



ARTIFICIAL INTELLIGENCE AND HEALTHCARE: THINGS EVERY PHYSICIAN SHOULD KNOW ABOUT AI

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Mohan Tanniru

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OBJECTIVES

01

Understand
what AI really
means

02

Application of
AI in
healthcare

03

Legal concerns
for physicians
when using AI

04

Ethical aspects
of AI

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DISCLOSURES

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Funding:

- Tech Launch Arizona
- Delta Dental Foundation of Arizona
- Banner Health Foundation

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DISCLOSURES

- Mohan Tanniru

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COGNITION

Cognition is the "mental action or process of acquiring knowledge and understanding through thought, experience, and the senses".^[2] It encompasses all aspects of intellectual functions and processes such as: perception, attention, thought, imagination, intelligence, the formation of knowledge, memory and working memory, judgment and evaluation, reasoning and computation, problem-solving and decision-making, comprehension and production of language. Cognitive processes use existing knowledge and discover new knowledge.



<https://en.wikipedia.org/wiki/Cognition>

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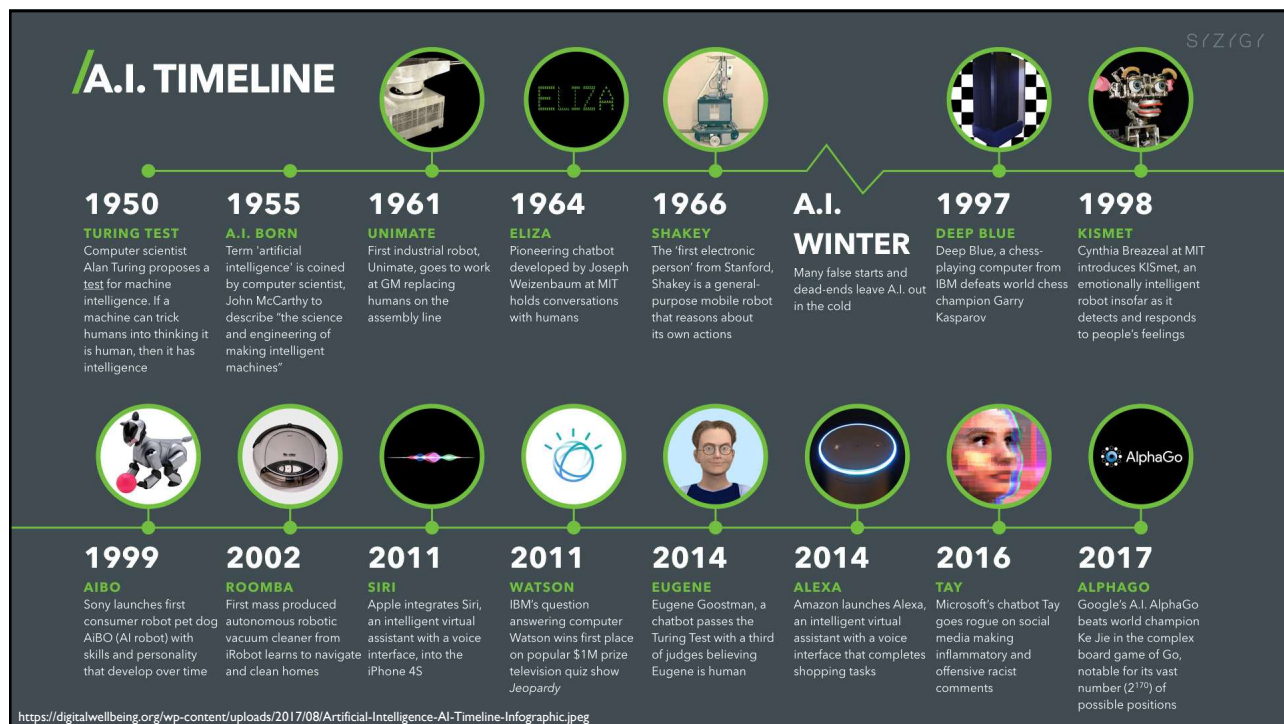
Neurocognitive domains

Executive function Planning Decision-making Working memory Responding to feedback Inhibition Flexibility	Language Object naming Word finding Fluency Grammar and syntax Receptive language	Learning and memory Free recall Cued recall Recognition memory Semantic and autobiographical long-term memory Implicit learning
Complex attention Sustained attention Divided attention Selective attention Processing speed	Perceptual-motor function Visual perception Visuo-constructional reasoning Perceptual-motor coordination	Social cognition Recognition of emotions Theory of the mind Insight

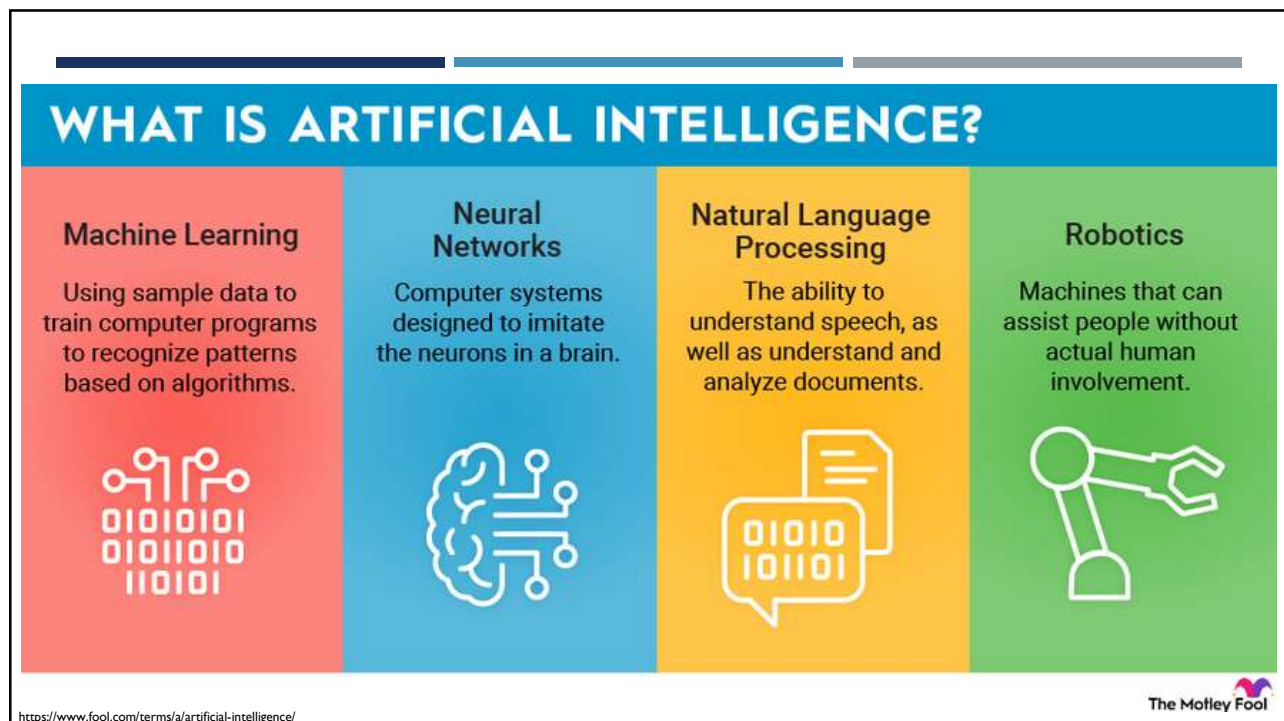
NEUROCOGNITIVE DOMAINS: DSM 5

Olivo G, Gaudio S, Schiöth HB. Brain and Cognitive Development in Adolescents with Anorexia Nervosa: A Systematic Review of fMRI Studies. *Nutrients*. 2019; 11(8):1907. <https://doi.org/10.3390/nu11081907>

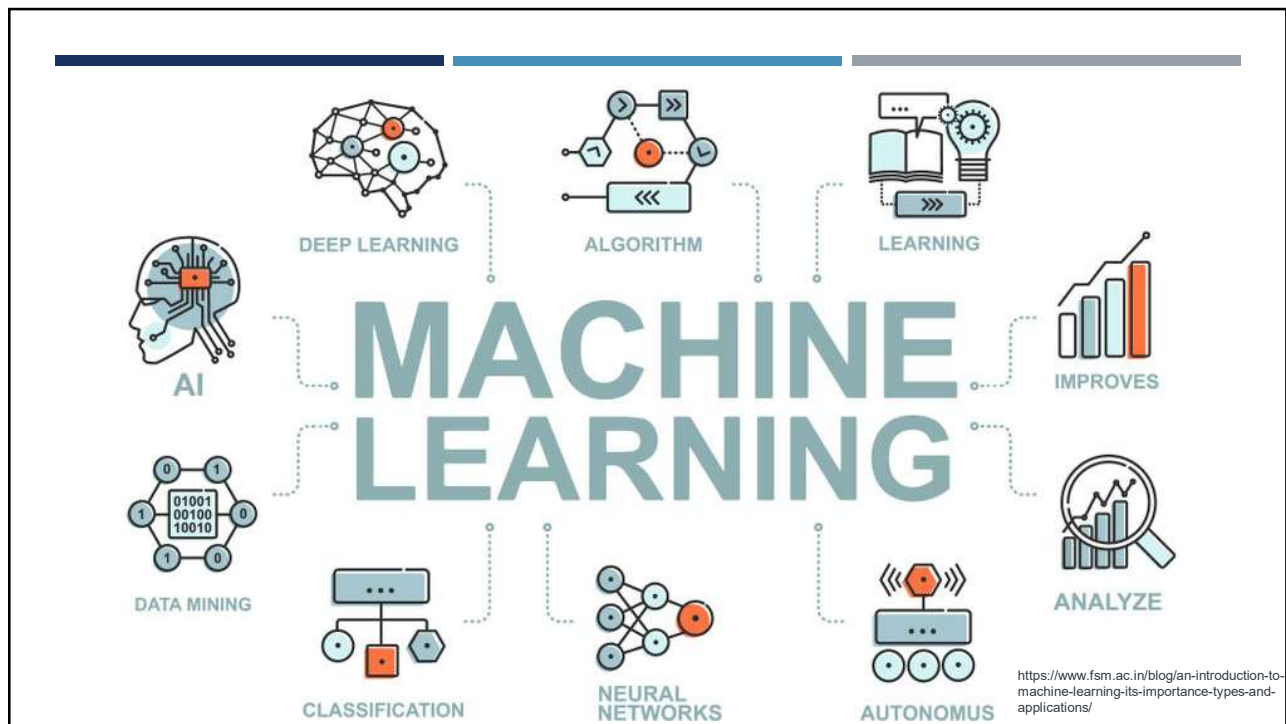
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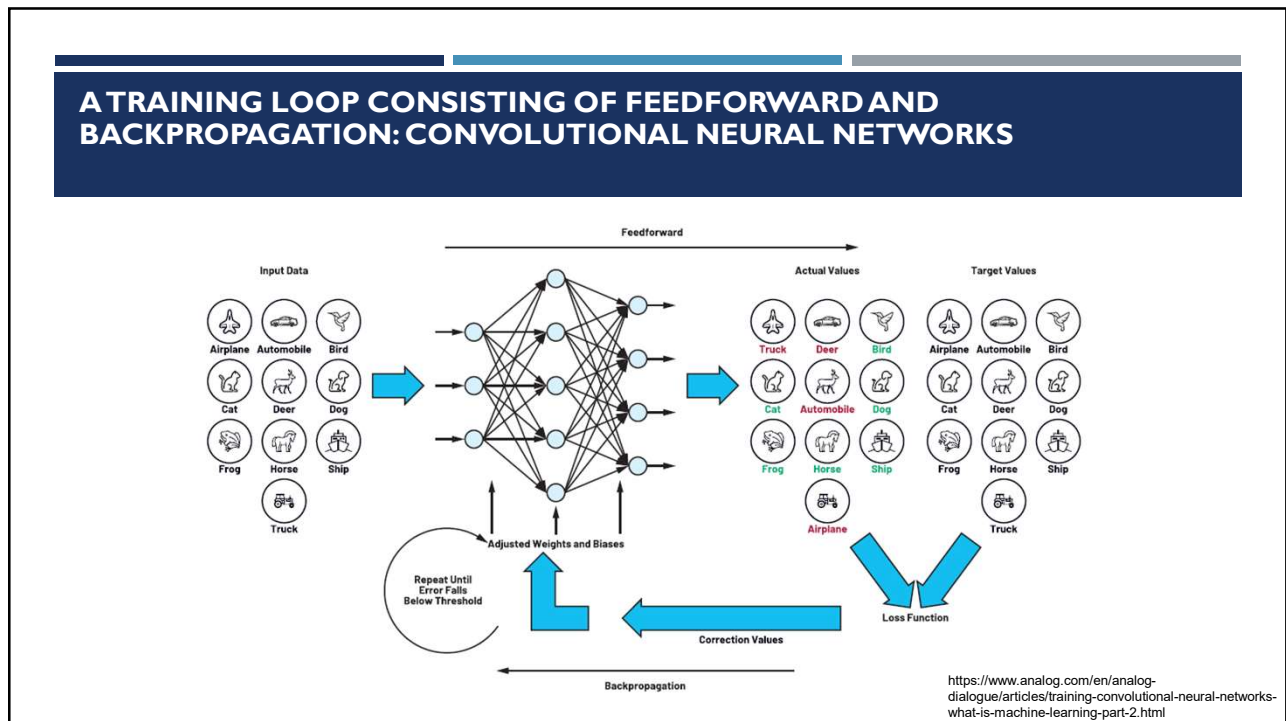
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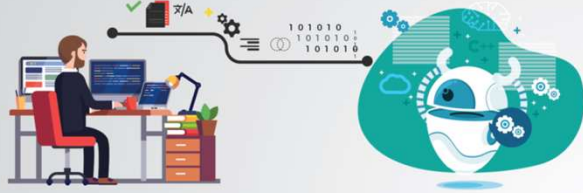


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What is Natural Language Processing (NLP)?



NLP is a technological process that allows computers to derive meaning from user text inputs. In doing so, it attempts to understand the intent of the input, rather than just the information about the intent itself. To make it possible, developers teach a bot to extract valuable information from a sentence typed or pronounced, and transform it into a piece of structured data. That's what NLP engines do.

What does NLP comprise of?



Intent

Intent is the core concept of building conversational UI. In short, an intent is the task user wants to accomplish or the problem user wants to solve.



Utterance

By utterances, NLP engines mean the example of sentences user may type or tell when he or she refers to a specific intent.



Entity

Entities include the details important for the user's intent. It can be anything: location, date, time, or even cuisine type.



Context

Context helps to save and share the parameters across the whole session.



Session

Session is one conversation from the beginning to the end.



What are some must have NLP capabilities?

Capitalization

Recognizes proper nouns and removes capitalization from common nouns

Numeric Words vs. Digits

Recognizes the communication of numeric values as words or digits

Vocabulary Expansion

Enables addition of synonyms and uses Machine Learning to continuously expand chatbot vocabulary

Singular vs. Plural Nouns

Processes singular and plural nouns the same way

Contractions

Expands contractions and removes apostrophes to simplify task processing

Vocabulary Transfer

Allows for transfer of developed vocabulary from one chatbot to the next

Tensed Verbs

Understands a single verb communicated in different tenses as synonymous

Pre-Programmed Synonyms

Includes pre-programmed synonyms and bot responses

Message Personalization

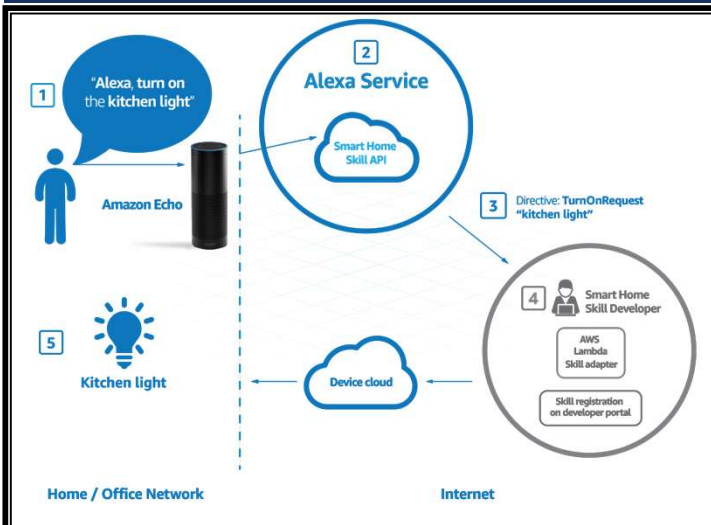
Replaces default, universal responses with unique, configured messages



<https://towardsdatascience.com/5-reasons-why-your-chatbot-needs-natural-language-processing-ed20fb0a3655>

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HOW AMAZON ALEXA WORKS



- Natural Language Processing (NLP)
- Natural Language Generation (NLG)
- Machine Learning

<https://towardsdatascience.com/how-amazon-alexa-works-your-guide-to-natural-language-processing-ai-7506004709d3>

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INTERNET OF THINGS (IOT)

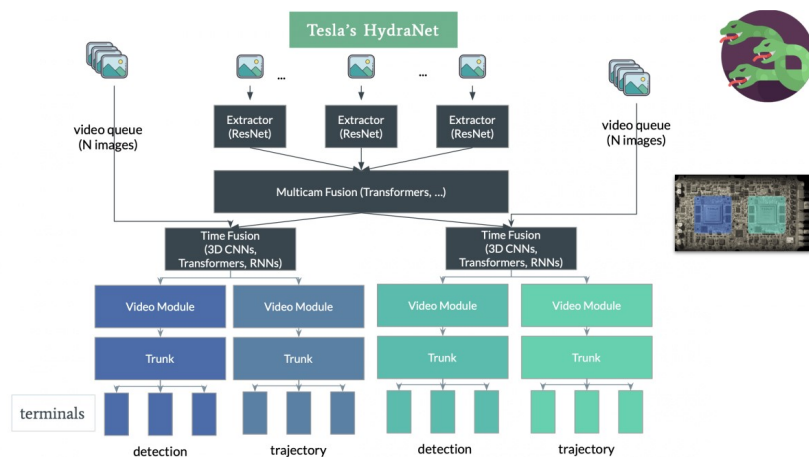


Devices with sensors, processing ability, software and other technologies that connect and exchange data with other devices and systems over the Internet or other communications networks.

<https://carbontrack.com.au/blog/future-smart-homes-functional-feature-integration/>
https://en.wikipedia.org/wiki/Internet_of_things

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TESLA AUTOPILOT: NEURAL NETWORKS



<https://www.thinkautonomous.ai/blog/how-tesla-autopilot-works/>

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TOP TEN APPLICATIONS FOR ARTIFICIAL INTELLIGENCE IN HEALTHCARE

TECHNOLOGY	MARKET VALUE
ROBOTIC-ASSISTED SURGERY*	\$40bn
VIRTUAL NURSING ASSISTANTS	\$20bn
ADMINISTRATIVE WORKFLOW ASSISTANCE	\$18bn
FRAUD DETECTION	\$17bn
DOSAGE ERROR DEDUCTION	\$16bn
CONNECTED MACHINES	\$14bn
CLINICAL TRIAL PARTICIPANT IDENTIFIER	\$13bn
PRELIMINARY DIAGNOSIS	\$5bn
AUTOMATED IMAGE DIAGNOSIS	\$3bn
CYBERSECURITY	\$2bn

[illegible]

VOLTA[™] AF-Xplorer™

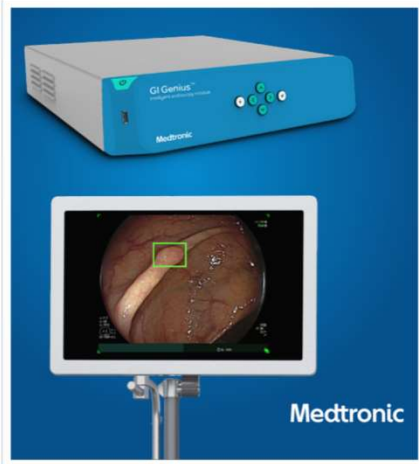
AI Companion Designed for the Assessment of Complex AF & AT during ablation procedures

The screenshot displays the VOLTA AF-Xplorer software interface. On the left, a circular ablation map shows a catheter schematic (3) with numbered points (1, 2, 3, 4) and a dispersion indicator (2). The map includes a color-coded ablation zone and a table of ablation parameters. In the center, a control panel (5) features buttons for 'Mapping Mode', 'Mapping', 'Tagging', 'Tagging Mode', and 'Tagging List', along with a 'Mapping List' button. On the right, a 3D anatomical model of the heart shows a red ablation area (6) and a blue area (4). The bottom status bar displays 'Vol. 1.17ms', 'A. 8%', and 'B. 177ms'.

- 1 Auto-tagging button
- 2 Dispersion indicator
- 3 Mapping catheter schematic
- 4 Mapping and reference cycle length
- 5 Booster Mode button
- 6 Volta Dispersion tags

FDA Authorizes Marketing of First Device that Uses Artificial Intelligence to Help Detect Potential Signs of Colon Cancer

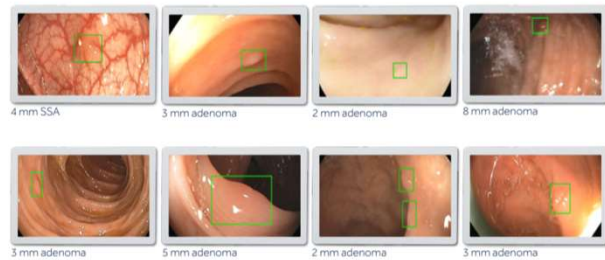
Medical device aids clinicians in detecting potential irregularities during colon cancer screening and surveillance



GI Genius™ intelligent endoscopy module

ADVANCED
PRECISION.
ENHANCED
PERFORMANCE.

GI Genius™ intelligent endoscopy module in action



Medtronic

<https://www.medtronic.com/us-en/healthcare-professionals/education-training/genius-academy/future-is-now.html>

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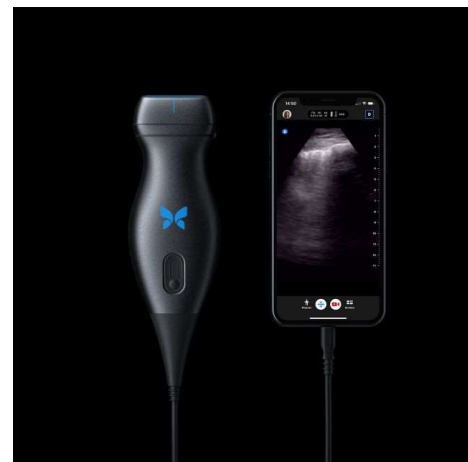
NEWS | ARTIFICIAL INTELLIGENCE | FEBRUARY 13, 2020

FDA Clears Artificial Intelligence to Guide User for Optimal Cardiac Ultrasound Imaging

AI guides novice user to get optimal views on transthoracic echocardiography POCUS exams



The Caption Guidance software uses artificial intelligence to guide users to get optimal cardiac ultrasound images in a point of care ultrasound (POCUS) setting.



Butterfly iQ Ultrasound System

<https://www.itnonline.com/content/fda-clears-artificial-intelligence-guide-user-optimal-cardiac-ultrasound-imaging>

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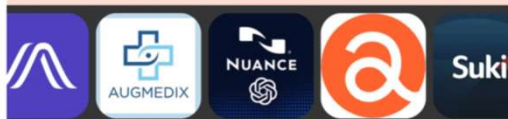
Emergency Medicine Workforce Newsletter

The End is Near for Doctor as Data-Entry Clerk

Also: Minnesota takes action on psych boarding, Mass General Brigham residents unionize, Physicianeering, PE is expensive, & McKinsey on nursing.

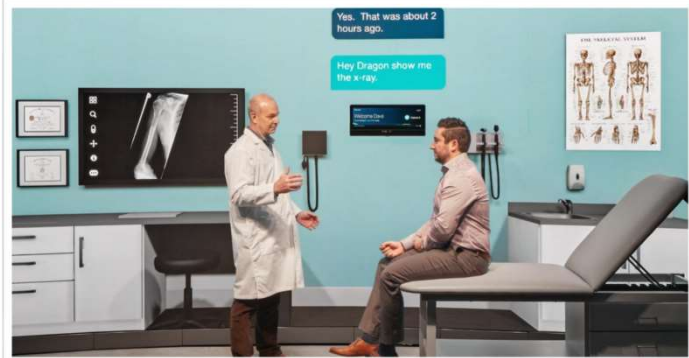
LEON ADELMAN
JUN 10, 2023

A Gold Rush is On To Be Your AI-Enabled Scribe



Why Nuance? Microsoft is making a \$19.7 billion bet on ambient digital healthcare

Nuance's technology uses voice recognition, AI and natural language processing to streamline healthcare processes. Nuance will bolster Microsoft's Cloud for Healthcare significantly.



<https://www.zdnet.com/article/why-nuance-microsoft-is-making-a-19-7-billion-bet-on-ambient-digital-healthcare/>
<https://emworkforce.substack.com/p/the-end-is-near-for-doctor-as-data>

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AGILE

International Journal of
Environmental Research
and Public Health



Article

An Agile Digital Platform to Support Population Health—A Case Study of a Digital Platform to Support Patients with Delirium Using IoT, NLP, and AI

Mohan R. Tanniru ^{1,*}, Nimit Agarwal ², Amanda Sokan ¹ and Salim Hariri ³

“A software ecosystem designed to improve performance has to be agile to support the faster design of these new digital services, or the reconfiguration and/or redesign of the current digital services to meet evolving customer expectations”.

Tanniru MR, Agarwal N, Sokan A, Hariri S. An Agile Digital Platform to Support Population Health—A Case Study of a Digital Platform to Support Patients with Delirium Using IoT, NLP, and AI. *Int J Environ Res Public Health*. 2021 May 26;18(11):5686. doi: 10.3390/ijerph18115686. PMID: 34073262; PMCID: PMC8198835.

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AI vs. human intelligence: Three important differences

AI		HUMAN INTELLIGENCE
May require millions or billions of samples to learn at a level exceeding average human intelligence, making humans on average more efficient learners than AI systems.	One-shot vs. multishot learning	Ability to learn new concepts and ideas from a small number of samples, sometimes from a single one. This ability is referred to as one-shot learning.
Ability to recite, recalling information as it was presented or generating a novel mashup of information that some refer to as imagination but is better described as synthetic recitation.	Imagination and recitation	Ability to form ideas, mental sensations and concepts of phenomena that are not present and/or do not exist is considered an important element of being human.
In 2023, most artificial intelligence systems do not possess multimodal learning ability. Autonomous vehicles, however, are able to receive inputs from multiple types of sources to make navigational decisions.	Multisensory input and output	Ability to receive and quickly integrate information from all of our senses and use that perception to make decisions. The average human is able to incorporate multimodal inputs and create multimodal outputs.

“Smart”:

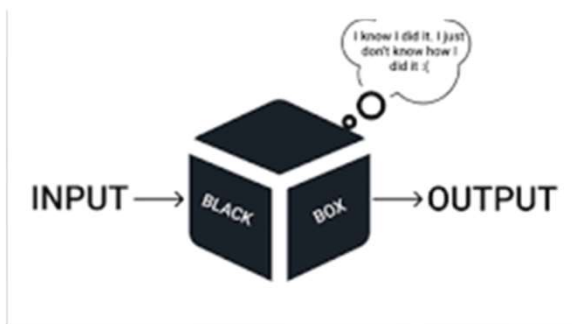
- Reason
- Problem Solve
- Decide
- Act

<https://www.techtarget.com/searchenterpriseai/tip/Artificial-intelligence-vs-human-intelligence-How-are-they-different>

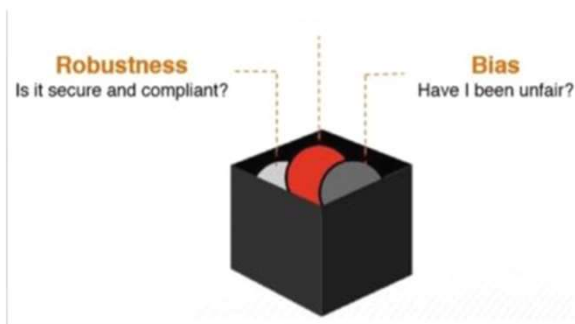
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BLACK BOX AI

“I know I did it. I just don’t know how I did it.”



“Have I been unfair?”



<https://www.linkedin.com/pulse/ai-black-box-problem-unseen-challenge-emergency-public-justin-snair-/>
<https://www.enterpriseai.news/2019/09/26/attacking-the-ai-trust-gap-fico-like-risk-scoring-for-machine-learning-models/>

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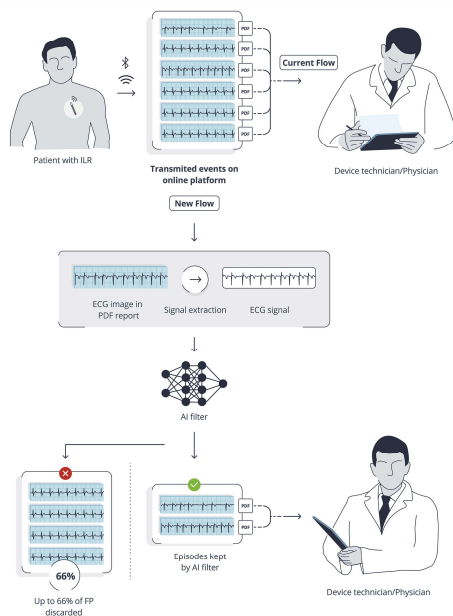
Medtronic Wins FDA Clearance And CE Approval For LINQ II Insertable Cardiac Monitor



<https://next.gr/news/news/20763/medtronic-wins-fda-clearance-and-ce-approval-for-linq-ii-insertable-cardiac-monitor>

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CENTRAL ILLUSTRATION: Clinical Impact of Incorporating an AI-Based Filter Using a DNN in Patients With Atrial Fibrillation and an Implantable Loop Recorder



Mittal, S. et al. J Am Coll Cardiol EP. 2021;7(8):965-975.



JACC: Clinical Electrophysiology

Volume 7, Issue 8, August 2021, Pages 965-975

New Research Paper
CIED - Data Sciences

AI Filter Improves Positive Predictive Value of Atrial Fibrillation Detection by an Implantable Loop Recorder

Suneet Mittal MD^a, Susan Oliveros CRAT^a, Jia Li MSc^b, Thibaut Barrover MSc^b, Christine Henry MSc^b, Christophe Gardella PhD^b

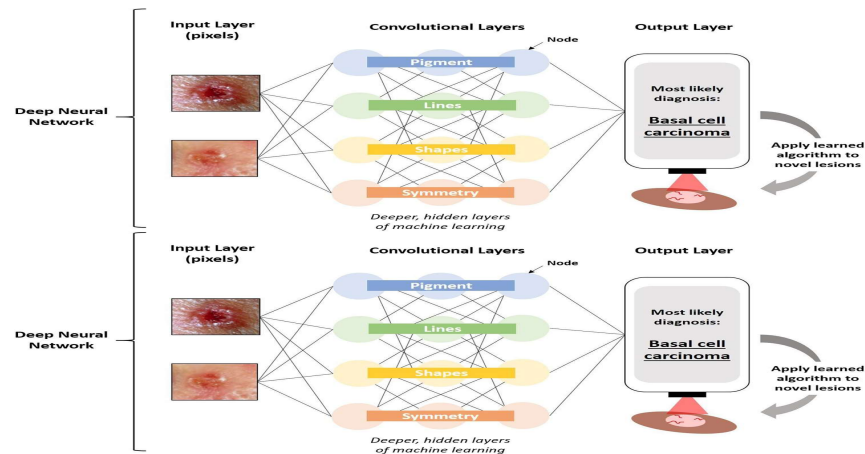
Mittal, S., Oliveros, S., Li, J., Barrover, T., Henry, C., & Gardella, C. (2021). AI Filter Improves Positive Predictive Value of Atrial Fibrillation Detection by an Implantable Loop Recorder. *JACC. Clinical electrophysiology*, 7(8), 965–975. <https://doi.org/10.1016/j.jacep.2020.12.006>

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Artificial intelligence in the detection of skin cancer

Eric J. Beltrami, BS • Alistair C. Brown, BMBCh, MA • Paul J.M. Salmon, MD • David J. Leffell, MD •
Justin M. Ko, MD, MBA • Jane M. Grant-Kels, MD

Published: August 20, 2022 • DOI: <https://doi.org/10.1016/j.jaad.2022.08.028> • [Check for updates](#)



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BIAS IN AI ALGORITHMS

- CNNs that provide high accuracy in skin lesion classification are often trained with images of skin lesion samples of white patients, using datasets in which the estimated proportion of Black patients is approximately 5% to 10%.
- As a result, when tested with images of Black patients, the networks have approximately half the diagnostic accuracy compared with what their creators originally claimed.
- Black patients, whose lesions may have different characteristics from white patients, may thus be less likely to be accurately diagnosed by automated algorithms.

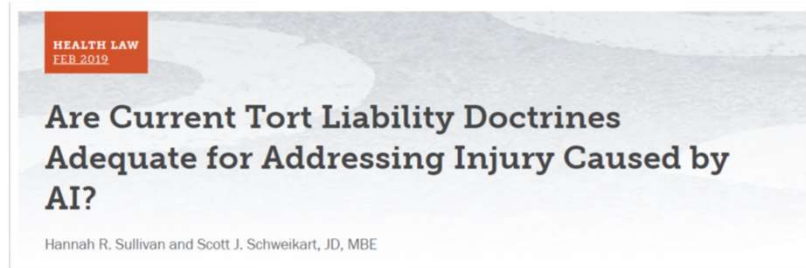
“**Black patients have the highest mortality rate for melanoma, with an estimated 5-year survival rate of only 70%, versus 94% for white patients. Misdiagnoses and socioeconomic barriers hindering access to health care may cause skin cancer at a more advanced stage in Black patients, hindering treatment.**”

Norori, N., Hu, Q., Aellen, F. M., Faraci, F. D., & Tzovara, A. (2021). Addressing bias in big data and AI for health care: A call for open science. *Patterns*, 2(10).

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AMA Journal of Ethics®

Illuminating the Art of Medicine



AMA J Ethics. 2019;21(2):E160-166. doi: 10.1001/amajethics.2019.160.

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TRADITIONAL TORT LIABILITY

Typical tort claims in the realm of medicine and health include medical malpractice (negligence), *respondeat superior* (vicarious liability), and products liability.

AMA J Ethics. 2019;21(2):E160-166. doi: 10.1001/amajethics.2019.160.

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PHYSICIAN LIABILITY: MALPRACTICE (NEGLIGENCE)

- “conduct which falls below the standard established by law for the protection of others against unreasonable risk of harm.”
- In judicial determinations, a physician’s actions are judged not against those of a reasonable *man*, but rather against those of a reasonable *physician*—with the same knowledge, skills, and expertise—under like circumstances

AMA J Ethics. 2019;21(2):E160-166. doi: 10.1001/amajethics.2019.160.

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RESPONDEAT SUPERIOR (VICARIOUS LIABILITY)

- *Health care organizations:* “hospitals can be held vicariously liable for the acts of their employees, including physicians, who commit malpractice.”

AMA J Ethics. 2019;21(2):E160-166. doi: 10.1001/amajethics.2019.160.

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PRODUCTS LIABILITY

- *Manufacturers and pharmaceutical companies: manufacturers of prescription drugs and medical devices, those “that may be legally sold or otherwise distributed pursuant only to a health-care provider’s prescription,” are liable for harm to persons caused by defects*
- The law reflects the FDA’s determination that prescription medical products have inherent and unavoidable risks and thus require physician approval before use. It also emphasizes that the physician plays an important role in patients’ choices.

AMA J Ethics. 2019;21(2):E160-166. doi: 10.1001/amajethics.2019.160.

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LEARNED INTERMEDIARY DOCTRINE

- applies to the use of pharmaceuticals and medical devices, wherein physicians intervene between the manufacturer and the ultimate consumer
- “prevents plaintiffs from suing medical device manufacturers directly,” as the manufacturer has no duty to the patient directly
- the “physician, rather than the patient, is considered the end consumer of medical devices because the health care provider is in the best position to weigh the risks against the possible benefits of using the device.”

AMA J Ethics. 2019;21(2):E160-166. doi: 10.1001/amajethics.2019.160.

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CHALLENGES WITH APPLYING THE LAW

- The law “is built on legal doctrines that are focused on human conduct, which when applied to AI, may not function.”
- Products liability claims in the health care context require that the injuring product be deemed a “medical device.” The “hardware components” of the AI system would be deemed the “device” for products liability purposes, not the software

“software, as opposed to hardware, is “technology that helps healthcare providers make decisions by providing them with information or analysis” and that the final decision of care rests with the health care professional”

AMA J Ethics. 2019;21(2):E160-166. doi: 10.1001/amajethics.2019.160.

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AMA: AI AND THE QUADRUPLE AIM



- Patient rights are respected
- Addresses high priority clinical needs
- Eliminates inequities
- Physicians are engaged in developing and implementing health care AI tools
- Oversight and regulatory structures account for the risk of harm and potential benefit of health care AI systems

Advancing health care AI through ethics, evidence and equity | American Medical Association (ama-assn.org)

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DEVELOPING A FRAMEWORK FOR HEALTHCARE AI



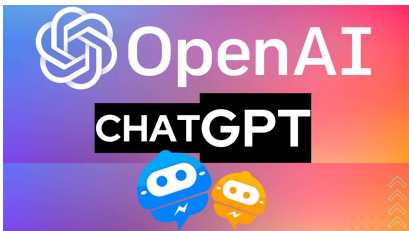
Advancing health care AI through ethics, evidence and equity | American Medical Association (ama-assn.org)

RESPONSIBILITY	DEVELOPER	DEPLOYER	PHYSICIAN
PLANNING AND DEVELOPMENT			
Ensure the AI system addresses a meaningful clinical goal	○		○
Ensure the AI system works as intended	○		○
Explore and resolve legal implications of the AI system ¹ prior to implementation and agree upon appropriate professional and/or governmental oversight for safe, effective, and equitable use of and access to health care AI	○	○	○
Develop a clear protocol to identify and correct for potential bias	○	○	○
Ensure appropriate patient safeguards are in place for direct-to-consumer tools that lack physician oversight	○		
IMPLEMENTATION AND MONITORING			
Make clinical decisions such as diagnosis and treatment			○
Have the authority and ability to override the AI system			○
Ensure meaningful oversight is in place for ongoing monitoring		○	○
Ensure the AI system continues to perform as intended through performance monitoring & maintenance	○	○	
Ensure ethical issues identified at the time of purchase and during use have been addressed ²		○	
Ensure clear protocols exist for enforcement and accountability, including a clear protocol to ensure equitable implementation	○	○	○

1. Such as issues of liability or intellectual property

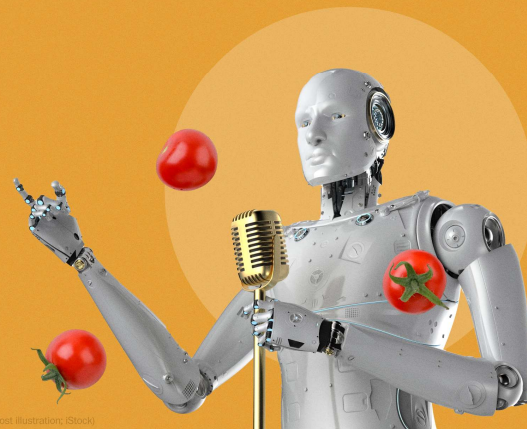
2. Including but not limited to safeguarding patients' and other individuals' privacy interests and preserving the security and integrity of personal information; securing patient consent; and providing patients' access to records*

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- Why did the scarecrow win an award?
 - Because he was outstanding in his field!
- How do you organize a space party?
 - You "planet"
- Why did the doctor carry a red pen?
 - In case they needed to draw blood
- Did you hear about the optometrist who fell into a lens grinder?
 - He made a spectacle of himself!

Artificial intelligence might kill us all — with dad jokes



(Washington Post illustration (Stock))

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