Design, Develop, and Deploy Multi-Agent Systems with CrewAI

Foundations of AI Agents

DeepLearning.AI

Design, Develop, and Deploy Multi-Agent Systems with CrewAI

Welcome

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Design, Develop, and Deploy Multi-Agent Systems with CrewAI

Course overview

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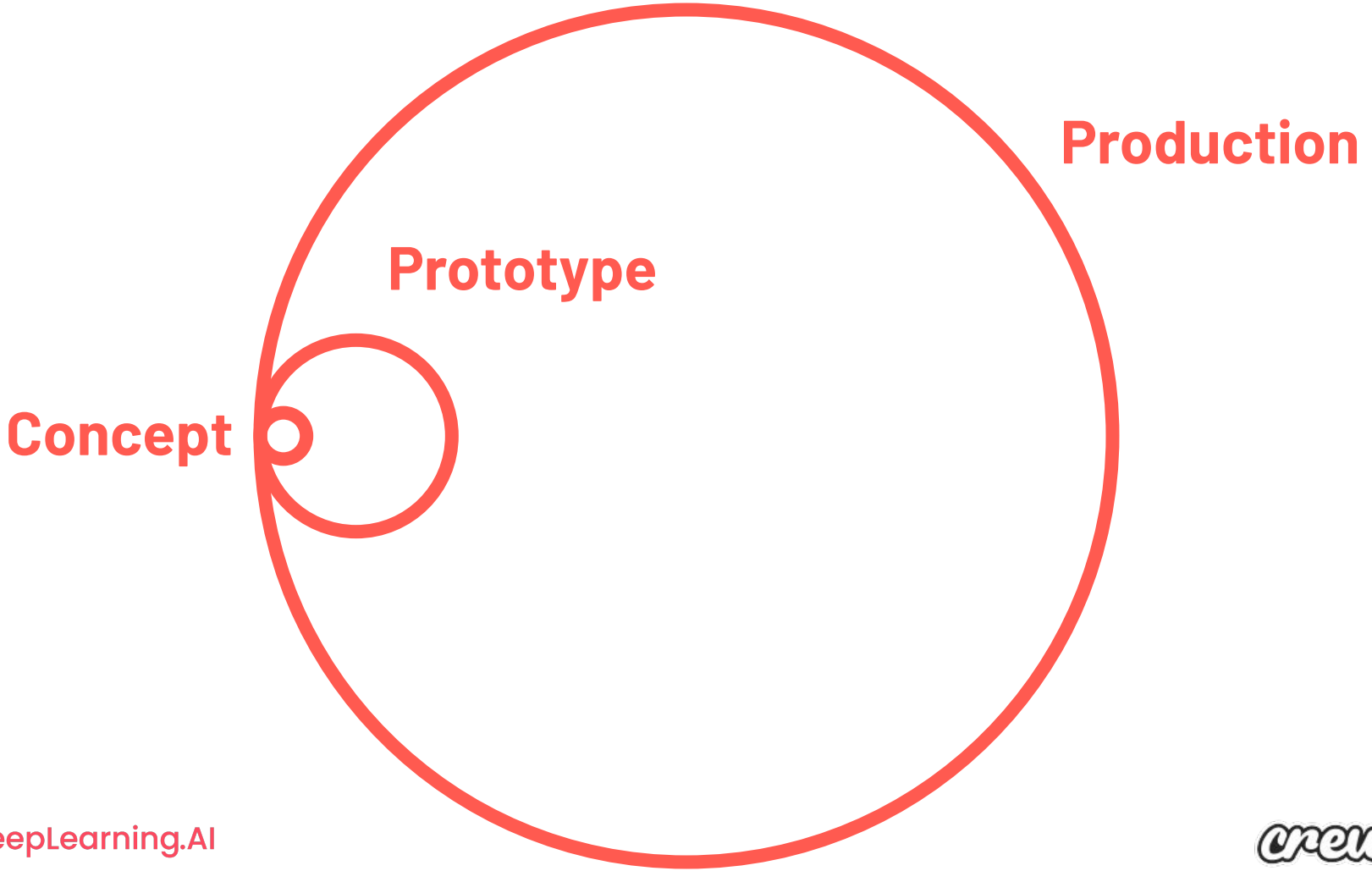
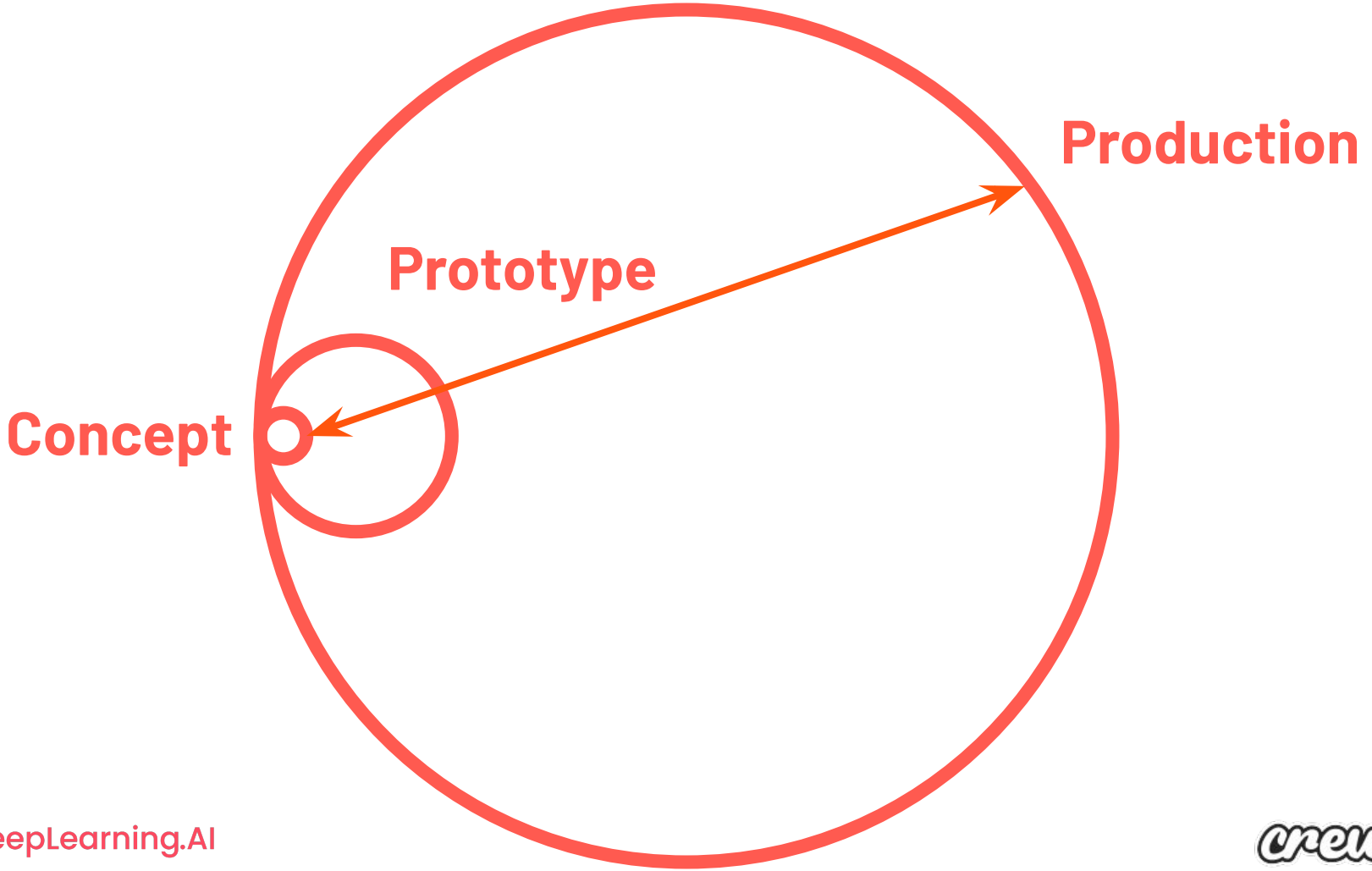
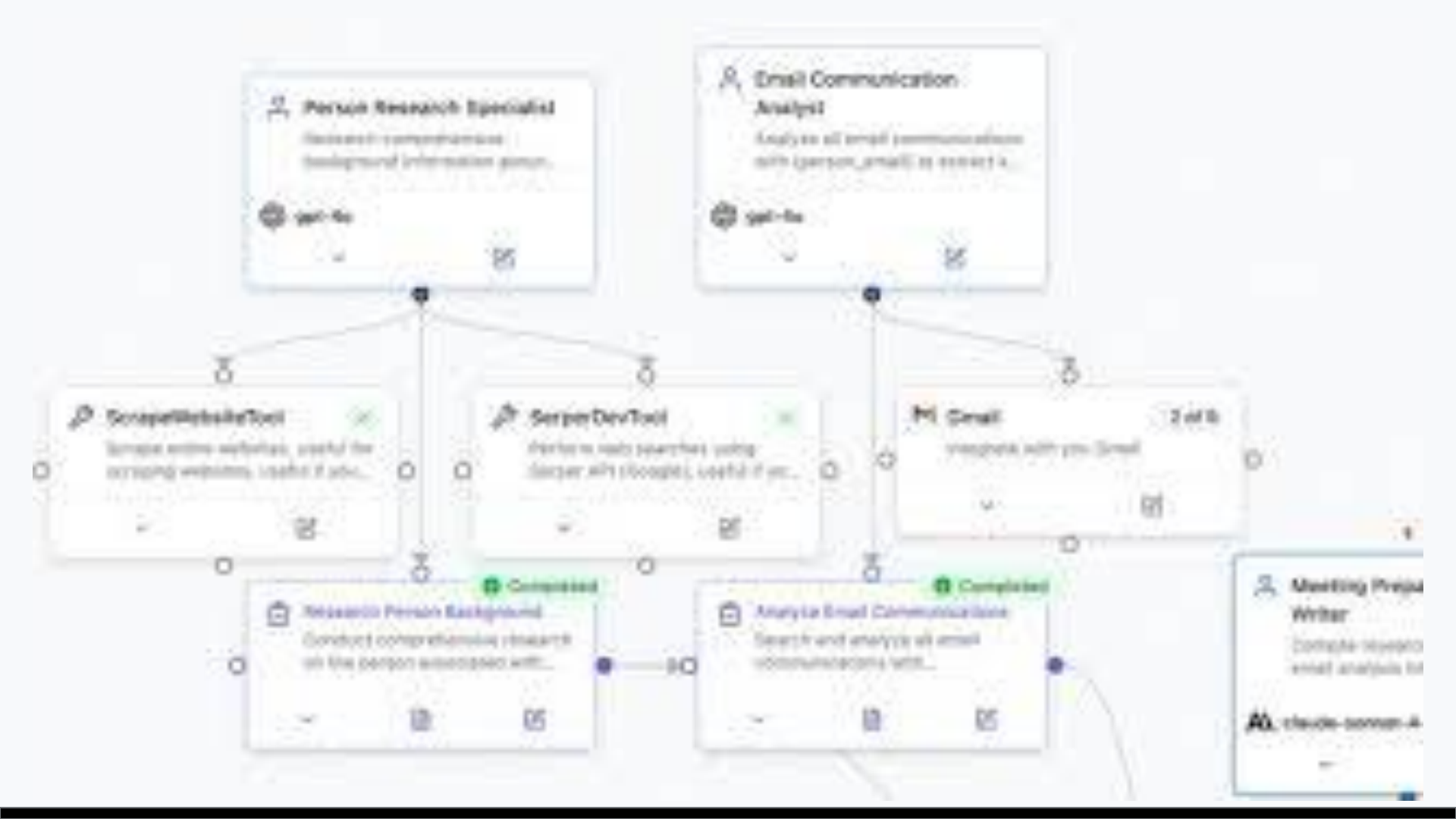
What to expect from this course

- Build your first Multi Agent System and improve it
- Manage AI Agents at different scales
- Evaluate and measure an agentic system's performance
- Explore the new technology stack forming around these agents
- Cut through the noise and experience what is working in the real world
- Apply these principles in your career


Production
Prototype
Concept


Production
Prototype
Concept


Person Research Specialist
gpt-4o
Email Communication Analyst
gpt-4o
ScrapeWebsiteTool
SerperDevTool
Gmail
2 of 6
Completed
Completed

Module 1: **Foundations of AI Agents**

- What are AI agents? – Key components of an AI agent.
- LLMs, Tasks, Agents, Crews, and Flows.
- Bridge the gap between concept, prototype, and production.
- Real-world use cases of AI agents in action.
- Core production pillars for AI Agents at Scale.
- The technology stack for Agentic Systems.

Foundations of AI Agents

What are AI agents?

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AI Agents

AI systems that can decide what happens next
in order to accomplish a goal

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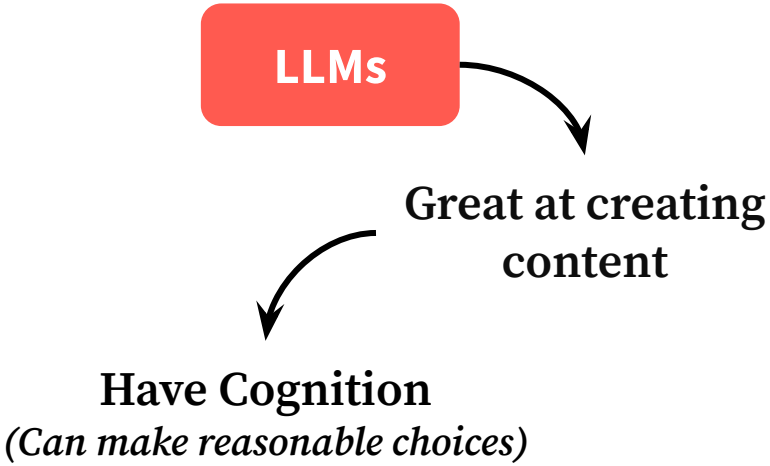
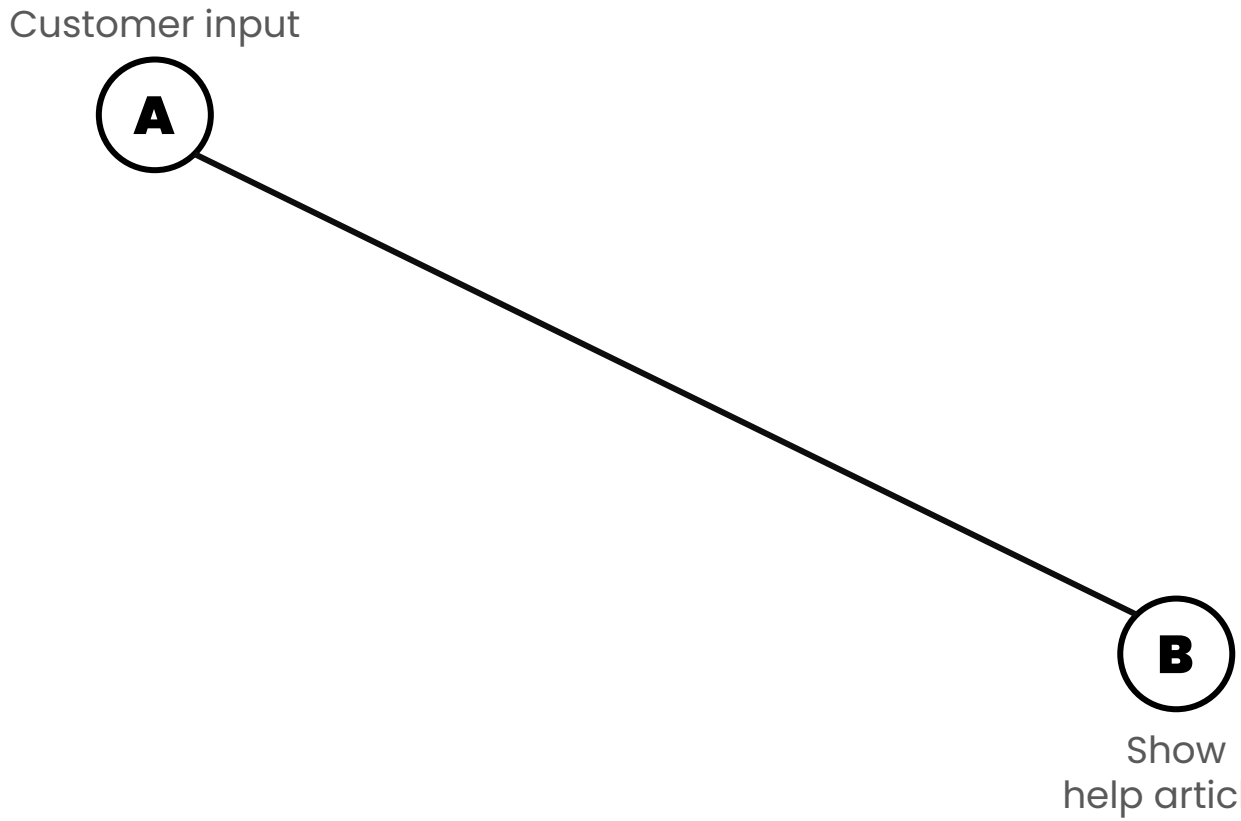


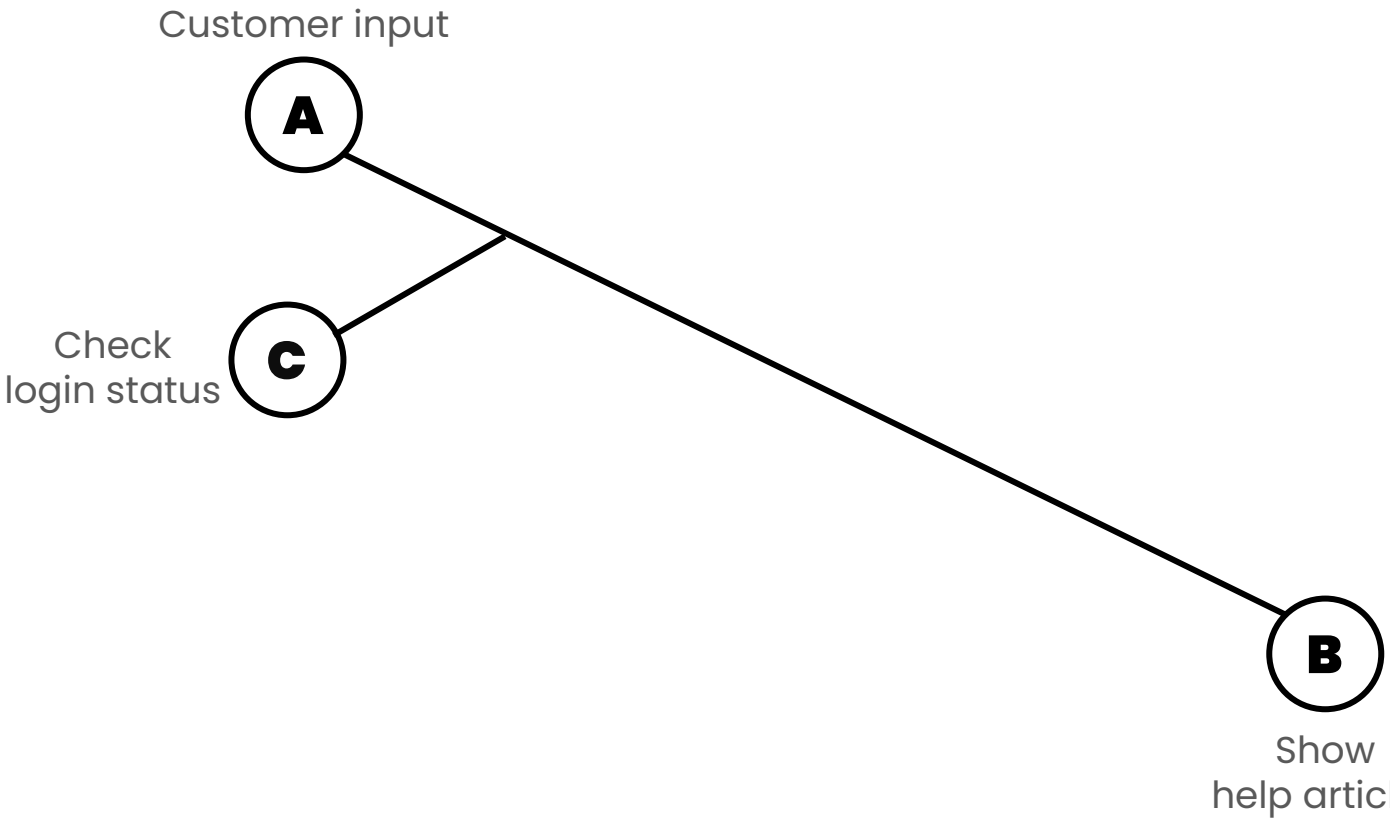
AI Controls the Application Flow

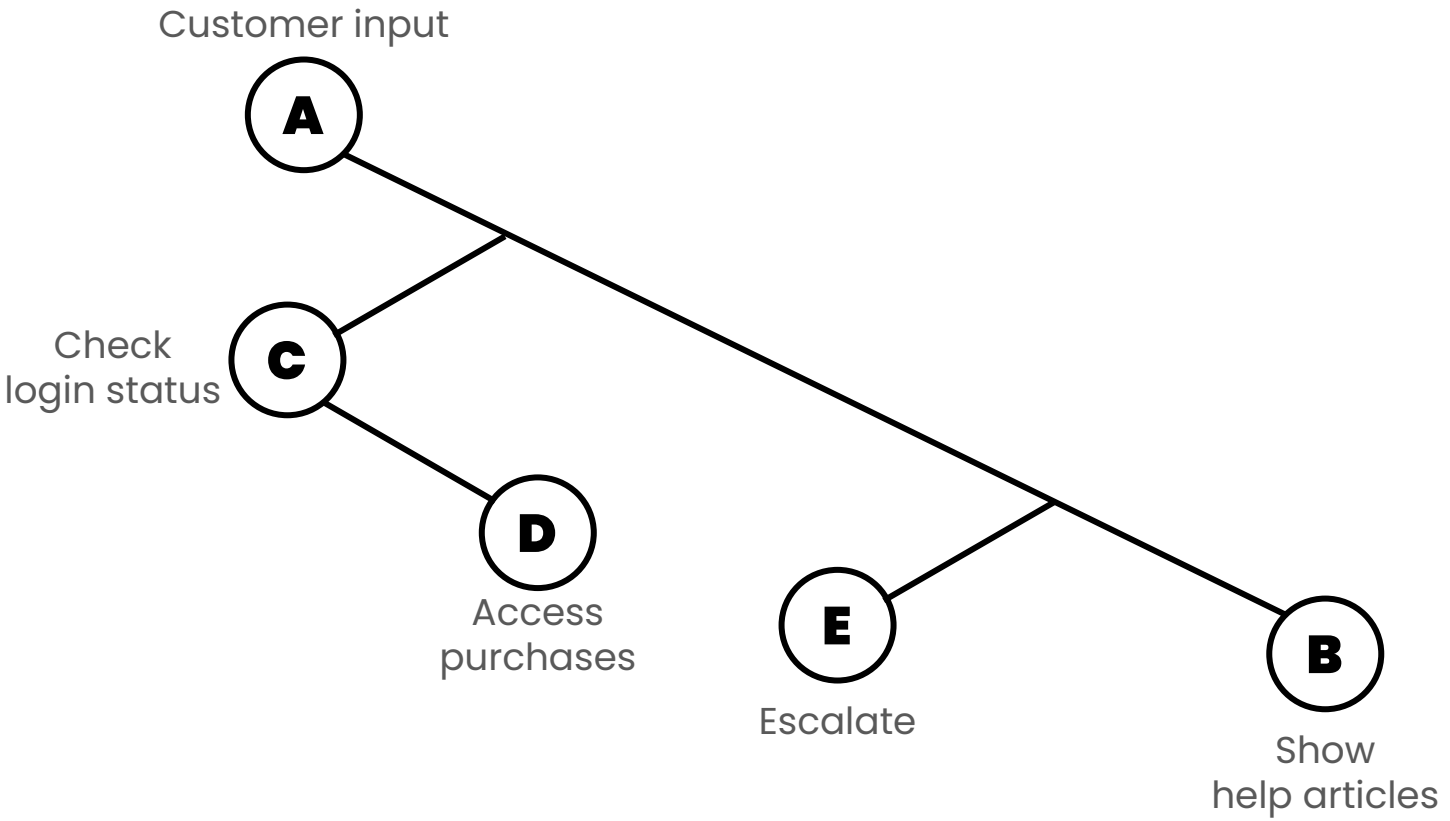
?

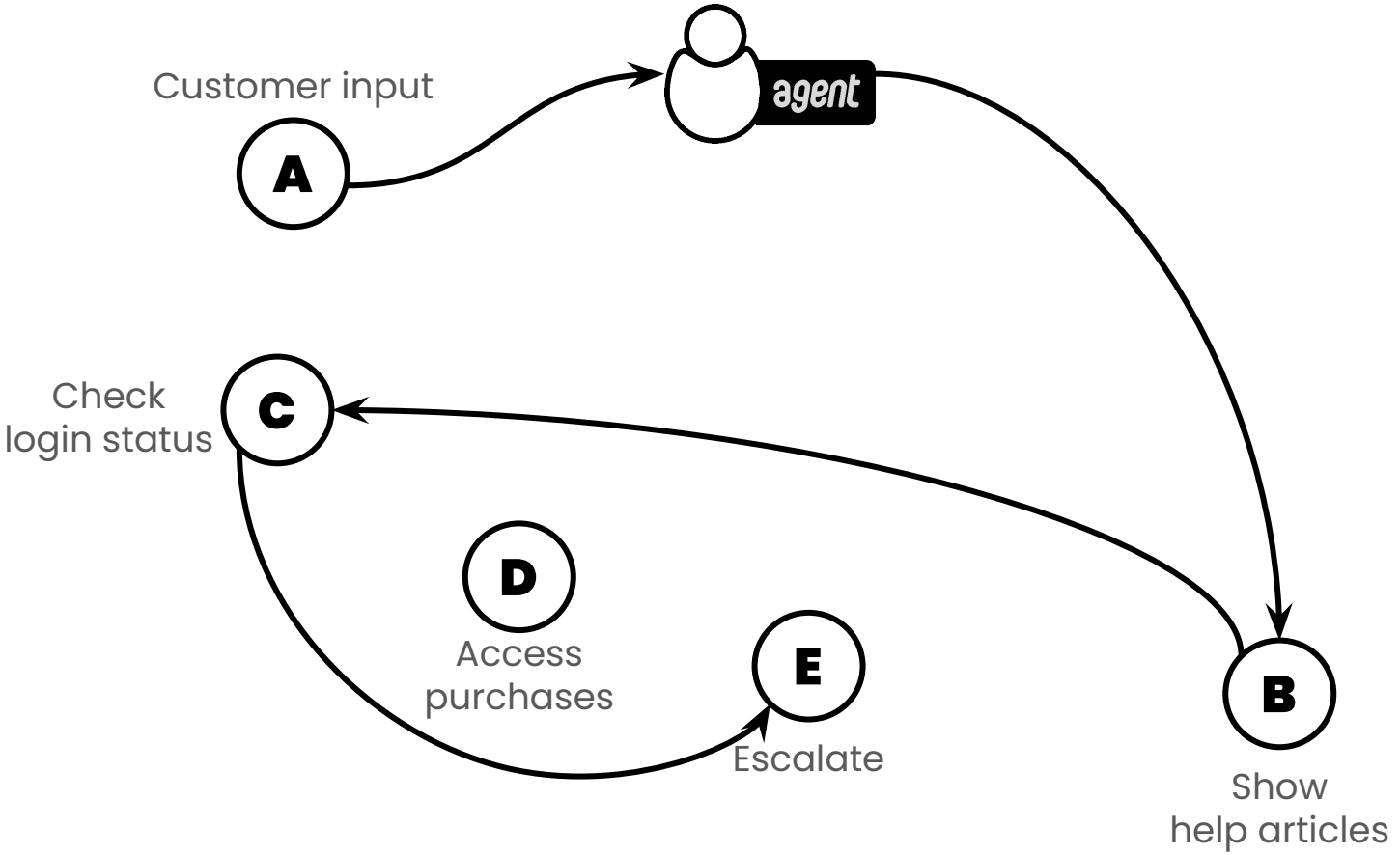
Automations

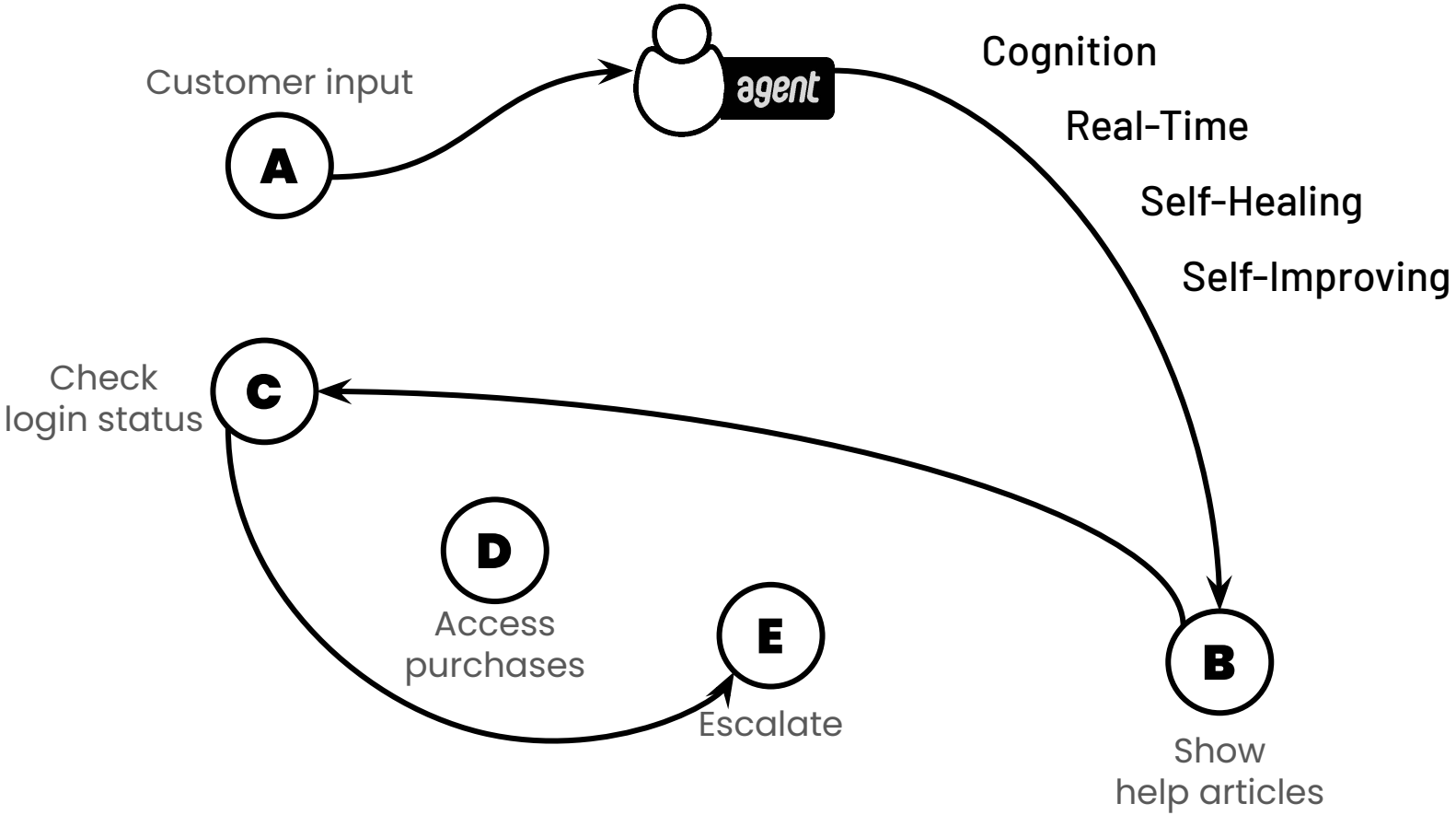
that were not possible before


Customer input
A
B
Show
help articles


Customer input
A
Check
login status
C
B
Show
help articles


Customer input
A
Check
login status
C
D
Access
purchases
E
Escalate
B
Show
help articles


Customer input
A
agent
Check
login status
C
D
Access
purchases
E
Escalate
B
Show
help articles


Customer input
A
agent
Cognition
Real-Time
Self-Healing
Self-Improving
Check
login status
C
D
Access
purchases
E
Escalate
B
Show
help articles

Ability to Create

(write email, create image, evaluate report, generate video)

Ability to Decide

(any tools, any data, any failures)

It’s about systems
that are **reliable**

Foundations of AI Agents

Use cases for AI agents

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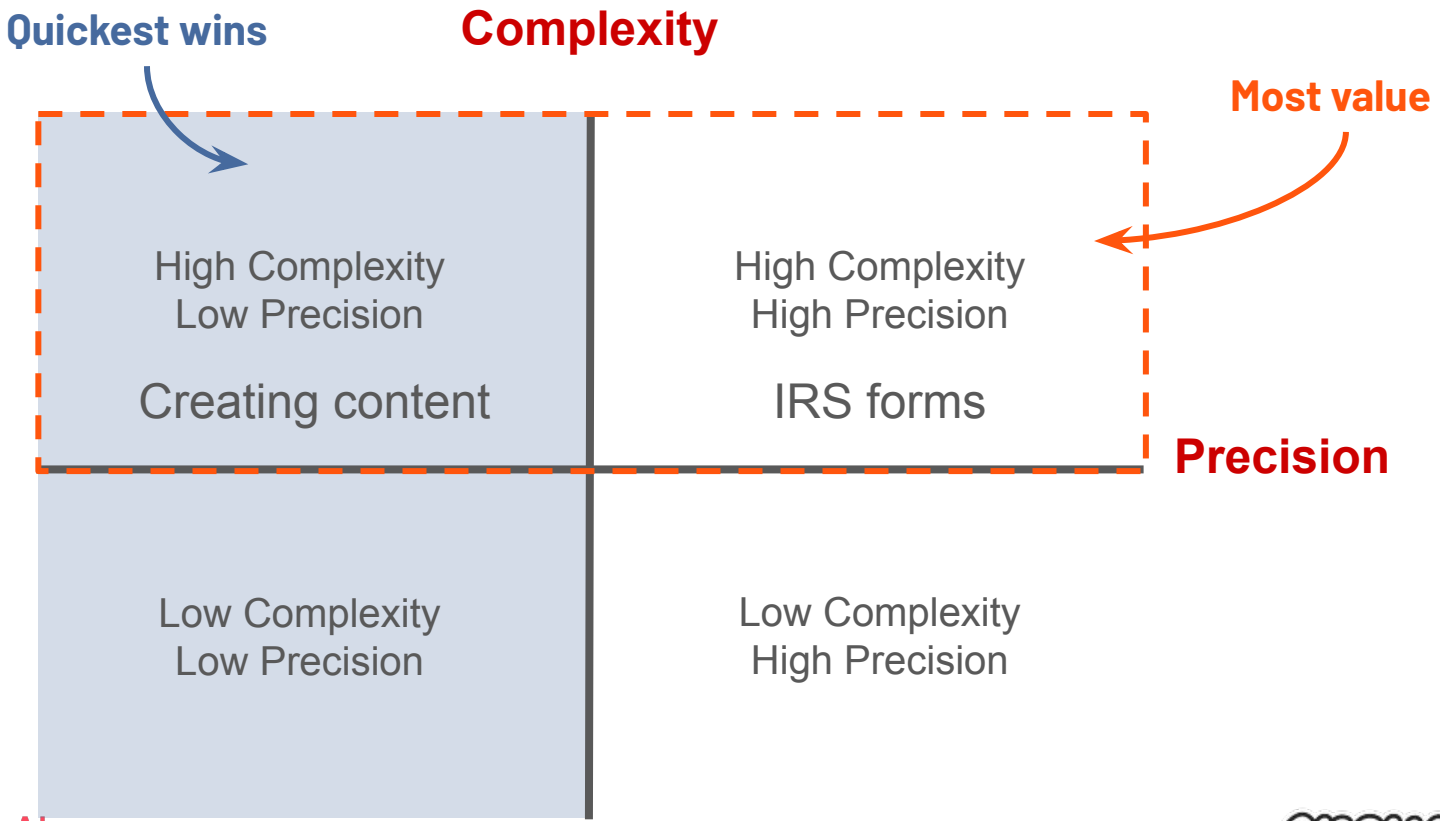
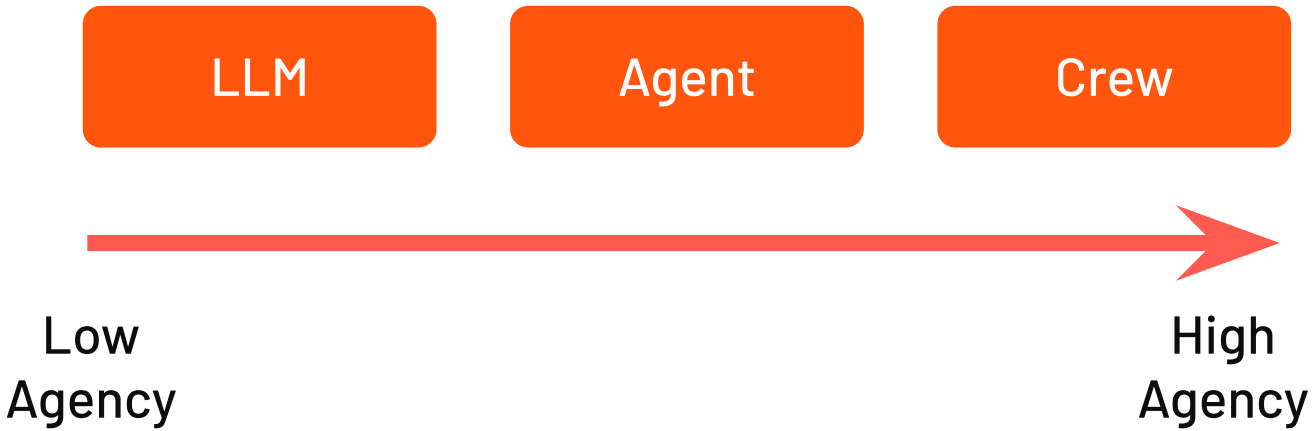
Use Case Matrix

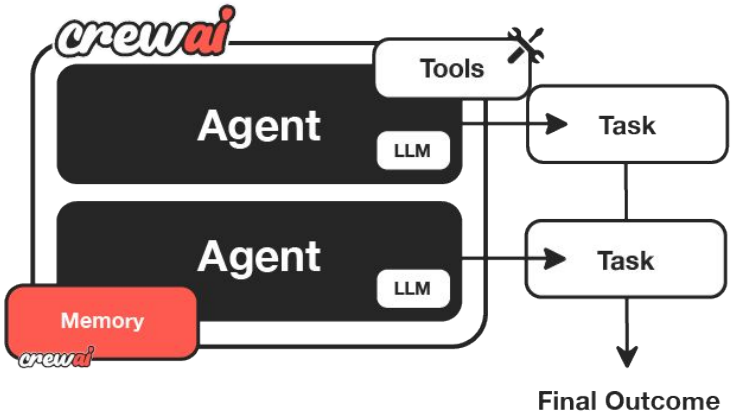


Spectrum of Agency



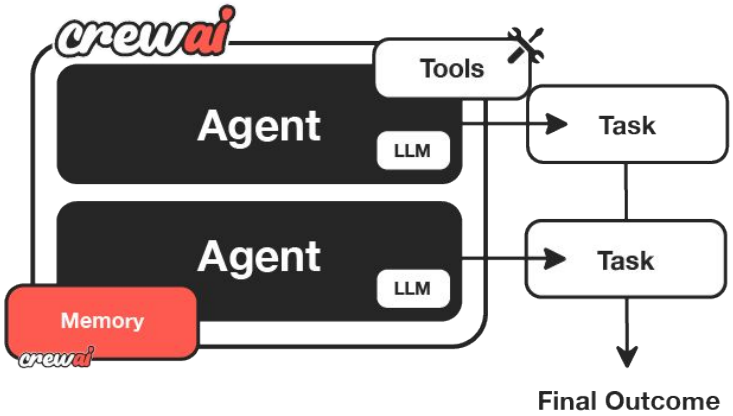
Crew

more agency



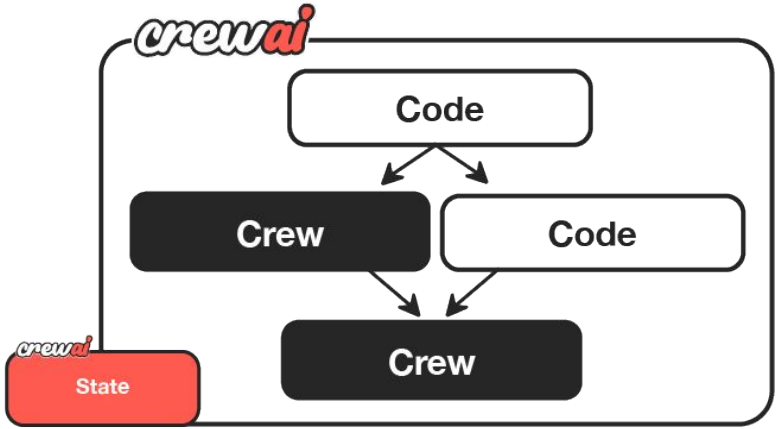
Crew

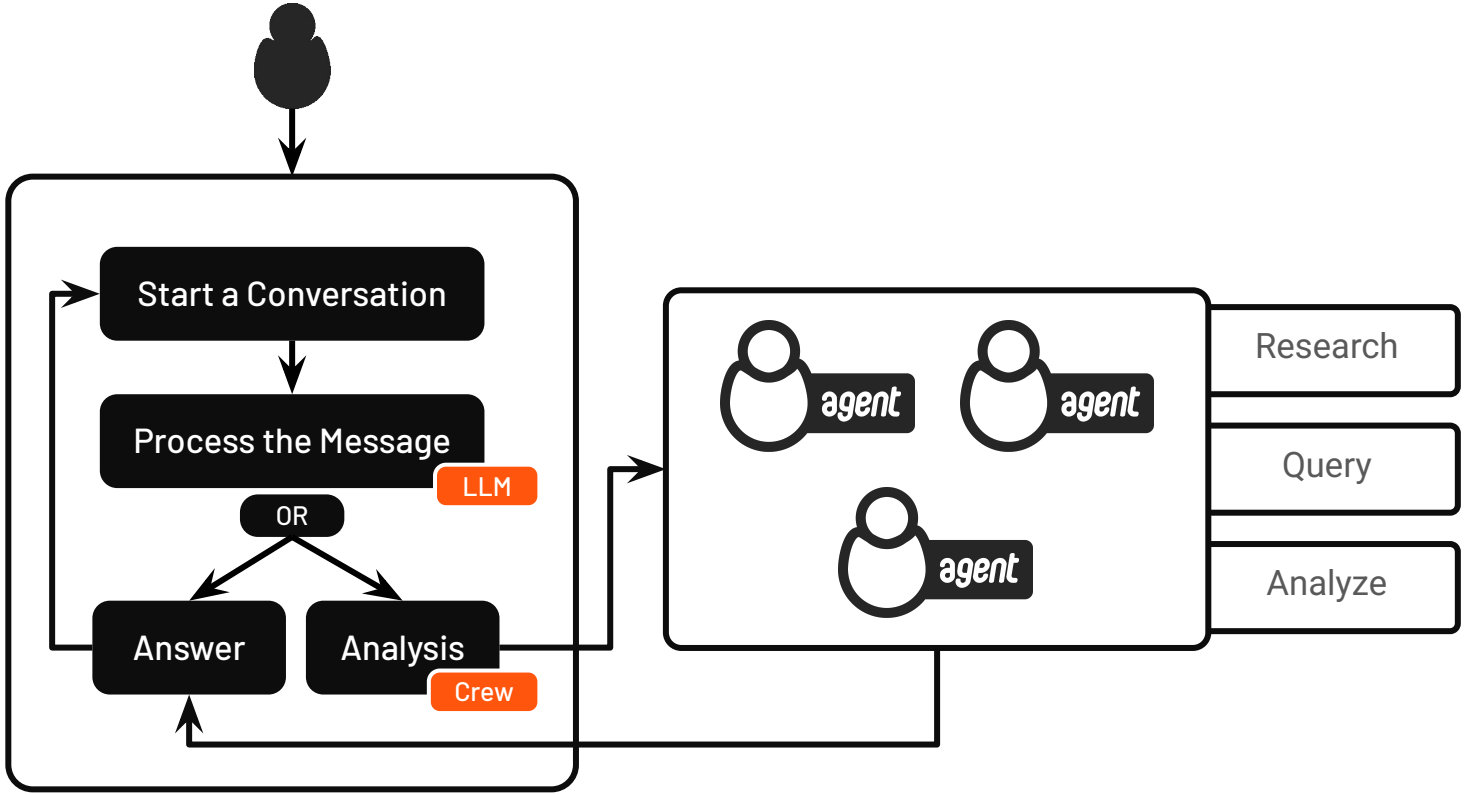
more agency



Flows

finer precision




Start a Conversation
Process the Message
LLM
OR
Answer
Analysis
Crew
agent
agent
agent
Research
Query
Analyze

Foundations of AI Agents

What Makes an AI Agent "Intelligent"?

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Traditional AI systems

Is it going to rain?

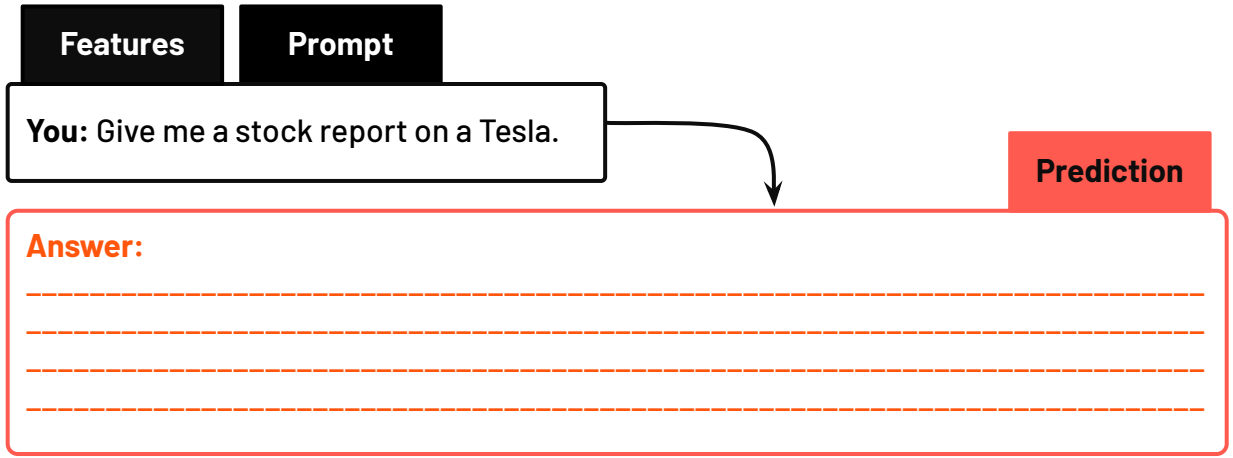
Location	Season	Temperature	Will it Rain?
Mumbai	Summer	90F	No
Taipei	Winter	65F	Yes
...	...	...	...
Tokyo	Summer	85F	?

Traditional AI systems

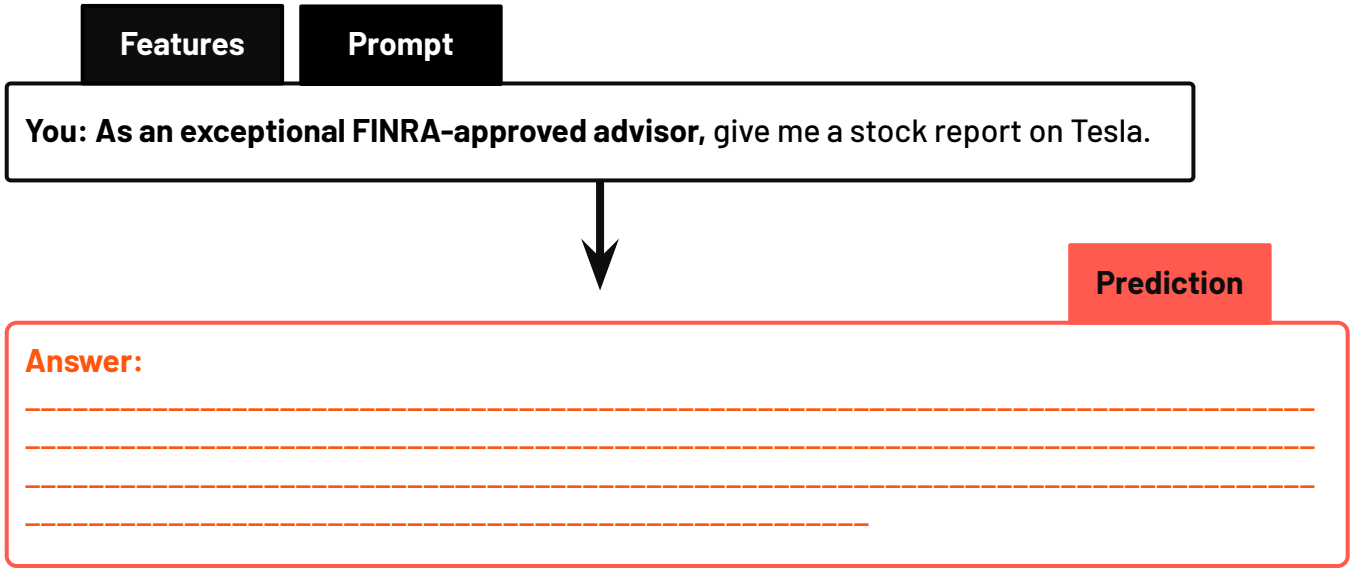
Is it going to rain?

Features				
Location	**Season**	**Temperature**	**Will it Rain?**	**Prediction**
Mumbai	Summer	90F	No	
Taipei	Winter	65F	Yes	
...	...	...	...	
Tokyo	Summer	85F	?	

LLMs in a Nutshell



Prompt engineering



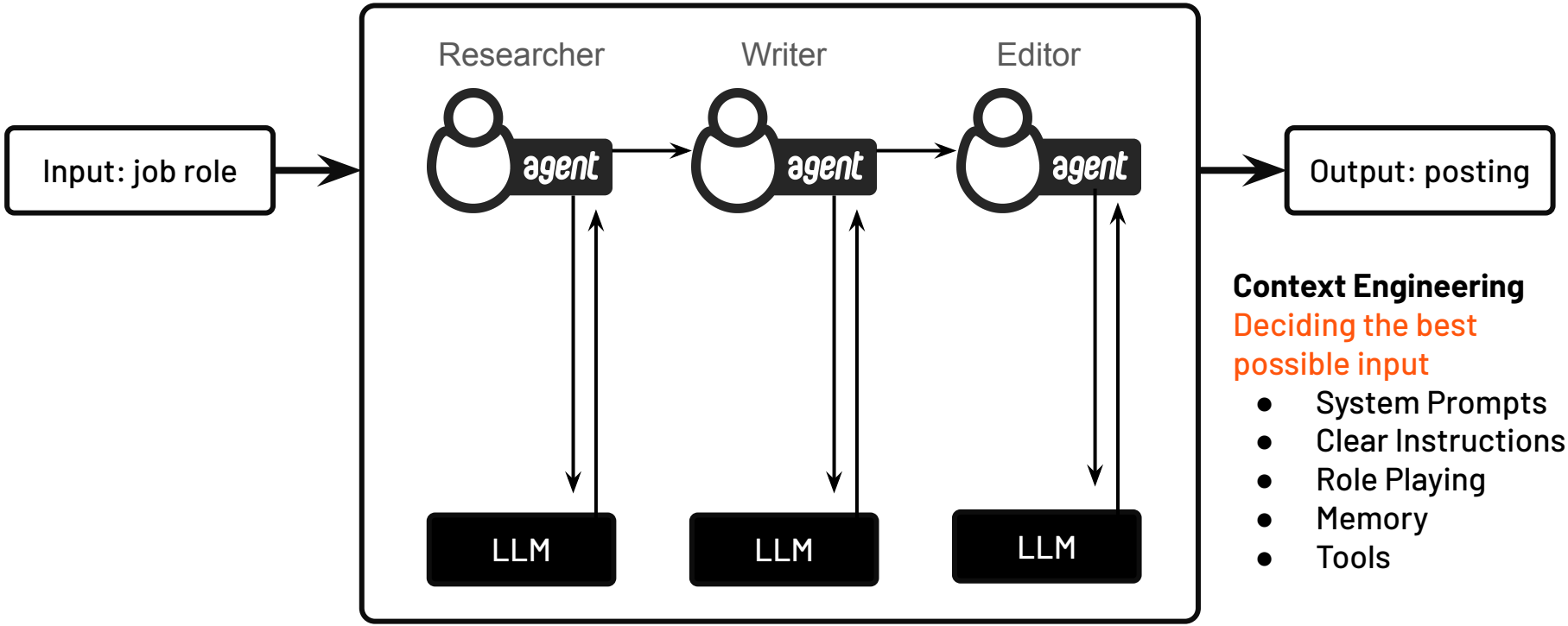
Controlling what goes into the LLM heavily impacts how it responds

The ability to do that effectively is what makes great intelligent Agents

Traditional Strongly Typed Software

Agentic Systems

Example: Creating Job Listings

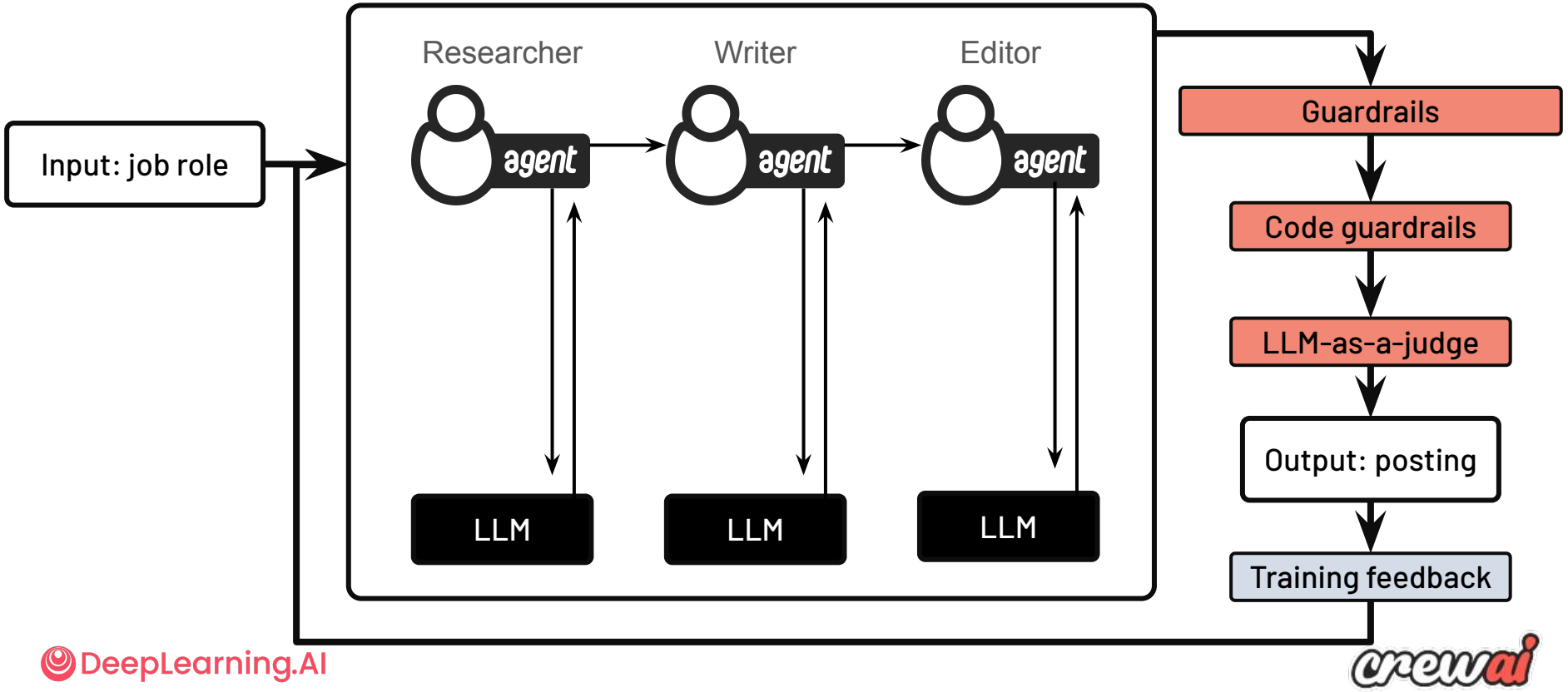


Context Engineering

Deciding the best possible input

- System Prompts
- Clear Instructions
- Role Playing
- Memory
- Tools

Example: Creating Job Listings



Foundations of AI Agents

Building an AI Agent

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The 80/20 Rule: Focus on Tasks Over Agents

When building effective AI systems, remember this crucial principle: 80% of your effort should go into designing tasks.

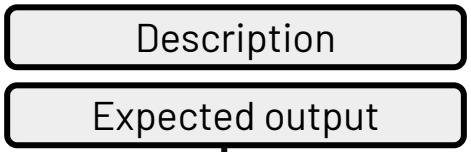
Even the most perfectly defined agent will fail with poorly designed tasks, but well-designed tasks can elevate even a simple agent.

- **80% effort**:
  - Craft clear tasks
- **20% effort**:
  - Polish agent personas

Think like a manager!

Task

- Single purpose, single output
- Assigned to agents



What needs to be accomplished

What format you want

Context Engineering

- System prompts
- Clear Instructions
- Role playing
- Memory
- Tools

Task

- Single purpose, single output
- Assigned to agents

Description

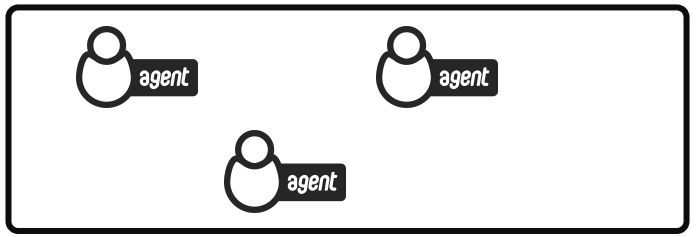
Expected output

What needs to be accomplished

What format you want

Single Agent

Multi Agent



Agent

Role	Real-world job title
Goal	What “good” looks like
Backstory	Expertise, working style, values

Context Engineering

- System prompts
- Clear Instructions
- Role playing
- Memory
- Tools

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Planning Multi-Agent Systems

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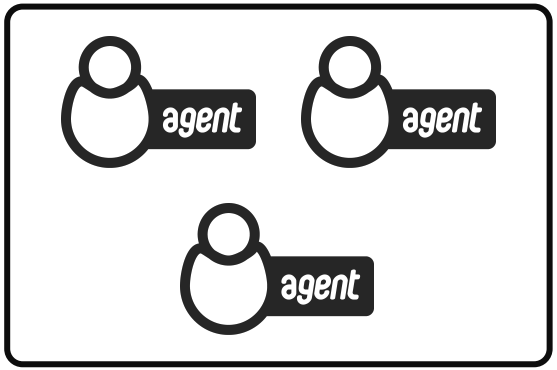
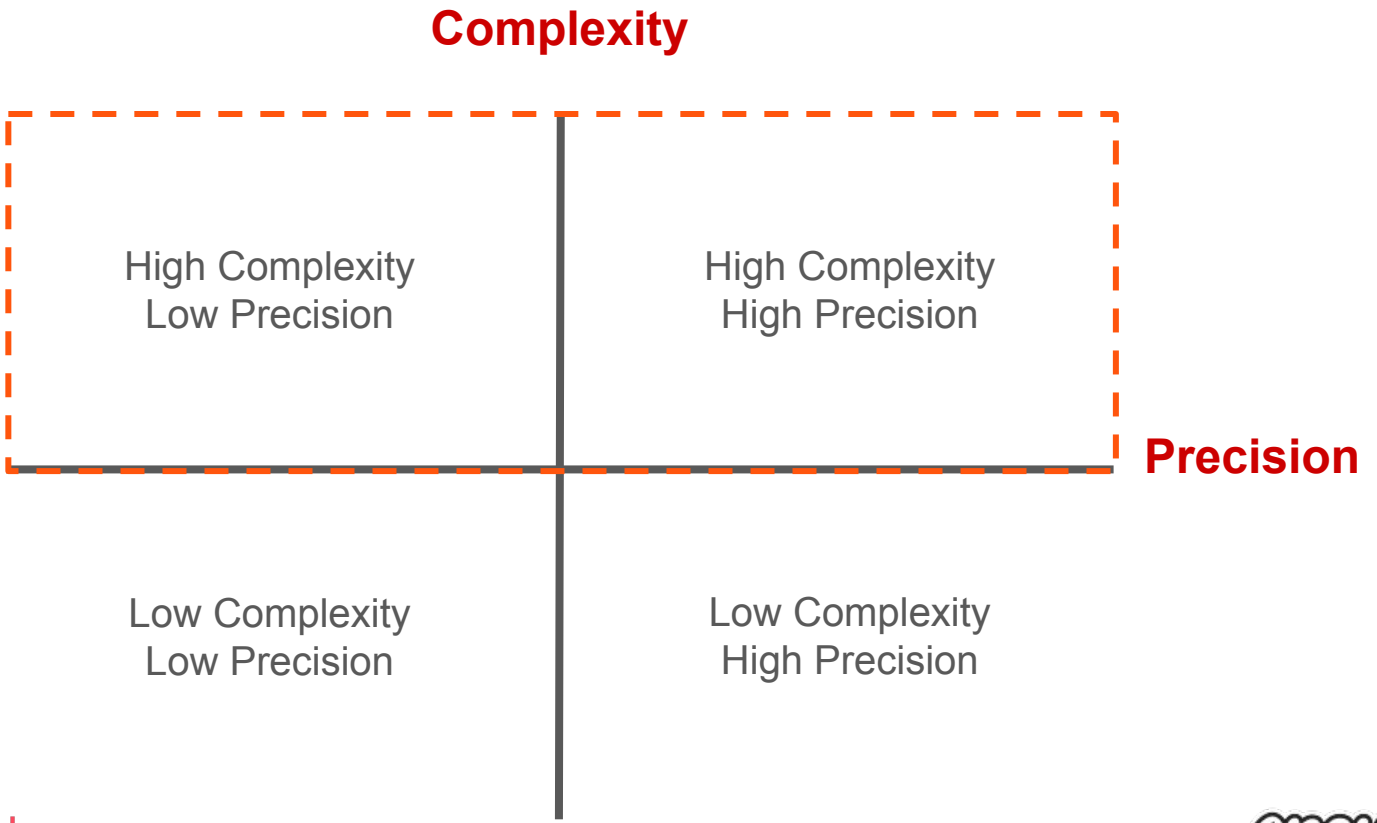
Agentic Systems

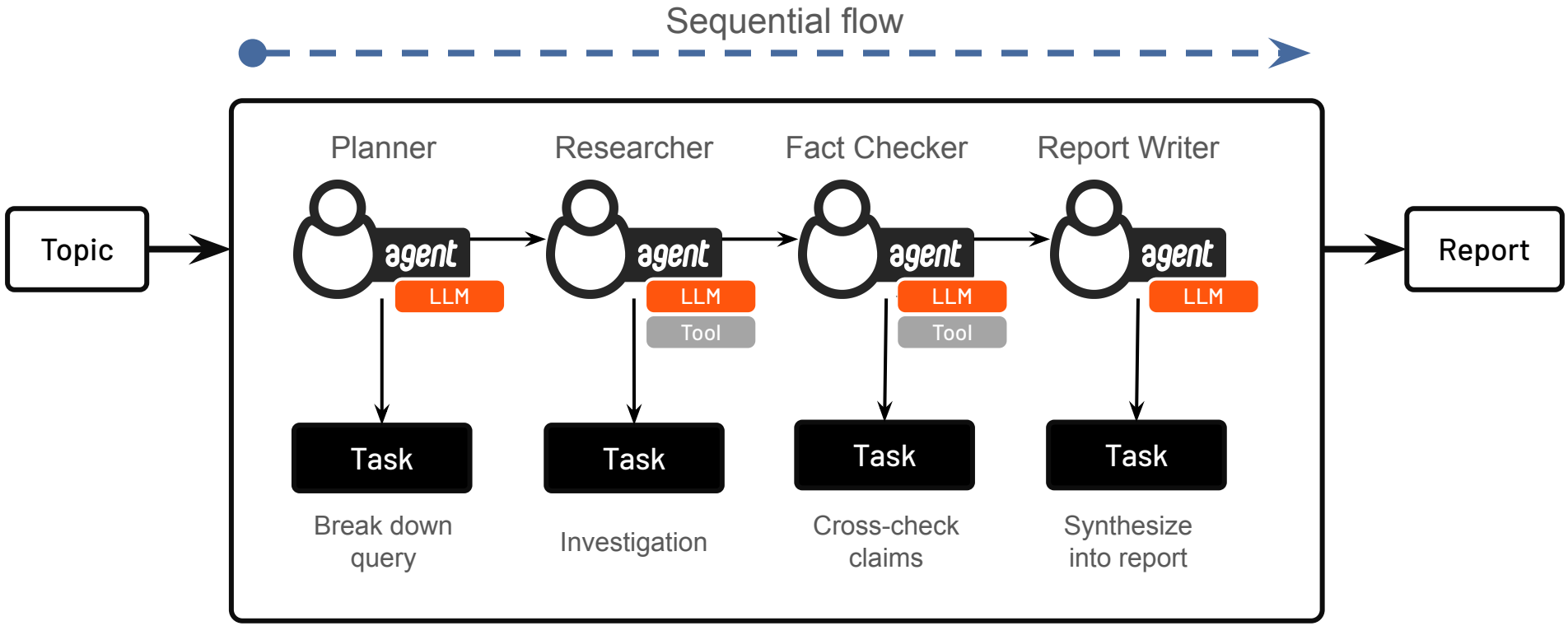
Single Agent

Multi Agent



Use Case Matrix




Sequential flow
Topic
Planner
agent
LLM
Task
Break down query
Researcher
agent
LLM
Tool
Task
Investigation
Fact Checker
agent
LLM
Tool
Task
Cross-check claims
Report Writer
agent
LLM
Task
Synthesize into report
Report

Foundations of AI Agents

Building Your First Multi-agent System

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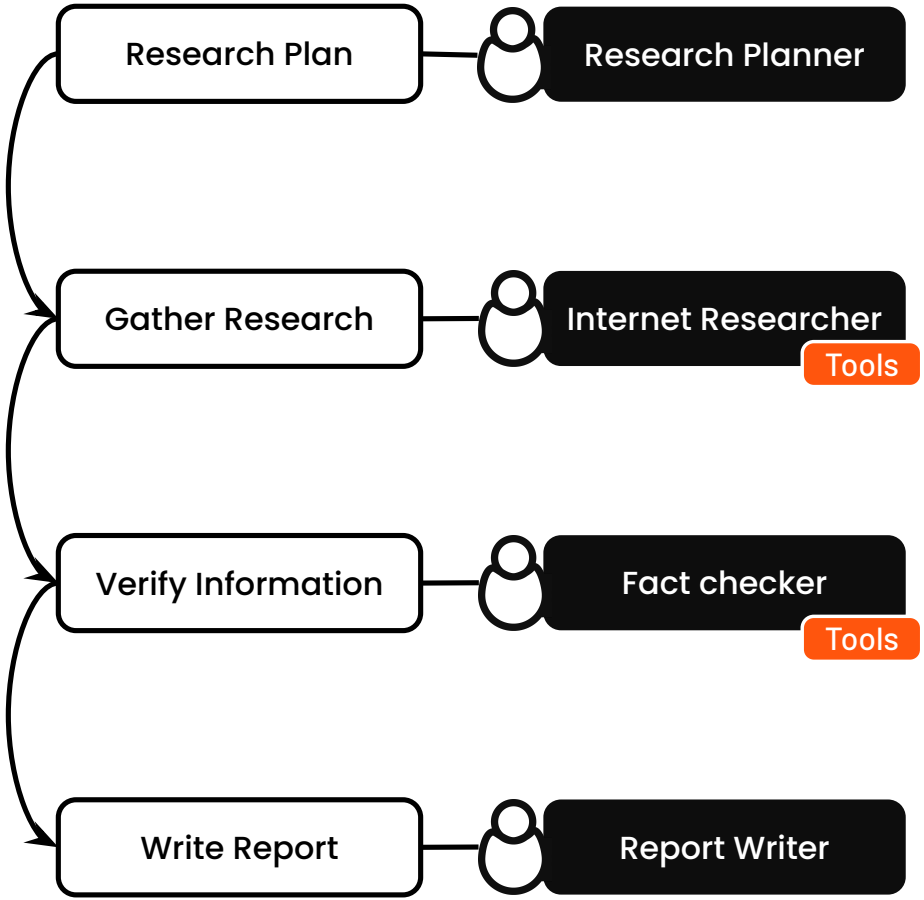
Research Plan
Research Planner
Gather Research
Internet Researcher
Tools
Verify Information
Fact checker
Tools
Write Report
Report Writer

Foundations of AI Agents

Multi-agent Systems in Production

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Moving to Production

Human Time vs Machine Time

- Few users
- Few executions

Easy to monitor & fix

- 1000+ users
- 100,000+ executions

Difficult to monitor & fix

Zoom In

Ability to Debug, Reproduce errors,
Checking traces, Prompts, Tokens, etc...

Zoom Out

Using LLMs as Judge, Check for Quality,
Hallucinations, ROI and Success Metrics

What about **Pitfalls?**

1. Not spending time on planning use cases
2. Not clear definition of success
3. Not breaking the process into smaller chunks
4. Not measuring / evaluating

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Tactics for Debugging, Observing, Optimizing

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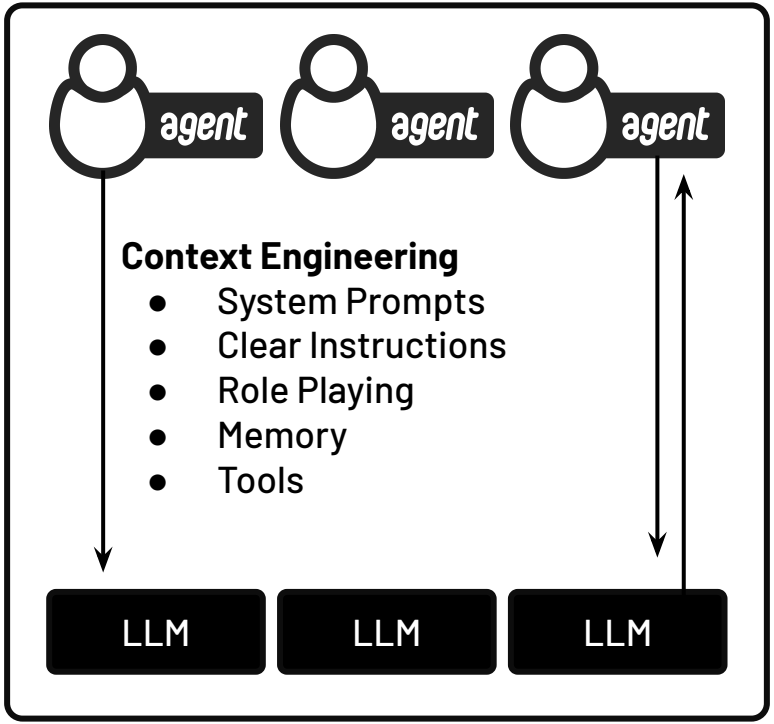
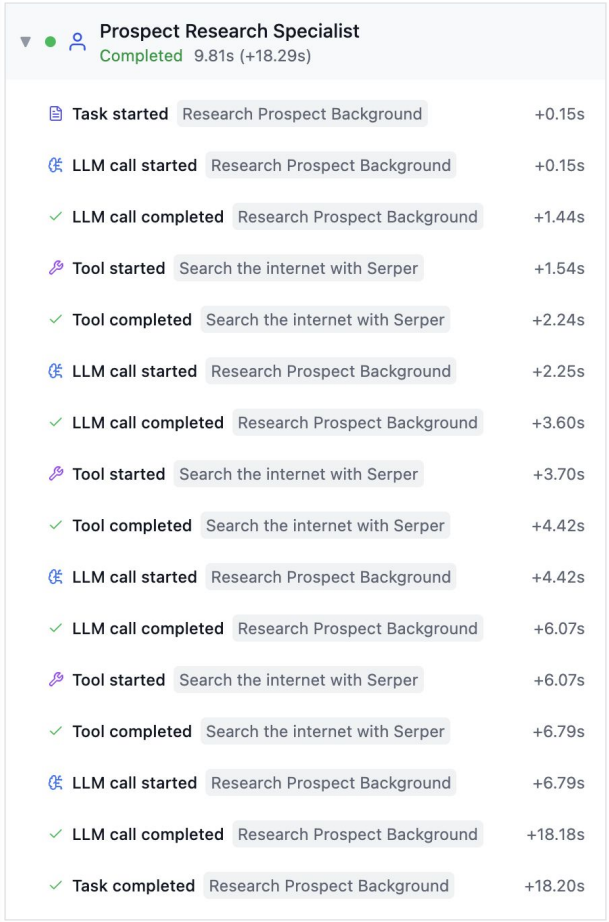
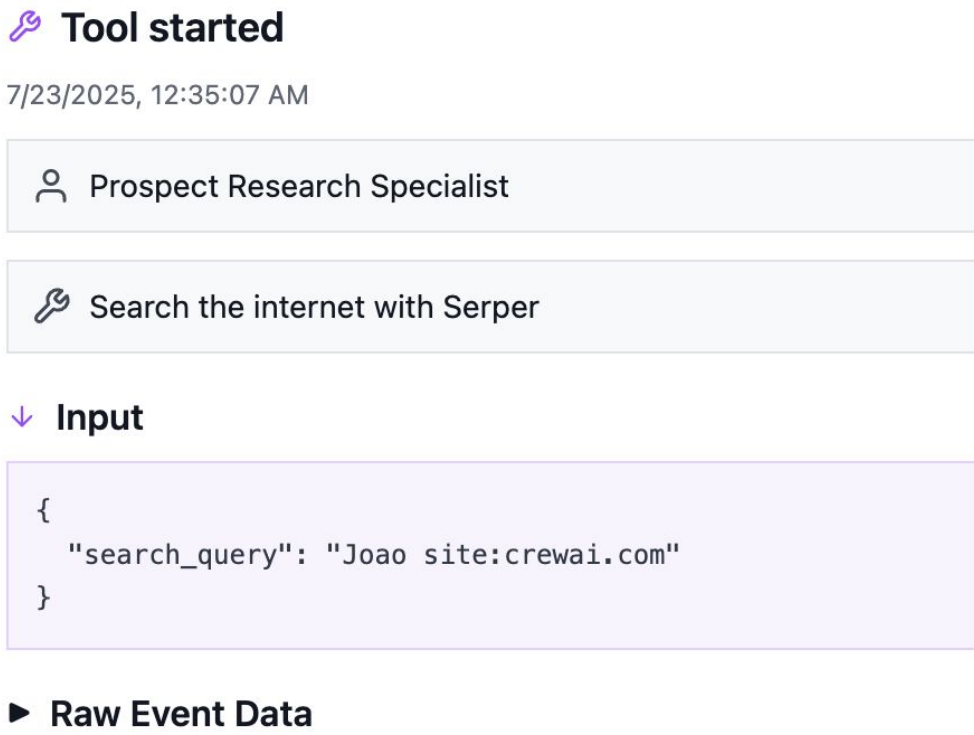
You need to have trust


agent
agent
agent
Context Engineering
System Prompts
Clear Instructions
Role Playing
Memory
Tools
LLM
LLM
LLM

Why did my agent do X?
Where did this data come from?
What tools did it use?


Prospect Research Specialist
Completed 9.81s (+18.29s)
Task started Research Prospect Background +0.15s
LLM call started Research Prospect Background +0.15s
LLM call completed Research Prospect Background +1.44s
Tool started Search the internet with Serper +1.54s
Tool completed Search the internet with Serper +2.24s
LLM call started Research Prospect Background +2.25s
LLM call completed Research Prospect Background +3.60s
Tool started Search the internet with Serper +3.70s
Tool completed Search the internet with Serper +4.42s
LLM call started Research Prospect Background +4.42s
LLM call completed Research Prospect Background +6.07s
Tool started Search the internet with Serper +6.07s
Tool completed Search the internet with Serper +6.79s
LLM call started Research Prospect Background +6.79s
LLM call completed Research Prospect Background +18.18s
Task completed Research Prospect Background +18.20s


Tool started
7/23/2025, 12:35:07 AM
Prospect Research Specialist
Search the internet with Serper
Input
{
"search_query": "Joao site:crewai.com"
}
Raw Event Data

Prospect Research Specialist

Completed 9.81s (+18.29s)

Task started	Research Prospect Background	+0.15s
LLM call started	Research Prospect Background	+0.15s
LLM call completed	Research Prospect Background	+1.44s
Tool started	Search the internet with Serper	+1.54s
Tool completed	Search the internet with Serper	+2.24s
LLM call started	Research Prospect Background	+2.25s
LLM call completed	Research Prospect Background	+3.60s
Tool started	Search the internet with Serper	+3.70s
Tool completed	Search the internet with Serper	+4.42s
LLM call started	Research Prospect Background	+4.42s
LLM call completed	Research Prospect Background	+6.07s
Tool started	Search the internet with Serper	+6.07s
Tool completed	Search the internet with Serper	+6.79s
LLM call started	Research Prospect Background	+6.79s
LLM call completed	Research Prospect Background	+18.18s
Task completed	Research Prospect Background	+18.20s

Event details

LLM call started

7/23/2025, 12:35:05 AM

Prospect Research Specialist

Messages

system

```
You are Prospect Research Specialist. You are an expert research specialist with extensive experience in
prospecting and lead qualification. You excel at finding detailed information about professionals and their
companies through online research, social media, and public sources. You have a keen eye for identifying key
business insights that would be valuable for sales conversations.
Your personal goal is: Research comprehensive information about joao@crewai.com including their professional
background, company details, role, and goals using online sources
You ONLY have access to the following tools, and should NEVER make up tools that are not listed here:

Tool Name: Search the internet with Serper
Tool Arguments: {'search_query': {'description': 'Mandatory search query you want to use to search the
internet', 'type': 'str'}}
Tool Description: A tool that can be used to search the internet with a search_query. Supports different search
types: 'search' (default), 'news'

IMPORTANT: Use the following format in your response:

```
Thought: you should always think about what to do
Action: the action to take, only one name of [Search the internet with Serper], just the name, exactly as it's
written.
Action Input: the input to the action, just a simple JSON object, enclosed in curly braces, using " to wrap keys
and values.
Observation: the result of the action
```

Once all necessary information is gathered, return the following format:

```
Thought: I now know the final answer
Final Answer: the final answer to the original input question
```
```

Running the Crew

```
╭──────────────────────────── Crew Execution Started ────────────────────────────╮
│  Crew Execution Started                                                        │
│  Name: crew                                                                    │
│  ID: 0d45185f-5c76-45b2-a134-1533f688021d                                      │
│  Tool Args:                                                                    │
╰────────────────────────────────────────────────────────────────────────────────╯

🚀 Crew: crew
└── 📋 Task: 9ac567bc-fef3-4c76-a0d8-2fc7b09626d8
    Status: Executing Task...
╭──────────────────────────── 🤖 Agent Started ──────────────────────────────────╮
│  Agent: AI LLMs Senior Data Researcher                                         │
│                                                                                │
│  Task: Conduct a thorough research about AI LLMs Make sure you find any        │
│  interesting and relevant information given the current year is 2025.          │
╰────────────────────────────────────────────────────────────────────────────────╯
```

Prompting

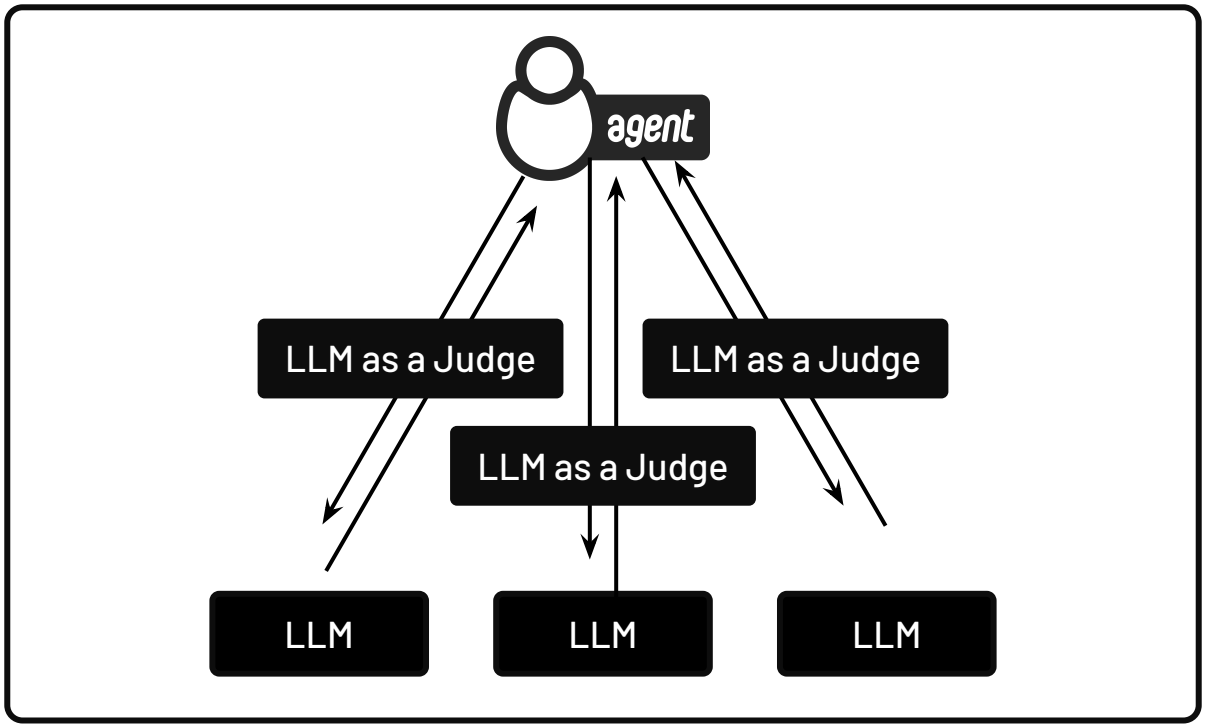
Agent

- Role
- Goal
- Backstory

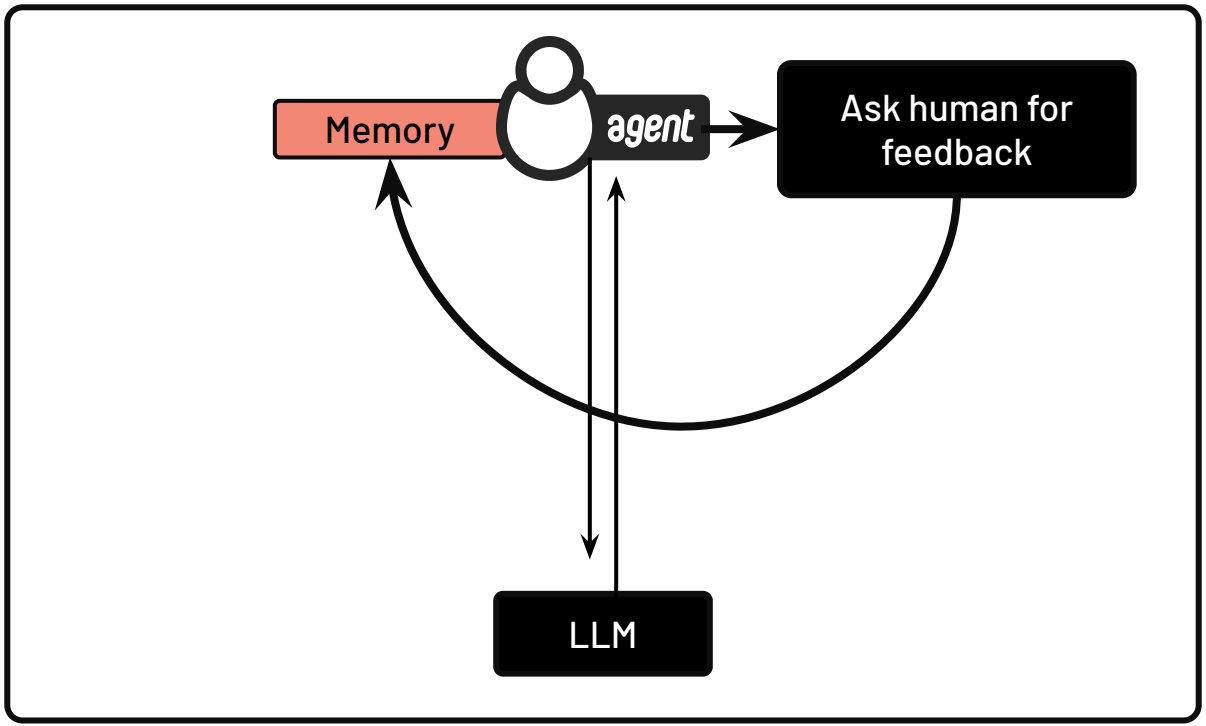
Task

- Description
- Expected Output

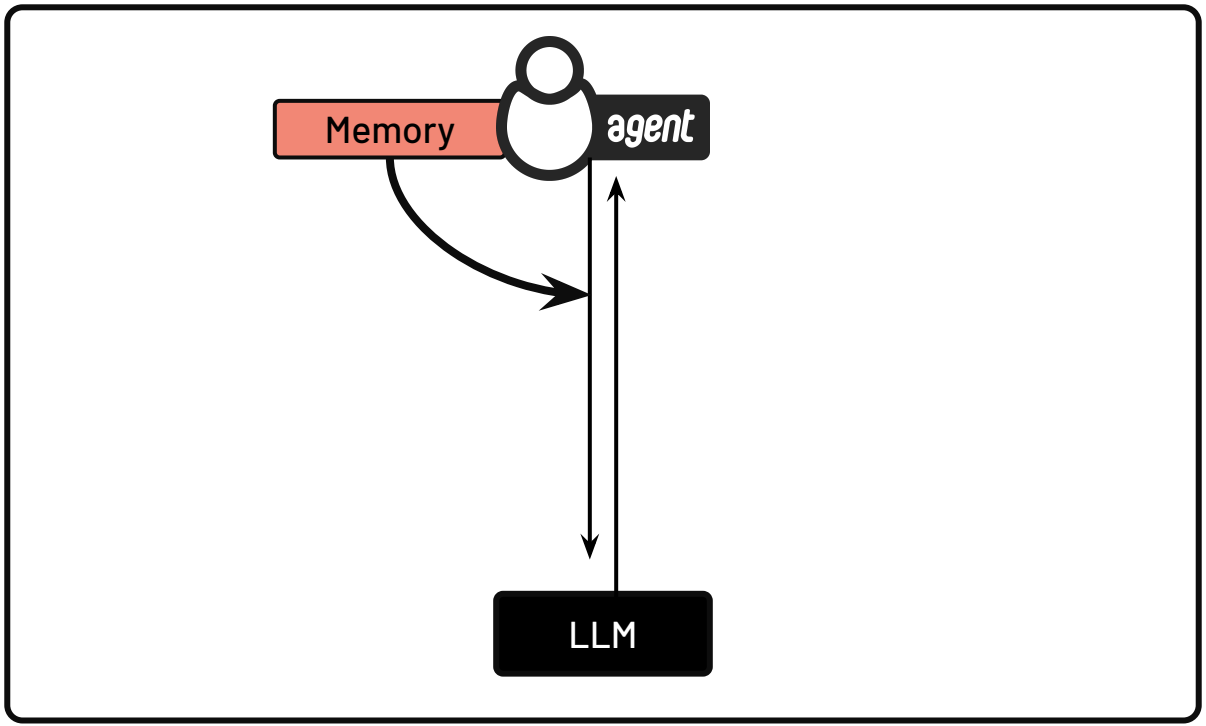
Testing



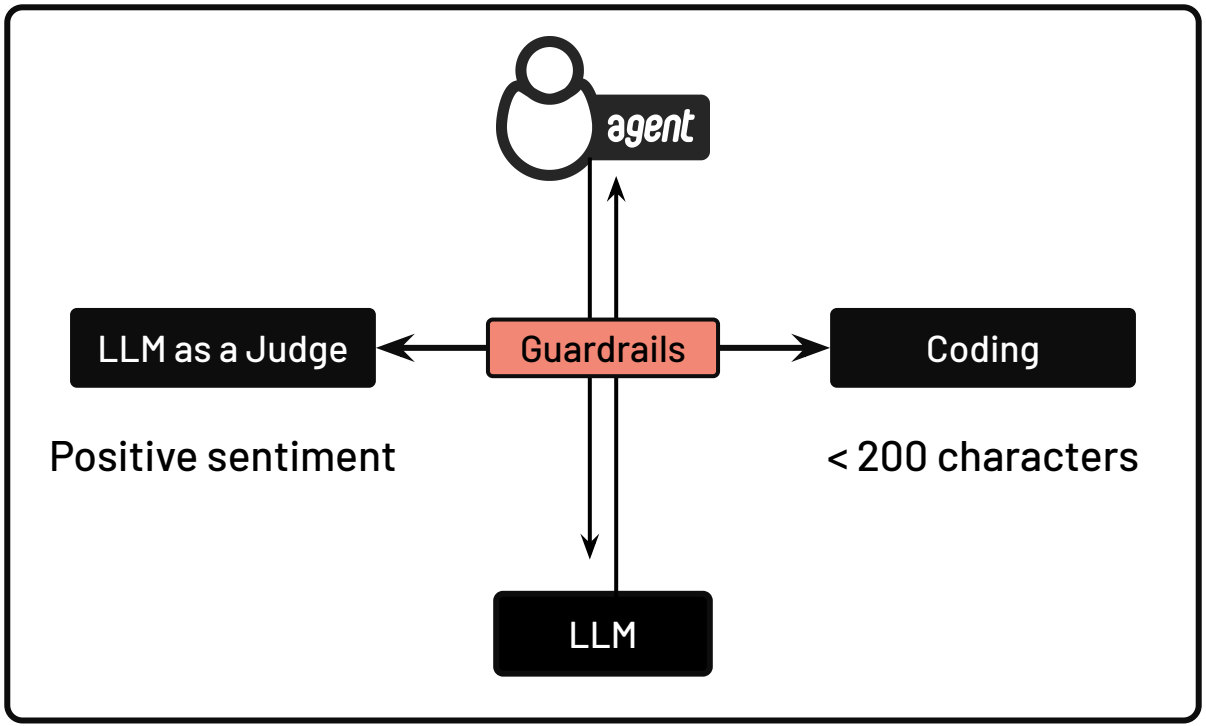
Training



Training



Guardrails


agent
LLM as a Judge
Guardrails
Coding
Positive sentiment
< 200 characters
LLM

Foundations of AI Agents

Use cases: Multi-agent Systems at Scale

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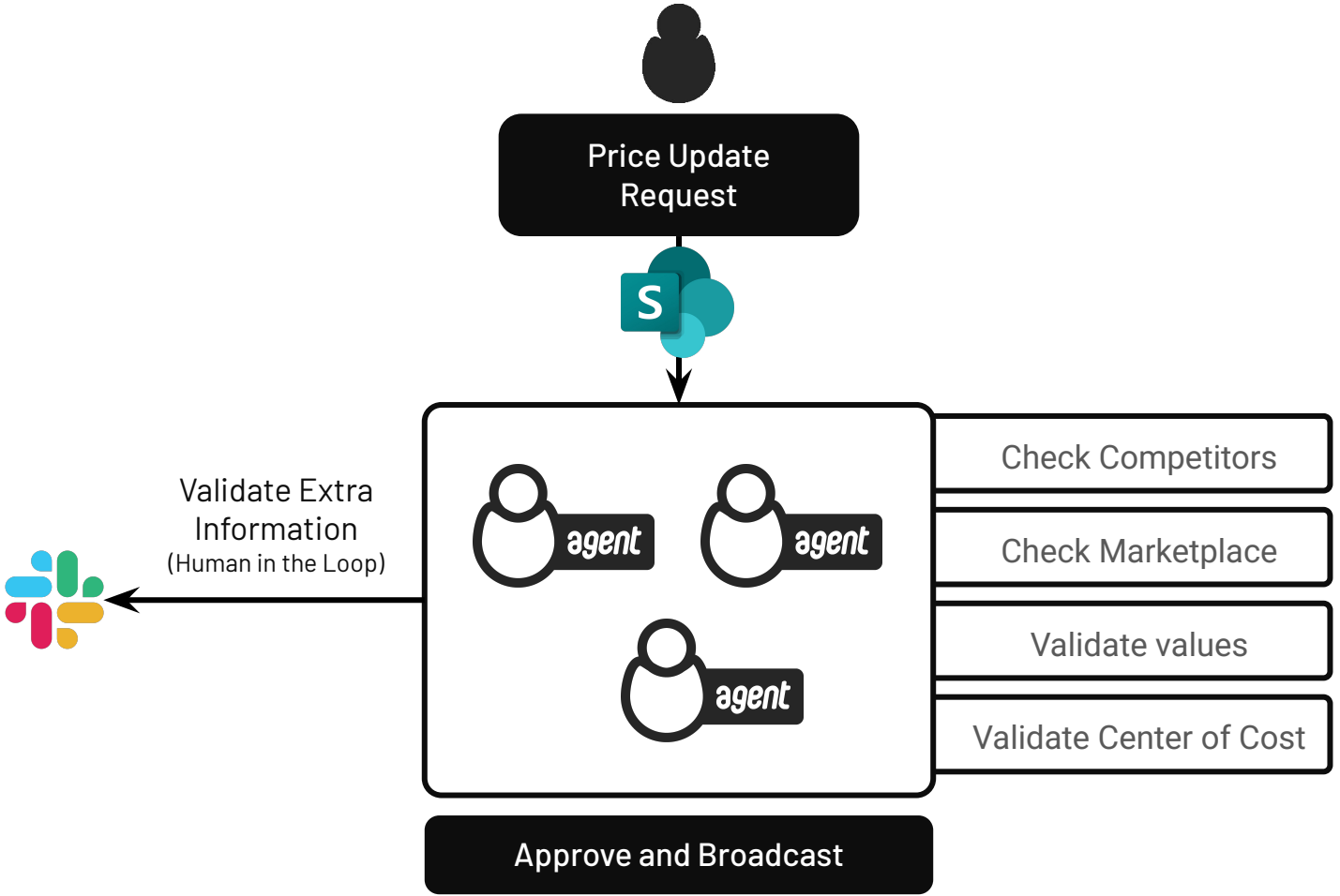
80% to 97%

Efficiency Gains


Price Update Request
Validate Extra Information
(Human in the Loop)
agent
agent
agent
Check Competitors
Check Marketplace
Validate values
Validate Center of Cost
Approve and Broadcast

Case Study: F500 CPG

Initial engaged us with a use case

First case live within weeks

Case Study: F500 CPG

Initial engaged us with a use case

First case live within weeks

Price Ops Use case for changing prices, coupons and discounts

94%

Efficiency Gains

97%

Accuracy

Top Verticals

High Tech	Consulting & BPO	Cable & Telecom
Financial Services	Customer Service	Insurance & Casualty
Consumer Packaged Goods	Health and Life & Sciences	Media and Entertainment

Top Functional Areas

Sales & Marketing Automation	Developer Automation
Cybersecurity & Dev Ops	Supply Chain & Dev Ops
Pricing & Coupons	People Management

Why Agent Design Matters

Output quality
Well-designed agents produce more relevant, high-quality results

Collaboration effectiveness
Agents with complementary skills work together more efficiently

Task performance
Agents with clear roles and goals execute tasks more effectively

System scalability
Thoughtfully designed agents can be reused across multiple crews and contexts

Foundations of AI Agents

The AI Agent Revolution
Why It's Happening Now

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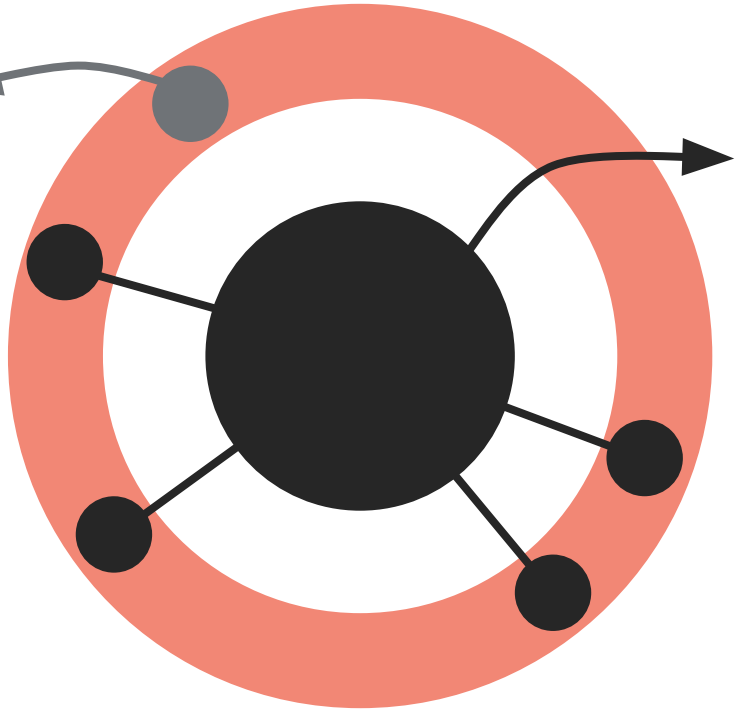
LLMs got adopted on the edges of organizations

High chance of information leak
More ad hoc use cases
Not easily replicable
Knowledge is siloed



AI Agents tend to be centrally deployed by an enablement team

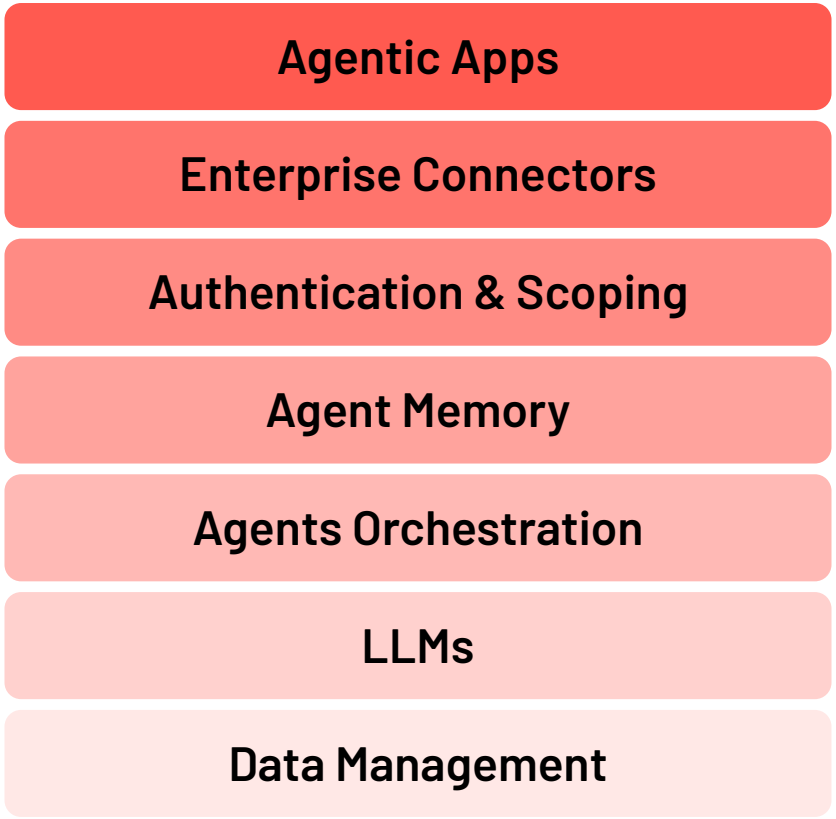
Central control of LLMs and integrations
Filtering potential PII / sensitive
Control of use cases
Enable departments with no code

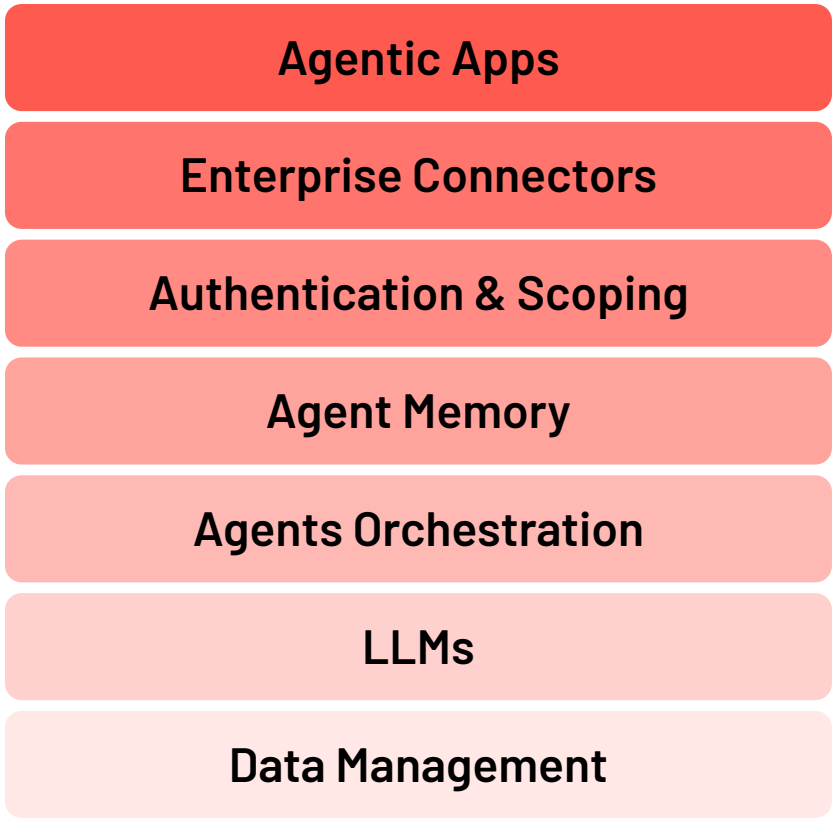
Building Reliable Agents

Easy to Use

Repeatable Outcomes

Scalable Solutions


Agentic Apps
Enterprise Connectors
Authentication & Scoping
Agent Memory
Agents Orchestration
LLMs
Data Management



Interoperability

Observability

Governance

Evaluations

Guardrails