

# Lab Title: Build a Multi-Agent System with LangGraph, Tools, and Memory

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## Prerequisites

1. Python 3.9+ environment
2. OpenAI API key (or any LLM like Mistral, Anthropic via LangChain)
3. Install required packages:

```
pip install langgraph langchain openai faiss-cpu duckduckgo-search
```

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## Step 1: Understand the Agent Roles

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- **Planner Agent:** Interprets the user goal and breaks it down into subtasks.
  - **Retriever Agent:** Queries search tools or vector stores to fetch information.
  - **Summarizer Agent:** Synthesizes all retrieved content into a final output.
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## Step 2: Setup the LangGraph Environment

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Create a new Python file (e.g., `multi_agent_langgraph.py`) and import core libraries:

```
from langgraph.graph import StateGraph
from langchain.agents import Tool
from langchain.memory import ConversationBufferMemory
from langchain.chat_models import ChatOpenAI
from langchain.tools import DuckDuckGoSearchRun
from langchain.prompts import PromptTemplate
```

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## Step 3: Create Shared Memory

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```
memory = ConversationBufferMemory(return_messages=True)
```

This memory stores agent interactions, accessible across agents.

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## Step 4: Define Tools for the Retriever

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```
search = DuckDuckGoSearchRun()
search_tool = Tool(
    name="WebSearch",
```

```
        func=search.run,
        description="Useful for answering general knowledge queries"
)
```

You can later expand this with tools like calculator, code executor, vector DBs, etc.

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## Step 5: Define the LLM for Each Agent

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```
llm = ChatOpenAI(temperature=0)
```

This shared LLM instance will be wrapped in each agent function with a specific prompt.

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## Step 6: Define Agent Prompts and Functions

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### Planner Agent

```
from langchain.chains import LLMChain

planner_prompt = PromptTemplate.from_template(
    "You are a planner agent. Break down the task: {input}
    into a list of steps."
)
planner_chain = LLMChain(llm=llm, prompt=planner_prompt)

def planner_node(state):
    steps = planner_chain.run(state["input"])
    return {"planner_output": steps, "step": "retrieve"}
```

### Retriever Agent

```
retriever_prompt = PromptTemplate.from_template(
    "Use the web search to find info on: {planner_output}"
)
retriever_chain = LLMChain(llm=llm, prompt=retriever_prompt)

def retriever_node(state):
    query = state["planner_output"]
    result = search.run(query)
    return {"retrieved_info": result, "step": "summarize"}
```

### Summarizer Agent

```
summarizer_prompt = PromptTemplate.from_template(
    "Summarize the following information for the user: {retrieved_info}"
)
summarizer_chain = LLMChain(llm=llm, prompt=summarizer_prompt)
```

```
def summarizer_node(state):
    final_output = summarizer_chain.run(state["retrieved_info"])
    return {"final_output": final_output, "step": "end"}
```

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## Step 7: Build the LangGraph

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```
graph = StateGraph()
graph.add_node("planner", planner_node)
graph.add_node("retrieve", retriever_node)
graph.add_node("summarize", summarizer_node)

graph.set_entry_point("planner")
graph.add_edge("planner", "retrieve")
graph.add_edge("retrieve", "summarize")
graph.add_edge("summarize", "end")

app = graph.compile()
```

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## Step 8: Run the Multi-Agent System

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```
response = app.invoke({"input": "Tell me what's new about Mars exploration
this month."})
print("\n✓ Final Output:\n", response["final_output"])
```

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## Optional Enhancements

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- Add **Graph memory** to keep track of multi-turn steps
  - Use **LangChain Expression Language (LCEL)** for node logic
  - Integrate **RAG retriever** instead of DuckDuckGo for structured KBs
  - Log each step to build observability into the graph
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## Outcome

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You've now built a **fully functional LangGraph multi-agent pipeline** with:

- Distinct agent roles
  - Web search as a tool
  - Memory buffer across agents
  - Deterministic step-by-step execution
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