Practical Bioinformatics

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  ```
  "ATGCTGTA".upper() == "ATgcTgTA".upper()
  ```

  (And treat RNA as cDNA)

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- Statements that precede code blocks (if, def, for, while, ...) end with a colon.

```
def mean(x):
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    for i in x:
        s += i
    return s/len(x)
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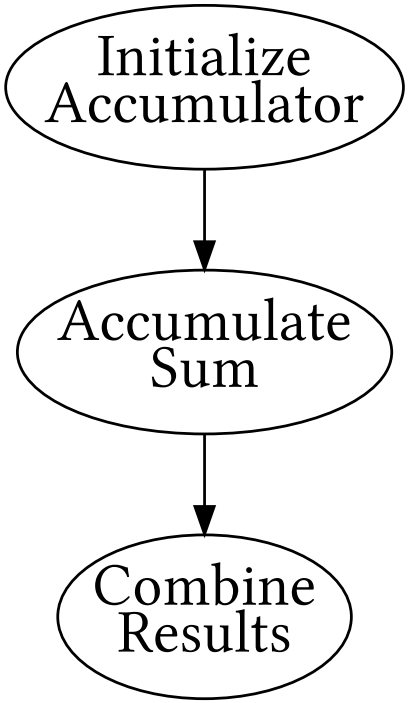
- You can use tab and shift-tab in IPython to indent/unindent blocks of code
- Loop variables retain their state after the loop is finished (so if you want to reuse the variable, you need to reinitialize it).

Mean

```
def mean(x):
    s = 0.0
    for i in x:
        s += i
    return s/len(x)

def mean(x):
    return sum(x)/float(len(x))
```



Standard Deviation

$$\sigma_x = \sqrt{\frac{\sum_i^N (x_i - \bar{x})^2}{N-1}}$$

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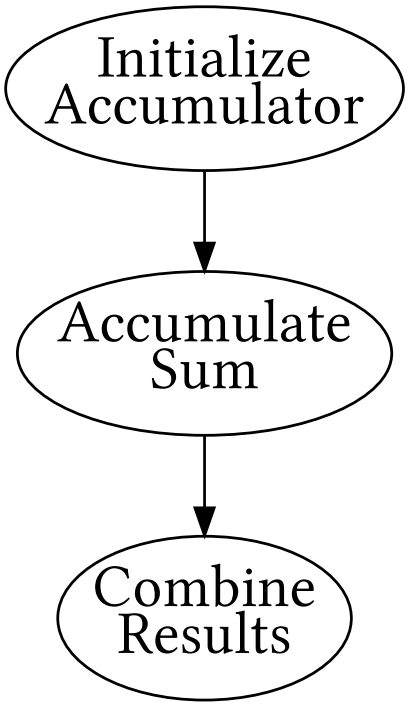
```
def stdev(x):
    m = mean(x)
    s = 0.0
    for i in x:
        s += (i - m)**2
    from math import sqrt
    return sqrt(s/(len(x) - 1))
```



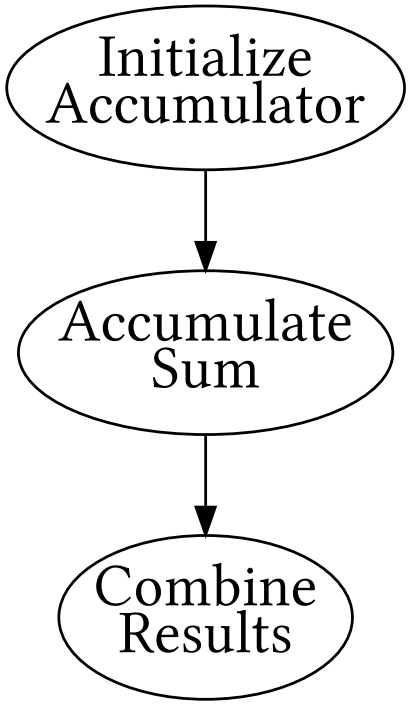
Pearson's Correlation Coefficient

$$r(x,y) = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2}\sqrt{\sum_i (y_i - \bar{y})^2}}$$

Pearson's Correlation Coefficient

```
def pearson(x,y):
    mx = mean(x)
    my = mean(y)
    sxy = 0.0
    ssx = 0.0
    ssy = 0.0
    for i in range(len(x)):
        dx = x[i] - mx
        dy = y[i] - my
        sxy += dx*dy
        ssx += dx**2
        ssy += dy**2
    from math import sqrt
    return sxy/sqrt(ssx*ssy)
```

$$r(x,y) = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2}\sqrt{\sum_i (y_i - \bar{y})^2}}$$



Subject, verb that noun!

return_value = object.function(parameter, ...)
"Object, do *function* to *parameter*"

- file = open("myfile.txt")
- file.read()
- file.readlines()
- for line in file:
- string.split() and string.join()
- file.write()

Binary files are like genomic DNA

hexdump -C computers.png

```
00000000  89 50 4e 47 0d 0a 1a 0a  00 00 00 0d 49 48 44 52  |.PNG........IHDR|
00000010  00 00 03 5f 00 00 02 cc  08 06 00 00 00 1b c3 08  |..._............|
00000020  30 00 00 00 04 73 42 49  54 08 08 08 08 7c 08 64  |0....sBIT....|.d|
00000030  88 00 00 00 09 70 48 59  73 00 00 2e 23 00 00 2e  |.....pHYs...#...|
00000040  23 01 78 a5 3f 76 00 00  00 19 74 45 58 74 53 6f  |#.x.?v....tEXtSo|
00000050  66 74 77 61 72 65 00 77  77 77 2e 69 6e 6b 73 63  |ftware.www.inksc|
00000060  61 70 65 2e 6f 72 67 9b  ee 3c 1a 00 00 20 00 49  |ape.org..<... .I|
00000070  44 41 54 78 9c ec 9d 79  9c 25 57 59 fe bf cf 39  |DATx...y.%WY...9|
00000080  75 6f 2f 33 93 cc 92 c9  1e 48 42 08 01 45 92 a0  |uo/3.....HB..E..|
00000090  04 c2 26 88 08 8a 80 0a  b2 28 18 14 54 14 45 04  |..&......(..T.E.|
000000a0  7f 02 a2 2c b2 aa 2c 0a  28 22 3b ca 26 20 8b b2  |...,..,.(";.& ..|
000000b0  08 c8 26 9b 61 4d 08 6b  08 d9 c8 be cd 4c 4f 77  |..&.aM.k.....LOw|
000000c0  df 7b eb 9c f7 f7 c7 7b  aa fb e6 ce bd 3d dd 93  |.{.....{.....=..|
000000d0  59 32 a4 9e fe d4 e7 76  55 9d 53 75 ea d4 a9 aa  |Y2.....vU.Su....|
000000e0  77 7d 8e cc 8c 16 2d 5a  b4 68 d1 a2 c5 8f 27 24  |w}....-Z.h....'$|
000000f0  75 81 00 f4 cc cc 24 45  a0 03 d4 66 56 8f 94 ed  |u.....$E...fV...|
00000100  00 b1 ac ee b2 7f 42 d9  15 cb ed 2f 48 da 0a 9c  |......B..../H...|
00000110  08 1c 0d 5c 0f 5c 05 9c  6f 66 fd 03 da b0 9b 29  |...\.\..of.....)|
00000120  24 4d 03 66 66 bd b2 5e  01 15 30 30 b3 b4 86 e3  |$M.ff..^..00....|
00000130  3c 1c 78 2a f0 25 33 7b  f2 1a db b0 01 f8 58 59  |<.x*.%3{......XY|
00000140  7d a0 99 5d bf 96 fa 2d  f6 0c 92 8e 01 9e 08 dc  |}..]...-........|
00000150  01 38 0a 10 f0 7b 66 f6  8d 03 d4 9e 67 01 0f 02  |.8...{f.....g...|
00000160  de 69 66 2f 3f 10 6d d8  9f 08 07 ba 01 2d 5a b4  |.if/?.m......-Z.|
00000170  68 d1 a2 45 8b 7d 8a af  01 0b c0 ed cb fa 6f 97  |h..E.}........o.|
```

```
fp = open("computers.png")
fp.read(50)
fp.close()
```

Text files are like ORFs

hexdump -C 3_4_2010.txt

```
00000000  4d 65 65 74 20 77 2f 20  4a 6f 65 20 72 65 3a 20  |Meet w/ Joe re: |
00000010  77 69 72 65 6c 65 73 73  20 74 68 65 72 6d 6f 73  |wireless thermos|
00000020  74 61 74 73 0a 20 20 20  2d 2d 3e 20 64 6f 6e 65  |tats.   --> done|
00000030  0a 20 20 20 20 20 20 42  75 79 20 74 68 65 72 6d  |.      Buy therm|
00000040  6f 73 74 61 74 73 20 66  72 6f 6d 20 68 74 74 70  |ostats from http|
00000050  3a 2f 2f 77 77 77 2e 6f  6d 65 67 61 2e 63 6f 6d  |://www.omega.com|
00000060  0a 20 20 20 20 20 20 20  20 20 20 20 53 74 61 72 74  |.           Start|
00000070  20 77 69 74 68 3a 0a 20  20 20 20 20 20 20 20 20  | with:.         |
00000080  20 20 20 20 52 6f 75 74  65 72 20 55 57 54 43 52  |    Router UWTCR|
00000090  45 43 33 20 28 61 62 6f  75 74 20 24 31 32 30 29  |EC3 (about $120)|
000000a0  0a 20 20 20 20 20 20 20  20 20 20 20 20 20 20 20  |.               |
000000b0  20 43 61 6e 20 72 65 63  65 69 76 65 20 66 72 6f  | Can receive fro|
000000c0  6d 20 31 32 20 74 72 61  6e 73 6d 69 74 74 65 72  |m 12 transmitter|
000000d0  73 0a 20 20 20 20 20 20  20 20 20 20 20 20 20 20  |s.              |
000000e0  20 20 43 61 6e 20 70 75  73 68 20 63 6f 6e 66 69  |  Can push confi|
000000f0  67 75 72 61 74 69 6f 6e  20 74 6f 20 74 72 61 6e  |guration to tran|
00000100  73 6d 69 74 74 65 72 73  0a 20 20 20 20 20 20 20  |smitters.       |
00000110  20 20 20 20 20 20 20 20  20 43 6f 6d 6d 75 6e 69  |         Communi|
00000120  63 61 74 65 20 76 69 61  20 65 74 68 65 72 6e 65  |cate via etherne|
00000130  74 20 70 6f 72 74 20 61  6e 64 20 65 6d 62 65 64  |t port and embed|
00000140  64 65 64 20 77 65 62 20  73 65 72 76 65 72 0a 20  |ded web server. |
00000150  20 20 20 20 20 20 20 20  20 20 20 20 20 20 20 41  |               A|
00000160  73 73 69 67 6e 20 73 74  61 74 69 63 20 49 50 20  |ssign static IP |
00000170  61 64 64 72 65 73 73 20  61 6e 64 20 63 6f 6e 6e  |address and conn|
```

OS X *sometimes* uses CR newlines

hexdump -C macfile.txt

```
00000000  4d 65 65 74 20 77 2f 20  4a 6f 65 20 72 65 3a 20  |Meet w/ Joe re: |
00000010  77 69 72 65 6c 65 73 73  20 74 68 65 72 6d 6f 73  |wireless thermos|
00000020  74 61 74 73 0d 20 20 20  2d 2d 3e 20 64 6f 6e 65  |tats.   --> done|
00000030  0d 20 20 20 20 20 20 42  75 79 20 74 68 65 72 6d  |.      Buy therm|
00000040  6f 73 74 61 74 73 20 66  72 6f 6d 20 68 74 74 70  |ostats from http|
00000050  3a 2f 2f 77 77 77 2e 6f  6d 65 67 61 2e 63 6f 6d  |://www.omega.com|
00000060  0d 20 20 20 20 20 20 20  20 20 20 20 53 74 61 72  |.           Star|
00000070  20 77 69 74 68 3a 0d 20  20 20 20 20 20 20 20 20  | with:.         |
00000080  20 20 20 20 52 6f 75 74  65 72 20 55 57 54 43 52  |    Router UWTCR|
00000090  45 43 33 20 28 61 62 6f  75 74 20 24 31 32 30 29  |EC3 (about $120)|
000000a0  0d 20 20 20 20 20 20 20  20 20 20 20 20 20 20 20  |.               |
000000b0  20 43 61 6e 20 72 65 63  65 69 76 65 20 66 72 6f  | Can receive fro|
000000c0  6d 20 31 32 20 74 72 61  6e 73 6d 69 74 74 65 72  |m 12 transmitter|
000000d0  73 0d 20 20 20 20 20 20  20 20 20 20 20 20 20 20  |s.              |
000000e0  20 20 43 61 6e 20 70 75  73 68 20 63 6f 6e 66 69  |  Can push confi|
000000f0  67 75 72 61 74 69 6f 6e  20 74 6f 20 74 72 61 6e  |guration to tran|
00000100  73 6d 69 74 74 65 72 73  0d 20 20 20 20 20 20 20  |smitters.       |
00000110  20 20 20 20 20 20 20 20  20 43 6f 6d 6d 75 6e 69  |         Communi|
00000120  63 61 74 65 20 76 69 61  20 65 74 68 65 72 6e 65  |cate via etherne|
00000130  74 20 70 6f 72 74 20 61  6e 64 20 65 6d 62 65 64  |t port and embed|
00000140  64 65 64 20 77 65 62 20  73 65 72 76 65 72 0d 20  |ded web server. |
00000150  20 20 20 20 20 20 20 20  20 20 20 20 20 20 20 41  |               A|
00000160  73 73 69 67 6e 20 73 74  61 74 69 63 20 49 50 20  |ssign static IP |
00000170  61 64 64 72 65 73 73 20  61 6e 64 20 63 6f 6e 6e  |address and conn|
```

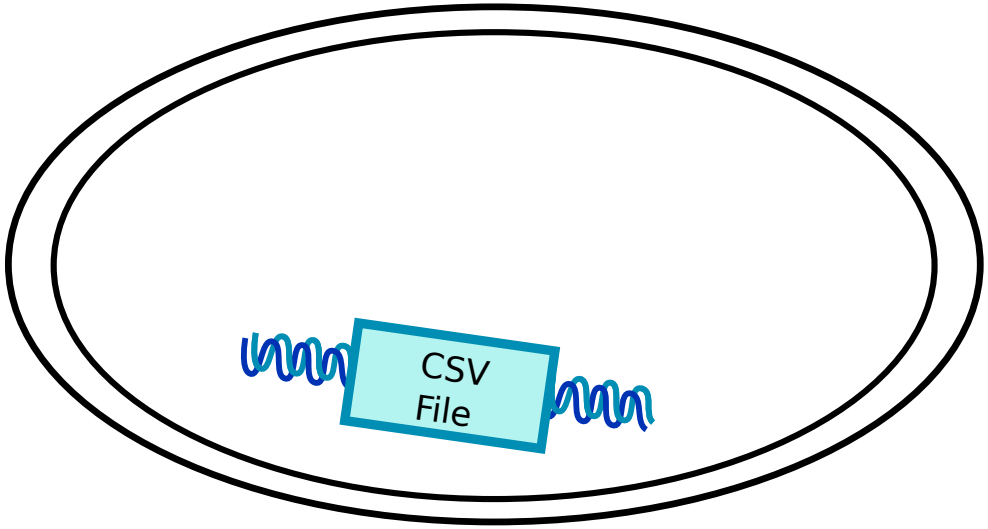
tr '\r' '\n' < macfile.txt > unixfile.txt

Windows uses CRLF newlines

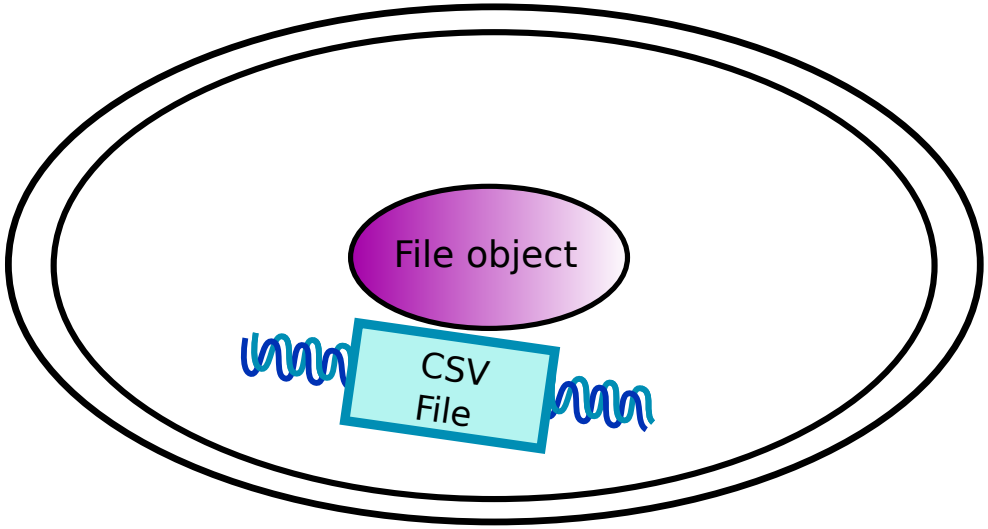
hexdump -C dosfile.txt

```
00000000  4d 65 65 74 20 77 2f 20  4a 6f 65 20 72 65 3a 20  |Meet w/ Joe re: |
00000010  77 69 72 65 6c 65 73 73  20 74 68 65 72 6d 6f 73  |wireless thermos|
00000020  74 61 74 73 0d 0a 20 20  20 2d 2d 3e 20 64 6f 6e  |tats..   --> don|
00000030  65 0d 0a 20 20 20 20 20  20 42 75 79 20 74 68 65  |e..      Buy the|
00000040  72 6d 6f 73 74 61 74 73  20 66 72 6f 6d 20 68 74  |rmostats from ht|
00000050  74 70 3a 2f 2f 77 77 77  2e 6f 6d 65 67 61 2e 63  |tp://www.omega.c|
00000060  6f 6d 0d 0a 20 20 20 20  20 20 20 20 20 20 53 74  |om..          St|
00000070  61 72 74 20 77 69 74 68  3a 0d 0a 20 20 20 20 20  |art with:..     |
00000080  20 20 20 20 20 20 20 20  52 6f 75 74 65 72 20 55  |        Router U|
00000090  57 54 43 52 45 43 33 20  28 61 62 6f 75 74 20 24  |WTCREC3 (about $|
000000a0  31 32 30 29 0d 0a 20 20  20 20 20 20 20 20 20 20  |120)..          |
000000b0  20 20 20 20 20 20 43 61  6e 20 72 65 63 65 69 76  |      Can receiv|
000000c0  65 20 66 72 6f 6d 20 31  32 20 74 72 61 6e 73 6d  |e from 12 transm|
000000d0  69 74 74 65 72 73 0d 0a  20 20 20 20 20 20 20 20  |itters..        |
000000e0  20 20 20 20 20 20 20 20  43 61 6e 20 70 75 73 68  |        Can push|
000000f0  20 63 6f 6e 66 69 67 75  72 61 74 69 6f 6e 20 74  | configuration t|
00000100  6f 20 74 72 61 6e 73 6d  69 74 74 65 72 73 0d 0a  |o transmitters..|
00000110  20 20 20 20 20 20 20 20  20 20 20 20 20 20 20 20  |                |
00000120  43 6f 6d 6d 75 6e 69 63  61 74 65 20 76 69 61 20  |Communicate via |
00000130  65 74 68 65 72 6e 65 74  20 70 6f 72 74 20 61 6e  |ethernet port an|
00000140  64 20 65 6d 62 65 64 64  65 64 20 77 65 62 20 73  |d embedded web s|
00000150  65 72 76 65 72 0d 0a 20  20 20 20 20 20 20 20 20  |erver..         |
00000160  20 20 20 20 20 20 20 41  73 73 69 67 6e 20 73 74  |       Assign st|
00000170  61 74 69 63 20 49 50 20  61 64 64 72 65 73 73 20  |atic IP address |
```

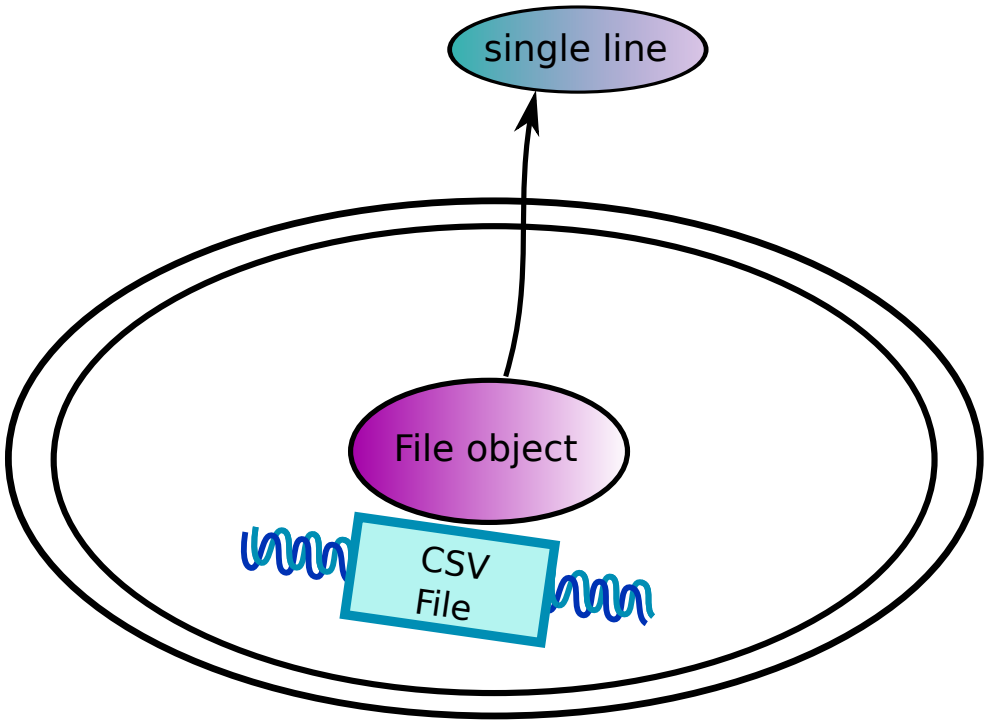
supp2data.csv



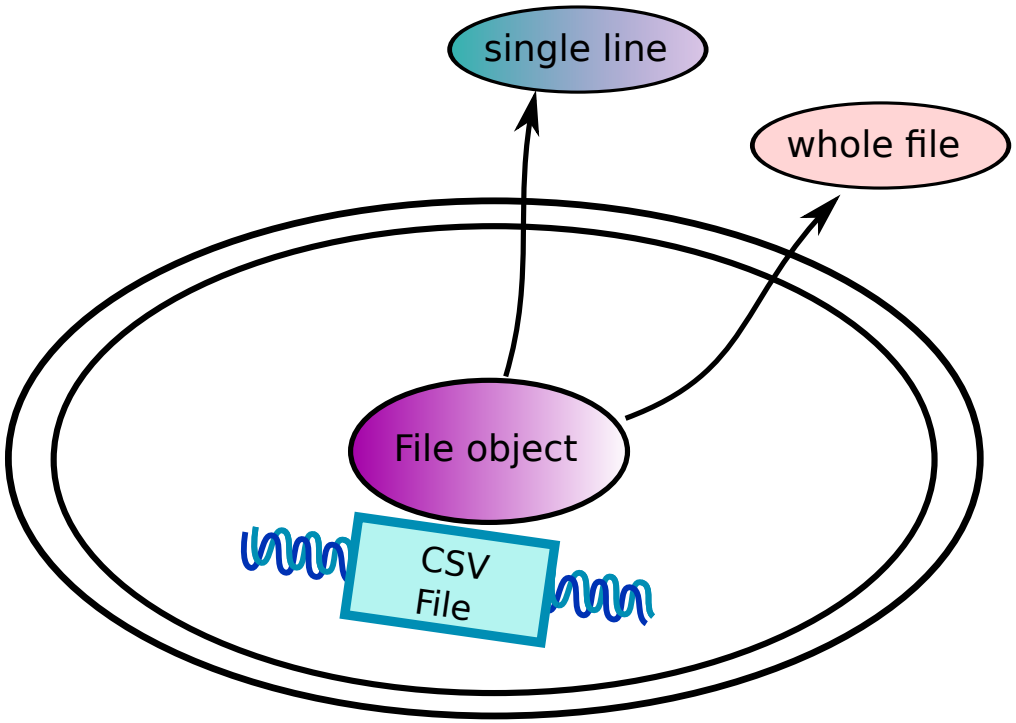
open("supp2data.csv")



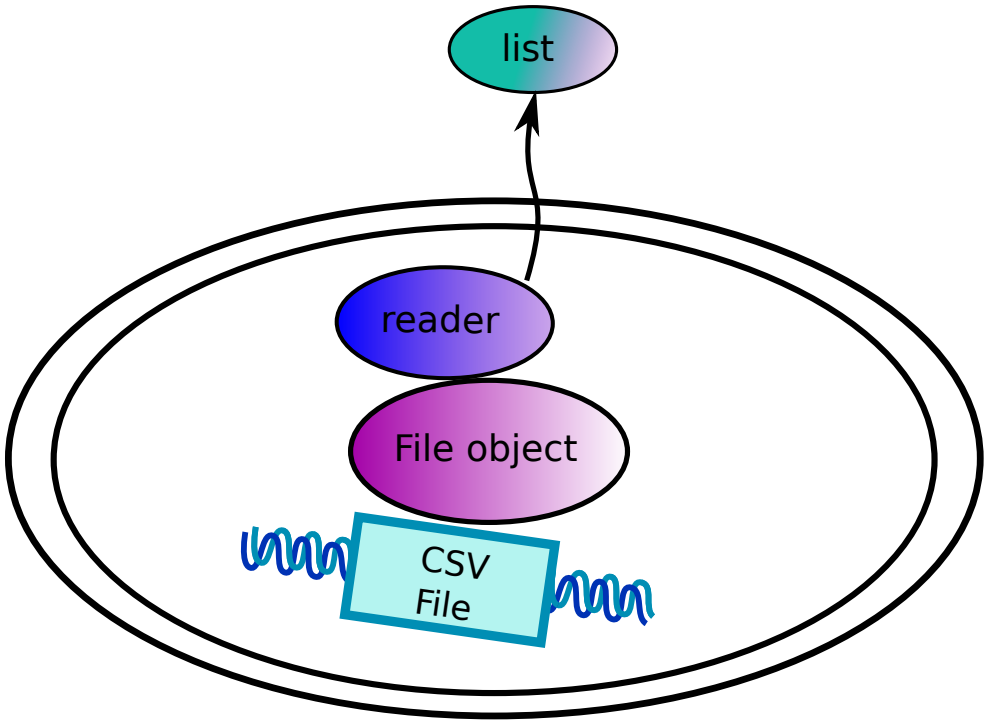
open("supp2data.csv").next()



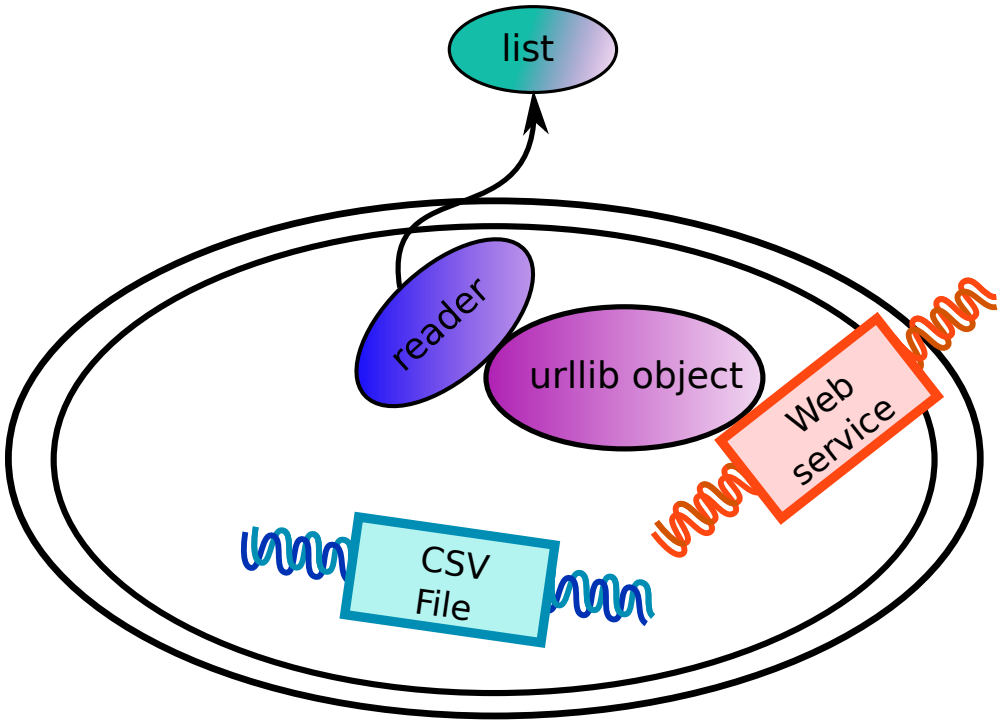
open("supp2data.csv").read()



csv.reader(open("supp2data.csv")).next()

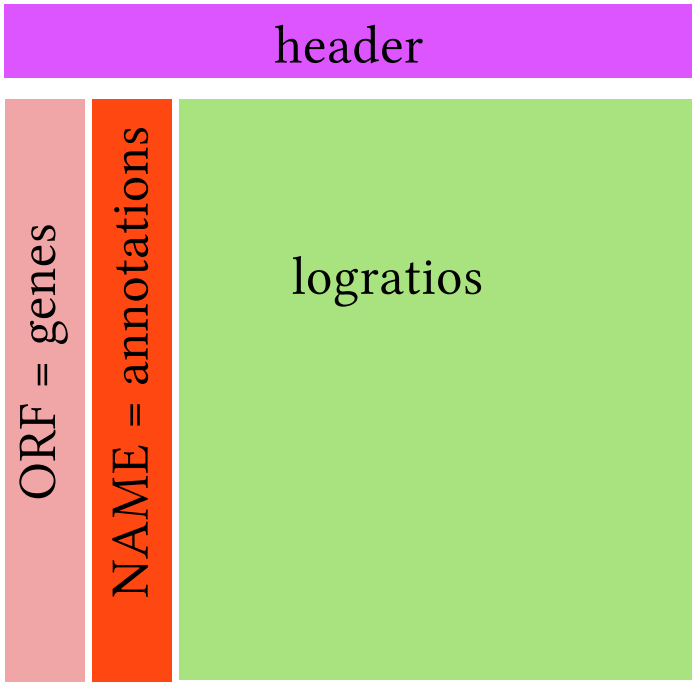


csv.reader(urlopen("http://example.com/csv")).next()

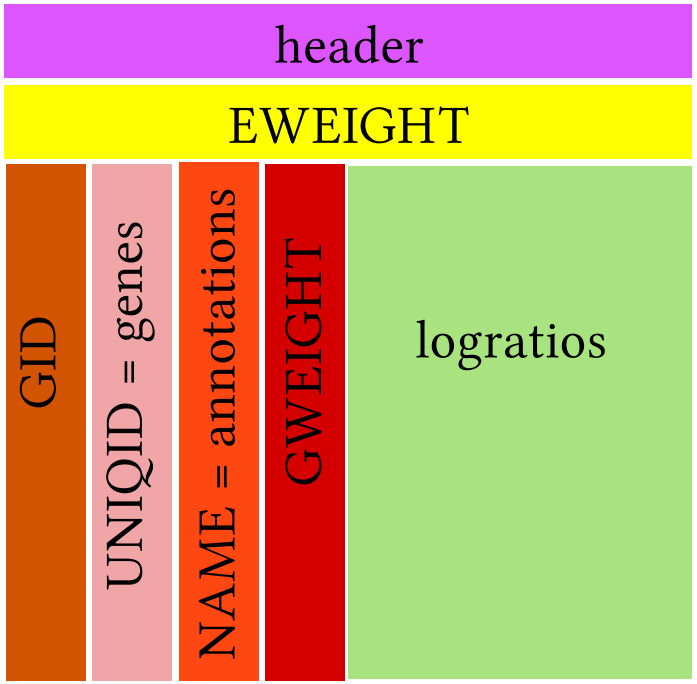


The CDT file format

Minimal CLUSTER input



Cluster3 CDT output



- Tab delimited (\t)
- UNIX newlines (\n)
- Missing values $\rightarrow$ empty cells

Homework

1. Try reading the first few bytes of different files on your computer. Can you distinguish binary files from text files?
2. Create a simple data table in your favorite spreadsheet program and save it in a text format (*e.g.*, save as CSV or tab-delimited text from Excel[1]). Practice reading the data from Python.
3. Write a function to disect supp2data.cdt into three lists of strings (gene names, gene annotations, and experimental conditions) and one matrix (list of lists) of log ratio values (as floats, using *None* or *0.* to represent missing values).
4. If you are familiar with Python classes, write a CDT class based on the parse in the previous exercise. Provide methods for looking up annotations and log ratios by gene name.

[1] Note for Mac users: Excel will offer you Macintosh and DOS/Windows text formats. Choose *DOS/Windows*; otherwise, Python will think that the entire file is a single line.