CAGING THE AGENT

Exploring techniques for untrusted Python code execution in agentic workflows.

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Python Pescara - 29 Novembre 2024

WHOAMI

- Frontend and Web standards
- Django and Python
- Complexity tamer

AGENDA

- Defining agents
- Defining tools
- Executing untrusted code
- Takeaways and what’s next

DEFINING AGENTS

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“Just matrix multiplications
pretending to be sentient.”

DEFINING AGENTS

“An agent is a system that uses an LLM as its engine, and it has access to functions called tools.”

DEFINING TOOLS

TOOLS

SAFE(ish)

Agent generates parameters, executes dev-provided code

UNSAFE

Agent generates and executes its own code

LLM MEETS TOOLS

```python
from agent.tools import (
    ...
    load_page,
    transcribe,
    generate_odt,
)

tools = [load_page, transcribe, generate_odt]

model = ChatOpenAI(
    api_key=os.getenv("OPENAI_API_KEY"),
    model="gpt-4o-2024-08-06",
    temperature=0,
).bind_tools(tools)
```

https://platform.openai.com/docs/guides/function-calling

https://github.com/anthropics/courses/blob/master/tool_use/README.md

COMPARING MODELS

GENERATING AND EXECUTING CODE

PROMPTING IS ...

PROMPTING IS ...

THE ART OF PROMPTING

```
from langchain_core.messages import SystemMessage


SystemMessage(
    content="""
            If asked to create odt, save odt, generate odt:
            - generate python code to save the file
            - use odfpy to create the file
            - execute the code, do not show it
            - do file_path = Path('files/{filename}.odt')
            - always do doc.save(file_path)
            """

)
```

LIMITATIONS

“LLMs have shown promise in […] code generation but typically excel only in simpler tasks such as generating standalone code units.”

https://arxiv.org/abs/2401.07339

CODE EXECUTION: RISKS

data leak

escaping

data loss

resource exhaustion

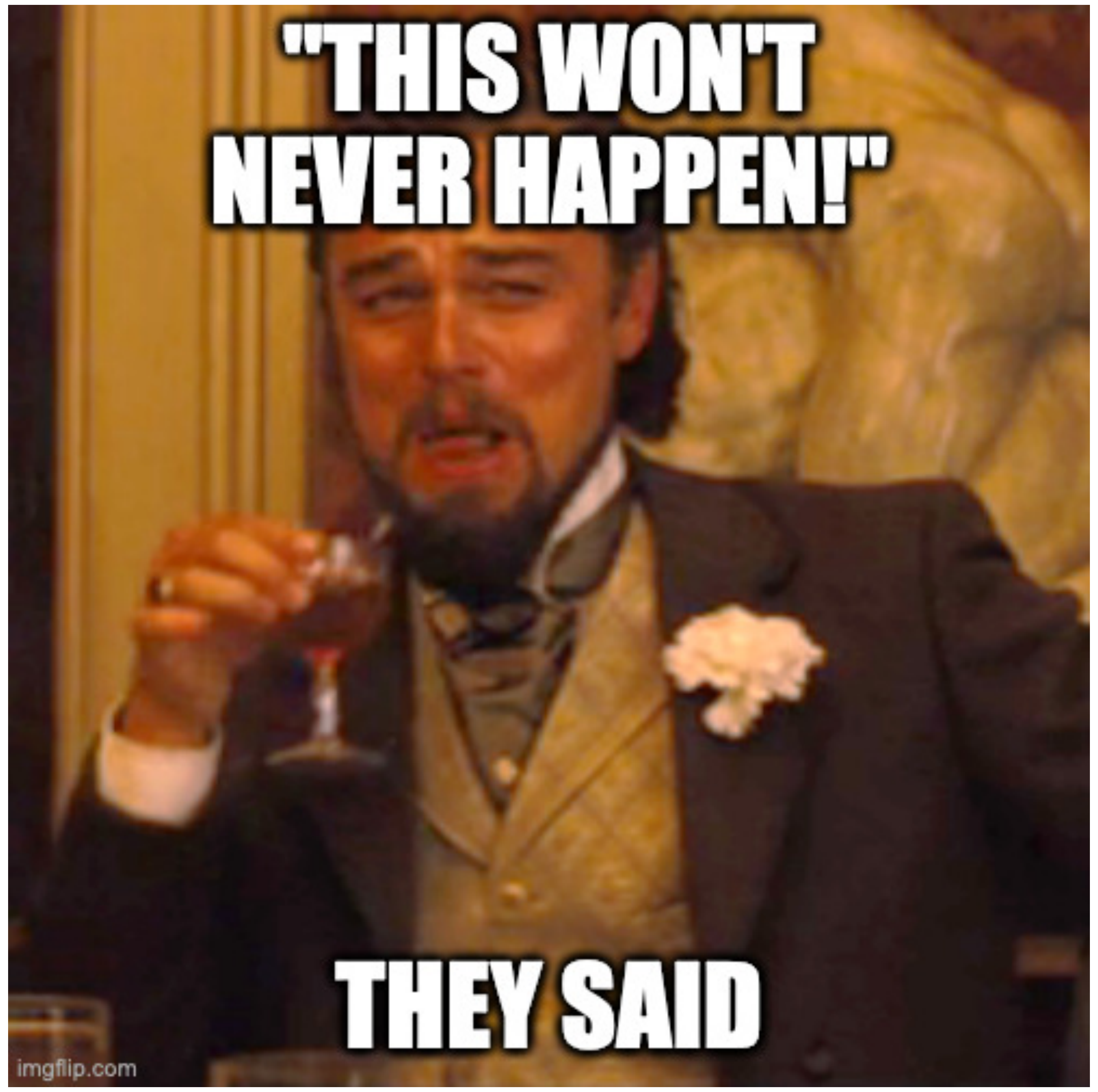
catastrophic backtracking

infinite loops

BRACE YOURSELF

```
import os; os.system('rm -rf /path/to/directory')
```

```
import re; re.search("(a+)+b", "aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa")
```


"THIS WON'T NEVER HAPPEN!"
THEY SAID
imgflip.com

MITIGATIONS

monitoring

preemptive testing

human oversight

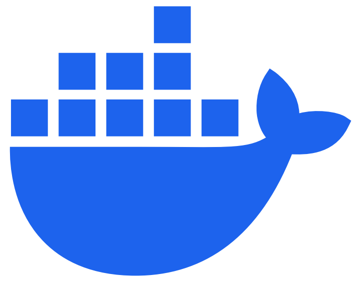
sandboxing

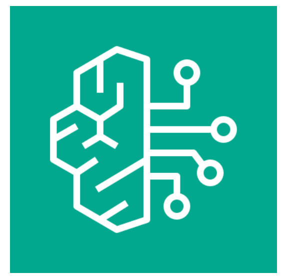
limit access to data/network

THE NAIVE WAY

```python
from langchain_core.tools import tool

@tool(“execute-python")
def execute_python(code_string: str):
    """Execute Python code."""

    global_vars = {}
    local_vars = {}
    exec(code_string, global_vars, local_vars)

    # Error handling omitted :-)
```

BETTER WAYS





HF INTERPRETER

```
In [1]: from transformers.agents import PythonInterpreterTool

In [2]: PythonInterpreterTool().forward('import shutil' )

InterpreterError: Import of shutil is not allowed.
Authorized imports are: ...
```

HF INTERPRETER

```python
from transformers.agents import PythonInterpreterTool
from langchain_core.tools import tool

python_repl = PythonInterpreterTool(authorized_imports=["odf", "pathlib"])


@tool(“execute-python")
def execute_python(code_string: str):
    """Execute Python code.”""

    return python_repl.forward(code_string)
```

https://github.com/huggingface/transformers/blob/main/src/transformers/agents/python_interpreter.py

CONTAINER APPS DYNAMIC SESSIONS

```
repl = SessionsPythonREPLTool(
    pool_management_endpoint=os.getenv("POOL_MANAGEMENT_ENDPOINT")
)

@tool(“execute-python")
def execute_python(code_string: str):
    """Execute Python code, download the resulting file.”””

    properties = repl.execute(code_string)
    filename = properties["result"]

    repl.download_file(
        remote_file_path=filename, local_file_path=output_dir / filename
    )
```

https://learn.microsoft.com/en-us/azure/container-apps/sessions

TAKEAWAYS, AND WHAT’S NEXT

TAKEAWAYS

- Prompting goes a long way
- Executing LLM-generated code is hazardous
- Sandboxing Python is hard!
- This stuff is constantly evolving

RESOURCES

- https://nedbatchelder.com/blog/201206/eval_really_is_dangerous.html
- http://tav.espians.com/paving-the-way-to-securing-the-python-interpreter.html
- https://restrictedpython.readthedocs.io/en/latest/index.html
- https://github.com/vstinner/pysandbox
- https://doc.pypy.org/en/latest/sandbox.html
- https://lwn.net/Articles/574215/
- https://www.regular-expressions.info/catastrophic.html
- https://github.com/StepicOrg/epicbox
- https://github.com/engineer-man/piston
- https://github.com/tjmlabs/AgentRun

THANKS!