

LECTURE 4

OBJECT-ORIENTED PROGRAMMING

OPERATOR OVERLOADING

MCS 275 Spring 2022

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LECTURE 4: OPERATOR OVERLOADING

Course bulletins:

- At this point you **must** have read the syllabus.
- Discord open (link in the zoom chat or Blackboard).

OBJECT-ORIENTED PROGRAMMING

Today we're starting our unit on object-oriented programming (OOP).

We assume knowledge of: Class definitions, creating instances, accessing attributes, calling methods.

Need to review these? See:

- [MCS 260 Lecture 25](#)
- [MCS 260 Fall 2021 OOP sample code](#)

We DO NOT assume knowledge of: Subclasses, inheritance, operator overloading.

REVIEW OF SOME KEY CONCEPTS

- **class** -- A type in that combines attributes (data) and methods (behavior).
- **instance** or **object** -- A value whose type is a certain class (e.g. "hello" is an instance of `str`)
- **attribute** -- A variable local to an object, accessed as `objname.attrname`.
- **constructor** -- The method named `__init__` that is called when a new object is created.

SPECIAL METHODS / OVERLOADING

In Python, built-in operations are often silently translated into method calls.

e.g. `A+B` turns into `A.__add__(B)`

These special method names begin and end with two underscores (`__`). They are used to customize the way your classes work with built-in language features.

Using these to add special behavior for operators like `+`, `-`, `*` is called operator overloading.

OPERATOR EXAMPLES

Expression	Special method
$A==B$	<code>A.__eq__(B)</code>
$A+B$	<code>A.__add__(B)</code>
$A-B$	<code>A.__sub__(B)</code>
$A*B$	<code>A.__mul__(B)</code>
A/B	<code>A.__truediv__(B)</code>
$A**B$	<code>A.__pow__(B)</code>

[List of many more](#) in the Python documentation.

MORE SPECIAL METHODS

Expression	Actually calls
<code>str(A)</code>	<code>A.__str__()</code>
<code>len(A)</code>	<code>A.__len__()</code>
<code>abs(A)</code>	<code>A.__abs__()</code>
<code>bool(A)</code>	<code>A.__bool__()</code>
<code>A[k]</code>	<code>A.__getitem__(k)</code>
<code>A[k]=v</code>	<code>A.__setitem__(k,v)</code>

LIVE CODING

Let's build classes:

- `Point2` — point in the plane (a location in 2D)
- `Vector2` — vector in the plane (e.g. the displacement between two points)

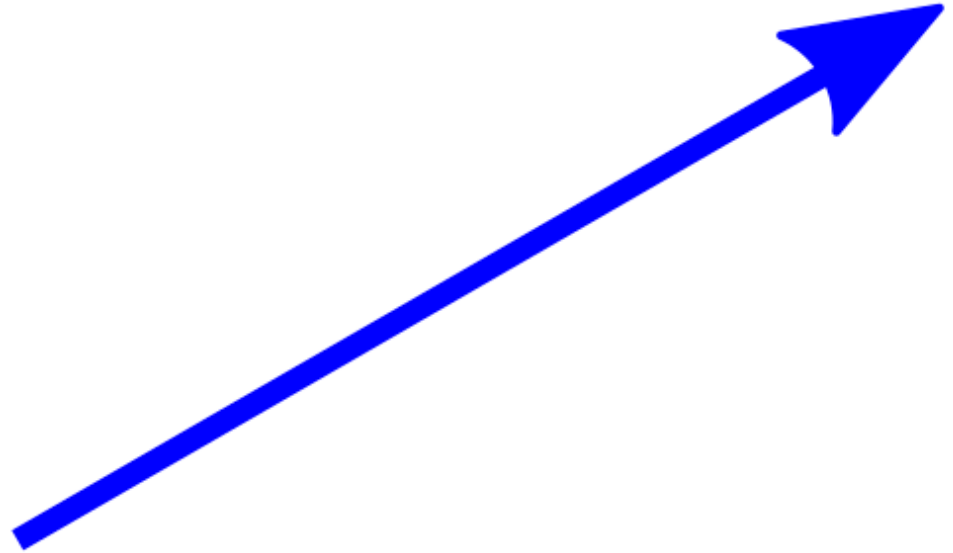
Difference of two `Point2`s is a `Vector2`.

Can multiply a `Vector2` by a float or add it to a `Point2`.

`Point2` plus `Vector2` is a `Point2`.

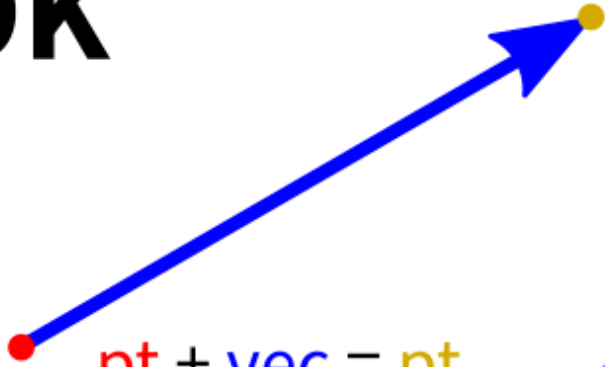


Point
(where?)

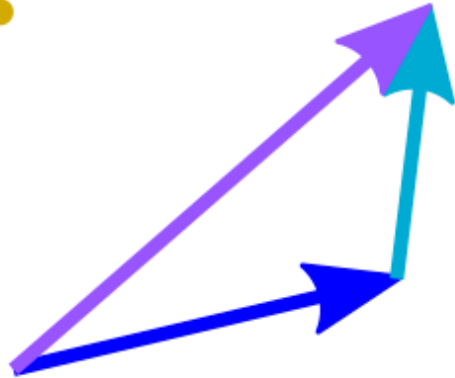


Vector
(which way, how far?)

OK



$$\begin{aligned} \text{pt} + \text{vec} &= \text{pt} \\ \text{pt} - \text{pt} &= \text{vec} \end{aligned}$$



$$\text{vec} + \text{vec} = \text{vec}$$



$$1.5 \times \text{vec} = \text{vec}$$

Meaningless

$\text{pt} + \text{pt} = ?$

$1.5 \times \text{pt} = ?$

LANGUAGE FEATURES USED

- `isinstance(obj, classname)` -- returns bool indicating whether `obj` is an instance of the named class (or subclass thereof)
- `NotImplemented` -- Special value that operators should return if the operation is not supported

`__ADD__` & `__RADD__`

In evaluating $A+B$, Python first tries

```
A.__add__(B)
```

but if that fails (returns `NotImplemented`), it will try

```
B.__radd__(A)
```

There are reflected versions of all the binary operations (e.g. `__rmul__`).

OVERLOADING DANGER

Given the very flexible overloading system in Python, it's easy to be too clever.

Overloading is best used when a function or operator has a clear meaning for a class, and when the operation is so frequently used that direct method calls would be cumbersome.

Avoid overloading when it makes code harder to understand!

SINGLETONS

When a class is designed so that it only ever has one instance, the class (or the only instance of it) is called a **singleton**.

We've seen two of these so far:

- `None`, the only instance of `NoneType`
- `NotImplemented`, the only instance of `NotImplementedType`

REFERENCES

- I discussed overloading in [MCS 260 Fall 2021 Lecture 26](#).
- See Lutz, Chapter 30 for more information about overloading.
- Lutz, Chapters 26-32 discuss object-oriented programming.

REVISION HISTORY

- 2022-01-19 Initial publication

