I Basic Types Values and Expressions

-int, float and bool
-operators for both numbers and boolean types; operator precedence
-assignment

Problem. Find the type and value of each of the expressions below

(a) ((17//2)//2//2)
(b) 17/2.0/2.0
(c) 17//2*2.0
(d) 17%2%2
(e) x**x**x after first executing x=3
(f) n%2==n%3 after first executing n=31
(g) x!=y after first executing the sequence
   x=2
   y=x
   x+=1

2 Basic control structures

-if, elif, else
-while

Problem. What is the value of the variable count after executing the following sequence of statements? What if we instead initially set x to 3 and y to 7? Describe precisely what count is telling you given arbitrary integer values x and y. Write a single expression involving count, x and y that has exactly the same effect.

count=0
x=7
y=3
while(y<x):
    y+=1
    count+=1
**Problem.** The two fragments of code below differ only in the indentation of the `elif` clause. Each fragment prints a letter 'A', 'B' or 'C' depending on the value of a variable `x` of type float. Thus each fragment divides the real numbers into four classes (since there are some values that might lead to nothing being printed).

For each fragment, make a sketch on a number line of the four classes. (So you will have two sketches, and each sketch will have four colors.)

```python
if x<=3:
    if x>-7:
        print ('A')
    elif x>=-13:
        print ('B')
else:
    print ('C')
```

vs.

```python
if x<=3:
    if x>-7:
        print ('A')
    elif x>=-13:
        print ('B')
else:
    print ('C')
```

3 Functions

-parameters and return values
-scope of names
-optional arguments

**Problem:** (a) Describe what the following function does, assuming the argument `x` is an int. (For instance, find an apt descriptive name for the function.)

```python
def what(x):
    for n in range(x+1):
        if x==n**2:
            return True
    return False
```

(b) Do the same for this function:
def what2(x):
    return int(x**(1.0/3))**3==x

(c) Write a fragment of code that calls what2 and prints a table of all the values of x less than 2000 for which what2(x) returns True. As added practice, write this fragment using

while True:

to control the loop. (How will you get out of this infinite loop?)

4 Sequence types

- general operations on sequence types, subscripting, length, concatenation, repetition
- looping through a sequence with for

- strings
- lists; multidimensional lists, list comprehension, lists as return values and function arguments
- tuples

- sorting and searching: binary search versus sequential search, selection sort versus merge sort.

Problem. Find the output printed by the following sequence of statements. Some of the statements are not legal Python and will lead to error messages, and you should identify when this is the case. If you include these statements in a script, Python will abort execution after the first error, but in your solution to this problem, you should continue executing the statements after an error is encountered.

```python
s='ijk'
t='lmno'
s_list=['eye','jay','kay']
t_list=['ell','em','en','oh']
s_tuple=(12,13,14)
t_tuple=(15,16,17,18)
print (len(s[:2]+t[2:4]))
print s[:2]+t[2:4]
t.append('p')
print (t)
s_list.append(t_list)
```
Problem. (a) Write a function that takes a list as an argument and removes all the elements with even index. That is, typing

```python
x=[3,5,4,2,1,8,7]
f1(x)
print (x)
```

will produce output

```
[5,2,8]
```

(You will have to use the built-in methods of the list class for deleting items from lists.)

(b) Write a function that takes a list as an argument and returns the sublist consisting of all the elements with odd index. That is, typing

```python
x=[3,5,4,2,1,8,7]
print (f2(x))
print (x)
```

will produce output

```
[5,2,8]
[3,5,4,2,1,8,7]
```

(c) Write a single expression using list comprehension that takes a list x and whose value is the sublist of x consisting of all the elements with odd index.

5 Mapping type (Python dictionaries)

Problem. (a) Write a sequence of statements that constructs a dictionary whose keys are all the integers in the range 1 to 10000, and for which the value corresponding to a key
is a list of the divisors of n. For instance, one of the items in the dictionary is 42: [1, 2, 3, 7, 14, 21, 42]
(b) Then write a sequence of statements that uses this dictionary to create a list of the integers in the range 1 to 10000 sorted in descending order of the number of factors.

6 File I/O

7. Recursion

Basic recursion: Factorial and Towers of Hanoi, goal-seeking with backtracking (8 queens and Sudoku), recursive graphics, recursive implementations of binary search and merge sort.

Problem. What does this function return when its input is the string 'goodbye'?

def huh(s):
    if len(s) == 0:
        return s
    else:
        return huh(s[1:]) + s[0]

Problem. Write a function whose parameters include a TkInter canvas, together with some others, that draws the figure shown below in the canvas. You may assume the canvas is 500X500 pixels and use these numbers in the initial call to the function.

If you're confused as to how the figure was constructed: it begins with a very large red square, then draws two blue squares with half the side length in the upper left and lower right corners, then two red squares with half the side lengths.