

# Introduction to Computational Thinking and Python Programming

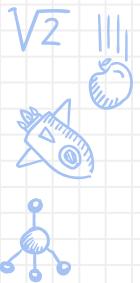
# Sarom Leang, Ph.D. (Instructor)

## Jesse McCandlish (Mentor)

# March 4, 2023

# Session 3





[REMINDER]

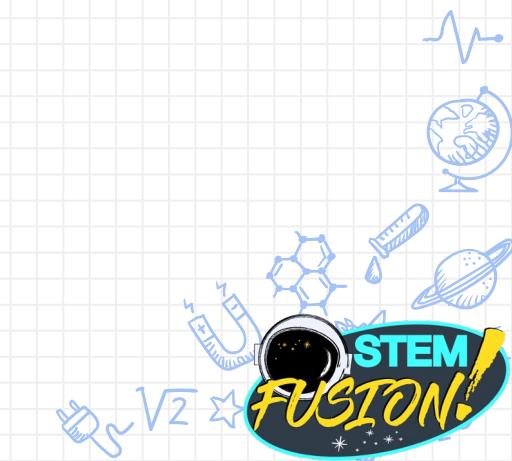
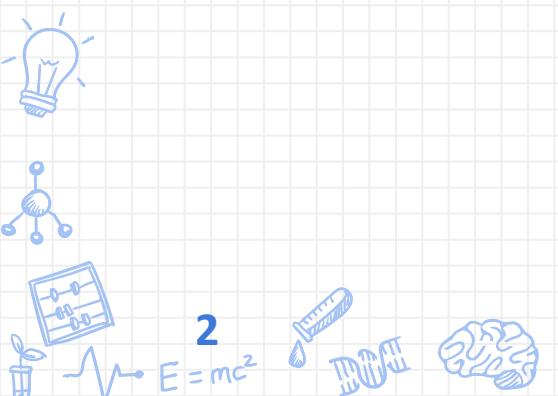
# Names and Faces and Pronouns

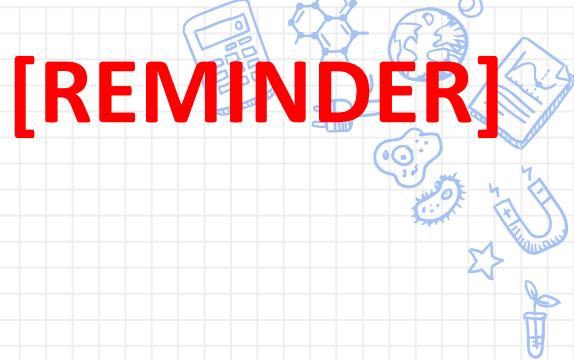
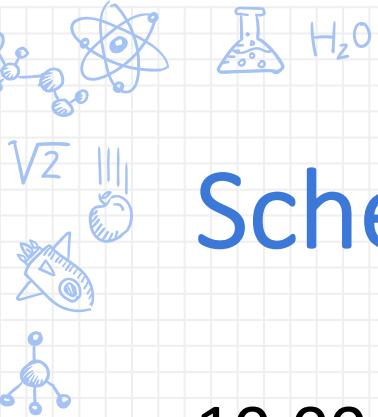
**Sarom Leang, Ph.D. (Instructor)**

- Professor
- Instructor
- Mr. Leang

**Jesse McCandlish (Mentor)**

- Jesse





[REMINDER]

# Schedule

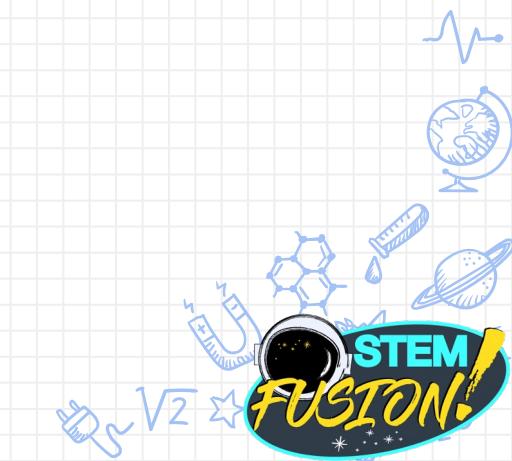
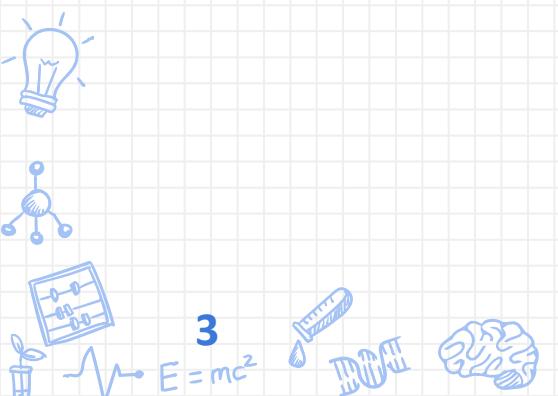
10:00 AM – 10:15 AM Homeroom

10:15 AM – 11:35 AM G1 Block

11:35 AM – 12:35 PM Break/Lunch

12:40 PM – 02:00 PM G2 Block

**80 minutes of class time**





[REMINDER]

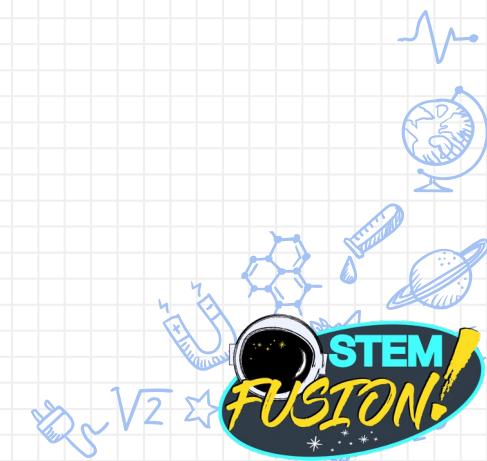
# Student Expectations

- **NO FOOD**
- **NO DRINKS** (on the table)
- Be respectful to individuals and property
- Be open to learning
- Be open to not understanding
- Be patient with yourself
- Ask questions
- Explore
- **Embrace failure**



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$$E=mc^2$$





[UPDATED]

# Lesson Plan

## Session #1 – October 29, 2022

- ~~Entrance survey~~
- Python programming environment, “Hello World”

## Session #2 – December 3, 2022

- ~~Parallel computing~~
- ~~Python programming environment, “Hello World”~~
- Python arithmetic operators, integer and float data types

## Session #3 – March 4, 2023

- Generative AI
- Python arithmetic operators, integer and float data types
- Python Booleans data type, comparison and logical operators, truth tables

## Session #4 – March 25, 2023

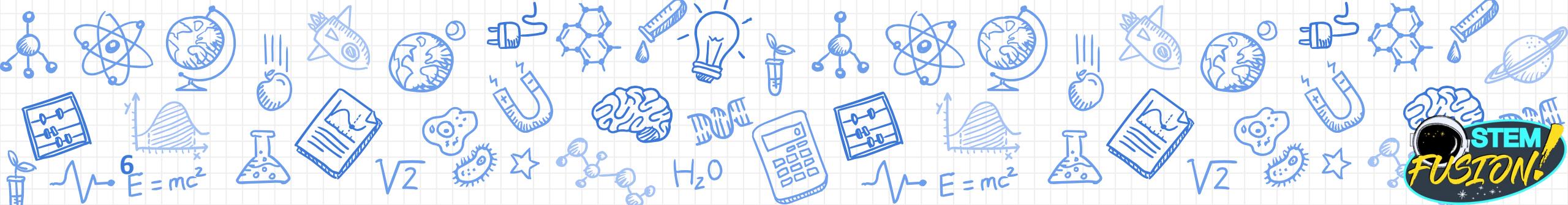
- Python string data type, control structures, and collections {list, dictionary, tuple}

## Session #5 – April 22, 2023

- Decomposition, pattern recognition, abstraction, and algorithms

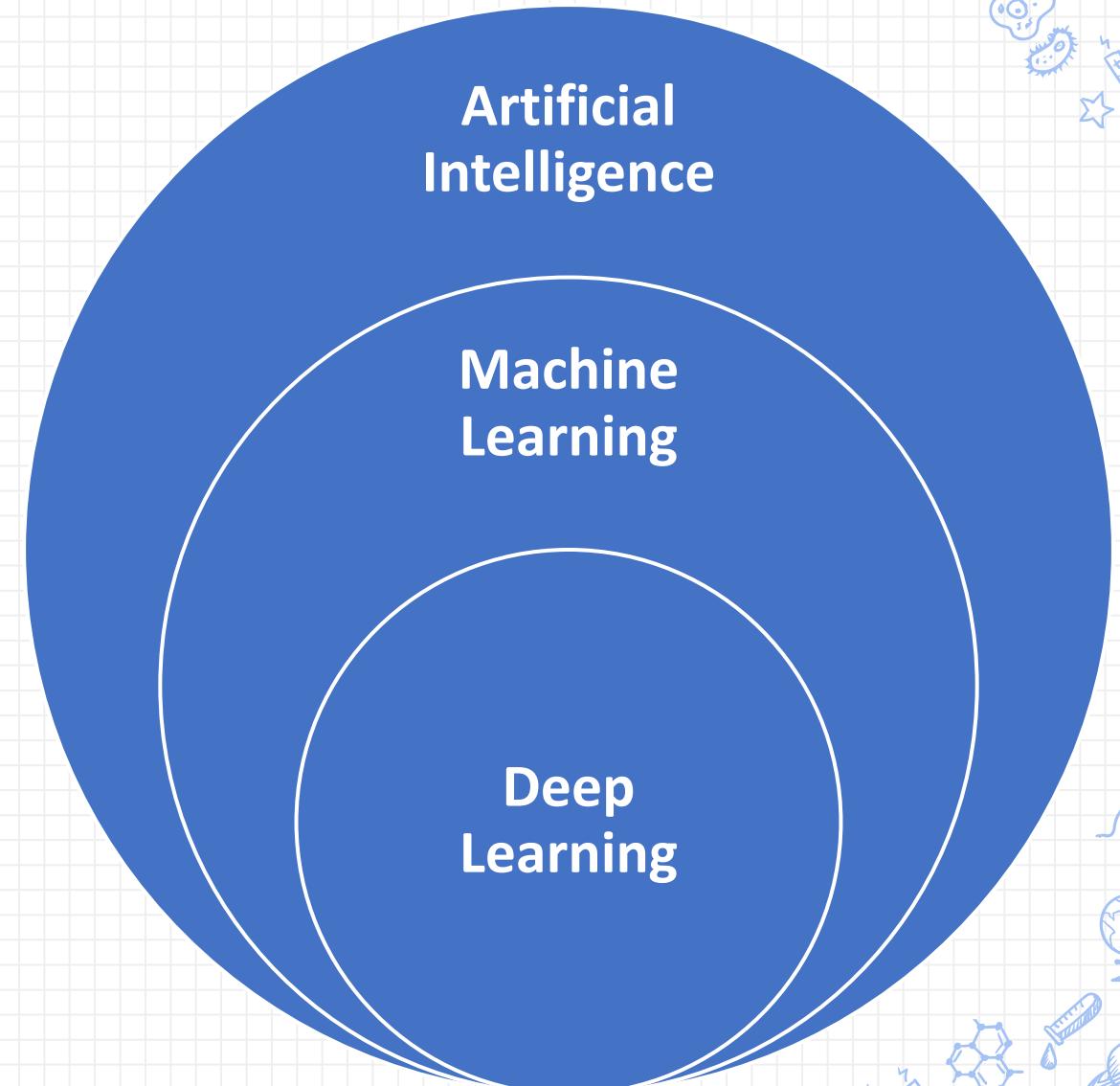


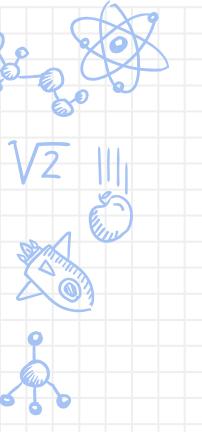
# Generative AI



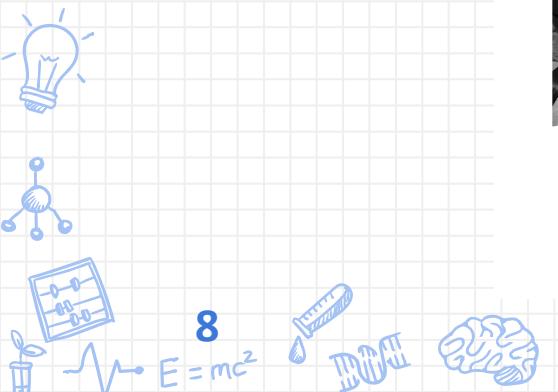
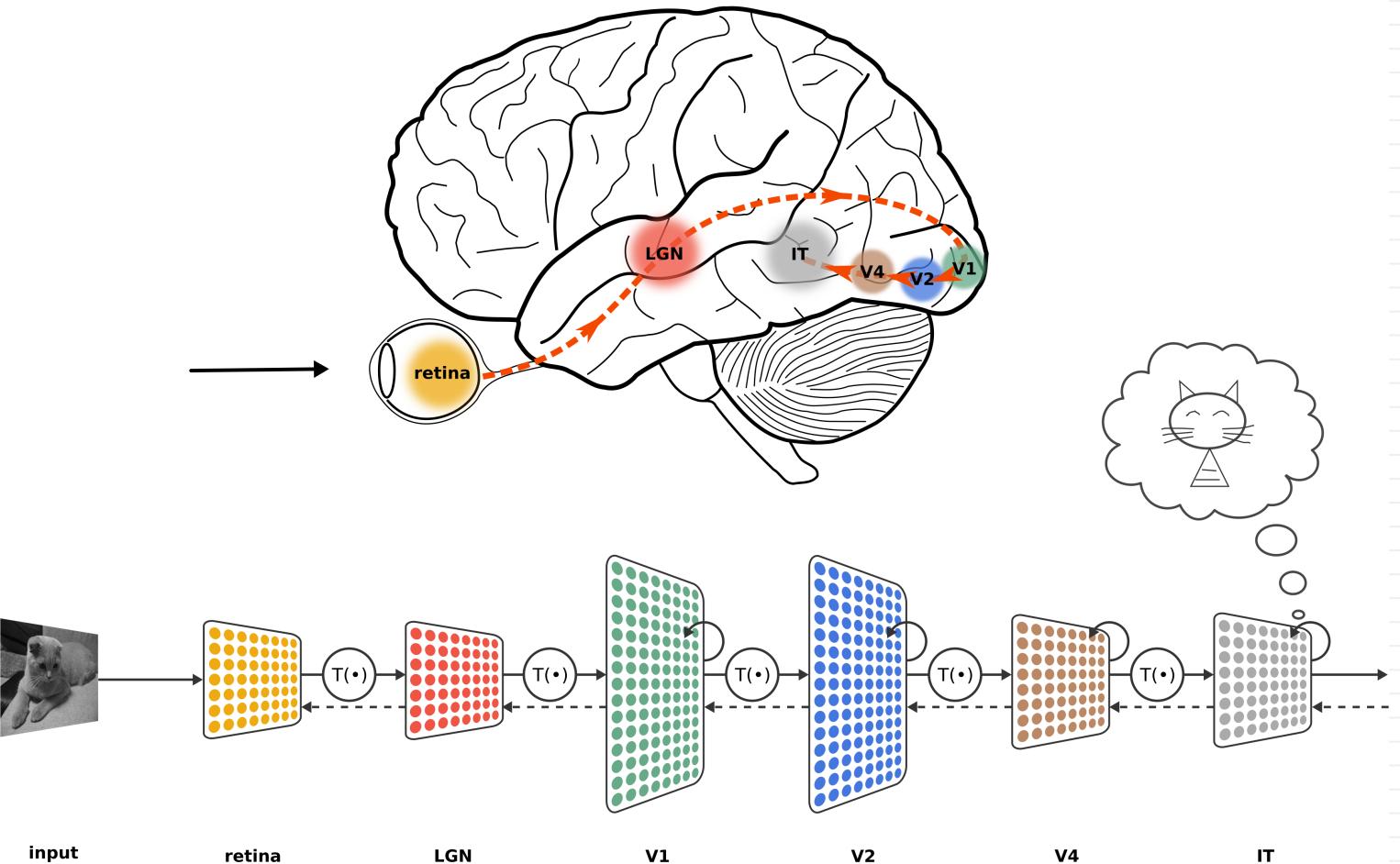
# Buzzwords: AI/ML/DL

- AI - Creation of **intelligent machines** that can **perform tasks** that would typically **require human intelligence** to complete.
  - ML - teaching computers to **learn** and **make decisions** on their own.
  - DL - type of ML that uses multi-layer neural networks to **analyze** and **interpret data** (**recognize patterns**).





# Neural Networks

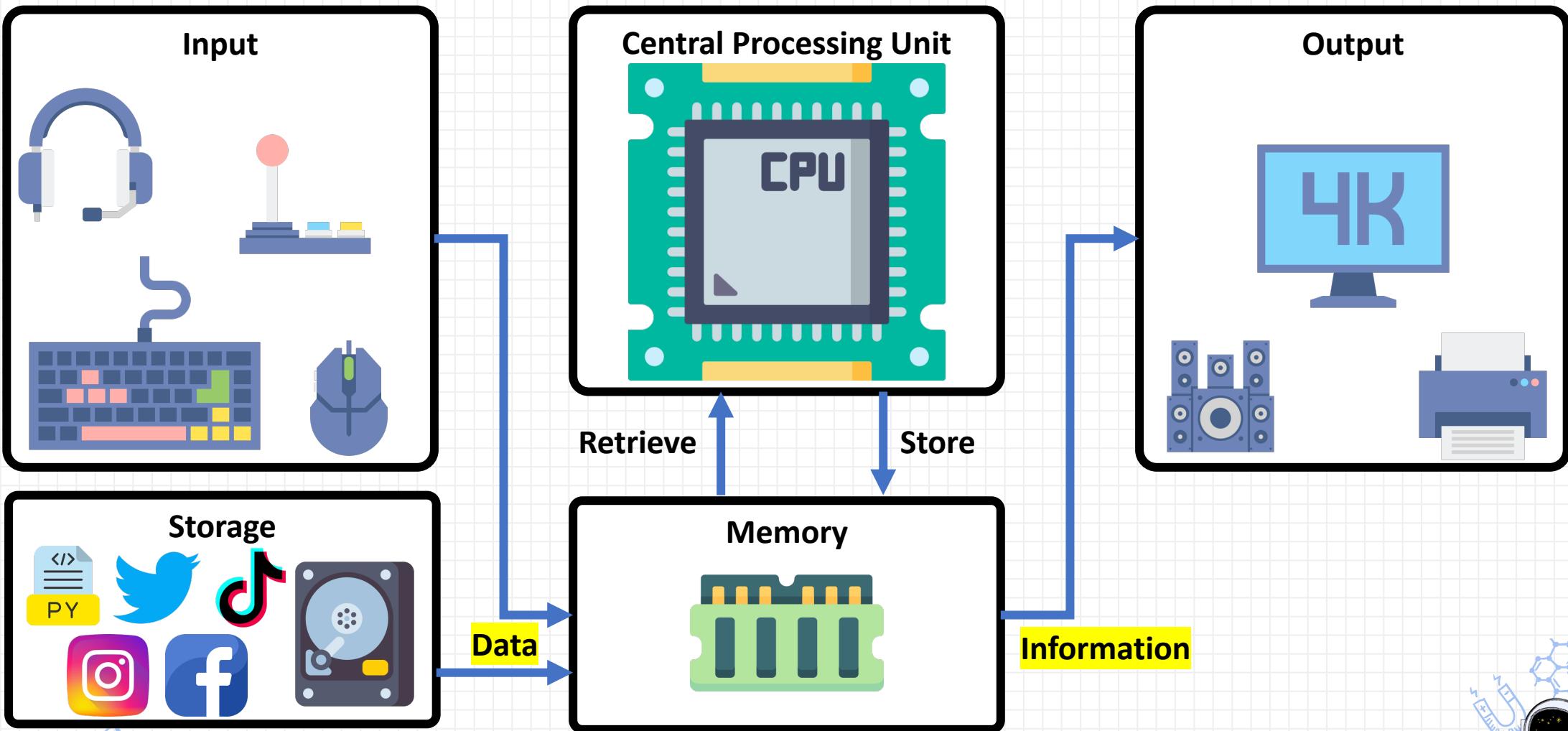


# What is Generative AI?

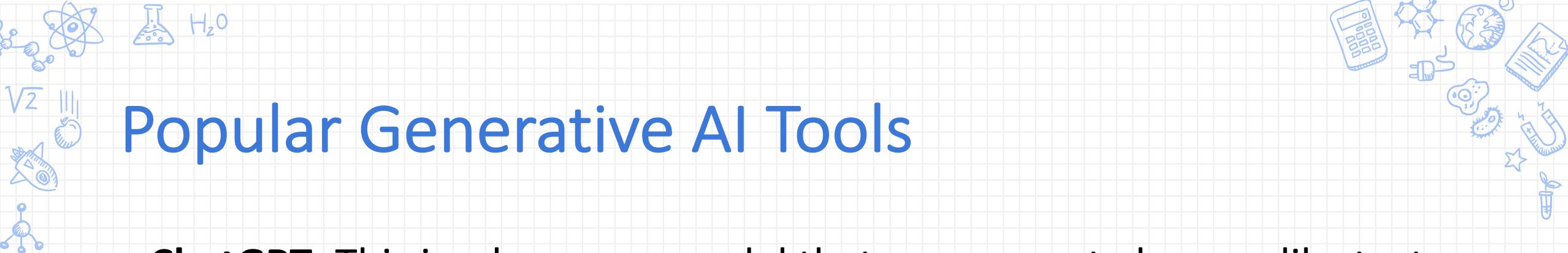
- Generative AI is a type of artificial intelligence that can **create new content that is similar to the original data it was trained on**.
  - It **learns patterns and relationships in data**, and **uses that knowledge to generate new content**, such as images, music, or text.
  - It's used in many different applications, including art, music, writing, and video game development.
  - It can also be used to create more realistic simulations for scientific research and to **generate synthetic data** for machine learning models.

# [SESSION 1]

## Data -> Information

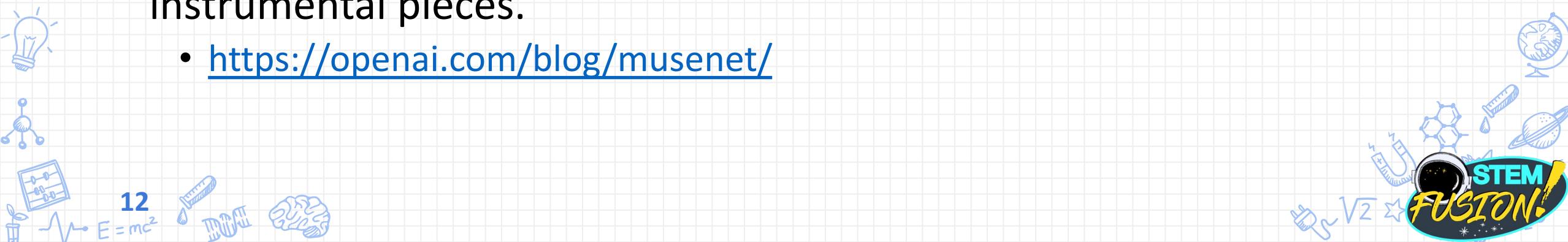


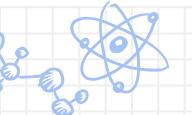




# Popular Generative AI Tools

- **ChatGPT:** This is a language model that can generate human-like text based on a given prompt.
  - <https://openai.com/api/gpt-3/>
- **DALL-E:** This is an image generation AI that can generate images from textual descriptions.
  - <https://openai.com/dall-e-2/>
- **MuseNet:** This model can generate original music along with multi-instrumental pieces.
  - <https://openai.com/blog/musenet/>





H<sub>2</sub>O

$\sqrt{2}$



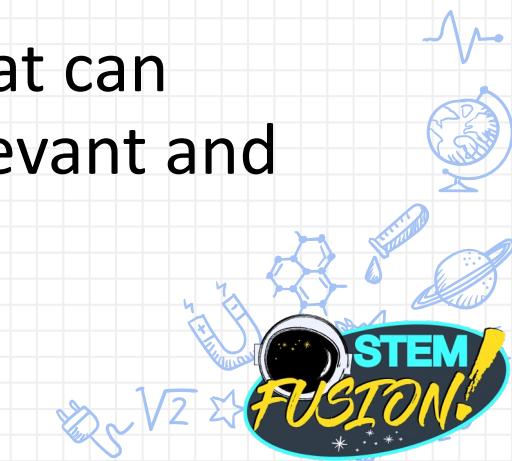
# ChatGPT

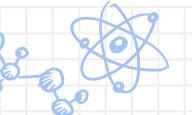
- Interact with this AI model by providing prompts.
- Prompts may describe a task being asked of the model.
- Prompts are inputs to the model.
- Generative content are the outputs from the model.
- The performance (quality of the output) of these models are dependent on the inputs.
- Prompt Engineering - creating specific prompts or inputs that can guide the generative AI model to produce output that is relevant and coherent.



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$$E=mc^2$$





H<sub>2</sub>O

$\sqrt{2}$



# ChatGPT Prompts

- Classify the named entities in this text: George Washington and his troops crossed the Delaware River on December 25, 1776 during the American Revolutionary War.
- Translate this text into Portuguese: Welcome to the Matrix

- Explain this python code:

```
r=int(input("Enter upper limit: "))  
for a in range(2,r+1):  
    k=0  
    for i in range(2,a//2+1):  
        if(a%i==0):  
            k=k+1  
        if(k<=0):  
            print(a)
```



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STEM  
FUSION!





# ChatGPT Prompts

- Write a positive Yelp review of Café Renaissance in Vienna, Virginia. Highlighting their grilled halibut dish in almond and lemon butter sauce.
  - More witty and colorful.
  - End with: It was a wonderful way to spend Valentines Day.
  - Also highlight the Escargot à la Bourguignonne appetizer which was cooked in garlic butter parsley and brandy.
- Create a template for a letter of recommendation for Dr. Sarom Leang. Dr. Leang was an Early Identification Program scholar during undergrad. Dr. Leang earned his BS in Chemistry and a minor in Computer Science from George Mason University in 2004 and completed his PhD in Quantum Chemistry from Iowa State University in 2012.



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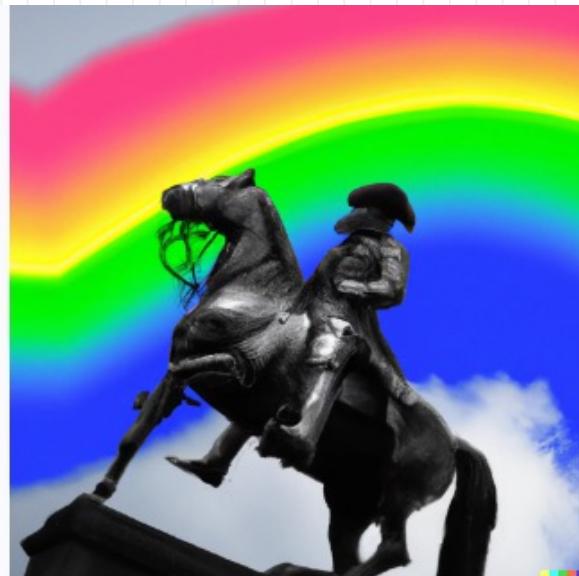


# ARE YOU NOT ENTERTAINED?



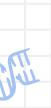


# DALL-E: An abstract image of George Mason on a horse riding into a rainbow sunset



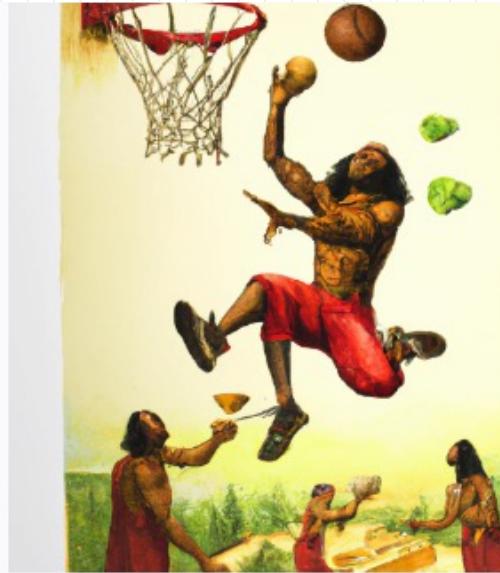
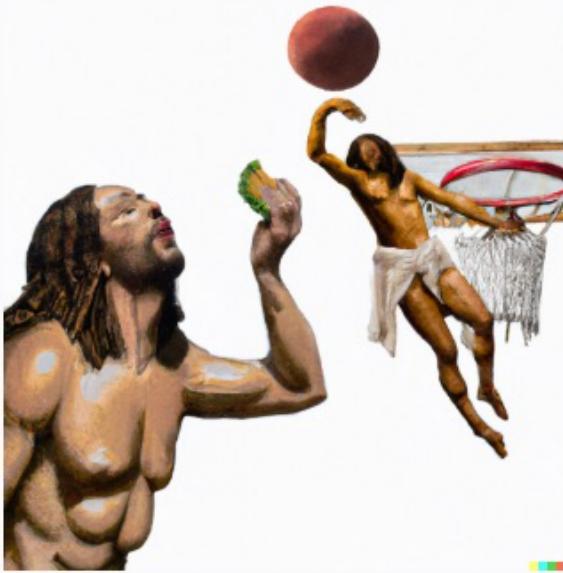
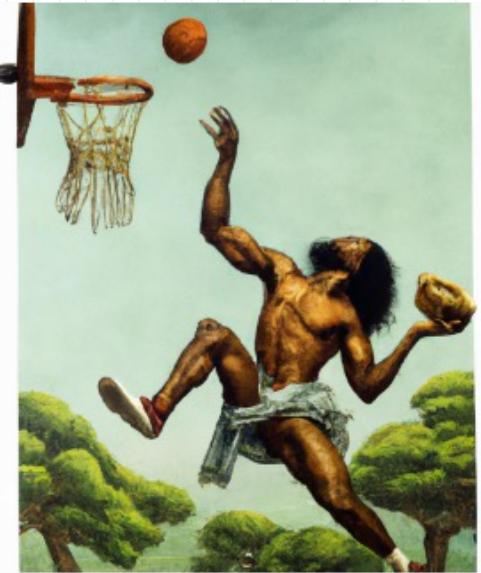
17

$$E=mc^2$$





# DALL-E: A painting of Michael Jordan slam dunking in the air while eating an avocado



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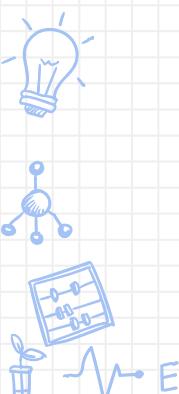
$$E=mc^2$$

$$\sqrt{2}$$





# DALL-E: Synthwave George Mason University logo



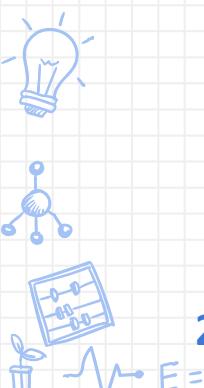
19

$E=mc^2$

STEM  
FUSION!

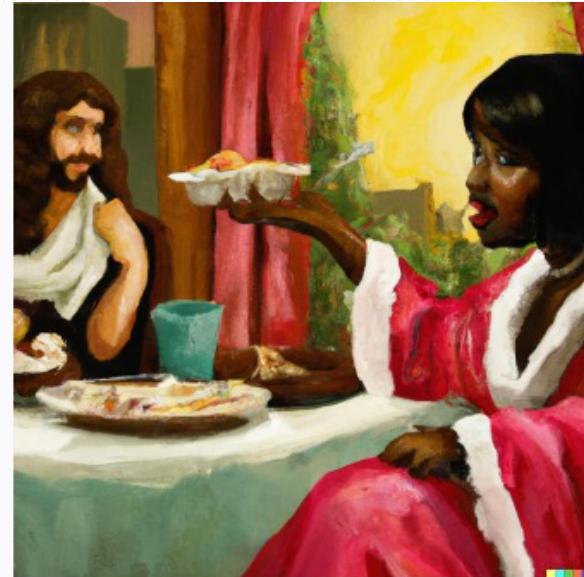


# DALL-E: A photo of an avocado playing basketball with a pomegranate





# DALL-E: A painting of dark-skinned female Santa having dinner with dark-skinned female Jesus



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$$E=mc^2$$



# Generative AI Inception

- Ask ChatGPT to generate a prompt for DALL-E.

Create an image of a fantastical underwater city, with towering structures and bustling streets, where mermaids and other sea creatures live and work alongside human-like beings. The city should have a distinct aesthetic, with colors and architectural elements that evoke the feeling of being submerged in the depths of the ocean.

The image should also include unique transportation methods, such as aquatic vehicles or creatures that are used for travel.



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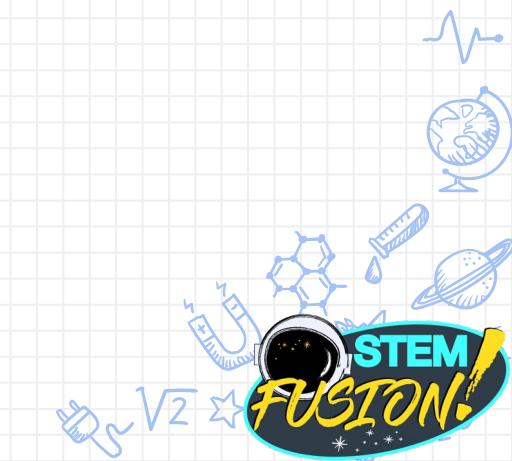
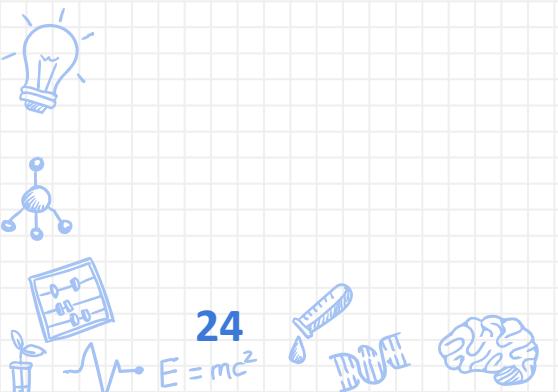
# Generative AI and Academic Code of Conduct

- Cheating or violating academic code of conduct using generative AI is unethical and has serious consequences.
  - Disciplinary action may include failing the assignment or course, or even expulsion from school.
  - Long-term consequences may include damaging a student's reputation and future academic and career prospects.
  - **Use generative AI responsibly and in accordance with the academic code of conduct.**



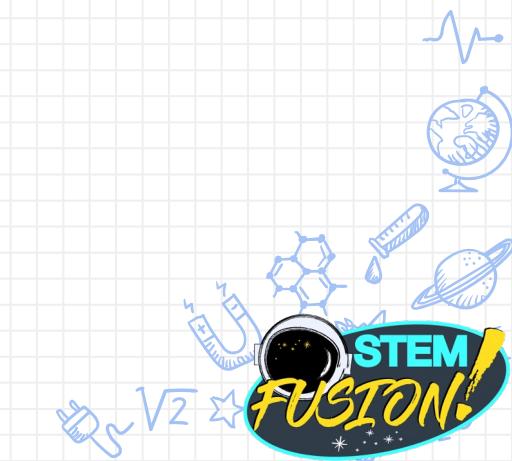
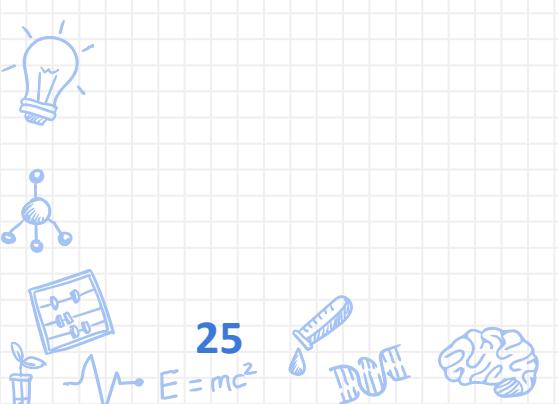
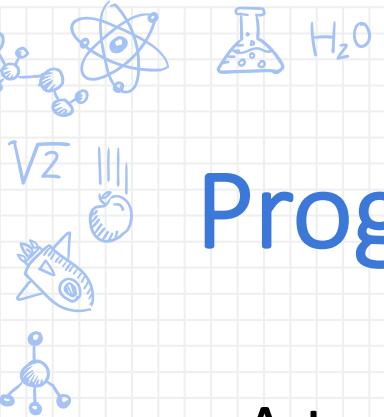
# ChatGPT Prompts

- Act as a high school instructor and describe how to write a “Hello World” program in Python using the Sublime Text editor and running the program on a Windows 10 system.



# Programming Environment

- A text editor
  - Sublime <https://www.sublimetext.com>
- A Python interpreter
  - Python 3.11.0 <https://www.python.org>



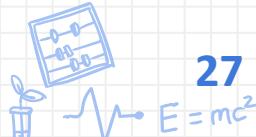
# First Programming Exercise: Hello World

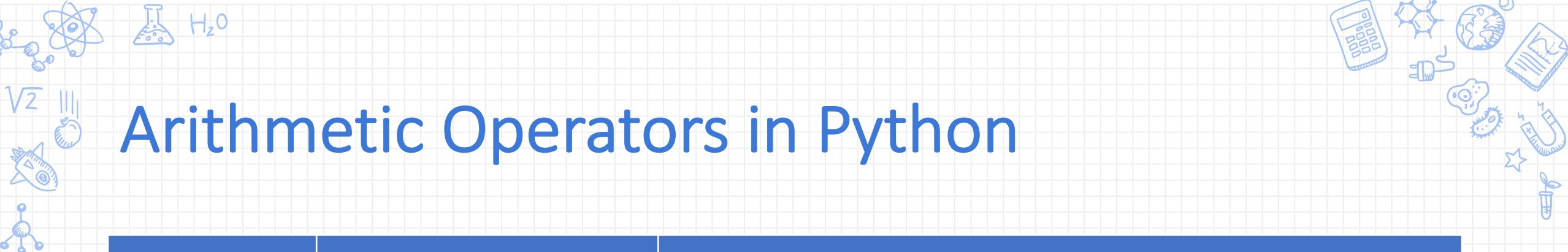
- Open up a blank document in the Sublime editor
  - Type: `print("Hello World!")`
  - Save the file as `hello.py` into your **Documents** folder
  - Open up the command prompt
    1. Test if python is working: type `python` and hit enter
    2. If you get an error then: type  
`set PATH=%PATH%;C:\Python311`  
and hit enter
    3. Repeat step 1
  - Execute your script:
    - Switch into the directory containing `hello.py`
      - `cd Documents`
    - Call the python program to interpret and execute your code
      - `python hello.py`

# Discussion – What are computers good at?

- Math (computations)
- Processing power is measured in Hertz (Hz)
  - 1 Hz = 1 clock cycle per second = 1 CPU fetch and execution of an instruction
  - A 1 Hz CPU can do 1 instruction per second
  - 2 GHz = 2 billion clock cycles per second = 2 billion instructions per second!
- NASA Apollo Guidance Computer (1960s) : 0.043 MHz =  $0.043 \times 10^6$  Hz
- Apple iPhone 14 (2022) : 17 THz =  $17 \times 10^{12}$  Hz

$$\frac{17 \times 10^{12}}{0.043 \times 10^6} \approx 4 \times 10^8 = 400,000,000 \text{ times faster}$$

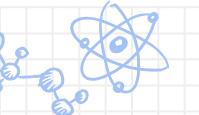




# Arithmetic Operators in Python

Operator	Usage	Operation
+	<code>x + y</code>	Addition
-	<code>x - y</code>	Subtraction
*	<code>x * y</code>	Multiplication
/	<code>x / y</code>	Division
%	<code>x % y</code>	Remainder
**	<code>x ** y</code>	Exponentiation
//	<code>x // y</code>	Floor division





H<sub>2</sub>O

$\sqrt{2}$



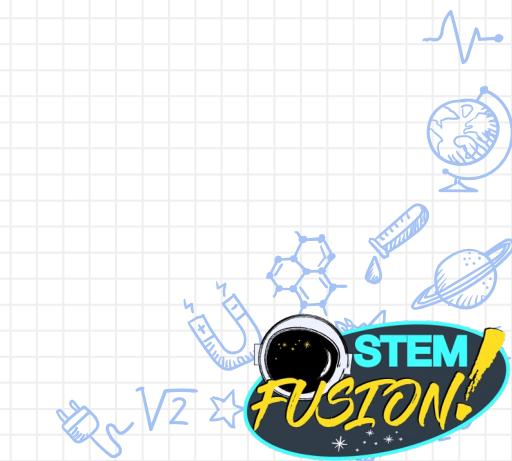
# Second Programming Exercise: Maths!

Operation	Result
Let <b>x = 8</b> and <b>y = 2</b>	
print(x + y)	
print(x - y)	
print(-x)	
print(x*y)	
print(x/y)	
print(x//y)	
print(x%y)	
print(x**y)	

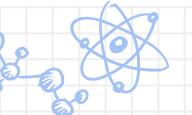


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$E=mc^2$



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 $H_2O$  $\sqrt{2}$ 

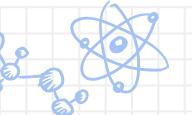
# Third Programming Exercise: More Maths!!

Operation	Result
Let $x = 9$ and $y = 4$	
<code>print(x + y)</code>	
<code>print(x - y)</code>	
<code>print(-x)</code>	
<code>print(x*y)</code>	
<code>print(x/y)</code>	
<code>print(x//y)</code>	
<code>print(x%y)</code>	
<code>print(x**y)</code>	



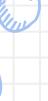
30

E=mc<sup>2</sup>



H<sub>2</sub>O

$\sqrt{2}$



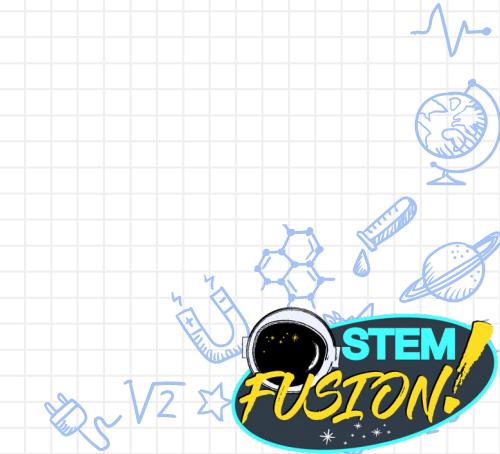
# Operator Precedence

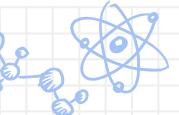


- In Python, operators will be evaluated in order of precedence.
- Order of operations – **PEMDAS**
  1. Parentheses ( )
  2. Exponentiation \*\*
  3. Multiplication \* and Division /, //, %
  4. Addition + and Subtraction –
- After **PEMDAS**, order goes left to right.
- Use parentheses to override order.



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H<sub>2</sub>O

✓<sup>2</sup>



# Class Exercise: PEMDAS

Try to determine the solution by hand and then verify with Python

$$1 + 2 * 4 = ?$$

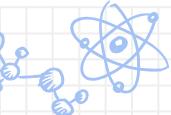
$$(1 + 2) * 4 = ?$$

$$5 + (4 - 2) * 2 + 4 \% 2 - 4 // 3 - (5 - 3) / 1 = ?$$



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H<sub>2</sub>O

$\sqrt{2}$



# Class Exercise: PEMDAS

$$1 + 2 * 4 = ?$$

$$1 + 2 * 4 = ?$$

$$1 + 8 = 9$$

$$(1 + 2) * 4 = ?$$

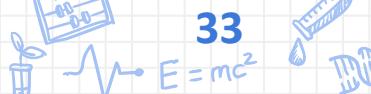
$$(1 + 2) * 4 = ?$$

$$3 * 4 = 12$$

$$5 + (4 - 2) * 2 + 4 \% 2 - 4 // 3 - (5 - 3) / 1 = ?$$

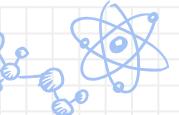


33



$\sqrt{2}$



 $H_2O$  $\sqrt{2}$ 

# Class Exercise: PEMDAS

$5 + (4 - 2) * 2 + 4 \% 2 - 4 // 3 - (5 - 3) / 1 = ?$

$5 + (4 - 2) * 2 + 4 \% 2 - 4 // 3 - (5 - 3) / 1 = ?$

$5 + 2 * 2 + 4 \% 2 - 4 // 3 - 2 / 1 = ?$

$5 + 2 * 2 + 4 \% 2 - 4 // 3 - 2 / 1 = ?$

$5 + 4 + 0 - 1 - 2 = 6$



$E = mc^2$

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H<sub>2</sub>O

$\sqrt{2}$



# ChatGPT Prompts

- Act as an high school instructor and explain the order of operations for the following:

$$5 + (4 - 2) * 2 + 4 \% 2 - 4 // 3 - (5 - 3) / 1$$





H<sub>2</sub>O

$\sqrt{2}$



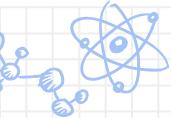
# Basic Data Types in Python

- Integer
- Floating-point
- String
- Boolean
- List
- Tuple
- Set
- Dictionary



$$E=mc^2$$



 $H_2O$  $\sqrt{2}$ 

# Integer



In Python, any number **without** a decimal is considered an integer:

0

1

100

1000000000000000000000000000000000000001

-1000000000000000000000000000000000000001

-100

-1



$E=mc^2$





H<sub>2</sub>O



# Floating-point

In Python, any number **with** a decimal is considered an floating-point:

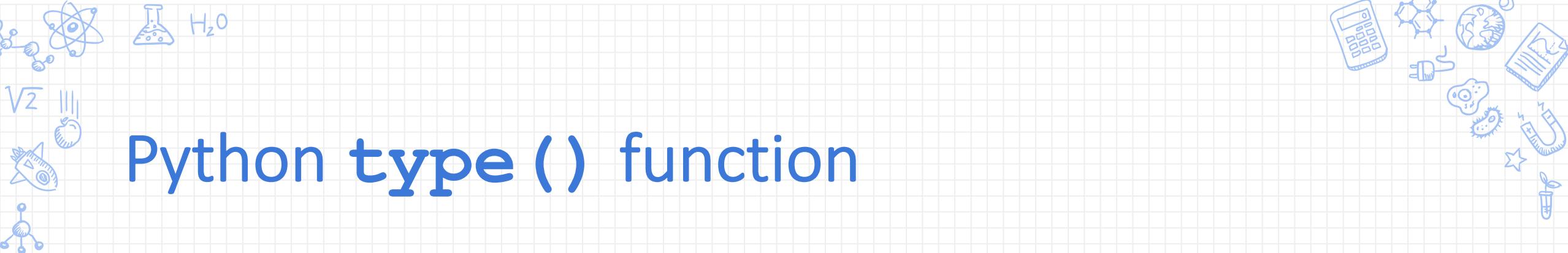
1 . 0

100.0

-100.0

$$-1.0$$

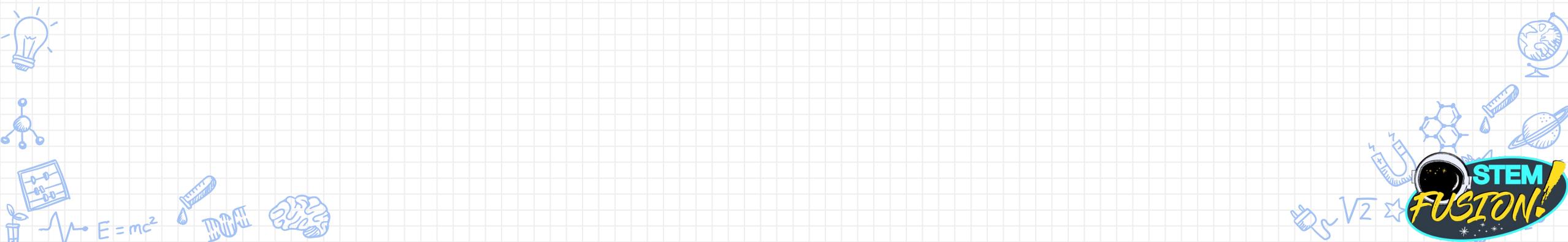


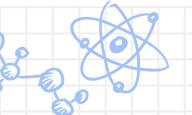


# Python `type()` function

Returns the type of the argument passed as a parameter.

```
print(type(1))  
print(type(1.0))
```





# Third Programming Exercise: More Maths!!!

Operation	Result	Operation	Result
<b>Let x = 4 and y = 2</b>		<b>Let x = 4.0 and y = 2</b>	
print(type(x + y))		print(type(x + y))	
print(type(x - y))		print(type(x - y))	
print(type(-x))		print(type(-x))	
print(type(x*y))		print(type(x*y))	
print(type(x/y))		print(type(x/y))	
print(type(x//y))		print(type(x//y))	
print(type(x%y))		print(type(x%y))	
print(type(x**y))		print(type(x**y))	

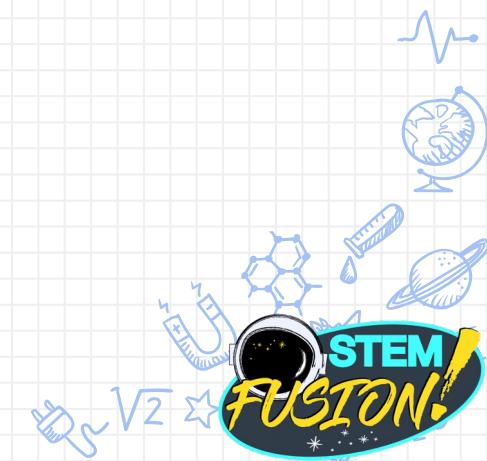




# String

In Python, a string is a sequence (array) of characters.

```
print("Early Identification Program")
print('Early Identification Program')
print("""Early Identification Program""")
print("""Early
Identification
Program""")
```



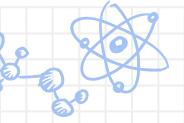


A hand-drawn flask containing bubbles and the label "H<sub>2</sub>O".

# String Methods

Method	Result
String.capitalize()	Converts first character to capital letter
String.upper()	Returns uppercased string
String.lower()	Returns lowercased string
String.swapcase()	Returns string with casing swapped
String.count( <i>substring</i> )	Returns occurrences of substring within string
String.replace( <i>old, new, count</i> )	Replace occurrences of <i>old</i> with <i>new</i> in string





H<sub>2</sub>O

$\sqrt{2}$



# String Methods

"Early Identification Program".capitalize()

"Early Identification Program".upper()

"Early Identification Program".lower()

"Early Identification Program".swapcase()

"Early Identification Program".count("ti")

"Early Identification Program".replace("ti","",1)

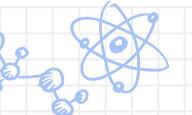
"Early Identification Program".replace("ti","",2)

"Early Identification Program".replace("ti","",)



E=mc<sup>2</sup>





H<sub>2</sub>O

✓<sup>2</sup>



# Type Casting (Type Conversion)

```
print(type(1))  
print(type(1.0))  
print(type('1'))
```



 $H_2O$  $\sqrt{2}$ 

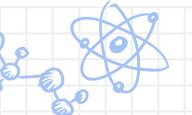
# Type Casting (Type Conversion)

```
print(float(1))  
print(int(1.0))  
print(str(1.0))  
print(str(1)+1)  
print(str(1)+'1')  
print(int(1.0) +'1')  
print(int(1.0)+int('1'))
```



$$E=mc^2$$





H<sub>2</sub>O

$\sqrt{2}$

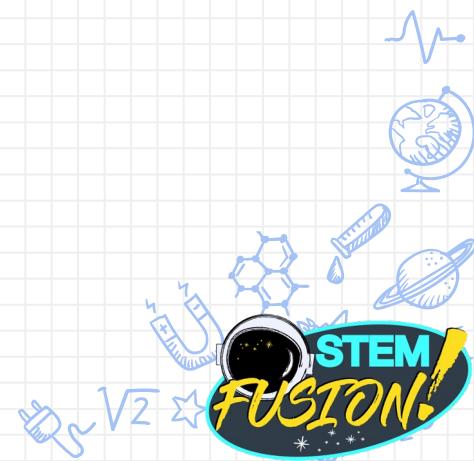


# Basic Data Types in Python

- Integer
- Floating-point
- String
- Boolean
- List
- Tuple
- Set
- Dictionary

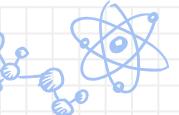


$$E=mc^2$$



$\sqrt{2}$

STEM  
FUSION!



H<sub>2</sub>O

✓<sup>2</sup>



# Boolean

A data type with only two possible values (True, False) used for logic.

Typecast using `bool ()`



$$E=mc^2$$





H<sub>2</sub>O

$\sqrt{2}$



# Boolean in Python

```
print(True)  
print(False)  
print(bool(0))  
print(bool(1))  
print(bool(1123.23))  
print(bool(-500))  
print(bool('a'))
```



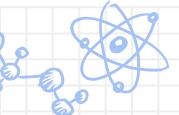
$$E=mc^2$$



BOE



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H<sub>2</sub>O

$\sqrt{2}$

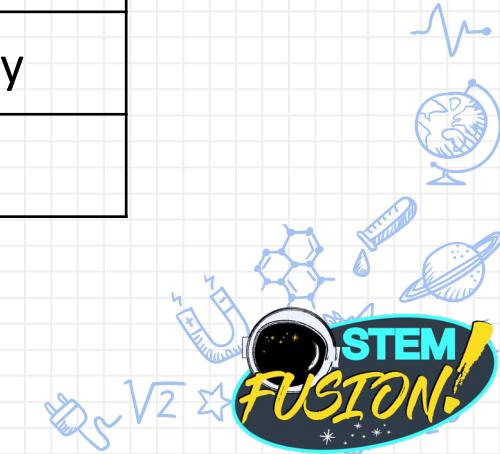


# Comparison Operators in Python

Operation	Description
x == y	True if the value of x is <b>equal</b> to the value of y
x != y	True if the value of x is <b>not equal</b> to the value of y
x <> y	True if the value of x is <b>not equal</b> to the value of y
x > y	True if the value of x is <b>greater than</b> the value of y
x < y	True if the value of x is <b>less than</b> the value of y
x >= y	True if the value of x is <b>greater than or equal to</b> the value of y
x <= y	True if the value of x is <b>less than or equal to</b> the value of y



$$E=mc^2$$



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