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INTRODUCING STRUCTURAL PATTERN MATCHING

PEP 634, 635, 636

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PERSONAL INTRODUCTION

- Sebastiaan Zeeff (35)
- Software Engineer for the Ordina Pythoneers
- Python Discord

Larry Hastings commenting on "Gauging sentiment on pattern matching"
-- https://discuss.python.org/t/gauging-sentiment-on-pattern-matching/5770/21

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“…but it is Python.”

Jan-Hein Bührman, private correspondence

PART I: MATCHING BY STRUCTURE AND SHAPE

What is Structural Pattern Matching?

- Structural Pattern Matching is not ***just*** *a C-style Switch statement.*

What is Structural Pattern Matching?

```
switch (status_code)
{
    case 200:
        printf("Got an OK response from server!");
        break;
    case 404:
        printf("The resource wasn't found...");
        break;
    default:
        printf("Something unexpected happened!");
        break;
}
```

What is Structural Pattern Matching?

```
match status_code:
    case 200:
        print("Got an OK response from server!")
    case 404:
        print("The resource wasn't found...")
    case _:
        print("Something unexpected happened!")
```

What is Structural Pattern Matching?

```
if status_code == 200:
    print("Got an OK response from server!")
elif status_code == 404:
    print("The resource wasn't found...")
else:
    print("Something unexpected happened!")
```

What is Structural Pattern Matching?

```
match status_code:
    case 200:
        print("Got an OK response from server!")
    case 404:
        print("The resource wasn't found...")
    case _:
        print("Something unexpected happened!")
```

What is Structural Pattern Matching?

- Structural Pattern Matching is not ***just*** *a C-style Switch statement.*
- If it's not *just* matching literals, what ***is*** Structural Pattern Matching?

On Shape and Structure

- *Structural* Pattern Matching tries matching objects by their "*shape*".

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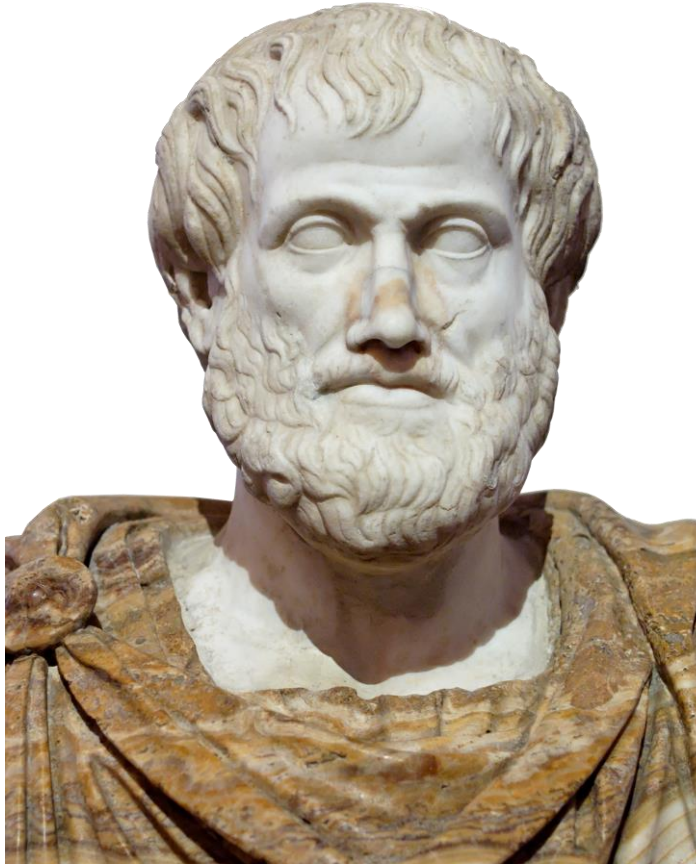
- What is the shape of an object?

On Shape and Structure

- *Structural* Pattern Matching tries matching objects by their "*shape*".
- What is the shape of an object?



The shape of an object

```
the_answer = 42
game_command = ["MOVE", "NORTH", 10]
my_introduction = {"name": "Sebastiaan", "age": 35}
```

The shape of an object

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the_answer = 42
game_command = ["MOVE", "NORTH", 10]
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```

- How would you describe the shape of these objects?

The shape of an object

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the_answer = 42
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```

The shape of an object

```
the_answer = 42
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```

- The value of the object

The shape of an object

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the_answer = 42
game_command = ["MOVE", "NORTH", 10]
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```

- The value of the object
- The type of the object

The shape of an object

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game_command = ["MOVE", "NORTH", 10]
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```

- The value of the object
- The type of the object
- For sequences: Which and/or how many elements does a sequence have?

The shape of an object

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- The value of the object
- The type of the object
- For sequences: Which and/or how many elements does a sequence have?
- For mappings: Which keys does a mapping have?

The shape of an object

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the_answer = 42
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- The value of the object
- The type of the object
- For sequences: Which and/or how many elements does a sequence have?
- For mappings: Which keys does a mapping have? What kind of values?

The shape of an object

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the_answer = 42
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```

- The value of the object
- The type of the object
- For sequences: Which and/or how many elements does a sequence have?
- For mappings: Which keys does a mapping have? What kind of values?
- For all types: Which attributes does this object have?

Fill in the blanks: A match statement.

```
match <target>:
    case <pattern> [if <guard>]:
        <block of code>
    case <pattern> [if <guard>]:
        <block of code>
    ...
```

Fill in the blanks: A match statement.

```
match <target>:
    case <pattern> [if <guard>]:
        <block of code>
    case <pattern> [if <guard>]:
        <block of code>
    ...
```

```
match my_target:
    case int():
        print("My target is an instance of `int`")
    case str():
        print("My target is an instance of `str`")
```

Fill in the blanks: A match statement.

```
match <target>:
    case <pattern> [if <guard>]:
        <block of code>
    case <pattern> [if <guard>]:
        <block of code>
    ...
```

```
match my_target:
    case int() if my_target > 100:
        print("This integer is larger than 100.")
    case str() if len(my_target) == 3:
        print("This string has a length of 3")
```

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PART II: THE PATTERNS

Wildcard Pattern

```
match my_target:
    case _:
        print("This always matches!")
```

- A wildcard pattern **always** matches.

Wildcard Pattern

```
match my_target:
    case _:
        print("This always matches!")
```

- A wildcard pattern **always** matches.
- The case above is **a tautology**: It always matches.
  - Tautological cases must come last within a match statement.

Wildcard Pattern

```
match my_target:
    case _:
        print("This always matches!")
```

- A wildcard pattern **always** matches.
- The case above is **a tautology**: It always matches.
  - Tautological cases must come last within a match statement.
- Wildcard patterns, like any pattern, can be embedded within other patterns.

Capture Pattern

```
match my_target:
    case some_name:
        print(f"I matched with {some_name!r}!")
```

- Just like a Wildcard Pattern, a Capture Pattern **always** matches.
  - The same rules for tautologies apply here as well!
- It will **capture the matched value** by *binding* a name to it.
  - Note: A Wildcard Pattern **does not** bind the underscore!
- As with all patterns, it can be used nested within another pattern.

Literal Pattern

```
match my_target:
    case 100:
        print("Matched with the int `100`")
    case "hello":
        print("Matched with the str ``'hello'``")
    case True:
        print("Matched with `True`")
```

Matched literals:

- Numbers (incl. complex)
- Strings
- True
- False
- None

- The Literal Pattern matches some types of literals
- Numbers and strings are compared using equality (`a == b`)
- The "singleton literals" are compared by identity (`a is b`)

OR Pattern

```
match my_target:
    case 100 | 200 | 300 | 400:
        print("Look at all those numbers!")
    case "hello" | "goodbye":
        print("Are you leaving so soon?")
    case None | _:
        print("Hey, we've embedded a Wildcard Pattern")
```

- You can combine subpatterns in an OR-pattern using `|` (pipe)
- Each subpattern **must bind the same set of names**

Sequence Pattern

```
player_command = ["MOVE", "NORTH", 10]

match player_command:
    case "MOVE", direction, distance:
        move_player(direction, distance)
```

- This a sequence pattern: subpatterns separated by commas
- It matches instances of collections.abc.Sequence (except str, bytes, bytearray)

Sequence Pattern

```
player_command = ["MOVE", "NORTH", 10]

match player_command:
    case ("MOVE", direction, distance):
        move_player(direction, distance)
```

- You can also wrap a sequence pattern in parentheses for a tuple-look
- It still matches all sequences (except str, bytes, bytearray), not *just* tuples!

Sequence Pattern

```
player_command = ["MOVE", "NORTH", 10]

match player_command:
    case ["MOVE", direction, distance]:
        move_player(direction, distance)
```

- This pattern matches still matches all sequences, not just list!

Sequence Pattern with a Star Pattern

```
player_command = ["MOVE", "NORTH", 10]

match player_command:
    case ["MOVE", direction, distance]:
        move_player(direction, distance)
    case ["SELL", *items]:
        sell_items(items)
```

- You can use a Star Pattern to capture a variable number of values.
- This will bind the name `items` to a list with the captured values.

Sequence Pattern with a Star Pattern

```
player_command = ["MOVE", "NORTH", 10]

match player_command:
    case ["MOVE", direction, distance]:
        move_player(direction, distance)
    case ["SELL", *items]:
        sell_items(items)
    case ["TRAVEL", *intermediate, destination]:
        travel(*intermediate, destination)
```

- Like with unpacking/packing, the star pattern does not have to be at the end

Sequence Pattern with a Star Pattern

```
match player_command:
    case ["FIRST", *_, "LAST"]:
        print("This sequence starts with FIRST and ends with LAST")
```

- You can also use the Wildcard Pattern with a star expression.
- In this case, we dismiss all elements between the first and last, if present.

Caveat: be aware of partial matches binding names

```
target = [1, 2, 3, 4]

match target:
    case [a, b, 1000, d]:
        print("This won't match, 3 != 100")
```

- CPython will already bind names while trying to match a pattern
- Here, it fails at element 3, after having bound **a** & **b**, but before binding **d**
- **a** & **b** will remain bound to **1** and **2**

Mapping Pattern

```
my_introduction = {"name": "Sebastiaan", "age": 35}

match my_introduction:
    case {"age": 35}:
        print("Someone's age is 35.")
    case {"name": "Sebastiaan", "age": 35}:
        print("Sebastiaan is 35 years old.")
    case _:
        print("I wasn't able to match anything.")
```

Mapping Pattern

```
my_introduction = {"name": "Sebastiaan", "age": 35}

match my_introduction:
    case {"age": 35}:
        print("Someone's age is 35.")
    case {"name": "Sebastiaan", "age": 35}:
        print("Sebastiaan is 35 years old.")
    case _:
        print("I wasn't able to match anything.")
```

- This will match the first case block!

Mapping Pattern

```
my_introduction = {"name": "Sebastiaan", "age": 35}

match my_introduction:
    case {"name": "Sebastiaan", "age": 35}:
        print("Sebastiaan is 35 years old.")
    case {"age": 35}:
        print("Someone's age is 35.")
    case _:
        print("I wasn't able to match anything.")
```

- Lesson: match more specific patterns first!

Mapping Pattern

```
my_introduction = {"name": "Sebastiaan", "age": 35}

match my_introduction:
    case {"name": "Sebastiaan", "age": age}:
        print(f"Sebastiaan is {age} years old.")
```

- You can use any pattern for the values, including a Capture Pattern.

Class Pattern

```
person = Person(name="Sebastiaan")  # person.name = "Sebastiaan"

match person:
    case Person():
        print("This is an instance of Person")
```

- A Class Pattern is a type followed by parenthesis; e.g., `ClassName()`

Class Pattern

```
person = Person(name="Sebastiaan")  # person.name = "Sebastiaan"

match person:
    case Person():
        print("This is an instance of Person")
```

- A Class Pattern is a type followed by parenthesis; e.g., `ClassName()`
- The match target will then be checked with `isinstance(target, ClassName)`

Class Pattern: Matching attributes

```
person = Person(name="Sebastiaan")  # person.name = "Sebastiaan"
person.age = 35

match person:
    case Person(age=35):
        print("This person is 35.")
```

- You can also match objects by their attributes.
- Here, the object is matched using a keyword attribute pattern.

Class Pattern: Matching attributes

```
person = Person(name="Sebastiaan")  # person.name = "Sebastiaan"
person.age = 35

match person:
    case Person(age=captured_age):
        print(f"This person's age is {captured_age}.")
```

- We can also use other patterns as value patterns.
- Here we use a Capture Pattern to capture the value.

PART III: A PRACTICAL EXAMPLE

Parsing a Search API response

- We want to use a Search API that responds in the following way:

```
response = {
    "query": "<your query>",
    "results": [<a list with results matching the query>],
}
```

- If the query did not result in any matches, the list will be empty.

Parsing a Search API response

```
response = requests.get("https://search.local?q=hello")

match response.json():
    case {"query": query, "result": []}:
        handle_no_results(query)
    case {"query": query, "result": [result]}:
        handle_single_result(query, result)
    case {"query": query, "result": [*results]}:
        handle_multiple_results(query, results)
    case error_response:
        log.error("Got an unexpected response", response=error_response)
```

WRAPPING IT UP

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Summary

- Structural Pattern Matching is a very powerful tool
- It does require you to learn a new mini-language
- I've had a lot of fun playing around with Structural Pattern Matching

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Slides available: https://sebastiaanzeeff.nl

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QUESTIONS?