



Smith College

Computer Science

Lecture Notes

Week 11

Class Inheritance

CSC111 Spring 2018

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Lists of Lists And Solving Everyday Problems with Lists

Two Types of Lists

Useful List Operations

Sorting out cats

Two Approaches to Filtering Data

Examples

Useful List Operations

```
Python Shell
Python 3.1.1 (r311:74543, Aug 24 2009, 18:44:04)
[GCC 4.0.1 (Apple Inc. build 5493)] on darwin
Type "copyright", "credits" or "license()" for more information.
>>> L = [3, 10, 3, 5, 1, -1, 0, 6]
>>> L
[3, 10, 3, 5, 1, -1, 0, 6]
>>> L.sort()
>>> L
[-1, 0, 1, 3, 3, 5, 6, 10]
>>> L.reverse()
>>> L
[10, 6, 5, 3, 3, 1, 0, -1]
>>> L[0]
10
>>> L[0:3]
[10, 6, 5]
>>> L[-3:]
[1, 0, -1]
>>> S = set( L )
>>> S
{0, 1, 3, 5, 6, 10, -1}
>>> L = list( S )
>>> L
[0, 1, 3, 5, 6, 10, -1]
>>> |
```

Ln: 25 Col: 4

Useful List Operations

Sorting Tuples

```
Python Shell
Python 3.1.1 (r311:74543, Aug 24 2009, 18:44:04)
[GCC 4.0.1 (Apple Inc. build 5493)] on darwin
Type "copyright", "credits" or "license()" for more information.
>>> L = [ (10, "Smith"), (1, "Amherst"), (3, "Umass"), (5, "Hampshire" )]
>>> L
[(10, 'Smith'), (1, 'Amherst'), (3, 'Umass'), (5, 'Hampshire')]
>>> L.sort()
>>> L
[(1, 'Amherst'), (3, 'Umass'), (5, 'Hampshire'), (10, 'Smith')]
>>>
>>>
>>> L2 = [ ("Smith", 10), ("Amherst", 1), ("Umass", 3 ), ("Hampshire", 5 ) ]
>>> L2.sort()
>>> L2
[('Amherst', 1), ('Hampshire', 5), ('Smith', 10), ('Umass', 3)]
>>> |
```

Ln: 16 Col: 4

Two Types of Lists

Useful List Operations

Sorting out cats

Two Approaches to Filtering Data

Examples

```
*sortingCats.py - /Users/thiebaut/Desktop/Dropbox/111/sortingCats.py (3.5.4)*

def __str__( self ):
    if self.vaccinated == True:
        vacc = "vaccinated"
    else:
        vacc = "not vaccinated"
    return "{0:20}==> {1:1}, {2:1}, {3:1} yrs old".format(
        self.name, self.breed, vacc, self.age )

def main():
    cats = [ ]
    cats.append( Cat( "Minou", 3, True, "stray" ) )
    cats.append( Cat( "Max", 1, False, "Burmese" ) )
    cats.append( Cat( "Gizmo", 2, True, "Bengal" ) )
    cats.append( Cat( "Garfield", 2, False, "Orange Tabby" ) )

    print( "\nComplete list: " )
    for cat in cats:
        print( cat )

    print( "\nCats sorted by age: " )
    cats.sort()
    for cat in cats:
        print( cat )

main()

Ln: 57 Col: 20
```

Complete list:

```
Minou           ==> stray, vaccinated, 3 yrs old
Max             ==> Burmese, not vaccinated, 1 yrs old
Gizmo          ==> Bengal, vaccinated, 2 yrs old
Garfield       ==> Orange Tabby, not vaccinated, 2 yrs old
```

Cats sorted by age:

Traceback (most recent call last):

```
File "/Users/thiebaut/Desktop/Dropbox/111/sortingCats.py", line 58, in <modul
e>
```

```
    main()
```

```
File "/Users/thiebaut/Desktop/Dropbox/111/sortingCats.py", line 55, in main
    cats.sort()
```

```
TypeError: unorderable types: Cat() < Cat()
```

```
>>>
```


Default < > == != Operators

```
*sortingCats.py - /Users/thiebaut/Desktop/Dropbox/111/sortingCats.py (3.5.4)*
# Cats.py
# D. Thiebaut
# Minou, 3, vac, stray
# Max, 1, not-vac, Burmese
# Gizmo, 2, vac, Bengal
# Garfield, 4, not-vac, Orange Tabby

class Cat:
    def __init__( self, na, ag, vacc, bre ):
        self.name      = na
        self.age       = ag
        self.vaccinated = vacc
        self.breed     = bre
        return

    def __gt__( self, otherCat ):
        return self.age > otherCat.age

    def __lt__( self, otherCat ):
        return self.age < otherCat.age

    def getName( self ):
        return self.name
```

Ln: 16 Col: 0

https://docs.python.org/3/reference/datamodel.html?highlight=__gt__#object.__gt__

Two Types of Lists

Useful List Operations

Sorting out cats

Filtering Data (Everyday Python)

Examples

Two Types of Filtering Problems...

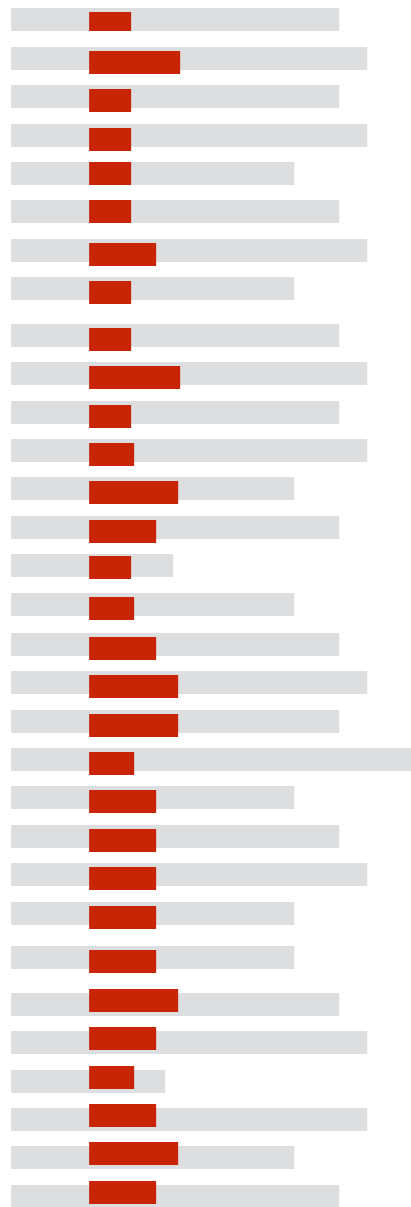


The Problem at Hand



Textual Info.

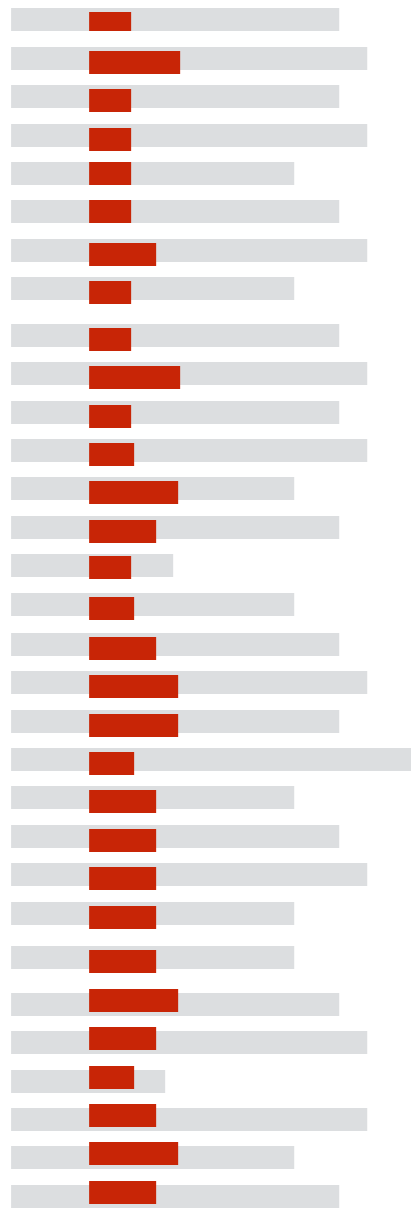
The Problem at Hand



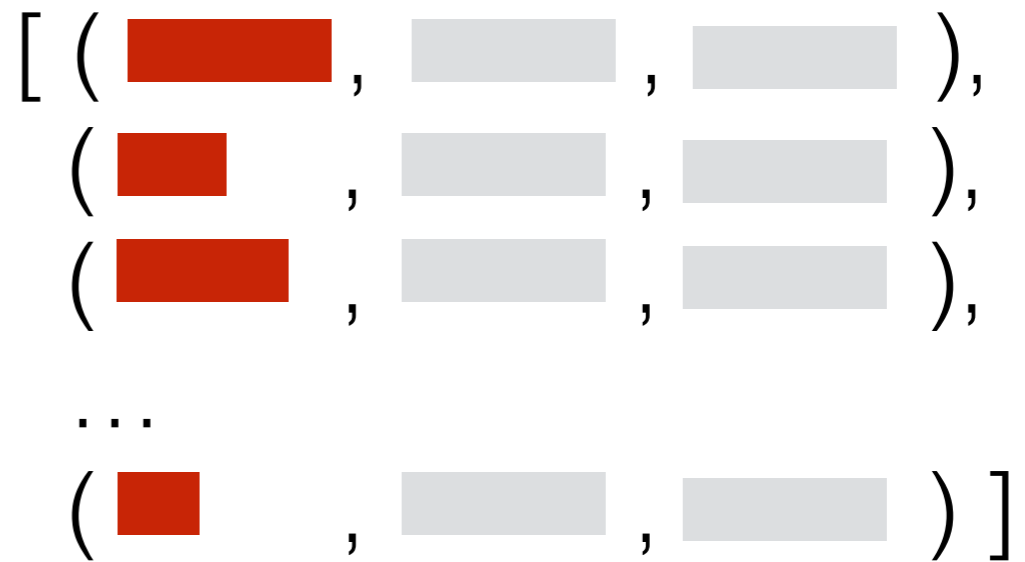
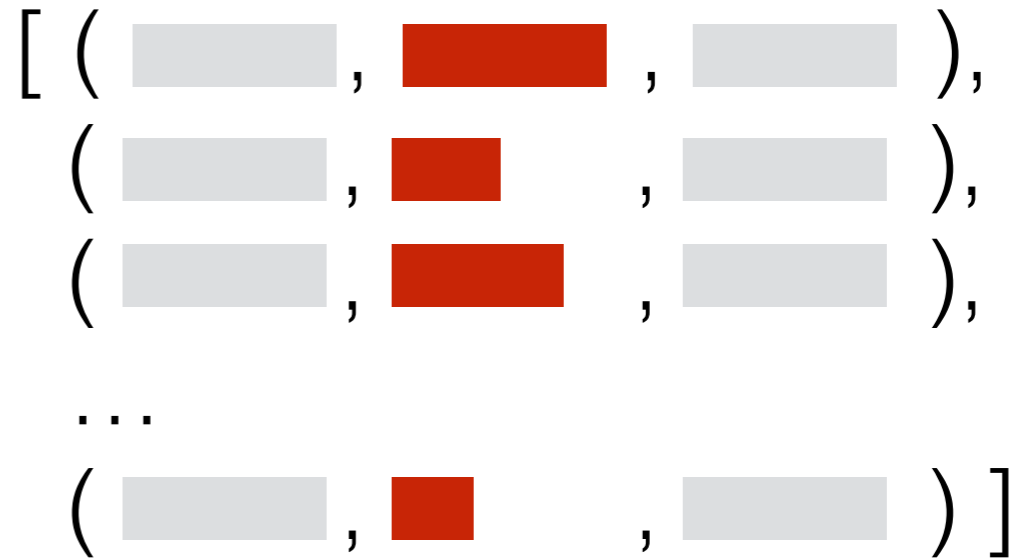
Textual Info.

OPTION 1:
We are only interested
in the red information,
and only the smaller
or larger items...

The Problem at Hand



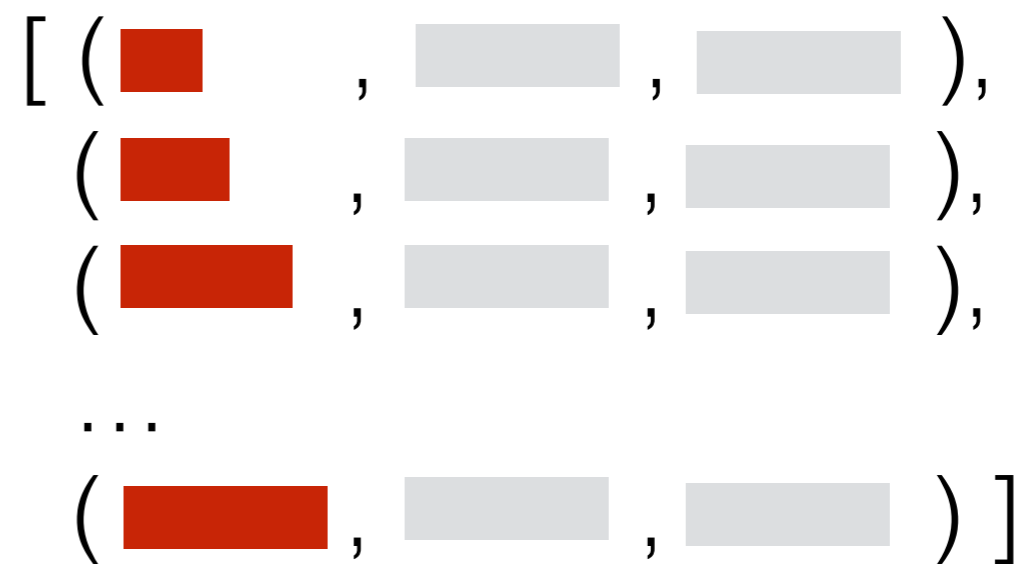
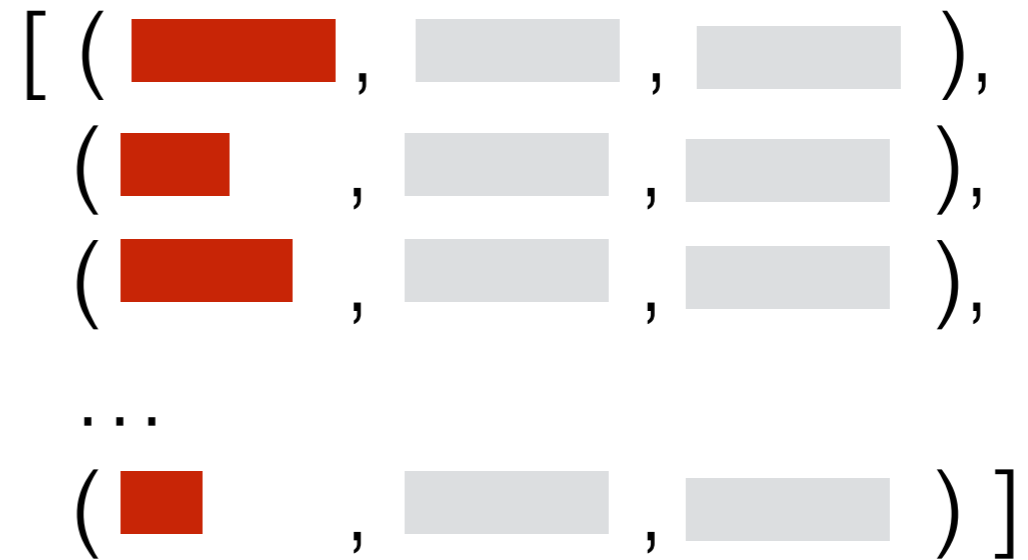
Textual Info.



The Problem at Hand



Textual Info.



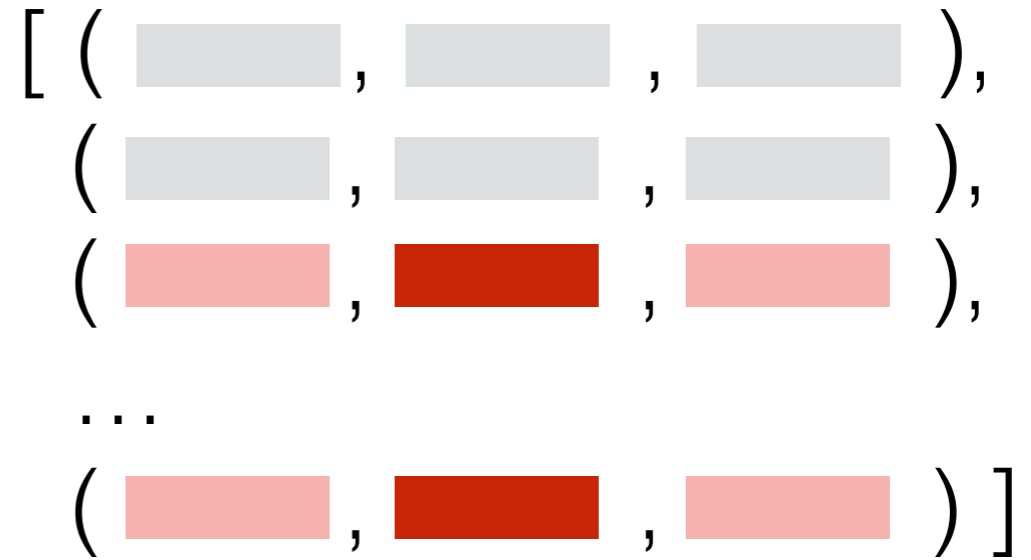
The Problem at Hand



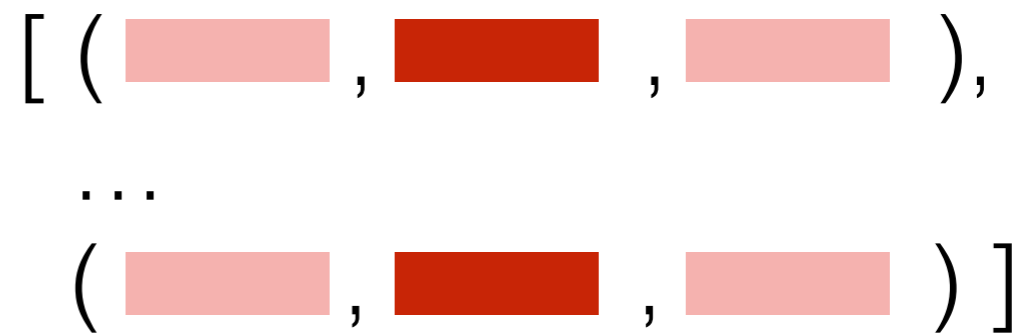
Textual Info.

OPTION 2:
We are only interested
in the lines that contain
the red information

The Problem at Hand



FILTER



Textual Info.

Two Types of Lists

Useful List Operations

Two Approaches to Filtering Data

Examples

Example 1

10 **Rainiest** Months In **Cambridge**, U.K.?

<http://cs.smith.edu/~dthiebaut/UKTemperatures/>

<https://www.metoffice.gov.uk/public/weather/climate-historic/#?tab=climateHistoric>

- Mean daily maximum temperature (tmax)
- Mean daily minimum temperature (tmin)
- Days of air frost (af)
- Total rainfall (rain)
- Total sunshine duration (sun)

Example 2

Ammie@hampshire.edu
Bessie@smith.edu
Carylon@smith.edu
Cheryll@smith.edu
Cordelia@smith.edu
Illa@smith.edu
Lisbeth@smith.edu
Mackenzie@smith.edu
Maryellen@smith.edu
Matha@smith.edu
Patrica@hampshire.edu
Sanjuana@smith.edu
Sharie@smith.edu
Sonya@smith.edu
Yuko@smith.edu

Cheryll@smith.edu
Codi@smith.edu
Cordelia@smith.edu
Elenore@smith.edu
Emelia@smith.edu
Josie@smith.edu

...



List of email addresses for students enrolled in several classes.

Need a list of all Smith students without duplicates and a list of all 5-College students without duplicates

Example 3

U.S. Presidents

text=""Presidency ,President, Took office ,Left office ,Party , Home State
1, George Washington, 30/04/1789, 4/03/1797, Independent, Virginia
2, John Adams, 4/03/1797, 4/03/1801, Federalist, Massachusetts
3, Thomas Jefferson, 4/03/1801, 4/03/1809, Democratic-Republican, Virginia
4, James Madison, 4/03/1809, 4/03/1817, Democratic-Republican, Virginia
5, James Monroe, 4/03/1817, 4/03/1825, Democratic-Republican, Virginia
6, John Quincy Adams, 4/03/1825, 4/03/1829, Democratic-Republican/National Republican, Massachusetts
7, Andrew Jackson, 4/03/1829, 4/03/1837, Democratic, Tennessee
8, Martin Van Buren, 4/03/1837, 4/03/1841, Democratic, New York
9, William Henry Harrison, 4/03/1841, 4/04/1841, Whig, Ohio
10, John Tyler, 4/04/1841, 4/03/1845, Whig, Virginia
11, James K. Polk, 4/03/1845, 4/03/1849, Democratic, Tennessee
12, Zachary Taylor, 4/03/1849, 9/07/1850, Whig, Louisiana
13, Millard Fillmore, 9/07/1850, 4/03/1853, Whig, New York
14, Franklin Pierce, 4/03/1853, 4/03/1857, Democratic, New Hampshire
15, James Buchanan, 4/03/1857, 4/03/1861, Democratic, Pennsylvania
16, Abraham Lincoln, 4/03/1861, 15/04/1865, Republican/National Union, Illinois
17, Andrew Johnson, 15/04/1865, 4/03/1869, Democratic/National Union, Tennessee
18, Ulysses S. Grant, 4/03/1869, 4/03/1877, Republican, Ohio
19, Rutherford B. Hayes, 4/03/1877, 4/03/1881, Republican, Ohio
20, James A. Garfield, 4/03/1881, 19/09/1881, Republican, Ohio
21, Chester A. Arthur, 19/09/1881, 4/03/1885, Republican, New York
22, Grover Cleveland, 4/03/1885, 4/03/1889, Democratic, New York
23, Benjamin Harrison, 4/03/1889, 4/03/1893, Republican, Indiana
24, Grover Cleveland, 4/03/1893, 4/03/1897, Democratic, New York
25, William McKinley, 4/03/1897, 14/9/1901, Republican, Ohio
26, Theodore Roosevelt, 14/9/1901, 4/3/1909, Republican, New York
27, William Howard Taft, 4/3/1909, 4/03/1913, Republican, Ohio
28, Woodrow Wilson, 4/03/1913, 4/03/1921, Democratic, New Jersey
29, Warren G. Harding, 4/03/1921, 2/8/1923, Republican, Ohio
30, Calvin Coolidge, 2/8/1923, 4/03/1929, Republican, Massachusetts
31, Herbert Hoover, 4/03/1929, 4/03/1933, Republican, Iowa
32, Franklin D. Roosevelt, 4/03/1933, 12/4/1945, Democratic, New York
33, Harry S. Truman, 12/4/1945, 20/01/1953, Democratic, Missouri
34, Dwight D. Eisenhower, 20/01/1953, 20/01/1961, Republican, Texas
35, John F. Kennedy, 20/01/1961, 22/11/1963, Democratic, Massachusetts
36, Lyndon B. Johnson, 22/11/1963, 20/1/1969, Democratic, Texas
37, Richard Nixon, 20/1/1969, 9/8/1974, Republican, California
38, Gerald Ford, 9/8/1974, 20/01/1977, Republican, Michigan
39, Jimmy Carter, 20/01/1977, 20/01/1981, Democratic, Georgia
40, Ronald Reagan, 20/01/1981, 20/01/1989, Republican, California
41, George H. W. Bush, 20/01/1989, 20/01/1993, Republican, Texas
42, Bill Clinton, 20/01/1993, 20/01/2001, Democratic, Arkansas
43, George W. Bush, 20/01/2001, 20/01/2009, Republican, Texas""



**Who was
president
in 1939?**



**We stopped here
last time...**

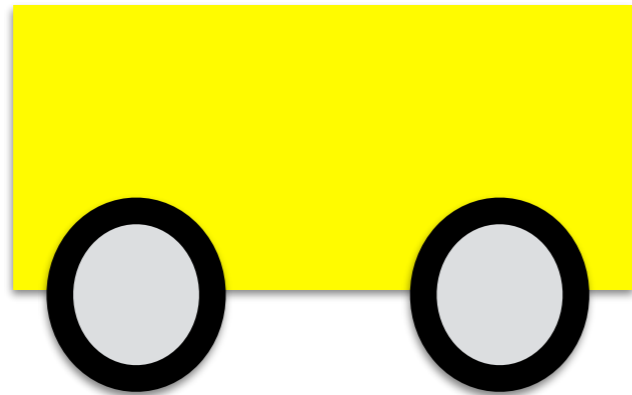
Class Inheritance

(End of Chapter 12)

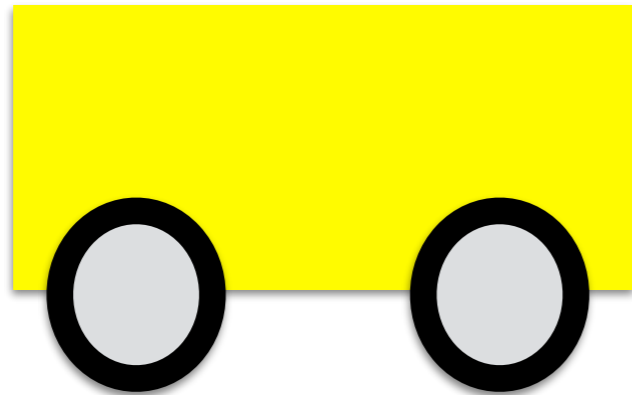
Class Inheritance



The Idea...

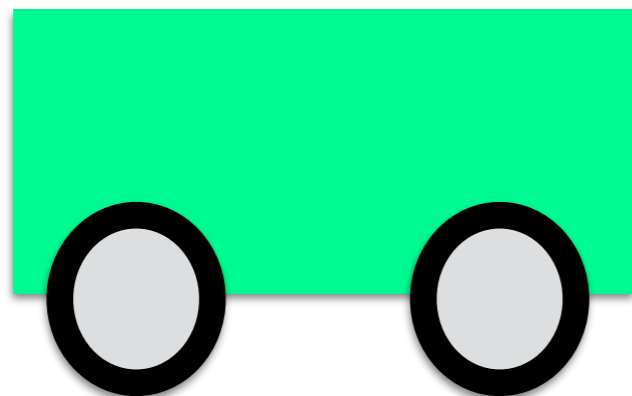


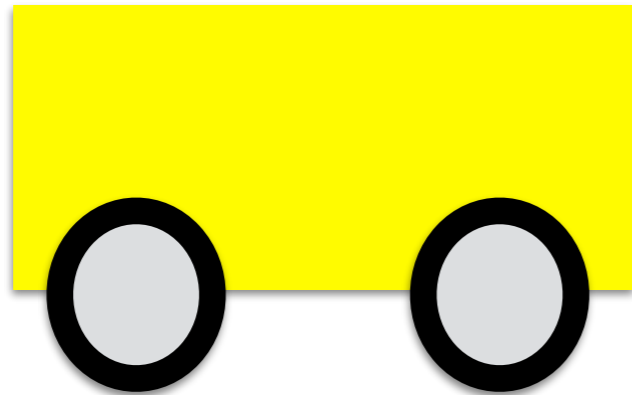
```
Car class
- constructor
- draw
- move
- undraw
- changeColor
- etc...
```



```
Car class
- constructor
- draw
- move
- undraw
- etc...
```

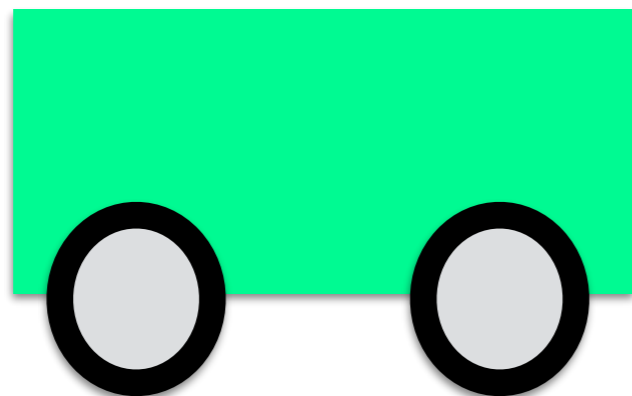
**Wanted
with same
features**



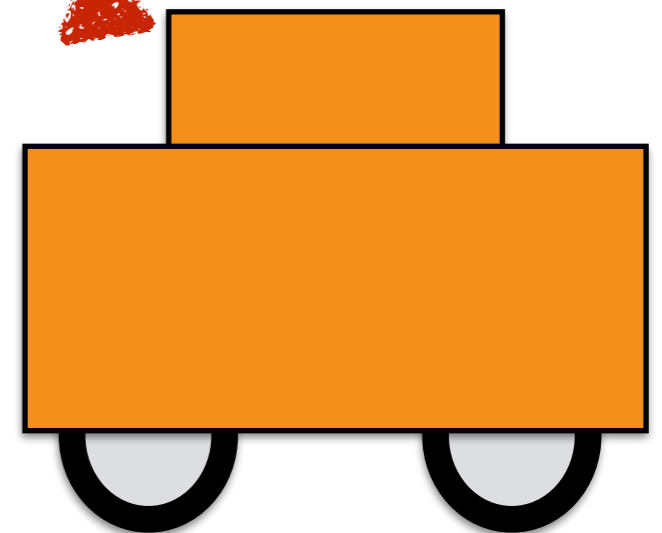


```
Car class
- constructor
- draw
- move
- undraw
- changeColor
- etc...
```

**Wanted
with same
features**



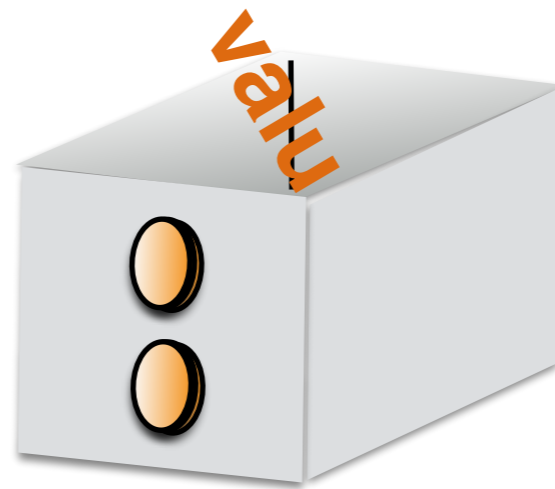
**Wanted
with different
features**



- We *could* write complete new classes for the two new car shapes...
- But instead, we can **save code, save time, save debugging aggravation**, by reusing the original Car class.

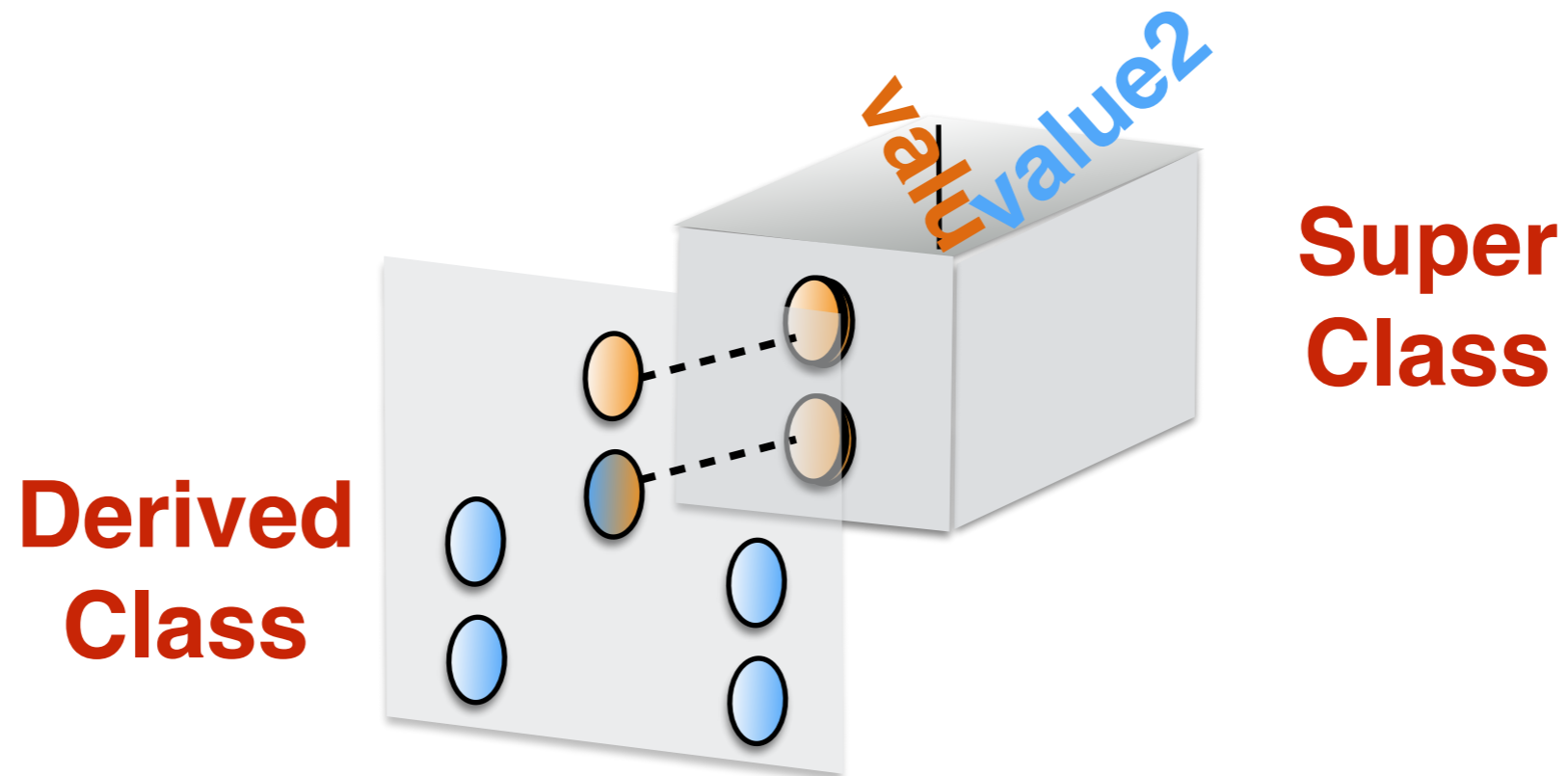
- We *could* write complete new classes for the two new car shapes...
- But instead, we can **save code, save time, save debugging aggravation**, by reusing the original Car class.
- We will **derive** a new class from the Car class. The new class will be **derived** from it, and will **inherit** all its member variables and methods.
- The original Car class will become the **super** class.

Another Way of Looking at Inheritance



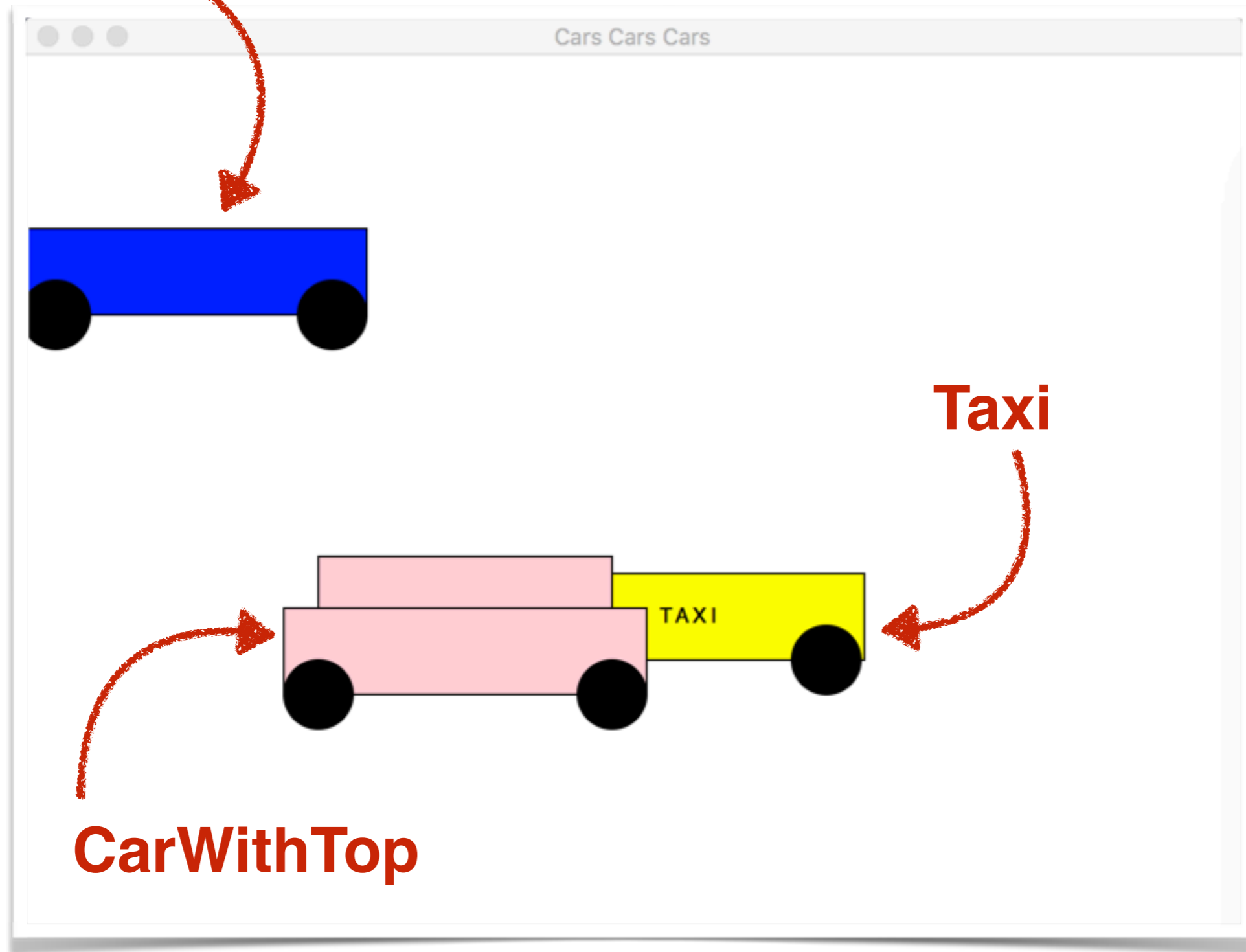
Class

Another Way of Looking at Inheritance



Coding Exercise

GenericCar



Coding Exercise

- Create a generic car class with 2 **wheels** and a **body**. Add **methods** to set the *speed* and to set the *color*. Add a **move** method.
- **Derive** a **Taxi** class from the generic class. The color will always be *yellow*, and the word "TAXI" will be on the body.
- **Derive** a car with a **top** from the generic car class.

```

genericCar.py - /Users/thiebaut/Desktop/Dropbox/111/genericCar.py (3.5.4)*
# genericCar.py
# D. Thiebaut
# The definition for a generic Car class
from graphics import *
from random import *

class GenericCar:
    """Definition for a car with a body and two wheels"""

    def __init__(self, win, topLeft, width, height ):
        """constructs a car made of 1 rectangle with top-left
        point topLeft, dimension width x height, and two wheels
        away from left and right by 10 pixels"""
        # save width and height of car
        self.width = width
        self.height = height

        # create bottom-right point
        x1 = topLeft.getX()
        y1 = topLeft.getY()
        P2 = Point( x1+width, y1+height )

        # body is a rectangle between topLeft and P2
        self.body = Rectangle( topLeft, P2 )
        self.body.setFill( "yellow" )

        # create wheel #1

```

The Super Class

Ln: 14 Col: 38

```
# useGenericCar.py
# D. Thiebaut

from genericCar import *
from graphics import *

def main():
    win = GraphWin( "Cars Cars Cars", 700, 500 )

    car = GenericCar( win, Point( 100, 100 ), 200, 50 )
    car.draw( win )
    car.setSpeed( -1.5 )
    car.setFill( "blue" )

    taxi = Taxi( win, Point( 150, 300 ), 200, 50 )
    taxi.setSpeed( +2.0 )
    taxi.setFill( "grey" )
    taxi.draw( win )

    car2 = CarWithTop( win, Point( 250, 320 ), 210, 50 )
    car2.setSpeed( -1.5 )
    car2.setFill( "pink" )
    car2.draw( win )

    while True:
        car.move( )
        taxi.move( )
```

The Main Program

Two Different Syntaxes

```
def draw( self, win ):  
    super().draw( win )  
    self.top.draw( win )
```

```
def draw( self, win ):  
    GenericCar.draw( self, win )  
    self.top.draw( win )
```


Two Different Syntaxes

```
def draw( self, win ):  
    super().draw( win )  
    self.top.draw( win )
```

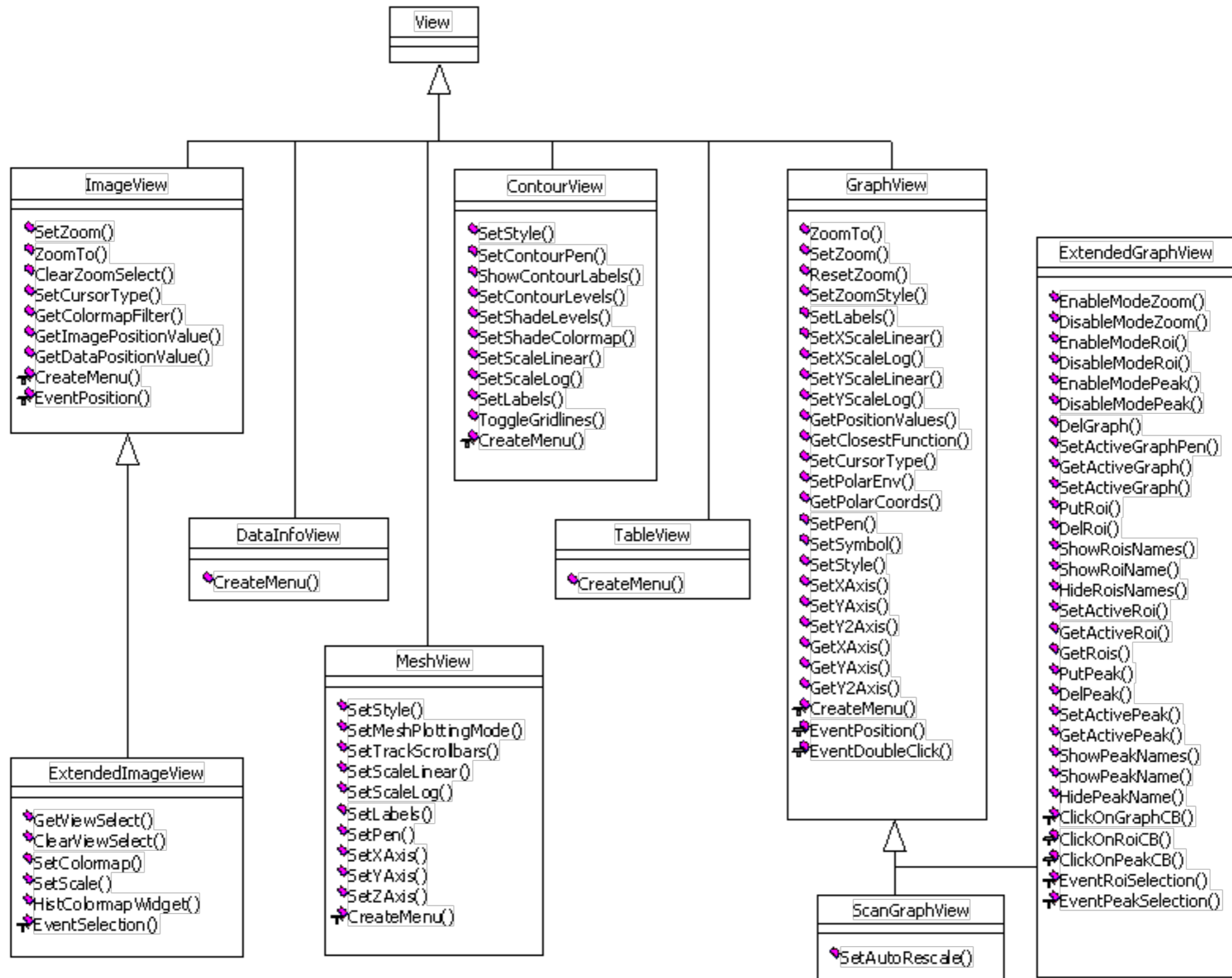
```
def draw( self, win ):  
    Car.draw( self, win )  
    self.top.draw( win )
```

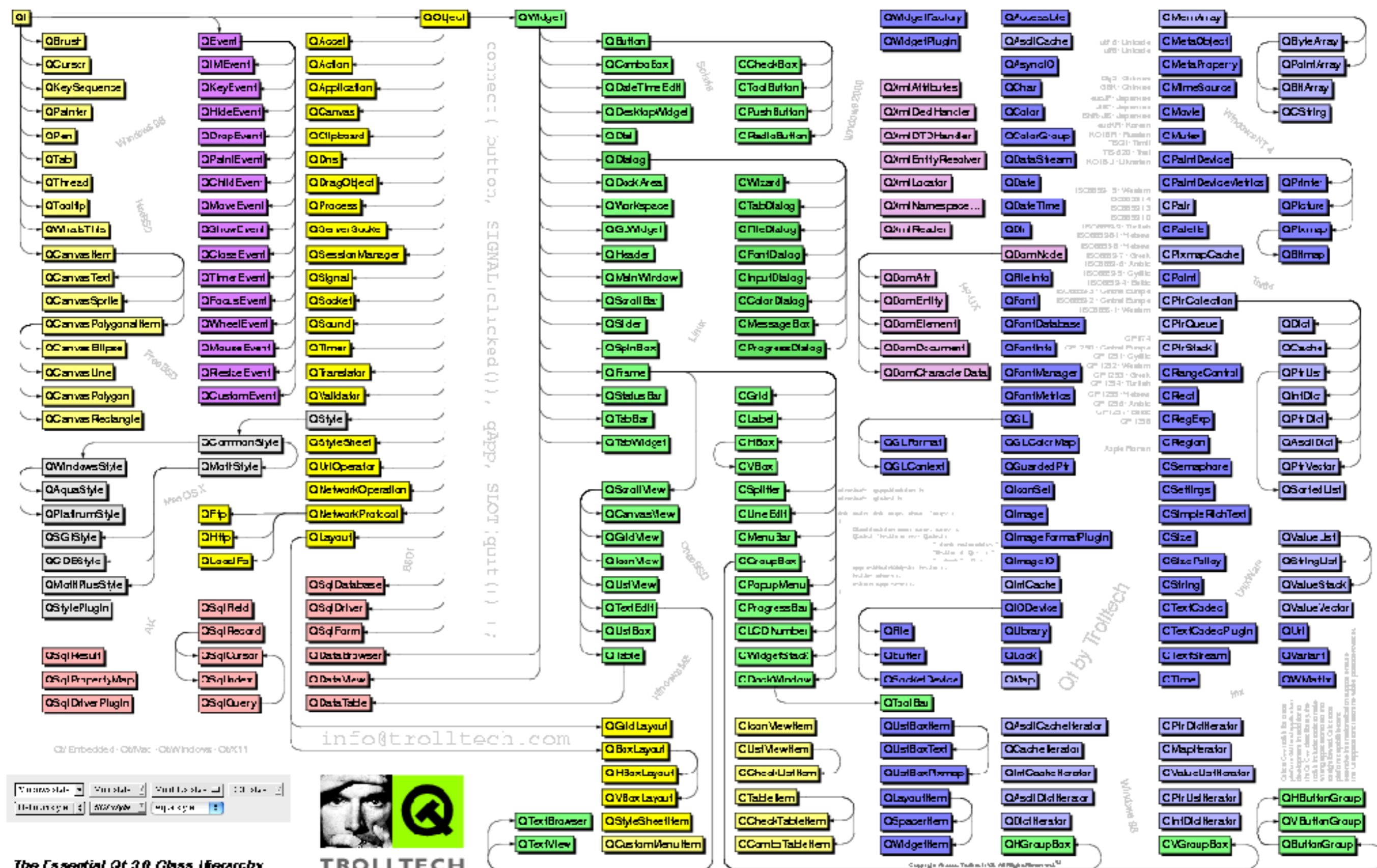


Cleaner code

**Graphic Libraries
Are Built on
Inheritance:**

Hierarchy of Classes





Qt Script for Applications Developer

File Edit Project Search Tools Layout Preview Qt Script Editor Q: Script Project Window Help

Common Widgets

- PushButton
- RadioButton
- CheckBox
- ButtonGroup
- ListBox
- LineEdit
- SpinBox
- TextEdit
- ComboBox
- TextLabel
- Spacer

Buttons

Containers

Views

Database

Input

Display

Custom Widgets

Settings for Euro Converter

Convert Range

Column: 1

Start at Row: 1

End at Row: 1

Output Column: 1

Convert from: MKK

Calculate Cancel

sheet

- EuroSettings
- EuroSettings [Source]
- main.qs
- sheet1
- sheet2

Properties

Property	Value
name	roSettings
enabled	True
sizePolicy	Preferred/Pre...
minimumSize	[], 0]
maximumSize	[32767, 327...
sizeIncrement	[1, 0]
baseSize	[], 0]
paletteForeg...	
paletteBackg...	

Objects Members Class

Functions

- public
- init()
- destroy()
- buttonCancel_click...

EuroSettings

```

function init()
{
    if ( Application.sheet1.numSelections > 0 ) {
        var r = Application.sheet1.selection( 0 );

        spinStartRow.value = r.y + 1;
        spinEndRow.value = r.y + r.height;
        spinColumn.value = r.x + 1;
        spinOutputColumn.
    }
}

function destroy()
{
}

function buttonCancel_click
{

```

Line: 8 Col: 19

Run Function (F5)



class inheritance hierarchy example

All **Images** Maps Videos News More

employee

uml

c++

composition

java

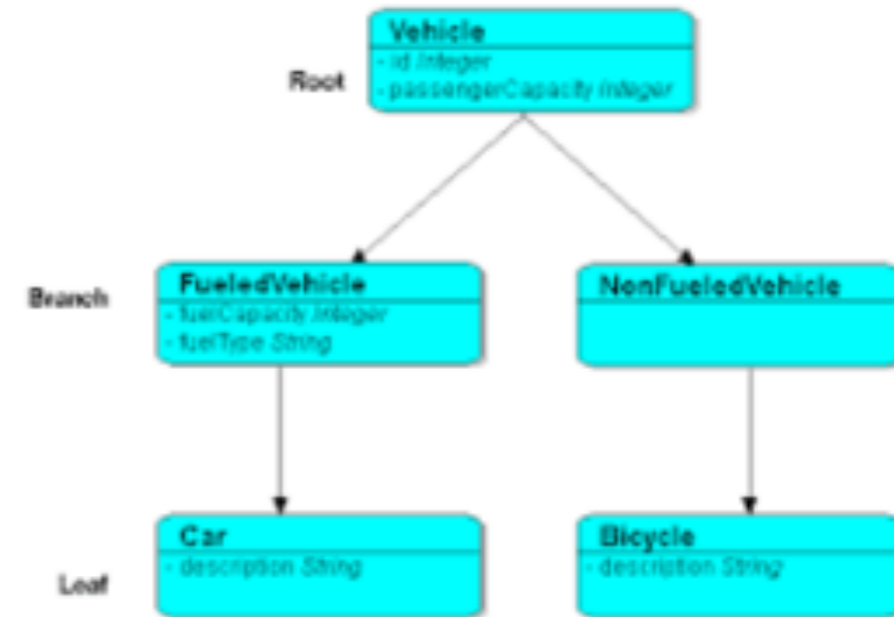
uml class

swir

Java Inheritance Hierarchy:



Fig: Hierarchical Inheritance



Vehicle

Coding Exercises, Cont'd

- Open the **graphics.py** library
- Locate the **Rectangle** class and observe its code
- In a new program (**RectLabelClass.py**), create a new class derived from Rectangle that supports a **text label** in the middle of the rectangle.

RectLabelClass.py