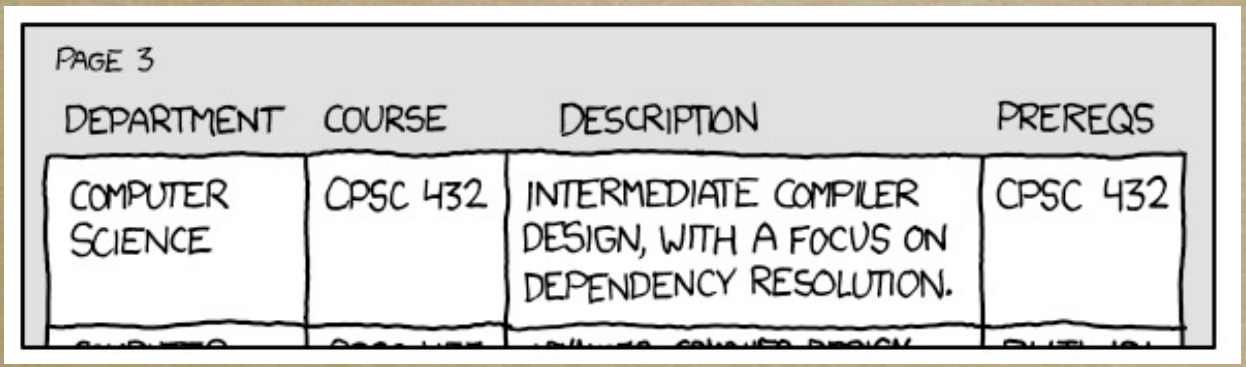
Python

Lecture 9

© Jeff Parker

Fall, 2018



Tonight's outline

Review Homework

Garbage Collection

Object Oriented Programming

Viewing Method invocation with Debugger

Magic Methods

Inheritance

How to approach problem

I’m going to spend class time reviewing the problem

How can you solve this with least amount of effort?

http://www.catb.org/jargon/html/H/hacker.html

hacker: n.

[originally, someone who makes furniture with an axe]

Hacker vs Cracker

http://www.catb.org/~esr/faqs/hacker-howto.html

ESRaymond - How to become a hacker

The Problem

```
    def __init__(self, hour, minute, sec):
        self.hour   = hour
        self.minute = minute
        self.second = sec


def main():
    start = Time(39, 75, 00)
    start.print_time()
```

```
39:75:00
```

Changing display

```
def __str__(self):
    return '%.2d:%.2d:%.2d' %
        (self.hour, self.min, self.sec)
```

Problems

- Print seconds
- Prints leading 0 in 01:23:45
- Need to print AM/PM
- First hour in each half is called 12 rather than zero

Changing display

```
def __str__(self):
    return '%.2d:%.2d' %
        (self.hour, self.minutes)
```

Problems

- ~~Print seconds~~
- Prints leading 0 in 01:23:45
- Need to print AM/PM
- First hour in each half is called 12 rather than zero

Changing display

```
def __str__(self):
    return '%d:%.2d' %
        (self.hour, self.minutes)
```

Problems

- ~~**Print seconds**~~
- ~~Prints leading 0 in 01:23:45~~
- Need to print AM/PM
- First hour in each half is called 12 rather than zero

Changing display

```
if (self.hour >= 12):
    period = 'PM'
else:
    period = 'AM'
```

See different solution in Notebook

Problems

- ~~Print seconds~~
- ~~Prints leading 0 in 01:23:45~~
- ~~**Need to print AM/PM**~~
- First hour in each half is called 12 rather than zero

Changing display

```
adjusted_hour = self.hour % 12
if (adjusted_hour == 0):
    adjusted_hour = 12
```

We cannot mess with hour

Needed to distinguish 1 AM from 1 PM

Problems

- ~~Print seconds~~
- ~~Prints leading 0 in 01:23:45~~
- ~~Need to print AM/PM~~
- ~~**First hour in each half is called 12 rather than zero**~~

Changing display

```
def __str__(self):
    if (self.hour >= 12):
        period = 'PM'
    else:
        period = 'AM'
    adjusted_hour = self.hour % 12
    if (adjusted_hour == 0):
        adjusted_hour = 12
    return '%d:%.2d %s' %
      (adjusted_hour, self.minute, period)
```

Comments

```
def __str__(self):
    # AM or PM? - jdp
    if (self.hour >= 12):
        period = 'PM'
    else:
        period = 'AM'
    # Civilian time - jdp
    adjusted_hour = self.hour % 12
    if (adjusted_hour == 0):
        adjusted_hour = 12
    return '%d:%.2d %s' %
           (adjusted_hour, self.minute, period)
```

Always sign edits in shared code

Clipping Hours

```
    def __init__(self, hour, minute, sec):
        self.hour   = hour
        self.minute = minute
        self.second = sec


def main():
    start = Time(39, 75, 00)
    start.print_time()
```

```
39:75:00
```

Is this a real problem?

Can’t I throw an exception if asked to create an illegal time?

Is this a real problem?

Can’t I throw an exception if asked to create an illegal time?

I start watching a movie at 10:45

When it is over, I wonder what time it is.

Something every clock deals with once a day.

Don’t throw a hissy fit: deal with it

Clipping hours to < 24

What needs to change? What methods are there?

```
def __init__(self, hour=0, minute=0, second=0):
def __str__(self):
def print_time(self):
def time_to_int(self):
def is_after(self, other):
def is_valid(self):
def __add__(self, other):
def __radd__(self, other):
def add_time(self, other):
def increment(self, seconds):
def int_to_time(seconds):
```

Some only report status

Some only report status - Display string, convert to int, compare, Test for validity

```
def __str__(self):
def print_time(self):
def time_to_int(self):
def is_after(self, other):
def is_valid(self):
```

Some only report status

Some only report status - Display string, convert to int, compare,

Test for validity

```
def __str__(self):
def print_time(self):
def time_to_int(self):
def is_after(self, other):
def is_valid(self):  Useful to change this?
```

is_valid()

```
def is_valid(self):
    if self.hour < 0 or self.minute < 0 or
self.second < 0:
        return False
    if self.minute >= 60 or self.sec >= 60:
        return False
    if self.hour >= 24:  # - jdp
        return False
    return True
```

Use is_valid: before

```
def __add__(self, other):
    if isinstance(other, Time):
        return self.add_time(other)
    else:
        return self.increment(other)
```

Use is_valid: after

```
def __add__(self, other):
    assert self.is_valid()
```

When the value passed to assert is False

Throws an error

How to use: after

```
def __add__(self, other):
    assert self.is_valid()
    if isinstance(other, Time):
        assert other.is_valid()
        result = self.add_time(other)
        assert result.is_valid()
        return result
    else:
        ...
```

Scaffolding

```
def __add__(sel
    assert self
    if isinstan
        assert o
        result =
        assert r
        return result
    else:
```

Scaffolding

Useful when working: removed when done

Clipping hours to < 24

The rest change times. *Or do they?*

```
def __init__(self, hour=0, min=0, sec=0):
def __add__(self, other):
def __radd__(self, other):
def add_time(self, other):
def increment(self, seconds):
def int_to_time(seconds):
```

Clipping hours to < 24

__init__() is used by the Time constructor, and must be changed

```
def __init__(self, hour=0, min=0, sec=0):
    self.hour   = hour
    self.minute = minute
    self.second = second
```

Clipping hours to < 24

__init__() is used by the Time constructor, and must be changed

```
def __init__(self, hour=0, min=0, sec=0):
    self.hour   = (hour % 24)   # jdp
    self.minute = minute
    self.second = second
```

Clipping hours to < 24

__init__() is used by the Time constructor, and must be changed

```
def __init__(self, hour=0, min=0, sec=0):
    self.hour   = (hour % 24)   # jdp
    self.minute = minute
    self.second = second
```

Does this fix the problem of 75 minutes?

Clipping hours to < 24

__init__() is used by the Time constructor, and must be changed

```
def __init__(self, hour=0, min=0, sec=0):
    self.hour   = (hour % 24)   # jdp
    self.minute = (minute % 60)
    self.second = (second % 60)
```

We could also decide to carry extras over

See divmod() in int_to_time()

divmod()

```
def int_to_time(seconds):
    """Makes a new Time object.
    seconds: int seconds since midnight.
    """
    minutes, second = divmod(seconds, 60)
    hour, minute = divmod(minutes, 60)
    return Time(hour, minute, second)
```

Clipping hours to < 24

```
def __init__(self, hour=0, min=0, sec=0):
```

The remaining methods change times. *Or do they?*

Take each in turn

```
def __add__(self, other):
def __radd__(self, other):
def add_time(self, other):
def increment(self, seconds):
def int_to_time(seconds):
```

Clipping hours to < 24

```
def __add__(self, other):
    if isinstance(other, Time):
        return self.add_time(other)
    else:
        return self.increment(other)

def __radd__(self, other):
def add_time(self, other):
def increment(self, seconds):
def int_to_time(seconds):
```

Clipping hours to < 24

```
def __radd__(self, other):
    """Adds two Time objects or a Time
object and a number."""
    return self.__add__(other)

def add_time(self, other):
def increment(self, seconds):
def int_to_time(seconds):
```

Clipping hours to < 24

```
def add_time(self, other):
    """Adds two time objects."""
    seconds = self.time_to_int() +
        other.time_to_int()
    return int_to_time(seconds)

def increment(self, seconds):
def int_to_time(seconds):
```

Clipping hours to < 24

```
def increment(self, seconds):
    """Returns a new Time..."""
    seconds += self.time_to_int()
    return int_to_time(seconds)

def int_to_time(seconds):
```

Clipping hours to < 24

```
def int_to_time(seconds):
    """Makes a new Time object.
    seconds: int seconds since midnight.
    """
    minutes, second = divmod(seconds, 60)
    hour, minute = divmod(minutes, 60)
    return Time(hour, minute, second)
```

Changes

If Increment had updated an existing time, we would have had to fix something

But none of these routines change the time:

they create a new Time Object

We have fixed the initialization of new Time

Initialization

```
def __init__(self, hour=0, min=0, sec=0):
    self.hour   = (hour % 24)
    self.minute = (minute % 60)
    self.second = (second % 60)
```

Testing

```
# Testing
print(Time(0, 0, 0))
print(Time(0, 1, 2))
print(Time(11, 30, 59))
print(Time(12, 0, 3))
print(Time(23, 2, 2))
print()
print(Time(25, 45, 00))
```

Test increment

```
start = Time(9, 45, 00)
start.print_time()

# Test Increment
# 24 x 60 x 60 = 86,400
end = start.increment(86500)
assert end.is_valid()
print(end)
```

Tonight's outline

Review Homework

Garbage Collection

Object Oriented Programming

Viewing Method invocation with Debugger

Magic Methods

Inheritance

Dynamic Memory

Dynamic Memory - Challenge in programming in C or C++

- Programmer must allocate and free memory
  - Too few frees lead to Memory Leaks
  - Too many frees lead to miss access

```
void f(int n) {
   int* array = calloc(n, sizeof(int));
   do_some_work(array);
   free(array);
}
```

Dynamic Memory

It is easy to loose track of memory

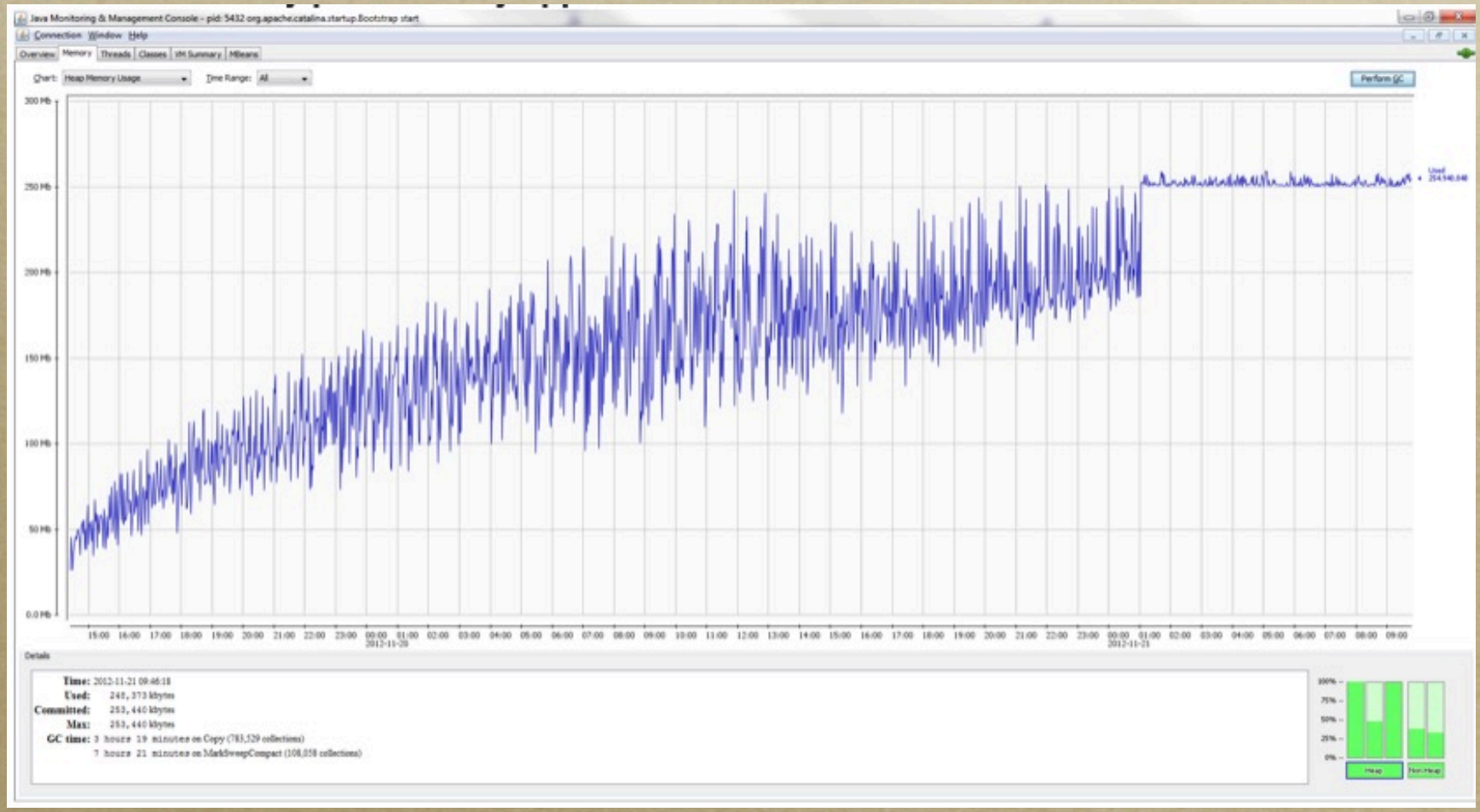
What if there was an exception in do_some_work?

Those lost blocks are Garbage

```
void f(int n) {
   int* array = calloc(n, sizeof(int));
   do_some_work(array);
   free(array);
}
```

Dynamic Memory

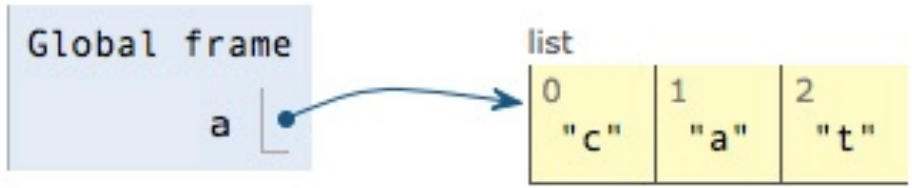
https://stackoverflow.com/questions/13483796/memory-leak-in-a-java-web-application



Python Tutor

Python 3.6

```
1  a = ['c', 'a', 't']
2  b = a
3
4  a = ['d', 'o', 'g']
```



Python 3.6

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1  a = ['c', 'a', 't']
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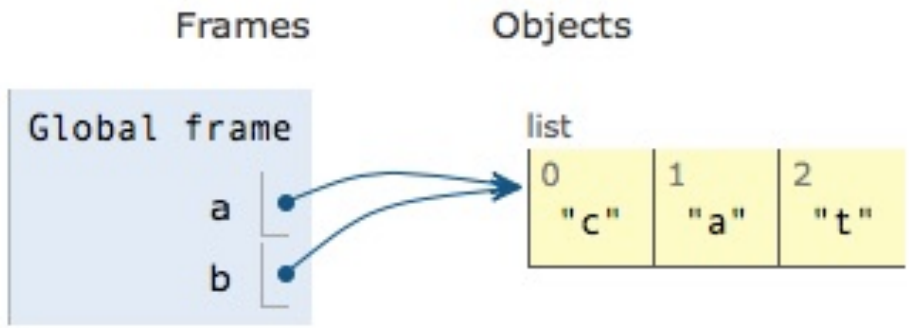
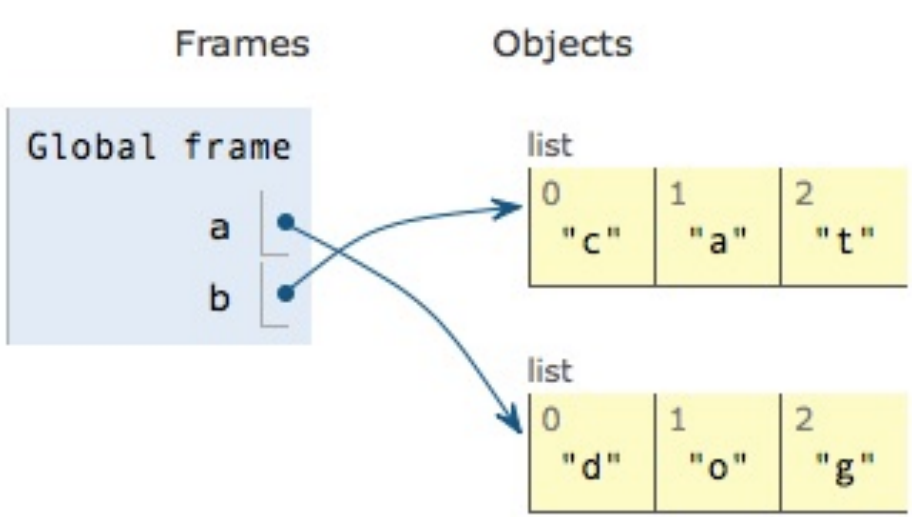


Python 3.6

```
1  a = ['c', 'a', 't']
2  b = a
3
4  a = ['d', 'o', 'g']
```

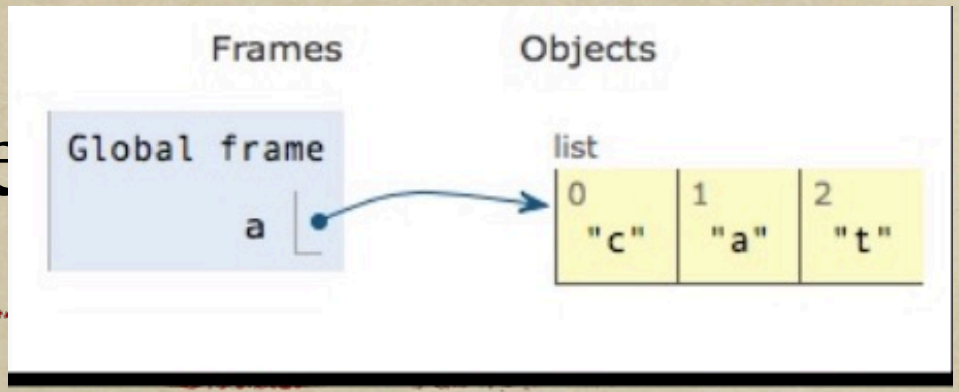
Edit this code

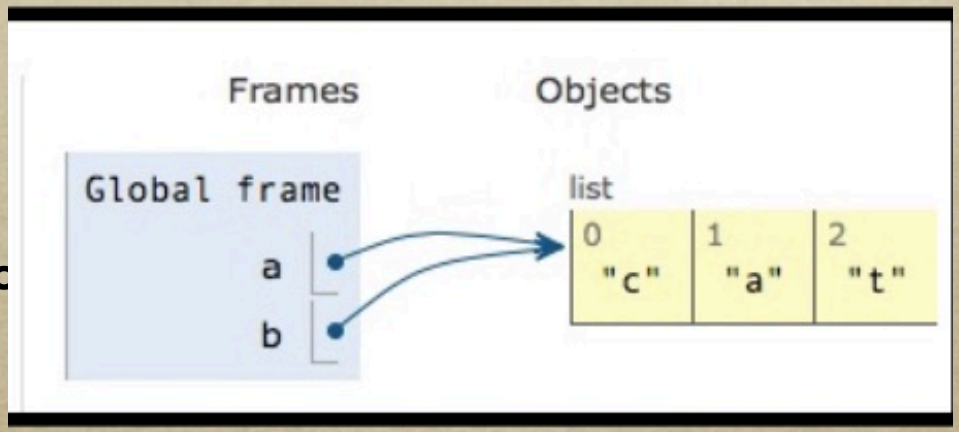
cuted

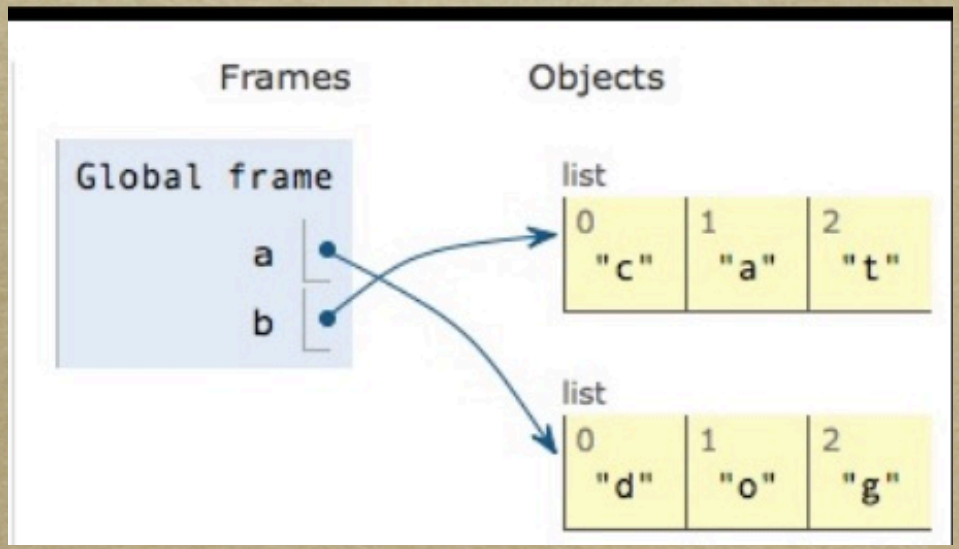


Reference

```
>>> import sys
>>> a = list('cat')
>>> print(sys.getrefcount(a))
2                # There is an extra co
>>> b = a
>>> print(sys.getrefcount(a))
3
>>> a = list('dog')
>>> print(sys.getrefcount(b))
2
```

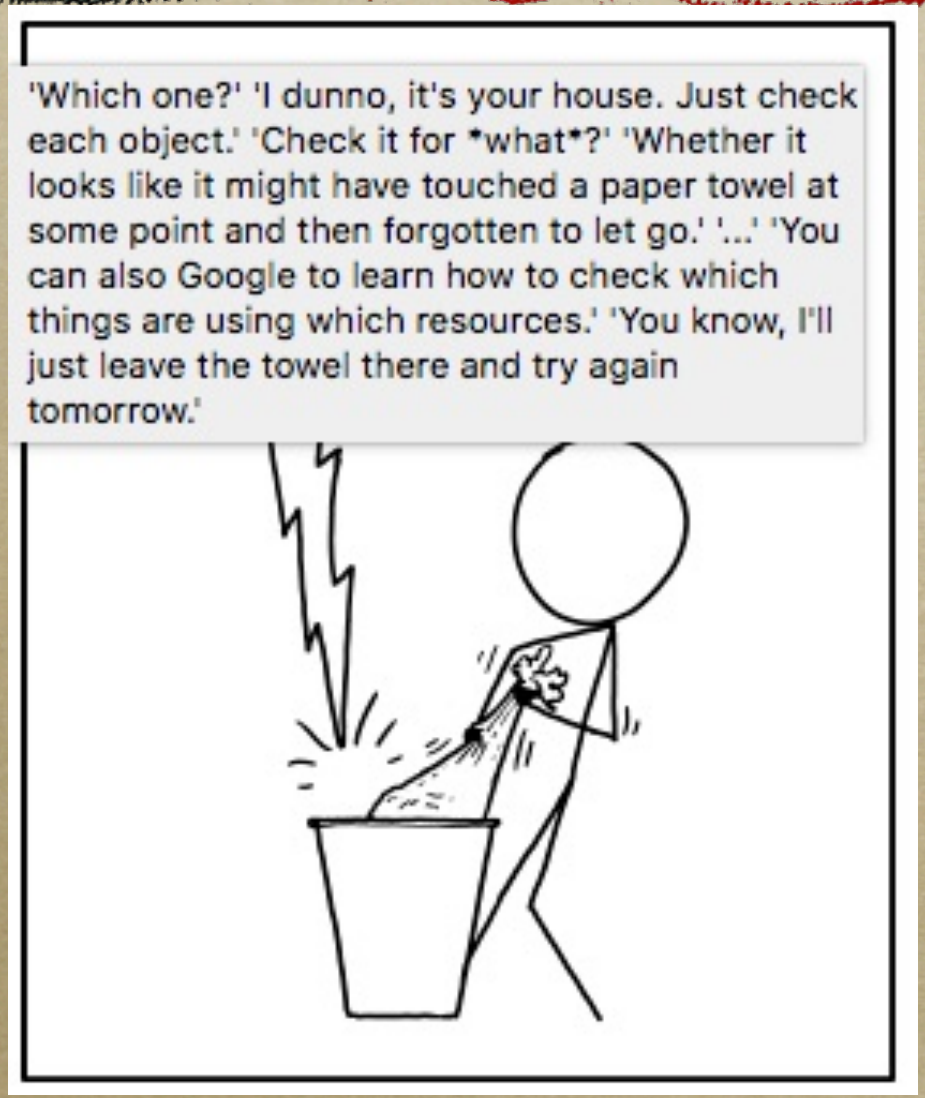






Garbage Collection

Garbage Collection



Real Time Systems

Real Time Systems need to respond in a fixed time

Your power steering must respond in real time

Garbage Collection was time consuming

Real Time Systems avoided languages with GC

Modern GC is faster, but more memory also helps

Tonight's outline

Review Homework

Garbage Collection

Object Oriented Programming

Viewing Method invocation with Debugger

Magic Methods

Inheritance

OO Goals

Encapsulation: Split Interface from Implementation

You should be able to change how we implement a Dictionary

If we preserve Interface, old programs still work

Protect the Implementation from poorly-written programs

Inherit functionality from superclass

Tonight's outline

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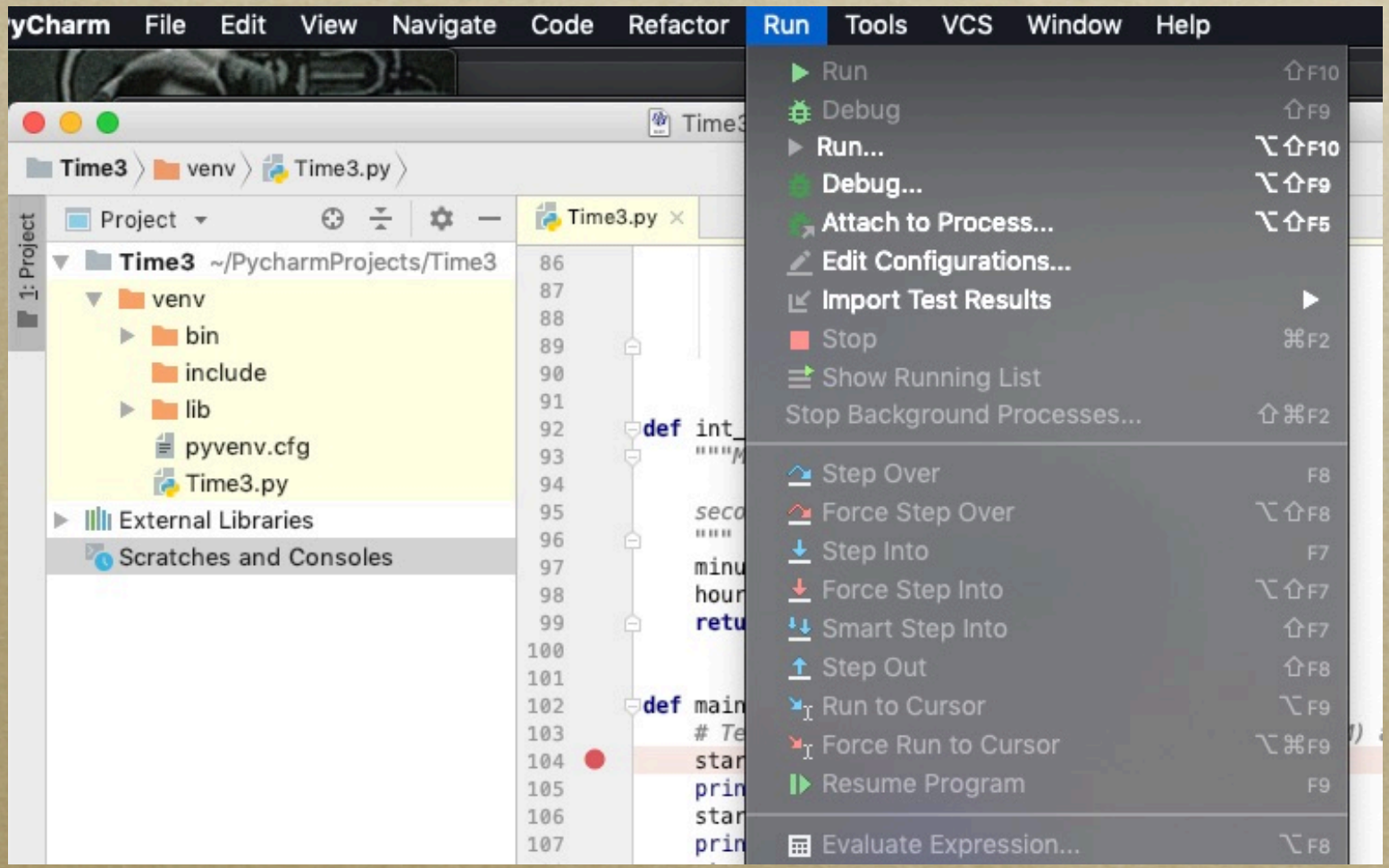
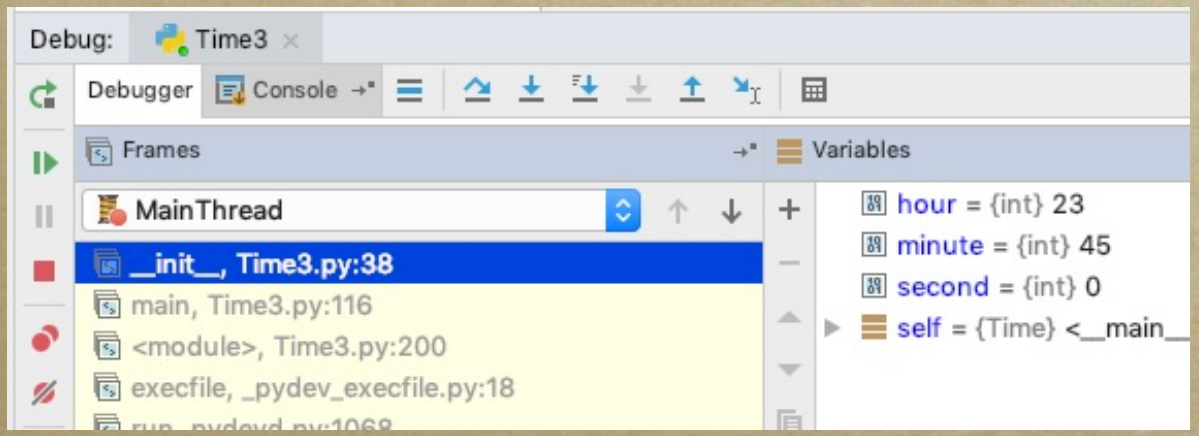
Debugger


yCharm File Edit View Navigate Code Refactor Run Tools VCS Window Help
Time3 venv Time3.py
Project
Time3 ~/PycharmProjects/Time3
venv
bin
include
lib
pyvenv.cfg
Time3.py
External Libraries
Scratches and Consoles
Time3.py
1: Project
Run ⇧F10
Debug ⇧F9
Run... ⌥⇧F10
Debug... ⌥⇧F9
Attach to Process... ⌥⇧F5
Edit Configurations...
Import Test Results
Stop ⌘F2
Show Running List
Stop Background Processes... ⇧⌘F2
Step Over F8
Force Step Over ⌥⇧F8
Step Into F7
Force Step Into ⌥⇧F7
Smart Step Into ⇧F7
Step Out ⇧F8
Run to Cursor ⌥F9
Force Run to Cursor ⌥⌘F9
Resume Program F9
Evaluate Expression... ⌥F8

__init__

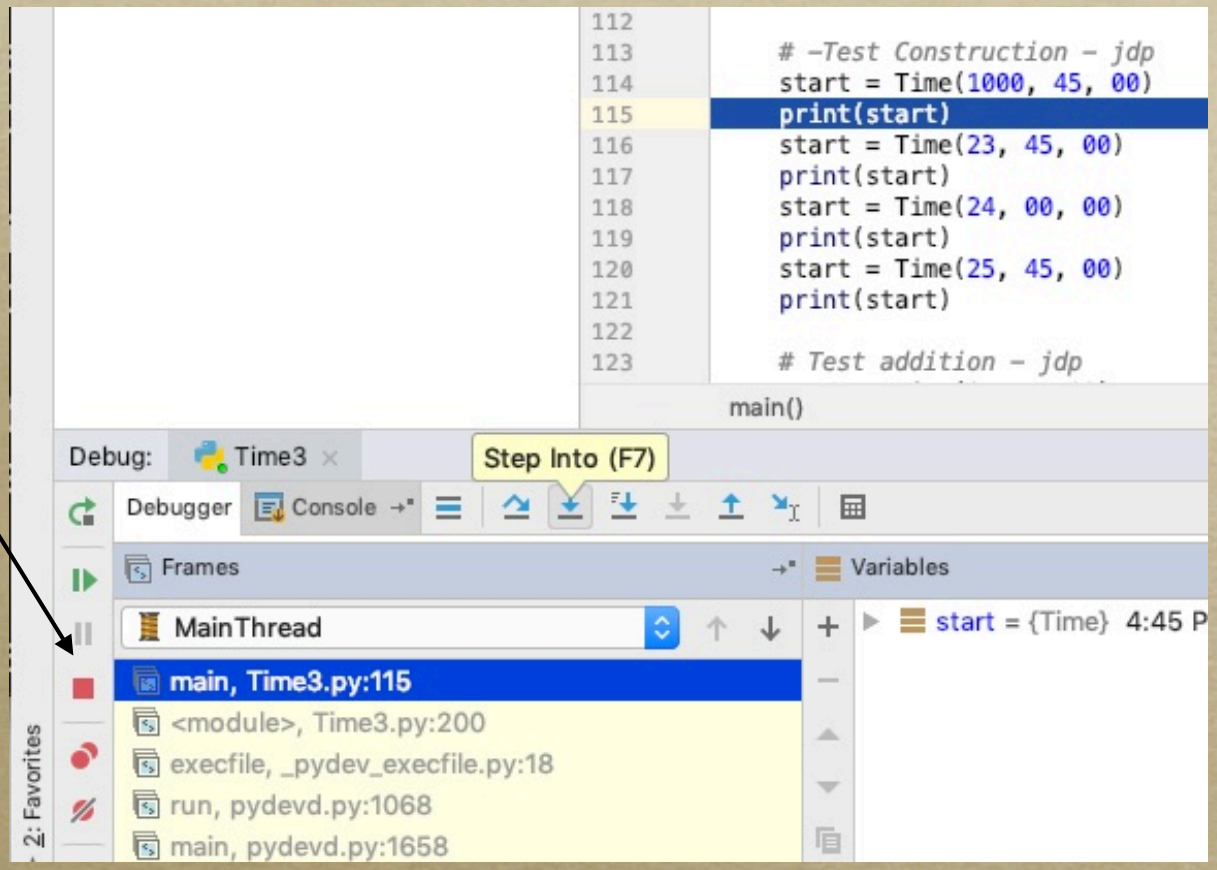
```
36
37      def __init__(self, hour=0, minute=0, second=0):  self: <__main__.Time object at 0x
38          self.hour = (hour % 24)
39          self.minute = minute
40          self.second = second
41
```




```
start = Time(23, 45)
```

Execution

Stack



Who called __str__?

```
17
18  class Time(object):
19      """Represents the time of day.
20
21      attributes: hour, minute, second
22      """
23
24      def __str__(self):  self:  4:45 PM
25          # Morning or night - jdp
26          # AM or PM?
27          if (self.hour >= 12):
28              period = 'PM'
29          else:
30              period = 'AM'
31          # Civilian time - jdp
32          adjusted_hour = self.hour % 12
33          if (adjusted_hour == 0):
34              adjusted_hour = 12
35          return '%2d:%.2d %s' % (adjusted_hour, self.minute, period)
```

Who called __str__?

```
17
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29          else:
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31          # Civilian time - jdp
32          adjusted_hour = self.hour % 12
33          if (adjusted_hour == 0):
34              adjusted_hour = 12
35          return '%2d:%.2d %s' % (adjusted_hour, self.minute, period)
```
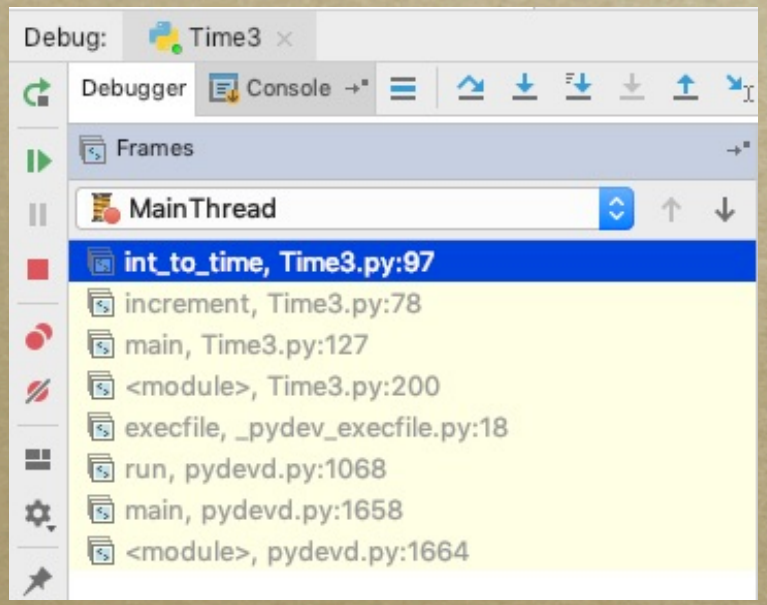

Caller

```
102  def main():
103      # Test printing.  Key difficulty is midnigh
104      start = Time(0, 45, 00)  start: 12:45 AM
105      print(start)
106      start = Time(11, 45, 00)
107      print(start)
```

Int2Time

```
91
92      def int_to_time(seconds):  seconds: 36437
93          """Makes a new Time object.
94
95          seconds: int seconds since midnight.
96          """
97          minutes, second = divmod(seconds, 60)
98          hour, minute = divmod(minutes, 60)
99          return Time(hour, minute, second)
100
101
```



Testing

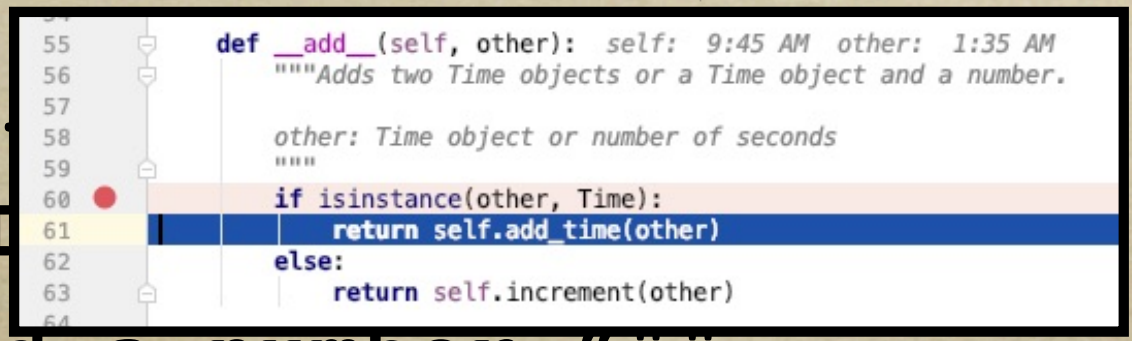
```
start = Time(9, 45)
duration = Time(23, 35)
print(start + duration)
```

Testing

```
def __add__(self, other):
  """Adds two Time objects or a
Time object and a number."""

  if isinstance(other, Time):
    return self.add_time(other)
  else:
    return self.increment(other)
```

Testing

```
def __add__(se
  """Adds two T
Time object and a number."""

  if isinstance(other, Time):
    return self.add_time(other)
  else:
    return self.increment(other)
```



Testing

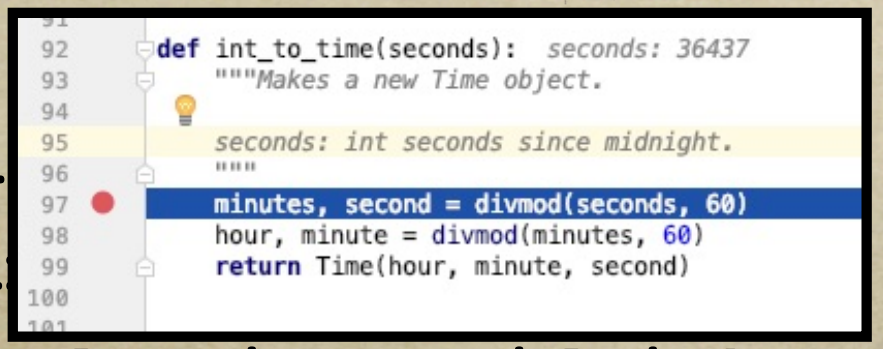
```
def add_time(self, other):
    """Adds two time objects."""
    assert self.is_valid() and
      other.is_valid()
    seconds = self.time_to_int() +
      other.time_to_int()
    return int_to_time(seconds)
```

int_to_time

```
def int_to_time(seconds):
    """Makes a new Time object.
    seconds: int seconds since midnight.
    """
    minutes, second = divmod(seconds, 60)
    hour, minute = divmod(minutes, 60)
    return Time(hour, minute, second)
```

int_to_time

```
def int_to_time(secon
    """Makes a new Ti
    seconds: int seconds since midnight.
    """
    minutes, second = divmod(seconds, 60)
    hour, minute = divmod(minutes, 60)
    return Time(hour, minute, second)
```



Tonight's outline

Review Homework

Garbage Collection

Object Oriented Programming

Viewing Method invocation with Debugger

Magic Methods

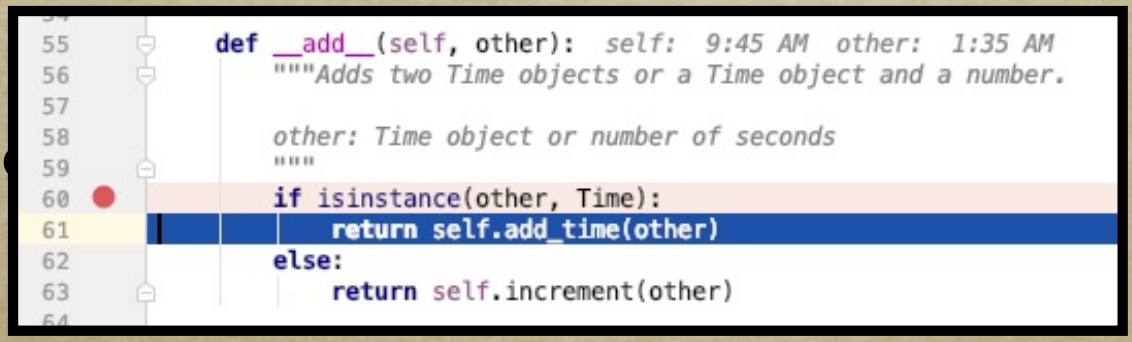
Inheritance

Magic Methods

```
def __add__(self, other):
    if isinstance(other, Time):
        return self.add_time(other)
    else:
        return self.increment(other)


start = Time(9, 45)
duration = Time(1, 35)
print(start + duration)
print(start + 1337)
```

Magic Methods

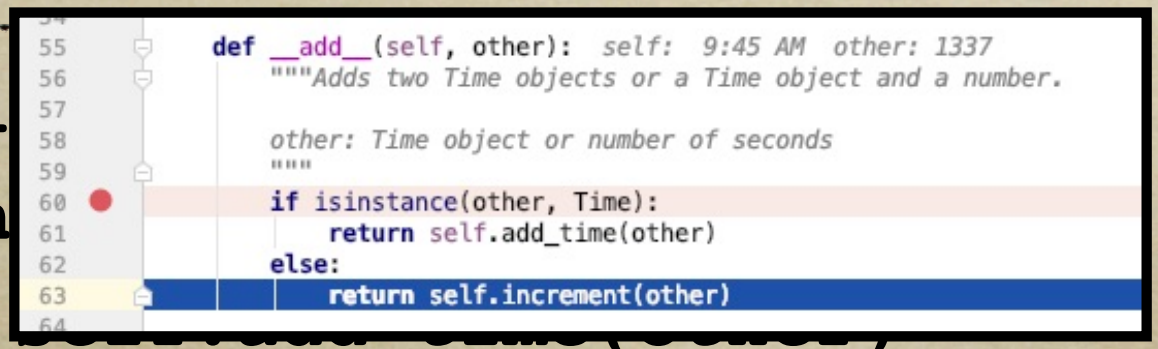
```
def __add__(self, other):
    if isinstance(other, Time):
        return self.add_time(other)
    else:
        return s
```




```
start = Time(9, 45)
duration = Time(1, 35)
print(start + duration)
print(start + 1337)
```

Magic Methods

```
def __add__(sel
    if isinstan
        return
    else:
        return self.increment(other)
```




```
start = Time(9, 45)
duration = Time(1, 35)
print(start + duration)
print(start + 1337)
```

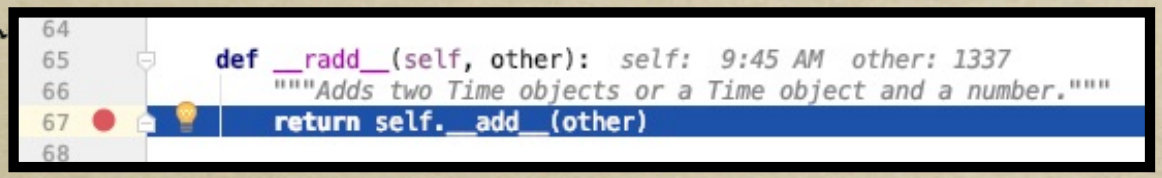
Magic Methods

```
def __add__(self, other):
    if isinstance(other, Time):
        return self.add_time(other)
    else:
        return self.increment(other)


start = Time(9, 45)
...
print(start + 1337)
print(1337 + start) # How do we resolve?
```

Magic Methods

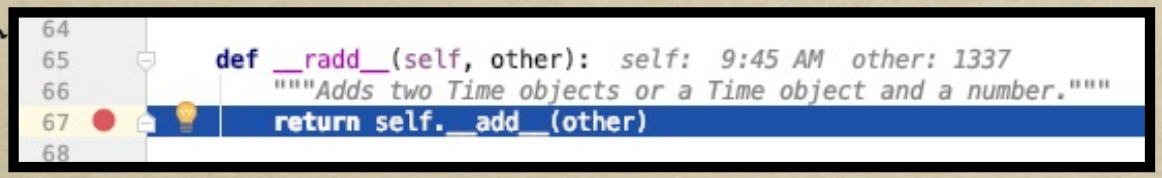
```
def __add__(self, other):
    if isinstance(other, Time):
        return self.add_time(other)
    else:
        return self.increment(other)

start = Time(9, 45)
...
print(start + 1337)
print(1337 + start) # int.__add__(Time)
```

Magic Methods

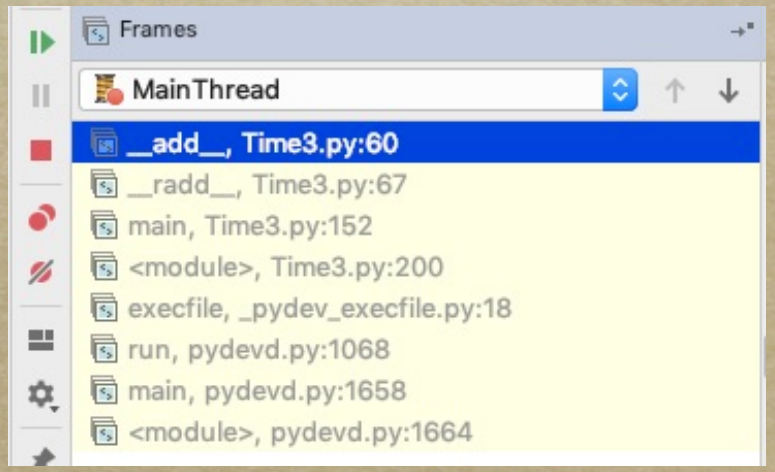



```
def __radd__(self, other):
    return self.__add__(other)


start = Time(9, 45)
...
print(start + 1337)
print(1337 + start)
```

Magic Methods

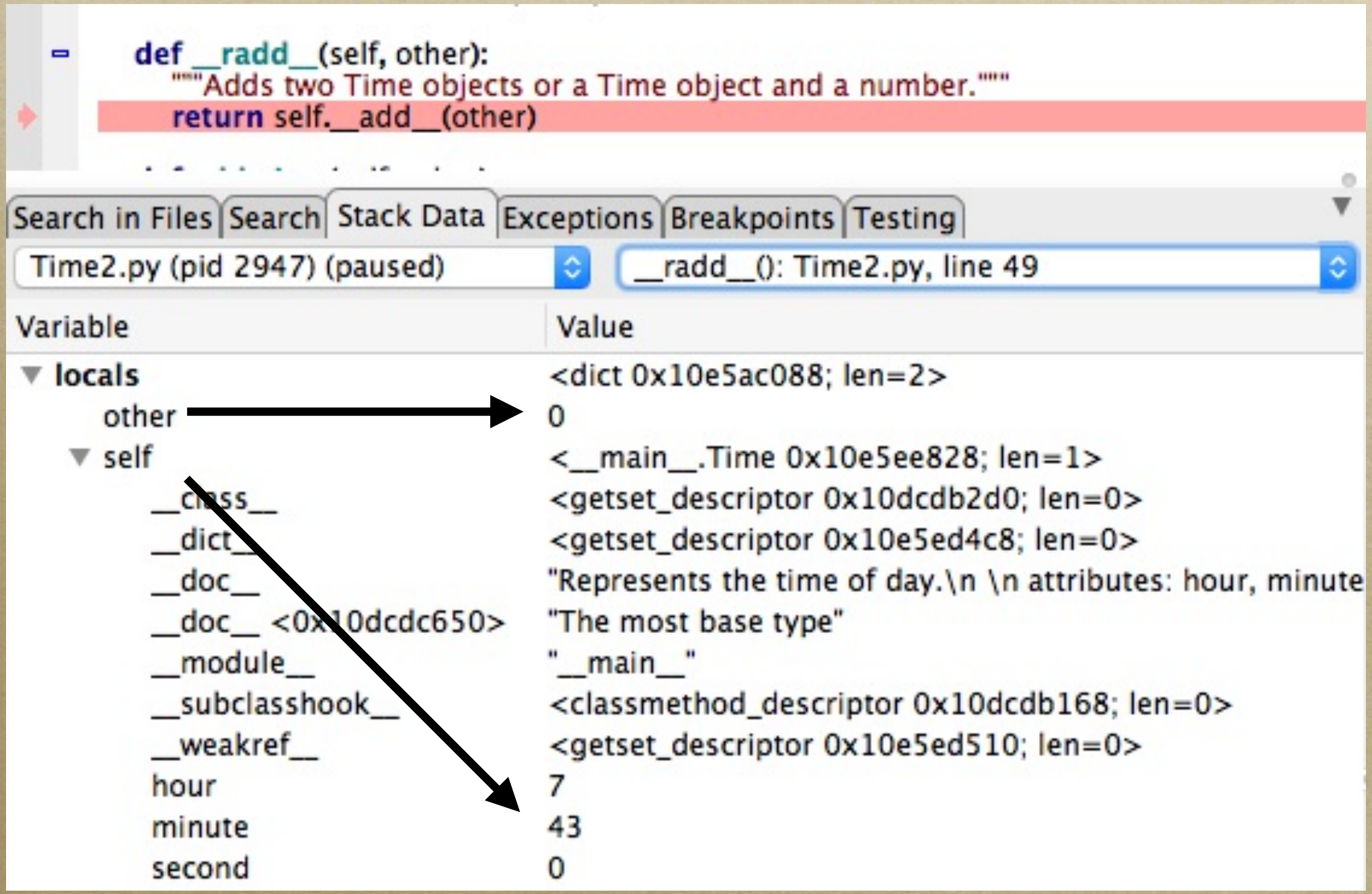


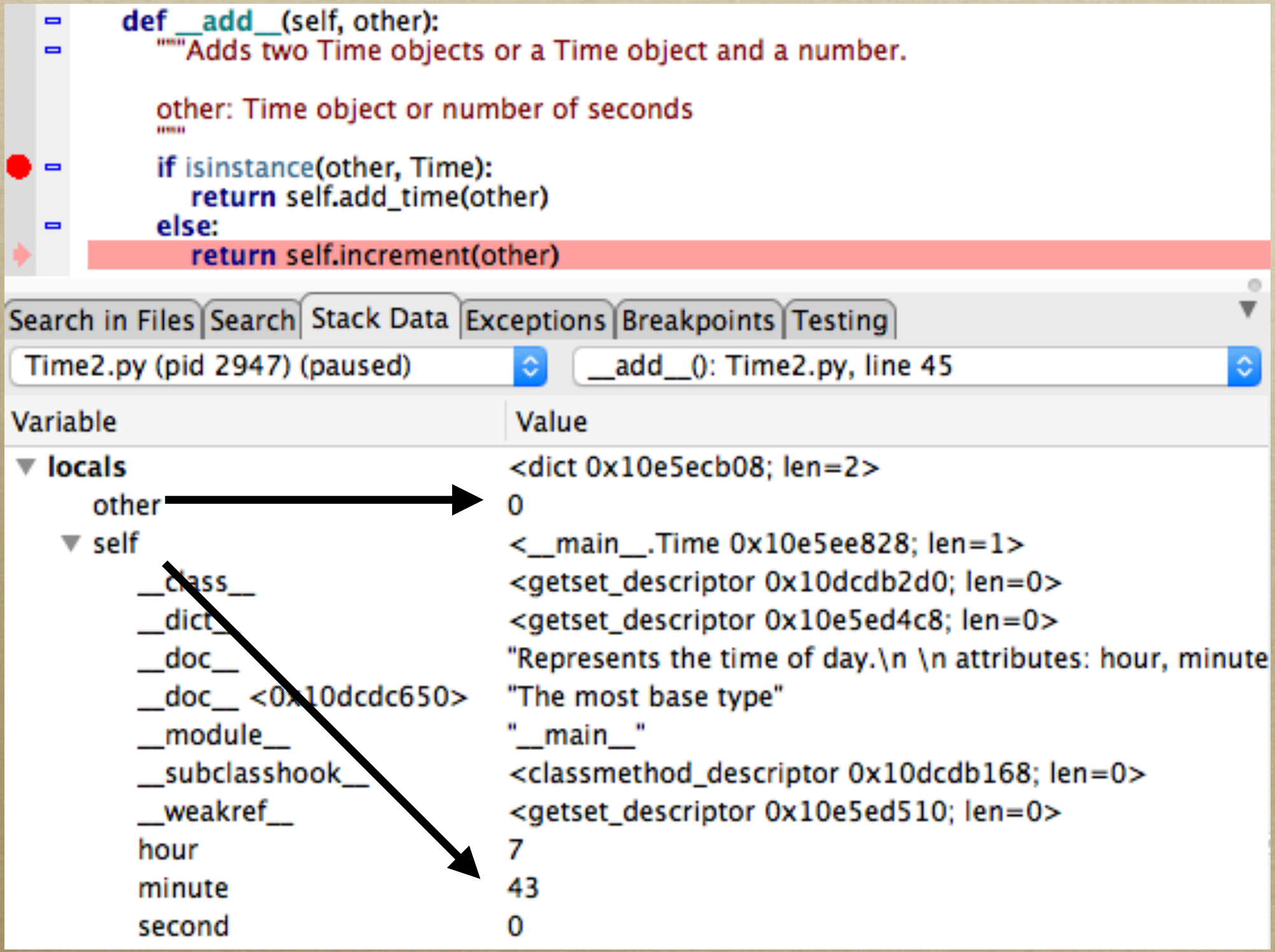

```
def __radd__(self, other):
    return self.__add__(other)


start = Time(9, 45)
...
print(start + 1337)
print(1337 + start)
```



Sum

```
print('Example of polymorphism')
t1 = Time(7, 43)
t2 = Time(7, 41)
t3 = Time(7, 37)
total = sum([t1, t2, t3])
print(total)
```


def __radd__(self, other):
"""Adds two Time objects or a Time object and a number."""
return self.__add__(other)
Search in Files
Search
Stack Data
Exceptions
Breakpoints
Testing
Time2.py (pid 2947) (paused)
__radd__(): Time2.py, line 49
Variable
Value
locals
<dict 0x10e5ac088; len=2>
other
0
self
<__main__.Time 0x10e5ee828; len=1>
__class__
<getset_descriptor 0x10dcdb2d0; len=0>
__dict__
<getset_descriptor 0x10e5ed4c8; len=0>
__doc__
"Represents the time of day.\n \n attributes: hour, minute
__doc__ <0x10dcdc650>
"The most base type"
__module__
"__main__"
__subclasshook__
<classmethod_descriptor 0x10dcdb168; len=0>
__weakref__
<getset_descriptor 0x10e5ed510; len=0>
hour
7
minute
43
second
0


def __add__(self, other):
"""Adds two Time objects or a Time object and a number.
other: Time object or number of seconds
"""
if isinstance(other, Time):
return self.add_time(other)
else:
return self.increment(other)
Search in Files
Search
Stack Data
Exceptions
Breakpoints
Testing
Time2.py (pid 2947) (paused)
__add__(): Time2.py, line 45
Variable
Value
locals
<dict 0x10e5ecb08; len=2>
other
0
self
<__main__.Time 0x10e5ee828; len=1>
__class__
<getset_descriptor 0x10dcdb2d0; len=0>
__dict__
<getset_descriptor 0x10e5ed4c8; len=0>
__doc__
"Represents the time of day.\n \n attributes: hour, minute
__doc__ <0x10dcdc650>
"The most base type"
__module__
"__main__"
__subclasshook__
<classmethod_descriptor 0x10dcdb168; len=0>
__weakref__
<getset_descriptor 0x10e5ed510; len=0>
hour
7
minute
43
second
0

```
def __add__(self, other):
    """Adds two Time objects or a Time object and a number.

    other: Time object or number of seconds
    """
    if isinstance(other, Time):
        return self.add_time(other)
    else:
        return self.increment(other)
```

Search in Files | Search | Stack Data | Exceptions | Breakpoints | Testing

Time2.py (pid 2947) (paused) | __add__(): Time2.py, line 43

Variable	Value
▼ locals	<dict 0x10e608648; len=2>
▼ other	<__main__.Time 0x10e5ee908; len=1>
__class__	<getset_descriptor 0x10dcdb2d0; len=0>
__dict__	<getset_descriptor 0x10e5ed4c8; len=0>
__doc__	"Represents the time of day.\n \n attributes: hour, minu
__doc__ <0x10dcdc650>	"The most base type"
__module__	"__main__"
__subclasshook__	<classmethod_descriptor 0x10dcdb168; len=0>
__weakref__	<getset_descriptor 0x10e5ed510; len=0>
hour	7
minute	41
second	0
▼ self	<__main__.Time 0x10e5eeb38; len=1>
__class__	<getset_descriptor 0x10dcdb2d0; len=0>
__dict__	<getset_descriptor 0x10e5ed4c8; len=0>
__doc__	"Represents the time of day.\n \n attributes: hour, minu
__doc__ <0x10dcdc650>	"The most base type"
__module__	"__main__"
__subclasshook__	<classmethod_descriptor 0x10dcdb168; len=0>
__weakref__	<getset_descriptor 0x10e5ed510; len=0>
hour	7
minute	43
second	0

```
total = sum
```

```
def __add__(self, other):
    """Adds two Time objects or a Time object and a number.

    other: Time object or number of seconds
    """
    if isinstance(other, Time):
        return self.add_time(other)
    else:
        return self.increment(other)
```

Search in Files | Search | Stack Data | Exceptions | Breakpoints | Testing

Time2.py (pid 2947) (paused) | __add__(): Time2.py, line 43

Variable	Value
▼ locals	<dict 0x10e605888; len=2>
▼ other	<__main__.Time 0x10e5ee860; len=1>
__class__	<getset_descriptor 0x10dcdb2d0; len=0>
__dict__	<getset_descriptor 0x10e5ed4c8; len=0>
__doc__	"Represents the time of day.\n \n attributes: hour, minu
__doc__ <0x10dcdc650>	"The most base type"
__module__	"__main__"
__subclasshook__	<classmethod_descriptor 0x10dcdb168; len=0>
__weakref__	<getset_descriptor 0x10e5ed510; len=0>
hour	7
minute	37
second	0
▼ self	<__main__.Time 0x10e5ee978; len=1>
__class__	<getset_descriptor 0x10dcdb2d0; len=0>
__dict__	<getset_descriptor 0x10e5ed4c8; len=0>
__doc__	"Represents the time of day.\n \n attributes: hour, minu
__doc__ <0x10dcdc650>	"The most base type"
__module__	"__main__"
__subclasshook__	<classmethod_descriptor 0x10dcdb168; len=0>
__weakref__	<getset_descriptor 0x10e5ed510; len=0>
hour	15
minute	24
second	0

total = sum