Using Stackless

Andrew Dalke / dalke@dalkescientific.com

Stackless is Python

(with a few additions)

Stackless is CPython

(with a few modifications)

```
[josiah:~] dalke% spython
Python 2.5 Stackless 3.1b3 060516 (release25-maint:53731,
Feb 10 2007, 23:25:41)
[GCC 4.0.1 (Apple Computer, Inc. build 5367)] on darwin
Type "help", "copyright", "credits" or "license" for more
information.
>>> print "Hello, PyCon 2007!"
Hello, PyCon 2007!
>>>
```

Stackless adds:

tasklets
channels
cooperative multitasking

Stackless vs. Threads

tasklet(f)		Thread(target=f)
channel()	~	Queue(1)
.send(x)		.put(x)
.receive()		.get()
.balance		

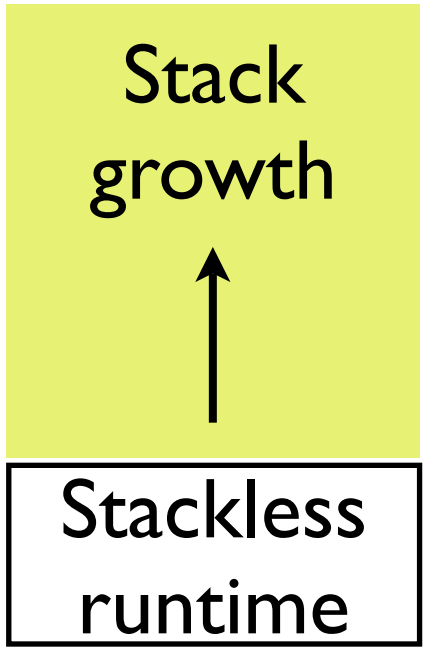
run()
schedule() } tasklet scheduling

```
import stackless

def writeln(s):
    print s

stackless.tasklet(writeln)("Hello, PyCon 2007!")
stackless.run()
```

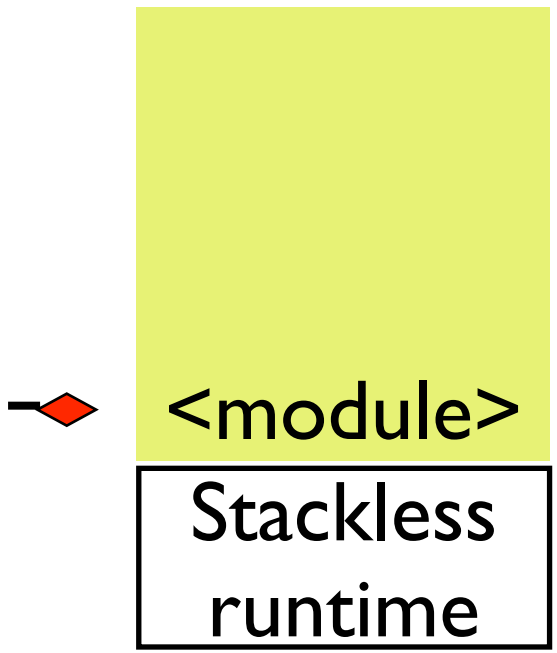
```
% spython simple.py
Hello, PyCon 2007!
```

Starting a new tasklet

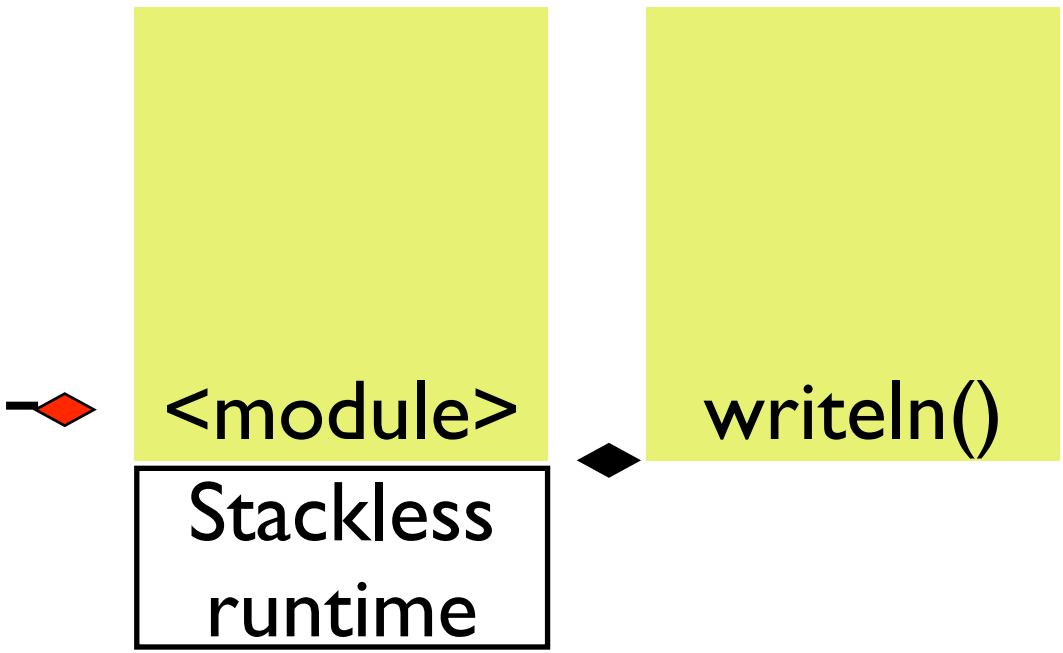
```
import stackless

def writeln(s):
    print s

stackless.tasklet(writeln)("Hello, PyCon 2007!")
stackless.run()
```



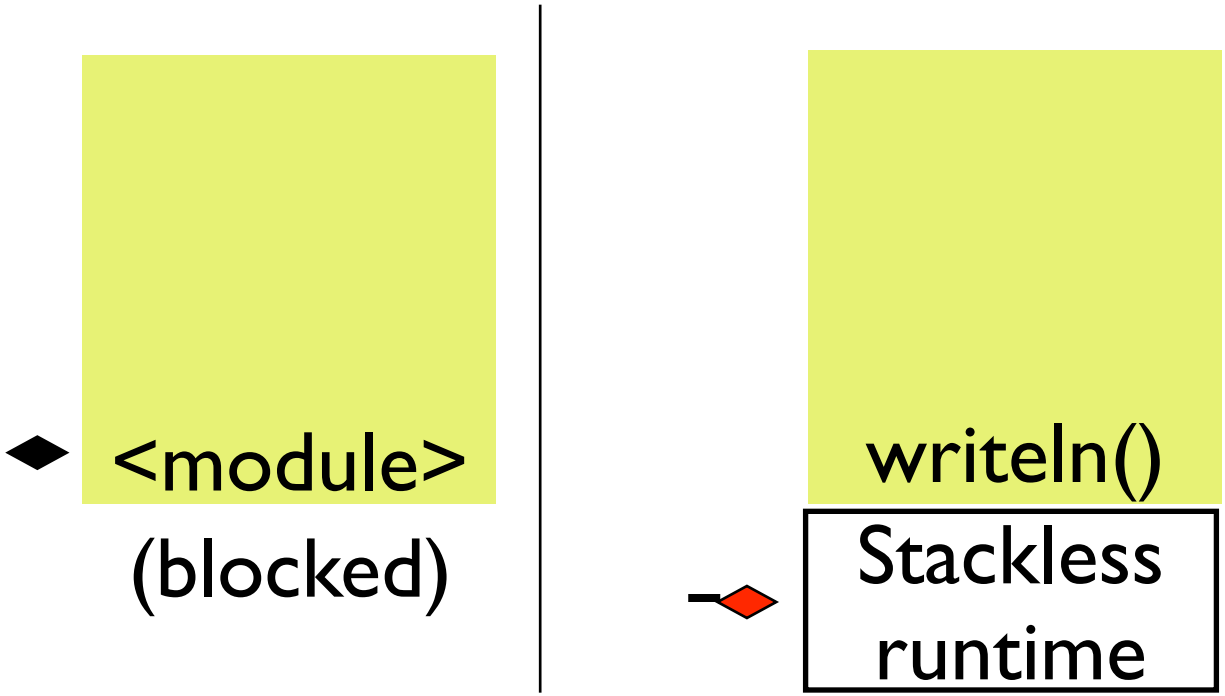
```
import stackless

def writeln(s):
    print s

stackless.tasklet(writeln)("Hello, PyCon 2007!")
stackless.run()
```



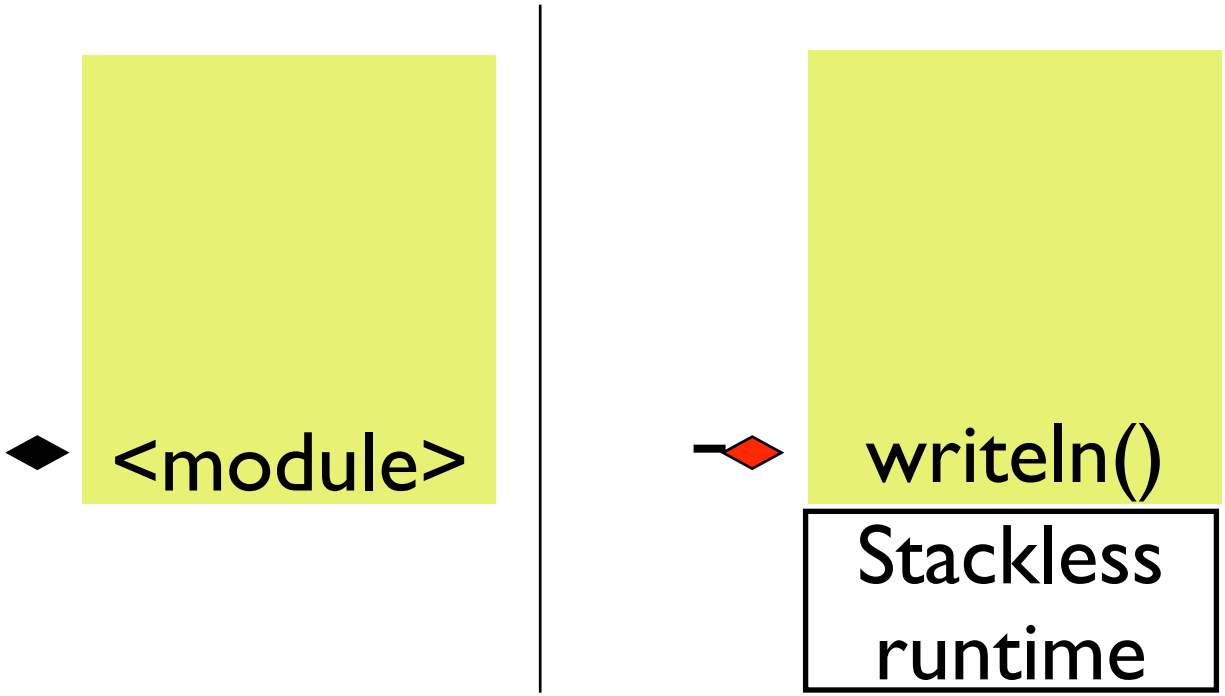
```
import stackless

def writeln(s):
    print s

stackless.tasklet(writeln)("Hello, PyCon 2007!")
stackless.run()
```



```
import stackless

def writeln(s):
    print s

stackless.tasklet(writeln)("Hello, PyCon 2007!")
stackless.run()
```

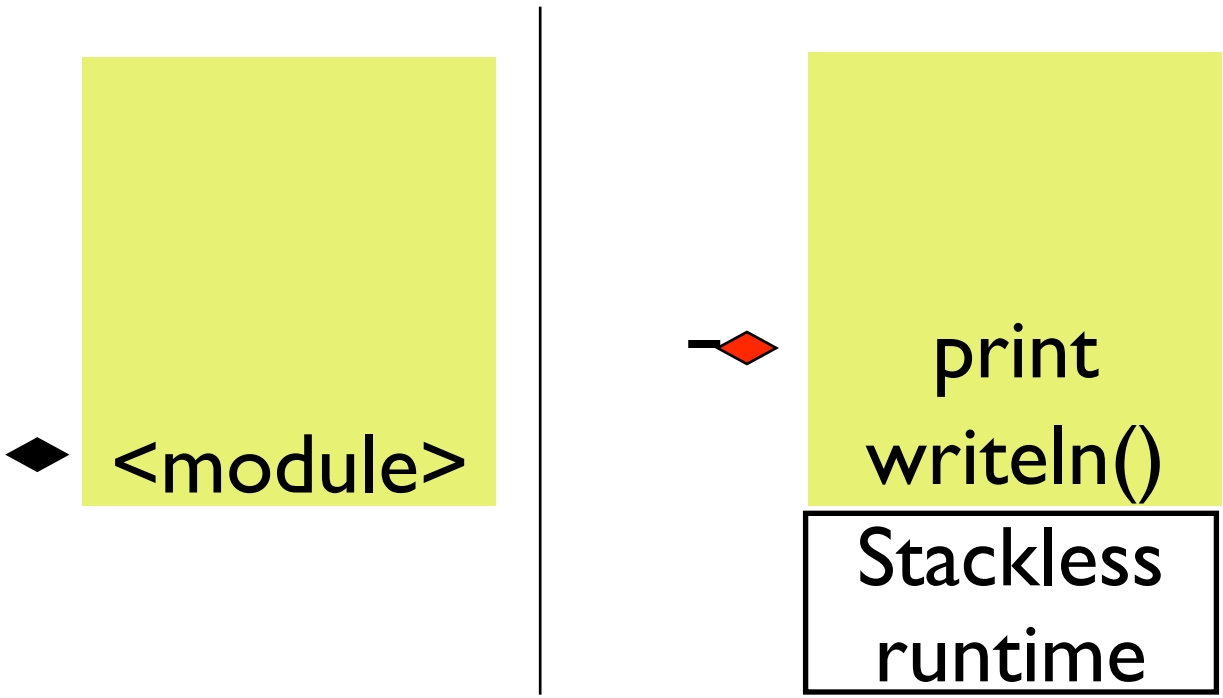


```
import stackless

def writeln(s):
    print s

stackless.tasklet(writeln)("Hello, PyCon 2007!")
stackless.run()
```



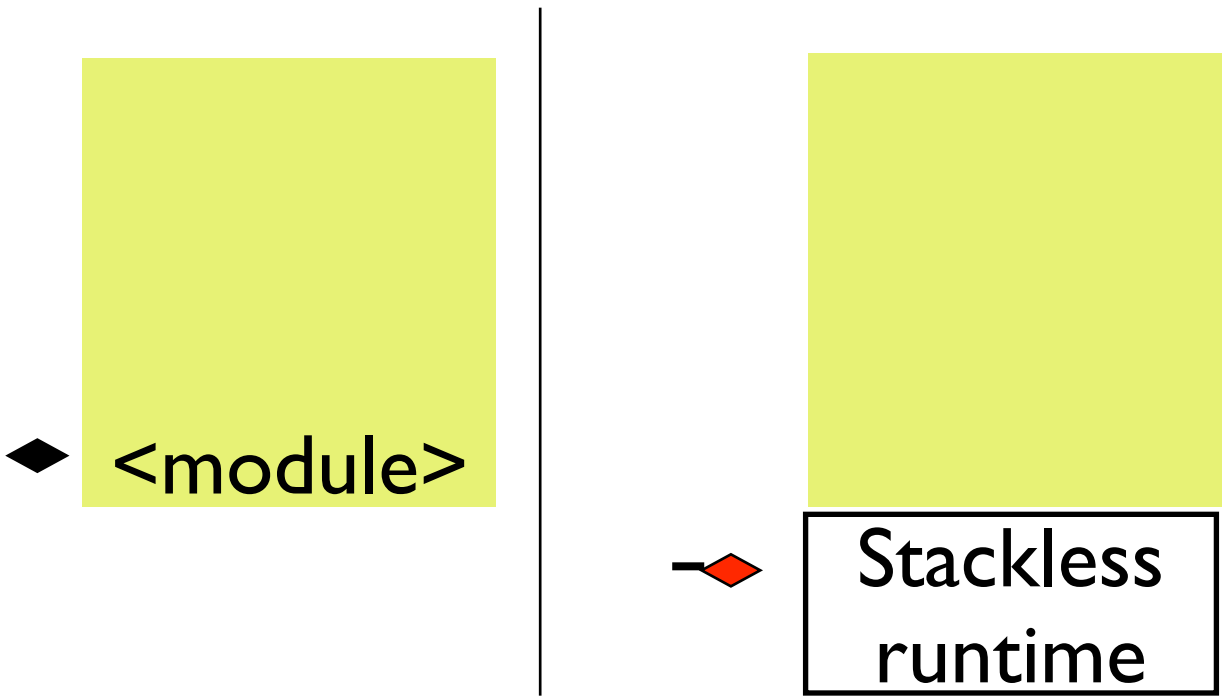
```
import stackless

def writeln(s):
    print s

stackless.tasklet(writeln)("Hello, PyCon 2007!")
stackless.run()
```

```
Hello, PyCon 2007!
```



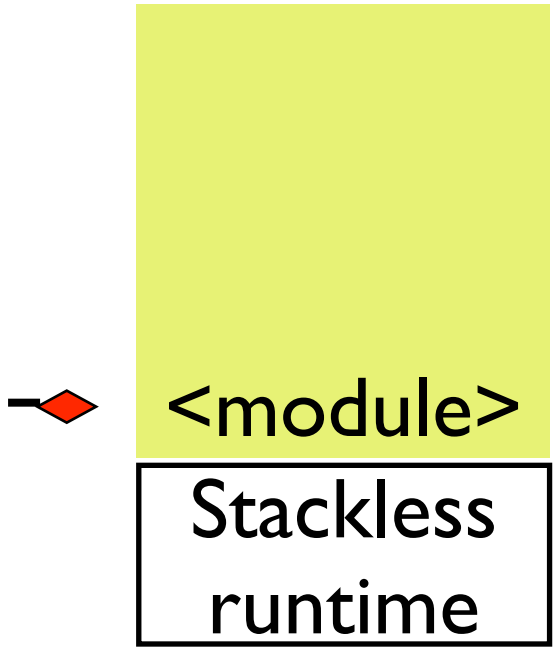
```
import stackless

def writeln(s):
    print s

stackless.tasklet(writeln)("Hello, PyCon 2007!")
stackless.run()
```

```
Hello, PyCon 2007!
```



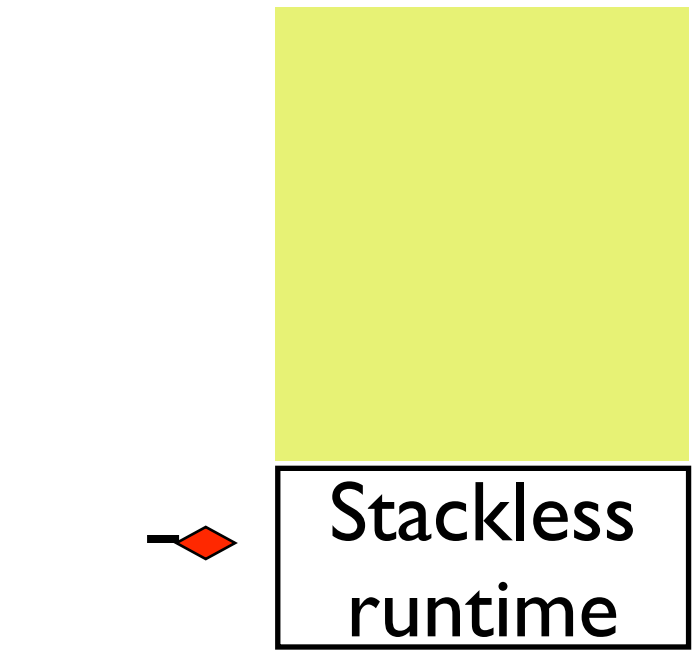
```
import stackless

def writeln(s):
    print s

stackless.tasklet(writeln)("Hello, PyCon 2007!")
stackless.run()
```

```
Hello, PyCon 2007!
```



```
import stackless

def writeln(s):
    print s

stackless.tasklet(writeln)("Hello, PyCon 2007!")
stackless.run()
```

```
Hello, PyCon 2007!
```



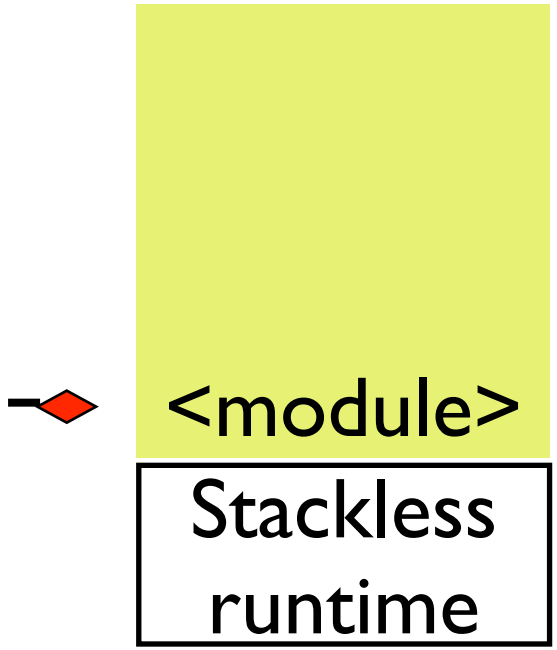
... and Stackless exits

```
import stackless

def greet(s):
    print "Hello,", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

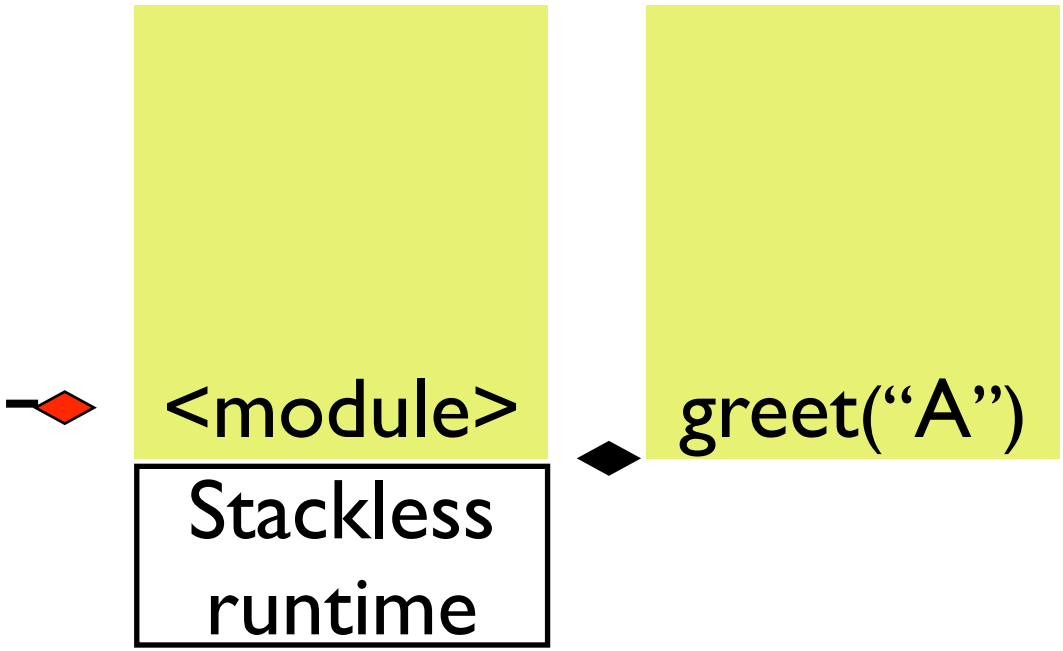
```
Hello, A
Hello, B
```

Starting two tasklets

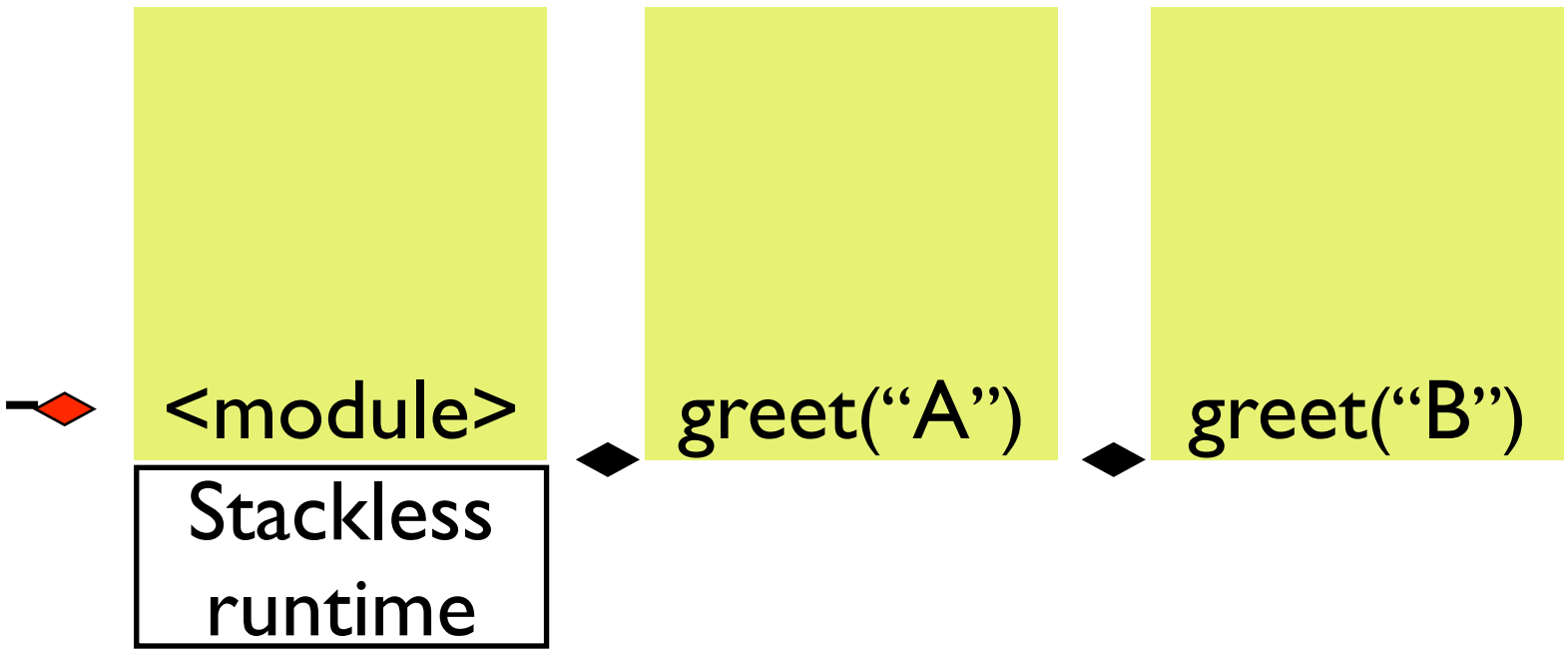
```
import stackless

def greet(s):
    print "Hello,", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```



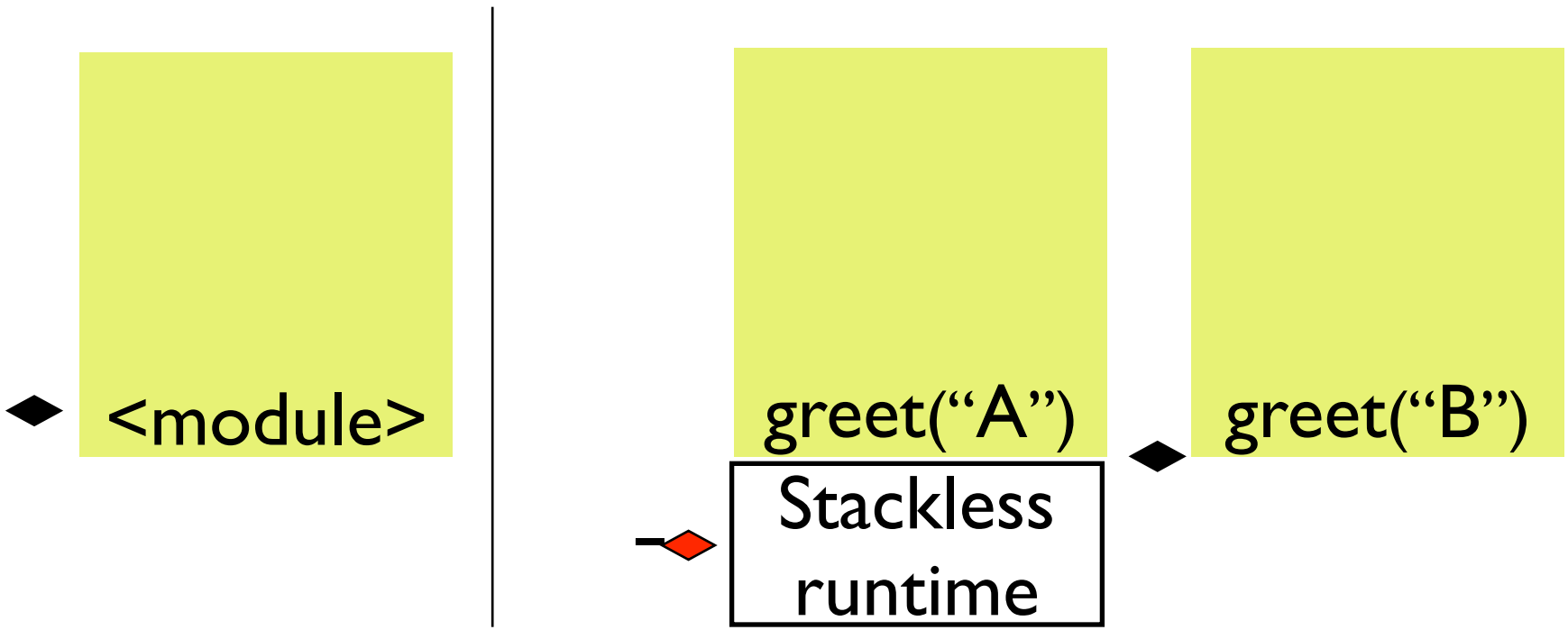
```
import stackless

def greet(s):
    print "Hello,", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```



```
import stackless

def greet(s):
    print "Hello,", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```



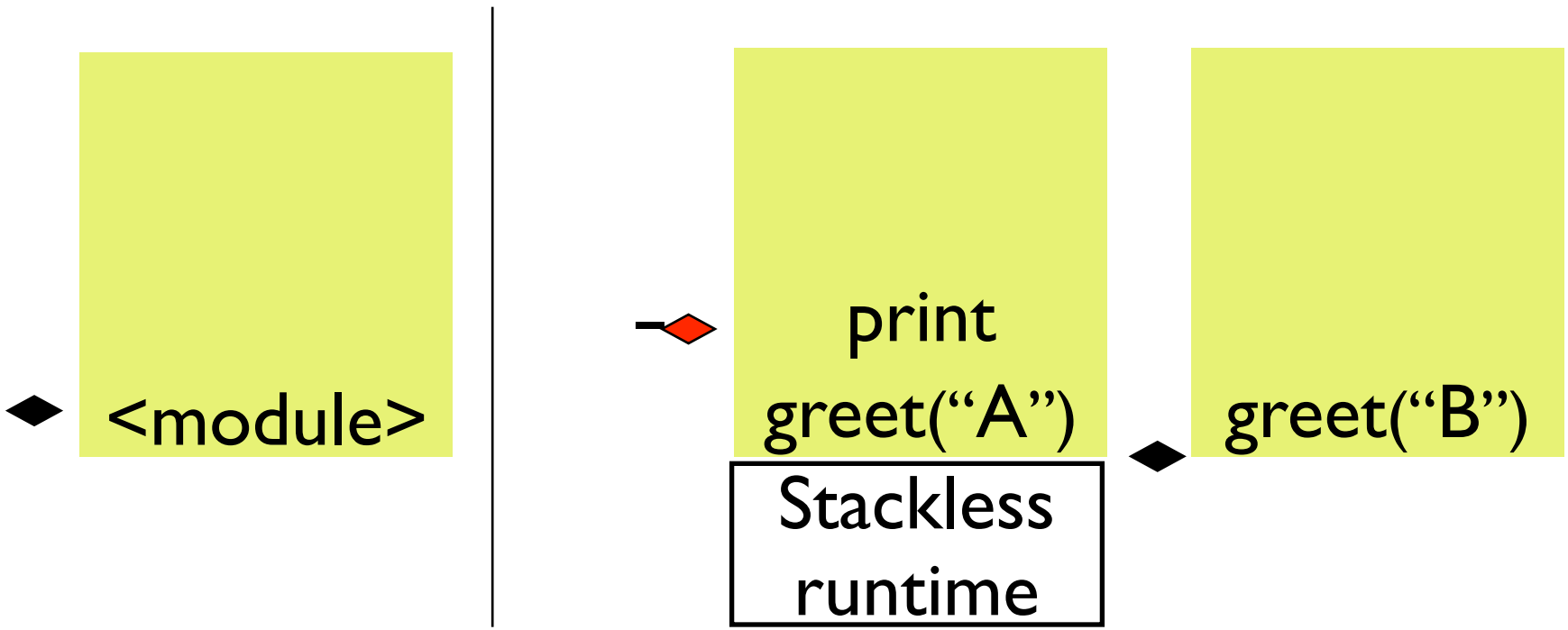
```
import stackless

def greet(s):
    print "Hello,", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```



```
import stackless

def greet(s):
    print "Hello,", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

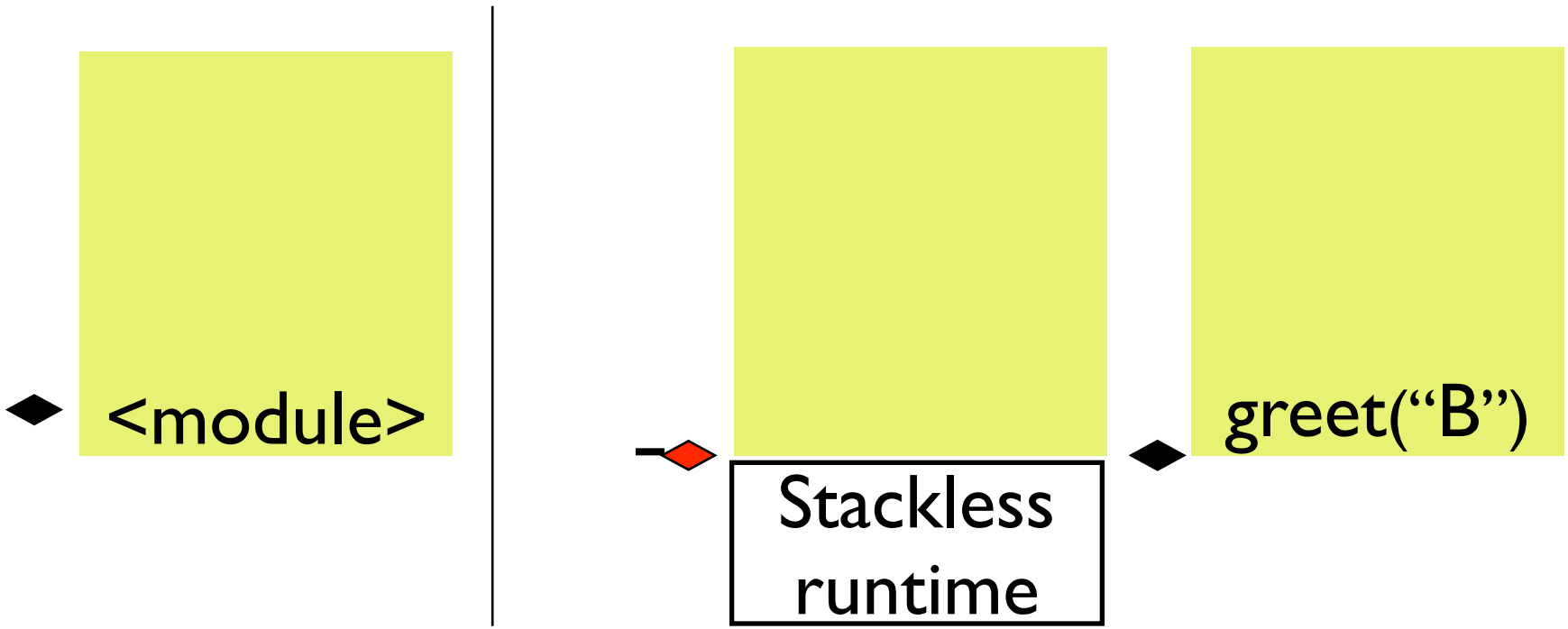
```
import stackless

def greet(s):
    print "Hello,", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

```
Hello, A
```



```
import stackless

def greet(s):
    print "Hello,", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

```
Hello, A
```



```
import stackless

def greet(s):
    print "Hello,", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

```
Hello, A
```

```
import stackless

def greet(s):
    print "Hello,", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

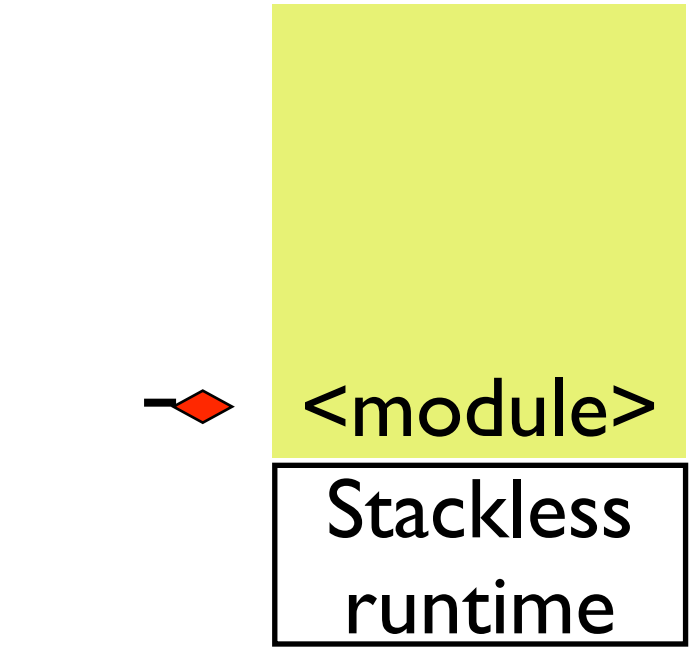
```
Hello, A
Hello, B
```

```
import stackless

def greet(s):
    print "Hello,", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

```
Hello, A
Hello, B
```

```
import stackless

def greet(s):
   print "Hello,", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

```
Hello, A
Hello, B
```



... and Stackless exits

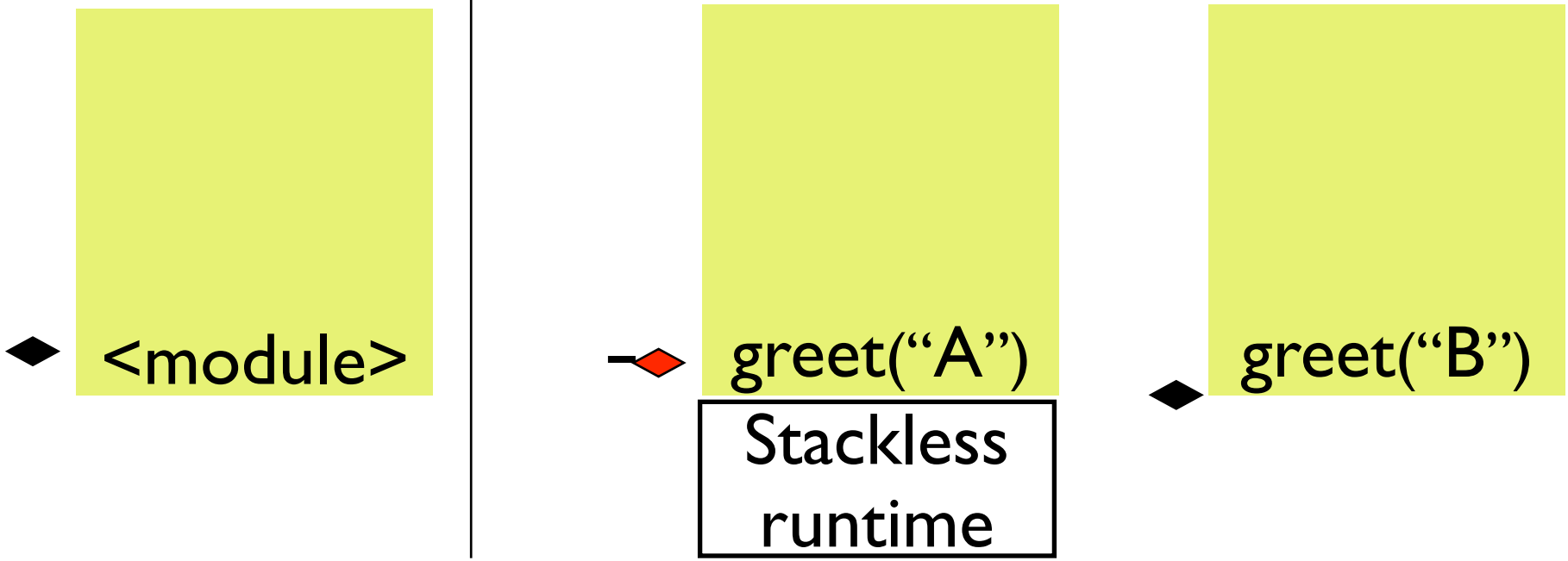
```
import stackless

def greet(s):
    print "Hello,", s
    stackless.schedule()
    print "Goodbye", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

```
Hello, A
Hello, B
Goodbye A
Goodbye B
```

Round-robin scheduling

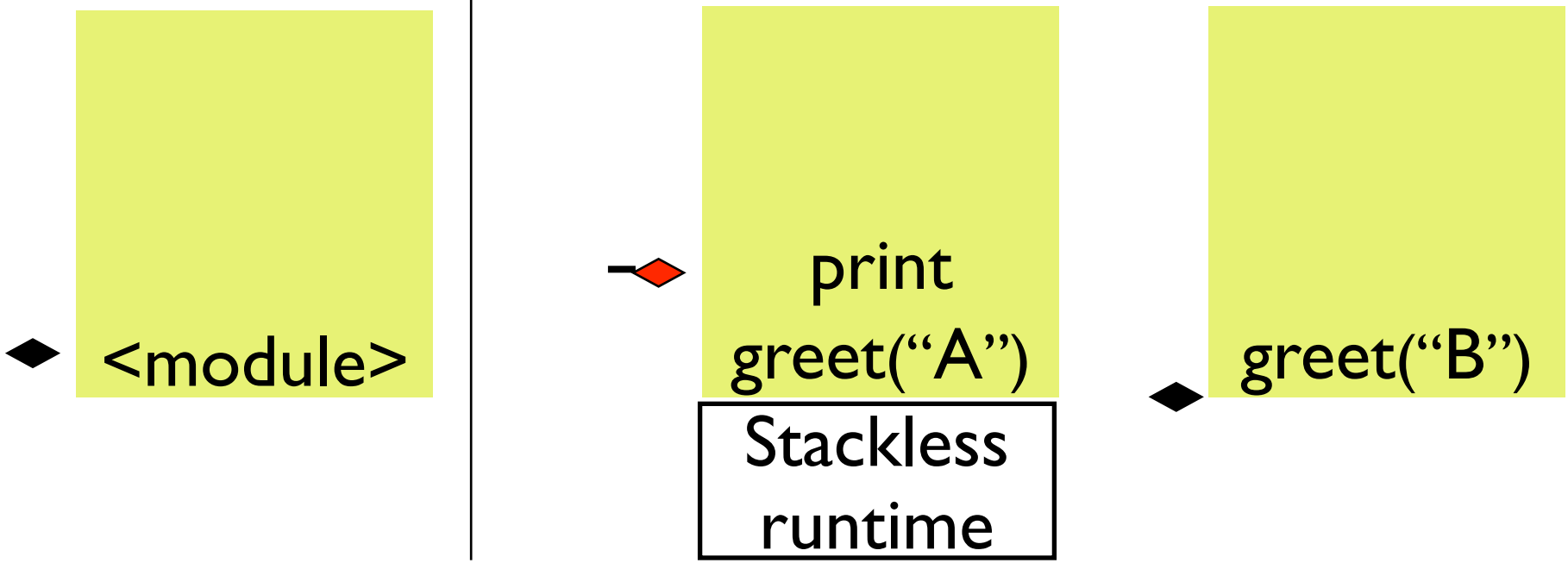
Yield control using “schedule()”

```
import stackless

def greet(s):
    print "Hello,", s
    stackless.schedule()
    print "Goodbye", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```



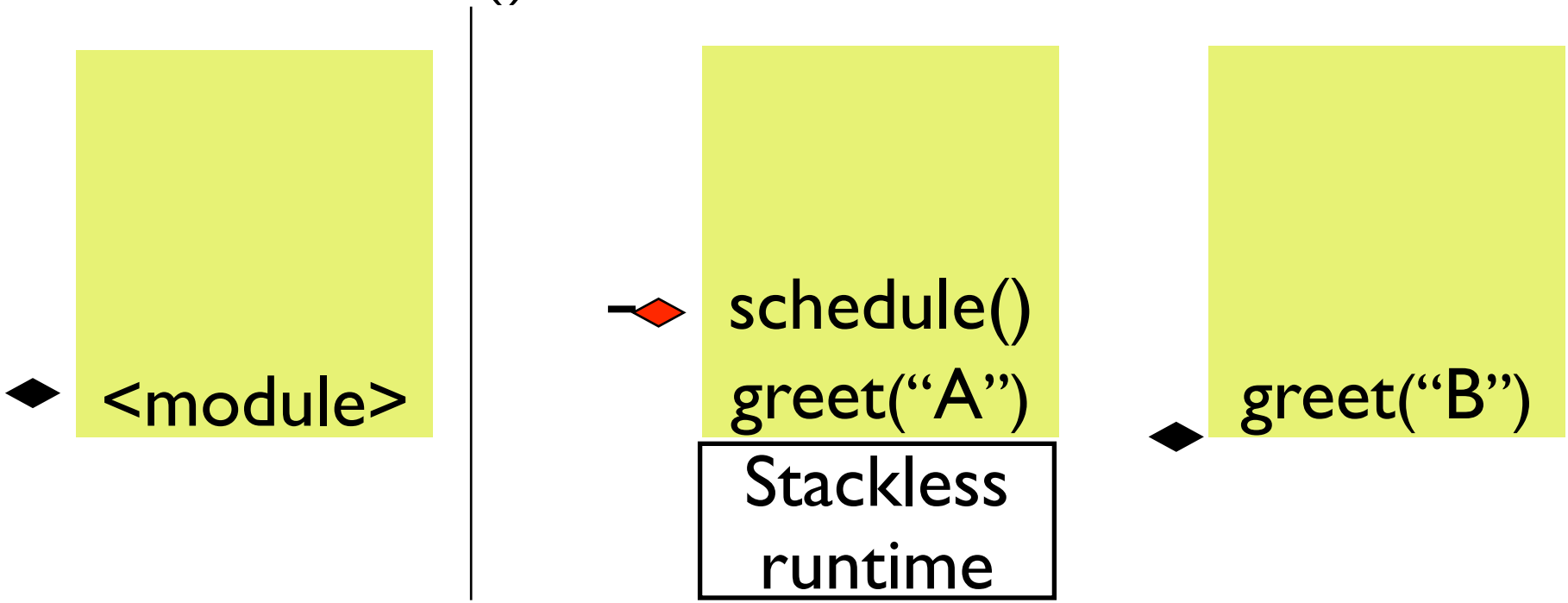
```
import stackless

def greet(s):
    print "Hello,", s
    stackless.schedule()
    print "Goodbye", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

```
Hello, A
```



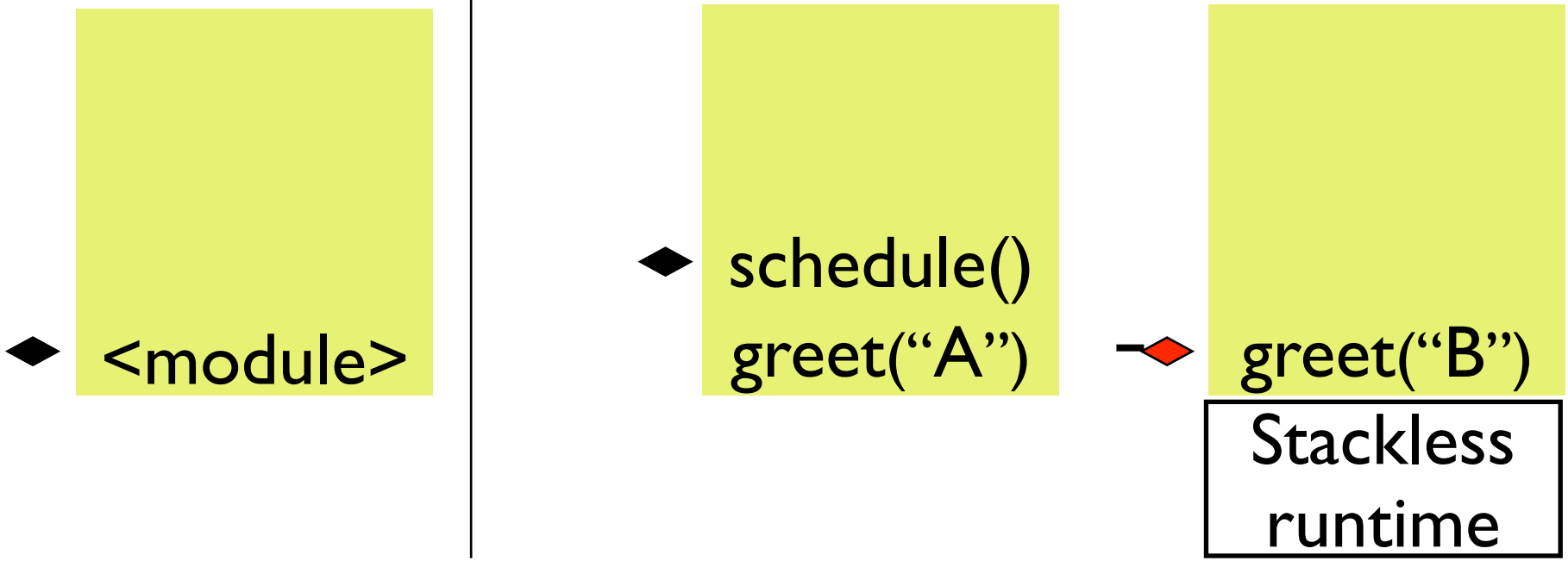
```
import stackless

def greet(s):
    print "Hello,", s
    stackless.schedule()
    print "Goodbye", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

```
Hello, A
```



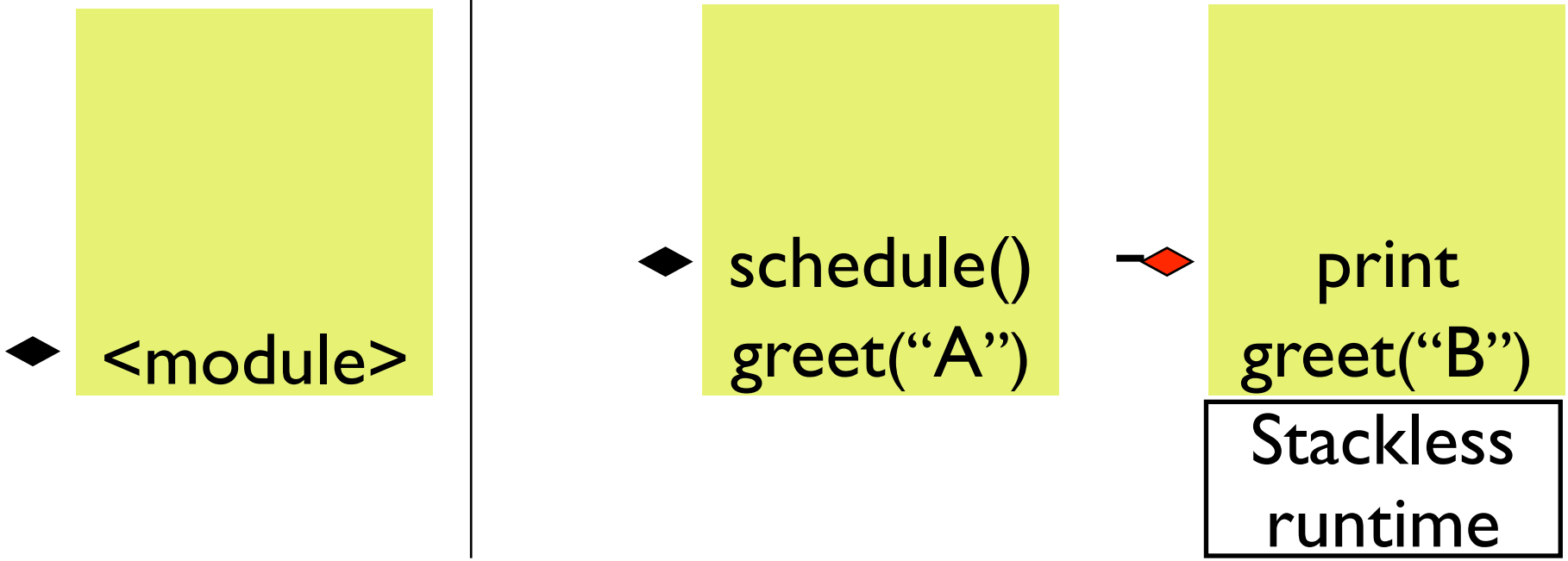
```
import stackless

def greet(s):
    print "Hello,", s
    stackless.schedule()
    print "Goodbye", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

```
Hello, A
```



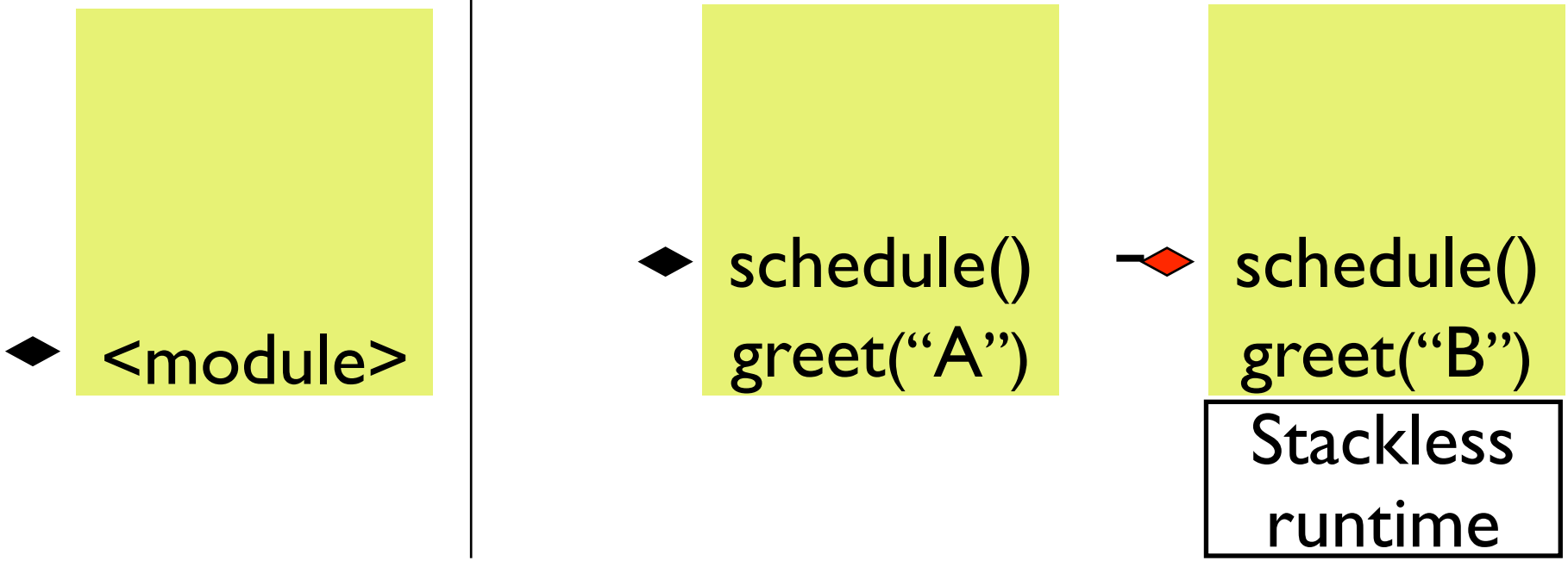
```
import stackless

def greet(s):
    print "Hello,", s
    stackless.schedule()
    print "Goodbye", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

```
Hello, A
Hello, B
```



```
import stackless

def greet(s):
    print "Hello,", s
    stackless.schedule()
    print "Goodbye", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

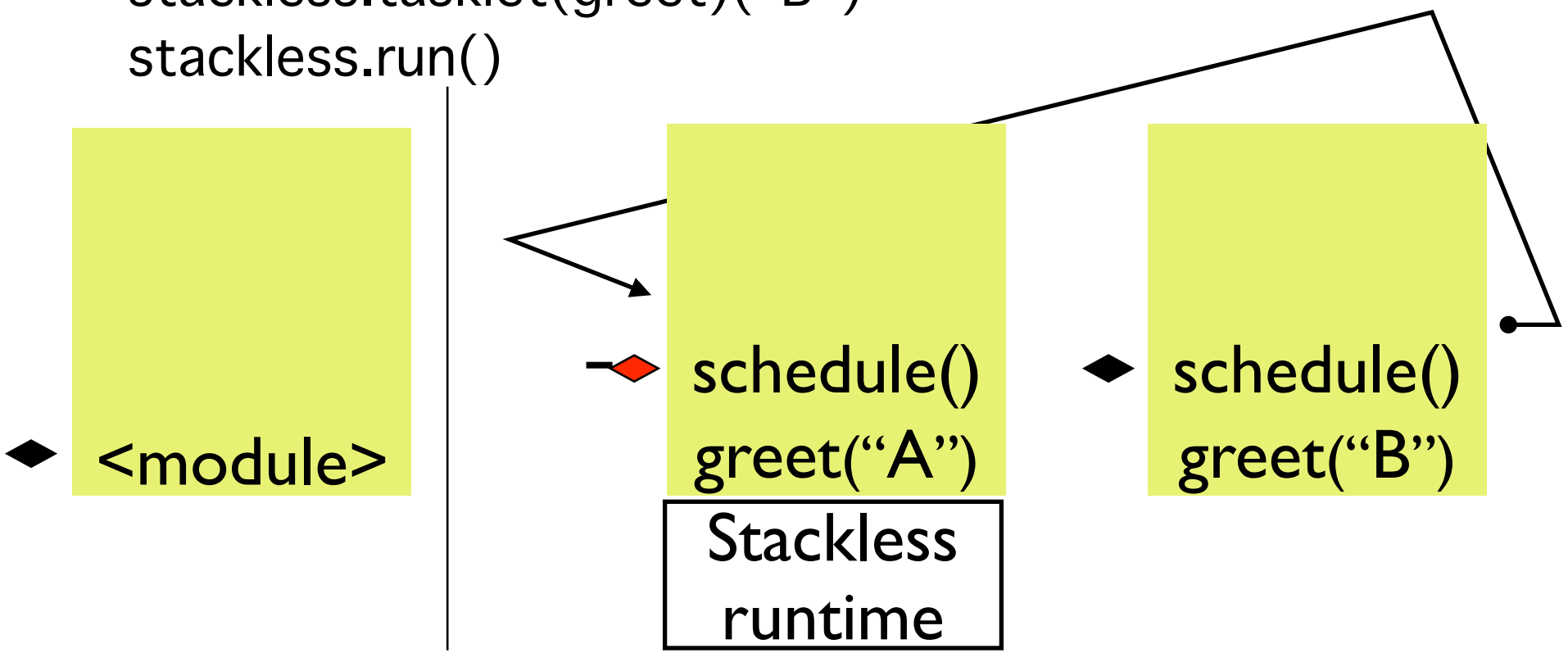
```
Hello, A
Hello, B
```



```
import stackless

def greet(s):
    print "Hello,", s
    stackless.schedule()
    print "Goodbye", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

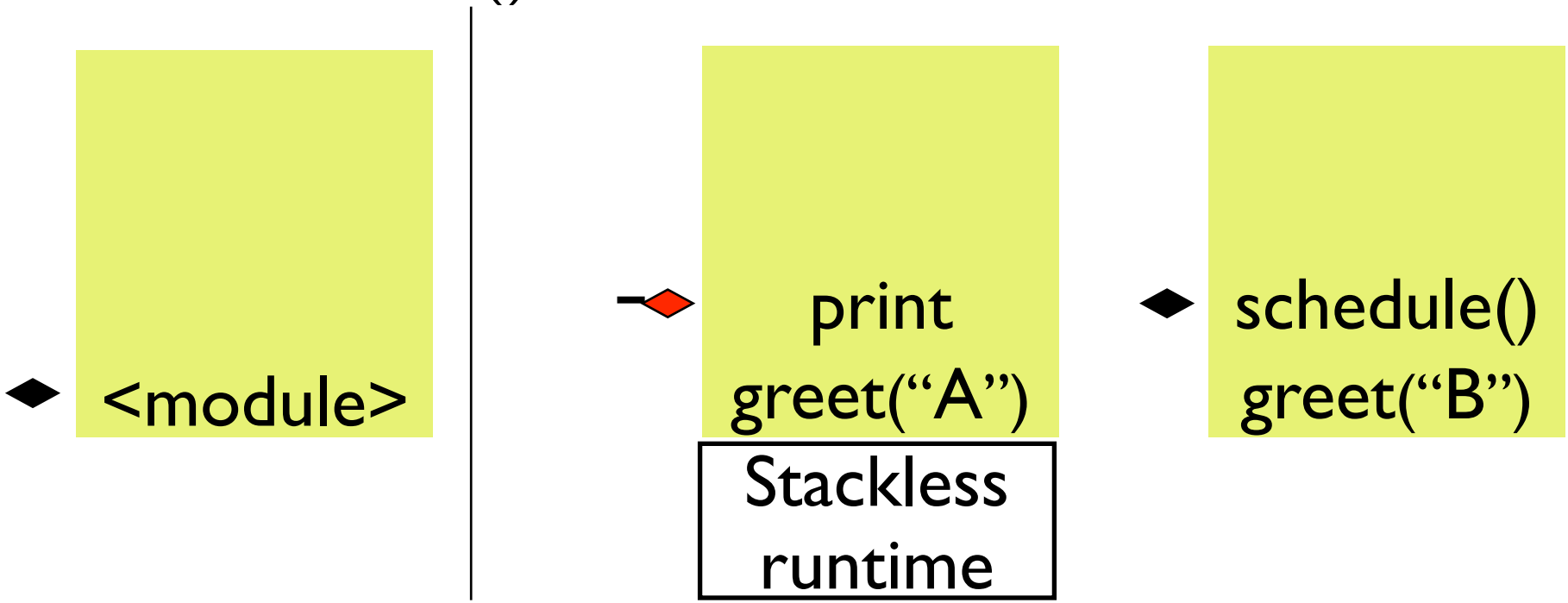
```
Hello, A
Hello, B
```

round-robin to 1st tasklet



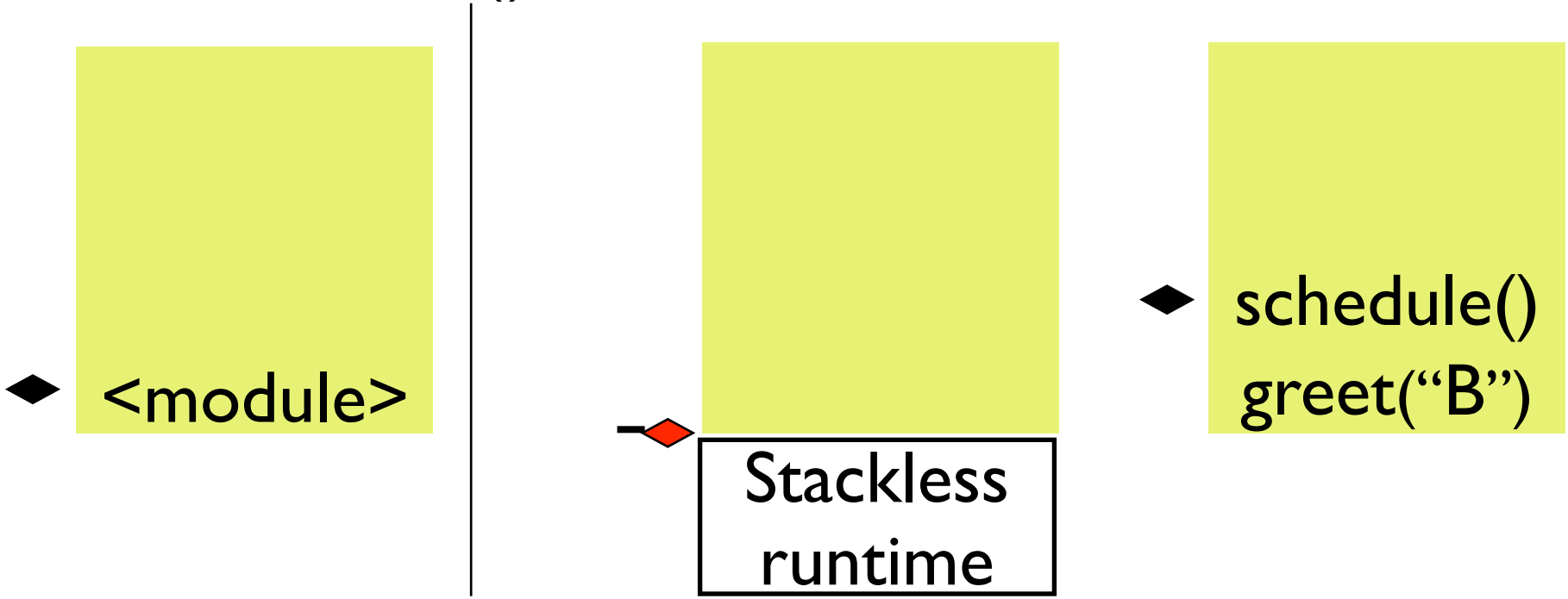
```
import stackless

def greet(s):
    print "Hello,", s
    stackless.schedule()
    print "Goodbye", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

```
Hello, A
Hello, B
Goodbye, A
```



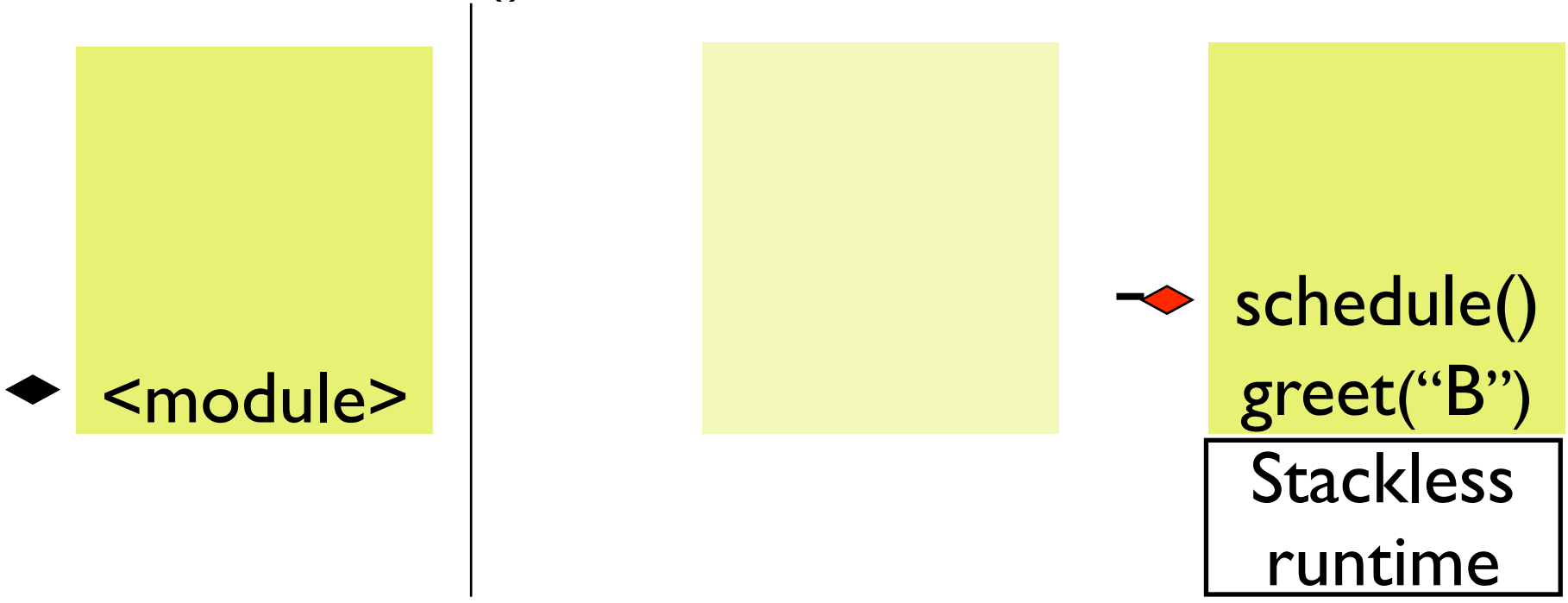
```
import stackless

def greet(s):
    print "Hello,", s
    stackless.schedule()
    print "Goodbye", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

```
Hello, A
Hello, B
Goodbye, A
```



```
import stackless

def greet(s):
    print "Hello,", s
    stackless.schedule()
    print "Goodbye", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

```
Hello, A
Hello, B
Goodbye, A
```



```
import stackless

def greet(s):
    print "Hello,", s
    stackless.schedule()
    print "Goodbye", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

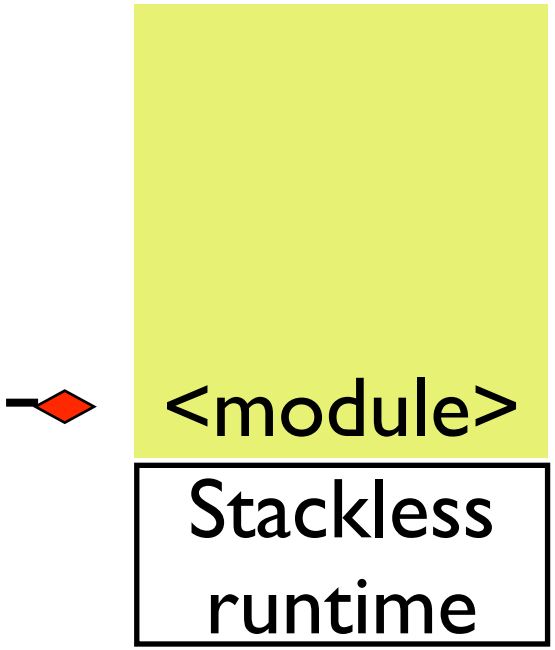
```
Hello, A
Hello, B
Goodbye, A
Goodbye, B
```

```
import stackless

def greet(s):
    print "Hello,", s
    stackless.schedule()
    print "Goodbye", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

```
Hello, A
Hello, B
Goodbye, A
Goodbye, B
```

```
import stackless

def greet(s):
    print "Hello,", s
    stackless.schedule()
    print "Goodbye", s

stackless.tasklet(greet)("A")
stackless.tasklet(greet)("B")
stackless.run()
```

```
Hello, A
Hello, B
Goodbye, A
Goodbye, B
```



... and Stackless exits

Channels

```
ch = stackless.channel()
```

Sending tasklet

```
x = 5
ch.send(x)
print "Sent."
```

Receiving tasklet

```
x = ch.receive()
assert x == 5
```

"send" and "receive" block if the channel has no waiting receiving/sending tasklets.

Blocked tasklets are removed from the run queue and moved to the channel's queue.

```
import stackless

def sending():
    x = 5
    ch.send(x)
    print "Sent."

def receiving():
    x = ch.receive()
    assert x == 5

ch = stackless.channel()
stackless.tasklet(sending)()
stackless.tasklet(receiving)()
stackless.run()
```

```
Sent.
```

Sending tasklet

```
x = 5
ch.send(x)
print "Sent."
```

Receiving tasklet

```
x = ch.receive()
assert x == 5
```

'ch' channel

balance = 0
queue = None

Sending tasklet

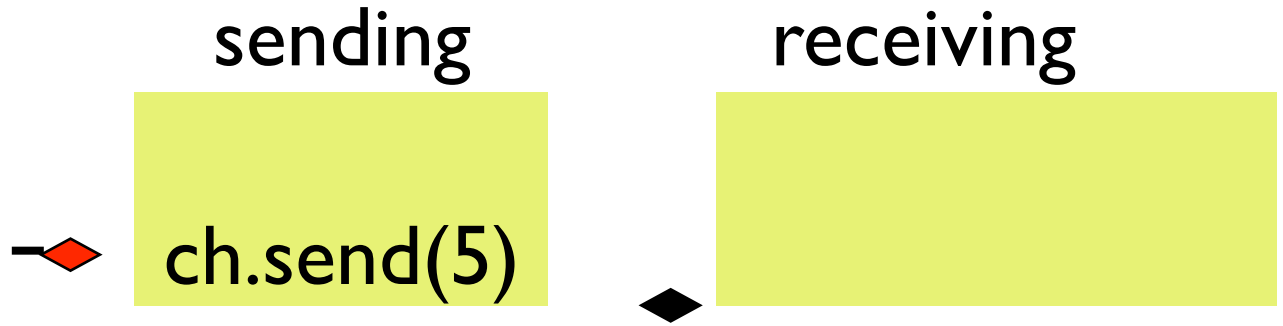
```
x = 5
ch.send(x)
print "Sent."
```

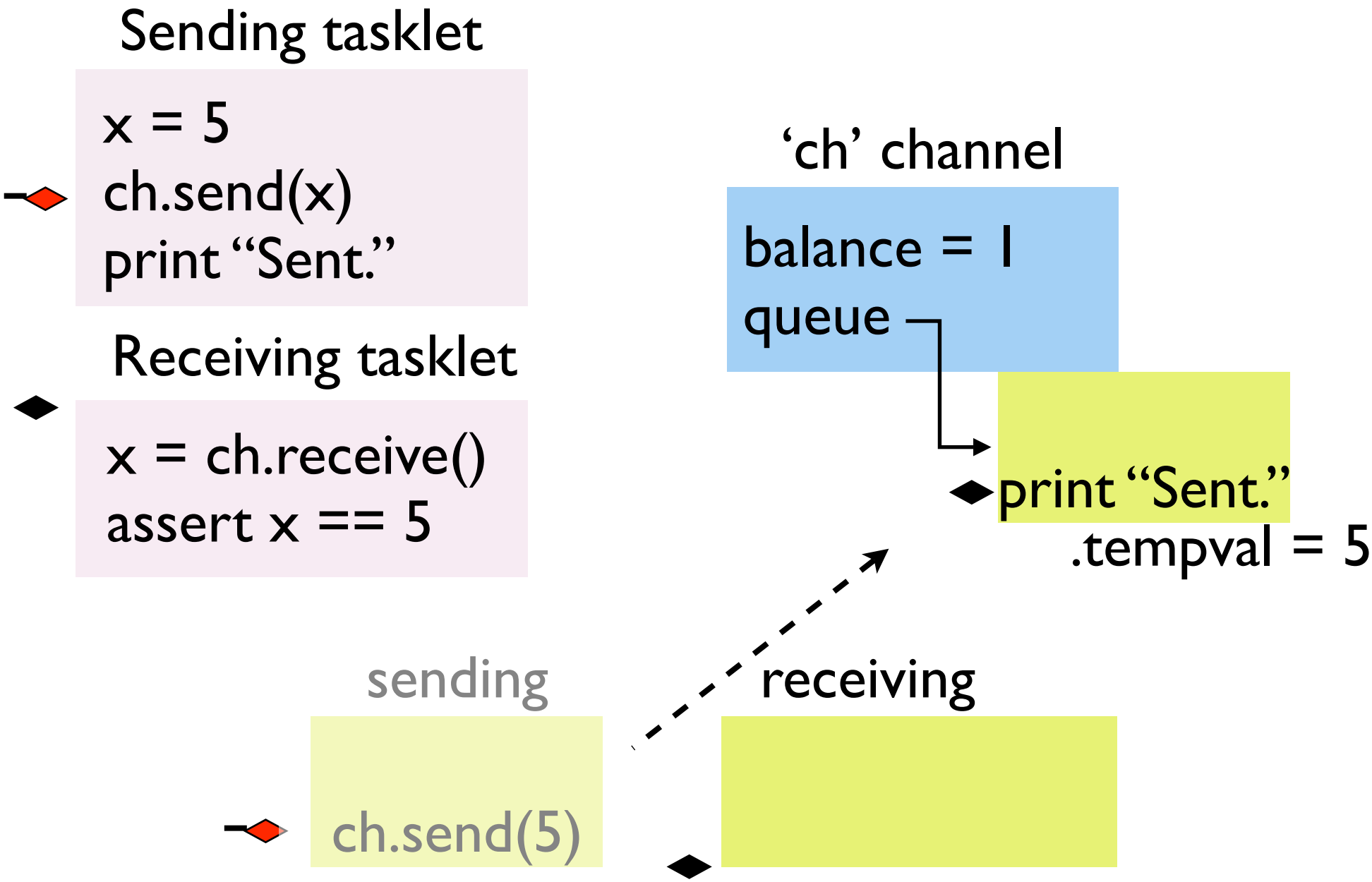
Receiving tasklet

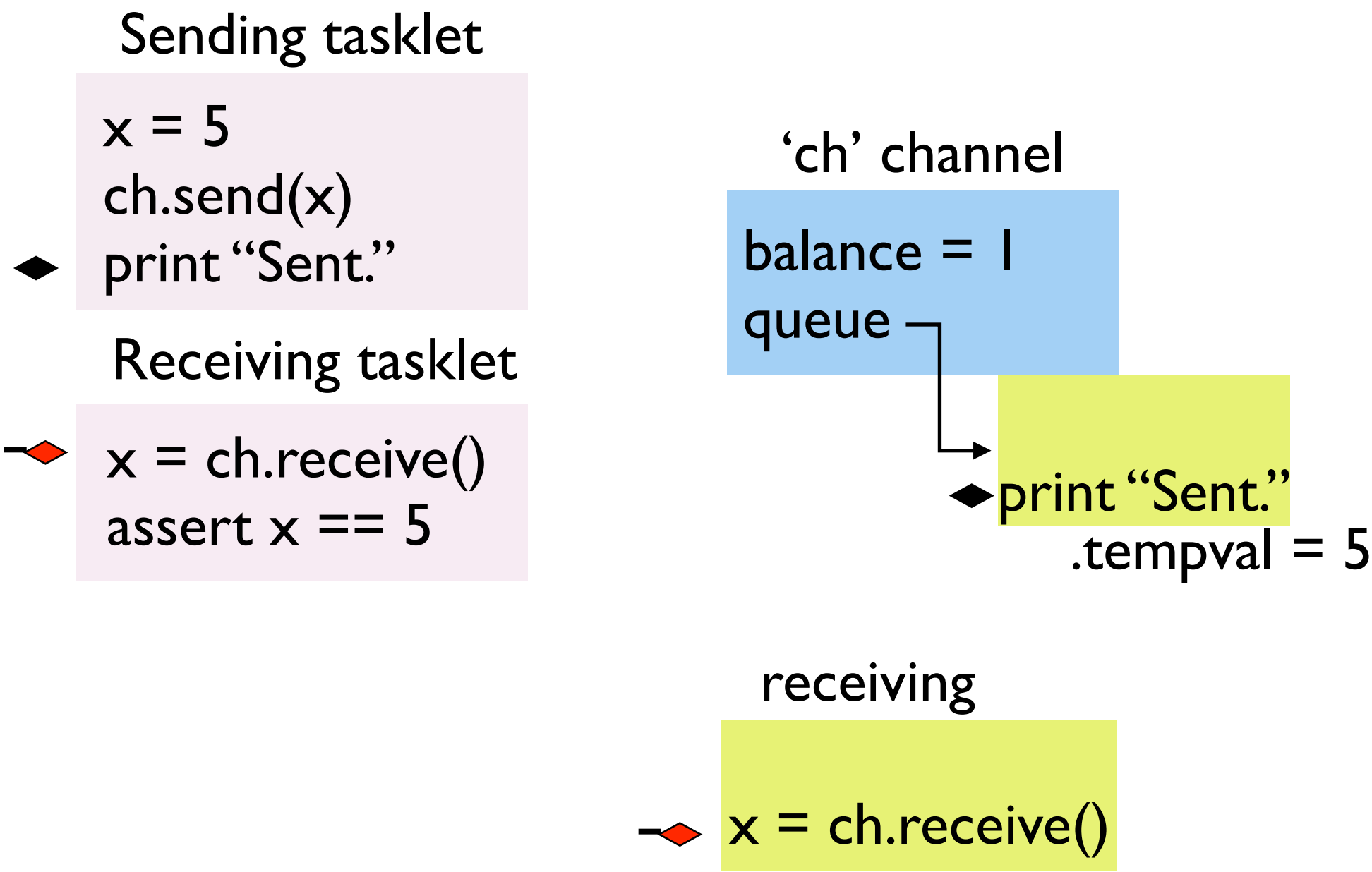
```
x = ch.receive()
assert x == 5
```

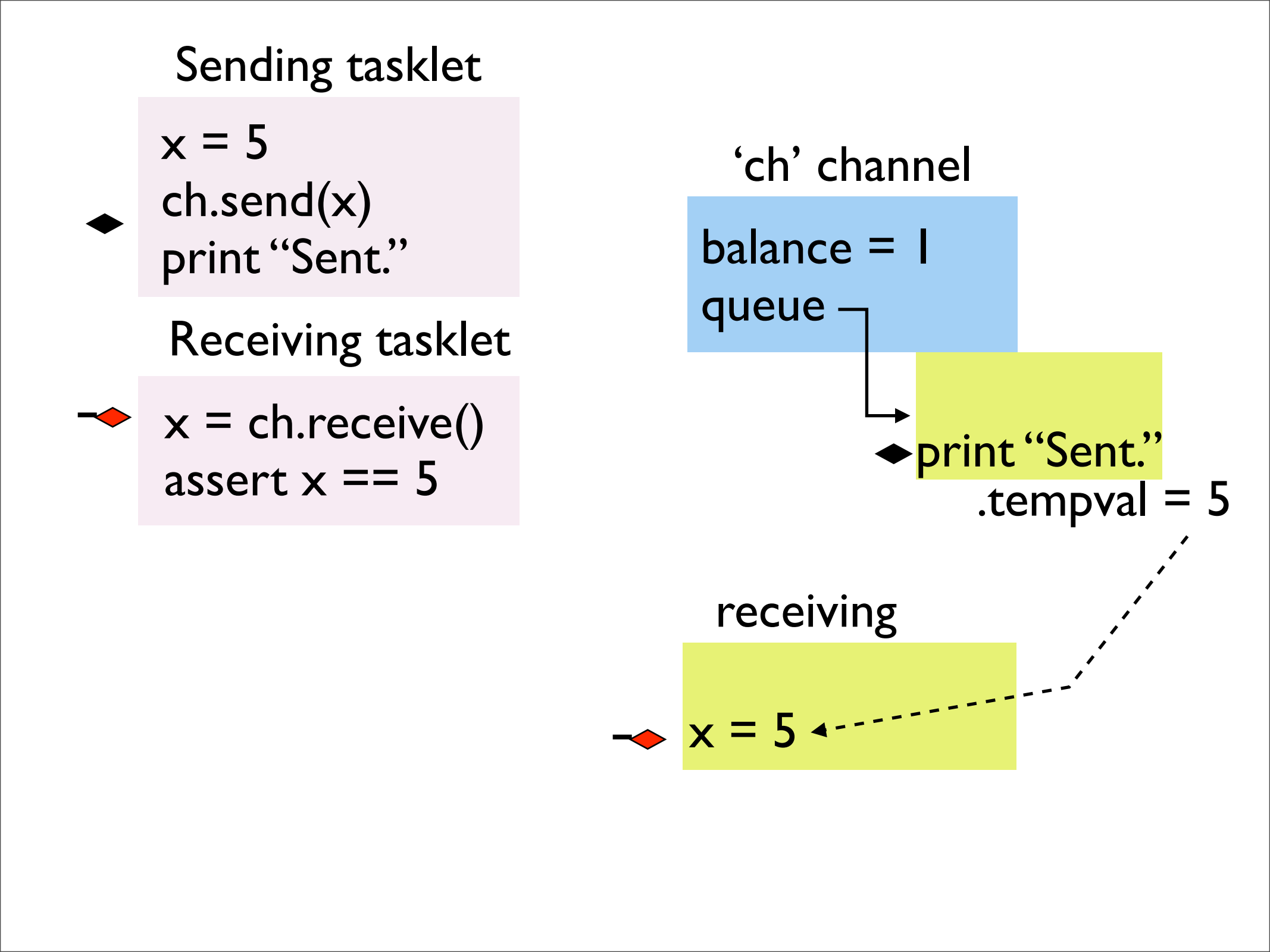
'ch' channel

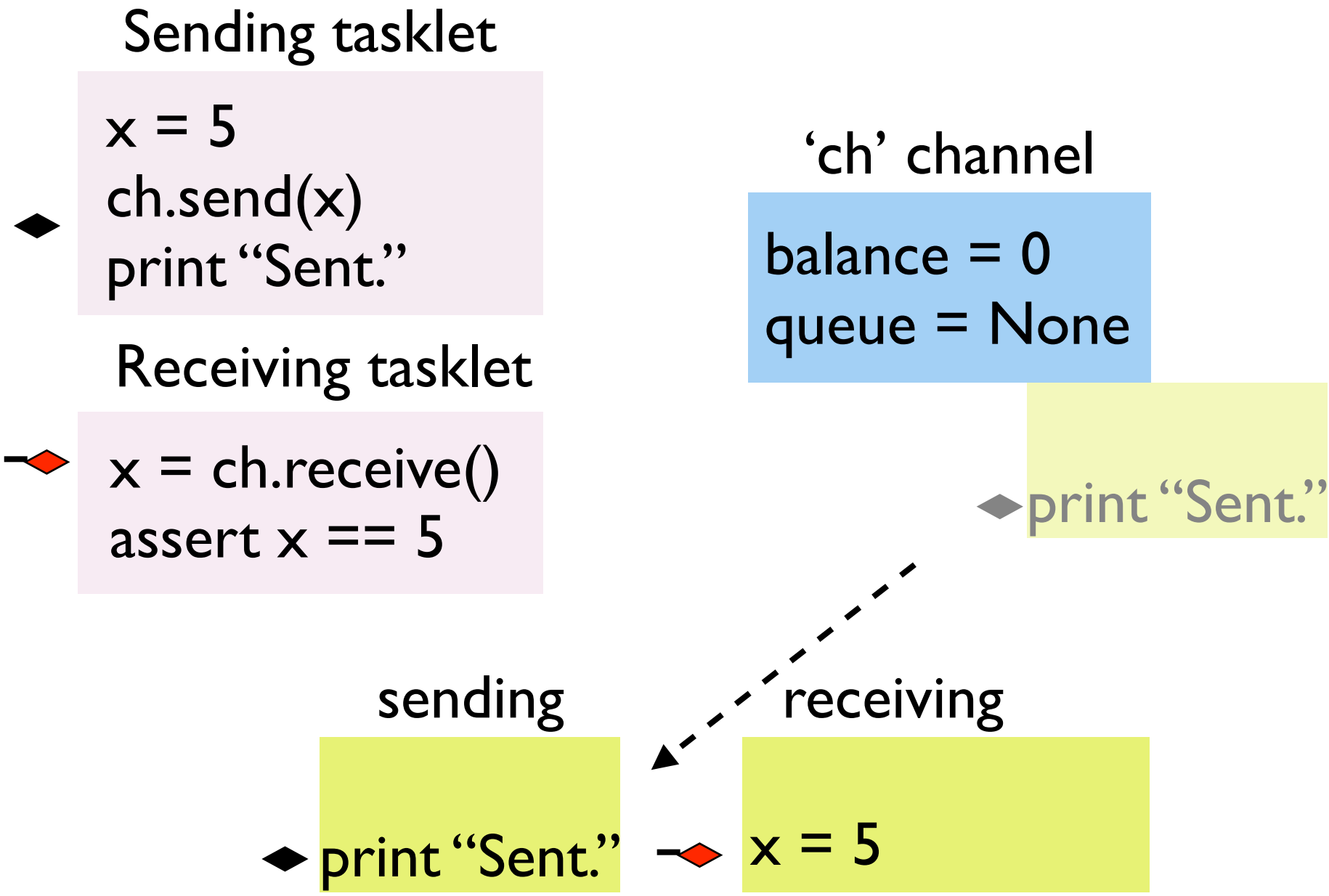
```
balance = 0
queue = None
```




Sending tasklet
x = 5
ch.send(x)
print "Sent."
Receiving tasklet
x = ch.receive()
assert x == 5
'ch' channel
balance = 1
queue
print "Sent."
.tempval = 5
sending
receiving
ch.send(5)


Sending tasklet
x = 5
ch.send(x)
print "Sent."
Receiving tasklet
x = ch.receive()
assert x == 5
'ch' channel
balance = 1
queue
print "Sent."
.tempval = 5
receiving
x = ch.receive()


Sending tasklet
x = 5
ch.send(x)
print "Sent."
Receiving tasklet
x = ch.receive()
assert x == 5
'ch' channel
balance = 1
queue
print "Sent."
.tempval = 5
receiving
x = 5


Sending tasklet
x = 5
ch.send(x)
print "Sent."
Receiving tasklet
x = ch.receive()
assert x == 5
'ch' channel
balance = 0
queue = None
print "Sent."
sending
receiving
print "Sent."
x = 5

Sending tasklet

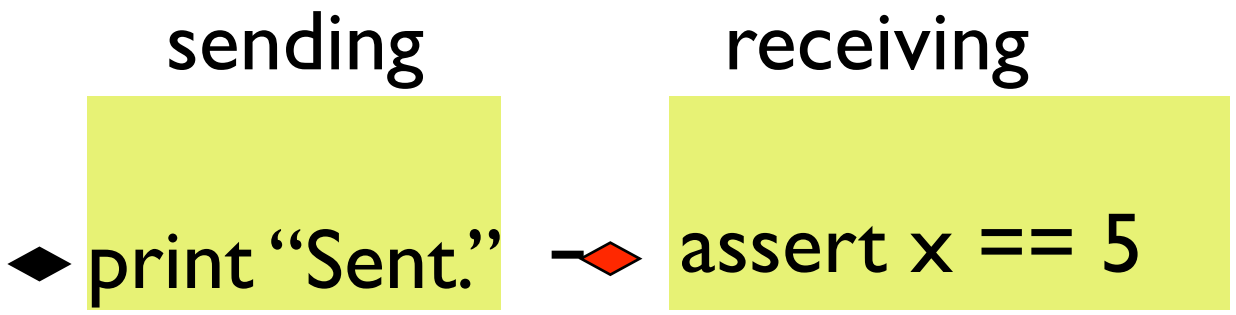
```
x = 5
ch.send(x)
print "Sent."
```

Receiving tasklet

```
x = ch.receive()
assert x == 5
```

'ch' channel

```
balance = 0
queue = None
```



Sending tasklet

```
x = 5
ch.send(x)
print "Sent."
```

Receiving tasklet

```
x = ch.receive()
assert x == 5
```

'ch' channel

```
balance = 0
queue = None
```

sending

```
print "Sent."
```

receiving

Sending tasklet

```
x = 5
ch.send(x)
print "Sent."
```

Receiving tasklet

```
x = ch.receive()
assert x == 5
```

'ch' channel

```
balance = 0
queue = None
```

sending

```
print "Sent."
```

Producer / Consumer

```
import stackless

def producer1():
    print "Starting producer1"
    ch.send("A")
    ch.send("B")

def producer2():
    print "Starting producer2"
    ch.send_sequence( (1, 2, 3) )

def consumer():
    print "Starting consumer"
    for x in ch:
        print repr(x)

ch = stackless.channel()
#ch.preference = 1
for f in (consumer, producer1, producer2):
    stackless.tasklet(f)()
stackless.run()
```

```
Starting consumer
Starting producer1
'A'
Starting producer2
1
'B'
2
3
```

Bidirectional

```
import stackless

request_ch = stackless.channel()
response_ch = stackless.channel()

def divider():
    while 1:
        x, y = request_ch.receive()
        response_ch.send( x/y )
```

```
def divide(top, bottom):
    request_ch.send( (top, bottom) )
    return response_ch.receive()

def main(top, bottom):
    result = divide(top, bottom)
    print "%s/%s = %s" % (top, bottom, result)

stackless.tasklet(divider)()
stackless.tasklet(main)(8, 4)
stackless.run()
```

```
8/4 = 2
```

Exceptions

```
... import and channel setup ...

def divider():
    while 1:
        x, y = request_ch.receive()
        response_ch.send( x/y )
```

```
def divide(top, bottom):
    request_ch.send( (top, bottom) )
    return response_ch.receive()

def main(top, bottom):
    try:
        result = divide(top, bottom)
    except ZeroDivisionError:
        result = None
    print "%s/%s = %s" % (top, bottom, result)

stackless.tasklet(divider)()
stackless.tasklet(main)(8, 0)
stackless.run()
```

```
Traceback (most recent call las
  File "divider.py", line 24, i
    stackless.run()
  File "divider.py", line 9, in
    response_ch.send( x/y )
ZeroDivisionError: integer divi
```

Uncaught exceptions forwarded to main tasklet

```
def divider():
    while 1:
        x, y = request_ch.receive()
        try:
            response_ch.send( x/y )
        except ZeroDivisionError, err:
            response_ch.send_exception(ZeroDivisionError, *err.args)
```

```
def divide(top, bottom):
    request_ch.send( (top, bottom) )
    return response_ch.receive()

def main(top, bottom):
    try:
        result = divide(top, bottom)
    except ZeroDivisionError:
        result = None
    print "%s/%s = %s" % (top, bottom, result)

stackless.tasklet(divider)()
stackless.tasklet(main)(8, 0)
stackless.run()
```

```
8/0 = None
```

Forwarding exceptions

```
while 1:
    x, y = request_ch.receive()
    try:
        response_ch.send( x/y )
    except ZeroDivisionError, err:
        response_ch.send_exception(ZeroDivisionError, *err.args)
```

Ugly

What I would prefer

```
while 1:
    x, y = request_ch.receive()
    try:
        response_ch.send( x/y )
    except ZeroDivisionError, err:
        response_ch.send_exception(err)
```

Can fake it with

```
    ...
    except Exception:
        response_ch.send_exception(WrapperException, sys.exc_info())
```

plus an unwrapper and 3-arg raise around the channel receive

Recursion and the stack

```
def factorial(n):
    if n <= 1:
        return 1
    return n * factorial(n-1)

print "5! =", factorial(5)
try:
    factorial(1000)
except Exception, err:
    print "1000! :", err
```

```
>>> sys.getrecursionlimit()
1000
>>>
```

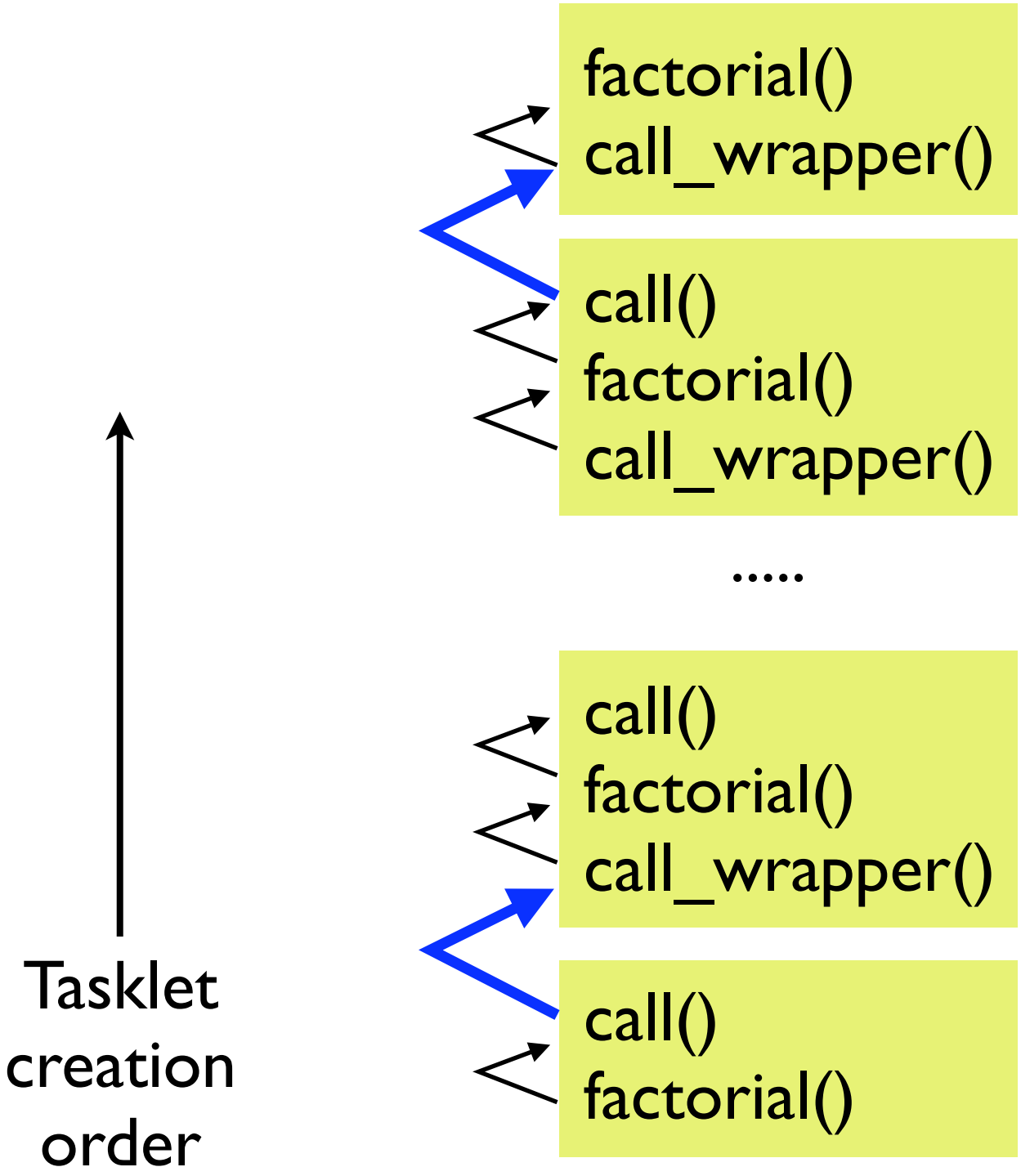
```
5! = 120
1000! : maximum recursion depth exceeded
```

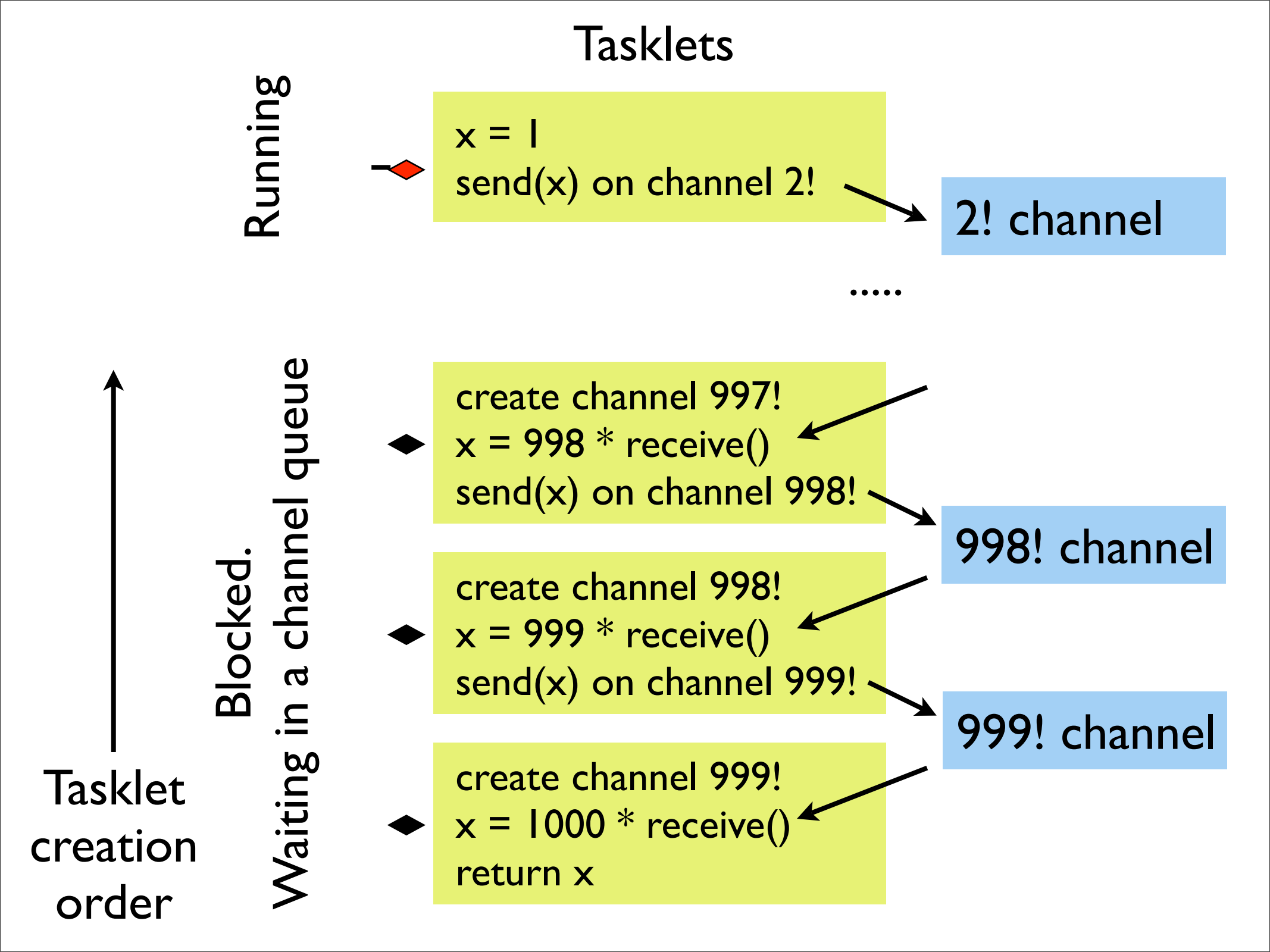
Stackless Recursion

```
import stackless

def call_wrapper(f, args, kwargs, result_ch):
    result_ch.send(f(*args, **kwargs))
    # ... should also catch and forward exceptions ...

def call(f, *args, **kwargs):
    result_ch = stackless.channel()
    stackless.tasklet(call_wrapper)(f, args, kwargs, result_ch)
    return result_ch.receive()

def factorial(n):
    if n <= 1:
        return 1
    return n * call(factorial, n-1)

print "5! =", factorial(5)
print "1000! / 998! =", factorial(1000)/factorial(998)
```

Create a new tasklet and channel for each call

```
5! = 120
1000! / 998! = 999000
```


factorial()
call_wrapper()
call()
factorial()
call_wrapper()
.....
call()
factorial()
call_wrapper()
call()
factorial()
Tasklet
creation
order


Tasklets
Running
x = 1
send(x) on channel 2!
2! channel
.....
Blocked.
Waiting in a channel queue
create channel 997!
x = 998 * receive()
send(x) on channel 998!
998! channel
create channel 998!
x = 999 * receive()
send(x) on channel 999!
999! channel
create channel 999!
x = 1000 * receive()
return x
Tasklet creation order

Scalability

1000 channels, 1000 tasklets
Try that with threads!

What's the overhead in computing 998! ?

Normal Python, recursive algorithm: `2.93 ms`
Stackless Python, recursive algorithm: `3.62 ms`
Stackless Python, Stackless algorithm: `10.3 ms`

Stackless algorithm has 6x more function calls.
The send/receive calls add only 0.8 ms.
1000 calls of object() takes 0.27 ms

Why use Stackless?

Scalable, light-weight threads
Fast inter-tasklet communication

Can use Stackless solutions where you might be cautious of threads

- Convert callback processing into an iterator
- Implement blocking APIs with asynchronous I/O
- Games and simulation programming

XML parsing with SAX

```
import xml.sax

class ElementCountHandler(xml.sax.ContentHandler):
    def startDocument(self):
        self.count = 0
    def startElement(self, tag, attrs):
        self.count += 1

handler = ElementCountHandler()

parser = xml.sax.make_parser()
parser.setContentHandler(handler)
# manually removed the DTD link
parser.parse("iTunes Music Library.xml")

print handler.count, "elements"
```

```
220523 elements
```

What's the problem?

Most people don't like callbacks.

```
count = 0
for event, args in iterparse("iTunes Music Library.xml"):
    if event == "startElement":
        count += 1

print count, "elements"
```

(BTW, Python 2.5 includes ElementTree in the stdlib.
xml.etree.ElementTree.iterparse has a different API.)

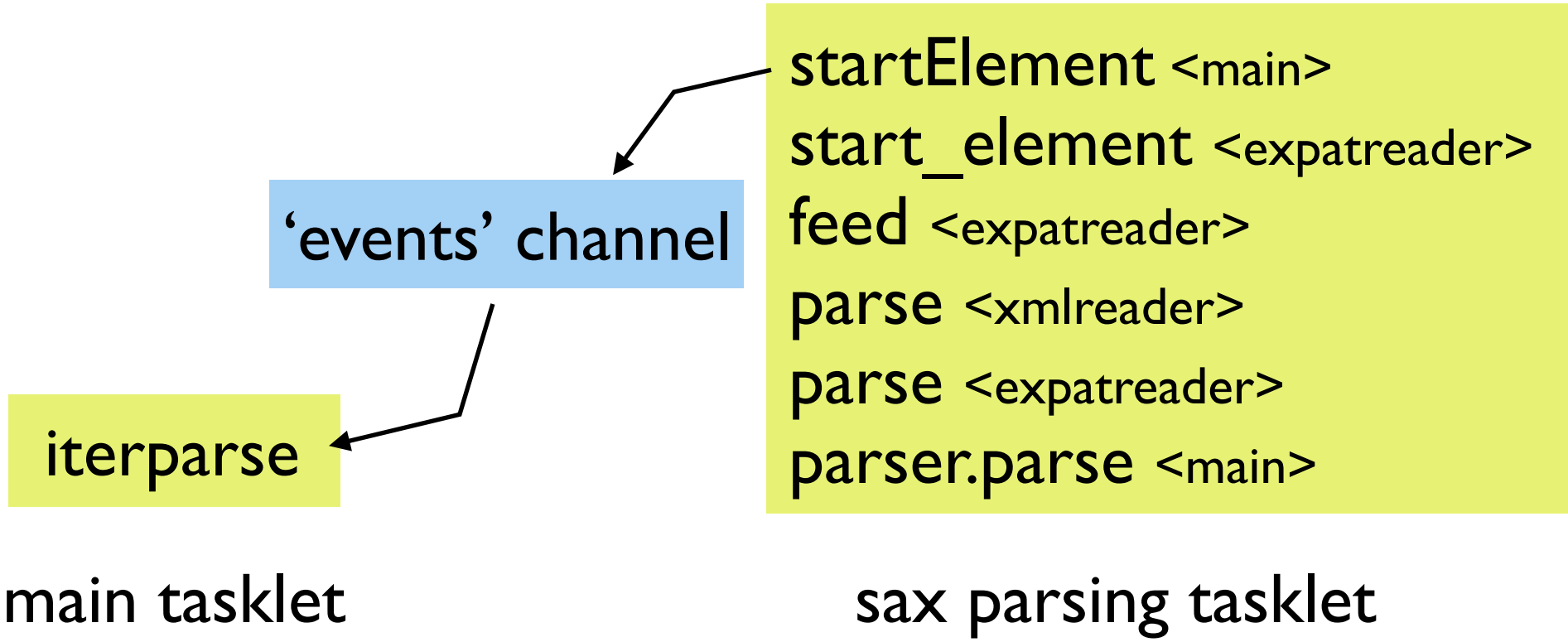
Can't (easily) switch to a generator

Calls expat, a C library

```
File "pycon_sax.py", line 13, in <module>
  parser.parse("iTunes Music Library.xml")
File ".../python2.5/xml/sax/expatreader.py", line 107, in parse
  xmlreader.IncrementalParser.parse(self, source)
File ".../python2.5/xml/sax/xmlreader.py", line 123, in parse
  self.feed(buffer)
File ".../python2.5/xml/sax/expatreader.py", line 207, in feed
  self._parser.Parse(data, isFinal)
File ".../python2.5/xml/sax/expatreader.py", line 301, in start_element
  self._cont_handler.startElement(name, AttributesImpl(attrs))
File "pycon_sax.py", line 7, in startElement
  1/0
```

Added "1/0" to get the stack trace

With Stackless you control the stack



```
import xml.sax
import stackless

class StacklessIterHandler(xml.sax.ContentHandler):
    def __init__(self, events):
        self.events = events

    def startElement(self, tag, attrs):
        self.events.send( ("startElement", (tag, attrs)) )


def iterparse(filename):
    events = stackless.channel()

    handler = StacklessIterHandler(events)
    parser = xml.sax.make_parser()
    parser.setContentHandler(handler)
    stackless.tasklet(parser.parse)(filename)

    return iter(events)
```

```
220523 elements
```

“robust” implementation must handle XML errors

set an error handler and send any errors to the ‘events’ channel as an exception

- and/or -

put a wrapper around parser.parse() which catches all exceptions and forwards them to the ‘events’ channel

Scalability

Parsing an 6 MB XML file with 220,523 elements

Normal Python, counter in handler:	1.46 s
Stackless Python, counter in handler:	1.49 s
Stackless iterparser:	2.25 s
threaded, lock around a deque:	2.34 s
threaded, using Queue.Queue(1000):	13.1 s

lock+deque based on approach by Santiago Gala
Queue version almost identical to Stackless version

Networking APIs

Blocking

Use threads for parallel I/O

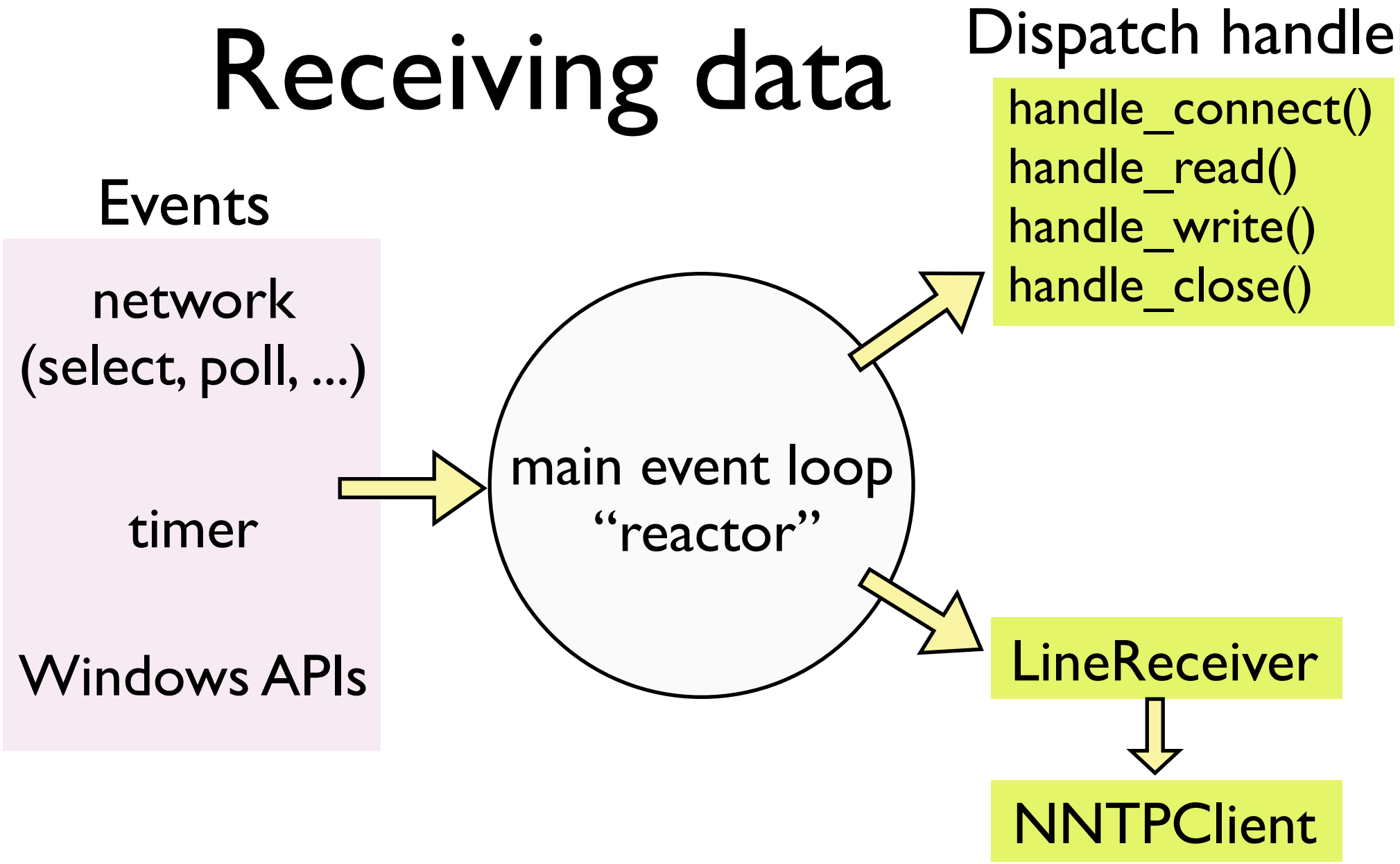
Asynchronous

Event and callback based

- asyncore (in stdlib)
- Twisted

```
f = urllib2.urlopen(url)
print f.read()
```

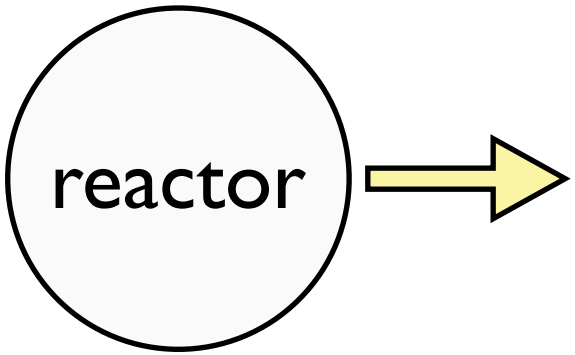
Receiving data



Handlers are callback functions

```
import asyncore, socket

class http_client(asyncore.dispatcher):
    def __init__(self, host, path):
        asyncore.dispatcher.__init__(self)
        self.create_socket(socket.AF_INET, socket.SOCK_STREAM)
        self.connect( (host, 80) )
        self.buffer = ('GET %s HTTP/1.0\r\nHost: %s\r\n\r\n' %
                       (path, host))
    def handle_connect(self):
        pass

    def writable(self):
        return (len(self.buffer) > 0)

    def handle_write(self):
        sent = self.send(self.buffer)
        self.buffer = self.buffer[sent:]

    def handle_read(self):
        print self.recv(8192)

    def handle_close(self):
        self.close()

c = http_client('www.python.org', '/')
asyncore.loop()
```

Based on the example in the asyncore documentation



stackless_http_client

```
handle_read():
  read_channel.send(self.recv(8192))
handle_close()
  read_channel.close()
```

stackless_urlopen

```
parse url
make ‘read_channel’
make stackless_http_client tasklet
return StacklessFileAdapter
```

‘read_channel’

StacklessFileAdapter

```
read():
  s = "".join(read_channel)
  i = s.index("\r\n\r\n")
  return s[i+4:]
```

```
f = stackless_urlopen(url)
print f.read()
```

Details

```
import asyncore, socket, urlparse, stackless

class stackless_http_client(asyncore.dispatcher):
  def __init__(self, host, path, read_channel):
    asyncore.dispatcher.__init__(self)
    self.create_socket(socket.AF_INET, socket.SOCK_STREAM)
    self.connect( (host, 80) )
    self.buffer = 'GET %s HTTP/1.0\r\nHost: %s\r\n\r\n' % (path, host)
    self.read_channel = read_channel

  def handle_connect(self):
    pass

  def handle_read(self):
    self.read_channel.send(self.recv(8192))

  def handle_close(self):
    self.read_channel.close()
    self.close()

  def writable(self):
    return (len(self.buffer) > 0)

  def handle_write(self):
    sent = self.send(self.buffer)
    self.buffer = self.buffer[sent:]
```

```
class StacklessFileAdapter(object):
  def __init__(self, read_channel):
    self.read_channel = read_channel
  def read(self):
    s = "".join(self.read_channel)
    # Skip the http response headers
    i = s.index("\r\n\r\n")
    return s[i+4:]


def stackless_urlopen(url):
  scheme, netloc, path, query, fragment = \
          urlparse.urlsplit(url)
  if ":" in netloc:
    raise TypeError("bad netloc")
  read_channel = stackless.channel()
  stackless.tasklet(stackless_http_client)(
         netloc, path, read_channel)
  return StacklessFileAdapter(read_channel)
```

This almost works

```
def call_asyncore_loop():
    while 1:
        stackless.schedule()
        asyncore.loop(count=1)

def fetch(url):
    f = stackless_urlopen(url)
    print f.read()

stackless.tasklet(call_asyncore_loop)()
stackless.tasklet(fetch)("http://www.python.org/")
stackless.tasklet(fetch)("http://docs.python.org/")
stackless.run()
```

This almost works

```
def call_asyncore_loop():
    while 1:
        stackless.schedule()
        asyncore.loop(count=1)

def fetch(url):
    f = stackless_urlopen(url)
    print f.read()

stackless.tasklet(call_asyncore_loop)()
stackless.tasklet(fetch)("http://www.python.org/")
stackless.tasklet(fetch)("http://docs.python.org/")
stackless.run()
```

Daemon does not know when to exit

Blocks for 30 seconds while waiting for I/O: Non-I/O tasklets don't run

Never returns (call_asyncore_loop never finishes)

App-specific questions

- When does your program exit?
- Are there background/low-priority tasks?
- Any non-I/O tasks yielding time with schedule()?
- Can tasks sleep?
- Does it use gtk, qt, wx, Windows, ... event loop?
- Or work with multiple event loops?
- Do tasklets communicate with system threads?
- Is busy-waiting okay?

Don’t block in asyncore if other tasklets are running

```
def call_asyncore_loop():
    while 1:
        stackless.schedule()
        # Are there any non-blocked tasklets?
        # This tasklet and the main tasklet are
        # always running.
        if stackless.getruncount() == 2:
            timeout = 30
        else:
            timeout = 0
        asyncore.loop(timeout=timeout, count=1)
```

Distinguish between daemonic and non-daemonic tasklets

```
# Assume normal tasklets are daemonic
stackless.tasklet(call_asyncore_loop)()

# Track “run tasklets” which must go to completion
run_tasklet(fetch)("http://www.python.org/")
run_tasklet(fetch)("http://docs.python.org/")

# Run until all “run tasklets” are finished
run_all_tasklets()
```

(You might prefer using an “is_finished” flag.)

Implementation

(kinda ugly)

```
_running_tasklet_count = 0

def run_tasklet(f):
    global _running_tasklet_count
    _running_tasklet_count += 1

    def tasklet_wrapper(*args, **kwargs):
      global _running_tasklet_count
      try:
          return f(*args, **kwargs)
      finally:
          _running_tasklet_count -= 1

    return stackless.tasklet(tasklet_wrapper)

def run_all_tasklets():
    while 1:
        stackless.schedule()
        if _running_tasklet_count == 0:
            break
```

Turn it into a library?

Maybe.

Experimental

Does 80/20 apply?

Use Twisted? It understands the hard parts.
("Stackless and Twisted" talk for next year?)

Does anyone really want this approach?

Monkeypatching

Richard Tew's "stacklessocket.py" module implements the socket module API

```
import sys
import stacklesssocket
sys.modules["socket"] = stacklesssocket
```

```
>>> import socket
>>> socket is stacklesssocket
True
>>> import httplib
>>> httplib.socket is stacklesssocket
True
>>>
```

Some stdlib modules "just work"

```
import urllib2

def fetch(url):
    f = urllib2.urlopen(url)
    print f.read()

# Provide my own manager
stacklesssocket.managerRunning = True
stackless.tasklet(call_asyncore_loop)()

run_tasklet(fetch)("http://www.python.org/")
run_tasklet(fetch)("http://docs.python.org/")
run_all_tasklets()
```

It's a hack! But very cool.

Blocking calls still block

- "subprocess" module uses `waitpid` and `select`
- can those be monkeypatch?

Some stdlib modules aren't thread-safe

- but Stackless has weaker requirements
  than system threads

Actor-based programming

Semi-independent interacting objects with complex actions

Games: each character, spaceship, gun, bullet, door, ... gets its own tasklet

```
def squarebot(bot):
  while 1:
    for _ in range(3):
      bot.shoot()
      bot.forward(10)
      bot.turn(90)
    bot.shoot()
    bot.forward(10)
    bot.turn(randrange(0, 360))
```

```
def spinbot(bot):
  while 1:
    bot.turn(5)
    bot.shoot()
```

```
def bullet(bullet, dx, dy):
  x, y = bullet.pos
  while in_bounds(bullet):
    x += dx; y += dy
    bullet.move_to(x, y)
    bot = find_bot(bullet)
    if bot is not None:
      bot.add_damage(-10)
      break
    stackless.schedule()
```

Actor-based programming

EVE Online from CCP Games uses 100,000s of tasklets

For more on games and simulation programming, see Grant Olson's excellent tutorial "*Introduction to Concurrent Programming with Stackless Python*"

http://members.verizon.net/olsongt/stackless/why_stackless.html

or follow link from the Stackless home page

State of Stackless

Stable. Working. Supported.

Will not be part of core CPython.
Is an implementation for PyPy
See Christian Tismer's talk on Sunday, 1:30pm

Not widely used but is in successful commercial use

Needs documentation, tools, and advocacy

Missing experience and concrete idea of best practices

http://stackless.com/