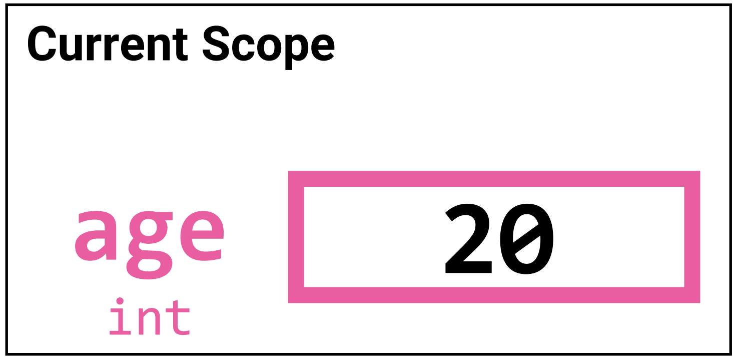
Variables

- **Variables** allow your programs to *store*, *load*, and *change* values in memory.

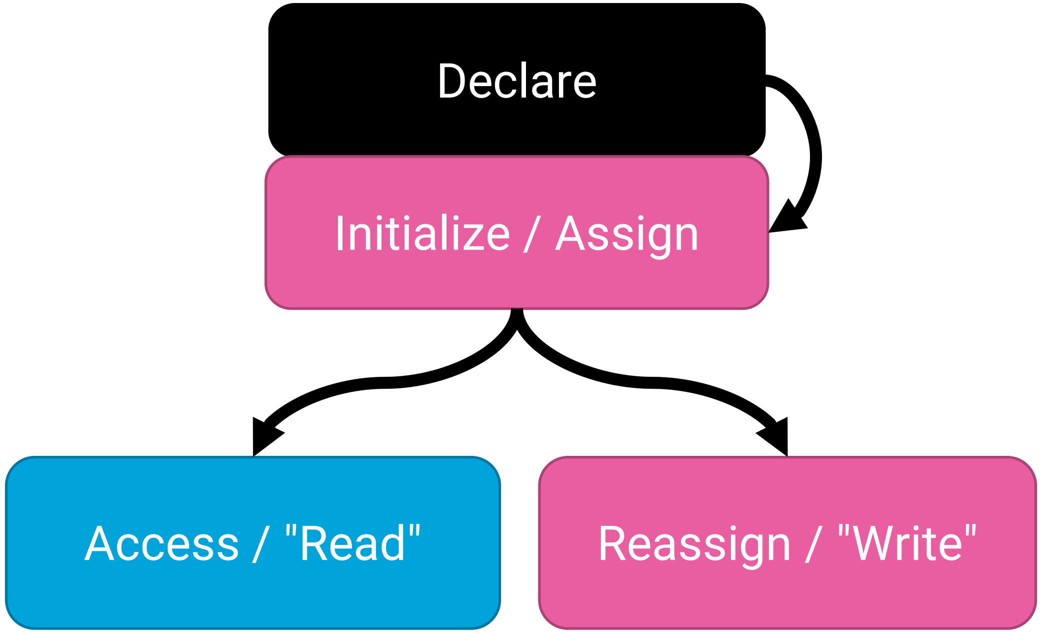
- *Every* variable:

  1. has a **name** and
  2. is bound to a value of a specific **data type**



Current Scope

How to use a variable, generally...



1. **Declare** the variable with name & type
2. **Initialize / Assign** variable its first value

(Steps 1 and 2 can be combined!)

Once 1 and 2 are done, then you can*:

- **Access** the value stored in a variable, or,
- **Reassign** new values to the variable

* There are additional rules governing where you can access and assign a variable from.

Variable Declaration Syntax (1/2)

- When you **declare** a variable, you are proclaiming... “henceforth, the identifier <some name> shall refer to a(n) <some type> value stored in memory”

```
age: int
```

  - “the identifier **`age`** shall refer to an **`int`** value stored in memory.”

- General form:

```
[identifier]: [type]
```

- The type can be: **`int, float, str, bool`**
  `(and more types to come)`

Variable Name & Identifier Rules (1/2)

Variable names are an example of an *identifier*.

Identifiers cannot contain spaces, must begin with a letter or underscore, and contain only letters, numbers, and underscores.

In Python, it is traditional to use `snake_casing` for multiword variable names.

For example, a variable to store "year of birth" would be named:

```
year_of_birth
```

Variable Assignment Syntax (1/4)

- The assignment statement **binds** a value to a variable

```
age = 21
```

  - “age is bound to the value 21”
  - "age is assigned 21"
  - “age takes the value of 21”
  - “age is now 21”
  - *Notice: **None of these readings uses the word “equals”!***

- General form:

```
[identifier] = [expression]
```

- The single equal symbol's name is the **assignment operator**.

Variable Assignment Semantics (2/4)

When this line of code runs:

```
    age = 20
```

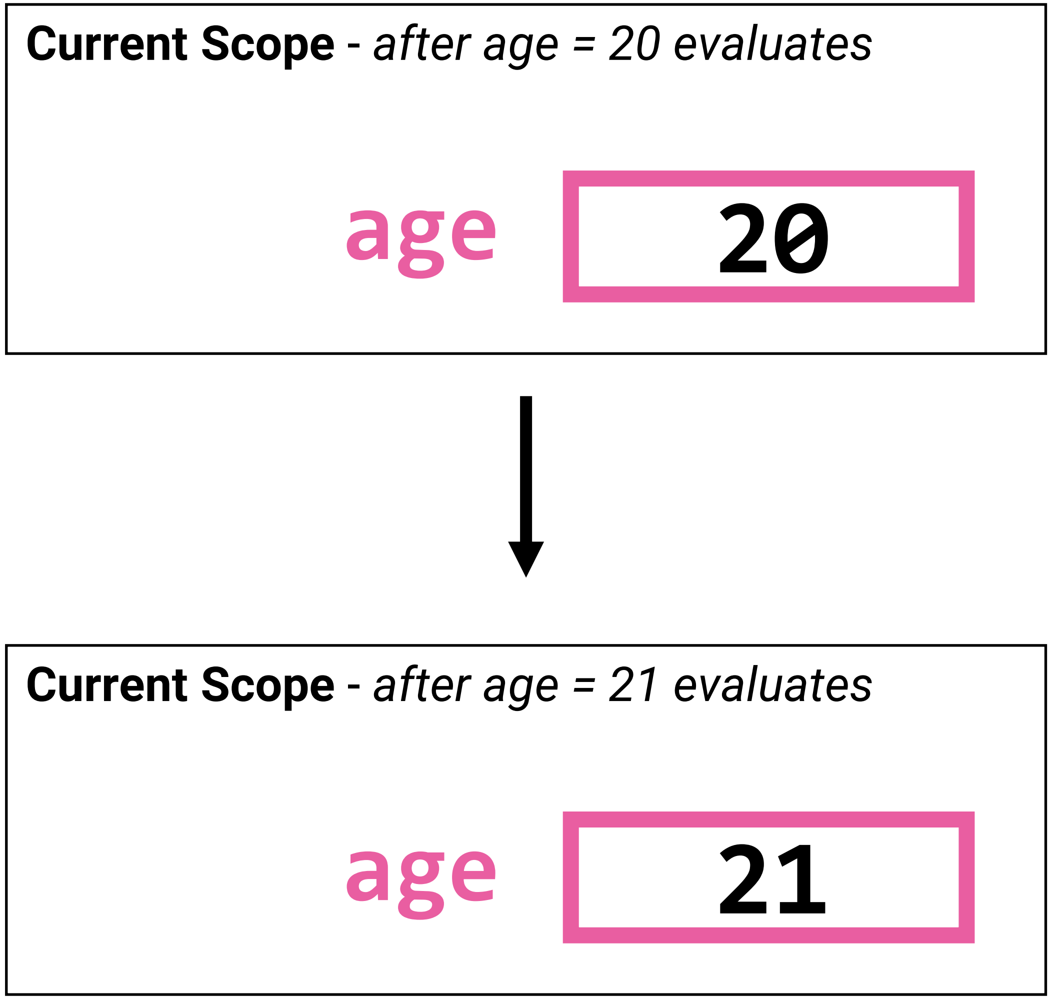
The identifier age is bound to a space in memory holding the value 20.

Later, if the following line ran:

```
    age = 21
```

The identifier age is now bound to a space in memory holding the value 21.

Assignment is *not* equality!



Current Scope - *after age = 20 evaluates*

Current Scope - *after age = 21 evaluates*

Variable Assignment Rules (3/4)

- **A variable's value can change** as the program runs
  - Just assign another value to the same variable!
  - After an assignment statement evaluates, when a subsequent line of code accesses the variable it will have the most recently assigned value.

- **The assignment operator is not commutative!**

```
[identifier] = [expression]  # OK
[expression] = [identifier]  # NOT OK
```

  The *variable's name must be on the left* of the assignment operator (=) and *the value being assigned must be on the right*.

- **You should not refer to a variable until after its name defined and bound!**
  - `Try: `**`print(unbound_variable)`**
  - `Result: NameError: name 'unbound_variable' is not defined`

- **For COMP110: expression's type *must match* the variable's declared type**

Variable Assignment Rules - Expressions (4/4)

- Notice the *right-hand side (RHS)* of assignment is an ***expression***!

```
[identifier] = [expression]
```

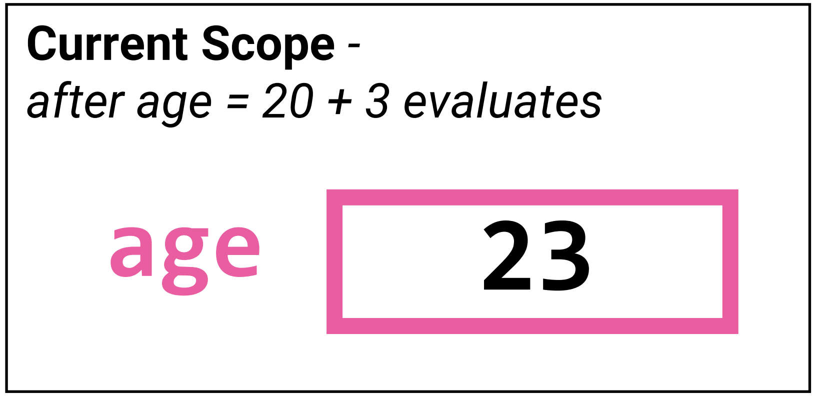
- Remember! *Every expression evaluates to a single value at runtime*.

- To know *what* value the variable name will be bound to, the expression of an assignment statement must first be evaluated.

- If the following line ran:

```
age = 20 + 3
```

1. The computer evaluates the RHS expression
2. The name age is bound to the result of it



Current Scope -
after age = 20 + 3 evaluates

age 23

Variable Initialization (1 / 2)

- **Initialization** is the *first* time you assign a value to a variable.
  - After initialization a variable is considered *defined* or *"bound"*.

- **Always, always, always initialize your variables!**

- You can **declare** *and* **initialize** it in two steps:

```
lucky: int
lucky = 13
```

- Or, you can combine these steps into a single statement:

```
lucky: int = 13
```

Variable Initialization – Type Inference (2 / 2)

- Notice there is some redundancy in this statement:

```
lucky: int = 13
```

- "Let lucky be an ***int*** variable that is initially assigned the ***int*** 13."

- If you combine declaration and initialization, a modern programming language will ***infer*** the variable's type for you. So you can write:

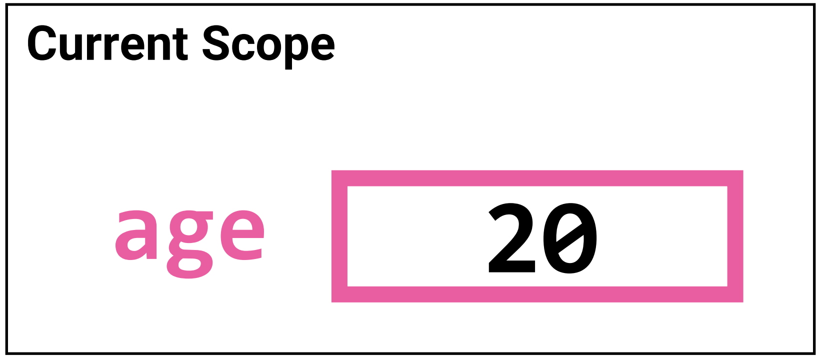
```
lucky = 13
```

- You are encouraged to use type inference when you know a variable's initial value at declaration.

Variable Access Expression – "Read" (1/2)

- *After* you have declared a variable *and* initialized it…

- You can **access** ("read", "look up") a variable’s value in memory **by its name**



Current Scope

age

20

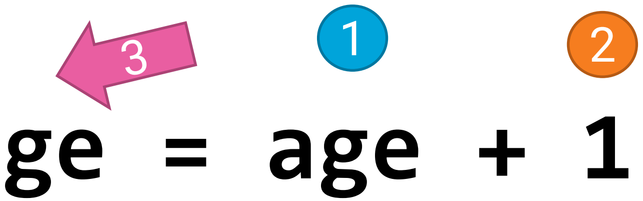
```
print(age)
```

- “Find the name age and print the value it is bound to as output on the screen.”

- Caution! This is *very different* than: print("age");
  - This would output the textual value "age" to the screen!

Variable Access in an Assignment Statement (2/2)

- Consider the following assignment statement:

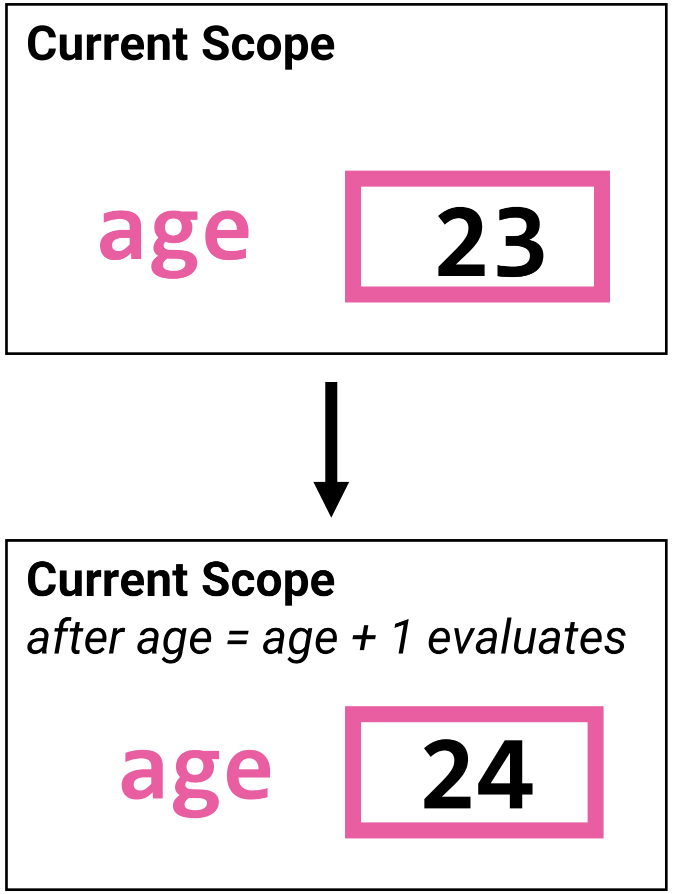


```
age = age + 1
```

“age is assigned the current value of age plus one”

Steps:

1. current value of **age** is accessed ("read")
2. The integer value 1 is added to it
3. **age** is bound to the resulting value in memory



Current Scope

age 23

Current Scope
after age = age + 1 evaluates

age 24

Variable Assignment *is not Equality*

Imagine the following code:

```
1.  print(“Donations”)

2.  total: int = 0

3.  total = total + 20

4.  total = total + 50

5.  print(total)

6.  total = total + 40

7.  print("total is " + str(total))
```

`total`'s value in memory:

```
1.  Undefined

2.  0

3.  20

4.  70

5.  70

6.  110

7.  110
```