

# Variables and Input/Output

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**Description:** Learn to store data in variables, understand the IPO model, and design algorithms that interact with users using flowcharts and pseudocode.

**Duration:** 20-30 minutes

**Learning Mode:** Read explanations, watch videos, complete exercises



## Watch: Variables and Input/Output

Watch this video introduction to variables and input/output before continuing with the lesson content.

**Video:** <https://www.youtube.com/watch?v=XcC3CY-Yexs>

The slide has a dark background with light blue text. The title 'Variables' is at the top in a large, bold, blue font. Below it is a paragraph of text. Underneath that is a section titled 'Variable Declaration' in bold. To the left of this section are three lines of code examples, each preceded by a bullet point. To the right of the code examples are three small colored squares with the words 'Python', 'C++', and 'Visual Basic' respectively. At the bottom of the slide is a short explanatory sentence.

A variable is a value used in programming for a value that will change based on user input or other calculations. Since we cannot predict the possibilities of what a user could enter into a program, we create a word to represent and store the input a user enters. In order to create a word to use as a variable, we must conduct a variable declaration.

### Variable Declaration

When a variable is declared, it is conducted at the beginning of the code so it can be used within the program. Variables can be named anything by the programmer wants, but it is good intrinsic documentation practice to use relevant names so that specific variables are easier to remember and recall.

- name = input("What is your name?")      Python
- int count = 0      C++
- DIM answer as boolean      Visual Basic

A variables data type should also be established in the variable declaration so that the program knows what type of data to expect and how to process it. For example, unless a variable is declared as an integer or real number, the program will not be able to use the value for calculations since it may only see the data as text. Objects may also be assigned to variable in order to gather data from a programs GUI elements.

## Variables and Input/Output

### Learning Objectives

- Understand what variables are and how to use them
- Apply the **IPO (Input-Process-Output) model** to algorithm design
- Use **flowchart symbols** for input and output operations
- Write **pseudocode** following HSC conventions
- Design algorithms with clear **data flow**

### The IPO Model: Algorithm Foundation

Almost every algorithm follows the **IPO model**:



Stage	Description	Examples
Input	Data coming into the algorithm	User typing, file reading, sensor data
Process	Calculations and transformations	Calculations, comparisons, sorting
Output	Results going out	Screen display, file writing, sending data

## Designing with IPO in Mind

When given a problem, ask yourself:

1. **What inputs do I need?** (What data is provided?)
2. **What processing must happen?** (What transformations?)
3. **What output is expected?** (What result should appear?)

## Understanding IPO

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**Question:** In an algorithm that calculates the area of a rectangle, which represents the INPUT?

- **A)** The area value calculated
- **B)** The length and width values
- **C)** The multiplication operation
- **D)** The print statement

**Show Answer**

**Answer:** B

**Explanation:** The INPUT is the data that enters the algorithm — in this case, the length and width. The multiplication is PROCESS, and printing the area is OUTPUT.

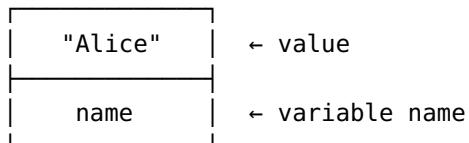
## What is a Variable?

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**A variable is a named storage location that holds data during algorithm execution.**

Think of it like a labeled box:

- The **name** identifies what's inside
- The **value** is what's actually stored
- You can **change** the value at any time



## Variable Naming Best Practices

Good Names	Bad Names	Why
studentAge	a	Descriptive vs cryptic
totalScore	x123	Meaningful vs random
isValid	flag	Intent clear vs vague

## Quick Check: Variables

**Question:** In the pseudocode `score = 85`, what is `score`?

- **A)** A number
- **B)** A variable name
- **C)** An output command
- **D)** A string

**Show Answer**

**Answer:** B

**Explanation:** `score` is the variable name — it's the label for the storage location that holds the value 85.

## Input and Output in Pseudocode (HSC Standard)

**Input** — Receiving data from outside (usually from a user typing)

**Output** — Displaying results (usually on screen)

### HSC Pseudocode Keywords:

Keyword	Purpose	Example
INPUT	Get data from user	INPUT name
OUTPUT	Display a result	OUTPUT total
DISPLAY	Show a message	DISPLAY "Hello"

### Assignment (Setting Variable Values):

In HSC pseudocode, you can assign values to variables in two ways:

```
SET age T0 25          // Using SET ... T0
age = 25                // Using equals sign
```

**Both forms are acceptable.** Use whichever is clearer for your algorithm.

### Example Algorithm:

```
BEGIN GreetUser
    OUTPUT "What is your name?"
    INPUT name
    SET greeting T0 "Hello, " + name + "!"
    OUTPUT greeting
END GreetUser
```

### String Concatenation (Joining Text)

The `+` symbol can join text together. This is called **concatenation**:

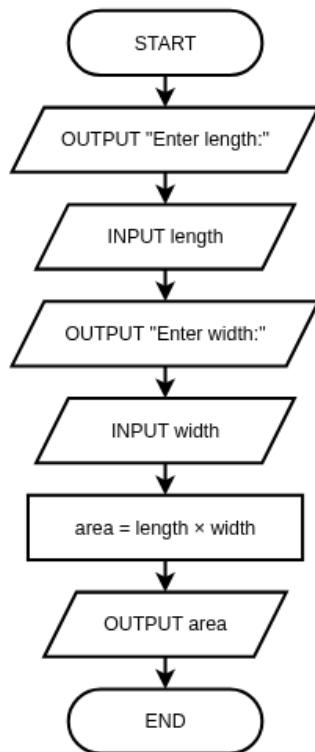
```
SET firstName T0 "John"
SET lastName T0 "Smith"
SET fullName T0 firstName + " " + lastName
// fullName now contains "John Smith"
```

When you write `"Hello, " + name`, you're joining the text "Hello, " with whatever value is stored in `name`.



### Input/Output Flowchart: Calculate Rectangle Area

A sequential algorithm demonstrating **INPUT** (parallelogram), **PROCESS** (rectangle), and **OUTPUT** (parallelogram) — NESA HSC standard symbols



## Flowchart Symbols for I/O

Notice in the flowchart above:

Shape	Symbol	Purpose
Parallelogram ▱	Input/Output	Used for both INPUT and OUTPUT operations
Rectangle □	Process	Used for calculations and assignments
Rounded Rectangle ○	Terminal	START and END only

### Key Points:

- The **parallelogram** is used for ALL data input and output operations
- Prompts ("Enter length:") are OUTPUT operations
- Getting user data (`INPUT length`) is an INPUT operation
- Calculations (`area = length × width`) are PROCESS operations

### Flowchart Symbol Check

**Question:** Which flowchart shape should you use for 'INPUT score'?

- **A)** Rectangle — because it's an action
- **B)** Diamond — because it's a decision

- **C)** Parallelogram — because it's an input/output operation
- **D)** Rounded rectangle — because it's a start/end

Show Answer

**Answer:** C

**Explanation:** The parallelogram shape is used for all input and output operations. This includes INPUT, OUTPUT, DISPLAY, READ, and WRITE operations.



## Practice: Pseudocode for Calculator

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Write pseudocode for a simple calculator that: 1. Gets two numbers from the user 2. Calculates and displays the sum, difference, and product

Remember to use OUTPUT for prompts, INPUT to get values, and SET...TO or = for calculations.

### Starter Code:

```
BEGIN SimpleCalculator
    // Get the two numbers

    // Calculate results

    // Display results

END SimpleCalculator
```

**Hints:** - Use OUTPUT to display prompts to the user - Use INPUT to get values from the user - Use SET ... TO or = for calculations - Remember to OUTPUT all three results

```
# Write your pseudocode here as Python comments
# Remember to use proper indentation and HSC conventions

"""
BEGIN SimpleCalculator
    // Get the two numbers

    // Calculate results

    // Display results

END SimpleCalculator
"""
```

### Example Answer

```

# Example solution
BEGIN SimpleCalculator
    OUTPUT "Enter first number:"
    INPUT num1
    OUTPUT "Enter second number:"
    INPUT num2

    SET sum T0 num1 + num2
    SET difference T0 num1 - num2
    SET product T0 num1 * num2

    OUTPUT "Sum: " + sum
    OUTPUT "Difference: " + difference
    OUTPUT "Product: " + product
END SimpleCalculator

```

## Algorithm Design: Data Flow

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**Question:** When designing an algorithm, why is it important to identify ALL variables before writing code?

- **A)** To make the code run faster
- **B)** To know what data will flow through the algorithm and how it transforms
- **C)** Variables aren't important — you can add them later
- **D)** Only input variables matter

**Show Answer**

**Answer:** B

**Explanation:** Identifying variables helps you understand the data flow: what comes in, what intermediate values are needed, and what goes out. This is part of algorithmic thinking — planning before coding.

## Trace Tables: Tracking Data Flow

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A **trace table** is a tool for tracking how variable values change during algorithm execution.

### Example: Calculate Total Price

```

quantity = 3
price = 10
total = quantity * price
tax = total * 0.1
final = total + tax

```

Step	quantity	price	total	tax	final
1	3	—	—	—	—

Step	quantity	price	total	tax	final
2	3	10	—	—	—
3	3	10	30	—	—
4	3	10	30	3	—
5	3	10	30	3	33

## Why Use Trace Tables?

- **Debug** — Find where values go wrong
- **Verify** — Confirm algorithm correctness
- **Understand** — See data flow step by step

## Trace Table Skill

**Question:** Given this algorithm, what is the final value of `result` ?

```
a = 5
b = 3
result = a + b
a = 10
result = result + a
```

- A) 8
- B) 18
- C) 13
- D) 15

**Show Answer**

**Answer:** B

**Explanation:** Trace through:  $a=5$ ,  $b=3$ ,  $result=5+3=8$ ,  $a=10$ ,  $result=8+10=18$ . The key insight is that changing 'a' later doesn't affect the first calculation.

## Designing Input-Output Algorithms

### Algorithm Design Checklist:

1. **Identify all inputs** — What data does the user/system provide?
2. **Identify all outputs** — What results must be displayed/returned?
3. **Identify intermediate variables** — What values are needed during processing?
4. **Define the processing steps** — How do inputs become outputs?
5. **Consider edge cases** — What if input is zero? Empty? Negative?

### Example Design: Age Calculator

**Problem:** Calculate how old someone will be in a future year.

Element	Value
Inputs	birthYear , futureYear
Outputs	futureAge
Processing	futureAge = futureYear - birthYear
Edge case	What if futureYear < birthYear? (negative age!)

## IPO Design Practice

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**Question:** For an algorithm that converts temperature from Celsius to Fahrenheit, identify the correct IPO breakdown:

- **A)** Input: Fahrenheit, Process: Subtract 32, Output: Celsius
- **B)** Input: Celsius, Process: Multiply by 9/5 and add 32, Output: Fahrenheit
- **C)** Input: Temperature, Process: Convert, Output: Temperature
- **D)** Input: Formula, Process: Apply, Output: Result

**Show Answer**

**Answer:** B

**Explanation:** The input is the Celsius value, the process is applying the formula ( $C \times 9/5 + 32$ ), and the output is the Fahrenheit result. Option C is too vague — good algorithm design requires specificity.

## Algorithm Design Thinking

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**Question:** When designing an algorithm to calculate average test scores, which of these is an 'intermediate variable'?

- **A)** The list of test scores (input)
- **B)** The average result (output)
- **C)** The running total of scores (processing)
- **D)** The print statement

**Show Answer**

**Answer:** C

**Explanation:** The running total is an intermediate variable — it's not input or output, but it's needed during processing to calculate the final average. Identifying these helps plan your algorithm.



## Reflection: Variables in Real Programs

Think about a mobile app or game you use. What information might it store in variables? List at least 3 examples and explain what type of data each would hold (text/string, number, etc.).

### Example Answer

In a game like Minecraft, variables might store: 1) The player's health as a number (e.g., health = 20). 2) The player's username as text/string (e.g., username = "Steve"). 3) The player's inventory count as a number (e.g., diamonds = 5). 4) Whether the player is in creative mode as true/false (e.g., creative\_mode = True).

## Implementing in Python

Now that you understand the concepts in pseudocode and flowcharts, here's how to implement input/output in Python:

### Pseudocode vs Python Comparison:

Pseudocode	Python	Purpose
INPUT name	name = input()	Get user input
OUTPUT result	print(result)	Display output
SET x TO 5	x = 5	Assign value
"Hello, " + name	"Hello, " + name	Concatenation (same!)

## Working with Numbers in Python

When you get input from a user in Python, it's always **text** (a string). To do maths, you need to convert it:

```
age_text = input("Enter your age: ")    # This is text: "25"
age = int(age_text)                      # Convert to number: 25
next_year = age + 1                      # Now maths works!
print("Next year you will be", next_year)
```

Or combine it in one line:

```
age = int(input("Enter your age: "))
```



## Practice: Your First Input/Output Program

Write a Python program that: 1. Asks the user for their favourite colour 2. Creates a message saying "Your favourite colour is [colour]!" 3. Prints the message

Use the `input()` function to get user input and `print()` to display output. Use `+` to join strings together (concatenation).

**Hints:** - Use `input()` with a prompt message to ask the user - Store the user's answer in a variable - Use `+` to join strings together (concatenation) - Use `print()` to display the final message

```
# Ask for the user's favourite colour  
  
# Create a message using concatenation (+)  
  
# Print the message
```

## Example Solution

```
# Example solution  
# Ask for the user's favourite colour  
colour = input("What is your favourite colour? ")  
  
# Create a message using concatenation (+)  
message = "Your favourite colour is " + colour + "!"  
  
# Print the message  
print(message)
```

## Understanding Type Conversion

**Question:** What will happen if you run: `result = "5" + "3"` ?

- **A)** result will be 8 (a number)
- **B)** result will be "53" (a string)
- **C)** Python will show an error
- **D)** result will be 15

**Show Answer**

**Answer:** B

**Explanation:** When you use `+` with strings, Python concatenates (joins) them. `"5" + "3"` = "53". To add numbers, you need: `int("5") + int("3") = 8`

## Lesson Complete!

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You've completed this lesson. Make sure you:

- ✓ Watched all videos
- ✓ Read all explanations
- ✓ Completed all exercises
- ✓ Answered all quiz questions

**Ready for the next lesson?** Continue to the next notebook!