Descriptor HowTo Guide

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1 Abstract

Defines descriptors, summarizes the protocol, and shows how descriptors are called. Examines a custom descriptor and several built-in Python descriptors including functions, properties, static methods, and class methods. Shows how each works by giving a pure Python equivalent and a sample application.

Learning about descriptors not only provides access to a larger toolset, it creates a deeper understanding of how Python works and an appreciation for the elegance of its design.

2 Definition and Introduction

In general, a descriptor is an object attribute with "binding behavior", one whose attribute access has been overridden by methods in the descriptor protocol. Those methods are `__get__()`, `__set__()`, and `__delete__()`. If any of those methods are defined for an object, it is said to be a descriptor.

The default behavior for attribute access is to get, set, or delete the attribute from an object's dictionary. For instance, `a.x` has a lookup chain starting with `a.__dict__['x']`, then `type(a).__dict__['x']`, and continuing through the base classes of `type(a)` excluding metaclasses. If the looked-up value is an object defining one of the descriptor methods, then Python may override the default behavior and invoke the descriptor method instead. Where this occurs in the precedence chain depends on which descriptor methods were defined.

Descriptors are a powerful, general purpose protocol. They are the mechanism behind properties, methods, static methods, class methods, and `super()`. They are used throughout Python itself to implement the new style classes introduced in version 2.2. Descriptors simplify the underlying C-code and offer a flexible set of new tools for everyday Python programs.

3 Descriptor Protocol

`descr.__get__(self, obj, type=None) -> value`

`descr.__set__(self, obj, value) -> None`

`descr.__delete__(self, obj) -> None`

That is all there is to it. Define any of these methods and an object is considered a descriptor and can override default behavior upon being looked up as an attribute.

If an object defines `__set__()` or `__delete__()`, it is considered a data descriptor. Descriptors that only define `__get__()` are called non-data descriptors (they are typically used for methods but other uses are possible).

Data and non-data descriptors differ in how overrides are calculated with respect to entries in an instance's dictionary. If an instance's dictionary has an entry with the same name as a data descriptor, the data descriptor takes precedence. If an instance's dictionary has an entry with the same name as a non-data descriptor, the dictionary entry takes precedence.

To make a read-only data descriptor, define both `__get__()` and `__set__()` with the `__set__()` raising an `AttributeError` when called. Defining the `__set__()` method with an exception raising placeholder is enough to make it a data descriptor.

4 Invoking Descriptors

A descriptor can be called directly by its method name. For example, `d.__get__(obj)`.

Alternatively, it is more common for a descriptor to be invoked automatically upon attribute access. For example, `obj.d` looks up `d` in the dictionary of `obj`. If `d` defines the method `__get__()`, then `d.__get__(obj)` is invoked according to the precedence rules listed below.

The details of invocation depend on whether `obj` is an object or a class.

For objects, the machinery is in `object.__getattribute__()` which transforms `b.x` into `type(b).__dict__['x'].__get__(b, type(b))`. The implementation works through a precedence chain that gives data descriptors priority over instance variables, instance variables priority over non-data descriptors, and assigns lowest priority to `__getattr__()` if provided. The full C implementation can be found in `PyObject_GenericGetAttr()` in Objects/object.c.

For classes, the machinery is in `type.__getattribute__()` which transforms `B.x` into `B.__dict__['x'].__get__(None, B)`. In pure Python, it looks like:

```
def __getattribute__(self, key):
    "Emulate type_getattro() in Objects/typeobject.c"
    v = object.__getattribute__(self, key)
    if hasattr(v, '__get__'):
        return v.__get__(None, self)
    return v
```

The important points to remember are:

- descriptors are invoked by the `__getattribute__()` method
- overriding `__getattribute__()` prevents automatic descriptor calls
- `object.__getattribute__()` and `type.__getattribute__()` make different calls to `__get__()`.
- data descriptors always override instance dictionaries.
- non-data descriptors may be overridden by instance dictionaries.

The object returned by `super()` also has a custom `__getattribute__()` method for invoking descriptors. The attribute lookup `super(B, obj).m` searches `obj.__class__.__mro__` for the base class `A` immediately following `B` and then returns `A.__dict__['m'].__get__(obj, B)`. If not a descriptor, `m` is returned unchanged. If not in the dictionary, `m` reverts to a search using `object.__getattribute__()`.

The implementation details are in `super_getattro()` in Objects/typeobject.c. and a pure Python equivalent can be found in Guido's Tutorial.

The details above show that the mechanism for descriptors is embedded in the `__getattribute__()` methods for `object`, `type`, and `super()`. Classes inherit this machinery when they derive from `object` or if they have a meta-class providing similar functionality. Likewise, classes can turn-off descriptor invocation by overriding `__getattribute__()`.

5 Descriptor Example

The following code creates a class whose objects are data descriptors which print a message for each get or set. Overriding `__getattribute__()` is alternate approach that could do this for every attribute. However, this descriptor is useful for monitoring just a few chosen attributes:

```
class RevealAccess(object):
    """A data descriptor that sets and returns values
       normally and prints a message logging their access.
    """
```

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```
    def __init__(self, initval=None, name='var'):
        self.val = initval
        self.name = name

    def __get__(self, obj, objtype):
        print('Retrieving', self.name)
        return self.val

    def __set__(self, obj, val):
        print('Updating', self.name)
        self.val = val

>>> class MyClass(object):
...     x = RevealAccess(10, 'var "x"')
...     y = 5
...
>>> m = MyClass()
>>> m.x
Retrieving var "x"
10
>>> m.x = 20
Updating var "x"
>>> m.x
Retrieving var "x"
20
>>> m.y
5
```

The protocol is simple and offers exciting possibilities. Several use cases are so common that they have been packaged into individual function calls. Properties, bound methods, static methods, and class methods are all based on the descriptor protocol.

6 Properties

Calling `property()` is a succinct way of building a data descriptor that triggers function calls upon access to an attribute. Its signature is:

```
property(fget=None, fset=None, fdel=None, doc=None) -> property attribute
```

The documentation shows a typical use to define a managed attribute `x`:

```
class C(object):
    def getx(self): return self.__x
    def setx(self, value): self.__x = value
    def delx(self): del self.__x
    x = property(getx, setx, delx, "I'm the 'x' property.")
```

To see how `property()` is implemented in terms of the descriptor protocol, here is a pure Python equivalent:

```
class Property(object):
    "Emulate PyProperty_Type() in Objects/descrobject.c"

    def __init__(self, fget=None, fset=None, fdel=None, doc=None):
        self.fget = fget
        self.fset = fset
        self.fdel = fdel
        if doc is None and fget is not None:
```

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```
            doc = fget.__doc__
        self.__doc__ = doc

    def __get__(self, obj, objtype=None):
        if obj is None:
            return self
        if self.fget is None:
            raise AttributeError("unreadable attribute")
        return self.fget(obj)

    def __set__(self, obj, value):
        if self.fset is None:
            raise AttributeError("can't set attribute")
        self.fset(obj, value)

    def __delete__(self, obj):
        if self.fdel is None:
            raise AttributeError("can't delete attribute")
        self.fdel(obj)

    def getter(self, fget):
        return type(self)(fget, self.fset, self.fdel, self.__doc__)

    def setter(self, fset):
        return type(self)(self.fget, fset, self.fdel, self.__doc__)

    def deleter(self, fdel):
        return type(self)(self.fget, self.fset, fdel, self.__doc__)
```

The `property()` builtin helps whenever a user interface has granted attribute access and then subsequent changes require the intervention of a method.

For instance, a spreadsheet class may grant access to a cell value through `Cell('b10').value`. Subsequent improvements to the program require the cell to be recalculated on every access; however, the programmer does not want to affect existing client code accessing the attribute directly. The solution is to wrap access to the value attribute in a property data descriptor:

```
class Cell(object):
    . . .
    def getvalue(self):
        "Recalculate the cell before returning value"
        self.recalc()
        return self._value
    value = property(getvalue)
```

7 Functions and Methods

Python's object oriented features are built upon a function based environment. Using non-data descriptors, the two are merged seamlessly.

Class dictionaries store methods as functions. In a class definition, methods are written using `def` or `lambda`, the usual tools for creating functions. Methods only differ from regular functions in that the first argument is reserved for the object instance. By Python convention, the instance reference is called *self* but may be called *this* or any other variable name.

To support method calls, functions include the `__get__()` method for binding methods during attribute access. This means that all functions are non-data descriptors which return bound methods when they are invoked from an object. In pure Python, it works like this:

```
class Function(object):
    . . .
    def __get__(self, obj, objtype=None):
        "Simulate func_descr_get() in Objects/funcobject.c"
        if obj is None:
            return self
        return types.MethodType(self, obj)
```

Running the interpreter shows how the function descriptor works in practice:

```
>>> class D(object):
...     def f(self, x):
...         return x
...
>>> d = D()

# Access through the class dictionary does not invoke __get__.
# It just returns the underlying function object.
>>> D.__dict__['f']
<function D.f at 0x00C45070>

# Dotted access from a class calls __get__() which just returns
# the underlying function unchanged.
>>> D.f
<function D.f at 0x00C45070>

# The function has a __qualname__ attribute to support introspection
>>> D.f.__qualname__
'D.f'

# Dotted access from an instance calls __get__() which returns the
# function wrapped in a bound method object
>>> d.f
<bound method D.f of <__main__.D object at 0x00B18C90>>

# Internally, the bound method stores the underlying function,
# the bound instance, and the class of the bound instance.
>>> d.f.__func__
<function D.f at 0x1012e5ae8>
>>> d.f.__self__
<__main__.D object at 0x1012e1f98>
>>> d.f.__class__
<class 'method'>
```

8 Static Methods and Class Methods

Non-data descriptors provide a simple mechanism for variations on the usual patterns of binding functions into methods.

To recap, functions have a `__get__()` method so that they can be converted to a method when accessed as attributes. The non-data descriptor transforms an `obj.f(*args)` call into `f(obj, *args)`. Calling `klass.f(*args)` becomes `f(*args)`.

This chart summarizes the binding and its two most useful variants:

Transformation	Called from an Object	Called from a Class
function	f(obj, *args)	f(*args)
staticmethod	f(*args)	f(*args)
classmethod	f(type(obj), *args)	f(klass, *args)

Static methods return the underlying function without changes. Calling either `c.f` or `C.f` is the equivalent of a direct lookup into `object.__getattribute__(c, "f")` or `object.__getattribute__(C, "f")`. As a result, the function becomes identically accessible from either an object or a class.

Good candidates for static methods are methods that do not reference the `self` variable.

For instance, a statistics package may include a container class for experimental data. The class provides normal methods for computing the average, mean, median, and other descriptive statistics that depend on the data. However, there may be useful functions which are conceptually related but do not depend on the data. For instance, `erf(x)` is handy conversion routine that comes up in statistical work but does not directly depend on a particular dataset. It can be called either from an object or the class: `s.erf(1.5) --> .9332` or `Sample.erf(1.5) --> .9332`.

Since staticmethods return the underlying function with no changes, the example calls are unexciting:

```
>>> class E(object):
...     def f(x):
...         print(x)
...     f = staticmethod(f)
...
>>> E.f(3)
3
>>> E().f(3)
3
```

Using the non-data descriptor protocol, a pure Python version of `staticmethod()` would look like this:

```
class StaticMethod(object):
    "Emulate PyStaticMethod_Type() in Objects/funcobject.c"

    def __init__(self, f):
        self.f = f

    def __get__(self, obj, objtype=None):
        return self.f
```

Unlike static methods, class methods prepend the class reference to the argument list before calling the function. This format is the same for whether the caller is an object or a class:

```
>>> class E(object):
...     def f(klass, x):
...         return klass.__name__, x
...     f = classmethod(f)
...
>>> print(E.f(3))
('E', 3)
>>> print(E().f(3))
('E', 3)
```

This behavior is useful whenever the function only needs to have a class reference and does not care about any underlying data. One use for classmethods is to create alternate class constructors. In Python 2.3, the classmethod `dict.fromkeys()` creates a new dictionary from a list of keys. The pure Python equivalent is:

```
class Dict(object):
    . . .
    def fromkeys(klass, iterable, value=None):
        "Emulate dict_fromkeys() in Objects/dictobject.c"
        d = klass()
        for key in iterable:
            d[key] = value
        return d
    fromkeys = classmethod(fromkeys)
```

Now a new dictionary of unique keys can be constructed like this:

```
>>> Dict.fromkeys('abracadabra')
{'a': None, 'r': None, 'b': None, 'c': None, 'd': None}
```

Using the non-data descriptor protocol, a pure Python version of `classmethod()` would look like this:

```
class ClassMethod(object):
    "Emulate PyClassMethod_Type() in Objects/funcobject.c"

    def __init__(self, f):
        self.f = f

    def __get__(self, obj, klass=None):
        if klass is None:
            klass = type(obj)
        def newfunc(*args):
            return self.f(klass, *args)
        return newfunc
```

Argparse Tutorial

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Contents

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This tutorial is intended to be a gentle introduction to `argparse`, the recommended command-line parsing module in the Python standard library.

Note: There are two other modules that fulfill the same task, namely `getopt` (an equivalent for `getopt()` from the C language) and the deprecated `optparse`. Note also that `argparse` is based on `optparse`, and therefore very similar in terms of usage.

1 Concepts

Let's show the sort of functionality that we are going to explore in this introductory tutorial by making use of the **ls** command:

```
$ ls
cpython  devguide  prog.py  pypy  rm-unused-function.patch
$ ls pypy
ctypes_configure  demo  dotviewer  include  lib_pypy  lib-python ...
$ ls -l
total 20
drwxr-xr-x 19 wena wena 4096 Feb 18 18:51 cpython
drwxr-xr-x  4 wena wena 4096 Feb  8 12:04 devguide
-rwxr-xr-x  1 wena wena  535 Feb 19 00:05 prog.py
drwxr-xr-x 14 wena wena 4096 Feb  7 00:59 pypy
-rw-r--r--  1 wena wena  741 Feb 18 01:01 rm-unused-function.patch
$ ls --help
Usage: ls [OPTION]... [FILE]...
List information about the FILEs (the current directory by default).
Sort entries alphabetically if none of -cftuvSUX nor --sort is specified.
...
```

A few concepts we can learn from the four commands:

- The **ls** command is useful when run without any options at all. It defaults to displaying the contents of the current directory.
- If we want beyond what it provides by default, we tell it a bit more. In this case, we want it to display a different directory, `pypy`. What we did is specify what is known as a positional argument. It's named so because the program should know what to do with the value, solely based on where it appears on the command line. This concept is more relevant to a command like **cp**, whose most basic usage is `cp SRC DEST`. The first position is *what you want copied,* and the second position is *where you want it copied to*.
- Now, say we want to change behaviour of the program. In our example, we display more info for each file instead of just showing the file names. The `-l` in that case is known as an optional argument.
- That's a snippet of the help text. It's very useful in that you can come across a program you have never used before, and can figure out how it works simply by reading its help text.

2 The basics

Let us start with a very simple example which does (almost) nothing:

```
import argparse
parser = argparse.ArgumentParser()
parser.parse_args()
```

Following is a result of running the code:

```
$ python3 prog.py
$ python3 prog.py --help
usage: prog.py [-h]

optional arguments:
  -h, --help  show this help message and exit
$ python3 prog.py --verbose
usage: prog.py [-h]
prog.py: error: unrecognized arguments: --verbose
$ python3 prog.py foo
```

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```
usage: prog.py [-h]
prog.py: error: unrecognized arguments: foo
```

Here is what is happening:

- Running the script without any options results in nothing displayed to stdout. Not so useful.
- The second one starts to display the usefulness of the `argparse` module. We have done almost nothing, but already we get a nice help message.
- The `--help` option, which can also be shortened to `-h`, is the only option we get for free (i.e. no need to specify it). Specifying anything else results in an error. But even then, we do get a useful usage message, also for free.

3 Introducing Positional arguments

An example:

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument("echo")
args = parser.parse_args()
print(args.echo)
```

And running the code:

```
$ python3 prog.py
usage: prog.py [-h] echo
prog.py: error: the following arguments are required: echo
$ python3 prog.py --help
usage: prog.py [-h] echo

positional arguments:
  echo

optional arguments:
  -h, --help  show this help message and exit
$ python3 prog.py foo
foo
```

Here is what's happening:

- We've added the `add_argument()` method, which is what we use to specify which command-line options the program is willing to accept. In this case, I've named it `echo` so that it's in line with its function.
- Calling our program now requires us to specify an option.
- The `parse_args()` method actually returns some data from the options specified, in this case, `echo`.
- The variable is some form of 'magic' that `argparse` performs for free (i.e. no need to specify which variable that value is stored in). You will also notice that its name matches the string argument given to the method, `echo`.

Note however that, although the help display looks nice and all, it currently is not as helpful as it can be. For example we see that we got `echo` as a positional argument, but we don't know what it does, other than by guessing or by reading the source code. So, let's make it a bit more useful:

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument("echo", help="echo the string you use here")
```

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```
args = parser.parse_args()
print(args.echo)
```

And we get:

```
$ python3 prog.py -h
usage: prog.py [-h] echo

positional arguments:
  echo        echo the string you use here

optional arguments:
  -h, --help  show this help message and exit
```

Now, how about doing something even more useful:

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument("square", help="display a square of a given number")
args = parser.parse_args()
print(args.square**2)
```

Following is a result of running the code:

```
$ python3 prog.py 4
Traceback (most recent call last):
  File "prog.py", line 5, in <module>
    print(args.square**2)
TypeError: unsupported operand type(s) for ** or pow(): 'str' and 'int'
```

That didn't go so well. That's because `argparse` treats the options we give it as strings, unless we tell it otherwise. So, let's tell `argparse` to treat that input as an integer:

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument("square", help="display a square of a given number",
                    type=int)
args = parser.parse_args()
print(args.square**2)
```

Following is a result of running the code:

```
$ python3 prog.py 4
16
$ python3 prog.py four
usage: prog.py [-h] square
prog.py: error: argument square: invalid int value: 'four'
```

That went well. The program now even helpfully quits on bad illegal input before proceeding.

4 Introducing Optional arguments

So far we have been playing with positional arguments. Let us have a look on how to add optional ones:

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument("--verbosity", help="increase output verbosity")
args = parser.parse_args()
if args.verbosity:
    print("verbosity turned on")
```

And the output:

```
$ python3 prog.py --verbosity 1
verbosity turned on
$ python3 prog.py
$ python3 prog.py --help
usage: prog.py [-h] [--verbosity VERBOSITY]

optional arguments:
  -h, --help            show this help message and exit
  --verbosity VERBOSITY
                        increase output verbosity
$ python3 prog.py --verbosity
usage: prog.py [-h] [--verbosity VERBOSITY]
prog.py: error: argument --verbosity: expected one argument
```

Here is what is happening:

- The program is written so as to display something when `--verbosity` is specified and display nothing when not.
- To show that the option is actually optional, there is no error when running the program without it. Note that by default, if an optional argument isn't used, the relevant variable, in this case `args.verbosity`, is given `None` as a value, which is the reason it fails the truth test of the `if` statement.
- The help message is a bit different.
- When using the `--verbosity` option, one must also specify some value, any value.

The above example accepts arbitrary integer values for `--verbosity`, but for our simple program, only two values are actually useful, `True` or `False`. Let's modify the code accordingly:

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument("--verbose", help="increase output verbosity",
                    action="store_true")
args = parser.parse_args()
if args.verbose:
    print("verbosity turned on")
```

And the output:

```
$ python3 prog.py --verbose
verbosity turned on
$ python3 prog.py --verbose 1
usage: prog.py [-h] [--verbose]
prog.py: error: unrecognized arguments: 1
$ python3 prog.py --help
usage: prog.py [-h] [--verbose]

optional arguments:
```

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```
  -h, --help  show this help message and exit
  --verbose   increase output verbosity
```

Here is what is happening:

- The option is now more of a flag than something that requires a value. We even changed the name of the option to match that idea. Note that we now specify a new keyword, `action`, and give it the value `"store_true"`. This means that, if the option is specified, assign the value `True` to `args.verbose`. Not specifying it implies `False`.
- It complains when you specify a value, in true spirit of what flags actually are.
- Notice the different help text.

4.1 Short options

If you are familiar with command line usage, you will notice that I haven't yet touched on the topic of short versions of the options. It's quite simple:

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument("-v", "--verbose", help="increase output verbosity",
                    action="store_true")
args = parser.parse_args()
if args.verbose:
    print("verbosity turned on")
```

And here goes:

```
$ python3 prog.py -v
verbosity turned on
$ python3 prog.py --help
usage: prog.py [-h] [-v]

optional arguments:
  -h, --help     show this help message and exit
  -v, --verbose  increase output verbosity
```

Note that the new ability is also reflected in the help text.

5 Combining Positional and Optional arguments

Our program keeps growing in complexity:

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument("square", type=int,
                    help="display a square of a given number")
parser.add_argument("-v", "--verbose", action="store_true",
                    help="increase output verbosity")
args = parser.parse_args()
answer = args.square**2
if args.verbose:
    print("the square of {} equals {}".format(args.square, answer))
else:
    print(answer)
```

And now the output:

```
$ python3 prog.py
usage: prog.py [-h] [-v] square
prog.py: error: the following arguments are required: square
$ python3 prog.py 4
16
$ python3 prog.py 4 --verbose
the square of 4 equals 16
$ python3 prog.py --verbose 4
the square of 4 equals 16
```

- We've brought back a positional argument, hence the complaint.
- Note that the order does not matter.

How about we give this program of ours back the ability to have multiple verbosity values, and actually get to use them:

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument("square", type=int,
                    help="display a square of a given number")
parser.add_argument("-v", "--verbosity", type=int,
                    help="increase output verbosity")
args = parser.parse_args()
answer = args.square**2
if args.verbosity == 2:
    print("the square of {} equals {}".format(args.square, answer))
elif args.verbosity == 1:
    print("{}^2 == {}".format(args.square, answer))
else:
    print(answer)
```

And the output:

```
$ python3 prog.py 4
16
$ python3 prog.py 4 -v
usage: prog.py [-h] [-v VERBOSITY] square
prog.py: error: argument -v/--verbosity: expected one argument
$ python3 prog.py 4 -v 1
4^2 == 16
$ python3 prog.py 4 -v 2
the square of 4 equals 16
$ python3 prog.py 4 -v 3
16
```

These all look good except the last one, which exposes a bug in our program. Let's fix it by restricting the values the `--verbosity` option can accept:

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument("square", type=int,
                    help="display a square of a given number")
parser.add_argument("-v", "--verbosity", type=int, choices=[0, 1, 2],
                    help="increase output verbosity")
args = parser.parse_args()
answer = args.square**2
if args.verbosity == 2:
    print("the square of {} equals {}".format(args.square, answer))
elif args.verbosity == 1:
    print("{}^2 == {}".format(args.square, answer))
else:
    print(answer)
```

And the output:

```
$ python3 prog.py 4 -v 3
usage: prog.py [-h] [-v {0,1,2}] square
prog.py: error: argument -v/--verbosity: invalid choice: 3 (choose from 0, 1, 2)
$ python3 prog.py 4 -h
usage: prog.py [-h] [-v {0,1,2}] square

positional arguments:
  square                display a square of a given number

optional arguments:
  -h, --help            show this help message and exit
  -v {0,1,2}, --verbosity {0,1,2}
                        increase output verbosity
```

Note that the change also reflects both in the error message as well as the help string.

Now, let's use a different approach of playing with verbosity, which is pretty common. It also matches the way the CPython executable handles its own verbosity argument (check the output of `python --help`):

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument("square", type=int,
                    help="display the square of a given number")
parser.add_argument("-v", "--verbosity", action="count",
                    help="increase output verbosity")
args = parser.parse_args()
answer = args.square**2
if args.verbosity == 2:
    print("the square of {} equals {}".format(args.square, answer))
elif args.verbosity == 1:
    print("{}^2 == {}".format(args.square, answer))
else:
    print(answer)
```

We have introduced another action, "count", to count the number of occurrences of a specific optional arguments:

```
$ python3 prog.py 4
16
$ python3 prog.py 4 -v
4^2 == 16
$ python3 prog.py 4 -vv
the square of 4 equals 16
$ python3 prog.py 4 --verbosity --verbosity
the square of 4 equals 16
$ python3 prog.py 4 -v 1
usage: prog.py [-h] [-v] square
prog.py: error: unrecognized arguments: 1
$ python3 prog.py 4 -h
usage: prog.py [-h] [-v] square

positional arguments:
  square           display a square of a given number

optional arguments:
  -h, --help       show this help message and exit
  -v, --verbosity  increase output verbosity
$ python3 prog.py 4 -vvv
16
```

- Yes, it's now more of a flag (similar to `action="store_true"`) in the previous version of our script. That should explain the complaint.

- It also behaves similar to "store_true" action.
- Now here's a demonstration of what the "count" action gives. You've probably seen this sort of usage before.
- And if you don't specify the `-v` flag, that flag is considered to have `None` value.
- As should be expected, specifying the long form of the flag, we should get the same output.
- Sadly, our help output isn't very informative on the new ability our script has acquired, but that can always be fixed by improving the documentation for our script (e.g. via the `help` keyword argument).
- That last output exposes a bug in our program.

Let's fix:

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument("square", type=int,
                    help="display a square of a given number")
parser.add_argument("-v", "--verbosity", action="count",
                    help="increase output verbosity")
args = parser.parse_args()
answer = args.square**2

# bugfix: replace == with >=
if args.verbosity >= 2:
    print("the square of {} equals {}".format(args.square, answer))
elif args.verbosity >= 1:
    print("{}^2 == {}".format(args.square, answer))
else:
    print(answer)
```

And this is what it gives:

```
$ python3 prog.py 4 -vvv
the square of 4 equals 16
$ python3 prog.py 4 -vvvv
the square of 4 equals 16
$ python3 prog.py 4
Traceback (most recent call last):
  File "prog.py", line 11, in <module>
    if args.verbosity >= 2:
TypeError: '>=' not supported between instances of 'NoneType' and 'int'
```

- First output went well, and fixes the bug we had before. That is, we want any value >= 2 to be as verbose as possible.
- Third output not so good.

Let's fix that bug:

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument("square", type=int,
                    help="display a square of a given number")
parser.add_argument("-v", "--verbosity", action="count", default=0,
                    help="increase output verbosity")
args = parser.parse_args()
answer = args.square**2
if args.verbosity >= 2:
    print("the square of {} equals {}".format(args.square, answer))
elif args.verbosity >= 1:
    print("{}^2 == {}".format(args.square, answer))
else:
    print(answer)
```

We've just introduced yet another keyword, `default`. We've set it to `0` in order to make it comparable to the other int values. Remember that by default, if an optional argument isn't specified, it gets the `None` value, and that cannot be compared to an int value (hence the `TypeError` exception).

And:

```
$ python3 prog.py 4
16
```

You can go quite far just with what we've learned so far, and we have only scratched the surface. The `argparse` module is very powerful, and we'll explore a bit more of it before we end this tutorial.

6 Getting a little more advanced

What if we wanted to expand our tiny program to perform other powers, not just squares:

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument("x", type=int, help="the base")
parser.add_argument("y", type=int, help="the exponent")
parser.add_argument("-v", "--verbosity", action="count", default=0)
args = parser.parse_args()
answer = args.x**args.y
if args.verbosity >= 2:
    print("{} to the power {} equals {}".format(args.x, args.y, answer))
elif args.verbosity >= 1:
    print("{}^{} == {}".format(args.x, args.y, answer))
else:
    print(answer)
```

Output:

```
$ python3 prog.py
usage: prog.py [-h] [-v] x y
prog.py: error: the following arguments are required: x, y
$ python3 prog.py -h
usage: prog.py [-h] [-v] x y

positional arguments:
  x                 the base
  y                 the exponent

optional arguments:
  -h, --help        show this help message and exit
  -v, --verbosity
$ python3 prog.py 4 2 -v
4^2 == 16
```

Notice that so far we've been using verbosity level to *change* the text that gets displayed. The following example instead uses verbosity level to display *more* text instead:

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument("x", type=int, help="the base")
parser.add_argument("y", type=int, help="the exponent")
parser.add_argument("-v", "--verbosity", action="count", default=0)
args = parser.parse_args()
answer = args.x**args.y
if args.verbosity >= 2:
    print("Running '{}'".format(__file__))
```

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```
if args.verbosity >= 1:
    print("{}^{} == ".format(args.x, args.y), end="")
print(answer)
```

Output:

```
$ python3 prog.py 4 2
16
$ python3 prog.py 4 2 -v
4^2 == 16
$ python3 prog.py 4 2 -vv
Running 'prog.py'
4^2 == 16
```

6.1 Conflicting options

So far, we have been working with two methods of an `argparse.ArgumentParser` instance. Let's introduce a third one, `add_mutually_exclusive_group()`. It allows for us to specify options that conflict with each other. Let's also change the rest of the program so that the new functionality makes more sense: we'll introduce the `--quiet` option, which will be the opposite of the `--verbose` one:

```
import argparse

parser = argparse.ArgumentParser()
group = parser.add_mutually_exclusive_group()
group.add_argument("-v", "--verbose", action="store_true")
group.add_argument("-q", "--quiet", action="store_true")
parser.add_argument("x", type=int, help="the base")
parser.add_argument("y", type=int, help="the exponent")
args = parser.parse_args()
answer = args.x**args.y

if args.quiet:
    print(answer)
elif args.verbose:
    print("{} to the power {} equals {}".format(args.x, args.y, answer))
else:
    print("{}^{} == {}".format(args.x, args.y, answer))
```

Our program is now simpler, and we've lost some functionality for the sake of demonstration. Anyways, here's the output:

```
$ python3 prog.py 4 2
4^2 == 16
$ python3 prog.py 4 2 -q
16
$ python3 prog.py 4 2 -v
4 to the power 2 equals 16
$ python3 prog.py 4 2 -vq
usage: prog.py [-h] [-v | -q] x y
prog.py: error: argument -q/--quiet: not allowed with argument -v/--verbose
$ python3 prog.py 4 2 -v --quiet
usage: prog.py [-h] [-v | -q] x y
prog.py: error: argument -q/--quiet: not allowed with argument -v/--verbose
```

That should be easy to follow. I've added that last output so you can see the sort of flexibility you get, i.e. mixing long form options with short form ones.

Before we conclude, you probably want to tell your users the main purpose of your program, just in case they don't know:

```
import argparse

parser = argparse.ArgumentParser(description="calculate X to the power of Y")
group = parser.add_mutually_exclusive_group()
group.add_argument("-v", "--verbose", action="store_true")
group.add_argument("-q", "--quiet", action="store_true")
parser.add_argument("x", type=int, help="the base")
parser.add_argument("y", type=int, help="the exponent")
args = parser.parse_args()
answer = args.x**args.y

if args.quiet:
    print(answer)
elif args.verbose:
    print("{} to the power {} equals {}".format(args.x, args.y, answer))
else:
    print("{}^{} == {}".format(args.x, args.y, answer))
```

Note that slight difference in the usage text. Note the `[-v | -q]`, which tells us that we can either use `-v` or `-q`, but not both at the same time:

```
$ python3 prog.py --help
usage: prog.py [-h] [-v | -q] x y

calculate X to the power of Y

positional arguments:
  x              the base
  y              the exponent

optional arguments:
  -h, --help     show this help message and exit
  -v, --verbose
  -q, --quiet
```

7 Conclusion

The `argparse` module offers a lot more than shown here. Its docs are quite detailed and thorough, and full of examples. Having gone through this tutorial, you should easily digest them without feeling overwhelmed.

Curses Programming with Python

Release 3.8.3

Guido van Rossum
and the Python development team

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Contents

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Abstract

This document describes how to use the `curses` extension module to control text-mode displays.

1 What is curses?

The curses library supplies a terminal-independent screen-painting and keyboard-handling facility for text-based terminals; such terminals include VT100s, the Linux console, and the simulated terminal provided by various programs. Display terminals support various control codes to perform common operations such as moving the cursor, scrolling the screen, and erasing areas. Different terminals use widely differing codes, and often have their own minor quirks.

In a world of graphical displays, one might ask "why bother"? It's true that character-cell display terminals are an obsolete technology, but there are niches in which being able to do fancy things with them are still valuable. One niche is on small-footprint or embedded Unixes that don't run an X server. Another is tools such as OS installers and kernel configurators that may have to run before any graphical support is available.

The curses library provides fairly basic functionality, providing the programmer with an abstraction of a display containing multiple non-overlapping windows of text. The contents of a window can be changed in various ways—adding text, erasing it, changing its appearance—and the curses library will figure out what control codes need to be sent to the terminal to produce the right output. curses doesn't provide many user-interface concepts such as buttons, checkboxes, or dialogs; if you need such features, consider a user interface library such as Urwid.

The curses library was originally written for BSD Unix; the later System V versions of Unix from AT&T added many enhancements and new functions. BSD curses is no longer maintained, having been replaced by ncurses, which is an open-source implementation of the AT&T interface. If you're using an open-source Unix such as Linux or FreeBSD, your system almost certainly uses ncurses. Since most current commercial Unix versions are based on System V code, all the functions described here will probably be available. The older versions of curses carried by some proprietary Unixes may not support everything, though.

The Windows version of Python doesn't include the `curses` module. A ported version called UniCurses is available. You could also try the Console module written by Fredrik Lundh, which doesn't use the same API as curses but provides cursor-addressable text output and full support for mouse and keyboard input.

1.1 The Python curses module

The Python module is a fairly simple wrapper over the C functions provided by curses; if you're already familiar with curses programming in C, it's really easy to transfer that knowledge to Python. The biggest difference is that the Python interface makes things simpler by merging different C functions such as `addstr()`, `mvaddstr()`, and `mvwaddstr()` into a single `addstr()` method. You'll see this covered in more detail later.

This HOWTO is an introduction to writing text-mode programs with curses and Python. It doesn't attempt to be a complete guide to the curses API; for that, see the Python library guide's section on ncurses, and the C manual pages for ncurses. It will, however, give you the basic ideas.

2 Starting and ending a curses application

Before doing anything, curses must be initialized. This is done by calling the `initscr()` function, which will determine the terminal type, send any required setup codes to the terminal, and create various internal data structures. If successful, `initscr()` returns a window object representing the entire screen; this is usually called `stdscr` after the name of the corresponding C variable.

```
import curses
stdscr = curses.initscr()
```

Usually curses applications turn off automatic echoing of keys to the screen, in order to be able to read keys and only display them under certain circumstances. This requires calling the `noecho()` function.

```
curses.noecho()
```

Applications will also commonly need to react to keys instantly, without requiring the Enter key to be pressed; this is called cbreak mode, as opposed to the usual buffered input mode.

```
curses.cbreak()
```

Terminals usually return special keys, such as the cursor keys or navigation keys such as Page Up and Home, as a multibyte escape sequence. While you could write your application to expect such sequences and process them accordingly, curses can do it for you, returning a special value such as `curses.KEY_LEFT`. To get curses to do the job, you'll have to enable keypad mode.

```
stdscr.keypad(True)
```

Terminating a curses application is much easier than starting one. You'll need to call:

```
curses.nocbreak()
stdscr.keypad(False)
curses.echo()
```

to reverse the curses-friendly terminal settings. Then call the `endwin()` function to restore the terminal to its original operating mode.

```
curses.endwin()
```

A common problem when debugging a curses application is to get your terminal messed up when the application dies without restoring the terminal to its previous state. In Python this commonly happens when your code is buggy and raises an uncaught exception. Keys are no longer echoed to the screen when you type them, for example, which makes using the shell difficult.

In Python you can avoid these complications and make debugging much easier by importing the `curses.wrapper()` function and using it like this:

```
from curses import wrapper

def main(stdscr):
    # Clear screen
    stdscr.clear()

    # This raises ZeroDivisionError when i == 10.
    for i in range(0, 11):
        v = i-10
        stdscr.addstr(i, 0, '10 divided by {} is {}'.format(v, 10/v))

    stdscr.refresh()
    stdscr.getkey()

wrapper(main)
```

The `wrapper()` function takes a callable object and does the initializations described above, also initializing colors if color support is present. `wrapper()` then runs your provided callable. Once the callable returns, `wrapper()` will restore the original state of the terminal. The callable is called inside a `try`…`except` that catches exceptions, restores the state of the terminal, and then re-raises the exception. Therefore your terminal won't be left in a funny state on exception and you'll be able to read the exception's message and traceback.

3 Windows and Pads

Windows are the basic abstraction in curses. A window object represents a rectangular area of the screen, and supports methods to display text, erase it, allow the user to input strings, and so forth.

The `stdscr` object returned by the `initscr()` function is a window object that covers the entire screen. Many programs may need only this single window, but you might wish to divide the screen into smaller windows, in order to redraw or clear them separately. The `newwin()` function creates a new window of a given size, returning the new window object.

```
begin_x = 20; begin_y = 7
height = 5; width = 40
win = curses.newwin(height, width, begin_y, begin_x)
```

Note that the coordinate system used in curses is unusual. Coordinates are always passed in the order *y,x*, and the top-left corner of a window is coordinate (0,0). This breaks the normal convention for handling coordinates where the *x* coordinate comes first. This is an unfortunate difference from most other computer applications, but it's been part of curses since it was first written, and it's too late to change things now.

Your application can determine the size of the screen by using the `curses.LINES` and `curses.COLS` variables to obtain the *y* and *x* sizes. Legal coordinates will then extend from `(0,0)` to `(curses.LINES - 1, curses.COLS - 1)`.

When you call a method to display or erase text, the effect doesn't immediately show up on the display. Instead you must call the `refresh()` method of window objects to update the screen.

This is because curses was originally written with slow 300-baud terminal connections in mind; with these terminals, minimizing the time required to redraw the screen was very important. Instead curses accumulates changes to the screen and displays them in the most efficient manner when you call `refresh()`. For example, if your program displays some text in a window and then clears the window, there's no need to send the original text because they're never visible.

In practice, explicitly telling curses to redraw a window doesn't really complicate programming with curses much. Most programs go into a flurry of activity, and then pause waiting for a keypress or some other action on the part of the user. All you have to do is to be sure that the screen has been redrawn before pausing to wait for user input, by first calling `stdscr.refresh()` or the `refresh()` method of some other relevant window.

A pad is a special case of a window; it can be larger than the actual display screen, and only a portion of the pad displayed at a time. Creating a pad requires the pad's height and width, while refreshing a pad requires giving the coordinates of the on-screen area where a subsection of the pad will be displayed.

```
pad = curses.newpad(100, 100)
# These loops fill the pad with letters; addch() is
# explained in the next section
for y in range(0, 99):
    for x in range(0, 99):
        pad.addch(y,x, ord('a') + (x*x+y*y) % 26)

# Displays a section of the pad in the middle of the screen.
# (0,0) : coordinate of upper-left corner of pad area to display.
# (5,5) : coordinate of upper-left corner of window area to be filled
#         with pad content.
# (20, 75) : coordinate of lower-right corner of window area to be
#          : filled with pad content.
pad.refresh( 0,0, 5,5, 20,75)
```

The `refresh()` call displays a section of the pad in the rectangle extending from coordinate (5,5) to coordinate (20,75) on the screen; the upper left corner of the displayed section is coordinate (0,0) on the pad. Beyond that difference, pads are exactly like ordinary windows and support the same methods.

If you have multiple windows and pads on screen there is a more efficient way to update the screen and prevent annoying screen flicker as each part of the screen gets updated. `refresh()` actually does two things:

1) Calls the `noutrefresh()` method of each window to update an underlying data structure representing the desired state of the screen.

2) Calls the function `doupdate()` function to change the physical screen to match the desired state recorded in the data structure.

Instead you can call `noutrefresh()` on a number of windows to update the data structure, and then call `doupdate()` to update the screen.

4 Displaying Text

From a C programmer's point of view, curses may sometimes look like a twisty maze of functions, all subtly different. For example, `addstr()` displays a string at the current cursor location in the `stdscr` window, while `mvaddstr()` moves to a given y,x coordinate first before displaying the string. `waddstr()` is just like `addstr()`, but allows specifying a window to use instead of using `stdscr` by default. `mvwaddstr()` allows specifying both a window and a coordinate.

Fortunately the Python interface hides all these details. `stdscr` is a window object like any other, and methods such as `addstr()` accept multiple argument forms. Usually there are four different forms.

Form	Description
str or *ch*	Display the string *str* or character *ch* at the current position
str or *ch*, *attr*	Display the string *str* or character *ch*, using attribute *attr* at the current position
y, *x*, *str* or *ch*	Move to position *y,x* within the window, and display *str* or *ch*
y, *x*, *str* or *ch*, *attr*	Move to position *y,x* within the window, and display *str* or *ch*, using attribute *attr*

Attributes allow displaying text in highlighted forms such as boldface, underline, reverse code, or in color. They'll be explained in more detail in the next subsection.

The `addstr()` method takes a Python string or bytestring as the value to be displayed. The contents of bytestrings are sent to the terminal as-is. Strings are encoded to bytes using the value of the window's `encoding` attribute; this defaults to the default system encoding as returned by `locale.getpreferredencoding()`.

The `addch()` methods take a character, which can be either a string of length 1, a bytestring of length 1, or an integer.

Constants are provided for extension characters; these constants are integers greater than 255. For example, `ACS_PLMINUS` is a +/- symbol, and `ACS_ULCORNER` is the upper left corner of a box (handy for drawing borders). You can also use the appropriate Unicode character.

Windows remember where the cursor was left after the last operation, so if you leave out the *y,x* coordinates, the string or character will be displayed wherever the last operation left off. You can also move the cursor with the `move(y,x)` method. Because some terminals always display a flashing cursor, you may want to ensure that the cursor is positioned in some location where it won't be distracting; it can be confusing to have the cursor blinking at some apparently random location.

If your application doesn't need a blinking cursor at all, you can call `curs_set(False)` to make it invisible. For compatibility with older curses versions, there's a `leaveok(bool)` function that's a synonym for `curs_set()`. When *bool* is true, the curses library will attempt to suppress the flashing cursor, and you won't need to worry about leaving it in odd locations.

4.1 Attributes and Color

Characters can be displayed in different ways. Status lines in a text-based application are commonly shown in reverse video, or a text viewer may need to highlight certain words. curses supports this by allowing you to specify an attribute for each cell on the screen.

An attribute is an integer, each bit representing a different attribute. You can try to display text with multiple attribute bits set, but curses doesn't guarantee that all the possible combinations are available, or that they're all visually distinct. That depends on the ability of the terminal being used, so it's safest to stick to the most commonly available attributes, listed here.

Attribute	Description
`A_BLINK`	Blinking text
`A_BOLD`	Extra bright or bold text
`A_DIM`	Half bright text
`A_REVERSE`	Reverse-video text
`A_STANDOUT`	The best highlighting mode available
`A_UNDERLINE`	Underlined text

So, to display a reverse-video status line on the top line of the screen, you could code:

```
stdscr.addstr(0, 0, "Current mode: Typing mode",
              curses.A_REVERSE)
stdscr.refresh()
```

The curses library also supports color on those terminals that provide it. The most common such terminal is probably the Linux console, followed by color xterms.

To use color, you must call the `start_color()` function soon after calling `initscr()`, to initialize the default color set (the `curses.wrapper()` function does this automatically). Once that's done, the `has_colors()` function returns TRUE if the terminal in use can actually display color. (Note: curses uses the American spelling 'color', instead of the Canadian/British spelling 'colour'. If you're used to the British spelling, you'll have to resign yourself to misspelling it for the sake of these functions.)

The curses library maintains a finite number of color pairs, containing a foreground (or text) color and a background color. You can get the attribute value corresponding to a color pair with the `color_pair()` function; this can be bitwise-OR'ed with other attributes such as `A_REVERSE`, but again, such combinations are not guaranteed to work on all terminals.

An example, which displays a line of text using color pair 1:

```
stdscr.addstr("Pretty text", curses.color_pair(1))
stdscr.refresh()
```

As I said before, a color pair consists of a foreground and background color. The `init_pair(n, f, b)` function changes the definition of color pair *n*, to foreground color f and background color b. Color pair 0 is hard-wired to white on black, and cannot be changed.

Colors are numbered, and `start_color()` initializes 8 basic colors when it activates color mode. They are: 0:black, 1:red, 2:green, 3:yellow, 4:blue, 5:magenta, 6:cyan, and 7:white. The `curses` module defines named constants for each of these colors: `curses.COLOR_BLACK`, `curses.COLOR_RED`, and so forth.

Let's put all this together. To change color 1 to red text on a white background, you would call:

```
curses.init_pair(1, curses.COLOR_RED, curses.COLOR_WHITE)
```

When you change a color pair, any text already displayed using that color pair will change to the new colors. You can also display new text in this color with:

```
stdscr.addstr(0,0, "RED ALERT!", curses.color_pair(1))
```

Very fancy terminals can change the definitions of the actual colors to a given RGB value. This lets you change color 1, which is usually red, to purple or blue or any other color you like. Unfortunately, the Linux console doesn't support this, so I'm unable to try it out, and can't provide any examples. You can check if your terminal can do this by calling `can_change_color()`, which returns `True` if the capability is there. If you're lucky enough to have such a talented terminal, consult your system's man pages for more information.

5 User Input

The C curses library offers only very simple input mechanisms. Python's `curses` module adds a basic text-input widget. (Other libraries such as Urwid have more extensive collections of widgets.)

There are two methods for getting input from a window:

- `getch()` refreshes the screen and then waits for the user to hit a key, displaying the key if `echo()` has been called earlier. You can optionally specify a coordinate to which the cursor should be moved before pausing.
- `getkey()` does the same thing but converts the integer to a string. Individual characters are returned as 1-character strings, and special keys such as function keys return longer strings containing a key name such as `KEY_UP` or `^G`.

It's possible to not wait for the user using the `nodelay()` window method. After `nodelay(True)`, `getch()` and `getkey()` for the window become non-blocking. To signal that no input is ready, `getch()` returns `curses.ERR` (a value of -1) and `getkey()` raises an exception. There's also a `halfdelay()` function, which can be used to (in effect) set a timer on each `getch()`; if no input becomes available within a specified delay (measured in tenths of a second), curses raises an exception.

The `getch()` method returns an integer; if it's between 0 and 255, it represents the ASCII code of the key pressed. Values greater than 255 are special keys such as Page Up, Home, or the cursor keys. You can compare the value returned to constants such as `curses.KEY_PPAGE`, `curses.KEY_HOME`, or `curses.KEY_LEFT`. The main loop of your program may look something like this:

```
while True:
    c = stdscr.getch()
    if c == ord('p'):
        PrintDocument()
    elif c == ord('q'):
        break  # Exit the while loop
    elif c == curses.KEY_HOME:
        x = y = 0
```

The `curses.ascii` module supplies ASCII class membership functions that take either integer or 1-character string arguments; these may be useful in writing more readable tests for such loops. It also supplies conversion functions that take either integer or 1-character-string arguments and return the same type. For example, `curses.ascii.ctrl()` returns the control character corresponding to its argument.

There's also a method to retrieve an entire string, `getstr()`. It isn't used very often, because its functionality is quite limited; the only editing keys available are the backspace key and the Enter key, which terminates the string. It can optionally be limited to a fixed number of characters.

```
curses.echo()            # Enable echoing of characters

# Get a 15-character string, with the cursor on the top line
s = stdscr.getstr(0,0, 15)
```

The `curses.textpad` module supplies a text box that supports an Emacs-like set of keybindings. Various methods of the `Textbox` class support editing with input validation and gathering the edit results either with or without trailing spaces. Here's an example:

```
import curses
from curses.textpad import Textbox, rectangle

def main(stdscr):
    stdscr.addstr(0, 0, "Enter IM message: (hit Ctrl-G to send)")

    editwin = curses.newwin(5,30, 2,1)
    rectangle(stdscr, 1,0, 1+5+1, 1+30+1)
    stdscr.refresh()
```

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```
    box = Textbox(editwin)

    # Let the user edit until Ctrl-G is struck.
    box.edit()

    # Get resulting contents
    message = box.gather()
```

See the library documentation on `curses.textpad` for more details.

6 For More Information

This HOWTO doesn't cover some advanced topics, such as reading the contents of the screen or capturing mouse events from an xterm instance, but the Python library page for the `curses` module is now reasonably complete. You should browse it next.

If you're in doubt about the detailed behavior of the curses functions, consult the manual pages for your curses implementation, whether it's ncurses or a proprietary Unix vendor's. The manual pages will document any quirks, and provide complete lists of all the functions, attributes, and `ACS_*` characters available to you.

Because the curses API is so large, some functions aren't supported in the Python interface. Often this isn't because they're difficult to implement, but because no one has needed them yet. Also, Python doesn't yet support the menu library associated with ncurses. Patches adding support for these would be welcome; see the Python Developer's Guide to learn more about submitting patches to Python.

- Writing Programs with NCURSES: a lengthy tutorial for C programmers.
- The ncurses man page
- The ncurses FAQ
- "Use curses… don't swear": video of a PyCon 2013 talk on controlling terminals using curses or Urwid.
- "Console Applications with Urwid": video of a PyCon CA 2012 talk demonstrating some applications written using Urwid.