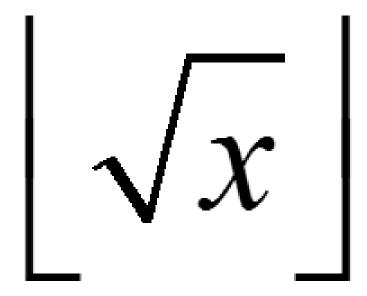
CSE 373 Optional Section Runtime Analysis

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Interview Question / Runtime Analysis

 How do we find the integer square root of a number?



- Increment through the list of numbers from 1 to χ . Call this value i.
- What cases do we have?
 - If $i \times i < \chi$ increment i
 - If $i \times i == \chi$ return i
 - If $i \times i > \chi$ return i 1

Implementation:

```
int i = 1
while(i * i < x)
    i++
return i - 1</pre>
```

Runtime

```
-O(n^{0.5})
```

Implement it in Java together & add timing

- Binary search
- Imagine all of the numbers are in an array (indexed by itself) and search for the integer root
- What number should we start with first?
 - -0, 1, x/2, x

$$\sqrt{x}$$

- Starting with i, $jump = \chi$; $search(\chi, i, jump)$
- Proposition A: $i \times i <= \chi$
- Proposition B: $(i + 1) \times (i + 1) > \chi$
- What do we do in each case?
 - A & B return i
 - A only jump /= 2; search(x, i + jump, jump)
 - B only jump /= 2; search(x, i - jump, jump)
 - Neither throw WhatJustHappenedException()

Implement

```
intSqrt(x):
   return search(x, x / 2, x / 2)
Search (x, i, jump):
   if(i * i \le x)
       if((i+1)(i+1) > x)
           return i
       else
           jump /= 2
           return search (x, i + jump, jump)
   else
       jump /= 2
       return search(x, i - jump, jump)
```

Runtime

$$-T(1) = 1$$

$$-T(N) = 1 + T(N / 2)$$

$$-O(\log(n))$$

Stuck on Proof by Induction?

- Khan Academy!
 - https://www.khanacademy.org/math/trigonometr
 y/seq induction/proof by induction/v/proof-by-induction