Artificial Intelligence (AI): Impact on Safe and Effective Prescribing Practices

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Relevant Financial Disclosure(s)

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- I have nothing to disclose.

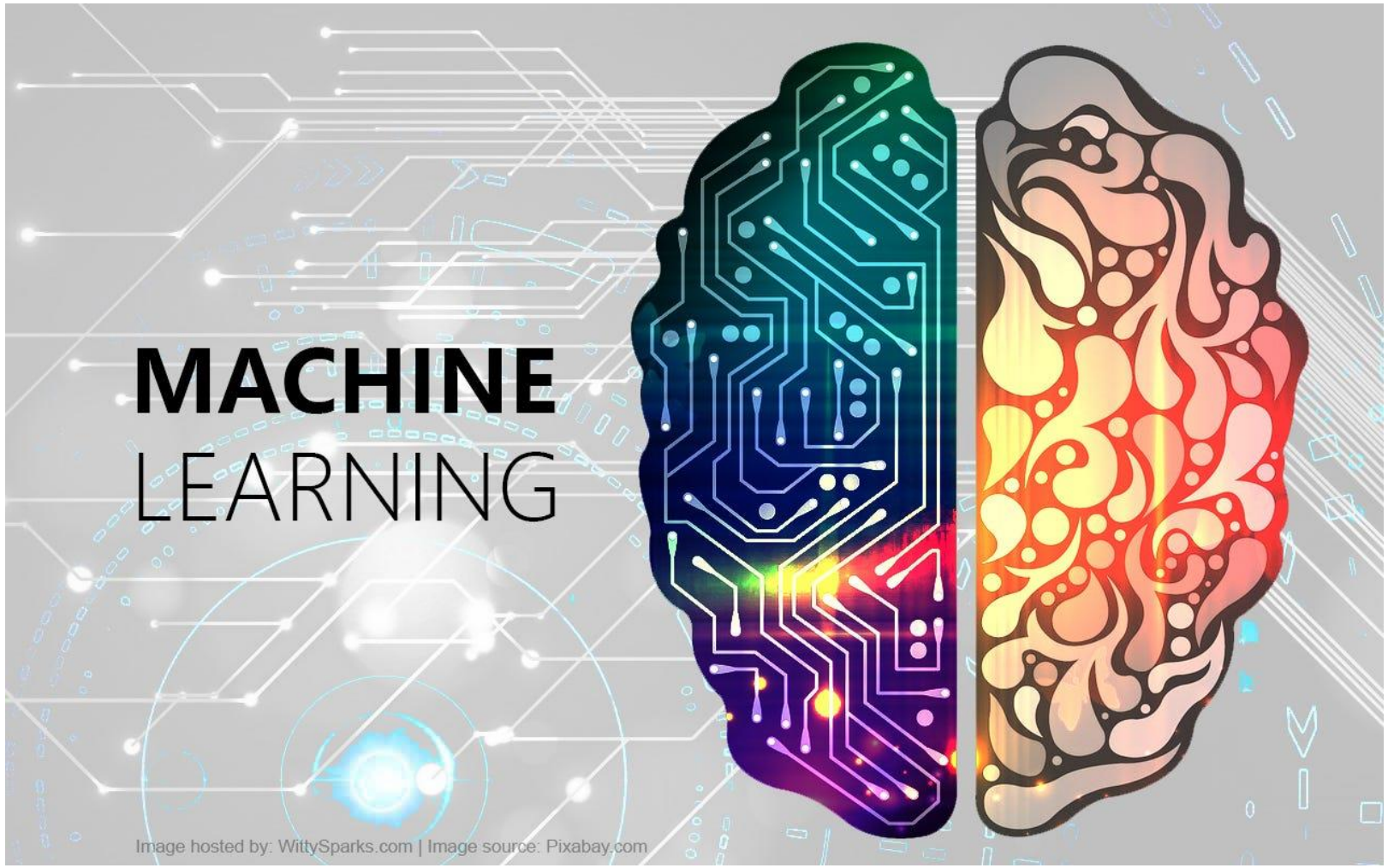
Objectives

- The Objectives of this presentation are as follows:
  - To provide a general overview of machine intelligence, commonly known as artificial intelligence or AI, and its application to healthcare and the pharmaceutical industry
  - To trace the path of several current AI-developed drugs through the pipeline of new drug discovery and development toward FDA approval
  - To explore the risks, benefits, and ethical concerns relevant to pharmacology and AI
  - To identify gaps in Advanced Practice Provider pharmacology education regarding AI

What is Artificial Intelligence (AI)?

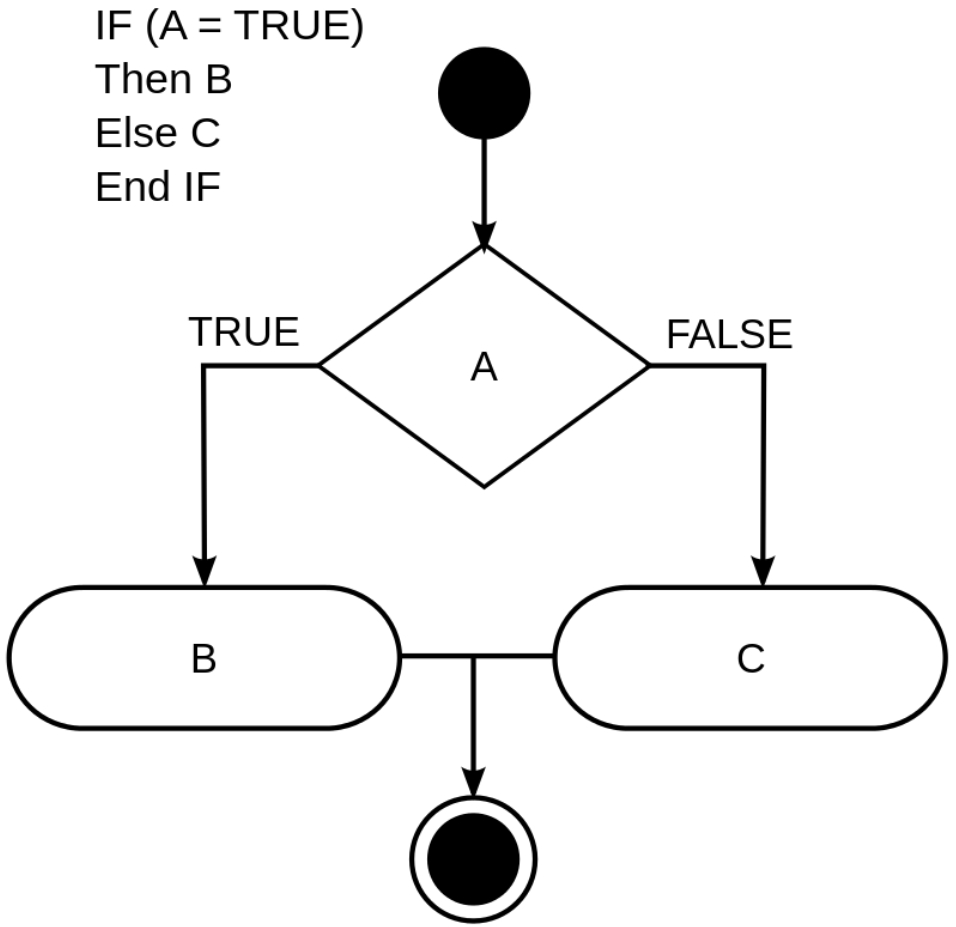
Programming computer systems to perform tasks normally requiring human cognition:

- Perception
- Language understanding
- Reasoning
- Learning
- Planning
- Problem-solving

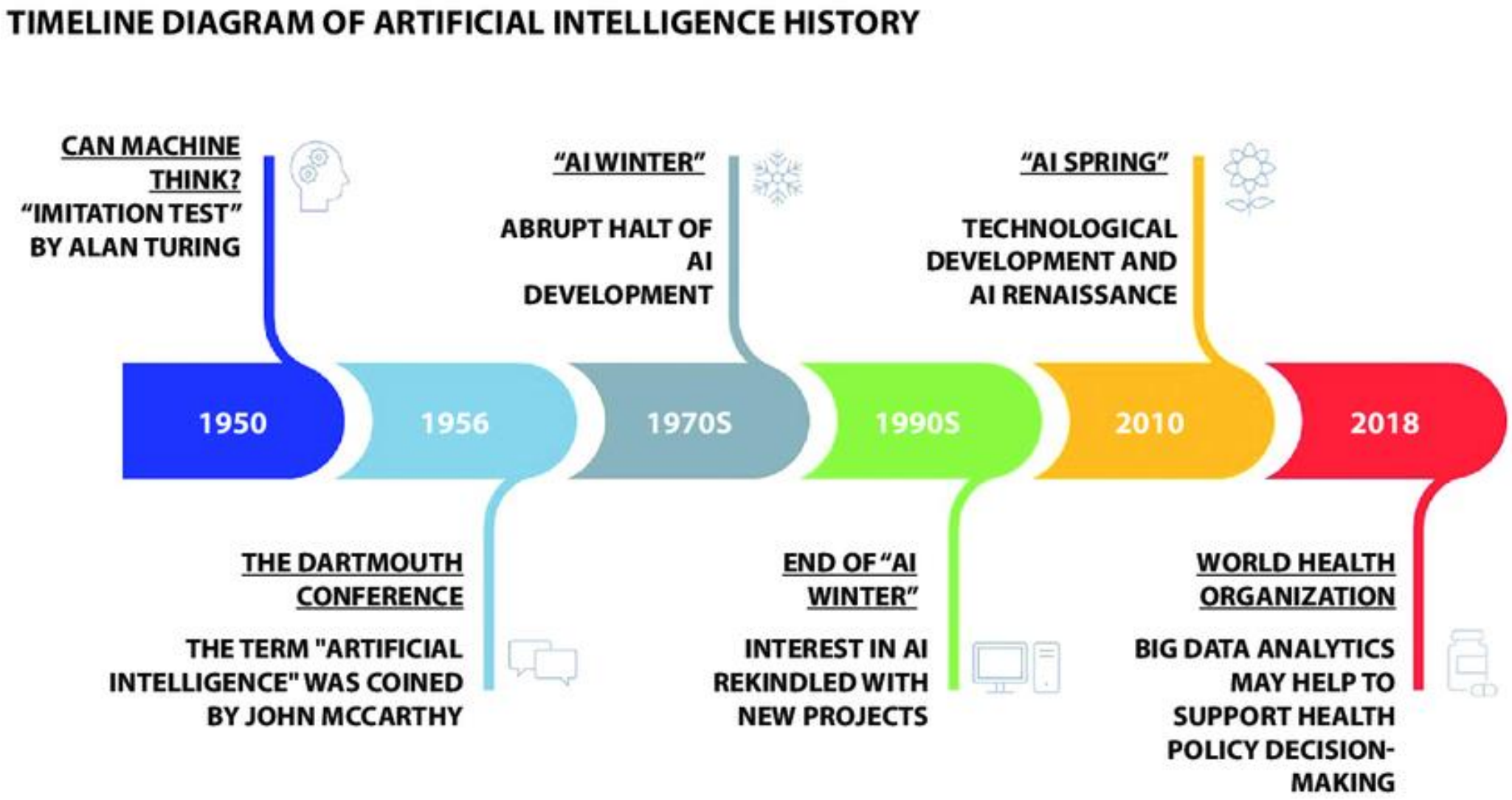


History of AI

- Alan Turing: 1950 publication posed the question: “Can machines think?”
  - The “Imitation Game” or “Turing Test”
- John McCarthy: 1956, 2004 definition “The science of making intelligent computer programs.”
- Subfields of AI:
  - Natural language processing (NLP)
  - Machine learning (ML)
    - Deep learning (DL)
  - Computer vision (CV)



Timeline AI Development



Timeline of Recent Generative AI Events

Feb 2018	Feb 2019	June 2020	Nov 2022	Feb 2023
GPT-1 release (117M parameters)	GPT-2 release (1.5B parameters)	GPT-3 release (175B parameters)	ChatGPT Released	ChatGPT Plus Subscription Service Released

Mar 14, 2023	Mar 14, 2023	Mar 15, 2023	Mar 16, 2023	Mar 20, 2023
GPT-4 Released (1.76T parameters)	Anthropic launched Claude	GPT-4 passes bar exam (90th percentile)	Microsoft announces Copilot (available 11/1)	OpenAI suffers data breach (patched/ announced 3/24)

Mar 21, 2023	Mar 23, 2023	Mar 31, 2023	May 15, 2023	May 23, 2023
Google launched Bard	ChatGPT plugin support made available	Italy banned ChatGPT (restored 4/28)	OpenAI launches ChatGPT iOS app	Microsoft announces Bing use of ChatGPT

June 2, 2023	June 25, 2023	July 7, 2023	July 13, 2023	Sept 25, 2023
Libel case filed against ChatGPT in Georgia	ChatGPT officiates Colorado wedding	Silverman/ others file copyright suit against OpenAI	FTC opens investigation into OpenAI	ChatGPT image and voice capabilities announced

https://ediscoverytoday.com/2023/10/17/a-timeline-of-recent-generative-ai-events-artificial-intelligence-trends/

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Timeline AI in Healthcare

- MYCIN: Early 1970s- Stanford University
  - AI-driven “backward chaining” expert system
  - Could help identify bacteria causing severe infections
  - Issues affecting uptake of MYCIN:
    - Liability
    - Cost-effectiveness questionable
    - Integration with existing workflow
    - Rapid pace of new antibiotic developments
- DXplain: 1986- University of Massachusetts
  - Input symptoms to generate Differential Diagnoses
- Watson: 2007- IBM
  - Open-domain “question-answer” system
  - In 2017, *Watson* successfully identified new RNA-binding proteins altered in ALS
  - 2020: IBM AI-driven computing systems facilitated Covid-19 mitigation & response

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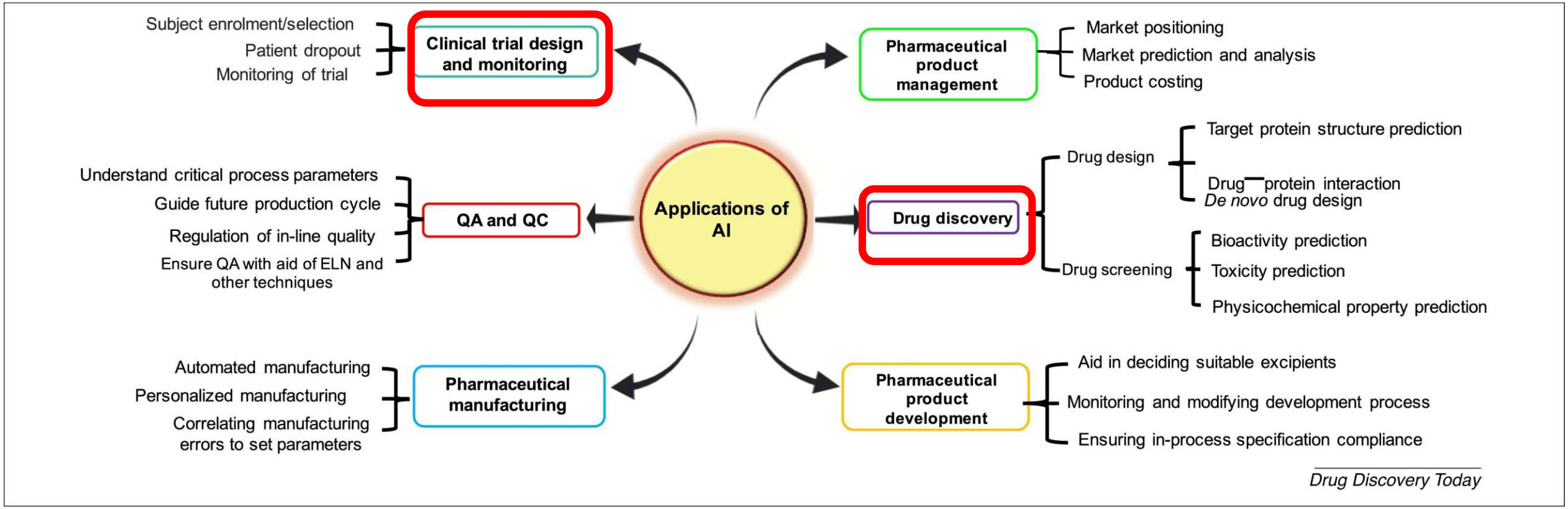
Application of AI in Pharmaceutical Industry



Drug discovery to pharmaceutical product management: From Bench to Bedside

Pharmacology-AI

- What is Pharmacology-AI?
  - Machine Learning analysis of “Big Data”
  - Objective: To identify genomic or medical features that drive a drug response
  - Outcome: Identify sub-groups of patients most likely to respond to a drug
- Medical providers: assists in finding “right drug for right patient”
- Pharma: supports decision-making process for existing drugs and expedites clinical trials
- Hospitals: helps prevent medical errors and reduce hospital readmissions
- Healthcare information system: helps workflow optimization and efficiency and reduces cost from duplicate or unnecessary procedures

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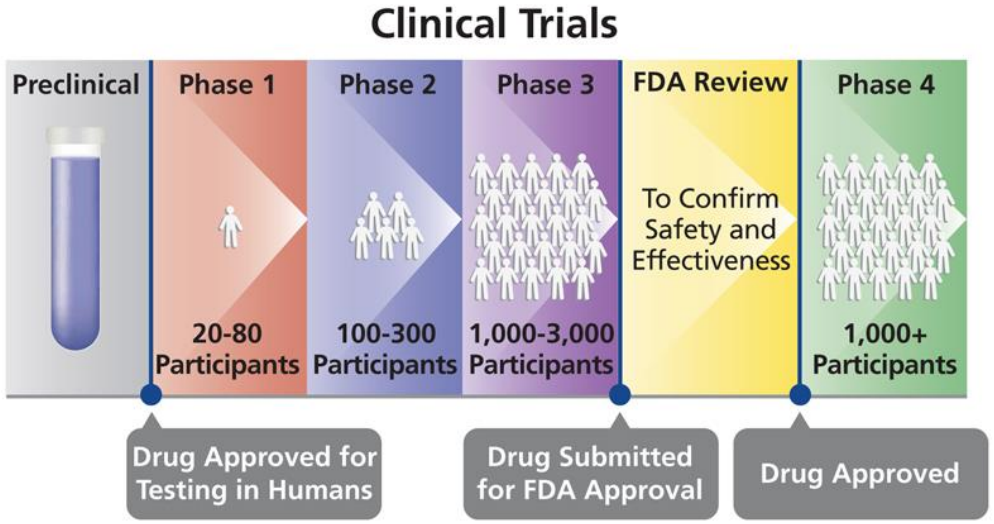
Research Evidence: AI-Assisted Prescribing

- 2023: Clinical decision-making for de-prescribing benzodiazepines
  - Healthcare providers compared with AI chatbot, ChatGPT-4
  - Overall agreement 75-91%
  - AI-based Clinical Support Tools can be valuable
    - Decreasing HCP burnout
    - Enhancing HCP quality of care
- 2023: Comparing evaluation of depression and recommended treatment between ChatGPT-3.5 & 4 and primary care physicians
  - Eight case studies hypothetical patients with symptoms of depression
  - ChatGPT-4 responses compared with norms of 1249 primary care MDs
  - ChatGPT consistently recommended referral for psychotherapy; physicians most often recommended pharmacological treatment +/- referral for psychotherapy
  - AI systems has potential to enhance decision-making in primary care

AI-Derived Drugs in Clinical Trials



- Phase 2/3 drugs
  - Compound REC-2282: Recursion Pharmaceuticals
    - First-in-class, oral, CNS-penetrating small molecule
    - Indication: Neurofibromatosis Type 2 pts with progressive sporadic meningiomas driven by mutations in the NF2 gene
    - Other indications: Cerebral cavernous malformation, Familial adenomatous polyposis, *C-diff* infection
- Phase 2 drugs
  - Compound BEN-2293: BenevolentAI: Atopic dermatitis
  - Compound INS081_055: Insilico Medicine: Idiopathic pulmonary fibrosis
  - Compound NDI-010976/GS-0976: Nimbus Therapeutics: Nonalcoholic steatohepatitis
  - Compound REC-994: Recursion Pharmaceuticals: Cerebral cavernous malformation
  - Compound OPL-0310: Valo Health: Post-MI LVD; Acute kidney injury
  - Compound OPL-0401: Valo Health: Diabetic retinopathy; Diabetic complications

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Benefits, Risks, and Ethical Concerns

- Benefits:
  - Facilitate personalized medicine
  - Increased collaboration
  - Improved diagnostic accuracy
  - Clinical Decision Support System (CDSS)
  - Improve management chronic disease
  - Optimized dosing narrow-therapeutic-window drugs
  - Perform real-time evaluations of drug-efficacy
  - Detection of potentially inappropriate medications (PIMs)
  - Patient education and medication adherence
  - Optimize patient health monitoring using wearable devices

Benefits, Risks, and Ethical Concerns

- Risks:
  - Data privacy and security
  - Patient consent
  - Bias in data collection used to “train” AI models
  - “Overfitting”
  - Lack of empirical evidence proving efficacy

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Benefits, Risks, and Ethical Concerns

- Ethical Concerns:
  - Data privacy and security
  - Accountability: Poor decisions have serious consequences!
    - Who is responsible? The developer or the clinician?
  - Bias and discrimination
    - May lead to unequal treatment or inaccurate diagnosis for certain groups
  - Social concern for job security
  - Impact on clinician-patient relationship
    - AI must be a support tool rather than a replacement for human judgment
    - Human element in healthcare: Empathy, complex reasoning, understanding of individual patient needs

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APP Pharmacology Education and AI

- 2024: Multi-national, cross-sectional study
  - Pharmacology students and faculty members' knowledge, attitudes, and practices regarding AI technology
  - 92.6% had heard of AI
  - 39.5% had a good understanding of AI concepts
  - 18% reported having received education/training on AI technology
  - AI knowledge higher among students than faculty
- Equipping students to navigate AI-driven pharmacologic options
- Quality Improvement focus in APP-DNP education: AI-based possibilities
- APP students must understand ethics and responsible use of AI in healthcare decision-making

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Summary

- AI is becoming integrated into various facets of the pharmaceutical sector
  - Drug target identification
  - Screening of large databases to identify potential drug candidates
  - Drug “repurposing” to identify new therapeutic uses
  - Generating new molecules based on specific requirements
  - Toxicity prediction
  - Personalized medicine
- Successful application depends on:
  - High-quality data
  - Addressing ethical concerns
  - Recognizing limitations of AI-based approaches

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Questions?

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