61A Lecture 16

Monday, March 2

Announcements

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  - Homework/Project party Tuesday 3/3 5pm-6:30pm in 2050 VLSB

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- Hog strategy contest winners will be announced on Wednesday 3/4 in lecture

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- The **repr** is legible to the Python interpreter

The **str** and **repr** strings are often the same, but not always

The repr String for an Object

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(Demo)

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Example:

Classes that implement `__repr__` and `__str__` methods that return Python- and human-readable strings implement an interface for producing string representations

Property Methods

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>>> f = Rational(3, 5)
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>>> f.numer = 4
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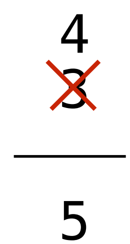

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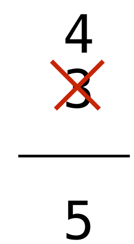

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>>> f.denom -= 3
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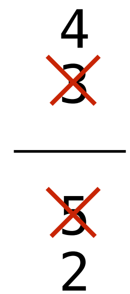

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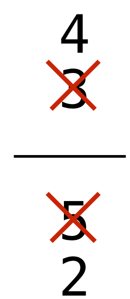

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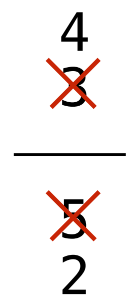

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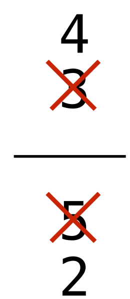

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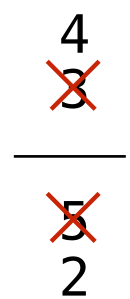

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(Demo)

Example: Complex Numbers

Multiple Representations of Abstract Data

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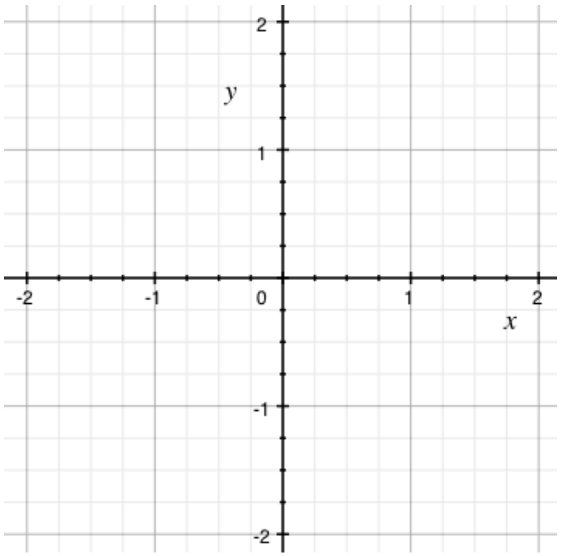

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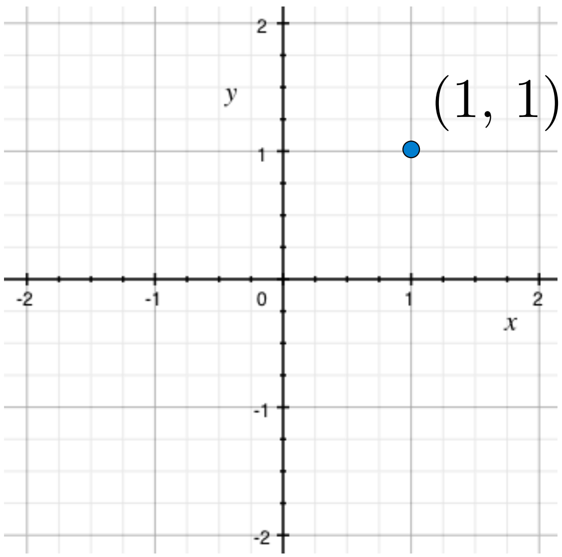

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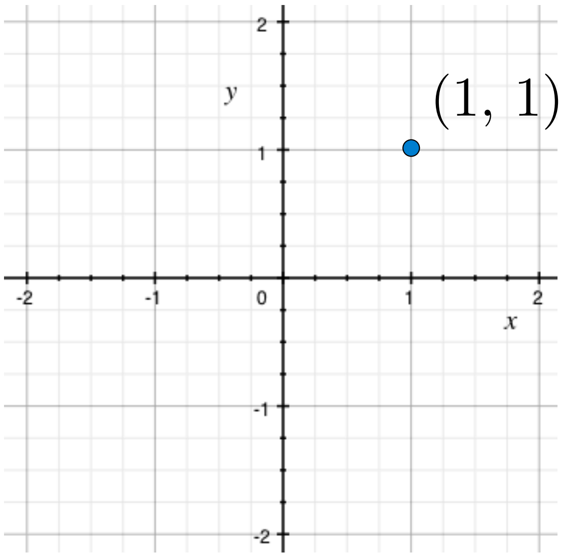

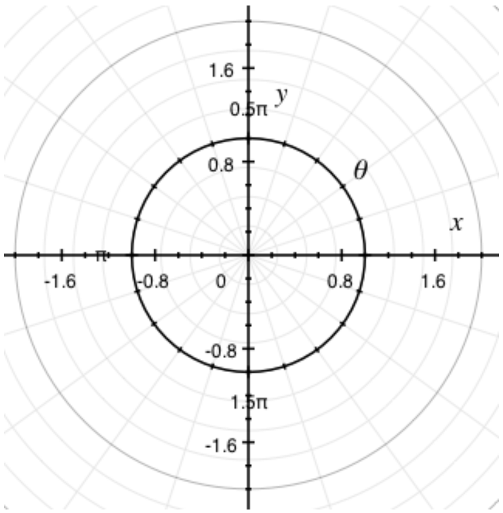

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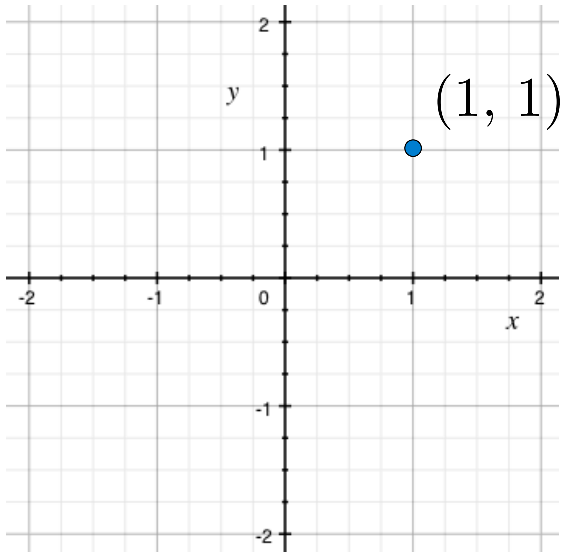

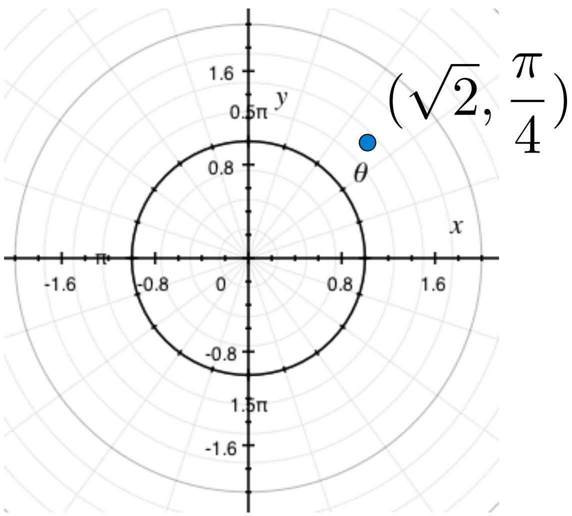

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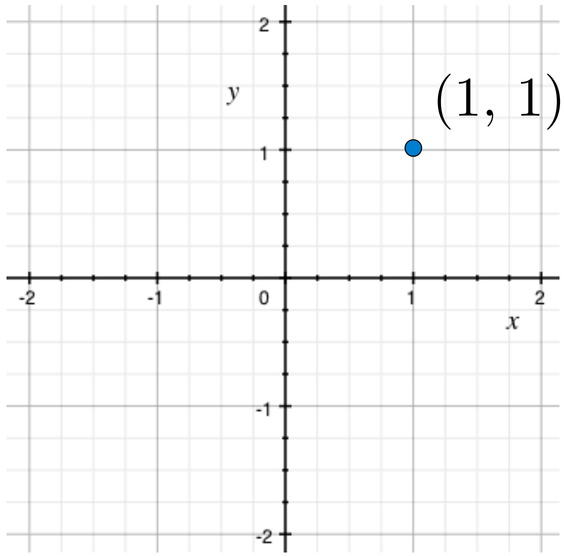

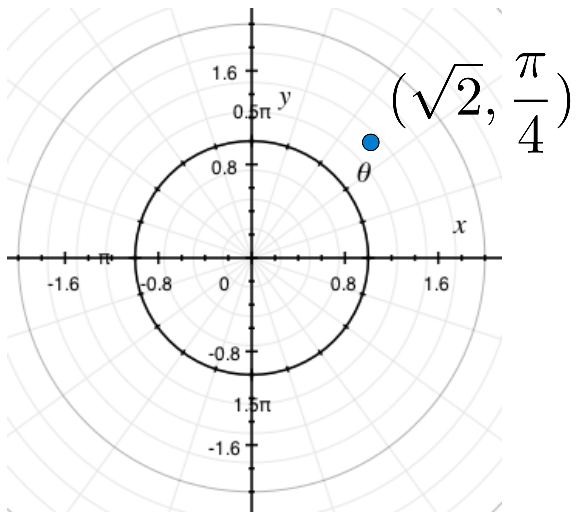

Most programs don't care about the representation

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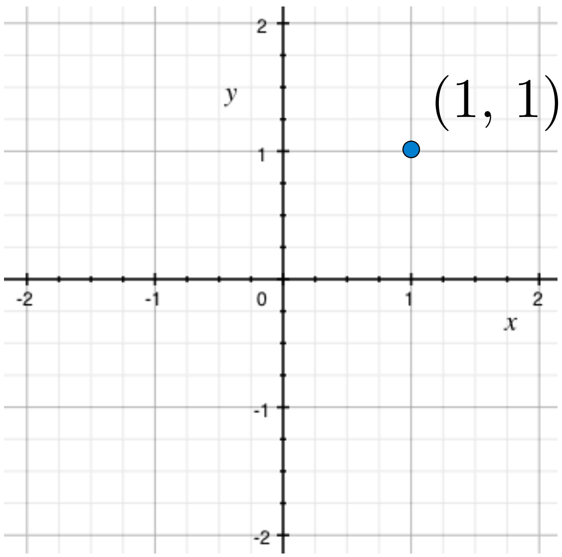

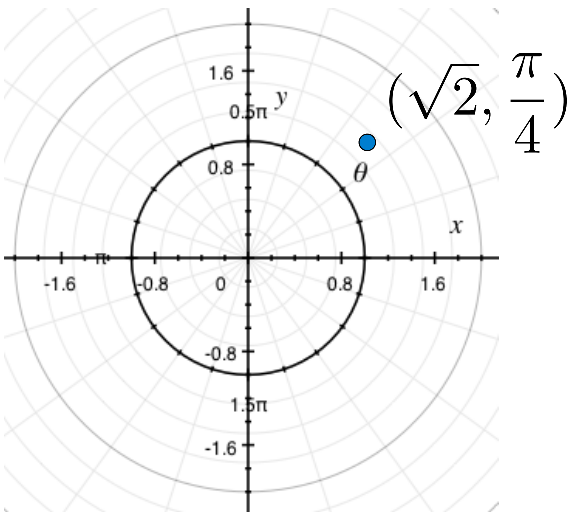

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Some arithmetic operations are easier using one representation than the other

Implementing Complex Arithmetic

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Assume that there are two different classes that both represent Complex numbers

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$$1 + \sqrt{-1}$$

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Number	Rectangular representation	Polar representation
$1 + \sqrt{-1}$	**ComplexRI**(1, 1)	**ComplexMA**(sqrt(2), pi/4)

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class Complex:
    def add(self, other):
        return ComplexRI(self.real + other.real,
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    def add(self, other):
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    def mul(self, other):
        return ComplexMA(self.magnitude * other.magnitude,
                         self.angle + other.angle)
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Complex Arithmetic Abstraction Barriers

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Parts of the program that...	Treat complex numbers as...	Using...

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Use complex numbers to perform computation	whole data values	x.add(y), x.mul(y)

Complex Arithmetic Abstraction Barriers

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Parts of the program that...	Treat complex numbers as...	Using...
Use complex numbers to perform computation	whole data values	x.add(y), x.mul(y)
Add complex numbers		

Complex Arithmetic Abstraction Barriers

Parts of the program that...	Treat complex numbers as...	Using...
Use complex numbers to perform computation	whole data values	x.add(y), x.mul(y)
Add complex numbers	real and imaginary parts	

Complex Arithmetic Abstraction Barriers

Parts of the program that...	Treat complex numbers as...	Using...
Use complex numbers to perform computation	whole data values	x.add(y), x.mul(y)
Add complex numbers	real and imaginary parts	real, imag, ComplexRI

Complex Arithmetic Abstraction Barriers

Parts of the program that...	Treat complex numbers as...	Using...
Use complex numbers to perform computation	whole data values	x.add(y), x.mul(y)
Add complex numbers	real and imaginary parts	real, imag, ComplexRI
Multiply complex numbers		

Complex Arithmetic Abstraction Barriers

Parts of the program that...	Treat complex numbers as...	Using...
Use complex numbers to perform computation	whole data values	x.add(y), x.mul(y)
Add complex numbers	real and imaginary parts	real, imag, ComplexRI
Multiply complex numbers	magnitudes and angles	

Complex Arithmetic Abstraction Barriers

Parts of the program that...	Treat complex numbers as...	Using...
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Complex Arithmetic Abstraction Barriers

Parts of the program that...	Treat complex numbers as...	Using...
Use complex numbers to perform computation	whole data values	`x.add(y), x.mul(y)`
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Implementation of the Python object system

Implementing Complex Numbers

An Interface for Complex Numbers

An Interface for Complex Numbers

All complex numbers should have `real` and `imag` components

An Interface for Complex Numbers

`All complex numbers should have real and imag components`

`All complex numbers should have a magnitude and angle`

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All complex numbers should have a `magnitude` and `angle`

All complex numbers should share an implementation of `add` and `mul`

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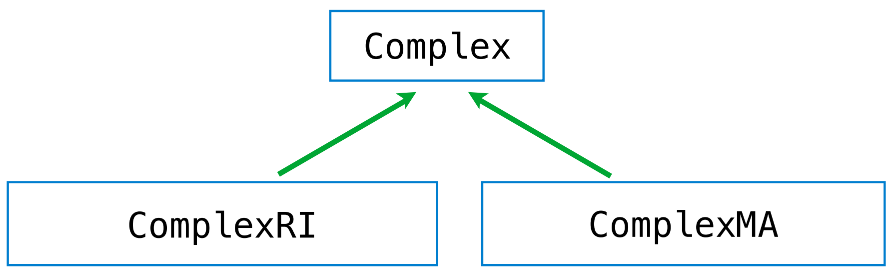

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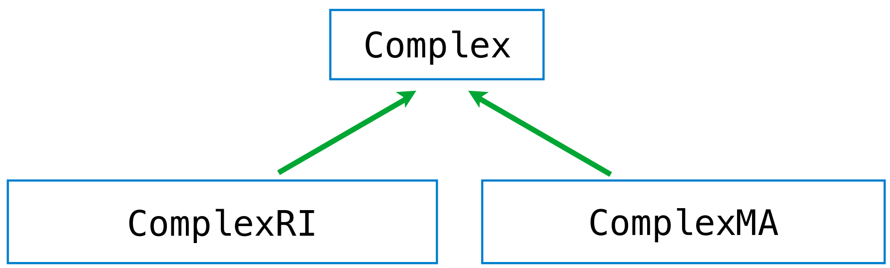

(Demo)

The Rectangular Representation

The @property decorator allows zero-argument methods to be called without the standard call expression syntax, so that they appear to be simple attributes

The Rectangular Representation

```
class ComplexRI:
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    def __init__(self, real, imag):
        self.real = real
        self.imag = imag
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class ComplexRI:

    def __init__(self, real, imag):
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        self.imag = imag

    @property
    def magnitude(self):
        return (self.real ** 2 + self.imag ** 2) ** 0.5
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Property decorator: "Call this function on attribute look-up"

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math.atan2(y,x): Angle between x-axis and the point (x,y)

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    def __repr__(self):
        return 'ComplexRI({0:g}, {1:g})'.format(self.real, self.imag)
```

Property decorator: "Call this function on attribute look-up"

math.atan2(y,x): Angle between x-axis and the point (x,y)

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The Polar Representation

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```
class ComplexMA:
```

The Polar Representation

```
class ComplexMA:

    def __init__(self, magnitude, angle):
        self.magnitude = magnitude
        self.angle = angle
```

The Polar Representation

```
class ComplexMA:

    def __init__(self, magnitude, angle):
        self.magnitude = magnitude
        self.angle = angle

    @property
    def real(self):
        return self.magnitude * cos(self.angle)
```

The Polar Representation

```
class ComplexMA:

    def __init__(self, magnitude, angle):
        self.magnitude = magnitude
        self.angle = angle

    @property
    def real(self):
        return self.magnitude * cos(self.angle)

    @property
    def imag(self):
        return self.magnitude * sin(self.angle)
```

The Polar Representation

```
class ComplexMA:

    def __init__(self, magnitude, angle):
        self.magnitude = magnitude
        self.angle = angle

    @property
    def real(self):
        return self.magnitude * cos(self.angle)

    @property
    def imag(self):
        return self.magnitude * sin(self.angle)

    def __repr__(self):
        return 'ComplexMA({0:g}, {1:g} * pi)'.format(self.magnitude, self.angle / pi)
```

Using Complex Numbers

Either type of complex number can be either argument to `add` or `mul`:

Using Complex Numbers

Either type of complex number can be either argument to add or mul:

```
class Complex:
    def add(self, other):
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    def mul(self, other):
        return ComplexMA(self.magnitude * other.magnitude,
                         self.angle + other.angle)
```

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$1 + 4 \cdot \sqrt{-1}$

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ComplexRI(1, 4) .... $1 + 4 \cdot \sqrt{-1}$

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ComplexMA(1, 1 * pi)
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ComplexRI(1, 4) ··· $1 + 4 \cdot \sqrt{-1}$

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ComplexRI(1, 4) .... $1 + 4 \cdot \sqrt{-1}$

ComplexMA(1, 1 * pi) .... -1