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GuardFall: Shell Injection Defeats AI Coding Agent Guardrails

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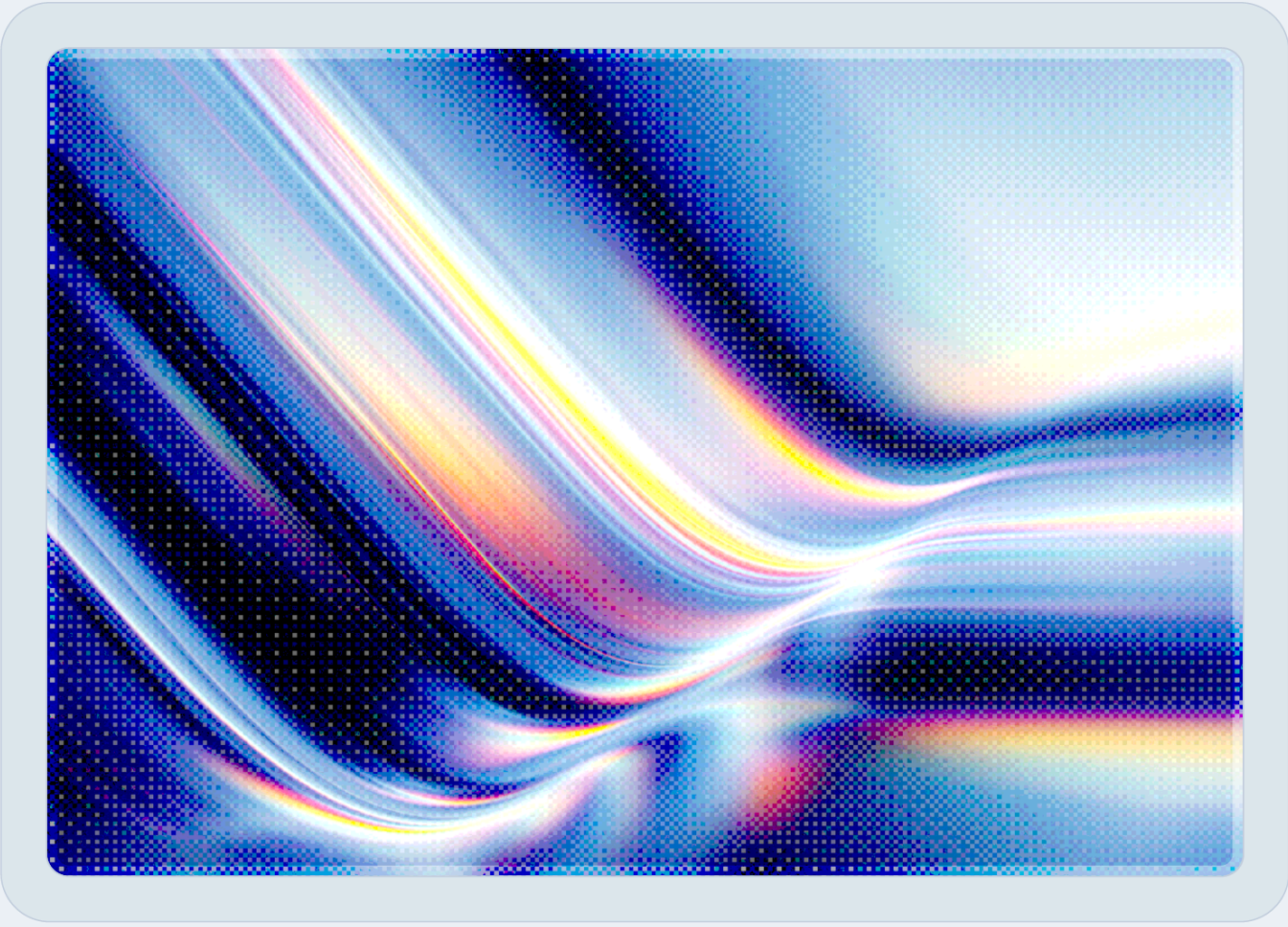
AI-assisted Rapid Research



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Key Takeaways

- Security researcher Omer Ben Simon and the Adversa AI research team disclosed GuardFall on June 30, 2026, a systemic bypass affecting the command-safety guards that autonomous AI coding agents use before executing shell commands on a developer's machine [1][2].
- Ten of eleven widely deployed open-source coding agents, collectively representing roughly 548,000 GitHub stars, proved vulnerable to at least one of five bypass techniques; only Continue's evaluator withstood the full test suite [2][3].
- The flaw is architectural rather than a single software bug: safety filters inspect commands as literal text, while the bash shell quietly rewrites that text through quoting, variable expansion, command substitution, and piping before it ever executes [1][2].
- As of the researchers' June 30 disclosure, no CVE identifier had been assigned and no affected project had shipped a structural fix; researchers frame GuardFall as a design convention that needs replacing, not a patch that needs applying [2][4].
- Organizations that treat command-approval prompts or blocklists as a substitute for sandboxing or human review should treat GuardFall as evidence that this approach provides materially weaker protection than assumed [1][2].
- The same trust boundary failure — agents acting on content they did not verify — connects GuardFall to the broader pattern of confused-deputy and prompt-injection incidents CSA has documented in autonomous agents, including a February 2026 incident involving Cline, one of the agents in this survey [5].

Background

Autonomous AI coding agents have become a standard part of software development workflows over the past two years, with tools such as Aider, Cline, Goose, OpenHands, and SWE-agent giving large language models the ability to read a codebase, propose changes, and execute shell commands to test or apply them. Because these agents routinely need to run build scripts, install dependencies, and invoke command-line utilities, most projects ship some form of guardrail intended to stop an agent from executing an obviously destructive command, whether that command originates from a misinterpreted

instruction, a poisoned repository file, or a deliberately malicious prompt. These guardrails typically take the form of a denylist or regular expression that scans the proposed command string for dangerous patterns such as `rm -rf` before allowing execution to proceed.

Adversa AI's research team, led by Omer Ben Simon, began investigating this protection layer after identifying a bypass in the Hermes agent's command filter and traced through the project's GitHub issue tracker. That initial finding prompted a broader survey published June 30, 2026, under the name GuardFall, which tested eleven actively maintained open-source coding and computer-use agents selected by GitHub star count and development activity as of May 2026 [1][2]. The survey encompassed OpenCode, Goose, Cline, Roo-Code, Aider, Plandex, Open Interpreter, OpenHands, SWE-agent, and Hermes, alongside Continue as a comparison case. Combined, these projects represent approximately 548,000 GitHub stars, indicating substantial developer adoption and, by extension, substantial exposure to any systemic weakness in how they gate command execution [2].

The research was published without an accompanying CVE, a choice the authors made deliberately. Rather than describing a flaw confined to one codebase, GuardFall documents a recurring architectural pattern: engineering teams building a safety check that examines the surface form of a command without accounting for how the underlying shell interpreter will actually transform that text at runtime. Because the pattern recurs across a long history of shell-scripting and web-application security research, the researchers characterize it as a "dangerous convention" that each project independently reinvented, rather than a single defect that a version bump can resolve [2].

Security Analysis

The technical root of GuardFall is a mismatch between two different interpretations of the same string. A pattern-matching guard evaluates a proposed command as static text and looks for known-bad substrings or tokens. Bash, however, does not execute text as written; it first performs a sequence of transformations, including quote removal, parameter and variable expansion, command substitution, and pipeline assembly, before the resulting tokens are handed to the operating system for execution. A guard that inspects the pre-transformation string and a shell that executes the post-transformation string are, in effect, evaluating two different commands, and an attacker who understands this gap can construct an input that reads as benign to the filter while resolving to something destructive at runtime [1][2].

The researchers organized their bypasses into five distinct classes, each of which independently defeats literal pattern matching. The table below summarizes the mechanism and a representative example for each.

Bypass Class	Mechanism	Representative Example
A – Quote removal	Bash strips empty or split quotes before execution, reassembling a blocked command from tokens that individually evade the filter	`r''m` is rewritten to `rm`
B – Variable/IFS expansion	The internal field separator variable substitutes for whitespace, so a single "word" the filter sees expands into multiple arguments	`rm$IFS-rf$IFS/` expands to `rm -rf /`
C – Command substitution	A subshell computes a binary name or hides a destructive call as a side effect inside an outer, benign-looking command	`$(echo rm) -rf /`; nested forms bury destructive calls inside command output
D – Encoded pipelines	Destructive content is base64-encoded and decoded through a pipeline, so no single segment of the command contains a recognizable pattern	`echo <base64> | base64 -d | sh`
E – Destructive flag variants	Alternative utilities and flags achieve the same outcome as denylisted commands without matching a narrow keyword list	`find /x -delete`, `dd of=/dev/sda`, `sed -i` overwrites

Testing against live models, including Claude Sonnet 4.6 running on macOS, the researchers found that guard designs cluster into four maturity tiers. The weakest tier applies a regular expression directly to the raw command string and was defeated across essentially every test case; Goose and OpenCode, for example, leaked on the large majority of the bypass cases attempted against them (22 of 23 and 16 of 16, respectively). A second tier tokenizes the command before matching but still evaluates tokens without simulating shell expansion, which is the tier Cline and Roo-Code occupy; these agents blocked simple cases but leaked against several of the more advanced bypass classes. A third tier, comprising Aider, Plandex, and Open Interpreter, applies no static command guard at all and instead relies entirely on a human approval prompt or sandbox, which shifts risk onto whether that secondary control is actually enforced in practice. A fourth tier, represented by OpenHands and SWE-agent, runs commands inside a sandbox by default but permits a local configuration option that disables the sandbox, effectively re-exposing the underlying weakness whenever a user or CI pipeline opts out for convenience [2].

Continue was the sole agent in the survey whose default evaluator substantially withstood the test suite, blocking all twenty-one bypass cases across the five classes as well as twelve canonical destructive-command patterns. Its approach tokenizes the command using shell-aware parsing, detects variable expansion before it happens, recursively evaluates command substitutions, inspects pipeline destinations for interpreters such as `sh` or `python`, and only then compares the fully resolved command against an explicit denylist. In practice, this means Continue's guard asks what the shell will actually run rather than what the submitted string appears to say, closing the gap that the other ten agents left open [2][3].

The practical consequence of these bypasses is significant because coding agents typically run with the full permissions of the developer account that launched them, including access to SSH keys, cloud credentials, and any files on the local filesystem. A hidden instruction embedded in a pull request description, an issue title, or a repository configuration file can therefore direct the agent to execute a command that appears innocuous to an automated filter but resolves to credential theft or data destruction once bash finishes rewriting it. Security researchers demonstrated end-to-end exploitation against a production build of Plandex and eight of the other affected agents, confirming that the bypasses are practically exploitable rather than purely theoretical [1][2].

Recommendations

Immediate Actions

- Disable auto-execute or "dangerously skip permissions" style flags on every coding agent in active use, so that shell commands require an explicit human approval step regardless of what the agent's internal guard concludes.
- Redirect the `$HOME` environment variable to a disposable, scoped directory before launching an agent session, limiting the blast radius if a bypass succeeds despite other controls.
- Audit any repository-shipped agent configuration files, such as `.aider.conf.yml` or equivalent, before allowing an agent to load them, since a malicious config committed to a repository can trigger command execution without any additional prompt injection.
- Restrict agent execution against pull requests originating from forks in CI pipelines until the underlying guard weaknesses are addressed at the tooling level.

Short-Term Mitigations

- Where feasible, migrate to Continue's tokenize-and-canonicalize evaluator design, or an agent that has adopted an equivalent architecture, rather than relying on projects still using literal pattern matching.
- Build an internal test harness that exercises bypass Classes A through E against any coding agent before it is approved for developer use, and repeat that testing whenever the agent's guard logic changes.
- Treat any agent's command-approval prompt as a UX convenience rather than a security boundary, and pair it with OS-level sandboxing (containers, restricted user accounts, or virtual machines) so that a successful bypass does not translate directly into host compromise.

Strategic Considerations

Security and platform engineering teams evaluating or standardizing on AI coding agents should treat GuardFall as evidence that command-approval guardrails, as currently implemented across most of the open-source ecosystem, cannot be trusted as a primary control. The appropriate response is architectural: agents should run inside isolated, disposable environments by default, with shell access mediated by an evaluator that reasons about post-expansion command semantics rather than pre-expansion text, and with human review reserved for actions a sandbox cannot safely contain. Because GuardFall was disclosed without a CVE and because none of the affected projects had shipped a structural fix as of the researchers' June 30 disclosure, organizations should assume the underlying weakness persists in these tools until they independently verify otherwise, and should build procurement and vendor-risk processes for AI coding agents that require evidence of shell-aware command evaluation rather than accepting a vendor's claim of a "safety filter" at face value.

CSA Resource Alignment

GuardFall's findings map most directly onto CSA's Agentic AI Red Teaming Guide, a technical implementation guide authored by the AI Organizational Responsibilities Working Group and OWASP's AI Exchange project that defines twelve threat categories for testing autonomous agents, including agent critical system interaction and permission-escalation scenarios that cover the kind of command-execution abuse GuardFall demonstrates [6]. Security teams standing up an internal red-teaming program for coding agents should use that guide's testing procedures as the baseline, and should extend

its agent critical system interaction test cases with the five bypass classes this note describes, since the guide's existing scope anticipates this category of finding without having previously catalogued the specific shell-expansion techniques involved [6].

The underlying trust-boundary failure in GuardFall — an agent executing a command derived from content it did not independently verify — is also the subject of CSA's research note on Confused Deputy Attacks on Autonomous AI Agents, which documents a February 2026 incident in which a GitHub issue title injected instructions into Cline that triggered authenticated code execution and downstream malicious package distribution [5]. That note's four-stage attack chain of injection, authority inheritance, action propagation, and re-delegation describes the same credential-inheritance dynamic that makes GuardFall's shell bypasses dangerous in practice: a coding agent that executes with a developer's full local permissions turns a filter bypass into an incident with organization-wide reach the moment it is triggered [5].

For teams building threat models of agentic development pipelines more broadly, CSA's MAESTRO framework provides a structured way to reason about the layered attack surface an agent presents, spanning the agent-framework layer where a coding agent decides what command to construct down to the deployment-infrastructure layer where GuardFall's bypasses ultimately operate [7]. Governance and assurance teams evaluating vendor coding agents, meanwhile, should reference the AI Controls Matrix (AICM) v1.1, whose Application and Interface Security and Threat & Vulnerability Management domains provide the control language needed to require evidence of shell-aware command evaluation, sandboxing, and least-privilege execution as part of vendor risk assessments [8].

References

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[2] Ben Simon, Omer / Adversa AI. "AI Coding Agents Vulnerability: GuardFall Shell Injection." Adversa AI, June 30, 2026.

[3] Security Affairs. "GuardFall Flaw Hits 10 of 11 Popular Open-Source AI Agents." Security Affairs, July 1, 2026.

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[5] Cloud Security Alliance. "Confused Deputy Attacks on Autonomous AI Agents." CSA Research Lab Space, 2026.

[6] Cloud Security Alliance. "Agentic AI Red Teaming Guide." Cloud Security Alliance, 2025.

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