Copyright 2025 Google LLC.

Licensed under the Apache License, Version 2.0 (the "License");

```
# @title Licensed under the Apache License, Version 2.0 (the "License");
# you may not use this file except in compliance with the License.
# You may obtain a copy of the License at
#
# https://www.apache.org/licenses/LICENSE-2.0
#
# Unless required by applicable law or agreed to in writing, software
# distributed under the License is distributed on an "AS IS" BASIS,
# WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
# See the License for the specific language governing permissions and
# limitations under the License.
```

🚀 Agent Tool Patterns and Best Practices

Welcome to Day-2 of the Kaggle 5-day Agents course!

In the previous notebook, you learned how to add custom Python functions as tools to your agent. In this notebook, we'll take the next step: **consuming external MCP services** and handling **long-running operations**.

In this notebook, you'll learn how to:

- ✅ **Connect to external MCP servers**
- ✅ **Implement long-running operations** that can pause agent execution for external input
- ✅ **Build resumable workflows** that maintain state across conversation breaks
- ✅ Understand when and how to use these patterns

‼️ Please Read

> ❌ ℹ️ **Note: No submission required!** This notebook is for your hands-on practice and learning only. You **do not** need to submit it anywhere to complete the course.

> ⏸️ **Note:** When you first start the notebook via running a cell you might see a banner in the notebook header that reads **"Waiting for the next available notebook"**. The queue should drop rapidly; however, during peak bursts you might have to

wait a few minutes.

> ❌ **Note:** Avoid using the **Run all** cells command as this can trigger a QPM limit resulting in 429 errors when calling the backing model. Suggested flow is to run each cell in order - one at a time. See FAQ on 429 errors for more information.

For help: Ask questions on the Kaggle Discord server.

📖 Get started with Kaggle Notebooks

If this is your first time using Kaggle Notebooks, welcome! You can learn more about using Kaggle Notebooks in the documentation.

Here's how to get started:

1. Verify Your Account (Required)

To use the Kaggle Notebooks in this course, you'll need to verify your account with a phone number.

You can do this in your Kaggle settings.

2. Make Your Own Copy

To run any code in this notebook, you first need your own editable copy.

Click the `Copy and Edit` button in the top-right corner.

This creates a private copy of the notebook just for you.

3. Run Code Cells

Once you have your copy, you can run code.

Click the ▶️ Run button next to any code cell to execute it.

Run the cells in order from top to bottom.

4. If You Get Stuck

To restart: Select `Factory reset` from the `Run` menu.

For help: Ask questions on the Kaggle Discord server.

Section 1: Setup

1.1: Install dependencies

The Kaggle Notebooks environment includes a pre-installed version of the google-adk library for Python and its required dependencies.

To install and use ADK in your own Python development environment outside of this course, you can do so by running:

```
pip install google-adk
```

1.2: Configure your Gemini API Key

This notebook uses the Gemini API, which requires an API key.

1. Get your API key

If you don't have one already, create an API key in Google AI Studio.

2. Add the key to Kaggle Secrets

Next, you will need to add your API key to your Kaggle Notebook as a Kaggle User Secret.

1. In the top menu bar of the notebook editor, select `Add-ons` then `Secrets`.
2. Create a new secret with the label `GOOGLE_API_KEY`.
3. Paste your API key into the "Value" field and click "Save".
4. Ensure that the checkbox next to `GOOGLE_API_KEY` is selected so that the secret is attached to the notebook.

3. Authenticate in the notebook

Run the cell below to access the `GOOGLE_API_KEY` you just saved and set it as an environment variable for the notebook to use:

```
import os
from kaggle_secrets import UserSecretsClient

try:
    GOOGLE_API_KEY = UserSecretsClient().get_secret("GOOGLE_API_KEY")
    os.environ["GOOGLE_API_KEY"] = GOOGLE_API_KEY
```

```
    print("    Setup and authentication complete.")
except Exception as e:
    print(
        f"    Authentication Error: Please make sure you have added 'GOOGLE_API_KEY' to your Kaggle secrets. Details: {e}"
    )
```

1.3: Import ADK components

Now, import the specific components you'll need from the Agent Development Kit. This keeps your code organized and ensures we have access to the necessary building blocks.

```
import uuid
from google.genai import types

from google.adk.agents import LlmAgent
from google.adk.models.google_llm import Gemini
from google.adk.runners import Runner
from google.adk.sessions import InMemorySessionService

from google.adk.tools.mcp_tool.mcp_toolset import McpToolset
from google.adk.tools.tool_context import ToolContext
from google.adk.tools.mcp_tool.mcp_session_manager import StdioConnectionParams
from mcp import StdioServerParameters

from google.adk.apps.app import App, ResumabilityConfig
from google.adk.tools.function_tool import FunctionTool

print("✅ ADK components imported successfully.")
```

1.4: Configure Retry Options

When working with LLMs, you may encounter transient errors like rate limits or temporary service unavailability. Retry options automatically handle these failures by retrying the request with exponential backoff.

```
retry_config = types.HttpRetryOptions(
    attempts=5,  # Maximum retry attempts
    exp_base=7,  # Delay multiplier
    initial_delay=1,
    http_status_codes=[429, 500, 503, 504],  # Retry on these HTTP errors
)
```

Section 2: Model Context Protocol

So far, you have learned how to create custom functions for your agents. But connecting to external systems (GitHub, databases, Slack) requires writing and maintaining API clients.

Model Context Protocol (MCP) is an open standard that lets agents use community-built integrations. Instead of writing your own integrations and API clients, just connect to an existing MCP server.

MCP enables agents to:

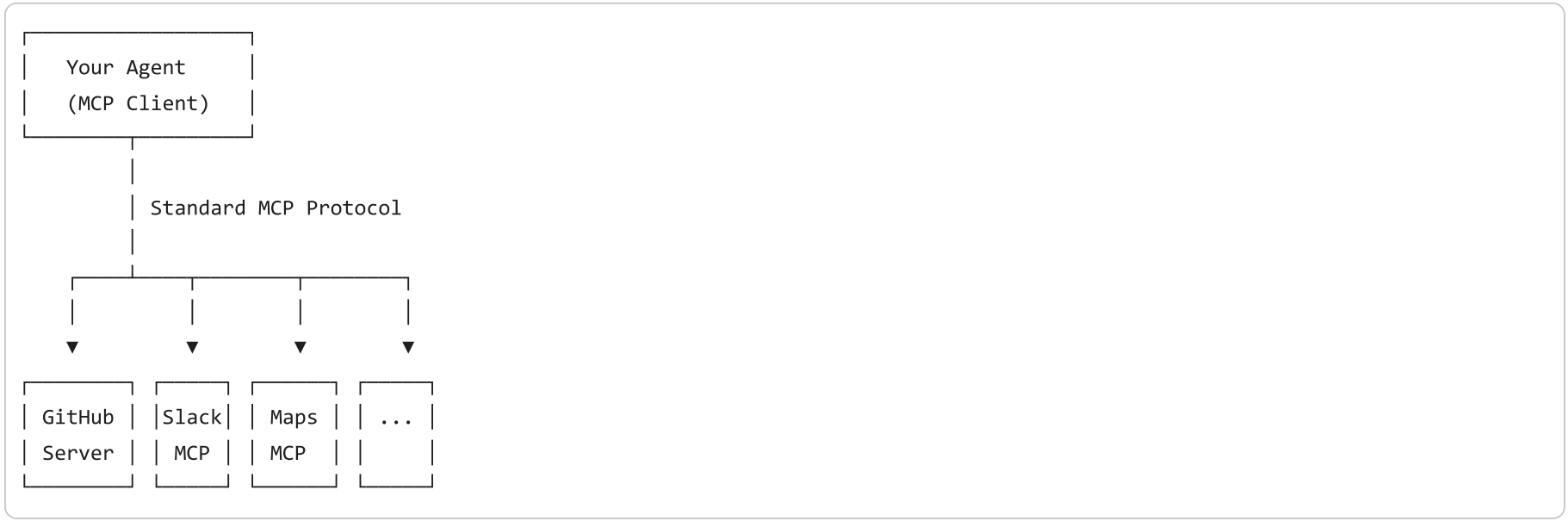
✅ **Access live, external data** from databases, APIs, and services without custom integration code
✅ **Leverage community-built tools** with standardized interfaces
✅ **Scale capabilities** by connecting to multiple specialized servers

2.1: How MCP Works

MCP connects your agent (the **client**) to external **MCP servers** that provide tools:

- **MCP Server**: Provides specific tools (like image generation, database access)
- **MCP Client**: Your agent that uses those tools
- **All servers work the same way** - standardized interface

Architecture:



2.2: Using MCP with Your Agent

The workflow is simple:

1. Choose an MCP Server and tool
2. Create the MCP Toolset (configure connection)
3. Add it to your agent
4. Run and test the agent

Step 1: Choose MCP Server

For this demo, we'll use the **Everything MCP Server** - an npm package (`@modelcontextprotocol/server-everything`) designed for testing MCP integrations.

It provides a `getTinyImage` tool that returns a simple test image (16x16 pixels, Base64-encoded). **Find more servers:** modelcontextprotocol.io/examples

‼️ **NOTE: This is a demo server to learn MCP.** In production, you'll use servers for Google Maps, Slack, Discord, etc.

Step 2: Create the MCP Toolset

The `McpToolset` is used to integrate an ADK Agent with an MCP Server.

What the code does:

- Uses `npx` (Node package runner) to run the MCP server
- Connects to `@modelcontextprotocol/server-everything`
- Filters to only use the `getTinyImage` tool (the server has others, but we only need this one)

```
# MCP integration with Everything Server
mcp_image_server = McpToolset(
    connection_params=StdioConnectionParams(
        server_params=StdioServerParameters(
            command="npx",  # Run MCP server via npx
            args=[
                "-y",  # Argument for npx to auto-confirm install
                "@modelcontextprotocol/server-everything",
            ],
            tool_filter=["getTinyImage"],
        ),
        timeout=30,
    )
)
```

```
print("   MCP Tool created")
```

Behind the scenes:

1. **Server Launch**: ADK runs `npx -y @modelcontextprotocol/server-everything`
2. **Handshake**: Establishes stdio communication channel
3. **Tool Discovery**: Server tells ADK: "I provide getTinyImage" functionality
4. **Integration**: Tools appear in agent's tool list automatically
5. **Execution**: When agent calls `getTinyImage()`, ADK forwards to MCP server
6. **Response**: Server result is returned to agent seamlessly

Why This Matters: You get instant access to tools without writing integration code!

Step 3: Add MCP tool to agent

Let's add the `mcp_server` to the agent's tool array and update the agent's instructions to handle requests to generate tiny images.

```
# Create image agent with MCP integration
image_agent = LlmAgent(
    model=Gemini(model="gemini-2.5-flash-lite", retry_options=retry_config),
    name="image_agent",
    instruction="Use the MCP Tool to generate images for user queries",
    tools=[mcp_image_server],
)
```

Create the runner:

```
from google.adk.runners import InMemoryRunner

runner = InMemoryRunner(agent=image_agent)
```

Step 4: Test the agent

Ask the agent to generate an image. Watch it use the MCP tool:

```
response = await runner.run_debug("Provide a sample tiny image", verbose=True)
```

Display the image:

The server returns base64-encoded image data. Let's decode and display it:

```
from IPython.display import display, Image as IPImage
import base64

for event in response:
    if event.content and event.content.parts:
        for part in event.content.parts:
            if hasattr(part, "function_response") and part.function_response:
                for item in part.function_response.response.get("content", []):
                    if item.get("type") == "image":
                        display(IPImage(data=base64.b64decode(item["data"])))
```

2.3: Extending to Other MCP Servers

The same pattern works for any MCP server - only the `connection_params` change. Here are some examples:

👉 **Kaggle MCP Server** - For dataset and notebook operations

Kaggle provides an MCP server that lets your agents interact with Kaggle datasets, notebooks, and competitions.

Connection example:

```
McpToolset(
    connection_params=StdioConnectionParams(
        server_params=StdioServerParameters(
            command='npx',
            args=[
                '-y',
                'mcp-remote',
                'https://www.kaggle.com/mcp'
            ],
        ),
        timeout=30,
    )
)
```

What it provides:

- 📊 Search and download Kaggle datasets
- 📓 Access notebook metadata

- 🏆 Query competition information etc.,

Learn more: Kaggle MCP Documentation

👉 **GitHub MCP Server** - For PR/Issue analysis

```
McpToolset(
    connection_params=StreamableHTTPServerParams(
        url="https://api.githubcopilot.com/mcp/",
        headers={
            "Authorization": f"Bearer {GITHUB_TOKEN}",
            "X-MCP-Toolsets": "all",
            "X-MCP-Readonly": "true"
        },
    ),
)
```

More resources: ADK Third-party Tools Documentation

🔄 Section 3: Long-Running Operations (Human-in-the-Loop)

So far, all tools execute and return immediately:

> `User asks → Agent calls tool → Tool returns result → Agent responds`

But what if your tools are long-running or you need human approval before completing an action?

Example: A shipping agent should ask for approval before placing a large order.

> `User asks → Agent calls tool → Tool PAUSES and asks human → Human approves → Tool completes → Agent responds`

This is called a **Long-Running Operation (LRO)** - the tool needs to pause, wait for external input (human approval), then resume.

When to use Long-Running Operations:

- 💰 **Financial transactions** requiring approval (transfers, purchases)
- 🗑️ **Bulk operations** (delete 1000 records - confirm first!)

- 📋 **Compliance checkpoints** (regulatory approval needed)
- 💸 **High-cost actions** (spin up 50 servers - are you sure?)
- ⚠️ **Irreversible operations** (permanently delete account)

3.1: What We're Building Today

Let's build a **shipping coordinator agent with one tool** that:

- Auto-approves small orders (≤5 containers)
- **Pauses and asks for approval** on large orders (>5 containers)
- Completes or cancels based on the approval decision

This demonstrates the core long-running operation pattern: **pause ⟶ wait for human input ⟶ resume**.

3.2: The Shipping Tool with Approval Logic

Here's the complete function.

The `ToolContext` Parameter

Notice the function signature includes `tool_context: ToolContext`. ADK automatically provides this object when your tool runs. It gives you two key capabilities:

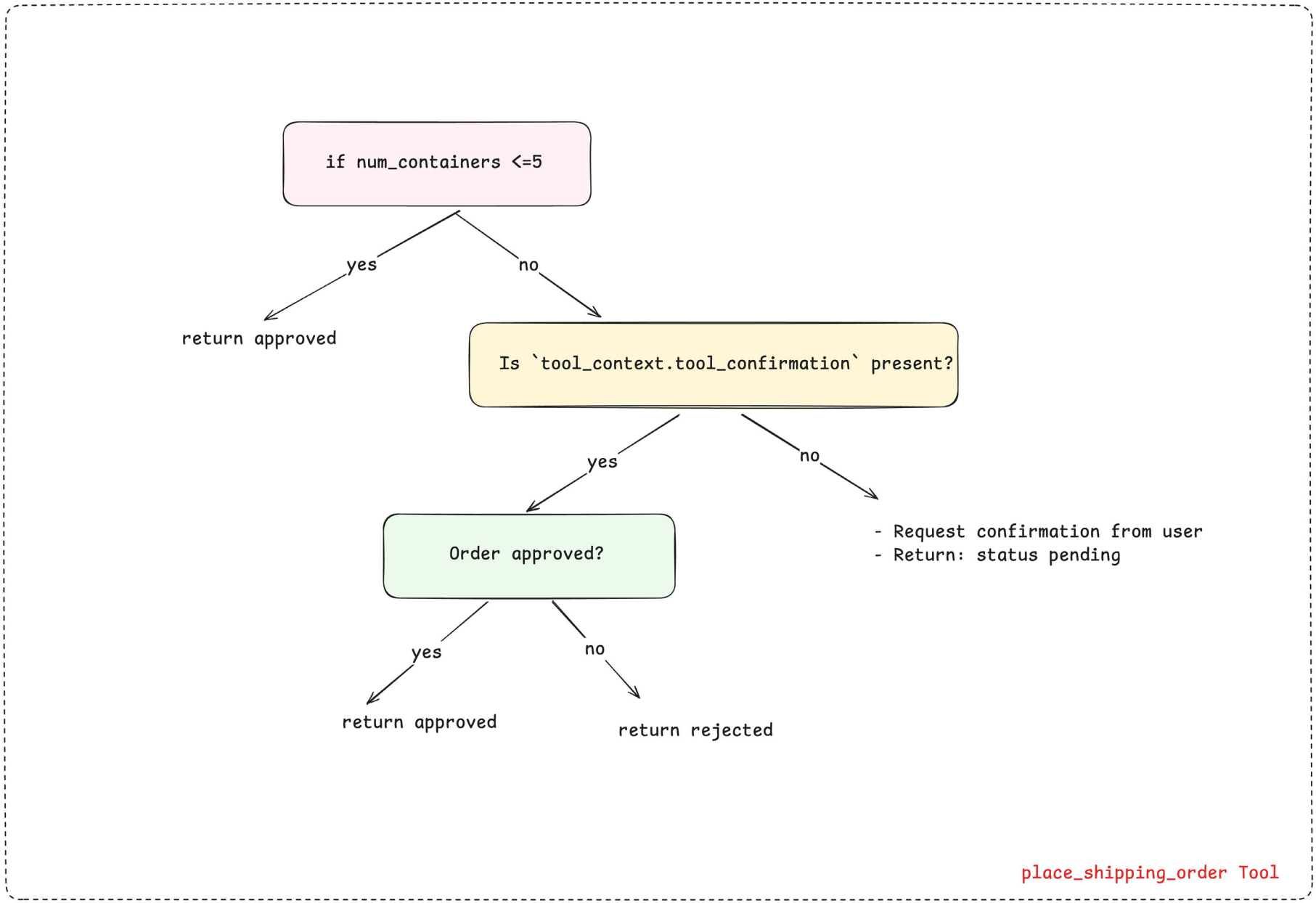
1. **Request approval:** Call `tool_context.request_confirmation()`
2. **Check approval status:** Read `tool_context.tool_confirmation`

```
LARGE_ORDER_THRESHOLD = 5


def place_shipping_order(
    num_containers: int, destination: str, tool_context: ToolContext
) -> dict:
    """Places a shipping order. Requires approval if ordering more than 5 containers (LARGE_ORDER_THRESHOLD).

    Args:
        num_containers: Number of containers to ship
        destination: Shipping destination

    Returns:
        Dictionary with order status
    """
```

```
    # ------------------------------------------------------------------------------------------------
    # ------------------------------------------------------------------------------------------------
    # SCENARIO 1: Small orders (≤5 containers) auto-approve
    if num_containers <= LARGE_ORDER_THRESHOLD:
        return {
            "status": "approved",
            "order_id": f"ORD-{num_containers}-AUTO",
            "num_containers": num_containers,
            "destination": destination,
            "message": f"Order auto-approved: {num_containers} containers to {destination}",
        }

    # ------------------------------------------------------------------------------------------------
    # ------------------------------------------------------------------------------------------------
    # SCENARIO 2: This is the first time this tool is called. Large orders need human approval - PAUSE here.
    if not tool_context.tool_confirmation:
        tool_context.request_confirmation(
            hint=f"⚠️ Large order: {num_containers} containers to {destination}. Do you want to approve?",
            payload={"num_containers": num_containers, "destination": destination},
        )
        return {  # This is sent to the Agent
            "status": "pending",
            "message": f"Order for {num_containers} containers requires approval",
        }

    # ------------------------------------------------------------------------------------------------
    # ------------------------------------------------------------------------------------------------
    # SCENARIO 3: The tool is called AGAIN and is now resuming. Handle approval response - RESUME here.
    if tool_context.tool_confirmation.confirmed:
        return {
            "status": "approved",
            "order_id": f"ORD-{num_containers}-HUMAN",
            "num_containers": num_containers,
            "destination": destination,
            "message": f"Order approved: {num_containers} containers to {destination}",
        }
    else:
        return {
            "status": "rejected",
            "message": f"Order rejected: {num_containers} containers to {destination}",
        }


print("   Long-running functions created!")
```

3.3: Understanding the Code

Now that you've seen the complete function, let's break down how it works.



How the Three Scenarios Work

The tool handles three scenarios by checking `tool_context.tool_confirmation`:

Scenario 1: Small order (≤5 containers): Returns immediately with auto-approved status.

- `tool_context.tool_confirmation` is never checked

Scenario 2: Large order - FIRST CALL

- Tool detects it's a first call: `if not tool_context.tool_confirmation:`
- Calls `request_confirmation()` to request human approval
- Returns `{'status': 'pending', ...}` immediately
- **ADK automatically creates `adk_request_confirmation` event**
- Agent execution pauses - waiting for human decision

Scenario 3: Large order - RESUMED CALL

- Tool detects it's resuming: `if not tool_context.tool_confirmation:` is now False
- Checks human decision: `tool_context.tool_confirmation.confirmed`
- If True → Returns approved status
- If False → Returns rejected status

Key insight: Between the two calls, your workflow code (in Section 4) must detect the `adk_request_confirmation` event and resume with the approval decision.

3.4: Create the Agent, App and Runner

Step 1: Create the agent

Add the tool to the Agent. The tool decides internally when to request approval based on the order size.

```
# Create shipping agent with pausable tool
shipping_agent = LlmAgent(
    name="shipping_agent",
    model=Gemini(model="gemini-2.5-flash-lite", retry_options=retry_config),
    instruction="""You are a shipping coordinator assistant.

  When users request to ship containers:
   1. Use the place_shipping_order tool with the number of containers and destination
   2. If the order status is 'pending', inform the user that approval is required
   3. After receiving the final result, provide a clear summary including:
      - Order status (approved/rejected)
      - Order ID (if available)
      - Number of containers and destination
   4. Keep responses concise but informative
  """,
```

```
    tools=[FunctionTool(func=place_shipping_order)],
)

print("   Shipping Agent created!")
```

Step 2: Wrap in resumable App

The problem: A regular `LlmAgent` is stateless - each call is independent with no memory of previous interactions. If a tool requests approval, the agent can't remember what it was doing.

The solution: Wrap your agent in an **`App`** with **resumability enabled**. The App adds a persistence layer that saves and restores state.

What gets saved when a tool pauses:

- All conversation messages so far
- Which tool was called (`place_shipping_order`)
- Tool parameters (10 containers, Rotterdam)
- Where exactly it paused (waiting for approval)

When you resume, the App loads this saved state so the agent continues exactly where it left off - as if no time passed.

```
# Wrap the agent in a resumable app - THIS IS THE KEY FOR LONG-RUNNING OPERATIONS!
shipping_app = App(
    name="shipping_coordinator",
    root_agent=shipping_agent,
    resumability_config=ResumabilityConfig(is_resumable=True),
)

print("✅ Resumable app created!")
```

Step 3: Create Session and Runner with the App

Pass `app=shipping_app` instead of `agent=...` so the runner knows about resumability.

```
session_service = InMemorySessionService()

# Create runner with the resumable app
shipping_runner = Runner(
    app=shipping_app,  # Pass the app instead of the agent
    session_service=session_service,
)

print("✅ Runner created!")
```

✅ **Recap: Your pausable shipping agent is now complete!**

You've created:

1. ✅ A tool that can pause for approval (`place_shipping_order`)
2. ✅ An agent that uses this tool (`shipping_agent`)
3. ✅ A resumable app that saves state (`shipping_app`)
4. ✅ A runner that can handle pause/resume (`shipping_runner`)

Next step: Build the workflow code and test that our Agent detects pauses and handles approvals.

🏗️ Section 4: Building the Workflow

‼️ **Important:** The workflow code uses ADK concepts like Sessions, Runners, and Events. **We'll cover what you need to know for long-running operations** in this notebook. For deeper understanding, we will cover these topics in Day 3, or you can check out the ADK docs and this video.

4.1: ⚠️ The Critical Part - Handling Events in Your Workflow

The agent won't automatically handle pause/resume. **Every long-running operation workflow requires you to:**

1. **Detect the pause:** Check if events contain `adk_request_confirmation`
2. **Get human decision:** In production, show UI and wait for user click. Here, we simulate it.
3. **Resume the agent:** Send the decision back with the saved `invocation_id`

4.2 Understand Key Technical Concepts

👉 `events` - ADK creates events as the agent executes. Tool calls, model responses, function results - all become events

👉 `adk_request_confirmation` **event** - This event is special - it signals "pause here!"

- Automatically created by ADK when your tool calls `request_confirmation()`
- Contains the `invocation_id`
- Your workflow must detect this event to know the agent paused

👉 `invocation_id` - Every call to `run_async()` gets a unique `invocation_id` (like "abc123")

- When a tool pauses, you save this ID

- When resuming, pass the same ID so ADK knows which execution to continue
- Without it, ADK would start a NEW execution instead of resuming the paused one

4.3: Helper Functions to Process Events

These handle the event iteration logic for you.

`check_for_approval()` - Detects if the agent paused

- Loops through all events and looks for the special `adk_request_confirmation` event
- Returns `approval_id` (identifies this specific request) and `invocation_id` (identifies which execution to resume)
- Returns `None` if no pause detected

```
def check_for_approval(events):
    """Check if events contain an approval request.

    Returns:
        dict with approval details or None
    """
    for event in events:
        if event.content and event.content.parts:
            for part in event.content.parts:
                if (
                    part.function_call
                    and part.function_call.name == "adk_request_confirmation"
                ):
                    return {
                        "approval_id": part.function_call.id,
                        "invocation_id": event.invocation_id,
                    }
    return None
```

`print_agent_response()` - Displays agent text

- Simple helper to extract and print text from events

```
def print_agent_response(events):
    """Print agent's text responses from events."""
    for event in events:
        if event.content and event.content.parts:
            for part in event.content.parts:
```

```
                if part.text:
                    print(f"Agent > {part.text}")
```

`create_approval_response()` - Formats the human decision

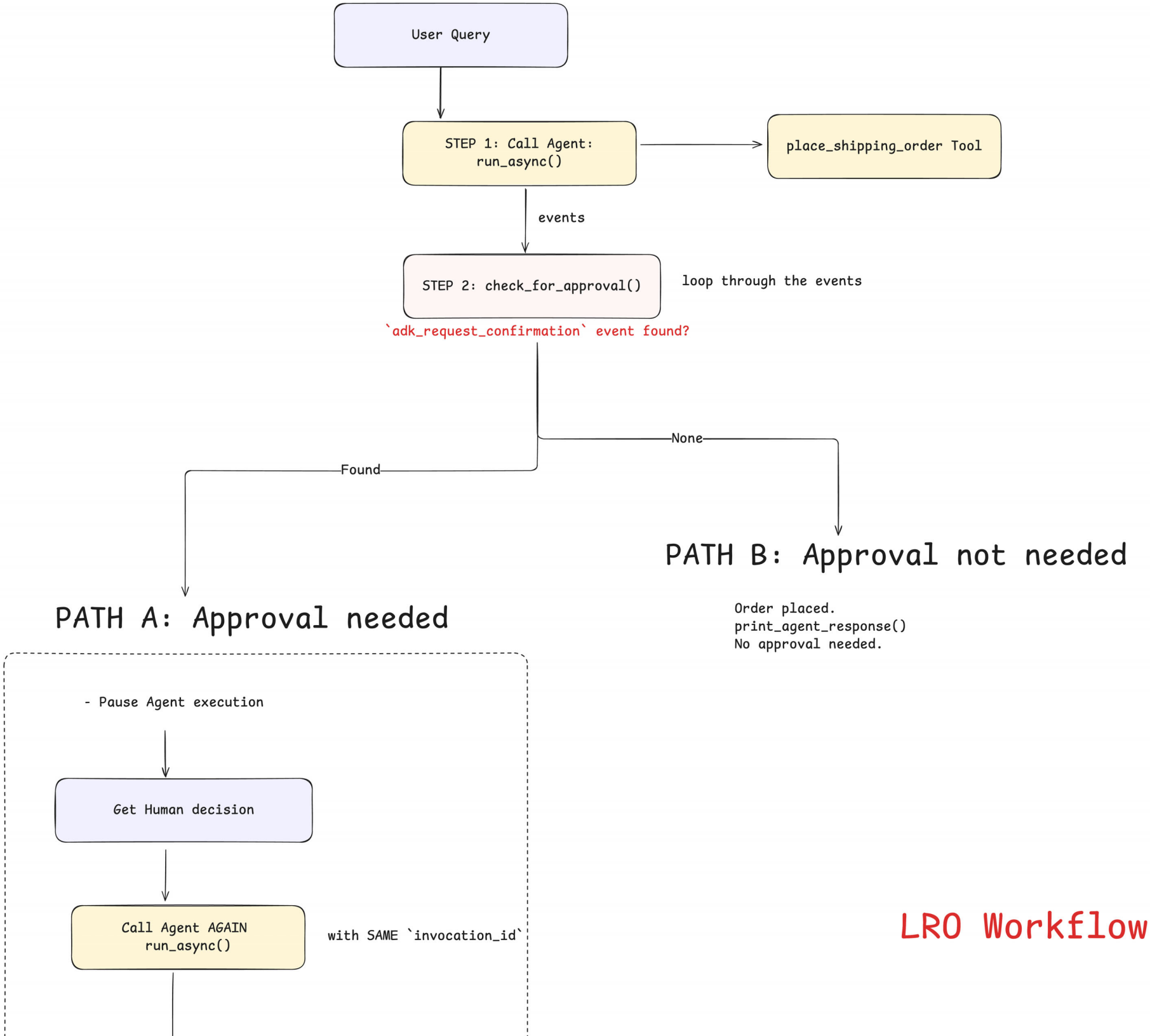
- Takes the approval info and boolean decision (True/False) from the human
- Creates a `FunctionResponse` that ADK understands
- Wraps it in a `Content` object to send back to the agent

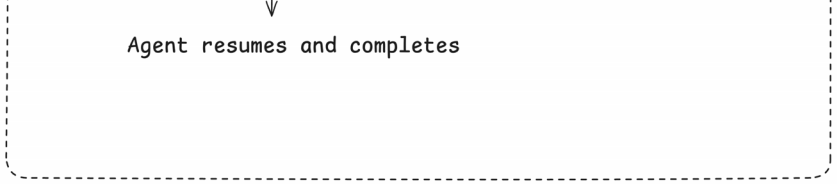
```
def create_approval_response(approval_info, approved):
    """Create approval response message."""
    confirmation_response = types.FunctionResponse(
        id=approval_info["approval_id"],
        name="adk_request_confirmation",
        response={"confirmed": approved},
    )
    return types.Content(
        role="user", parts=[types.Part(function_response=confirmation_response)]
    )


print("✅ Helper functions defined")
```

4.4: The Workflow Function - Let's tie it all together!

The `run_shipping_workflow()` function orchestrates the entire approval flow.

Look for the code explanation in the cell below.


User Query
STEP 1: Call Agent:
run_async()
place_shipping_order Tool
events
STEP 2: check_for_approval()
loop through the events
`adk_request_confirmation` event found?
Found
None
PATH A: Approval needed
PATH B: Approval not needed
Order placed.
print_agent_response()
No approval needed.
- Pause Agent execution
Get Human decision
Call Agent AGAIN
run_async()
with SAME `invocation_id`
LRO Workflow




```
async def run_shipping_workflow(query: str, auto_approve: bool = True):
    """Runs a shipping workflow with approval handling.

    Args:
        query: User's shipping request
        auto_approve: Whether to auto-approve large orders (simulates human decision)
    """

    print(f"\n{'='*60}")
    print(f"User > {query}\n")

    # Generate unique session ID
    session_id = f"order_{uuid.uuid4().hex[:8]}"

    # Create session
    await session_service.create_session(
        app_name="shipping_coordinator", user_id="test_user", session_id=session_id
    )

    query_content = types.Content(role="user", parts=[types.Part(text=query)])
    events = []

    # -----------------------------------------------------------------------------------------------
    # -----------------------------------------------------------------------------------------------
    # STEP 1: Send initial request to the Agent. If num_containers > 5, the Agent returns the special `adk_request_confirmation` event
    async for event in shipping_runner.run_async(
        user_id="test_user", session_id=session_id, new_message=query_content
    ):
        events.append(event)

    # -----------------------------------------------------------------------------------------------
    # -----------------------------------------------------------------------------------------------
    # STEP 2: Loop through all the events generated and check if `adk_request_confirmation` is present.
    approval_info = check_for_approval(events)

    # -----------------------------------------------------------------------------------------------
    # -----------------------------------------------------------------------------------------------
    # STEP 3: If the event is present, it's a large order - HANDLE APPROVAL WORKFLOW
    if approval_info:
        print(f"⏸️  Pausing for approval...")
        print(f"🤔 Human Decision: {'APPROVE ✅' if auto_approve else 'REJECT ❌'}\n")
```

```
        # PATH A: Resume the agent by calling run_async() again with the approval decision
        async for event in shipping_runner.run_async(
            user_id="test_user",
            session_id=session_id,
            new_message=create_approval_response(
                approval_info, auto_approve
            ),  # Send human decision here
            invocation_id=approval_info[
                "invocation_id"
            ],  # Critical: same invocation_id tells ADK to RESUME
        ):
            if event.content and event.content.parts:
                for part in event.content.parts:
                    if part.text:
                        print(f"Agent > {part.text}")

    # ---------------------------------------------------------------------------------------------
    # ---------------------------------------------------------------------------------------------
    else:
        # PATH B: If the `adk_request_confirmation` is not present - no approval needed - order completed immediately.
        print_agent_response(events)

    print(f"{'='*60}\n")


print("   Workflow function ready")
```

Code breakdown

Step 1: Send initial request to the Agent

- Call `run_async()` to start agent execution
- Collect all events in a list for inspection

Step 2: Detect Pause

- Call `check_for_approval(events)` to look for the special event: `adk_request_confirmation`
- Returns approval info (with `invocation_id`) if the special event is present; `None` if completed

Step 3: Resume execution

PATH A:

- If the approval info is present, at this point the Agent *pauses* for human input.
- Once the Human input is available, call the agent again using `run_async()` and pass in the Human input.

- **Critical:** Same `invocation_id` (tells ADK to RESUME, not restart)
- Display agent's final response after resuming

PATH B:

- If the approval info is not present, then approval is not needed and the agent completes execution.

🎬 4.5: Demo: Testing the Workflow

Now, let's run our demos. Notice how much cleaner and easier to read they are. All the complex logic for pausing and resuming is now hidden away in our `run_workflow` helper function, allowing us to focus on the tasks we want the agent to perform.

Note: You may see warnings like `Warning: there are non-text parts in the response: ['function_call']` - this is normal and can be ignored. It just means the agent is calling tools in addition to generating text.

```
# Demo 1: It's a small order. Agent receives auto-approved status from tool
await run_shipping_workflow("Ship 3 containers to Singapore")

# Demo 2: Workflow simulates human decision: APPROVE ✅
await run_shipping_workflow("Ship 10 containers to Rotterdam", auto_approve=True)

# Demo 3: Workflow simulates human decision: REJECT ❌
await run_shipping_workflow("Ship 8 containers to Los Angeles", auto_approve=False)
```

4.6: (Optional) Complete execution flow

Here's an example trace of the whole workflow.

TL;DR: Tool pauses at TIME 6, workflow detects it at TIME 8, resumes at TIME 10 with same `invocation_id="abc123"`.

Detailed timeline:

Here's what happens step-by-step when you run `run_shipping_workflow("Ship 10 containers to Rotterdam", auto_approve=True)`:

```
TIME 1: User sends "Ship 10 containers to Rotterdam"
        ↓
TIME 2: Workflow calls shipping_runner.run_async(...)
        ADK assigns a unique invocation_id = "abc123"
        ↓
TIME 3: Agent receives user message, decides to use place_shipping_order tool
```

```
        ↓
TIME 4: ADK calls place_shipping_order(10, "Rotterdam", tool_context)
        ↓
TIME 5: Tool checks: num_containers (10) > 5
        Tool calls tool_context.request_confirmation(...)
        ↓
TIME 6: Tool returns {'status': 'pending', ...}
        ↓
TIME 7: ADK creates adk_request_confirmation event with invocation_id="abc123"
        ↓
TIME 8: Workflow detects the event via check_for_approval()
        Saves approval_id and invocation_id="abc123"
        ↓
TIME 9: Workflow gets human decision → True (approve)
        ↓
TIME 10: Workflow calls shipping_runner.run_async(..., invocation_id="abc123")
         Passes approval decision as FunctionResponse
         ↓
TIME 11: ADK sees invocation_id="abc123" - knows to RESUME (instead of starting new)
         Loads saved state from TIME 7
         ↓
TIME 12: ADK calls place_shipping_order again with same parameters
         But now tool_context.tool_confirmation.confirmed = True
         ↓
TIME 13: Tool returns {'status': 'approved', 'order_id': 'ORD-10-HUMAN', ...}
         ↓
TIME 14: Agent receives result and responds to user
```

Key point: The `invocation_id` is how ADK knows to resume the paused execution instead of starting a new one.

📊 Section 5: Summary - Key Patterns for Advanced Tools

In this notebook, you implemented two powerful, production-ready patterns for extending your agent's capabilities beyond simple functions.

Pattern	When to Use It
MCP Integration	You need to connect to **external, standardized services** (like time, databases, or file systems) without writing custom integration code.
Long-Running Operations	You need to **pause a workflow** to wait for an external event, most commonly for **human-in-the-loop** approvals or long background tasks or for compliance/security c

🚀 Production Ready Concepts

You now understand how to build agents that:

- 🌐 **Scale**: Leverage community tools instead of building everything
- ⏳ **Handle Time**: Manage operations that span minutes, hours, or days
- 🔒 **Ensure Compliance**: Add human oversight to critical operations
- 🔄 **Maintain State**: Resume conversations exactly where they paused

Start Simple: Begin with custom tools → Add MCP services → Add long-running as needed

🎯 Exercise: Build an Image Generation Agent with Cost Approval

The scenario:

Build an agent that generates images using the MCP server, but requires approval for "bulk" image generation:

- Single image request (1 image): Auto-approve, generate immediately
- Bulk request (>1 image): Pause and ask for approval before generating multiple images
- Explore different publicly available Image Generation MCP Servers

---

🎉 Congratulations! You've Learned Agent Patterns and Best Practices

You've successfully learned how to build agents that handle complex, real-world workflows integrating external systems and spanning time.

ℹ️ **Note: No submission required!**

This notebook is for your hands-on practice and learning only. You **do not** need to submit it anywhere to complete the course.

📚 Learn More

- ADK Documentation
- MCP Tools Documentation
- Long-Running Operations Guide
- Model Context Protocol Specification
- The `App` and `Runner`

🎯 Next Steps

You've built the foundation for production-ready agent systems. Ready for the next challenge?

Continue to **Day 3** to learn about **State and Memory Management**!

Authors

Laxmi Harikumar