Brute Force Algorithms: Linear Search

Brute Force Algorithms

- A brute force algorithm solves a problem through exhaustion: it goes through all possible choices until a solution is found.
- The time complexity of a brute force algorithm is often proportional to the input size.
- Brute force algorithms are simple and consistent, but very slow.

```
# pseudocode that prints all divisors
of n by brute force

define printDivisors, n
    for all numbers from 1 to n
        if the number is a divisor of n
            print the number
```

Searching for smallest or largest value using linear search

Linear search can be used to search for the smallest or largest value in an unsorted list rather than searching for a match. It can do so by keeping track of the largest (or smallest) value and updating as necessary as the algorithm iterates through the dataset.

```
Create a variable called max_va
Set max_value_index to the inde
  For each element in the searc
    if element is greater than
      Set max_value_index equal
return max_value_index
```

Linear Search best case

For a list that contains n items, the best case for a linear search is when the target value is equal to the first element of the list. In such cases, only one comparison is needed.
Therefore, the best case performance is O(1).

Linear Search Complexity

Linear search runs in linear time and makes a maximum of n comparisons, where n is the length of the list. Hence, the computational complexity for linear search is O(N).
The running time increases, at most, linearly with the size of the items present in the list.

Linear Search expressed as a Function

A linear search can be expressed as a function that compares each item of the passed dataset with the target value until a match is found.
The given pseudocode block demonstrates a function that performs a linear search. The relevant index is returned if the target is found and -1 with a message that a value is not found if it is not.

```
For each element in the array
  if element equal target value
    return its index
  if element is not found, retu
    “Value Not Found” message
```

Return value of a linear search

A function that performs a linear search can return a message of success and the index of the matched value if the search can successfully match the target with an element of the dataset. In the event of a failure, a message as well as `-1` is returned as well.

```
For each element in the array
  if element equal target value
    print success message
    return its index
  if element is not found
    print Value not found messa
    return -1
```

Modification of linear search function

A linear search can be modified so that all instances in which the target is found are returned. This change can be made by not 'breaking' when a match is found.

```
For each element in the searchL
  if element equal target value
    Add its index to a list of
if the list of occurrences is e
  raise ValueError
otherwise
  return the list occurrences
```

Linear search

Linear search sequentially checks each element of a given list for the target value until a match is found. If no match is found, a linear search would perform the search on all of the items in the list.
For instance, if there are n number of items in a list, and the target value resides in the $n-5$ th position, a linear search will check $n-5$ items total.

Linear search as a part of complex searching problems

Despite being a very simple search algorithm, linear search can be used as a subroutine for many complex searching problems. Hence, it is convenient to implement linear search as a function so that it can be reused.

Linear Search Best and Worst Cases

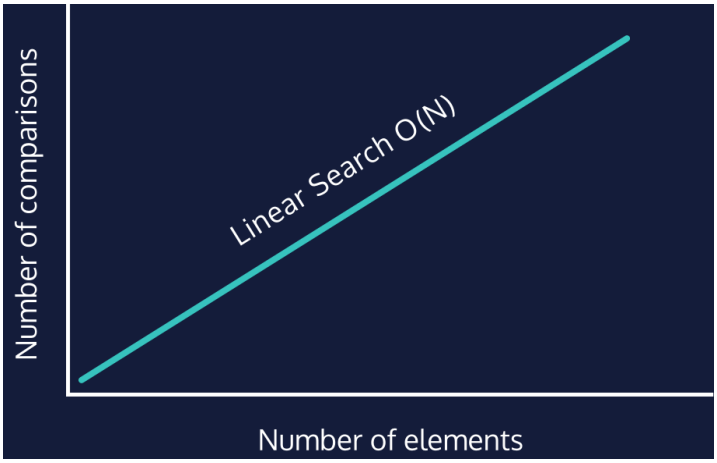
The best-case performance for the Linear Search algorithm is when the search item appears at the beginning of the list and is O(1). The worst-case performance is when the search item appears at the end of the list or not at all. This would require N comparisons, hence, the worse case is O(N).

Linear Search Average Runtime

The Linear Search Algorithm performance runtime varies according to the item being searched. On average, this algorithm has a Big-O runtime of O(N), even though the average number of comparisons for a search that runs only halfway through the list is N/2.

Linear Search Runtime

The Linear Search algorithm has a Big-O (worst case) runtime of O(N). This means that as the input size increases, the speed of the performance decreases linearly. This makes the algorithm not efficient to use for large data inputs.



Throwing Exception in Linear Search

The linear search function may throw a `ValueError` with a message when the target value is not found in the search list. Calling the linear search function inside a `try` block is recommended to catch the `ValueError` exception in the `except` block.

```
def linear_search(lst, match):
  for idx in range(len(lst)):
    if lst[idx] == match:
      return idx
    else:
      raise ValueError("{0} not in
list".format(match))

recipe = ["nori", "tuna", "soy sauce",
"sushi rice"]
ingredient = "avocado"
try:
  print(linear_search(recipe,
ingredient))
except ValueError as msg:
  print("{0}".format(msg))
```

Find Maximum Value in Linear Search

The Linear Search function can be enhanced to find and return the maximum value in a list of numeric elements. This is done by maintaining a variable that is compared to every element and updated when its value is smaller than the current element.

```
def find_maximum(lst):
  max = None
  for el in lst:
    if max == None or el > max:
      max = el
  return max
test_scores = [88, 93, 75, 100, 80, 67,
71, 92, 90, 83]
print(find_maximum(test_scores)) #
returns 100
```

Linear Search Multiple Matches

A linear search function may have more than one match from the input list. Instead of returning just one index to the matched element, we return a list of indices. Every time we encounter a match, we add the index to the list.

```
def linear_search(lst, match):
  matches = []
  for idx in range(len(lst)):
    if lst[idx] == match:
      matches.append(idx)
  if matches:
    return matches
  else:
    raise ValueError("{0} not in
list".format(match))

scores = [55, 65, 32, 40, 55]
print(linear_search(scores, 55))
```

Raise Error in Linear Search

A Linear Search function accepts two parameters:
1) input list to search from
2) target element to search for in the

If the target element is found in the list, the function returns the element index. If it is not found, the function raises an error. When implementing in Python, use the `raise` keyword with `ValueError()`.

```
def linear_search(lst, match):
  for idx in range(len(lst)):
    if lst[idx] == match:
      return idx
  raise ValueError('Sorry, {0} is not found.'.format(match))
```

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