

Python unplugged

Mining for hidden batteries



\$ whoami

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Solutions
- **dev since:** +12y
- **first code:** ~25y if you count creating a
crappy Amiga Quickbasic
textadventure or reproducing the
famous DVD logo which never hits the
corner
- **other stuff:** Being a proud dad and
husband; Reading; Tabletennis;



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 necessary¹
 - ¹*for simple cases!*
- better portable one-off scripts!
- (sometimes) even easier!
- also useful in day2day work

What am I NOT trying to solve?

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

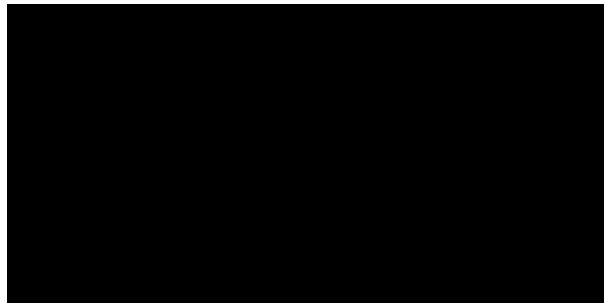
Outline: 4 Chapters

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

What's the story?

- Who is familiar with *Terry Pratchett*?
- We are working on a project in *Ankh Morpork*
- The "Unseen Library" and its 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

```
"""
Or it might be useful to have it this way (not here though ;)
"""
from typing import TypedDict, Required

class Book(TypedDict, total=False):
    title: Required[str]
    author: Required[str]
    lent_by: str
    lent_since: str
    lent_times: Required[int]
    year: Required[str]
    catalogued: Required[str]
    location: Required[str]
    excerpt: Required[str]
```

This is what it might like (Autocompletion <3>)

```
2     catalogued: str
1
0     lo
9     ex π 'year'
8     π 'title'
7     π 'author'
6     def fe π 'lent_by'      Response:
5     re π 'excerpt'        rlopen(URL_BOOK).read()
4     re π 'location'       sponse)
3     π 'lent_since'
2     π 'lent_times'
1     def ma π 'catalogued'
0
7     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 resources
- 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

Batching

```
from csv import DictWriter
from itertools import batched

LIBRARY_DB = Path("library_raw.csv")

# fetches the keys from 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 we might have learned something new

Trivial

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

- `csv ("duh!")`
- `json ("Yeah I knew that!")`
- `TypedDict` with (Not)Required keys (Maybe new for a few?)
- All of those are in more detail in the `/code` folder inside the repository

urllib.requests

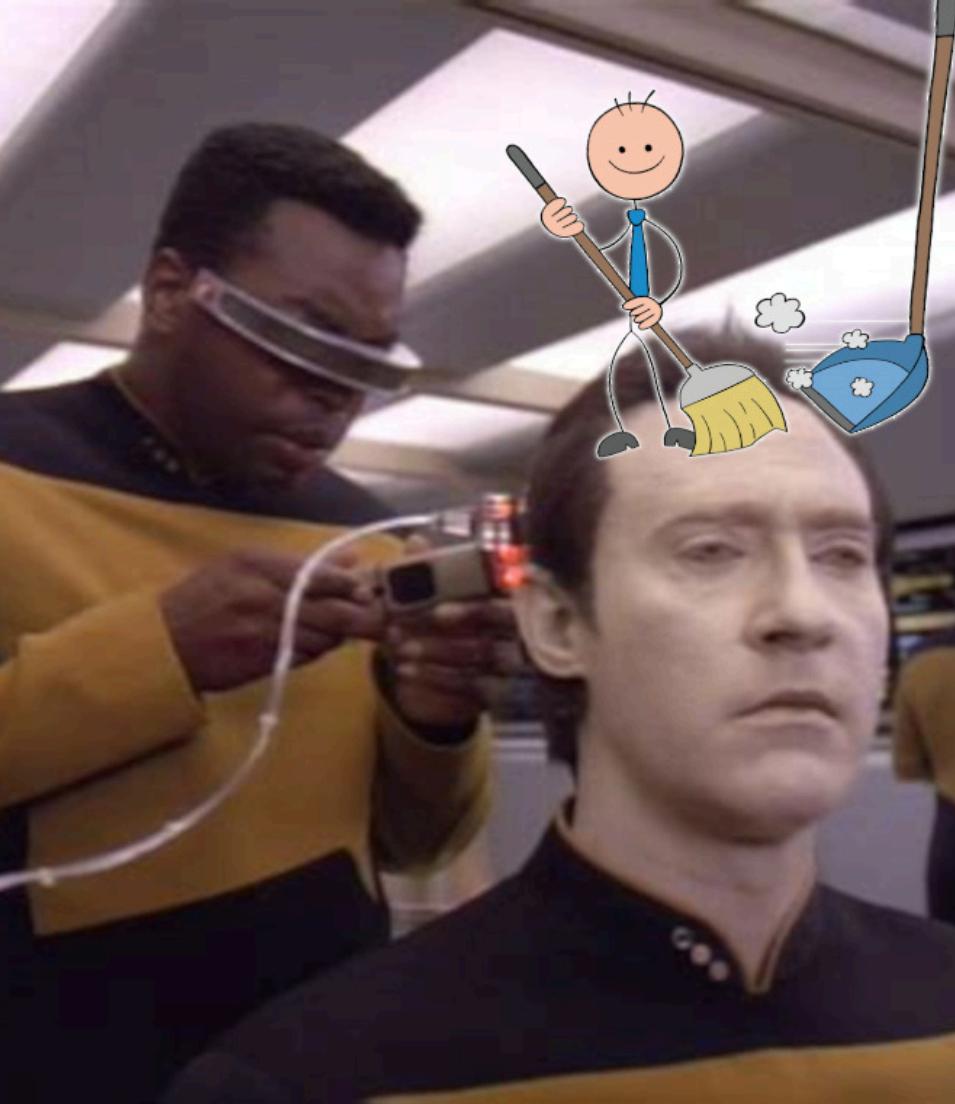
- fetch and send data via HTTP(S)
- restricted to `GET` / `POST` (`POST` by setting the `data` parameter)
- not as bad to use as one might think, considering the vast amount of modules to replace it
- definitely worth a try, if you only have very few non-async requests

itertools.islice

- basically works like `mylist[from:to:steps]`
- but also works on Generators with unknown size :)
- cannot go backwards or use negative indices:
 - 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 is in NP
 - also: no super clever text similarity or duplication algorithms



```
"""
itertools.chain to the rescue!
It lazily chains multiple iterators without effort
"""

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:
    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 large¹ 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 `collections.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))`
- Full example in repository in `/code/chapter2`

Saving the deduplicated data

Basically just an excuse to show grouping of contextmanagers

```
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

```
"""
But how do we know this really does what we want?
We could try it, but this is boring and doesn't scale!
"""

import re

def extract_year(morporkyear: str) -> int:
    return int(re.search(r"(\d)", morporkyear).group(0))

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

Doctest - to the rescue

We will need some documentation



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(
```

```
python -m doctest [...]/04_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 surprising 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?

-
- Perfect time to learn a new thing
 - 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

How I would do it

```
class BookMeta(typing.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

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

Count Words

```
from collections import defaultdict

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

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

    return word_counter
```

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

flatten = chain.from_iterable

def words_in_a_book(book: Book) -> Iterable[str]:
    return chain(
        book['title'].split(),
        book['author'].split(),
        book['excerpt'].split(),
    )

def generate_words_from_library(books: Iterable[Book]) -> Iterable[str]:
    yield from flatten(
        words_in_a_book(book)
        for book in books
    )

def most_common_words_in_data(books: Iterable[Book]):
    word_generator = generate_words_from_library(books)
    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)

```
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:
    only_lent_books = sorted((b for b in books if b["lent_by"]る), key=family_name)

    books_by_family_name = groupby(only_lent_books, key=family_name)

    family, lent_books = max(
        (
            (family, list(group))
            for family, group in books_by_family_name
        ),
        key=lambda item: len(item[1]),
    )

    return BiggestLender(family, len(lent_books))
```

To recap:

- YES! The sorted(...) part consumes our iterator
- `groupby` **needs** a sorted iterator, to be somewhat useful
- It returns not a dict, but a sequence of tuples: `[(key, items), ...]`

But the librarian changed requirements again...

:/

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

```
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 our Problem, 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),
    )
```

Nope, it doesn't :(

Reduced Tee

Two tools which might help us:

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

Let's start with reduce!



Solving this with reduce

```
@dataclass class StatisticsAccumulator:...  
  
def statistics_reducer(  
    acc: StatisticsAccumulator, book: Book,  
) -> StatisticsAccumulator:  
    if book['lent_by']:  
        acc.lenders.add(book['lent_by'])  
        acc.families.add(family_name(book))  
    else:  
        acc.unlent += 1  
  
    return acc  
  
def gather_statistics(books: Iterable[Book]) -> Statistics:  
    accumulated_stats = reduce(  
        statistics_reducer,  
        books,  
        StatisticsAccumulator(),  
    )  
  
    return Statistics( # Why different object?  
        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?



```
from itertools import tee

def gather_statistics(books: Iterable[Book]) -> Statistics:
    """
    Now we create 3 "references" of the generator
    Caveat:
        - This is only a pseudo solution to show off tee!
    """
    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
 - The `tees` wouldn't catch up!
2. It's not thread safe: it might cause
`RuntimeError`
 - threading usage: `asyncstdlib`
 - There is an `async tee` (`atree`)
implementation in
`code/chapter3/04_async_tee.py` in
the repo
3. Space consumption, if the 3 generators
advance in very different speed



Miscellaneous

(We might not get to this, 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 is annoying:

```
__lt__(), __le__(), __gt__(), __ge__()
```

Order objects

```
from functools import total_ordering

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

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

    def __eq__(self, other: 'Book') -> bool:
        # Good to have, but not necessary
        own_year = extract_year(self.year)
        other_year = extract_year(other.year)
        return own_year == other.year
```

with suppress

```
import contextlib

def ignore_failing_call():
    with contextlib.suppress(RuntimeError):
        """We still don't care about failing"""
        might_fail_but_I_dont_care()
```

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. A pure python server (means: very simple and unmighty Flask/FastAPI)
 2. Argument parsing (not as beautiful as typer, but easy to work with)
 3. partials of functions/methods (basically lambdas in pythonic)
 4. Caching



Questions?

Konec a poděkování

(The end of the talk and thank you)

