Warmup (L4)

- Write a function `checkWithin(result, expected, tolerance, name)` that generalizes our **`assert`**-based tolerance checking
  - (That is, it **`assert`**s that `result` is within the `tolerance` of `expected`, with `name` as the name/message for the assertion)
- Note: Don't use this in your submissions; MarkUs won't detect the separate tests ☺

CS114

Module 2: Making decisions

Making decisions

CS114 M2

Assertions

- Remember “==” and “<” from our assertions?
- What do they actually do?

```
print(hypotenuse(4, 5) < 7)
True
```

Conditionals

- `hypotenuse(4, 5) < 7` is simply a fact: it is true
- We can *conditionalize code* based on facts
  - That is, rather than just asserting that something is true as a test, we check if it's true, then choose what to do next

Why?

- Remember:
  computation =
    calculation +
    repetition +
    decision making
- We did calculation in Module 1
- Conditions will give us *decision making*

Decision making

```
def pos(x: float) -> float:
    """
    If x is not zero, return the absolute value of x.
    Otherwise, return 1.
    """
    if x < 0:
        return -x
    elif x == 0:
        return 1
    else:
        return x

assert pos(42) == 42,
assert pos(-42) == 42,
assert pos(0) == 1, "
```

This code only runs if x < 0

This code only runs if x == 0
(**elif** means “else if”)

This code only runs if x > 0
That condition is implicit: it only runs if neither previous case matched.

Decision making

```
def pos(x: float) -> float:
    """
    If x is not zero, return the absolute value of x.
    Otherwise, return 1.
    """
    if x < 0:
        return -x
    elif x == 0:
        return 1
    else:
        return x
```

Indenting again to show what happens conditionally and what doesn't

```
assert pos(42) == 42, "Absolute value of positive is positive."
assert pos(-42) == 42, "Absolute value of negative is positive."
assert pos(0) == 1, "Special case pos(0) is 1."
```

Decision making

```
def multiOp(x: float, y: float, op: int) -> float:
    """
    Return "x op y", where the operation is given as
    a code in op:
        0: addition
        1: subtraction
        2: multiplication
    """
    assert op >= 0, "No negative operation codes"
    assert op <= 2, "Operation codes go up to 4"
    if op == 0:
        return x + y
    if op == 1:
        return x - y
    return x * y

assert multiOp(1, 1, 0) == 2, "Simple addition"
assert multiOp(4, -3, 2) == -12, "Simple multiplication"
# … more tests …
```

Decision making

```
def multiOp(x: float, y: float, op: int) -> float:
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# … more tests …
```

We write <= for ≤ and >= for ≥

Decision making

```
def multiOp(x: float, y: float, op: int) -> float:
    """
    Return "x op y", where the operation is given as
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# … more tests …
```

else/elif are not required

Still imperative

- Anything indented under **`if`** is executed conditionally
- Anything after **`if`** (unindented) is executed *unconditionally*. It's simply run in order.
  - Except for *early return*
- Let's add some `print`s to our `multiOp` function in Jupyter to understand what is and isn't run

Decision making

```
def multiOp(x: float, y: float, op: int) -> float:
    """
    Return "x op y", where the operation is given as
    a code in op:
        0: addition
        1: subtraction
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assert multiOp(1, 1, 0) == 2, "Simple addition"
assert multiOp(4, -3, 2) == -12, "Simple multiplication"
# … more tests …
```

Variable naming aside

- I told you to use descriptive names, but I just named my parameters "`x`" and "`y`"
- Names are for what the variable means *to the function*, not to whoever calls the function
- In the case of `multiOp`, `x` means nothing to us, so `x` is as good as any other name
- `op` gets a real name because it means something to `multiOp`!

In-lecture quiz (L4)

- https://student.cs.uwaterloo.ca/~cs114/quiz/
- Q1: Which of these Python function definitions is valid?

A.
```
def return(x: int) -> int:
    return x
```

B.
```
def roundBadly(x: float) -> int:
    if x < 0:
        return int(x) - 1
    return int(x)
```

C.
```
def greater(x: float, y: float) -> float:
    if x > y:
    return x
    return y
```

D.
```
void iGotLost(const std::string &user) {
    cout << "Aren't you glad you're learning "
            "Python instead of C++?"
         << std::endl;
}
```

In-lecture quiz (L4)

- https://student.cs.uwaterloo.ca/~cs114/quiz/
- Q2: What will this code print?

```
def f(x: int) -> None:
    if x > 5:
        print("Big")
    print("Small")
f(42)
```

A. Big
B. Small
C. Big
   Small
D. Nothing

Boolean logic

CS114 M2

Booleans

- `True` and `False` are *values*
- Although it's weird, you can, e.g., store it in a variable:

```
x = hypotenuse(4, 5) < 7
```

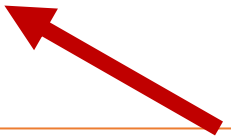
- Just as `True` is a value, so is `False`:

```
print(hypotenuse(4, 5) > 7)
False
```

Booleans

- These are called *boolean values*, named for logician George Boole
  - For the type checker, "`bool`"
- Math with booleans is called *boolean logic*
- We get booleans with our comparators:

```
==, !=, <, <=, >, >=
```



!= for ≠ (not equal to)

Multiple conditions

- You can put **`if`**s in **`if`**s

```
if op < 2:
    if op == 0:
        return x + y
    else:
        return x - y
else:
    return x * y
```

- Let's add some `print`s to understand this

Multiple conditions

- There are also operators to combine conditions:

```
if op >= 0 and op <= 2:
    # … do it …
else: # op out of range
    return -1
```

- **and** for both, **or** for either

Multiple conditions

- There are also operators to combine conditions:

```
if op >= 0 and op <
    # … do it …
else: # op out of r
    return -1
```

It's sometimes useful to comment an **`else`** to make it clear when it happens.

- **`and`** for both, **`or`** for either

Nesting vs. combining

- When you put an **`if`** inside of another **`if`**, that's called *nesting* conditionals
- Sometimes it's unavoidable (or would be ugly to avoid)
  - In particular, when you need to nest a condition *and* do something else
- When you can avoid it, you usually should. It results in *pyramids of doom* (code so nested that it gets indented so far that it's annoying to read)
  - But use common sense!

A note on or

- In common use, "**`or`**" can be ambiguous
  - If CS114 is my favorite class *or* I fail it, I'll remember it well.
  - What if CS114 is your favorite class *and* you fail it?
- In CS, "**`or`**" always means "and/or", so, e.g., "`1 == 1` **`or`** `2 == 2`" is true.

Complex combos

- You can also invert a condition with **`not`**, and group things with parentheses just like in numerical math

```
if not (op < 0 or op > 2):
    # … do it …
else: # op out of range
    return -1
```

Mind your precedence

- BEDMAS is now BEDMASCN&O

  (pronounced bed-masc-nando)

  - Brackets/parentheses, exponents, division and multiplication, addition and subtraction, …
  - Conditionals (`==`, `!=`, `<`, `<=`, `>`, `>=`)
  - **`not`**
  - **`and`**
  - **`or`**

Mind your precedence

- Confused?
- When in doubt, just use parentheses to make it clear
- Don't double up (e.g., `((a<b))`). Otherwise, it's never bad style.
  - (Using parentheses around **`assert`** isn't bad style, it's just incorrect.)

Booleans are *values*

- Here's a new version of `multiOp`:

```
def multiOp(x: float, y: float, op: int) -> float:
    """

    …
    """

    if opInRange(op):
        if op == 0:
            return x + y
        elif op == 1:
            return x - y
        return x * y
    else:
        return -1
```

- Let's write `opInRange` to work with it.

Booleans are *values*

- Here's a new version of `multiOp`:

```
def multiOp(x: float, y: float, op: int) -> float:
    """
    ...
    """
    if opInRange(op):
        if op == 0:
            return x
        elif op == 1:
            return x
        return x * y
    else:
        return -1
```

There's no comparison here (at least, not directly!). We got a `bool` because that's what `opInRange` returned!

- Let's write `opInRange` to work with it.