# Data Structure and Algorithms

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### Binary Search

1. Leetcode 69: Sqrt(x)

   Given a non-negative integer, $x$, return the square root of $x$ rounded down to the nearest integer. The returned integer should be non-negative as well.

   You may not use any built-in exponent function. For example, `x**0.5` in python.

   Example:

   ```
   Input: x=4
   Output: 2

   Input: x=8
   Output: 2
   ```

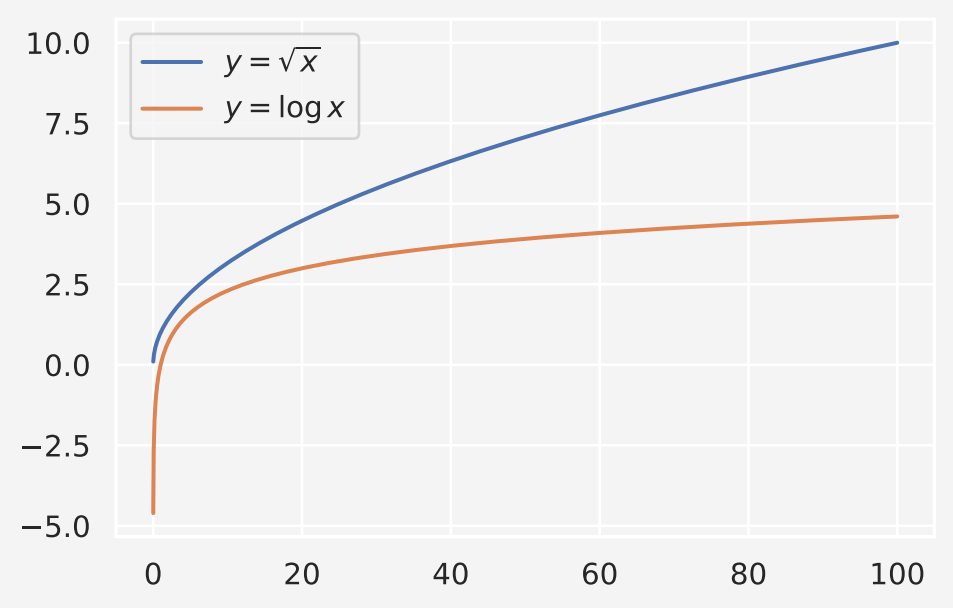
   Explanation: Square root of 4 is 2 and square root of 8 is 2.8284. But we need to round down to any fraction. Therefore, the square root of 8 is also 2.

   **Solution:**

   The square root of any number $x \geq 0$ is less than or equal to $x$. The brute force solution to this would be $\mathcal{O}(\sqrt{n})$. Because, say $x = 8$, then

   for $i = 1$ to 8:

   $$1^2 = 1 < 8$$
   $$2^2 = 4 < 8$$
   $$3^2 = 9 > 8$$




In contrast, if we explore binary search then the time complexity reduces to $\mathcal{O}(\log n)$. Say the square root is $s$ which is the middle value in the range of 1 to $x$. Then if $s^2 > x$, we search for the root in the left half. Otherwise, if $s^2 < x$ then we search the right side. However, when $s^2 < x$, then $s$ is a possible candidate for the square root.

*Algorithm:*

1. set left value $l = 0$, right value $r = x$
2. Compute the middle value $m = l + (r - l)/2$
3. If $m^2 > x$ then search the left side: set $r = m - 1$
4. If $m^2 < x$ then search the right side: set $l = m + 1$

```
def square_root(x):
  l, r = 0, x
  sq = 0
  while l<=r:
    m = l + (r-l)//2
    if m**2 > x:
      r= m-1
    elif m**2 < x:
      l = m+1
      sq = m
    else:
```

```
        return m
    return sq

print(square_root(6))
```

2

2. item

3. item