APS106

UNIVERSITY OF TORONTO

Objects & Strings: Operators & Methods.

Week 4 | Lecture 3 (4.3)

While waiting, open the Jupyter Notebook for today's lecture

Upcoming

- NO lab due this Friday.
- Lab 3 Released Thursday 6:00 pm.
- Reflection 5 Released Friday 6:00 pm.
- Tutorial (in-person AND online) running all week.
- Practical sessions (in-person AND online) running ONLY Friday this week.

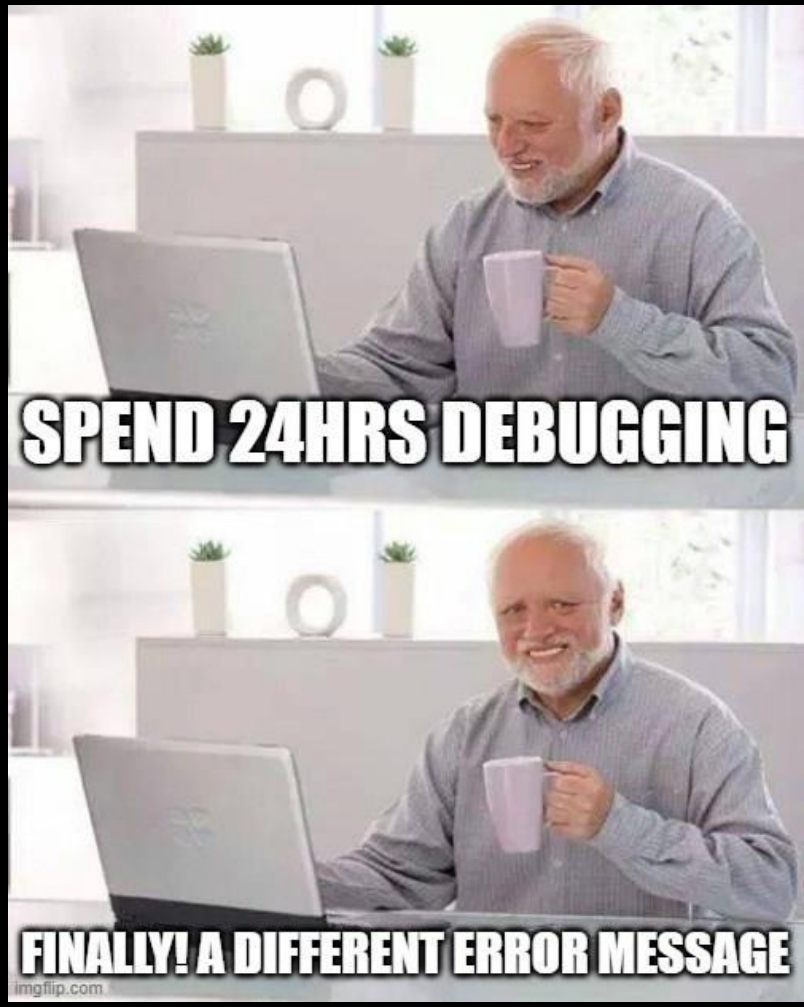
if nothing else, write #cleancode

This Week's Content

- **Lecture 5.1**
  - **Objects & Strings: Operators and Methods**
- **Lecture 5.2**
  - Strings: Conversions, Indexing, Slicing, and Immutability
- **Lecture 5.3**
  - Introduction to Object-Oriented Programming and the File Object

Error Reduction vs Debugging

- It is pretty much impossible to write code without errors.
  - *Error Reduction*: techniques we can use to reduce the number and severity of errors.
    - Write Readable Code
    - Comment comment comment!
    - Test test test!
  - *Debugging*: techniques for identifying and correcting errors
    - How to use a debugger video coming in the How Does That Work? (HDTW) series on Quercus.



Do 'software'/coding engineers need to worry about Designing for Safety?

Therac-25:
A Cancer Radiation Therapy Machine

- "Improvement" on Therac-20
  - Previous versions used hardware guards
  - Therac-25 relied only on software
- Meaningless error messages
  - Many misleading/incorrect errors
  - No clarification or mention of severity
    - MALFUNCTION 54
- Nothing checked if the strength of radiation was appropriate
  - How might you fix this?

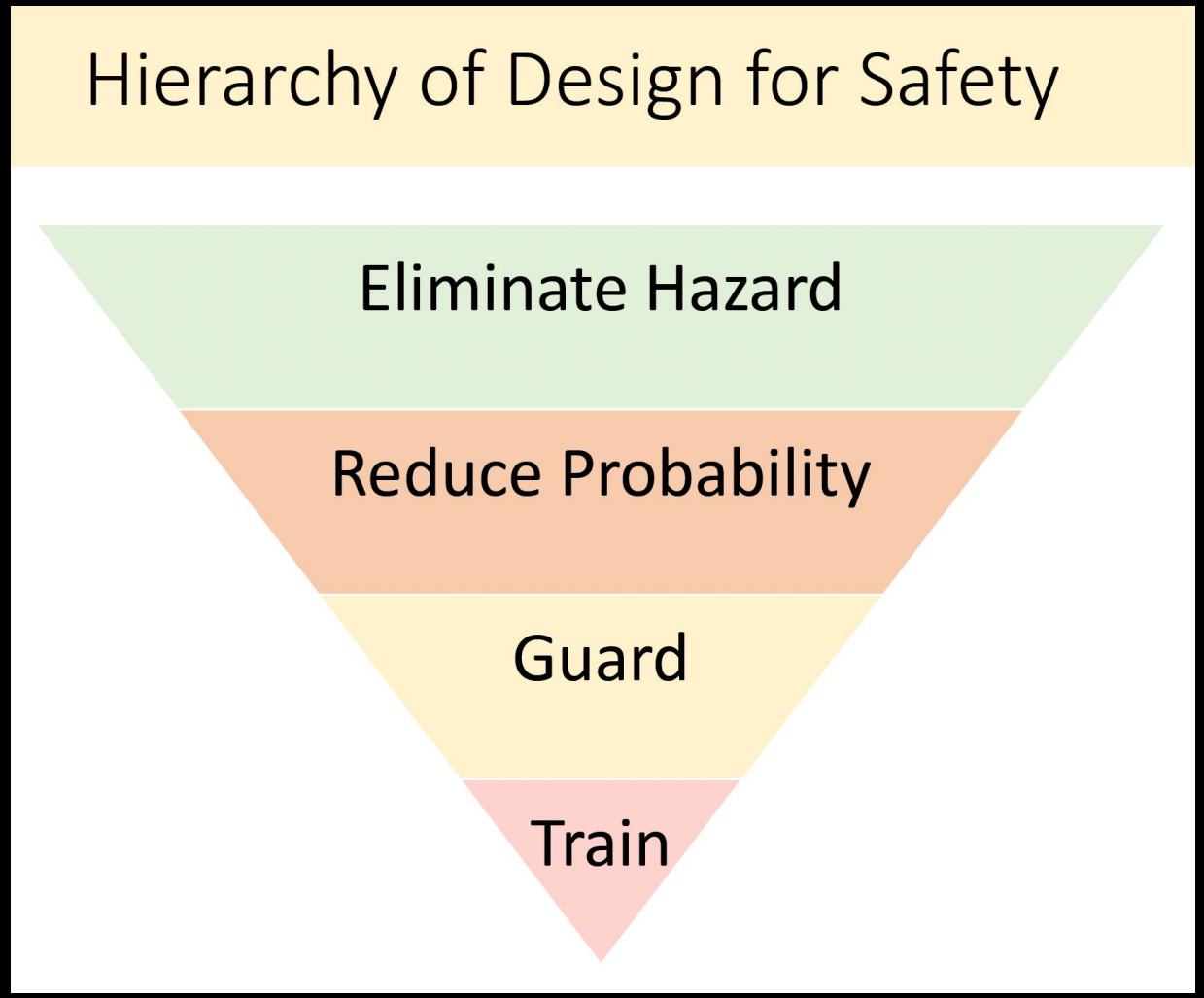
```
PATIENT NAME: John
TREATMENT MODE: FIX          BEAM TYPE: E     ENERGY (KeV):     10

                             ACTUAL           PRESCRIBED
        UNIT RATE/MINUTE       0.000000         0.000000
        MONITOR UNITS        200.000000       200.000000
        TIME(MIN)              0.270000         0.270000

GANTRY ROTATION (DEG)          0.000000         0.000000      VERIFIED
COLLIMATOR ROTATION (DEG)    359.200000       359.200000      VERIFIED
COLLIMATOR X (CM)             14.200000        14.200000      VERIFIED
COLLIMATOR Y (CM)             27.200000        27.200000      VERIFIED
WEDGE NUMBER                   1.000000         1.000000      VERIFIED
ACCESSORY NUMBER               0.000000         0.000000      VERIFIED

DATE: 2012-04-16      SYSTEM: BEAM READY      OP.MODE: TREAT      AUTO
TIME: 11:48:58        TREAT: TREAT PAUSE                X-RAY   173777
OPR ID: 033-tfs3p     REASON: OPERATOR        COMMAND:
```

Therac-25:
An Engineering Disaster

- Technicians began ignoring the misleading error messages
  - "the boy who cried wolf"
- Machine delivered radiation hundreds of times greater than normal
- 4 patients died and others severely injured…


```
if radiation_level < max_safe_level:
    give_radiation(radiation_level)
```

When Designing for Safety: Training/warnings/labels are the last resort!



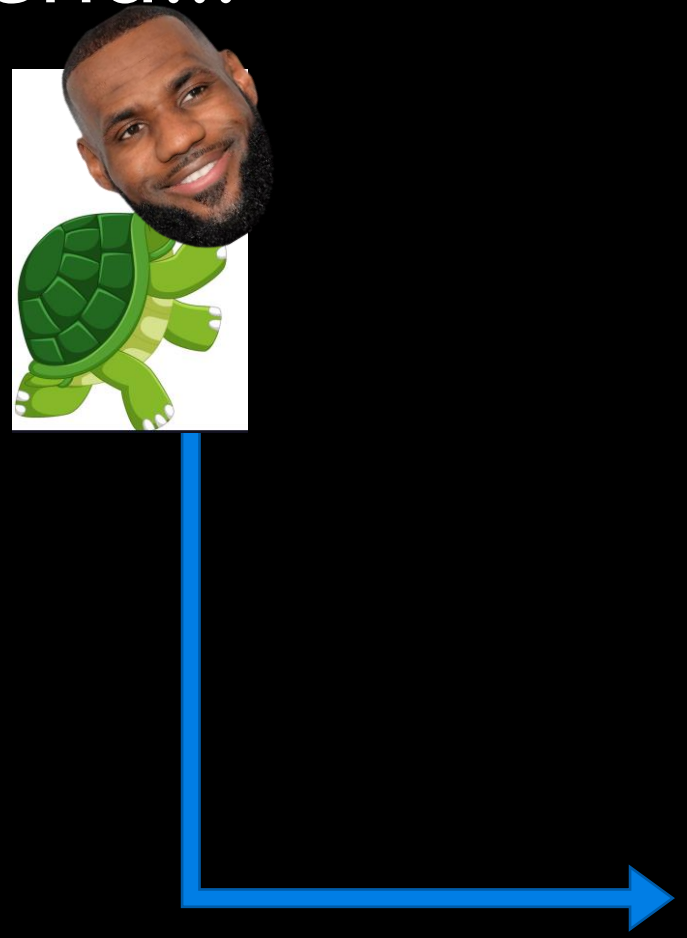
Remember:

No matter how bad today's midterm went...

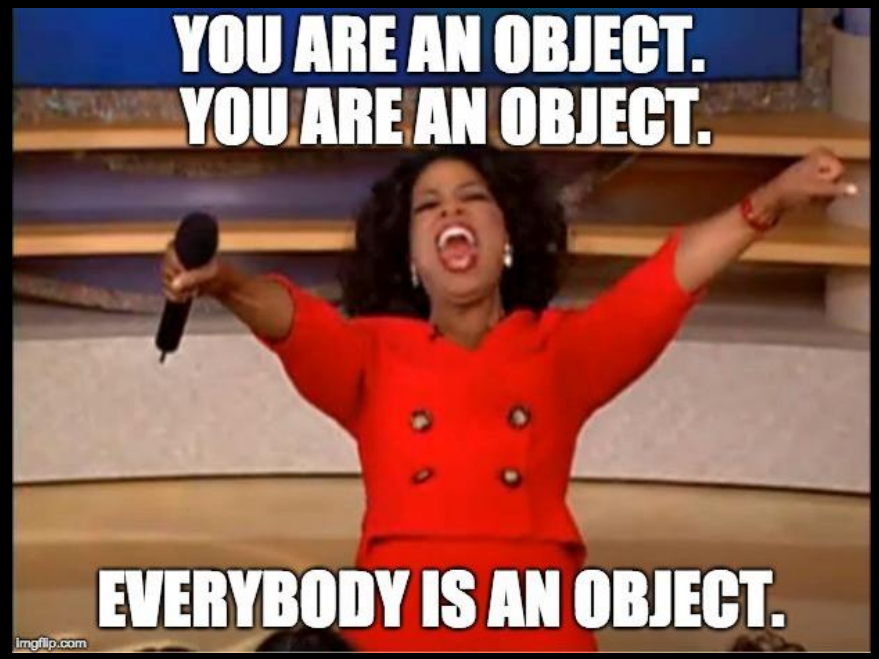
You are safe.
&
You didn't harm anyone with incorrect code.

Let's revisit our Turtle friend...

```
import turtle
LeBron = turtle.Turtle()

LeBron.right(90)
LeBron.forward(200)
LeBron.left(90)
LeBron.forward(100)

turtle.done()
```



Everything is an Object!



- Python keeps track of every value, variable, function, etc. as an object
- There is a function that you can call to confirm:

```
>>> isinstance(4, int)
True
>>> isinstance("Hello", str)
True
```

```
>>> isinstance(4, object)
True
>>> isinstance('Hello", object)
True
```

Everything is an Object!

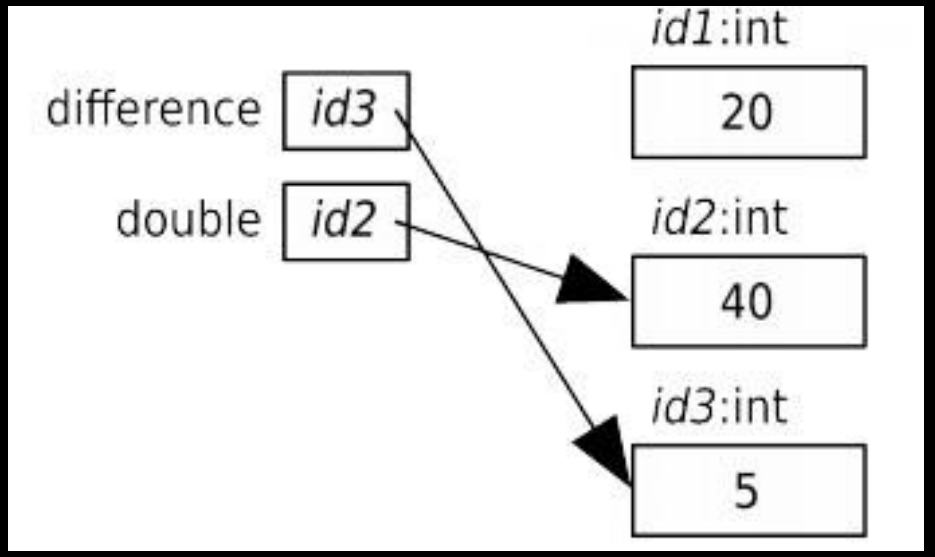
- Remember the id (or identity) function
  - It returns each object's location in memory

```
>>> id(4)
4482837280
>>> id(int)
4482678880
```

```
>>> id('a')
140432546199344
>>> id(str)
4482716800
```

Memory Visualization Example

```
>>> difference = 20
>>> double = 2 * difference
>>> double
40
>>> difference = 5
>>> double
40
```



Objects have Methods

- Each Python object has certain functions that can only be applied to that object
  - These are called methods
- The general form for calling a method is:

```
object_name.method_name(arguments)
```

- Since methods are applied to objects, we need to provide the object name with the "dot operator" (".") before the method name. Look familiar?

Let's revisit our friend LeBron...

```
import turtle
LeBron = turtle.Turtle()

LeBron.right(90)
LeBron.forward(200)
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turtle.done()
```
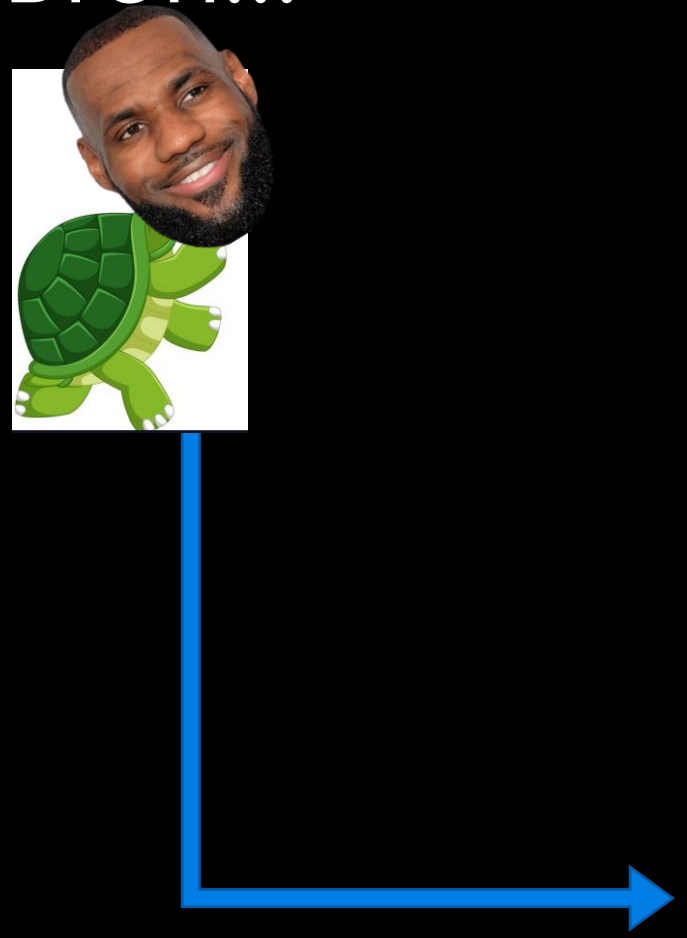
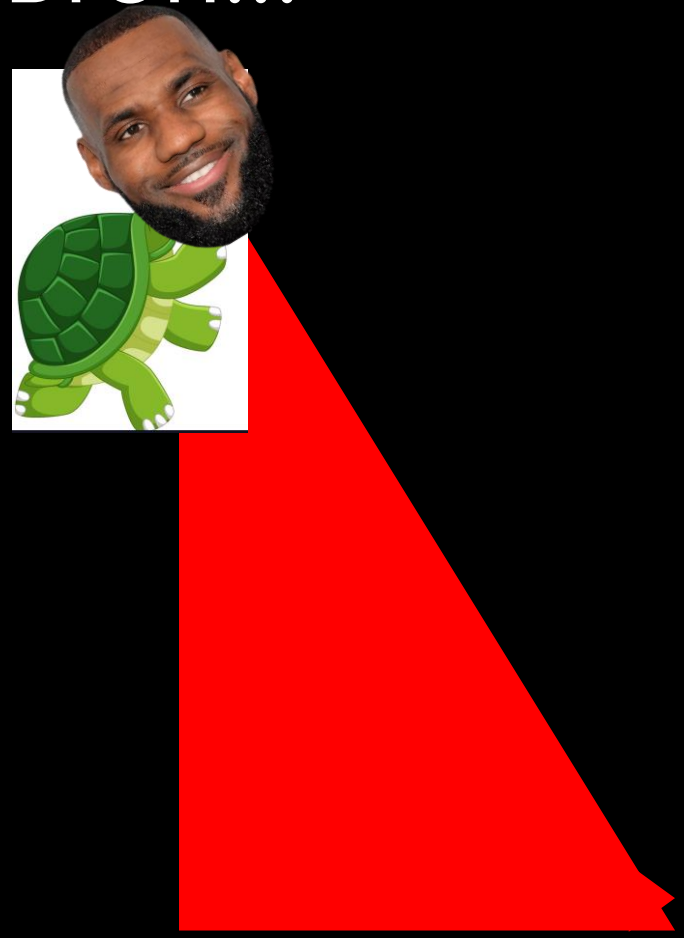



Let's revisit our friend LeBron…

```
import turtle
LeBron = turtle.Turtle()

LeBron.begin_fill()
LeBron.color('red')
LeBron.right(90)
LeBron.forward(200)
LeBron.left(90)
LeBron.forward(100)
LeBron.end_fill()

turtle.done()
```



Let's Code!

- Let's take a look at how this works in Python!
  - id function to get object's memory address
  - isinstance function to determine object type
  - Turtle LeBron drawing shapes!

Open your notebook

Click Link:
1. Objects & Methods

RECAP: Input and Output

- Python has a built-in Input/Output functions:
  - print – for displaying text to the user
  - input – for reading text from the user

- These functions require a good understanding of strings and string formatting

Working with Strings

- The string (str) type was briefly introduced in previous weeks
- Let's take our string knowledge to the next level!
  - escape sequences
  - str operations
  - type conversion
  - str indexing and slicing
  - str methods

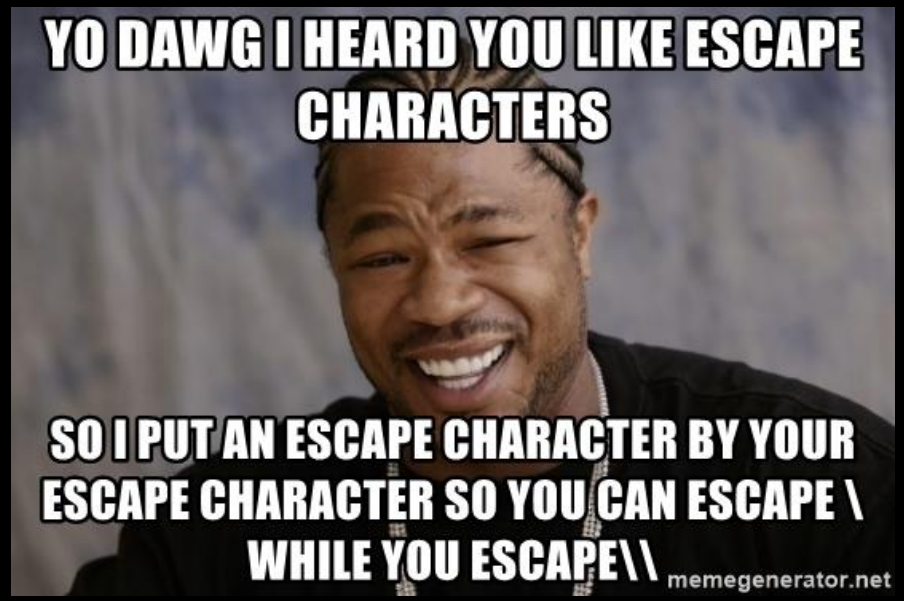
Escape Sequences

- Special character called an escape character: \ (backslash)
- When used in a string, the character following the escape character is treated differently from normal.

Escape sequence	Name	Example	Output
\n	newline (ASCII - line feed)	`"How\nare\nyou?"`	How are you?
\t	tab (ASCII - horizontal tab)	`'3\t4\t5'`	3 4 5
****	backslash (\)	`'\\'`	\
\'	single quote (')	`'don\'t'`	don't
\"	double quote (")	`"He says, \"Hi\"."`	He says, "hi".

Let's Code!

- Let's take a look at how this works in Python!
  - Working with the print function
  - Escape sequences!
    - New lines
    - Tabs
    - Quotes



Open your notebook

Click Link:
2. Escape Sequences

String Operators

- There are certain mathematical operators that can be applied on strings
  - The * and + obey standard precedence rules (i.e. * before +)
  - All other mathematical operators and operands result in a TypeError

Expression	Name	Example	Output
str1 + str2	concatenate str1 and str1	print('ab' + 'c')	abc
str1 * int1	concatenate int1 copies of str1	print('a' * 5)	aaaaa
int1 * str1	concatenate int1 copies of str1	print(4 * 'bc')	bcbcbcbc

Let's Code!

- Let's take a look at how this works in Python!
  - Concatenation
    - + operator
    - * operator

Open your notebook

Click Link:
3. String Operators

Working with Strings

- The string (str) type was briefly introduced in previous weeks
- Let's take our string knowledge to the next level!
  - escape sequences ✓
  - str operations ✓
  - type conversion
  - str indexing and slicing
  - str methods

Type Conversion

- The built-in function `str` takes any value and returns a string representation of that value
- Like our built-in functions `int` and `float` that can take a string and attempt to return a number representation of the string

```
>>> str(4)
'4'

>>> str(4482678880)
'4482678880'
```

```
>>> int('12345')
12345

>>> int(-99.9)
-99
```

```
>>> float('-43.2')
-43.2

>>> float('432')
432.0
```

Let's Code!

- Let's take a look at how this works in Python!
  - Type conversion
    - int/float to string
    - string to int/float

Open your notebook

Click Link:
4. Type Conversions

Breakout Coding Session!

- Ask the user how many times they would like to see the string "knock knock knock… Penny" repeated. Then, print it!
- Can you customize the name?

Open Python
(PyCharm or Jupyter)

Work with your table to solve this problem!

Consider this…

- Ask the user how many times they would like to see the string "knock knock knock… Penny" repeated, and print it!
- Can you customize the name?

Hints for getting started:

- Ask the user for a number of times (think: input function)
  - Remember input function returns a string…
- Repeated string (think: concatenation, * operator might be useful)
- Make the output readable (think: escape characters)

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