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PROBIODIGITAL.AI

Pramoda Kumar Sabat
Sterling, Virginia, USA

Abstract:

- Future advances in medical Biotechnology depend critically on the ability of medical biotechnology researchers to use advanced ProBioDigital.AI solutions effectively.
- The biotechnology industry currently heavily lacks on data storage, filtering, analysis and sharing. Drug manufacturing, chemical analysis of various compounds, sequencing of RNA and DNA, enzyme studies, and other similar biological processes all require strong support from AI software solutions to move faster and reduce manual errors.
- The successful implementaion of ProBioDigital.AI in medical biotechnology today are relies entirely on digital technology to function and therefore digitalization of data is the very first step towards AI application.
- Digital transformation can help accelerate the development and use of AI in biotechnology by providing access to big data and automating certain tasks, which can help improve the efficiency and accuracy of research and development.

Introduction:

ProBioDigital.AI is an application of Artificial Intelligence (AI) in the field of Medical Biotechnology for the research and development of living organisms providing solution to a wide range of bio medical processes which includes Digital lab simulation, Digital clinical trial, Drug discovery, Drug safety, Functional and structural genomics, Proteomics, Metabolomics, Pharmacology, Pharmacogenetics, Pharmacogenomics. Early detection of diseases, Personalize therapy and drug procedure.

In the context of medical biotechnology, digital transformation can involve the introduction of new technologies and processes to improve the efficiency, accuracy, and speed of research and development and enable the development of entirely new and disruptive products and services.

Goal of ProBioDigital.AI:

- Biomanufacturing processes are complex because of the many variables involved in their execution, interactions among those variables, and concerns about required external components. Such complexity makes it difficult to institute an accurate and robust management infrastructure for analytical control.
- Goal of ProBioDigital.AI is to build a AI based software using capabilities of Machine Learning (ML), Data Science and Data engineering. This sofware will provide an platform with modules that can learn autonomously from previous experience with no human-in-the-loop.The software will have modules for understanding intelligence for designing and developing algorithms that can learn from data to gain knowledge from experience and improve their learning behavior over time.
- ProBioDigital.AI is a subset of ML that uses artificial neural networks with many layers to learn and make decisions. It is particularly useful for tasks that involve analyzing large amounts of data, such as images (e.g., DALL-E2) or text (e.g., ChatGPT).
- It will play a critical role in solving that problem in real time, contemporary physical-world data produced by on-line monitoring with the infinite data storage and processing capabilities available in the cloud.
- It can be the best tool to solve problems with high product yield, equipment effectiveness, deviation management, anomaly detection, and various demands for pattern recognition which can't be solved traditional monolothic methods and technologies.

The Literature Review:

- Medical Biotechnology industry give rise to various challenges related to digital bio lab simulation, digital clinical trais, data management and analysis, as well as the comprehension of complete bioprocesses.
- Development and approval of new biologics is costly and the time from production to clinic is too long.
- Routine manufacturing processes are not cost-effective, operate sub-optimally, or lead to failed batches.
- Shortage of highly skilled workers in statistical analysis and machine learning
- It is difficult for humans to analyse and understand high-dimensional bioprocess datasets. Depended on humen experiece to analyse the lab result, estimate the risk and future predection will result to error prone result.

ProBioDigital.AI Methodology:

The Internet Of Things (IoT) connects varopis boi physical objects to cloud capabilities, enabling secure data bridges, *big-data* storage, and unlimited parallel computing. Thus, multivariate techniques are applied to large data sets to produce cybercopies of the physical systems that produced the data.

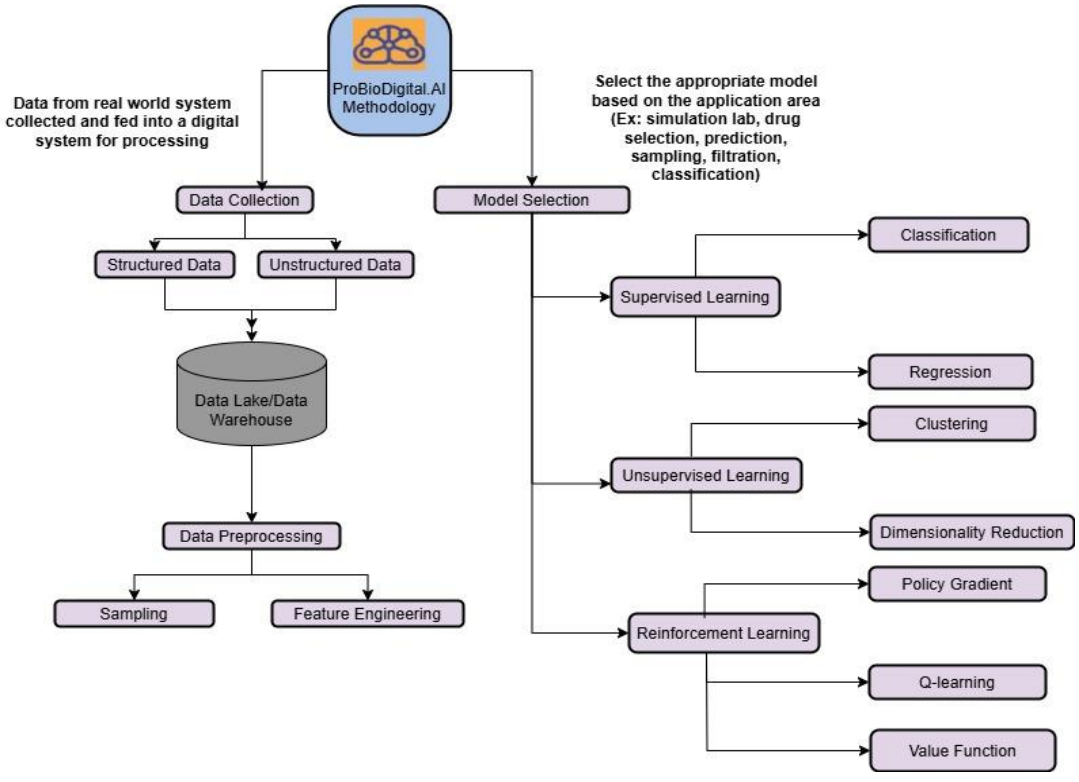
Seeking to coordinate such technologies within single systems, initiatives such as the push to adopt Unified Namespace (UNS) software layers will support ProBioDigital.AI as the next step in the natural evolution of digitalization as applied to industrial activities and assets.

Programs such as risk-based management (RBM) assess and govern data collection and distribution based upon analysis of the information's value and of the consequences of failure to acquire such data.

- Analyze large amounts of diverse data, identify patterns, learn from them, and present conclusions or predictions that would be impossible for humans to conceive through even math-supported analysis using following Machine Leaning algorithms.
  - ✓ Linear regression uses statical methods that shows relationship betwen two ifferent variables (independent and dependent) for predective analysis.
  - ✓ Decision tree uses tree like stracture to classify and predict outcomes.
  - ✓ Support Vector Machine algorithms for classification and regression of tasks for solving binary classification problems.
  - ✓ Logistic regression algorithms for binary classificaiton of tasks which can be further devided used to find probability of outcomes.
  - ✓ Rendom forest algorithm that uses multiple decision trees to reach a single result for making predection decision.
- Evaluate both variability and complexity as natural parameters of a power equation managed by AI/ML algorithems.
- Leveraging AI-supported analysis of the petabytes of data that are collected throughout various bio devices, bio reactores, sensors, research report, clinical trials, historical data, drug's product life cycle.
- Build AI algorithms using deep-learning and neural networks (NNs) for image recognisation, speech recognisation, natural language processing which provides ability to automatically extract complex features from data, handle high dimentional datasets helping to mimic humen like decision by identifying completed patterns in complex datasets which is near impossible with traditional approach.
- Adopted ALCOA+ principles (for data attributability, legibility, contemporaneity, originality, accuracy, completeness, consistency, and endurance) and FAIR guidelines for ensuring the confidentiality, integrity, and availability of product and process information.

- Observability module that ensures data are reliable, trustworthy, and appropriate. Data observability module ensures that data produced from various soruces reliable, trustworthy, and appropriate.
- Create visualizations and reports which provide insights into data-use patterns and performance metrics with large volumes of diverse data from complex sources
- Enable Drift monitoring process which ensures AI/ML model performance and relevance to the targeted outcome.
- Cloud-based systems to store vast amount of data and bolster computing power through automated data governance and integration, advanced multimodal analytics, natural language processing (NLP) for querying, interactive data visualization, intelligent-result and excursion notifications.
- AI chatbots for interupted digital user support.
- AI/ML based predictive models for analysis, optimise, monitor, and control bioprocess development and manufacturing operations
- Use of data lake or data warehouse for storing data which can be queryable and structured.
- Event driven AI process to act on realtime data.

Picture describing the ProBioDigital.AI methodology



Algorithm for ProBioDigital.AI modles:

- **Explanable Result:** Enable explainable artificial intelligence (XAI) for end users translating the result into User Interface (UI). This helping to understand the reason behind the algorithm's decisions or predictions. This capability builds stakeholder trust in model outputs, generates mechanisms for accountability, facilitates regulatory compliance, and enables stakeholders to understand and address errors and potential bias.
- **Data Transparency:** Process data visualization with the help of Bigdata APIs in a distributed a system

- **Self Learn:** AI/ML module to re-process historic result and real time knowledge to self prepare for the future chellanges.
- **Monitoring:** Sampling, steatch and de-duping of metadata, model training and generated outputs and predictions through out the life cycle.
- **Validation:** Customize module to veiry and analyze the algorithem is permorming as described, adhers to the retulatory standards. This will ensure consistant outputs minimizing the error or deviation.

Simple example showing how ProBioDigital.AI process works:

```
class ProBioDigital_AI {

#1. Data Collection: Collect data frous various resources (Medical devices, sensors, clinical reports, lab analysis, data centers, medical reactors, hospitals, drug menufacturer)

    data = pd.read_csv("medical_bio_data.csv")

#2. Data Preprocessing (Data cleaning and preparation, e.g.handling missing values)

#3. Feature Selection (Fictitious features for this example )

    features = data['lab result', 'average_age',
'vaccination_rate','social_distancing']

#4. AI / ML Model: Train a machine learning model to predict efficiency. In this example, we will use a Random Forest Regressor

    model = LogisticRegression()

#5. Load and Process the data

    X = features

    y = data['disease_identify']

    y_test = train_test_split(X, y, test_size = 0.2, random_state = 42)

#6. Model Training: Split the data into training and testing sets

    model.fit(X_train, y_train)

#7. Model Evaluation:

    y_pred = model.predict(X_test)

    accuracy = accuracy_score(y_test, y_pred)

    print("Model Accuracy:", accuracy)

#8. Predictions: Use the trained model to predict the editing efficiency #Suppose we have new input data to predict disease spread

    new_data = pd.DataFrame({'population_mobility, ': [0.5],
'average_age': [35],'vaccination_rate': [0.75], 'social_distancing': [0.2]})

    prediction = model.predict(new_data)

    print("Disease Spread Prediction:", prediction)

#9. Effective Response Planning (Requires a specific approach)
```

#10. Continuous Monitoring: Monitoring and Improvement, Continuously monitor the results of gene editing and update the model to improve accuracy and efficiency

#Continue collecting data and adjusting the model as necessary

}

ProBioDigital.AI and Medical Biotechnology:

- Bioprocess data come with high dimensionality and complexity, which arise from interactions among multiple variables.
- The variety of data sources and formats presents operational issues, including variability and "noise" in measurement, both of which diminish standardization and interoperability. Such problems make it difficult, using classical techniques, to identify meaningful patterns within bioprocess data and to understand underlying relationships among many variables.
- Advances in process monitoring and analytics have increased the volumes and types of data to be accounted for, driving demand for better data-processing and process-control techniques. Recent developments in AI automation, process intensification, and continuous processing have magnified such needs.
- ProBioDigital.AI with the use of Mechine Learning (ML) is enabling researchers and engineers to analyze, model, and control bioprocesses based on data-driven approaches.
- ProBioDigital.AI promices to or emulating the complexity of biological processes and for addressing all of the difficulties related to the continuous variability associated with biopharmaceutical operations.
- In continuous manufacturing, processes take place in one contiguous train, without interruption and with material charging and product discharging simultaneously. It is complex, and an advanced dynamic-control system is required to monitor and interact with the equipment and products in real time.
- Plus uptake of contineous menufacture has lagged in downstream operations where ProBioDigital.AI could improve diafiltration and other downstream steps by recommendation feature to minimize the requisite number of cycles.

Technology Used:

AWS Cloud Computing, Microservices, Event Driven System, Python, Java, Scala, Spark, ETL, Data warehouse, Data Lake, JavaScript, ReactJS, TypeScript, Docker, Kubernetes, CI/CD, GIT, Swagger, Machine Learning (ML), Artifical Inteligence.

Result:

ProBioDigital.AI can revolutionize medical biotechnology by enabling the faster, more accurate and more cost-effective identification and development beyond new drugs.

Some specific ways in which ProBioDigital.AI can be used in medical biotechnology include:

Drug target identification: AI can be used to analyze data fromvarious sources, such as genomic data and protein-protein interaction data, to identify potential therapeutic targets for the treatment of diseases. This can involve the use of machine learning algorithms to identify patterns and correlations that may not be apparent to humans.

Drug screening: AI can be used to analyze data on the activity of potential drugs against different targets to identify those that are most likely to be effective. This can involve the use of ML algorithms to predict the likelihood of a particular drug being effective based on its characteristics and the characteristics of the target.

Image screening: AI can be used to analyze medical images, such as CT scans and MRI images, to identify abnormalities and diagnose diseases. This can involve the use of DL algorithms to automatically segment and classify structures in medical images.

Predictive modelling: AI can be used to analyze data from various sources, such as electronic healtProBioDigital.AIs and wearable devices, to make predictions about an individual's health. This can include the use of machine learning algorithms to predict the likelihood of an individual developing a particular disease or the likelihood of a particular treatment being effective.

- AI-enabled ProBioDigital can enhance manufacturing activities, helping to produce optimal batches consistently by interpreting and sometimes acting upon real-time process data and by interacting with historical data files.
- It's ProBioDigital.AI capability makes it possible to simulate conditions and occurrences, predict undesired episodes, and recommend multivariate results that help to maximize efficient production of high-quality products.
- ProBioDigital.AI analysis of historic, current, and predicted data will increase flexibility and responsiveness, supporting better demand forecasts.
- Quality control scientists can also leverage ProBioDigital.AI to discover and understand critical quality attributes and process parameters, develop quality control plans, maintain electronic laboratory notebooks and laboratory information-management system dashboards, and support reduction and distribution of new data.

Enabling ProBioDigital.AI to sail the medical Biotechnology future:

ProBioDigital.AI can rapidly reduce the high dimensionality, format complexity, and diversity of measurements in biopharmaceutical activities to actionable conclusions. In industrial bio drug production it promises of producing all batches under the expected conditions, all day and every day, without operator attention.

- Bioprocess simulation, analysis, understanding, development, and control can be improved significantly implementing industry standard AI-enabled ProBioDigital.AI.
- Data-driven biopharmaceutical manufacturing facilities equipped with knowledge of physicochemical properties of substances, bioprocesses, and products in near future.

Conclusion:

ProBioDigital.AI is empowering analysis of heterogeneous data from numerous analytical instruments and probes, enabling multiparametric simulations. AI analysis of historic, current, and predicted data could increase flexibility and responsiveness, supporting better demand forecasts.

- Simplifies the simulation of bio lab processes. Lab result analysis, decision making, high visibility, accurate and predecive result.
- Reduce the humen intervantion maximising productivity with decisive data driven produt automation.
- During the phased trials (postmarketing surveillance), ProBioDigital.AI assists in monitoring, analysis, and alerts facilitating data distribution required to assess a drug's real-world performance, enabling early identification of rare side effects and other issues.
- ProBioDigital.AI can be applied to historical data, even more possibilities emerge when such knowledge is managed in real time. That strategy requires adequate mechanisms such as ProBioDigital.AI for consistent, bidirectional information exchange between the physical and virtual worlds
- Specialization supports excellence in individual disciplines but can limit appreciation of broader implications.

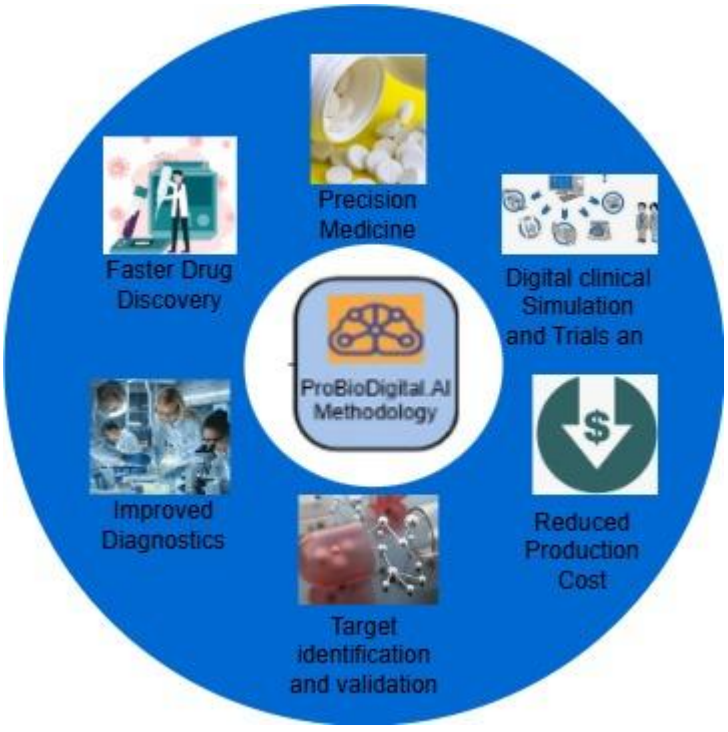
ProBioDigital.AI factors on business growth and Public Health:

ProBioDigital.AI will have significent role in medical biotechnolgoy sector by 2027 accelarating business growth and public health.

Business Growth:

Facilitates improved drug discovery, digital clinical simulation & clinical trials, improving overall efficiency which will lead to reduced time-to-market gap, reduce production costs, thus driving ubstantial revenue of US$5.75 billion by 2027 and market expansion for companies working in this sector.

ProBioDigital.AI factors accelerating business growth



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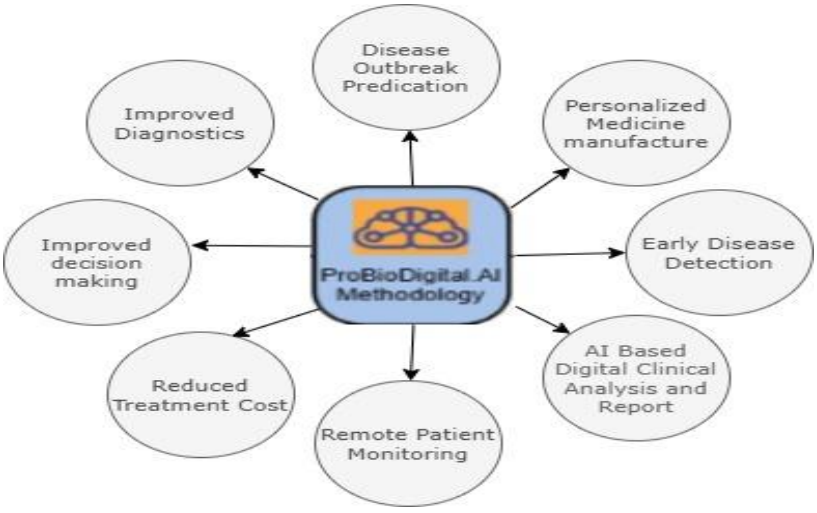
Public Health:

Improved decission making with AI based health measuring devices, personalized medicine menufacture, early disease detectation, reduced treatment costs, remote patient monitoring, AI based digital clinical analysis and reports, improved diagnostic through ProBioDitital.AI based image analysis for cancer and other crititica diseases, and potentially introducing AI model of health treatments with better outcomes and measures for 340 milion population in USA.

ProBioDigital.AI factors improving public health:



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