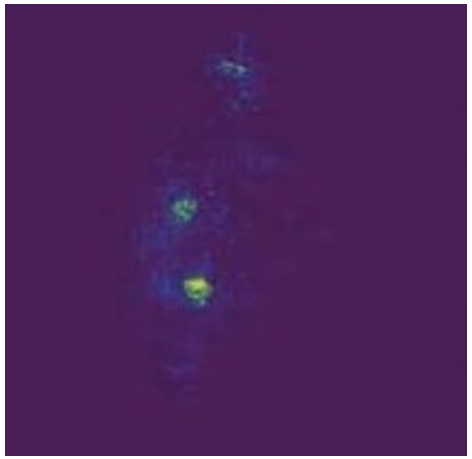
Ouyang D, He B, Ghorbani A, Yuan N, Ebinger J, Langlotz CP, Heidenreich PA, Harrington RA, Liang DH, Ashley EA, Zou JY. Video-based AI for beat-to-beat assessment of cardiac function. Nature. 2020 Apr;580(7802):252-256. doi: 10.1038/s41586-020-2145-8. Epub 2020 Mar 25. PMID: 32269341; PMCID: PMC8979576.

Echokardiografie
Dyskinesie & Schrittmacherdrähte



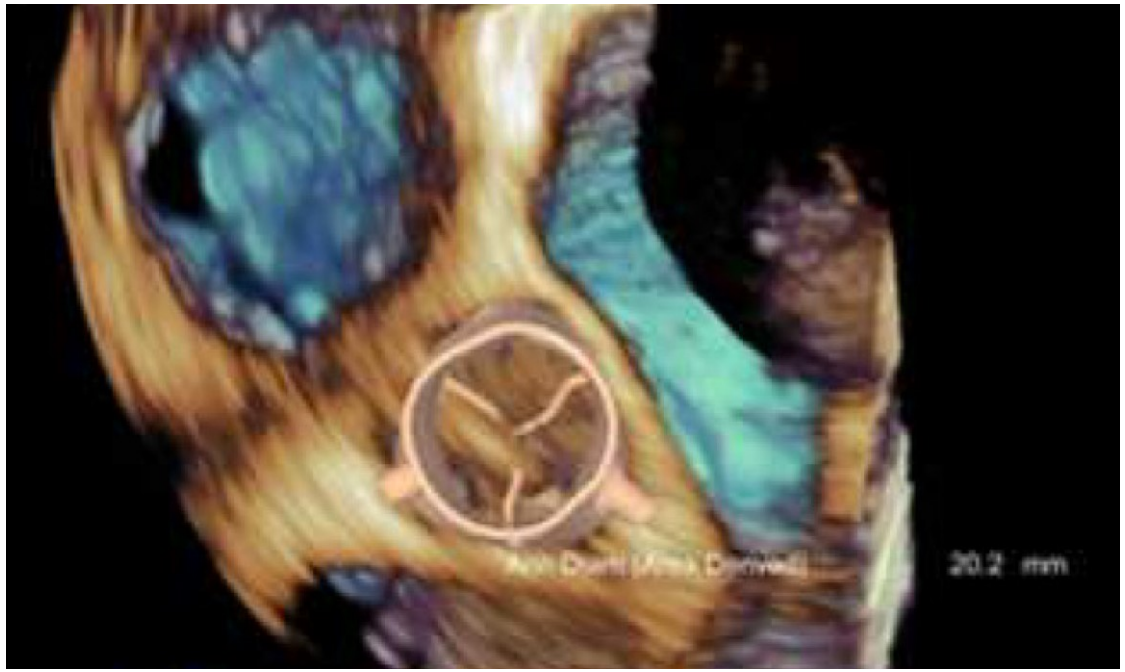


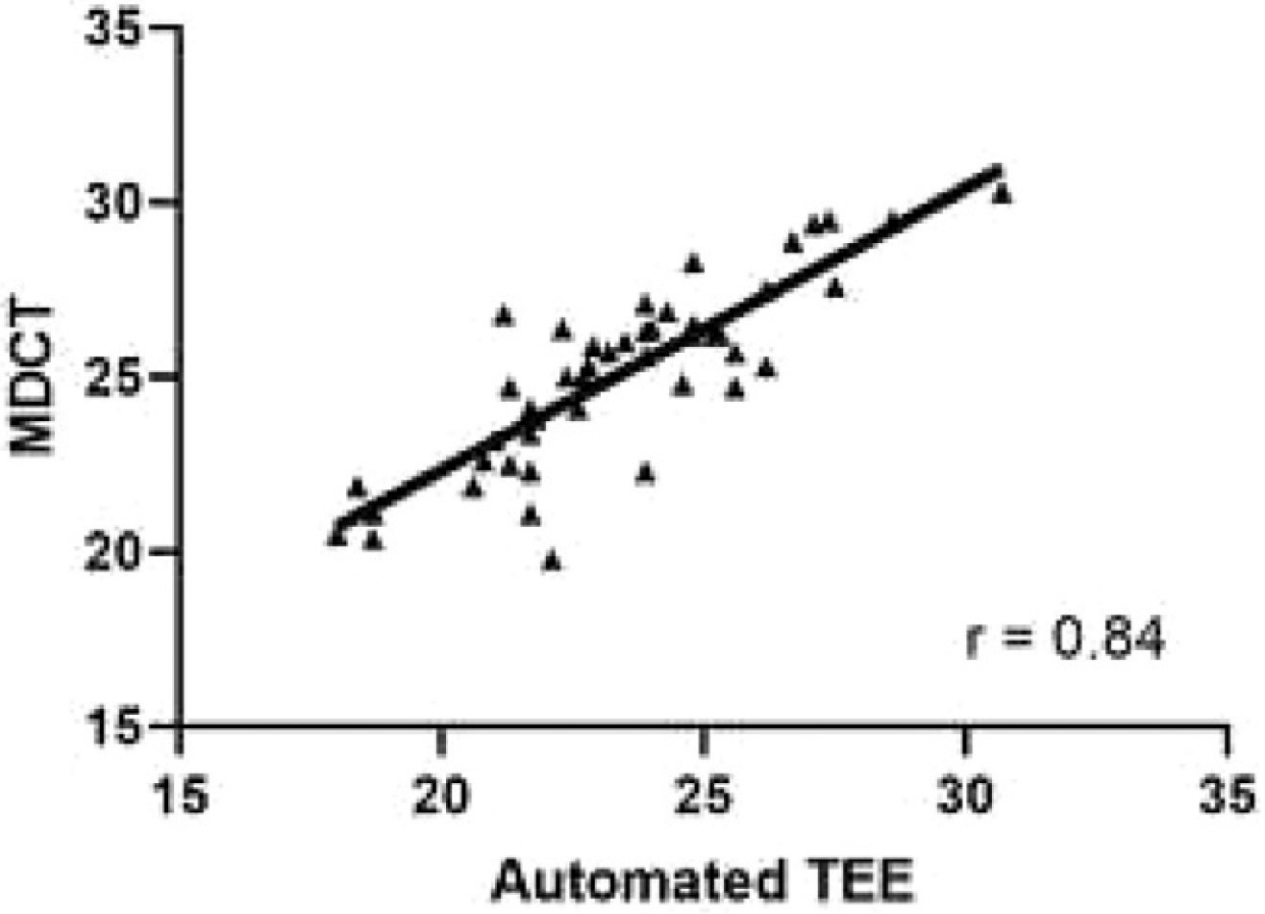




Ghorbani A, Ouyang D, Abid A, He B, Chen JH, Harrington RA, Liang DH, Ashley EA, Zou JY. Deep learning interpretation of echocardiograms. NPJ Digit Med. 2020 Jan 24;3:10. doi: 10.1038/s41746-019-0216-8. PMID: 31993508; PMCID: PMC6981156.

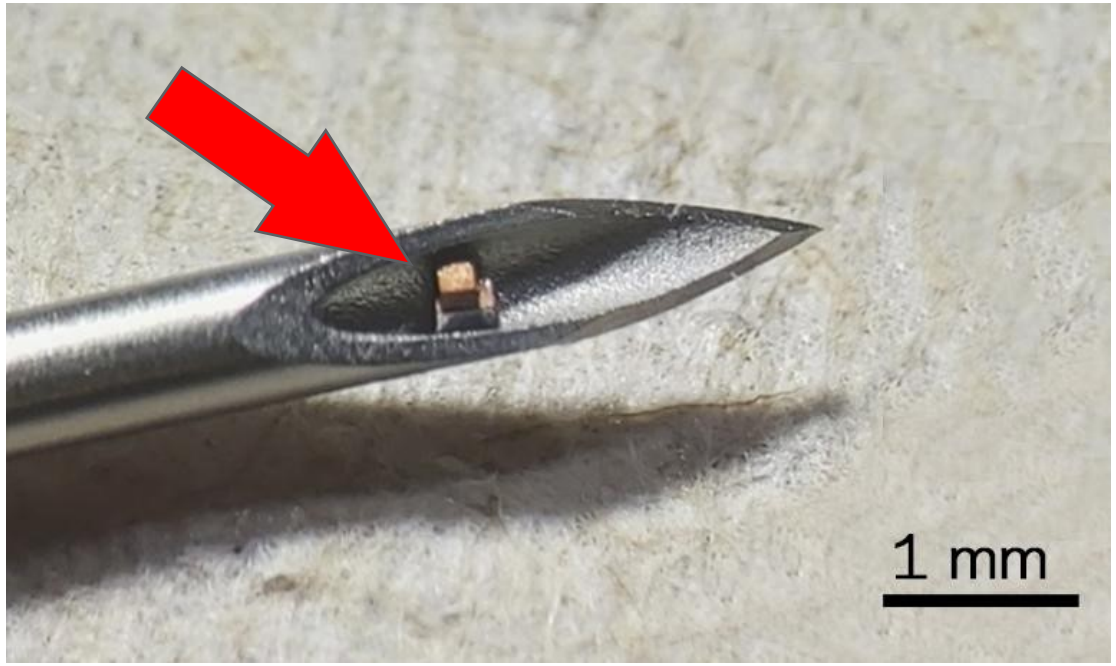
Echokardiografie
Vitien

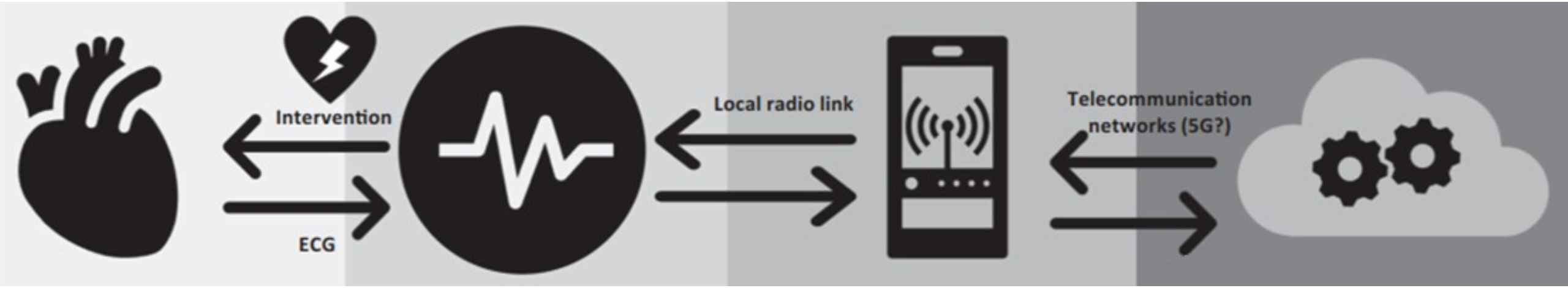




Thalappillil R, Datta P, Datta S, Zhan Y, Wells S, Mahmood F, Cobey FC. Artificial Intelligence for the Measurement of the Aortic Valve Annulus. J Cardiothorac Vasc Anesth. 2020 Jan;34(1):65-71. doi: 10.1053/j.jvca.2019.06.017. Epub 2019 Jun 17. PMID: 31351874.

Was bringt die Zukunft?





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