Booleans

The Python Boolean type is one of Python's built-in data types. It's used to represent the truth value of an expression. For example, the expression 1 <= 2 is True, while the expression 0 == 1 is False. Understanding how Python Boolean values behave is important to programming well in Python. Python implements all of the usual operators for Boolean logic, but uses English words (and, or, etc.) rather than symbols (&&, ||, etc.):

```
t = True
f = False
print(type(t)) # Prints "<class 'bool '>"
print(t and f) # Logical AND; prints "False"
print(t or f) # Logical OR; prints "True"
print(not t) # Logical NOT; prints "False"
```

Another example

```
a = 6
b = 7
c = 42
print(1, a == 6)
print(2, a == 7)
print(3, a == 6 and b == 7)
print(4, a == 7 and b == 7)
print(5, not a == 7 and b == 7)
print(6, a == 7 or b == 7)
print(7, a == 7 or b == 6)
print(8, not (a == 7 and b == 6))
print(9, not a == 7 and b == 6)
```

I. Exercises

1. Given a=True, b=False. Determine whether the following conditions are True or False?
    a. a and b
    b. b and a
    c. not a and b
    d. not a and not b
    e. a or b
    f. not a or not b
    g. a or not b
2. Given A=True, B=False, C=True. Determine whether the following conditions are True or False?
    a. (A and B) or C
    b. (A or C) and B
    c. (Not A and B) or not C
    d. (A and not B) and not C
    e. A or B or C
    f. A and (B or not C)
    g. (B and C) or not A
    h. (B or not C) and A
3. Given p=True; q= False. Determine whether the following conditions are True or False? (Hint $p \rightarrow q$ is equivalent to $\neg p \vee q$)
    a. $p \rightarrow q$
    b. $\neg p \rightarrow q$

c. $\neg p \rightarrow \neg q$
d. $p \rightarrow \neg q$

4. Determine whether the following conditions are True or False given that over_18 = True and over_21 = False:
    a. over_18 and over_21
    b. over_18 or over_21
    c. not over_18
    d. not over_21 or (over_21 or over_18)
5. Set age as equal to 20 and include a comparison operator to check whether age is
    a. Less than 13?
    b. Greater than or equal to 20 and less than 21?
    c. Equal to 21?
6. Write a python function to calculate logical *implication*.
   For example, let p=True, q=True, then your function should print out: True.
7. Write a python function to calculate logical *if and only if*.
   For example, let p=True, q=False, then your function should print out: False.