Essential Algorithm Patterns

Description: Master the six fundamental algorithm patterns that form the building blocks of programming: Counter, Accumulator, Flag, Best-So-Far, Filter, and Transform.

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

Essential Algorithm Patterns

Learning Objectives

- Recognize and apply the **six fundamental patterns**
- Choose the correct pattern for a given problem
- Combine patterns to solve complex problems

Why Learn Patterns?

Most algorithms are built from a small set of reusable patterns. Once you master these patterns, you can solve a huge variety of problems by recognizing which pattern applies.

Pattern	Purpose	Example Use
Counter	Count occurrences	"How many students passed?"
Accumulator	Compute a total	"What is the sum of all sales?"
Flag	Track true/false state	"Does any item match the criteria?"
Best-So-Far	Find maximum/minimum	"What was the highest score?"
Filter	Select matching items	"Which products cost under $50?"
Transform	Change each item	"Apply 10% discount to all prices"

Pattern 1: Counter

Counts how many items match a condition.

Pseudocode Template:

```
BEGIN CountPattern
    SET count TO 0
    FOR EACH item IN collection
        IF item matches condition THEN
            SET count TO count + 1
        ENDIF
    NEXT item
    OUTPUT count
END CountPattern
```

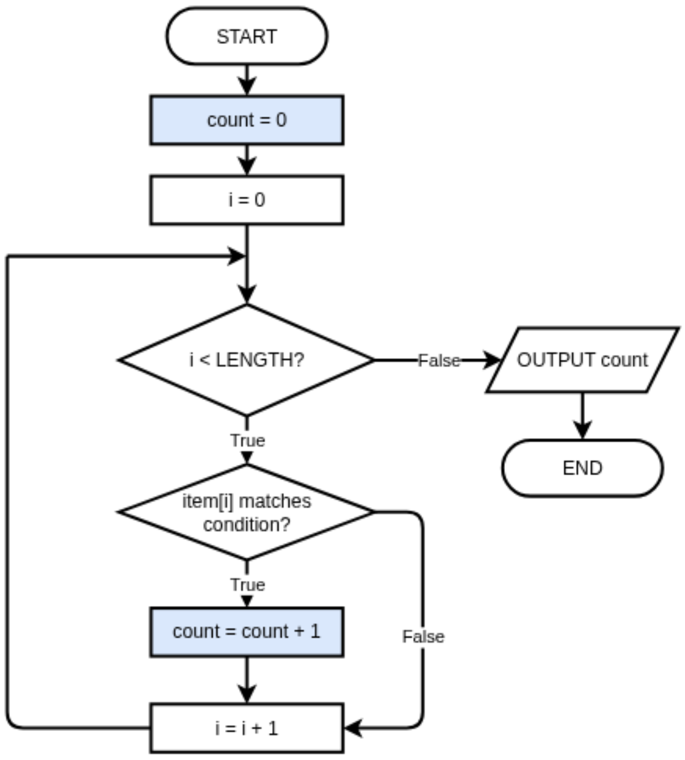
Example: Count Passing Scores

```
BEGIN CountPassing
    SET scores TO [85, 42, 91, 55, 78, 33, 88]
    SET passCount TO 0

    FOR i = 0 TO LENGTH(scores) - 1 STEP 1
        IF scores[i] >= 50 THEN
            SET passCount TO passCount + 1
        ENDIF
    NEXT i

    OUTPUT "Passing students: " + passCount
END CountPassing
```

Output: Passing students: 5

📊 Counter Pattern Flowchart

Counter Pattern: Initialize count to 0, increment when condition is true. Blue boxes highlight the counter-specific steps. Loop-back joins above the decision diamond per NESA spec.



Pattern 2: Accumulator

Builds up a running total or combined result.

Pseudocode Template:

```
BEGIN AccumulatorPattern
    SET total TO 0    ' or empty string, 1 for product, etc.
    FOR EACH item IN collection
        SET total TO total + item
    NEXT item
    OUTPUT total
END AccumulatorPattern
```

Example: Sum of Sales

```
BEGIN SumSales
    SET sales TO [150.50, 280.00, 95.75, 320.25]
    SET total TO 0

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

    OUTPUT "Total sales: $" + total
END SumSales
```

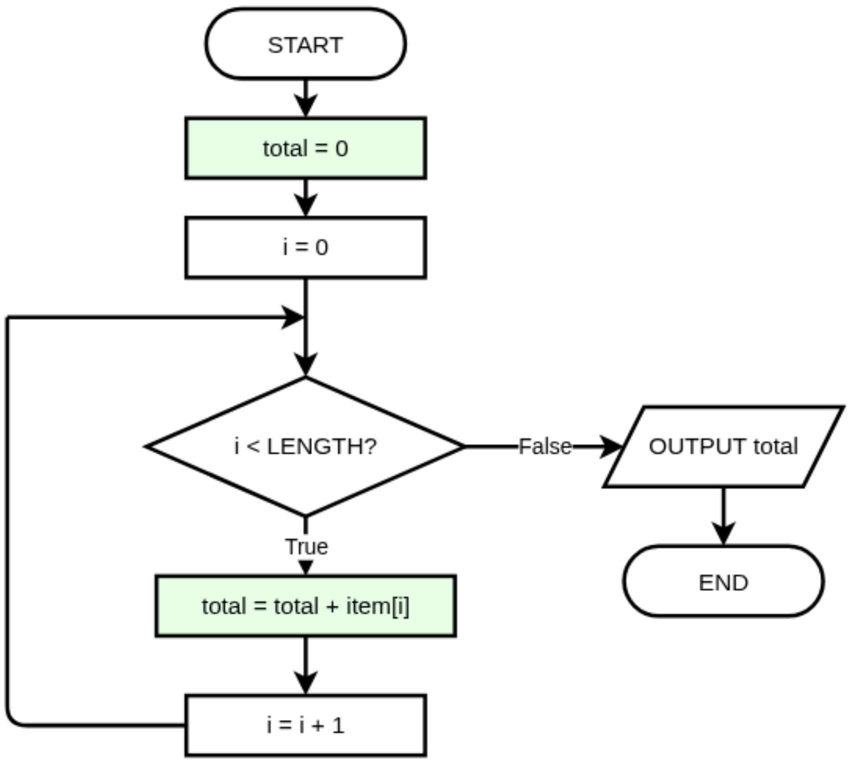
Output: Total sales: $846.50

Variations:

- **Product:** Start with 1, multiply instead of add
- **String concatenation:** Start with empty string, concatenate

📊 Accumulator Pattern Flowchart

Accumulator Pattern: Initialize total to 0, add each item to the running total. Green boxes highlight accumulator steps. Loop-back joins above the decision diamond per NESA spec.



🧪 Quick Check: Counter vs Accumulator

Question: You want to find the average age of users. Which patterns do you need?

- **A)** Counter only
- **B)** Accumulator only
- **C)** Counter AND Accumulator
- **D)** Neither — use Find Maximum

Show Answer

Answer: C

Explanation: Average = sum ÷ count. You need an Accumulator to sum all ages, and either a Counter or LENGTH() to count them, then divide.

Pattern 3: Flag

Tracks whether something is true or false. Often used to check if ANY item matches, or if ALL items match.

Pseudocode Template:

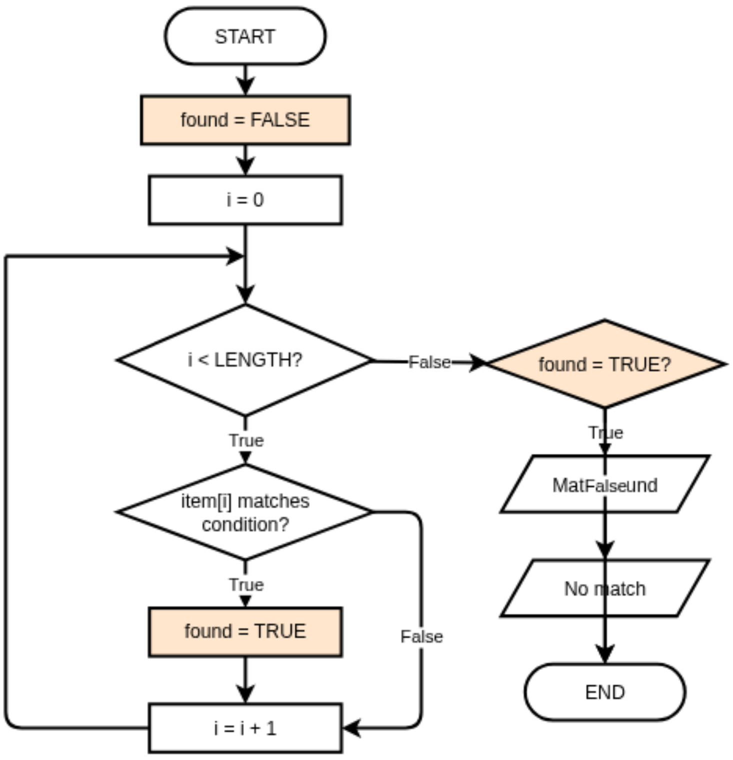
```
BEGIN FlagPattern
    SET found TO FALSE    ' or valid TO TRUE
    FOR EACH item IN collection
        IF item matches condition THEN
            SET found TO TRUE
        ENDIF
    NEXT item
    IF found = TRUE THEN
        OUTPUT "At least one match found"
    ELSE
        OUTPUT "No matches found"
    ENDIF
END FlagPattern
```

Example: Check for Failing Student

```
BEGIN HasFailingScore
    SET scores TO [85, 72, 91, 42, 78]
    SET hasFail TO FALSE

    FOR i = 0 TO LENGTH(scores) - 1 STEP 1
        IF scores[i] < 50 THEN
            SET hasFail TO TRUE
        ENDIF
    NEXT i

    IF hasFail = TRUE THEN
        OUTPUT "Warning: At least one student failed"
    ELSE
        OUTPUT "All students passed!"
    ENDIF
END HasFailingScore
```

📊 Flag Pattern Flowchart

Flag Pattern: Start FALSE, set TRUE when condition met. Orange boxes highlight flag-specific steps. Check flag after loop. Loop-back joins above the decision diamond per NESA spec.



Pattern 4: Best-So-Far

Finds the maximum or minimum value by comparing each item to the current best.

Pseudocode Template:

```
BEGIN BestSoFarPattern
    SET best TO collection[0]    ' Start with first item
    FOR i = 1 TO LENGTH(collection) - 1 STEP 1
        IF collection[i] is better than best THEN
            SET best TO collection[i]
        ENDIF
    NEXT i
    OUTPUT best
END BestSoFarPattern
```

Example: Find Highest Score

```
BEGIN FindHighest
    SET scores TO [78, 92, 65, 88, 91, 73]
    SET highest TO scores[0]

    FOR i = 1 TO LENGTH(scores) - 1 STEP 1
        IF scores[i] > highest THEN
            SET highest TO scores[i]
        ENDIF
    NEXT i

    OUTPUT "Highest score: " + highest
END FindHighest
```

Output: Highest score: 92

Key Point:

Start with `collection[0]` not with 0 or a guessed value. What if all values are negative? Starting with 0 would give wrong answer!

Pattern 5: Filter

Selects a subset of items that match a condition.

Pseudocode Template:

```
BEGIN FilterPattern
    SET result TO []    ' Empty list for results
    FOR EACH item IN collection
        IF item matches condition THEN
            APPEND item TO result
        ENDIF
    NEXT item
    OUTPUT result
END FilterPattern
```

Example: Find Passing Scores

```
BEGIN GetPassingScores
    SET scores TO [85, 42, 91, 55, 38, 78]
    SET passing TO []

    FOR i = 0 TO LENGTH(scores) - 1 STEP 1
        IF scores[i] >= 50 THEN
            APPEND scores[i] TO passing
        ENDIF
    NEXT i

    OUTPUT "Passing scores: " + passing
END GetPassingScores
```

Output: Passing scores: [85, 91, 55, 78]

Pattern 6: Transform (Mapping)

Creates a new list by applying an operation to each item.

Pseudocode Template:

```
BEGIN TransformPattern
    SET result TO []
    FOR EACH item IN collection
        SET transformed TO operation(item)
        APPEND transformed TO result
    NEXT item
    OUTPUT result
END TransformPattern
```

Example: Apply Discount

```
BEGIN ApplyDiscount
    SET prices TO [100, 50, 75, 200]
    SET discounted TO []
    SET discountRate TO 0.1    ' 10% discount

    FOR i = 0 TO LENGTH(prices) - 1 STEP 1
        SET newPrice TO prices[i] * (1 - discountRate)
        APPEND newPrice TO discounted
    NEXT i

    OUTPUT "Discounted prices: " + discounted
END ApplyDiscount
```

Output: Discounted prices: [90, 45, 67.5, 180]

🧪 Pattern Recognition 1

Question: You need to find the cheapest product from a list of prices. Which pattern?

- **A)** Counter
- **B)** Accumulator
- **C)** Flag
- **D)** Best-So-Far

Show Answer

Answer: D

Explanation: Best-So-Far pattern finds the minimum (cheapest) by starting with the first price and updating whenever a lower price is found.

🧪 Pattern Recognition 2

Question: You need to check if a username already exists in a list of users. Which pattern?

- **A)** Counter
- **B)** Accumulator
- **C)** Flag
- **D)** Filter

Show Answer

Answer: C

Explanation: Flag pattern is perfect for 'does any item match?' questions. Set found=FALSE, then TRUE if username matches any existing user.

🧪 Pattern Recognition 3

Question: You need to get a list of all students who scored above 80. Which pattern?

- **A)** Counter
- **B)** Best-So-Far
- **C)** Filter
- **D)** Transform

Show Answer

Answer: C

Explanation: Filter creates a subset of items matching a condition (score > 80). You're not counting them, finding the best, or changing them.

🧪 Pattern Recognition 4

Question: You need to convert all temperatures from Celsius to Fahrenheit. Which pattern?

- **A)** Counter
- **B)** Accumulator
- **C)** Filter
- **D)** Transform

Show Answer

Answer: D

Explanation: Transform (mapping) applies an operation to each item. Every Celsius value becomes a new Fahrenheit value: $F = C \times 9/5 + 32$.

✍️ Practice: Combining Patterns

Write pseudocode to find the average of all passing scores (>= 50).

You'll need to combine: 1. **Filter**: Only consider scores >= 50 2. **Accumulator**: Sum the passing scores 3. **Counter**: Count the passing scores 4. Calculate average = sum ÷ count

Starter Code:

```
BEGIN AveragePassingScore
    SET scores TO [85, 42, 91, 55, 38, 78, 92, 45]

    ' Find average of passing scores only

    OUTPUT "Average passing score: " + average
END AveragePassingScore
```

Hints: - Initialize both sum and count to 0 - Only add to sum AND increment count when score >= 50 - Check count > 0 before dividing to avoid division by zero

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

"""
BEGIN AveragePassingScore
    SET scores TO [85, 42, 91, 55, 38, 78, 92, 45]

    ' Find average of passing scores only

    OUTPUT "Average passing score: " + average
END AveragePassingScore
"""
```

Example Answer

```
# Example solution
BEGIN AveragePassingScore
    SET scores TO [85, 42, 91, 55, 38, 78, 92, 45]
    SET sum TO 0
    SET count TO 0

    FOR i = 0 TO LENGTH(scores) - 1 STEP 1
        IF scores[i] >= 50 THEN
            SET sum TO sum + scores[i]
            SET count TO count + 1
        ENDIF
    NEXT i

    IF count > 0 THEN
        SET average TO sum / count
    ELSE
        SET average TO 0
    ENDIF

    OUTPUT "Average passing score: " + average
END AveragePassingScore
```

✍️ Practice: Find Longest Word

Write pseudocode to find the longest word in a list of words.

Use the Best-So-Far pattern, but compare word lengths instead of values.

Starter Code:

```
BEGIN FindLongestWord
    SET words TO ["cat", "elephant", "dog", "hippopotamus", "ant"]

    ' Find the longest word

    OUTPUT "Longest word: " + longest
END FindLongestWord
```

Hints: - Initialize longest to words[0] (first word) - Compare LENGTH(words[i]) with LENGTH(longest) - If current word is longer, update longest to the current word

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

"""
BEGIN FindLongestWord
    SET words TO ["cat", "elephant", "dog", "hippopotamus", "ant"]

    ' Find the longest word

    OUTPUT "Longest word: " + longest
END FindLongestWord
"""
```

Example Answer

```
# Example solution
BEGIN FindLongestWord
    SET words TO ["cat", "elephant", "dog", "hippopotamus", "ant"]
    SET longest TO words[0]

    FOR i = 1 TO LENGTH(words) - 1 STEP 1
        IF LENGTH(words[i]) > LENGTH(longest) THEN
            SET longest TO words[i]
        ENDIF
    NEXT i

    OUTPUT "Longest word: " + longest
END FindLongestWord
```

Pattern Summary Table

Pattern	Initialize	Loop Action	Use When
Counter	`count = 0`	`count = count + 1` when condition	Counting matches
Accumulator	`total = 0`	`total = total + item`	Computing sum/product
Flag	`found = FALSE`	`found = TRUE` when condition	Checking if ANY match
Best-So-Far	`best = list[0]`	Update if better	Finding max/min
Filter	`result = []`	Append if condition	Selecting subset
Transform	`result = []`	Append modified item	Changing all items

How to Choose a Pattern

Ask yourself these questions:

1. **"How many...?"** → Use **Counter**
2. **"What is the total/sum/product?"** → Use **Accumulator**
3. **"Is there any...?" or "Are all...?"** → Use **Flag**
4. **"What is the biggest/smallest/best?"** → Use **Best-So-Far**
5. **"Which items match...?"** → Use **Filter**
6. **"What if we change each item?"** → Use **Transform**

Combining Patterns

Real problems often need **multiple patterns** working together:

- **Average** = Accumulator (sum) + Counter (count), then divide
- **Count items over average** = Accumulator + Counter, then another Counter
- **Top 3 scores** = Filter (passing) + multiple Best-So-Far passes

> 🎯 **Key Insight**: Once you recognise which pattern(s) a problem needs, writing the algorithm becomes much easier!

🐍 Python Translation: Combined Patterns

Translate the 'Average of Passing Scores' algorithm to Python.

This demonstrates combining Counter and Accumulator patterns with a Filter condition.

Hints: - Use 'for score in scores:' to loop - Only add to total and increment count when score >= 50 - The calculation and print are already provided

```
scores = [85, 42, 91, 55, 38, 78, 92, 45]

# Find average of passing scores (>= 50)
total = 0
count = 0

# Loop through scores

# Calculate and print average
if count > 0:
    average = total / count
    print(f"Average passing score: {average:.1f}")
else:
    print("No passing scores")
```

Example Solution

```
# Example solution
scores = [85, 42, 91, 55, 38, 78, 92, 45]

# Find average of passing scores (>= 50)
total = 0
count = 0

for score in scores:
    if score >= 50:
        total = total + score
        count = count + 1

# Calculate and print average
if count > 0:
    average = total / count
    print(f"Average passing score: {average:.1f}")
else:
    print("No passing scores")
```

Pseudocode to Python Translation

Pattern	HSC Pseudocode	Python
Counter	`SET count TO count + 1`	`count += 1`
Accumulator	`SET total TO total + item`	`total += item`
Flag	`SET found TO TRUE`	`found = True`
Best-So-Far	`SET best TO item`	`best = item`
Filter	`APPEND item TO result`	`result.append(item)`
Transform	`APPEND modified TO result`	`result.append(modified)`

📝 Reflection: Patterns in Real Apps

Think of an app you use regularly (social media, music, games, shopping). Identify TWO of the six patterns that the app likely uses. For each: 1. What pattern is it? 2. What data is being processed? 3. What's the purpose?

Example Answer

Spotify likely uses:

1. **Filter Pattern**: When I search for songs, Spotify filters its entire music library to show only songs matching my search query. It loops through millions of songs and keeps only those where the title/artist contains my search term.

2. **Counter Pattern**: Spotify counts how many times I've listened to each song to create my 'Top Songs' playlist. Every time a song plays, it increments a counter for that song.

✅ 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!