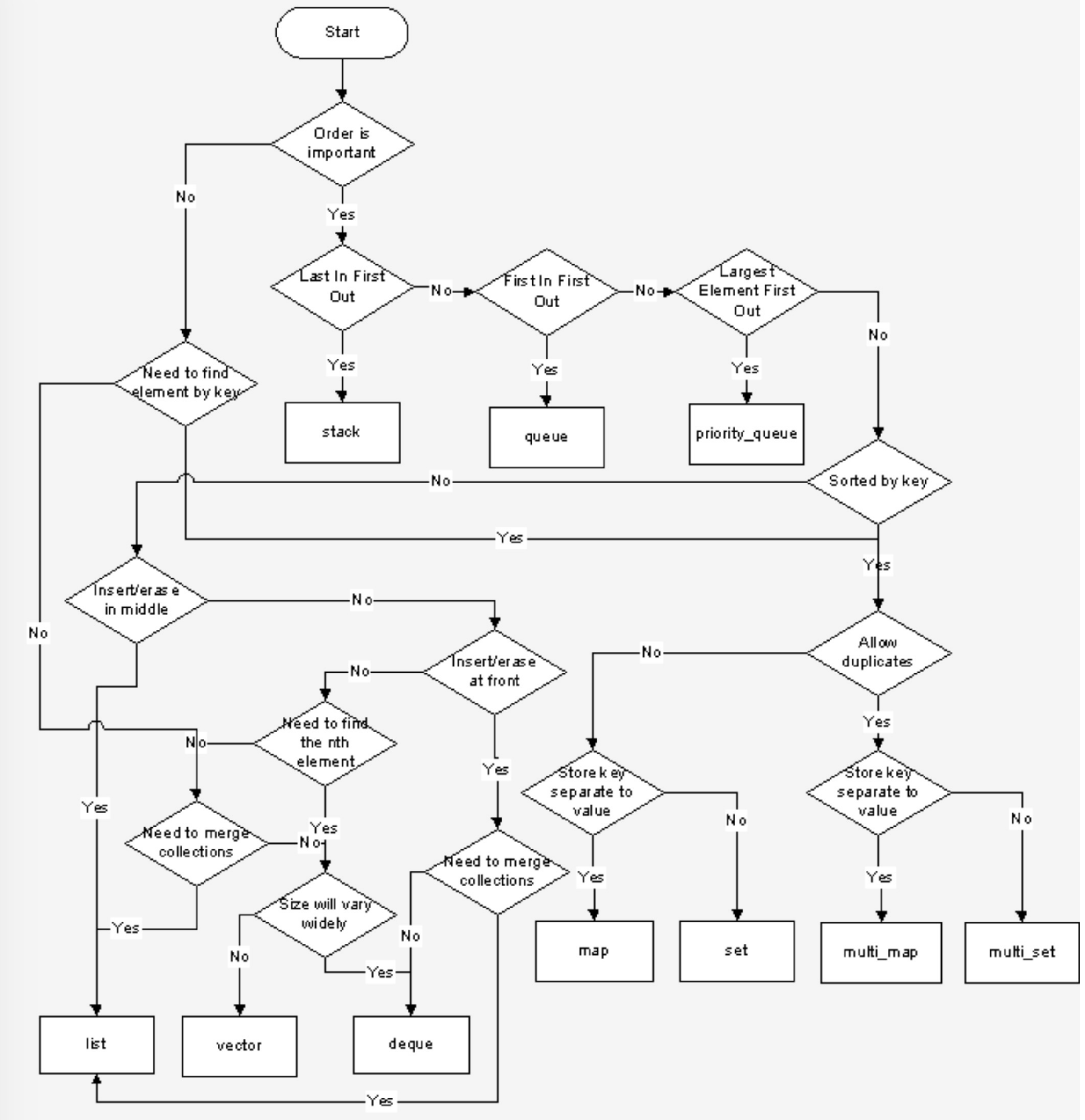
DATA STRUCTURES IN C++
(Quick Recap)

Data Structure Decision Diagram



Note: I don't have the source of this diagram. If you know it, please drop me a msg so I can add it here.

- The following diagram gives you the direction to which data structure to use in C++ according to the problem you are trying to solve

Arrays

- Fixed-size collection of elements of the same type
- Stored in **contiguous memory**
- Declared with syntax: **`type arrayName[size]`**

  Example:

  ```
  int numbers[5]
  ```
- Can also be initialized at declaration:

  ```
  int arr[3] = {1 ,2, 3}
  ```
- Cannot resize after declaration
- Size can be calculated by **`sizeoff(arr) / sizeof(arr[0])`**
- stdlib provides **`std::array<type, size>`**
- Includes header: **#include <array>**
- **Example:**

  ```
  std::array<int, 3> a = {1, 2, 3};
  ```

Arrays (vectors)

- std::vector is a sequence container that encapsulates dynamic sized arrays*
- Stored in **contiguous memory** (like arrays)
- Declared with syntax: **std::vector<type> vectorName**

  Example:

  ```
  std::vector<int> numbers
  ```
- Can be initialized at declaration:

  ```
  std::vector<int> vec = {1, 2, 3}
  ```
- **Can resize dynamically** during runtime
- Size accessed with **.size()** method
- Includes header: **#include <vector>**

  Example:

  ```
  std::vector<int> v = {1, 2, 3};
  v.push_back(4);
  v.pop_back();
  ```

*https://en.cppreference.com/w/cpp/container/vector

Linked List

- Dynamic collection of elements connected by pointers (implemented as doubly-linked list in C++)
- Stored in **non-contiguous memory** locations
- Declared with syntax: **std::list<type> listName**

  Example:

  ```
  std::list<int> numbers
  ```
- Can be initialized at declaration:

  ```
  std::list<int> lst = {1, 2, 3}
  ```
- **Can resize dynamically** during runtime
- Size accessed with **.size()** method
- Includes header **#include <list>**
- **Example:**

  ```
  std::list<int> l = {1, 2, 3};
  l.push_front(0);
  ```

Stack

- **LIFO** (Last In, First Out) data structure
- Elements added and removed from the **top** only
- Declared with syntax:

  std::stack<type> stackName

  Example:

  ```
  std::stack<int> numbers
  ```
- Cannot be initialized with list at declaration
- **Can resize dynamically** during runtime
- Size accessed with **.size()** method
- Includes header **#include <stack>**
- **Example:**

  ```
  std::stack<int> s;
  s.push(1);
  s.pop();
  ```

*https://en.cppreference.com/w/cpp/container/vector

Queue

- **FIFO** (First In, First Out) data structure
- Elements added at **back** and removed from **front**
- Declared with syntax: **std::queue<type> queueName**
- **Example**:

```
std::queue<int> numbers
```

- Cannot be initialized with list at declaration
- **Can resize dynamically** during runtime
- Size accessed with **.size()** method
- Includes header **#include <queue>**
- **Example:**

```
std::queue<int> q;
q.push(1);
q.pop();
```

*https://en.cppreference.com/w/cpp/container/vector

Heap

- **Priority queue** data structure (max-heap by default)
- Elements automatically ordered by **priority/value**
- Declared with syntax:

  std::priority_queue<type> heapName
- **Example**:

  `std::priority_queue<int> numbers`
- Can be initialized from container: `std::priority_queue<int> pq(vec.begin(), vec.end())`
- **Can resize dynamically** during runtime
- Size accessed with **.size()** method
- Includes header **#include <queue>**
- **Example:**

  ```
  std::priority_queue<int> h;
  h.push(3); h.push(1);
  h.top(); // returns 3
  ```

Hash Table

- **Key-value pairs** with fast O(1) average lookup
- Uses **hash function** to map keys to indices
- Declared with syntax: **std::unordered_map<keyType, valueType> mapName**
- **Example**:

  ```
  std::unordered_map<string, int> ages
  ```
- Can be initialized at declaration: `std::unordered_map<string, int> map = {{"key", 1}}`
- **Can resize dynamically** during runtime
- Size accessed with **.size()** method
- Includes header **#include <unordered_map>**
- **Example:**

  ```
  std::unordered_map<string, int> m;
  m["alice"] = 25;
  m.at("alice");
  ```

Tree

- **Hierarchical** data structure with nodes and edges
- Each node has **parent-child relationships** (except root)
- No built-in tree class - typically **implemented manually**
- **Example**:

```
struct TreeNode {
   int val;
   TreeNode* left;
   TreeNode* right;  }
```

- Cannot be initialized with simple syntax
- **Can resize dynamically** by adding/removing nodes
- Size calculated by **traversing all nodes**
- No standard header required (custom implementation)
- **Example:**

```
TreeNode* root = new TreeNode(1);
root->left = new TreeNode(2);
```