An Introduction to Objects:

Beyond the Procedural Paradigm

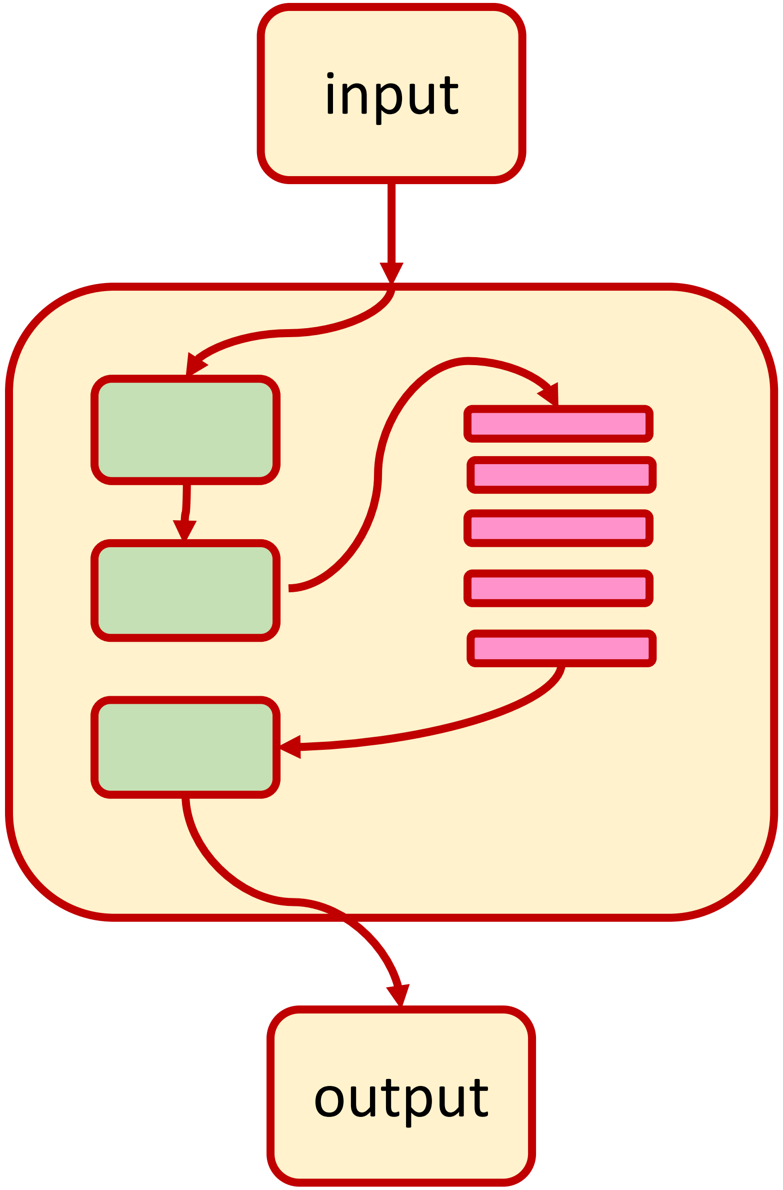
DS 2000
Intro. Programming with Data

Northeastern University

The procedural paradigm

Programs are *recipes*: a series of statements that transform our data into visualizations and insight.

In procedural programming, we manage complexity by being **modular**: adhering to top-down programming practices that break down difficult tasks into a sequence of more manageable sub-tasks.



Recipes are a powerful metaphor for data science!

start with
raw data

load
data

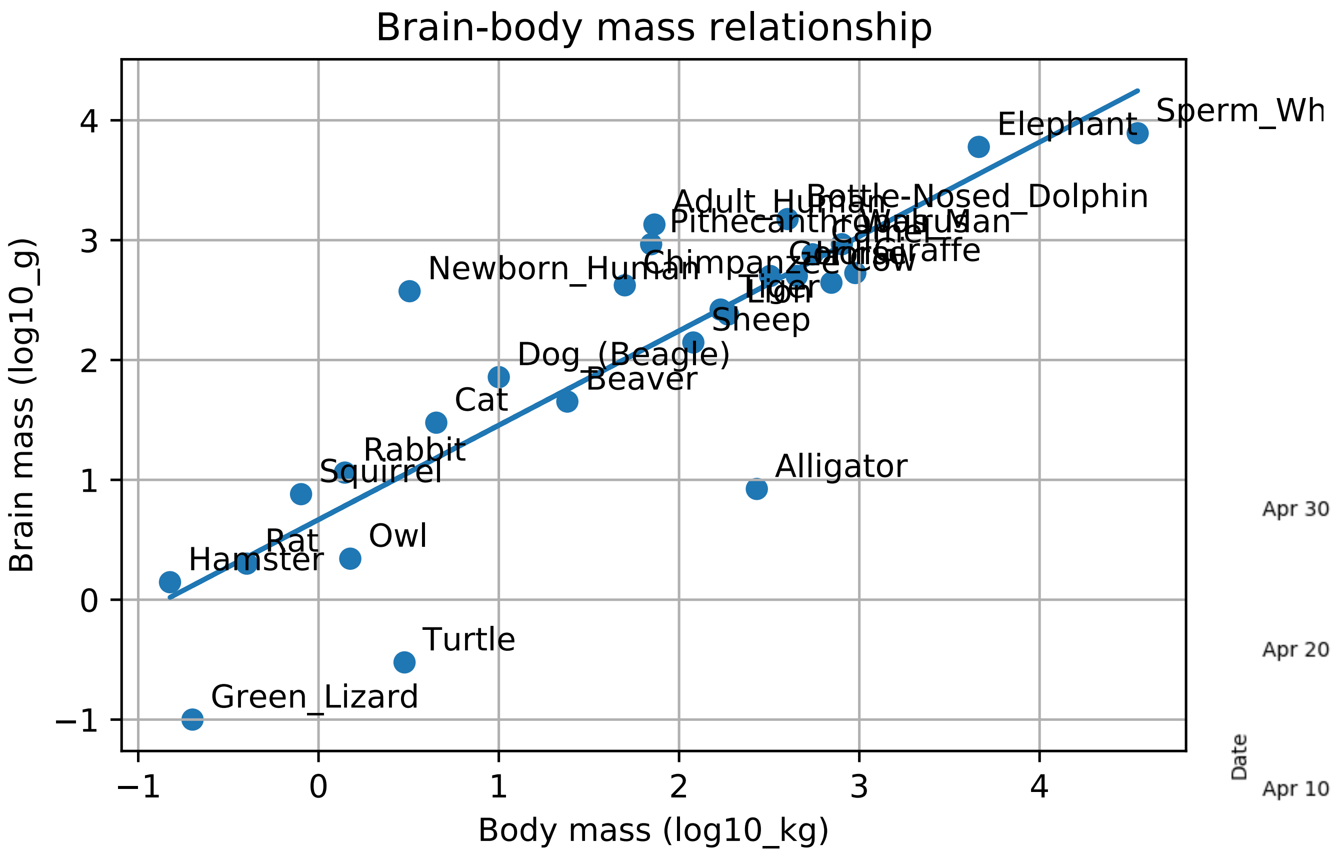
data refinement
(munging)

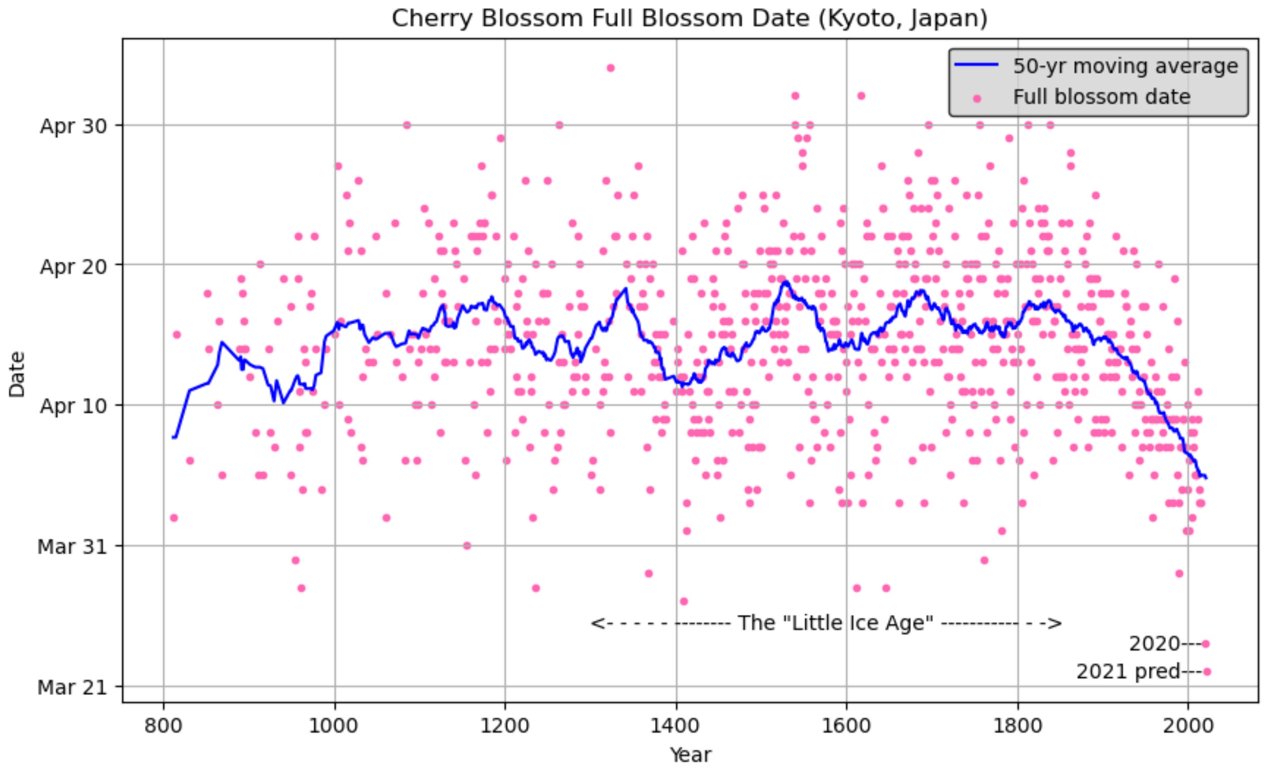
build data
structures

processing
and
visualization

don’t forget
to label your
axes!

…and it’s adequate for a wide range of use-cases!





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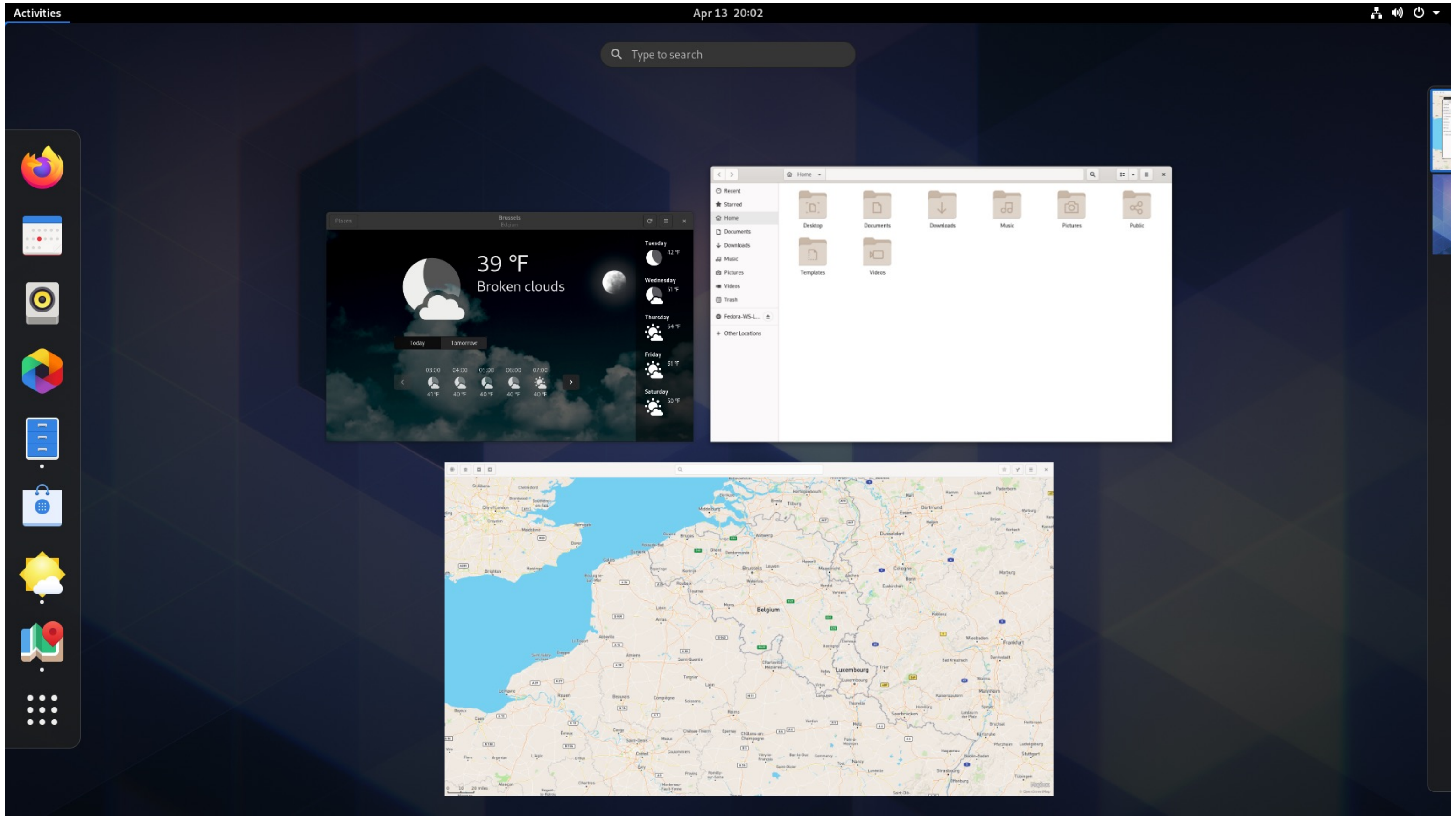
But consider the Desktop



source: https://www.gnome.org

We **interact** with the desktop **interface** by performing actions on **objects** that each support well-defined **behaviors**.

<u>Objects</u>

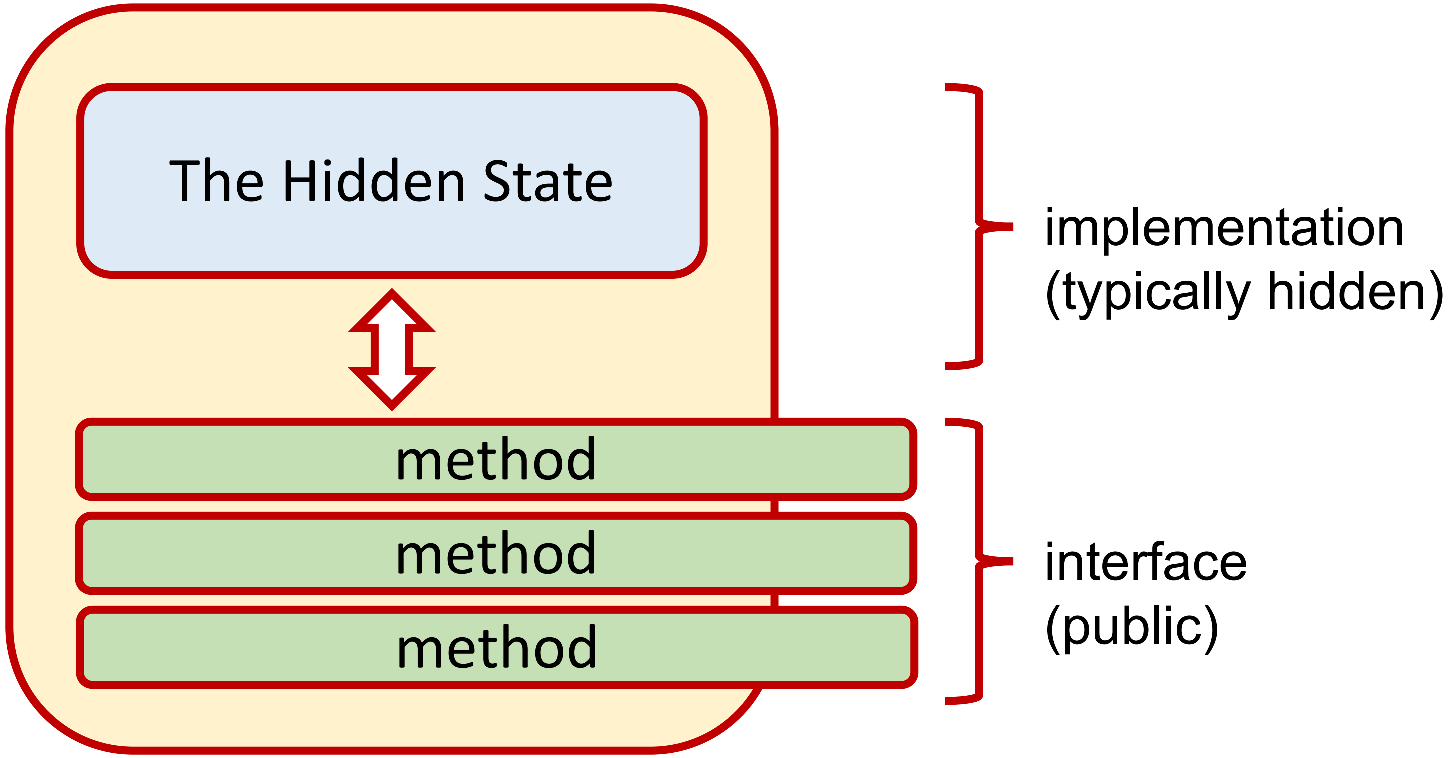
- files and folders
- windows
- apps
- menus
- status bar

<u>Behaviors</u>

- open/close
- move
- resize

The paradigm has clearly changed!

The object paradigm: Objects are containers

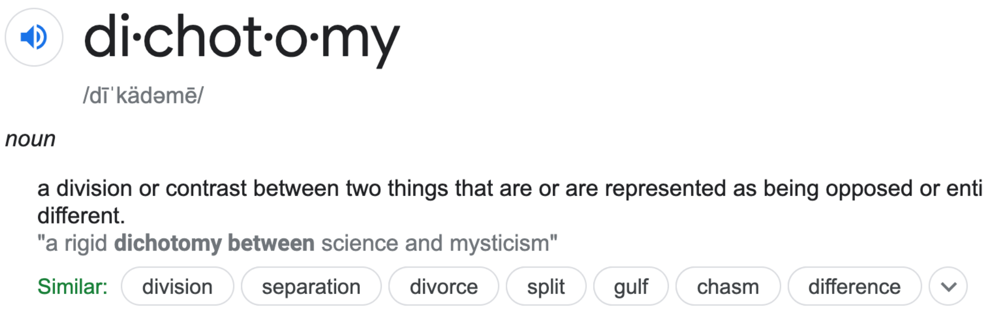


Objects have fields and attributes that constitute the **state** of the object. These are the objects **attributes**.

The state is accessed and modified through various **methods** that constitute the object’s **interface**.

The layout and organization of the state (i.e., the **implementation**) is usually shielded from the user.

The Interface/Implementation Dichotomy



di·chot·o·my

/dīˈkädəmē/

noun

a division or contrast between two things that are or are represented as being opposed or entirely different.

"a rigid **dichotomy between** science and mysticism"

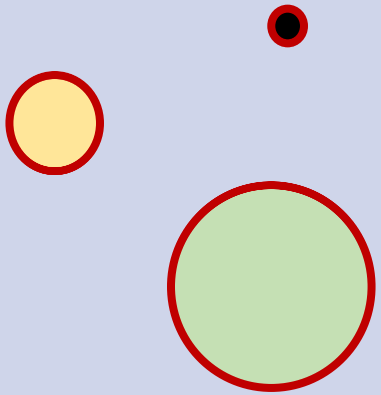
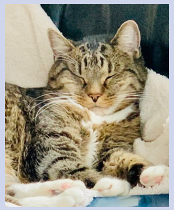
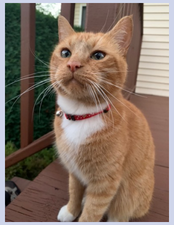
Similar: division separation divorce split gulf chasm difference

We can operate complex machines without knowing what's *under the hood*.

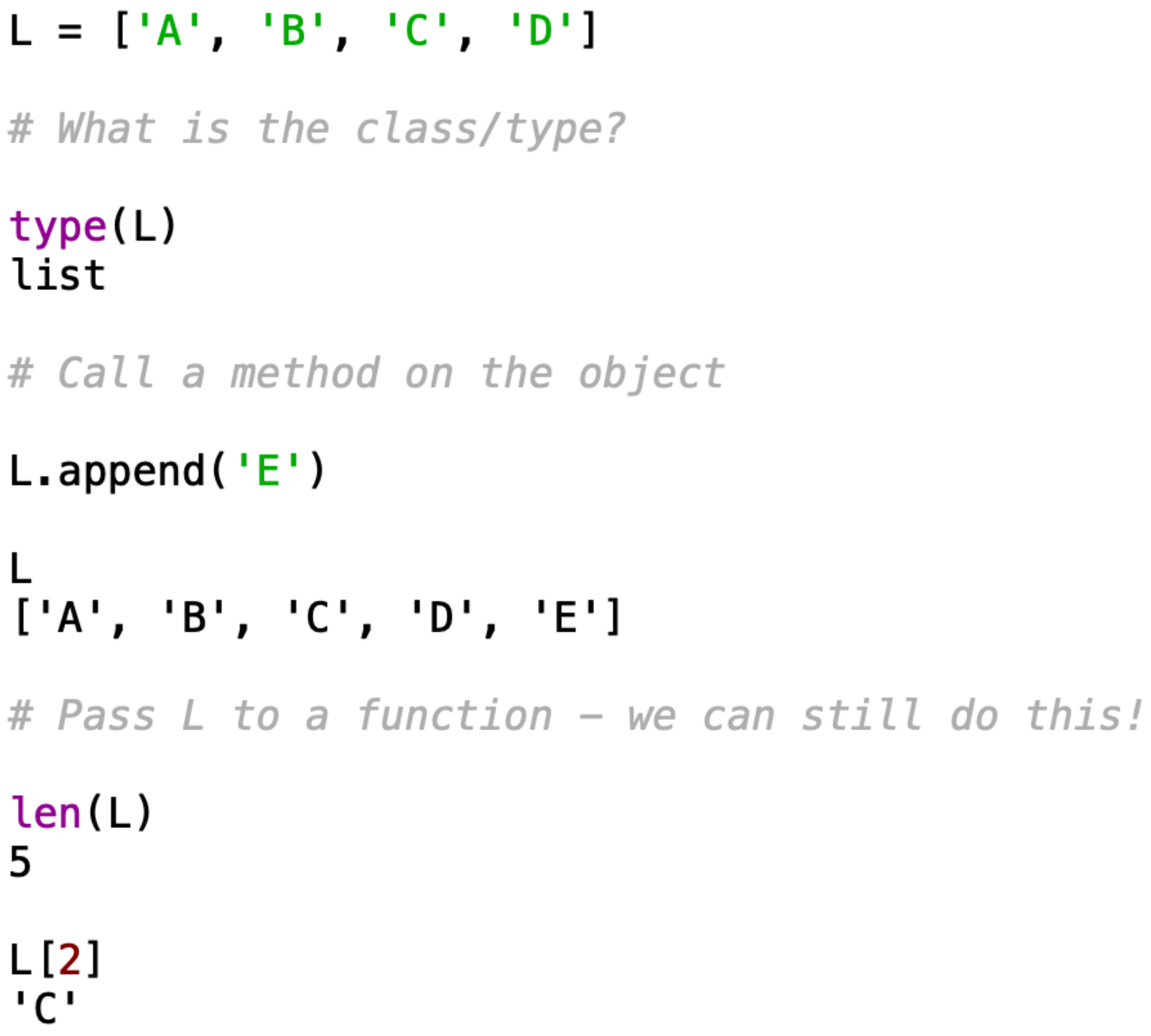
Similarly, to build more complex software, we need to express ideas at a higher level of abstraction with a focus of interface over implementation. Object-oriented thinking enables us to do this.

Classes and Objects

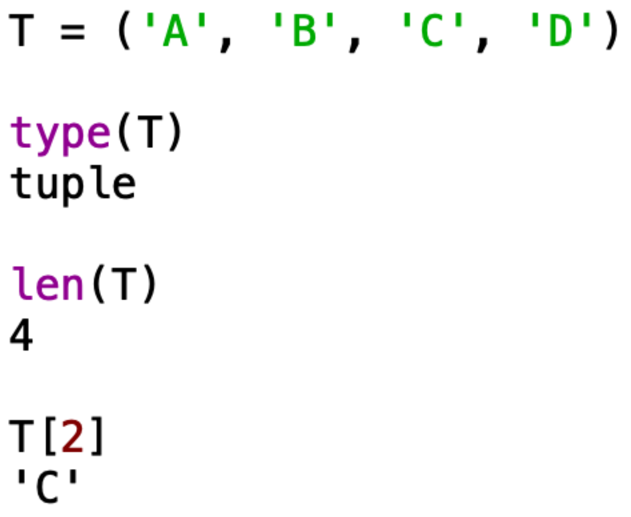
Classes define a **type**. It acts as a *template* or blueprint.
We then construct many objects that are **instances** of a particular class.

Class (Type)	List	Circle	Cat	Account
Object Instances	[1, 2, 3] [‘Jack’, ‘Abby’] [] [(0,0), (5,7), (-2,2)]		 my_cat  not_my_cat	MyChecking MySavings . . *etc.*

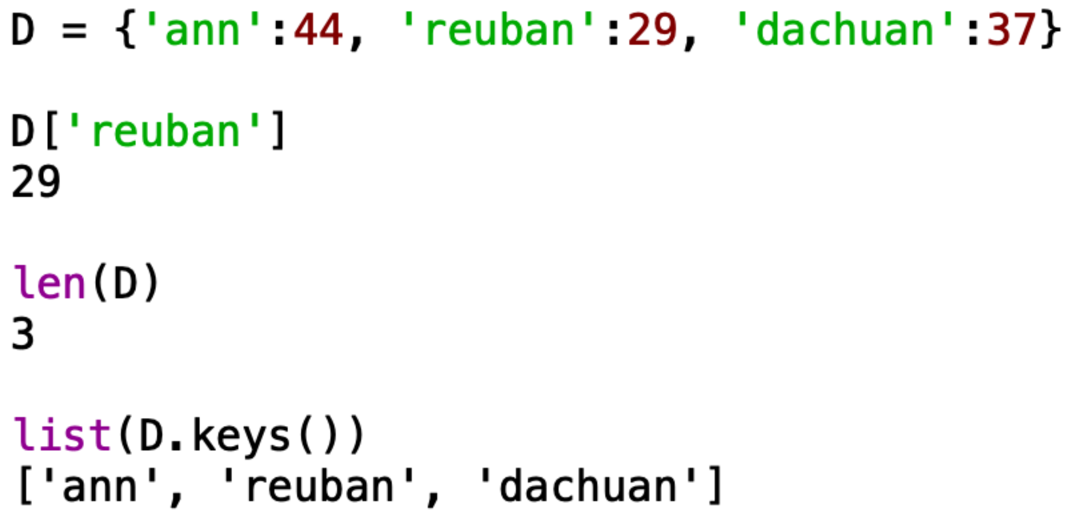
Lists, Tuples, and Dictionaries are objects!



```
L = ['A', 'B', 'C', 'D']

# What is the class/type?

type(L)
list

# Call a method on the object

L.append('E')

L
['A', 'B', 'C', 'D', 'E']

# Pass L to a function – we can still do this!

len(L)
5

L[2]
'C'
```

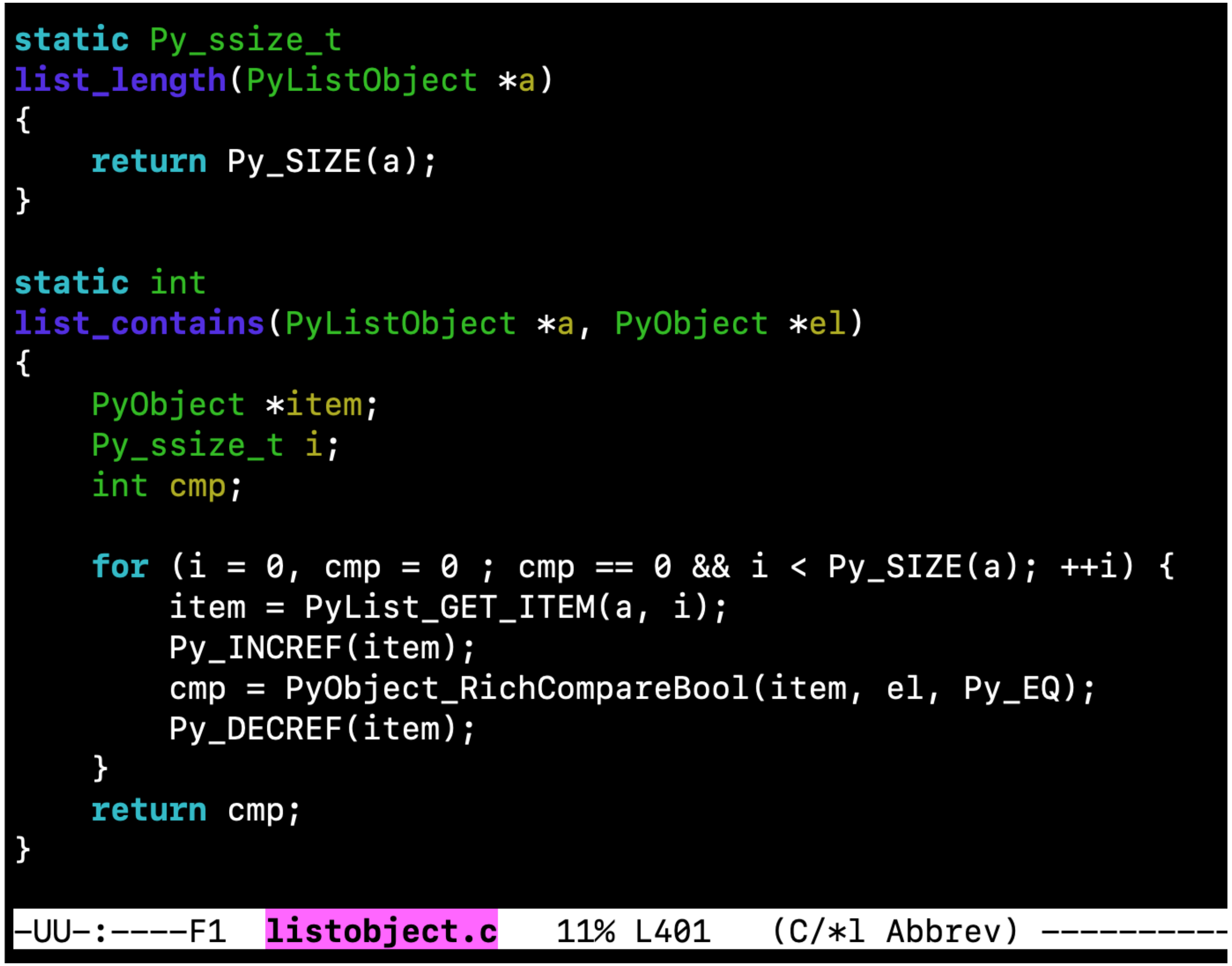


```
T = ('A', 'B', 'C', 'D')

type(T)
tuple

len(T)
4

T[2]
'C'
```



```
D = {'ann':44, 'reuban':29, 'dachuan':37}

D['reuban']
29

len(D)
3

list(D.keys())
['ann', 'reuban', 'dachuan']
```

The Hidden List Implementation of Python 3.9.2



```
static Py_ssize_t
list_length(PyListObject *a)
{
    return Py_SIZE(a);
}

static int
list_contains(PyListObject *a, PyObject *el)
{
    PyObject *item;
    Py_ssize_t i;
    int cmp;

    for (i = 0, cmp = 0 ; cmp == 0 && i < Py_SIZE(a); ++i) {
        item = PyList_GET_ITEM(a, i);
        Py_INCREF(item);
        cmp = PyObject_RichCompareBool(item, el, Py_EQ);
        Py_DECREF(item);
    }
    return cmp;
}

-UU-:----F1  listobject.c   11% L401   (C/*l Abbrev) ----------
```

Object-Oriented Python

Let’s construct some objects!

(Python syntax for creating classes and objects)