Files, formatted output, passing parameters

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Programming and Data Structures with Python

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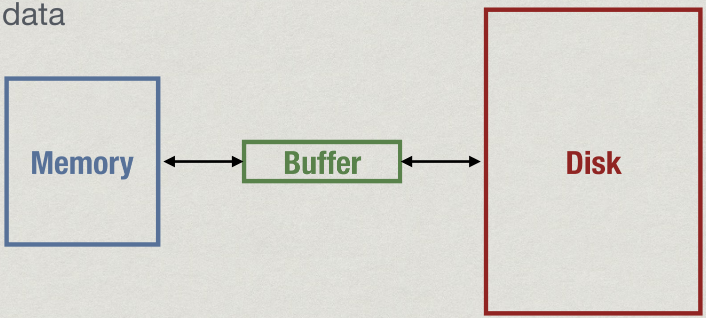
Dealing with files

- Standard input and output is not convenient for large volumes of data
- Instead, read and write files on the disk
- Disk read/write is much slower than memory

Disk buffers

- Disk data is read/written in large blocks
- “Buffer” is a temporary parking place for disk data



Reading/writing disk data

- Open a file — create file handle to file on disk
  - Like setting up a buffer for the file
- Read and write operations are to file handle
- Close a file
  - Write out buffer to disk (flush)
  - Disconnect file handle

Opening a file

```
fh = open("gcd.py", "r")
```

- First argument to `open` is file name
  - Can give a full path
- Second argument is mode for opening file
  - Read, `"r"`: opens a file for reading only
  - Write, `"w"`: creates an empty file to write to
  - Append, `"a"`: append to an existing file

Read through file handle

```
contents = fh.read()
```

- Reads entire file into name as a single string

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  - String includes the `'\n'`, unlike `input()`

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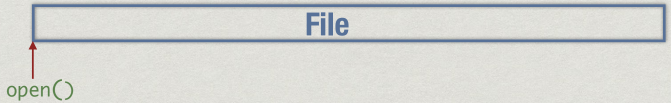
- Reads one line into name—lines end with `'\n'`
  - String includes the `'\n'`, unlike `input()`

```
contents = fh.readlines()
```

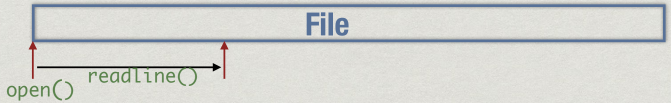
- Reads entire file as list of strings
  - Each string is one line, ending with `'\n'`

Reading files



- Reading is a sequential operation
  - When file is opened, point to position 0, the start

Reading files



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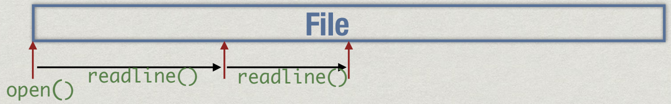
Reading files



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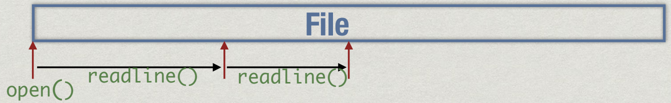
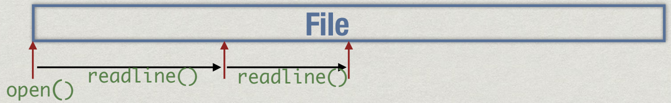
Reading files



- Reading is a sequential operation
  - When file is opened, point to position 0, the start
  - Each successive `readline()` moves forward
- `fh.seek(n)` — moves pointer to position `n`

Reading files



- Reading is a sequential operation
    - When file is opened, point to position 0, the start
    - Each successive `readline()` moves forward
- `fh.seek(n)` — moves pointer to position `n`
- `block = fh.read(12)` — read a fixed number of characters

End of file

- When reading incrementally, important to know when file has ended
- The following both signal end of file
  - `fh.read()` returns empty string `""`
  - `fh.readline()` returns empty string `""`

Writing to a file

```
fh.write(s)
```

- Write string `s` to file
  - Returns number of characters written
  - Include `'\n'` explicitly to go to a new line

Writing to a file

```
fh.write(s)
```

- Write string s to file
  - Returns number of characters written
  - Include '\n' explicitly to go to a new line

```
fh.writelines(l)
```

- Write a list of lines l to file
  - Must includes '\n' explicitly for each string

```
for l in f1.readlines() :
    f2..write(l)
```

```
f2.writelines(
    f1.readlines())
```

Closing a file

```
fh.close()
```

- Flushes output buffer and decouples file handle
    - All pending writes copied to disk

Closing a file

```
fh.close()
```

- Flushes output buffer and decouples file handle
  - All pending writes copied to disk

```
fh.flush()
```

- Manually forces write to disk

Processing file line by line

```
contents = fh.readlines()
for l in contents:
    . . .
```

- Even better

```
for l in fh.readlines():
    . . .
```

Copying a file

```
infile = open("input.txt", "r")
outfile = open("output.txt", "w")
for line in infile.readlines():
  outfile.write(line)
infile.close()
outfile.close()
```

Copying a file

```
infile = open("input.txt", "r")

outfile = open("output.txt", "w")

contents = infile.readlines()

outfile.writelines(contents)

infile.close()

outfile.close()
```

Strip whitespace

- `s.rstrip()` removes trailing whitespace

  ```
  for line in contents:
    s = line.rstrip()
  ```

- `s.lstrip()` removes leading whitespace
- `s.strip()` removes leading and trailing whitespace

Splitting a string

- Export spreadsheet as “comma separated value” text file
- Want to extract columns from a line of text
- Split the line into chunks between commas

```
columns = s.split(",")
```

  - Can split using any separator string
- Split into at most `n` chunks

```
columns = s.split(" : ", n)
```

Joining strings

- Recombine a list of strings using a separator

```
columns = s.split(",")
joinstring = ","
csvline = joinstring.join(columns)

date = "16"
month = "08"
year = "2016"
today = "-".join([date,month,year])
```

Formatted printing

- Recall that we have limited control over how `print()` displays output
  - Optional argument `end="…"` changes default new line at the end of print
  - Optional argument `sep="…"` changes default separator between items

String format() method

- By example

```
>>> "First: {0}, second: {1}".format(47,11)
'First: 47, second: 11'

>>> "Second: {1}, first: {0}".format(47,11)
'Second: 11, first: 47'
```

- Replace arguments by position in message string

format() method ...

- Can also replace arguments by name

```
>>> "One: {f}, two: {s}".format(f=47,s=11)
'One: 47, two: 11'

>>> "One: {f}, two: {s}".format(s=11,f=47)
‘One: 47, two: 11'
```

Now, real formatting

```
>>> "Value: {0:3d}".format(4)
```

- `3d` describes how to display the value `4`
- `d` is a code specifies that `4` should be treated as an integer value
- `3` is the width of the area to show `4`

```
'Value:   4'
```

Now, real formatting

```
>>> "Value: {0:6.2f}".format(47.523)
```

- `6.2f` describes how to display the value `47.523`
- `f` is a code specifies that `47.523` should be treated as a floating point value
- `6` — width of the area to show `47.523`
- `2` — number of digits to show after decimal point

```
"Value:  47.52"
```

Real formatting

- Codes for other types of values
  - String, octal number, hexadecimal …
- Other positioning information
  - Left justify
  - Add leading zeroes
- Derived from `printf()` of C, see Python documentation for details

Passing values to functions

- Argument value is substituted for name

```
def power(x,n):
  ans = 1
  for i in range (0,n):
    ans = ans*x
  return(ans)
```

- Like an implicit assignment statement

a = 3
b = 5

```
power(3,5)
```

$$\overset{a}{3} \quad \overset{b}{5}$$

$\downarrow$

```
x = 3
n = 5
ans = 1
for i in range ...
```

Passing arguments by name

```
def power(x,n):
  ans = 1
  for i in range (0,n):
    ans = ans*x
  return(ans)
```

- Call `power(n=5,x=4)`

Default arguments

- Recall `int(s)` converts string to integer
  - `int("76")` is `76`
  - `int("A5")` generates an error
- Actually `int(s,b)` takes two arguments, string `s` and base `b`
  - `b` has default value `10`
  - `int("A5",16)` is `165` $(10 \times 16 + 5)$

Default arguments

- Recall `int(s)` converts string to integer
  - `int("76")` is 76
  - `int("A5")` generates an error
- Actually `int(s,b)` takes two arguments, string `s` and base `b`
  - `b` has default value 10
  - `int("A5",16)` is 165 $(10 \times 16 + 5)$

```
            s
def int( ,b=10):
  ...
```

- Default value is provided in function definition
- If parameter is omitted, default value is used
  - Default value must be available at definition time
  - `def Quicksort(A,l=0,r=len(A):` does not work

Default arguments

```
def f(a,b,c=14,d=22):
  ...
```

- `f(13,12)` is interpreted as `f(13,12,14,22)`
- `f(13,12,16)` is interpreted as `f(13,12,16,22)`
- Default values are identified by position, must come at the end
    - Order is important

Function definitions

- `def` associates a function body with a name
- Flexible, like other value assignments to name
- Definition can be conditional

```
if condition:
   def f(a,b,c):
     ...
else:
   def f(a,b,c):
     ....
```

Function definitions

- `def` associates a function body with a name
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if condition:
   def f(a,b,c):
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```

- Can assign a function to a new name

```
def f(a,b,c):
    ...

g = f
```

- Now `g` is another name for `f`

Passing functions as parameters

- Apply `f` to `x` `n` times

```
def apply(f,x,n):
  res = x
  for i in range(n):
    res = f(res)
  return(res)
```

$$f^n(x)$$

$$x = f^0(x)$$

Passing functions as parameters

- Apply `f` to `x` `n` times

```
def apply(f,x,n):
  res = x
  for i in range(n):
    res = f(res)
  return(res)

def square(x):
  return(x*x)


apply(square,5,2)

square(square(5))

625
```

Passing functions as parameters

- Apply `f` to `x` `n` times

```
def apply(f,x,n):
  res = x
  for i in range(n):
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def square(x):
  return(x*x)

apply(square,5,2)

square(square(5))

625
```

- Useful for customizing functions such as sort
- Define `cmp(x,y)` that returns `-1` if `x < y`, `0` if `x == y` and `1` if `x > y`
  - `cmp("aab","ab")` is `-1` in dictionary order
  - `cmp("aab","ab")` is `1` if we compare by length
- `def mysort(l,cmp=defaultcmp):`

Passing functions as parameters

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square(square(5))


625
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