AI-assisted Development

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Thanks to Luca Scionis for helping prepare this material.

Disclaimer

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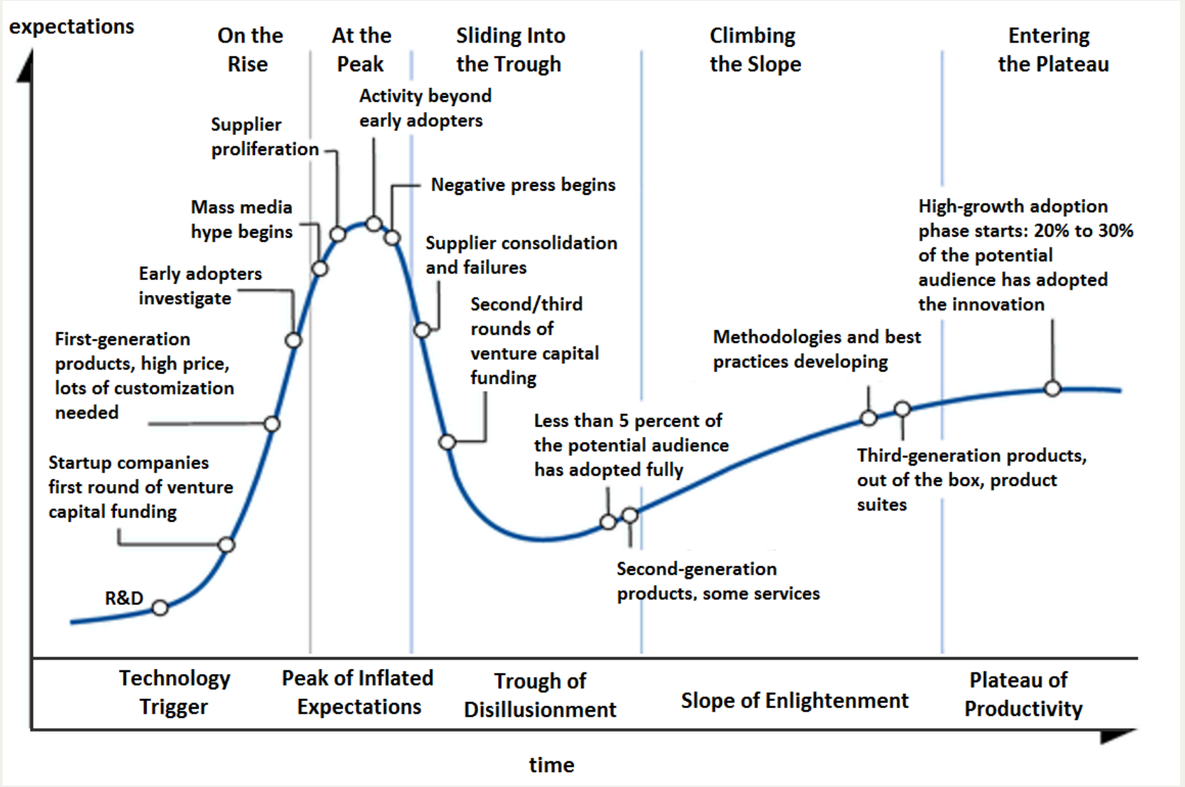

Where are we? Here (complete data)

LLMs for coding

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To improve the coding ability of LLMs, the training sets can be better curated to include more structured and comprehensive data related to developing tasks.

Moreover, code-specific LLMs are often fine-tuned on tasks like code completion, bug fixing, refactoring, etc.

LLMs for coding

LLMs can be used in almost all the software development phases, potentially accelerating all those processes:

- project management
- requirements collection
- design
- implementation
- documentation
- code inspection (e.g., for bugs and security issues)
- optimization
- tests
- debugging and bug fix
- refactoring

LLMs for coding

Some concrete examples:

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- scaffolding (automated building of the fundamental software structure)
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- writing documentation and tests
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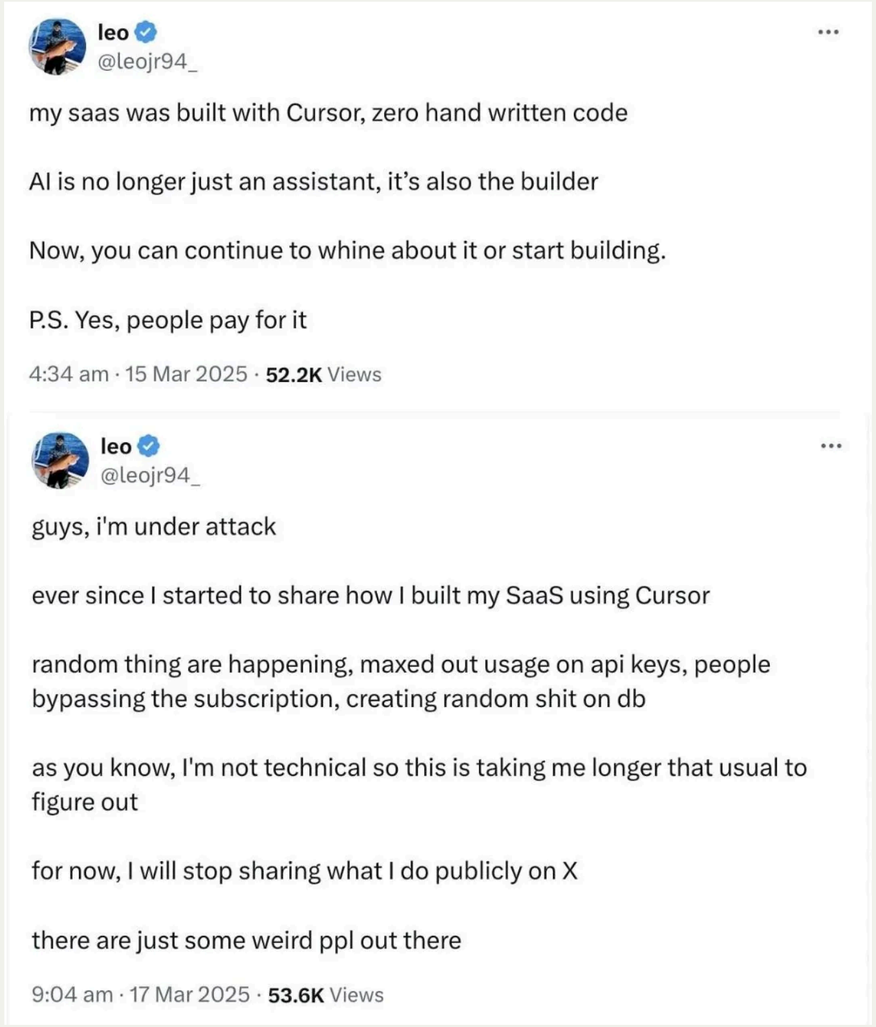
- ...
- *vibe coding*: creating software without writing (and even reviewing) a single line of code, but only expressing in natural language all the requirements
    - is it the future? not yet...

Are we ready for vibe coding?



leo
@leojr94_

my saas was built with Cursor, zero hand written code

AI is no longer just an assistant, it's also the builder

Now, you can continue to whine about it or start building.

P.S. Yes, people pay for it

4:34 am · 15 Mar 2025 · **52.2K** Views

leo
@leojr94_

guys, i'm under attack

ever since I started to share how I built my SaaS using Cursor

random thing are happening, maxed out usage on api keys, people bypassing the subscription, creating random shit on db

as you know, I'm not technical so this is taking me longer that usual to figure out

for now, I will stop sharing what I do publicly on X

there are just some weird ppl out there

9:04 am · 17 Mar 2025 · **53.6K** Views

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We will now review the current technologies for AI-assisted development, and then better focus on their issues and limitations, and the best practices that should be followed.

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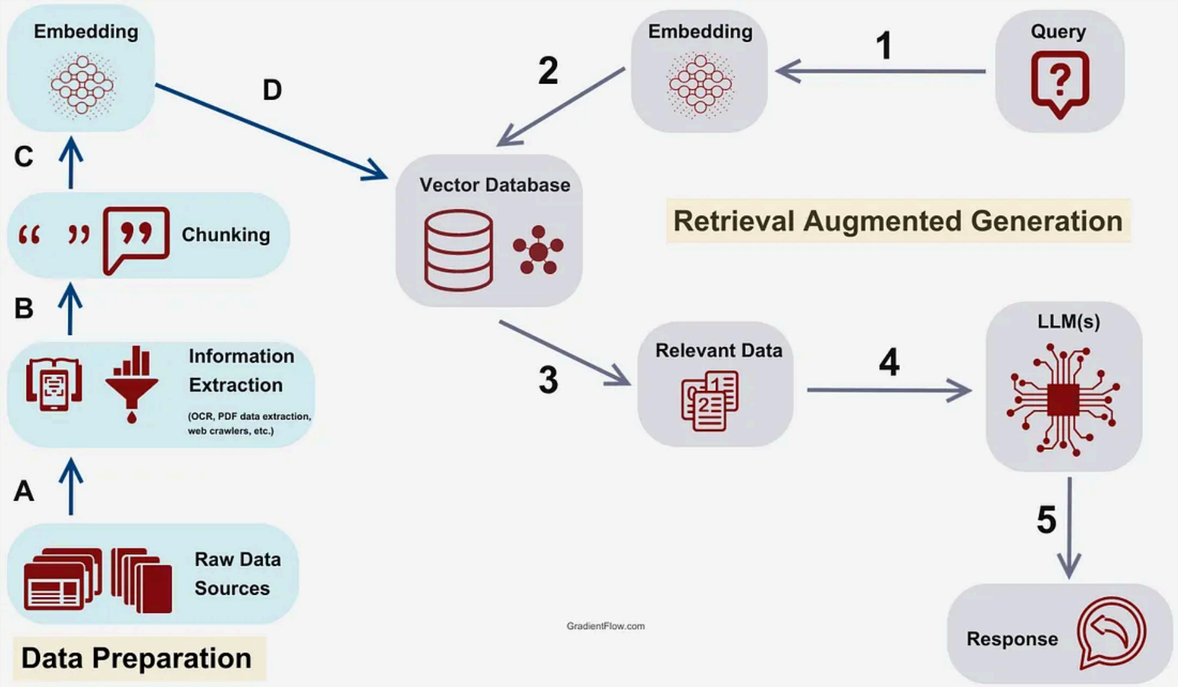

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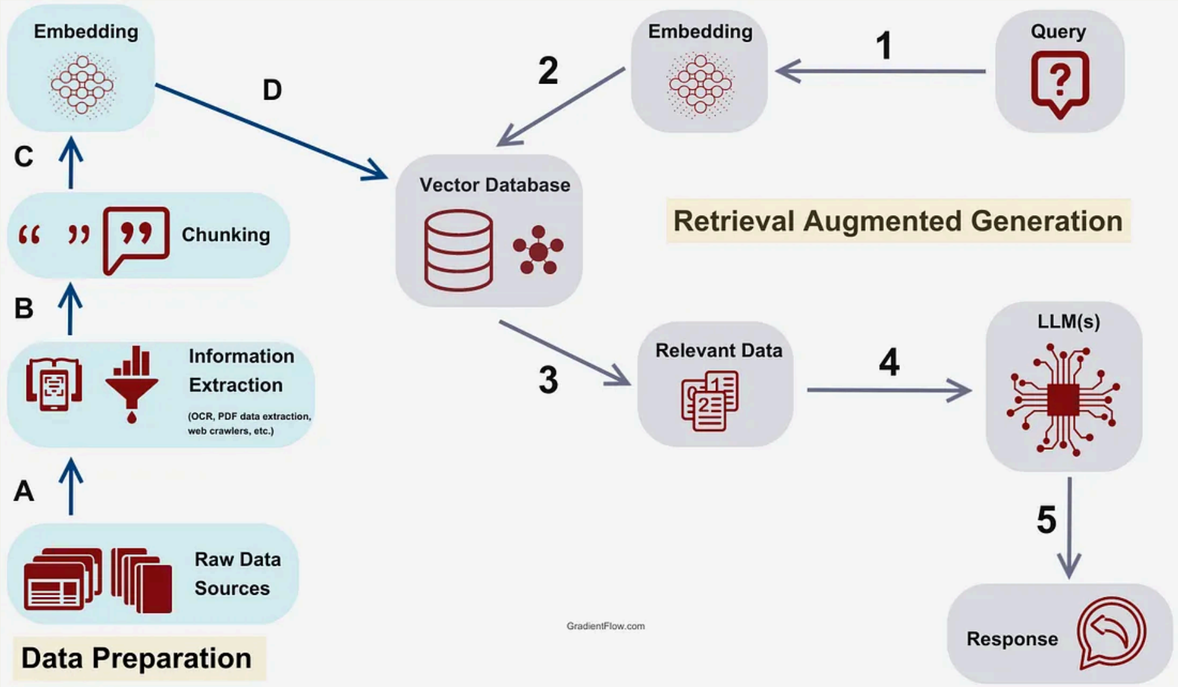
This mitigates some of the previosuly discussed limitations: makes the answers more factual, update the model knowledge without retraining it, and allows customizing the AI-tools for specific tasks (e.g., by linking LLMs to companies data assets)



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Cons:

- limited functionalities and processed context
- low customization
- non-trivial tasks can be hard to accomplish, e.g., need to copy-paste the specific code snippets back and forth from the prompt area to other applications, defining the request afterwards (e.g., “check bugs in this code”, or “help me sanitizing the input”, etc.)

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Cons:

- effective only through proper app integration
- integration might be complex and not always available (or limited to specific functionalities)

CLI Tools

Almost all the LLMs providers and third-party alternatives currently supports a CLI (Command Line Interface) application to use their tools through the command line. (e.g., Codex CLI, Gemini CLI, Claude Code).

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Cons:

- some complex tasks may require multiple commands
- less usable in certain scenarios, e.g., when interactions are needed, or when the output should be further processed

Agents

*"An **agent** is just something that acts (agent comes from the Latin agere, to do). Of course, all computer programs do something, but computer agents are expected to do more: operate autonomously, perceive their environment, persist over a prolonged time period, adapt to change, and create and pursue goals. A **rational agent** is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome."*

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So what is an AI agent?

LLM + tools calling + RAG = autonomy + reasoning and planning + tool use and integration + learning and memory

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Cons:

- high responsibilities and power must be delegated
- complex to build and manage

Agents Frameworks

There are several frameworks to build LLM-powered agents:

- LangChain/LangGraph
- LlamaIndex
- smolagents

AGENTS.md

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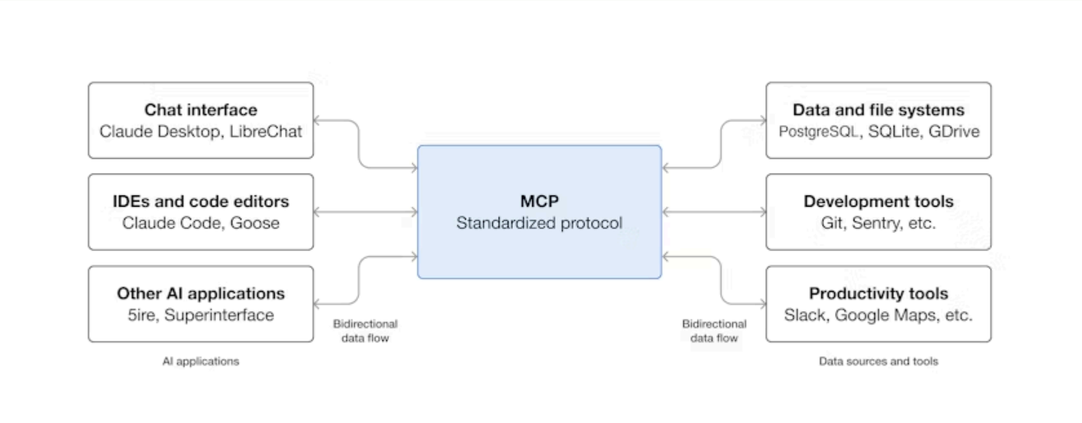
It usually contains:

- project overview
- build and test commands
- code style guidelines
- testing instructions
- security considerations
- guidelines for versioning systems (e.g., git)

Model Context Protocol

Model Context Protocol (MCP) is an open-source standard for connecting AI applications to external systems, such as data sources, tools and workflows.



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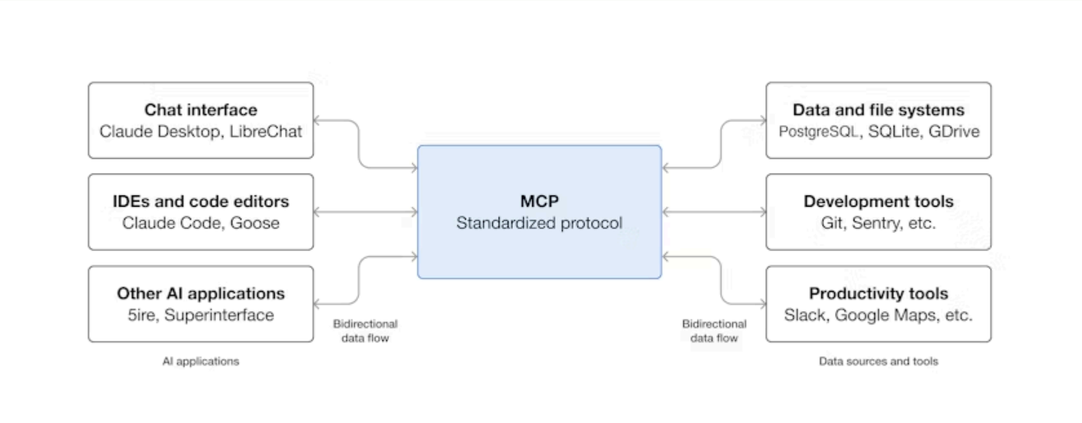

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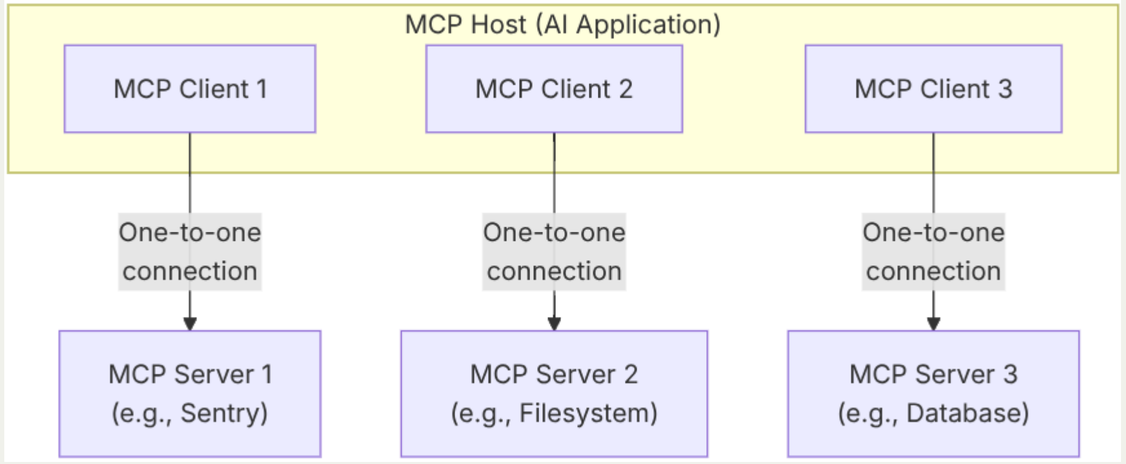
It reduces development time and complexity when building/integrating AI-based applications, providing a standardized way to access a wide range of external systems and increasing scalability.

Model Context Protocol

MCP follows a stateful client-server architecture where an **MCP host** - an AI application - establishes connections to one or more local or remote **MCP servers**. The MCP host accomplishes this by creating one **MCP client** for each MCP server. Each MCP client maintains a dedicated one-to-one connection with its corresponding MCP server.



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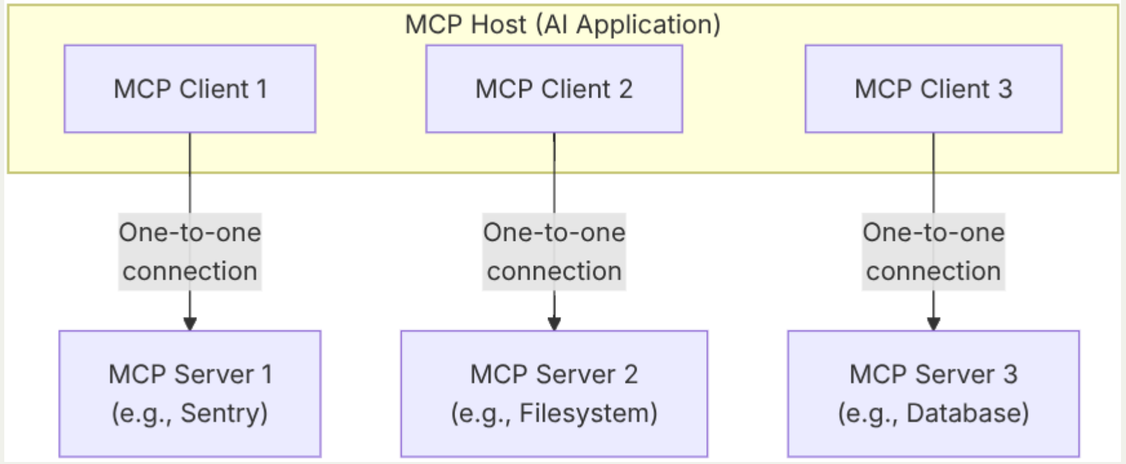

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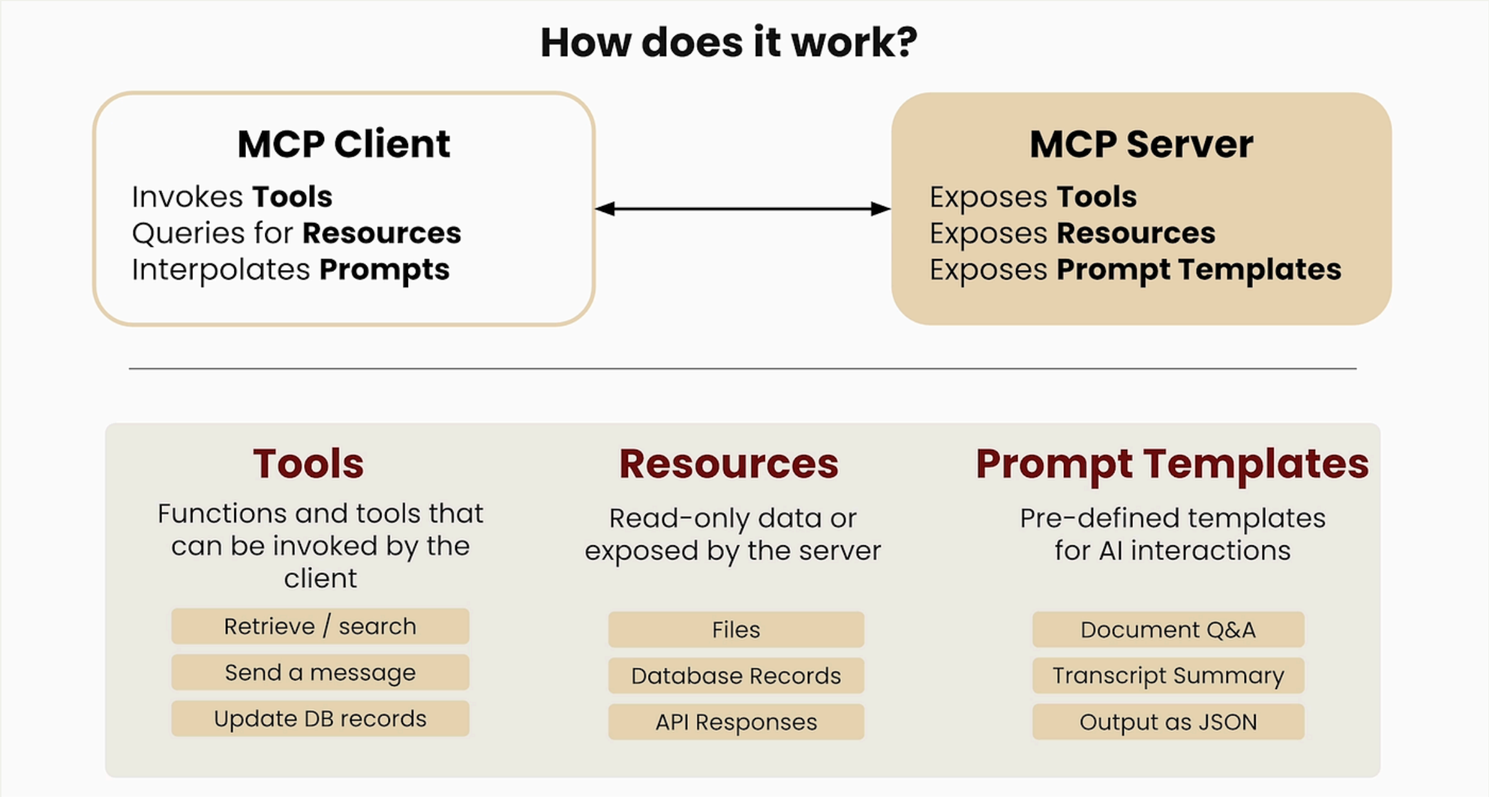
The exchanged data are JSON-RPC messages that allows to discover the available tools and actions, invoke them and receive the outputs.

Model Context Protocol

MCP servers expose tools, resources and (reusable) prompts.



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Security Issues

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1. **Prompt Injection.** The LLMs behavior, which depends on the input prompt, might be altered in unintended ways. Malicious actors can potentially exploit that to achieve disruptive results. Often the prompt injections are imperceptible to humans.
    - Mitigations: constrain model behavior with the system prompt; define, validate and filter input/output; enforce privilege control and least privilege access; require human approval for high-risk actions; separate user prompts from external content.

2. **Sensitive Information Disclosure.** During their training, LLMs incorporate sensitive data (countermeasures are often not sufficient to filter this content). It might happen that this data is then exposed in their responses, either unintentionally or after malicious prompts.
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4. **Data and Model Poisoning.** The data used to train LLMs can be manipulated to alter the model behavior (e.g., introduce vulnerabilities, backdoor or biases).

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OWASP also collects the available tools to improve the LLMs security: https://genai.owasp.org/ai-security-solutions-landscape/

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Additionally (although we will not address that), the produced code may be protected by copyright...

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- **Integration of Security Tools:** agents can be integrated (e.g., through MCP) with external tools to enhance the development and review process

Can LLMs detect never-seen-before vulnerabilities?

Our research experience:

Explainability-based debugging of machine learning for vulnerability discovery

Evaluating Line-level Localization Ability of Learning-based Code Vulnerability Detection Models

...other works have shown that also more recent models are not yet reliable (although agents seem promising)

LLMs Cannot Reliably Identify and Reason About Security Vulnerabilities (Yet?): A Comprehensive Evaluation, Framework, and Benchmarks

MCP security

Another security concern is related to the MCP protocol, whose design initially did not consider security aspects.

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For MCP-based AI applications, new threats emerged, requiring specific prevention and mitigation strategies

- but also "conventional" threats still stand (and can even be amplified in these scenarios)
- interesting readings: MCP Security Best Practices, Model Context Protocol (MCP) Security

(some) MCP Attacks and Mitigations

- **Identity Spoofing:** weak or misconfigured authentication in MCP deployments could allow attackers to impersonate legitimate clients or the agents acting on their behalf, corrupting audit trails or gaining unauthorized access to server resources
  - Mitigation: secure identity, authentication and authorization for all the involved actors (users, agents, servers, etc.); secure delegation and access control

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- **Tool Poisoning:** malicious modification of tool metadata, configuration, or descriptors injected into clients via the tools/list method. This can cause AI agents or MCP components to invoke, trust, or execute compromised tools, potentially leading to data leaks or system compromise. As the MCP specification notes, 'descriptions of tool behavior such as annotations should be considered untrusted, unless obtained from a trusted server' (Key Principles), making tool poisoning a recognized risk when clients connect to unvetted servers.
  - Mitigation: input and data validation/sanitization/filtering, guardrails

- **Resource Content Poisoning:** attackers embed hidden malicious instructions within data sources (databases, documents, API responses) that MCP servers retrieve and provide to LLMs, causing the poisoned content to execute as commands when processed, effectively achieving persistent prompt injection through trusted data channels rather than direct user input.
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- **Overreliance on the LLM:** MCP server developers may implement overly permissive tools, assuming the LLM will invoke them correctly and safely. However, model-level controls (trained refusals, safety classifiers, etc.) are not ironclad—even capable models can be manipulated through prompt injection, make errors in judgment, or be replaced with weaker models that lack equivalent safeguards.
    - Mitigation: secure tool and UX design

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- Never forget the non-functional requirements

An Industrial Perspective

The DevOps Research and Assessment (DORA) group of Google Cloud provides very interesting insights about the adoption of AI technologies in software development companies.

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Moreover, the true impact of AI on product development is still unclear:

- in certain cases, despite the positive perceived impact by developers (on productivity, code quality, team performance), AI returned a lot of promising results but also increased software delivery instability (quality and reliability of the software delivery process)
- developers didn't notice differences in terms of friction and burnout in their work

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Let's see some concrete examples:

- **Code reviews and handoffs:** consider where AI can accelerate and clarify existing steps. For example, AI-generated first-pass reviews can reveal issues quickly and reduce time spent on routine feedback. Structuring AI input to highlight risks or summarize diffs can also make reviews easier and faster for humans.

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- **Code reviews and handoffs:** consider where AI can accelerate and clarify existing steps. For example, AI-generated first-pass reviews can reveal issues quickly and reduce time spent on routine feedback. Structuring AI input to highlight risks or summarize diffs can also make reviews easier and faster for humans.
- **Integration and deployment pipelines:** AI-generated code moves fast—can your systems keep up? CI/CD pipelines may need to evolve to reduce wait states and allow for higher-frequency delivery. Quality checks powered by AI can be layered in without adding manual gates, improving flow without sacrificing assurance.

- **Data infrastructure:** invest in updating data infrastructure. AI’s benefits for productivity and code quality are amplified when AI models and tools are connected to internal data (repos, work tracking tools, documentation, decision logs, etc.). Adding this valuable context improves the output of AI tools, and the benefits are larger when data is AI-accessible, accurate, and complete.

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- **Change management and cultural alignment:** like any organizational transformation, AI adoption needs vision, support, and communication:
    - leaders should articulate the long-term goals of AI transformation and support the transition with training, shared practices, and realistic expectations
    - teams need permission to experiment, make mistakes, build fluency, and share what they learn.

  In general, companies should estabilish comprehensive internal protocols for using AI tools.

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- **AI-native collaboration models:** emerging practices like agentic workflows and swarming are beginning to reshape how humans and AI work together. Agentic workflows assign tasks to autonomous AI agents, while swarming enables teams and AI to converge dynamically on complex problems.

The future: AI model collapse?

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As those models are trained on large-scale datasets scraped from the web, researchers investigated what happens when training data is recursively AI-generated.

The results have shown that their performance gradually degraded, a phenomenon known as **model collapse**

- There is still debate on its real-world impact
- Research is already developing possible mitigation strategies

We'll see what will happen in the future...