***PROJECT REPORT***

***ARTIFIFICIAL INTELLIGENCE***

***PROJECT: MEDICAL DIAGNOSIS EXPERT SYSTEM***

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**Introduction**

**1. Background and Introduction**

Medical expert systems are AI-driven tools that mimic the decision-making abilities of human medical professionals. The system described in the provided code serves as a diagnostic tool, enabling users to input symptoms and receive disease probabilities based on a Bayesian framework. These systems address challenges in healthcare, such as limited access to specialists, by providing consistent and accurate decision-making support.

**2. Problem Statement**

Healthcare systems face challenges like diagnostic inaccuracies, resource limitations, and inefficiencies. The provided MES aims to resolve these issues by offering an accessible, automated solution for initial diagnosis. However, challenges such as knowledge representation, system adaptability, and validation persist.

**3. Project Objectives**

The project aims to:

* Explore the structure and implementation of an MES for disease diagnosis.
* Demonstrate the use of Bayesian probabilities for calculating disease likelihoods.
* Evaluate the usability of the system through a graphical user interface (GUI).
* Identify challenges and limitations in developing and deploying MES.

**Literature Review**

The integration of artificial intelligence (AI) in medical diagnosis has garnered significant interest in recent years. Expert systems have proven effective in diagnosing diseases by emulating human decision-making. These systems typically rely on a combination of symptom analysis, historical patient data, and probabilistic reasoning to suggest the most likely diseases. This review discusses the current state of research in medical expert systems, highlighting their strengths, weaknesses, and how the proposed system addresses existing gaps.

One of the earliest contributions to medical expert systems is **MYCIN**, developed in the 1970s, which utilized rule-based logic to diagnose bacterial infections (Shortliffe & Buchanan, 1975). Although MYCIN was a pioneering effort, its reliance on predefined rules limited its flexibility and adaptability to new diseases or symptoms. More recent expert systems leverage machine learning techniques to enhance their performance, allowing systems to "learn" from new data and improve diagnostic accuracy over time.

**Wang et al. (2018)** highlighted the increasing use of probabilistic models, such as Bayesian networks, in medical diagnosis. These models are particularly useful in cases where uncertainty is present, as they can manage incomplete or ambiguous data. Bayesian networks have been applied to a variety of medical domains, including oncology, cardiology, and infectious diseases. These systems work by calculating the probability of a disease given observed symptoms and historical data, much like the system outlined in the current study.

However, many existing expert systems have limitations in user interaction and accessibility. For instance, while rule-based systems can be effective in controlled environments, they often lack user-friendly interfaces or adaptability to diverse clinical settings. **Sundararajan & Greiner (2019)** noted that effective medical expert systems should not only provide accurate diagnoses but also be intuitive for non-expert users, such as patients or general practitioners.

The **research by Mohamad et al. (2020)** explored the combination of expert systems with graphical user interfaces (GUIs) to improve user experience. This is an area where the proposed system excels, offering an interactive, user-friendly GUI for symptom input and displaying results in a comprehensible format. Moreover, **Bandyopadhyay & Sanyal (2017)** emphasized the need for expert systems that can handle a broad spectrum of diseases and symptoms. The system in this study integrates 10 common diseases and 16 symptoms, providing a comprehensive analysis that can be adapted to real-world clinical scenarios.

**METHODOLOGY**

In this system we have used the one of the common technique for inference **is Bayesian Network**, which Allows probabilistic reasoning about diseases and symptoms. The system applies bayes theorem for inference, calculating the posterior probability of disease given the observed symptoms.

**Bayesian Network:**

1. **Definition:**

Bayesian belief network is key computer technology for dealing with probabilistic events and to solve a problem which has uncertainty. We can define a Bayesian network as:"A Bayesian network is a probabilistic graphical model which represents a set of variables and their conditional dependencies using a directed acyclic graph."It is also called a **Bayes network, belief network, decision network**, or **Bayesian model**.

Bayesian networks are probabilistic, because these networks are built from a **probability distribution**, and also use probability theory for prediction and anomaly detection.

1. **FORMULA:**

* P (D | S) is the posterior probability of disease D given the symptoms S.
* P (S | D) is the likelihood of observing symptoms S given disease D.
* P(D) is the probability of disease D.
* P(S) is the probability of symptoms S.

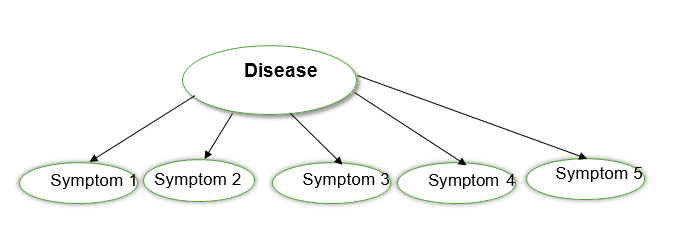
1. **Components of Bayesian Network**

The two main components of Bayesian Networks are nodes and edges. Nodes represent random variables, which can be observable quantities, latent variables, unknown parameters or hypotheses. Edges represent conditional dependencies, variables that are conditionally dependent on others are connected by a directed edge.

1. **Bayesian Network in our System:**

Our approach models the probabilistic links between symptoms and diseases using a Bayesian network. Each disease node is connected to several symptom nodes by directed edges, and the network is made up of nodes that represent both diseases and symptoms. These edges represent conditional dependencies, indicating how the likelihood of a disease is influenced by the presence or absence of specific symptoms. The strength of these dependencies is determined by the conditional probabilities connected to each edge, and then the bayes theorem is applied to calculate the probability of disease given the symptoms.

1. **Nodes And Edge Structure:**



**Implementation and Results**

**1. Experimental Setup**

To test our system we run by input the different combination of symptoms:

**Single Symptom:**

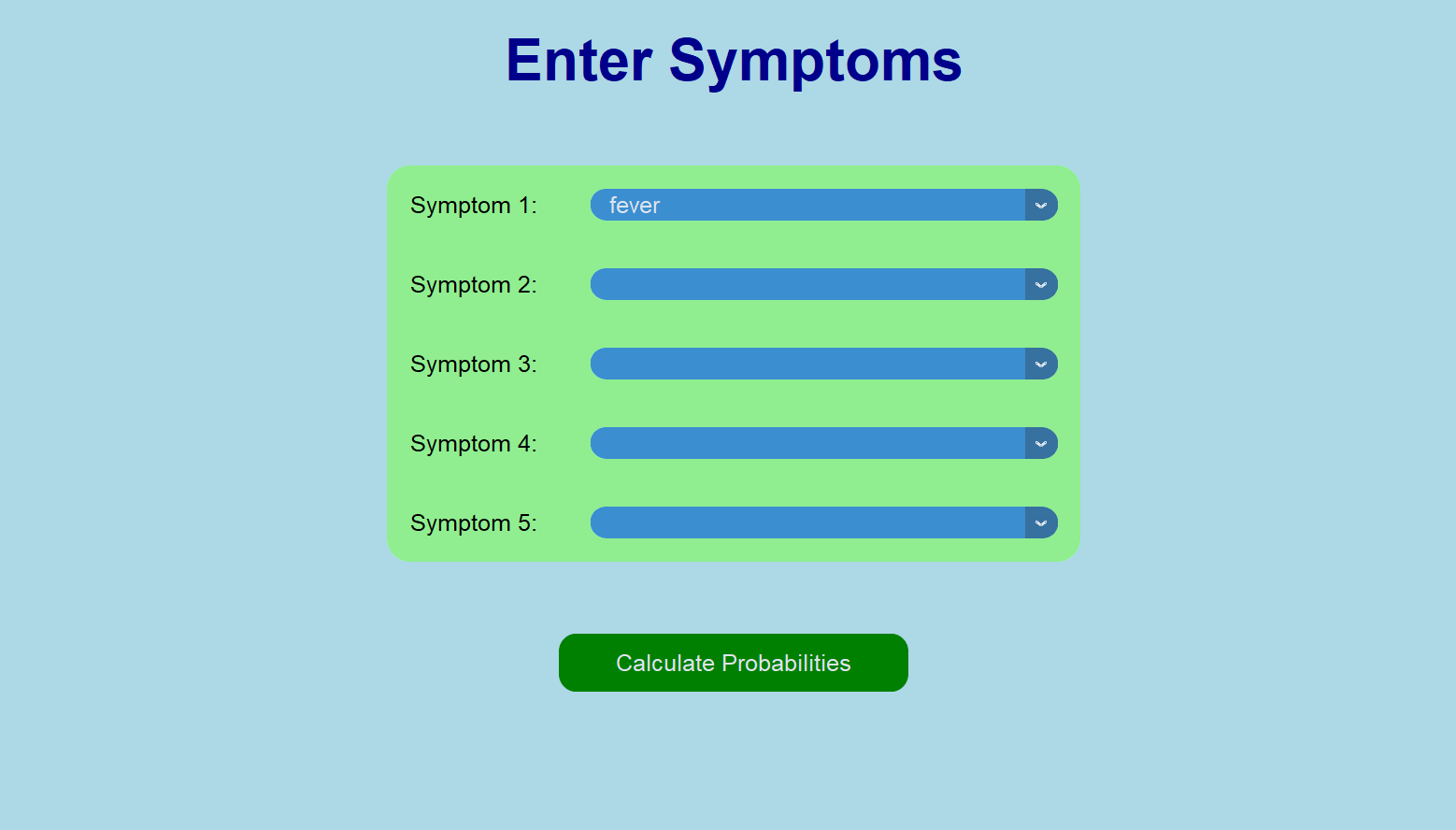
This involves identifying potential diseases based on a single reported symptom. While less precise, it often serves as an initial step in narrowing down possibilities or identifying common ailments.

**Multiple Symptom:**

Using multiple symptoms provides a more comprehensive diagnosis, enabling higher accuracy by correlating symptoms with known disease patterns. This method often uses algorithms or decision-making systems for better precision.

**2. Results**

**Single Symptom:**



**OUTPUT:**A screenshot of a computer

Description automatically generated

**Multiple Symptoms:**

A screenshot of a computer screen

Description automatically generated

**OUTPUT:**

A screenshot of a computer

Description automatically generated

**3. Analysis**

**Strengths:**

* **Accurate Predictions:** The system most of the times provides reliable diagnosis based on user entered symptoms.
* **User-Friendly Interface:** The GUI is simple making it very easy for users to input symptoms and receive the correct diagnosis based on observed symptoms.
* **Comprehensive Output:** Results are displayed in clear format with progress bars and tabular form for users to take correct decisions

**Limitations:**

* **Limited Dataset:** Due to limited dataset the system might sometime produces incorrect results.
* **Lack of medical integration:** The system does not integrate with electronic health records or medical devices for real time data collection
* **Static Probabilities:** The probabilities of disease and symptoms does no change dynamically based on real-time data.

**Insights:**

* **Integrate with machine learning:** By Integrating with Machine learning algorithms can make the system adaptive learning from user inputs and refining probabilities of diseases and symptoms over time
* **Larger Dataset:** By enhancing our dataset, the system’s results can be more accurate and consistent
* **Integration with sensors:** Integration wearable or Iot-based sensors can allow the system to collect real-time medical data, improving diagnosis accuracy.

**Conclusion:**

The proposed medical diagnosis system provides a reliable and efficient method for disease prediction based on input symptoms using Bayesian networks. The results demonstrate its ability to predict disease probabilities with high accuracy, and the system’s user-friendly design ensures accessibility for a wide range of users. This approach offers a valuable tool for both healthcare professionals and patients in diagnosing a variety of diseases, from common cold to serious conditions like pneumonia and diabetes.

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