
GIL

Google: can Python into threads?

"CPython doesn't support multi-threading"

1992

1992

- me

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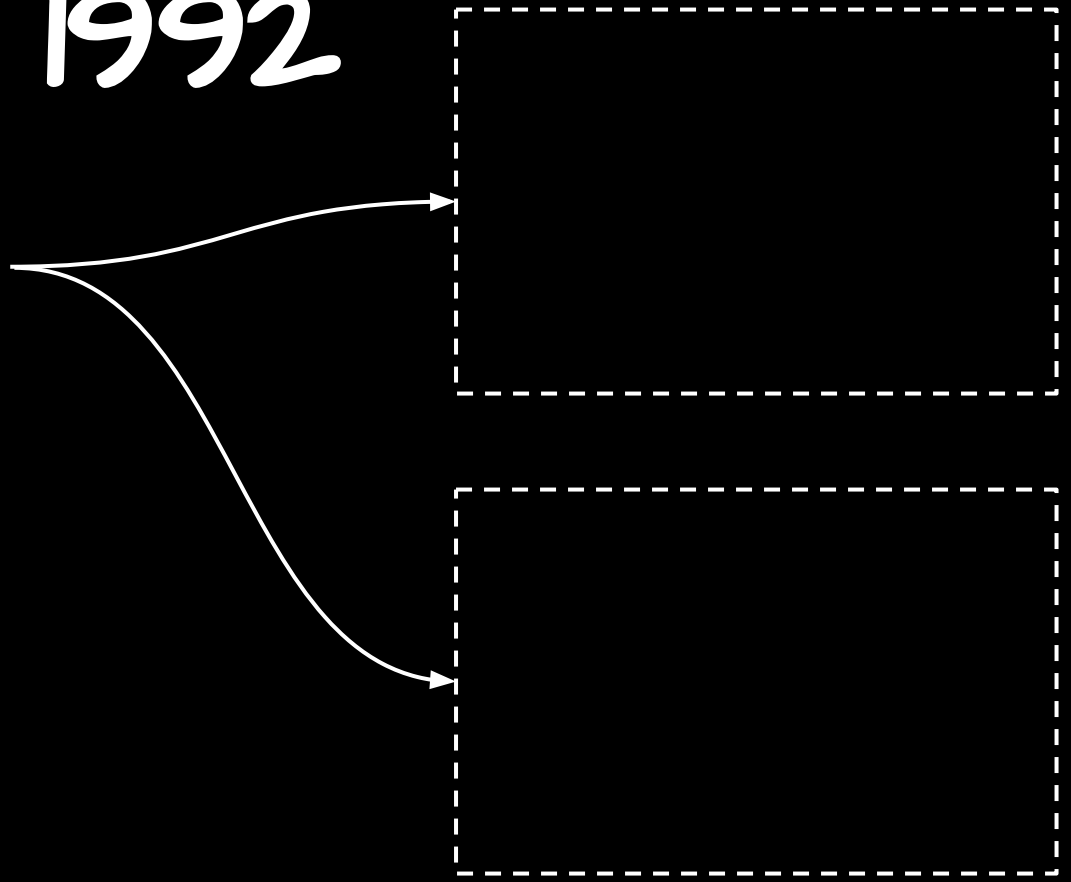
- me
- Java & JavaScript



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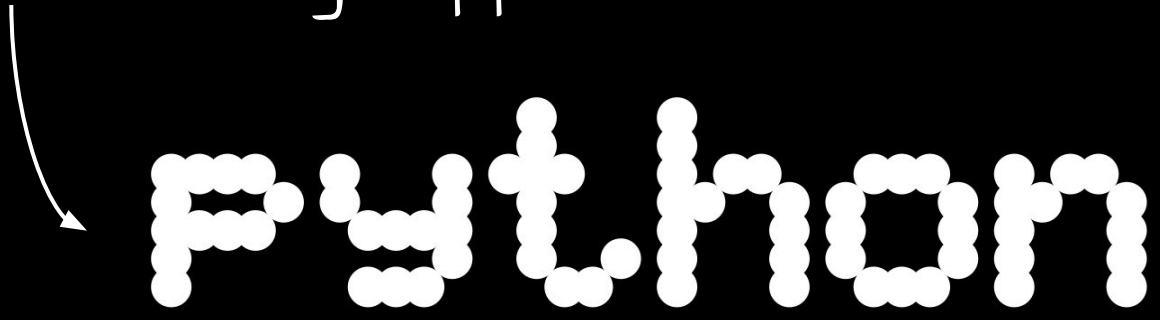
- Java & JavaScript
- consumer-grade multi-core CPUs
- Python (with threading support)



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× „CPython can run only on single core"
✓ "CPython process can execute Python bytecode in one thread at the time"

kolodziejj.info
@unit03


allegro


allegro

GIL

GIL: prerequisites

Threads

Threads

- process

Threads

- process:
  - instance of an application

Threads

- process:
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  - instance of an application
  - one or more threads
  - shared memory
- `import threading`
  - system (kernel/native/Posix) threads
  - vs. green threads, greenlets, coroutines etc.
- thread state:
  - ready/runnable
  - running
  - blocked/waiting (e.g. for system calls, e.g. I/O)

Parallelism

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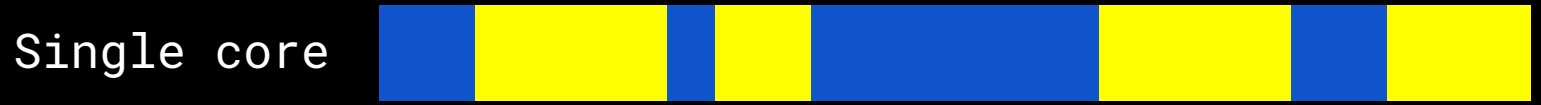
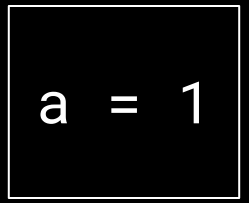
- other forms:



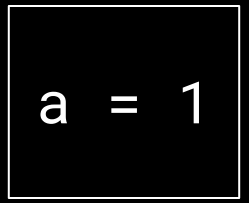
Race conditions and locks

Race conditions



Race conditions

Thread 0
`a = a - 1`



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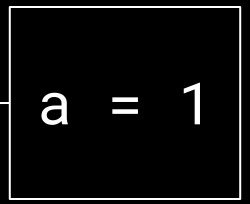


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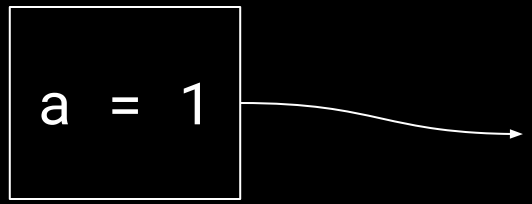


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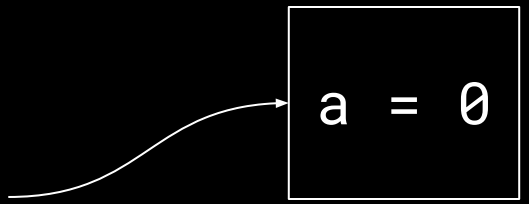


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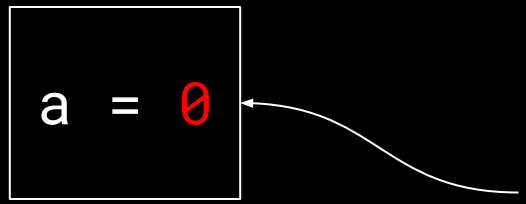


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Locks

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- or: mutex - **mut**ual **ex**clusion
- tool for preventing race-conditions
- lock (hold) and unlock (release)

Locks

```
lock = threading.Lock()
```

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with lock:
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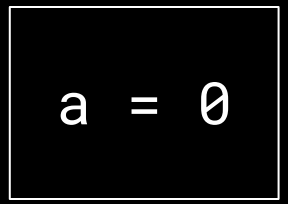


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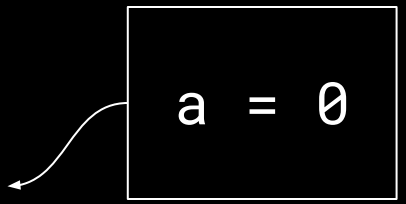


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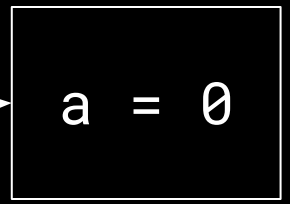


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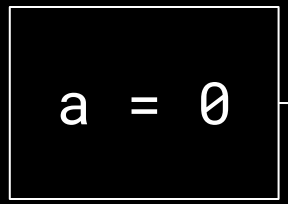


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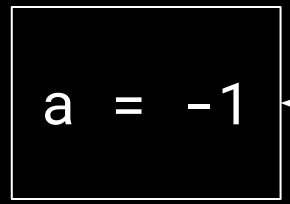


```
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Memory management

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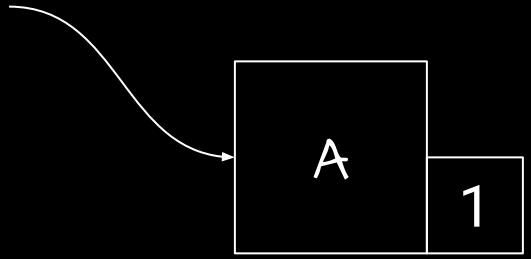

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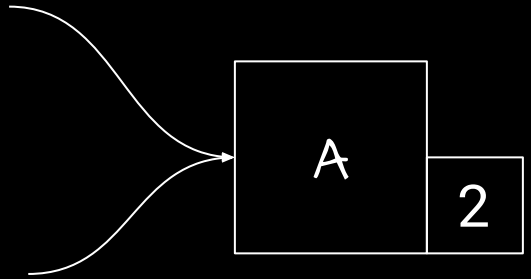

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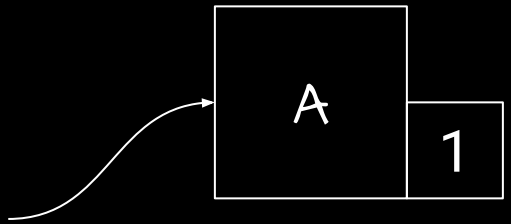

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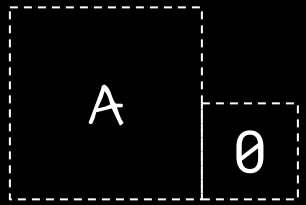

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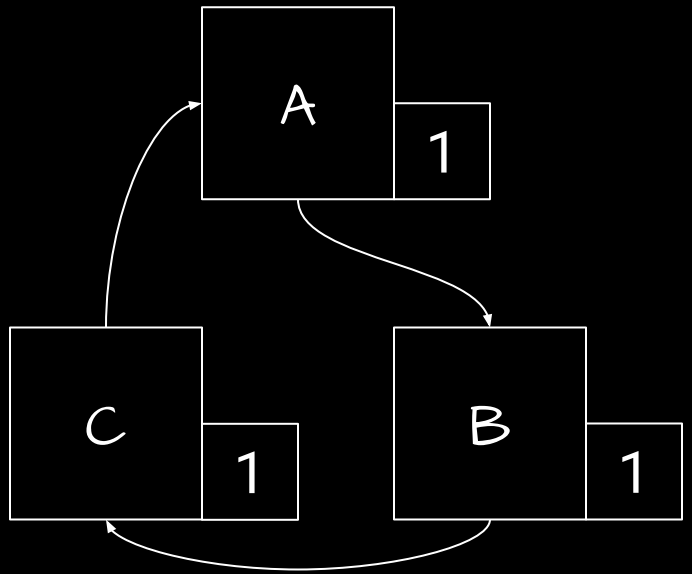

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  - but more **complex**

Python bytecode

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a = 1

print(a)
```

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```
  2 LOAD_CONST    1 (1)
  4 STORE_FAST    0 (a)
  6 LOAD_GLOBAL   1 (NULL + print)
 18 LOAD_FAST     0 (a)
 20 PRECALL       1
 24 CALL          1
```

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- bytecode -> interpreter -> execution

finally

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- protects against race conditions:
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  - internal global state
  - atomic APIs
- C extensions/binary modules assumes GIL

GIL

- holding the GIL not needed when:

GIL

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GIL

- holding the GIL not needed when:
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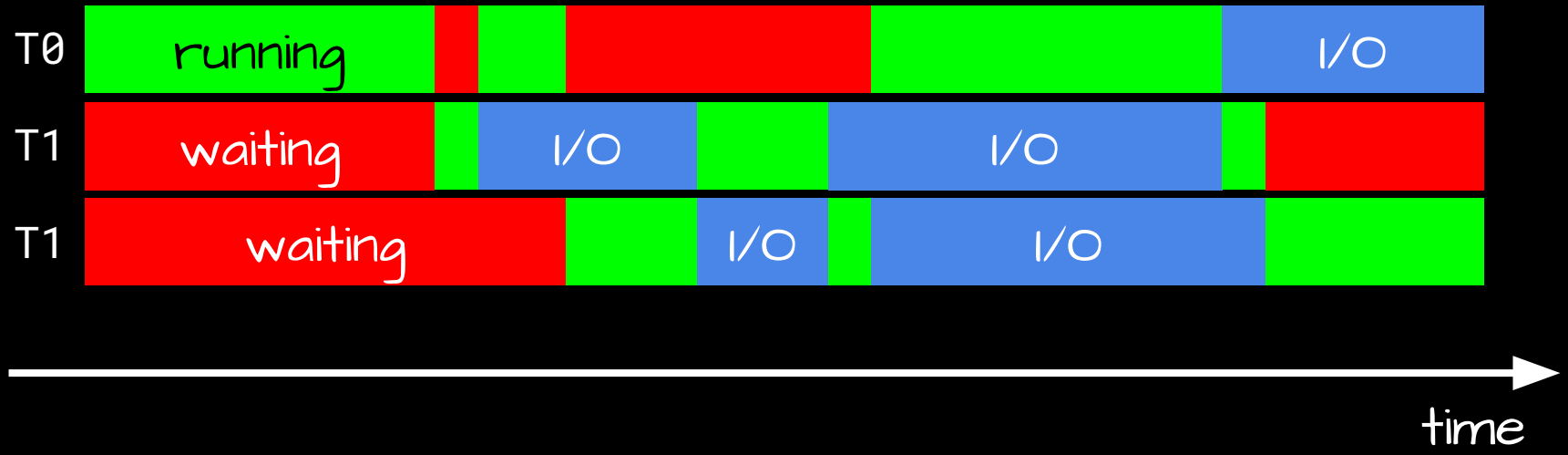
  - executing code that doesn't access Python objects


T0
running
T1
waiting
T1
waiting
time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I/O
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GIL: implementation

- "ceval" loop: Python/ceval.c
  - the GIL part: Python/ceval_gil.c
- GIL data structure: Include/internal/pycore_gil.h


GIL

De-GIL'ing

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De-GIL'ing attempts

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- 2016: GILectomy

- 2023: PEP 703 - Making the Global Interpreter Lock Optional in CPython

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  - changes in reference counting, garbage collection, thread-safety of container types, memory allocation... (go read the PEP)

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  - `--disable-gil`

De-GIL'ing expectations

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De-GIL'ing expectations

1. Performance:
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   - single-threaded code: not significantly slower
2. Gradual migration path for C-extensions
3. CPython codebase: not significantly more complex than with the GIL

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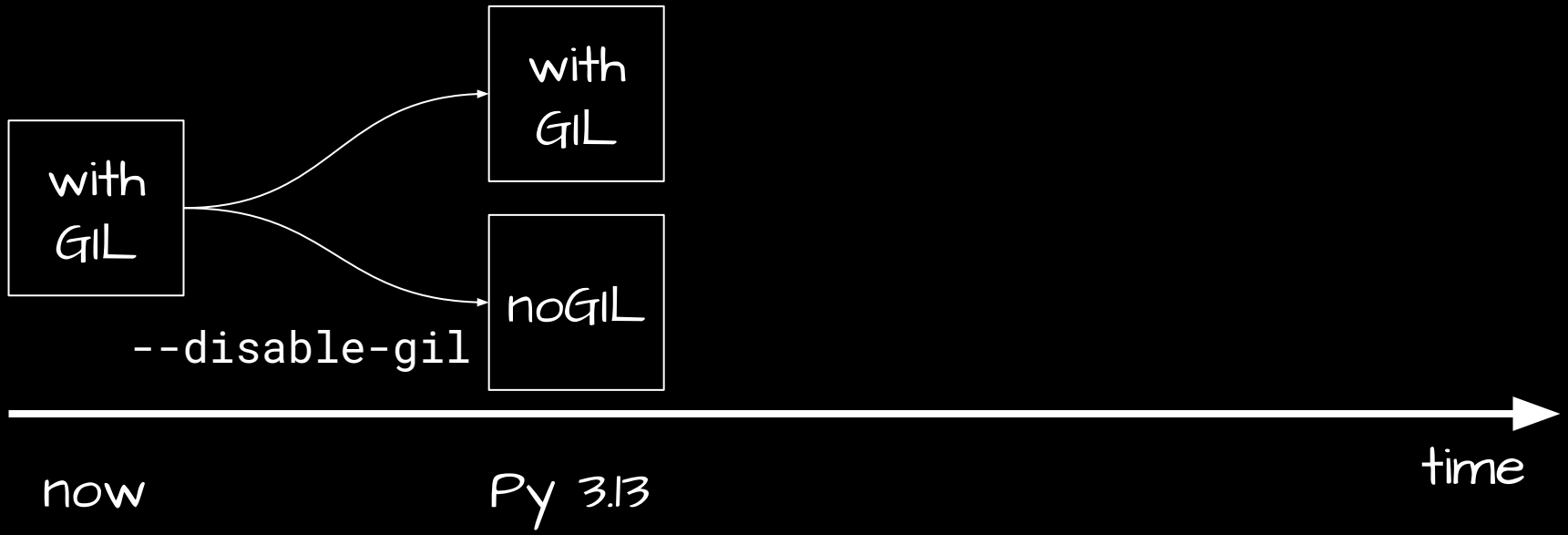

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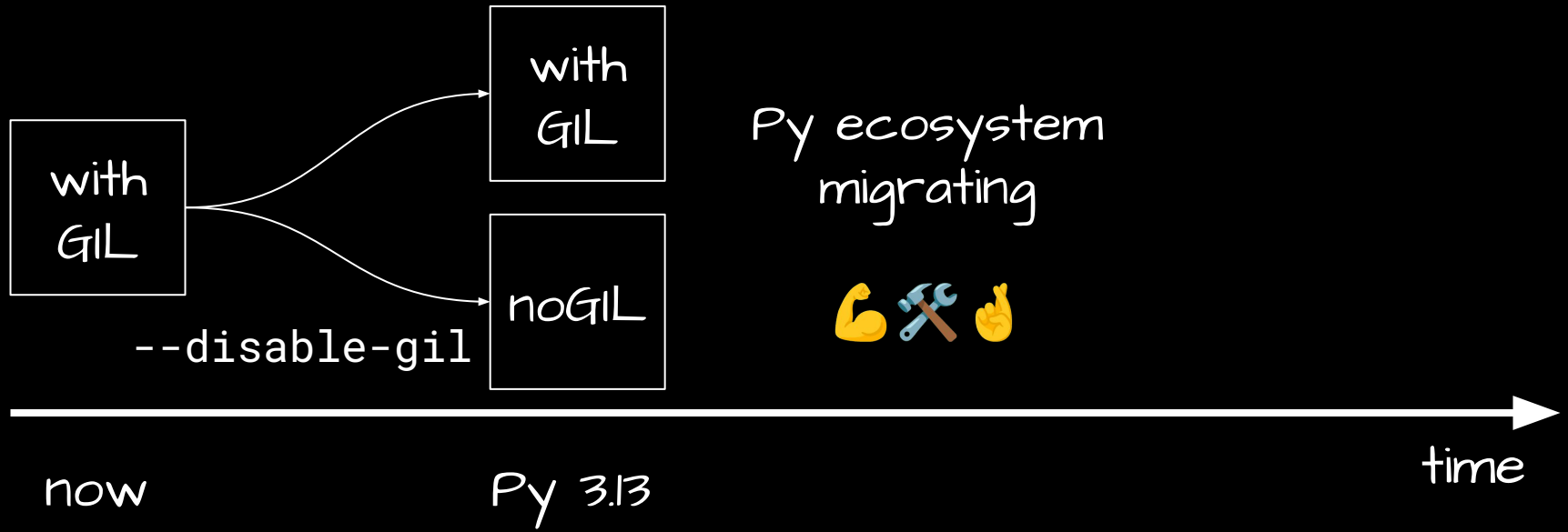

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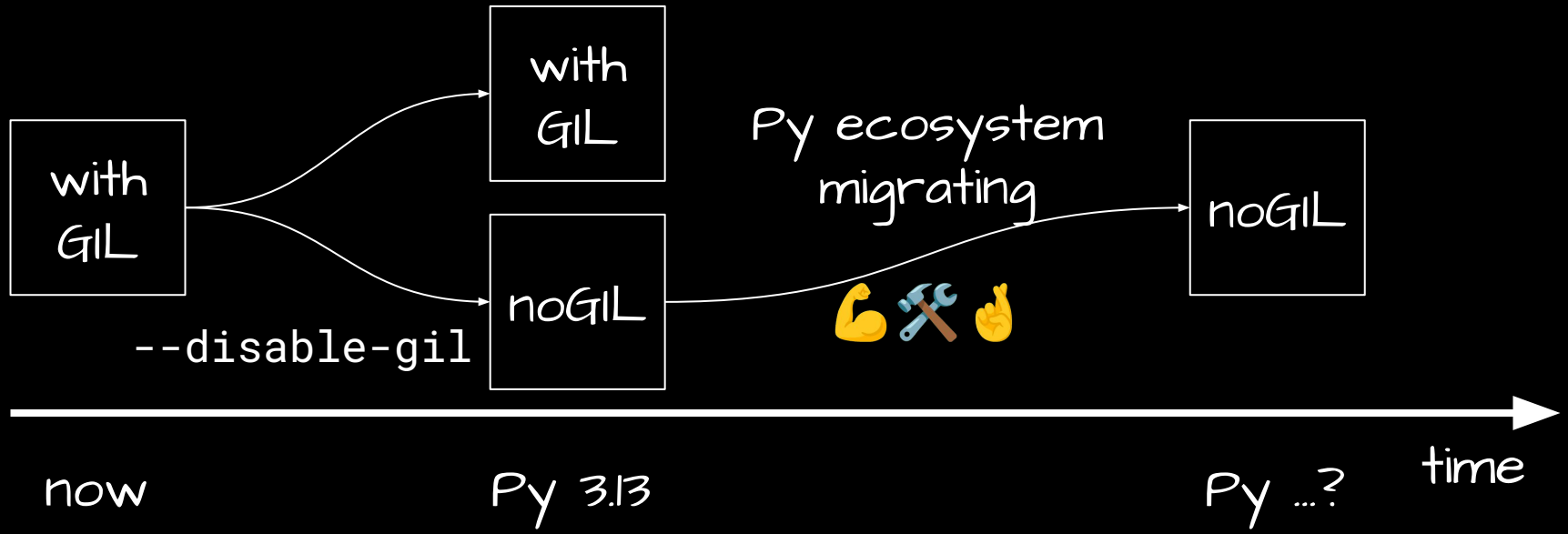

In the meantime: what to do?

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  - profile! (cProfile, perf...)

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  - non-Python alternatives
  - weigh all pros and cons!

- 🤞 for PEP 708 and friends

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Thank you! :)
Questions?

kolodziejj.info/talks/gil