# LECTURE 4

# OBJECT-ORIENTED PROGRAMMING

## OPERATOR OVERLOADING

MCS 275 Spring 2023

David Dumas

# LECTURE 4: OPERATOR OVERLOADING

Reminders and announcements:

- Syllabus update coming soon to account for strike
- Project 1 due date will be postponed, details TBA

# 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 structure that allows data (attributes) and behavior (methods) to be bundled together, e.g. `Point2`.
- **instance** or **object** — A value belonging to a class, e.g. `p = Point2(5,7)`
- **attribute** — data stored in an object, e.g. `p.x`
- **method** — function that is part of an object (uses and/or modifies its attributes), e.g. `p.radius()`

# 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` | `A.__eq__(B)` |
| `A+B` | `A.__add__(B)` |
| `A-B` | `A.__sub__(B)` |
| `A*B` | `A.__mul__(B)` |
| `A/B` | `A.__truediv__(B)` |
| `A**B` | `A.__pow__(B)` |

List of many more in the Python documentation.

# MORE SPECIAL METHODS

| Expression | Actually calls |
| --- | --- |
| `str(A)` | `A.__str__()` |
| `len(A)` | `A.__len__()` |
| `abs(A)` | `A.__abs__()` |
| `bool(A)` | `A.__bool__()` |
| `A[k]` | `A.__getitem__(k)` |
| `A[k]=v` | `A.__setitem__(k,v)` |

# LIVE CODING

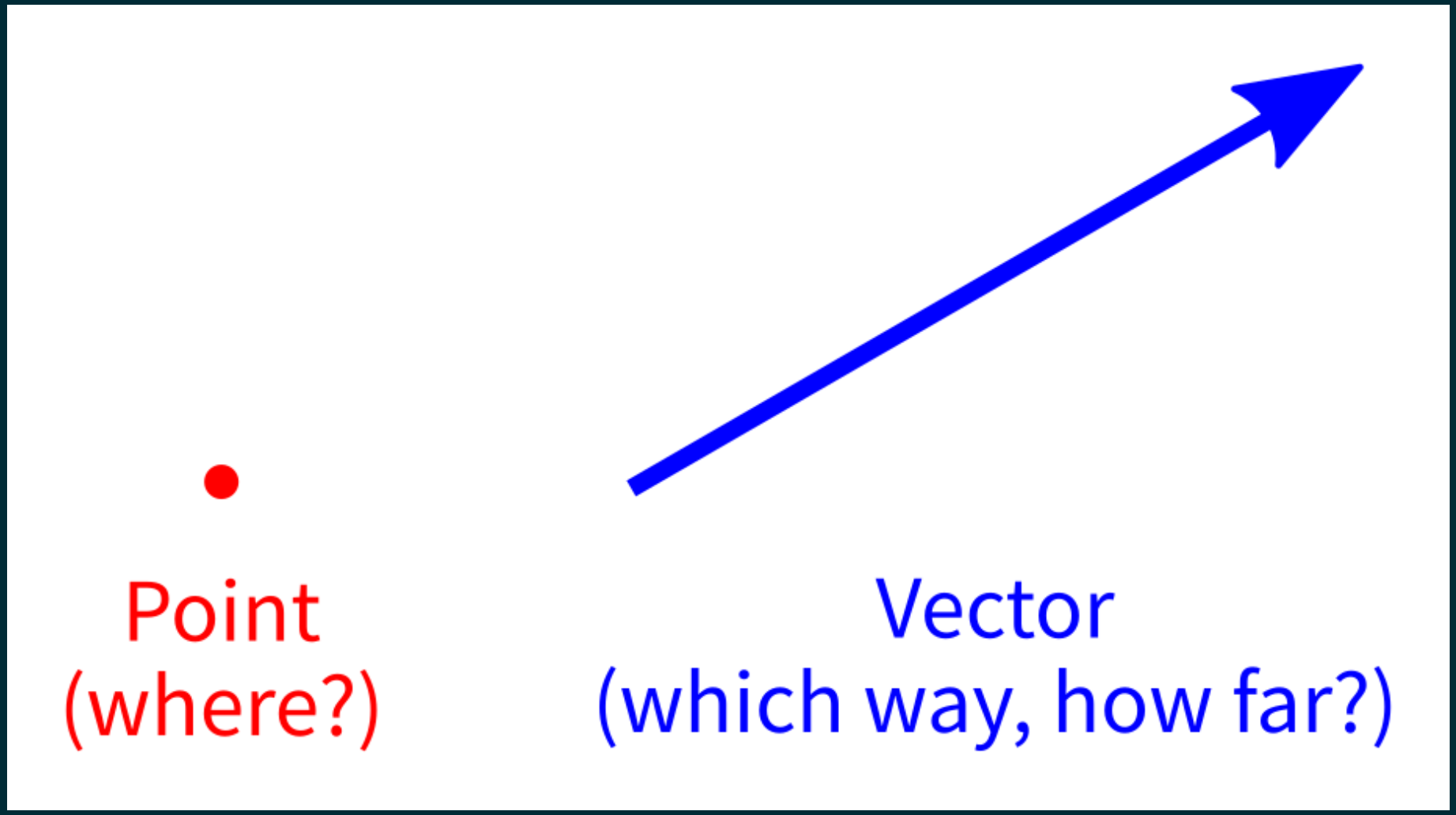
Let's work on

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

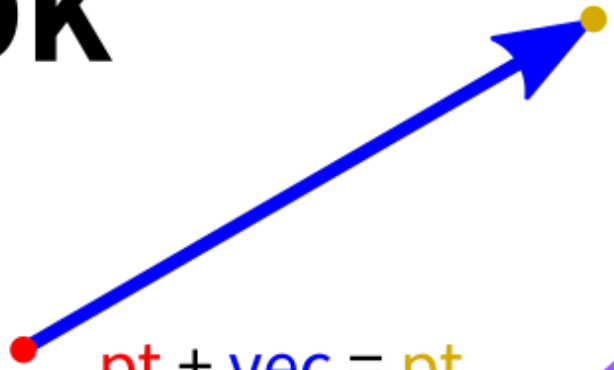
Difference of two `Point2`s is a `Vector2`.

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

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

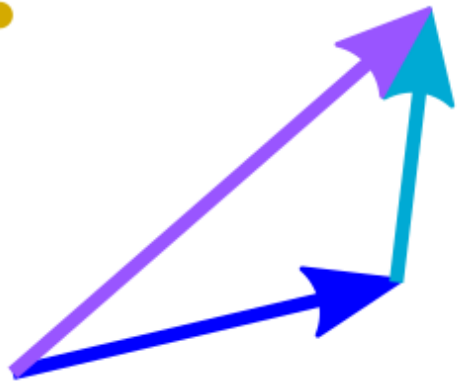

Point
(where?)
Vector
(which way, how far?)

# OK



pt + vec = pt

pt - pt = vec



vec+vec=vec

1.5 × vec = vec

---

## Meaningless

pt + pt = ?

1.5 × 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

Overloading is best used when a function or operator has a clear, natural meaning for a class.

If used too much or in unintuitive ways, it makes programs 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 Previous course source material
- 2023-01-23 Update for spring 2023