Search Medium

Write Sign up Sign In

Published in Dev Learning Daily

The Educative Team
Mar 23, 2020 · 14 min read · Listen

7 JavaScript data structures you must know

Written by Ryan Thelin and Amanda Fawcett

When solving coding problems, efficiency is paramount — from the number of coding hours to runtime, to the amount of memory devoted to a solution. Thankfully, JavaScript developers use many pre-established data structures designed to solve common needs and solve real-world problems. Mastery over data structures is a major factor in marking the difference between a fresh developer and a practiced, hireable veteran.

Maybe you're just starting out with data structures, or maybe you've been coding f[illegible] just need a refresher. Today, we will walk you through the top 7 data structures that any JS developer needs to know.

Here is what we'll cover today

- What are data structures
- Top 7 JS data structures
- Data structures interview questions
- Resources

Let's get started

. . .

What are data structures

Data structures, at a high level, are techniques for storing and organizing data that make it easier to modify, navigate, and access. Data structures determine how data is collected, the functions we can use to access it, and the relationships between data. Data structures are used in almost all areas of computer science and programming, from operating systems to basic vanilla code to artificial intelligence.

Data structures enable us to:

- Manage and utilize large datasets
- Search for particular data from a database
- Design algorithms that are tailored towards particular programs
- Handle multiple requests from users at once
- Simplify and speed up data processing

The Educative Team
12.1K Followers
Master in-demand coding skills with Educative's hands-on courses & tutorials.
Follow

More from Medium

Aditya Anand
100 DAYS OF DATA STRUCTURES AND ALGORITHMS

Alexander Ng... in Level Up Co...
How I got in to Amazon, Microsoft, Google. All from studying these resources

Frank Andrade in Geek Culture
My Top 5 Paid Subscriptions I'll Never Cancel as a Programmer

mxnuchim
How I code for 8 hours without feeling tired.

Help Status Writers Blog Careers Privacy Terms About Knowable

Data structures are vital for efficient, real-world problem solving. After all, the way we organize data has a lot of impact on performance and useability. In fact, most top companies require a strong understanding of data structures. These skills demonstrate that you know how to manage your data effectively. Anyone looking to crack the coding interview will need to master data structures.

JavaScript has primitive and non-primitive data structures. **Primitive data structures** and data types are native to the programming language. These include boolean, null, number, string, etc. **Non-primitive data structures** are not defined by the programming language but rather by the programmer. These include linear data structures, static data structures, and dynamic data structures, like queue and linked lists.

Now that you have a sense of why data structures are so important, let's discuss the top 7 data structures that every JavaScript developer needs to know.

7 JavaScript data structures you need to know

Array

The most basic of all data structures, an array stores data in memory for later use. Each array has a fixed number of cells decided on its creation, and each cell has a corresponding numeric index used to select its data. Whenever you'd like to use the array, all you need are the desired indices, and you can access any of the data within.

Advantages

- Simple to create and use.
- Foundational building block for complex data structures

Disadvantages

- Fixed size
- Expensive to insert/delete or resequence values
- Inefficient to sort

Applications

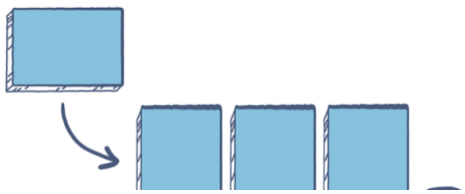
- Basic spreadsheets
- Within complex structures such as hash tables

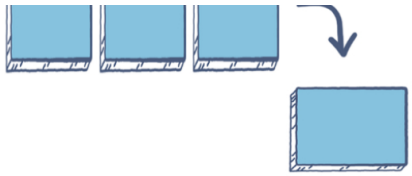
For a more in-depth explanation, please see our Edpresso article on arrays!

. . .

Queues

Queues are conceptually similar to stacks; both are sequential structures, but queues process elements in the order they were entered rather than the most recent element. As a result, queues can be thought of as a FIFO (First In, First Out) version of stacks. These are helpful as a buffer for requests, storing each request in the order it was received until it can be processed.





For a visual, consider a single-lane tunnel: the first car to enter is the first car to exit. If other cars should wish to exit, but the first stops, all cars will have to wait for the first to exit before they can proceed.

Advantages

- Dynamic size
- Orders data in the order it was received
- Low runtime

Disadvantages

- Can only retrieve the oldest element

Applications

- Effective as a buffer when receiving frequent data
- Convenient way to store order-sensitive data such as stored voicemails
- Ensures the oldest data is processed first

. . .

Linked List

Linked lists are a data structure which, unlike the previous three, does not use physical placement of data in memory. This means that, rather than indexes or positions, linked lists use a referencing system: elements are stored in nodes that contain a pointer to the next node, repeating until all nodes are linked. This system allows efficient insertion and removal of items without the need for reorganization.

Advantages

- Efficient insertion and removal of new elements
- Less complex than restructuring an array

Disadvantages

- Uses more memory than arrays
- Inefficient to retrieve a specific element
- Inefficient to traverse the list backward

Applications

- Best used when data must be added and removed in quick succession from unknown locations

For a more in-depth explanation, please see our Edpresso article on linked lists!

. . .

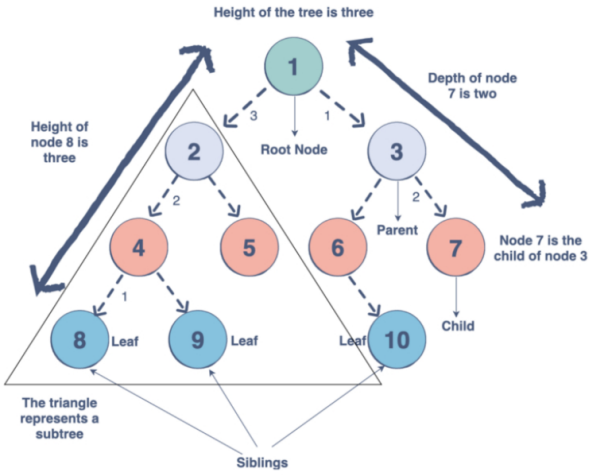
Trees

Trees are another relation-based data structure, which specialize in representing hierarchical structures. Like a linked list, nodes contain both elements of data and pointers marking its relation to immediate nodes.

Each tree has a “root” node, off of which all other nodes branch. The root contains references to all elements directly below it, which are known as its “child nodes”. This continues, with each child node, branching off into more

child nodes.

Nodes with linked child nodes are called internal nodes while those without child nodes are external nodes. A common type of tree is the "binary search tree" which is used to easily search stored data. These search operations are highly efficient, as its search duration is dependent not on the number of nodes but on the number of levels down the tree.



This type of tree is defined by four strict rules:

1. The left subtree contains only nodes with elements lesser than the root.
2. The right subtree contains only nodes with elements greater than the root.
3. Left and right subtrees must also be a binary search tree. They must follow the above rules with the "root" of their tree.
4. There can be no duplicate nodes, i.e. no two nodes can have the same value.

Advantages

- Ideal for storing hierarchical relationships
- Dynamic size
- Quick at insert and delete operations
- In a binary search tree, inserted nodes are sequenced immediately.
- Binary search trees are efficient at searches; length is only O(height).

Disadvantages

- Slow to rearrange nodes
- Child nodes hold no information about their parent node
- Binary search trees are not as fast as the more complicated hash table
- Binary search trees can degenerate into linear search (scanning all elements) if not implemented with balanced subtrees.

Applications

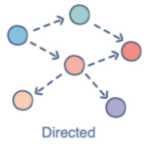
- Storing hierarchical data such as a file location.
- Binary search trees are excellent for tasks needing searching or ordering of data.

For a more in-depth explanation, please see our Edpresso article on trees!

. . .

Graphs

Graphs are a relation-based data structure helpful for storing web-like relationships. Each node, or vertex, as they're called in graphs, has a title (A, B, C, etc.), a value contained within, and a list of links (called edges) it has with other vertices.



In the above example, each circle is a vertex, and each line is an edge. If produced in writing, this structure would look like:

V = {a, b, c, d}

E = {ab, ac, bc, cd}

While hard to visualize at first, this structure is invaluable in conveying relationship charts in textual form, anything from circuitry to train networks.

Advantages

- Can quickly convey visuals over text
- Usable to model a diverse number of subjects so long as they contain a relational structure

Disadvantages

- At a higher level, text can be time-consuming to convert to an image.
- It can be difficult to see the existing edges or how many edges a given vertex has connected to it

Applications

- Network representations
- Modeling social networks, such as Facebook.

For a more in-depth explanation, please see our Edpresso article on graphs!

. . .

Hash Tables (Map)

Hash tables are a complex data structure capable of storing large amounts of information and retrieving specific elements efficiently. This data structure relies on the concept of key/value pairs, where the "key" is a searched string and the "value" is the data paired with that key.

Each searched key is converted from its string form into a numerical value, called a hash, using a predefined hash function. This hash then points to a storage bucket — a smaller subgroup within the table. It then searches the bucket for the originally entered key and returns the value associated with that key.

Advantages

- Key can be in any form, while array's indices must be integers
- Highly efficient search function
- Constant number of operations for each search
- Constant cost for insertion or deletion operations

Disadvantages

- Collisions: an error caused when two keys convert to the same hash code or two hash codes point to the same value.
- These errors can be common and often require an overhaul of the hash function.

Applications

- Database storage
- Address lookups by name

Each hash table can be very different, from the types of the keys and values, to the way their hash functions work. Due to these differences and the multi-layered aspects of a hash table, it is nearly impossible to encapsulate so generally.

For a more in-depth explanation, please see our Edpresso article on hash tables!

Keep the learning going.

Learn JavaScript data structures without scrubbing through videos or documentation. Educative's text-based courses are easy to skim and feature live coding environments — making learning quick and efficient.

Data Structures in JavaScript: an interview refresher

. . .

Data structure interview questions

For many developers and programmers, data structures are most important for cracking coding interviews. Questions and problems on data structures are fundamental to modern-day coding interviews. In fact, they have a lot to say over your hireability and entry-level rate as a candidate.

Today, we will be going over seven common coding interview questions for JavaScript data structures, one for each of the data structures we discussed above. Each will also discuss its time complexity based on the BigO notation theory.

Array: Remove all even integers from an array

Problem statement: Implement a function `removeEven(arr)`, which takes an array arr in its input and removes all the even elements from a given array.

Input: An array of random integers

```
[1,2,4,5,10,6,3]
```

Output: an array containing only odd integers

```
[1,5,3]
```

There are two ways you could solve this coding problem in an interview. Let's discuss each.

Solution #1: Doing it "by hand"

```
function removeEven(arr) {
  var odds = []
  for (let number of arr) {
    if (number % 2 != 0) // Check if the item in the list is NOT even ('%' is the modulus symbol)
      odds.push(number) //If it isn't even append it to the empty list
  }
 return odds // Return the new list
}
console.log(removeEven([3, 2, 41, 3, 34]))
```

RUN

Output 3.311s

```
[ 3, 41, 3 ]
```

This approach starts with the first element of the array. If that current element is not even, it pushes this element into a new array. If it is even, it will move to the next element, repeating until it reaches the end of the array. In regards to time complexity, since the entire array has to be iterated over, this solution is in *O(n)O(n)*.

Solution #2: Using filter() and lambda function

```
function removeEven(arr) {
    return arr.filter((v => (v % 2) != 0))
}
console.log(removeEven([3,2,41,3,34]))
```

This solution also begins with the first element and checks if it is even. If it is even, it filters out this element. If not, skips to the next element, repeating this process until it reaches the end of the array.

The filter function uses lambda or arrow functions, which use shorter, simpler syntax. The filter filters out the element for which the lambda function returns false. The time complexity of this is the same as the time complexity of the previous solution.

. . .

Stack: Check for balanced parentheses using a stack

Problem statement: Implement the `isBalanced()` function to take a string containing only curly `{}`, square `[]`, and round `()` parentheses. The function should tell us if all the parentheses in the string are balanced. This means that every opening parenthesis will have a closing one. For example, `{[]}` is balanced, but `{[}]` is not.

Input: A string consisting solely of `(`, `)`, `{`, `}`, `[` and `]`

```
exp = "{[({})]}"
```

Output: Returns `False` if the expression doesn't have balanced parentheses. If it does, the function returns `True`.

```
True
```

To solve this problem, we can simply use a stack of characters. **To see the code for this solution, please go to Educative.io to run the code in an embedded environment.**

This process will iterate over the string one character at a time. We can determine that the string is unbalanced based on two factors:

1. The stack is empty.
2. The top element in the stack is not the right type.

If either of these conditions is true, we return `False`. If the parenthesis is an opening parenthesis, it is pushed into the stack. If by the end all are balanced, the stack will be empty. If it is not empty, we return `False`. Since we traverse the string exp only once, the time complexity is *O(n)*.

. . .

Queue: Generate Binary Numbers from 1 to n

Problem statement: Implement a function `findBin(n)`, which will generate binary numbers from `1` to `n` in the form of a string using a queue.

Input: A positive integer n

```
n = 3
```

Output: Returns binary numbers in the form of strings from `1` up to `n`

```
result = ["1","10","11"]
```

The easiest way to solve this problem is using a queue to generate new numbers from previous numbers. Let's break that down.

```
"use strict";
const Queue = require('./Queue.js');
function findBin(n) {
    let result = [];
    let myQueue = new Queue();
    var s1, s2;
    myQueue.enqueue("1");
    for (var i = 0; i < n; i++) {

        result.push(myQueue.dequeue());
        s1 = result[i] + "0";
        s2 = result[i] + "1";

        myQueue.enqueue(s1);
        myQueue.enqueue(s2);

    }

    return result;
}

console.log(findBin(10))
```

Output:
['1', '10', '11', '100', '101', '110', '111', '1000', '1001', '1010']

> *To see the rest of the code for this solution, please go to Educative.io to run the code in an embedded environment.*

The key is to generate consecutive binary numbers by appending 0 and 1 to previous binary numbers. To clarify,

- 10 and 11 can be generated if 0 and 1 are appended to 1.
- 100 and 101 are generated if 0 and 1 are appended to 10.

Once we generate a binary number, it is then enqueued to a queue so that new binary numbers can be generated if we append 0 and 1 when that number will be enqueued. Since a queue follows the *First-In First-Out*

number will be enqueued. Since a queue follows the *First In First Out* property, the enqueued binary numbers are dequeued so that the resulting array is mathematically correct.

Look at the code above. On line 7, `1` is enqueued. To generate the sequence of binary numbers, a number is dequeued and stored in the array `result`. On lines 11-12, we append `0` and `1` to produce the next numbers. Those new numbers are also enqueued at lines 14-15. The queue will take integer values, so it converts the string to an integer as it is enqueued.

The time complexity of this solution is in *O(n)O(n)* since constant-time operations are executed for n times.

. . .

Linked List: Reverse a linked list

Problem statement: Write the `reverse` function to take a singly linked list and reverse it in place.

Input: a singly linked list

```
LinkedList = 0->1->2->3-4
```

Output: a reverse linked list

```
LinkedList = 4->3->2->1->0
```

The easiest way to solve this problem is by using iterative pointer manipulation. Let's take a look.

```
"use strict";
const LinkedList = require('./LinkedList.js');
const Node = require('./Node.js');

function reverse(list) {
  let previousNode = null;
  let currentNode = list.getHead(); // The current node
  let nextNode = null; // The next node in the list

  //Reversal
  while (currentNode != null) {
    nextNode = currentNode.nextElement;
    currentNode.nextElement = previousNode;
    previousNode = currentNode;
    currentNode = nextNode;
  }

  //Set the last element as the new head node
  list.setHead(previousNode);

}

let list = new LinkedList();
list.insertAtHead(4);
list.insertAtHead(9);
list.insertAtHead(6);
list.insertAtHead(1);
list.insertAtHead(0);
list.printList();
reverse(list);
list.printList();
```

Output:
0 -> 1 -> 6 -> 9 -> 4 -> null
4 -> 9 -> 6 -> 1 -> 0 -> null

> *To see the rest of the code for this solution, please go to Educative.io to run the code in an embedded environment.*

We use a loop to iterate through the input list. For a `current` node, its link with the `previous` node is reversed. then, `next` stores the next node in the list. Let's break that down by line.

- Line 22- Store the `current` node's `nextElement` in `next`
- Line 23 — Set `current` node's `nextElement` to `previous`
- Line 24 — Make the `current` node the new `previous` for the next iteration
- Line 25 — Use `next` to go to the next node
- Line 29 — We reset the `head` pointer to point at the last node

Since the list is traversed only once, the algorithm runs in *O(n)*.

. . .

Tree: Find the Minimum Value in a Binary Search Tree

Problem statement: Use the `findMin(root)` function to find the minimum value in a Binary Search Tree.

Input: a root node for a binary search tree

```
bst = {
    6 -> 4,9
    4 -> 2,5
    9 -> 8,12
    12 -> 10,14
}
where parent -> leftChild,rightChild
```

Output: the smallest integer value from that binary search tree

```
2
```

Let's look at an easy solution for this problem.

Solution: Iterative `findMin( )`

This solution begins by checking if the root is `null`. It returns `null` if so. It then moves to the left subtree and continues with each node's left child until the left-most child is reached.

```
"use strict";
const BinarySearchTree = require('./BinarySearchTree.js');
const Node = require('./Node.js');

function findMin(rootNode)
{
  if(rootNode == null)
    return null;
  else if(rootNode.leftChild == null)
      return rootNode.val
  else
    return findMin(rootNode.leftChild)
}
var BST = new BinarySearchTree(6)
BST.insertBST(20)
BST.insertBST(-1)

console.log(findMin(BST.root))
```

Output:
-1

. . .

Graph: Remove Edge

Problem statement: Implement the removeEdge function to take a source and a destination as arguments. It should detect if an edge exists between them.

Input: A graph, a source, and a destination

Vertex	Edges
0	1, 2
1	3
2	3, 4
3	null
4	0

Output: A graph with the edge between the source and the destination removed.

```
removeEdge(graph, 2, 3)
```

Vertex	Edges
0	1, 2
1	3
2	4
3	null
4	0

The solution to this problem is fairly simple: we use Indexing and deletion. Take a look

```
"use strict";
const LinkedList = require('./LinkedList.js');
const Node = require('./Node.js');
const Graph = require('./Graph.js');

function removeEdge(graph, source, dest){
  if(graph.list.length == 0){
    return graph;
  }

  if(source >= graph.list.length || source < 0){
    return graph;
  }

  if(dest >= graph.list.length || dest < 0){
    return graph;
  }

  graph.list[source].deleteVal(dest);
  return graph;
}


let g = new Graph(5);
g.addEdge(0, 1);
g.addEdge(0, 2);
g.addEdge(1, 3);
g.addEdge(2, 4);
g.addEdge(4, 0);
console.log("Before removing edge")
g.printGraph();

removeEdge(g, 1, 3);

console.log("\nAfter removing edge")
g.printGraph();
```

> *To see the rest of the code for this solution, please go to Educative.io to run the code in an embedded environment.*

Since our vertices are stored in an array, we can access the `source` linked list. We then call the `delete` function for linked lists. The time complexity for

We then call the `delete` function for linked lists. The time complexity for this solution is O(E) since we may have to traverse E edges.

. . .

Hash Table: Convert Max-Heap to Min-Heap

Problem statement: Implement the function `convertMax(maxHeap)` to convert a binary max-heap into a binary min-heap. `maxHeap` should be an array in the `maxHeap` format, i.e the parent is greater than its children.

Input: a Max-Heap

```
maxHeap = [9,4,7,1,-2,6,5]
```

Output: returns the converted array

```
result = [-2,1,5,9,4,6,7]
```

To solve this problem, we must min heapify all parent nodes. Take a look.

```javascript
function minHeapify(heap, index) {
    var left = index * 2;
    var right = (index * 2) + 1;
    var smallest = index;

    if ((heap.length > left) && (heap[smallest] > heap[left])) {
        smallest = left
    }
    if ((heap.length > right) && (heap[smallest] > heap[right]))
        smallest = right
    if (smallest != index) {
        var tmp = heap[smallest]
        heap[smallest] = heap[index]
        heap[index] = tmp
        minHeapify(heap, smallest)
    }
    return heap;
}

function convertMax(maxHeap) {
    for (var i = Math.floor((maxHeap.length) / 2); i > -1; i--)
        maxHeap = minHeapify(maxHeap, i)
    return maxHeap
}

var maxHeap = [9,4,7,1,-2,6,5]
console.log(convertMax(maxHeap))
```

RUN

Output 2.193s

```
[ -2, 1, 4, 5, 7, 6, 9 ]
```

We consider `maxHeap` to be a regular array and reorder it to accurately represent a min-heap. You can see this done in the code above. The `convertMax()` function then restores the heap property on all nodes from the lowest parent node by calling the `minHeapify()` function. In regards to time complexity, this solution takes *O(nlog(n))O(nlog(n))* time.

. . .

Resources

There's clearly a lot to learn when it comes to data structures in JavaScript. That's why we've compiled this list of resources to get you up to speed with the need-to-know info.

Articles

- JavaScript ES6 Tutorial: refresh your JavaScript skills and stay updated with all the new stuff since ES6 and beyond
- 5 tried and true techniques to prepare for a coding interview: learn tips from the experts when it comes to preparing and performing at coding interviews
- StackOverflow JavaScript Data Structures Library: a great resource to discover useful libraries such as JSClass, Buckets, and more

Courses

- Data Structures in JavaScript: An Interview Refresher: the definitive guide for anyone looking to tackle data structures in JavaScript. It comes loaded with over 160 code playgrounds and 60 hands-on challenges on top of its detailed review of all data structures and their implementation.
- Data Structures in JavaScript — Visualization and Exercises: want more hands-on practice? This course cuts to the core of data structures problems with simple visuals and quizzes.
- Master the JavaScript Interview: once you get down your data structures skills, it's time to refresh your knowledge on everything related to JS interviews. This course has it all.

Books

- Learning JS Data Structures and Algorithms: get a strong grasp on all the popular data structures through solutions for notable programming problems
- Free Code Champ list of books on data structures: skip the searching and reference this useful list of the most recommended books for JS data structures and algorithms

24 1

Sign up for Dev Learning Weekly
By Dev Learning Daily
The internet's top programming tips and tutorials delivered to your inbox. Take a look.
By signing up, you will create a Medium account if you don't already have one. Review our Privacy Policy for more information about our privacy practices.
Get this newsletter

More from Dev Learning Daily
Follow
Learn in-demand programming skills. Accelerate your career. New tips and tutorials every day.

The Educative Team · Mar 3, 2020 Member-only
Android Tutorial: How to Develop an Android App
Android development is all the hype these days as it continues to dominate the world of mobile development. Fun projects, great pay, and tons of job prospects are just some of the reasons developers are...
Android 13 min read

Share your ideas with millions of readers. Write on Medium

The Educative Team · Feb 18, 2020 Member-only
SASS for CSS: Advance your frontend skills with CSS preprocessor
If you're a frontend developer, you know that CSS can be fun, but as your stylesheets get larger, they get harder to maintain and organize....
Web Development 9 min read

Fahim ul Haq · Feb 18, 2020 Member-only

TypeScript Tutorial: A step-by-step guide to learn TypeScript

Introducing Typescript What is Typescript? Typescript is a typed superset of JavaScript and was created by Microsoft in 2012 to aid...

Typescript 11 min read

The Educative Team · Feb 12, 2020 Member-only

The practical approach to machine learning for software engineers

"If you can apply practical machine learning skills to industry projects, companies aren't going to require you to understand ML theory insid...

Machine Learning 7 min read

The Educative Team · Feb 12, 2020

15 JavaScript courses: Learn Web Development, HTML, and CSS

JavaScript (JS) is the programming language that makes web pages come to life. Anyone interested in building websites and web...

Java Script 11 min read

Read more from Dev Learning Daily

Recommended from Medium

Zoltan Kohalmy

Setup-Components in React

Michal Jurkowski

How to make basic Authentication in Vue.js using Google Firebase

Shahriar Islam Sakil

10 Methods in JavaScript that Confuses Beginners

Lucas Calje in Geek Culture

Mock API Responses With a Chrome Extension Called OhMyMock

Pushkar Desai in Dev Genius

React component patterns to use based on need (Part 2)

FAM in Level Up Coding

Break your app into boxes!

TiShow

Handle FileList with Array (React)

Restarone Solutio... in The Start...

Unit Testing Complex React Components With Jest & Enzyme