Introduction to Computing and Programming in Python:

A Multimedia Approach

Chapter 5 : Conditional Statements

Decision Structures

- Some problems simply *cannot* be solved by performing a set of ordered steps, one after another (sequential execution)
- For example consider a company payroll program that determines whether an employee has worked overtime
  - If the employee has worked more than 40 hours, he or she gets paid a higher wage for the hours over 40
  - Otherwise, the overtime calculation should be skipped
- Solving this kind of problem requires a **decision structure** or **conditional branching (**a.ka. **Selection statements)**

Conditions

- Decision structures are based on a condition
- A condition is a logical (Boolean) expression that yields a value
- Conditions are typically written using the relational (comparison) operators.
- Boolean (logical) operators can also be used

Relational/Comparison Operators

>	Greater than
<	Less than
>=	Greater than or Equal to
<=	Less than or Equal to
==	Equal to
!=	Not Equal to

- Comparison operators pose a question and yield a value (true or false)

Relational/Comparison Operators

- True is stored in memory as 1
- False is stored in memory as 0
- Examples:
  - 3 >= 4 false
  - 5 > 0 true
  - “A” != “a” true
  - 5 + 3 == 8 true
- **NOTE: =** is not the same as **==**
  - Age = 19 #variable age stores value 19 (fact)
  - Age == 19 #checking if Age is equal to 19 (question)

Boolean/Logical Operators

- and or not

P	Q	P and Q
True	**True**	**True**
True	False	False
False	True	False
False	False	False

P	Q	P or Q
True	True	True
True	False	True
False	True	True
False	**False**	**False**

P	not P
True	False
False	True

Boolean/Logical Operators

- Examples:

```
>>> P = (2 > 0)
>>> Q = (10 <= 20)
>>> print P
>>> print Q
>>> print (P and Q)
>>> print (P or Q)
>>> print (not P)
```

Conditions

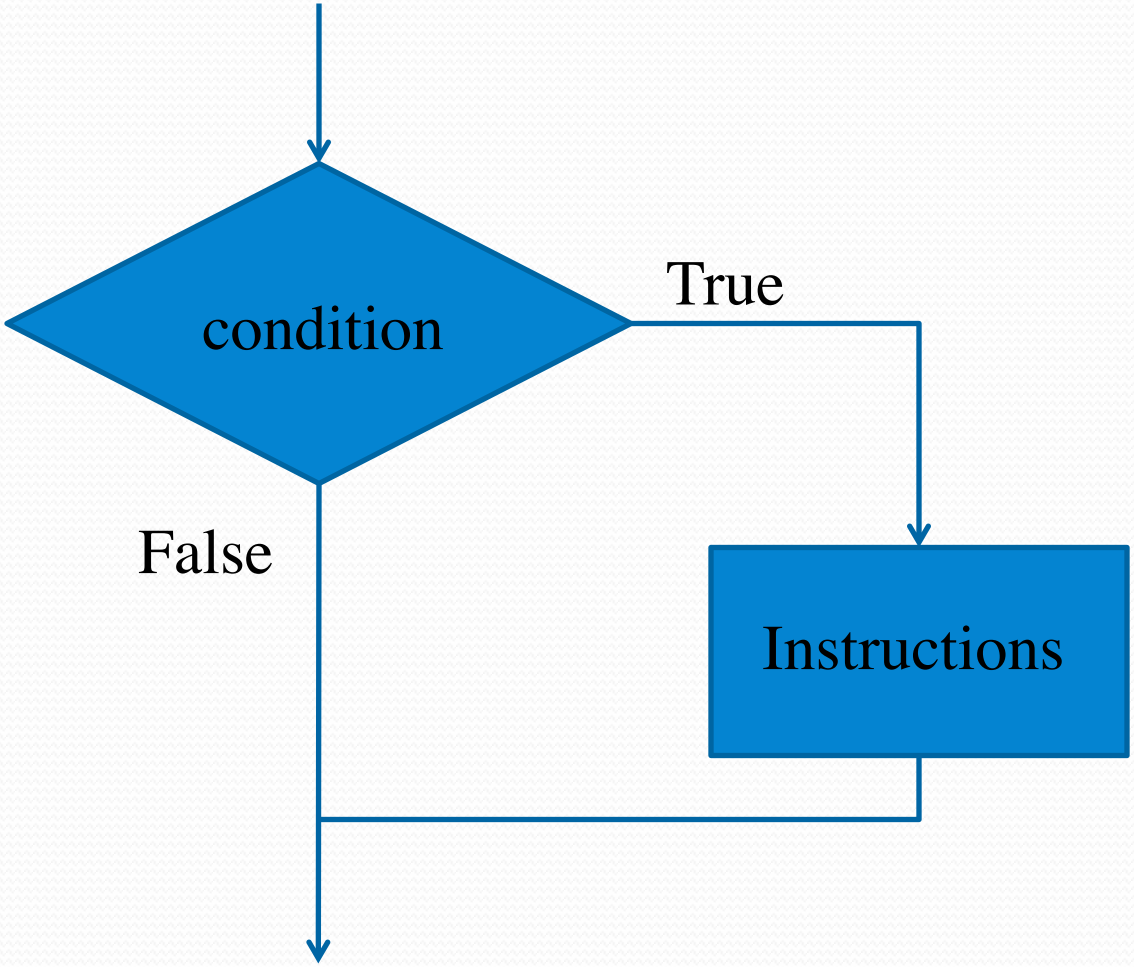
- We use the relational operators and the Boolean operators to write conditions or questions, also know as Boolean expressions
- Example:
  - age > 21
  - today == “Tuesday” and time > 10
- Boolean expressions yield a value that is either true (1) or false (0)

Making decisions

- In a program we make decisions with the if statement:
- **if** is a keyword
- The keyword **if** is followed by a condition which ends with a colon **:**
- Then follows a indented block of instructions
- Example:

```
if (red > 100) :
    red = red * 1.25
    blue = blue * 0.5
```

If statement



How does the if statement work?

- First the condition is evaluated
- If the result of the condition is true the block of instructions is performed
- If the result of the condition is false the block of instructions is skipped (ignored)

- Conclusion: the block of instructions associated to the if is performed only when the result of the condition is true

For loops and if statements

- We can always use an if statement inside a for loop (or vice versa)

```
for p in getPixels(source):
  if (getRed(p) <  getBlue(p)):
        setColor(p, newColor)
```

Distance between colors

- How do we measure distance between two points?
  - In the Cartesian coordinate system, the distance between two

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

- In JES the `distance ()` function measures the distance between two colors:

$$\sqrt{(red_1 - red_2)^2 + (green_1 - green_2)^2 + (blue_1 - blue_2)^2}$$

Example: `>>> dist =distance(color1, color2)`

The `distance()` function

- JES provides us with a function that measures the “distance” between two colors
- This function receives two colors as the input and it returns a number
- Example:

```
>>> d = distance (blue, red)
>>> print  d
>>> 360.624
```

Threshold values

- Sometimes we need to know if two values are “pretty close” so we can consider them to be “equal”
- In these cases a good rule is to find out if the values are “close enough” by using a *threshold* value.
- Example:

```
    if (distance (red, myColor) < 165):
```

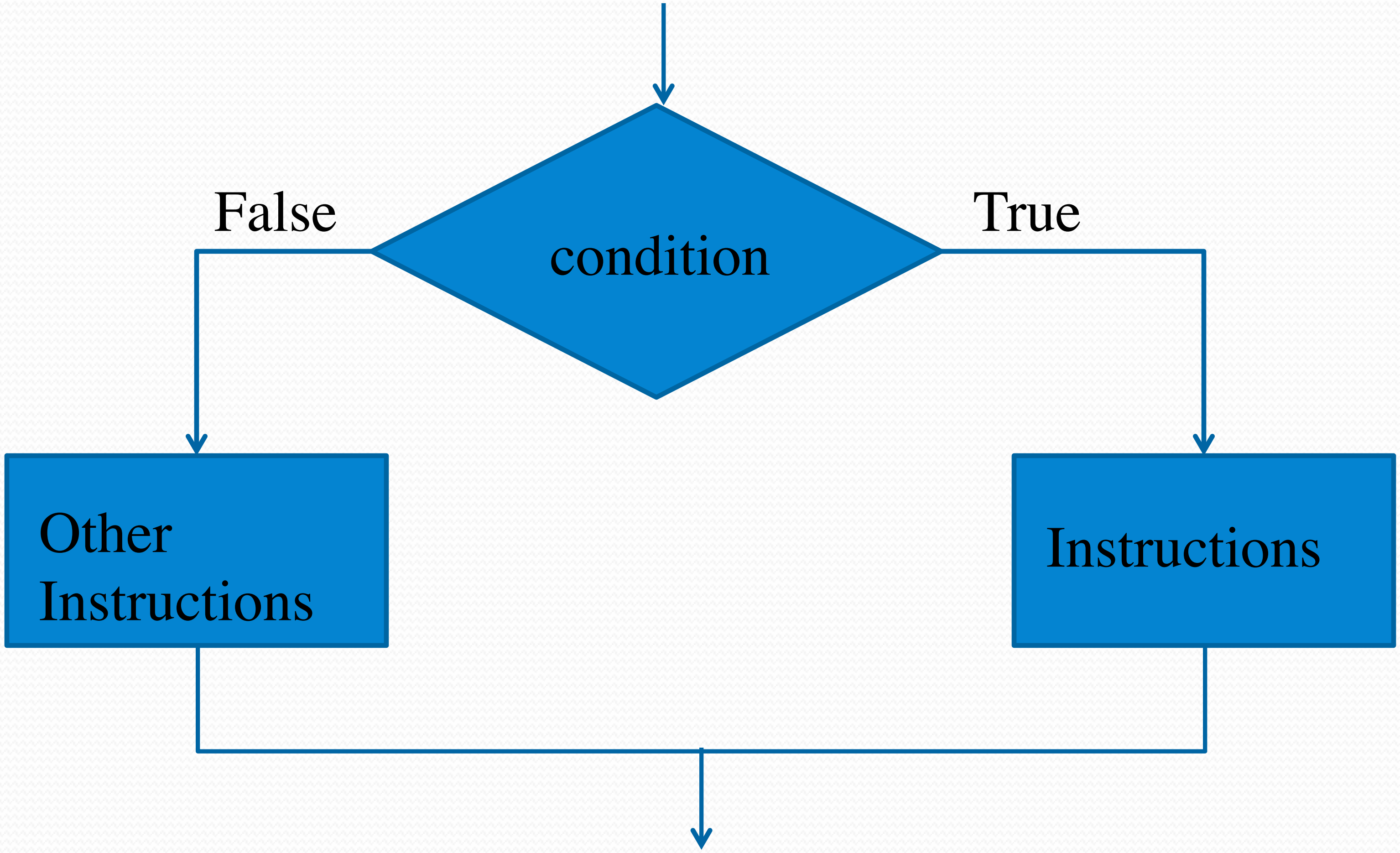
  - Here the threshold value is 165. If the distance between **`red`** and **`myColor`** is less than 165 we will consider both colors to be “**close enough**”
- You as a programmer decide what is a good threshold value
  - It may take some experimentation to find a good value

Example

```
removeRedEye(pic, startX, startY, endX, endY, newColor)
```

- The use of parameters in this function, makes it a very general, re-usable function.

if….. else: choosing between two set of instructions



if... else

- format:

```
if some_condition :
  Instructions
else :
  Other instructions
```

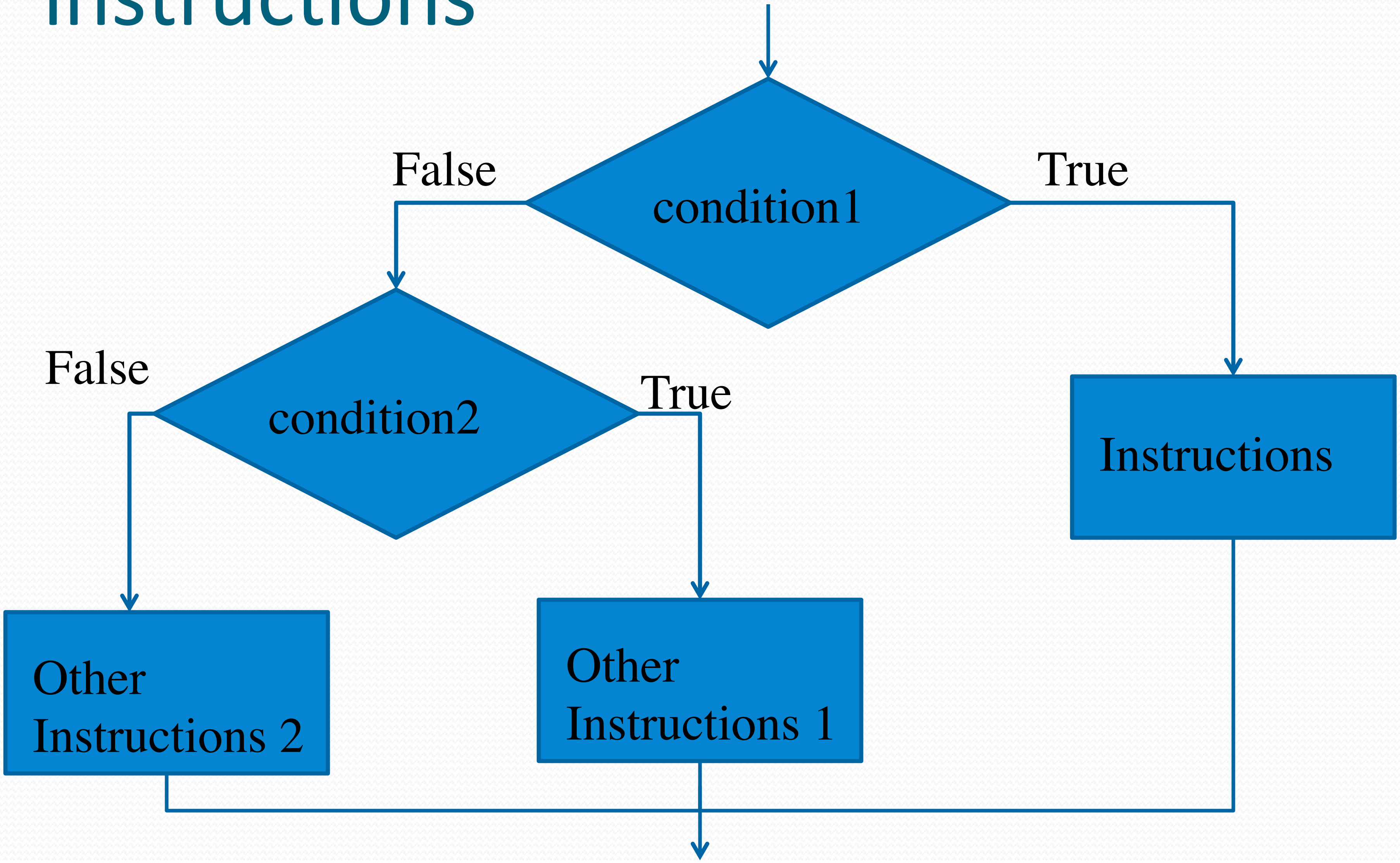
- Example:

```
if (red > 100) :
   red = red * 1.25
else
   red = red * 0.25
```

- Example: `posterizeGrey (picture)`

NOTE: posterizing ➔ reducing the number of colors in the picture

Choosing among multiple set of instructions



elif

- format:

```
if condition1 :
  Instructions
elif condition2 :
  Other instructions1
else :
  Other instructions2
```

- Example:

```
if (red > 50 and red < 100) :
   red = red * 1.25
elif (red >= 100 and red < 200) :
   red = red * 0.25
else :
  red = red * 0.10
```

- Example: `posterize(picture)`

Nested if

- As with for loops, if statements can be nested.
- Example:

```
if (red > 191):
    red = red * 1.08
    if (red > 255):  #cap red channel to 255, the max
        red = 255
    blue = blue * 0.9
```

- How does it work? Evaluate the outer if statement first, if true then work on it's block. When a inner if statement is found inside the outer block, evaluate inner if statement, if true execute it's block, otherwise skip it
- Example: `sepiaTint(picture)`

Expressions inside a condition

- A condition can contain an expression.
- The final result of the condition is always true or false
- Example:

```
    if (x + y + z) > 30  :
```

- Chromakey example: background color of a picture is replaced with another background, while the foreground of the original pictures stays.
  - It's easier to do with an original background that is green → there's less overlap with common colors
  - Pictures must be of the same size

Some new JES commands and keywords

- Predefined colors: black, white, blue, red, green, gray, lightGray, darkGray, yellow, orange, pink, magenta, cyan.
- Drawing functions:

```
addText(pict, x, y, string, color)
addLine(pict, x1, y1, x2, y2, color)
addRect(pict, x, y, width, height, color)
addRectFilled(pict, x, y, width, height, color)
addArc(pict, x, y, width, height, start, angle, color)
addArcFilled(pict, x, y, width, height, start, angle, color)
addOval(pict, x, y, width, height, color)
addOvalFilled(pict, x, y, width, height, color)
```

- Drawing example

One more thing about range and for loops

- Negative increase = decrease

```
>>> print range (25, 0, -1)
```

- Increasing/decreasing by more than just 1

```
>>> print range (0, 25, 2)
>>> print range (25, 0, -2)
```

- Combine these ideas with a for loop:

```
for index in range (25, 0, -2)
```

- Example: coolPic()

Example: Edge detection

- We are going to compare each pixel luminance to the pixel *below* it and to the *right* of it.

here x, y	right x+1, y
down x, y +1	

- If there is a *suitable difference* in luminance below *and* to the right, we will make the pixel black, *otherwise*, we will make it white.
- Here again we will use a threshold value, this time to check if the difference between two values *is “close enough”*

Debugging your programs

- A bug is an error in your program
- There are two kinds of errors
  - Syntax errors
  - Logic or semantic errors

Syntax Errors

- A syntax error is an error that occurs when a program cannot understand a command that has been entered.
- This happens when a statement in the program violates the rules of the programming language
- Examples:

```
def myFuntion(pic)  #colon missing at the end of the line

For x in range (0, getWidth(pic)): #For is not a keyword
```

- A syntax error must be fixed before the program can be executed

Logic / Semantic Errors

- A logic or semantic error causes the program to operate incorrectly, but not to fail
  - that is, you can still run the program but you will get erroneous or unintended results.
- Example:

```
if (red < 100 and red > 200) :  #probably meant to use or
```

- Since the program will still run, the programmer must be careful examining the results of the program to detect if there is a mistake in the logic of it
  - Lucky for us, this kind of mistakes should be easy to spot in our images resulting from our functions

Midterm Exam

- **Date**: Tuesday October 28
- **Time**: During the lecture period
- **Room**: Curtis 342
- Exam is closed book/ closed notes
  - A handout with the Python and JES commands will be provided
- You need to bring:
  - Pencil, eraser, and student ID
- Study Guide is posted in Learn