Introduction to

with Application to Bioinformatics

- Day 4

Review

- Why does it matter what type a variable has?
  - What is the difference between `'1'*2` and `1*2`?
  - Is `'2' < '12'`?
- How (and when) can you change the type of those? When does it not work?
  - How do you make the string `'0.29'` into a number?
- You have worked with a number of data containers; lists, sets, dictionaries. What is the difference between them and when should you use which?
- What is a function?
  - Write a function that multiplies the input argument by 2.

Review

- Why does it matter what type a variable has?

Review

- Why does it matter what type a variable has?

Values of different types stores different types of information.

Different types can be used with different operations, functions and methods.

1+2

In [ ]:
```
"1"+"2"
```

In [ ]:
```
"1"+2
```

In [ ]:
```
"1"*2
```

Take extra care when comparing values

In [ ]:
```
2 < 12
```

In [ ]:
```
"2" < "12"
```

Review

- How can you change (convert) the type of a value? When does it not work?

Review

- How can you change (convert) the type of a value? When does it not work?

In [ ]:
```
float("1")
```

In [ ]:
```
int("1")
```

In [ ]:
```
str(1)
```

Review

- How can you change (convert) the type of a value? When does it not work?

In [ ]:
```
float("1")
```

In [ ]:
```
int("1")
```

In [ ]:
```
str(1)
```

In [ ]:
```
int("2.2")
```

Converting between strings and lists

In [ ]:
```
list("hello")
```

Converting between strings and lists

In [ ]:
```
list("hello")
```

In [ ]:
```
str(['h', 'e', 'l', 'l', 'o'])
```

Converting between strings and lists

In [ ]:
```
list("hello")
```

In [ ]:
```
str(['h', 'e', 'l', 'l', 'o'])
```

In [ ]:
```
''.join(['h', 'e', 'l', 'l', 'o'])
```

Review

- You have worked with a number of data containers; lists, sets, dictionaries. What is the difference between them and when should you use which?

Review

- You have worked with a number of data containers; lists, sets, dictionaries. What is the difference between them and when should you use which?

- **lists**: when order is important
- **dictionaries**: to keep track of the relation between keys and values
- **sets**: to check for membership. No order, no duplicates.

Review

- You have worked with a number of data containers; lists, sets, dictionaries. What is the difference between them and when should you use which?

- **lists**: when order is important
- **dictionaries**: to keep track of the relation between keys and values
- **sets**: to check for membership. No order, no duplicates.

In [ ]:
```
mylist = ["comedy", "drama", "drama", "sci-fi"]
myset = set(mylist)
print('All genres', myset)
mydict = {"genre": "drama", "title": "Toy Story"}
```

Review

- What is a function?

Review

- What is a function?

A named piece of code that performs a specific task.

A relation between input data (arguments) and a result (output data).

Function structure

```
def functionName(arg1, arg2, arg3):

    finalValue = 0

    # Here is some code where you can do
    # calculations etc, on arg1, arg2, arg3
    # and update finalValue

    return FinalValue
```

Function structure

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def functionName(arg1, arg2, arg3):

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```

- The `def` keyword

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```

- The `def` keyword
- Arguments

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```

- The `def` keyword
- Arguments
- Indentation!

Function structure

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def functionName(arg1, arg2, arg3):

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    # calculations etc, on arg1, arg2, arg3
    # and update finalValue

    return FinalValue
```

- The `def` keyword
- Arguments
- Indentation!
- `return`

Multiply by two

In [ ]:
```
def multiply_by_two(x):
    return x*2

multiply_by_two(2)
```

In [ ]:
```
def multiply_by_two(x):
    print(x*2)

multiply_by_two(2)
```

Multiply by two - return values

Multiply by two - return values

In [ ]:

```
def multiply_by_two(x):
    return x*2

result = multiply_by_two(2)
print('Result', result)
```

Multiply by two - return values

In [ ]:
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def multiply_by_two(x):
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In [ ]:
```
def multiply_by_two(x):
    x*2

res = multiply_by_two(2)
print('Result', result)
```

TODAY

- Loops and functions, code structure
- Pandas - explore your data!

Common concepts

Scope

Scope

In [ ]:
```
a
```

Scope

In [ ]:
```
a
```

In [ ]:
```
def myfunc(a, b):
    print(a)

a
```

Scope

In [ ]:
```
a
```

In [ ]:
```
def myfunc(a, b):
    print(a)

a
```

In [ ]:
```
a = 5

def myfunc(a):
    a += 2
    return a

b = myfunc(8)

a, b
```

Scope

In [ ]:
```
a
```

In [ ]:
```
def myfunc(a, b):
    print(a)

a
```

In [ ]:
```
a = 5

def myfunc(a):
    a += 2
    return a

b = myfunc(8)

a, b
```

The local `a` in `myfunc` *shadows* the global `a`.

Scope

In [ ]:
```
a
```

In [ ]:
```
def myfunc(a, b):
    print(a)

a
```

In [ ]:
```
a = 5

def myfunc(a):
    a += 2
    return a

b = myfunc(8)

a, b
```

The local `a` in `myfunc` *shadows* the global `a`.

The variables inside functions are *local*. To avoid confusion, use different variable names.

In [ ]:
```
global_a = 5

def myfunc(value):
    value += 2
    return value

result = myfunc(8)

global_a, result
```

No confusion!

`myfunc` has unique variable names.

Return values

In [ ]:
```
def multiply_by_two(x):
    return x*2

result = multiply_by_two(2)
print('Result', result)
```

In [ ]:
```
def multiply_by_two(x):
    print(x*2)

result = multiply_by_two(2)
print('Result', result)
```

In [ ]:
```
def multiply_by_two(x):
    x*2

res = multiply_by_two(2)
print('Result', result)
```

None

None

What is `None`? Why? When is it used?

`None`

What is `None`? Why? When is it used?

- What is it?
  - A keyword with a constant value (like `True`, `False`)
  - `Null`

`None`

What is `None`? Why? When is it used?

- What is it?
  - A keyword with a constant value (like `True`, `False`)
  - `Null`

- Why and when?
  - To signal "emtpy values"
  - Variables with no values yet
  - Functions that don't return anything meaningful

Comparing None

In [ ]:

```
value = None
if value is not None:
    print('value is something')
else:
    print('no value!')
```

Comparing None

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value = None
if value is not None:
    print('value is something')
else:
    print('no value!')
```

In [ ]:
```
None == True
```

In [ ]:
```
None == False
```

Comparing None

In [ ]:
```
myvalue = None
if myvalue > 10:
    print('Big value')
```

Comparing None

In [ ]:
```
myvalue = None
if myvalue > 10:
    print('Big value')
```

In [ ]:
```
myvalue = None
if myvalue is not None and myvalue > 10:
    print('The value is not None')
else:
    print('The value is None')
```

Exercise A

Write a function that takes one argument called `value`.

- If `value` is not None and if it is greater to or equal to 10, the function should print "big number".
- If it is not None, and if it is between 0 and 10, the function should print "small number".
- Otherwise, the function should print "No number".

In [ ]:
```
def tester(value):
    if value is not None and value >= 10:
        print("big number")
    elif value is not None and 0 < value < 10:
        print("small number")
    else:
        print("No number")
```

In [ ]:
```
tester(11)
```

In [ ]:
```
tester(3)
```

In [ ]:
```
tester(None)
```

Keyword arguments

Keyword arguments

```
open('../files/250.imdb', 'r', encoding='utf-8')
```

In [ ]:

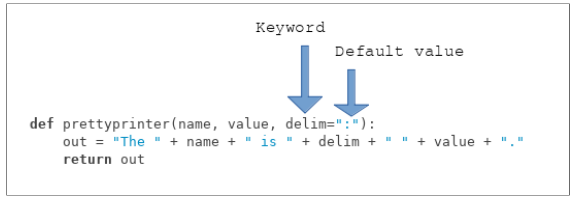
```
def prettyprinter(name, value, delim=":"):
    out = "The " + name + " is " + delim + " " + value + "."
    return out
```

In [ ]:
```
def prettyprinter(name, value, delim=":"):
    out = "The " + name + " is " + delim + " " + value + "."
    return out
```

- Programmer can set default values

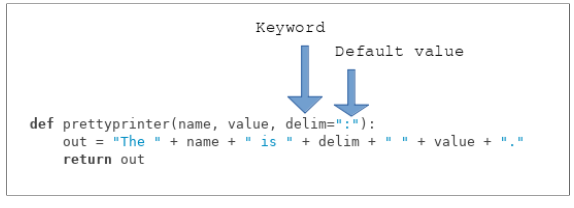
In [ ]:
```
def prettyprinter(name, value, delim=":"):
    out = "The " + name + " is " + delim + " " + value + "."
    return out
```

- Programmer can set default values



In [ ]:
```
def prettyprinter(name, value, delim=":"):
    out = "The " + name + " is " + delim + " " + value + "."
    return out
```

- Programmer can set default values



In [ ]:
```
prettyprinter("title", "Movie")
```

- User can ignore the arguments (default value is used)

```
def prettyprinter(name, value, delim=":"):
    out = "The " + name + " is " + delim + " " + value + "."
    return out
```

```
def prettyprinter(name, value, delim=":"):
    out = "The " + name + " is " + delim + " " + value + "."
    return out
```

In [ ]:
```
prettyprinter("genre", "Drama", delim="=")
```

```
def prettyprinter(name, value, delim=":"):
    out = "The " + name + " is " + delim + " " + value + "."
    return out
```

In [ ]:
```
prettyprinter("genre", "Drama", delim="=")
```

In [ ]:
```
prettyprinter("genre", "Drama", "=")
```

In [ ]:

```
def prettyprinter(name, value, delim=":", end=None):
    out = "The " + name + " is " + delim + " " + value
    if end:
        out += end
    return out

my_str = prettyprinter("title", "Movie")
print(my_str)
```

In [ ]:

```
def prettyprinter(name, value, delim=":", end=None):
    out = "The " + name + " is " + delim + " " + value
    if end:
        out += end
    return out

my_str = prettyprinter("title", "Movie")
print(my_str)
```

In [ ]:

```
prettyprinter("genre", "Drama", "=", ".")
```

In [ ]:
```
def prettyprinter(name, value, delim=":", end=None):
    out = "The " + name + " is " + delim + " " + value
    if end:
        out += end
    return out

my_str = prettyprinter("title", "Movie")
print(my_str)
```

In [ ]:
```
prettyprinter("genre", "Drama", "=", ".")
```

In [ ]:
```
prettyprinter("genre", "Drama", end="!", delim="=")
```

```
open(file, mode='r', buffering=-1, encoding=None, errors=None,
     newline=None, closefd=True, opener=None)
```

```
open(file, mode='r', buffering=-1, encoding=None, errors=None,
     newline=None, closefd=True, opener=None)
```

- Gives better overview

```
open(file, mode='r', buffering=-1, encoding=None, errors=None,
     newline=None, closefd=True, opener=None)
```

- Gives better overview

```
open('../files/250.imdb', 'r', encoding='utf-8')
```

```
open(file, mode='r', buffering=-1, encoding=None, errors=None,
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- Gives better overview

```
open('../files/250.imdb', 'r', encoding='utf-8')
```

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```
open(file, mode='r', buffering=-1, encoding=None, errors=None,
     newline=None, closefd=True, opener=None)
```

- Gives better overview

```
open('../files/250.imdb', 'r', encoding='utf-8')
```

```
open('../files/250.imdb', mode='r', encoding='utf-8')
```

```
open('../files/250.imdb', encoding='utf-8', mode='r')
```

Keyword arguments

- programmer: set default values
- user: ignore arguments
- better overview

Exercise B

Rewrite the function from previous exercise, so that it takes one **keyword argument**, `value`. The default value of this argument is `None`.

- If `value` is not None and if it is greater to or equal to 10, the function should print "big number".
- If it is not None, and if it is between 0 and 10, the function should print "small number".
- Otherwise, the function should print "No number".

In [ ]:
```
def tester(value=None):
    if value is not None and value >= 10:
        print("big number")
    elif value is not None and 0 < value < 10:
        print("small number")
    else:
        print("No number")
```

In [ ]:
```
tester(11)
```

In [ ]:
```
tester(3)
```

In [ ]:
```
tester()
```

Controlling loops - `break`

Controlling loops - `break`

```
for x in lines_in_a_big_file:
    if x.startswith('>'):  # this is the only line I want!
        do_something(x)
```

Controlling loops - `break`

```
for x in lines_in_a_big_file:
    if x.startswith('>'):  # this is the only line I want!
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```

...waste of time!

Controlling loops - `break`

```
for x in lines_in_a_big_file:
    if x.startswith('>'):  # this is the only line I want!
        do_something(x)
```

...waste of time!

```
for x in lines_in_a_big_file:
    if x.startswith('>'):  # this is the only line I want!
        do_something(x)
        break  # break the loop
```

break

```
for line in file:
    if line.startswith('#'):
        break
    do_something(line)


print("I am done")
```

Controlling loops - `continue`

Controlling loops - `continue`

```
for x in lines_in_a_big_file:
    if x.startswith('>'):  # this is a comment
        # just skip this! don't do anything
    do_something(x)
```

Controlling loops - `continue`

```
for x in lines_in_a_big_file:
    if x.startswith('>'):  # this is a comment
        # just skip this! don't do anything
    do_something(x)
```

```
for x in lines_in_a_big_file:
    if x.startswith('>'):  # this is a comment
        continue  # go on to the next iteration
    do_something(x)
```

Controlling loops - `continue`

```
for x in lines_in_a_big_file:
    if x.startswith('>'):  # this is a comment
        # just skip this! don't do anything
    do_something(x)
```

```
for x in lines_in_a_big_file:
    if x.startswith('>'):  # this is a comment
        continue  # go on to the next iteration
    do_something(x)
```

```
for x in lines_in_a_big_file:
    if not x.startswith('>'):  # this is *not* a comment
        do_something(x)
```

continue

```
for line in file:
    if line.startswith('#'):
        continue
    do_something(line)


print("I am done")
```

Exercise 1

```
pick_movie(year=1996, rating_min=8.5)
The Bandit
pick_movie(rating_max=8.0, genre="Mystery")
Twelve Monkeys
```

→ **Notebook Day_4_Exercise_1**

A short note on code structure

- functions
- modules (files)
- documentation

Remember?

Why functions?

- Cleaner code
- Better defined tasks in code
- Re-usability
- Better structure

Why modules?

- Cleaner code
- Better defined tasks in code
- Re-usability
- Better structure

Why modules?

- Cleaner code
- Better defined tasks in code
- Re-usability
- Better structure

- Collect all related functions in one file / module
- Import a module to use its functions
- Only need to understand what the functions do, not how

Example: sys

```
import sys

sys.argv[1]
```

or

```
import imbd_parser as imdb
imdb.parse('250.imdb')
```

Python standard modules

Check out the module index (https://docs.python.org/3.6/py-modindex.html)

How to find the right module?

How to understand it?

How to find the right module?

- look at the module index
- search PyPI (http://pypi.org)
- ask your colleagues
- search the web!

How to understand it?

How to understand it?

In [ ]:
```
import math

help(math)
```

In [ ]:
```
help(math.sqrt)
```

In [ ]:
```
math.sqrt(3)
```

Importing

In [ ]:
```
import math

math.sqrt(3)
```

Importing

In [ ]:
```
import math

math.sqrt(3)
```

In [ ]:
```
import math as m
m.sqrt(3)
```

Importing

In [ ]:
```
import math

math.sqrt(3)
```

In [ ]:
```
import math as m
m.sqrt(3)
```

In [ ]:
```
from math import sqrt
sqrt(3)
```

Documentation and commenting your code

Remember `help()`?

Works because somebody else has documented their code!

In [ ]:

```
def process_file(filename, chrom, pos):
    for line in open(filename):
        if not line.startswith('#'):
            columns = line.split('\t')
            if col[0] == chrom and col[1] == pos:
                print(col[9:])
```

In [ ]:

```
def process_file(filename, chrom, pos):
    for line in open(filename):
        if not line.startswith('#'):
            columns = line.split('\t')
            if col[0] == chrom and col[1] == pos:
                print(col[9:])
```

?

In [ ]:
```
def process_file(filename, chrom, pos):
    for line in open(filename):
        if not line.startswith('#'):
            columns = line.split('\t')
            if col[0] == chrom and col[1] == pos:
                print(col[9:])
```

?

In [ ]:
```
def process_file(filename, chrom, pos):
    """Read a vcf file, search for lines matching chromosome chrom and position pos.

    Print the genotypes of the matching lines.
    """
    for line in open(filename):
        if not line.startswith('#'):
            columns = line.split('\t')
            if col[0] == chrom and col[1] == pos:
                print(col[9:])
```

In [ ]:
```
def process_file(filename, chrom, pos):
    for line in open(filename):
        if not line.startswith('#'):
            columns = line.split('\t')
            if col[0] == chrom and col[1] == pos:
                print(col[9:])
```

?

In [ ]:
```
def process_file(filename, chrom, pos):
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    Print the genotypes of the matching lines.
    """
    for line in open(filename):
        if not line.startswith('#'):
            columns = line.split('\t')
            if col[0] == chrom and col[1] == pos:
                print(col[9:])
```

In [ ]:
```
help(process_file)
```

Your code may have two types of users:

- library users
- maintainers (maybe yourself!)

Your code may have two types of users:

- library users
- maintainers (maybe yourself!)

Write documentation for both of them!

- library users: `"""What does this function do?"""` (doc strings)
- maintainers: `# implementation details` (comments)

Documentation:

Documentation:

- At the beginning of the file

```
"""This module provides functions for..."""
```

Comments:

Comments:

```
my_list[5] += other_list[3]  # explain why you do this!
```

Read more:

https://realpython.com/documenting-python-code/ (https://realpython.com/documenting-python-code/)

https://www.python.org/dev/peps/pep-0008/?#comments (https://www.python.org/dev/peps/pep-0008/?#comments)

Formatting

Formatting

In [ ]:
```
title = 'Great movie'
rating = 10
print('The result is: '+ title + 'with rating: ' + rating)
```

Formatting

In [ ]:
```
title = 'Great movie'
rating = 10
print('The result is: '+ title + 'with rating: ' + rating)
```

Formatting!

In [ ]:
```
print('The result is: {} with rating {}'.format(title, rating))
```

Formatting

In [ ]:
```
title = 'Great movie'
rating = 10
print('The result is: '+ title + 'with rating: ' + rating)
```

Formatting!

In [ ]:
```
print('The result is: {} with rating {}'.format(title, rating))
```

Formatting - f-strings

In [ ]:
```
print(f'The result is: {title} with rating {rating}')  # python version >= 3.6
```

Formatting

In [ ]:
```
title = 'Great movie'
rating = 10
print('The result is: '+ title + 'with rating: ' + rating)
```

Formatting!

In [ ]:
```
print('The result is: {} with rating {}'.format(title, rating))
```

Formatting - f-strings

In [ ]:
```
print(f'The result is: {title} with rating {rating}')  # python version >= 3.6
```

Formatting - the old way

In [ ]:
```
print('The result is: %s with rating %s' % (title, rating))  # python2
```

Formatting

```
f'some text {variable:^50} text'  # center in a 50 character wide column
f'some text {variable:<50} text'  # left align in 50 character wide column
f'some text {variable:.2f} text'  # round a float to 2 digits
```

Learn more from the Python docs: https://docs.python.org/3.4/library/string.html#format-string-syntax (https://docs.python.org/3.4/library/string.html#format-string-syntax)

Exercise 2

→ **Notebook Day_4_Exercise_2**

Pandas

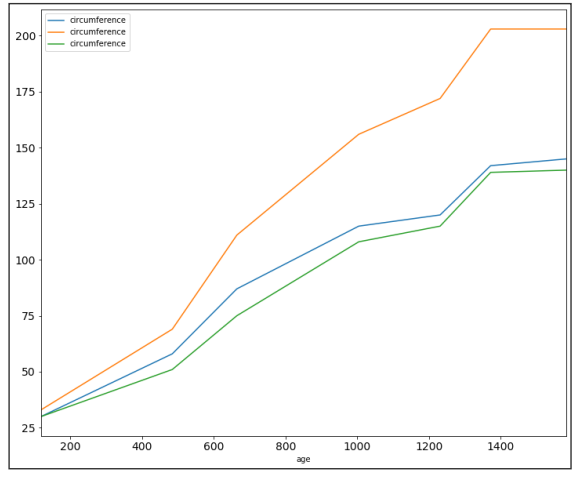
Library for working with tabular data

- comma separated (csv)
- tab separated (tsv)
- ...

Data analysis, graph plotting...

Pandas

	circumference	height
age		
1	2	30
2	3	35
3	5	40
4	10	50


circumference
circumference
circumference
200
175
150
125
100
75
50
25
200
400
600
800
1000
1200
1400
age

Pandas - a short overview

In [ ]:
```
import pandas as pd
```

In [ ]:
```
help(pd)
```

Orange tree data

`Orange_1.tsv`:

```
age   circumference  height
1        2             30
2        3             35
3        5             40
4        10            50
```

Orange tree data

`Orange_1.tsv`:

```
age   circumference  height
1        2             30
2        3             35
3        5             40
4        10            50
```

In [ ]:
```
tree_growth = pd.read_table('../downloads/Orange_1.tsv', index_col=0)
```

Dataframes

In [ ]:
```
tree_growth
```

- One index (in this case `age`)
- A bunch of colums (in this case `circumference` and `height`)
- A bunch of rows (identified by their index)

Dataframes

In [ ]:
```
tree_growth
```

- One index (in this case `age`)
- A bunch of colums (in this case `circumference` and `height`)
- A bunch of rows (identified by their index)

In [ ]:
```
tree_growth.columns
```

Dataframes

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tree_growth
```

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- A bunch of colums (in this case `circumference` and `height`)
- A bunch of rows (identified by their index)

In [ ]:
```
tree_growth.columns
```

In [ ]:
```
tree_growth.index
```

Exploring the data - picking a column

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In [ ]:
```
tree_growth.circumference
```

```
dataframe.columnname
```

```
dataframe['columnname']
```

Exploring the data - picking a column

In [ ]:
```
tree_growth.circumference
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```
dataframe.columnname

dataframe['columnname']
```

In [ ]:
```
tree_growth.height
```

Exploring the data - picking a column

In [ ]:
```
tree_growth.circumference
```

```
dataframe.columnname

dataframe['columnname']
```

In [ ]:
```
tree_growth.height
```

In [ ]:
```
tree_growth.circumference.max()
```

Exploring the data - picking a row

Exploring the data - picking a row

In [ ]:
```
tree_growth.loc[4]
```

`dataframe.loc[row_name]`

Reading data

```
dataframe = pandas.read_table(filepath, index_col=N)

dataframe.columnname

dataframe.loc[row_name]
```

Exercise 3

- Read the `Orange_1.tsv`
- Print the height column
- Print the data for the tree at age 2

In [ ]:

```
tree_growth = pd.read_table('../downloads/Orange_1.tsv', index_col=0)
tree_growth
```

In [ ]:
```
tree_growth = pd.read_table('../downloads/Orange_1.tsv', index_col=0)
tree_growth
```

In [ ]:
```
tree_growth.height
```

In [ ]:
```
tree_growth.loc[2]
```

Many trees!

Orange.tsv

```
Tree    age circumference
1     118       30
1     484       58
1     664       87
1    1004      115
...
2     118       33
2     484       69
...
```

In [ ]:

```
tree_growth = pd.read_table('../downloads/Orange.tsv', index_col=0)
tree_growth
```

In [ ]:
```
tree_growth.index
```

In [ ]:
```
tree_growth.columns
```

In [ ]:
```
tree_growth.age
```

In [ ]:
```
tree_growth.age
```

In [ ]:
```
tree_growth.age.values
```

In [ ]:
```
tree_growth.age.unique()
```

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```
tree_growth.age.unique()
```

Works like a normal list:

In [ ]:
```
tree_growth.age.unique()
```

Works like a normal list:

In [ ]:
```
tree_growth.age.unique()[0]
```

In [ ]:
```
tree_growth.age.unique()
```

Works like a normal list:

In [ ]:
```
tree_growth.age.unique()[0]
```

In [ ]:
```
len(tree_growth.age.unique())
```

Columns

`dataframe.columnname`

Methods:

`.max()`, `.min()`, `unique()`, `.values`, `.mean()`, `.sum()`…

Selecting parts of the table

Selecting parts of the table

In [ ]:
```
tree_growth.circumference   # selecting a column
```

Selecting parts of the table

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```
tree_growth.circumference   # selecting a column
```

In [ ]:
```
tree_growth.loc[2]  # selecting rows with index 2
```

Selecting parts of the table

In [ ]:
```
tree_growth.circumference   # selecting a column
```

In [ ]:
```
tree_growth.loc[2]  # selecting rows with index 2
```

```
tree_growth.loc[ criteria ]  # select all rows that fullfills this criteria
```

Selecting parts of the table

Find the data points where the tree is younger than 200 years!

- Find *rows* => use `tree_growth.loc[]`
- Select these based on the value of column age => `tree_growth.age`

In [ ]:
```
# The answer...
```

Selecting parts of the table

Find the data points where the tree is younger than 200 years!

- Find *rows* => use `tree_growth.loc[]`
- Select these based on the value of column age => `tree_growth.age`

In [ ]:
```
# The answer...
```

In [ ]:
```
young = tree_growth.loc[tree_growth.age < 200]
young
```

Exercise 4

- Read the data `Orange.tsv`
- Find the maximum circumference
- What tree reached that circumference, and how old was it at that time?

```
tree_growth.loc[ tree_growth.age < 200 ]
```

In [ ]:

```
import pandas as pd

tree_growth = pd.read_table('../downloads/Orange.tsv',index_col=0)
```

In [ ]:
```
import pandas as pd

tree_growth = pd.read_table('../downloads/Orange.tsv',index_col=0)
```

In [ ]:
```
max_c = tree_growth.circumference.max()

print(max_c)
```

In [ ]:
```
import pandas as pd

tree_growth = pd.read_table('../downloads/Orange.tsv',index_col=0)
```

In [ ]:
```
max_c = tree_growth.circumference.max()

print(max_c)
```

In [ ]:
```
tree_growth.loc[tree_growth.circumference == max_c]
```

Plotting

```
df.columnname.plot()
```

Plotting

```
df.columnname.plot()
```

In [ ]:
```
orange_1 = pd.read_table('../downloads/Orange_1.tsv')
orange_1.circumference.plot()
```

Plotting

What if no plot shows up?

```
%pylab inline   # jupyter notebooks
```

or

```
import matplotlib.pyplot as plt
plt.show()
```

Plotting - many trees

Plotting - many trees

- Plot a bar chart

Plotting - many trees

- Plot a bar chart

In [ ]:
```
tree_growth.plot(kind='bar')
```

In [ ]:
```
tree_growth.plot(kind='bar', figsize=(12, 12), fontsize=12)
```

Plotting

- Plot a line graph

Plotting

- Plot a line graph

In [ ]:
```
# Starting with tree number 1
tree1 = tree_growth.loc[1]
```

In [ ]:
```
tree1
```

Plotting

- Plot a graph: `dataframe.plot(kind="line", x=..., y=...)`

In [ ]:
```
tree1.plot(x='age', y='circumference', fontsize=14, figsize=(12,10))
```

Plotting

- Plot a graph: `dataframe.plot(kind="line", x="..", y="...")`

Plotting

- Plot a graph: `dataframe.plot(kind="line", x="..", y="...")`

Let's plot all the trees!

In [ ]:
```
tree_growth.plot(kind='line', x='age', y='circumference', figsize=(12, 10), fontsize=14)
```

In [ ]:
```
tree_growth.plot(kind='line', x='age', y='circumference', figsize=(12, 10), fontsize=14)
```

:(

Plotting

- Plot a graph: `dataframe.plot(kind="scatter", x="..", y="...")`

In [ ]:
```
tree_growth.plot(kind='scatter', x='age', y='circumference', figsize=(12, 10), fontsize=14)
```

Plotting

What about the lines?

Plotting

What about the lines?

- Group the table by the index (make subtrees / subdataframes)
- Get one board to plot all the lines
- Draw them one by one

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```
dataframe.groupby([what])
```

Plotting

What about the lines?

- Group the table by the index (make subtrees / subdataframes)
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- Draw them one by one

```
dataframe.groupby([what])
```

```
import matplotlib.pyplot as plt
fig, ax = plt.subplots()
```

Plotting

Plotting

In [ ]:

```
import matplotlib.pyplot as plt

fig, ax = plt.subplots()

for index, subtree in tree_growth.groupby(['Tree']):
    subtree.plot(x='age', y='circumference', ax=ax, kind='line', fontsize=14, figsize=(12,10))
```

Exercise 5

- Use Pandas to read IMDB
- Explore it by making graphs