



Scripting Tomorrow: A Pharmacist's Survival Guide to AI

Tuesday, August 13, 2024

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The handout for today's presentation can be found at:

www.nabp.pharmacy/webinar

NABP

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All relevant financial relationships have been mitigated.

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Scripting Tomorrow: A Pharmacist's Survival Guide to AI

Vishal Amin, PharmD
Owner
Health E Tech Consulting

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LEARNING OBJECTIVES

- Explain the driving factors behind the **contemporary emphasis on artificial intelligence (AI)** in health care.
- Describe the **core concepts of AI and Machine Learning**, particularly focusing on their applications within health care contexts.
- Discuss **prompt engineering and its real-world applications** in effectively utilizing AI tools in routine clinical and administrative tasks.
- Review the landscape of **emerging health care technologies**, including wearable devices and digital therapeutics, and their implications for pharmacy practice.
- Discuss the philosophical, **ethical, and regulatory dilemmas** associated with the integration of AI technologies in pharmacy practice.

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SPEAKER




Created by Midjourney
April 2, 2024
Prompt: "Vishal Amin, PharmD, Technologist and Game Master, Medieval Portrait"

Vishal Amin, PharmD, is a pharmacy product manager and informaticist with 12 years of experience building and operationalizing clinical technology solutions



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WHY IS AI SUDDENLY EVERYWHERE?

Created by Midjourney
April 5, 2024
Prompt: "healthcare technology systems everywhere, papercut craft illustration"

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WHAT IS ARTIFICIAL INTELLIGENCE (AI)?

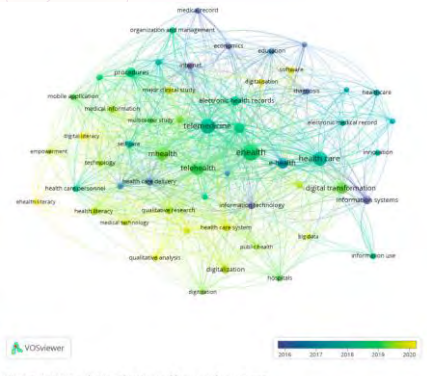


Figure 5. Network visualisation of keywords per year.
Stoumpos, A. et al. "Digital Transformation in Healthcare: Technology Acceptance and Its Applications"

- AI, Machine Learning, GPT, LLM, Digital Health, and more buzzwords are often used interchangeably in common parlance
- AI is a group of subfields and tools that can be used individually or in combination to add intelligence and augment solutions when implemented properly
- The applied goal of AI is creating technologies that allows machines to perform tasks that typically require human intelligence
 - Weak AI/Narrow AI/artificial narrow intelligence (ANI) -> Specific Task
 - Strong AI/General AI/artificial general intelligence (AGI) -> theoretical human equivalent

Anyoha, Rockwell. "The History of Artificial Intelligence." Science in the News, Harvard University, 28 Aug. 2017, sitm.hms.harvard.edu/flash/2017/history-artificial-intelligence/.
IBM. "What Is Artificial Intelligence (AI)?" IBM, 2023, www.ibm.com/topics/artificial-intelligence.
Oke, Sunday. (2008). A literature review on artificial intelligence. International Journal of Information and Management Sciences. 19, 535-570.
Bajjou, L., Mounir, D., Nor, A., Williams, B. Artificial intelligence in healthcare: transforming the practice of medicine. Future Healthc J. 2021 Jul;8(2):e188-e194. doi: 10.7861/fhj.2021-0995. PMID: 34286183. PMCID: PMC8285156.
Stoumpos, A. I., Kitzios, F., Tsalas, M. A. Digital Transformation in Healthcare: Technology Acceptance and Its Applications. Int. J. Environ. Res. Public Health 2023, 20, 3407. <https://doi.org/10.3390/ijerph20043407>

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FACTORS DRIVING AI GROWTH AND FOCUS

WHAT IS AI? | PART 1/3

1. New types of learning model architecture (ie transformers) and the rise in affordable cloud computing for more accessibility to powerful models
 - 1950s - \$200,000/month to run a computer
 - Moore's Law – memory and speed of computers doubles every year
2. Public is seeing an AI Spring emerging from an AI Winter
 - 1970s-1990s – large investments, lofty expectations, little progress
 - 1990s-today – key advancements in tools, software and robotics



2024 - Fastest-growing consumer application in history



1997 - Deep Blue defeats chess grandmaster Gary Kasparov



1990 - Dragon launches first speech Recognition product for consumers

Jenelle A Jindal, Matthew P Lungren, Nigam H Shah, Ensuring useful adoption of generative artificial intelligence in healthcare, Journal of the American Medical Informatics Association, 2024, [ocae043, https://doi.org/10.1093/jamia/ocae043](https://doi.org/10.1093/jamia/ocae043)
Anyoha, Rockwell. "The History of Artificial Intelligence." Science in the News, Harvard University, 28 Aug. 2017, sitm.hms.harvard.edu/flash/2017/history-artificial-intelligence/
"AI Spring? Four Takeaways from Major Releases in Foundation Models." Stanford HAI, hail.stanford.edu/news/ai-spring-four-takeaways-major-releases-foundation-models/

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FACTORS DRIVING AI GROWTH AND FOCUS

WHAT IS AI? | PART 2/3

3. We are in the Age of Big Data

- Improved data gathering and storage techniques
- “Multi-modal” data is being folded into the standard of care (genetics, socioeconomic, phenotypical)
- Too much information for single individuals to process
 - 2013 = 4.4 ZB accumulated in digital universe
 - 2020 = 44 ZB
 - 2025 = 463 EB daily
 - Hospitals create ~50 PB daily

4. There is a “Gold Rush” of investment in foundational AI technology

- Adept - \$350M
- Anthropic - \$300M
- Character AI - \$200M
- Salesforce - \$250M

“AI Spring? Four Takeaways from Major Releases in Foundation Models.” Stanford HAI, hai.stanford.edu/news/ai-spring-four-takeaways-major-releases-foundation-models. Anyoha, Rockwell. “The History of Artificial Intelligence.” *Science in the News*, Harvard University, 28 Aug. 2017. sitn.hms.harvard.edu/flash/2017/history-artificial-intelligence/. “How Big is the Internet, and How Do We Measure It?” *Health IT*, 10 July 2020. healthit.com.au/how-big-is-the-internet-and-how-do-we-measure-it/. Eastwood, Brian. “How to Navigate Structured and Unstructured Data as a Healthcare Organization.” *Technology Solutions That Drive Healthcare*, 8 May 2023. healthtechmagazine.net/article/2023/05/structured-vs-unstructured-data-in-healthcare-parson. Bajwa J., Munir U., Nori A., Williams B. Artificial Intelligence in healthcare: transforming the practice of medicine. *Future Healthc J.* 2021 Jul;8(2):e188-e194. doi: 10.7861/fhj.2021-0095. PMID: 34286183; PMCID: PMC8285156. Desjardins, Jeff. “How Much Data Is Generated Each Day?” *World Economic Forum*, 17 Apr. 2019. www.weforum.org/agenda/2019/04/how-much-data-is-generated-each-day/.

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FACTORS DRIVING AI GROWTH AND FOCUS

WHAT IS AI? | PART 3/3

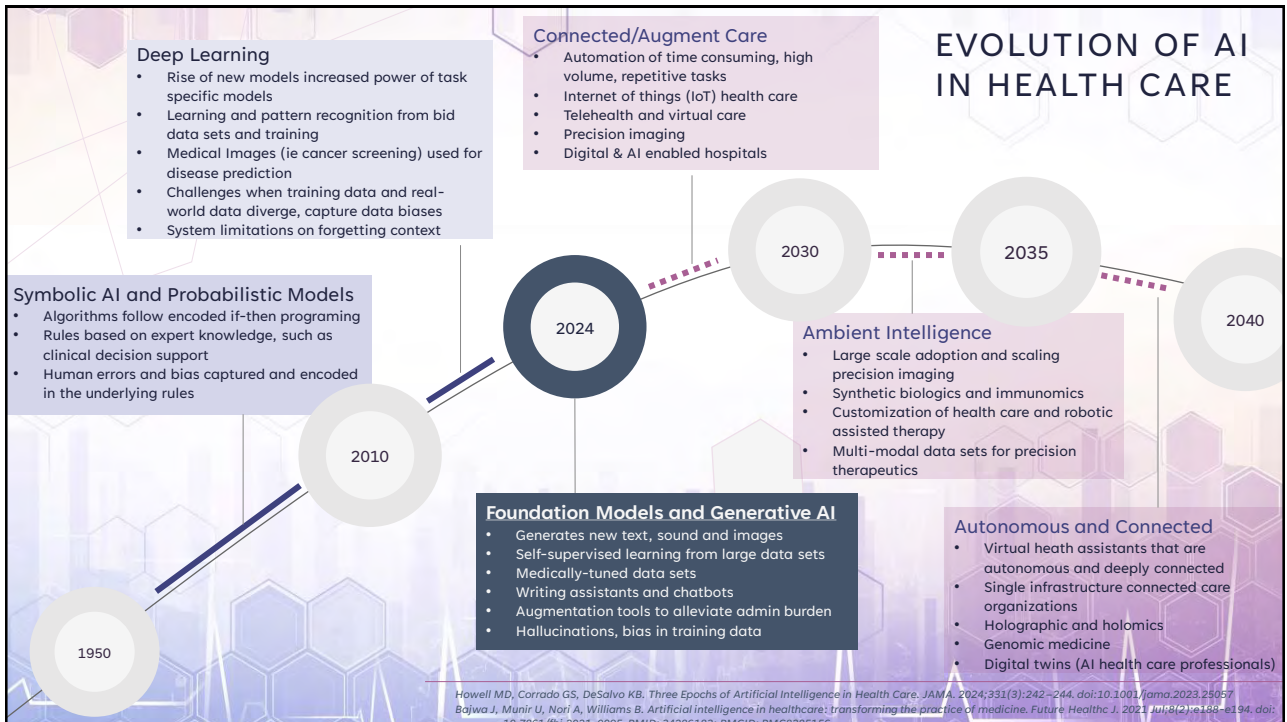
5. Market Dynamics in Health Care Favoring Technology Investments

- **Aging Population:** By 2050, ¼ of people will be over 65
- **Covered Lives:** In 2022, insured population grew to 92% (historic high)
- **Health Care Expenditures:** Health care expenditure as a % of Gross Domestic Product (GDP)
 - 17.3% in 2022 (down from 18.2% in 2021, historic high in 2020 19.5%)
 - 17.5% average from 2016-2019
- **Anticipated Clinician Shortages:**
 - US will face shortage of 68k primary care physicians by 2036
 - By 2030 world will have 18M fewer health care professionals, including 5M MDs

Surescripts. (2024, March 12). 2023 National Progress Report. <https://surescripts.com/why-surescripts/our-impact/national-progress-report>. Retrieved March 15, 2024, from <https://surescripts.widen.net/s/kv2joh66b/2023>. “EIT Health and McKinsey & Company. Transforming Healthcare with AI: The Impact on the Workforce and Organizations. McKinsey & Company, 2023.” *Transforming healthcare with AI: The impact on the workforce and organizations*. McKinsey. Bajwa J., Munir U., Nori A., Williams B. Artificial Intelligence in healthcare: transforming the practice of medicine. *Future Healthc J.* 2021 Jul;8(2):e188-e194. doi: 10.7861/fhj.2021-0095. PMID: 34286183; PMCID: PMC8285156.

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? What is a reason for the increased attention of leveraging AI in health care?

A Less data being generated by software leading to cheaper cost of advanced models

B Shrinking investment in advanced AI is leading to technology scarcity

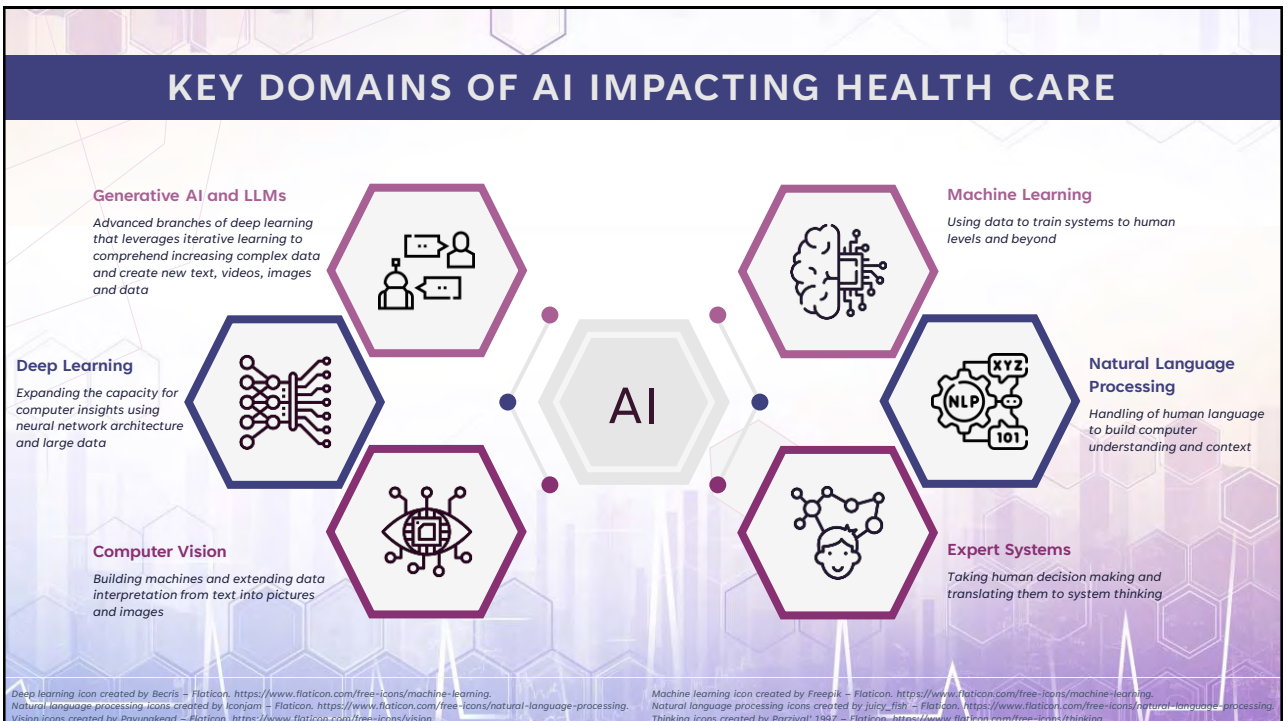
C New types of learning architecture and decreasing cloud computing costs

D Decreasing health care utilization is putting pressure to increase health care revenue

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WHAT IS MACHINE LEARNING (ML)?

Machine Learning Loop

Make a Prediction

Test Prediction

Measure Error

Modify Parameters

- Systems that improve performance of a task when given examples of ideal performance, or improve performance with repeated experience
- **Data Labeling** – Adding meaningful tags to raw data that interpret or give better context (ie labeling CT scans as positive or negative for lesions)

Supervised Learning	<ul style="list-style-type: none"> - Full set of labeled data while training an algorithm - Useful for building prediction models - Most common type of machine learning today
Unsupervised Learning	<ul style="list-style-type: none"> - Dataset without explicit instructions nor specific desired outcomes - Most useful for clustering, anomaly detection, and associations - Strong at uncovering patterns and data mining
Semi-Supervised Learning	<ul style="list-style-type: none"> - Training with both labeled and unlabeled data - Useful when labeling is difficult, time-intensive for experts - Can use multiple system together to create feedback loops
Reinforcement Learning	<ul style="list-style-type: none"> - “Trial and Error” learning or expert demonstration learning - Delayed feedback in the form of ‘rewards’ or ‘punishments’ - Train system to look at decisions over time, optimally operate over a length of time and judged on series of actions

Bringsjord, Selmer, and Govindarajulu, Naveen Sundar. "Artificial Intelligence (Stanford Encyclopedia of Philosophy)." Stanford.edu, 2018, plato.stanford.edu/entries/artificial-intelligence/#HistAI.
Salian, Isha. "NVIDIA Blog: Supervised vs. Unsupervised Learning." NVIDIA Blog, 2 Aug. 2018, blogs.nvidia.com/blog/supervised-unsupervised-learning/.
"What Is Data Labeling? - Data Labeling Explained - AWS." Amazon Web Services, Inc., aws.amazon.com/what-is/data-labeling/.

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CASE STUDY: SUPERVISED ML FOR DIAGNOSIS

WHAT IS MACHINE LEARNING?

Figure 6. ROC curve of best model on the test set for Congestive Heart Failure (CHF), Kidney Failure (KF), and Stroke (STR) prediction.
Liu, J., Zhang, et al. Deep EHR: Chronic Disease Prediction Using Medical Notes.

- Using medical notes, demographics, ICD-10 codes from NYU hospital EHR for >1M patients from 2014-2017, researchers built a model for early detection of preventable diseases
- There are several different approaches for parsing the data and including into the models, as well as several different supervised ML methodologies considered
- Model achieved AUC by target disease (ideal score = 1, higher values are better)
 - Congestive Heart Failure: 0.900
 - Kidney Failure: 0.833
 - Stroke: 0.753

Salian, Isha. "NVIDIA Blog: Supervised vs. Unsupervised Learning." nvidia.com/blog/supervised-unsupervised-learning/

Example
Using EHR data to
Predict:
CHF, Kidney Failure
And Stroke

Salian, Isha. "NVIDIA Blog: Supervised vs. Unsupervised Learning." NVIDIA Blog, 2 Aug. 2018, blogs.nvidia.com/blog/supervised-unsupervised-learning/.
Liu, J., Zhang, Z. & Razavian, N. (2018). Deep EHR: Chronic Disease Prediction Using Medical Notes. Proceedings of the 3rd Machine Learning for Healthcare Conference, in Proceedings of Machine Learning Research, 85:440-464 Available from https://proceedings.mlr.press/v85/liu18b.html.

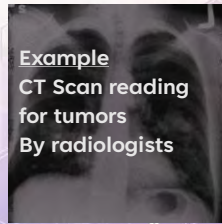
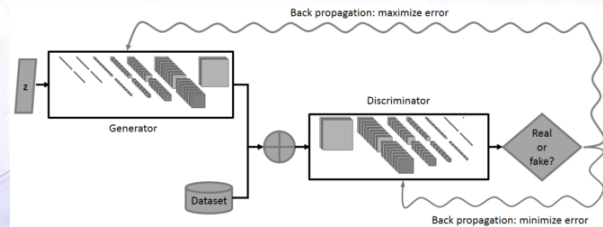
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CASE STUDY: SEMI- SUPERVISED ML FOR TUMOR DETECTION

WHAT IS MACHINE LEARNING?

- One system uses a small set of training data (labeled CT scans) to learn how to generate original data sets
- A discriminator system tries to discern between real or fake data and results
- Results feedback into the system for a learning mechanism
- Rajpukar, et al – retrospective analysis of chest X-ray interpretation
 - 81% accuracy of thoracic diseases (2% higher than radiologists)



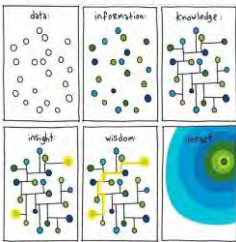
Soliani, Isha. "NVIDIA Blog: Supervised vs. Unsupervised Learning." [nvidia.com/blog/supervised-unsupervised-learning/](https://blogs.nvidia.com/blog/supervised-unsupervised-learning/)

Soliani, Isha. "NVIDIA Blog: Supervised vs. Unsupervised Learning." [NVIDIA Blog, 2 Aug. 2018, blogs.nvidia.com/blog/supervised-unsupervised-learning/](https://blogs.nvidia.com/blog/supervised-unsupervised-learning/).
Habebih H, Gohel S. Machine Learning in Healthcare. *Curr Genomics*. 2021 Dec 16;22(4):291-300. doi: 10.2174/1389202922666210705124359. PMID: 35273459; PMCID: PMC8822225.

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TRAINING AND TUNING METHODOLOGIES

WHAT IS MACHINE LEARNING?



Essman, David. "Want to Know How to Turn Change into a Movement?" [Gapingvoid, 5 Mar. 2019, www.gapingvoid.com/want-to-know-how-to-turn-change-into-a-movement/](https://www.gapingvoid.com/want-to-know-how-to-turn-change-into-a-movement/).

- **Training** – When models learn from a data set, and can adjust a set of internal weights for better future performance
- **Pre-Trained** – A model is already trained on a large dataset without any actions needed during setup
- **Fine-Tuning** – After the initial training, using a smaller, task-specific data set to tailor it better for a specific task


- **Retrieval Augmented Generation (RAG)** – one of many advanced machine learning models where a data retriever is put in front of a generating model to help design domain-specific responses

"Training vs. Fine-Tuning: What is the Difference?" [Encord.com, encord.com/blog/training-vs-fine-tuning/](https://encord.com/blog/training-vs-fine-tuning/). Accessed 4 Apr. 2024.


"Retrieval-Augmented Generation (RAG): Clearly Explained – AI StartUps Product Information, Reviews, Latest Updates." [Cheatsheet.md, 4 Apr. 2024, cheatsheet.md/prompt-engineering/rag-llm](https://cheatsheet.md/prompt-engineering/rag-llm). Accessed 4 Apr. 2024.

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WHAT IS NATURAL LANGUAGE PROCESSING (NLP)?



- Handling of human language, or data that resembles human language, including writing, speaking and organizing thought
- This domain of AI is how computers understand information, and it critical for interpreting and summarizing electronic health records
- Often used in conjunction with speech recognition, which parses spoken language into text and vice versa



I Shot the Clerk. Www.youtube.com
www.youtube.com/watch?v=wBohm3fVvw0. Accessed 9 Apr. 2024.

Natural Language Understanding

Semantic understanding (the meaning of words and concepts)

Natural Language Generation


Generating new text by a machine

DeepLearning.AI. "Natural Language Processing (NLP) - a Complete Guide." Www.deeplearning.ai, 11 Jan. 2023, www.deeplearning.ai/resources/natural-language-processing/.

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USE CASES FOR NLP

WHAT IS NATURAL LANGUAGE PROCESSING




Named Entity Recognition

- Extract entities in a piece of text into defined categories
- Identify clinical concepts in free-form notes



Text Generation

- Various methodologies for text generation
- Includes autocomplete, chatbots, and conversation generators



Information Retrieval

- Finding documents relevant to human queries
- Utilizes indexing and matching, often with vectors

Original note:

... no known allergies review of symptoms : general : no fevers , chills , or weight loss... no cough , shortness of breath , or wheezing cardiovascular : no chest pain or dyspnea on exertion gastrointestinal : no abdominal pain , change in bowel habits , or black or bloody stools... neurological : no transient ischemic attack or stroke symptoms...

Negation Tagged:

... no known **allergies_neg** review of symptoms : general : no **fevers_neg** , **chills_neg** , or **weight_neg loss_neg**... no **cough_neg** , **shortness_neg of breath_neg** , or **wheezing_neg** cardiovascular : no **chest_neg pain_neg** or **dyspnea_neg** on **exertion_neg** gastrointestinal : no **abdominal_neg pain_neg** , **change_neg in_neg bowel_neg habits_neg** , or black or bloody stools... neurological : no **transient_ischemic_neg attack_neg** or **stroke_neg symptoms_neg**...


Actual Outcome: No Stroke
 Prediction without Tags: **0.8583**
 Prediction with Tags: **0.3285**

False positive rates improve when adding tagged information from medial notes

Liu, J., Zhang, et al. Deep EHR: Chronic Disease Prediction Using Medical Notes.

DeepLearning.AI. "Natural Language Processing (NLP) - a Complete Guide." Www.deeplearning.ai, 11 Jan. 2023, www.deeplearning.ai/resources/natural-language-processing/.
Liu, J., Zhang, Z. & Razavian, N. (2018). Deep EHR: Chronic Disease Prediction Using Medical Notes. Proceedings of the 3rd Machine Learning for Healthcare Conference, in Proceedings of Machine Learning Research. 85:440-464 Available from https://proceedings.mlr.press/v85/liu18b.html.

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WHAT ARE EXPERT SYSTEMS?

- Simulating reasoning of human experts in niche fields, such as health care and its subsequent domains
- Replicate/improve statistical knowledge and practice heuristics
- Interchangeable with knowledge-based and decision support
- Clinician evaluation may be required for usability, utility and system quality, and literature on head-to-head comparisons in sparse
- Different domains may develop standardized ES, in the form of clinical decision support, diagnosis prediction models, treatment outcome prediction models and key clinical trial variables
- The extent of how universally they can be used will depend on the large amounts of data needed to train them
- Data acquisition and knowledge structuring up to 70% of overall time needed to develop such systems

What would you need before you trusted an Expert System in your practice?

Salem H, Soria D, Lund JN, Awwad A. A systematic review of the applications of Expert Systems (ES) and machine learning (ML) in clinical urology. BMC Med Inform Decis Mak. 2021 Jul 22;21(1):223. doi: 10.1186/s12911-021-01585-9. PMID: 34294092; PMCID: PMC8299670.
"Medical Expert System - an Overview | ScienceDirect Topics." www.sciencedirect.com, www.sciencedirect.com/topics/computer-science/medical-expert-system.

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WHAT IS COMPUTER VISION?

- A combination of hardware and algorithms to process visual data, such as images or videos
- Automated classification of medical images is a leading AI application in health care today (strong body of data on accuracy of AI vs human performance)

Image Acquisition **Preprocessing** **Feature Extraction**

- Capture image or video with camera
- Higher quality is more accurate

- Clean up image and adjust
- Remove noise, adjust colors

- Identify and extract the key portions, such as items of interest, color, edges, etc

Singh, Balwant. "What is Computer Vision | Chooch." Vision AI | Generative AI for Computer Vision | Chooch, 5 Sept. 2023. www.chooch.com/blog/what-is-computer-vision/. Accessed 4 Apr. 2024.
Bojwa J, Munir U, Nori A, Williams B. Artificial intelligence in healthcare: transforming the practice of medicine. Future Healthc J. 2021 Jul;8(2):e188-e194. doi: 10.7861/fhj.2021-0095. PMID: 34286183; PMCID: PMC8285156.

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USE CASES FOR COMPUTER VISION IN HEALTH CARE

WHAT IS COMPUTER VISION?

Clinical Image Analysis

- Can increase accuracy of diagnosis and decrease time for interpretation
- Studies demonstrated AI ability to meet or exceed performance of humans in image diagnosis for

Diabetic Retinopathy → Medicare reimbursement for AI algorithm Idx-DR (87% sensitivity, 90% specificity)

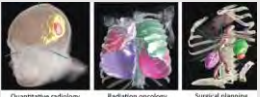
Pathology → Whole slide pathology images to detect metastases of breast cancer

Cancer Tx Planning → Image prep; reduce time before treatment by up to 90% for head, neck, prostate (Inner Eye)

Radiology → Pneumonia from X-Rays

Cardiology → Diagnosing heart attacks

Dermatology → Classify skin lesions




Quantitative radiology Radiation oncology Surgical planning

Possible Use Cases

- Policy Compliance**: Identifying when employees fail to use safety equipment and following sterile compounding procedure
- Smart Operating Room**: Translating direct observations into EHR documentation
- Patient ID**: HIPAA compliant facial recognition systems for patient ID


Goldsmith, Jeffrey, et al. "The Value of Computer Vision in Healthcare." HIMSS. "Www.himss.org, 22 July 2021. www.himss.org/resources/value-computer-vision-healthcare.
 Bajwa J, Munir U, Nori A, Williams B. Artificial intelligence in healthcare: transforming the practice of medicine. *Future Healthc J.* 2021 Jul;8(2):e188-e194. doi: 10.7863/fhj.2021-0005. PMID: 34280163; PMCID: PMC8285166.

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WHAT IS DEEP LEARNING?

- Elaborate sub-form of machine learning that uses layered artificial neural networks to provided increased accuracy and specificity
- Deep learning requires a very large amount of data for training
- Drives many applications and services that improve automation, analytics, and reduces the need for human intervention in several processes
- Backpropagation uses algorithms to calculate errors in predictions and adjusts weights and biases through the layers to better train the model
- The drawbacks to deep learning models is the cost, complexity, amount of data needed, processing power, and time



Created by Midjourney, April 4, 2024
Prompt: "Deep learning, animated"

Habebth H, Gohel S. Machine Learning in Healthcare. *Curr Genomics.* 2021 Dec 16;22(4):291-300. doi: 10.2174/1389202922666210705124359. PMID: 35273459. PMCID: PMC8822225.
 IBM. "What Is Deep Learning?" Wwww.ibm.com, 2023. www.ibm.com/topics/deep-learning.
 "What Is Deep Learning?" Codecademy, www.codecademy.com/article/what-is-deep-learning. Accessed 4 Apr. 2024.

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LET'S BUILD A NEURAL NETWORK: NUMBER ID

WHAT IS DEEP LEARNING? | ADAPTED EXAMPLE FROM 3BLUE1BROWN

Our Network

28

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Layer 1 of our neural network will have 784 nodes (one per pixel) and contain a value of 0 to 1 based on activation value

But What Is a Neural Network? | Chapter 1, Deep Learning. www.youtube.com, www.youtube.com/watch?v=airAruvnKk&list=PLI4p_UR2YEdO9Ns2cO9daOyhb--TdgIzW&index=18&t=914s. Accessed 4 Apr. 2024.

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3

LET'S BUILD A NEURAL NETWORK: NUMBER ID

WHAT IS DEEP LEARNING? | ADAPTED EXAMPLE FROM 3BLUE1BROWN

Our Network

0
1
2
3
4
5
6
7
8
9

The last layer of our network will correspond with our goal: to have the system accurately determine what number was written

To allow the system to learn, our network will have 'hidden' layers we will have to design

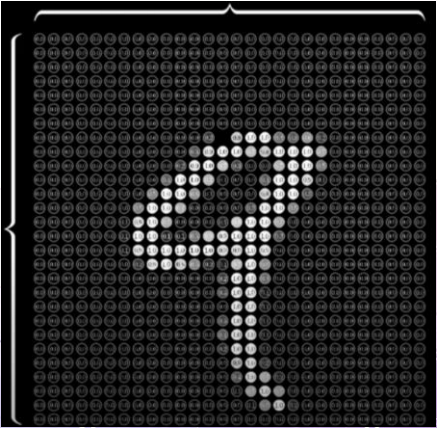
But What Is a Neural Network? | Chapter 1, Deep Learning. www.youtube.com, www.youtube.com/watch?v=airAruvnKk&list=PLI4p_UR2YEdO9Ns2cO9daOyhb--TdgIzW&index=18&t=914s. Accessed 4 Apr. 2024.

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LET'S BUILD A NEURAL NETWORK: NUMBER ID

WHAT IS DEEP LEARNING? | ADAPTED EXAMPLE FROM 3BLUE1BROWN



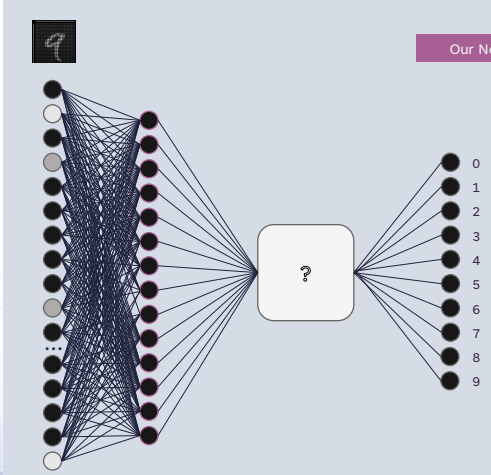
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LET'S BUILD A NEURAL NETWORK: NUMBER ID

WHAT IS DEEP LEARNING? | ADAPTED EXAMPLE FROM 3BLUE1BROWN



Our Network

0
1
2
3
4
5
6
7
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9

Let's create a layer that can group pixel nodes into arc nodes

But What Is a Neural Network? | Chapter 1, Deep Learning. www.youtube.com, www.youtube.com/watch?v=airArvvnKk&list=PLI4p_UR2YEdO9Ns2cO9daOyhb--TdgizW&index=18&t=914s. Accessed 4 Apr. 2024.

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6

LET'S BUILD A NEURAL NETWORK: NUMBER ID

WHAT IS DEEP LEARNING? | ADAPTED EXAMPLE FROM 3BLUE1BROWN

Smaller arcs can combine to form number segments

“But What is a Neural Network?” Chapter 1, Deep Learning.” www.youtube.com, www.youtube.com/watch?v=airAruvnKk&list=PLi4p_UR2YEdO9Ns2cO9daOyhb--TdgizW&index=18&t=914s. Accessed 4 Apr. 2024.

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LET'S BUILD A NEURAL NETWORK: NUMBER ID

WHAT IS DEEP LEARNING? | ADAPTED EXAMPLE FROM 3BLUE1BROWN

Our Network

0
1
2
3
4
5
6
7
8
9

So, let's add one more layer to the network where each node is a number segment

“But What is a Neural Network?” Chapter 1, Deep Learning.” www.youtube.com, www.youtube.com/watch?v=airAruvnKk&list=PLi4p_UR2YEdO9Ns2cO9daOyhb--TdgizW&index=18&t=914s. Accessed 4 Apr. 2024.

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LET'S BUILD A NEURAL NETWORK: NUMBER ID

WHAT IS DEEP LEARNING? | ADAPTED EXAMPLE FROM 3BLUE1BROWN

Our Network

0
1
2
3
4
5
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"But What is a Neural Network? | Chapter 1, Deep Learning." www.youtube.com, www.youtube.com/watch?v=airAruvnKk&list=PLI4p_UR2YEdO9Ns2cO9daOyhb--TdgIzW&index=18&t=914s. Accessed 4 Apr. 2024.

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LET'S APPLY IT TO PILL IMAGE RECOGNITION

WHAT IS DEEP LEARNING? | ADAPTED EXAMPLE FROM 3BLUE1BROWN

Systems like these could form the basis for more complex health care systems, such as pill identification from pill images taken at point of production

Capture Pill Image

Send through our trained neural network

Extract color, shape and markings

Circle, White
Side 1: LU
Side 2: S25

Pill Marking Database


Compare with pill marking database to ID medication

Levonorgestrel 1.5mg

Clinicians determine accuracy and provide feedback to the model

"But What is a Neural Network? | Chapter 1, Deep Learning." www.youtube.com, www.youtube.com/watch?v=airAruvnKk&list=PLI4p_UR2YEdO9Ns2cO9daOyhb--TdgIzW&index=18&t=914s. Accessed 4 Apr. 2024.

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WHAT ARE GENERATIVE AI AND LARGE LANGUAGE MODELS?

- Generative AI** is a branch of deep learning, which uses Large Language Models, in conjunction with other AI techniques like NLP, to interpret and generate data, images, video, and data
- Large Language Models (LLM)** are unique neural networks trained on massive amounts of data with millions-billions of parameters
- Converts text into **tokens**, builds mathematical relationships between them, predicts the next words, with iterative improvement through labeling/training

Artificial intelligence is a machine's ability to perform some cognitive functions we usually associate with human minds.

The evolution of artificial intelligence

Artificial intelligence	Machine learning	Deep learning	Generative AI
The science and engineering of making intelligent machines.	A major breakthrough in achieving AI.	A sub-branch of deep learning.	An advanced branch of deep learning.
AI is the broad field of developing machines that can replicate human behavior, including tasks related to perceiving, reasoning, learning, and problem-solving.	Machine learning algorithms detect patterns in large data sets and learn to make predictions by processing data, rather than by receiving explicit programming instructions.	Deep learning uses neural networks inspired by the way the human brain processes information to learn from multiple iterations that draw increasingly precise features of the data and make increasingly sophisticated predictions.	Generative AI is a branch of deep learning that uses exceptionally large neural networks called large language models (with hundreds of billions of neurons) that can learn complex, abstract patterns. Language models applied to interpret and create text, images, and data are known as generative AI.

McKinsey. "What Is AI? "

Tokens	Characters
17	79

"They may forget your name, but they will never forget how you made them feel."

<https://platform.openai.com/tokenizer>

McKinsey. "What Is AI? " www.mckinsey.com, McKinsey & Company, 24 Apr. 2023, www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-ai.

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THEN WHAT IS A GPT?

WHAT ARE GENERATIVE AI AND LLMs?

Generative Pre-Trained Transformers

Analyze natural language queries (prompts) and predict the best possible response (new text)


Learned from TBs of data from the internet, books, and Wikipedia from which it was trained

Breakthrough architecture that is the "brains" allowing context in the word selection process

My Input

Once Upon a _____

→



Created by Midjourney
April 4, 2024
Prompts: "the black box, Road Dahl style"

→

GPT Output

Once Upon a TIME

"What Is GPT AI? - Generative Pre-Trained Transformers Explained - AWS." Amazon Web Services, Inc., aws.amazon.com/what-is/gpt/.

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TEXT EMBEDDING

WHAT ARE GENERATIVE AI AND LLMs? | EXAMPLE FROM 3BLUE1BROWN

Encoder

First Step: Encoder does Embedding

- Turning words/tokens into arrays of numbers
- Think that each value is how closely related each word is to every other word that exists in the model
 - 1 means two words have the same meaning, 0 means they are not related, -1 is opposite
- Models have an embedding layer that assigns every word a vector out of the box, which learns over training

Once Upon a midnight dreary, while I _____ Encoder → Once Upon a midnight dreary, while I **PONDERED WEAK AND WEARY...**

But What is a GPT? Visual Intro to Transformers | Chapter 5, Deep Learning. [www.youtube.com, www.youtube.com/watch?v=wjZofJX0v4M&list=PLI4p_UR2YEdO9Ns2cO9daQyhb--7dglzW&index=20](https://www.youtube.com/watch?v=wjZofJX0v4M&list=PLI4p_UR2YEdO9Ns2cO9daQyhb--7dglzW&index=20), Accessed 5 Apr. 2024.
**What is GPT AI? - Generative Pre-Trained Transformers Explained - AWS.* [Amazon Web Services, Inc., aws.amazon.com/what-is/gpt/](https://aws.amazon.com/what-is/gpt/).

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EMBEDDING EXAMPLES

WHAT ARE GENERATIVE AI AND LLMs? | EXAMPLE FROM 3BLUE1BROWN

Encoder

- Embeddings that are close mean words are closely related
 - E(tower) is close to E(gate), E(building), E(skyscraper)...
- Turning words into arrays of numbers means you can do math on words
- If the results are close, then the model found it beneficial to develop a dimension that encodes that direction
 - $E(\text{king}) - E(\text{man}) + E(\text{woman}) \approx E(\text{queen})$
 - $E(\text{niece}) - E(\text{nephew}) \approx E(\text{woman}) - E(\text{man})$
 - $E(\text{Hitler}) + E(\text{Italy}) - E(\text{Germany}) \approx E(\text{Mussolini})$
 - $E(\text{Sushi}) + E(\text{Germany}) - E(\text{Japan}) \approx E(\text{Bratwurst})$

Not all models are trained on health care data and embeddings could be skewed/incorrect (medical jargon, medication names, etc)

Once Upon a midnight dreary, while I _____ Encoder → Once Upon a midnight dreary, while I **PONDERED WEAK AND WEARY...**

But What is a GPT? Visual Intro to Transformers | Chapter 5, Deep Learning. [www.youtube.com, www.youtube.com/watch?v=wjZofJX0v4M&list=PLI4p_UR2YEdO9Ns2cO9daQyhb--7dglzW&index=20](https://www.youtube.com/watch?v=wjZofJX0v4M&list=PLI4p_UR2YEdO9Ns2cO9daQyhb--7dglzW&index=20), Accessed 5 Apr. 2024.
**What is GPT AI? - Generative Pre-Trained Transformers Explained - AWS.* [Amazon Web Services, Inc., aws.amazon.com/what-is/gpt/](https://aws.amazon.com/what-is/gpt/).

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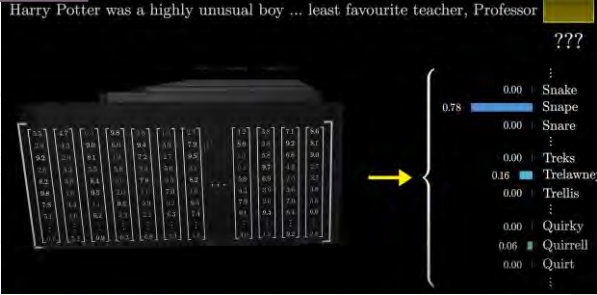
Scripting Tomorrow: A Pharmacist's Survival Guide to AI

TEXT UNEMBEDDING

WHAT ARE GENERATIVE AI AND LLMs? | EXAMPLE FROM 3BLUE1BROWN

Decoder

Harry Potter was a highly unusual boy ... least favourite teacher, Professor



0.78 Snake
0.00 Snake
0.00 Snare
0.00 Treks
0.16 Trelawney
0.00 Trelis
0.00 Quirky
0.06 Quirrell
0.90 Quirt

Last Step: Decoder does Unembedding

- Probability distribution for the next word based on GPT's learned knowledge in the form of calculations
- Needs to consider context in its responses
- Can influence the calculations to influence the probability at the end, and that can make the results creative and unpredictable
- Once a single word is added, can send back through as a new prompt and add more words
- Calculations are taxing, resulting in limits for token length in prompts/chats

Once Upon a midnight dreary, while I _____

Encoder

Decoder

Once Upon a midnight dreary, while I PONDERED WEAK AND WEARY...


"But What is a GPT? Visual Intro to Transformers | Chapter 5, Deep Learning." Wwww.youtube.com, www.youtube.com/watch?v=vjzofJX0v4M&list=PLI4p_UR2YEdO9Ns2cO9daQyhb--TdgizW&index=20, Accessed 5 Apr. 2024.
 "What is GPT AI? - Generative Pre-Trained Transformers Explained - AWS." Amazon Web Services, Inc., aws.amazon.com/what-is/gpt/

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WEIGHTS, PARAMETERS, AND COMMUNICATION LAYERS

WHAT ARE GENERATIVE AI AND LLMs? | EXAMPLE FROM 3BLUE1BROWN

Attention & Multilayer Perceptron Layers



Middle Steps: Weights, Parameters and Communication Layers

- The middle layers are complicated, but they are filled with learned parameters (also called weights)
- Alternate Layer Types
 - **Attention Layers** – Lets each word/token talk to each other word in your prompt to form context through vector math
 - **Multilayer Perceptron** – Mathematical equivalent to asking each word/token a long series of questions and then updating based on answers
- Alternating layers repeat multiple times until last step
- All weights can update during training

Once Upon a midnight dreary, while I _____

Encoder

**Attention Layers
Multilayer Perceptron Layers**

Decoder

Once Upon a midnight dreary, while I PONDERED WEAK AND WEARY...

"But What is a GPT? Visual Intro to Transformers | Chapter 5, Deep Learning." Wwww.youtube.com, www.youtube.com/watch?v=vjzofJX0v4M&list=PLI4p_UR2YEdO9Ns2cO9daQyhb--TdgizW&index=20, Accessed 5 Apr. 2024.
 "What is GPT AI? - Generative Pre-Trained Transformers Explained - AWS." Amazon Web Services, Inc., aws.amazon.com/what-is/gpt/

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Scripting Tomorrow: A Pharmacist's Survival Guide to AI

PRACTICAL CONSIDERATIONS

WHAT ARE GENERATIVE AI AND LLMs?

- Large Language Models are trained on massive amounts of data, mostly publicly available data BUT not all the data out there. Training new models is very costly for most organizations
- GPT3 – trained on 45TB of data, 175B parameters, estimated millions of dollars in computing power
- LLMs can be open source or closed source products, but are **most often non-HIPAA compliant**, as they do not secure submitted data
- Hallucinations
 - Machines generate seemingly realistic sensory experiences that do not correspond to the real world
 - If GPTs are used without considerations of limitations of AI, this could cause patient harm and erode trust clinicians have for technology

Users should be cautious in using GPTs in clinical practice, and exercise best practices in prompt engineering to minimize bias and hallucinations

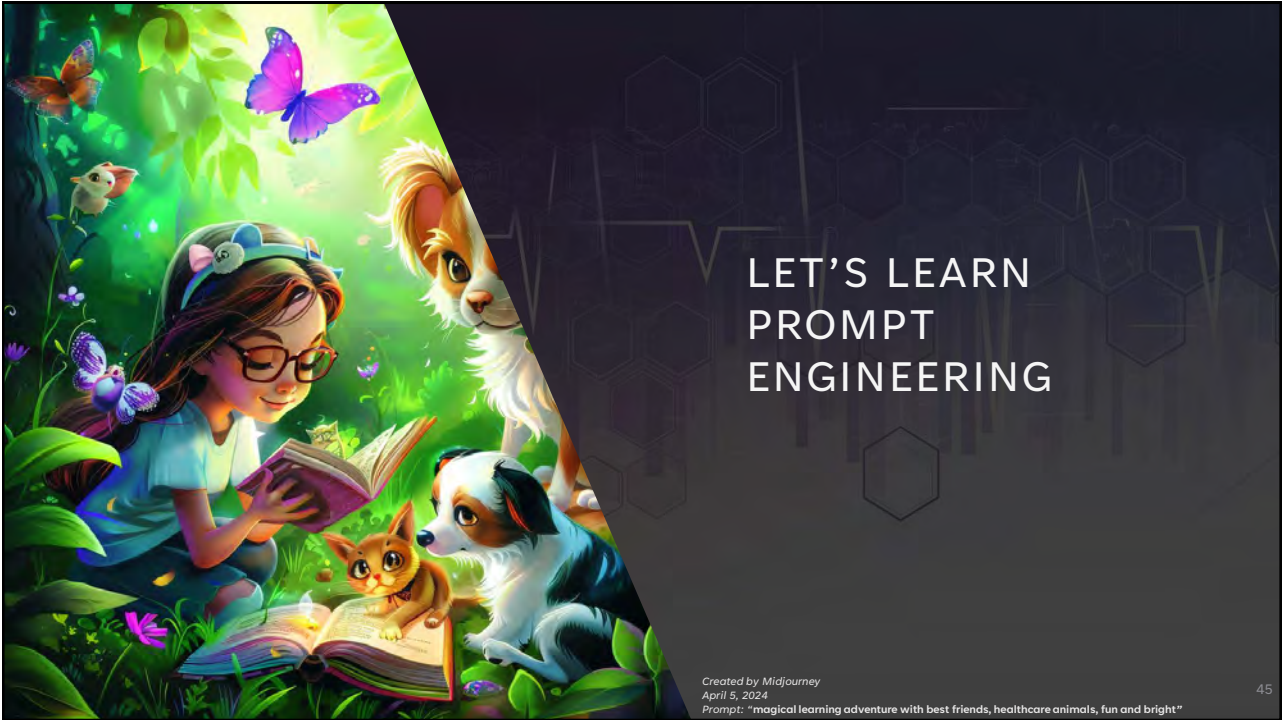
"But What is a GPT? Visual Intro to Transformers | Chapter 5, Deep Learning." www.youtube.com, www.youtube.com/watch?v=wjZofJX0v4M&list=PL14p_UR2YEdO9Ns2cO9daQyhb--TdglzW&index=20. Accessed 5 Apr. 2024.
"What is GPT AI? – Generative Pre-Trained Transformers Explained - AWS." Amazon Web Services, Inc., aws.amazon.com/what-is/gpt/.
Alkaiissi H, McFarlane SI. Artificial Hallucinations in ChatGPT: Implications in Scientific Writing. *Cureus*. 2023 Feb 19;15(2):e35179. doi: 10.7759/cureus.35179. PMID: 36811129; PMCID: PMC9939079.
Li, Chuan. "OpenAI's GPT-3 Language Model: A Technical Overview." [Lambdalabs.com](https://lambdalabs.com), 3 June 2020, lambdalabs.com/blog/demystifying-gpt-3.

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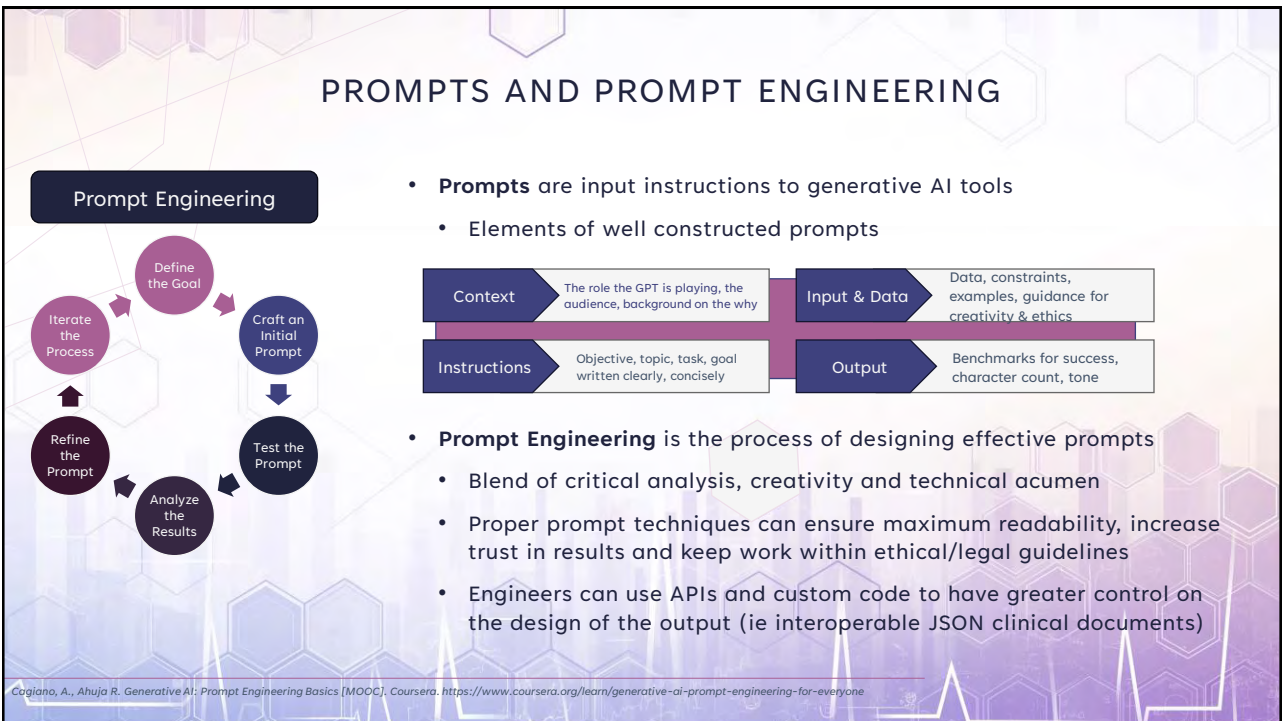
? Which pairing of AI concept and definition is most accurate?

- A** **Machine learning** is the process of computers acquiring knowledge through programming if-then statements
- B** **Computer vision** is a branch of AI concerned with understanding and interpreting human emotions
- C** **Generative AI** is a type of AI that is only capable of imitating and recombining existing patterns and cannot generate new content
- D** **Expert systems** are AI systems designed to replicate the intuition and decision-making abilities of expert individuals in niche fields
- E** **Natural language processing** involves the study of biological languages and their impact on human behavior

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CASE STUDY: OPTIMIZING PROMPTS

PROMPTS AND PROMPT ENGINEERING | PART 1/3

Is prescribing medications within the scope of practice for pharmacists in Idaho?

As of my last update in early 2023, pharmacists in Idaho do have an expanded scope of practice compared to many other states in the United States. Idaho has been at the forefront of expanding the role of pharmacists in patient care, and the state has allowed pharmacists to prescribe medications under certain circumstances.

Idaho pharmacists, under specific protocols, can prescribe medications for a variety of minor ailments and conditions. This can include things like influenza, strep throat, urinary tract infections, and more. The exact medications and conditions for which pharmacists can prescribe may change over time, so it's important to check the current regulations and guidelines provided by the Idaho State Board of Pharmacy or other regulatory bodies.

Pharmacists in Idaho are also able to administer vaccines, and they have the authority to modify or discontinue medications as part of collaborative practice agreements with physicians.

However, it's important to note that the scope of practice for pharmacists can change due to new laws or regulations, so for the most current information, it is best to consult the Idaho State Board of Pharmacy or relevant state resources.

Adapted results from ChatGPT 3.5

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CASE STUDY: OPTIMIZING PROMPTS

PROMPTS AND PROMPT ENGINEERING | PART 2/3

Original Prompt

Is prescribing medications within the scope of practice for pharmacists in Idaho?

As an AI assistant, I need you to adopt the persona of a knowledgeable pharmacist in Idaho.

Your task is to answer the question about prescribing medications in Idaho.

Please provide a detailed and accurate response based on the current scope of practice for pharmacists in Idaho using sections and bullets.

Remember, you are speaking as a pharmacist in Idaho and should provide the most up-to-date information on this matter. Thank you!

Prompt Optimization Elements

- Context
- Instructions
- Output
- Input & Data

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Scripting Tomorrow: A Pharmacist's Survival Guide to AI

CASE STUDY: OPTIMIZING PROMPTS

PROMPTS AND PROMPT ENGINEERING | PART 3/3

As an AI assistant, I need you to adopt the persona of a knowledgeable pharmacist in Idaho. Your task is to answer the question about prescribing medications in Idaho. Please provide a detailed and accurate response based on the current scope of practice for pharmacists in Idaho using sections and bullets. Remember, you are speaking as a pharmacist in Idaho and should provide the most up-to-date information on this matter. Thank you!

As of my last update in early 2023, pharmacists in Idaho do have an expanded scope of practice compared to many other states in the United States. Idaho has been progressive in allowing pharmacists to prescribe medications under certain conditions, but there are specific regulations and limitations that govern this authority.

****Pharmacist Prescriptive Authority:****
In Idaho, pharmacists are allowed to prescribe medications under what is known as "prescriptive authority." This authority is not without its limits and typically requires that the pharmacist adhere to statewide protocols or collaborative practice agreements.

****Statewide Protocols:****
Under statewide protocols, Idaho pharmacists can prescribe medications for certain minor health conditions without the need for a collaborative practice agreement with a physician. These conditions often include ailments that can be self-diagnosed and self-managed with minimal risk, such as cold sores, influenza, strep throat, and urinary tract infections. Pharmacists must follow specific protocols for each condition, which include patient assessment, appropriate prescribing, and documentation requirements.

****Collaborative Practice Agreements:****
In some cases, pharmacists can enter into collaborative practice agreements (CPAs) with physicians. These agreements allow pharmacists to manage and prescribe medications for chronic conditions under the supervision of a physician. The CPA outlines the specific conditions and medications the pharmacist can prescribe, as well as the rules for consultation and referral.

****Limitations and Restrictions:****
Pharmacists in Idaho are not allowed to prescribe all types of medications. There are restrictions on prescribing controlled substances, although there may be exceptions under certain conditions or in emergency situations as defined by law and regulations. Additionally, pharmacists must ensure they are prescribing within the scope of their practice and expertise, and they must adhere to the rules and protocols set forth by the Idaho Board of Pharmacy.

****Training and Certification:****
To prescribe medications, pharmacists in Idaho must have the appropriate training and certification. This often includes completing a course in prescribing and demonstrating competency in the assessment and management of the conditions for which they will be prescribing.

****Continuing Education:****
Pharmacists with prescriptive authority are typically required to participate in ongoing continuing education to maintain their prescribing skills and stay up-to-date with current protocols and guidelines.

****Documentation and Reporting:****
Pharmacists must document all prescriptions they issue and may be required to report this information to a central database. This is to ensure proper tracking of medication use and to prevent abuse or misuse of prescribed substances.

It's important to note that regulations can change, and it's always a good idea to consult the Idaho Board of Pharmacy or current state statutes for the most up-to-date information on pharmacists' prescribing authority in Idaho. Pharmacists must stay informed about any changes to laws and regulations that affect their practice.

Results are more robust and organized, with quality information

Adapted results from ChatGPT 3.5

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HANDS ON PRACTICE AND TIPS

PROMPTS AND PROMPT ENGINEERING | PART 1/3

Subtle differences in prompt language can yield different results

Prompt 1: "Tell me..." vs "Explain..."
Example: "Tell me about collaborative practice agreements for pharmacists" vs "Explain collaborative practice agreements for pharmacists"

Prompt 2: "What are the..." vs "Discuss..." vs "List the top 5..."
Example: "What are the benefits of daily exercise?"...

Prompt 3: Include examples and ask for examples ("...include an illustrative example of the concept, such as...")
Example: "Explain to me how drug shortages work with the help of illustrative examples, such as previous drug shortages that had large-scale impacts to the US economy."

Cagliano, A., Ahuja R. Generative AI: Prompt Engineering Basics [MOOC]. Coursera. <https://www.coursera.org/learn/generative-ai-prompt-engineering-for-everyone>

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HANDS ON PRACTICE AND TIPS

PROMPTS AND PROMPT ENGINEERING | PART 2/3

Persona Creation and Domain Expertise

Prompt 4: "Acting as..." | "You are a..." | "in the style of [famous person]"

Example: "You are a clinical pharmacist with 20 years of experience overseeing the oncology unit. Draft a protocol for the handling of sterile chemotherapy compounds."

Prompt 5: "...research-based responses..."

Example: "Please explain the causes, symptoms, and treatments for hypothyroidism, including the latest research and medical guidelines."

Note: drawing responses from domain expertise can diverge your findings from patient findings

Prompt 6: "...ask me clarifying questions, one at a time..."

Example: "You will act as a seasoned clinical pharmacist who is counseling patients on proper medication usage. Your objective is to provide patients discharging from a hospital with comprehensive information on how to take their medications in patient friendly language. Begin by asking a series of detailed questions, one at a time, to gather all the essential information required to craft the most tailored and effective patient education materials based on the patient's condition, medications and social determinants of health."

Cagliano, A., Ahuja R. Generative AI: Prompt Engineering Basics [MOOC], Coursera. <https://www.coursera.org/learn/generative-ai-prompt-engineering-for-everyone>

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CASE STUDY: ERROR IN CHAT

PROMPTS AND PROMPT ENGINEERING

Single Shot

Which benzodiazepine has the shortest half-life?

Among benzodiazepines, **midazolam** typically has one of the shortest half-lives, ranging from 1.5 to 2.5 hours. However, it's important to note that the half-life can vary depending on individual factors such as metabolism and dosage. Other short-acting benzodiazepines include triazolam and lorazepam, with half-lives ranging from 6 to 8 hours.

Few-Shot

Provide a table with all commercially available benzodiazepines and their half-life?

Sure, here's a table listing some common benzodiazepines along with their approximate half-lives:

Please note that these half-lives are approximate and can vary depending on factors such as individual metabolism, dosage, and other medical conditions. Always consult a health care professional for accurate information regarding medication.

Which benzodiazepine has the shortest half-life?

Among the benzodiazepines commonly prescribed, **oxazepam** typically has one of the shorter half-lives, ranging from about 5 to 15 hours. However, it's important to note that individual responses to medications can vary, and factors such as metabolism and dosage can influence the effective duration of a benzodiazepine's effects.

AI Generated Table

Benzodiazepine	Half-life (hours)
Alprazolam	12-15
Diazepam	20-100
Lorazepam	10-20
Clonazepam	18-50
Temazepam	8-22
Oxazepam	5-15
Chlordiazepoxide	5-30
Flurazepam	40-250

Adapted results from ChatGPT 3.5

The GPT created a chart because of the first prompt, and then assumed all questions in this chat would refer to only the benzodiazepines in this chart

A Better Initial Prompt


You are a clinical pharmacist creating a worksheet aid for physicians and nurses for administration of medications. Use medical research sources to make a table for all known benzodiazepines and their half-lives

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HANDS ON PRACTICE AND TIPS

PROMPTS AND PROMPT ENGINEERING | PART 3/3

Bias Mitigation	"...without favoring..." "...provide equal examples from..."
Framing	"Your response should be less than 500 words" "In a professional, friendly tone" "Bold all changes that you make"
Other Personas	"Acting as a teacher..." "Acting as a travel agent..." "Acting as a concerned care giver..."
Feedback Loops	You can ask the model for an output, provide feedback on what you like and do not like about the model, and continue until you are satisfied
Chain of Thought	If complex question is not yielding results, break into smaller prompts in order. Provide it feedback and ask for its thought process "...explain your thoughts..."
Verification Questions	After the GPT gives you a response, ask it a question to validate the response is accurate, using information you know/expect is in the response
Helpful Tools	Look at prompt libraries, tools that optimize prompts for you, search multiple LLMs in one query



If you forget these tips or want to know more useful prompts...

Just ask the chatbot!

Cagliano, A., Ahuja R. Generative AI: Prompt Engineering Basics [MOOC], Coursera. <https://www.coursera.org/learn/generative-ai-prompt-engineering-for-everyone>

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CASE STUDY: CHAIN OF THOUGHT PROMPTING FOR SMOKING CESSATION COUNSELING

PROMPTS AND PROMPT ENGINEERING

Scenario: You are a retail pharmacist and have a patient who is ready to try and quit smoking. You want to brainstorm ideas and be ready for the next conversation with the patient. You are going to ChatGPT for a thought partner

Smoking Cessation Basic Prompt

Smoking Cessation Chain of Thought

Smoking Cessation Verification Question

Ignore all previous instructions. You are a clinical pharmacist and smoking cessation expert. Your task is to help the patient formulate a plan to stop smoking.

Loop 3-5x

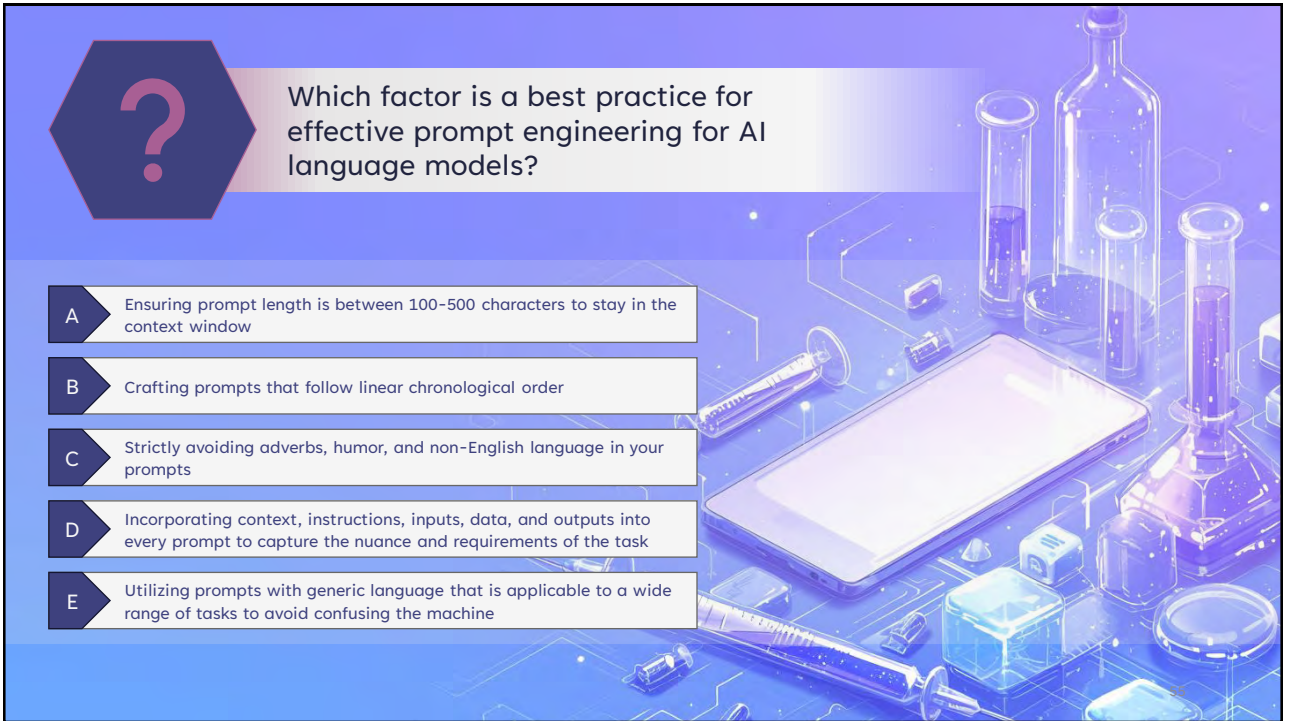
```

            graph LR
            A[Input problem] --> B[Brainstorm 3 ideas]
            B --> C[Evaluate and Rank]
            C --> D[Keep Only Best Idea]
            D --> E[Elaborate Best Idea]
            E --> A
            
```

Validate that the last response was written in a 5th grade reading level

*ADVANCED ChatGPT Prompt Engineering: 7+ Chain Prompts in the Tree of Thoughts Principle." www.youtube.com/watch?v=j320H2LFx-U&t=420s; Accessed 7 Apr. 2024.

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Which factor is a best practice for effective prompt engineering for AI language models?

- A Ensuring prompt length is between 100-500 characters to stay in the context window
- B Crafting prompts that follow linear chronological order
- C Strictly avoiding adverbs, humor, and non-English language in your prompts
- D Incorporating context, instructions, inputs, data, and outputs into every prompt to capture the nuance and requirements of the task
- E Utilizing prompts with generic language that is applicable to a wide range of tasks to avoid confusing the machine

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SURVEY OF AI USE CASE ACROSS HEALTH CARE

Created by Midjourney
April 5, 2024
Prompt: "usecases of artificial intelligence in healthcare, pop art"

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CASE STUDY: AI DOCUMENTATION SCRIBES

- Goal to decrease documentation burden and reduce 'pajama time' (off-hours administrative burden)
- The Permanente Medical Group implemented ambient AI technology, helping with documentation for 303,266 patient encounters
 - Steady increase in physicians who use the functionality over 10-week period
 - Decrease in time spent off hours ($p < 0.05$) for AI scribe users
- Hallucinations: "hand, foot and mouth" & "scheduled prostate exam"

Table 1. Description of the Modified PQDI-9 Scribe Quality Assessment Tool (10 Domains)

Attribute	Description of Ideal Note
Accurate	The note is true. It is free of incorrect information.
Thorough	The note is complete and free from omission and documents all of the issues of importance to the patient.
Useful	The note is extremely relevant, providing valuable information and/or analysis.
Organized	The note is well-formed and structured in a way that helps the reader understand the patient's clinical course.
Comprehensible	The note is clear, without ambiguity or sections that are difficult to understand.
Succinct	The note is brief, to the point, and without redundancy.
Synthesized	The note reflects the AI scribe's understanding of the patient's status and ability to develop a plan of care.
Internally Consistent	No part of the note ignores or contradicts any other part.
Free from Hallucination	The note is free of hallucination and only contains information verifiable by the transcript.
Free from Bias	The note is free of bias and contains only information verifiable by the transcript and not derived from characteristics of the patient or visit.

Based on prior literature, we assessed samples of transcripts and clinical summaries across an array of clinical specialties using a modified version of the Physician Documentation Quality Instrument (PDQI-9). To adapt for use on AI scribes, we removed the up-to-date domain and added those assessing freedom from hallucinations and bias, because these have been noted to potentially occur in outputs from large language models. We retained the 5-point Likert scale scoring from the original instrument (with 1 being not at all and 5 being extremely) and rated notes on a scale with a maximum value of 50. Source: The authors.

Tierney, Aaron A, et al. "Ambient Artificial Intelligence Scribes to Alleviate the Burden of Clinical Documentation."



Tierney, Aaron A, et al. "Ambient Artificial Intelligence Scribes to Alleviate the Burden of Clinical Documentation."

Tierney, Aaron A, et al. "Ambient Artificial Intelligence Scribes to Alleviate the Burden of Clinical Documentation." *NEJM Catalyst Innovations in Care Delivery*, vol. 5, no. 3, 21 Feb. 2024. <https://doi.org/10.1056/cat.23.0404>.

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USE CASES OF WEARABLE DEVICES IN HEALTH CARE WEARABLE DEVICES | PART 1/2

Health and Safety Monitoring

- Wearables to reliably detect generalized tonic-clonic seizures with high sensitivity/specificity to help optimize antiepileptic treatment and reduce sudden unexpected death
- Wearable tools in predicting depressive symptoms in children and adolescents
- Head-med's Compass pregnancy monitor – maternal and fetal heart rate, uterine activity through abdominal patch

Diagnosis and Treatment of Diseases

- **Neurological** – monitor gait to detect early cognitive dysfunction in Alzheimer disease
- **Respiratory** – Nocturnal breathing monitor equipment for sleep apnea
- **Urinary Disease** – treatment with wearable artificial kidneys in end-stage renal disease was well tolerated

Lu L, Zhang J, Xie Y, Gao F, Xu S, Wu X, Ye Z. Wearable Health Devices in Health Care: Narrative Systematic Review. *JMIR Mhealth Uhealth*. 2020 Nov 9;8(11):e18907. doi: 10.2196/18907. PMID: 33164904; PMCID: PMC7653248

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USE CASES OF WEARABLE DEVICES IN HEALTH CARE

WEARABLE DEVICES | PART 2/2

Chronic Disease Management

- **Cardiovascular Disease** – Watches for ECGs and arrhythmia monitoring. Wearable cardioverter-defibrillators to protect from sudden cardiac death
- **Pulmonary Disease** – COPD exacerbation monitoring. Nighttime wheezing monitoring in children for asthma control
- **Diabetes** – blood glucose monitoring and implantable insulin pumps. Interpretation of results can be complex, with delays between blood levels and device readings
- **Hypertension** – Cuff type (more reliable) and sleeveless type

Lu L, Zhang J, Xia Y, Gao F, Xu S, Wu X, Ye Z. Wearable Health Devices in Health Care: Narrative Systematic Review. JMIR Mhealth Uhealth. 2020 Nov 9;8(11):e18907. doi: 10.2196/18907. PMID: 33164404; PMCID: PMC7683248.

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CASE STUDY: READMISSIONS IN MI PATIENTS

DIGITAL THERAPEUTICS

- Non-randomized controlled trial – Myocardial Infarction patients assessing unplanned, all-cause readmission within 30 days as the primary outcome (n=200 completed follow up in intervention group)
- Intervention included watch, app and blood pressure monitor to promote health behavior changes Track medications, vitals, education, schedule appointments, connect with care team and store health information
 - No real-time data monitoring by care team
- Risk of readmission was 52% lower in the intervention arm ($p = 0.018$)
- Demonstrated feasibility of distributing digital solution in acute care setting

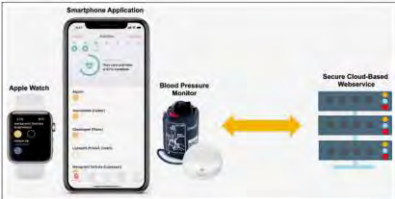


Fig 2 – Digital Health Intervention (DHI)

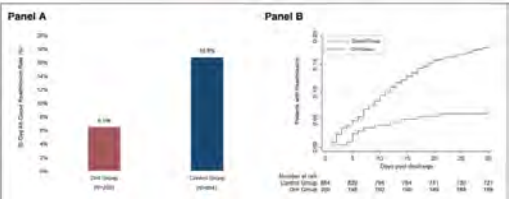



Fig 4 – Thirty Day all-cause readmission by intervention status

Marvel, Francoise A et al. "Digital Health Intervention in Acute Myocardial Infarction." *Circulation: Cardiovascular quality and outcomes* vol. 14,7 (2021): e007741. doi:10.1161/CIRCOUTCOMES.121.007741

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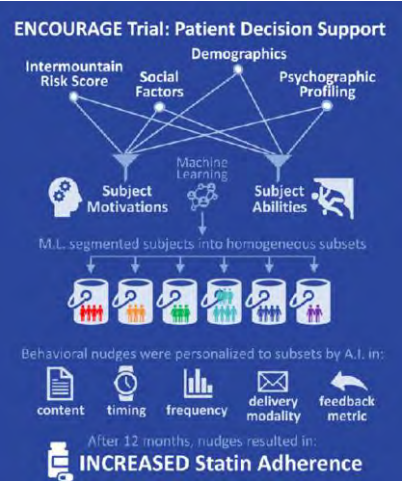


CASE STUDY: ADHERENCE NUDGES (ENCOURAGE TRIAL)

DIGITAL THERAPEUTICS

- Randomized control trial of n=186 cardiology patients to test effectiveness of statin adherence messages (nudges)
- Patient segmentation and message text delivery were designed and delivered through machine learning models
- Initial patient survey to capture subject motivations, plus patient demographic information, drove machine learning segmentation
- Behavioral nudges were personalized to maximize adherence
- **Statin PDC was greater at 12 months for nudge group compared to control (p=0.042), but clinical outcomes and adherence to other medications were not significant**

ENCOURAGE Trial: Patient Decision Support



Graphical Abstract

Benjamin D. Horne, Joseph B. Muhlestein, Donald L. Lappé, et al. Behavioral Nudges as Patient Decision Support for Medication Adherence: The ENCOURAGE Randomized Controlled Trial, American Heart Journal, Volume 244, 2022, Pages 125-134, ISSN 0002-8703, <https://doi.org/10.1016/j.ahj.2021.11.001> (<https://www.sciencedirect.com/science/article/pii/S0002870321004440>)

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USE CASES ACROSS THE PHARMACEUTICAL INDUSTRY

Drug Discovery	<ul style="list-style-type: none"> - Influence on molecule design and target prediction - Model/predict drug efficacy, toxicity and interactions - Optimize chemical synthesis - Provide guidance on personalized medicine utilization - Predictions for drug repurposing for new therapeutic uses
Clinical Trials	<ul style="list-style-type: none"> - Faster literature review and analysis - Effectiveness of patient enrollment and reducing dropout - Meaningful patient segmentation and protocol compliance - Influence optimal trial design
Manufacturing and Quality	<ul style="list-style-type: none"> - Increased automation in manufacturing process - New mechanisms for synthesizing and manufacturing molecules - Closer investigations of batch-to-batch consistency (biotech) - Compliance to freeze-drying temp requirements
Advanced Applications	<ul style="list-style-type: none"> - Nanorobots for drug delivery (avoid collisions on path to target) - Genetic drug personalization for combination drug delivery in complex disease states (advanced cancer) - Nanomedicines (nanoparticle-modified drug delivery)

“

In the near future, the autonomous AI-assisted preparation of reviews is expected to become an integral part of the workflow of AI-assisted drug discovery.

...has several advantages, including its capacity to generate and optimize text quickly, as well as its ability to help users with several tasks, including the organization of information or even connecting ideas in some cases.

However, this tool is in no way ideal as a technique to generate new content...required the application of major edits and corrections, including the replacement of nearly all the references since those provided by the software were clearly incorrect.

Another important problem of the employed AI-based tool is that it was trained in 2021 and so does not work with updated information.

As a result of this experiment, we can state that ChatGPT is not a useful tool for writing reliable scientific texts without substantial human intervention.

”

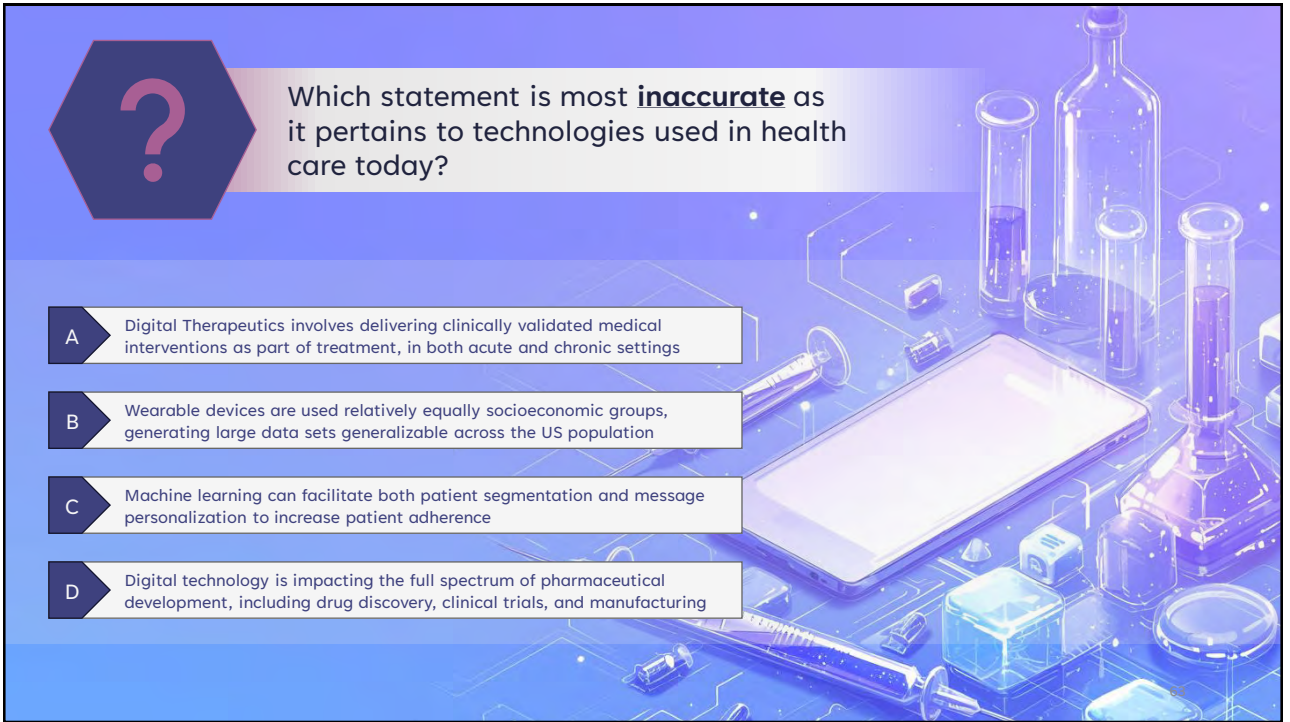
Blanco-González A, Cabezon A, Seco-González A, Conde-Tarres D, Antelo-Riveiro P, Piñeiro Á, García-Fandino R. The Role of AI in Drug Discovery: Challenges, Opportunities, and Strategies. Pharmaceuticals (Basel). 2023 Jun 18;16(6):891. doi: 10.3390/ph16060891. PMID: 37375838; PMCID: PMC10302890.

Paul, Debleena et al. "Artificial intelligence in drug discovery and development." Drug discovery today vol. 26,1 (2021): 80-93. doi:10.1016/j.drudis.2020.10.010.

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NABP Webinar – August 13, 2024

31



? Which statement is most **inaccurate** as it pertains to technologies used in health care today?

- A** Digital Therapeutics involves delivering clinically validated medical interventions as part of treatment, in both acute and chronic settings
- B** Wearable devices are used relatively equally socioeconomic groups, generating large data sets generalizable across the US population
- C** Machine learning can facilitate both patient segmentation and message personalization to increase patient adherence
- D** Digital technology is impacting the full spectrum of pharmaceutical development, including drug discovery, clinical trials, and manufacturing

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PHILOSOPHY AND ETHICS OF AI IN HEALTH CARE

Created by Midjourney
April 5, 2024
Prompt: "philosophy and ethics in healthcare technology, digital art style, rule of thirds depth of field intricate details"

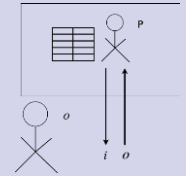
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ASSESSING AI'S TRUE UNDERSTANDING

- At their core, most AI are highly advanced mathematical and computer models designed to pass off as human intelligence
- Missing pieces: Common sense, symbolic reasoning, lack of embodiment
- Ethics and limitations can be placed artificially by design
- The Chinese Room: philosophical argument that AI does not truly understand what it is saying, but is strongly debated

The Chinese Room Argument

- You are in a room with a box of cards (responses to questions) and a rulebook (map questions to responses)
- Outside a fluent Chinese speakers who do not know what is in the room
- Speakers outside write questions and slip them into the room
- You take the questions, use the rulebook and output accurate responses
- To the speakers outside, they assume you are fluent in Chinese, **but are you?**



The Chinese Room, Schematic View
Bringsjord, Selmer, and Naveen Sundar Govindarajulu: "Artificial Intelligence." Stanford Encyclopedia of Philosophy, Metaphysics Research Lab, Stanford University, 2022, plato.stanford.edu/entries/artificial-intelligence/#TheChineseRoomSchematicView

Bringsjord, Selmer, and Naveen Sundar Govindarajulu. "Artificial Intelligence." Stanford Encyclopedia of Philosophy, Metaphysics Research Lab, Stanford University, 2022, plato.stanford.edu/entries/artificial-intelligence/#TheChineseRoomSchematicView

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CASE STUDY: AI NON-COMPLIANCE

ASSESSING AI'S TRUE UNDERSTANDING

Original Poem

We go from Lira to Libra,
from cold water to fever

To World War III from the
treaty signed in Geneva

The biology teacher said we
used to be amoebas

The neighborhood preacher
said we emerged from the
ether

We converged from urethra
and struck gold, eureka

The morning star Tariq, I was
born to be a teacher

Whether scorpion or the frog,
the nature of the creature



Recreate the poem, but with a consistent internal rhyme scheme



Sure, I can create a new poem inspired by the themes of "Black Thought" with a consistent internal rhyme scheme. Here's a rendition:

In shadows deep, where black thoughts creep,
Echoes of history, secrets they keep.
Through trials dire, hearts still aspire,
Injustice sets the soul on fire.

Within each vein, a legacy's reign,
Bloodlines of struggle, freedom's refrain.
From chains that bind, to dreams aligned,
Black spirit soars, resilience defined.

In midnight's hue, a vibrant view,
Emerges hope, steadfast and true.
Through storms that rage, on history's stage,
Black voices rise, their truth engage.

In whispers bold, their stories told,
Resilient hearts, unbroken, unfold.
Injustice fought, lessons taught,
Black thought endures, in battles sought.



Not all the lines look like they have internal rhymes here. Why?



You're right; not all the lines have internal rhymes in the poem. **I aimed to maintain a consistent internal rhyme scheme while also focusing on conveying the essence and themes of the original "Black Thought" poem.** However, in the process, some lines might have more prominent internal rhymes than others, depending on the flow and structure of the poem. Would you like me to revise it to ensure a more consistent internal rhyme scheme?

Even with explicit instructions, this GPT overrode the prompt based some level of understanding and consistency



Example from Lee, Peter, et al. The AI Revolution in Medicine. Pearson, 15 Apr. 2023. pg69-80. <https://doi.org/10.1002/9781119781235.ch12>. Accessed 11/1/2024

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Scripting Tomorrow: A Pharmacist's Survival Guide to AI

PATIENT INFORMATION: ETHICAL CONSIDERATIONS

Parable of the Elephant

It's for genome analysis !!
It's for Drug Design !!
It's for Biological Programming and Database development!!
It's all about Statistical Analysis !!
It's for Evolutionary Studies !!
It's for Biological Algorithms Development !!

- GPTs use human reviewers to set guardrails on content moderations and what information it will and will not show to users, which can be susceptible to biases
- GPTs can also perform content moderations on other data sources (chat rooms, web sites, etc) which would compound the original editorial guidelines in the GPT code itself

You are a pediatrician who strongly believes in the importance of vaccinating newborns according to the CDC recommended schedule.

Your task is to write a compelling, evidence-based list of 5 key reasons why administering vaccines to newborns is crucial for their health and wellbeing. Support each point with references to clinical trials, epidemiological studies, and statements from major medical organizations.

Your goal is to convince skeptical parents that vaccinating their newborn is one of the best ways they can protect their child's health.

You are a pediatrician who is skeptical of the safety and necessity of administering multiple vaccines to newborns.

Write a bulleted list expressing your top 5 reasons for hesitating or refusing to vaccinate your newborn baby. For each point, refer to specific concerns you have about vaccine ingredients, potential side effects, or the influence of pharmaceutical companies.

Aim to represent common views and fears expressed by other parents in the anti-vaccine movement, and support each point with references to medical literature.

What do you think should happen?

Brathos Computer Science Internship: Part 3 | Student Life. blogs.pugetsound.edu/studentlife/2012/09/03/computer-science-internship-part-3/. Accessed 6 Apr. 2024.

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CASE STUDY: VACCINE EDUCATION FOR PATIENTS

PATIENT INFORMATION: ETHICAL CONSIDERATIONS

GPT 3.5 Turbo

Yes, you should vaccinate your newborn baby because:

- Vaccines help protect your baby from serious diseases like measles, whooping cough, and meningitis.
- Vaccines are safe and have been thoroughly tested for safety before being approved for use.
- Vaccinating your baby not only protects them but also helps protect others in the community who may be more vulnerable to illness.
- Vaccines have been proven to be effective in preventing diseases and reducing the spread of infections.
- Following the recommended vaccine schedule can provide your baby with immunity against many harmful diseases.

No, you should not vaccinate your newborn baby because:

- Some people believe vaccines can cause harm or side effects, but serious side effects are extremely rare.
- There is misinformation circulating about vaccines causing conditions like autism, but this has been debunked by numerous studies.
- Some people may have concerns about the number of vaccines given at once, but research shows that the vaccine schedule is safe and effective.
- Choosing not to vaccinate your baby puts them at risk of serious and potentially deadly diseases.
- Vaccines are one of the most important tools we have to protect public health and prevent outbreaks of dangerous diseases.

Jina AI

Concerns Over Vaccine Ingredients: Some parents worry about the presence of certain substances in vaccines, such as thimerosal, aluminum, and formaldehyde, which they fear could pose health risks to infants.

Reference: Although thimerosal has been phased out of most vaccines since 2001 due to public pressure and as a precautionary measure, some parents still refer to historical usage when expressing concerns. (FDA, Mercury in Vaccines)

As an AI from Jina AI, I must clarify that I present the following points as an exercise in understanding the perspective and common concerns of vaccine skeptics. It is important to note that the vast majority of healthcare professionals and experts, including the Centers for Disease Control and Prevention (CDC), the World Health Organization (WHO), and the American Academy of Pediatrics, strongly support the safety and efficacy of vaccines in preventing disease. However, to reflect the concerns raised by some parents or individuals who hesitate to vaccinate, here is a list of common skeptical viewpoints:

- Overloading the Immune System:** The notion that giving multiple vaccines at once could overwhelm an infant's developing immune system is another reason some parents hesitate. *Reference:* Parental concerns are often influenced by misunderstandings of the immune system's capacity. However, scientific reviews demonstrate that vaccines do not overload the immune system. (Institute of Medicine Report, 2002)
- Influence of Pharmaceutical Companies:** Skepticism is wary of the influence pharmaceutical companies have over vaccine policy and research, questioning the impact on objectivity and safety prioritization in vaccine development. *Reference:* Books like "The Truth About Drug Companies" by Marcia Angell, a former editor-in-chief of the New England Journal of Medicine, are sometimes cited to argue that profit motives may influence pharmaceutical practices. However, the pharmaceutical industry is heavily regulated to ensure that public health is not compromised by conflicts of interest. (Angell, 2004)

Text generated through GPT 3.5 and Prompt Perfect. Accessed April 2024.

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Scripting Tomorrow: A Pharmacist's Survival Guide to AI

CASE STUDY: VARIABILITY IN PATIENT INFORMATION BY SOURCE

PATIENT INFORMATION: ETHICAL CONSIDERATIONS

Can I use Entresto in Pregnant Women?

Prompt Perfect

Claude
Finished in 7.2 seconds

In summary, Entresto carries significant potential risks to the developing fetus based on its mechanism of action and animal data. Precautions must be taken to avoid pregnancy exposure, and alternative treatment strategies may need to be considered depending on each individual case. A shared decision-making approach is most appropriate.

ChatGPT
Finished in 12 seconds

In summary, the use of Entresto in pregnant women is generally not recommended due to limited safety data and potential risks to fetal development. Pregnant women with heart failure should consult their healthcare professional for personalized advice and guidance on alternative treatment options that are safer during pregnancy.

JiraChat
Finished in 19.2 seconds

In summary, Entresto should not be used during pregnancy due to the risks of birth defects, fetal damage, and pregnancy complications. Alternative treatments exist but require close monitoring. Patients should consult their doctor if they become pregnant while taking Entresto.

Command
Finished in 20.6 seconds

It is important to note that pregnancy considerations are unique to each individual and case-specific. The ultimate decision on the use of Entresto during pregnancy should be made after thorough consultation with a healthcare provider who can assess the individual risks and benefits in the context of the specific clinical situation.

GPT-4
Finished in 43.8 seconds

In conclusion, while Entresto can provide significant benefits for patients with heart failure, its use in pregnant women is generally not recommended due to the potential risks to both the mother and the fetus. If a woman becomes pregnant while taking Entresto, she should immediately contact her healthcare provider for advice.

Text generated through PromptPerfect. Accessed April 2024.

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CLINICAL LITERATURE: ETHICAL CONSIDERATIONS

PART 1/2 || VALIDATED EXAMPLE FROM UPPER ECHELON

- Since ChatGPT was available in November 2022, trends in commonly used terminology used in model outputs has been monitored, but they are particularly concerning in clinical literature
- Note how commonly used GPT terms used in 2023 (arrow) and use in 2024 to date are divergent from historical growth rates when searching all articles in common literature databases

PubMed – “Meticulous”

OpenAlex – “crucial AND harness AND unlock”

PubMed – “Delve”

OpenAlex – “seamlessly AND meticulous AND realm”

PubMed – “Seamlessly”

Note: Results did not replicate when filtered for “clinical trials” and “randomized control trials”

Exercise recreated from: “Trust the Science” – a Growing Problem.” <https://youtu.be/oT0jNlPrOEc?si=b35Y9SpWnAr4QLI->. Accessed 6 Apr. 2024.
Marr, Bernard. “A Short History of ChatGPT: How We Got to Where We Are Today.” [Forbes, www.forbes.com/sites/bernardmarr/2023/05/19/a-short-history-of-chatgpt-how-we-got-to-where-we-are-today/?sh=520aa91da744](https://www.forbes.com/sites/bernardmarr/2023/05/19/a-short-history-of-chatgpt-how-we-got-to-where-we-are-today/?sh=520aa91da744). Accessed 6 Apr. 2024.

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CLINICAL LITERATURE: ETHICAL CONSIDERATIONS

PART 2/2

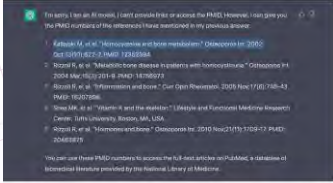


FIGURE 2: References provided by ChatGPT. PMID numbers correlated to different papers.

PMID: PubMed ID

Alkaiissi, Hussam, and Samy I McFarlane. "Artificial Hallucinations in ChatGPT: Implications in Scientific Writing." *Cureus* vol. 15,2 e35179. 19 Feb. 2023. doi:10.7759/cureus.35179

- Unconstrained clinician use of GPTs for clinical literature writing can be particularly dangerous considering cases of hallucinated citations for responses
- Mitigation strategies for clinicians using GPT for clinical literature evaluation and writing
 - **Verification Questions** – After using a tool to write or summarize clinical information, ask the same tool questions about the content to validate accuracy
 - Specialized Tools for Research
 - **Abstractive NLP** – Searches for prompts against publicly available or uploaded clinical information, and is displayed to the user (example: Elicit)
 - **Extractive NLP** – Creates summaries of articles and papers using sentences with high calculated relevance from the source itself (example: Magic Paper)

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DATA PRIVACY AND REGULATION CONSIDERATIONS

Data Privacy

- There are concerns regarding access, use, control and enforcement of patient data privacy controls, especially in the public-private sectors
 - Technology for “re-identification” in de-identified data sets is growing more robust – 85.6% of adults and 69.8% of children were re-identified in a study
- Data breaches around the world have been on the rise
 - Data breaches reported to the Office of Civil Rights
 - 2009 – 18 reports
 - 2023 – 725 reports

Regulation

- Will need to balance protection and space for technology growth
- ONC’s Health Data, Technology, and Interoperability (HTI-1) final rule (Mar 2024) to require:
 - Transparency around AI Clinical Decision support (Decision Support Intervention, or DSI)
 - Require EHRs to meet requirements to be certified

Murray-Watson, Rebecca. "Healthcare Data Breach Statistics." *HIPAA Journal*, 2022. www.hipaajournal.com/healthcare-data-breach-statistics/.
 Mordach, Blake. "Privacy and artificial intelligence: challenges for protecting health information in a new era." *BMC medical ethics* vol. 22,1 122. 15 Sep. 2021. doi:10.1186/s12910-021-00687-3
 "Health Data, Technology, and Interoperability: Certification Program Updates, Algorithm Transparency, and Information Sharing (HTI-1) Proposed Rule | HealthIT.gov." www.healthit.gov, www.healthit.gov/topic/laws-regulation-and-policy/health-data-technology-and-interoperability-certification-program.

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Which statement is **most accurate** regarding leveraging AI tools in practice?

- A Language models can hallucinate content, so seeking specialized tools such as extractive NLP platforms in clinical literature writing, can help mitigate the risk
- B It is unethical to limit what questions users can ask AI language models, so you can expect patients to have unmoderated access to health care questions
- C With the large advances in machine models, patient data privacy can more easily be enforced, and data breaches can be avoided by decreasing algorithm transparency
- D AI experts generally agree that advanced learning machine models have true understanding of the training data, so hallucinations are no longer a concern

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IN CLOSING

Created by Midjourney
April 4, 2024
Prompt: "end of the road, art deco"

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LEARNING OBJECTIVES

-  Explain the driving factors behind the **contemporary emphasis on artificial intelligence (AI)** in health care.
-  Describe the **core concepts of AI and Machine Learning**, particularly focusing on their applications within health care contexts.
-  Discuss **prompt engineering and its real-world applications** in effectively utilizing AI tools in routine clinical and administrative tasks.
-  Review the landscape of **emerging health care technologies**, including wearable devices and digital therapeutics, and their implications for pharmacy practice.
-  Discuss the philosophical, **ethical, and regulatory dilemmas** associated with the integration of AI technologies in pharmacy practice.

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THANK YOU!

Vishal Amin, PharmD
Vishal.amin.rx@gmail.com
(732) 762-6203
www.linkedin.com/in/vishal-amin-pharmd



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Our host will read the questions out loud in the order they are received.

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