This is CS50

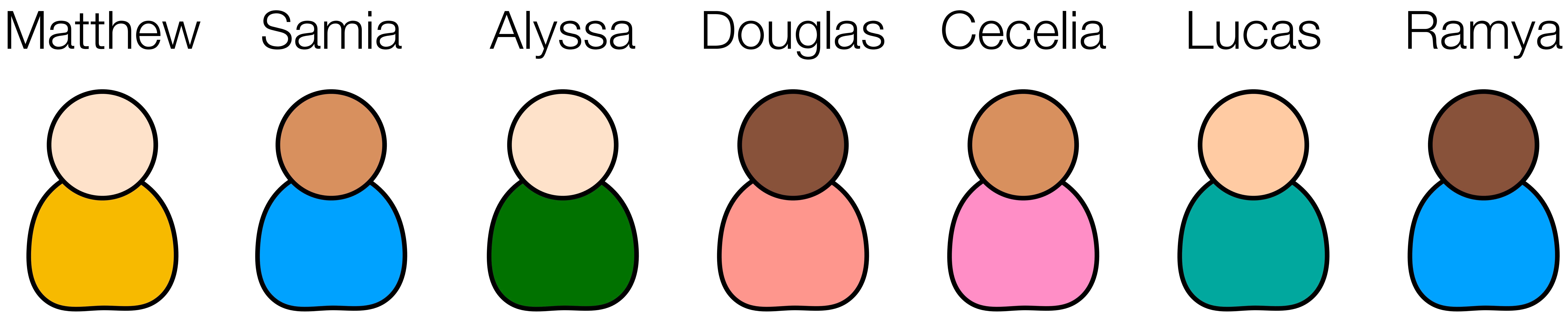
Week 3

Today

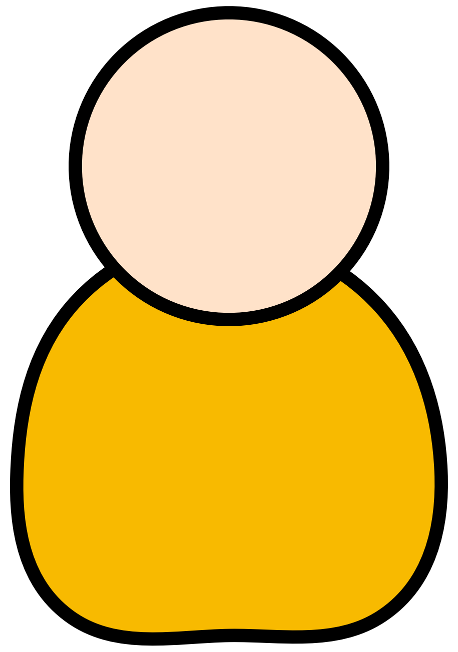
- How can we compare algorithms with O and Ω notation?
- What are **structs**?
- How can we make use of **recursion**?

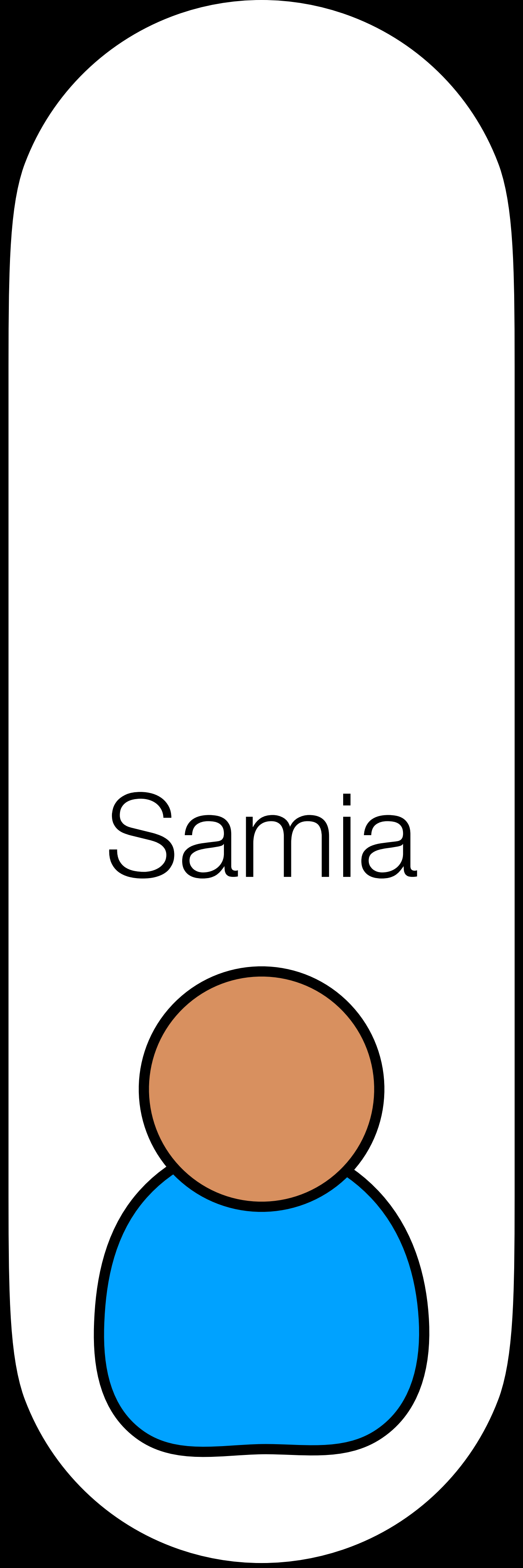
Searching and Sorting

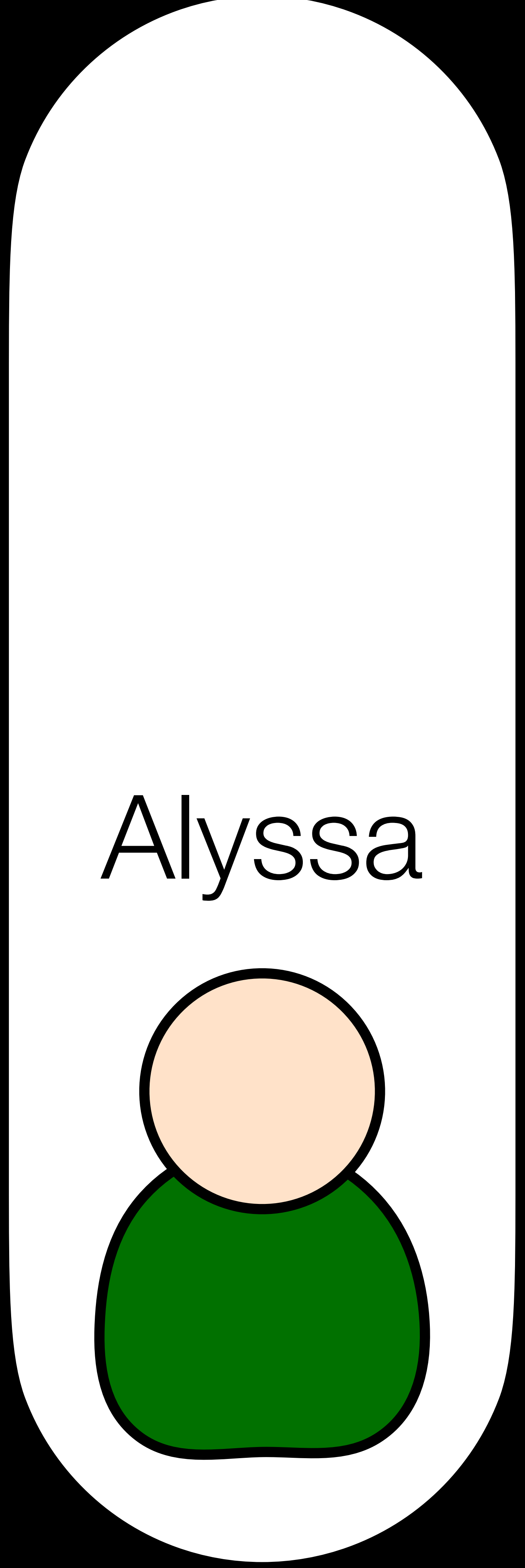
(and O and Ω notation)

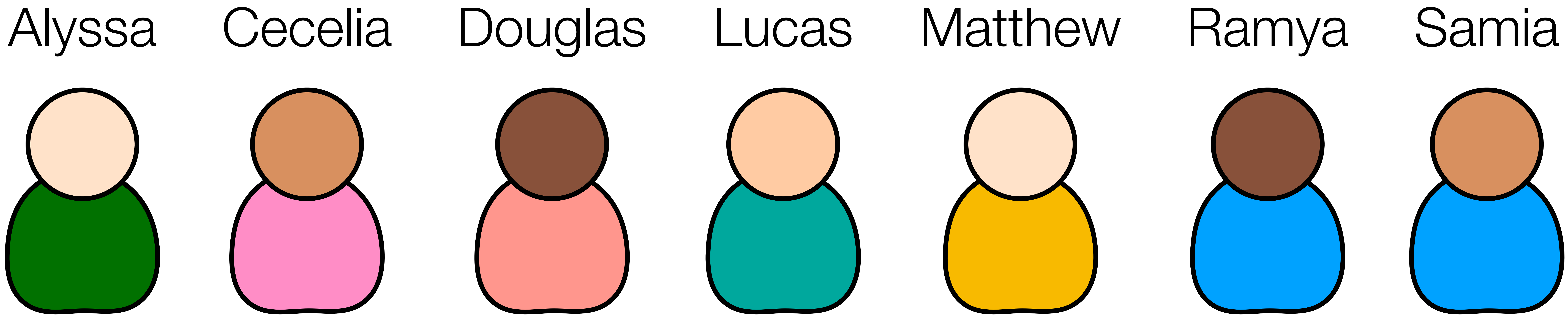

Matthew
Samia
Alyssa
Douglas
Cecelia
Lucas
Ramya

Matthew

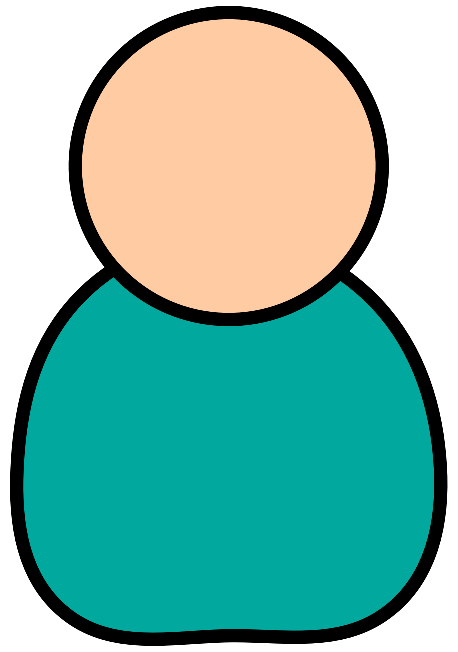



Samia

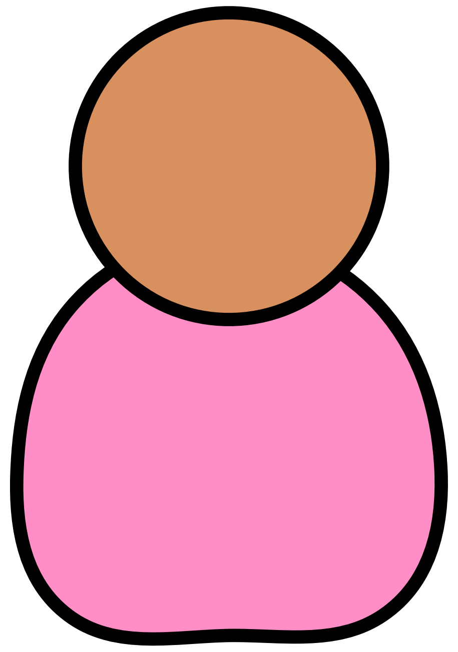

Alyssa

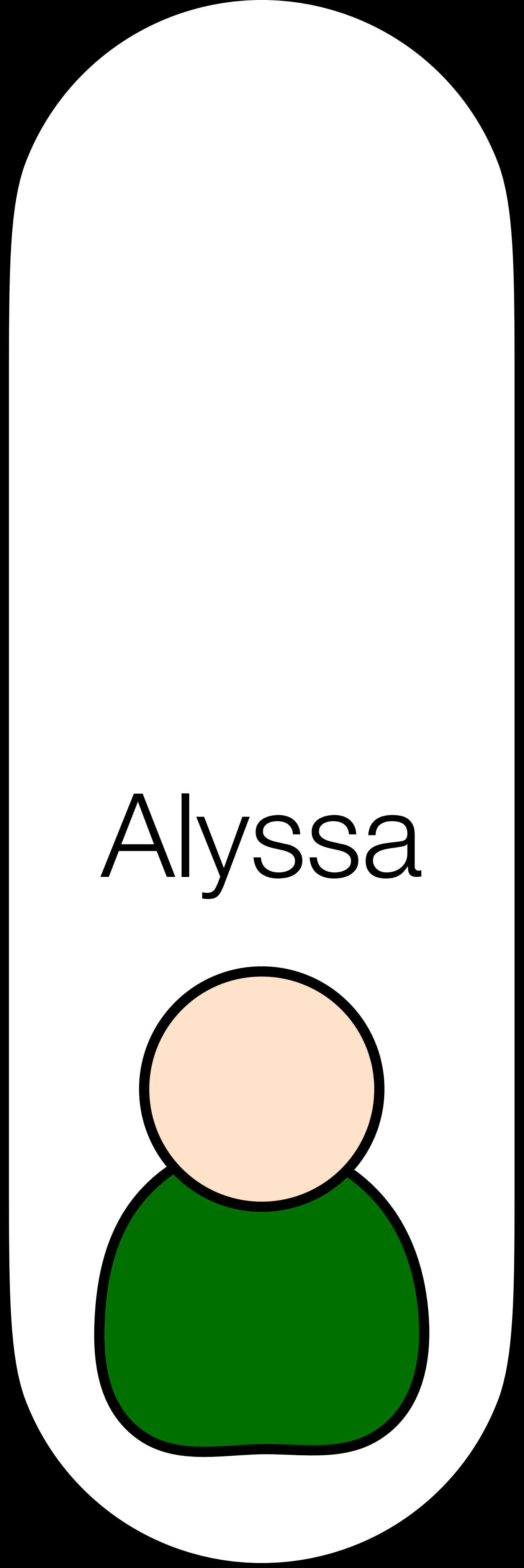

Alyssa
Cecelia
Douglas
Lucas
Matthew
Ramya
Samia

Lucas



Cecelia




Alyssa

How many steps did each algorithm take?

Linear Search	Binary Search

How many steps did each algorithm take?

Linear Search	Binary Search
3	3

What's the greatest number of steps this algorithm will *ever* take?

Linear Search	**Binary Search**

What's the greatest number of steps this algorithm will *ever* take?

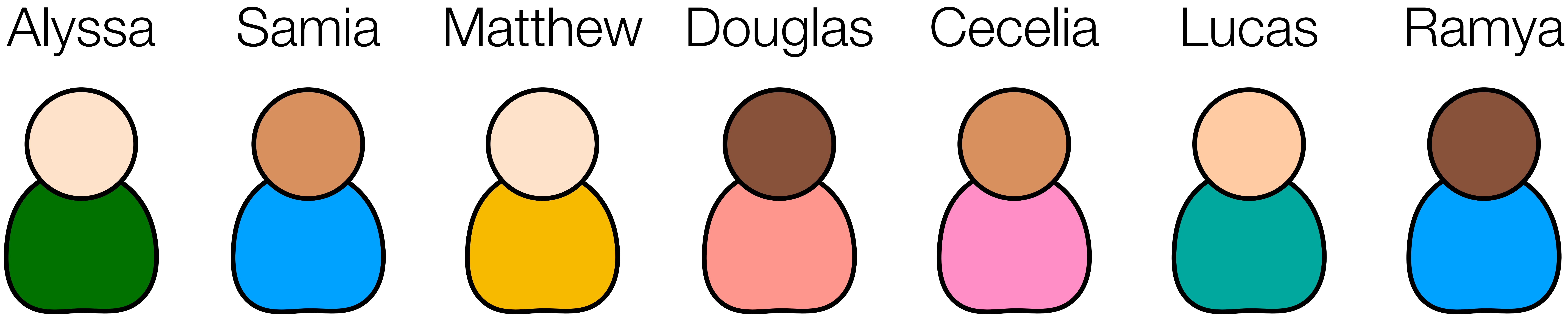
Linear Search	Binary Search
7	$log_2(7)$

What's the greatest number of steps this algorithm will *ever* take?

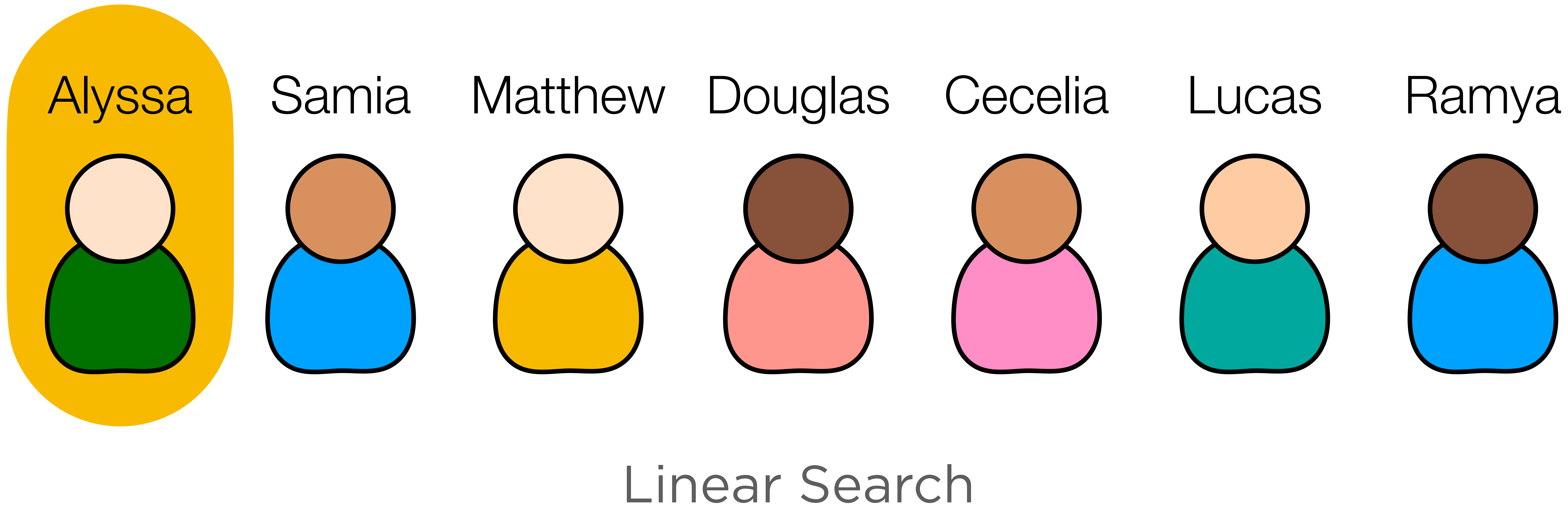
Linear Search	**Binary Search**
N	$log_2(N)$

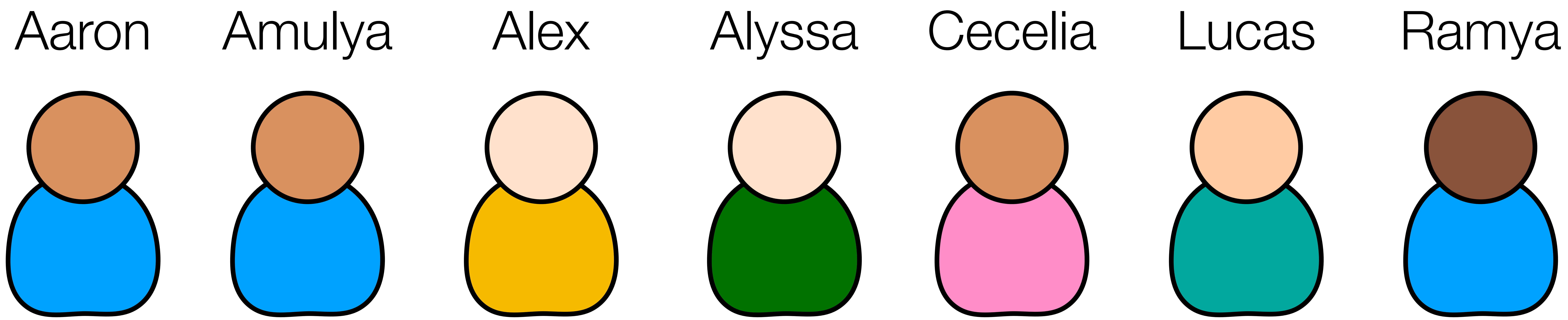
What's (approximately!) the greatest number of steps this algorithm will *ever* take?

Linear Search	Binary Search
$O(N)$	$O(log(N))$

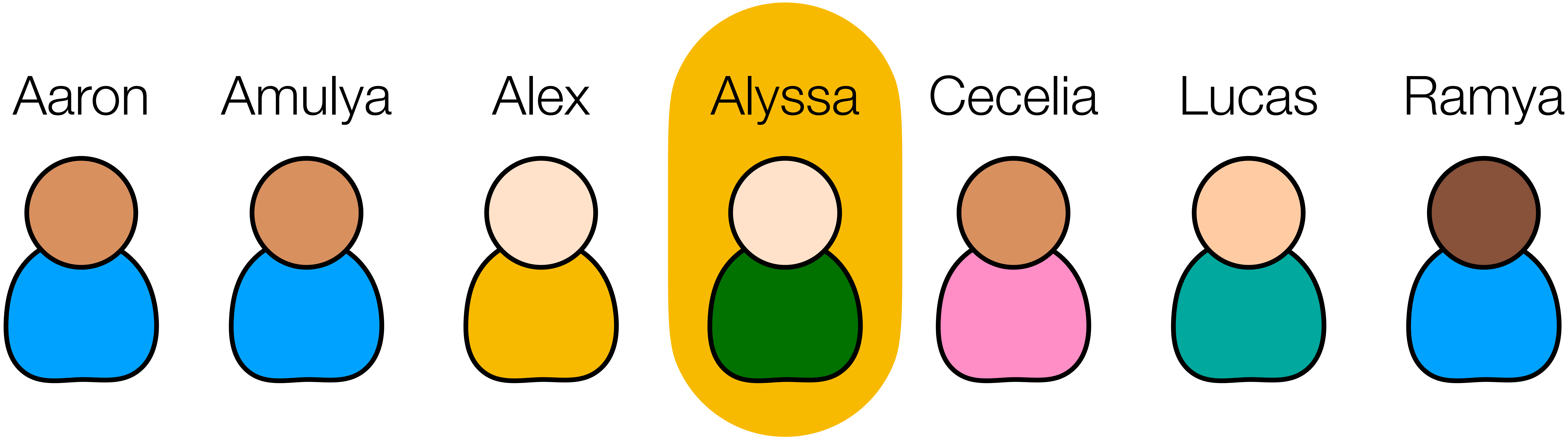


Linear Search


Alyssa
Samia
Matthew
Douglas
Cecelia
Lucas
Ramya
Linear Search



Binary Search



Binary Search

How many steps did each algorithm take?

Linear Search	Binary Search

How many steps did each algorithm take?

Linear Search	Binary Search
1	1

What's the *fewest* number of steps this algorithm could ever take?

Linear Search	Binary Search

What's the *fewest* number of steps this algorithm could ever take?

Linear Search	Binary Search
1	1

What's (approximately!) the *fewest* number of steps this algorithm will ever take?

Linear Search	**Binary Search**
$\Omega(1)$	$\Omega(1)$

Thought Question

- Suppose that you create a new algorithm and assess its runtime.
- The *fewest* steps this algorithm will ever take is 2, and only 2.
- What is the Ω notation for this algorithm?

Common Notations

- $O(1)$
- $O(log(N))$
- $O(N)$
- $O(N^2)$

- $\Omega(1)$
- $\Omega(log(N))$
- $\Omega(N)$
- $\Omega(N^2)$

Sort

Algorithm	O	Ω
Merge Sort	$O(Nlog(N))$	$\Omega(Nlog(N))$
Selection Sort	$O(N^2)$	$\Omega(N^2)$
Bubble Sort	$O(N^2)$	$\Omega(N)$

Algorithm	`reversed50000.txt`	`sorted50000.txt`
Sort1		
Sort2		
Sort3		

Structs

```
typedef struct
{
    string name;
    int votes;
}
candidate;
```

```
typedef struct
{
    string name;
    int votes;
}
candidate;
```

Create a new "type", which holds a collection of other basic types.

```
typedef struct
{
    string name;
    int votes;
}
candidate;
```

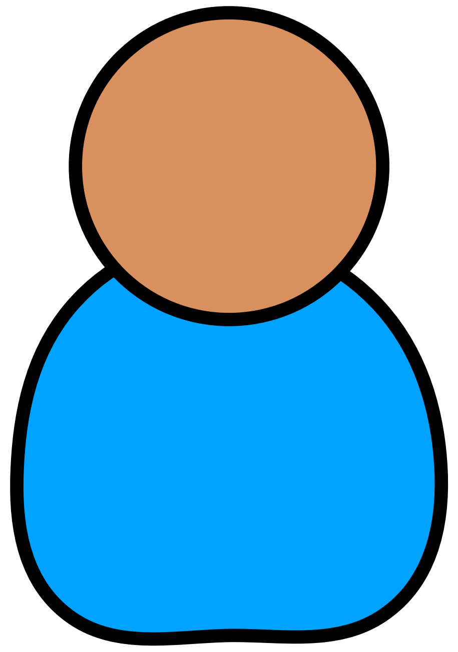
Give the struct a name that can be re-used in the rest of the file.

```
typedef struct
{
    string name;
    int votes;
}
candidate;
```

Known as a structure's **members**.

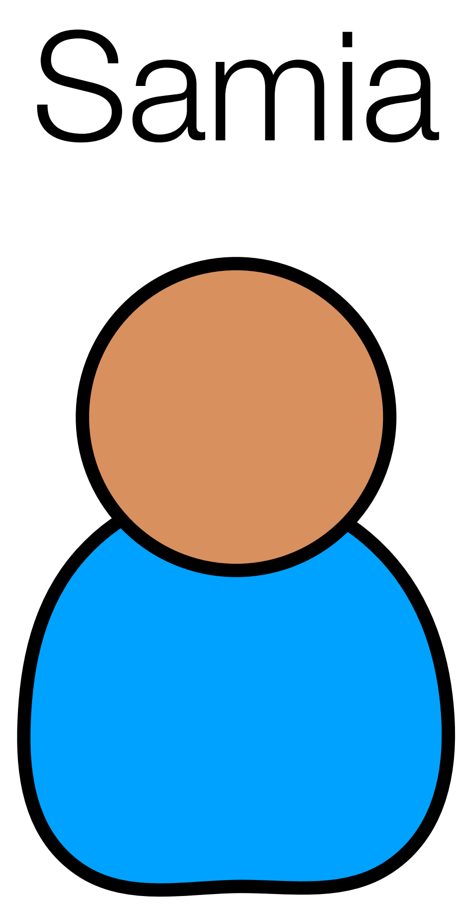
```
typedef struct
{
    string name;
    int votes;
}
candidate;

candidate president;
```



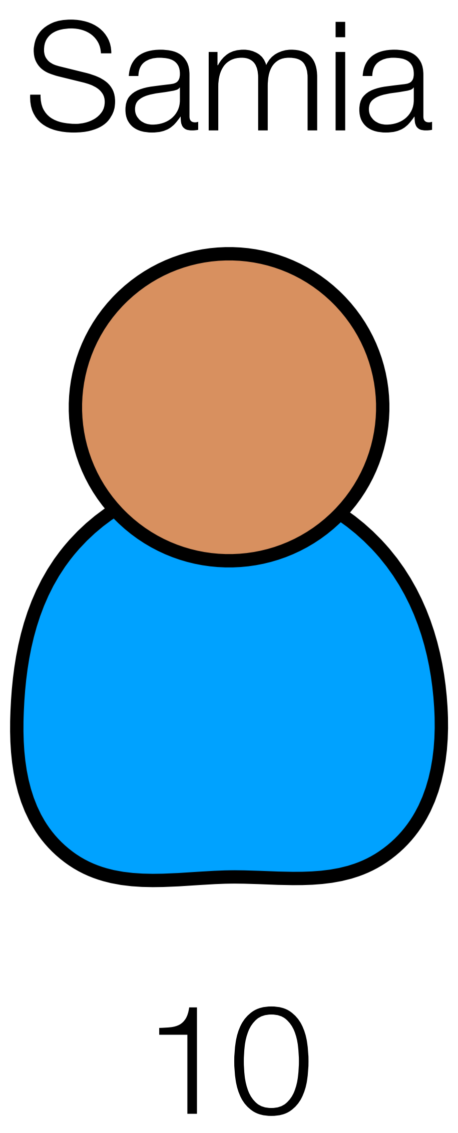
```
typedef struct
{
    string name;
    int votes;
}
candidate;

candidate president;
president.name = "Samia";
```



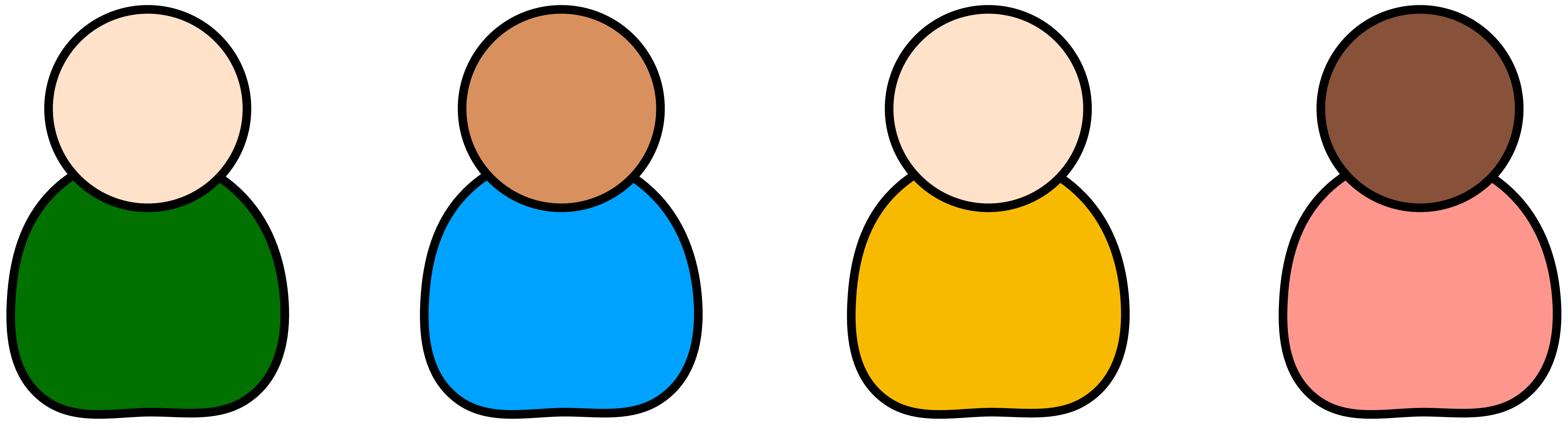
```
typedef struct
{
    string name;
    int votes;
}
candidate;

candidate president;
president.name = "Samia";
president.votes = 10;
```



```
typedef struct
{
    string name;
    int votes;
}
candidate;

candidate candidates[4];
```



Most Votes

- Create an array of candidates.
- Search the array to find the most votes awarded to any single candidate.
- Print out that candidate's name.

Recursion

Factorial

1! = 1

2! = 2 * 1

3! = 3 * 2 * 1

4! = 4 * 3 * 2 * 1

Factorial

```
         1! = 1
     2! = 2 * 1
 3! = 3 * 2 * 1
4! = 4 * 3 * 2 * 1
```

Factorial

$4! = ?$

Factorial

$$4! = 4 * \underbrace{3!}_{\text{Recursive call}}$$

Factorial

```
4! = 4 * 3!
3! = 3 * 2!
2! = 2 * 1!
1! = 1
```

Base case

Factorial

$4! = 4 * 3!$

$3! = 3 * 2!$

$2! = 2 * 1!$

$1! = 1$

Call stack

Factorial

$$4! = 4 * 3!$$

$$3! = 3 * 2!$$

$$2! = 2 * 1$$

Factorial

$$4! = 4 * 3!$$

$$3! = 3 * 2 * 1$$

Factorial

```
4! = 4 * 3 * 2 * 1
```

Creating a Factorial Function

- In a file called **factorial.c**, implement a function called **factorial** to return the factorial of a given number.
- Call **factorial** from **main** and print the result from **factorial**.

This is CS50

Week 3