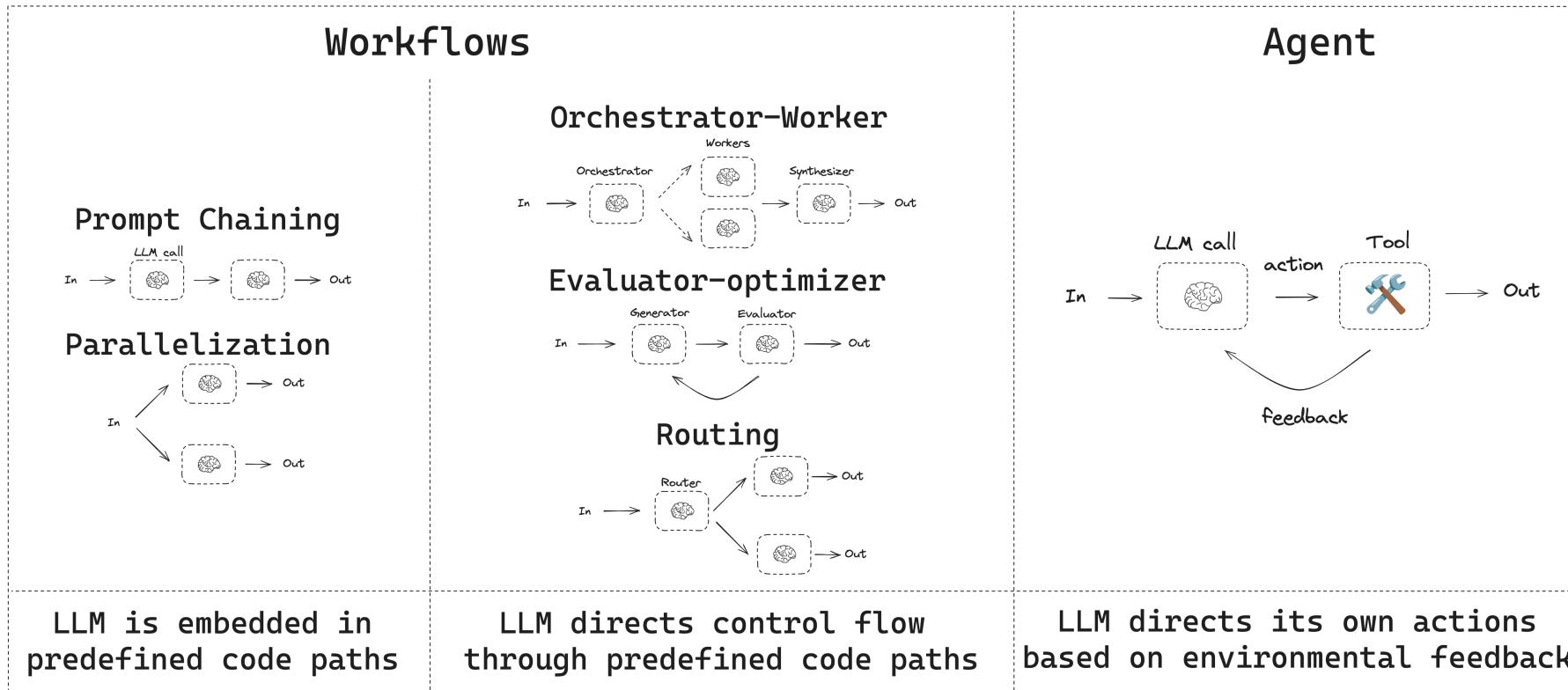


# Workflows and Agents

This guide reviews common patterns for agentic systems. In describing these systems, it can be useful to make a distinction between "workflows" and "agents". One way to think about this difference is nicely explained in Anthropic's [Building Effective Agents](#) blog post:

Workflows are systems where LLMs and tools are orchestrated through predefined code paths. Agents, on the other hand, are systems where LLMs dynamically direct their own processes and tool usage, maintaining control over how they accomplish tasks.

Here is a simple way to visualize these differences:



When building agents and workflows, LangGraph offers a number of benefits including persistence, streaming, and support for debugging as well as deployment.

## Set up

You can use [any chat model](#) that supports structured outputs and tool calling. Below, we show the process of installing the packages, setting API keys, and testing structured outputs / tool calling for Anthropic.

### Install dependencies

```
pip install langchain_core langchain-anthropic langgraph
```

## Initialize an LLM

API Reference: [ChatAnthropic](#)

```
import os
import getpass

from langchain_anthropic import ChatAnthropic

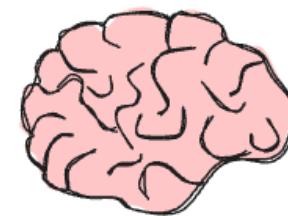
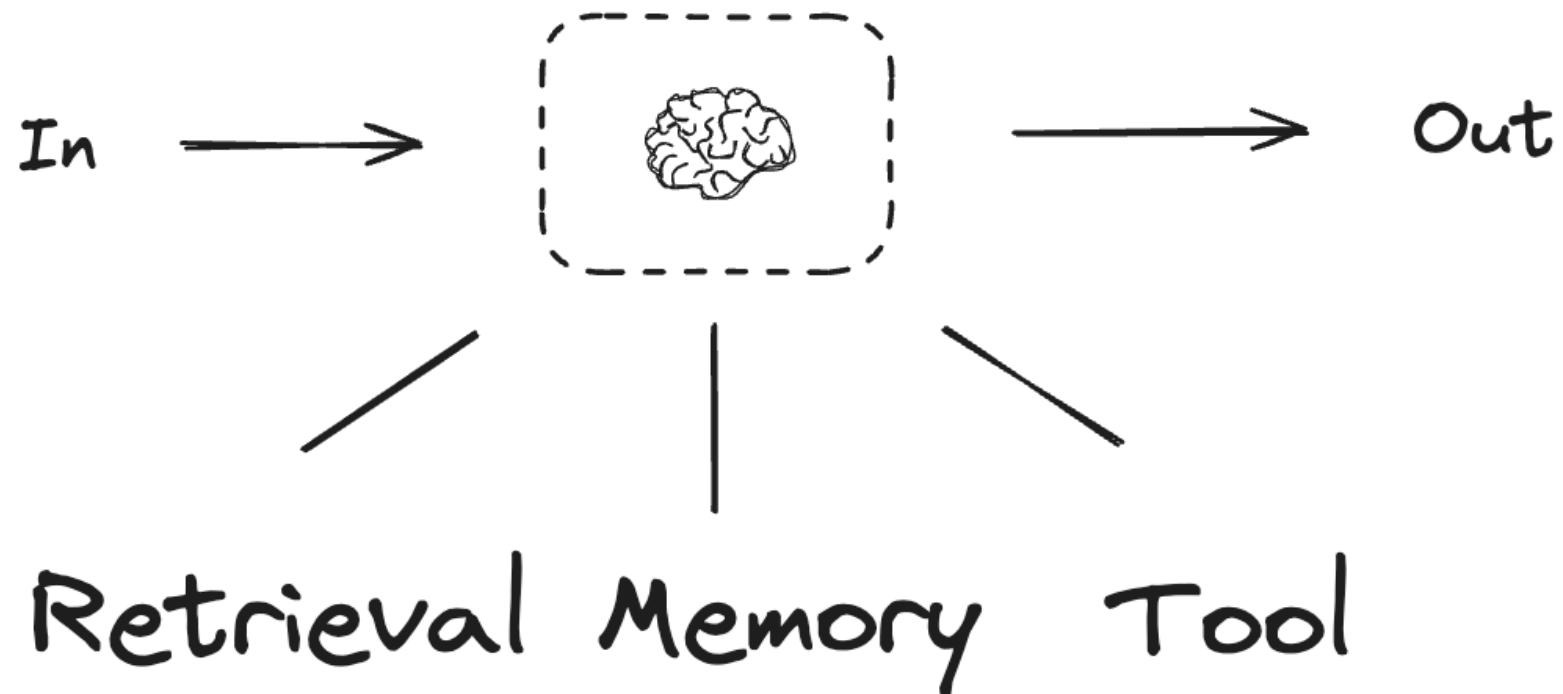
def _set_env(var: str):
    if not os.environ.get(var):
        os.environ[var] = getpass.getpass(f"{var}: ")

_set_env("ANTHROPIC_API_KEY")

llm = ChatAnthropic(model="claude-3-5-sonnet-latest")
```

## Building Blocks: The Augmented LLM

LLM have augmentations that support building workflows and agents. These include structured outputs and tool calling, as shown in this image from the Anthropic blog on [Building Effective Agents](#):



```
# Schema for structured output
from pydantic import BaseModel, Field

class SearchQuery(BaseModel):
    search_query: str = Field(None, description="Query that is optimized web search.")
    justification: str = Field(
        None, description="Why this query is relevant to the user's request."
    )

# Augment the LLM with schema for structured output
structured_llm = llm.with_structured_output(SearchQuery)

# Invoke the augmented LLM
output = structured_llm.invoke("How does Calcium CT score relate to high cholesterol?")

# Define a tool
def multiply(a: int, b: int) -> int:
    return a * b

# Augment the LLM with tools
llm_with_tools = llm.bind_tools([multiply])

# Invoke the LLM with input that triggers the tool call
msg = llm_with_tools.invoke("What is 2 times 3?")

# Get the tool call
msg.tool_calls
```

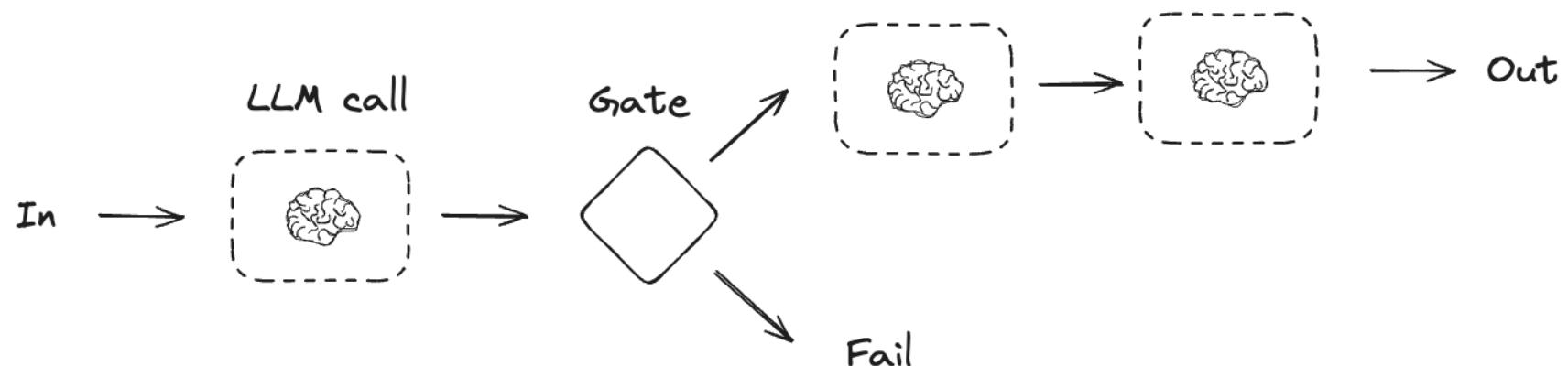
## Prompt chaining

In prompt chaining, each LLM call processes the output of the previous one.

As noted in the Anthropic blog on [Building Effective Agents](#):

Prompt chaining decomposes a task into a sequence of steps, where each LLM call processes the output of the previous one. You can add programmatic checks (see "gate" in the diagram below) on any intermediate steps to ensure that the process is still on track.

When to use this workflow: This workflow is ideal for situations where the task can be easily and cleanly decomposed into fixed subtasks. The main goal is to trade off latency for higher accuracy, by making each LLM call an easier task.



## Graph API

```
from typing_extensions import TypedDict
from langgraph.graph import StateGraph, START, END
from IPython.display import Image, display

# Graph state
```

```
class State(TypedDict):
    topic: str
    joke: str
    improved_joke: str
    final_joke: str

# Nodes
def generate_joke(state: State):
    """First LLM call to generate initial joke"""

    msg = llm.invoke(f"Write a short joke about {state['topic']}")  
    return {"joke": msg.content}

def check_punchline(state: State):
    """Gate function to check if the joke has a punchline"""

    # Simple check - does the joke contain "?" or "!"
    if "?" in state["joke"] or "!" in state["joke"]:
        return "Pass"
    return "Fail"

def improve_joke(state: State):
    """Second LLM call to improve the joke"""

    msg = llm.invoke(f"Make this joke funnier by adding wordplay: {state['joke']}")  
    return {"improved_joke": msg.content}

def polish_joke(state: State):
    """Third LLM call for final polish"""

    msg = llm.invoke(f"Add a surprising twist to this joke: {state['improved_joke']}")  
    return {"final_joke": msg.content}
```

```
# Build workflow
workflow = StateGraph(State)

# Add nodes
workflow.add_node("generate_joke", generate_joke)
workflow.add_node("improve_joke", improve_joke)
workflow.add_node("polish_joke", polish_joke)

# Add edges to connect nodes
workflow.add_edge(START, "generate_joke")
workflow.add_conditional_edges(
    "generate_joke", check_punchline, {"Fail": "improve_joke", "Pass": END}
)
workflow.add_edge("improve_joke", "polish_joke")
workflow.add_edge("polish_joke", END)

# Compile
chain = workflow.compile()

# Show workflow
display(Image(chain.get_graph().draw_mermaid_png()))

# Invoke
state = chain.invoke({"topic": "cats"})
print("Initial joke:")
print(state["joke"])
print("\n--- --- ---\n")
if "improved_joke" in state:
    print("Improved joke:")
    print(state["improved_joke"])
    print("\n--- --- ---\n")

    print("Final joke:")
    print(state["final_joke"])
else:
    print("Joke failed quality gate - no punchline detected!")
```

## LangSmith Trace

<https://smith.langchain.com/public/a0281fca-3a71-46de-beee-791468607b75/r>

### Resources:

#### LangChain Academy

See our lesson on Prompt Chaining [here](#).

#### Functional API

```
from langgraph.func import entrypoint, task

# Tasks
@task
def generate_joke(topic: str):
    """First LLM call to generate initial joke"""
    msg = llm.invoke(f"Write a short joke about {topic}")
    return msg.content

def check_punchline(joke: str):
    """Gate function to check if the joke has a punchline"""
    # Simple check - does the joke contain "?" or "!"
    if "?" in joke or "!" in joke:
        return "Fail"

    return "Pass"

@task
def improve_joke(joke: str):
```

```
"""Second LLM call to improve the joke"""
msg = llm.invoke(f"Make this joke funnier by adding wordplay: {joke}")
return msg.content

@task
def polish_joke(joke: str):
    """Third LLM call for final polish"""
    msg = llm.invoke(f"Add a surprising twist to this joke: {joke}")
    return msg.content

@entrypoint()
def prompt_chaining_workflow(topic: str):
    original_joke = generate_joke(topic).result()
    if check_punchline(original_joke) == "Pass":
        return original_joke

    improved_joke = improve_joke(original_joke).result()
    return polish_joke(improved_joke).result()

# Invoke
for step in prompt_chaining_workflow.stream("cats", stream_mode="updates"):
    print(step)
    print("\n")
```

## LangSmith Trace

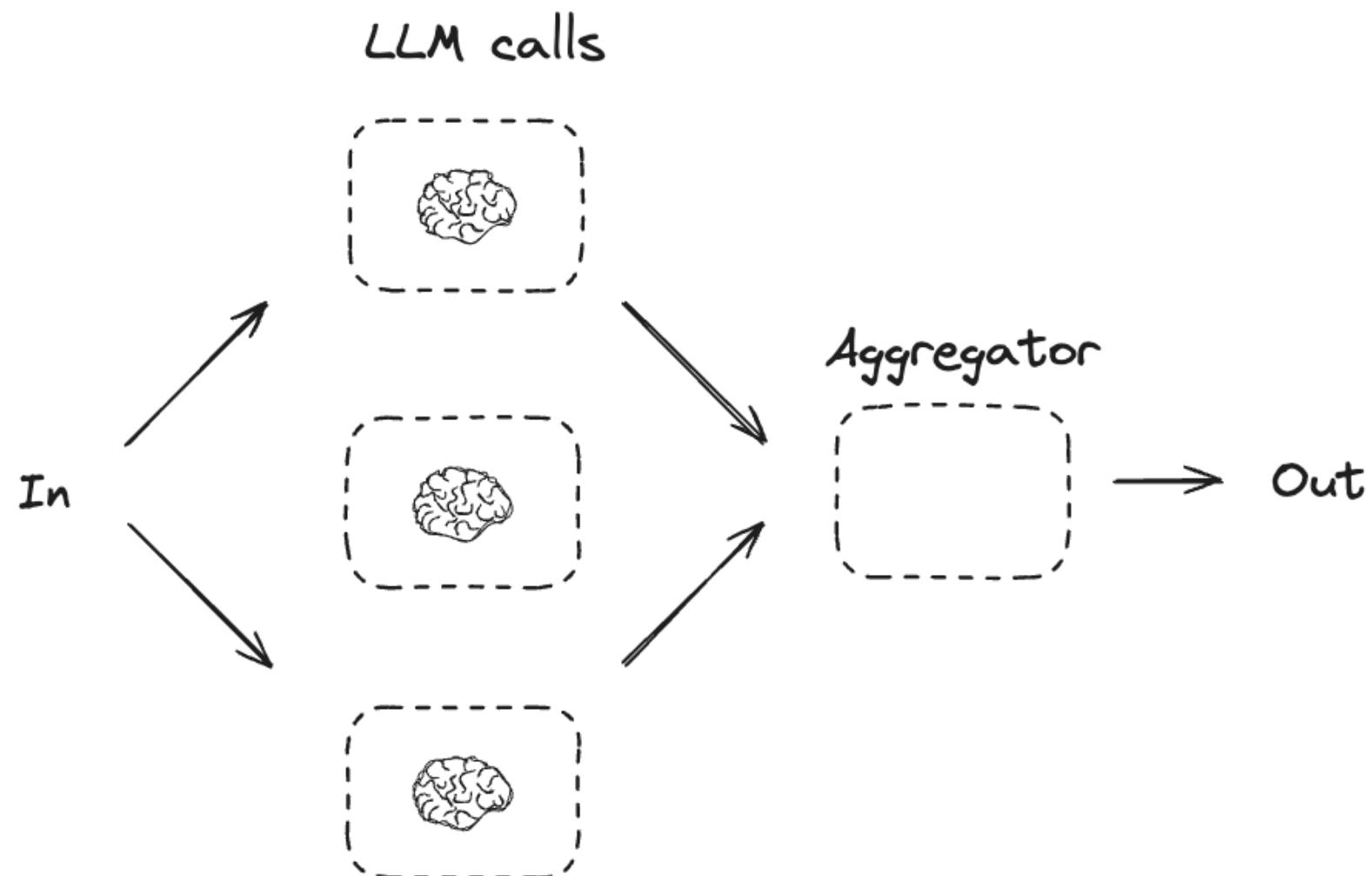
<https://smith.langchain.com/public/332fa4fc-b6ca-416e-baa3-161625e69163/r>

## Parallelization

With parallelization, LLMs work simultaneously on a task:

LLMs can sometimes work simultaneously on a task and have their outputs aggregated programmatically. This workflow, parallelization, manifests in two key variations: Sectioning: Breaking a task into independent subtasks run in parallel. Voting: Running the same task multiple times to get diverse outputs.

When to use this workflow: Parallelization is effective when the divided subtasks can be parallelized for speed, or when multiple perspectives or attempts are needed for higher confidence results. For complex tasks with multiple considerations, LLMs generally perform better when each consideration is handled by a separate LLM call, allowing focused attention on each specific aspect.



## Graph API

```
# Graph state
class State(TypedDict):
    topic: str
    joke: str
    story: str
    poem: str
    combined_output: str

# Nodes
def call_llm_1(state: State):
    """First LLM call to generate initial joke"""

    msg = llm.invoke(f"Write a joke about {state['topic']}")  

    return {"joke": msg.content}

def call_llm_2(state: State):
    """Second LLM call to generate story"""

    msg = llm.invoke(f"Write a story about {state['topic']}")  

    return {"story": msg.content}

def call_llm_3(state: State):
    """Third LLM call to generate poem"""

    msg = llm.invoke(f"Write a poem about {state['topic']}")  

    return {"poem": msg.content}

def aggregator(state: State):
    """Combine the joke and story into a single output"""

    state["combined_output"] = state["joke"] + state["story"] + state["poem"]
```

```
combined = f"Here's a story, joke, and poem about {state['topic']}!\n\n"
combined += f"STORY:\n{state['story']}\n\n"
combined += f"JOKE:\n{state['joke']}\n\n"
combined += f"POEM:\n{state['poem']}"
return {"combined_output": combined}

# Build workflow
parallel_builder = StateGraph(State)

# Add nodes
parallel_builder.add_node("call_llm_1", call_llm_1)
parallel_builder.add_node("call_llm_2", call_llm_2)
parallel_builder.add_node("call_llm_3", call_llm_3)
parallel_builder.add_node("aggregator", aggregator)

# Add edges to connect nodes
parallel_builder.add_edge(START, "call_llm_1")
parallel_builder.add_edge(START, "call_llm_2")
parallel_builder.add_edge(START, "call_llm_3")
parallel_builder.add_edge("call_llm_1", "aggregator")
parallel_builder.add_edge("call_llm_2", "aggregator")
parallel_builder.add_edge("call_llm_3", "aggregator")
parallel_builder.add_edge("aggregator", END)
parallel_workflow = parallel_builder.compile()

# Show workflow
display(Image(parallel_workflow.get_graph().draw_mermaid_png()))

# Invoke
state = parallel_workflow.invoke({"topic": "cats"})
print(state["combined_output"])
```

### LangSmith Trace

<https://smith.langchain.com/public/3be2e53c-ca94-40dd-934f-82ff87fac277/>

## Resources:

### Documentation

See our documentation on parallelization [here](#).

### LangChain Academy

See our lesson on parallelization [here](#).

### Functional API

```
@task
def call_llm_1(topic: str):
    """First LLM call to generate initial joke"""
    msg = llm.invoke(f"Write a joke about {topic}")
    return msg.content

@task
def call_llm_2(topic: str):
    """Second LLM call to generate story"""
    msg = llm.invoke(f"Write a story about {topic}")
    return msg.content

@task
def call_llm_3(topic):
    """Third LLM call to generate poem"""
    msg = llm.invoke(f"Write a poem about {topic}")
    return msg.content
```

```
@task
def aggregator(topic, joke, story, poem):
    """Combine the joke and story into a single output"""

    combined = f"Here's a story, joke, and poem about {topic}!\n\n"
    combined += f"STORY:{story}\n\n"
    combined += f"JOKE:{joke}\n\n"
    combined += f"POEM:{poem}"
    return combined

# Build workflow
@entrypoint()
def parallel_workflow(topic: str):
    joke_fut = call_llm_1(topic)
    story_fut = call_llm_2(topic)
    poem_fut = call_llm_3(topic)
    return aggregator(
        topic, joke_fut.result(), story_fut.result(), poem_fut.result()
    ).result()

# Invoke
for step in parallel_workflow.stream("cats", stream_mode="updates"):
    print(step)
    print("\n")
```

## LangSmith Trace

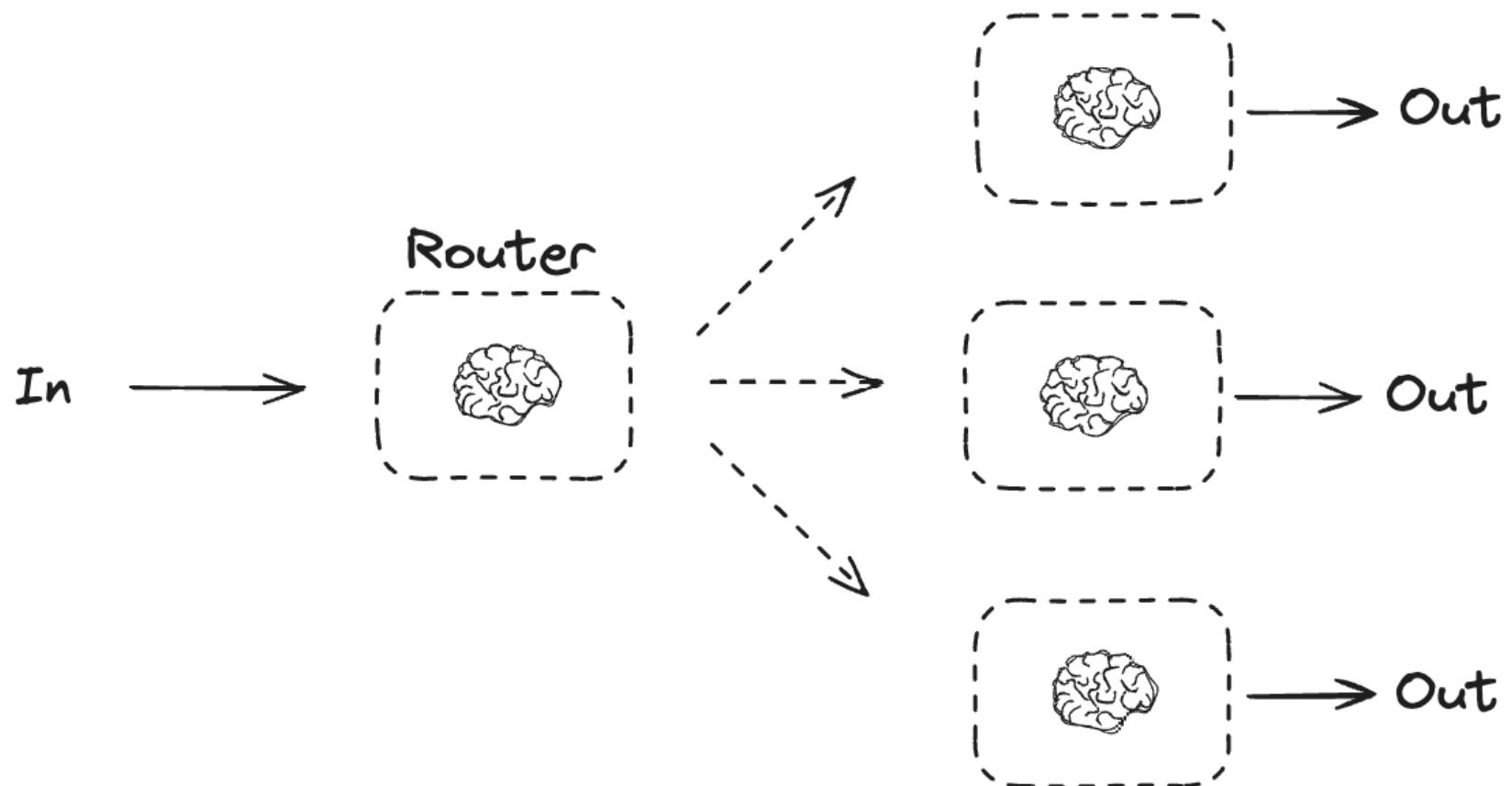
<https://smith.langchain.com/public/623d033f-e814-41e9-80b1-75e6abb67801/r>

## Routing

Routing classifies an input and directs it to a followup task. As noted in the Anthropic blog on [Building Effective Agents](#):

Routing classifies an input and directs it to a specialized followup task. This workflow allows for separation of concerns, and building more specialized prompts. Without this workflow, optimizing for one kind of input can hurt performance on other inputs.

When to use this workflow: Routing works well for complex tasks where there are distinct categories that are better handled separately, and where classification can be handled accurately, either by an LLM or a more traditional classification model/algorithm.



### Graph API

```
from typing_extensions import Literal
```

```
from langchain_core.messages import HumanMessage, SystemMessage

# Schema for structured output to use as routing logic
class Route(BaseModel):
    step: Literal["poem", "story", "joke"] = Field(
        None, description="The next step in the routing process"
    )

# Augment the LLM with schema for structured output
router = llm.with_structured_output(Route)

# State
class State(TypedDict):
    input: str
    decision: str
    output: str

# Nodes
def llm_call_1(state: State):
    """Write a story"""

    result = llm.invoke(state["input"])
    return {"output": result.content}

def llm_call_2(state: State):
    """Write a joke"""

    result = llm.invoke(state["input"])
    return {"output": result.content}

def llm_call_3(state: State):
```

```
"""Write a poem"""

result = llm.invoke(state["input"])
return {"output": result.content}

def llm_call_router(state: State):
    """Route the input to the appropriate node"""

    # Run the augmented LLM with structured output to serve as routing logic
    decision = router.invoke(
        [
            SystemMessage(
                content="Route the input to story, joke, or poem based on the user's request."
            ),
            HumanMessage(content=state["input"]),
        ]
    )

    return {"decision": decision.step}

# Conditional edge function to route to the appropriate node
def route_decision(state: State):
    # Return the node name you want to visit next
    if state["decision"] == "story":
        return "llm_call_1"
    elif state["decision"] == "joke":
        return "llm_call_2"
    elif state["decision"] == "poem":
        return "llm_call_3"

# Build workflow
router_builder = StateGraph(State)

# Add nodes
```

```
router_builder.add_node("llm_call_1", llm_call_1)
router_builder.add_node("llm_call_2", llm_call_2)
router_builder.add_node("llm_call_3", llm_call_3)
router_builder.add_node("llm_call_router", llm_call_router)

# Add edges to connect nodes
router_builder.add_edge(START, "llm_call_router")
router_builder.add_conditional_edges(
    "llm_call_router",
    route_decision,
    { # Name returned by route_decision : Name of next node to visit
        "llm_call_1": "llm_call_1",
        "llm_call_2": "llm_call_2",
        "llm_call_3": "llm_call_3",
    },
)
router_builder.add_edge("llm_call_1", END)
router_builder.add_edge("llm_call_2", END)
router_builder.add_edge("llm_call_3", END)

# Compile workflow
router_workflow = router_builder.compile()

# Show the workflow
display(Image(router_workflow.get_graph().draw_mermaid_png()))

# Invoke
state = router_workflow.invoke({"input": "Write me a joke about cats"})
print(state["output"])
```

## LangSmith Trace

<https://smith.langchain.com/public/c4580b74-fe91-47e4-96fe-7fac598d509c/r>

## Resources:

## LangChain Academy

See our lesson on routing [here](#).

### Examples

[Here](#) is RAG workflow that routes questions. See our video [here](#).

#### Functional API

```
from typing_extensions import Literal
from pydantic import BaseModel
from langchain_core.messages import HumanMessage, SystemMessage

# Schema for structured output to use as routing logic
class Route(BaseModel):
    step: Literal["poem", "story", "joke"] = Field(
        None, description="The next step in the routing process"
    )

# Augment the LLM with schema for structured output
router = llm.with_structured_output(Route)

@task
def llm_call_1(input_: str):
    """Write a story"""
    result = llm.invoke(input_)
    return result.content

@task
def llm_call_2(input_: str):
```

```
"""Write a joke"""
result = llm.invoke(input_)
return result.content

@task
def llm_call_3(input_: str):
    """Write a poem"""
    result = llm.invoke(input_)
    return result.content

def llm_call_router(input_: str):
    """Route the input to the appropriate node"""
    # Run the augmented LLM with structured output to serve as routing logic
    decision = router.invoke(
        [
            SystemMessage(
                content="Route the input to story, joke, or poem based on the user's request."
            ),
            HumanMessage(content=input_),
        ]
    )
    return decision.step

# Create workflow
@entrypoint()
def router_workflow(input_: str):
    next_step = llm_call_router(input_)
    if next_step == "story":
        llm_call = llm_call_1
    elif next_step == "joke":
        llm_call = llm_call_2
    elif next_step == "poem":
        llm_call = llm_call_3
```

```
    return llm_call(input_).result()

# Invoke
for step in router_workflow.stream("Write me a joke about cats", stream_mode="updates"):
    print(step)
    print("\n")
```

### LangSmith Trace

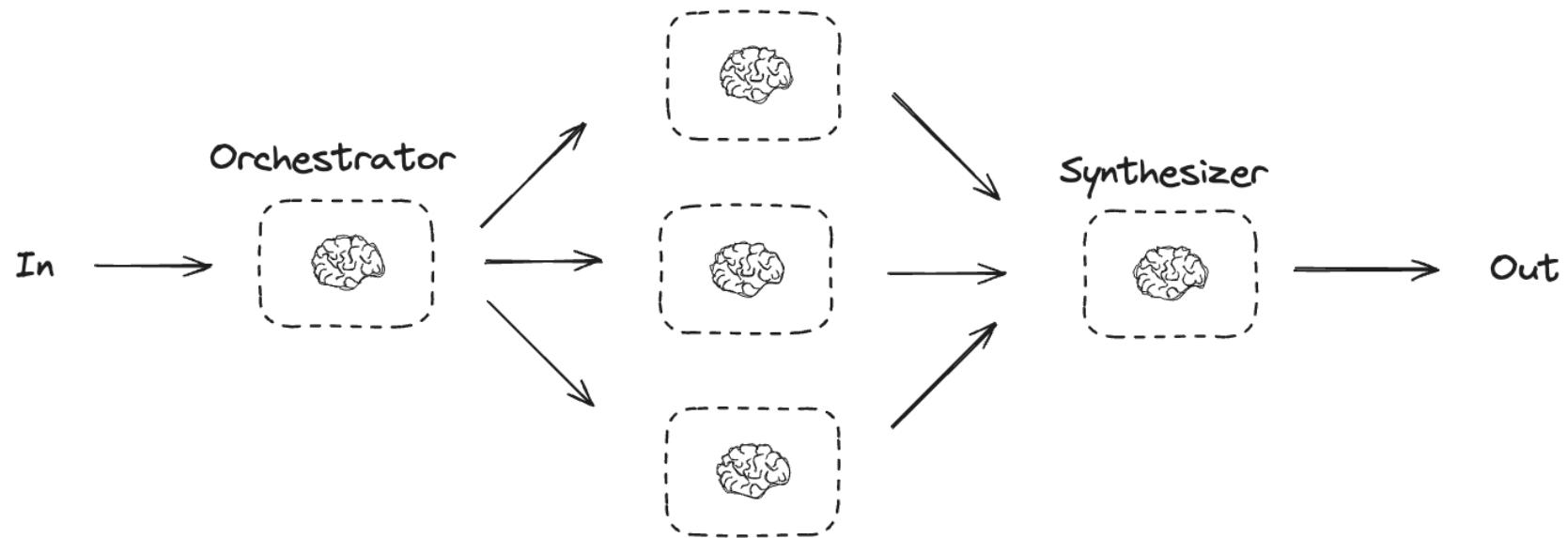
<https://smith.langchain.com/public/5e2eb979-82dd-402c-b1a0-a8cceaf2a28a/r>

## Orchestrator-Worker

With orchestrator-worker, an orchestrator breaks down a task and delegates each sub-task to workers. As noted in the Anthropic blog on [Building Effective Agents](#):

In the orchestrator-workers workflow, a central LLM dynamically breaks down tasks, delegates them to worker LLMs, and synthesizes their results.

When to use this workflow: This workflow is well-suited for complex tasks where you can't predict the subtasks needed (in coding, for example, the number of files that need to be changed and the nature of the change in each file likely depend on the task). Whereas it's topographically similar, the key difference from parallelization is its flexibility — subtasks aren't pre-defined, but determined by the orchestrator based on the specific input.



### Graph API

```
from typing import Annotated, List
import operator

# Schema for structured output to use in planning
class Section(BaseModel):
    name: str = Field(
        description="Name for this section of the report.",
    )
    description: str = Field(
        description="Brief overview of the main topics and concepts to be covered in this section.",
    )
```

```
class Sections(BaseModel):
    sections: List[Section] = Field(
        description="Sections of the report.",
    )

# Augment the LLM with schema for structured output
planner = llm.with_structured_output(Sections)
```

## Creating Workers in LangGraph

Because orchestrator-worker workflows are common, LangGraph **has the `Send` API to support this**. It lets you dynamically create worker nodes and send each one a specific input. Each worker has its own state, and all worker outputs are written to a *shared state* key that is accessible to the orchestrator graph. This gives the orchestrator access to all worker output and allows it to synthesize them into a final output. As you can see below, we iterate over a list of sections and `Send` each to a worker node. See further documentation [here](#) and [here](#).

```
from langgraph.types import Send

# Graph state
class State(TypedDict):
    topic: str # Report topic
    sections: list[Section] # List of report sections
    completed_sections: Annotated[
        list, operator.add
    ] # All workers write to this key in parallel
    final_report: str # Final report

# Worker state
class WorkerState(TypedDict):
    section: Section
    completed_sections: Annotated[list, operator.add]
```

```
# Nodes
def orchestrator(state: State):
    """Orchestrator that generates a plan for the report"""

    # Generate queries
    report_sections = planner.invoke(
        [
            SystemMessage(content="Generate a plan for the report."),
            HumanMessage(content=f"Here is the report topic: {state['topic']}"),
        ]
    )

    return {"sections": report_sections.sections}

def llm_call(state: WorkerState):
    """Worker writes a section of the report"""

    # Generate section
    section = llm.invoke(
        [
            SystemMessage(
                content="Write a report section following the provided name and description. Include no preamble for each section. Use markdown formatting."
            ),
            HumanMessage(
                content=f"Here is the section name: {state['section'].name} and description: {state['section'].description}"
            ),
        ]
    )

    # Write the updated section to completed sections
    return {"completed_sections": [section.content]}
```

```
def synthesizer(state: State):
    """Synthesize full report from sections"""

    # List of completed sections
    completed_sections = state["completed_sections"]

    # Format completed section to str to use as context for final sections
    completed_report_sections = "\n\n---\n\n".join(completed_sections)

    return {"final_report": completed_report_sections}

# Conditional edge function to create llm_call workers that each write a section of the report
def assign_workers(state: State):
    """Assign a worker to each section in the plan"""

    # Kick off section writing in parallel via Send() API
    return [Send("llm_call", {"section": s}) for s in state["sections"]]

# Build workflow
orchestrator_worker_builder = StateGraph(State)

# Add the nodes
orchestrator_worker_builder.add_node("orchestrator", orchestrator)
orchestrator_worker_builder.add_node("llm_call", llm_call)
orchestrator_worker_builder.add_node("synthesizer", synthesizer)

# Add edges to connect nodes
orchestrator_worker_builder.add_edge(START, "orchestrator")
orchestrator_worker_builder.add_conditional_edges(
    "orchestrator", assign_workers, ["llm_call"])
)
orchestrator_worker_builder.add_edge("llm_call", "synthesizer")
orchestrator_worker_builder.add_edge("synthesizer", END)

# Compile the workflow
```

```
orchestrator_worker = orchestrator_worker_builder.compile()

# Show the workflow
display(Image(orchestrator_worker.get_graph().draw_mermaid_png()))

# Invoke
state = orchestrator_worker.invoke({"topic": "Create a report on LLM scaling laws"})

from IPython.display import Markdown
Markdown(state["final_report"])
```

## LangSmith Trace

<https://smith.langchain.com/public/78cbcfc3-38bf-471d-b62a-b299b144237d/r>

### Resources:

#### LangChain Academy

See our lesson on orchestrator-worker [here](#).

### Examples

[Here](#) is a project that uses orchestrator-worker for report planning and writing. See our video [here](#).

### Functional API

```
from typing import List

# Schema for structured output to use in planning
class Section(BaseModel):
    name: str = Field(
        description="Name for this section of the report.",
```

```
)  
description: str = Field(  
    description="Brief overview of the main topics and concepts to be covered in this section.",  
)  
  
class Sections(BaseModel):  
    sections: List[Section] = Field(  
        description="Sections of the report.",  
)  
  
# Augment the LLM with schema for structured output  
planner = llm.with_structured_output(Sections)  
  
@task  
def orchestrator(topic: str):  
    """Orchestrator that generates a plan for the report"""  
    # Generate queries  
    report_sections = planner.invoke(  
        [  
            SystemMessage(content="Generate a plan for the report."),  
            HumanMessage(content=f"Here is the report topic: {topic}"),  
        ]  
    )  
  
    return report_sections.sections  
  
@task  
def llm_call(section: Section):  
    """Worker writes a section of the report"""  
  
    # Generate section  
    result = llm.invoke(  
        [  
    ]
```

```
        SystemMessage(content="Write a report section."),
        HumanMessage(
            content=f"Here is the section name: {section.name} and description: {section.description}"
        ),
    ]
)

# Write the updated section to completed sections
return result.content

@task
def synthesizer(completed_sections: list[str]):
    """Synthesize full report from sections"""
    final_report = "\n\n---\n\n".join(completed_sections)
    return final_report

@entrypoint()
def orchestrator_worker(topic: str):
    sections = orchestrator(topic).result()
    section_futures = [llm_call(section) for section in sections]
    final_report = synthesizer(
        [section_fut.result() for section_fut in section_futures]
    ).result()
    return final_report

# Invoke
report = orchestrator_worker.invoke("Create a report on LLM scaling laws")
from IPython.display import Markdown
Markdown(report)
```

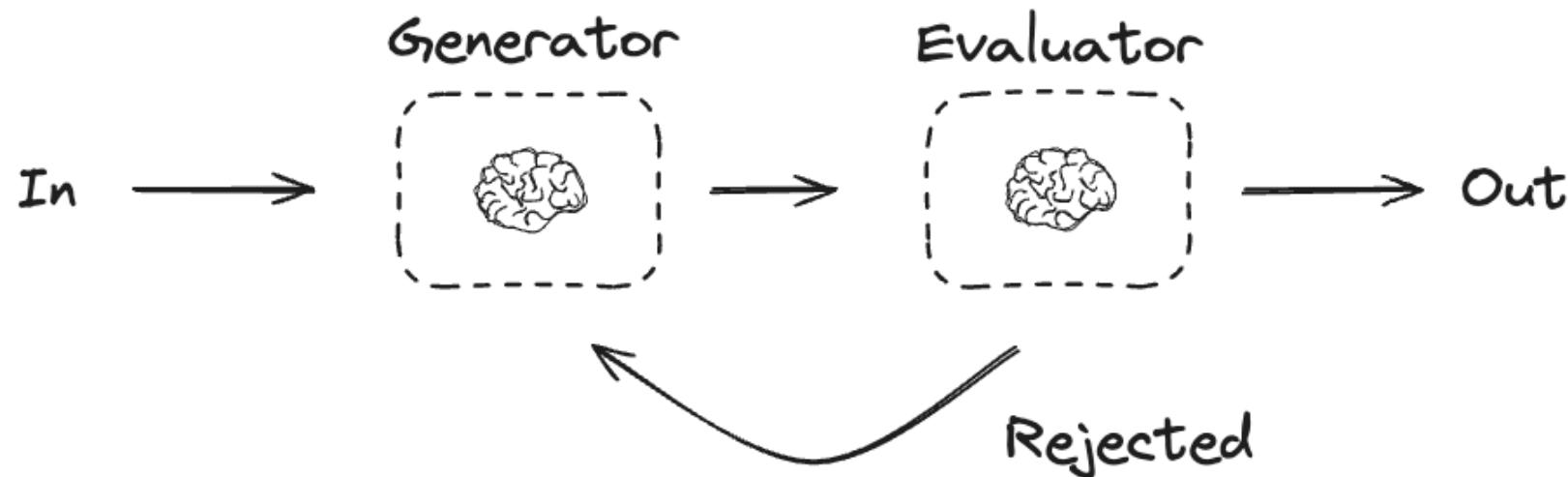
## LangSmith Trace

<https://smith.langchain.com/public/75a636d0-6179-4a12-9836-e0aa571e87c5/>

## Evaluator-optimizer

In the evaluator-optimizer workflow, one LLM call generates a response while another provides evaluation and feedback in a loop:

When to use this workflow: This workflow is particularly effective when we have clear evaluation criteria, and when iterative refinement provides measurable value. The two signs of good fit are, first, that LLM responses can be demonstrably improved when a human articulates their feedback; and second, that the LLM can provide such feedback. This is analogous to the iterative writing process a human writer might go through when producing a polished document.



### Graph API

```
# Graph state
class State(TypedDict):
    joke: str
```

```
topic: str
feedback: str
funny_or_not: str

# Schema for structured output to use in evaluation
class Feedback(BaseModel):
    grade: Literal["funny", "not funny"] = Field(
        description="Decide if the joke is funny or not.",
    )
    feedback: str = Field(
        description="If the joke is not funny, provide feedback on how to improve it.",
    )

# Augment the LLM with schema for structured output
evaluator = llm.with_structured_output(Feedback)

# Nodes
def llm_call_generator(state: State):
    """LLM generates a joke"""

    if state.get("feedback"):
        msg = llm.invoke(
            f"Write a joke about {state['topic']} but take into account the feedback: {state['feedback']}"
        )
    else:
        msg = llm.invoke(f"Write a joke about {state['topic']}")
    return {"joke": msg.content}

def llm_call_evaluator(state: State):
    """LLM evaluates the joke"""

    grade = evaluator.invoke(f"Grade the joke {state['joke']}")
    return {"funny_or_not": grade.grade, "feedback": grade.feedback}
```

```
# Conditional edge function to route back to joke generator or end based upon feedback from the evaluator
def route_joke(state: State):
    """Route back to joke generator or end based upon feedback from the evaluator"""

    if state["funny_or_not"] == "funny":
        return "Accepted"
    elif state["funny_or_not"] == "not funny":
        return "Rejected + Feedback"

# Build workflow
optimizer_builder = StateGraph(State)

# Add the nodes
optimizer_builder.add_node("llm_call_generator", llm_call_generator)
optimizer_builder.add_node("llm_call_evaluator", llm_call_evaluator)

# Add edges to connect nodes
optimizer_builder.add_edge(START, "llm_call_generator")
optimizer_builder.add_edge("llm_call_generator", "llm_call_evaluator")
optimizer_builder.add_conditional_edges(
    "llm_call_evaluator",
    route_joke,
    {
        # Name returned by route_joke : Name of next node to visit
        "Accepted": END,
        "Rejected + Feedback": "llm_call_generator",
    },
)
# Compile the workflow
optimizer_workflow = optimizer_builder.compile()

# Show the workflow
display(Image(optimizer_workflow.get_graph().draw_mermaid_png()))
```

```
# Invoke
state = optimizer_workflow.invoke({"topic": "Cats"})
print(state["joke"])
```

## LangSmith Trace

<https://smith.langchain.com/public/86ab3e60-2000-4bff-b988-9b89a3269789/r>

## Resources:

### Examples

[Here](#) is an assistant that uses evaluator-optimizer to improve a report. See our video [here](#).

[Here](#) is a RAG workflow that grades answers for hallucinations or errors. See our video [here](#).

## Functional API

```
# Schema for structured output to use in evaluation
class Feedback(BaseModel):
    grade: Literal["funny", "not funny"] = Field(
        description="Decide if the joke is funny or not.",
    )
    feedback: str = Field(
        description="If the joke is not funny, provide feedback on how to improve it.",
    )

# Augment the LLM with schema for structured output
evaluator = llm.with_structured_output(Feedback)

# Nodes
@task
```

```
def llm_call_generator(topic: str, feedback: Feedback):
    """LLM generates a joke"""
    if feedback:
        msg = llm.invoke(
            f"Write a joke about {topic} but take into account the feedback: {feedback}"
        )
    else:
        msg = llm.invoke(f"Write a joke about {topic}")
    return msg.content

@task
def llm_call_evaluator(joke: str):
    """LLM evaluates the joke"""
    feedback = evaluator.invoke(f"Grade the joke {joke}")
    return feedback

@entrypoint()
def optimizer_workflow(topic: str):
    feedback = None
    while True:
        joke = llm_call_generator(topic, feedback).result()
        feedback = llm_call_evaluator(joke).result()
        if feedback.grade == "funny":
            break

    return joke

# Invoke
for step in optimizer_workflow.stream("Cats", stream_mode="updates"):
    print(step)
    print("\n")
```

### LangSmith Trace

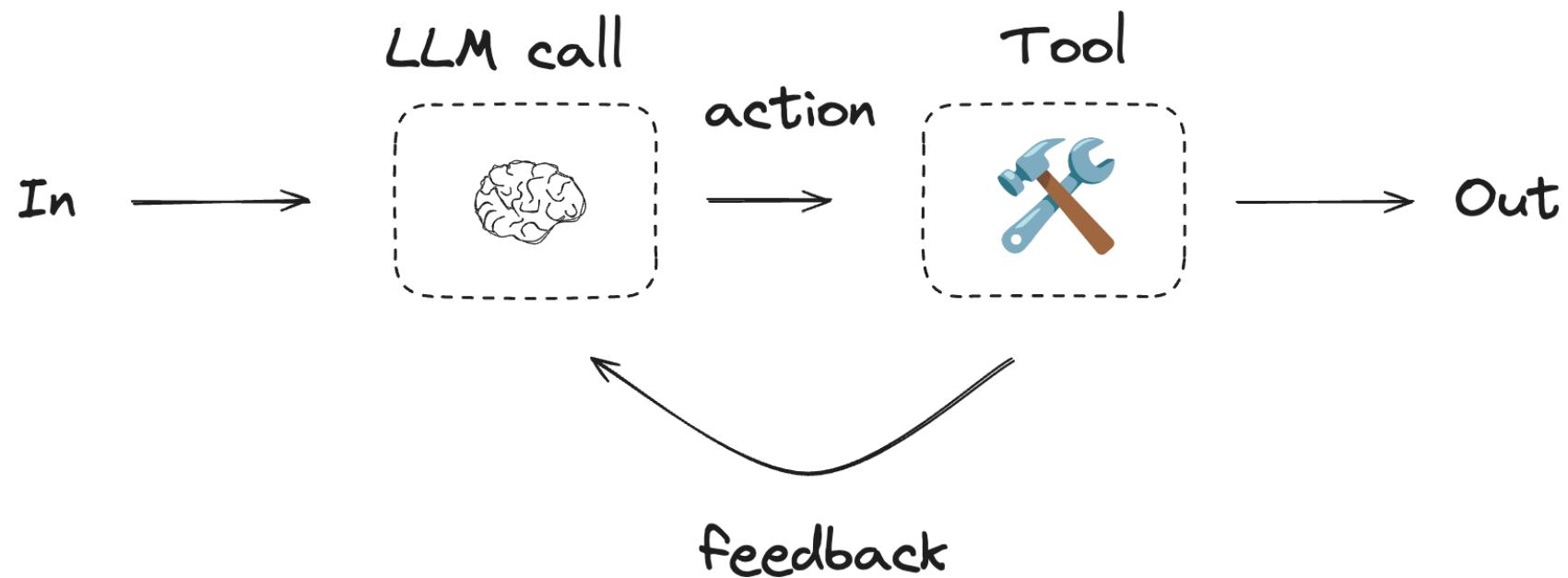
<https://smith.langchain.com/public/f66830be-4339-4a6b-8a93-389ce5ae27b4/r>

## Agent

Agents are typically implemented as an LLM performing actions (via tool-calling) based on environmental feedback in a loop. As noted in the Anthropic blog on Building Effective Agents :

Agents can handle sophisticated tasks, but their implementation is often straightforward. They are typically just LLMs using tools based on environmental feedback in a loop. It is therefore crucial to design toolsets and their documentation clearly and thoughtfully.

When to use agents: Agents can be used for open-ended problems where it's difficult or impossible to predict the required number of steps, and where you can't hardcode a fixed path. The LLM will potentially operate for many turns, and you must have some level of trust in its decision-making. Agents' autonomy makes them ideal for scaling tasks in trusted environments.



API Reference: [tool](#)

```
from langchain_core.tools import tool

# Define tools
@tool
def multiply(a: int, b: int) -> int:
    """Multiply a and b.

Args:
    a: first int
```

```
        b: second int
    """
    return a * b

@tool
def add(a: int, b: int) -> int:
    """Adds a and b.

    Args:
        a: first int
        b: second int
    """
    return a + b

@tool
def divide(a: int, b: int) -> float:
    """Divide a and b.

    Args:
        a: first int
        b: second int
    """
    return a / b

# Augment the LLM with tools
tools = [add, multiply, divide]
tools_by_name = {tool.name: tool for tool in tools}
llm_with_tools = llm.bind_tools(tools)
```

## Graph API

```
from langgraph.graph import MessagesState
```

```
from langchain_core.messages import SystemMessage, HumanMessage, ToolMessage

# Nodes
def llm_call(state: MessagesState):
    """LLM decides whether to call a tool or not"""

    return {
        "messages": [
            llm_with_tools.invoke(
                [
                    SystemMessage(
                        content="You are a helpful assistant tasked with performing arithmetic on a set of inputs."
                    )
                ]
                + state["messages"]
            )
        ]
    }

def tool_node(state: dict):
    """Performs the tool call"""

    result = []
    for tool_call in state["messages"][-1].tool_calls:
        tool = tools_by_name[tool_call["name"]]
        observation = tool.invoke(tool_call["args"])
        result.append(ToolMessage(content=observation, tool_call_id=tool_call["id"]))
    return {"messages": result}

# Conditional edge function to route to the tool node or end based upon whether the LLM made a tool call
def should_continue(state: MessagesState) -> Literal["Action", END]:
    """Decide if we should continue the loop or stop based upon whether the LLM made a tool call"""

    messages = state["messages"]
```

```
last_message = messages[-1]
# If the LLM makes a tool call, then perform an action
if last_message.tool_calls:
    return "Action"
# Otherwise, we stop (reply to the user)
return END

# Build workflow
agent_builder = StateGraph(MessagesState)

# Add nodes
agent_builder.add_node("llm_call", llm_call)
agent_builder.add_node("environment", tool_node)

# Add edges to connect nodes
agent_builder.add_edge(START, "llm_call")
agent_builder.add_conditional_edges(
    "llm_call",
    should_continue,
    {
        # Name returned by should_continue : Name of next node to visit
        "Action": "environment",
        END: END,
    },
)
agent_builder.add_edge("environment", "llm_call")

# Compile the agent
agent = agent_builder.compile()

# Show the agent
display(Image(agent.get_graph(xray=True).draw_mermaid())))

# Invoke
messages = [HumanMessage(content="Add 3 and 4.")]
messages = agent.invoke({"messages": messages})
```

```
for m in messages[ "messages" ]:  
    m.pretty_print()
```

## LangSmith Trace

<https://smith.langchain.com/public/051f0391-6761-4f8c-a53b-22231b016690/r>

## Resources:

### LangChain Academy

See our lesson on agents [here](#).

## Examples

[Here](#) is a project that uses a tool calling agent to create / store long-term memories.

## Functional API

```
from langgraph.graph import add_messages  
from langchain_core.messages import (  
    SystemMessage,  
    HumanMessage,  
    BaseMessage,  
    ToolCall,  
)  
  
@task  
def call_llm(messages: list[BaseMessage]):  
    """LLM decides whether to call a tool or not"""  
    return llm_with_tools.invoke(  
        [  
            SystemMessage(  
                ...  
            )  
        ]  
    )
```

```
        content="You are a helpful assistant tasked with performing arithmetic on a set of inputs."
    )
]
+ messages
)

@task
def call_tool(tool_call: ToolCall):
    """Performs the tool call"""
    tool = tools_by_name[tool_call["name"]]
    return tool.invoke(tool_call)

@entrypoint()
def agent(messages: list[BaseMessage]):
    llm_response = call_llm(messages).result()

    while True:
        if not llm_response.tool_calls:
            break

        # Execute tools
        tool_result_futures = [
            call_tool(tool_call) for tool_call in llm_response.tool_calls
        ]
        tool_results = [fut.result() for fut in tool_result_futures]
        messages = add_messages(messages, [llm_response, *tool_results])
        llm_response = call_llm(messages).result()

    messages = add_messages(messages, llm_response)
    return messages

# Invoke
messages = [HumanMessage(content="Add 3 and 4.")]
for chunk in agent.stream(messages, stream_mode="updates"):
    print(chunk)
```

```
print("\n")
```

## LangSmith Trace

<https://smith.langchain.com/public/42ae8bf9-3935-4504-a081-8ddbcbfc8b2e/r>

## Pre-built

LangGraph also provides a **pre-built method** for creating an agent as defined above (using the `create_react_agent` function):

<https://langchain-ai.github.io/langgraph/how-tos/create-react-agent/>

API Reference: `create_react_agent`

```
from langgraph.prebuilt import create_react_agent

# Pass in:
# (1) the augmented LLM with tools
# (2) the tools list (which is used to create the tool node)
pre_built_agent = create_react_agent(llm, tools=tools)

# Show the agent
display(Image(pre_built_agent.get_graph().draw_mermaid_png()))

# Invoke
messages = [HumanMessage(content="Add 3 and 4.")]
messages = pre_built_agent.invoke({"messages": messages})
for m in messages["messages"]:
    m.pretty_print()
```

## LangSmith Trace

<https://smith.langchain.com/public/abab6a44-29f6-4b97-8164-af77413e494d/r>

## What LangGraph provides

By constructing each of the above in LangGraph, we get a few things:

### Persistence: Human-in-the-Loop

LangGraph persistence layer supports interruption and approval of actions (e.g., Human In The Loop). See [Module 3 of LangChain Academy](#).

### Persistence: Memory

LangGraph persistence layer supports conversational (short-term) memory and long-term memory. See [Modules 2 and 5](#) of LangChain Academy:

### Streaming

LangGraph provides several ways to stream workflow / agent outputs or intermediate state. See [Module 3 of LangChain Academy](#).

### Deployment

LangGraph provides an easy on-ramp for deployment, observability, and evaluation. See [module 6](#) of LangChain Academy.