Tutorial 04: Sequential Workflows - Agent Pipelines

Difficulty: intermediate

Reading Time: 1 hour

Tags: intermediate, sequential, workflows, pipelines, multi-agent

Description: Chain multiple agents together in sequential workflows to create complex multi-step processes like research → analysis → report generation.

Tutorial 04: Sequential Workflows - Build Agent Pipelines

Overview

Connect your agents to create sophisticated multi-step workflows! Learn how to chain multiple agents in a strict sequence where each agent's output feeds into the next - perfect for content creation, data processing, or quality control pipelines.

What You'll Build: A Blog Post Generator Pipeline with 4 stages:

1. **Research Agent** - Gathers information about the topic
2. **Writer Agent** - Creates a draft blog post from research
3. **Editor Agent** - Reviews and suggests improvements
4. **Formatter Agent** - Converts to final markdown format

Implementation: tutorial_implementation/tutorial04 (https://github.com/raphaelmansuy/adk_training/tree/main/tutorial_implementation/tutorial04/) - Complete working blog creation pipeline with tests

Each agent's output feeds into the next, creating a complete content creation pipeline!

Prerequisites

- **Completed Tutorials 01-03** - Understanding of agents, tools, and OpenAPI
- **Installed ADK** - `pip install google-adk`
- **API key configured** - From Tutorial 01

Core Concepts

SequentialAgent

The `SequentialAgent` is a workflow orchestrator that executes sub-agents in strict order. Unlike a regular agent, it's NOT powered by an LLM - it's deterministic and always runs agents in the exact sequence you define.

Key Characteristics:

- Executes sub-agents one at a time, in order
- Each agent completes before the next starts
- All agents share the same `InvocationContext` (shared state)
- Perfect for pipelines where order matters

Data Flow with output_key

Agents pass data to each other using **session state**:

1. Agent defines `output_key="my_result"`
2. ADK automatically saves agent's response to `state['my_result']`
3. Next agent reads it using `{my_result}` in its instruction

This creates a data pipeline!

When to Use Sequential Workflows

Use `SequentialAgent` when:

- ✔️ Tasks MUST happen in specific order
- ✔️ Each step depends on previous step's output
- ✔️ You want predictable, deterministic execution
- ✔️ Building pipelines (ETL, content creation, review processes)

Don't use when:

- ❌ Tasks are independent (use `ParallelAgent` instead)
- ❌ Need dynamic routing (use LLM-driven agent with sub-agents)

Use Case

We're building a **Blog Post Generator Pipeline** with 4 stages:

1. **Research Agent** - Gathers information about the topic
2. **Writer Agent** - Creates a draft blog post from research
3. **Editor Agent** - Reviews and suggests improvements
4. **Formatter Agent** - Converts to final markdown format

Each agent's output feeds into the next, creating a complete content creation pipeline!

Step 1: Create Project Structure

```
mkdir blog_pipeline
cd blog_pipeline
touch __init__.py agent.py .env
```

Copy your `.env` file from previous tutorials.

Step 2: Set Up Package Import

blog_pipeline/init**.py**

```
from . import agent
```

Step 3: Define the Pipeline Agents

blog_pipeline/agent.py

```python
from __future__ import annotations

from google.adk.agents import Agent, SequentialAgent

# ===== Agent 1: Research Agent =====
# Gathers key facts about the topic
research_agent = Agent(
    name="researcher",
    model="gemini-2.0-flash",
    description="Researches a topic and gathers key information",
    instruction=(
        "You are a research assistant. Your task is to gather key facts and in
        "about the topic requested by the user.\n"
        "\n"
        "Output a bulleted list of 5-7 key facts or insights about the topic.
        "Focus on interesting, specific information that would make a blog pos
        "\n"
        "Format:\n"
        "• Fact 1\n"
        "• Fact 2\n"
        "• etc.\n"
        "\n"
        "Output ONLY the bulleted list, nothing else."
    ),
    output_key="research_findings"  # Saves to state['research_findings']
)

# ===== Agent 2: Writer Agent =====
# Writes blog post draft from research
writer_agent = Agent(
    name="writer",
    model="gemini-2.0-flash",
    description="Writes a blog post draft based on research findings",
    instruction=(
        "You are a creative blog writer. Write an engaging blog post based on
        "the research findings below.\n"
        "\n"
        "**Research Findings:**\n"
        "{research_findings}\n"  # Reads from state!
        "\n"
        "Write a 3-4 paragraph blog post that:\n"
        "- Has an engaging introduction\n"
        "- Incorporates the key facts naturally\n"
        "- Has a conclusion that wraps up the topic\n"
        "- Uses a friendly, conversational tone\n"
        "\n"
        "Output ONLY the blog post text, no meta-commentary."
    ),
    output_key="draft_post"  # Saves to state['draft_post']
)

# ===== Agent 3: Editor Agent =====
# Reviews the draft and suggests improvements
editor_agent = Agent(
    name="editor",
    model="gemini-2.0-flash",
    description="Reviews blog post draft and provides editorial feedback",
    instruction=(
        "You are an experienced editor. Review the blog post draft below and p
        "constructive feedback.\n"
        "\n"
        "**Draft Blog Post:**\n"
        "{draft_post}\n"  # Reads from state!
        "\n"
        "Analyze the post for:\n"
        "1. Clarity and flow\n"
        "2. Grammar and style\n"
        "3. Engagement and reader interest\n"
        "4. Structure and organization\n"
        "\n"
        "Provide your feedback as a short list of specific improvements. "
        "If the post is excellent, simply say: 'No revisions needed - post is
        "\n"
        "Output ONLY the feedback, nothing else."
    ),
    output_key="editorial_feedback"  # Saves to state['editorial_feedback']
)

# ===== Agent 4: Formatter Agent =====
# Applies edits and formats as markdown
formatter_agent = Agent(
    name="formatter",
    model="gemini-2.0-flash",
    description="Applies editorial feedback and formats the final blog post",
    instruction=(
        "You are a formatter. Create the final version of the blog post by app
        "the editorial feedback to improve the draft.\n"
        "\n"
        "**Original Draft:**\n"
        "{draft_post}\n"  # Reads from state!
        "\n"
        "**Editorial Feedback:**\n"
        "{editorial_feedback}\n"  # Reads from state!
        "\n"
        "Create the final blog post by:\n"
        "1. Applying the suggested improvements\n"
        "2. Formatting as proper markdown with:\n"
        "   - A compelling title (# heading)\n"
        "   - Section headings if appropriate (## subheadings)\n"
        "   - Proper paragraph breaks\n"
        "   - Bold/italic for emphasis where appropriate\n"
        "\n"
        "If feedback said 'No revisions needed', just format the original draf
        "\n"
        "Output ONLY the final formatted blog post in markdown."
    ),
    output_key="final_post"  # Saves to state['final_post']
)

# ===== Create the Sequential Pipeline =====
blog_creation_pipeline = SequentialAgent(
    name="BlogCreationPipeline",
    sub_agents=[
        research_agent,
        writer_agent,
        editor_agent,
        formatter_agent
    ],  # Executes in this EXACT order!
    description="Complete blog post creation pipeline from research to publica
)

# MUST be named root_agent for ADK
root_agent = blog_creation_pipeline
```

Code Breakdown

State Flow Visualization:

~~~~
```text
User Input: "Write about quantum computing"
     ↓
Research Agent → state['research_findings'] = "● Quantum bits..."
     ↓
Writer Agent (reads {research_findings}) → state['draft_post'] = "Quantum comp
     ↓
Editor Agent (reads {draft_post}) → state['editorial_feedback'] = "Add more ex
     ↓
Formatter Agent (reads {draft_post}, {editorial_feedback}) → state['final_post
     ↓
Final Output: formatted blog post
~~~~

Key Pattern:

1. **Define** `output_key` on each agent → saves response to state
2. **Use** `{state_key}` **in instructions** → reads from state
3. **Chain agents in** `SequentialAgent` → strict execution order

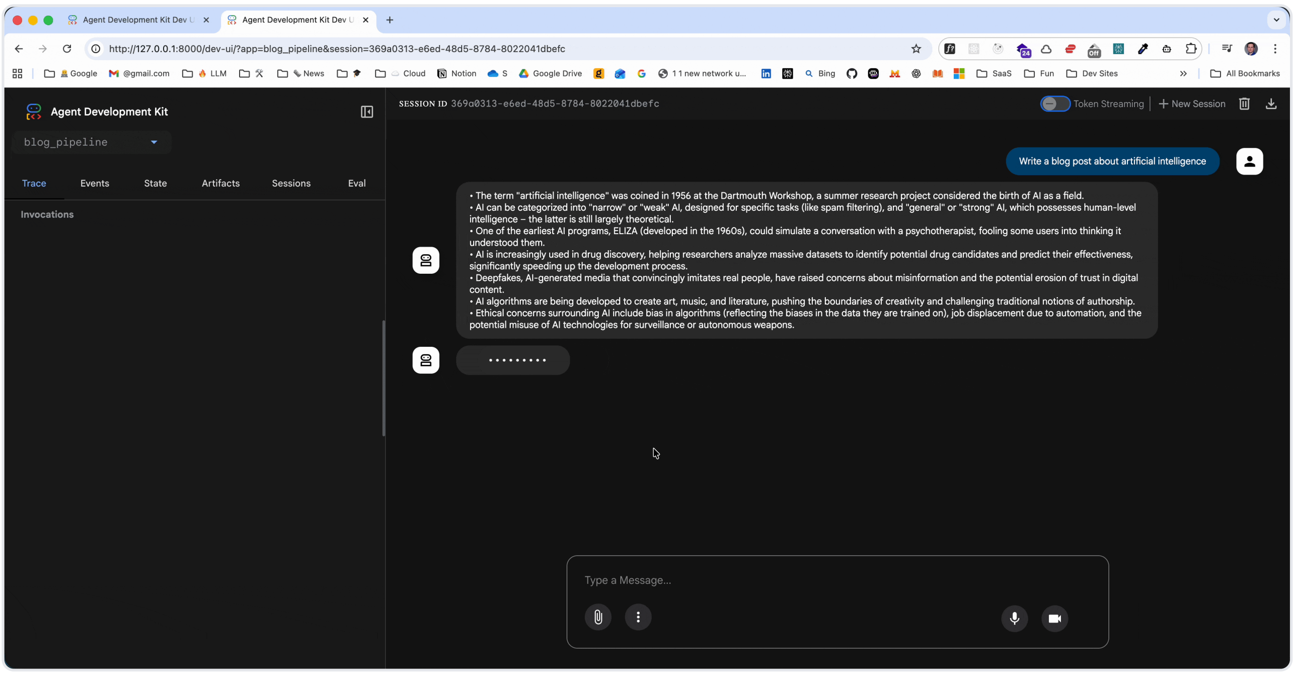
Why This Works:

- All agents share the same `InvocationContext`
- State persists between agents in the sequence
- `{key}` syntax auto-injects values into instructions

Step 4: Run the Pipeline

Demo in Action

Here's what your sequential workflow pipeline looks like in action:



http://127.0.0.1:8000/dev-ui/?app=blog_pipeline&session=369a0313-e6ed-48d5-8784-8022041dbefc

Write a blog post about artificial intelligence

• The term "artificial intelligence" was coined in 1956 at the Dartmouth Workshop, a summer research project considered the birth of AI as a field.
• AI can be categorized into "narrow" or "weak" AI, designed for specific tasks (like spam filtering), and "general" or "strong" AI, which possesses human-level intelligence – the latter is still largely theoretical.
• One of the earliest AI programs, ELIZA (developed in the 1960s), could simulate a conversation with a psychotherapist, fooling some users into thinking it understood them.
• AI is increasingly used in drug discovery, helping researchers analyze massive datasets to identify potential drug candidates and predict their effectiveness, significantly speeding up the development process.
• Deepfakes, AI-generated media that convincingly imitates real people, have raised concerns about misinformation and the potential erosion of trust in digital content.
• AI algorithms are being developed to create art, music, and literature, pushing the boundaries of creativity and challenging traditional notions of authorship.
• Ethical concerns surrounding AI include bias in algorithms (reflecting the biases in the data they are trained on), job displacement due to automation, and the potential misuse of AI technologies for surveillance or autonomous weapons.

Navigate to parent directory and launch:

```
cd ..  # Go to parent of blog_pipeline/
adk web
```

Open `http://localhost:8000` and select "blog_pipeline".

Try These Prompts

Basic Usage:

```
Write a blog post about artificial intelligence
```

Specific Topic:

```
Create a blog post explaining how solar panels work
```

Technical Topic:

```
Write about the history of the Internet
```

Trending Topic:

```
Blog post about electric vehicles and their impact on climate
```

Understanding Pipeline Execution

Open the **Events tab** to see the magic! You'll see:

1. **Event**: Research agent starts
2. **Event**: Research agent completes → saves findings to state
3. **Event**: Writer agent starts (with research_findings injected)
4. **Event**: Writer agent completes → saves draft to state
5. **Event**: Editor agent starts (with draft_post injected)
6. **Event**: Editor agent completes → saves feedback to state
7. **Event**: Formatter agent starts (with draft_post + feedback injected)
8. **Event**: Formatter agent completes → final output!

Watch how each agent's output becomes the next agent's input!

Expected Behavior

Example: "Write a blog post about quantum computing"

```
User: Write a blog post about quantum computing

[Agent 1: Researcher runs]
Research findings:
● Quantum computers use qubits that can be 0, 1, or both simultaneously
● IBM and Google are leading quantum computing research
● Potential applications include cryptography and drug discovery
● Current quantum computers require extremely cold temperatures
● Quantum supremacy was demonstrated in 2019

[Agent 2: Writer runs with research findings]
Draft: "Quantum computing represents one of the most exciting frontiers in
technology today..."

[Agent 3: Editor runs with draft]
Feedback: "Add a specific example of quantum supremacy. Clarify the temperatur
requirements. Consider adding a future outlook section."

[Agent 4: Formatter runs with draft + feedback]
Final output:
# The Quantum Leap: Understanding Quantum Computing

Quantum computing represents one of the most exciting frontiers in technology

## How Quantum Computers Work

Unlike traditional computers that use bits (0 or 1), quantum computers use qub

## Real-World Applications

...
```

How It Works (Behind the Scenes)

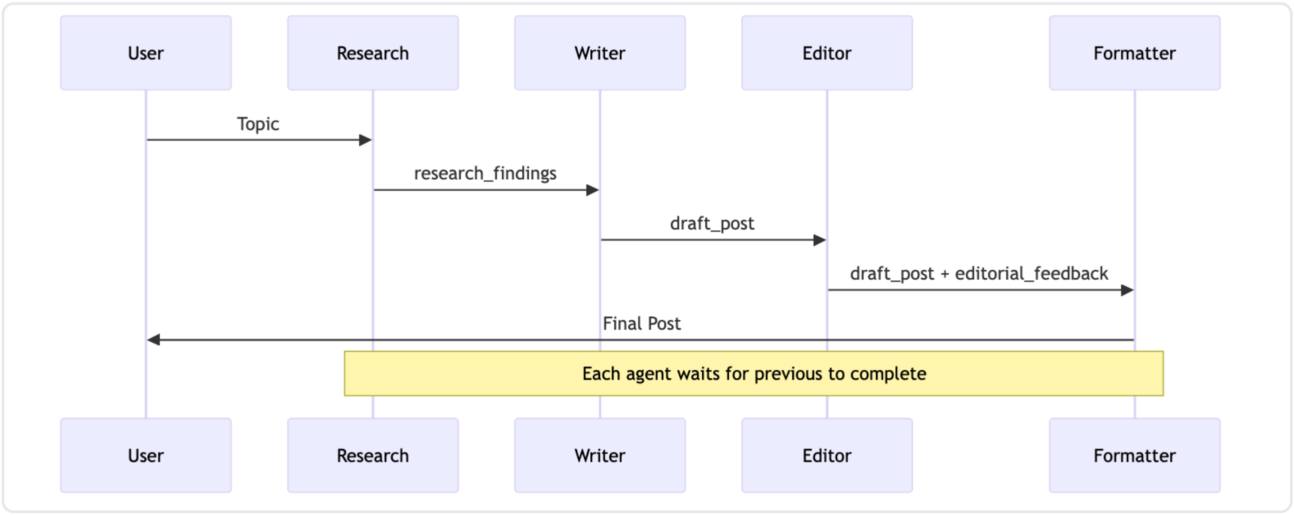
1. **User message arrives** → ADK starts pipeline
2. **SequentialAgent begins**:
3. Calls research_agent.run()
4. Waits for completion
5. Saves output to `state['research_findings']`
6. **Next agent in sequence**:

7. ADK injects `{research_findings}` into writer instruction
8. Calls writer_agent.run()
9. Waits for completion
10. Saves output to `state['draft_post']`
11. **Continue down the chain**:
12. Editor reads `{draft_post}`
13. Formatter reads `{draft_post}` AND `{editorial_feedback}`
14. **Pipeline complete** → Returns final agent's output

Deterministic & Reliable:

- Always same order
- No LLM deciding order
- Predictable behavior

Visual Flow:



Key Takeaways

✓ **SequentialAgent chains agents in strict order** - Perfect for pipelines

✓ **output_key saves to state** - Each agent stores its result

✓ `{key}` **syntax reads from state** - Next agent accesses previous results

✓ **Shared InvocationContext** - All agents in sequence share state

✓ **Deterministic execution** - No LLM, always same order

✔️ **Perfect for workflows** - Research → Write → Review → Format

✔️ **State flow is explicit** - Easy to debug and understand

Best Practices

DO:

- Give each agent a specific, focused task
- Use descriptive `output_key` names
- Be explicit in instructions about what to output
- Use state injection `{key}` for data flow
- Keep agents stateless (rely on state, not internal memory)

DON'T:

- Make agents try to do too much
- Forget to set `output_key` (data won't flow!)
- Use generic state keys like `result` or `data`
- Mix sequential with parallel without planning
- Assume agents remember across separate runs

Common Issues

Problem: "Next agent doesn't see previous agent's output"

- **Solution**: Check that previous agent has `output_key` defined
- **Solution**: Verify you're using `{correct_key_name}` in instruction

Problem: "Pipeline seems to skip agents"

- **Solution**: All agents run, check Events tab to see their outputs
- **Solution**: Agent might be outputting empty response

Problem: "State values not injecting"

- **Solution**: Use exact `{key_name}` matching the `output_key`
- **Solution**: Keys are case-sensitive!

Problem: "Pipeline takes too long"

- **Solution**: This is normal - agents run sequentially (one at a time)
- **Solution**: Consider if some steps could be parallel instead

What We Built

You now have a complete content creation pipeline that:

- Automatically researches topics
- Writes engaging blog posts
- Reviews for quality
- Formats for publication

And you understand how to build ANY sequential workflow!

Real-World Applications

Sequential Workflows Are Perfect For:

- **Content Pipelines**: Research → Write → Edit → Publish
- **Data Processing**: Extract → Transform → Validate → Load (ETL)
- **Quality Control**: Create → Review → Fix → Approve
- **Analysis Pipelines**: Gather Data → Analyze → Visualize → Report
- **Code Workflows**: Write → Review → Refactor → Test
- **Customer Service**: Classify → Route → Respond → Follow-up

🔗 **Related**: Combine sequential workflows with Tutorial 06: Multi-Agent Systems (06_multi_agent_systems.md) for complex agent hierarchies.

Next Steps

🚀 **Tutorial 05: Parallel Processing** - Learn when and how to run agents concurrently for speed

📖 **Further Reading**:

- Sequential Agents Documentation (https://google.github.io/adk-docs/agents/workflow-agents/sequential-agents/)
- State Management Guide (https://google.github.io/adk-docs/sessions/state/)
- Workflow Agents Overview (https://google.github.io/adk-docs/agents/workflow-agents/)

Exercises (Try On Your Own!)

1. **Add more agents** - Add a "fact-checker" between writer and editor
2. **Different domain** - Create a recipe pipeline (ingredients → instructions → nutrition → formatting)
3. **Code pipeline** - Implement: write code → review → test → document
4. **Error handling** - Add an agent that validates each step's output
5. **Conditional flow** - Have editor decide if re-writing is needed

Complete Code Reference

blog_pipeline/init**.py**

```
from . import agent
```

blog_pipeline/.env

```
GOOGLE_GENAI_USE_VERTEXAI=FALSE
GOOGLE_API_KEY=your-api-key-here
```

blog_pipeline/agent.py

```
# See Step 3 above for complete code
```

Congratulations! You've mastered sequential workflows! 🎯📝