

MDAgent Document.

Absolutely! I'd be glad to help you design a multi-agent AI system. To get started, I'll need some details about your requirements and goals for the system. Here are some questions to guide us:

### **A Purpose and Goals:**

- What is the primary goal of the system? (e.g., customer support, resource optimization, content generation)
- Are there specific problems or tasks you want the agents to solve?

Let's analyze the purpose and goals of the **Medical Decision-Making Agents (MDAgents) framework** based on the content provided. Here's a breakdown to address your questions:

### **Primary Goal of the System**

The primary goal of the **MDAgents framework** is to **assist in medical decision-making** by processing medical queries and performing the following steps:

1. **Medical Complexity Check**
2. **Recruitment of appropriate teams**
3. **Analysis and Synthesis** of data
4. **Final Decision** for solving medical problems.

This system is particularly designed to **manage complexity** by distributing cases to the appropriate levels of expertise (e.g., Primary Care Clinicians, Multidisciplinary Teams, or Integrated Care Teams).

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### **Specific Problems or Tasks the Agents Solve**

1. **Handling Medical Queries:**  
The system interprets diverse medical queries involving **diagnosis, differential diagnosis, and reasoning** using medical knowledge.
2. **Complexity Check:**  
The system determines the complexity of a medical case (low, moderate, or high).
  - **Low Complexity:** A Primary Care Clinician (PCC) handles simpler tasks.
  - **Moderate Complexity:** A Multidisciplinary Team (MDT) collaboratively discusses the case.
  - **High Complexity:** An Integrated Care Team (ICT) performs deep analysis and generates detailed reports.

### 3. Medical Problem Solving:

Examples of tasks include:

- Determining a correct diagnosis for a patient.
  - Prioritizing possible differential diagnoses.
  - Reasoning through complex, multi-modal information like imaging and pathology results.
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### B. Agents' Roles:

- Do you already have an idea of the types of agents you want in the system? (e.g., a recommendation agent, a data analysis agent, etc.)
- Should the agents specialize in different tasks, or would you like redundancy for resilience?

Let's align the **agents' roles** based on the **MDAgents framework** presented in the diagram and provided materials.

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## Types of Agents in the System

The framework already implies a multi-agent setup where agents handle different levels of complexity and tasks. Here's a breakdown:

### 1. Primary Care Clinician (PCC) Agent:

- Role: Handles **low-complexity** cases.
- Task: Provides **direct answers** to straightforward medical queries using basic medical knowledge and prompting.

### 2. Multidisciplinary Team (MDT) Agent:

- Role: Solves **moderate-complexity** cases through **collaborative discussion**.
- Task: Involves multiple agents interacting to analyze medical queries and exchange ideas (M-turns and N-rounds).

### 3. Integrated Care Team (ICT) Agent:

- Role: Focuses on **high-complexity** cases requiring advanced reasoning.

- Task: Performs **in-depth analysis**, generates detailed **reports**, and synthesizes findings across specialized agents or teams.
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## Specialization vs. Redundancy

- **Specialization:**

- Agents should specialize in specific tasks based on case complexity (e.g., PCC for simple cases, MDT for discussions, ICT for deep analysis).
- This specialization ensures efficiency and faster decision-making.

- **Redundancy for Resilience:**

- For **high-risk or critical cases**, you might introduce **redundancy** in the system where multiple agents cross-check solutions to minimize errors.
  - This would ensure resilience and reliability in medical decisions.
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## Suggested Agent Roles

To summarize, the roles can be:

1. **Recommendation Agent:** Suggests initial diagnoses or actions for low-complexity cases.
2. **Collaboration Agent:** Facilitates discussions among MDT agents.
3. **Data Analysis Agent:** Processes imaging, pathology, and other multi-modal data for complex cases.
4. **Report Generation Agent:** Synthesizes findings and generates detailed reports for ICT-level cases.

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## C. Target Audience and Environment:

- Who will use this system, and in what context? (e.g., internal business tools, end-user services, automation systems)
- Is the system operating in real-time, batch processing, or another mode?

Let's determine the **target audience** and **operating environment** based on the **MDAgents framework** materials provided.

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## Target Audience

The system is designed for **healthcare professionals** and teams in a **clinical or medical environment**. Specifically:

1. **Primary Care Clinicians (PCC):**

- Handle simple, low-complexity cases.
- Likely to use this system as an **internal diagnostic tool** for rapid decision-making.

2. **Multidisciplinary Teams (MDT):**

- Consist of specialists collaborating to solve moderate-complexity cases.
- Use the system for **collaborative discussions** and cross-disciplinary input.

3. **Integrated Care Teams (ICT):**

- A team of experts handling highly complex cases.
  - Utilize the system for **data analysis, report generation, and synthesis** of findings.
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## Context of Use

● **Clinical Decision Support:**

- The system serves as a **decision-support tool** in hospitals, clinics, or other healthcare settings.
- It processes medical queries to aid diagnosis, differential diagnosis, and reasoning.

● **Internal Medical Tools:**

- The system functions as an **internal tool** for doctors, specialists, and care teams rather than end-users (patients).
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## Operating Mode

1. **Real-Time Processing:**

- For low-complexity cases handled by PCC agents, the system likely provides **immediate prompts or suggestions** in real time.

2. **Near Real-Time Collaboration:**

- Moderate-complexity cases require interaction among MDT agents. This would involve near real-time discussions (M-turns and N-rounds).
3. **Batch Processing for High-Complexity Cases:**

- High-complexity cases processed by ICT agents involve:
    - **In-depth analysis of data** (e.g., imaging, pathology).
    - **Report generation**, which could operate in a **batch processing mode** due to the complexity of data synthesis.
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## Summary

- **Target Audience:** Healthcare professionals (PCC, MDT, ICT) in clinical settings.
- **Context:** Internal tools for medical decision-making and collaborative problem-solving.
- **Operating Mode:**
  - Real-time for simple tasks.
  - Near real-time for collaboration.
  - Batch processing for complex data analysis and reporting.

Does this match your understanding, or would you like me to clarify further on any point?

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## D. Data and Resources:

- What kind of data will the agents work with? (e.g., text, images, structured data)
- Do the agents need access to external APIs or databases?

Let's define the **data and resources** that the agents will work with, based on the **MDAgents framework** and your query.

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## Types of Data

The agents will work with various types of medical data depending on the case complexity and the level of reasoning required:

### 1. Text Data:

- Medical histories, symptoms, and notes (e.g., "19-year-old male with hypopigmented skin...").
- Differential diagnosis lists (e.g., probabilities for PSVT, anemia, etc.).
- Clinical descriptions and reasoning prompts.

## 2. Image Data:

- Medical images such as X-rays, pathology slides, or MRIs.
- Example in the diagram: Circle on an image requiring reasoning about “abnormal mitotic figures.”

## 3. Structured Data:

- Probabilities and numerical data for differential diagnosis (e.g., PSVT: 0.22, Panic attack: 0.14).
- Lab results, vitals, and pathology metrics, likely in tabular formats.

## 4. Multi-Modal Data:

- A combination of text, images, and structured data for complex cases requiring advanced reasoning.

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## Access to External APIs or Databases

Yes, agents will likely require access to external systems for:

### 1. Medical Knowledge Bases:

- APIs for clinical guidelines, diagnostic pathways, and up-to-date medical research (e.g., **PubMed**, medical ontologies).

### 2. Electronic Health Records (EHR):

- To retrieve patient history, lab results, and past diagnoses.

### 3. Imaging Databases:

- Access to medical imaging systems (e.g., PACS systems for radiology).

### 4. Decision Support Tools:

- External APIs for clinical calculators, medical risk scoring, or AI-assisted image analysis tools.

### 5. Data Storage Systems:

- For storing and retrieving generated reports, collaborative logs, and analysis outputs.

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## Summary

- **Types of Data:** Text, images, structured data, and multi-modal data.
- **Resource Access:** External APIs (medical knowledge, imaging tools) and databases (EHRs, structured data repositories).

## E. Integration and Communication:

- Should the agents communicate with each other, and if so, how? (e.g., message-passing, shared memory, hierarchical coordination)
- Will they need to interact with other systems or human users?

Let's align the **integration and communication** strategies for the agents based on the **MDAgents framework**.

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## Agent-to-Agent Communication

Yes, the agents need to communicate with each other to manage **different levels of complexity** effectively. The communication can follow these patterns:

### 1. Hierarchical Coordination:

- Agents operate at different complexity levels (PCC → MDT → ICT).
- **Low-complexity queries** are first handled by the **Primary Care Clinician (PCC)** agent.
- If unresolved, the query is escalated to the **Multidisciplinary Team (MDT)** agents, who collaborate to analyze the problem.
- For **high-complexity cases**, the problem is forwarded to the **Integrated Care Team (ICT)** agents, who perform in-depth reasoning and synthesis.

### 2. Flow: PCC → MDT → ICT.

### 3. Collaborative Communication:

- Within the **MDT** and **ICT levels**, agents interact through:
    - **Message-Passing:** Agents exchange diagnostic information, reasoning updates, and insights in **M-turns** and **N-rounds** (as shown in the MDT section).
    - **Shared Logs/Memory:** Collaborative discussions can be recorded in a **shared log** for transparency and future reference.
  - This ensures multiple agents contribute their specialized knowledge to solve complex problems.
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## Interaction with Other Systems

Yes, the agents need to integrate with **external systems** to retrieve and process medical data:

1. **Electronic Health Records (EHRs):**

- Access to patient history, symptoms, vitals, and past diagnoses.

2. **Medical Imaging Systems:**

- Integration with **PACS systems** to analyze radiology images.

3. **Knowledge Databases/APIs:**

- Clinical guidelines, medical ontologies, and diagnostic tools.

4. **Report Storage Systems:**

- Generated reports and analysis logs need to be stored and accessed by healthcare teams.
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## **Interaction with Human Users**

Yes, the system is designed to **assist healthcare professionals**, so human-agent interaction is critical:

1. **Primary Care Clinicians (PCC):**

- Receive direct answers or suggestions for low-complexity cases.

2. **Multidisciplinary Teams (MDT):**

- Collaborate through agents to support clinical decision-making.

3. **Integrated Care Teams (ICT):**

- Review synthesized reports and final decisions from the system.
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## **Summary**

1. **Agent-to-Agent Communication:**

- Hierarchical coordination with message-passing and shared logs/memory.

2. **System Integration:**

- Agents connect to EHRs, imaging systems, and medical knowledge APIs.

3. **Human Interaction:**

- Agents assist clinicians and teams with diagnostic support, collaborative discussions, and final decision synthesis.



## F. Constraints and Requirements:

- Are there any technical, ethical, or regulatory constraints? (e.g., latency limits, privacy concerns, resource restrictions)

Let's address the **constraints and requirements** for the system, focusing on the **MDAgents framework** and its use in a medical context.

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### 1. Technical Constraints

- **Latency Limits:**

- Real-time or near-real-time responses are essential for **low-complexity cases** (PCC).
- For moderate to high-complexity cases (MDT, ICT), a slight delay is acceptable due to collaborative discussions and detailed report generation.

- **Resource Limitations:**

- High-complexity tasks involving **multi-modal data** (e.g., images + text) may require significant computational resources (e.g., GPU processing for imaging).
- Scalability is crucial to handle a growing volume of medical queries.

- **Integration Requirements:**

- Agents need seamless integration with external systems like **EHRs**, imaging tools, and medical APIs.
  - Ensuring compatibility with existing hospital infrastructure and databases is key.
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### 2. Ethical Constraints

- **Patient Privacy and Confidentiality:**

- Compliance with **HIPAA** (in the U.S.) or **GDPR** (in Europe) to protect sensitive patient data.
- Agents must anonymize or encrypt data when transferring or storing patient information.

- **Bias and Fairness:**

- The system should be trained and validated on diverse datasets to avoid biases in diagnosis or recommendations.
- Regular audits are required to ensure fairness across demographic groups.

- **Explainability and Transparency:**

- Clinicians must understand the reasoning behind the agents' decisions (e.g., diagnostic suggestions).
  - Logs or **audit trails** of decision-making processes are essential for accountability.
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### 3. Regulatory Constraints

- **Medical Device Regulations:**

- If the system influences clinical decisions, it may need certification as a **medical device** (e.g., FDA approval in the U.S., CE marking in Europe).

- **Data Handling Compliance:**

- Strict adherence to regulations regarding **storage, transfer, and processing** of medical data.
  - Ensuring data security with robust encryption, access controls, and regular monitoring.
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### Summary

1. **Technical Constraints:**

- Real-time latency for simple cases, computational resources for complex tasks, and smooth system integration.

2. **Ethical Constraints:**

- Ensuring **privacy, fairness, and explainability** while avoiding biases.

3. **Regulatory Constraints:**

- Compliance with **HIPAA/GDPR**, and medical device certification for clinical use.

Once I have this information, I can propose a high-level architecture with specific agent roles, workflows, and communication mechanisms. If you'd like, I can also create diagrams to visually represent the system. Let me know how you'd like to proceed!