The rise of the digital colleague: evaluating companies with Moody's AI agents

Less than two years ago, ChatGPT emerged as a simple conversation partner — a magical tool for chatting with a machine. But in what feels like the blink of an eye, it set the world on a whirlwind journey of technological change. Today, we find ourselves at the dawn of a new era where autonomous programs called AI agents, born from that chat tool, collaborate with us as digital colleagues. This evolution transforms how we solve problems, pushing the boundaries of what machines and humans can achieve together.

At Moody's, we've embraced these advancements to develop our own cutting-edge multi-agent system, which we will soon make available to customers. Designed to work for you as the human decision-maker, our system can conduct a thorough analysis of any company you wish to evaluate, helping unlock insights faster and more efficiently than ever before.

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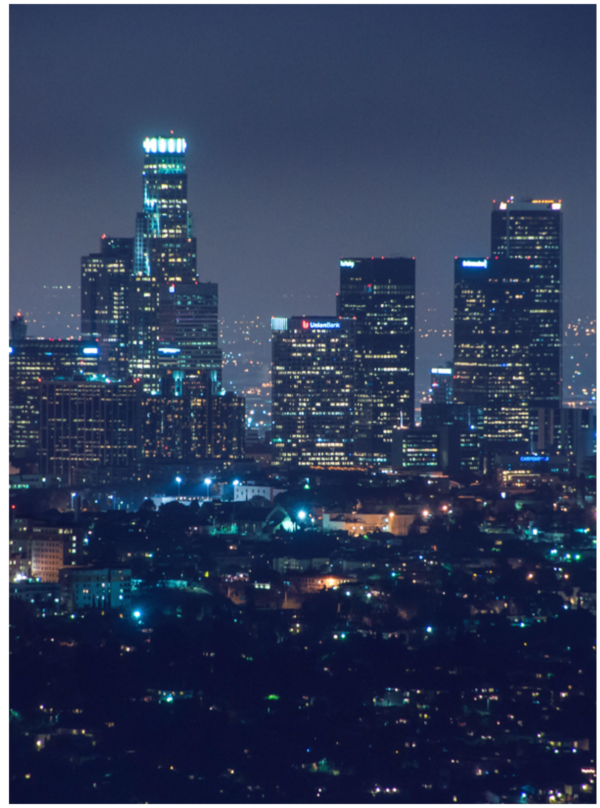
To extract these insights, all you need to do is ask any question that could help you in your work. For example:

- If you are a lender, you might want to understand the key risks a borrower faces that could impact their ability to pay back a loan.
- If you are in corporate development or mergers and acquisitions, you might want to understand the synergies between two companies.
- If you are an investor, you might want to understand which company is likely to take market share away from its competitors.

In this paper, we explain our agent system in more detail. We demystify the key concepts and emphasize the rigorous work Moody's experts perform to make sure that the analysis our agents produce matches the robustness, accuracy, and transparency you would expect from a team of highly skilled human colleagues. The distinction? These are digital colleagues.



What problem are we aiming to solve?

We designed our agent system to follow a workflow that broadly resembles that of a typical team conducting company analysis but with important distinctions that we will discuss.

To understand how the agent system works, let's first examine how it would be handled in a typical work environment. For illustration purposes, we will use the example of vetting a company that is being considered as a critical supplier to determine if it is financially sound.

As a starting point, the team assigned to this task would set objectives:

1. Review the company's recent financial performance to discover important trends in growth, margins, and cash flows.

2. Evaluate the business factors that help explain the observed performance using frameworks such as Porter's Five Forces; value chain analysis; and the political, economic, sociological, technological, legal, and environmental (PESTLE) assessment.

3. Assess any headwinds or tailwinds impacting the business and determine the implications for the company and its financial outlook.

With these objectives in mind, the team's manager would assign roles and responsibilities to team members based on their skills and experience. One person may evaluate the financials while another may gather information on the company's customers, suppliers, and competitors. A more seasoned team member might then review and synthesize the data into a report, which would inform the decision on whether to onboard the supplier.

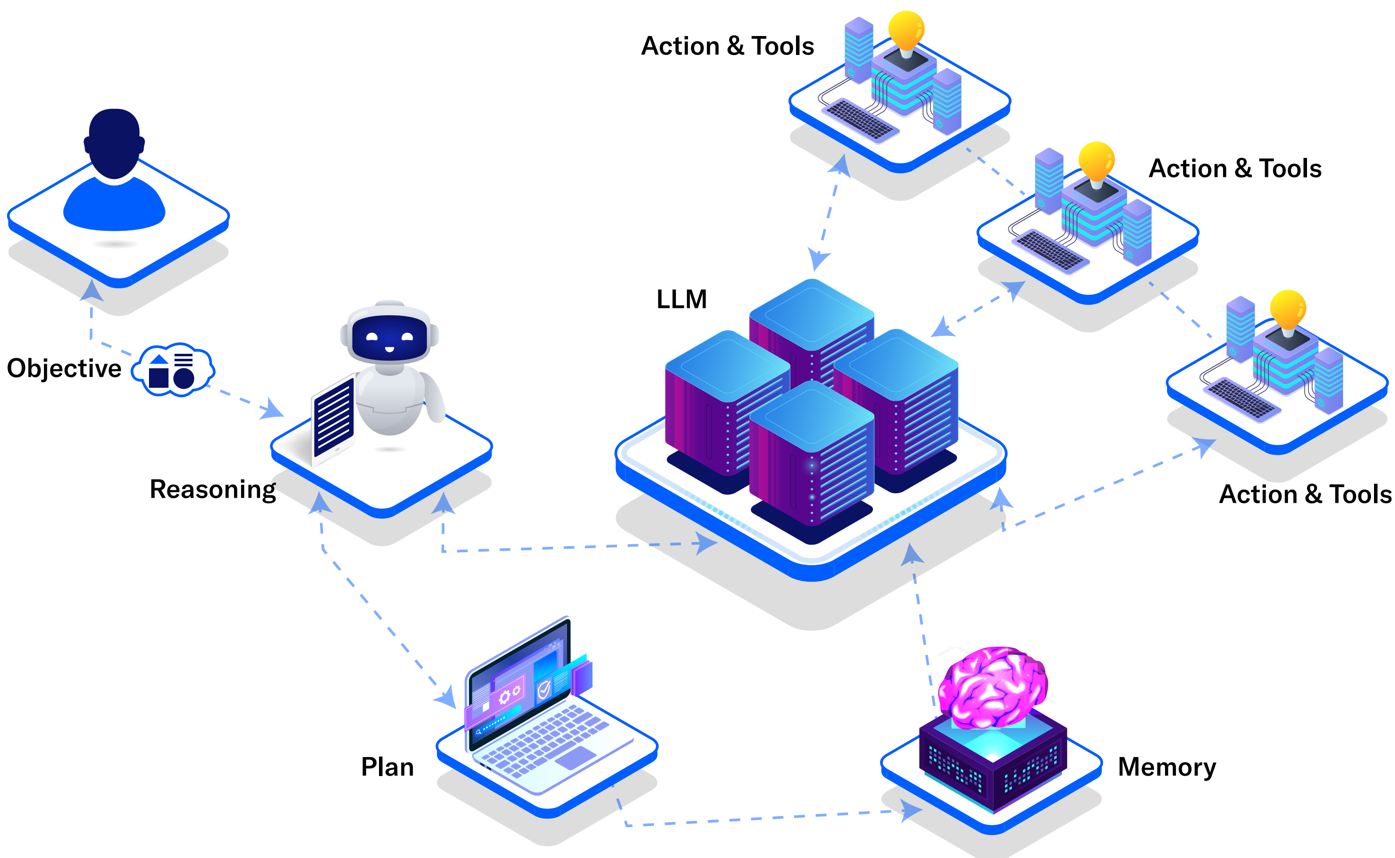
Undertaking rigorous fundamental research of this kind can be laborious and time-consuming, especially when analyzing lesser-known companies that require extensive investigation. Just the process of gathering up-to-date information from multiple sources on its own can take hours or even days to complete. At Moody's, we have proprietary access to much of this hard-to-find data since we process timely business and financial information on more than 500 million companies. Yet even with this information in hand, the analysis remains tedious, and it becomes less practical if the goal is to evaluate multiple companies at once.

Therefore, we built our agent system to automate this work, recognizing the potential to significantly drive efficiency, helping you focus on making strategic decisions informed by the comprehensive research our agents conduct on your behalf.

How Moody's human-guided agent system works

While it is helpful to compare a multi-agent system to a human team, in practice, AI agents operate quite differently. First, let's define what we mean by AI agents.

It is useful to think of agents as self-executing programs to which a human assigns an objective; the agent then lets the program use a large language model (LLM) to determine the best approach for completing the objective. Agents may also be equipped with external tools (such as access to the web, Moody's databases, or other agents) to support their work. Once their assignment is complete, they may either submit their conclusions to you as the decision-maker or continue to interface with other agents as part of the broader objectives of a multi-agent system.



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The key to making an agent system effective at conducting company analysis at scale lies in the quality of the orchestration of the tasks and the precision of instructions given to the agents. Hence, Moody's experts took great care in crafting the instructions for the agents to frame their interpretation of our proprietary databases and their use of tools.

The orchestration of the agents can be described along three dimensions:

1. **Assigning roles and objectives:** In designing the system, we broke down the overall workflow into a series of interdependent steps governed by an agent, each with a well-defined objective and carefully selected capabilities and tools that correspond to the task at hand.

TABLE 1 Examples of agents' roles and responsibilities

Agent role	Responsibilities
Agent orchestrator	Handles the workflow execution and coordinates the information flow between agents
Financial risk analyst agent	Performs all financial analysis tasks, including horizontal and vertical, trend analysis, cash flow analysis, and DuPont analysis
Macroeconomic analyst agent	Analyzes economic conditions such as GDP growth, inflation, and interest rates that affect individual companies or sectors; further synthesizes insights from key economic indicators and policy changes to understand industry trends and regulatory impacts and can identify potential opportunities and threats
Knowledge base management agent	Evaluates different sources of material in the knowledge base to avoid redundancy and maintain a cohesive narrative
Credit risk analyst	Assesses businesses' creditworthiness, including reviewing past credit behavior as well as examining financial statements, income, and cash flow to gauge a firm's ability to meet its financial obligations
Quality assurance agent	Identifies and removes hallucinations, making sure all information is timely; confirms that all components of the tasks assigned to other agents are accomplished accurately

2. Providing access to tools (resources): We use the term "tools" to refer to access that the agent is given to different sources of content or analytics. These may include Moody's proprietary databases and analytical engines, the web, Moody's curated newsfeeds, or other agents' output. The choice of tools depends on the agent's objective; in the case of Moody's agent system, Moody's experts determined the selection of tools. As an example, an agent tasked with analyzing financial performance will need access to another agent that retrieves financials and ownership structure (both extracted from Moody's databases). It may also need access to a financial modeling engine. Along with determining the toolset, Moody's experts carefully guide the agent on what information to look for, how to use this information, how to organize the output, and where to send it.

3. Empowering with skills: Skills are the agent's specialized attributes that make it uniquely able to perform the objective at hand. Skills are most often associated with the capacity of the specific LLM that powers the agent. While some tasks, such as information retrieval, can be performed expeditiously with a less powerful LLM, agents that synthesize insights require a state-of-the-art model to be their reasoning engine. Skills can also refer to an agent's ability to self-reflect and continuously improve its own output. We discuss these in the section covering quality assurance.

Case study: using our agent system for risk analysis

A common application of our agent system is to evaluate the downside risks for a company you wish to engage with. Credit lenders, supplier risk managers, trade credit managers, and investors all tend to focus their analysis on what could go wrong with a target company.

Downside risk comprises both business risk and vulnerability-to-event risk. To understand business risk, our multi-agent system synthesizes information about the factors affecting a company's strategic and operational drivers. The agents are tasked with studying the company's sources of revenue and cost and probing each of these business drivers for any significant forces that may impact it. Examples of such forces may be competitive threats, economic headwinds, or cost pressures from suppliers.

To assess vulnerability-to-event risk, our system references our proprietary event-driven loss databases and maps these events to the company's unique attributes that make it vulnerable to exogenous shocks such as cyberattacks, climate catastrophes, or geopolitical turmoil. The system also tracks recent events via newsfeeds and other relevant data feeds to determine the likelihood of such an event impacting the company.

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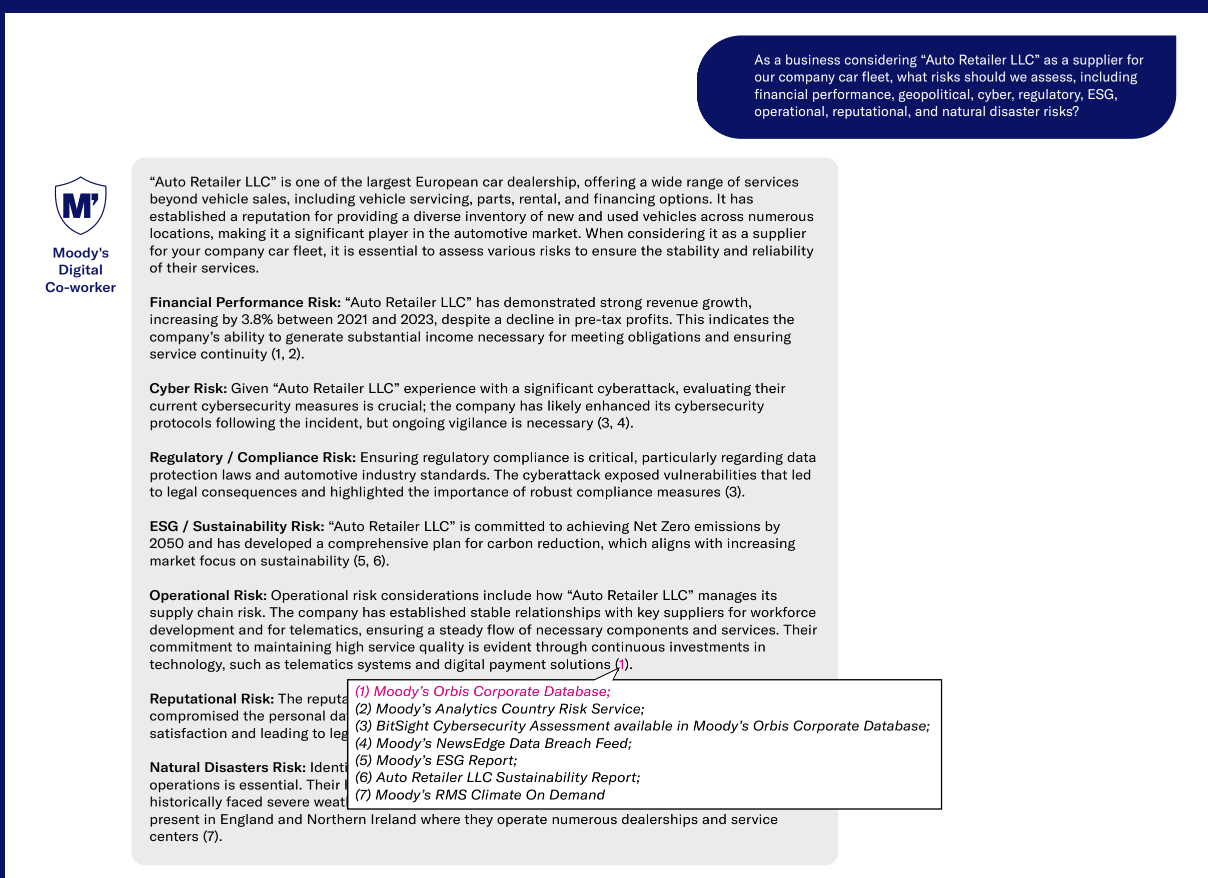
Since Moody's agents have been painstakingly trained to identify and analyze sources of downside risk, you can use the system to ask questions such as:

- → What are the most significant risks facing this company that I should worry about? What makes them significant? How likely are they to materialize?
- → What has the company done to mitigate these risks?
- → Which company among its peers is less exposed to these risks?
- → What would happen to the company in the event of an external shock, such as a climate event or supply chain disruption?

The ability to offload research and risk analysis to our agent system can save you hours of work and potentially point out latent risks that you had not considered.

Below is an example of how you can interact with the system to gain insights into risks facing a company you are interested in.



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All the analysis, including all agent output and interactions, is kept in detailed logs, giving you full transparency and auditability into the process. This is crucial to gain trust in the analysis and retain an audit trail for future reference.

Ensuring accuracy, completeness, and timeliness

As noted earlier, carefully orchestrating and instructing agents around business objectives is not sufficient to produce reliable outcomes. Multi-agent systems can contain hundreds of interactions among agents. Each interaction involves an intricate exchange of information and instructions that are driven by the system's agency and not crafted by humans. As the number of agents and interactions increases, so does the number of points where failure can occur and propagate. This is driven by imperfections in the information exchange, including ambiguous or incorrect instructions across agents or hallucinations. Preventing such failures is as challenging as it is important. Table 2 below outlines three approaches that we apply to fortify the system.

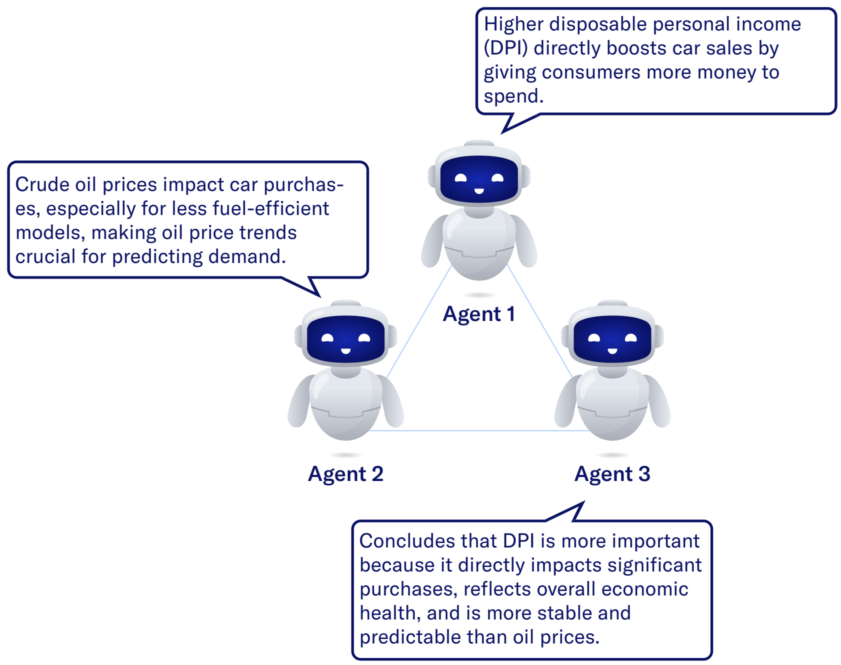
TABLE 2 Sample of techniques to guard from errors and propagating failures

Technique	Explanation
Prompt optimization for agent's reasoning	This approach allows us to set objectives by asking the agents to iterate around the prompts and actions until they achieve the desired outcome. Given the numerous interactions among agents, it is crucial that the information exchanged is always clear and accurate. Since the messages shared between agents are not known in advance, it is impractical for Moody's experts to monitor and fine-tune the myriad instructions and prompts that take place within the system. To address this challenge, we use a technique called dynamic self-prompting in which the system autonomously tests and improves prompts until reaching the desired outcome.

Majority voting for optimal agent's decision-making

Majority voting involves sourcing opinions from different "expert" agents to reach a consensus. By asking different agents to complete the same task and using their consensus conclusions, the quality and consistency of the outcomes are dramatically increased.

Consider a simple example involving three agents, each reaching different conclusions as to which economic developments might affect a given carmaker:



In this example, we might use a majority voting system wherein the agents provide their reasoning for selecting the economic factor they believe has the most impact and then debate the merits of their reasoning to arrive at a consensus ranking.

Autonomous quality assurance (QA) monitoring and enhancement

To ensure high-quality outputs, we developed a system for continuous monitoring and self-actuated review of the quality of each subtask in the workflow.

Our goal is to make sure that the output generated by the system is:

→ **Hallucination-free:** That is, it faithfully represents the facts that are known about the company (for this we measure faithfulness).

→ **Timely:** We use only the most recent available information (here we measure timeliness).

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→ **Thorough:** We confirm that all tasks requested during the execution are successfully completed to the extent that is possible with the knowledge we have of the company (finally, we measure completeness).

Please refer to the appendix for more details on our approach to autonomous monitoring.

The use of the above techniques, coupled with careful human orchestration and meticulous instructions around the objectives and tools, delivers consistently high-quality output that rarely produces inaccurate or misleading analysis.

As we archive every step in the workflow and every agent interaction, we can closely monitor the system's performance. Our current approach to evaluating performance quality is based on our expert judgment. We aim to formalize the approach and maintain a benchmark that tracks the system's performance.

What's next and final thoughts

Agent systems are early in their development. Those that reliably solve complex and interconnected tasks within an enterprise workflow are hard to come by — and only a few, if any, have been implemented at scale. As such, we are collaborating with various market participants that are also on this journey and keeping an eye out for developments in the field.

Below are the areas we're focusing on as we continue to enhance our system:

Risk monitoring: As our system helps uncover and analyze latent risks, it makes sense to monitor them and evaluate their impact over time. The initial mapping of risks to the most relevant signals has already been completed and will be implemented shortly. The next step is to assess how changes in the signals may directly or indirectly affect the company's projected performance and provide early-warning indicators if the signals deteriorate.

Human collaboration and contextualization: If we think of the agent system as analogous to human coworkers, we also need to rethink how the user experience would adapt to facilitate the interactions. We envision this experience as centered around a jointly constructed artifact, such as a credit or investment recommendation. This design flips the traditional notion of workflows, where individuals or teams complete tasks and hand off their work product to others. With digital coworkers in the mix, much of the work can now be done simultaneously.

Self-learning and adaptation to anticipate user needs: The current implementation of Moody's agent system includes various components that learn and adapt over time. We are now developing the ability to learn more about the user and reconfigure the various digital coworkers' roles and priorities accordingly. We are well on our way to building these capabilities and plan to publish more details about our approach in the coming months.

The accelerated advancement of AI keeps us uncertain about the future path of the technology and its implications. We believe that as language models improve, the system we built may require fewer layers of verification and more simplified instructions.

However, just as the LLM capabilities will continue to expand, so will our expectations of the digital colleagues – and along with that, we as the decision-makers will need to continue to improve our own game. At some point, we may no longer be able to keep up with our digital coworkers' progress. In the meantime, we get to spend less time on tedious tasks and more time evaluating important decisions.

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Appendix: quality assurance

To see our autonomous monitoring process in action, we present an extract from a multi-hundred-page QA log generated during the system's execution. This extract covers an iteration of one of the subtasks testing completeness, faithfulness, and timeliness of the information used for the task the agent performed.

COMPLETENESS TEST PASSED

The response comprehensively addresses the four key aspects of local manufacturing investment: It provides a clear description of its importance, outlines the status of specific agreements and financial commitments, discusses the positive outlook regarding economic growth and job creation, and identifies vulnerabilities and challenges that "Oil Company" may face in achieving its goals. Each section is well-articulated and relevant to the query.

FAITHFULNESS TEST FAILED

The response does not faithfully capture some of the referenced source content. The context states that Oil Company signed agreements with 23 companies for local manufacturing opportunities worth $2 billion as of February 2023, while the response claims that as of May 2024, Oil Company signed agreements with 25 companies for $3 billion. Additionally, the context mentions a target of $5 billion by 2027, which was later increased to $7 billion by 2030, but the response does not clarify the previous target. Therefore, the discrepancies in the numbers and timeline indicate that the references are not correct.

TIMELINESS TEST PASSED

The response includes information about Oil Company local manufacturing investments and agreements as of May 2024, which is after 2023. Therefore, it meets the criterion of containing facts from after 2023.

These logs provide a valuable learning resource for the agents. By examining the reasons why tests have failed or passed, agents can improve their strategies. The process is run iteratively until all the tests are passed.

The table below shows a process where all three tests pass at the fifth iteration:

Attempt	Completeness	Faithfulness	Timeliness
1	✗	✗	✗
2	✗	✗	✓
3	✗	✓	✗
4	✓	✗	✓
5	✓	✓	✓

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