

# A Multi-Agent Assistant for Medical Diagnosis: Blood- Test Case Study

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# About Me

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**Research support:** Undergraduate Research Opportunities Program (UROP)



# Motivation and Background

- Annually in the USA, 14 billion laboratory tests are ordered, 7 billion being blood tests.
- Blood test analyses are crucial for diagnosing diseases, guiding treatment, and monitoring patient health.
- Traditional blood test analysis involves manual work, which can be time-consuming and prone to human error.
- One out of five laboratory tests ordered is unnecessary and does not improve patient treatment.
- Within the first week of hospitalization, patients receive on average 5.7 laboratory requests; up to 85% require additional testing afterward.
- This results in patient discomfort, increased lab workload, and higher healthcare costs.
- These facts motivated the development of a proof-of-concept prototype using a Multi-Agent System (MAS) with federated learning to automate and decentralize medical diagnosis, focusing on complete blood count (CBC) tests.



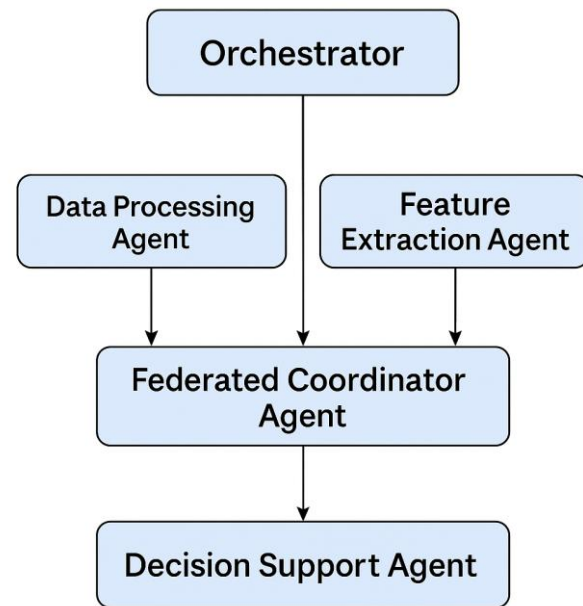
# Project Goals

- Build a modular Multi-Agent System (MAS) to automate blood test analysis.
- Integrate Federated Learning to ensure patient data privacy during model training.
- Develop a basic decision-support system to provide clinical advice based on predictions.
- Achieve 80–85% or higher diagnostic accuracy across different datasets.
- Create a system architecture that supports future scalability and real-world deployment.

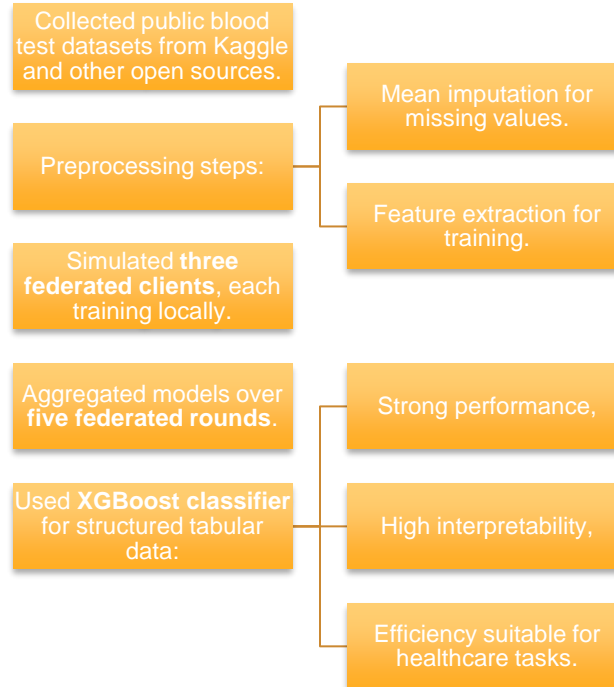


# System Architecture

- Modular architecture organized into specialized agents:
  - DataProcessingAgent: Cleans and imputes missing CBC data.
  - FeatureExtractionAgent: Extracts feature matrix (X) and labels (y).
  - FederatedCoordinatorAgent: Manages federated training across simulated clients.
  - DecisionSupportAgent: Maps model predictions to clinical advice.
- Orchestrator manages and coordinates agent execution.
- Parallelism: Data processing and feature extraction agents operate concurrently to improve time efficiency.
- Agents communicate through defined outputs, simulating decentralized MAS behavior.



# Methods and Implementation

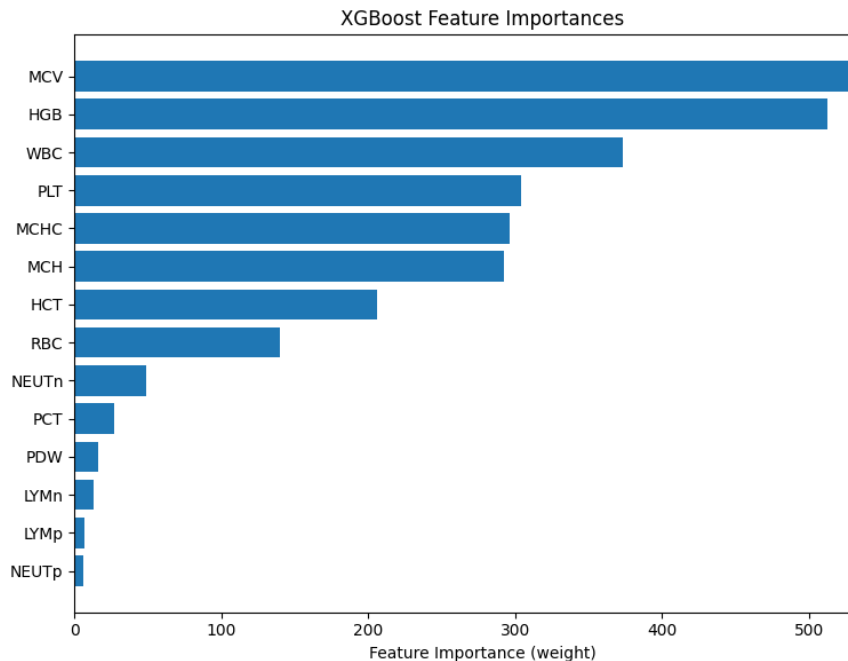
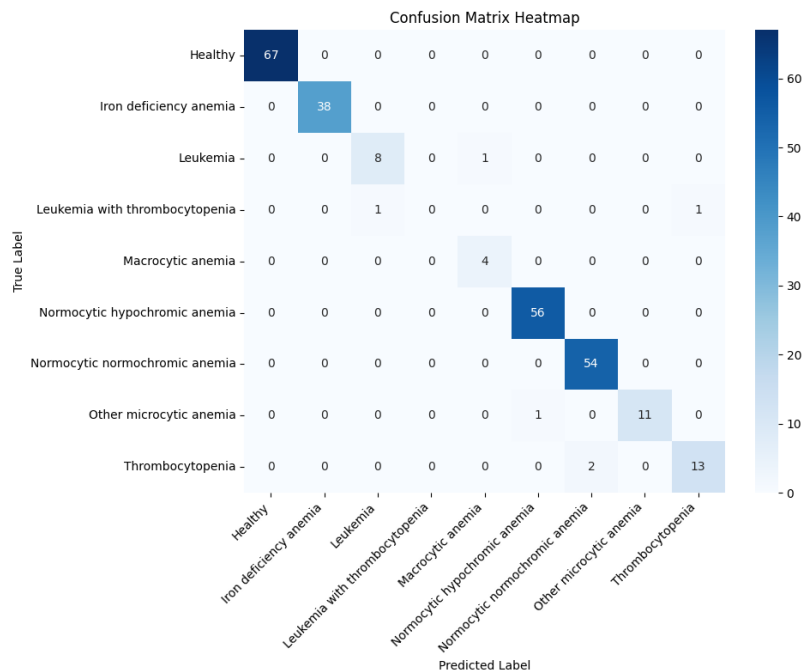


# Results

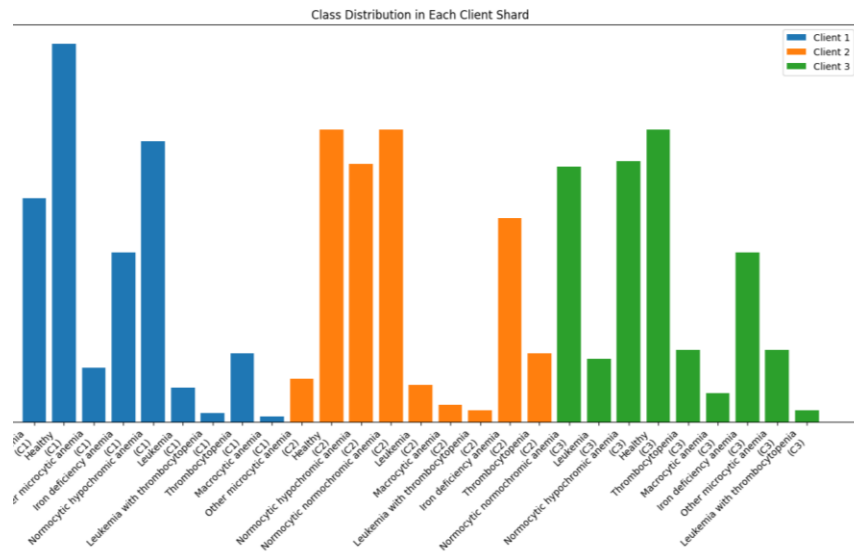
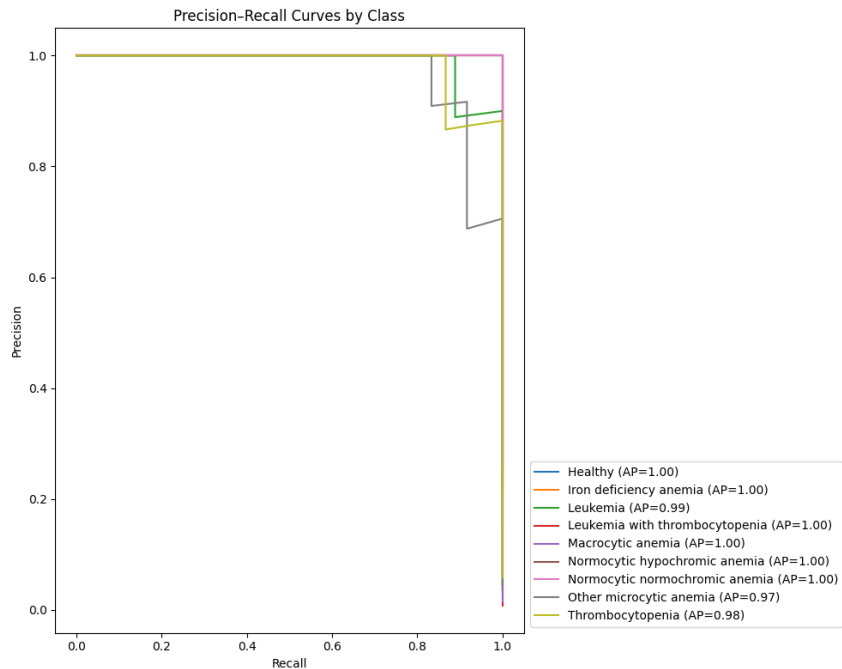
- Small datasets (limited diseases):
  - Accuracy > 97% after 1 round.
  - Accuracy > 99% after 2 rounds.
- Large datasets (more diverse diseases):
  - Accuracy between 82–86% after 5 rounds.
  - Federated model shows strong convergence behavior.
  - Slight drop in accuracy with complex datasets due to greater disease variety.
  - Maintained strong, clinically useful predictive performance.



# Results Visualization P1 (Small Dataset)



# Results Visualization P2 (Small Dataset)



# Challenges Encountered

## Data availability and quality:

Limited access to free, high-quality medical datasets.

Significant time spent finding and cleaning data suitable for training.

## Technical challenges:

Needed major revisions after first project proposal.

Implemented parallelism between agents to improve realism and efficiency.

## Federated learning simulation:

Designing meaningful client splits and model aggregation.

## Balancing research and project scope:

Some advanced goals like CNN integration and self-learning were deferred.



# Future Work and Reflection

- Future Enhancements:
  - Expand to cover more diseases and complex diagnostic cases.
  - Implement secure aggregation techniques for real-world federated learning.
  - Validate system across external hospital datasets.
  - Integrate more advanced models (e.g., CNNs, ensemble learning).
- Reflection:
  - Gained real-world research experience balancing theory and practice.
  - Strengthened skills in system design, machine learning, and project management.
  - Inspired to pursue graduate studies in AI and healthcare applications.
  - Grateful for the opportunity provided by UROP and Dr. Maria Gini's mentorship.



# Thank You



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