Debugging

COSC 101, 2018-01-31

Outline
- Warm-up
- Good programming practices
- Error messages
- Debugging strategies
- Debugging practice
- Programming practice

Warm-up
- Write a program that asks for the length and width of a rectangle and prints the area.
  
  ```python
  length = input("Length? ")
  width = input("Width? ")
  area = int(length) * int(width)
  print("Area = " + str(area))
  ```

Good programming practices
- Understand the target semantics --- i.e., what output should the program produce for various inputs?
- Decompose the solution and implement one step at a time
  - Run your program after you implement each step
  - Worst programming practice: write a full solution to a problem first, then run it
- Test on different inputs
  - Include boundary cases --- inputs that are at the extremes of the acceptable (or expected) range
- Example: Write a program that asks for three integers and prints the average.
  - Target semantics: average = sum of all provided integers divided by three
  - Decompose solution and implement one step:
    - Ask user for three integers
      one = input("First number? ")
      two = input("Second number? ")
      three = input("Third number? ")
    - Compute the average
    - Output the average
  - Test on different inputs:
    - Include temporary print statement
      print(one, two, three, four)
    - 1st test case: 1, 2, 3
    - 2nd test case: 1, 1, 1 (boundary)
    - 3rd test case: 0, 1, 2 (boundary)
  - Implement next step and retest
    average = \frac{\text{int}(\text{one}) + \text{int}(\text{two}) + \text{int}(\text{three})}{3}
  - Implement next step and retest
    print("Average=" + str(average))
Error messages

- **ParseError**
  - Which of the three types of errors we discussed last Wednesday is this error synonymous with?
    - syntax error
  - Provides line where parse error occurred --- sometimes the problem is on the preceding line
  - Strategy: comment out the line where the parse error occurred --- may cause other errors
  - What is the syntax error? How would you fix it?
    a. `myVar 10`
       *Missing equals sign: myVar = 10*
    b. `(1 + 2) * (3 + 4) * 5`
       *Mismatched parenthesis: (1 + 2) * (3 + 4) * 5*
    c. `print("This is a string")`
       *Mismatched string start and end of string: print("This is a string")*
    d. `print("Strings "are" fun")`
       *Double quotes used inside string: print(""Strings "are" fun""")*

- **TypeError**
  - When does this error occur? --- when you try to combine two incompatible types
  - What is an example of an expression that would cause a TypeError?
    - "Colgate" + 13
    - "Pi" + 3.14159
  - Strategy: just before the line causing the error, print out the value and type of every variable used in the line causing the error
    - Move your print statement backwards in your program to just before/after other assignments to the variable(s) causing problem
  - What is the type error? How would you fix it?
    a. "Hamilton" + ',' + ""NY"") + 13346
       *Cannot add strings and integers --- str(13346)*
    b. `input("Enter a number:") * 10`
       *Cannot multiply strings and integers --- int(input("Enter a number:"))*
    c. `len(999)`
       *Cannot get the length of an integer --- Len(str(999))*
    d. `print(1) + print(2)`
       *Print does not return a value --- put on separate lines*

- **NameError**
  - When does this error occur? --- when you use a variable that has not been created (using an assignment statement)
  - Strategy: add an assignment statement
  - Strategy: look for the assignment statement you thought you wrote --- there may just be a typo in the variable name

- **ValueError**
  - When does this error occur? --- when a value passed to a function is not conform to a set of criteria; e.g., call int() on a string with letters

**Debugging strategies**

- Add print statements
- Use CodeLens (also called Visualize) --- you will get practice with this in lab next week
Debugging practice
A scientist tried to write a program to that asks for a temperature in degrees fahrenheit and converts the temperature to degrees celsius and degrees kelvin. (Line numbers are included for reference.)

```python
f = input("Temperature in degrees fahrenheit:")
c = f - 32 * (9 / 5)
print("Temperature in degrees celsius:"+c)
k = c + 273.15
print("Temperature in degrees kelvin:+k")
```

1. Syntax error on line 3
   a. Comment out line 3 => syntax error on line 4; comment out line 4 => syntax error on line 5; suggests syntax error is before line 3
   b. Uncomment lines 3 and 4; comment out line 2 => syntax error goes away
   c. Add missing parenthesis
2. Type error on line 2
   a. Add print(f, type(f)) between lines 1 and 2 => f is a string
   b. Cannot subtract string and integer
   c. Add f = int(f) between lines 2 and 3
3. Type error on line 3
   a. Add print(c, type(c) between lines 2 and 3 => c is a float
   b. Cannot add string and float
   c. Add c = str(c) between lines 2 and 3
4. Type error on line 4
   a. Add print(c, type(c)) between lines 3 and 4 => c is a str
   b. We just added a conversion to fix the previous error, which caused a new problem
   c. Alternative fix for previous error: change line 3 to print("Temperature in degrees celsius:"+str(c))
5. Semantic error on line 5
   a. Update line 5 to print("Temperature in degrees kelvin:"+k)
6. Semantic error on line 3
   a. Update line 2 to c = (f - 32) * (9 / 5)

Programming practice
a. Write a program that asks for the cost of an item and prints the tax amount and total cost with a tax rate of 8%.
   b. Write a program that plays a short game of mad libs: ask for three words and fill them in a sentence. (E.g., She verb the adjective noun.)