

ROMA

17-18 marzo 2026

NEURO  **Young** ^{5th edition}
next generation in neurologia

Intelligenza artificiale in epilessia: quale ruolo nella gestione del futuro?

Antonio Cerasa

CNR

<https://antoniocerasa.com>

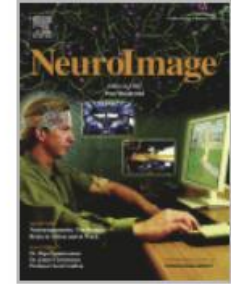
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VIA CRUCIS
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Automated MR image classification in temporal lobe epilepsy ☆

Niels K. Focke^a  , Mahinda Yogarajah^b, Mark R. Symms^b, Oliver Gruber^c, Walter Paulus^a,
John S. Duncan^b

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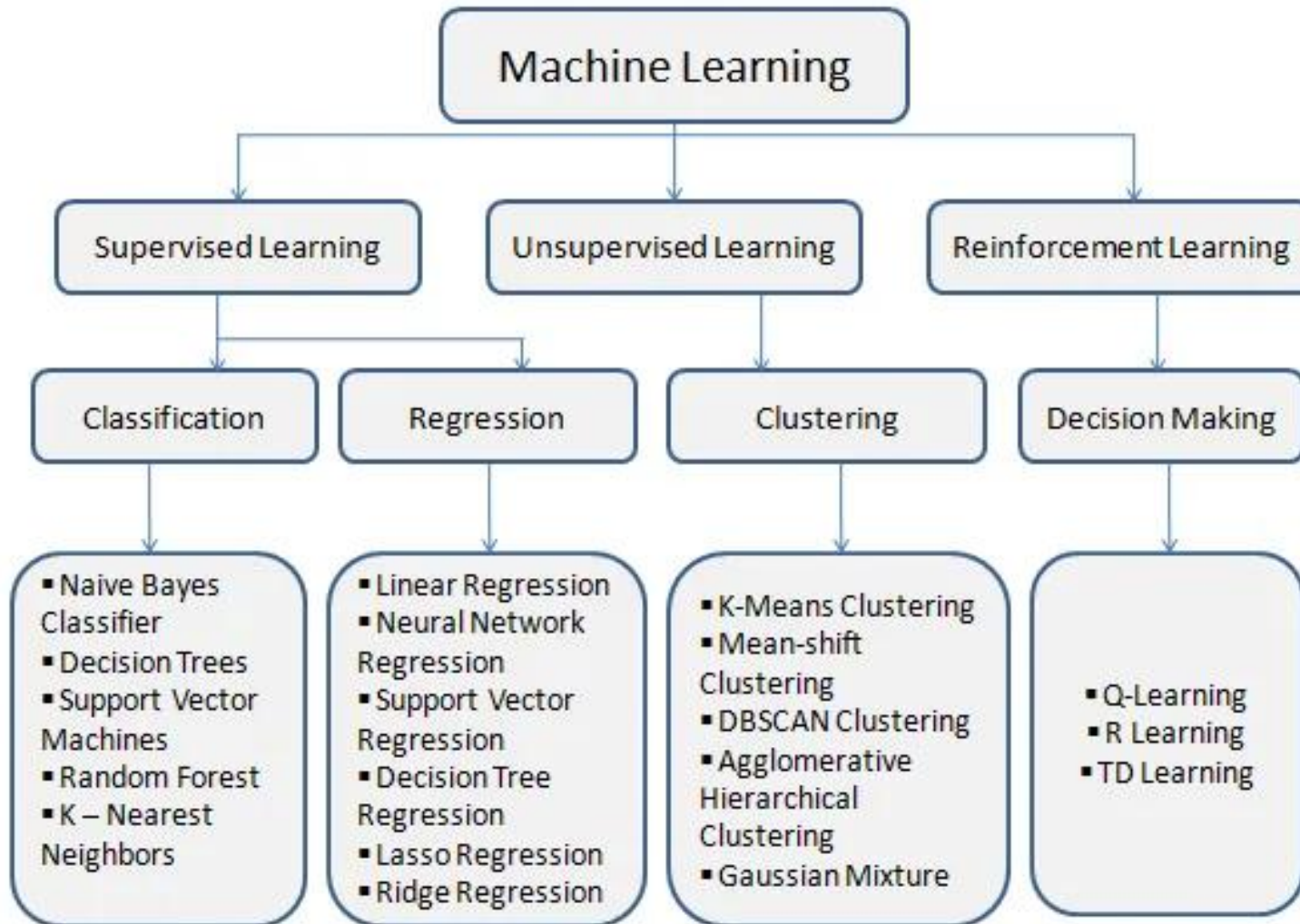
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AI In Medicine



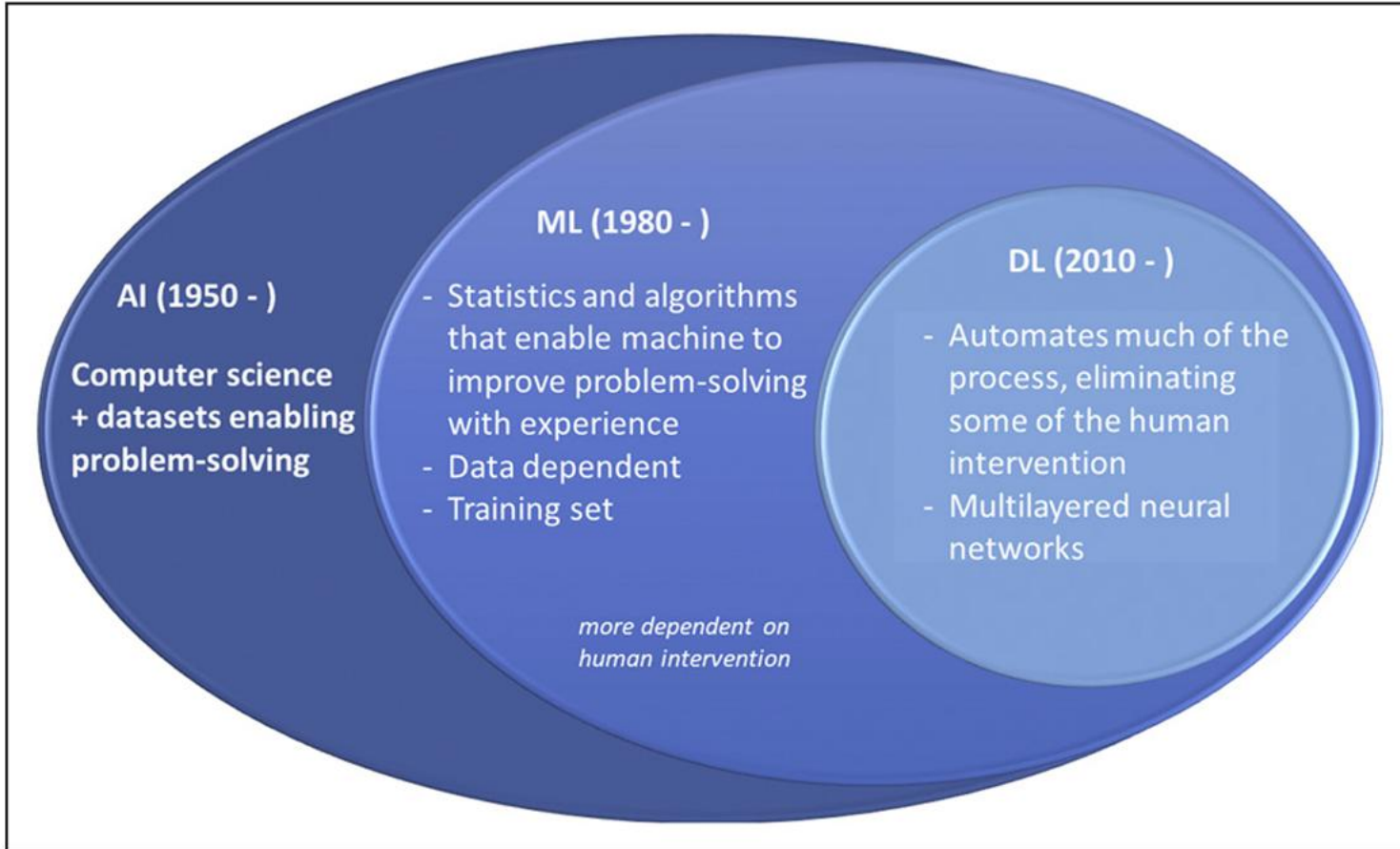
Artificial Intelligence in Medicine

Andrew L. Beam, Ph.D., Jeffrey M. Drazen, M.D., Isaac S. Kohane, M.D., Ph.D.,
Tze-Yun Leong, Ph.D., Arjun K. Manrai, Ph.D., and Eric J. Rubin, M.D., Ph.D.



AI In Medicine

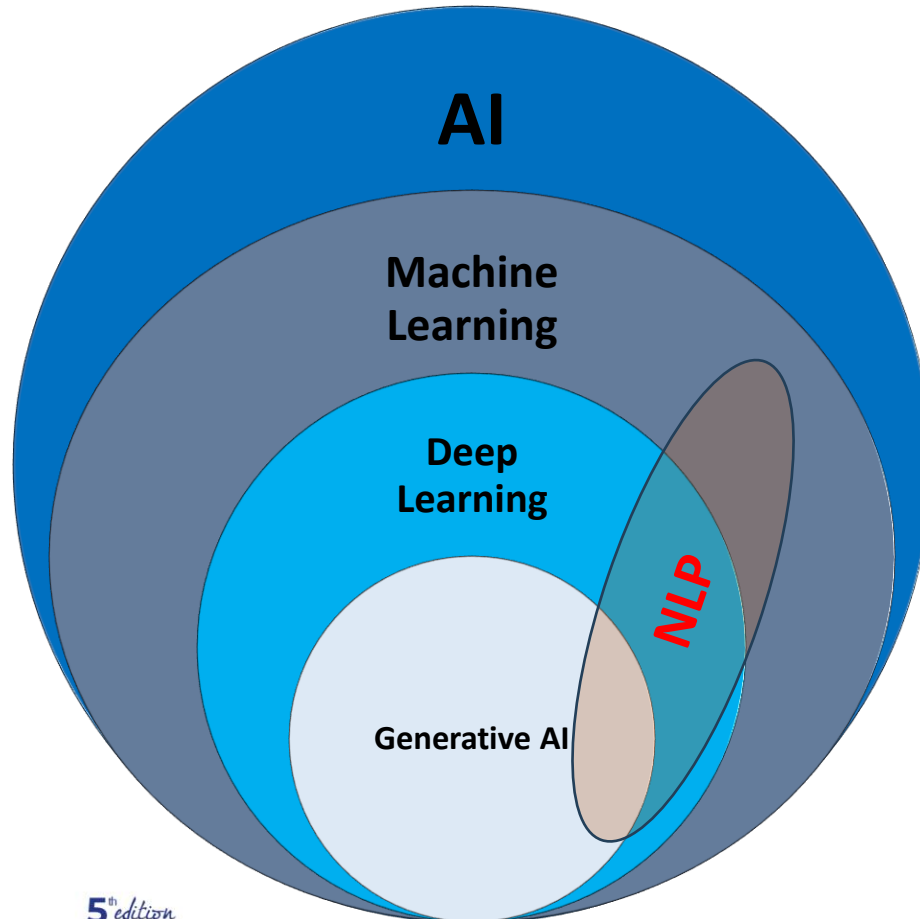
Machine Learning (ML) Vs Deep Learning (DL) algorithms



While ML is more data-driven, involves statistical models, and *depends on human intervention*, DL uses multiple layers of neural networks, **eliminating some human intervention**

AI In Medicine: Generative AI

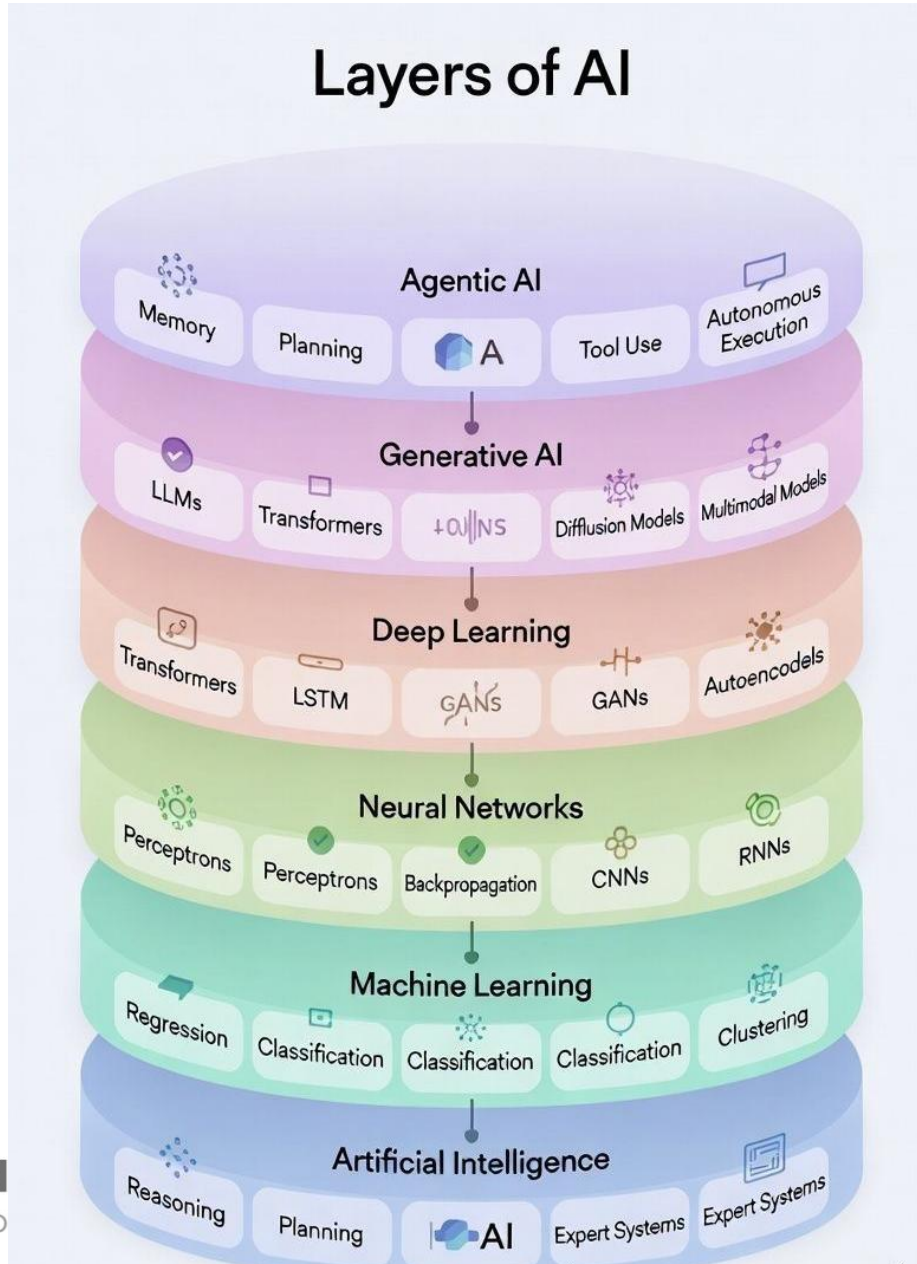
Generative AI (GenAI) Vs Natural Language processing (NLP) algorithms



GenAI: creates new content, such as text, images, audio and video. In NLP, GenAI is used for natural language generation (e.g. ChatGPT, Bard), but it can also extend beyond language

NLP: analyses, understands and manipulates human language. It is not limited to text generation, but also includes activities such as translation, entity recognition and sentiment analysis.

AI In Medicine: Agentic AI



GenAI: is designed to produce content based on human input. It responds to a prompt and generates outputs, but it does not act autonomously.

Agentic AI: is designed to achieve goals through autonomous action. It can plan steps, make decisions, and interact with tools or systems without continuous human prompting.

Generative AI generates answers; Agentic AI decides and does.

AI in Epilepsy: Machine Learning



TABLE 1 The 10 most productive countries in terms of research on ML applications in epilepsy.

Rank	Country	Articles	Citations	SCP	MCP	MCP ratio MCP
1	USA	279	7,470	198	81	0.29
2	China	268	4,126	214	54	0.201
3	India	116	2,178	89	27	0.233
4	Australia	54	1,376	30	24	0.444
5	Canada	48	1,136	23	25	0.521
6	United Kingdom	47	1,089	21	26	0.553
7	Germany	40	858	22	18	0.45
8	Turkey	31	1,057	30	1	0.032
9	Italy	30	590	21	9	0.3
10	Saudi Arabia	26	785	13	13	0.5

Huo et al., Front Neurol 2024

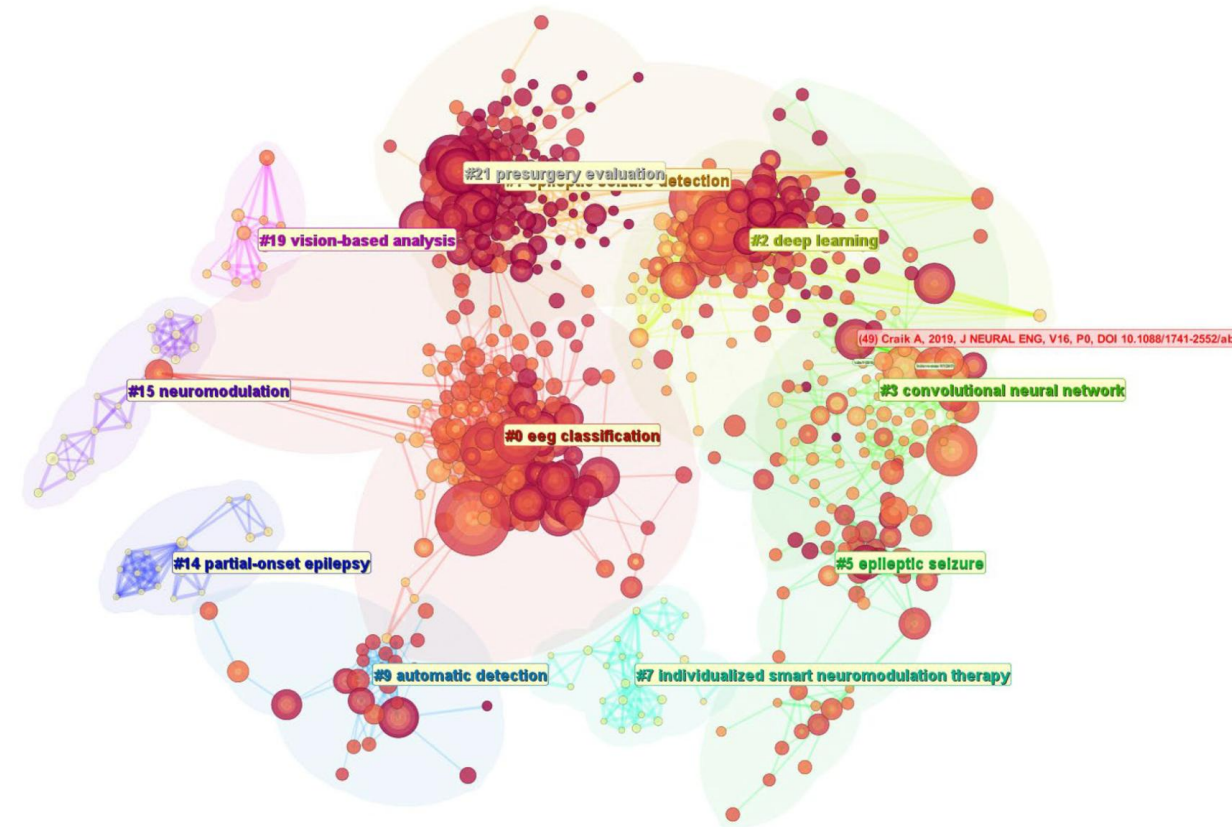
AI in Epilepsy: Deep Learning

Yiman & Wenqi, Digital Health 2025

Table 1. Top 10 productive countries regarding study on DL applications in epilepsy.

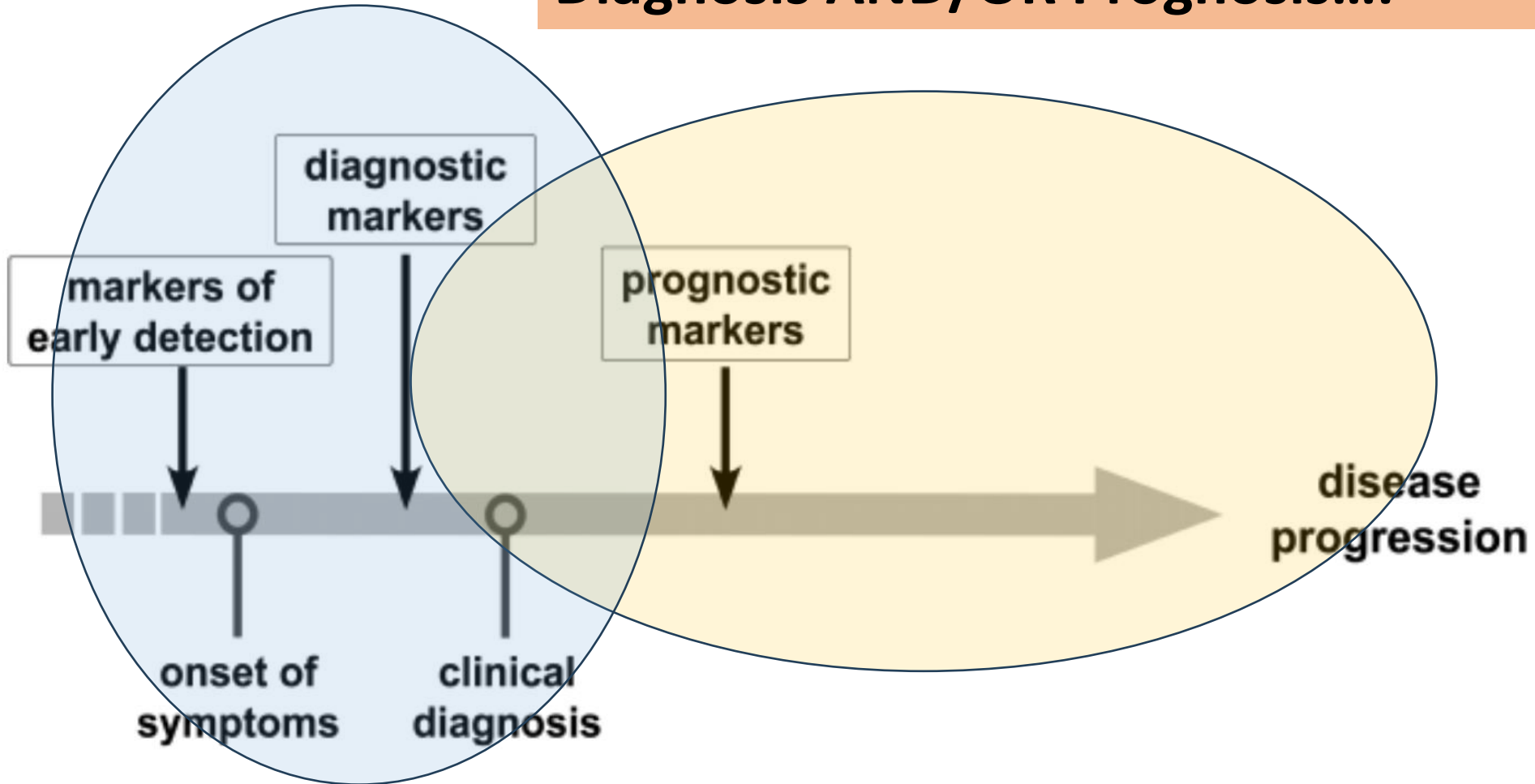
Rank	Country	Citations	Articles	Articles %	SCP	MCP	MCP %
1	China	5330	331	26.1	268	63	19
2	USA	9478	204	16.1	153	51	25
3	India	2689	154	12.2	126	28	18.2
4	Australia	2941	56	4.4	25	31	55.4
5	Korea	1435	42	3.3	32	10	23.8
6	Canada	2289	34	2.7	17	17	50
7	Germany	2350	34	2.7	17	17	50
8	Iran	1415	29	2.3	14	15	51.7
9	United Kingdom	880	29	2.3	11	18	62.1
10	France	786	24	1.9	16	8	33.3

DL-based seizure detection, prediction, and epilepsy management are key research hotspots.



AI In Neurology

Diagnosis AND/OR Prognosis....



AI algorithms have been applied for improving early detection of markers of disease or for improving classification of clinical phenotypes.

In the prognosis domain, AI is used for extracting reliable markers of disease and to improve prediction of outcome.

AI in Epilepsy: Diagnosis



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NeuroImage: Clinical

journal homepage: www.elsevier.com/locate/ynicl

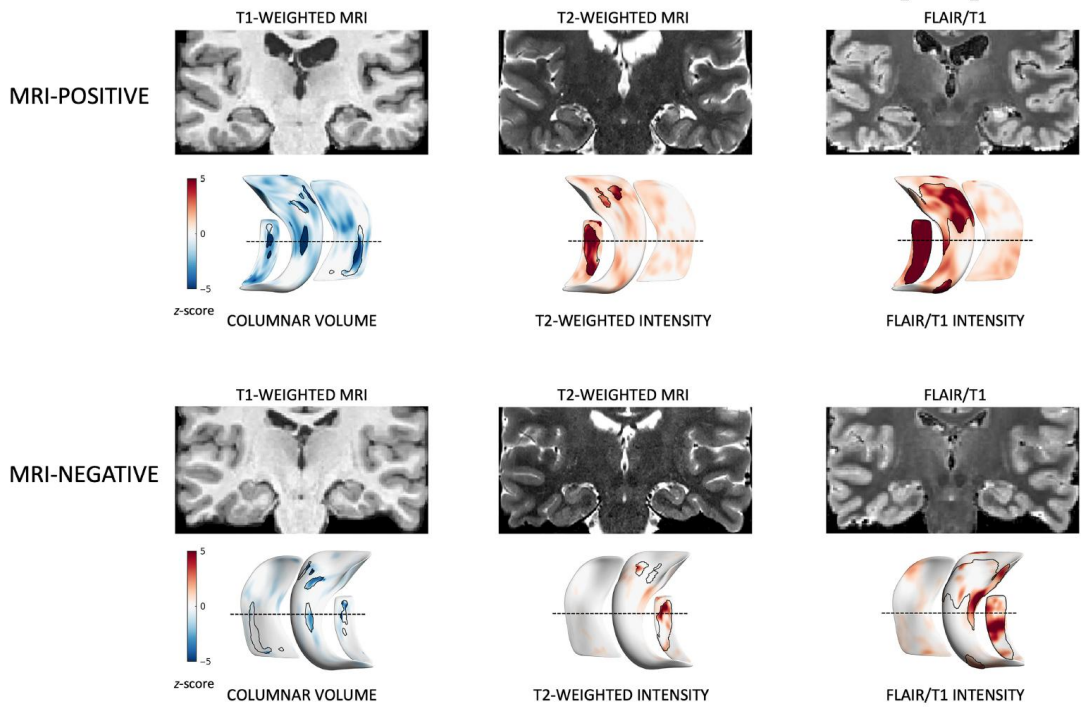


Artificial intelligence for classification of temporal lobe epilepsy with ROI-level MRI data: A worldwide ENIGMA-Epilepsy study

Ezequiel Gleichgerrcht ^{a,*}, Brent C. Munsell ^{b,c}, Saud Alhusaini ^{d,e}, Marina K.M. Alvim ^f,

BERNASCONI ET AL.

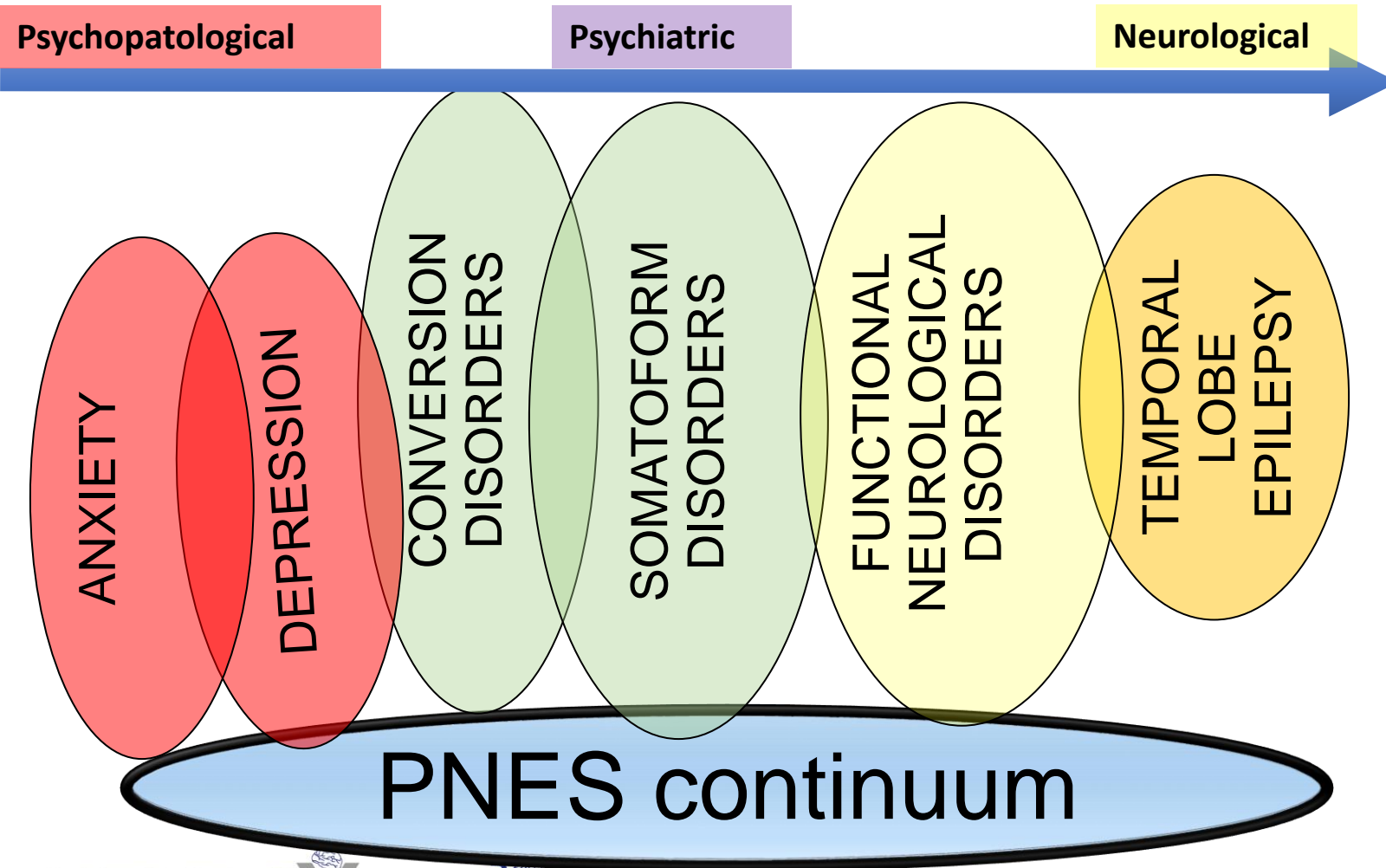
Epilepsia ³



1) TLE diagnosis HS

- Using ML/DL models on structural and diffusion MRI data, they found a similar accuracy in discriminating TLE+ from TL- and HC (66–74%)

AI in Epilepsy: Diagnosis



2) PNES

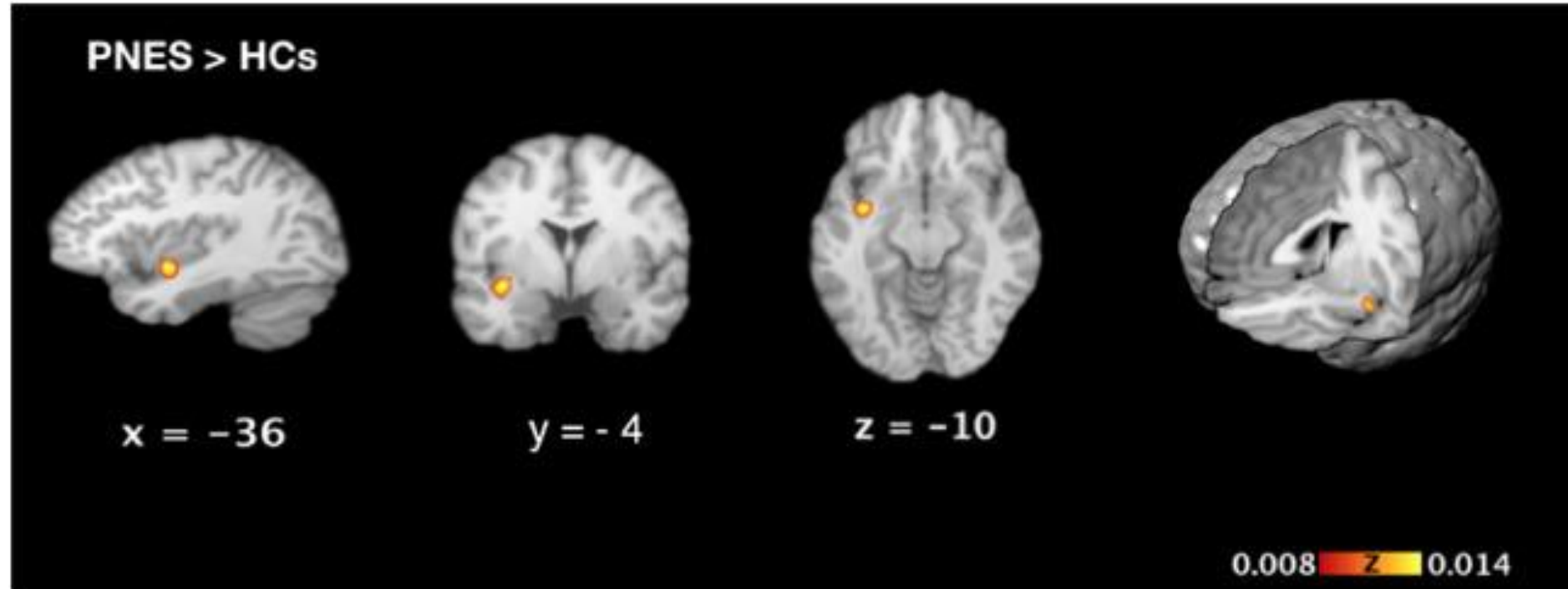
PNES are *episodic functional neurological symptoms* which superficially resemble epileptic seizures but which are not caused by epileptic discharges.

Current medical nosologies class PNES episodes as manifestation of **conversion/somatoform (DSM 5)** or **dissociative disorder (ICD-10)** without providing any additional insights into the likely neurobiological underpinnings of this “**MEDICALLY UNEXPLAINED**” disorder

Table 3
Neuroimaging studies of PNES and summary of results.

Study	Design	Imaging
Arthuis et al. (2015)	Retrospective	FDG-PET
Bolen et al. (2016)	Retrospective	sMRI
Devinsky et al. (2001)	Retrospective	sMRI, CT, EEG
Ding et al. (2013)	Case control	rsfMRI, DTI
Ding et al. (2014)	Case control	fMRI
Ettinger et al. (1998)	Case control	SPECT, interictal, postictal
Hernando et al. (2015)	Case control	DTI
Labate et al. (2012)	Case control	sMRI, CTH, VBM
Lee et al. (2015)	Retrospective	DTI
Li et al. (2014)	Case control	rsfMRI
Li et al. (2015)	Case control	rsfMRI
Neiman et al. (2009)	Retrospective	SPECT, SISOM
Reuber et al. (2002)	Retrospective	sMRI, EEG
Ristić et al. (2015)	Case control	sMRI, CTH
van der Kruijs et al. (2012)	Case control	rsfMRI, event-related fMRI
van der Kruijs et al. (2014)	Case control	rsfMRI
Varma et al. (1996)	Case control	SPECT, HMPAO

AI in Epilepsy: Diagnosis



2) PNES

Common Neural abnormality in PNES patients (Marco Mcsweeneya et al., 2017)

tion

AI in Epilepsy: Diagnosis

Epilepsy & Behavior 87 (2018) 167–172

Contents lists available at ScienceDirect

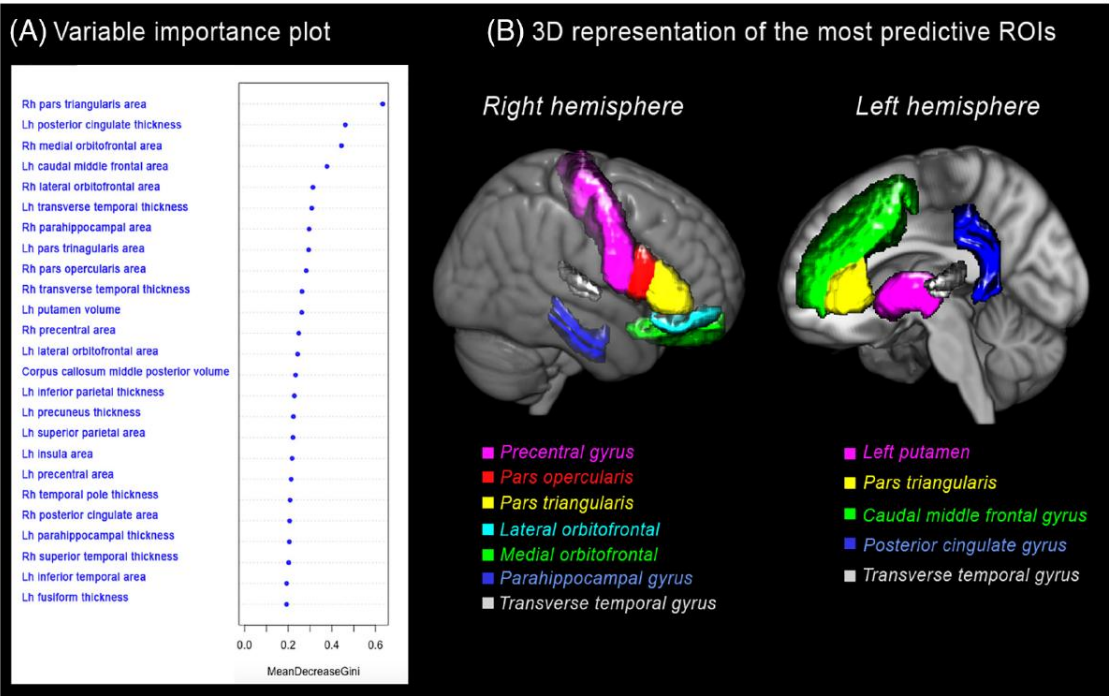
Epilepsy & Behavior

journal homepage: www.elsevier.com/locate/yebeh



The application of artificial intelligence to understand the pathophysiological basis of psychogenic nonepileptic seizures☆

Roberta Vasta^a, Antonio Cerasa^{b,c}, Alessia Sarica^a, Emanuele Bartolini^d, Iolanda Martino^a, Francesco Mari^d, Tiziana Metitieri^d, Aldo Quattrone^{a,b}, Antonio Gambardella^e, Renzo Guerrini^{d,f,*}, Angelo Labate^{e,**}



2) PNES

74.5% OF ACCURACY IN DISTINGUISHING PNES FROM CONTROLS.

AI in Epilepsy: Diagnosis

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RESEARCH ARTICLE | September 14, 2021

Check for updates

Multicenter Validation of a Deep Learning Detection Algorithm for Focal Cortical Dysplasia

This article has been corrected. [VIEW CORRECTION](#)

[VIEW EDITORIAL](#)

Ravnoor Singh Gill, PhD-cand , Hyo-Min Lee, PhD-cand, Benoit Caldaïrou, PhD, Seok-Jun Hong, PhD, Carmen Barba, MD , Francesco Deleo, MD , Ludovico D'Incerti, MD, ... [SHOW ALL ...](#), and Andrea Bernasconi, MD | [AUTHORS INFO & AFFILIATIONS](#)

3) Focal cortical dysplasia (FCD)

FCDs are often undetected on conventional MRI and the pre-surgical diagnosis depends heavily on the expertise of the examiner.

DL using multimodal MRI data could reliably identify previous MRI-negative FCD lesions (sensitivity 93%, specificity 89%), suggesting that DL shows promise for assisting non-expert clinicians in this challenging diagnosis.

AI in Epilepsy: Diagnosis

JAMA Neurology | **Original Investigation**









Automated Interpretation of Clinical Electroencephalograms Using Artificial Intelligence

Jesper Tveit, PhD; Harald Aurlen, MD, PhD; Sergey Plis, PhD; Vince D. Calhoun, PhD; William O. Tatum, DO; Donald L. Schomer, MD; Vibeke Arntsen, MD; Fieke Cox, MD, PhD; Firas Fahoum, MD; William B. Gallentine, DO; Elena Gardella, MD, PhD; Cecil D. Hahn, MD; Aatif M. Husain, MD; Sudha Kessler, MD; Mustafa Aykut Kural, MD, PhD; Fábio A. Nascimento, MD; Hatice Tankisi, MD, PhD; Line B. Ulvin, MD; Richard Wennberg, MD, PhD; Sándor Beniczky, MD, PhD

RESEARCH ARTICLE

Epilepsia™

Artificial intelligence-enhanced epileptic seizure detection by wearables

Shuang Yu¹  | Rima El Atrache²  | Jianbin Tang¹  | Michele Jackson²  | Adam Makarucha¹ | Sarah Cantley² | Theodore Sheehan²  | Solveig Vieluf²  | Bo Zhang² | Jeffrey L. Rogers³ | Iven Mareels¹ | Stefan Harrer^{1,4}  | Tobias Loddenkemper² 

4) EEG

- Can an artificial intelligence (AI) model be trained to interpret routine clinical electroencephalograms (EEGs) with accuracy equivalent to that of human experts?
- The SCORE-AI achieved high accuracy, with an **AUC between 0.89 and 0.96** for the different categories of EEG abnormalities, and performance similar to human experts.

AI in Epilepsy: Diagnosis

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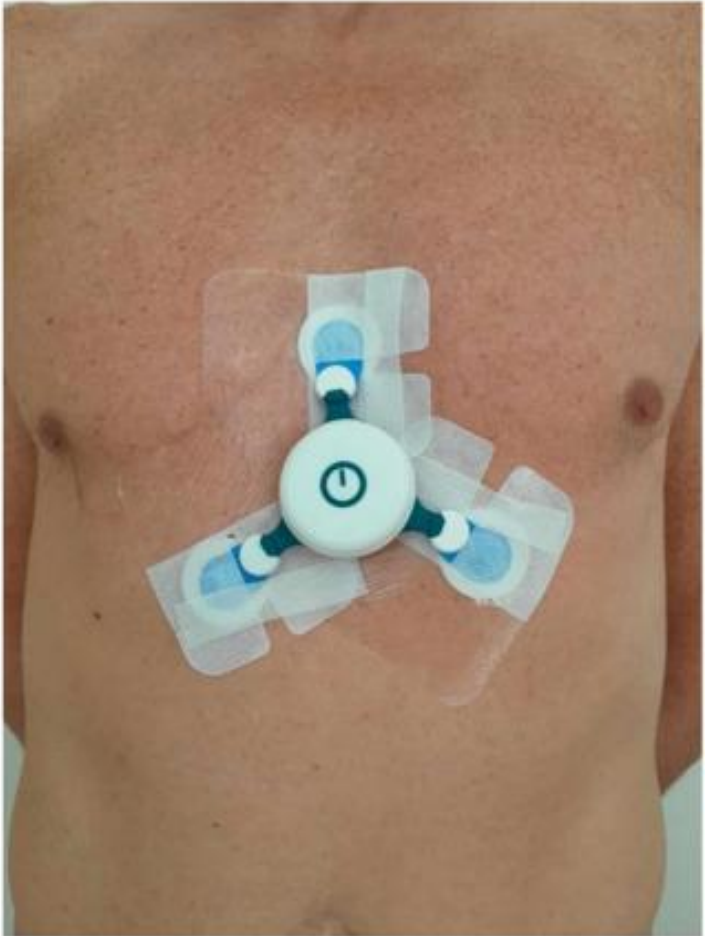
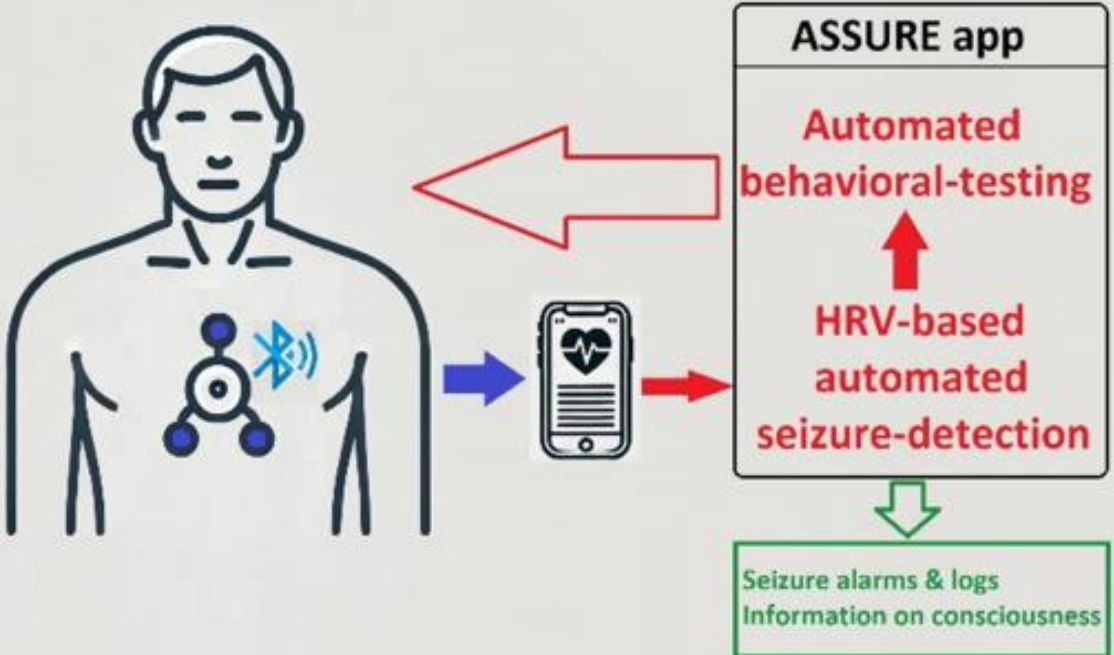
ARTICLES · Volume 120, 105952, October 2025 · Open Access [Download Full Issue](#)

Seizure detection using wearable electrocardiogram connected to a smartphone: a phase 3 clinical validation study

[Jesper Jeppesen](#)^{a,b} · [Jakob Christensen](#)^{b,c} · [Oliver Ahrenfeldt Petersen](#)^d · [Sarah Fenger](#)^d · [Sidsel Armand Larsen](#)^e · [Stephan Wüstenhagen](#)^e · et al. [Show more](#)

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- Sensitivity across all 42 seizures was 90.5%.
- All bilateral tonic-clonic seizures were detected, while sensitivity for other focal seizures was 82.6%
- Mean false alarm rate was 2.5/day
- Device deficiency time was 1.8% and signal loss was 4.5%

AI in Epilepsy: Diagnosis



frontiers | Frontiers in Neuroinformatics

TYPE Original Research
PUBLISHED 15 March 2024
doi 10.3389/fninf.2024.1324981

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Automated analysis and detection of epileptic seizures in video recordings using artificial intelligence

Pragya Rai^{*†}, Andrew Knight^{1,2}, Matias Hiillos¹, Csaba Kertész¹,
Elizabeth Morales¹, Daniella Terney³, Sidsel Armand Larsen³,
Tim Østerkjerhuus⁴, Jukka Peltola^{2,5} and Sándor Beniczky^{3,4,6}

5) Video Recording

The performance of a contactless, marker-free, **video-based motor seizure detection** system was compared to a standard video-EEG monitoring.

Accuracy:

1. Seizure tonic–clonic: 95.2%
2. Automatisms: 86.7%
3. PNES: 98%

AI in Epilepsy: Prognosis

The impact of epilepsy surgery on the structural connectome and its relation to outcome

Peter N. Taylor^{a,b,c,*}, Nishant Sinha^{a,b}, Yujiang Wang^{a,b,c}, Sjoerd B. Vos^{d,e}, Jane de Tisi^c, Anna Miserocchi^c, Andrew W. McEvoy^c, Gavin P. Winston^{c,e,1}, John S. Duncan^{c,e,1}

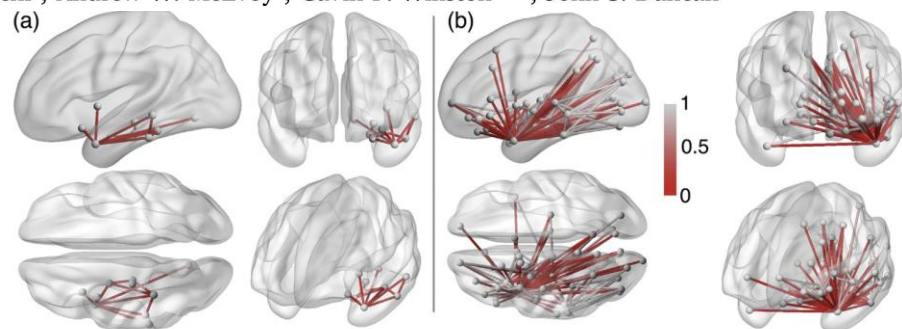
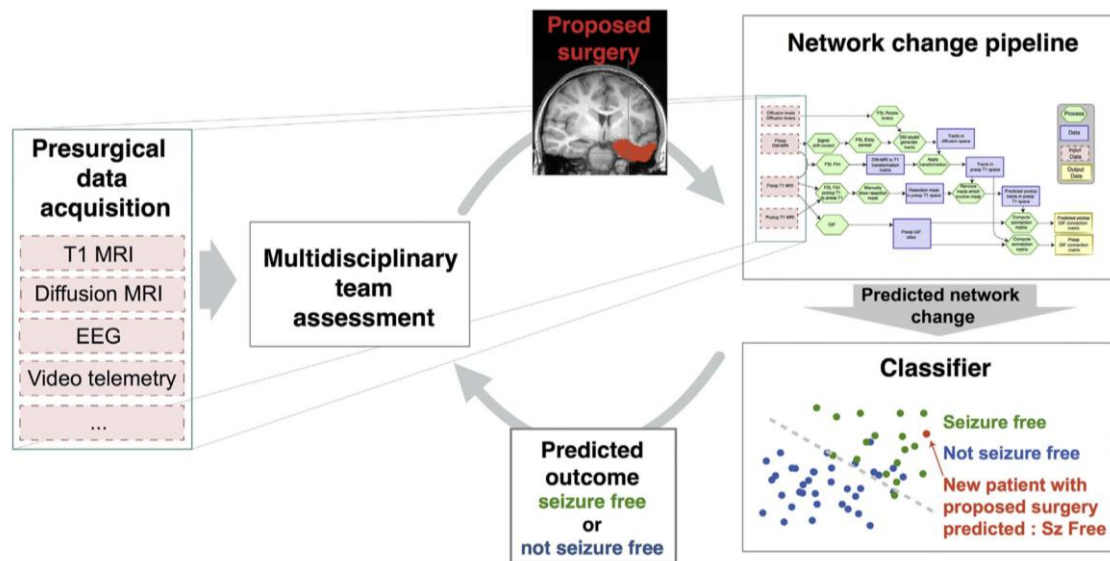


Fig. 5. Connectivity is disrupted by surgery. (a) Connections which are reduced in strength following change to a connection following surgery is a 0% (10% strength in the majority of patients (as opposed to 10%)



1) Neuroimaging predictors

- Structural and functional alterations beyond the mesial temporal lobe may contribute to negative seizure outcome
- Whole-brain WM microstructural features derived from DTI achieve high sensitivity (70%–86%), but modest specificity (35%–70%).

Structural connectome features have generally shown **high** predictive value for favorable post-surgical outcome, with an **AUC of .88**, but *specificity* for prediction of seizure relapse is low (**29%–54%**)

AI in Epilepsy: Prognosis

JAMA Neurology Search All Enter Search Term

This Issue Views **12,126** Citations **35** Altmetric **108**

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Original Investigation FREE

August 29, 2022

Development and Validation of a Deep Learning Model for Predicting Treatment Response in Patients With Newly Diagnosed Epilepsy

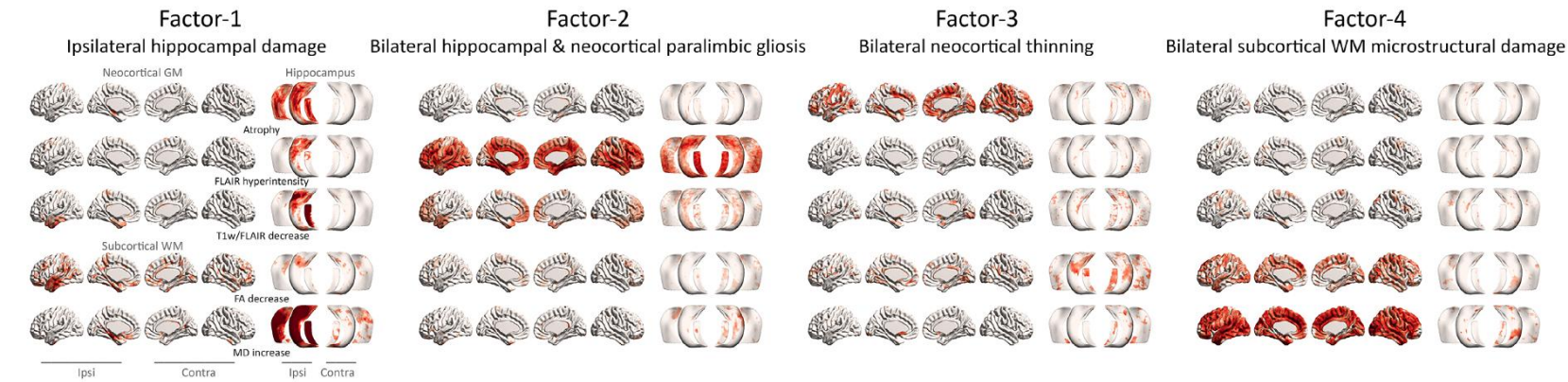
Haris Hakeem, MD^{1,2}; Wei Feng, MS^{3,4}; Zhibin Chen, PhD, CStat¹; et al

2) Omics data

- Can a machine learning model predict treatment success of the initial antiseizure medication?
- The DL model had accuracy ranging from 0.52 to 0.60 Number of pretreatment seizures, presence of psychiatric disorders, and EEG-brain imaging features (positive signs) were the most important clinical variables for predicted outcomes in both models

AI in Epilepsy: Prognosis

(A)

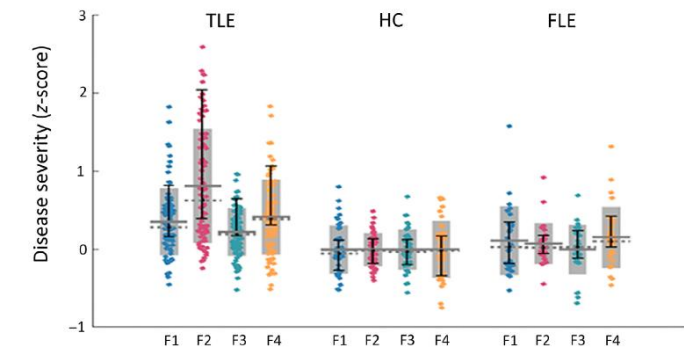


3) SubTyping

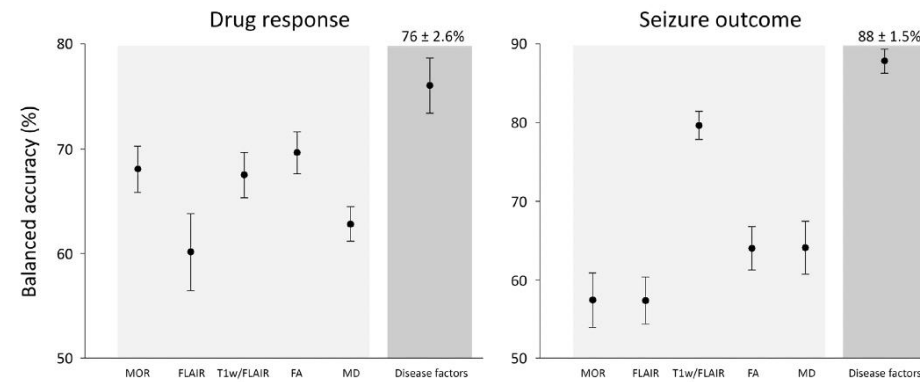
Patients similar diagnosis can be characterized by **different outcome trajectory**

Classifiers trained on the patients' factor composition predicted response to anti-seizure medications (76% accuracy) and seizure outcome (88%) (Lee et al., Brain 2022)

(B)



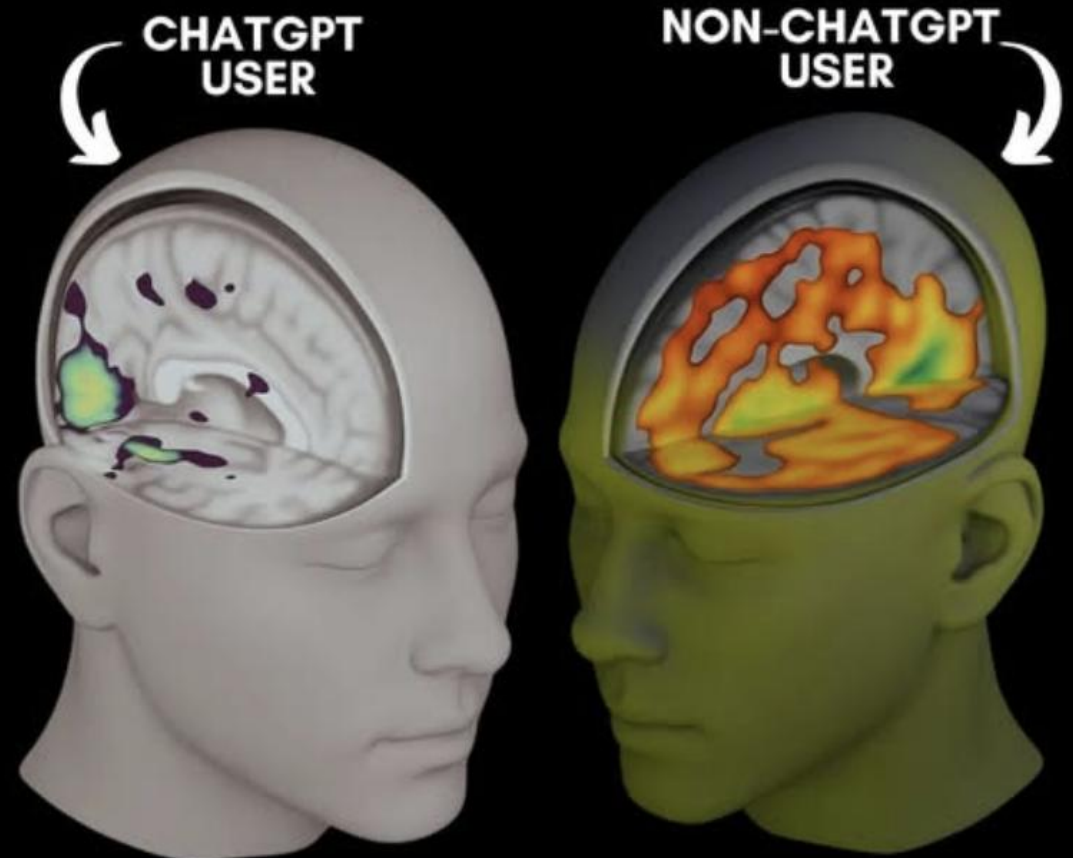
(C)



AI In Medicine: Generative AI

[Nataliya Kosmyrna et al., arXiv:2506.08872](#)

Scientists just completed the first **brain scan study** of **ChatGPT users**. The results are terrifying.



AI In Medicine: Generative AI

EDITORIAL

Generative artificial intelligence in neurology: Opportunities and risks

Dear Editor,

In this issue of the journal, Fonseca et al. [1] present results of a crea-

These early results point to a new era in which generative AI will provide substantial support to physicians throughout the clinical

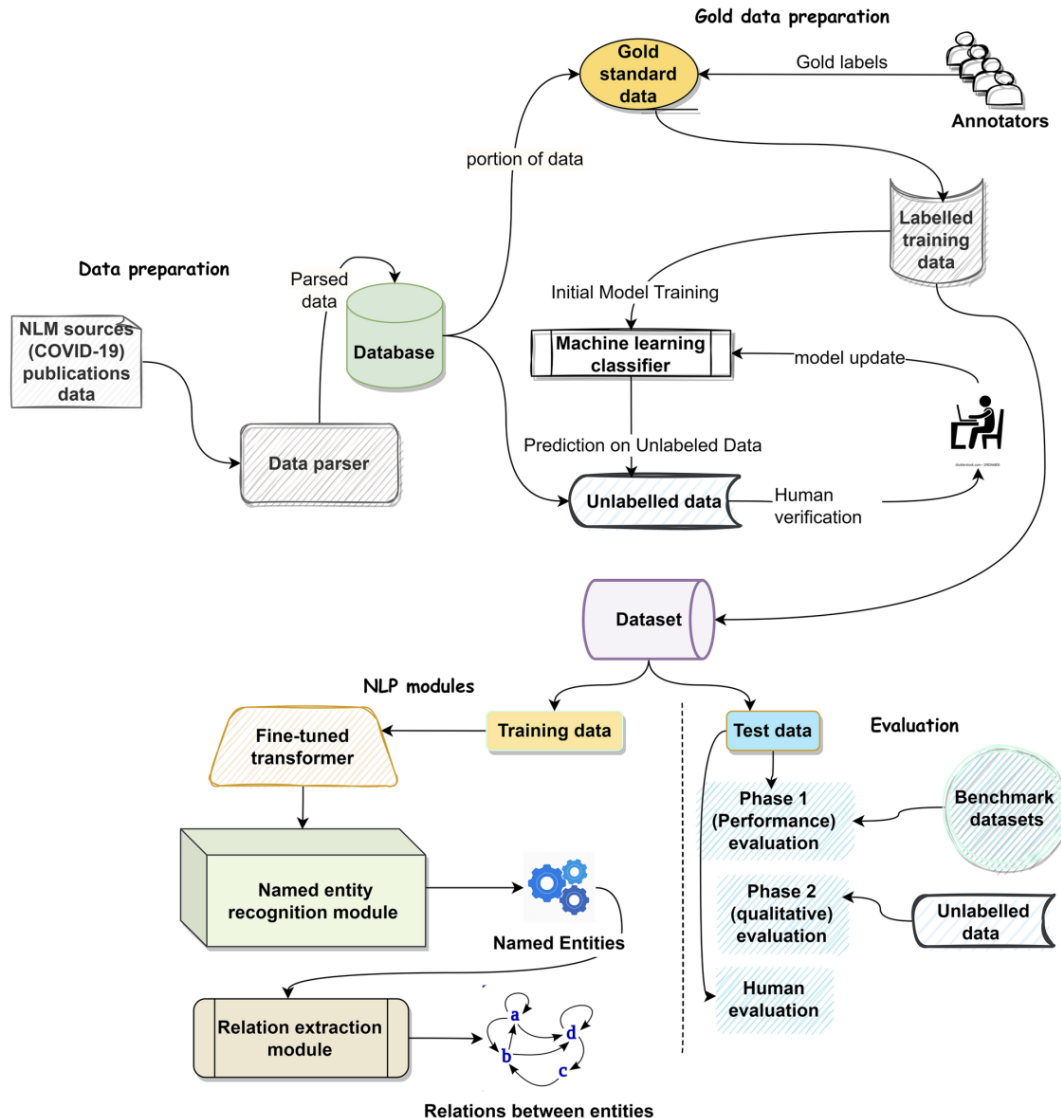


Figure 1. Proposed framework with data preparation, NLP modules and evaluation.

- **Generative AI**

Strong et al (*JAMA Intern Med. 2023*) found that GPT-4 performed better than medical students and achieved an overall score of **93% on free-text clinical reasoning responses** to standardized cases.

Zeltzer et al., (*Mayo Clin Proc Digit Health 2023*) GPT-4 **achieves 95% agreement** with the physician diagnoses in nearly half of cases presenting to a virtual primary care clinic.

BOX 1 Example prompts and outputs of GPT 3.5 in the context of a previously published clinical case

Prompt: I would like to present you with this clinical case report. Could you help me to improve my medical diagnosis? (Maggio et al., 2020)

ChatGPT 3.5: Certainly, I'd be happy to help! Please provide the details of the clinical case report, including relevant patient history, symptoms, physical exam findings, laboratory results, imaging studies, and any other pertinent information. The more details you provide, the better I can assist you in improving the medical diagnosis.

Prompt: A 50-year-old, right-handed, Italian woman attended our Institute (in day hospital regimen) from June to September 2019, owing to a right hemiparesis after a neurosurgical intervention for a left parietal meningioma (occurred in March 2019). She was an English/French teacher and an unmarried translator and lived with her 80-year-old mother. Her family and personal history were negative for neurological and psychiatric disorders. At the admission in Hospital, the patient presented with difficulty standing in the upright position, abnormal gait and right moderate hemiparesis, mainly involving the lower limb. No alteration of proprioception or sense of vibration was observed. No cognitive deficits were reported after the surgical intervention and during the rehabilitation period in another Hospital. However, when reviewing her past rehab history, we found that the patient systematically refused the exercises focused on her lower limb. No one investigated the reason why she behaved this way. The patient also reported that this was the first time she talked about this problem. A brain magnetic resonance scan revealed the results of the parietal vertex craniotomy, with the surgical cavity surrounded by peripheral gliotic reaction and Wallerian degeneration of the left corticospinal tract. No gadolinium enhancement was appreciable.

ChatGPT 3.5: Thank you for providing the detailed clinical case report. Based on the information provided, it seems that the patient is experiencing right hemiparesis following a neurosurgical intervention for a left parietal meningioma. Here are some key points to consider:

Clinical presentation: The patient presents with difficulty standing upright, abnormal gait, and right moderate hemiparesis, particularly affecting the lower limb. No alteration of proprioception or sense of vibration is observed. The patient did not report any cognitive deficits after the surgical intervention.

Rehabilitation history: The patient has a history of systematically refusing exercises focused on her lower limb during rehabilitation in another hospital. The reason for her refusal has not been investigated previously.

Neuroimaging findings: Brain magnetic resonance scan reveals the results of the parietal vertex craniotomy. Surgical cavity surrounded by peripheral gliotic reaction and Wallerian degeneration of the left corticospinal tract. No gadolinium enhancement is appreciable.

Social and personal history: The patient is a 50-year-old, right-handed, Italian woman who was an English/French teacher and translator. She lives with her 80-year-old mother, and there is no significant family history of neurological or psychiatric disorders.

Impressions and considerations: The neurological deficits observed can be correlated with the location of the meningioma and the subsequent surgical intervention. Wallerian degeneration of the left corticospinal tract may contribute to the observed hemiparesis. The patient's refusal of lower limb exercises during rehabilitation raises questions about potential psychological or behavioral factors that may be impacting her recovery. A multidisciplinary approach involving neurology, rehabilitation medicine, and psychology may be beneficial in addressing both the physical and psychological aspects of her recovery.

Recommendations: Consider a thorough psychological assessment to explore the reasons behind the patient's refusal of lower limb exercises. Collaborate with a rehabilitation team to tailor an exercise program that addresses the patient's concerns and encourages active participation. Follow-up neuroimaging and clinical assessments to monitor the progress of Wallerian degeneration and overall recovery. Engage the patient in open communication regarding her rehabilitation goals and expectations. It's

Generative AI

ificial Intelligence

TYPE Mini Review
PUBLISHED 06 June 2024
DOI 10.3389/frai.2024.1407905

Exploring ChatGPT's potential in the clinical stream of neurorehabilitation



Maria Grazia Maggio^{1†}, Gennaro Tartarisco^{2†}, Davide Cardile¹, Mirjam Bonanno¹, Roberta Bruschetta², Loris Pignolo³, Giovanni Pioggia², Rocco Salvatore Calabrò^{1*} and Antonio Cerasa^{2,3,4*}

Screenshot

Generative AI in Epilepsy?

Article

Can ChatGPT 4.0 Diagnose Epilepsy? A Study on Artificial Intelligence's Diagnostic Capabilities

Francesco Brigo ^{1,*}, Serena Broggi ², Eleonora Leuci ³, Gianni Turcato ⁴ and Arian Zaboli ¹

Epilepsy & Behavior 151 (2024) 109645

Contents lists available at [ScienceDirect](#)

Epilepsy & Behavior

journal homepage: www.elsevier.com/locate/yebeh



Evaluating the performance of the language model ChatGPT in responding to common questions of people with epilepsy

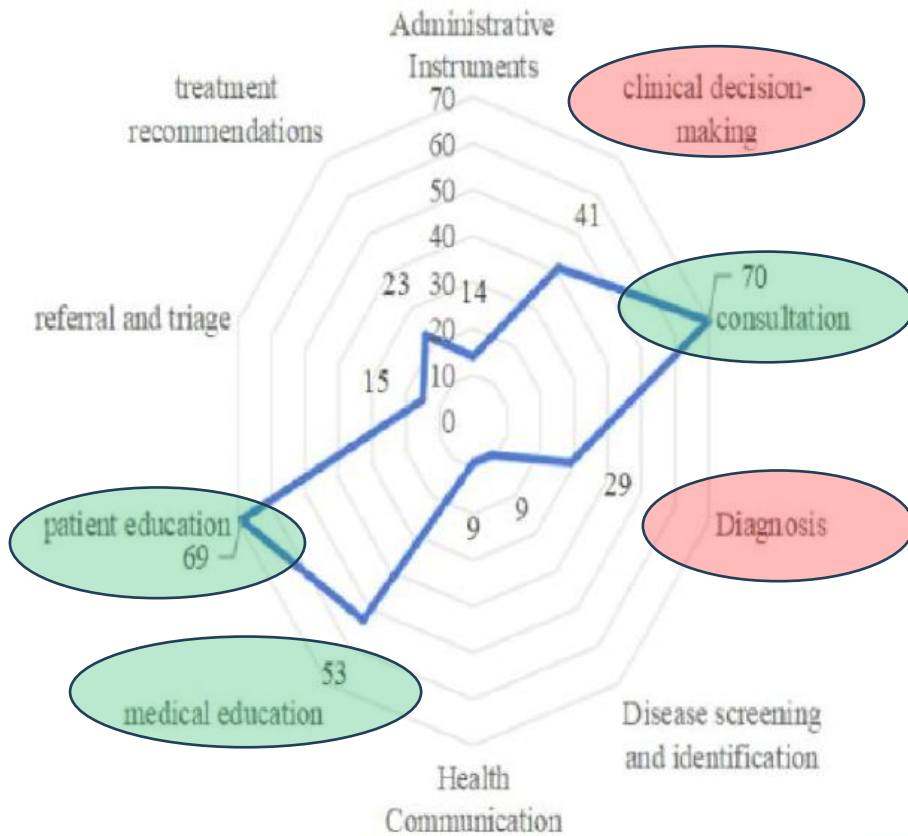
YuXin Wu ^{a,b}, Zaiyu Zhang ^{a,b}, Xinyu Dong ^{a,b}, Siqi Hong ^{a,b}, Yue Hu ^{a,b}, Ping Liang ^{a,b}, Lusheng Li ^{a,b}, Bin Zou ^{a,b}, Xuanxuan Wu ^{a,b}, Difei Wang ^{a,b}, Hui Chen ^{c,d}, Hanli Qiu ^{a,b}, Haotian Tang ^{a,b}, Kaiyi Kang ^{a,b}, Qinling Li ^{a,b,*}, Xuan Zhai ^{a,b,*}

Neurologists diagnosed epilepsy in 216 patients (36.2%), while ChatGPT diagnosed it in 109 patients (18.2%). ChatGPT's sensitivity was 17.6%, specificity was 81.4%, positive predictive value was 34.8%, and negative predictive value was 63.5%. **ChatGPT made diagnostic errors in 41.7%**

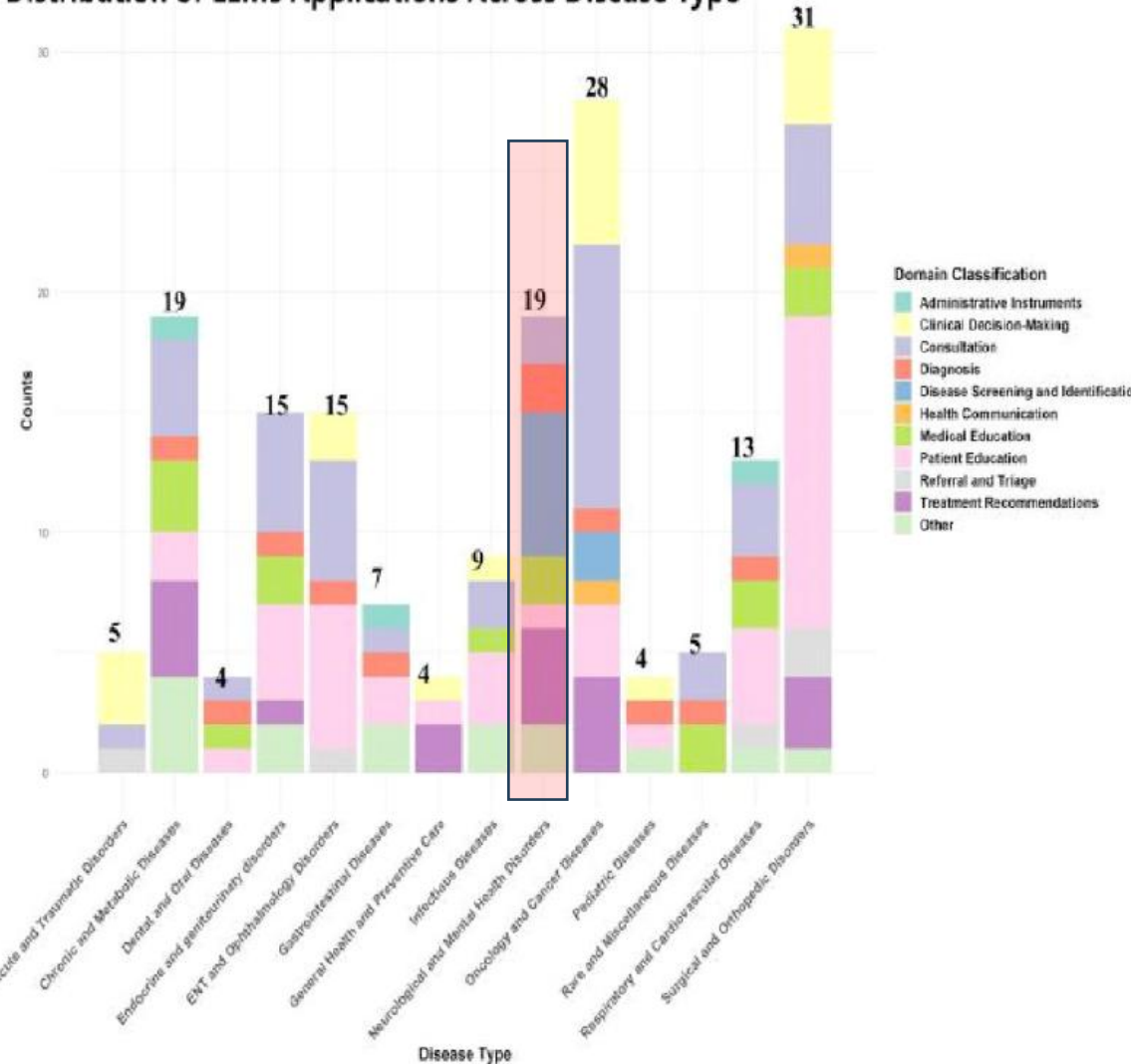
ChatGPT **provided "correct and comprehensive" answers to 68.4% of the questions.** The model provided reproducible answers for 82.3% questions. The model performed poorly in answering prognostic questions, with only 46.8% of the answers rated as comprehensive.

For what reason is generative AI used in medicine?

(a). TOP 10 Domain Classifications by Article Count



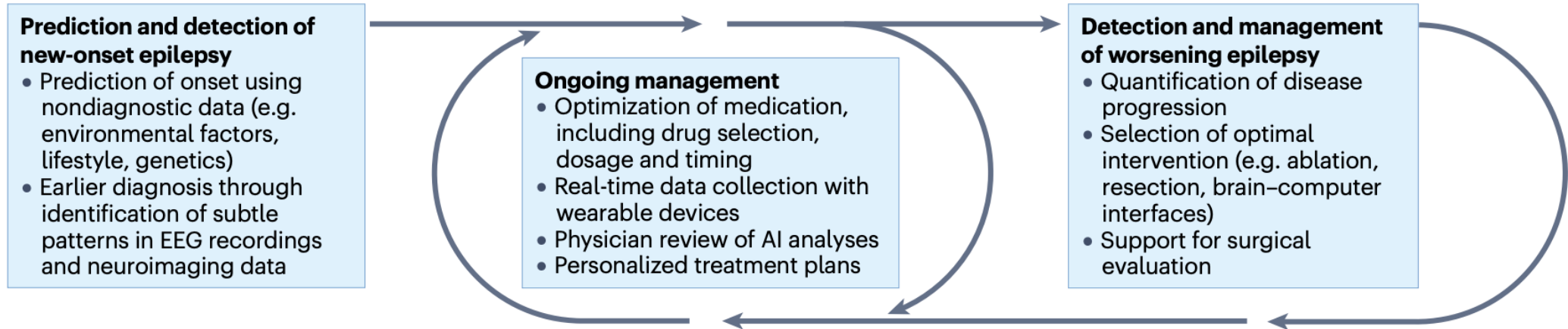
(b). Distribution of LLMs Applications Across Disease Type



Conclusions

- AI might allow for the **automated classification** and lateralizing of TLE or Focal DYSPLASIA, with moderate/good accuracy.
- ML/DL applied to MRI has successfully **uncovered POSSIBLE biomarkers predictive** of clinical outcomes. The most significant impact has been the development of lesion detection algorithms that have transformed MRI-negative into MRI-positive.
- AI-related algorithms **embedded into wearable systems** is one of the most promising field of studies in diagnostic and prognostic research.
- **Biotyping techniques exploiting** intra-and inter-subject variability have permitted characterization and thus offering optimized the prediction of outcomes.
 - *Bernasconi et al, Epilepsia 2024*

Conclusions



Imagine a future in which AI systems can predict epileptic seizures with **unparalleled accuracy hours or even days in advance** by analysing a multitude of clinical data genetic predispositions and environmental factors. These systems are so seamlessly integrated into daily life that wearable or even permanently implanted devices **continuously monitor and alert people** with epilepsy to potential triggers, perhaps even reacting by neuromodulating the brain or autonomously releasing medications directly into specific brain regions. In this future, AI-driven platforms also enable implementation of personalized treatment plans through analysis of individual responses to therapies, **creating a tailored, patient-centric care paradigm** that can adapt in real time between doctor's office visits (*Lucas et al., Nat Rev Neur 2024*)