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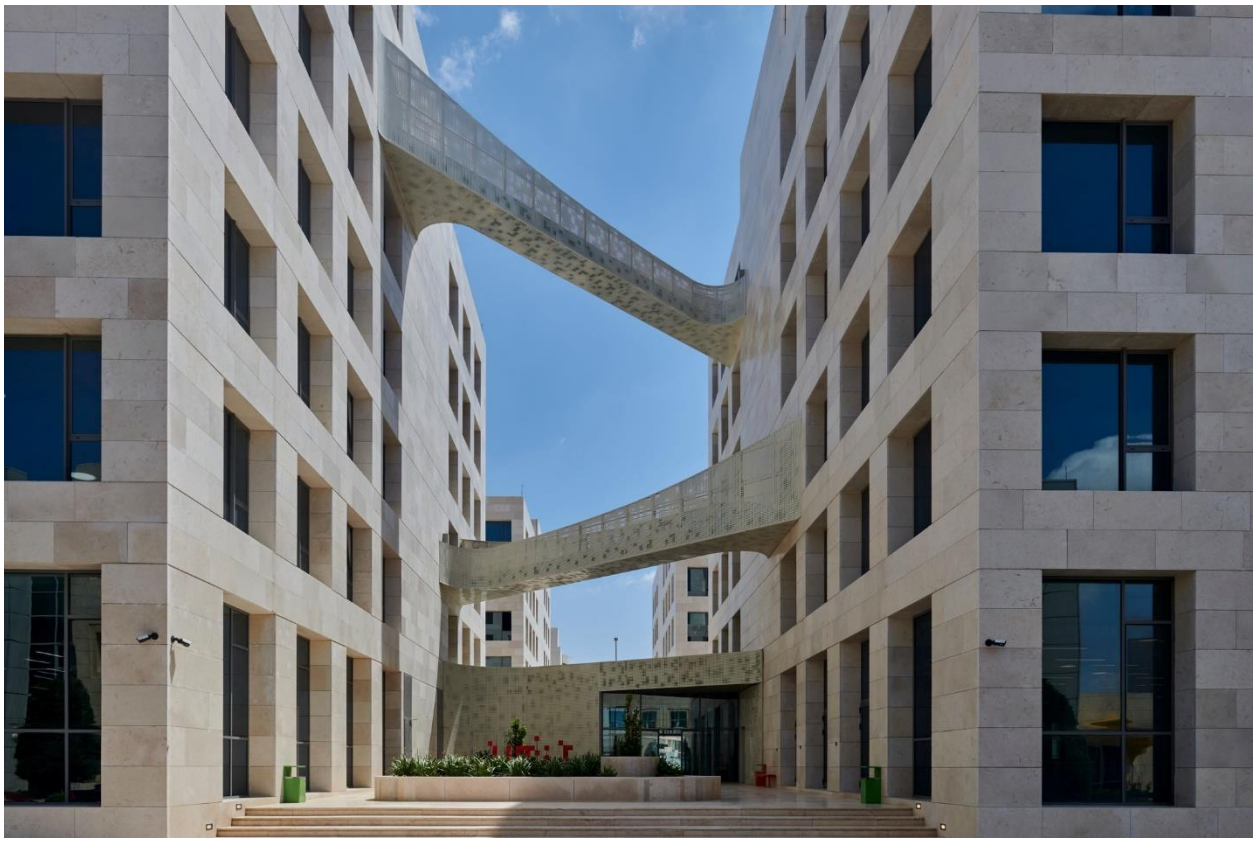
Al Hussein Technical University



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Data Science Lifecycle and Computing Systems in the ---- Sector

Introduction

1. Phases of the Data Science Lifecycle

1.1 Problem Definition

- **Define:** Identify the problem and obstacle facing the organization and understand it in detail in order to find the best way to determine the steps that must be taken to solve the problem.
- **Computing Systems**: JIRA, Trello, Asana (Srinivasan, 2024)
- **Example**: Sit with stakeholders and understand the problem in detail to determine the requirements we need know the best way to fill in the steps and using computer systems.

1.2 Data Collection

- **Define:** Collect all relevant data for the problem with a variety of sources from Internal to External Data, with Ensure Data Quality, by using appropriate tools and processes.
- **Computing Systems**: MySQL, Microsoft SQL Server, Postgre SQL, Oracle RDBMS (Nasikanov, 2024)
- **Example**: Collecting customer transaction data, social media activity, or medical records.

1.3 Data Cleaning

- **Define:** Verifying the validity of the data and ensuring that it is free of inconsistencies and illogical errors in the collected data.
- **Computing Systems**: TIBCO Clarity, OpenRefine, Trifacta Wrangler, Melissa Clean Suite. (Hillier, 2023)
- **Example**: Filling missing data, merging duplicate data, and deleting invalid data.

1.4 Data Exploration

- **Define:** Data, including data structure, relationships between data, and ups and downs in charts and diagrams, is analyzed to understand patterns, their movement, and what influences them.
- **Computing Systems**: Microsoft Power BI, IBM SPSS, Tableau. (Anon., 2024) (Jeralyn, 2024)
- **Example**: Seeing the relationship between the four seasons and the most popular products in each, understanding the change of trends and people's moods from time to time to keep up with it, and understanding the difference between cultures and what each race likes in order to satisfy all parties.

1.5 Feature Engineering

- **Define:** At this stage, the data is transformed into a format that is meaningful and easily understandable. By creating or modifying features that highlight important patterns and relationships, the data becomes more structured and suitable for machine learning models. Feature engineering helps define clear relationships between different data points, which improves the model's ability to predict future outcomes and trends, both in the short and long term.
- **Computing Systems**: Scikit-learn , FeatureTools, AutoFeat (Agrawal, 2024)
- **Example**: Predicting the sale of some products in a different seasons, predicting the rise of a certain stock or currency in the coming period.

1.6 Modeling and model evaluation

- **Define:** Here a machine learning model is built, which uses complex algorithms and huge databases to make comparisons and predict the rise and fall of patterns in charts by its own. Here the relationship between data science and artificial intelligence becomes clear.
- **Computing Systems**: Scikit-learn, TensorFlow, XGBoost

  (Anon., 2024) (Ambika, 2023) (Vidhya, 2023)

- **Example**: Building a predictive model to forecast customer churn based on past behavior, demographic data, and usage patterns.

1.7 Result visualization

- **Define:** The results are presented through visualizations or charts that illustrate future projections under different scenarios, as well as the current situation. This allows stakeholders and individuals with no background in data science to easily understand the key insights and implications.
- **Computing Systems**: Tableau, Infogram, ChartBlocks, Datawrapper

  (Chapman, 2019)

- **Example**: Visualize the profits every month in case of making every decision to find the best solution for a problem facing the organization.

2. Comparison of Computing Systems for Each Phase of the Data Science Lifecycle

2.1 Problem Definition

- **JIRA:**
  1. You can create Scrum boards to break large, complex projects into smaller, manageable tasks.

2. You can also keep track of projects with out-of-the-box dashboards and reports .
3. Friendly user and easy to use.

- **Trello:**
  1. You can get a quick project overview with a simple, Kanban-style layout.
  2. You can visualize your project's details as Boards, Lists, and Cards.
  3. Organizing project data, such as member details, due dates, attachments, etc., in one place.
- **Asana :**
  1. It helps you start your project quickly with pre-built project templates and an easy-to-use workflow builder.
  2. You can Manage resources effectively with features like workload management and time tracking**.**

     (Srinivasan, 2024)

2.2 Data Collection

- **MySQL:**
  1. The data development process is adjustable for small and heavy applications.
  2. Easy to learn the foundational features without a programming background.
  3. Open-source nature grant users' complete freedom to customize data.
- **Microsoft SQL Server:**
  1. Easy to set up a new database server from scratch.
  2. Creates various designs, tables, and view data without syntax.
  3. Can handle complicated queries and integrate with other programs.
  4. Allow for excellent data security and recovery.
- **Postgre SQL:**
  1. Storage and management of data at higher volumes.
  2. Relatively secured data processing than others.
- **Oracle RDBMS:**
  1. You can create partitions to have better administrative control over your data.
  2. Smooth transactional process and data security.

(Nasikanov, 2024) (William, 2024)

2.3 Data Cleaning

- **TIBCO Clarity:**
  1. Ideal for cleaning raw data and analyzing it all in one location.
  2. Ingests data from dozens of different sources.
  3. Offers everything from data mapping functionality.
- **OpenRefine:**
  1. Free to use and customize.

2. Let's you transform data between different formats and ensure that data is cleanly structured.
3. streamlines many complex tasks.

- **Trifacta Wrangler:**
  1. Lets you transform data, carry out analyses, and produce visualizations.
  2. Its artificial intelligence algorithms can easily identify and remove outliers.
  3. The tool's UI allows you produce data pipelines from scratch in a much more visual and intuitive way.
- **Melissa Clean Suite:**
  1. designed specifically to support the Salesforce and Microsoft Dynamics CRM systems.
  2. It cleans data as it is being collected. This minimizes effort later on.

(Hillier, 2023)

2.4 Data Exploration

- **Microsoft Power BI:**
  1. Provides easy-to-use AI features that can find patterns in data, create reports instantly, provide answers, and more.
  2. Easily embed and share reports in your other Microsoft services, including Teams, PowerPoint, Excel, and Power Platform.
  3. Offers very high protection and security.
- **IBM SPSS:**
  1. Offers a wide range of statistical procedures specifically designed to analyze social, behavioral, and economic data.
  2. Provides advanced features for survey research.
  3. It provides a user-friendly graphical interface that enables users to perform various statistical tests, data visualization, and predictive modeling.
- **Tableau:**
  1. Its interactive and visually appealing dashboards make it an ideal choice for data exploration and reporting.
  2. Allows users to explore data in a highly engaging and dynamic manner.

(Anon., 2024) (Jeralyn, 2024)

2.5 Feature Engineering

- **Scikit-learn:**
  1. Provides a toolbox for turning raw data into features that machine-learning models can process.
  2. Contains several modules for feature engineering, like feature selection module which offers a range of methods for identifying valuable features, and feature extraction module comprises a variety of methods to extract features from text and images.
  3. Allows you to conveniently combine the different building blocks.
- **FeatureTools:**
  1. Supports a lot of functionalities.
  2. Provides a whole lot of primitives.

3. It uses deep feature synthesis (DFS) to construct features.
4. Using relational databases to create new features.

- **AutoFeat:**
  1. Automates feature synthesis, feature selection, and fitting a linear machine learning model.
  2. The algorithm behind Autofeat is simple.

(Agrawal, 2024)

2.6 Modeling and Model Evaluation

- **Scikit-learn:**
  1. Offers a consistent and user-friendly API, making it straightforward for newcomers to utilize machine learning.
  2. Offers many conventional machine learning techniques, such as clustering, regression, and classification.
  3. It interfaces easily with other Python data science libraries.
- **TensorFlow:**
  1. It is made for processing big amounts of data
  2. Has a huge, active community that ensures constant updates, bug corrections, and thorough documentation.
  3. Powered by Google, TensorFlow gains from significant backing and ongoing development from Google's AI specialists.
- **XGBoost:**
  1. Known for its exceptional predictive accuracy.
  2. Can capture complex relationships and interactions between features.
  3. XGBoost provides insights into feature importance, helping us understand which features contribute the most to predictions.
     (Vidhya, 2023) (Ambika, 2023)

2.7 Result visualization

- **Tableau:**
  1. Output options include multiple chart formats as well as mapping capability.
  2. Lots of video tutorials to walk you through how to use it.
  3. Hundreds of data import options.
- **Infogram:**
  1. Includes 35+ chart types and 550+ map types.
  2. API for importing additional data sources.
- **ChartBlocks:**
  1. Easy to use wizard for importing the necessary data.
  2. Designers can create virtually any kind of chart, and the output is responsive.
- **Datawrapper:**
  1. Specifically designed for newsroom data visualization.
  2. Tool includes a built-in color blindness checker.
  3. Once data is imported, charts can be created with a single click.
     (Chapman, 2019)

3. Computing Systems in ---

Cost, **Performance**, **Stability**, and **Ease of Use**. (Low, Moderate, High)

Note: Prices vary for each subscription plan in every system, so I've listed the prices for the Highest plan available for each subscription.

Problem Definition

Criteria	JIRA	Trello	Asana
Cost	Moderate	Moderate	High
Performance	High	Moderate	High
Stability	High	High	High
Ease of Use	Moderate	High	High

Jira subscription comes at $16 per month, custom pricing for enterprise plans

Trello subscription comes at $17.50 per month for 50 users

Asana subscription comes at $30.49 per month, custom pricing for enterprise plans

(Srinivasan, 2024)

Data Collection/Acquisition

Criteria	MySQL	Microsoft SQL Server	Postgre SQL	Oracle RDBMS
Cost	Moderate	High	Free	Moderate
Performance	Moderate	High	Moderate	High
Stability	High	High	High	Moderate
Ease of Use	High	Moderate	Moderate	Moderate

MySQL Cluster CGE edition comes at $10,700

Microsoft SQL Server Enterprise license comes at $15,123

Oracle RDBMS Database Management - Cloud Databases comes at $0.05 per OCPU per hour

(Nasikanov, 2024)

Data Cleaning

Criteria	TIBCO Clarity	OpenRefine	Trifacta Wrangler	Melissa Clean Suite
Cost	High	Free	Moderate	Moderate
Performance	High	Moderate	High	High
Stability	High	High	High	High
Ease of Use	Moderate	Moderate	High	High

TIBCO Cloud™ Integration Premium subscription comes at $1500 per month

Trifacta Pro subscription comes at $419 per month, custom pricing for enterprise plans

The price of Melissa Clean Suite varies depending on how many credits you need, from 10,000 Credits for $40 to one million credits for $3200.

(Hillier, 2023) (Anon., 2021) (Anon., 2022) (Sinkgraven, 2024) (Anon., 2024)

Data Exploration & Visualization

Criteria	Microsoft Power BI	IBM SPSS	Tableau
Cost	low	High	Moderate
Performance	High	High	High
Stability	High	High	High
Ease of Use	High	Moderate	High

Power BI Premium comes at $20 per user per month, custom pricing for enterprise plans

IBM SPSS Perpetual licenses comes at $3,830 per user

Tableau Enterprise creator subscription comes at $115 per month

(Anon., 2024) (Jeralyn, 2024) (Anon., 2017) (Anon., 2017) (Anon., 2024)

Feature Engineering

Criteria	Scikit-learn	FeatureTools	AutoFeat
Cost	Free	Free	Free
Performance	High	High	High
Stability	High	Moderate	Moderate
Ease of Use	Moderate	High	High

They are all python Libraries, so it's unpaid

(Agrawal, 2024)

Modeling and model evaluation

Criteria	Scikit-learn	TensorFlow	XGBoost
Cost	Free	Free	Free
Performance	High	High	High
Stability	Moderate	High	High
Ease of Use	High	Moderate	Moderate

They are all python Libraries, so it's unpaid;

(Vidhya, 2023) (Ambika, 2023)

Result Visualization

Criteria	Tableau	Infogram	ChartBlocks	Datawrapper
Cost	Moderate	Moderate	Moderate	High
Performance	High	Moderate	Moderate	Moderate
Stability	High	Moderate	Moderate	High
Ease of Use	Moderate	High	High	High

Tableau Enterprise creator subscription comes at $115 per month

Infogram Team subscription comes at $149 per month, custom pricing for enterprise plans.

ChartBlocks Elite subscription comes at $65 per month

Datawrapper Custom subscription comes at $599 per month, custom pricing for enterprise plans.

(Chapman, 2019) (Anon., 2024) (Anon., 2024) (Anon., 2023) (Anon., 2024)

4. Justification of Suitability of Specific Systems for the --- Sector

Chose and justify the best systems for each phase.

- **Problem Definition:** I choose Trello, I need Visualizing workflows as a digital Kanban Board as well as anything else, which helps me understand the problem or the goal we need to reach well and know the stage we are currently in, and Trello is the best in this among all the programs in this phase, in addition to that it gives a high efficiency ratio and proportion to its very reasonable price. While Jira excels in issue tracking and project management, its built-in testing features are somewhat limited. Teams heavily focused on testing might need to integrate Jira with dedicated testing tools

  (Srinivasan, 2024) (Anon., 2024) (Ananda, 2024)

- **Data Collection:** I need security, performance, and a system that can work seamlessly with other systems together in one domain across all phases. Microsoft SQL Server is the best solution, especially if you use Microsoft technologies, such as Windows Server, Azure, .NET, etc., which provides an integrated system that works together, in addition to working with other different systems at high performance. In addition, it provides the best security measures that can be found in this phase, which is excellent for organizations that carry sensitive and private data, such as hospitals and government institutions. MySQL looks very good, but the downside is that queries crash even after an update or restart. PostgreSQL processing performance is slower than other systems which can cause us to face some problems.

  (Ambardar, 2024) (Nasikanov, 2024) (William, 2024)

- **Data Cleaning:** In terms of performance, I care a lot about high performance, lack of complexity in use, and access to the best data quality at this stage, Trifacta Wrangler is the best in these aspects. TIBCO Clarity has some Issues with SSL configuration options, OpenRefine is a bit complex. There are very limited reviews for Melissa Clean Suite CRM on the Salesforce AppExchange, and the total score comes in at 3.75 (out of 5). So, in the end, I choose Trifacta Wrangler as my choice.

(Hillier, 2023) (Anon., 2024) (Sinkgraven, 2023)

- **Data Exploration:** Microsoft Power BI is the best for me in terms of data exploration, and as usual with Microsoft, it provides very high protection and security, is high performance, and uses modern artificial intelligence technologies. In addition to all this, who among us does not use Office applications and Microsoft services in general? Microsoft Power BI allows you to easily embed and share reports in other Microsoft services, including Teams, PowerPoint, Excel, and Power Platform. On the other hand, SPSS was developed for research purposes in the social sciences, so it is an ideal choice for developing social media algorithms, but it is not the best in many other fields. Tableau is also a good choice, but for me, its best use is in terms of sales and business vision and developing sales operations more than other interests such as government sectors or healthcare. In the end, they are all good options, but your choice of one of them depends on your project and what is required of it, but I consider Power BI to be the most comprehensive among them.

  (Anon., 2024) (Jeralyn, 2024)

- **Feature Engineering:** FeatureTools is best for large projects that require huge datasets, as it is designed for these purposes, in addition to providing deep feature synthesis (DFS) to construct features and using relational databases to create new features, in addition to being easy to use and develop. Scikit-learn is an excellent choice but is designed more for simple projects, like a startup business and not for huge amounts of data. AutoFeat does not have all the features that FeatureTools and Scikit-learn have, some of which are missing.

  (Agrawal, 2024)

- **Modelling and Model Evaluation:** XGBoost is what you want If you need high speed, accuracy, and performance to build a machine learning model that handles large amounts of data, XGBoost is the best in these areas, as it captures complex relationships and interactions between features and can handle missing values in the data without requiring imputation, which makes it a favourite choice among data scientists, but its problem lies in its complexity. Scikit-Learn, as I mentioned before, is an excellent choice, but for small amounts of data and not for building a large machine learning model. TensorFlow is good for large projects, but it is designed for deep learning tasks more than almost anything else, which makes it less versatile than TensorFlow and XGBoost.

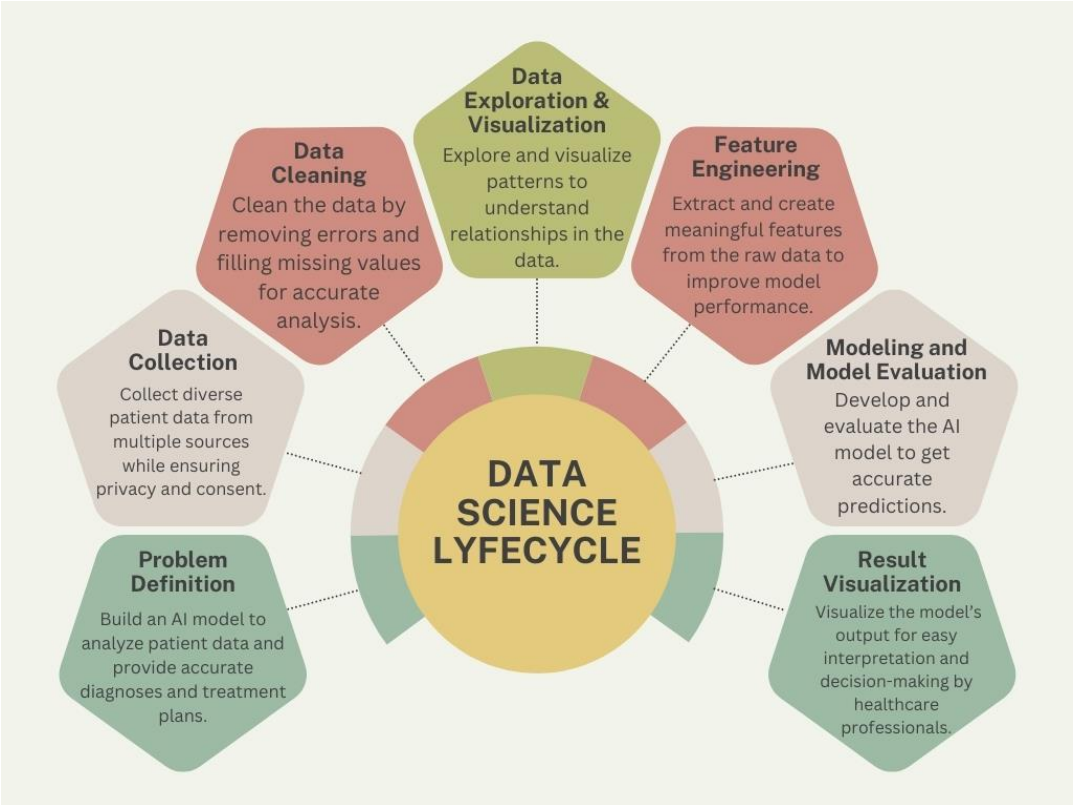
  (Anon., 2024) (Ambika, 2023) (Vidhya, 2023)

- **Result visualization:** Datawrapper is the best for me personally, because it's specifically designed for newsroom data visualization, which is what I need in this phase, and also being fast. Their visualization types include column, line, and bar charts, election donuts, area charts, scatter plots, choropleth and symbol maps,

and locator maps, among others. In contrast, Tableau's public version doesn't allow you to keep data analyses private, and ChartBlocks doesn't appear to have any mapping capability.

5. Data Science Lifecycle and Techniques Used in the ---- Sector

The goal is to develop an AI-powered system that can store and analyze medical data from thousands of patients. This includes details such as symptoms, medical history, medications, lab results, and final diagnoses. This system will be used to provide an accurate diagnosis for any patient and create a personalized treatment plan for each patient, adjusted based on the specific diagnosis.



6. Explanation of Techniques Used in Each Phase

1. Problem Definition:

- The primary objective is to develop an AI model that can analyze a patient's symptoms, medical history, test results, and medications to provide a reliable diagnosis and personalized treatment plan. The challenge is ensuring that the model is accurate, interprets complex medical data, and generalizes well across diverse patient populations.
- Trello will be used to visualize and track workflows, ensuring the project stays organized and progresses smoothly by clearly outlining the stages of development.

2. Data Collection:

- Data from multiple sources of thousands of past and present patients such as electronic health records, lab test results, medical history, and prescriptions should be collected and linking the recurring and similar patterns, after the patients' permission. This data will serve as the basis for training the AI model and should include diverse patient data to cover a wide range of medical conditions.

- I used Microsoft SQL Server to store data after collecting it from the largest number of sources, as the hospitals I dealt with use this system because it works with the highest possible efficiency with many Microsoft technologies, which provides an excellent workspace with amazing integration, and also because this system is the most secure database system in terms of the confidentiality of the existing data, and hospitals need very high data security because it is sensitive and private, which makes collecting data easy, as most hospitals use the same system to store their data and thus it can be collected easily.

3. Data Cleaning:

- The collected data contains missing values, duplicates, and invalid entries. The data must be cleaned and pre-processed to ensure accuracy and reliability. This step is essential to train an effective and unbiased model, and to avoid confusion or misdiagnosis.
- **Techniques**: Trifacta Wrangler is being used here for its high performance and ease of use in cleaning complex datasets. It will handle tasks like filling missing values, removing duplicates, and correcting errors to ensure the data is ready for analysis.

4. Data Exploration & Visualization:

- At this stage, the data will be explored to identify patterns and associations, such as how test results relate to symptoms that give us diagnoses, symptoms of specific medications and their positive or negative effects on the condition. Visualizing data relationships helps us understand underlying patterns and prepare the dataset for machine learning.
- For data exploration and visualization, Microsoft Power BI will allow for easy analysis of complex data relationships and helps in identifying trends and correlations. Power BI's integration with other Microsoft services also makes it a convenient choice for collaborative analysis.

5. Feature Engineering:

- In this phase, FeatureTools will be used to extract relevant features from the raw data. By creating new features that help highlight important relationships between data points, the model's predictions can be improved. Features will be derived such as the duration of symptoms, the effectiveness of a medication, or the extent to which certain tests affect specific individuals, enhancing the model's ability to make accurate predictions.

- FeatureTools will be employed to extract relevant features from the raw data. By creating new features that help highlight important relationships between data points, the model's predictions can be improved, For example, features such as symptom duration or medication effectiveness will be derived, enhancing the model's ability to make accurate predictions.

6. Modeling and Model Evaluation:

- At this stage, the machine learning model will be built, where complex algorithms are used to discover relationships between antigens. When the same diagnosis is repeated for several people with the same symptoms and the same test results, this is considered a pattern that the model benefits from and trains on. The model uses data from thousands of patients and discovers repetition in diseases, and becomes fully ready to diagnose new patients.
- The AI model is being built using XGBoost, a powerful machine learning algorithm suitable for large datasets. Complex relationships between variables will be captured and missing data will be handled without the need for additional inputs. All anomalies and new symptoms will be noted, and each case will be linked to the next.

7. Result Visualization:

- In the final stage, the result that was reached is displayed and tested on different patients to determine its effectiveness and accuracy. Its ability to read similarities and recurring patterns between patients' cases is also displayed and viewed in the form of graphs, and its efficiency in making short- and long-term treatment plans is seen effectively, and thus the final product is ready.
- The final model output will be presented using Datawrapper, which is designed for creating clear and interactive visualizations. This will allow healthcare professionals to easily understand the model's predictions and treatment recommendations. Visualizations such as probability charts and treatment timelines will be created to help doctors quickly interpret the data and make informed decisions.

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