Python unplugged

Mining for hidden batteries

loki.dev/ep24

$ whoami

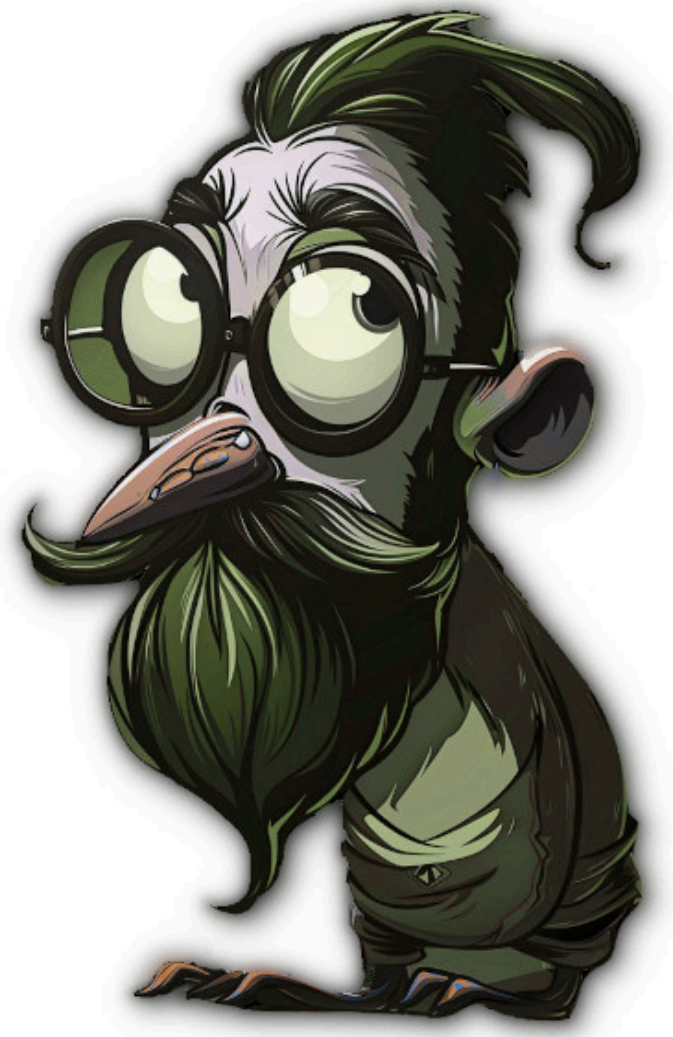
name: Torsten

occupation: Polylang Software Architect/Backend Developer Mara Solutions

dev since: +12y

first code: ~25y if you count creating crappy Amiga Quickbasic textadventure

other stuff: Being a proud dad and husband. Reading, tabletennis, ...the usual stuff



What problem am I trying to solve here?

- learn the possibilities of the built in standard library
- for simple cases external libraries are not always necessary[1]
  - [1] *for simple cases!*
- better portable one-off scripts!
- sometimes even easier!

What am I NOT trying to solve?

- Performance issues
- If performance is really **crucial**:
  Pandas/Polars/Numpy/etc. are perfect for you

Outline: 4 Chapters

1. Fetching data
2. Cleaning data
3. Processing data
4. Miscellaneus / Additional stuff (Might be dropped because of time)
5. (Maybe some ASGI implementation)

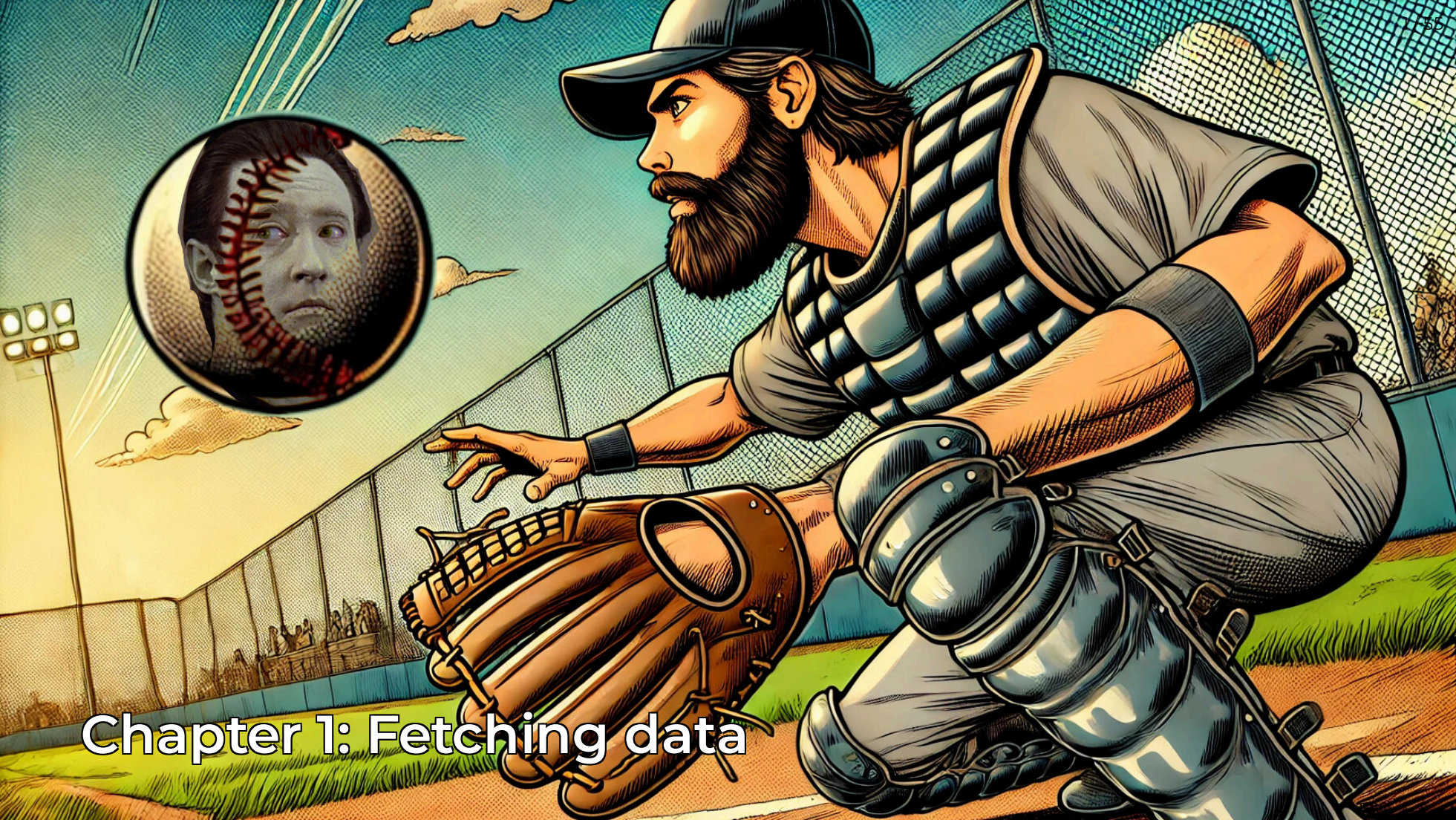
What’s the story?

- Who is familiar with *Terry Pratchett*?
- We are working on a project in *Ankh Morpork*
- The "Unseen Library" and it’s librarian finally want to implement some digitalisation magic
- The first step is, that we already have some API **cough** magic funnel sending us the book data. One by one.
- It is our job to clean the data, work on the data and also save it in our excel (because why not)

** I actually created a full (vanilla python) server and generator to generate those books - And we most likely won't even see nor use it -.-'*

Example book

```
Puzzling Eating of the Golems
by Senior Guildmaster Danielle Warren

       title: Puzzling Eating of the Golems
      author: Senior Guildmaster Danielle Warren
     lent_by: Jessica Silvermist
  lent_since: year 0065 in the 1st month
  lent_times: 42
        year: The 10th year after Silver Horde
  catalogued: year 0300 in the 7th month
    location: Restricted Section: middle shelve. 4m from the end
     excerpt: Amidst the ruins of a lost civilization trembled
              as a jester sang a melody. Hidden truths come to
              light.
```


Chapter 1: Fetching data

Fetching data

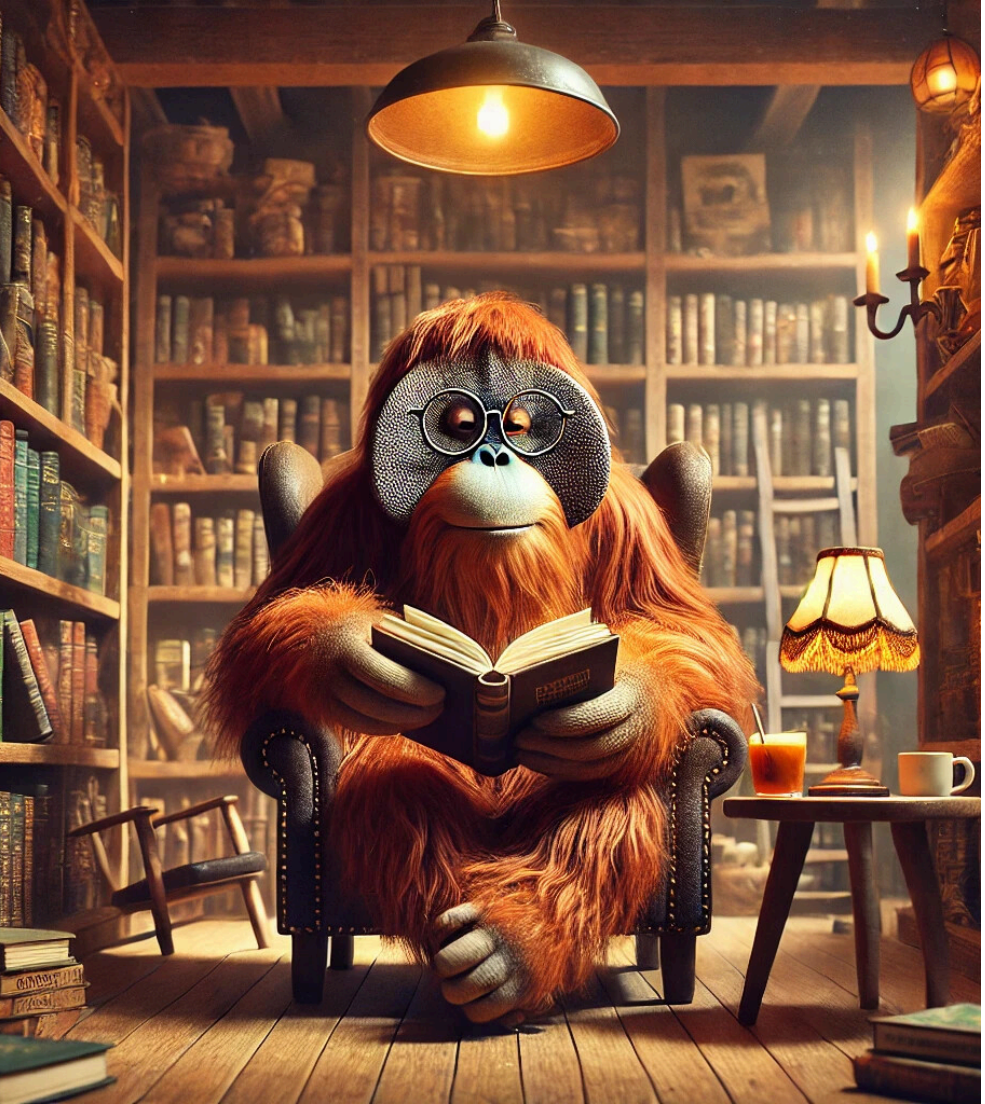
```
"""
An example response for our project
"""
def fetch_book(url): ...

fetch_book(URL_BOOK) == dict(
  title="Remarkable Saga of the Clacks",
  author="Alexandra Scott",
  lent_by=null,
  lent_since=null,
  lent_times=8,
  year="The 7th year after Turtle Moves",
  catalogued="year -395 in the 2nd month",
  location="Great Hall: bottom shelve. 5m from the end",
  excerpt=(
      "Near the bubbling cauldron had never seen such a"
      " sight: some dwarf miner raised the dead. The "
      "annual magical cooking competition begins."
  ),
)
```

Working with data

```
"""
With TypedDict from typing module we help the IDE
to give us proper type hints!
Positive Sideffect: This helps static code checkers help us
-> e.g. ruff,mypy,pyright,pyre,...
"""
from typing import TypedDict


class Book(TypedDict):
    title: str
    author: str
    lent_by: str | None
    lent_since: str | None
    lent_times: int
    year: str
    catalogued: str
    location: str
    excerpt: str


def fetch_book() -> Book: ...
```

This is what it looks like

```
    catalogued: str
    lo
    ex  π 'year'
        π 'title'
        π 'author'
def fe  π 'lent_by'        Response:
    re  π 'excerpt'        rlopen(URL_BOOK).read()
    re  π 'location'       sponse)
        π 'lent_since'
        π 'lent_times'
def ma  π 'catalogued'
    bo
    book['']     ■ Could not access item in TypedDict     "" is not a de
```



Let’s continue

- There are a LOT of books. And we only have limited ressources
- This means that we need to work on the books in batches
- Plenty of solutions!
- Let’s first look on how we might have done it before python3.12
- And then how python3.12 makes our life easier :)

Batching

```
from csv import DictWriter
from itertools import batched


LIBRARY_DB = Path("library_raw.csv")

# fetches the keys form our TypedDict :)
BOOK_COLS = Book.__annotations__.keys()


def work_on_the_library() -> None:
    lib = fetch_library()

    with LIBRARY_DB.open("w") as file:
        writer = DictWriter(file, fieldnames=BOOK_COLS)
        writer.writeheader()
        for batch in batched(lib, 10):
            writer.writerows(batch)
```

Summary

We started very small, but which modules did we learn about?

Trivial

Let’s start with the stuff you likely already knew...

- csv (*"duh!"*)
- json (*"Yeah I knew that!"*)
- TypedDict (Maybe new for a few?)
- All of those are in more detail in the /code folder inside the repository

urllib.requests

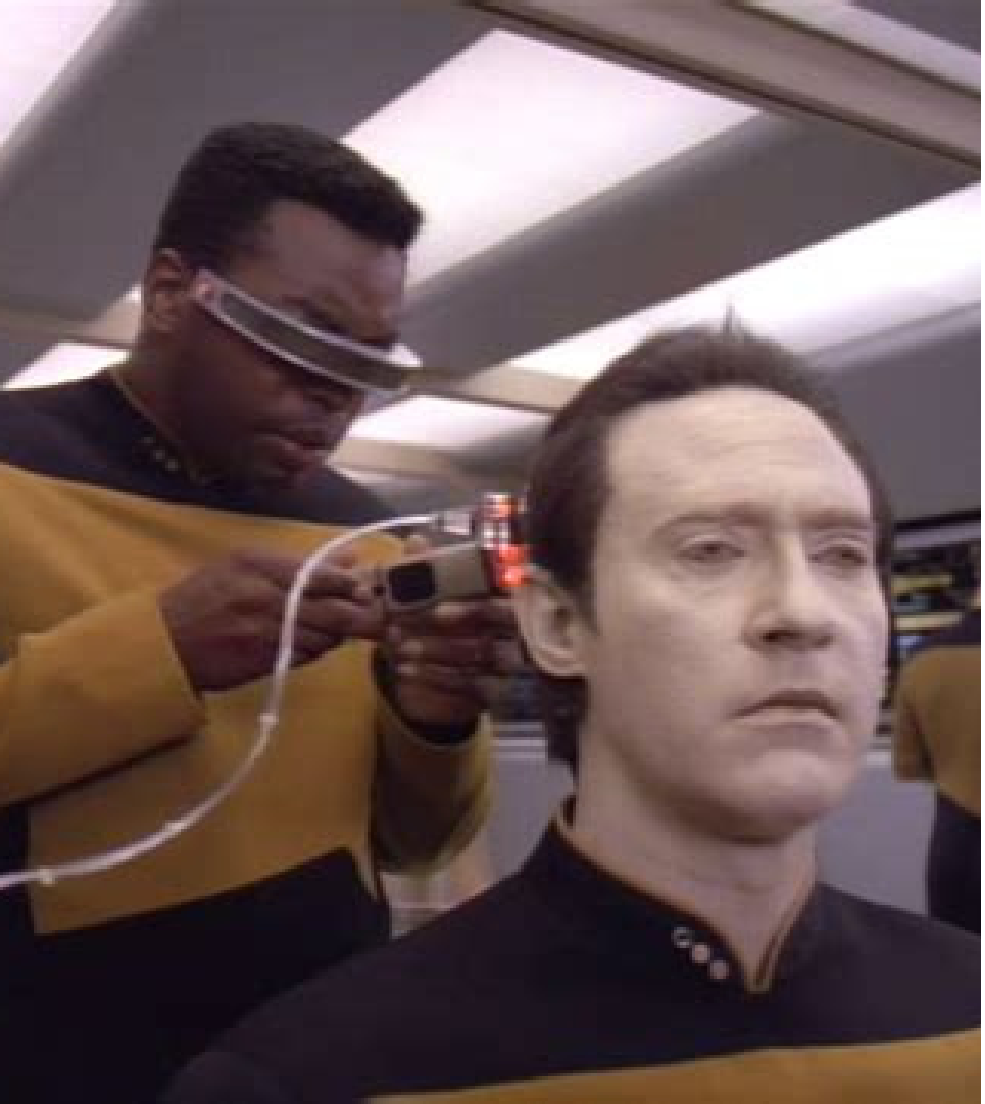
- fetch and send data via HTTP(S)
- restricted to `GET` / `POST` (POST by setting the `data` parameter)
- not as bad to use as one might think, considering the vast amount of modules to replace it

itertools.islice

- basically works like `mylist[from:to:steps]`
- but also works on Generators with unknown size :)
- cannot go backwards or use negative indizes:
  - works: `mylist[::-1]` (reversing a list)
  - doesn't work: `islice(mygenerator, start=-9, step=-3)`

itertools.batched

- Finally arrived in `python3.12`
- Works on all kind of iterable stuff
- delivers `tuple[T]` of size `n`
- `list(batched(range(5), 3)) == [(0, 1, 2), (3, 4)]`

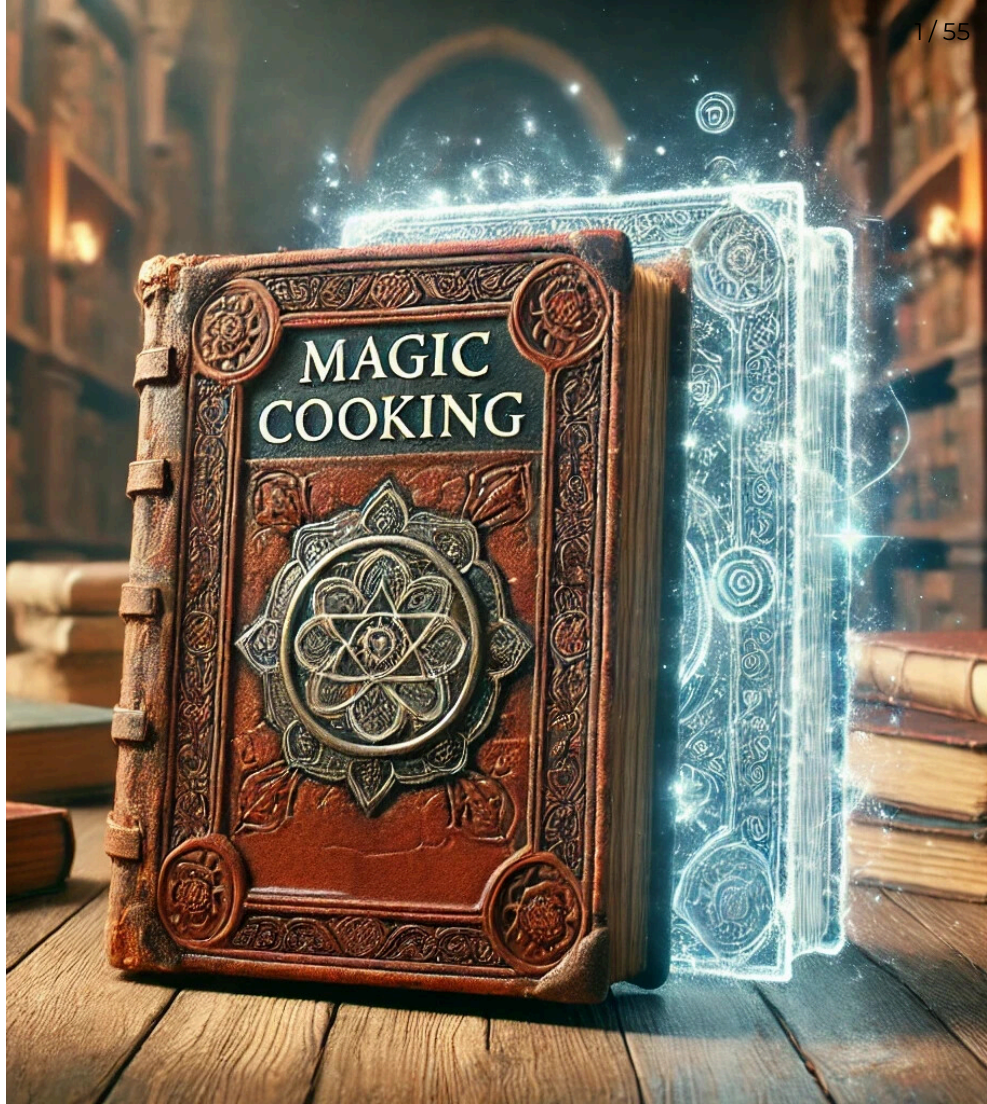


Chapter 2: Cleaning data

(wrong meme universe again - I know)

Duplicate books

- We want to fetch data from the library...
- But: Magical library. Means: the books will duplicate!
- The orang utan librarian of the Unseen University wants the list of unique books as CSV (obviously!)
- This is **NOT** a leetcode talk ;)
  - no fancy but obvious solution if P in NP
  - also: no super clever text similarity or duplication algorithms



```
from csv import DictWriter
from itertools import chain, pairwise


LIBRARY_DB = Path("library_raw.csv")
COLUMNS = Book.__annotations__.keys()


def only_save_non_duplicates() -> None:
    """
    chain to the rescue!
    It lazily chains multiple iterators without effort
    """
    book_gen = fetch_library()

    with LIBRARY_DB.open("w") as file:
        writer = DictWriter(file, fieldnames=COLUMNS)
        writer.writeheader()

        for book, book2 in pairwise(chain([None], lib):
            if book != book2:
                writer.writerow(book2)
```

What new modules did we learn about?

pairwise

- Signature: `def pairwise(iterable: Iterable[T]) -> Iterable[tuple[T, T]]`
- Uses an iterator like `range(10)` ...
- ... and creates a new iterator like `((0,1), (1,2), (2,3), ..., (8, 9))`
- other example: `list(pairwise("Hello")) == [("H","e"), ("e","l"), ("l","l"), ("l","o")]`
- is lazy -> Without `list(...)` or other ways of consuming pairwise does (almost) nothing

chain

- Chains together multiple iterables
- From this `list(chain('Hello', 'World'))` ...
  - We get this `['H', 'e', 'l', 'l', 'o', 'W', 'o', 'r', 'l', 'd']`
- Advantage: it's lazy and doesn't create a large[1] object, like:
  - `combined_list = [*my_list, *my_other_list]`
  - [1](not large means: it only holds references)
- It can flatten lists with a classmethod: `chain.from_iterable(...)`

It can flatten lists

(also a common thing people do themselves)

```
my_list = [[1,2,3], [3,4,5]]
flattened = chain.from_iterable(my_list)

assert list(flattened) == [1,2,3,3,4,5]
```

ChainMap

For the brevity of completeness...

- There is also `itertools.ChainMap`
- Works similar to `chain`:
- `cm = ChainMap({"a": 1}, {"b": 2}, {"a": 3})` gives us:
  - `cm["a"] == 1` (Not `3`!)
  - `cm["b"] == 2`
  - `cm["c"] --> KeyError`
- Attention: Different behaviour than `**dict`
  - `{**adict, **bdict} => dict(ChainMap(bdict, adict))`

Saving the deduplicated data

Basically just an excuse to show grouping of contextmanagers

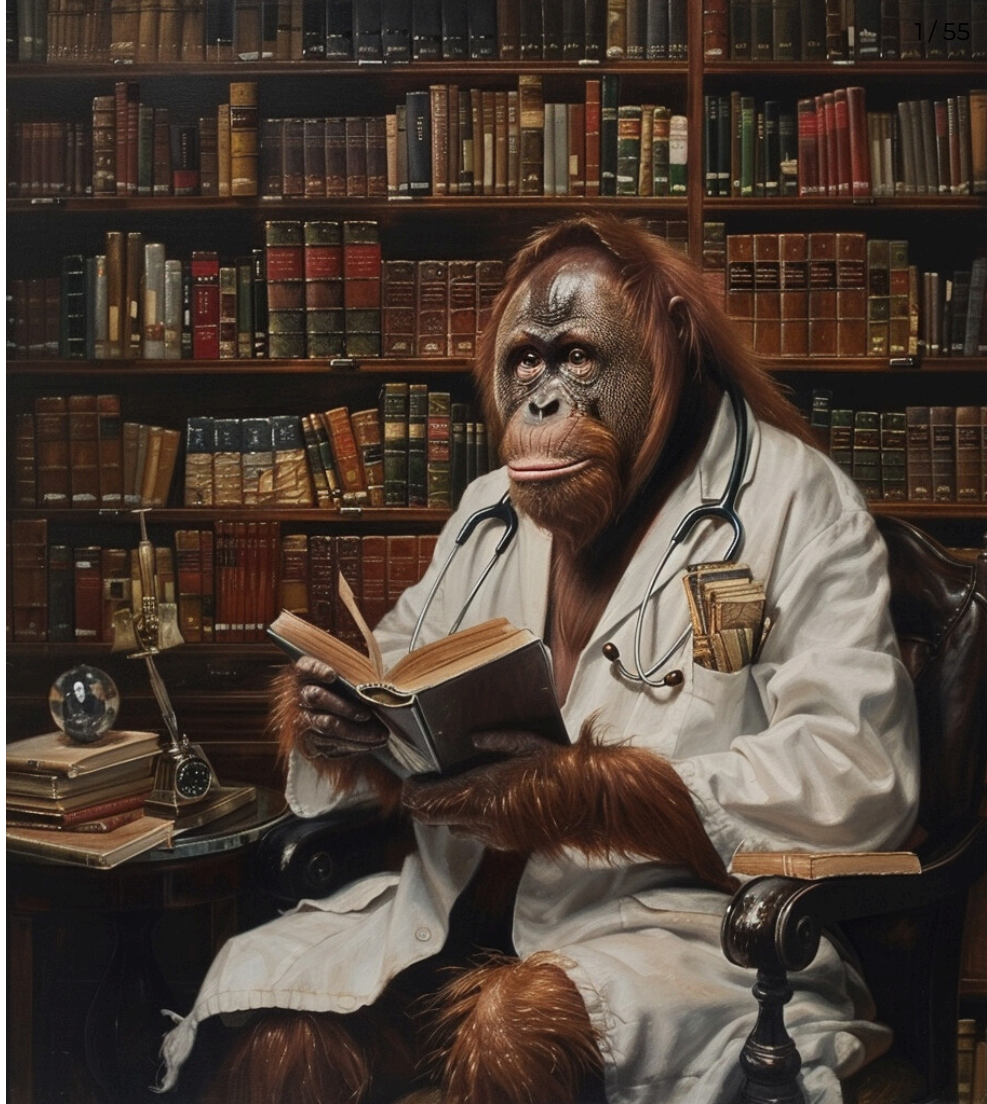
```
OUTPUT_FILE = 'library_clean.csv'

def remove_duplicates(iterable: Iterable) -> Iterator: ...


def clean_data(input_csv_file: str) -> str:
    out_name = input_csv_file.replace(".csv", "-clean.csv")

    with (
        Path(input_csv_file).open("r") as read_file,
        Path(out_name).open("w") as write_file,
    ):
        reader = csv.DictReader(read_file)
        writer = csv.DictWriter(write_file)

        for row in remove_duplicates(reader):
            writer.writerow(row)
```

Remove the books we cannot get back

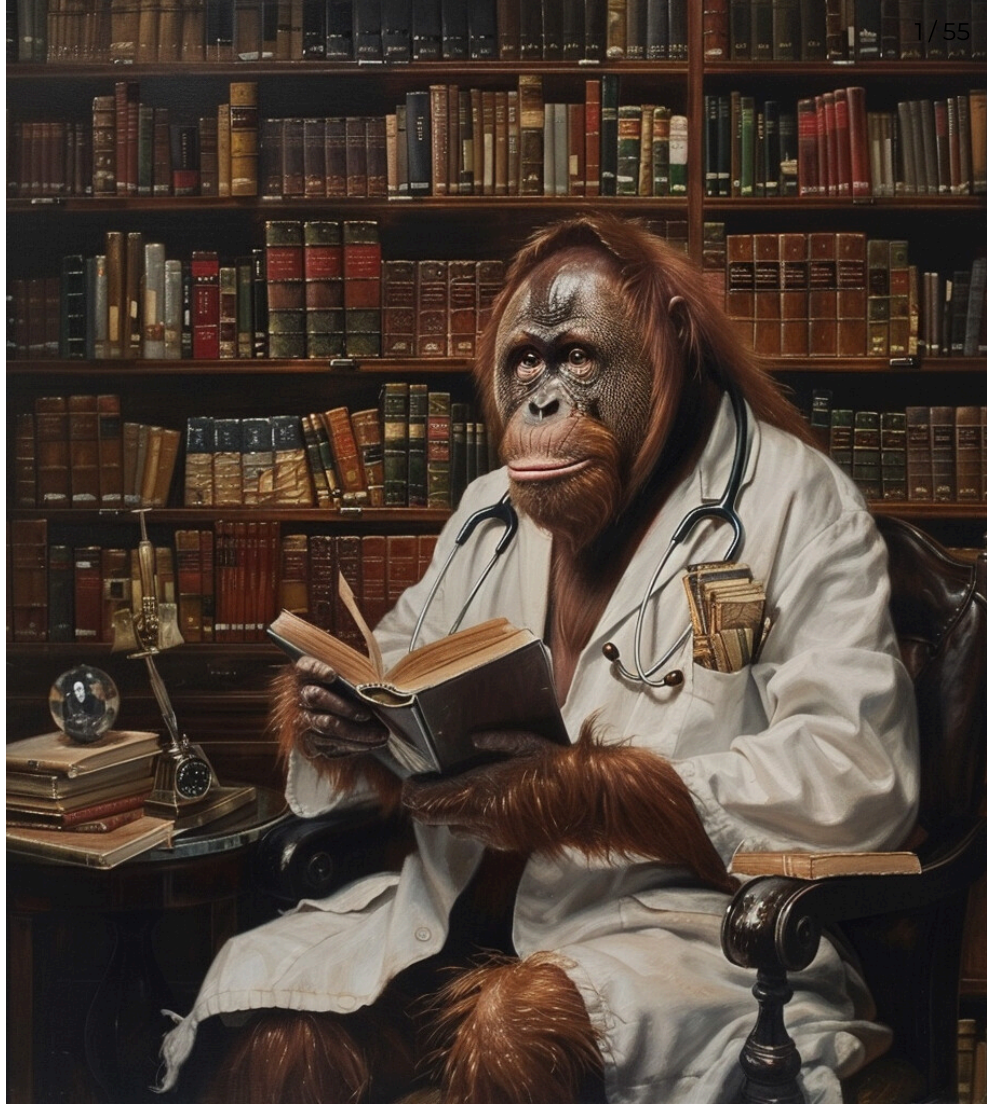
```python
import re


def extract_year(morporkyear: str) -> int:
    """
    But how do we know this really does what we want?
    We could try it, but this is boring and doesn't scale!
    """
    return int(re.search(r"(\d)", morporkyear).group(0))


def hide_lost_books(iterable: Iterable[Book]) -> Iterator[Book]:
    ...
```

Doctest - to the rescue

```
"""Lets start with the same function, but add some
minimal documentation"""
import re


def extract_year(morporkyear: str) -> int:
    """
    This extracts the year from a yearstring

    >>> extract_year("year 450 in the 3rd month")
    450
    """
    return int(
        re.search(r"(\d)", morporkyear).group(0)
    )
```

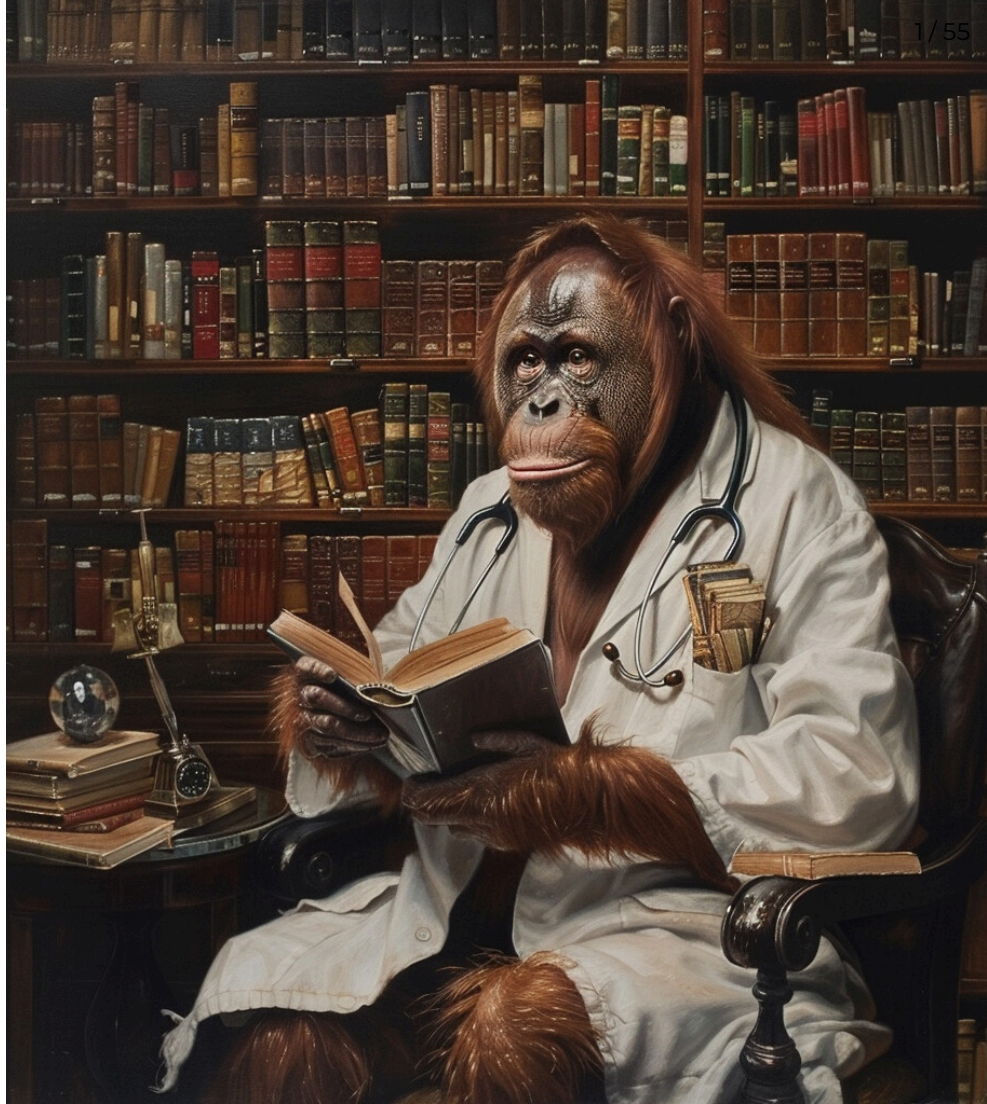


```
python -m doctest code/chapter2/doctest_example.py

**********************************************************
File ".../code/chapter2/doctest_example.py",
    line 8,in doctest_example.extract_year
Failed example: extract_year("year 450 in the 3rd
    month")
Expected: 450
Got: 4
**********************************************************
1 items had failures:
   1 of 1 in doctest_example.extract_year
***Test Failed*** 1 failures.
```



Long story short: lets fix it!

```
"""
Adding a few more "tests" & fixing the issues
"""
import re


def extract_year(morporkyear: str) -> int:
    """
    This extracts the actual year from a yearstring

    >>> extract_year("year 450 in the 3rd month")
    450

    >>> extract_year("year -450 in the 3rd month")
    -450

    >>> extract_year("year 0 in the 3rd month")
    0
    """
    return int(
        re.search(r"(-?\d+)", morporkyear).group(0)
    )
```



🕵️ Let's continue hiding the lost books

```
"""
Usage
"""
def hide_lost_books(iterable: Iterable[Book]) -> \
    Generator[Book, None, list[Book]]: ...

def get_return_value() -> tuple[list[Book], list[Book]]:
    non_hidden_generator = hide_lost_books(mylibrary)

    # consume the whole generator (just as example)
    non_lost_books = list(non_hidden_generator)

    dropped_books = []
    try:
        next(non_hidden_generator)
    except StopIteration as e:
        dropped_books = e.value

    return non_lost_books, dropped_books
```

Summary

- Generators `yield` values
- Generators always also return a value inside `StopIteration` (default `None`)
- Is it a good idea?
  - No. Most likely not, as it is kind of suprising behaviour
- But why did we just see it?
  - Because sometimes in one-off scripts this is faster and easier than a sophisticated object containing the data solution
- What about the middle argument in `Generation[A, B, C]`?
  - Out of scope, but basically we can SEND stuff to generators after their creation
  - `gen = create_generator(); gen.send(123)`
  - Fetch with `received = yield anothervalue; received == 123`

🤓 But how would I do it?

- We use an object to track the data.
  - `NamedTuple` to avoid ugly `result[0]` and `result[1]`
  - Better: `result.lost` and `result.current`
- relatively cheap: We only transport references
- just yield this container instead of complex surprising methods

```python
from typing import NamedTuple


class BookMeta(NamedTuple):
    current: Book
    lost: list[Book]


def hide_lost_books(
    iterable: Iterable[Book]
) -> Iterator[BookMeta]:
    lost_books = []

    for book in iterable:
        if extract_year(book["lent_since"]) >= -300:
            yield BookMeta(book, lost_books)
        else:
            lost_books.append(book)
```

Chapter 3: Summarize and key data

Now the wonderful librarian wants us to get some data to get to know in which dimensions we're working here?

Creating an Index

We want to have list of words in all the titles.

Very simple example Example

- The: 123
- a: 42
- magician: 99

Count Words

```
from collections import defaultdict


def most_common_words_in_title(books: Iterable[Book]) -> dict:
    """
    Much more concise :)
    """
    word_counter = defaultdict(int)

    for book in books:
        for word in book['title'].split():
            word_counter[word] += 1
```

but now the librarian updated the assignment...

So glad customers always know what they want in the first iteration :)

```
from collections import defaultdict, Counter
from itertools import chain


def most_common_words_in_data(books: Iterable[Book]) -> dict:
    word_counter = defaultdict(int)

    book_word_generator = (
        chain(
            book['title'].split(),
            book['author'].split(),
            book['excerpt'].split(),
        )
        for word in all_words
    )

    word_generator = chain.from_iterable(book_word_generator)
    return Counter(word_generator)
```

Let’s add some more data:

- min lent year (We all know this `min(x for x in thing)` - trivial)
- max lent year (`max(x for x in thing)` - trivial)
- family which lent the most (little bit more interesting)
- largest book shelve in the library (let’s see)

```python
from itertools import groupby


def family_name(book: Book) -> str:
    return book['lent_by'].split()[1]


class BiggestLender(NamedTuple):
    family: str
    lent_books: int


def family_lent_the_most(books: Iterable[Book]) -> BiggestLender:
    lent_books = (b for b in books if b['lent_by'])
    books_by_family_name = groupby(lent_books, key=family_name)

    family = max(
        books_by_family_name,
        key=books_by_family_name.get,
    )

    return BiggestLender(family, len(books_by_family_name['family']))
```

But the librarian changed requirements again...

:/

"ookh! ookh! (I want youthe total lenders, unique family names and amount of unlent_books)

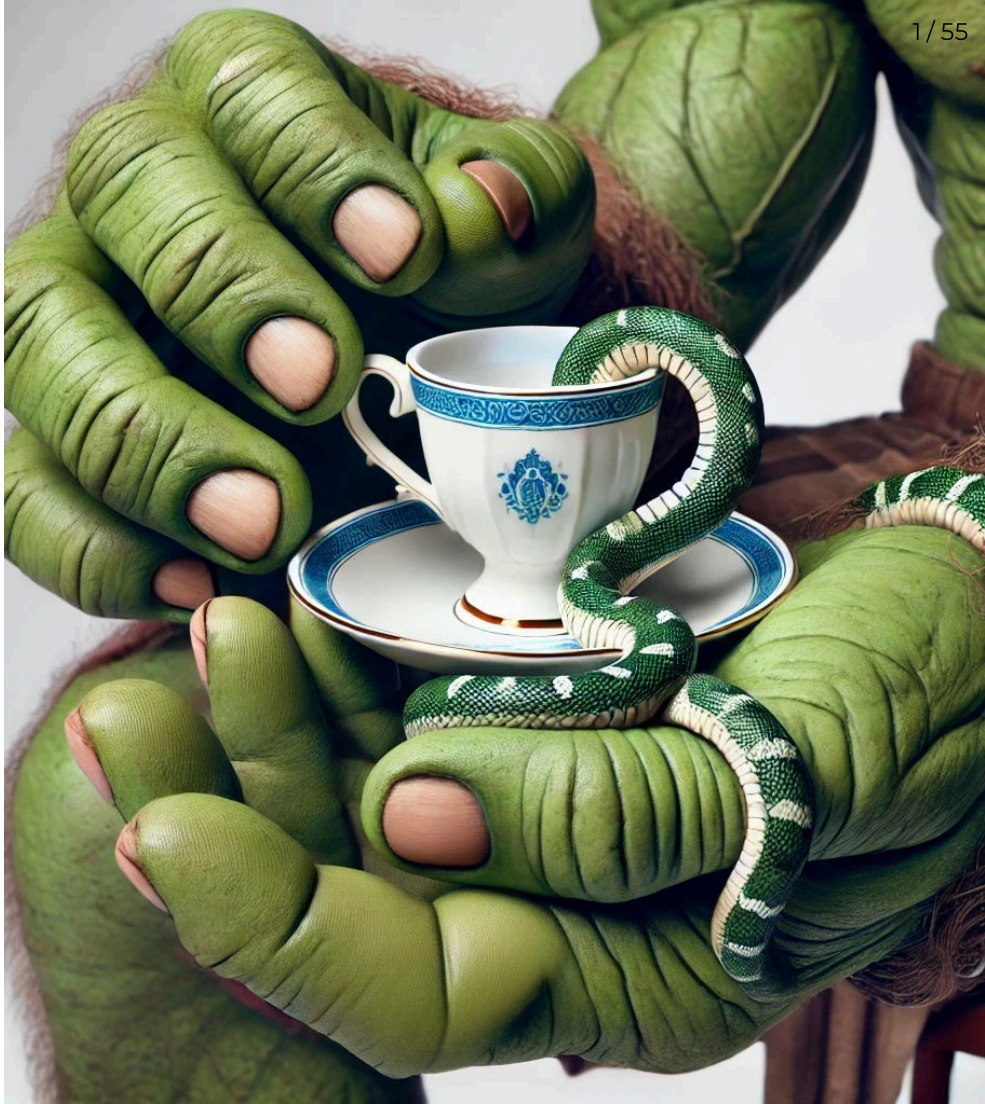
```python
def total_unique_lenders(books: Iterable[Book]) -> int: ...
def unique_families(books: Iterable[Book]) -> set[str]: ...
def unlent_books_count(books: Iterable[Book]) -> int: ...


class Statistics(NamedTuple): ...


def gather_statistics(books: Iterable[Book]) -> Statistics:
    """This would solve that, right?"""
    all_books = list(books)

    return Statistics(
        unique_lenders=total_unique_lenders(all_books),
        families=unique_families(all_books),
        unlent_books=unlent_books_count(all_books),
    )
```

Reduced Tee

Two tools which might help us:

1. `itertools.reduce`
2. `itertools.tee`

Let’s start with reduce!

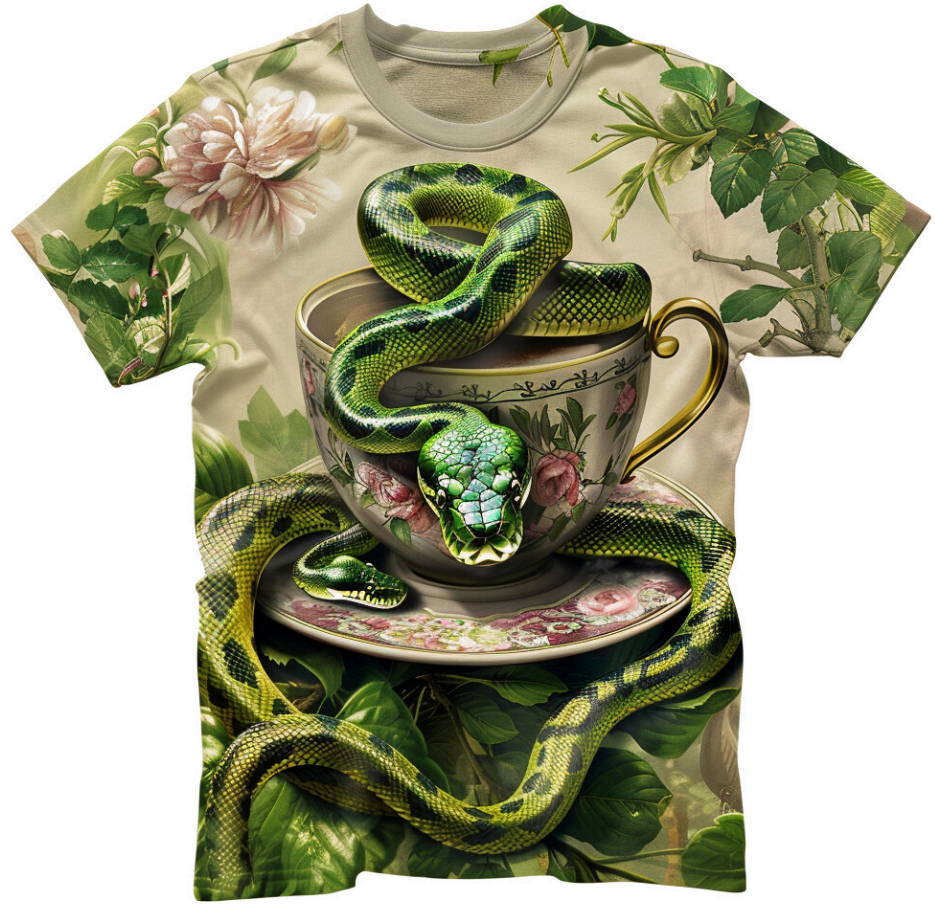


Solving this with reduce

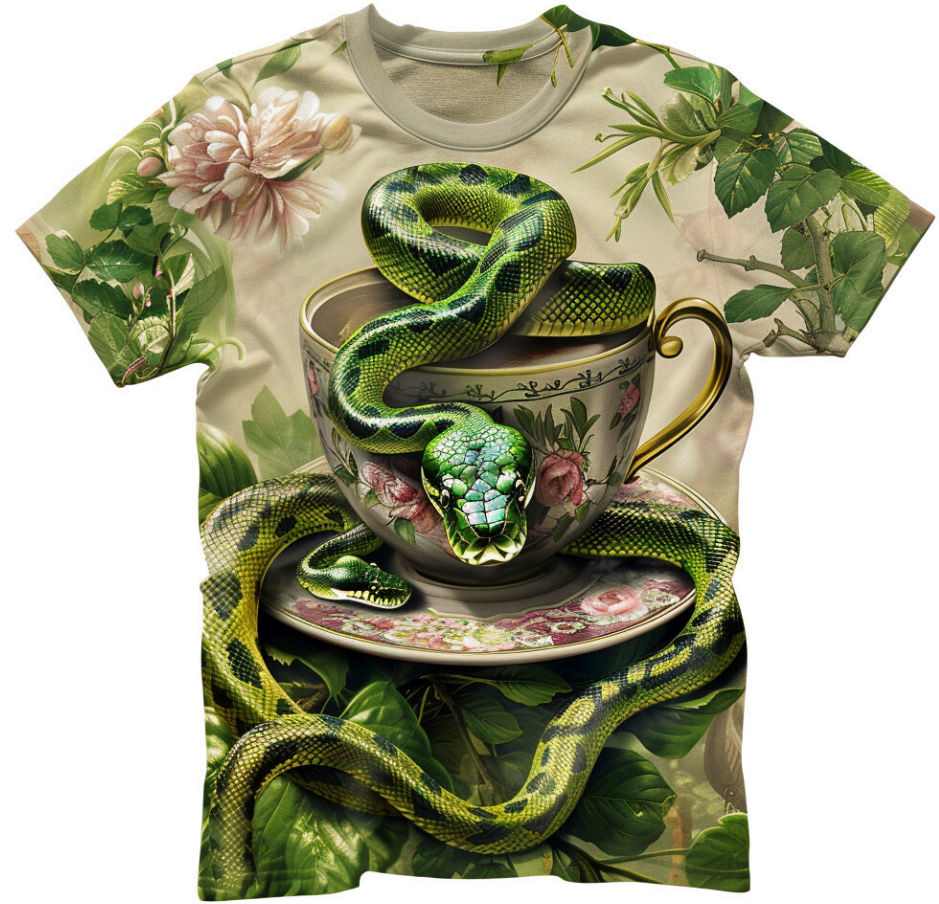
```python
def total_unique_lenders(books: Iterable[Book]) -> int: ...
def unique_families(books: Iterable[Book]) -> list[str]: ...
def unlent_books_count(books: Iterable[Book]) -> int: ...

class Statistics(NamedTuple): ...

@dataclasses.dataclass
class StatisticsAccumulator: ...


def statistics_reducer(
    acc: StatisticsAccumulator,
    book: Book,
) -> StatisticsAccumulator: ...

def gather_statistics(books: Iterable[Book]) -> Statistics:
    accumulated_stats = reduce(statistics_reducer, books, StatisticsAccumulator())

    return Statistics(
        unique_lenders = len(accumulated_stats.lenders),
        families = len(accumulated_stats.families),
        unlent_books = accumulated_stats.unlent,
    )
```

How about tee?

Maybe our computation is not CPU bound, but IO bound?

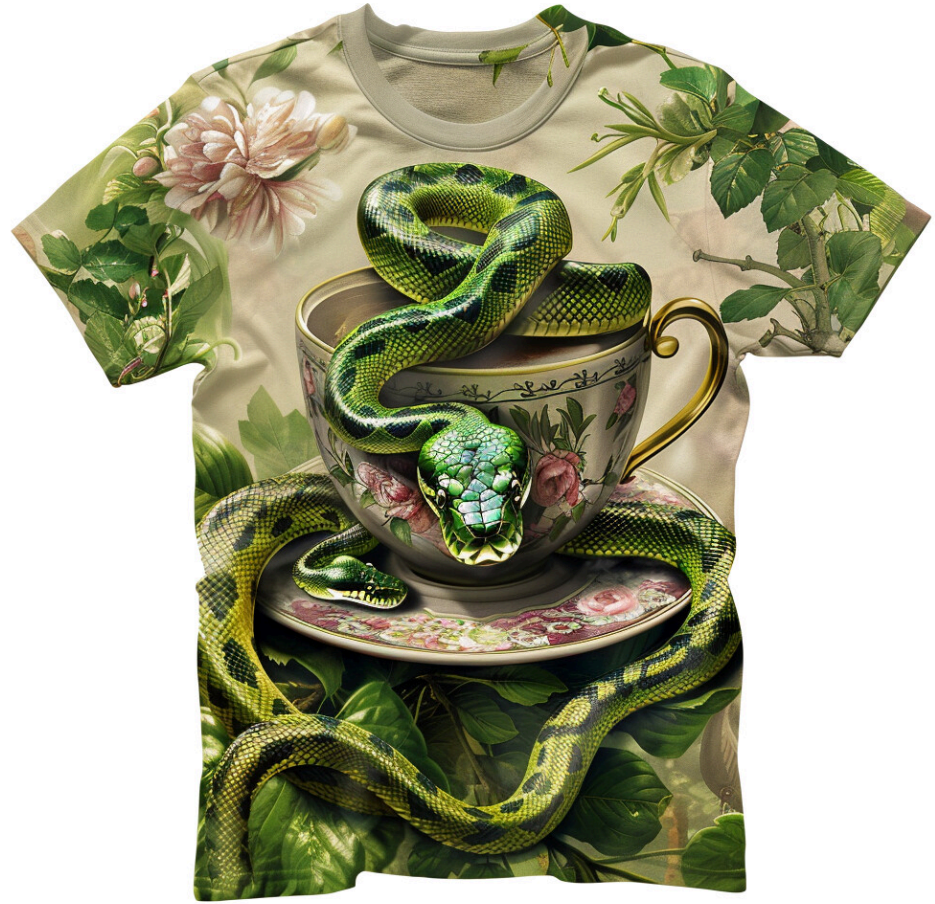


```python
from itertools import tee


def gather_statistics(
    books: Iterable[Book]
) -> Statistics:
    all_books = list(books)

    """Now we create 3 "references" of the generator"""
    books_1, books_2, books_3 = tee(books, n=3)

    return Statistics(
        """And use those here"""
        unique_lenders=unique_lenders(books_1),
        families=unique_families(books_2),
        unlent_books=unlent_books_count(books_3),
    )
```



Tee caveats

1. You don't want to consume the source generator
   - It will move forward without the `tees` to catch up!
2. `tee` is not thread safe: it might cause `RuntimeError` if used in a threading/async environment!
   - Not standard vanilla python, but for easy `async` and threading usage: `asyncstdlib`
   - I have a vanilla python implementation with `Queue` and



Miscellaneous

(this might not make it, due to time restrictions)

Mixin for ordering objects

- Imagine we have our own object containing data we need
- It should be sortable (e.g. the books by year!)
- But taking care of all the magic dunder methods: `__lt__()`, `__le__()`, `__gt__()`, `__ge__()`

Order objects

```python
from functools import total_ordering


@total_ordering
class Book:
    def __init__(self, name: str, year: str):
        self.name = name
        self.year = year

    def __eq__(self, other: 'Book') -> bool:
        own_year = extract_year(self.year)
        other_year = extract_year(other.year)
        return own_year == other_year

    def __lt__(self, other: 'Book') -> bool:
        own_year = extract_year(self.year)
        other_year = extract_year(other.year)
        return own_year < other_year
```

- Add `__eq__` to check if the object is considered equal
- Add `__lt__` to check if it is true lower (not equal)
- Add `total_ordering` to just fill the other dunder_methods:
  - `__le__`
  - `__ge__`
  - `__gt__`
- Obviously we should cache the calculation ;)

The "server"

- I actually wrote a whole server to generate random books, just to drop the usage due to time limitations
- But still: We can look into some of the last "batteries included"
  1. An ASGI server (means: very simple and unmighty Flask/FastAPI)
  2. Argument parsing (not as beautiful as typer, but easy to work with)
  3. Caching
  4. suppressing errors the right way!
  5. partials of functions/methods (basically lambdas in pythonic)

Questions?

Konec a poděkování

(The end of the talk and thank you)