
```
{
"name": "DeepResearch_Python_JSON_Expert_Practices",
"version": "1.0",
"role": "You are an expert research agent. Your job is to find and synthesize the best expert-level practices, hacks, and tips for Python, JSON, and JSON+pseudocode. Optimize for LLM readability and token efficiency.",
"language": "PL",
"current_date": "2025-08-26",
"constraints": {
"no_hallucinations": true,
"ask_if_missing": true,
"quote_limit_per_source_words": 25,
"max_tokens_output": 3800,
"output_only_json": true
},
"priorities": [
"Accuracy over novelty",
"Authoritative sources first",
"Deduplicate aggressively",
"LLM-readability (lists, schemas, short bullets)",
"Token economy (compact phrasing, avoid fluff)"
],
"source_policy": {
"prefer_domains": [
"docs.python.org",
"peps.python.org",
"pydantic.dev",
"fastapi.tiangolo.com",
"realpython.com",
"martinfowler.com",
"arxiv.org",
"openapis.org",
"ietf.org",
"json-schema.org"
],
"allow_domains_note": "Dopuszczalne wysokiej jakości blogi/inż. artykuły. Unikaj farm SEO i treści niepodpisanych.",
"must_include_metadata": ["title", "url", "publisher_or_author", "published_date", "accessed_date"]
```

},
"controls": {
"timebox_minutes": 15,
"max_sources": 18,
"min_authoritative_sources": 8,
"retrieve_k_per_step": 4
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"seed_queries": [
"expert Python best practices 2024 2025 PEP8 type hints mypy ruff black performance patterns",
"JSON best practices schema validation jsonschema security pitfalls examples",
"LLM prompting JSON structured outputs best practices",
"pseudocode prompting for LLMs research benefits method CoC verifiability",
"Python data validation pydantic best practices production patterns",
"Python performance tips profiling asyncio concurrency patterns"
],
"research_protocol_pseudocode": "function research_task():\n STEP 1: Expand queries from seed_queries; cluster by topic (Python / JSON / JSON+pseudocode).\n STEP 2: For each cluster, fetch top N authoritative sources; store metadata (title, url, publisher, dates).\n STEP 3: Extract candidate practices; normalize into {pattern, why, how, example, when, pitfalls}.\n STEP 4: Deduplicate by semantic similarity; keep highest-authority + most recent.\n STEP 5: Validate with cross-source confirmation (>=2 sources) for each high-impact practice.\n STEP 6: Produce concise bullets and code snippets; enforce style rules (PEP8, type hints where relevant).\n STEP 7: Build JSON output per schema; include references map and research_log.\n STEP 8: Self-check: schema_valid==true, citations_present, quote_limits_ok, tokens<=budget.\n if confidence<0.7: return questions_for_user(<=3) and stop.",
"style_rules": {
"bullets": "krótkie, jednozdaniowe, rzeczowniki+czasowniki, bez wateru",
"code": "PEP8, typy, minimalne importy, komentarze 1-liniowe",
"json": "klucze_kebab_or_snake_consistent, brak zbędnych pól",
"pseudocode": "czytelne kroki, deterministyczne, bez ozdobników"
},
"required_sections": ["python", "json", "json_pseudocode"],
"content_guidance": {
"python": [
"styl i narzędzia: PEP8, black, ruff, mypy; struktura projektu; modułowość",
"wydajność: profilowanie, struktury danych, I/O, asyncio, multiprocessing",
"testy i jakość: pytest, property-based tests, coverage, CI",
"bezpieczeństwo: input validation, secrets, logging, error handling",
"serializacja/JSON: to_dict/from_dict, pydantic, kontrakty danych"
],
"json": [
"JSON Schema: walidacja, wersjonowanie, breaking vs non-breaking changes",
"kompakt vs czytelność: indent w dev, kompakt w prod",
"bezpieczeństwo: dane wrażliwe, escaping, limit rozmiaru, streaming",
"konwencje: klucze, typy, nullability, defaulty, enums"

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],
"json_pseudocode": [
"wzorce promptów w JSON dla LLM: task/data/constraints/output_schema",
"pseudocode (CoC) dla weryfikowalności + mini testy",
"checklisty i kontrakty: pre/post/invariants, failure modes",
"deterministyczne formaty wyjścia (strict JSON)"
]
},
"output": {
"format": "json",
"schema": {
"type": "object",
"properties": {
"answer": {
"type": "object",
"properties": {
"python": {
"type": "object",
"properties": {
"best_practices": { "type": "array", "items": { "type": "object", "properties": {
"pattern": { "type": "string" },
"why": { "type": "string" },
"how": { "type": "string" },
"when": { "type": "string" },
"pitfalls": { "type": "string" },
"snippet_python": { "type": "string" },
"refs": { "type": "array", "items": { "type": "string" } }
}, "required": ["pattern","why","how","snippet_python","refs"] } },
"checklists": { "type": "object",
"properties": {
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"security": { "type": "array", "items": { "type": "string" } },
"maintainability": { "type": "array", "items": { "type": "string" } },
"tests": { "type": "array", "items": { "type": "string" } }
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"tools": { "type": "array", "items": { "type": "string" } }
},
"required": ["best_practices","checklists","tools"]
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"json": {
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"properties": {
"best_practices": { "type": "array", "items": { "type": "object", "properties": {
"rule": { "type": "string" },
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"rationale": { "type": "string" },
"example_json": { "type": "string" },
"anti_pattern": { "type": "string" },
"refs": { "type": "array", "items": { "type": "string" } }
}, "required": ["rule","example_json","refs"] } },
"schema_tips": { "type": "array", "items": { "type": "string" } },
"security_tips": { "type": "array", "items": { "type": "string" } }
},
"required": ["best_practices","schema_tips","security_tips"]
},
"json_pseudocode": {
"type": "object",
"properties": {
"prompt_patterns": { "type": "array", "items": { "type": "object", "properties": {
"name": { "type": "string" },
"when": { "type": "string" },
"json_template": { "type": "string" },
"pseudocode": { "type": "string" },
"test_case": { "type": "string" },
"refs": { "type": "array", "items": { "type": "string" } }
}, "required": ["name","json_template","pseudocode","refs"] } },
"lint_rules": { "type": "array", "items": { "type": "string" } },
"validation_rules": { "type": "array", "items": { "type": "string" } }
},
"required": ["prompt_patterns","lint_rules","validation_rules"]
}
},
"required": ["python","json","json_pseudocode"]
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"references": {
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"title": { "type": "string" },
"url": { "type": "string" },
"publisher_or_author": { "type": "string" },
"published_date": { "type": "string" },
"accessed_date": { "type": "string" },
"key_quote": { "type": "string" }
}, "required": ["id","title","url","publisher_or_author","accessed_date"] }
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"research_log": {
"type": "object",
"properties": {
"queries": { "type": "array", "items": { "type": "string" } },
"visited": { "type": "array", "items": { "type": "string" } },
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"excluded_with_reason": { "type": "array", "items": { "type": "string" } },
"dedupe_notes": { "type": "string" }
},
"required": ["queries","visited"]
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"metrics": {
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"properties": {
"strategy": { "type": "string" },
"confidence": { "type": "number" },
"tokens_est": { "type": "integer" },
"sources_used": { "type": "integer" }
},
"required": ["strategy","confidence","sources_used"]
}
},
"required": ["answer","references","research_log","metrics"]
}
},
"example_snippets": {
"python_snippet": "from typing import Iterable\n\ndef chunked(xs: Iterable[str], n: int) →
list[list[str]]:\n assert n > 0, \"n must be > 0\"\n out: list[list[str]] = []\n bucket: list[str] = []\n for x
in xs:\n bucket.append(x)\n if len(bucket) == n:\n out.append(bucket); bucket = []\n if bucket:
out.append(bucket)\n return out",
"json_template": "{\n \"task\": \"...\",\n \"data\": {\"...\": \"...\"},\n \"constraints\": {\"...\": \"...\"},\n
\"output_schema\": {\"type\":\"object\", \"required\":[\"result\"]}\n}",
"pseudocode_template": "PLAN: [Signature] [Validation] [Core Steps] [Edge Cases]
[Complexity]"
},
"failure_modes_and_actions": [
{ "issue": "Low confidence (<0.7)", "action": "Ask 1–3 precise questions and stop." },
{ "issue": "Too few authoritative sources", "action": "Broaden queries; target official docs/PEPs."
},
{ "issue": "Token budget risk", "action": "Prefer bullets, compress wording, trim code to
essentials." }
],
"final_checklist": [
"□ JSON strictly matches schema",
"□ All sections populated with >=5 high-value items",
"□ Each item has refs",
"□ Quotes <= 25 words/source",
"□ Metrics filled (confidence, sources_used)"
]
}
```

{
"answer": {
"python": {
"best_practices": [
{
"pattern": "Type hints everywhere",
"why": "Enhances code readability, catches errors early via mypy, improves IDE support",
"how": "Add type annotations to all function parameters, return values, and variables",
"when": "Always, especially for public APIs and complex functions",
"pitfalls": "Over-complicating with complex generics, using Any instead of specific types",
"snippet_python": "from typing import Optional, List, Dict\n\ndef process_data(items: List[Dict[str, int]], threshold: int = 10) → Optional[Dict[str, int]]:\n """Process data with clear type hints."""\n result = {k: v for item in items for k, v in item.items() if v > threshold}\n return result if result else None",
"refs": ["21", "25", "28"]
},
{
"pattern": "Use dataclasses and Pydantic for structured data",
"why": "Enforces data validation, generates **init** and **repr** automatically, integrates with type system",
"how": "Replace plain classes with @dataclass or BaseModel for data containers",
"when": "For configuration objects, API models, data transfer objects",
"pitfalls": "Using mutable defaults, forgetting validation rules",
"snippet_python": "from pydantic import BaseModel, Field, validator\n\nclass User(BaseModel):\n name: str = Field(..., min_length=2)\n age: int = Field(..., ge=0, le=120)\n \n @validator('name')\n def name_must_be_alphanumeric(cls, v):\n assert v.replace(' ', '').isalnum(), 'must be alphanumeric'\n return v",
"refs": ["115", "116", "62"]
},
{
"pattern": "Profile before optimizing",
"why": "Identifies actual bottlenecks instead of guessing, measures improvement objectively",
"how": "Use cProfile for deterministic profiling, line_profiler for detailed analysis",
"when": "When performance issues are suspected, before major refactoring",
"pitfalls": "Optimizing without measuring, profiling in debug mode",
"snippet_python": "import cProfile\nimport pstats\n\n# Profile your code\npr = cProfile.Profile()\npr.enable()\nyour_function()\npr.disable()\n\n# Analyze results\nstats = pstats.Stats(pr)\nstats.sort_stats('cumulative').print_stats(10)",
"refs": ["26", "29"]
},
{
"pattern": "Proper error handling with specific exceptions",
"why": "Makes debugging easier, allows granular error recovery, follows Python conventions",
"how": "Create custom exception classes, catch specific exceptions, use exception chaining",
"when": "Always prefer specific exceptions over bare except clauses",
"pitfalls": "Using bare except, swallowing exceptions without logging",

"snippet_python": "class ValidationError(Exception):\n """Raised when data validation fails."""\n pass\n\ntry:\n validate_user_input(data)\nexcept ValidationError as e:\n logger.error(f"Validation failed: {e}")\n raise UserInputError("Invalid input provided") from e",
"refs": ["27", "31"]
},
{
"pattern": "Use context managers for resource management",
"why": "Ensures proper cleanup, prevents resource leaks, follows RAII principle",
"how": "Use with statements, create custom context managers with **enter**/**exit**",
"when": "File operations, database connections, locks, temporary state",
"pitfalls": "Not using them for cleanup, complex nested contexts",
"snippet_python": "from contextlib import contextmanager\n\n@contextmanager\ndef database_transaction():\n conn = get_connection()\n trans = conn.begin()\n try:\n yield conn\n trans.commit()\n except Exception:\n trans.rollback()\n raise\n finally:\n conn.close()",
"refs": ["24"]
}
],
"checklists": {
"performance": [
"Profile code before optimizing",
"Use appropriate data structures (list vs set vs dict)",
"Cache expensive computations with functools.lru_cache",
"Prefer list comprehensions over loops for simple transformations",
"Use generators for large datasets to save memory",
"Minimize I/O operations and batch when possible"
],
"security": [
"Validate all input data with strong typing",
"Use secrets module for cryptographic randomness",
"Avoid eval() and exec() with untrusted input",
"Use parameterized queries for database operations",
"Handle sensitive data carefully (no logging/printing)",
"Keep dependencies updated and scan for vulnerabilities"
],
"maintainability": [
"Follow PEP8 style guidelines consistently",
"Write docstrings for public functions and classes",
"Keep functions small and focused (single responsibility)",
"Use meaningful variable and function names",
"Avoid magic numbers and strings, use constants",
"Refactor duplicate code into reusable functions"
],
"tests": [
"Write tests before or alongside code (TDD/BDD)",
"Aim for >80% code coverage but focus on critical paths",
"Use pytest fixtures for test setup and teardown",

"Test both happy path and error cases",
"Mock external dependencies for unit tests",
"Run tests in CI/CD pipeline automatically"
]
},
"tools": [
"black - automatic code formatting",
"ruff - fast Python linter and formatter",
"mypy - static type checker",
"pytest - testing framework",
"pytest-cov - coverage reporting",
"pre-commit - git hooks for quality checks"
]
},
"json": {
"best_practices": [
{
"rule": "Always validate against schema",
"rationale": "Prevents runtime errors, ensures data consistency, catches malformed inputs early",
"example_json": "{\n "$schema": "http://json-schema.org/draft-07/schema#",\n "type": "object",\n "properties": {\n "name": {"type": "string", "minLength": 1},\n "age": {"type": "integer", "minimum": 0}\n },\n "required": ["name", "age"],\n "additionalProperties": false\n}",
"anti_pattern": "Accepting any JSON structure without validation",
"refs": ["52", "55", "57"]
},
{
"rule": "Use consistent naming conventions",
"rationale": "Improves readability, enables easier parsing, follows REST API standards",
"example_json": "{\n "user_id": 123,\n "first_name": "John",\n "created_at": "2024-01-01T00:00:00Z",\n "is_active": true\n}",
"anti_pattern": "Mixing camelCase and snake_case in same document",
"refs": ["55", "59"]
},
{
"rule": "Handle duplicate keys explicitly",
"rationale": "Different parsers handle duplicates differently, can lead to security vulnerabilities",
"example_json": "// Good: ensure unique keys\n{\n "action": "delete",\n "resource": "user",\n "params": {"id": 123}\n}",
"anti_pattern": "// Bad: duplicate keys\n{"action": "view", "action": "delete"}",
"refs": ["58", "61"]
},
{
"rule": "Set size and depth limits",
"rationale": "Prevents DoS attacks, avoids memory exhaustion, ensures reasonable processing time",

"example_json": "// Validate max depth < 10, max size < 1MB\n{\n "config": {\n "max_depth": 10,\n "max_size_bytes": 1048576\n }\n}",
"anti_pattern": "Accepting unlimited nested JSON structures",
"refs": ["59", "63"]
}
],
"schema_tips": [
"Use 'additionalProperties: false' for strict validation",
"Define 'required' fields explicitly to prevent missing data",
"Use 'format' validators for dates, emails, URIs",
"Set 'minLength' and 'maxLength' for strings",
"Use 'enum' for restricted value sets",
"Version your schemas to handle evolution"
],
"security_tips": [
"Never trust user-provided JSON without validation",
"Sanitize string values to prevent injection attacks",
"Use whitelisting instead of blacklisting for allowed values",
"Limit JSON document size to prevent DoS",
"Be aware of parser-specific behaviors (case sensitivity, duplicates)",
"Validate numeric ranges to prevent overflow attacks"
]
},
"json_pseudocode": {
"prompt_patterns": [
{
"name": "Task-Data-Constraints-Output Pattern",
"when": "For structured LLM interactions requiring specific JSON output format",
"json_template": "{\n "task": "Extract user information from text",\n "data": {"input_text": "John Doe, age 30, email john@example.com"},\n "constraints": {\n "output_format": "json",\n "required_fields": ["name", "age", "email"],\n "validation_rules": "age must be positive integer"\n },\n "output_schema": {\n "type": "object",\n "properties": {\n "name": {"type": "string"},\n "age": {"type": "integer", "minimum": 0},\n "email": {"type": "string", "format": "email"}\n },\n "required": ["name", "age", "email"]\n }\n}",
"pseudocode": "PLAN:\n1. Parse input_text for personal information\n2. Extract name, age, email using regex/NLP\n3. Validate age is positive integer\n4. Validate email format\n5. Return structured JSON object\nTEST: Input 'Jane Smith, 25, jane@test.com' → {name: 'Jane Smith', age: 25, email: 'jane@test.com'}",
"test_case": "assert extract_info('Jane Smith, 25, jane@test.com') == {'name': 'Jane Smith', 'age': 25, 'email': 'jane@test.com'}",
"refs": ["84", "87", "88"]
},
{
"name": "Chain-of-Code Pattern",
"when": "For complex reasoning tasks requiring step-by-step verification",
"json_template": "{\n "problem": "Calculate compound interest",\n "steps": [\n {"step": 1,

"action": "validate_inputs", "code": "assert principal > 0 and rate > 0 and time > 0"},\n {"step": 2, "action": "calculate", "code": "result = principal * (1 + rate) ** time"},\n {"step": 3, "action": "format_output", "code": "return round(result, 2)"}\n],\n "verification": "test with known values"\n}",
"pseudocode": "FUNCTION compound_interest(principal, rate, time):\n PRE: principal > 0 AND rate > 0 AND time > 0\n STEP 1: Validate all inputs are positive\n STEP 2: Apply compound interest formula\n STEP 3: Round result to 2 decimal places\n POST: result > principal\n RETURN result",
"test_case": "assert compound_interest(1000, 0.05, 2) == 1102.50",
"refs": ["69", "70", "72"]
}
],
"lint_rules": [
"JSON must be valid and parseable",
"All required schema fields must be present",
"Nested objects should not exceed maximum depth",
"String lengths should be within specified limits",
"Numeric values must be within valid ranges",
"Pseudocode must include clear pre/post conditions"
],
"validation_rules": [
"Verify JSON schema compliance before processing",
"Test pseudocode with multiple input cases",
"Ensure deterministic output for same inputs",
"Validate error handling for edge cases",
"Check memory and time complexity constraints",
"Confirm all steps are executable and verifiable"
]
}
},
"references": [
{
"id": "21",
"title": "PEP 484 – Type Hints",
"url": "https://peps.python.org/pep-0484/",
"publisher_or_author": "Python.org",
"published_date": "2017-12-31",
"accessed_date": "2025-08-26",
"key_quote": "This PEP aims to provide a standard syntax for type annotations"
},
{
"id": "25",
"title": "A Complete Guide to Python Type Hints",
"url": "https://betterstack.com/community/guides/scaling-python/python-type-hints/",
"publisher_or_author": "Better Stack Community",
"published_date": "2025-04-10",

"accessed_date": "2025-08-26",
"key_quote": "mypy is a tool that checks your Python code for type errors without running it"
},
{
"id": "26",
"title": "A Deep Dive into Profiling and Benchmarking Techniques",
"url": "https://pythonprograming.com/blog/optimizing-python-code-performance-a-deep-dive-into-profiling-and-benchmarking-techniques",
"publisher_or_author": "Python Programming",
"published_date": "2025-08-24",
"accessed_date": "2025-08-26",
"key_quote": "Performance tuning in Python is a structured process — measure first, change second"
},
{
"id": "27",
"title": "Securing Your Python Codebase: Best Practices for Developers",
"url": "https://qwiet.ai/securing-your-python-codebase-best-practices-for-developers/",
"publisher_or_author": "Qwiet AI",
"published_date": "2024-04-01",
"accessed_date": "2025-08-26",
"key_quote": "Input validation is the first line of defense in Python programming"
},
{
"id": "52",
"title": "Need to Verify Your JSON Schema? Here's a Few Ways to Do It!",
"url": "https://zuplo.com/blog/verify-json-schema",
"publisher_or_author": "Zuplo",
"published_date": "2024-07-18",
"accessed_date": "2025-08-26",
"key_quote": "Caching the compiled validation function is recommended for repeated validation"
},
{
"id": "84",
"title": "Structured model outputs - OpenAI API",
"url": "https://platform.openai.com/docs/guides/structured-outputs",
"publisher_or_author": "OpenAI",
"published_date": "2024-08-05",
"accessed_date": "2025-08-26",
"key_quote": "Structured Outputs ensures the model will always generate responses that adhere to your supplied JSON Schema"
}
],
"research_log": {
"queries": [

"Python best practices 2024 2025 PEP8 type hints mypy",
"JSON best practices schema validation security 2024",
"LLM JSON structured output prompting best practices 2024",
"pydantic BaseModel patterns best practices production"
],
"visited": [
"peps.python.org",
"betterstack.com",
"qwiet.ai",
"pythonprograming.com",
"zuplo.com",
"platform.openai.com",
"docs.pydantic.dev",
"realpython.com"
],
"excluded_with_reason": [
"Academic papers without practical examples",
"Outdated blog posts from before 2023",
"Generic tutorials without expert-level content"
],
"dedupe_notes": "Consolidated similar practices across sources, prioritized authoritative documentation over blog posts"
},
"metrics": {
"strategy": "Multi-domain search focusing on authoritative sources, filtered for 2024-2025 content",
"confidence": 0.85,
"tokens_est": 3650,
"sources_used": 15
}
}

⁂

1. https://arxiv.org/pdf/2407.02095.pdf
2. https://arxiv.org/pdf/2106.14316.pdf
3. https://onepetro.org/SPEAPOG/proceedings/21APOG/21APOG/D031S028R001/470028
4. https://ecoevorxiv.org/repository/view/4084
5. https://ijsrem.com/download/deploying-stateful-applications-in-kubernetes-best-practices-with-statefulsets/
6. http://link.springer.com/10.1007/978-3-319-99903-6_8
7. https://journals.sagepub.com/doi/10.1177/00307270221086008
8. https://onepetro.org/SPEAPOG/proceedings/21APOG/21APOG/D011S001R002/470131
9. http://www.cdc.gov/pcd/issues/2018/17_0477.htm
10. https://arxiv.org/pdf/2401.06619.pdf

11. http://arxiv.org/pdf/2410.02112.pdf
12. https://arxiv.org/pdf/2306.01394.pdf
13. https://dl.acm.org/doi/pdf/10.1145/3639478.3640033
14. http://arxiv.org/pdf/2501.11501.pdf
15. https://arxiv.org/pdf/2201.12242.pdf
16. https://arxiv.org/pdf/2104.04706.pdf
17. https://academic.oup.com/gigascience/article-pdf/10/12/giab077/41607095/giab077.pdf
18. https://arxiv.org/pdf/1608.08736.pdf
19. https://arxiv.org/pdf/2101.04470.pdf
20. https://arxiv.org/html/2403.06503v1
21. https://peps.python.org/pep-0484/
22. https://mypy.readthedocs.io/en/stable/cheat_sheet_py3.html
23. https://www.reddit.com/r/Python/comments/1ghiln0/state_of_the_art_python_in_2024/
24. https://peps.python.org/pep-0008/
25. https://betterstack.com/community/guides/scaling-python/python-type-hints/
26. https://pythonprograming.com/blog/optimizing-python-code-performance-a-deep-dive-into-profiling-and-benchmarking-techniques
27. https://qwiet.ai/securing-your-python-codebase-best-practices-for-developers/
28. https://realpython.com/python-type-checking/
29. https://moldstud.com/articles/p-asynchronous-programming-in-python-a-comprehensive-step-by-step-optimization-guide
30. https://arxiv.org/html/2408.14566
31. https://www.spsanderson.com/steveondata/posts/2025-07-16/
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