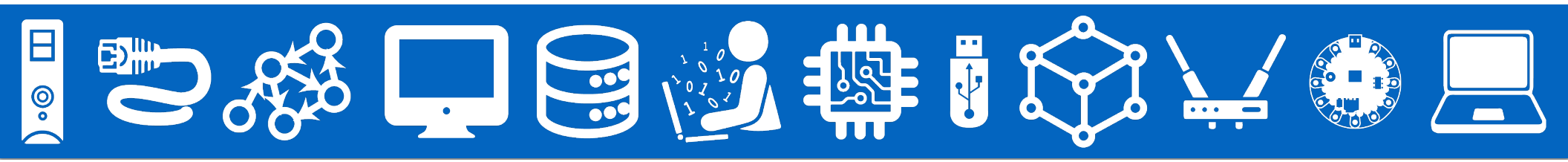
CS134:
Conditionals & Modules



Announcements & Logistics

- **Homework 2** is due tonight on Glow at 10 pm
- **Lab 2** due Wed 10pm / Thur 10pm
- Lab reminders:
  - You can work on lab machines any time
  - Make sure to keep your work consistent with what is on evolene
  - Best practice: Always push to evolene when done with a work session
  - If restarting work on a different machine:
    - If working on a machine on this lab for the 1st time: **clone** the repository just like you would when starting
    - Otherwise, make sure to **git pull** first
- Rohit will be covering Jeannie's class on Friday

Do You Have Any Questions?

Last Time

- Wrapped up functions
- Discussed return statements and variable **scope**
- Started learning about **conditionals**
    - **Boolean** data type
    - Making decisions in Python using `if else` statements

Today's Plan

- Learn about `if else` statements
- Look at more complex decisions in Python
  - Boolean expressions with **and**, **or**, **not**
- Choosing between many different options in our code
  - `If elif else` chained conditionals
- Testing our user-defined functions
  - As a **module** and as a **script**
- We are going to cover a lot of material in the next 3 lectures
  - Make sure you are keeping up and getting help if needed!

Review: Boolean Types

- Python has two values of **bool** type, written **`True`** and **`False`**
- These are called logical values or Boolean values, named after 19th century mathematician George Boole
- **`True`** and **`False`** must be capitalized!
  - Internally True = 1, False = 0
- Boolean values naturally result when answering a yes or no question
  - Is 10 greater than 5? Yes/True
  - Is 23 an even number? No/False
  - Does 'Williams' begin with a vowel? No/False
- Boolean values result naturally when using **relational** and **logical** operators

Relational Operators

< (less than), > (greater than)

<= (less than or equal to), > = (greater than or equal to)

== (equal to), ! = (not equal to)

Reminder that the single = is an assignment, double == is equality

```
>>> 3 > 5
False
>>> 5 != 6
True
>>> 5 == 5
True
```

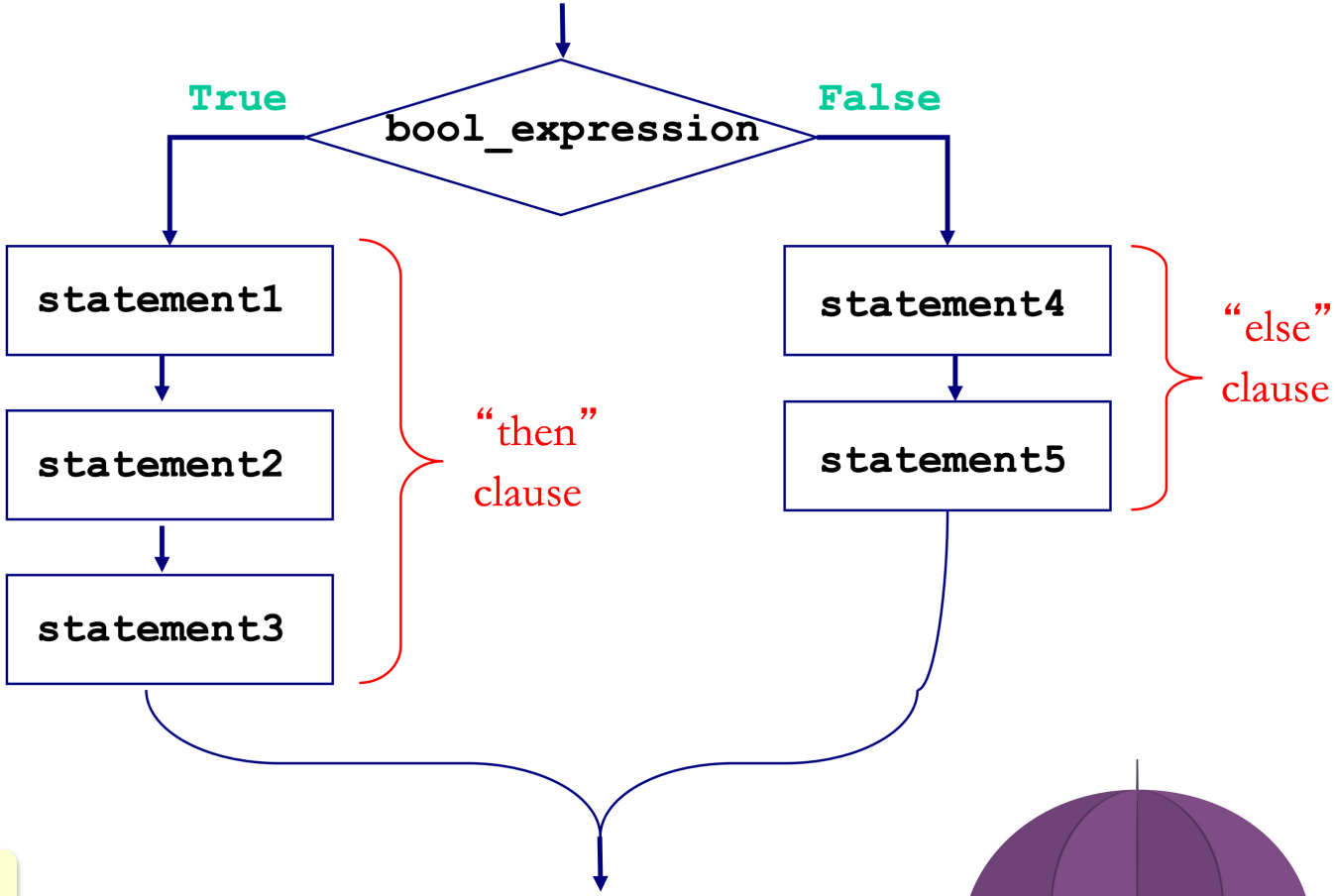
```
>>> 0 == True
False
>>> True == True
True
>>> int(False)
0
>>> int(True)
1
```

Boolean Expressions and If Statement

- Expressions that result in `True/False` are called **boolean expressions**
- Example: Checking if a number, `num`, is even
- How do we do this?
    - Even numbers are evenly divisible by 2 (i.e., give remainder zero)
    - Thus, `num % 2` should be zero if and only if `num` is even
- Now we have a Boolean expression we can test for: `num % 2 == 0`
- We implement "conditional statements" using Boolean expressions and **if-else statements**

Python Conditionals (`if` Statements)

```
if <boolean expression>:
    statement1
    statement2
    statement3
else:
    statement4
    statement5
```



Note: (syntax) Indentation and colon after if and else

Note: else clause is optional!

If it is raining, then bring an umbrella.
Else, bring your sunglasses.

Conditional Statements: If Else

- Consider the following functions that check if a number is even or odd
  - (More examples in today's notebook)

```
def printEven(num):
    """Takes a number as input, prints Even if
    it is even, else prints Odd"""
    if num % 2 == 0: # if even
        print("Even")
    else:
        print("Odd")
```

```
def isEven(num):
    """Takes a number as input, returns True if
    it is even, else returns False"""
    return num % 2 == 0
```

Logical Operators

- Logical operators **and**, **or**, **not** are used to combine Boolean values
- For two Boolean expressions `exp1` and `exp2`
  - **not** `exp1` (! in other languages) returns the opposite of `exp1`
  - `exp1` **and** `exp2` (&& in other languages) is True iff `exp1` and `exp2` are True
  - `exp1` **or** `exp2` (|| in other languages) is True iff either `exp1` or `exp2` are True

Truth Table for or

exp1	exp2	exp1 or exp2
True	True	**True**
True	False	**True**
False	True	**True**
False	False	**False**

Truth Table for and

exp1	exp2	exp1 and exp2
True	True	**True**
True	False	**False**
False	True	**False**
False	False	**False**

Nested Conditionals

- Sometimes, we need a more complicated conditional structure with more than 2 options
- Example: Write a function that takes a temp value in Fahrenheit
    - If temp is above 80, print "It is a hot one out there."
    - If temp is between 60 and 80, print "Nice day out, enjoy!"
    - If temp is below 60, print "Chilly day, don't forget a jacket."
- Notice that temp **can only be in one of those** ranges
    - If we find that temp is greater than 80, no need to check the rest!

Nested Conditionals

```
if booleanExpression1:
    statement 1
    ...
else:
    if booleanExpression2:
        statement 2
        ...
    else:
        statement 3
        ...
```

Attempt 1: Chained Conditionals

- We can **nest** if-else statements (using indentation to distinguish between matching if-else blocks)
- Works, but this can quickly become unnecessarily complex (and hard to read!)

```
def weather1(temp):
    if temp > 80:
        print("It is a hot one out there.")
    else:
        if temp >= 60:
            print("Nice day out, enjoy!")
        else:
            if temp >= 40:
                print("Chilly day, wear a sweater.")
            else:
                print("Its freezing out, bring a winter jacket!")
```

Attempt 2: Chained Ifs

- What if we use a bunch of if statements (w/o else) one after the other to solve this problem?
- What are the advantages/disadvantages of this approach?

```
def weather2(temp):
    if temp > 80:
        print("It is a hot one out there.")
    if temp >= 60 and temp <= 80:
        print("Nice day out, enjoy!")
    if temp <60 and temp >= 40:
        print("Chilly day, wear a sweater")
    if temp < 40:
        print("Its freezing out, bring a winter jacket!")
```

Attempt 2: Chained Ifs

- What if we use a bunch of if statements (w/o else) one after the other to solve this problem?
- What are the advantages/disadvantages of this approach?
    - Adv: More readable/less complex than Attempt 1
    - Disad: Unnecessary condition checking

```
def weather2(temp):
    if temp > 80:
        print("It is a hot one out there.")
    if temp >= 60 and temp <= 80:
        print("Nice day out, enjoy!")
    if temp <60 and temp >= 40:
        print("Chilly day, wear a sweater")
    if temp < 40:
        print("Its freezing out, bring a winter jacket!")
```

If Elif Else Statements

- Fortunately, there is a simpler way to specify several options by **chaining** conditionals

```
if booleanExpression1:
    statement 1
    ...
elif booleanExpression2:
    statement 2
    ...
else:
    statement 3
    ...
```

A better approach that avoids too many indented blocks and improves code readability

Can have any number of `elif` conditions, but only one (optional) `else` (at the end)

Attempt 3: Chained Conditionals

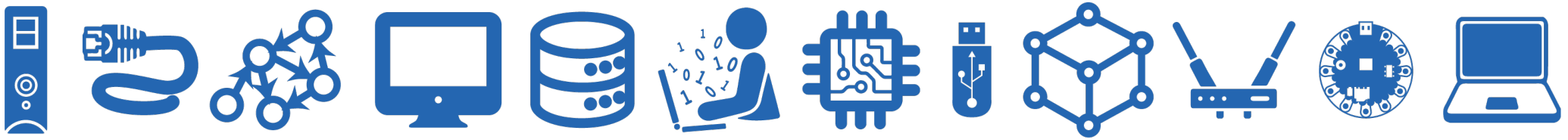
- We can chain together any number of elif blocks
- The else block is optional, but usually good to include

```
def weather3(temp):
    if temp > 80:
        print("It is a hot one out there.")
    elif temp >= 60:
        print("Nice day out, enjoy!")
    elif temp >= 40:
        print("Chilly day, wear a sweater.")
    else:
        print("Its freezing out, bring a winter jacket!")
```

Takeaway of Conditionals

- Chained conditionals avoid messy nested conditionals
- Chaining reduces complexity and improves readability
- Since only one branches in a chained `if-elif-else` block evaluates to `True`, using them avoids unnecessary checks incurred by chaining if statements one after the other

Exercise:
Leap Year Function



Exercise: `leapYear` Function

- Let's write a function `leapYear` that takes a `year` (int) as input, and returns `True` if `year` is a leap year, else returns `False`
- When is a given year a leap year?
  - "*Every year that is exactly divisible by four is a leap year, except for years that are exactly divisible by 100, but these centurial years are leap years, if they are exactly divisible by 400.*"

How do we structure this logic using booleans and conditionals?

Exercise: `leapYear` Function

- Let's write a function `leapYear` that takes a `year` (int) as input, and returns `True` if `year` is a leap year, else returns `False`
- When is a given year a leap year?
  - *"Every year that is exactly divisible by four is a leap year, except for years that are exactly divisible by 100, but these centurial years are leap years, if they are exactly divisible by 400."*

    Decomposition!
  - If year is **not** divisible by 4: year is not a leap year
  - Else (divisible by 4) and if **not** divisible by 100: is a leap year
  - Else (divisible by 4 and by 100) and **not** divisible by 400: not a leap year
  - Else (if we make it to here must be divisible by 400): is a leap year

Exercise: `leapYear` Function

```
def isLeap(year):
    """Takes a year (int) as input and returns
    True if it is a leap year, else returns False"""
    pass
```

Leap years between from 1900 to 2060:

Not a leap year

1900	1904	1908	1912	1916	1920	1924	1928	1932	1936
1940	1944	1948	1952	1956	1960	1964	1968	1972	1976
1980	1984	1988	1992	1996	2000	2004	2008	2016	2020
2024	2028	2032	2036	2040	2044	2048	2052	2056	2060

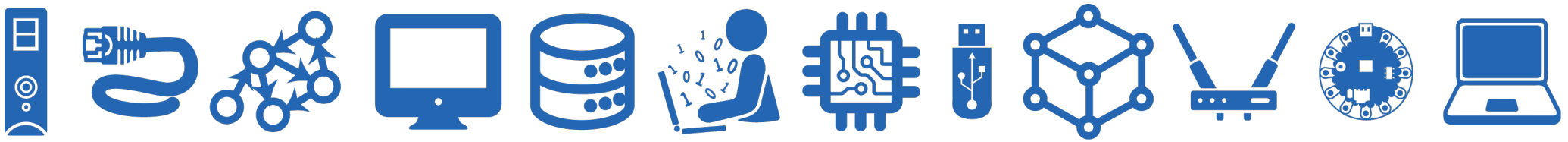
Next leap year

https://www.calendar.best/leap-years.html

Exercise: `leapYear` Function

```
def isLeap(year):
    """Takes a year (int) as input and returns
    True if it is a leap year, else returns False"""

    # if not divisible by 4 return False
    if year % 4 != 0:
        return False

    # is divisible by 4 but not divisible by 100
    elif year % 100 != 0:
        return True

    # is divisible by 4 and divisible by 100
    # but is not divisible by 400
    elif year % 400 != 0:
        return False

    # is divisible by 400 (and also 4, and 100)
    return True
```

Moving On:
Modules & Scripts



Modules and Scripts

- A **script** is a piece of code saved in a file, e.g., `leap.py`
  - Meant to be executed with: `python3 leap.py`
- A **module** is a collection of function definitions saved in a file (like a script)
  - Meant to be imported and used by other scripts
  - Can be used in interactive python
- Code in a `.py` file can serve as both a module and a script
- To distinguish between these two modes of operation, we can check the value of the special variable called `__name__`
- *Note: If a variable starts/ends with double __ in Python, it's a special variable*

Modules and Scripts

- Consider the code we wrote in `leap.py`
- When `leap.py` is run as a **script** then the `__name__` variable is set to the string `"__main__"`
- When we import the code as a **module**, the `__name__` variable is set to the name of the module `leap`
- Why does this matter?
    - We often want different behavior when the code is run as a script vs when it's imported as a module

`if __name__ == '__main__'`

- This is just an if statement with an equality Boolean expression:
  - Checks whether the `__name__` variable is set to the string `'__main__'`. Tells us the code is being run as a script
- We place code that we want to run only when our module is executed as a script inside the `if __name__ == "__main__"`: block
- Useful for testing code that we do not want to run when we import functions in interactive Python

Example: Script vs Module

```python
# name.py
# test the role of __name__ variable
print("__name__ is set to", __name__, "\n\n")
```

```
bash-3.2$ python3 name.py
__name__ is set to __main__


bash-3.2$ python3
Python 3.9.7 (v3.9.7:1016ef3790, Aug 30 2021, 16:25:35)
[Clang 12.0.5 (clang-1205.0.22.11)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> import name
__name__ is set to name
```

Running leap as a Script and Module

```python
# function to check if a given year is a leap year

def isLeap(year):
    """Takes a year (int) as input and returns
    True if it is a leap year, else returns False"""

    # if not divisible by 4 return False
    if year % 4 != 0:
        return False

    # is divisible by 4 but not divisible by 100
    elif year % 100 != 0:
        return True

    # is divisible by 4 and divisible by 100
    # but is not divisible by 400
    elif year % 400 != 0:
        return False

    # is divisible by 400 (and also 4, and 100)
    return True


#  following code only run when run as a script
if __name__ == "__main__":
    # ask user to enter year
    year = int(input("Enter a year: "))

    # call isLeap
    if isLeap(year):
        print(year, "is a leap year!")
    else:
        print(year, "is not a leap year.")
```

Running leap as a Script and Module

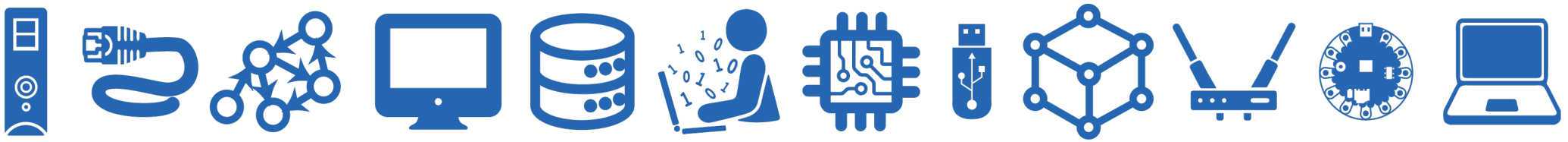
- Running leap.py as a script (notice the code in the if block runs!)

```
bash-3.2$ python3 leap.py
Enter a year: 1900
1900 is not a leap year.
bash-3.2$ python3 leap.py
Enter a year: 2040
2040 is a leap year!
```

- Running leap.py as a module in interactive Python

```
bash-3.2$ python3
Python 3.9.7 (v3.9.7:1016ef3790, Aug 30 2021, 16:25:35)
[Clang 12.0.5 (clang-1205.0.22.11)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> from leap import *
>>> isLeap(1900)
False
>>> isLeap(2040)
True
>>> exit()
```

Lab 2



Lab 2: Goals

- In this lab, you will be writing a **non-trivial Python** script to compute the current day of the week in Williamstown
- High-level learning goals:
  - Defining and calling **functions**.
  - Using **arithmetic operators** in Python.
  - Testing your code in **interactive** Python.
  - Writing **conditional (if else) statements** to make decisions in your code

How Computers Keep Track of Time

- On Unix machines time is represented by the **number of seconds,** starting from the beginning of Thursday, January 1, 1970
    - The date is arbitrary, but is called the Unix "epoch"
- In Python we can access this value using the time module()
- The time value is in UTC (current time in England)
- While the value is a float, we only need the integer part for this lab

```
$ python3
>>> from time import time
>>> time()
1612800680.9091752
```

Figuring Out the Day of the Week

- The `time` module gives us the total number of seconds since the Epoch
- Our goal: Use this value to figure out what the current day of the week is in England (for now, later we will deal with timezones)
- Approach (break down the problem):
    - How many minutes have elapsed since the Epoch?
    - How many hours? Days?
    - Suppose the number of days divide evenly by 7. What day of the week is it? What if they do not divide evenly?
- How do we do this using arithmetic operations?
    - Hint: Think about our example involving `numCoins` from last week

UTCDay(timeval)

- This function takes a floating point number as a parameter, `timeval`
  - `timeval` represents the UTC time in England
  - `timeval` is the total number of seconds since the Epoch
- This function should return:
  - A number between 0-6, which is the day of the week corresponding to `timeval`
  - Where 0 is Sunday, 1 is Monday, ..., 6 is Saturday

Interactively Testing Functions

- Enter interactive Python by typing `python3` at the Terminal
- Import the function and any modules you need

```
>>> from day import UTCDay
```

```
>>> from time import time
```

- Call your function and see if it returns the desired output
- If you need to make changes to the code in `day.py`:
  - Quit out of interactive python session (Ctrl-D or exit())
  - Restart interactive Python; re-import modules before resuming testing
  - Hint: Can press up on keyboard to see previously typed commands in interactive Python

Running as a Script

- To run a program as a script:
  - type `python3 (filename.py)` in the Terminal
- This ensures that the code block within `if __name__ == '__main__'` block is executed

```
if __name__ == "__main__":              # run as a script?
    now = time()                        # UTC time
    dayNumber = localDay(now, -4)       # Eastern day of week number
    dayName = dayOfWeek(dayNumber)      # get day name
    print("It's "+ dayName +"!")        # print it out
```

- Note: The code in this if block is not run in interactive Python