Array Study Note

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1. Definition

Array is a linear data structure consisting of a fixed-size block of contiguous memory that stores elements of the same data type.

It solves the problem of needing fast, index-based access to elements.

2. Visualization

Index : 0 1 2 3 4 ...

Value : 10 → 20 → 30 → 40 → 50 → ...

Memory:

- Boxes represent elements
- Bottom labels show indices
- Arrows may indicate traversal or logical sequence

3. charaterristics

- ordering : ordered by index
- Indexing : supports O(1) random access
- Dynamic size : static array are fixed-size
- Memory layout : Contiguous memory
- Typical operations : Access. modify. insert. delete. traversal

4. Time / Space Complexity

Operation	static Array	Dynamic Array
Access / search	O(1) / O(n)	O(1) / O(n)
Insert	O(n)	O(n)
Delete	O(n)	O(n)
Extra memory	O(n)	O(n)

5. Limitations

- Fixed size : resizing is difficult.
- Inserting or deleting non-end elements requires shifting many items
- Not idea for scenarios requiring frequent middle insert / deletions

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6. Pros / Cons

Pros :

- Extremely fast index-based access (O(1))
- Contiguous memory makes it cache-efficient
- simple and easy to use

Cons :

- Middle insert/delete operations are slow
- Static arrays lack flexibility in size
- Possible memory waste or overhead when resizing

7. Use Cases

1. Storing a fixed-size dataset
   - e.g. temperatures for 7 days.
2. When fast indexing is required
   - look up tables, prefix sums
3. As a foundation for other structures
   - used to implement stacks, queues, hash tables.