CSE 101: Introduction to Computational Thinking

Unit 2: Computer Programming Fundamentals

What is Python?

- Python is a computer programming language
  - It has a relatively simple **syntax**, or set of rules that programmers must follow when writing programs in the language
- With Python you can write very simple programs that do basic calculations or very complicated ones
  - You can even write basic games!
  - Python is popular with scientists because they can do complex data analysis by writing short programs
- Python can be installed on a wide variety of computer types and operating systems
- See the course website for installation instructions

What is a Computer Program?

- A computer program is basically a list of instructions that the computer executes to solve some well-defined problem
- The instructions or steps that the programmer writes constitute the **source code** or simply **code** of the program
- In Python, many of these instructions look like regular, everyday English with some extra punctuation thrown in
- There are two basic ways to give commands written in Python to the computer:
  1. We can type individual instructions via the **shell**, an interactive program that executes the commands
  2. We can write a complete, stand-alone **application** that we can run over and over

Python Console / Interactive Shell

- The **console** or interactive shell is basically a window where you type a single command or short set of commands to the computer, and the computer tries to execute them
- As we type Python instructions into the console and hit the Enter key, the Python **interpreter** reads the instructions and converts them into a form the computer's hardware understands
- The language that the hardware understands is called **machine language**
- No matter what programming language you use, at some point your code has to be translated into machine code for the computer to execute it

The PyCharm IDE

- Rather than typing console commands, in this course we will use an **integrated development environment** (IDE) called PyCharm
- PyCharm is an industry-grade piece of software used by professional software developers, but is still easy enough for novice programmers to use
- First download and install Python from www.python.org
- Then go to www.jetbrains.com/pycharm to download and install the free Community Edition of PyCharm
- More details about the software installation are on the Course Schedule and in the first lab assignment, but the next slide has some of the basics

PyCharm Basics

- To create and run a stand-alone Python program:

1. Start PyCharm and press the "Create New Project" button.
2. Pick a "Location" for your work on your hard drive and give a name to your project (e.g., "CSE 101/Classwork").
3. Select File Menu > New > Python File and enter the name of your file.
4. Write your program and save your work.
5. After saving your work, go to Run Menu > Run.
6. Select the name of your program to run it.

- The next time you want to run the program, just hit the green triangle in the lower-left corner of the screen.
- Or, right-click the name of the file and choose Run.

Commands and Expressions

- `'Hello, world!'` is an **expression**
  - It has a value
  - In this case, it's a **string** (a sequence of characters)
- Numbers are also expressions
  - 5 is an **integer** expression (recall that an integer is zero, or a positive or negative whole number that has no fractional part)
- 12.36 is a **floating-point** expression
  - **floating-point** is a format that computers use to represent **real** numbers (recall that a real number is zero, or a positive or negative number that might have a fractional part)

Commands and Expressions

- An expression usually consists of operators and operands
  - `2 * 9` is an expression and represents a multiplication
- Python also has **Boolean** expressions, which are expressions that can be `True` or `False`
- Boolean expressions allow us to write programs that change their behavior from one run to the next. More on this later.
- So we have at least three kinds of data in Python programming: strings, numbers and true/false values
- You will find that in computer programming we deal with a wide variety of data because there is a wide variety of problems that computers can help us solve

Arithmetic in Python

- Some of the simplest statements in Python involve arithmetical expressions, which contain numbers (operands) and mathematical operators
- Arithmetic in Python follows the same PEMDAS rules you learned in elementary school:
  1. First, evaluate all expressions in parentheses
  2. Then, perform exponentiations
  3. Next, perform multiplications and divisions in left-to-right order
  4. Finally, perform additions and subtractions in left-to-right order

Arithmetic in Python

- The symbols used for operators are commonly used in other languages and applications (e.g., spreadsheets)
  - add: +
  - subtract: –
  - multiplication: `*`
  - division for real numbers: `/`
  - division for integers: `//` (when we don't need the remainder)
  - remainder: `%` (gives the remainder of an *integer* division)
  - exponentiation: `**`

Examples of Arithmetic in Python

- `11 + 5  → 16`
- `11 – 5  → 6`
- `11 * 5  → 55`
- `11 / 5  → 2.2`
- `11 // 5 → 2`
  - This example shows **integer division**. Any remainder is discarded.
- `11 % 5  → 1`
  - The computer divides 11 by 5 and returns the remainder (which is 1) instead of the quotient (which is 2).
  - Use the remainder operator only with integers.

Arithmetic in Python

- The `**` operator lets us do exponentiation or raise a number to a power
- For example, `2 ** 5` would be `32` because $2^5 = 32$
- Perhaps you are aware that raising a number to the power ½ is the same as taking a square root
- So `16 ** 0.5` would be the same as $\sqrt{16}$, which is 4

Arithmetic in Python

- The constant π is built into Python
- First the programmer must make it available by **importing** the **`math` module**:
  - **`import math`**
- Then the expression **`math.pi`** can be used in expressions
  - **`math.pi * 2 + 1`**
- A Python module is a file consisting of Python codes that are all related somehow
- For example, the **`math`** module contains code pertaining to mathematical functions and constants

Variables

- A **variable** in computer programming is similar to the concept of a variable in mathematics: it is a name for some value or quantity of interest in a given problem
- For example, in a program we might use variables to store a person's age, GPA, name, or virtually any other kind of information
- The value is temporarily stored in the main memory (RAM) of the computer while the program is running
- A variable is a kind of **identifier** because it identifies (names) something in source code
- It is important to choose identifiers (e.g., variable names) that are informative and helpful

Variables

- For example, **`first_name`** would be a good variable to store a person's first name, whereas **`fn`** would not be as good because it's less informative
- Note how the underscore is used to separate words that define the identifier
  - Spaces are not allowed in variable names
- A Python variable name may contain lowercase letters, uppercase letters, digits and underscores
  - But, the first character must be a letter or underscore

Variables

- Lowercase and uppercase letters are treated as completely different characters
  - Because of this we say that Python is a **case-sensitive language**
  - `First_Name`, `first_name` and `FIRST_NAME` would all be treated as different identifiers
- There are a number of **keywords** built into the Python language that have pre-defined meanings
  - We aren't allowed to use these predefined keywords as variables
  - I’ll point them out as we go

Assignment Statements

- When we want give a value to a variable we write an **assignment statement**
- An assignment statement consists of a variable name, the equals sign, and a value or expression
- Examples:

  `number = 3` (“number is 3” or “number becomes 3”)

  `total = 3.85 + 12.9`

  `first_name = ‘Susan’`
- These examples show three different data types: an integer, a real number and a string

Assignment Statements

- After assigning a value to a variable, you can change the value of the variable with another assignment statement:

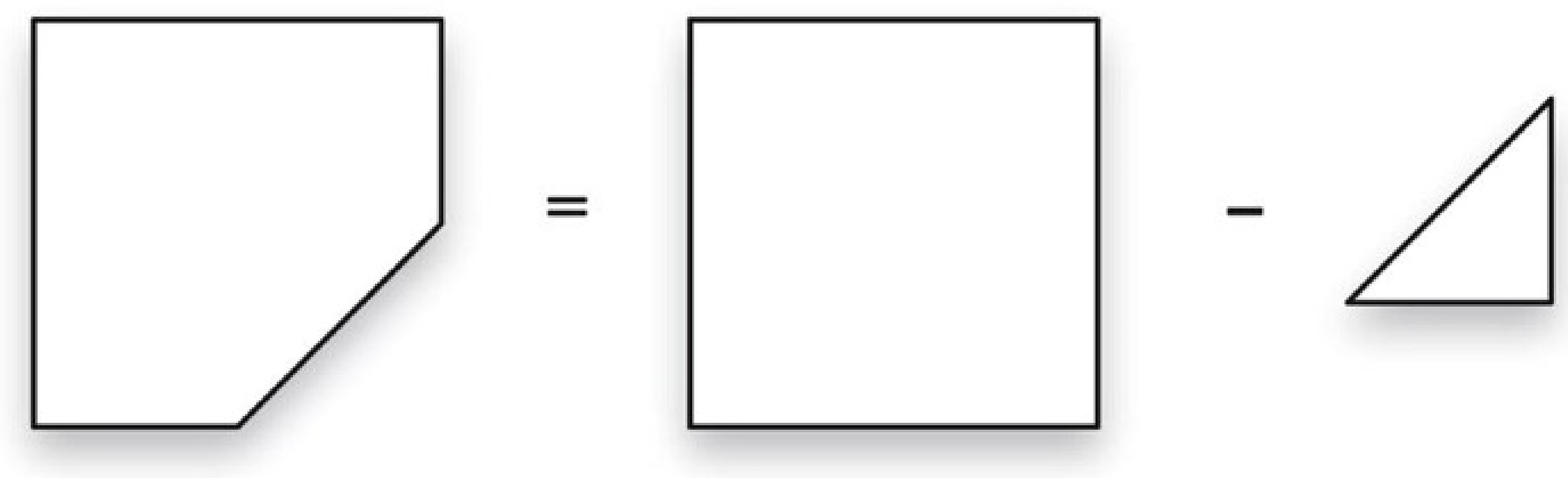
```
total = 5 + 8 + 3
… other code here …
total = 17 + 6
… etc. …
```

- Variables can also appear on the right-hand side (RHS) of an assignment statement:

```
next_year = this_year + 1
total_bill = subtotal + tax + tip
```

Example: Area Calculation

- Suppose we wanted to compute the area of a square countertop with one corner cut off, as shown in the image below



Example: Area Calculation

- Assume that the triangular cut-out begins halfway along each edge
- If we needed to perform the computation only once, say for a 100 cm-long countertop, we might write an expression like this:

```
area = 100**2 - 50*50/2
```

- Note that this code has a few issues with it:
  - It's just a formula of sorts with no explanation of what the numbers mean
  - The code works only for countertops exactly 100 cm long. What if we had countertops of other sizes?

Example: Area Calculation

- Let's address the first issue: lack of clarity

```
# area = area of square - area of triangle
# area of triangle is 1/2 base*height
area = 100**2 - 50*50/2
```

- The lines beginning with the # symbol are called **comments**
  - Comments are notes that the programmer writes to explain what the program does
  - Comments do not affect the input or output of the program or anything about how it runs

Example: Area Calculation

- Now let's address the other issue: lack of generality

```
side = 100
square = side**2
triangle = (side/2)**2 / 2
area = square – triangle
```

- To compute the area for a countertop of a different size, all we need to change is the first line: `side = 100`
- This code is also more readable; comments aren't needed
  - This is an example of **self-documenting code**
- The spacing in between variables, numbers and operators is optional, but is included here to make the formulas easier to read

Aside: Input Statements

- To improve this code even further, let's make it interactive so that the user can provide the value for **`side`**
- To that end we will write an **input statement**
- An input statement reads a string from the keyboard
- As part of an input statement, the programmer must give a **prompt** message that tells the user what he or she is actually supposed to enter
- Example: **`name = input('What is your name? ')`**
- The person's name will be *assigned to* the **`name`** variable
  - You could also say that we are *saving* the person's name in the **`name`** variable

Example: Area Calculation

- In our case, the user should enter a number, not a string
- If we want the user to enter an integer, we should type:
  `side = int(input('Enter side length: '))`
- But if we want a floating-point number, we should type:
  `side = float(input('Enter side length: '))`
- Which one we choose – **`int`** vs. **`float`** – depends on the application
- For this program we will read in a float so that we can enter a fraction of a centimeter if we wanted
- The last piece of the puzzle is how to display the final result on the computer screen. Let's look at that.

Aside: Print Statements

- **`print`** is a Python command
- It tells Python to do something, namely, to display some text on the screen
  - All Python commands are lowercase
- The syntax to print a basic message is just this: **`print('Hello, world!')`**
- Any text printed after this will appear on a new line
- If you want the next output to be on the same line, do this instead: **`print('Hello, world!', end='')`**
- This means *print this message, but do not automatically go to the next line*

Aside: Print Statements

- To print a number we need to convert it first into a string, like so: **`print('The area is ' + str(area))`**
  - The assumption is here is that **`area`** is a variable that contains the value we want to print
- When used in this fashion, the + symbol performs **string concatenation**, which is just a fancy way of saying we are joining two strings together into one
- We can now complete our area calculation program

Example: countertop.py

```
# This program prints the area of a
# countertop formed by cutting the
# corner off a square piece of material
# (e.g., granite).

side = float(input('Enter side length: '))
square = side**2
triangle = (side/2)**2 / 2
area = square - triangle
print('The area is ' + str(area))
```

Example: coins.py

- Let's see a practical example of the remainder operator and integer division
- Given a total number of cents, we want the computer to tell us how many dimes, nickels and pennies are needed to make that change while minimizing the number of coins
- We'll also make good use of variables
- We will use the **`str`** command to print variables containing numbers to the screen
  - Recall that **`str`** converts a number to a string so that it can be concatenated with other strings

Example: coins.py

```
cents = int(input("Enter the number of cents: "))

dimes = cents // 10
cents = cents % 10
nickels = cents // 5
cents = cents % 5
pennies = cents

print("That number of cents is equal to " +
      str(dimes) + " dimes, " + str(nickels) + "
      nickels and " + str(pennies) + " pennies.")
```

Escape Sequences

- Escape sequences in programming languages like Python allow you to print characters (symbols) on the screen that let you do some special things with print statements
- In Python, some of the escape sequences are:

  `\t` shifts the text to the right by one tab stop

  `\n` prints a newline

  `\"` prints a double quotation mark

  `\'` prints a single quotation mark
- A lone backslash character is called the **line-continuation character** (it's not really an escape sequence, though)
- This symbol is a signal to the Python interpreter that the statement we are writing spans two or more lines of a file

Example: limerick.py

Source code:

```
print('There was an old man with a beard\n\
Who said, \"It\'s just how I feared!\"\n\
\tTwo owls and a hen\n\
\tFour larks and a wren\n\
Have all built their nests in my beard.')
```

Output:

```
There was an old man with a beard
Who said, "It's just how I feared!"
	Two owls and a hen
	Four larks and a wren
Have all built their nests in my beard.
```

Functions

- Earlier we saw Python has a math module
  - The library has numbers (*e*, π , etc.)
  - It also has a variety of useful mathematical functions
- In programming, a **function** is a name given to a set of statements that perform a well-defined task
- For example, the **`input`** function performs a task (getting user input) and also **returns** (gives us) the value entered by the user
- **`print`**, **`int`**, **`float`** and **`str`** are also functions
- In the next example, we will see a new function, called **`format`**, that will let us format numerical output in a desired way

Example: BMI Calculator

- As we have seen, once numbers are stored in variables, we can perform calculations with them
- The Body Mass Index (BMI) is a metric used to gauge a person's general health
- Given a person's weight in pounds and total height in inches, a person's BMI is calculated as $BMI = \frac{weight \cdot 703}{height^2}$
- A BMI in the range 18.5 – 24.9 is considered "healthy"
- We will write a program that calculates and prints a person's BMI based on entered numbers
- The result will be printed to 15 digits of accuracy, which is more digits than necessary

Example: BMI Calculator

- To print a number to a designed number of digits we can use the **`format`** function
- Suppose we have a variable **`total_due`** that we want to print to two decimal places. Here is how you would do it:

```
print('Total due: $' +
      '{:.2f}'.format(total_due))
```

- If we wanted four digits, we would write **`{:.4f}`** instead
- Note that when using the **`format`** method, you do <u>not</u> also use **`str`** to print a number
- In the code for this program, you will see two print statements: one giving the BMI to the full accuracy, and a second that rounds the result to three decimal places

Example: bmi_v1.py

```
weight = float(input('Enter weight in pounds: '))
feet = float(input('Enter feet portion of height: '))
inches = float(input('Enter inches portion of height: '))

total_inches = feet * 12 + inches

bmi = (weight * 703) / total_inches ** 2

print('Your BMI is ' + str(bmi))
print('Your BMI is ' + '{:.3f}'.format(bmi))
```

- The blank lines you see here were inserted to make the code more readable. They do not affect program execution in any way.

More About Functions

- Here is some important terminology used when discussing functions:
  - When a function is used in an expression we **call** the function
  - A function can include **parameters**, also called **arguments**, which are **passed** in to the function
  - The arguments are data values the function needs to complete its task
  - Functions **return** values that can be used in the original expression
- For example, when the **`math.sqrt`** function is passed the value 8, it *returns* 2.8284...

Defining New Functions

- Functions in program have many benefits, including:
  - They make code easier to read and understand because we don’t need to know the details of how or why a function works
  - They allow code to be used more than once (code re-use)
- To define a new function in Python we use a **`def`** statement
- For example, suppose we want to write a function that computes a person's Body Mass Index
- We could then call this function as many times as we want
- The alternative would be to copy and paste the code
- First rule of programming: don’t repeat yourself (DRY)!

Example: bmi_v2.py

```
# Function definition
def bmi(w, h):
    return (w * 703) / (h ** 2)

# Main part of program starts here.
weight = float(input('Enter weight in pounds: ‘))
feet = float(input('Enter feet portion of height: ‘))
inches = float(input('Enter inches portion of height: '))

total_inches = feet * 12 + inches
my_bmi = bmi(weight, total_inches)
print('Your BMI is ' + '{:.3f}'.format(my_bmi))
```

Abstraction

- One of the most important concepts in computer science is **abstraction**
- A function like **`bmi`** is a small "package" of sorts
- From the outside we forget about the details: all we care about is the fact that we can call this function and it will do a computation
- Functions thereby allow us to solve a complex problem by subdividing it into smaller, more manageable sub-problems
- This process is called **problem decomposition**
- Often programmers use functions to engage in **top-down software design**, which means that they design the software as a series of steps, each of which corresponds to one or more functions

Example: bmi_v3.py

- A few observations about defining a new function:
  - A colon is typed at the end of the line starting with **`def`**
  - The statement(s) inside of the function areas indented
  - Both the colon and indentation are required
  - If a function contains multiple instructions, all the instructions must be indented
- Next we will look at an alternative way of implementing the **`bmi`** function that illustrates proper indentation and relies on two **local variables**, **`numerator`** and **`denominator`**
- A local variable is a variable accessible only inside the function where it is created

Example: bmi_v3.py

```
# Function definition
def bmi(w, h):
    numerator = w * 703
    denominator = h ** 2
    return numerator / denominator

# Main part of program starts here.
weight = float(input('Enter weight in pounds: ‘))
feet = float(input('Enter feet portion of height: ‘))
inches = float(input('Enter inches portion of height: '))

total_inches = feet * 12 + inches
my_bmi = bmi(weight, total_inches)
print('Your BMI is ' + '{:.3f}'.format(my_bmi))
```

Example: Distance Calculator

- Suppose we are given a distance traveled in miles, yards and feet, such as 3 miles, 68 yards, 16 feet
- We would like to convert this distance into total inches traveled and print the result
- To that end we need to perform some unit conversions
- Recall the following equivalences:
  - 1 foot = 12 inches
  - 1 yard = 3 feet
  - 1 mile = 5,280 feet
- Finally, to print a comma every three digits we can use the formatting string `'{:,}'` when printing an integer

Example: distance.py

```
# Function definition
def distance(m, y, f):
    return (m * 5280 * 12) + (y * 3 * 12) + (f * 12)

# Main program
miles = int(input('Enter the number of miles: ‘))
yards = int(input('Enter the number of yards: ‘))
feet = int(input('Enter the number of feet: '))

inches = distance(miles, yards, feet)

print('Distance in inches: ' + '{:,}'.format(inches))
```

Example: Mortgage Calculator

- The monthly payment on a fixed-rate mortgage can be calculated using this formula: $pmt = \dfrac{Pr}{1-1/(1+r)^n}$

  where *P* is the principal (the amount we borrowed), *r* is the *monthly* interest rate as a decimal (i.e., the annual interest rate as a decimal divided by 12), and *n* is the number of months the loan will last
- To include a comma every three digits, write your format string as **`'{:,.2f}'`** for floats
- Also, you can save a format string in a variable if you want to format a bunch of numbers in the same way:
  `fmt = '{:,.2f}'`
- Let's write a function to compute *pmt*

Example: mortgage.py

```
def monthly_payment(borrow_amt, monthly_rate, num_months):
    return (borrow_amt * monthly_rate) /
           (1 - 1 / (1 + monthly_rate) ** num_months)

# Main part of program starts here.
principal = float(input('Enter principal: '))
annual_rate = float(input('Enter annual interest rate as a percentage: '))
years = int(input('Enter term of mortgage in years: '))

payment = monthly_payment(principal, annual_rate / 12 / 100, years * 12)
totalPaid = payment * years * 12
totalInterest = totalPaid – principal
fmt = '{:,.2f}'  # formatter string
print('Principal: $' + fmt.format(principal))
print('Annual interest rate: ' + fmt.format(annual_rate) + '%')
print('Term of loan in years: ' + str(years))
print('Monthly payment: $' + fmt.format(payment))
print('Total money paid back: $' + fmt.format(totalPaid))
print('Total interest paid: $' + fmt.format(totalInterest))
```

Conditional Execution

- Often an algorithm needs to make a decision
- The steps which are executed next depend on the outcome of the decision
- Example: a person's income range determines the income taxation rate
  - If the income is above a certain minimum, use one tax rate; otherwise, use a lower rate
- In Python, an **if-statement** allows us to test conditions and execute different steps depending on the outcome

Example: Tuition Calculator

- Suppose part-time students (< 12 credits) at a fictional college pay $600 per credit and full-time students pay $5,000 per semester.
- Let's use an if-statement to write a short program that implements this logic

Example: tuition.py

```
numCredits = int(input('Enter number of credits: '))

if numCredits < 12:
    cost = numCredits*600
    print('A student taking ' + str(numCredits) +
          ' credits is part-time and will pay $' +
          str(cost) + ' in tuition.')
else:
    print('A student taking ' + str(numCredits) +
          ' credits is full-time and will pay
           $5,000 in tuition.')
```

Conditional Execution

- if-statements can also appear in functions:

```
def tax_rate(income):
  if income < 10000:
      return 0.0
  else:
      return 5.0
```

- Note that the value returned by this function depends on the value passed as a parameter
- The words **`if`** and **`else`** are keywords
- Note the colon at the end of the if and else **clauses**
- Note also how the statements to be executed are indented

Multi-way if-statements

- When an algorithm needs to choose among more than two alternatives it can use **`elif`** clauses
- **`elif`** is short for “else if”
- This function distinguishes between three tax brackets:

```
def marginal_tax_rate(income):
    if income < 10000:
        return 0.0
    elif income < 20000:
        return 5.0
    else:
        return 7.0
```

- We can use as many **`elif`** parts as we want or need

Boolean Expressions

- The expressions inside **`if`** and **`elif`** statements are special kinds of expressions
- The result of these expressions is either **`True`** or **`False`**
- An expression that evaluates to **`True`** or **`False`** is called a **Boolean expression**
- Boolean expressions often involve **relational operators**:
  - equal to / not equal to
  - greater than / greater than or equal to
  - less than / less than or equal to

Boolean Expressions

- The notation >= means "greater than or equal to" and is one of six **relational operators** supported by Python:

Mathematical Operator	**Python Equivalent**	**Recall = is for assignment!** **Meaning**
=	==	is equal to
≠	!=	is not equal to
>	>	is greater than
≥	>=	is greater than or equal to
<	<	is less than
≤	<=	is less than or equal to

Example: Overtime Calculator

- Someone who works more than 40 hours a week is entitled to “time-and-a-half” overtime pay
- How could we determine: (1) whether or not an employee is entitled to overtime pay, and (2) if so, how much?
- #1 is pretty simple: use an if-statement
- For #2, we have to do a different calculation depending on whether the employee will earn overtime pay or not
- Regular pay formula: hourly wage × hours worked
- The overtime formula has two parts:
  - The pay for first 40 hours
  - The pay for additional overtime hours

Example: paycheck.py

```
def compute_pay(hours, wage):
    if hours <= 40:
        paycheck = hours * wage
    else:
        paycheck = 40 * wage + (hours - 40) * 1.5 * wage
    return paycheck

hours_worked = float(input('Enter # of hours worked: ‘))
hourly_wage = float(input('Enter hourly wage: '))

pay = compute_pay(hours_worked, hourly_wage)
print('Your pay is $' + '{:.2f}'.format(pay))
```

Example: Hiring Decisions

- A hiring manager is trying to decide which candidates to hire
- Each potential hire is evaluated based on GPA, interview performance and an aptitude exam
- A GPA of at least 3.3 is worth 1 point
- An interview score of 7 or 8 (out of 10) is worth 1 point; a score of 9 or 10 is worth 2 points
- An aptitude test score above 85 is worth 1 point
- Hiring decisions are then based on point totals:
  - 0, 1 or 2 total points: Not hired
  - 3 total points: hired as a Junior Salesperson
  - 4 points: hired as a Manager-in-Training

Example: Hiring Decisions

- Let's look at a function that takes these three values and returns the hiring decision as a string
- The following Python capabilities/features will help us:
  - The **`+=`** operator can be used to increment a variable by some amount
  - **`-=`**, **`*=`** and **`/=`** also exist and perform analogous operations
  - We can use a variable to maintain a tally or running total
  - An if-statement can contain **`elif`** clauses without a final **`else`** clause

Example: hiring.py

```
def decision(gpa, interview, test):
    points = 0  # Point total accumulator

    if gpa >= 3.3:
        points += 1

    if interview >= 9:
        points += 2
    elif interview >= 7:
        points += 1  # note: no else clause

    if test > 85:
        points = points + 1

    if points <= 2:
        return 'Not hired'
    elif points == 3:
        return 'Junior Salesperson'
    else:
        return 'Manager-in-Training'
```

Ranges and Relational Operators

- The relational operators can be used to express ranges of values
- Examples:
  - An age in the range 1 through 25, inclusive:
    `1 <= age <= 25`
  - A length in the range 15 (inclusive) through 27:
    `15 <= length < 27`
  - A year in the range 1900 through 1972, exclusive of both:
    `1900 < year < 1972`

More About Strings

- Python strings can begin and end with single quote or double quotes
- For example, **`‘Stony Brook’`** and **`“Stony Brook”`** are both valid ways of defining the same string
- We saw earlier that the plus symbol joins two strings into a single longer string (concatenation)
- The asterisk repeats a string a specified number of times
- Example: **`'Hello' * 3`** will evaluate to **`'HelloHelloHello'`**

String Functions

- Because strings are so fundamental to programming, most languages support many functions and other operations for strings. Python is no exception.
- The Python function named **`len`** (short for "length") will count the number of characters in a string
- **`len`** counts every character in a string, including digits, spaces and punctuation marks
- Example:

```
school = 'Stony Brook University'
n = len(school)  # n will equal 22
```

String Methods

- Many other functions on strings are called using a different syntax
- Instead of writing **`func(s)`** we write **`s.func()`**
- In this new form, the name of the string is written first, followed by a period, and then the function name is written after the period
- Functions that are called using this syntax are referred to as **methods**

String Methods

- As an example of a string method, consider how we might figure out how many words are in a sentence
- If there is exactly one space between each word we just need to count the number of space characters
- The method named **`count`** does exactly that:

```
sentence = 'It was a dark and stormy night.'
sentence.count(' ') + 1   # equals 7
```

- Note that the argument passed to count is a string that contains exactly one character: a single space character.

String Methods

- Two other useful methods are **`startswith`** and **`endswith`**
- They are both Boolean functions and return **`True`** or **`False`** depending on whether a string begins or ends with a specified value
- Examples:

```
sentence = 'It was a dark and stormy night.'
sentence.startswith('It')     # True
sentence.startswith('it')     # False
sentence.startswith("It's")   # False
sentence.endswith('?')        # False
sentence.endswith('.')        # True
```

String Methods

- Another example:

```
filename = input('Enter a filename: ')
if filename.endswith('.py'):
    print('The file contains a Python program.')
else:
    print('The file does not contain a Python
          program.')
```