WHAT THE STRUCT?!

> whoami

> DIRECTOR, AI ENGINEERING @ S&P GLOBAL

> PYTHON FANATIC

> NEW DAD

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struct (C programming language)

From Wikipedia, the free encyclopedia

A **struct** in the C programming language (and many derivatives) is a composite data type (or record) declaration that defines a physically grouped list of variables under one name in a block of memory, allowing the different variables to be accessed via a single pointer or by the struct declared name which returns the same address. The struct data type can contain other data types so is used for mixed-data-type records such as a hard-drive directory entry (file length, name, extension, physical address, etc.), or other mixed-type records (name, address, telephone, balance, etc.).

The C struct directly references a *contiguous block* of physical memory, usually delimited (sized) by word-length boundaries. It corresponds to the similarly named feature available in some assemblers for Intel processors. Being a block of contiguous memory, each field within a struct is located at a certain fixed offset from the start.

Because the contents of a struct are stored in contiguous memory, the sizeof operator must be used to get the number of bytes needed to store a particular type of struct, just as it can be used for primitives. The alignment of particular fields in the struct (with respect to word boundaries) is implementation-specific and may include padding, although modern compilers typically support the `#pragma pack` directive, which changes the size in bytes used for alignment.[1]

In the C++ language, a struct is identical to a C++ class but has a different default visibility: class members are private by default, whereas struct members are public by default.

struct

Contents [hide]

In other languages [edit]

The struct data type in C was derived from the ALGOL 68 struct data type.[2]

Like its C counterpart, the struct data type in C# (*Structure* in Visual Basic .NET) is similar to a class. The biggest difference between a struct and a class in these languages is that when a struct is passed as an argument to a function, any modifications to the struct in that function will not be reflected in the original variable (unless pass-by-reference is used).[3]

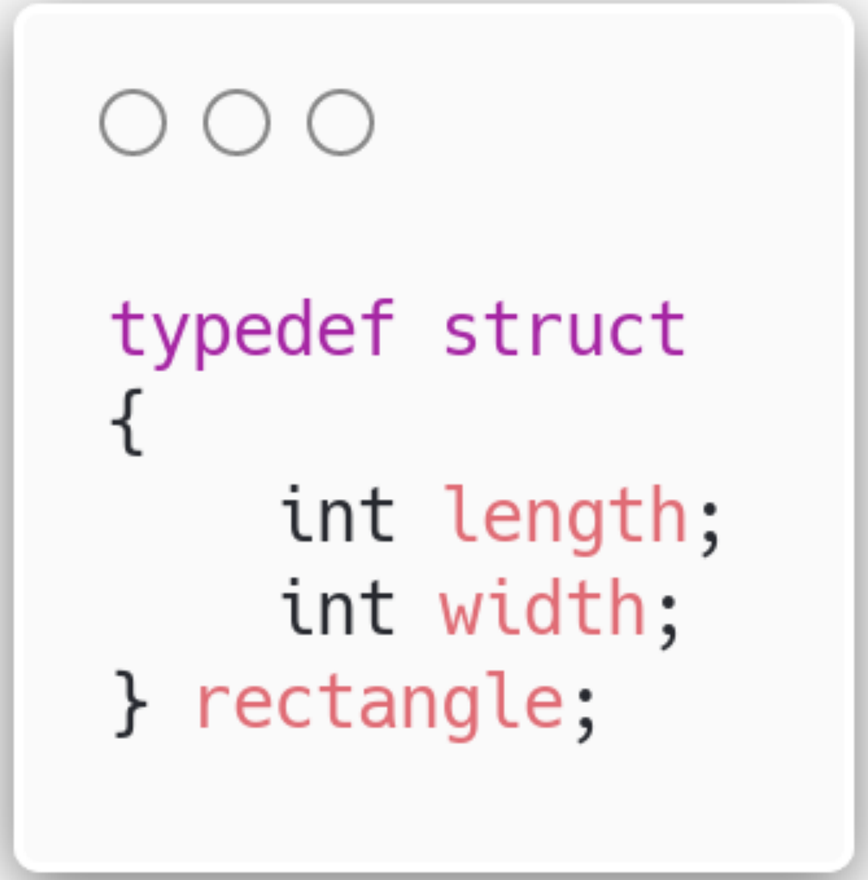
This differs from C++, where classes or structs can be statically allocated or dynamically allocated either on the stack (similar to C#) or on the heap, with an explicit pointer. In C++, the only difference between a struct and a class is that the members and base classes of a struct are public by default. (A class defined with the `class` keyword has private members and base classes by default.)

C

- MINIMAL PROGRAMMING LANGUAGE. CAME AFTER B
- PROCEDURAL. NO OBJECTS!

```c
#include <stdio.h>

int main(){
    int rect_length = 5;
    int rect_width = 4;
    int area = rect_length * rect_width;
    printf("Area is %d!\n", area);
}

// Area is 20!
```

```c
#include <stdio.h>

int main(){
    int rect_length_one = 5;
    int rect_width_one = 4;
    int rect_length_two = 6;
    int rect_width_two = 7;
    int area_one = rect_length_one * rect_width_one;
    int area_two = rect_length_two * rect_width_two;
    int area_diff = area_two - area_one;
    printf("Area difference is %d!\n", area_diff);
}

// Area difference is 22!
```



```
typedef struct
{
    int length;
    int width;
} rectangle;
```

```c
#include <stdio.h>

typedef struct
{
    int length;
    int width;
} rectangle;

int main(){
    rectangle firstRectangle = {4, 5};
    rectangle secondRectangle = {6, 7};
    int area_one = firstRectangle.length * firstRectangle.width;
    int area_two = secondRectangle.length * secondRectangle.width;
    int area_diff = area_two - area_one;
    printf("Area difference is %d!\n", area_diff);
}
```

```c
#include <stdio.h>

typedef struct
{
    int length;
    int width;
} rectangle;


int area(rectangle rect){
    return rect.length * rect.width;
}


int main(){
    rectangle firstRectangle = {4, 5};
    rectangle secondRectangle = {6, 7};
    int area_diff = area(secondRectangle) - area(firstRectangle);
    printf("Area difference is %d!\n", area_diff);
}

// Area difference is 22!
```

```c
#include <stdio.h>

typedef struct
{
    int length;
    int width;
} rectangle;

typedef struct
{
    rectangle first;
    rectangle second;
} rectangles;

int area(rectangle rect){
    return rect.length * rect.width;
}

int area_diff(rectangles rects){
    return area(rects.second) - area(rects.first);
}


int main(){
    rectangle firstRectangle = {4, 5};
    rectangle secondRectangle = {6, 7};
    rectangles twoRectangles = {firstRectangle, secondRectangle};
    printf("Area difference is %d!\n", area_diff(twoRectangles));
}

// Area difference is 22!
```

STRUCTURE++

READABILITY ++

REUSABILITY ++

ASIDE: STRUCTS AND MEMORY

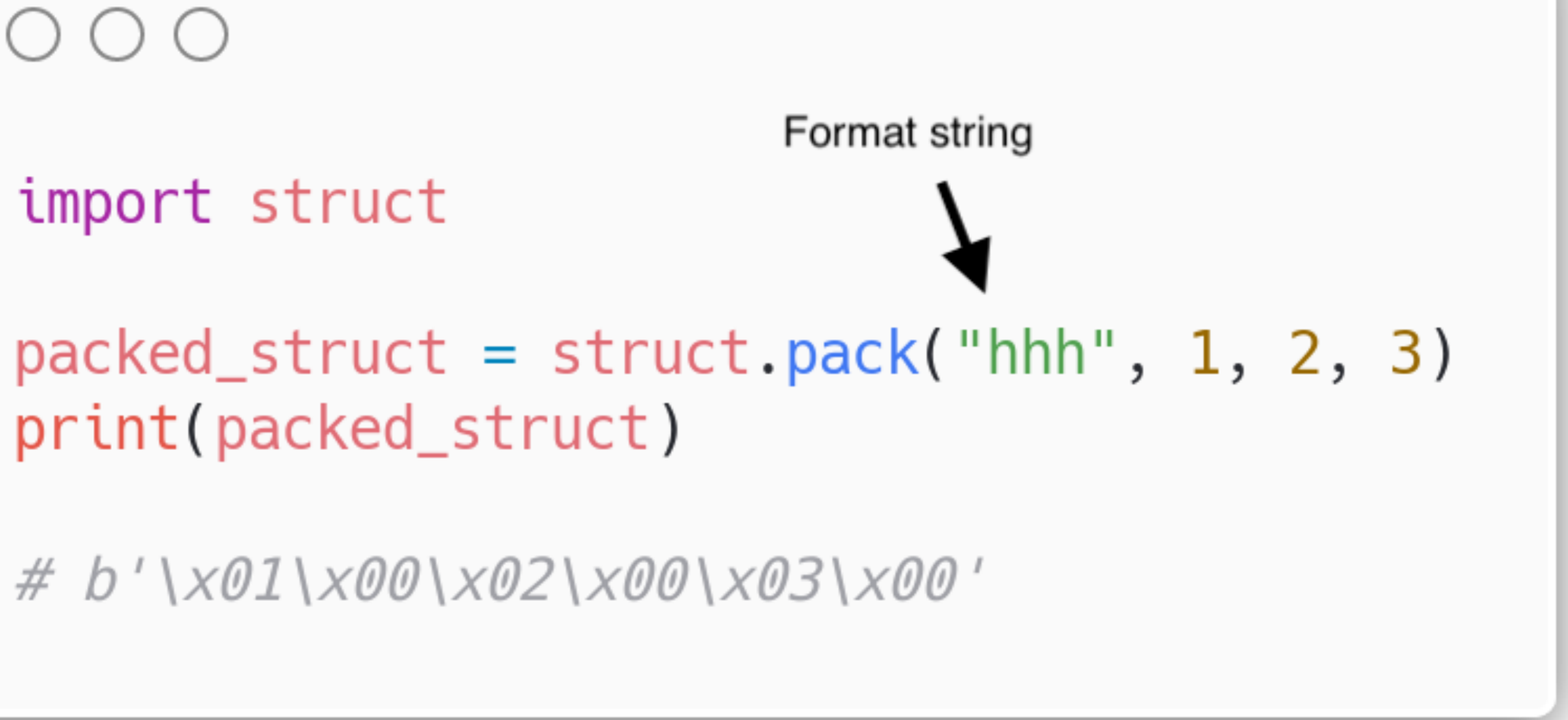
- C VARIABLES ARE STORED IN SPECIFIC MEMORY ADDRESSES
- USING A STRUCT, YOU CAN ENSURE THAT ADDRESSES FOR THE ELEMENTS IN THE STRUCT ARE AT CONTIGUOUS LOCATIONS IN MEMORY
- YOU CAN THEN READ AND WRITE THE STRUCT IN BINARY AS A SINGLE UNIT

PYTHON: STRUCT

`struct`

- PYTHON MODULE FOR UNPACKING AND REPACKING STRUCTS STORED AS BINARY DATA
- ONLY USEFUL FOR HIGH-PERFORMANCE CODE AND INTEROPERATING WITH C
- REQUIRES DECLARING FORMAT TYPES

```python
import struct

packed_struct = struct.pack("hhh", 1, 2, 3)
print(packed_struct)

# b'\x01\x00\x02\x00\x03\x00'
```


Format string
import struct
packed_struct = struct.pack("hhh", 1, 2, 3)
print(packed_struct)
# b'\x01\x00\x02\x00\x03\x00'

Format Characters

Format characters have the following meaning; the conversion between C and Python values should be obvious given their types. The 'Standard size' column refers to the size of the packed value in bytes when using standard size; that is, when the format string starts with one of `'<'`, `'>'`, `'!'` or `'='`. When using native size, the size of the packed value is platform-dependent.

Format	C Type	Python type	Standard size	Notes
`x`	pad byte	no value		
`c`	`char`	bytes of length 1	1	
`b`	`signed char`	integer	1	(1), (2)
`B`	`unsigned char`	integer	1	(2)
`?`	`_Bool`	bool	1	(1)
`h`	`short`	integer	2	(2)
`H`	`unsigned short`	integer	2	(2)
`i`	`int`	integer	4	(2)
`I`	`unsigned int`	integer	4	(2)
`l`	`long`	integer	4	(2)
`L`	`unsigned long`	integer	4	(2)
`q`	`long long`	integer	8	(2)
`Q`	`unsigned long long`	integer	8	(2)
`n`	`ssize_t`	integer		(3)
`N`	`size_t`	integer		(3)
`e`	(6)	float	2	(4)
`f`	`float`	float	4	(4)
`d`	`double`	float	8	(4)
`s`	`char[]`	bytes		
`p`	`char[]`	bytes		
`P`	`void *`	integer		(5)

Format Characters

Format characters have the following meaning; the conversion between C and Python values should be obvious given their types. The 'Standard size' column refers to the size of the packed value in bytes when using standard size; that is, when the format string starts with one of `'<'`, `'>'`, `'!'` or `'='`. When using native size, the size of the packed value is platform-dependent.

Format	C Type	Python type	Standard size	Notes
`x`	pad byte	no value		
`c`	`char`	bytes of length 1	1	
`b`	`signed char`	integer	1	(1), (2)
`B`	`unsigned char`	integer	1	(2)
`?`	`_Bool`	bool	1	(1)
`h`	`short`	integer	2	(2)
`H`	`unsigned short`	integer	2	(2)
`i`	`int`	integer	4	(2)
`I`	`unsigned int`	integer	4	(2)
`l`	`long`	integer	4	(2)
`L`	`unsigned long`	integer	4	(2)
`q`	`long long`	integer	8	(2)
`Q`	`unsigned long long`	integer	8	(2)
`n`	`ssize_t`	integer		(3)
`N`	`size_t`	integer		(3)
`e`	(6)	float	2	(4)
`f`	`float`	float	4	(4)
`d`	`double`	float	8	(4)
`s`	`char[]`	bytes		
`p`	`char[]`	bytes		
`P`	`void *`	integer		(5)

```python
import struct

packed_struct = struct.pack("hhh", 1, 2, 3)
print(packed_struct)

# b'\x01\x00\x02\x00\x03\x00'
```


import struct
packed_struct = struct.pack("lll", 1, 2, 3)
print(packed_struct)

```python
import struct

packed_struct = struct.pack("lll", 1, 2, 3)
print(packed_struct)

#
b'\x01\x00\x00\x00\x00\x00\x00\x00\x02\x00\x00\x00\x00\x00\x00\x00\x03\x00\x00\x00\x00\x00\x00\x00'
```

```python
import struct

packed_struct = struct.pack("cccc", b"z", b"a", b"c", b"h")
print(packed_struct)

# b'zach'
```

```python
import struct

packed_struct = struct.pack("cccc", b"z", b"a", b"c", b"h")
unpacked_struct = struct.unpack("cccc", packed_struct)
print(unpacked_struct)

# (b'z', b'a', b'c', b'h')
```

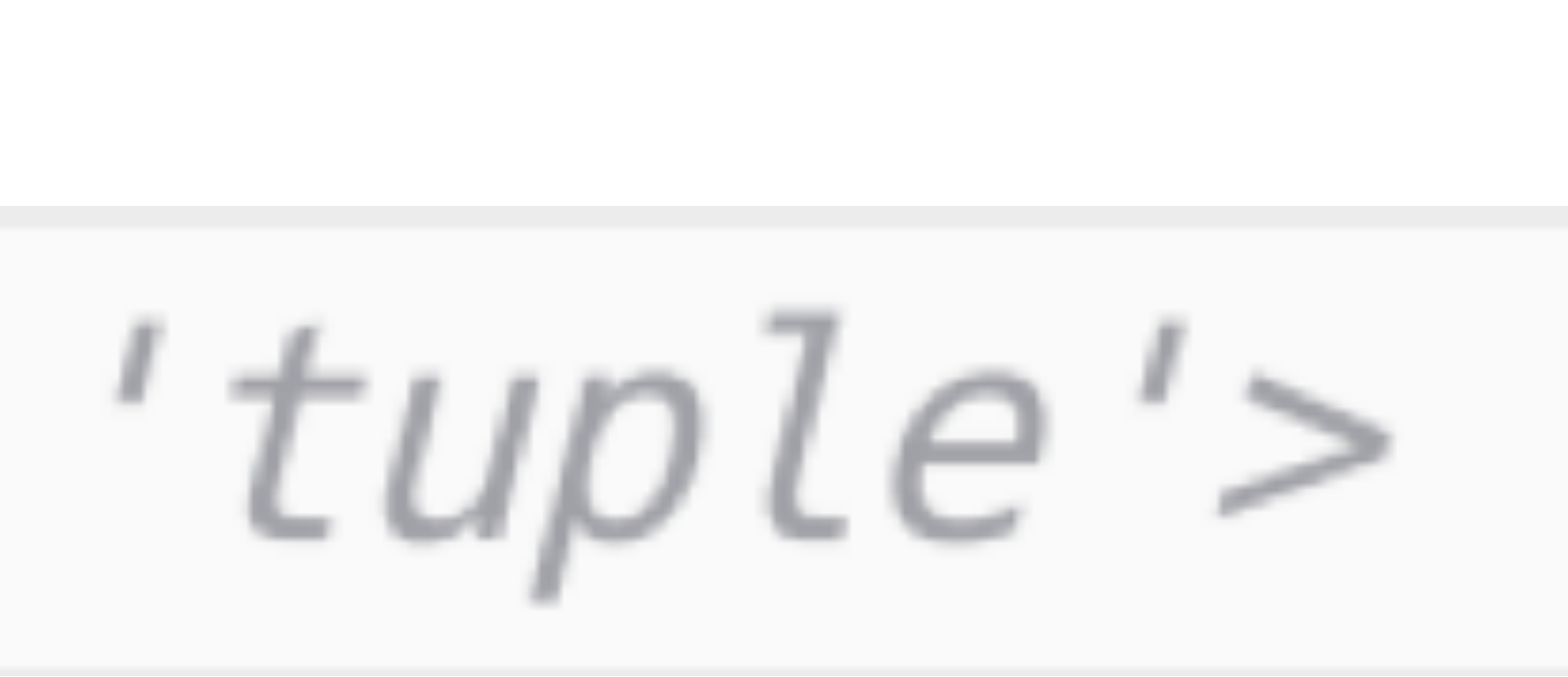
```python
import struct

packed_struct = struct.pack("cccc", b"z", b"a", b"c", b"h")
unpacked_struct = struct.unpack("cccc", packed_struct)
print(unpacked_struct)

# (b'z', b'a', b'c', b'h')
```

```python
import struct

packed_struct = struct.pack("cccc", b"z", b"a", b"c", b"h")
unpacked_struct = struct.unpack("cccc", packed_struct)

print(type(unpacked_struct))

# <class 'tuple'>
```

```python
import struct

packed_struct = struct.pack("cccc", b"z",
unpacked_struct = struct.unpack("cccc", pa

print(type(unpacked_struct))

# <class 'tuple'>
```

```
packed_struct = struct.pack(
unpacked_struct = struct.unpack(

print(type(unpacked_struct))

# <class 'tuple'>
```

```
# <class 'tuple'>
```


'tuple'>

WHAT THE STRUCT

```c
#include <stdio.h>

typedef struct
{
    int length;
    int width;
} rectangle;

int main(){
    rectangle firstRectangle = {4, 5};
    rectangle secondRectangle = {6, 7};
    int area_one = firstRectangle.length * firstRectangle.width;
    int area_two = secondRectangle.length * secondRectangle.width;
    int area_diff = area_two - area_one;
    printf("Area difference is %d!\n", area_diff);
}
```

```python
import struct

packed_struct = struct.pack("cccc", b"z", b"a", b"c", b"h")
unpacked_struct = struct.unpack("cccc", packed_struct)

print(unpacked_struct[0])

# b'z'
```

NAMEDTUPLE

`collections.namedtuple`

IT'S A TUPLE. WITH NAMES!

```python
import collections
import struct

packed_struct = struct.pack("cccc", b"z", b"a", b"c", b"h")
unpacked_struct = struct.unpack("cccc", packed_struct)

FourLetters = collections.namedtuple("FourLetters", "first second third
fourth")
my_name = FourLetters(*unpacked_struct)
print(my_name)

# FourLetters(first=b'z', second=b'a', third=b'c', fourth=b'h')
```

```python
import collections
import struct

packed_struct = struct.pack("cccc", b"z", b"a", b"c", b"h")
unpacked_struct = struct.unpack("cccc", packed_struct)

FourLetters = collections.namedtuple("FourLetters", "first second third
fourth")
my_name = FourLetters(*unpacked_struct)

print(my_name.first, my_name.second, my_name.third)

# b'z' b'a' b'c'
```

`namedtuple(typename, field_names)`

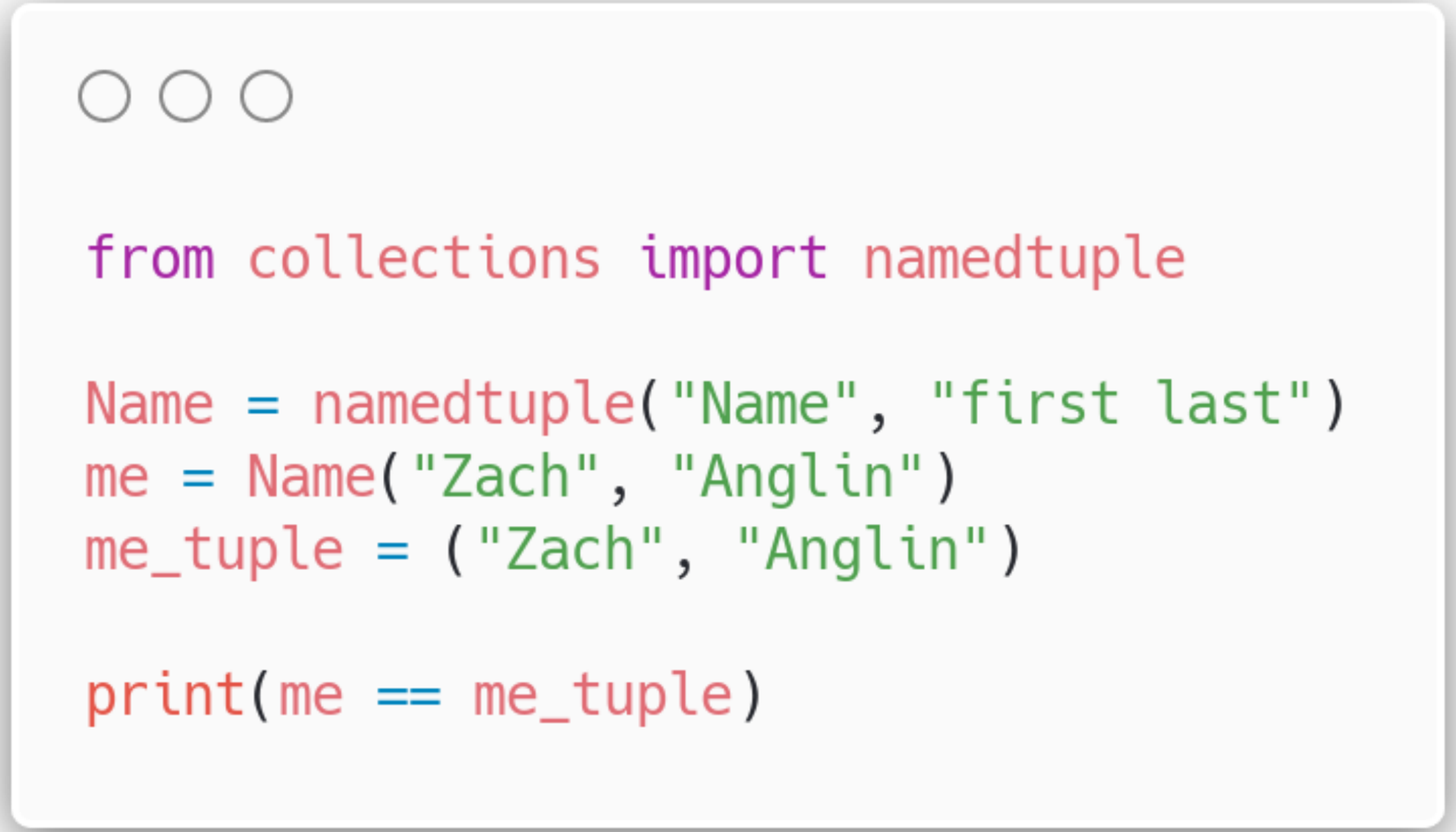
- CREATES A SUBTYPE OF `tuple` NAMED `typename`
- INHERITS ALL TUPLE METHODS
- GIVES NAMED ATTRIBUTE ACCESS TO FIELDS IN TUPLE

STILL A TUPLE

...STILL IMMUTABLE
...SAME MEMORY FOOTPRINT (NO `dict`)
...COMPARES EQUALLY TO `tuple`

```python
from collections import namedtuple

Name = namedtuple("Name", "first last")
me = Name("Zach", "Anglin")
print(me)

# Name(first='Zach', last='Anglin')
```

```python
from collections import namedtuple

Name = namedtuple("Name", "first last")
me = Name("Zach", "Anglin")
me_tuple = ("Zach", "Anglin")

print(me_tuple)
# ('Zach', 'Anglin')
```



```python
from collections import namedtuple

Name = namedtuple("Name", "first last")
me = Name("Zach", "Anglin")
me_tuple = ("Zach", "Anglin")

print(me == me_tuple)
```

```python
from collections import namedtuple

Name = namedtuple("Name", "first last")
me = Name("Zach", "Anglin")
me_tuple = ("Zach", "Anglin")

print(me == me_tuple)
# True
```

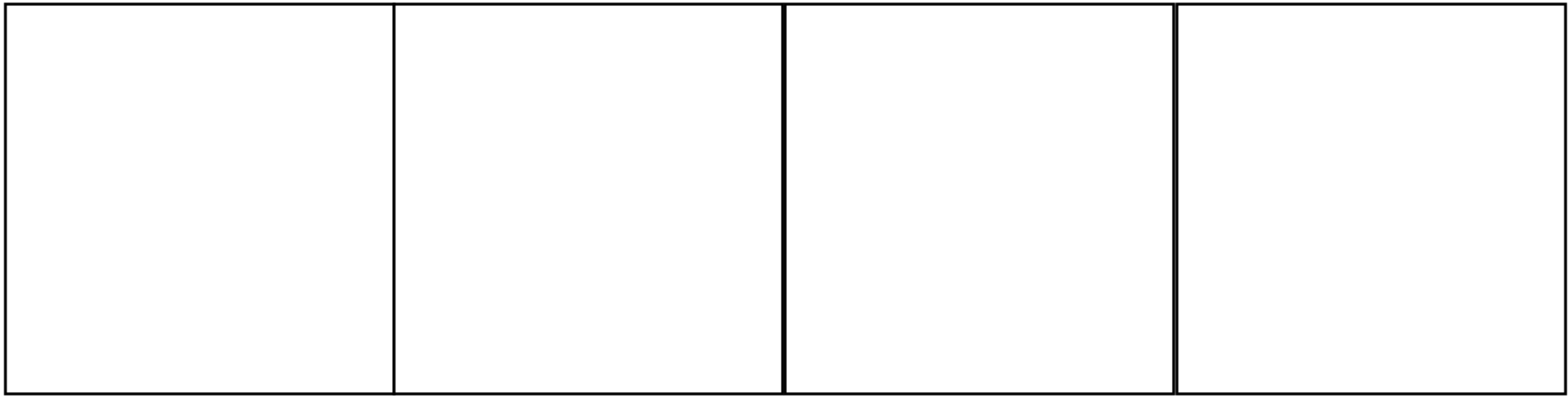
DEFAULT VALUES

```
from collections import namedtuple

Name = namedtuple("Name", "first last middle", defaults=["X"])
me = Name("Zach", "Angelin")

print(me)
# Name(first='Zach', last='Angelin', middle='X')
```

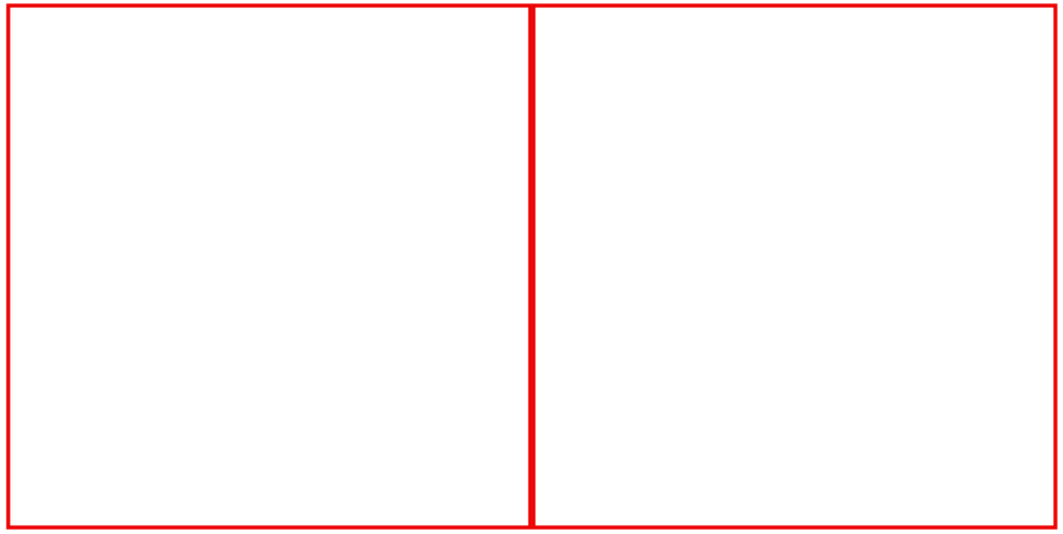
```python
from collections import namedtuple

Name = namedtuple("Name", "first last middle", defaults=["X"])
me = Name("Zach", "Anglin")

print(me)
# Name(first='Zach', last='Anglin', middle='X')
```

```
Student = namedtuple("Student", "name id age year", defaults=[10, 5])
```

Fields

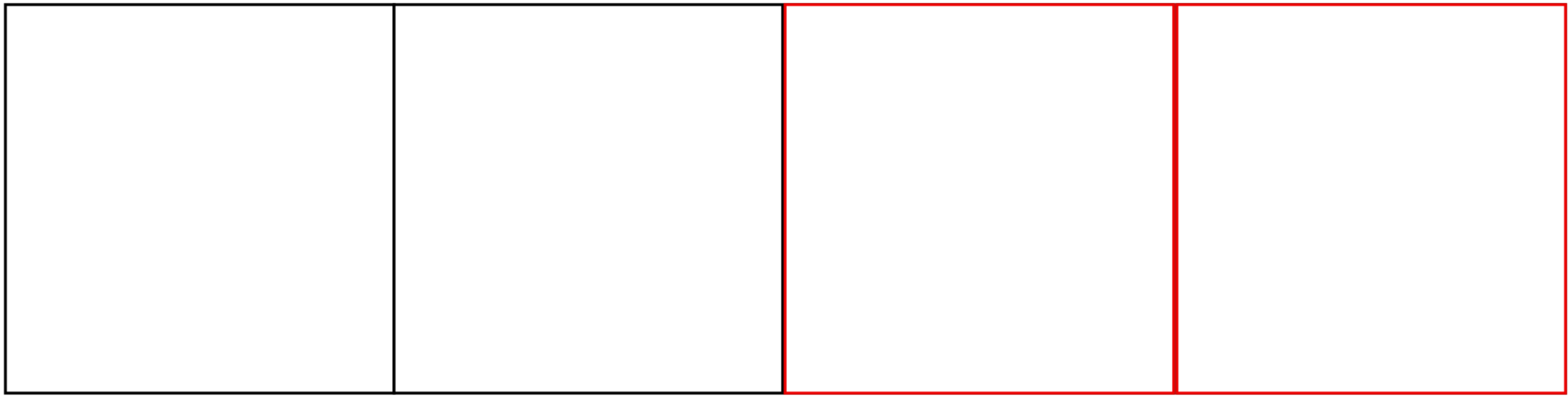


Defaults



Defaults

Fields



```python
from collections import namedtuple

Student = namedtuple("Student", "name id age year", defaults=[10, 5])
tommy = Student("tommy", 12345)

print(tommy)
# Student(name='tommy', id=12345, age=10, year=5)
```

DICT CONVERSION

```
print(tommy._asdict())
# OrderedDict([('name', 'tommy'), ('id', 12345), ('age', 10), ('year', 5)])
```

```python
from collections import namedtuple

Student = namedtuple("Student", "name id age year", defaults=[10, 5])
tommy = Student("tommy", 12345)

print(tommy._asdict())
# OrderedDict([('name', 'tommy'), ('id', 12345), ('age', 10), ('year', 5)])
```

IMMUTABILITY

```
from collections import namedtuple

Student = namedtuple("Student", "name id age year", defaults=[10, 5])
tommy = Student("tommy", 1245)
print(tommy)
tommy.age = 11
print(tommy)
```

```python
from collections import namedtuple

Student = namedtuple("Student", "name id age year", defaults=[10, 5])
tommy = Student("tommy", 12345)
print(tommy)
# Student(name='tommy', id=12345, age=10, year=5)

tommy.age = 11
print(tommy)
```

```python
from collections import namedtuple

Student = namedtuple("Student", "name id age year", defaults=[10, 5])
tommy = Student("tommy", 12345)
print(tommy)
# Student(name='tommy', id=12345, age=10, year=5)

tommy.age = 11
print(tommy)
```

AttributeError

TUPLES ARE IMMUTABLE

namedtuple._replace()

```python
from collections import namedtuple

Student = namedtuple("Student", "name id age year", defaults=[10, 5])
tommy = Student("tommy", 12345)
print(tommy)
# Student(name='tommy', id=12345, age=10, year=5)

tommy_plus_one = tommy._replace(age=11)
print(tommy_plus_one)
# Student(name='tommy', id=12345, age=11, year=5)
```

```python
from collections import namedtuple

Student = namedtuple("Student", "name id age year", defaults=[10, 5])
tommy = Student("tommy", 12345)
print(tommy)
# Student(name='tommy', id=12345, age=10, year=5)

tommy_plus_one = tommy._replace(age=11)
print(tommy_plus_one)
# Student(name='tommy', id=12345, age=11, year=5)
```

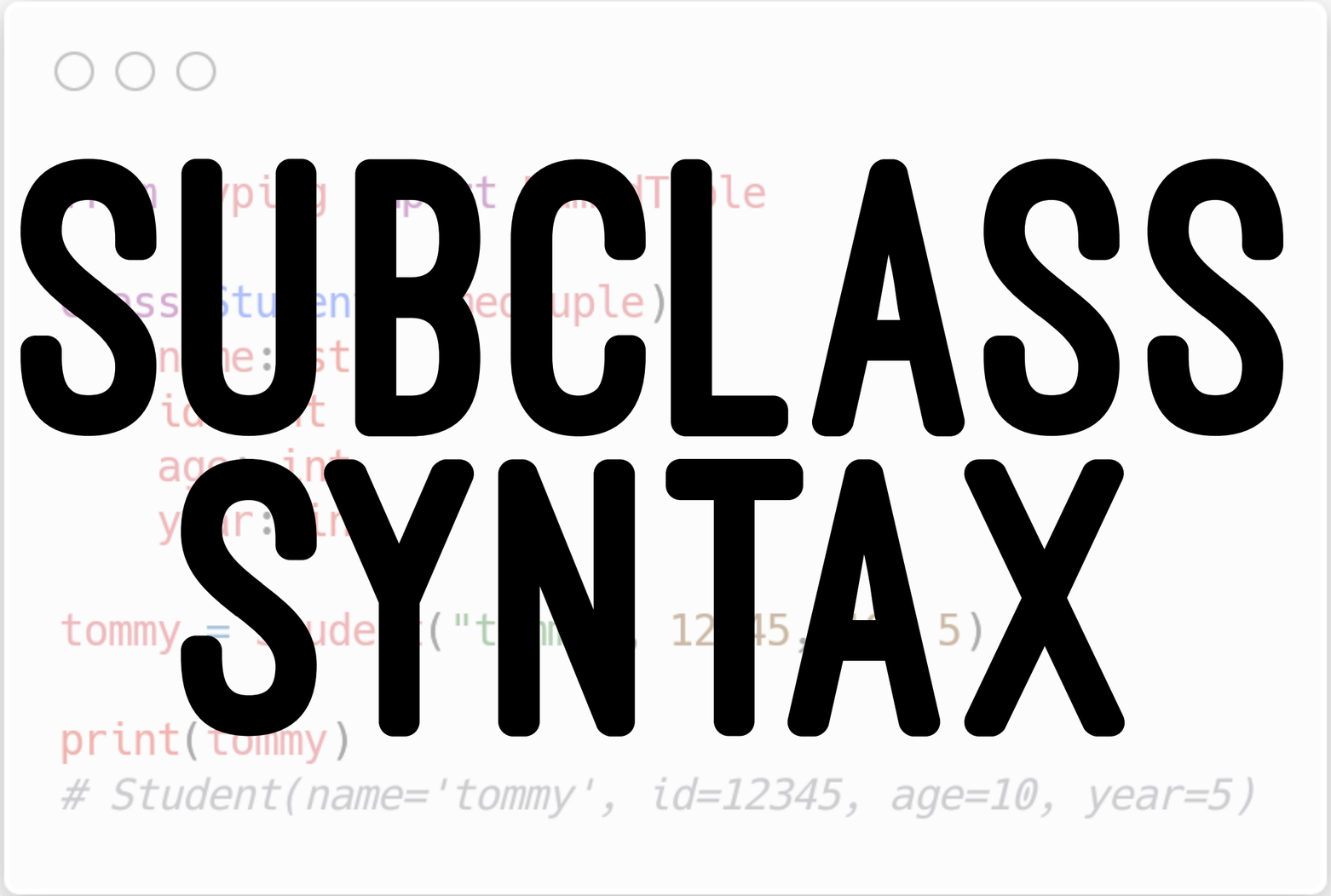
WHAT ABOUT TYPES?

typing.NamedTuple

`typing.NamedTuple`

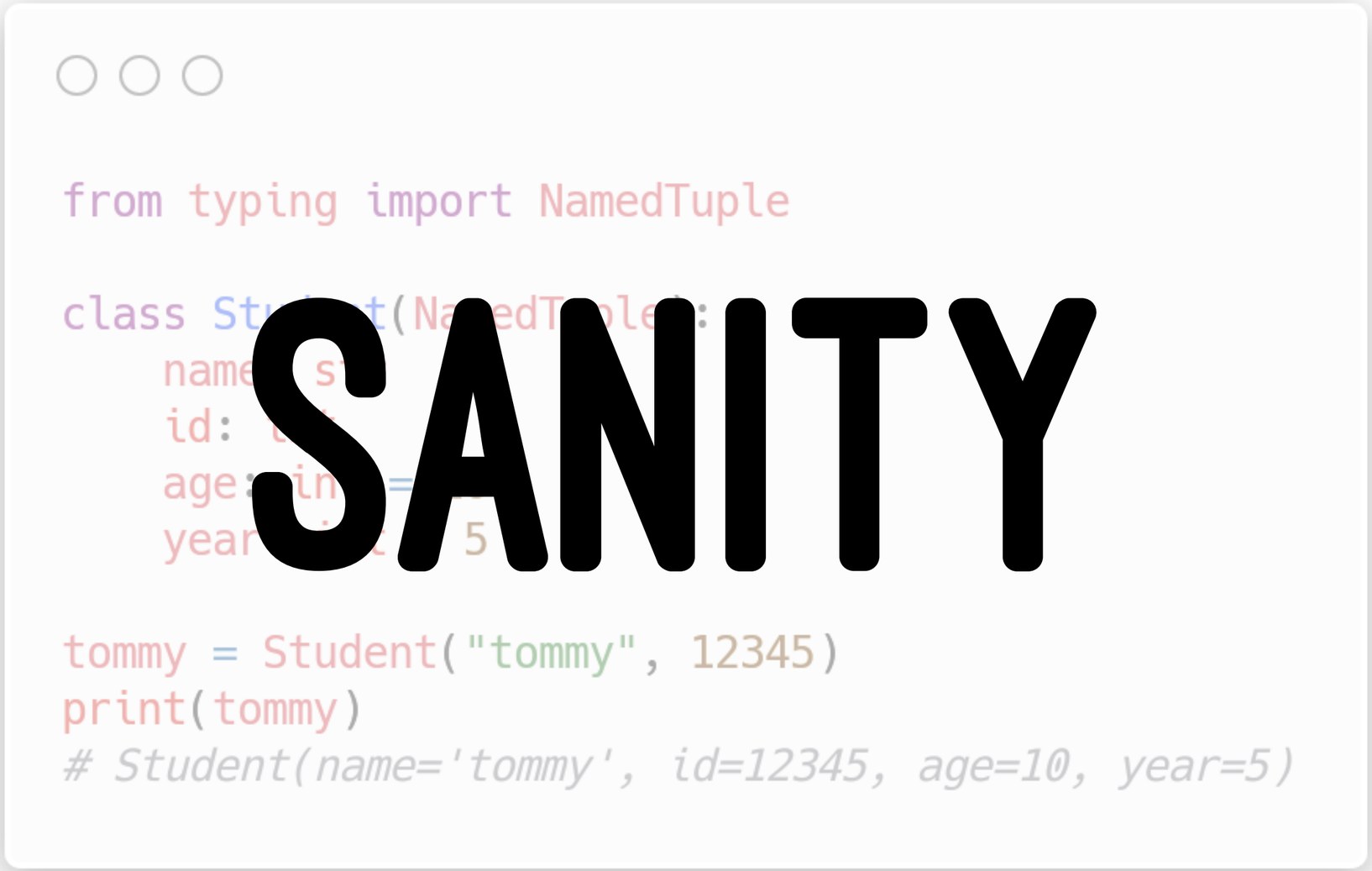
- INTRODUCED IN PYTHON 3.6
- PROVIDES STRUCTURAL SUBCLASS OF `tuple` WITH TYPED FIELDS
- INTRODUCES CLASS-BASED DECLARATION SYNTAX

```python
from typing import NamedTuple

Student = NamedTuple("Student", [("name", str),
                                 ("id", int),
                                 ("age", int),
                                 ("year", int)])
tommy = Student("tommy", 12345, 10, 5)

print(tommy)
# Student(name='tommy', id=12345, age=10, year=5)
```


SUBCLASS
SYNTAX

```python
from typing import NamedTuple

class Student(NamedTuple):
    name: str
    id: int
    age: int
    year: int

tommy = Student("tommy", 12345, 10, 5)

print(tommy)
# Student(name='tommy', id=12345, age=10, year=5)
```

```python
from typing import NamedTuple

class Student(NamedTuple):
    name: str
    id: int
    age: int = 10
    year: int = 5

tommy = Student("tommy", 12345)
print(tommy)
# Student(name='tommy', id=12345, age=10, year=5)
```

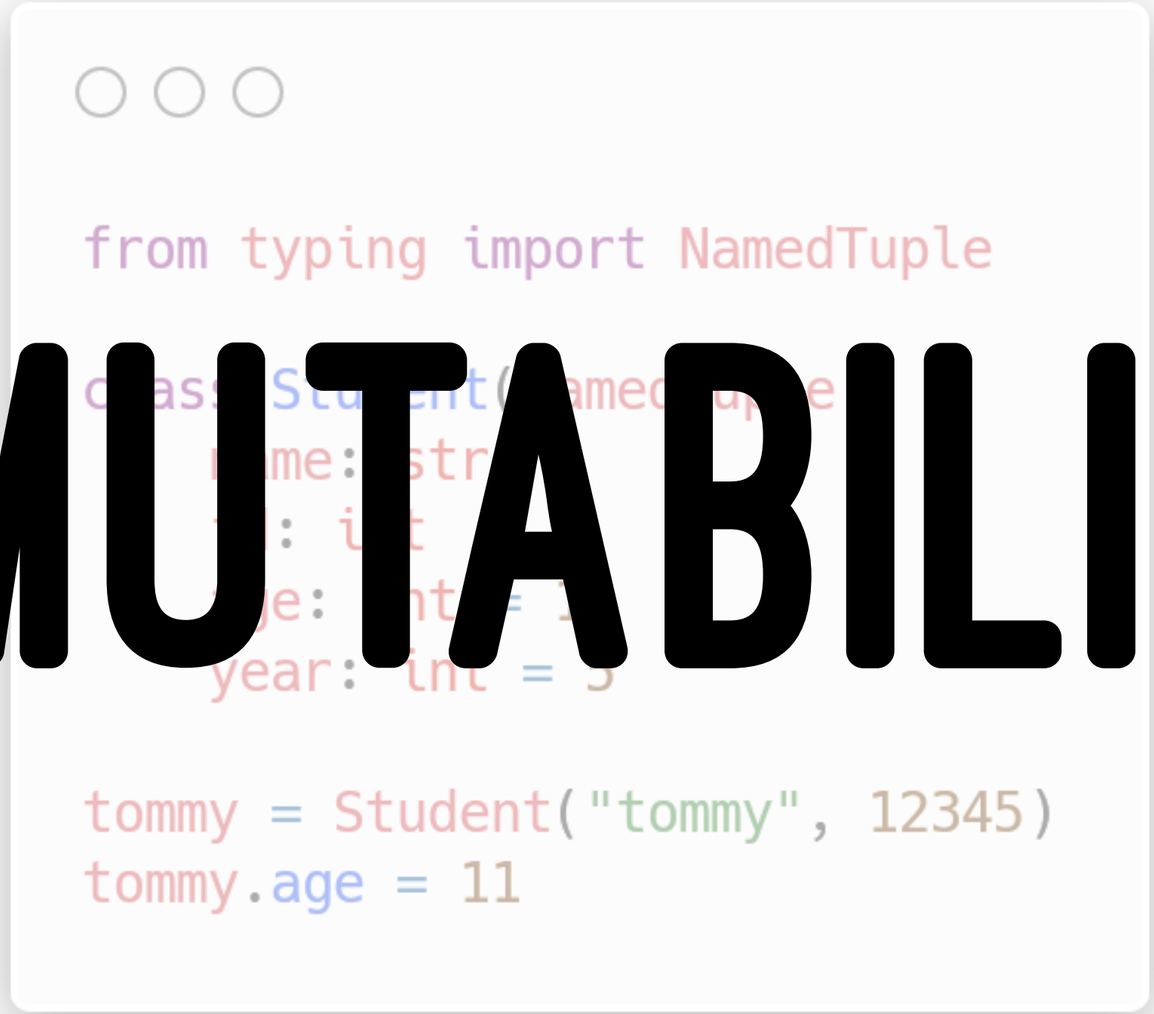

from typing import NamedTuple
class Student(NamedTuple):
name: str
id: int
age: int = 10
year: int = 5
tommy = Student("tommy", 12345)
print(tommy)
# Student(name='tommy', id=12345, age=10, year=5)
SANITY

COMPARISON WITH TUPLE

```python
from typing import NamedTuple

class Student(NamedTuple):
    name: str
    id: int
    age: int = 10
    year: int = 5

tommy = Student("tommy", 12345)

print(tommy == ("tommy", 12345, 10, 5))
# True
```

```
class Car(NamedTuple):
    color: str
    vin: int
    wheels: int
    tons: int

ginger = Student("ginger", id=321, age=4, year=1)
pickup = Car("ginger", vin=321, wheels=4, tons=1)

print(ginger == pickup)
# True
```

IMMUTABILITY



```python
from typing import NamedTuple

class Student(NamedTuple):
    name: str
    id: int
    age: int = 10
    year: int = 5

tommy = Student("tommy", 12345)
tommy.age = 11
```

AttributeError: can't set attribute

```
from typing import NamedTuple

class Student(NamedTuple):
    name: str
    id: int
    age: int = 10
    year: int = 5

tommy = Student("tommy", 12345)
tommy.age = 11
```

WHEN TO USE NAMED TUPLES?

- TO ADD STRUCTURE TO PROCESSED IMMUTABLE RECORDS
- TO GIVE DESCRIPTIVE NAMES IN COMPOUND DATA TYPES
- TO GET RID OF "MAGIC NUMBERS" (INDICES)

WHEN TO USE `typing.NamedTuple` OVER `collections.namedtuple`?

- BASICALLY ALL THE TIME
- OR, AT LEAST WHEN YOU'RE WORKING IN A TYPED CODEBASE

WHEN TO USE `typing.NamedTuple` OVER `collections.namedtuple`?

- BASICALLY ALL THE TIME
- OR, AT LEAST WHEN YOU'RE WORKING IN A TYPED CODEBASE
- (ALSO PLEASE WORK IN TYPED CODEBASES)

EXITING TUPLE-LAND

dataclasses

`dataclasses`

- INTRODUCED IN PYTHON 3.7
- SHORTHAND FOR CREATING LIGHTWEIGHT CLASSES
- CREATE INDEPENDENT TYPES. NO RELATION TO TUPLES

```python
from dataclasses import dataclass

@dataclass
class Student:
    name: str
    id: int
    age: int = 10
    year: int = 5

tommy = Student("tommy", 12345)

print(tommy)
# Student(name='tommy', id=12345, age=10, year=5)
```

```python
from dataclasses import dataclass

@dataclass
class Student:
    name: str
    id: int
    age: int = 10
    year: int = 5

tommy = Student("tommy", 12345)
tommy.age += 1

print(tommy)
# Student(name='tommy', id=12345, age=11, year=5)
```

```python
from dataclasses import dataclass

@dataclass
class Student:
    name: str
    id: int
    age: int = 10
    year: int = 5

tommy = Student("tommy", 12345)
tommy.age += 1

print(tommy)
# Student(name='tommy', id=12345, age=11, year=5)
```

NO AttributeError!

```python
from dataclasses import dataclass

@dataclass
class Student:
    name: str
    id: int
    age: int = 10
    year: int = 5

tommy = Student("tommy", 12345)

print(tommy[2])
```

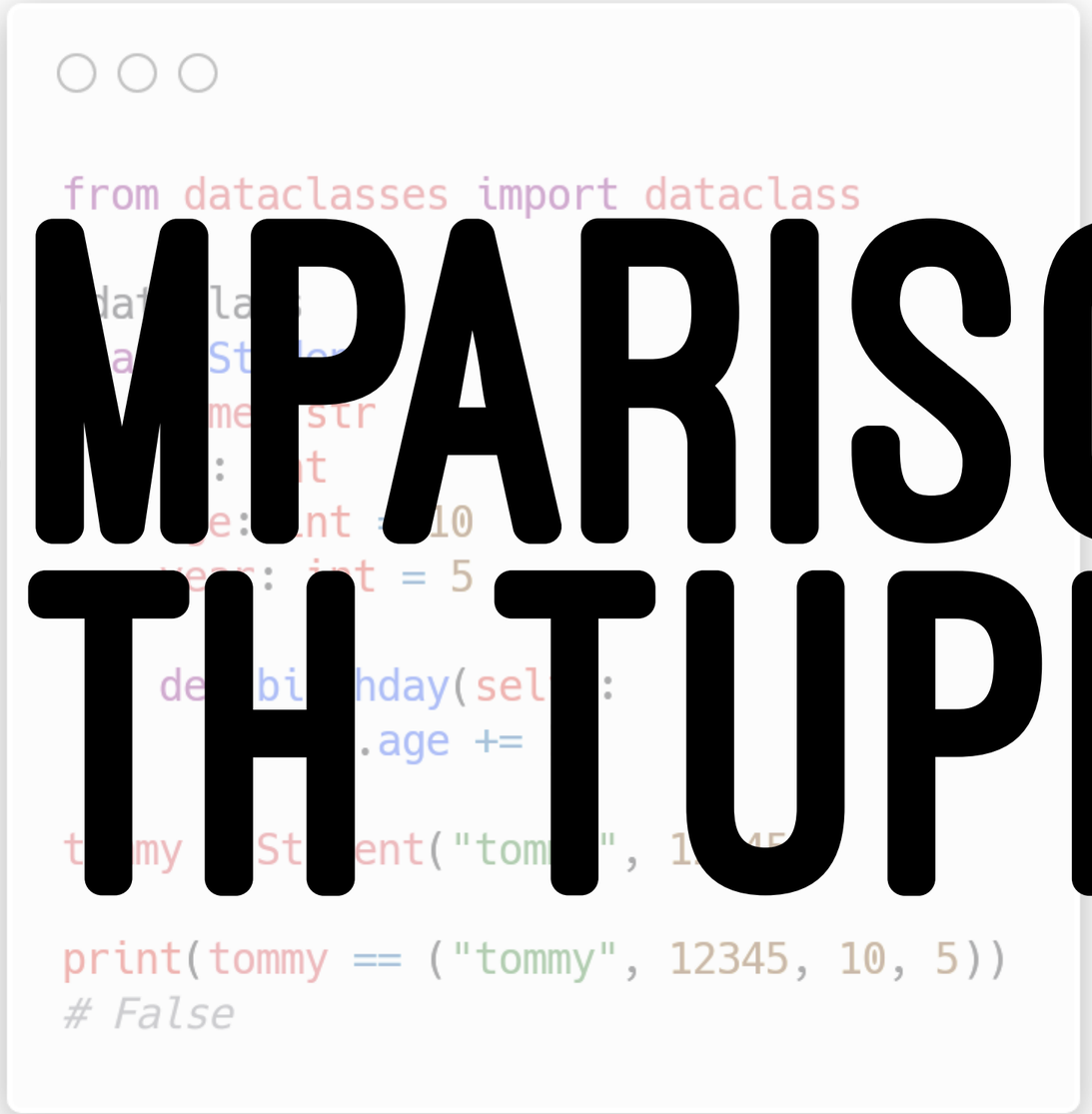
TypeError: 'Student' object is not subscriptable

```python
from dataclasses import dataclass

@dataclass
class Student:
    name: str
    id: int
    age: int = 10
    year: int = 5

tommy = Student("tommy", 12345)

print(tommy[2])
```

- MUTABLE BY DEFAULT
- NOT SUBSCRIPTABLE
- JUST PLAIN CLASSES

```python
from dataclasses import dataclass

@dataclass
class Student:
    name: str
    id: int
    age: int = 10
    year: int = 5

    def birthday(self):
        self.age += 1

tommy = Student("tommy", 12345)
tommy.birthday()

print(tommy)
# Student(name='tommy', id=12345, age=11, year=5)
```

COMPARISON WITH TUPLE

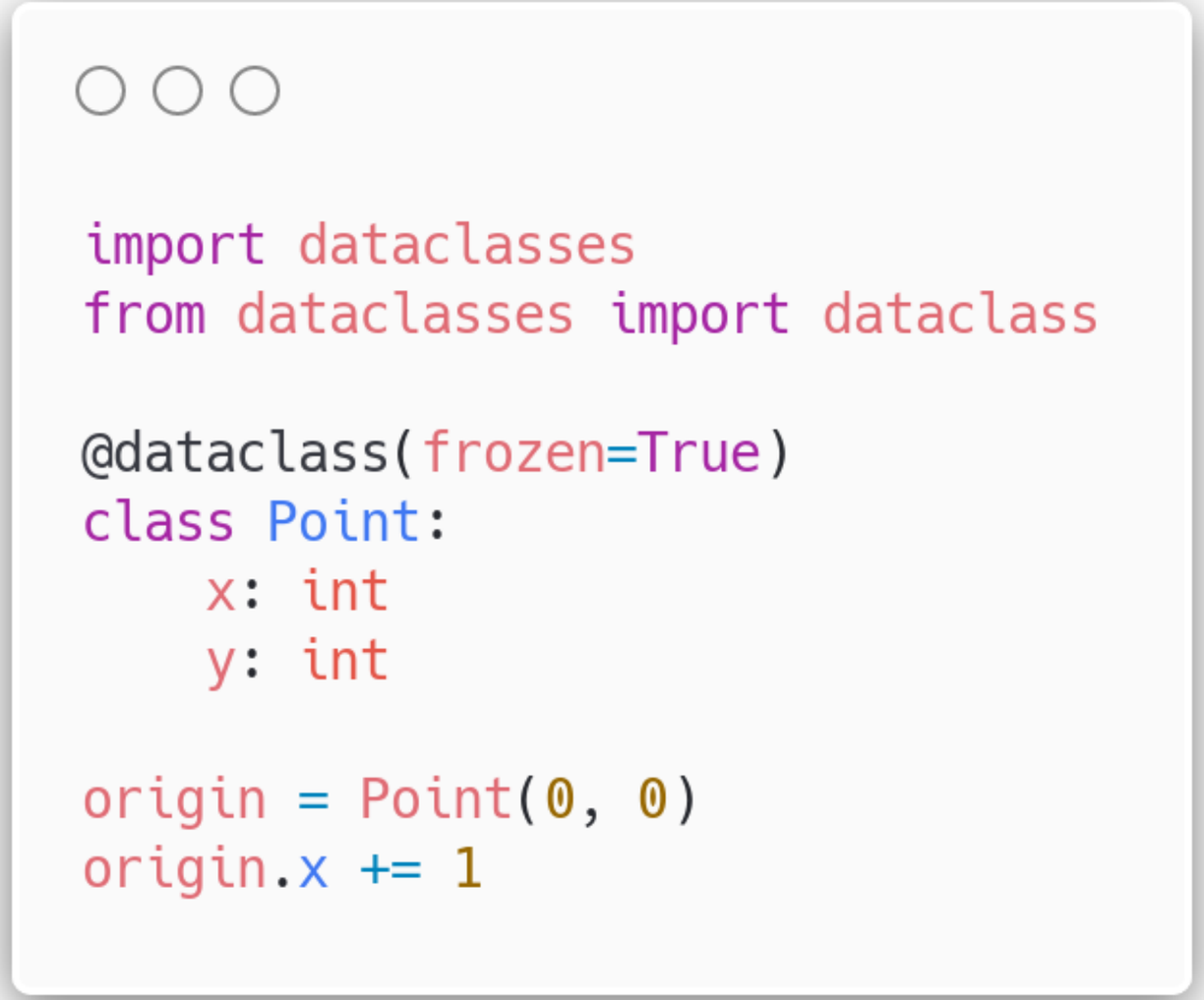


```python
from dataclasses import dataclass

@dataclass
class Student:
    name: str
    id: int
    age: int = 10
    year: int = 5

    def birthday(self):
        self.age += 1

tommy = Student("tommy", 12345)

print(tommy == ("tommy", 12345, 10, 5))
# False
```

```python
import dataclasses
from dataclasses import dataclass

@dataclass
class Student:
    name: str
    id: int
    age: int = 10
    year: int = 5

    def birthday(self):
        self.age += 1

tommy = Student("tommy", 12345)

print(dataclasses.astuple(tommy) == ("tommy", 12345, 10, 5))
# True
```

EMULATING IMMUTABILITY

```
import dataclasses
from dataclasses import dataclass

@dataclass(frozen=True)
class Point:
    x: int
    y: int

origin = Point(0, 0)
origin.x += 1
```



```python
import dataclasses
from dataclasses import dataclass

@dataclass(frozen=True)
class Point:
    x: int
    y: int

origin = Point(0, 0)
origin.x += 1
```

```
import dataclasses
from dataclasses import dataclass

@dataclass(frozen=True)
class Point:
    x: int
    y: int

origin = Point(0, 0)
origin.x += 1
```

FrozenInstanceError: cannot assign to field 'x'

```python
import dataclasses
from dataclasses import dataclass

@dataclass(frozen=True)
class Point:
    x: int
    y: int

origin = Point(0, 0)

origin.__dict__["x"] = 1

print(origin)
# Point(x=1, y=0)
```

"EMULATING"

```python
import dataclasses
from dataclasses import dataclass

@dataclass(frozen=True)
class Point:
    x: int
    y: int

origin = Point(0, 0)

origin.__dict__["x"] = 1

print(origin)
# Point(x=1, y=0)
```

dataclasses == python objects

dataclasses == python objects

tuples == C artifacts

Why not just use namedtuple?

- Any namedtuple can be accidentally compared to any other with the same number of fields. For example: `Point3D(2017, 6, 2) == Date(2017, 6, 2)`. With Data Classes, this would return False.
- A namedtuple can be accidentally compared to a tuple. For example `Point2D(1, 10) == (1, 10)`. With Data Classes, this would return False.
- Instances are always iterable, which can make it difficult to add fields. If a library defines:

```
Time = namedtuple('Time', ['hour', 'minute'])
def get_time():
    return Time(12, 0)
```

  Then if a user uses this code as:

```
hour, minute = get_time()
```

  then it would not be possible to add a `second` field to `Time` without breaking the user's code.

- No option for mutable instances.
- Cannot specify default values.
- Cannot control which fields are used for `__init__`, `__repr__`, etc.
- Cannot support combining fields by inheritance.

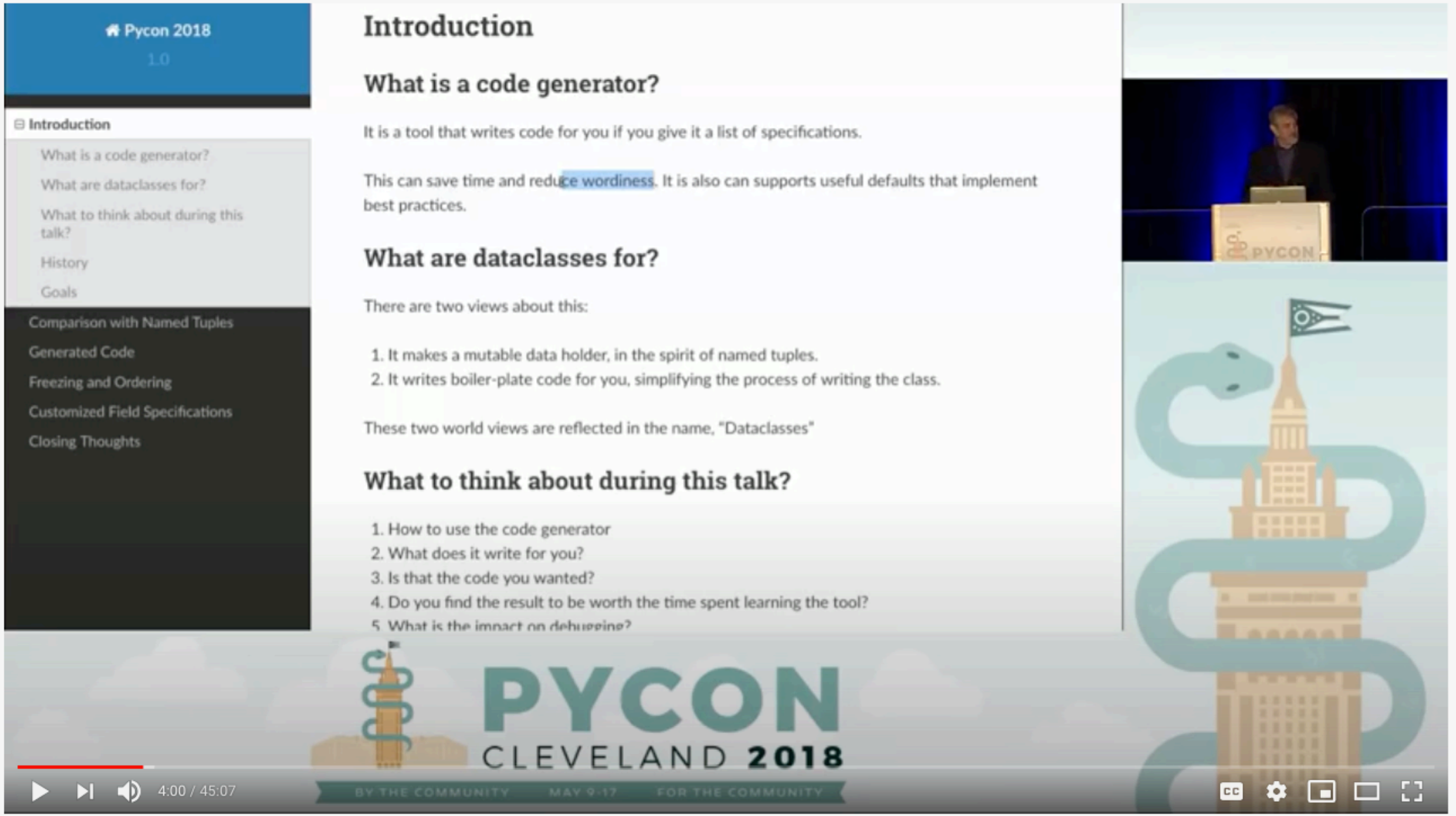
IF YOU WANT A SIMPLE TUPLE, USE TYPING.NAMEDTUPLE

IF YOU WANT A PYTHON OBJECT THAT CAN GROW IN COMPLEXITY, USE DATACLASSES

```python
import dataclasses
from dataclasses import dataclass
import math

@dataclass
class Point:
    x: int
    y: int
    magnitude: float = dataclasses.field(init=False)

    def __post_init__(self):
        self.magnitude = math.sqrt(self.x**2 + self.y**2)

pythag = Point(3, 4)

print(pythag)
# Point(x=3, y=4, magnitude=5.0)
```

__post_init__

```python
import dataclasses
from dataclasses import dataclass
import math

@dataclass
class Point:
    x: int
    y: int
    magnitude: float = dataclasses.field(init=False)

    def __post_init__(self):
        self.magnitude = math.sqrt(self.x**2 + self.y**2)

pythag = Point(3, 4)

print(pythag)
# Point(x=3, y=4, magnitude=5.0)
```



Raymond Hettinger - Dataclasses: The code generator to end all code generators - PyCon 2018

73,696 views • May 13, 2018

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PyCon 2018
19.9K subscribers

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TYPEDDICT

`typing.TypedDict`

- NEW IN PYTHON 3.8
- ADD TYPE HINTS TO DICTIONARY
- DOESN'T DEFINE NEW RUNTIME CLASS
- USEFUL FOR TYPECHECKERS LIKE `mypy`

```python
from typing import TypedDict

class Student(TypedDict):
    name: str
    id: int
    age: int
    year: int

tommy = Student(name="tommy", id=12345, age=10, year=5)
print(tommy)
# {'name': 'tommy', 'id': 12345, 'age': 10, 'year': 5}

print(isinstance(tommy, dict))
# True
```

WHEN TO USE `TypedDict`?

- WHEN YOU ARE PROCESSING DICTIONARIES (E.G., JSON)
- WHEN YOU WANT TO ADD STRUCTURE TO `Dict` TYPE ANNOTATIONS

EXITING THE STANDARD LIBRARY

attrs

attrs: Classes Without Boilerplate

- LIGHTWEIGHT SYNTAX FOR DECLARING CUSTOM TYPES
- BEEN AROUND SINCE PYTHON 2
- INSPIRED AND CONSULTED ON `dataclasses`

```python
import attr

@attr.s
class Point():
    x = attr.ib()
    y = attr.ib()

origin = Point(0, 0)

print(origin)
# Point(x=0, y=0)
```

VALIDATORS

```
import attr

@attr.s
class FirstQuadrantPoint():
    x = attr.ib()
    y = attr.ib()

    @x.validator
    @y.validator
    def check(self, attribute, value):
        if value <= 0:
            raise ValueError("Coordinates must be positive.")

origin = FirstQuadrantPoint(0, 0)
```

```python
import attr

@attr.s
class FirstQuadrantPoint():
    x = attr.ib()
    y = attr.ib()

    @x.validator
    @y.validator
    def check(self, attribute, value):
        if value <= 0:
            raise ValueError("Coordinates must be positive.")

origin = FirstQuadrantPoint(0, 0)
```

```
import attr

@attr.s
class FirstQuadrantPoint():
    x = attr.ib()
    y = attr.ib()
    @x.validator
    @y.validator
    def check(self, attribute, value):
        if value <= 0:
            raise ValueError("Coordinates must be positive.")

origin = FirstQuadrantPoint(0, 0)
```

ValueError: Coordinates must be positive.

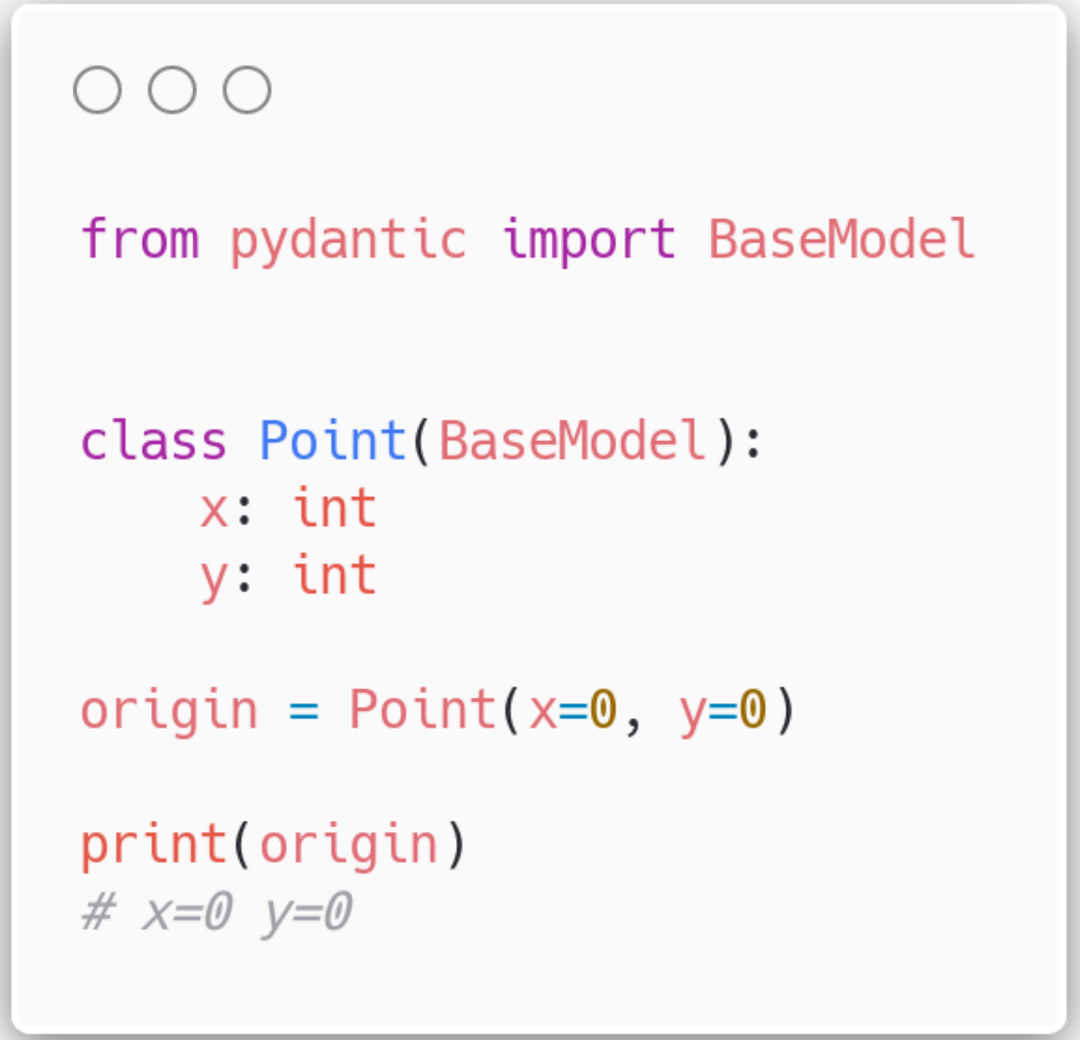
FEATURES OVER `dataclasses`:

- PYTHON 2/PYPY SUPPORT
- VALIDATORS
- CONVERTERS
- `__slots__`
- AND MORE

WHEN TO USE `attrs`:

- YOU NEED TO SUPPORT PYTHON 2 (:/)
- YOU NEED MORE ADVANCED FEATURES THAN `dataclasses` CAN PROVIDE
- YOU WANT TO BE ON THE BLEEDING EDGE


from pydantic import BaseModel
class Point(BaseModel):
x: int
y: int
origin = Point(x=0, y=0)
print(origin)
# x=0 y=0
pydantic



```python
from pydantic import BaseModel


class Point(BaseModel):
    x: int
    y: int

origin = Point(x=0, y=0)

print(origin)
# x=0 y=0
```

VALIDATORS

```python
from pydantic import BaseModel, ValidationError, validator

class FirstQuadrantPoint(BaseModel):
    x: int
    y: int

    @validator('x', 'y', allow_reuse=True)
    def must_be_positive(cls, i):
        if i <= 0:
            raise ValueError('Must be positive')
        return int(i)

origin = FirstQuadrantPoint(x=0, y=1)
```

```python
from pydantic import BaseModel, ValidationError, validator

class FirstQuadrantPoint(BaseModel):
    x: int
    y: int

    @validator('x', allow_reuse=True)
    @validator('y', allow_reuse=True)
    def must_be_positive(cls, i):
        if i <= 0:
            raise ValueError('Must be positive')
        return int(i)

origin = FirstQuadrantPoint(x=0, y=1)
```

```python
from pydantic import BaseModel, ValidationError, validator

class FirstQuadrantPoint(BaseModel):
    x: int
    y: int

    @validator('x', allow_reuse=True)
    @validator('y', allow_reuse=True)
    def must_be_positive(cls, i):
        if i <= 0:
            raise ValueError('Must be positive')
        return int(i)

origin = FirstQuadrantPoint(x=0, y=1)
```

Must be positive (type=value_error)

`pydantic`

- RECENT PROJECT TAKING ADVANTAGE OF TYPE ANNOTATIONS
- STRONG SUPPORT FOR DATA VALIDATION
- FULL `dataclasses` API AND STANDARD LIBRARY INTEROPERABILITY

dataclasses API

```python
import datetime

from pydantic.dataclasses import dataclass

@dataclass
class Conference:
    name: str
    time: datetime.datetime

pyjamas = Conference(name="PyJamas 2020", time="2020-12-05T21:00")

print(pyjamas)
# Conference(name='PyJamas 2020', time=datetime.datetime(2020, 12, 5, 21,
0))
```

```python
import datetime

from pydantic.dataclasses import dataclass

@dataclass
class Conference:
    name: str
    time: datetime.datetime

pyjamas = Conference(name="PyJamas 2020", time="2020-12-05T21:00")

print(pyjamas)
# Conference(name='PyJamas 2020', time=datetime.datetime(2020, 12, 5, 21,
0))
```

Complex serializations

```python
import datetime
from typing import List

from pydantic.dataclasses import dataclass

@dataclass
class Presentation:
    name: str
    title: str

@dataclass
class Conference:
    name: str
    time: datetime.datetime
    presentations: List[Presentation]

serialized_conference = {
    "name": "PyJamas 2020",
    "time": "2020-12-05T21:00",
    "presentations": [
        {
            "name": "Zach Anglin",
            "title": "What the struct?!",
        },
        {
            "name": "Mark Smith",
            "title": "Stupid Things I've Done with Python",
        }
    ],
}

pyjamas = Conference(**serialized_conference)

print(pyjamas.presentations[0].title)
# What the struct?!
```

```python
import datetime
from typing import List

from pydantic.dataclasses import dataclass

@dataclass
class Presentation:
    name: str
    title: str

@dataclass
class Conference:
    name: str
    time: datetime.datetime
    presentations: List[Presentation]

serialized_conference = {
        "name": "PyJamas 2020",
        "time": "2020-12-05T21:00",
        "presentations": [
            {
                "name": "Zach Anglin",
                "title": "What the struct?!",
            },
            {
                "name": "Mark Smith",
                "title": "Stupid Things I've Done with Python",
            }
        ],
    }

pyjamas = Conference(**serialized_conference)

print(pyjamas.presentations[0].title)
# What the struct?!
```

WHEN TO USE `pydantic`:

- WHEN YOU NEED POWERFUL DATA VALIDATION
- WHEN YOU'RE VALIDATING EXTERNAL DATA THROUGH AN API
- WHEN YOU NEED TO DESERIALIZE A COMPOUND STRUCTURE
- IF YOU'RE IN A TYPED CODEBASE :)

RECAP

- C structs
- Python structs
- collection.namedtuple
- typing.NamedTuple
- dataclasses
- typing.TypedDict
- attrs
- pydantic

THERE SHOULD BE ONE-- AND PREFERABLY ONLY ONE --OBVIOUS WAY TO DO IT.

- THE ZEN OF PYTHON

FIN