BINARY SEARCH

Based on PPT by David G. Sullivan

ALGORITHM EFFICIENCY

- For a given task, there may be more than one algorithm that works

- When choosing among algorithms, one important factor is their relative efficiency

    - Space efficiency: How much memory an algorithm requires

    - Time efficiency: How quickly an algorithm is executed
        - How many "operations" it performs

EXAMPLE OF COMPARING ALGORITHMS

- Consider the problem of finding a phone number in a phone book

- Let’s informally compare the time efficiency of two algorithms

ALGORITHM 1

- Look at every page of the phone book from left to right until number is found
- If there were 1000 pages in the phone book, how many pages would we look at in the worst case scenario?
- What if there were 1,000,000?

ALGORITHM 2

- Divide the book in half
- If the number is in first half, toss out the second half
- Else if number is in second half, toss out the first half
- Repeat above steps until number is found

- If there where 1,000 pages in the phonebook, how many pages would we look at in the worst case?

- What if there were 1,000,000 pages?

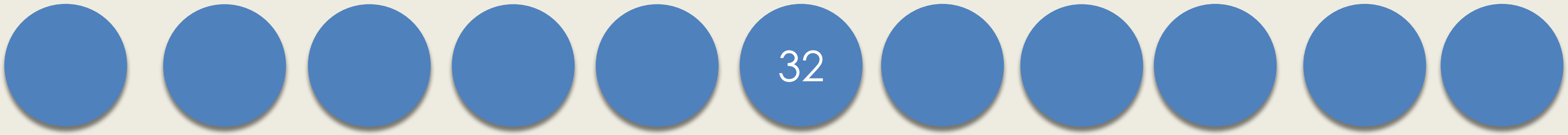
SEARCHING A COLLECTION OF DATA

- The phonebook problem is one example of a common task: searching for an item in a collection of data.

- Algorithm 1 is known as **sequential search**
  - Also known as **linear search**

- Algorithm 2 is known as **binary search**
  - **Only works if the items in the data collection are sorted**

ANOTHER EXAMPLE: CAN YOU FIND THE NUMBER 38?



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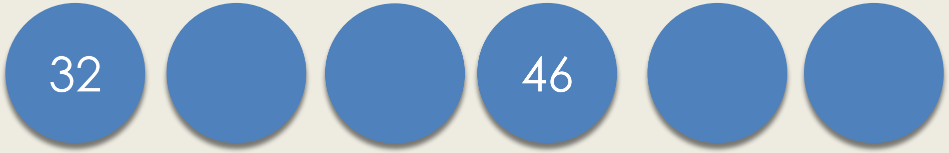

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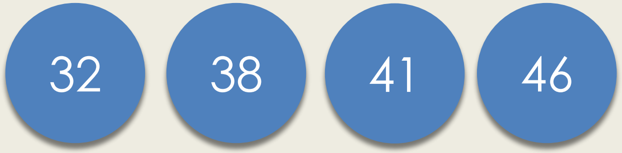

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A REVIEW OF LOGARITHMS

$Y = B^X$

is the same as

$\log_B Y = X$

TIME ANALYSIS

- In the worst case scenario, it takes at most $\log_2 n$ steps to find your item using binary search. Why?
    - After every step, we cut in half the size of the list we're looking at
    - n, n/2, n/4
    - Divide by 2 each time

- This is a lot faster than using sequential search, which takes n steps in the worst case

- Using binary search in the phonebook problem, leads to looking at $\log_2$ 1000 000 = ~20 in the worst case