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Single Day Event

Opportunities using AI/ML In Drug Development

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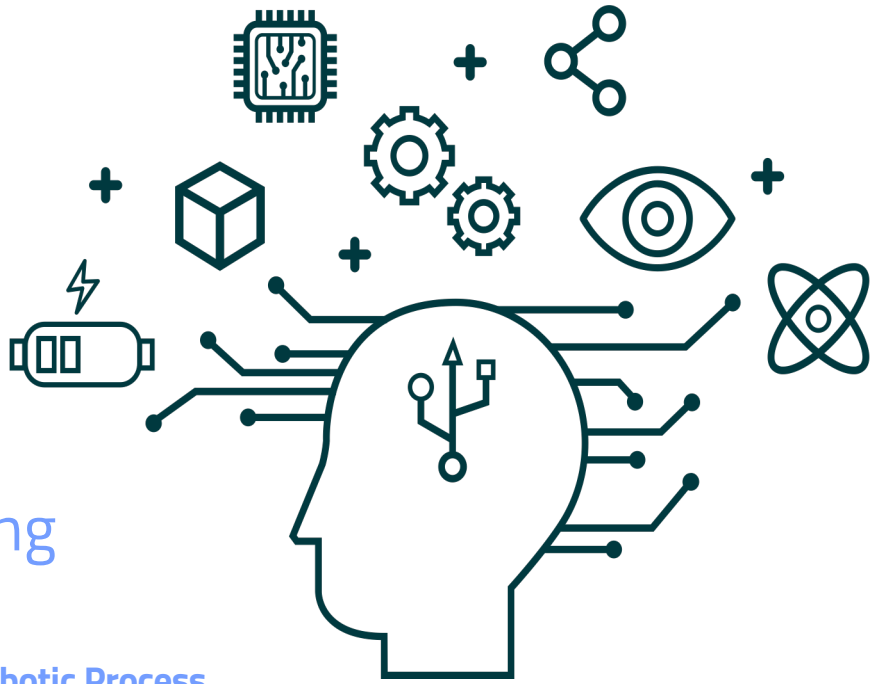
The AI Buzz

Big Data

Artificial Intelligence



Natural Language Processing

Adaptive Algorithms

Machine Learning

Predictive Analytics

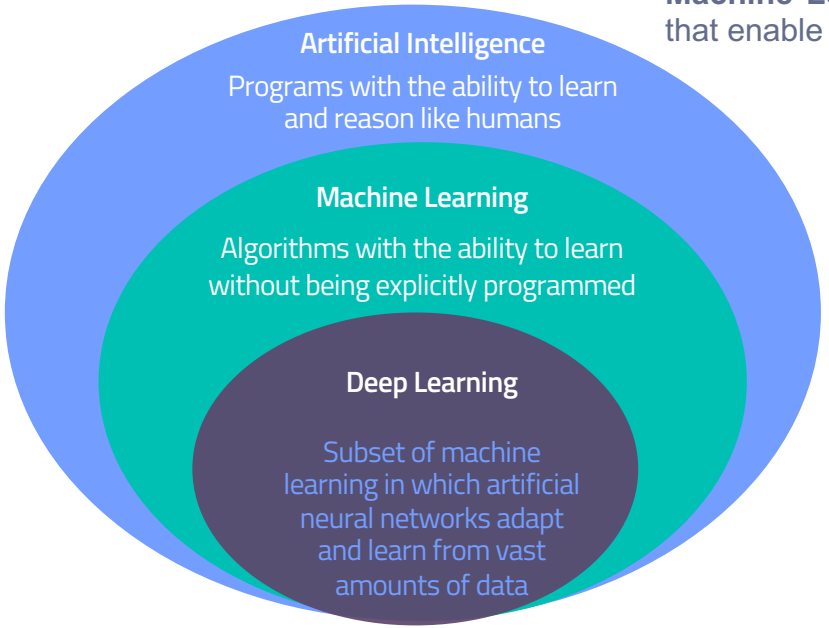
Robotic Process Automation

Intelligence Automation

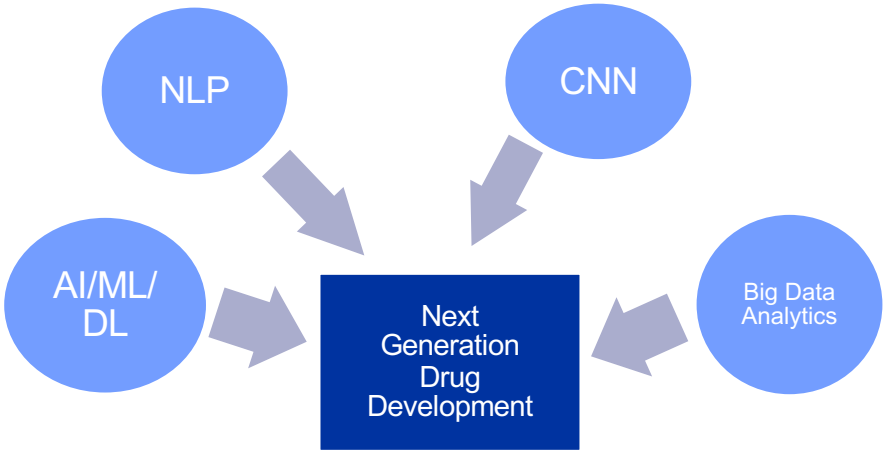
Recap of AI/ML/NLP Terminology

Artificial Intelligence: Any technique that enables computers to mimic human intelligence (e.g., logic, if-then rules, decision trees, and machine learning

Machine Learning: Subset of AI including statistical algorithms that enable machines to improve at tasks with experience



Deep Learning: Subset of machine learning using multilayered neural networks that can train themselves (self-learning ability) to perform tasks on vast amounts of data



AI/ML/NLP in Clinical Domain Industry

In the pharmaceutical industry and consumer healthcare business, AI and machine learning have played an important role.

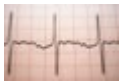
They are useful for detecting and diagnosing diseases, drug manufacturing, clinical trials, and predictive forecasting due to their ability to exploit meaningful relationships in data sets.

Artificial intelligence provides the most significant advantage in reducing the costs related to drug development, in turn, enhancing returns on investment, and even contributing to an overall cost reduction for end users.

Accelerate drug discovery and development

Better insight into patient behavior to improve drug delivery and effectiveness and healthcare outcomes

Optimize and improve efficacy of clinical trials



Improve safety and risk management

Target specific patient's populations more effectively

Gain improved insight into marketing and sales performance

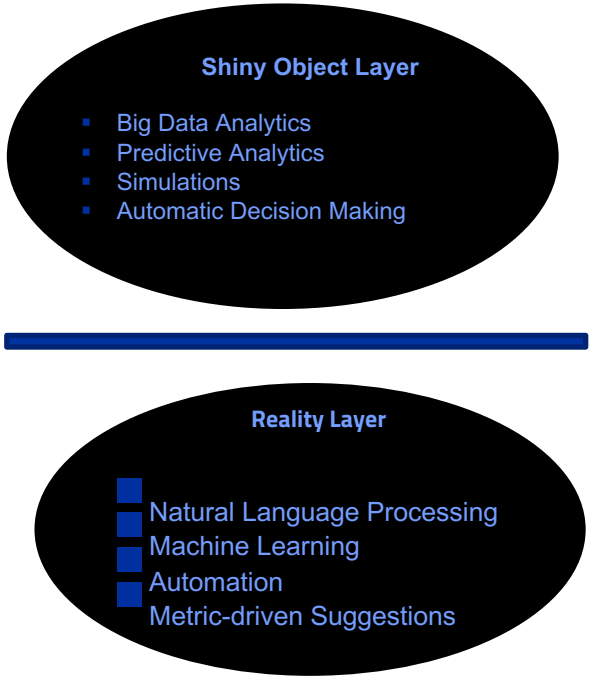
Artificial Intelligence in Clinical Trials (1/2)

AI refers to the field of computer science that can analyze complex medical data. Artificial Intelligence (AI) has made its way into the realm of clinical trials and is reshaping how studies are conducted.

Future of clinical development is on the verge of a major transformation due to
(1) Convergence of large new digital data sources,
(2) Computing power to identify clinically meaningful patterns in the data using efficient artificial intelligence and machine-learning algorithms,
(3) Regulators embracing this change through new collaborations.

<u>Value add for Stakeholders:</u>

- Efficacy and efficiency reached earlier on time, using AI/ML with research and development
- AI can identify suitable cohorts for clinical trials by analyzing medical records and social media content.
- Trial recruitment can be sped up by using AI technologies, to alert medical staff and patients about trial opportunities, as well as simplifying entry criteria to be more accessible for potential participants to get access to the medication.



Artificial Intelligence in Clinical Trials (2/2)

- Artificial Intelligence (AI) includes Machine Learning (ML) involves applying algorithms to data in order to create a system that 'learns' and improves.
- With machine learning, users can analyze large quantities of data, make inferences, and predict outcomes. Clinical trial systems can be automated using these insights, resulting in faster and more efficient clinical trials.
- Automating the process eliminates the need for human intervention and allows ML predictions to be fed back into the system as well as specific actions to be taken, which improves quality and speed at the same time. Each stage of the trial process can benefit from ML and automation.

Study Design & Setup

- Design of eProtocol
- Language Translation
- eCRF Design
- DB Creation

Managing Trails

- Site Selection
- Patient Enrollment
- Risk Based Monitoring
- Chatbots

Data Analysis

- Analyzing historical operational data
- Data Analysis
- Interim Analysis
- PV

Regulatory Submissions

- CSR Qc Automation
- Autogeneration of Documents

Artificial Intelligence applied in Pharma Domain

Application of AI

- Clinical trial design & monitoring
  - Subject enrolment section
  - Monitoring of trial
- Pharmaceutical product management
  - Market Positioning, Predication and Analysis
  - Product Costs
- Drug discovery
  - Target Protein structure prediction, Drug Protein Prediction and Analysis
  - De Nova Drug Design
  - Drug design
  - Drug screening
  - Bioactivity and Toxicity Prediction
  - Physicochemical generally Prediction
- Pharmaceutical product development
  - Monitoring & Modifying Development process
  - Ensuring in process specification compliances
- Pharmaceutical manufacturing
  - Automated manufacturing
  - Personalized manufacturing
  - Correlating manufacturing Errors to set parameters
- QA & QC
  - Understand critical process parameters
  - Guide future production cycle
  - Regulation of in-line quality
  - Ensure QA with aid of ELN and other techniques

Artificial Intelligence usage in Clinical Research Areas

Find and create big data to analyze

Uses AI to harvest between several databases and aggregate data

Use AI to extract structural biological knowledge to power drug discovery application

Cognitive approach to discover relationship

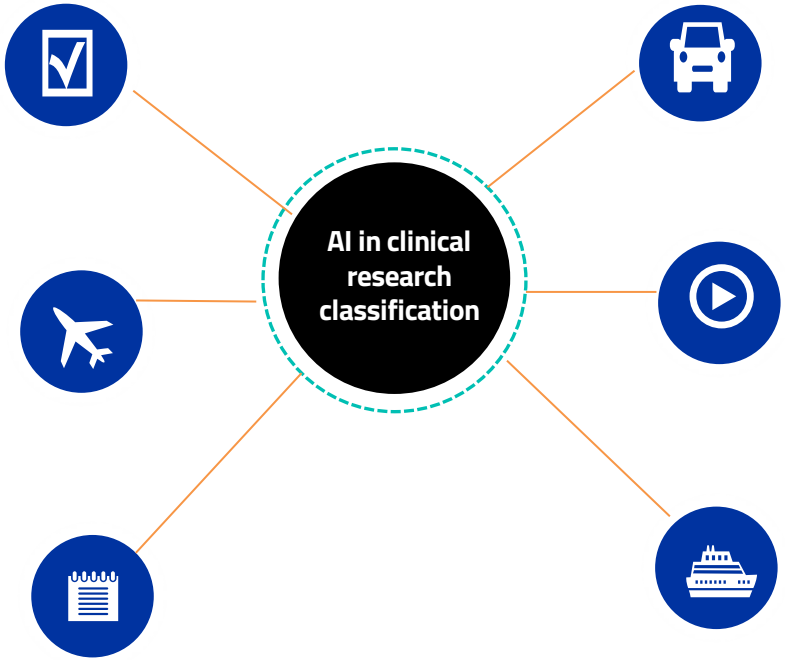
Uses AI to analyze genomic data related to cancer and other diseases,

Find applications for existing approved drugs or clinically validated candidates.

Optimize the process

Uses AI to create a Chat bot or machine learning system to prevent issue on clinical trials,

Optimize oncology drug development with a biomarker monitoring platform and millions of patient datapoints



Match the right patients to the right cure

Uses AI to enroll more patients in appropriate trials, or uses AI to Analyze medical records to find patients for clinical trials

Simulate clinical trials and silico

Uses AI to run experiments in a central lab from anywhere in the world, or use ai to Optimize, reproduce, automate, and scale experiment workflows.

Publish data

Uses AI to write a draft scientific manuscript based on provided data.

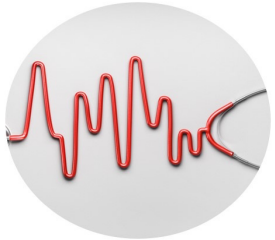
AI in Clinical Drug Development Process (1/2)

Protocol Design

Case Report Forms (CRFs)

- Protocol design and language translation can benefit from machine learning. System can generate a protocol for a new study from existing protocols and health libraries for specific therapeutic areas.
- ML models can also translate languages quickly, easily, and more accurately than traditional methods because they are taught from domain-specific language knowledge bases.
- A case report form and study database can be automated using ML.
- Through the training of ML models with libraries of CRFs for specific therapeutics and study designs, the model can design an optimal CRF with edit checks in accordance with the protocol. .
- Automation allows this ML-designed study to be set up and validated.
- Before go-live, designers will be able to apply the finishing touches based on the validation report. and AI/ML can be used create annotated SDTM studies or automate SDTM mapping

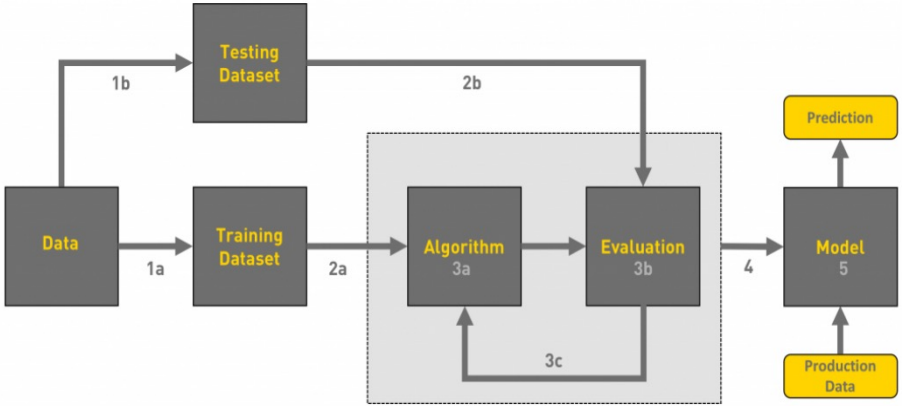
AI in Clinical Drug Development Process (2/2)

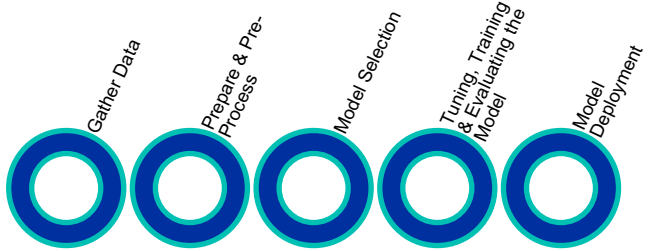


- Clinical trial data can be analyzed with machine learning before, during, and after the trial.
- Analyzing large datasets can be made easier using techniques like Classification, Clustering, and Prediction.
- Machine learning can be used to predict patient behavior, adverse events, etc.

- Clinical Study Report (CSR) can be automatically generated, and quality checked using machine learning by reading the Study Protocol and Study Analysis Report (SAR).
- CSRs can be rewritten using Natural Language Processing (NLP) algorithms, and narratives can also be generated using NLP algorithms.
- Medical Writers can then review these and edit them to produce the final CSR. The whole process can be completed in two to three days.
- In addition to shortening the submission process, this process improves the quality of the submission

AI/ML Model General Process flow





- AI/ML Models are built on patient medical data and thousands of clinical data points, such as symptoms, diagnoses, and test results.
- They are extracted from patient health records, execute the extraction process “while masking protected health information.”
- Next, the extracted clinical data points are aggregated to develop a clinical profile.
- The clinical profiles are used to find and compare populations, cohorts, and individual patients
- Process begins with a user uploading the research protocol documents.
- Risk factors are identified by analysing the protocol text, and any potential barriers to a successful trial. such as recruitment and retention, are reported.
- Based on the insights derived from the analysis, the AI/ML/NLP platform provides recommendations for mitigating risk to optimize the research protocol.
- Multiple team members collaborate on this platform to help navigate stakeholders through their trial.

AI Use case: QC in Medical Writing area

Problem Statement

- A major reason for delayed trial data reporting is CSR-QC, currently a manual process. Which is inadequate and presents significant challenges in terms of time, quality, and management of resources
- There is a high likelihood of observational errors during the CSR review cycle
- CSR-QC is the most important part of clinical trials, as it has a direct impact on clinical trial outcomes as well as patient safety. This is currently done manually, which not only takes a lot of time but also causes observation errors

Solution

- A Tool has been conceptualized considering the complex and repetitive process of verifying source data against supported data (Protocol, Template, Source Tables, References, etc.), which is prone to observational error and data discrepancies using AI/ML/NLP concepts.
- Several CSRs and supporting documents were reviewed to understand the possible data extraction pattern for in-text and source tables.
- By using a rule-based, machine-learning driven cognitive search algorithm, data can be retrieved from the CSR, mapped into the right section, then compared to present the differences.
- In the overall quality check process, an automated solution could potentially save time and effort.

Challenges

Extraction: In general, CSRs are created according to the ICH-E3 template and follow the applicable Medical Writing Style Guide Harvard or AMA Style; in-text tables and source tables, however, vary considerably according to the study requirements. Rule based automation not working properly due to variation in template.

Section Mapping: CSR and its supported documents having so many sections/sub-sections. It is very important to extract right section/sub-section and mapped with right section/subsection from supporting documents.

RTF/PDF Tables: RTF/PDF tables are quite complicated in structure and difficult to read for comparison. RTF/PDF table can be with border or without border.

Synonyms, tenses & abbreviations

More Use cases of AI in Clinical Trials

Radiology & Radiotherapy

Problem

- Minimizing the damage to healthy organs at risk by improving accuracy of radiotherapy

Solution

- A Machine Learning Algorithm that detects differences between healthy and cancerous tissues

Clinical Trial Research

Problem

- Identify optimal and appropriate patient population for an efficient trial

Solution

- Artificial Intelligence can analyze genetic information to identify the appropriate patient population for a trial. It can also determine the optimal sample size

Drug Discovery

Problem

- Lower success rates of clinical trials to get FDA approval

Solution

- Pharma businesses are using AI to increase the success rates of new drugs while decreasing operational costs at the same time
- Eventually, it would lead to lower drug cost for patients, while offering more treatment choices

Some AI used in action in Industry

- A Global Healthcare company uses AI to predict untested components to find new cures
- A Healthcare company is using AI to match patients with the right drug trial
- A biopharma start-up is using AI to predict the effect of new treatments for patients suffering from ALS and Alzheimer's
- An AI start-up is using image recognition to improve drug adherence
- A global healthcare is using Text mining on an annotated corpus leading to identification of cardiovascular proteins
- A Deep learning model that predicts diagnosis of Alzheimer disease 6 years before symptoms appear
- A technology startup helping healthcare's for Medical text understanding
- A life sciences start-up is using AI to proactively find drug trial candidates

New way to optimize Clinical Trials : Smart-Trials Era

Pharma/biomedical companies don't reach the patient

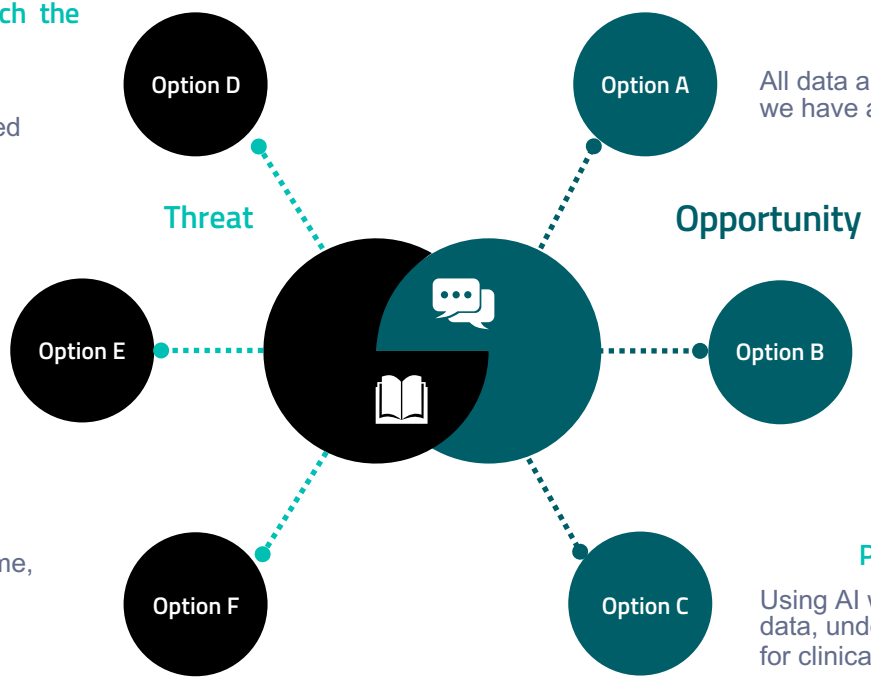
New change in relationship with the patient. All data responsibilities is now tied to the CRO or the provider

Differentiation and big data

From the previous model we could collect tons of data. We need to have automatic system in place to analyze

Real time

All the data can be collected in real time, but we need a right environment to process these data (formats, structured/unstructured etc)



Add value

All data are validated and ready to use. And we have a huge amount of data

Cost optimizer

We develop automated solutions, use lesson learnt using ML, and apply predictions to risk future investments

Personalize the therapy

Using AI we could collect and process data, underline only the data that is useful for clinical trial

AI Toolbox for quick reference

	PROCESS AUTOMATION Process Centric		INTERACTION Communication Centric		REASONING Data Centric	
Tools	Robotic Process Automation **(RPA)**	Intelligent Process Automation **(IPA)**	Natural Language Processing **(NLP)**	Natural Language Generation **(NLG)**	Machine Learning **(ML)**	True Artificial Intelligence **(AI)**
Purpose	**Automate** repetitive and predictable tasks	**Automate** non-routine tasks	**Analyze** text and voice	**Generate** text and voice	**Recognize patterns**	**Enable** self learning and optimization
Scope	No to simple decision making	Some decision making and problem solving	Knowledge gathering	Knowledge sharing	Prescriptive and predictive analysis	Deductive analysis

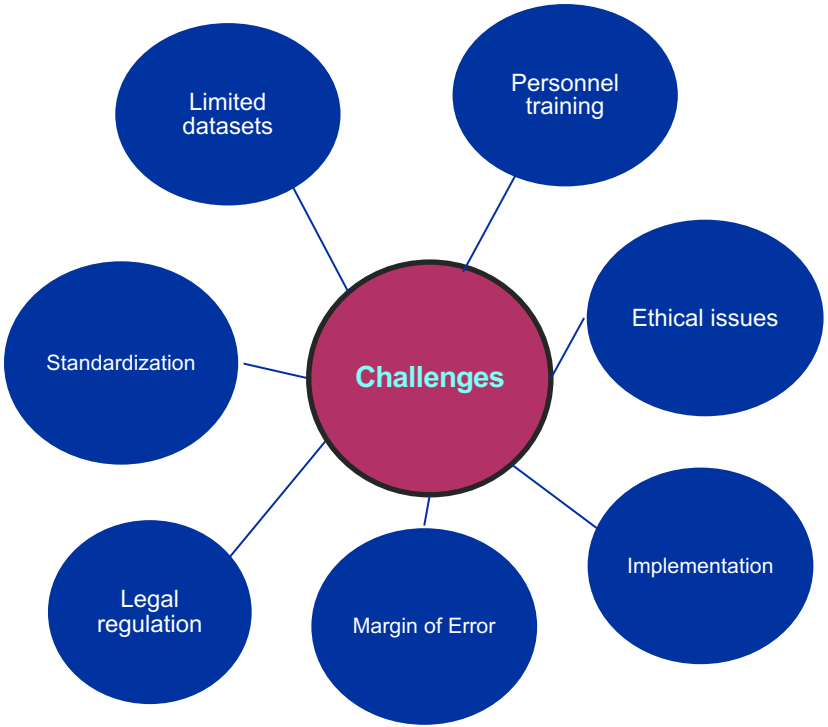
No deep process changes (Automation) — **Complexity & Value** — **Fundamental Process Changes (Transformation)**

Opportunities of AI in Drug development process

• Aggregate and Synthesize Information • Understand Mechanisms of Disease • Establish Biomarkers • Generate Data and Models • Repurpose Existing Drugs • Generate Novel Drug Candidates • Validate and Optimize Drug Candidates • Design Drugs • Design Preclinical Experiments • Run Preclinical Experiments • Design Clinical Trials • Recruit for Clinical Trials	• Optimize Clinical Trials • Publish Data • Analyze Real World Evidence • Virtual Assistant to support Clinical Project Management • Analyze Pattern to store the correct information • Predict a patients disease progression and treatment response for clinical trial stratification and Diagnostics.

Challenges in AI/ML

- Bias
- Margin of Error
- Lack of Quality Data
- High Costs of Creation
- Limited Implementation
- Inadequate Infrastructure
- Data Privacy and Security
- Transparency of Algorithm
- Lacking out of Box Thinking



Reference: Some Terminologies of AI/ML/NLP

Term	Definition
Machine learning (ML)	A mathematical model that is able to improve its performance on a task by exposure to data.
Deep neural networks	ML models with one or more latent (hidden) layers allowing for the generation of non-linear output and complex interactions between layers. Deep neural networks power "deep learning," which enables tasks, such as image recognition, natural language processing (NLP), and complex predictions. Subtypes of deep neural networks are classified based on the relationship between hidden layers and include convolutional, recurrent, gated graph, and generative adversarial neural networks.
Training, test, and validation sets	*Training set*: Dataset from which the model learns the optimal parameters to accomplish the task. *Test set*: Dataset on which the performance of a trained, parameterized model is evaluated. *Validation set*: Dataset that is used to evaluate the model's performance during training. Differs from a test set in that it is used during training to establish hyperparameters of the model.
Supervised learning	A subset of ML in which the outcomes to be learned by the model ("labels") are provided in the training set. For example, teaching a model to identify breast cancer patients for study inclusion would require training the model on a training set containing labeled patients with and without breast cancer prior to validating that model on a new set of *unlabeled* patients with and without breast cancer.
Unsupervised learning	A subset of ML in which there are no pre-specified labels for the model to learn to predict; instead, models identify hidden patterns in the data.
Natural language processing (NLP)	A form of artificial intelligence that enables the understanding of language. Much modern NLP uses deep neural networks in which words and their relationships to each other are encoded in a set of highly dimensional vectors, enabling the model to parse the meaning of new pieces of text it is presented with.

The Global Healthcare Data Science Community

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