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Welcome to this session:
Introduction to Algorithms and Problem Solving Methodologies

The session will start shortly...

Questions? Drop them in the chat.
We'll have dedicated moderators answering questions.

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What is Safeguarding?

Safeguarding refers to actions and measures aimed at protecting the human rights of adults, particularly vulnerable individuals, from abuse, neglect, and harm.

To report a safeguarding concern reach out to us via email:

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Live Lecture Housekeeping:

- The use of disrespectful language is prohibited in the questions, this is a supportive, learning environment for all - please engage accordingly.
- No question is daft or silly - ask them!
- For all non-academic questions, please submit a query: www.hyperiondev.com/support
- To report a safeguarding concern reach out to us via email: safeguarding@hyperiondev.com
- If you are hearing impaired, please kindly use your computer's function through Google chrome to enable captions.

Learning Outcomes

- **Define** and **explain** the concept of **algorithms** in computer science.
- **Describe** the characteristics of a **good algorithm** (correctness, efficiency, readability).
- **Identify** and **utilise basic problem-solving methodologies** such as divide-and-conquer, brute force, and greedy algorithms.
- **Illustrate the process** of translating a problem into a **step-by-step algorithm.**

Relevance

Think about your morning routine - from the moment you wake up until you arrive at class.

- *How many decisions do you make, and what's your process for making them efficiently?*
- *For example, do you optimize your route to avoid traffic, or plan your breakfast to save time?*

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Relevance

- This is actually an algorithm you've created!
- Could someone share their morning 'algorithm' and explain why they chose that specific sequence of steps?

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Relevance

- What happens when something unexpected disrupts your routine?
- Have you ever tried to optimize or improve your morning sequence?
- How do you handle multiple constraints like time, resources, and preferences?

What is an algorithm?

A. A detailed step-by-step procedure for solving a problem
B. A programming language
C. A hardware component
D. A design pattern

Which of the following is a characteristic of a good algorithm?

A. Complexity and Length
B. Correctness, Efficiency, and Readability
C. Use of Multiple Programming Languages
D. Randomness in Output

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Lecture Overview

- Introduction to Algorithms
- Fundamentals and Characteristics
- Problem-Solving Methods
- Putting it into Practice

Introduction to Algorithms

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What is an Algorithm?

- An **algorithm** is:
  - A precise, step-by-step procedure for solving a problem
  - Comparable to a recipe for computers
- Key Characteristics:
  - Precise: Clear instructions
  - Unambiguous: No room for interpretation
  - Finite: Must terminate
- Examples in Daily Life:
  - Following a cooking recipe
  - Giving directions to a destination

Why are algorithms important?

- **Foundation** of Computer Programming:
  - Core to software development
- **Efficiency** in Problem-Solving:
  - Streamlines complex tasks
- Applications in Various Fields:
  - Data Processing
  - Search Engines
  - Financial Systems
  - Machine Learning

Fundamentals and Characteristics

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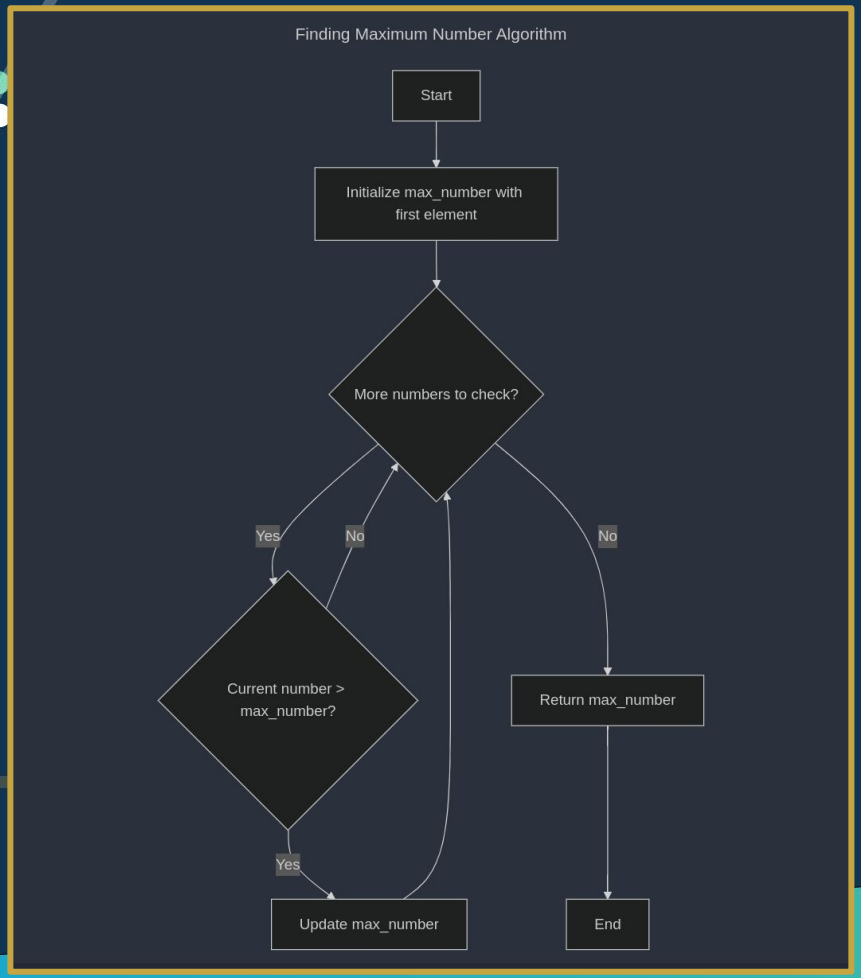
Characteristics of Good Algorithms

The Three Pillars:

- Correctness:
  - Produces the correct output for all valid inputs
- Efficiency:
  - Optimizes resource use (time and memory)
- Readability:
  - Clear, understandable, and maintainable code



Example: Finding the Maximum Number

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Example: Finding the Maximum Number

```python
def find_maximum(numbers):
    if not numbers:
        return None
    max_number = numbers[0]
    for number in numbers:
        if number > max_number:
            max_number = number
    return max_number
```

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Algorithm Analysis

- Using find_maximum as an example:
  - Correctness:
    - Works for all valid cases
  - Efficiency:
    - Checks each number once
  - Readability:
    - Clear variable names and logic

Common Problem Solving Methodologies

- **Divide-and-Conquer**
- **Brute Force**
- **Greedy Algorithms**
    - **TBC:** When we come back...

BREAK

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Problem Solving Methods

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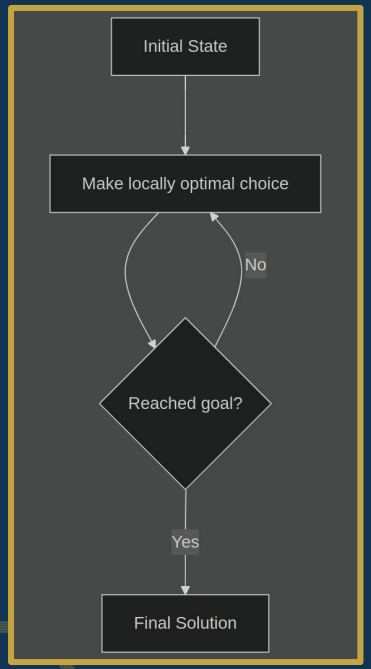
Brute Force Method

- **Definition:**
  - Try all possible solutions
- **Advantages:**
  - Simple, guaranteed solution
- **Disadvantages:**
  - Inefficient for large data
- **Best Used For:**
  - Small datasets
  - Validating other algorithms
  - When no optimized solution exists

Greedy Algorithms



1. **Make the locally optimal choice at each step**
2. **Assume it will lead to the globally optimal solution**

- **Examples:**
  - Coin Change Problem
  - Huffman Coding
  - Activity Selection

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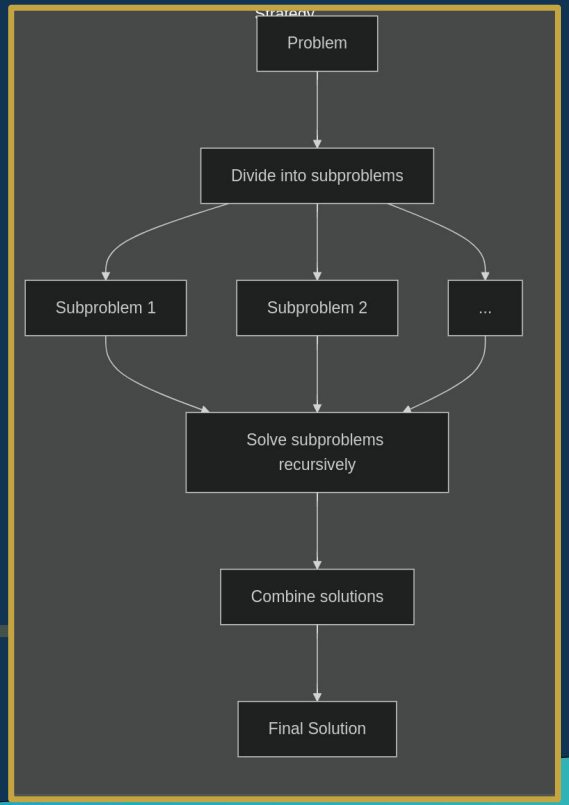
Divide and Conquer



1. Break the problem into smaller subproblems
2. Solve subproblems recursively
3. Combine results for the final solution

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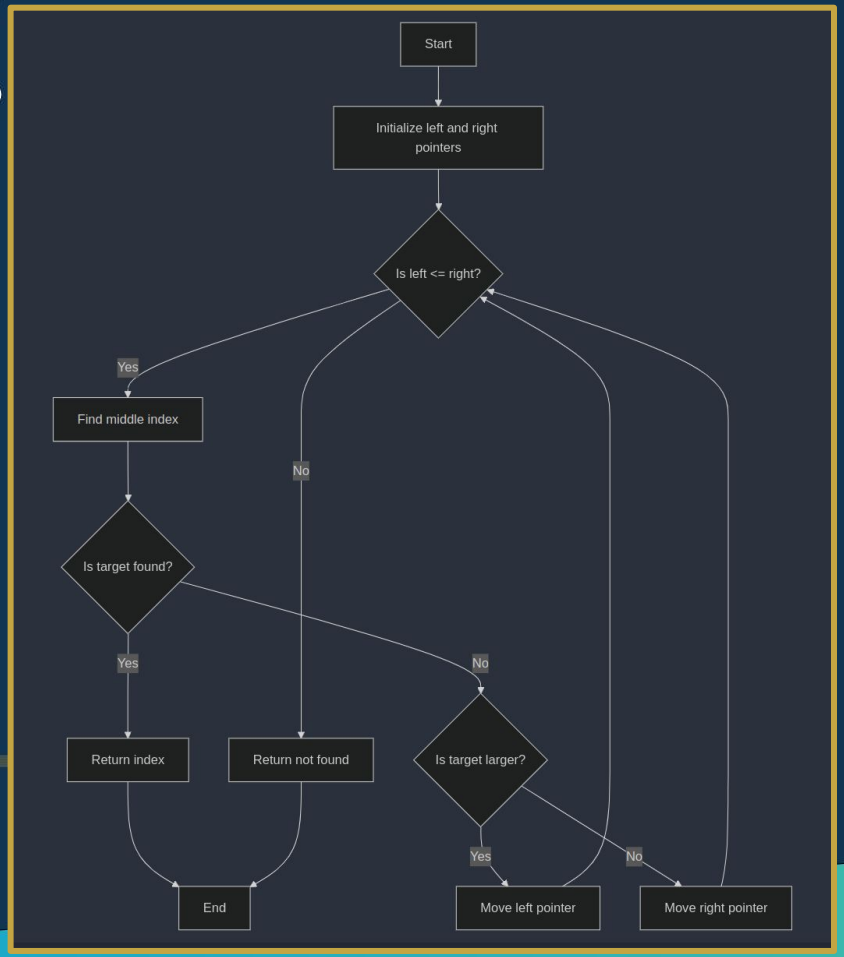

Binary Search Example

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Binary Search Example

```python
def binary_search(arr, target):
    left, right = 0, len(arr) - 1
    while left <= right:
        mid = (left + right) // 2
        if arr[mid] == target:
            return mid
        elif arr[mid] < target:
            left = mid + 1
        else:
            right = mid - 1
    return -1
```

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Real-World Application: Route Planning

- **Problem**: Find the shortest path between two points
- **Solutions**:
  - **Brute Force**: Try all routes
  - **Greedy**: Always move toward the destination
  - **Divide-and-Conquer**: Break down the journey into smaller steps

Putting it into Practice

Common Pitfalls in Algorithm Design

- Ignoring **edge cases**
- **Premature** optimization
- **Overcomplicating** the solution
- Failing to **validate inputs**
- Poor **documentation**

Best Practices

- Start with a **simple solution**
- **Test** with various **inputs**
- **Document** your code
- Consider **edge cases**
- **Optimize** only when necessary

Performance Considerations

- When designing algorithms, consider:
  - Time Complexity
  - Space Complexity
  - Input Size
  - Hardware Limitations
  - User Requirements

Steps to Success

- **Understand the Problem**
  - Read the problem carefully.
  - Identify inputs, outputs, constraints, and edge cases.
  - Ask clarifying questions if needed.
- **Plan Before You Code**
  - Use pseudocode or flowcharts to outline the solution.
  - Determine if the problem allows for brute-force solutions or needs optimization.

Steps to Success

- **Implement a Solution**
  - Code step-by-step, following the plan.
  - Test using example cases.
- **Optimise**
  - Identify inefficiencies.
  - Use better data structures or algorithmic paradigms to improve performance.

Summary

- Key Takeaways:
  - Algorithms are step-by-step solutions to problems
  - Good algorithms are correct, efficient, and readable
  - Practice different problem-solving methodologies
- Next Steps:
  - Continue practicing
  - Explore real-world applications

Additional Resources

- Python Documentation:
  - https://python.org
- Algorithm Visualizer:
  - https://visualgo.net
- Practice Problems:
  - https://leetcode.com

Which of these methodologies works by breaking the problem into smaller parts?

A. Brute Force
B. Divide-and-Conquer
C. Greedy Algorithm
D. Randomised Approach

Brute force algorithms are always the most efficient.

A. True
B. False

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Q & A SECTION

Please use this time to ask any questions relating to the topic, should you have any.


Thank you
for attending
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