INES – RUHENGERI
Faculty of Sciences and Information Technology
Department of Computer Science
SWE / YEAR 3 /DAY - 2024-2025

EXPERT SYSTEM FOR AGRICULTURAL PEST & DISEASE DIAGNOSIS

Scenario: AgriSmart AI Ltd., an Agriculture & Agri-Tech company in Rwanda, aims to address the challenge of early pest and disease detection faced by smallholder farmers due to limited access to agronomists and plant health experts. Crop diseases like maize lethal necrosis (MLN) and coffee rust threaten yields, leading to economic losses and food insecurity. To combat this, AgriSmart AI Ltd. is developing a **rule-based Expert System** that enables farmers to diagnose crop diseases by analyzing symptoms and receiving treatment recommendations. This **AI-powered solution** will be accessible via a **mobile-friendly web application**, ensuring efficient support for rural farmers in safeguarding their crops and improving productivity.

Question 1: Define an expert system in the context of AI.

Sample answer: An expert system is a computer-based application that uses AI to simulate human expertise in a specific domain, utilizing a knowledge base and inference engine to make decisions or provide recommendations.

Question 2: Identify three key components of an expert system.

Sample answer:

1. **Knowledge Base** – Stores domain-specific facts and rules.
2. **Inference Engine** – Applies logical rules to infer conclusions.
3. **User Interface** – Allows interaction between the user and the system.

Question 3: List four advantages of using an expert system in agriculture.

Sample answer:

1. Provides **instant diagnosis** without requiring an agronomist.
2. Improves **crop health management** and increases productivity.
3. Reduces **disease-related yield losses**.
4. Enhances **decision-making** for farmers.

Question 4: Explain how rule-based reasoning works in an expert system.

Sample answer: Rule-based reasoning applies **IF-THEN** logic to make decisions. The system checks input symptoms against predefined rules and provides an appropriate disease diagnosis and treatment recommendation.

Question 5: Summarize the main problem that AgriSmart AI Ltd. is trying to solve.

Sample answer: The company aims to **help smallholder farmers diagnose crop diseases** early, reducing yield losses caused by delayed intervention due to the lack of agronomists and plant health experts.

Question 6: Name two common crop diseases in Rwanda that the expert system should detect.

Sample answer:

1. **Maize Lethal Necrosis (MLN)**
2. **Coffee Rust**

Question 7: Describe the role of a knowledge base in an expert system.

Sample answer: The **knowledge base** contains **facts, rules, and heuristics** about crop diseases, enabling the system to make accurate diagnoses based on symptoms provided by the user.

Question 8: Differentiate between an expert system and a machine learning model.

Sample answer:

- **Expert System**: Uses **predefined rules** (IF-THEN statements) to make decisions.
- **Machine Learning Model**: **Learns from data** to predict outcomes.

Question 9: Explain why AgriSmart AI Ltd. is opting for a mobile-friendly web application.

Sample answer: Mobile access ensures that **farmers in rural areas** can easily use the system without requiring high-end computing resources.

Question 10: Classify the type of AI used in the proposed solution.

Sample answer: The AI used is **Traditional AI** (Rule-Based Expert System), as it relies on predefined IF-THEN rules rather than self-learning algorithms.

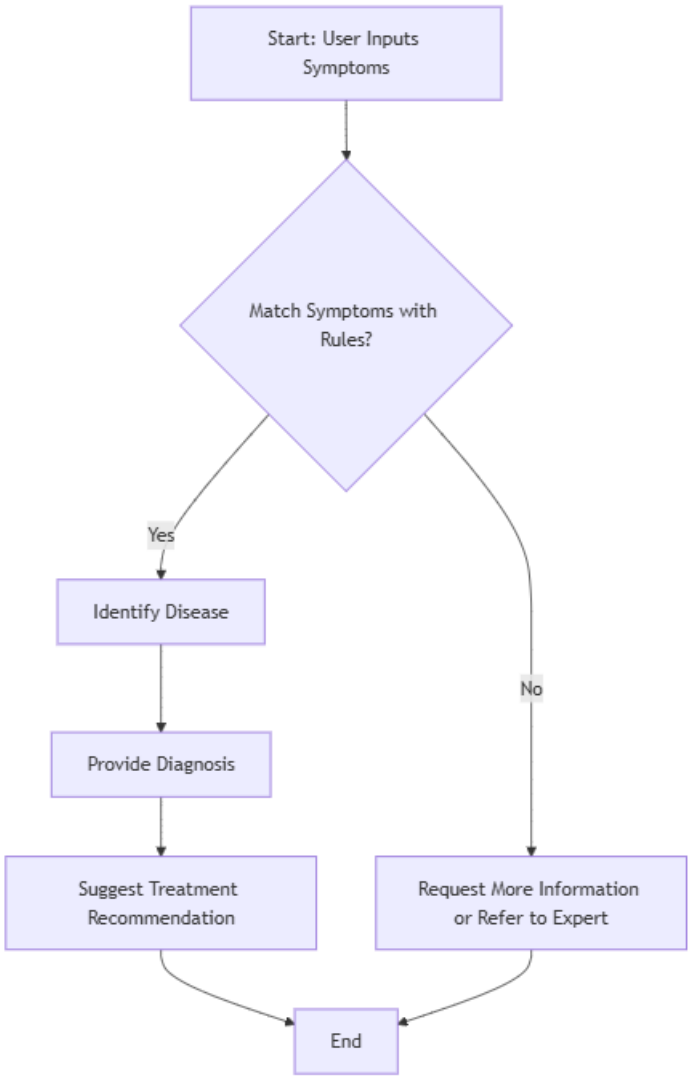
Question 11: Develop a rule-based inference for diagnosing maize lethal necrosis (MLN).

Sample answer:

IF leaves are yellowing **AND** wilting is present **AND** mold is visible,
THEN diagnose as **Maize Lethal Necrosis (MLN)** and recommend **fungicide XYZ**.

Question 12: Illustrate how the expert system's decision-making process works using a flowchart.

Sample answer:



Question 13: Compare a web-based expert system with a mobile app in terms of accessibility for farmers.

Sample answer:

- **Web-based:** Easily updated, accessible from any device with internet.
- **Mobile App:** Works offline but requires frequent updates.

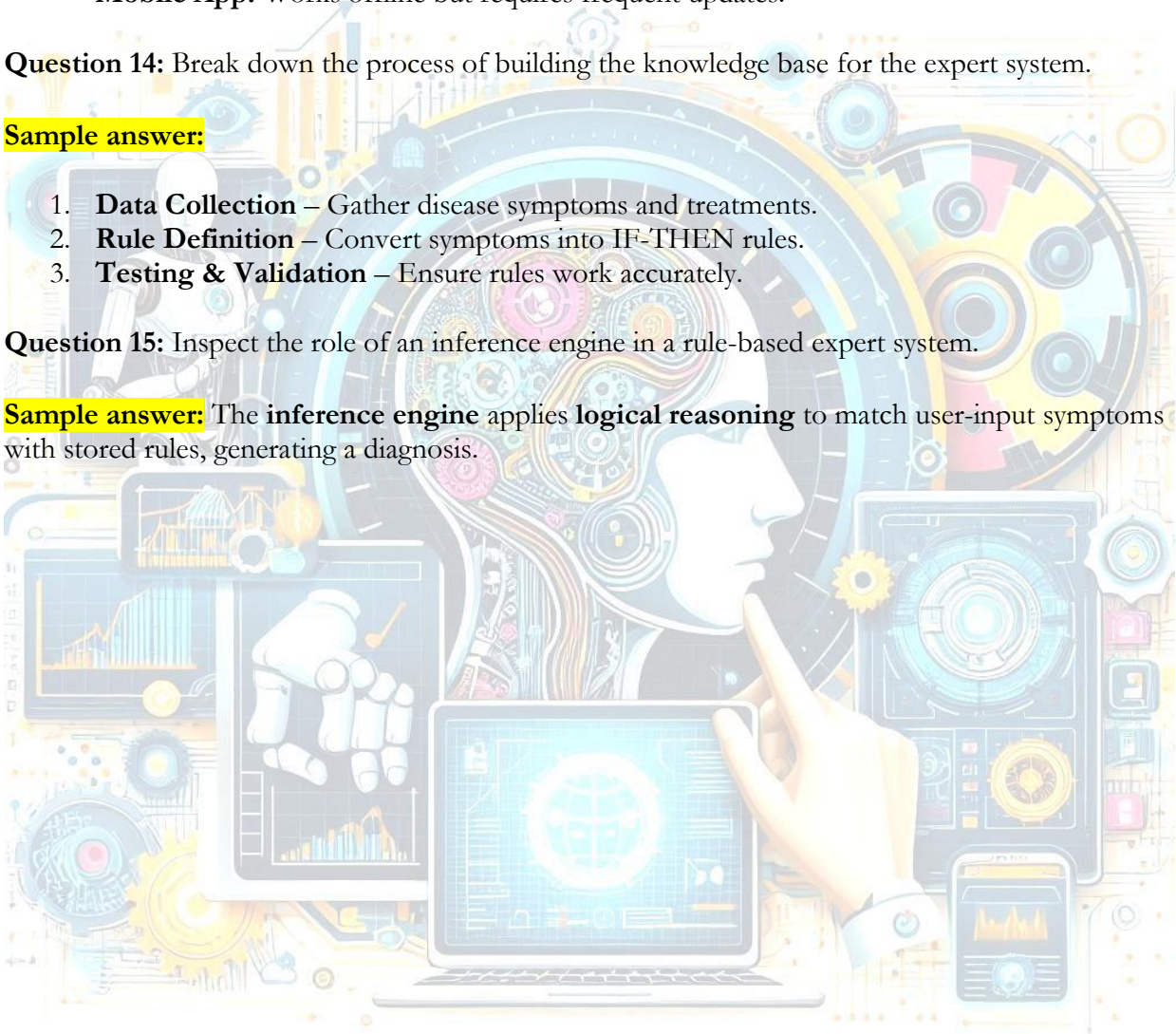
Question 14: Break down the process of building the knowledge base for the expert system.

Sample answer:

1. **Data Collection** – Gather disease symptoms and treatments.
2. **Rule Definition** – Convert symptoms into IF-THEN rules.
3. **Testing & Validation** – Ensure rules work accurately.

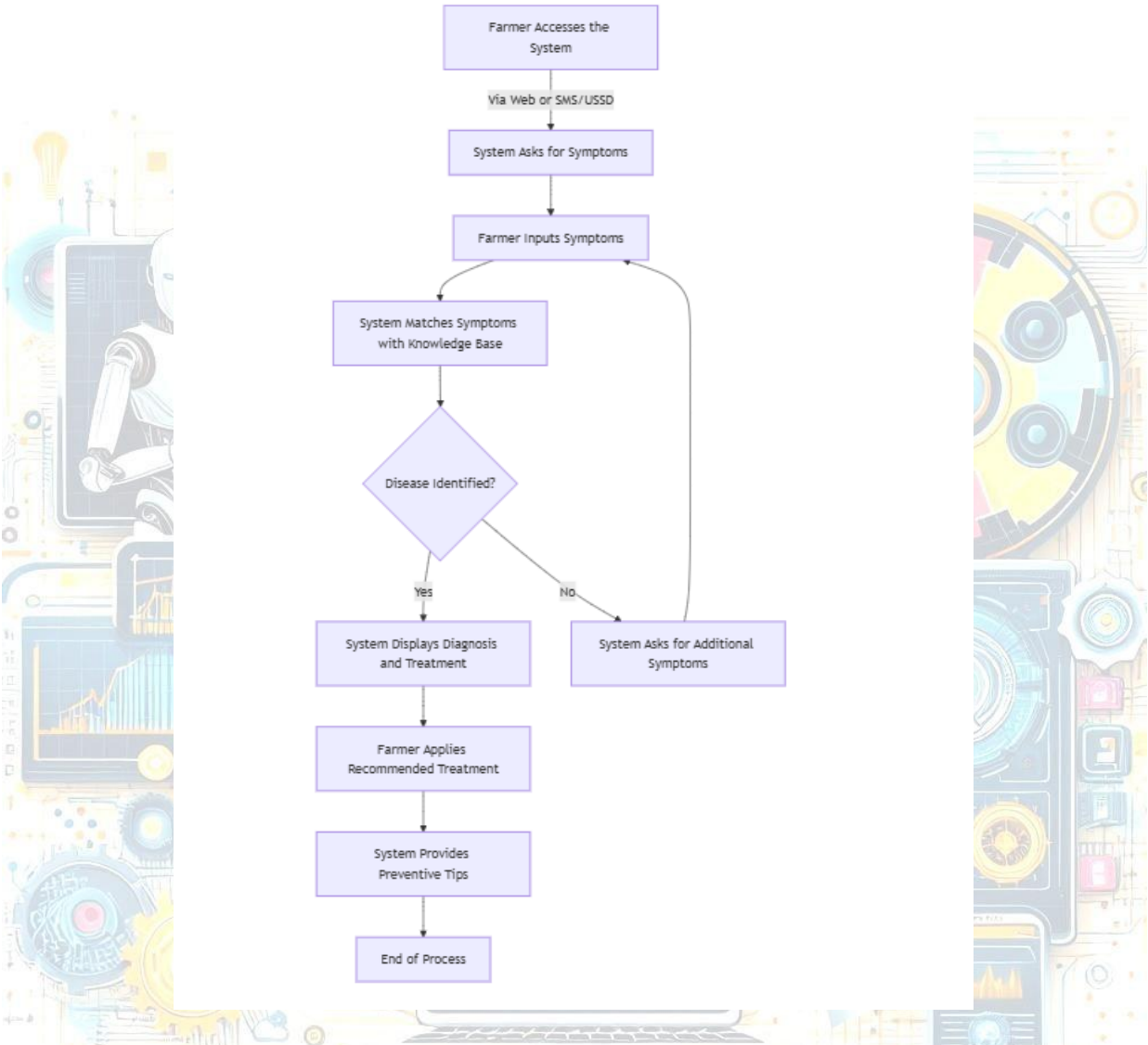
Question 15: Inspect the role of an inference engine in a rule-based expert system.

Sample answer: The **inference engine** applies **logical reasoning** to match user-input symptoms with stored rules, generating a diagnosis.



Question 16: Demonstrate how a farmer can interact with the system to diagnose a crop disease.

Sample answer:



Question 17: Predict the possible challenges farmers might face while using the expert system.

Sample answer:

1. **Limited internet access** in remote areas.
2. **Language barriers** if the system does not support Kinyarwanda.
3. **Incorrect data entry** leading to inaccurate diagnoses.

Question 18: Differentiate between backward and forward chaining in expert systems.

Sample answer:

- **Backward Chaining:** Starts from **possible diagnoses** and works **backward** to check symptoms.
- **Forward Chaining:** Starts from **symptoms** and moves **forward** to infer diagnoses.

Question 19: Relate the expert system's knowledge base to a real-life agronomist's expertise.

Sample answer: Just like an agronomist relies on experience and field knowledge, the **expert system stores structured knowledge** in the form of rules for automated decision-making.

Question 20: Compute the storage requirements for a knowledge base with 100 diseases and 500 rules.

Sample answer:

Assumptions:

1. Each disease name takes about 30 bytes (e.g., "Maize Lethal Necrosis").
2. Each rule contains:
   - Symptoms (100 bytes per rule)
   - IF-THEN logic (50 bytes per rule)
   - Treatment recommendation (100 bytes per rule)
3. Each rule takes about 250 bytes in total.

Storage Calculation:

- Diseases storage: 100 diseases × 30 bytes = 3,000 bytes (≈3 KB)
- Rules storage: 500 rules × 250 bytes = 125,000 bytes (≈125 KB)
- Total Storage Required: 3 KB + 125 KB = 128 KB

Conclusion:

The knowledge base would need approximately 128 KB of storage, which is very small and can easily be stored in a simple text-based database or a structured file like JSON or SQL.

Question 21: Design an improvement to make the expert system more effective.

Sample answer: Integrate **AI image recognition** so farmers can upload plant images for **automatic disease detection**.

Question 22: Propose an alternative method to deploy the system in areas with no internet access.

Sample answer: Implement **USSD & SMS support**, allowing farmers to **text symptoms** and receive **diagnosis via SMS**.

Question 23: Justify why a rule-based system is preferable over a machine learning model for this problem.

Sample answer: A rule-based system is **transparent, easy to update, and requires no training data**, making it ideal for **low-resource environments**.

Question 24: Prioritize key features that should be included in the system's user interface for ease of use.

Sample answer:

1. **Simple symptom selection dropdown**
2. **Voice-based input for illiterate farmers**
3. **Offline mode** for poor connectivity areas

Question 25: Defend the need for continuous updates in the knowledge base.

Sample answer: As **new crop diseases emerge**, the knowledge base **must evolve** to include updated treatment recommendations.

Question 26: Evaluate the economic impact of the expert system on smallholder farmers.

Sample answer: **Increases yield**, **reduces losses**, and **lowers dependency on agronomists**, improving **farmer profitability**.

Question 27: Create a business strategy for scaling this expert system beyond Rwanda.

Sample answer: Expand to **other African countries** with similar agricultural challenges, adding **multilingual support**.

Question 8: Criticize potential ethical concerns regarding AI decision-making in agriculture.

Sample answer:

1. **Over-reliance on AI** may lead to incorrect diagnoses.
2. **Data privacy concerns** with farmer input data storage.

Question 29: Organize a training program for farmers on how to use the system.

Sample answer: Conduct **field workshops** and provide **video tutorials in local languages**.

Question 30: Appraise the sustainability of this AI-powered expert system in the long run.

Sample answer: Sustainability depends on **regular updates, government partnerships, and ongoing farmer education**.