Working with Lists (Arrays)

Description: Learn to select appropriate data structures and apply standard algorithms for processing collections of data.

Duration: 20-30 minutes
Learning Mode: Read explanations, watch videos, complete exercises

Working with Lists (Arrays)

Learning Objectives

- Understand when to use **lists** (arrays) vs single variables
- Apply **standard list algorithms** (traverse, search, find max/min)
- Recognize patterns for list processing
- Choose the right approach for list problems

When to Use Lists

Lists (called arrays in pseudocode) store multiple related values in a single structure.

Decision Guide:

Situation	Use
Fixed number of known values	Individual variables
Collection of related items	List
Unknown number of items	List
Need to process items uniformly	List
Data naturally groups together	List

Example Problem:

Imagine storing scores for 30 students. With individual variables you'd need `score1`, `score2`, ... `score30`. With a list, you just need `scores` and can process all 30 with a loop!

🧪 Data Structure Selection

Question: You need to store and process test scores for a class of 30 students. Which approach is best?

- **A)** 30 individual variables (score1, score2, ...)
- **B)** A single list containing all 30 scores

- **C)** 30 separate variables and manual processing
- **D)** It doesn't matter — both work equally well

Show Answer
Answer: B **Explanation:** A list allows you to use loops to process all scores uniformly. With 30 variables, you'd need 30 separate statements for each operation — not scalable or maintainable.

Array Basics in Pseudocode

Declaring Arrays:

```
DECLARE scores AS ARRAY OF INTEGER
SET scores TO [85, 92, 78, 90, 88]
```

Accessing Elements by Index:

Each item has a position called an **index**. **Indexes start at 0!**

```
fruits = ["apple", "banana", "cherry", "date"]
           ↑          ↑          ↑          ↑
         index 0    index 1    index 2    index 3
```

Pseudocode Access:

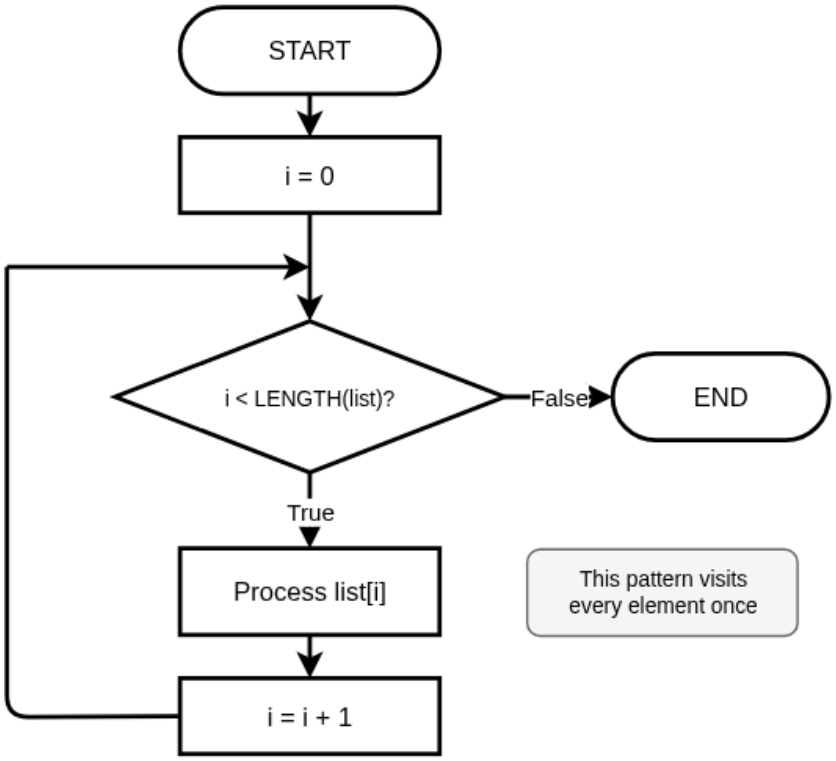
```
SET first TO fruits[0]      ' "apple" — first item
SET second TO fruits[1]     ' "banana" — second item
SET last TO fruits[3]       ' "date" — last item
```

Common Mistake:

```
OUTPUT fruits[4]    ' ERROR! Index out of range
                    ' Valid indexes are 0, 1, 2, 3
```

📊 List Traversal Flowchart

List Traversal Pattern: Use an index counter to visit every element from 0 to LENGTH-1. This is the foundation of all list algorithms.



Click the diagram to open in full editor

🧪 Quick Check: Indexing

Question: Given `numbers = [10, 20, 30, 40, 50]`, what is `numbers[2]`?

- **A)** 10
- **B)** 20
- **C)** 30
- **D)** 40

Show Answer
Answer: C **Explanation:** Index 2 is the THIRD element (since we start counting from 0). Index 0=10, Index 1=20, Index 2=30.

Standard List Algorithms

These algorithms appear repeatedly in programming. Master them!

1. Traversal (Visit Every Element)

```
BEGIN TraverseList
    FOR i = 0 TO LENGTH(list) - 1 STEP 1
        OUTPUT list[i]
    NEXT i
END TraverseList
```

2. Sum All Elements (Accumulator Pattern)

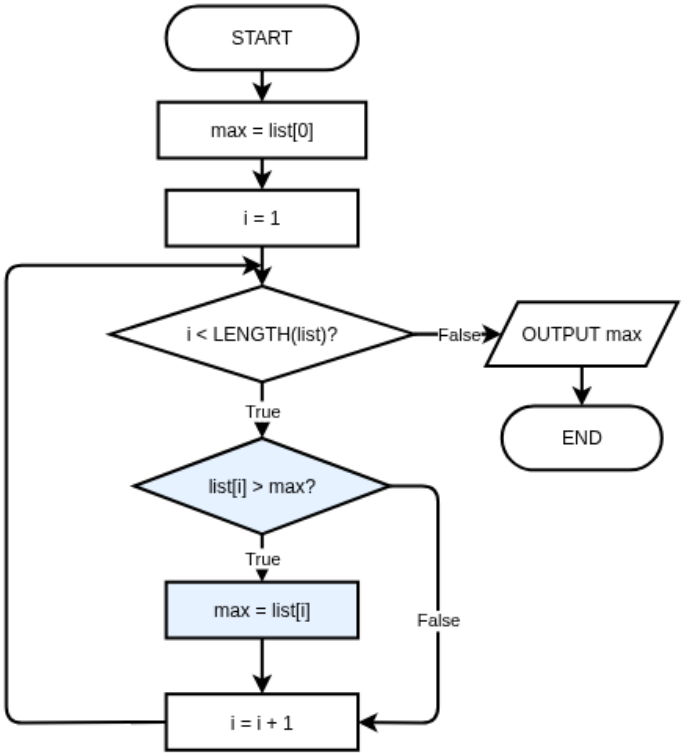
```
BEGIN SumList
    SET total TO 0
    FOR i = 0 TO LENGTH(numbers) - 1 STEP 1
        SET total TO total + numbers[i]
    NEXT i
    OUTPUT total
END SumList
```

3. Find Maximum (Best-So-Far Pattern)

```
BEGIN FindMaximum
    SET maximum TO numbers[0]
    FOR i = 1 TO LENGTH(numbers) - 1 STEP 1
        IF numbers[i] > maximum THEN
            SET maximum TO numbers[i]
        ENDIF
    NEXT i
    OUTPUT maximum
END FindMaximum
```

📊 Find Maximum Flowchart

Find Maximum Algorithm: Start with first element as 'best so far', then compare each remaining element and update if better.



Click the diagram to open in full editor

✍️ Practice: Sum of List

Write pseudocode to calculate the sum of all numbers in a list.

Use the accumulator pattern: 1. Initialize total to 0 2. Loop through each element 3. Add each element to total

Starter Code:

```
BEGIN SumList
    SET numbers TO [10, 25, 30, 15, 20]

    ' Calculate sum using a loop

    OUTPUT "Sum: " + total
END SumList
```

Hints: - Initialize total = 0 before the loop - Use FOR i = 0 TO LENGTH(numbers) - 1 - Add numbers[i] to total each iteration

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

"""
BEGIN SumList
    SET numbers TO [10, 25, 30, 15, 20]

    ' Calculate sum using a loop

    OUTPUT "Sum: " + total
END SumList
"""
```

Example Answer:

```
# Example solution
BEGIN SumList
    SET numbers TO [10, 25, 30, 15, 20]
    SET total TO 0

    FOR i = 0 TO LENGTH(numbers) - 1 STEP 1
        SET total TO total + numbers[i]
    NEXT i

    OUTPUT "Sum: " + total
END SumList
```

✍️ Practice: Find Minimum

Write pseudocode to find the minimum (smallest) value in a list.

This is the opposite of Find Maximum - use `<` instead of `>`.

Starter Code:

```
BEGIN FindMinimum
    SET numbers TO [34, 67, 23, 89, 12, 78]

    ' Find minimum using best-so-far pattern

    OUTPUT "Minimum: " + minimum
END FindMinimum
```

Hints: - Initialize minimum to the first element: numbers[0] - Loop starting from index 1 (we already have index 0) - If current number is SMALLER than minimum, update minimum

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

"""
BEGIN FindMinimum
    SET numbers TO [34, 67, 23, 89, 12, 78]

    ' Find minimum using best-so-far pattern

    OUTPUT "Minimum: " + minimum
END FindMinimum
"""
```

Example Answer:

```
# Example solution
BEGIN FindMinimum
    SET numbers TO [34, 67, 23, 89, 12, 78]
    SET minimum TO numbers[0]

    FOR i = 1 TO LENGTH(numbers) - 1 STEP 1
        IF numbers[i] < minimum THEN
            SET minimum TO numbers[i]
        ENDIF
    NEXT i

    OUTPUT "Minimum: " + minimum
END FindMinimum
```

Linear Search Algorithm

Searching is a fundamental operation - finding whether a value exists in a list and where it is.

Linear Search Pseudocode:

```
BEGIN LinearSearch
    SET list TO [10, 25, 30, 15, 40]
    SET target TO 30
    SET found TO FALSE
    SET position TO -1

    FOR i = 0 TO LENGTH(list) - 1 STEP 1
        IF list[i] = target THEN
            SET found TO TRUE
            SET position TO i
        ENDIF
    NEXT i

    IF found = TRUE THEN
        OUTPUT "Found at index " + position
    ELSE
        OUTPUT "Not found"
    ENDIF
END LinearSearch
```

Key Characteristics:

- Checks each element one by one (hence "linear")
- Works on unsorted lists
- Simple but can be slow for very large lists

✍️ Practice: Count Matching Items

Write pseudocode to count how many even numbers are in a list.

Remember: A number is even if `number MOD 2 = 0`

Starter Code:

```
BEGIN CountEvens
    SET numbers TO [1, 4, 6, 7, 9, 10, 12, 15, 18]

    ' Count even numbers

    OUTPUT "Even count: " + count
END CountEvens
```

Hints: - Initialize count = 0 - Loop through each number - Check if numbers[i] MOD 2 = 0 (even) - If even, increment count

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

"""
BEGIN CountEvens
    SET numbers TO [1, 4, 6, 7, 9, 10, 12, 15, 18]

    ' Count even numbers

    OUTPUT "Even count: " + count
END CountEvens
"""
```

Example Answer:

```
# Example solution
BEGIN CountEvens
    SET numbers TO [1, 4, 6, 7, 9, 10, 12, 15, 18]
    SET count TO 0

    FOR i = 0 TO LENGTH(numbers) - 1 STEP 1
        IF numbers[i] MOD 2 = 0 THEN
            SET count TO count + 1
        ENDIF
    NEXT i

    OUTPUT "Even count: " + count
END CountEvens
```

🧪 Understanding LENGTH()

Question: If `data = [5, 10, 15, 20]`, what is the valid range of indexes?

- **A)** 1 to 4
- **B)** 0 to 4
- **C)** 0 to 3
- **D)** 1 to 3

Show Answer
Answer: C **Explanation:** The list has 4 elements (LENGTH=4). Indexes start at 0, so valid indexes are 0, 1, 2, 3 (that's 0 to LENGTH-1).

🧪 Choosing the Right Algorithm

Question: You need to find all numbers greater than 50 from a list of test scores. Which standard algorithm applies?

- **A)** Traversal — visit each element
- **B)** Search — find a specific element
- **C)** Filter — select elements matching a condition
- **D)** Transform — change each element

Show Answer
Answer: C **Explanation:** Filter selects a subset of elements that match a condition (score > 50). Search finds ONE specific element. Transform would change the values, not select them.

Algorithm Design with Lists

Key Questions When Processing Lists:

1. **Do I need all elements?** → Traversal
2. **Do I need to find something?** → Search
3. **Do I need the best/worst?** → Find max/min
4. **Do I need a subset?** → Filter
5. **Do I need to change values?** → Transform
6. **Do I need a single value from all?** → Reduce (sum, count, etc.)

Common Mistakes to Avoid:

Mistake	Problem	Solution
Index out of range	Accessing beyond LENGTH	Use LENGTH() - 1 as upper bound
Forgetting lists are zero-indexed	Off-by-one errors	First element is index 0
Not initializing accumulator	Undefined starting value	Set to 0, first element, or empty list

🧪 List Algorithm Analysis

Question: To find the average of a list, which combination of operations is needed?

- **A)** Just traversal
- **B)** Search and filter
- **C)** Sum (accumulator) and count (or LENGTH)
- **D)** Transform and filter

Show Answer
Answer: C **Explanation:** Average = sum ÷ count. You need to reduce the list to a sum (accumulator pattern), then divide by the count of elements (using LENGTH() or counter pattern).

🐍 Python Translation: Find Maximum

Now let's see how the Find Maximum algorithm translates to Python.

Notice the pseudocode patterns translate directly: - `FOR i = 0 TO LENGTH(list) - 1` → `for i in range(len(numbers))` - `list[i]` → `numbers[i]`

Hints: - Initialize maximum to numbers[0] (first element) - Loop from index 1 to len(numbers)-1 - Compare each element to maximum - Update maximum when you find a larger value

```
numbers = [34, 67, 23, 89, 45, 12, 78]

# Find maximum using best-so-far pattern
maximum = numbers[0]  # Start with first element

# Loop through remaining elements

# Print the result
print("Maximum:", maximum)
```

Example Solution:

```
# Example solution
numbers = [34, 67, 23, 89, 45, 12, 78]

# Find maximum using best-so-far pattern
maximum = numbers[0]  # Start with first element

for i in range(1, len(numbers)):
    if numbers[i] > maximum:
        maximum = numbers[i]

# Print the result
print("Maximum:", maximum)
```

Pseudocode to Python Translation

HSC Pseudocode	Python
`DECLARE list AS ARRAY`	`list = []`
`SET list TO [1, 2, 3]`	`list = [1, 2, 3]`
`list[0]`	`list[0]`
`LENGTH(list)`	`len(list)`
`FOR i = 0 TO LENGTH(list) - 1 STEP 1`	`for i in range(len(list)):`
`FOR EACH item IN list`	`for item in list:`

🧪 Empty List Edge Case

Question: What happens if you try to find the maximum of an empty list using `maximum = list[0]`?

- **A)** Returns 0
- **B)** Returns None
- **C)** Causes an IndexError
- **D)** Works fine — just returns nothing

Show Answer

Answer: C **Explanation:** Accessing list[0] on an empty list causes an IndexError — there is no first element! Always check if the list is empty before accessing elements.

📝 Reflection: Lists in Applications

Think about an app or system you use (social media, games, school systems). Identify ONE place where a list might be used behind the scenes. What data would be in the list? What operations might be performed on it?

Example Answer:

Instagram probably uses a list to store the posts on your feed. Each item in the list would be a post object with data like the image URL, caption, likes count, and username. Operations would include: adding new posts to the top of the list, removing posts you've hidden, and looping through the list to display each post on screen.

✅ Lesson Complete!

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!