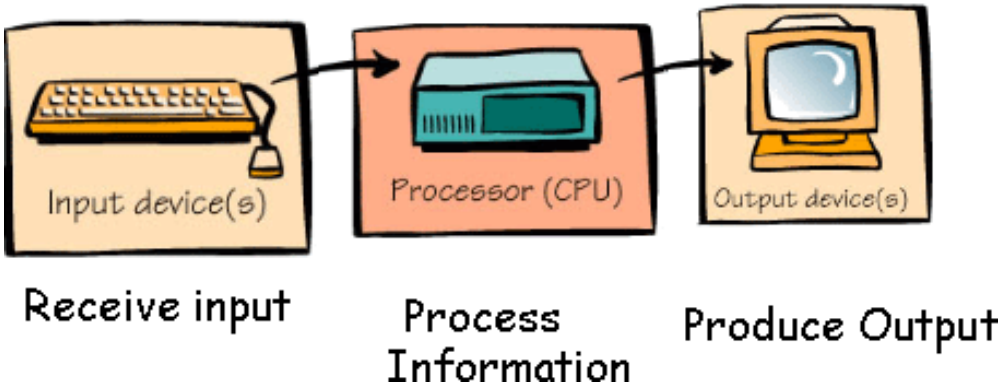
What Computers Do



Week 3 - Lecture 3

Simple Algorithms

Edited by: Heshan Du

Autumn 2023

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Overview

- Sorting Algorithms
- Search Algorithms
- Type Casting
- Array of Pointers

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Example: Module Mark

- There are 3 students in the year. Each of them has taken 2 modules.
- Read their marks one by one, student by student, then print them out module by module.

```c
#include<stdio.h>

int main(void){

    const int NUM_STUDENTS = 3;
    const int NUM_MOD = 2;
    int marks[NUM_STUDENTS][NUM_MOD];

    int s = 0;
    int m = 0;
    for(s =0; s< NUM_STUDENTS; s++){

        for(m = 0; m < NUM_MOD; m++){

            printf("Student %d, module %d: ", s+1, m+1);

            int mark=0;
            scanf("%d", &mark);
            marks[s][m] = mark;


        }
    }

    printf("\n\nThe marks entered:\n");
    for(m=0; m< NUM_MOD; m++){

        for(s=0; s< NUM_STUDENTS; s++){

            printf("Student %d, module %d: %d\n", s+1, m+1, marks[s][m]);


        }
    }

    return 0;
}
```

Use nested for loops to solve this problem.

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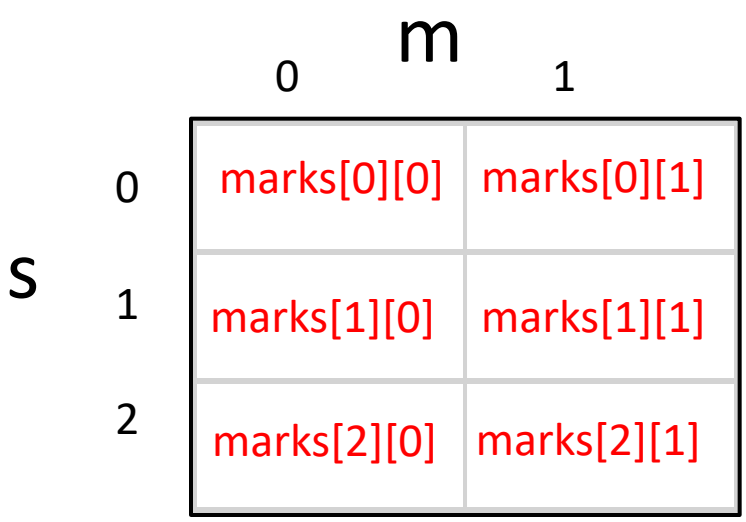
marks

s \ m	0	1
0	marks[0][0]	marks[0][1]
1	marks[1][0]	marks[1][1]
2	marks[2][0]	marks[2][1]



marks[s][m]

marks[0][0]
marks[0][1]
marks[1][0]
marks[1][1]
marks[2][0]
marks[2][1]

3

```
for (s = 0; s < NUM_STUDENTS; s++)
{
        for (m = 0; m < NUM_MOD; m++)
        {
                ............. marks[s][m]............
        }
}
```

2

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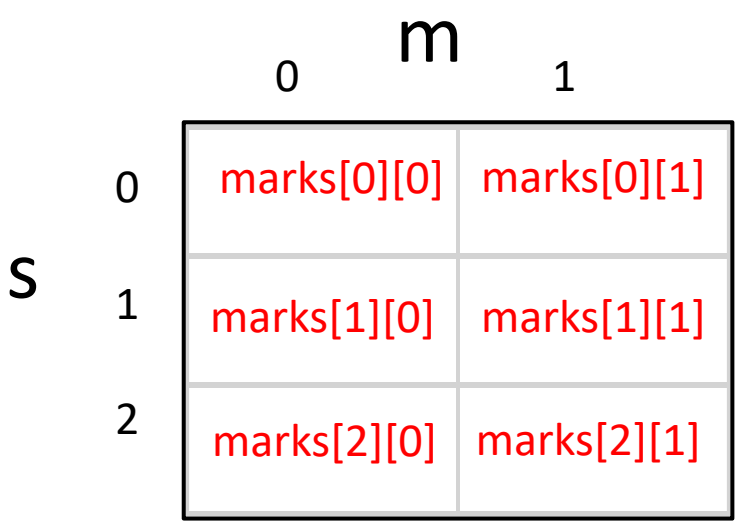
marks



marks[s][m]

marks[0][0]
marks[1][0]
marks[2][0]
marks[0][1]
marks[1][1]
marks[2][1]

2

```
for (m = 0; m < NUM_MOD; m++)
{
                                    3
        for (s = 0; s < NUM_STUDENTS; s++)
        {
                ..... marks[s][m].....
        }
}
```

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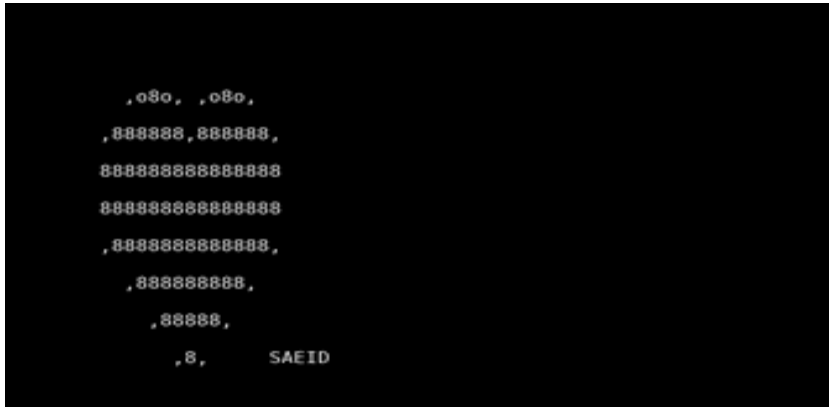
Example: 2D shapes

- Create a program that holds an 80 x 25 array of characters to show a shape.
- You can change the values in the array as if you were drawing.
- E.g., http://www.ascii-art.de/ascii/



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Overview

- **Sorting Algorithms**
- Searching Algorithms
- Type Casting
- Array of Pointers

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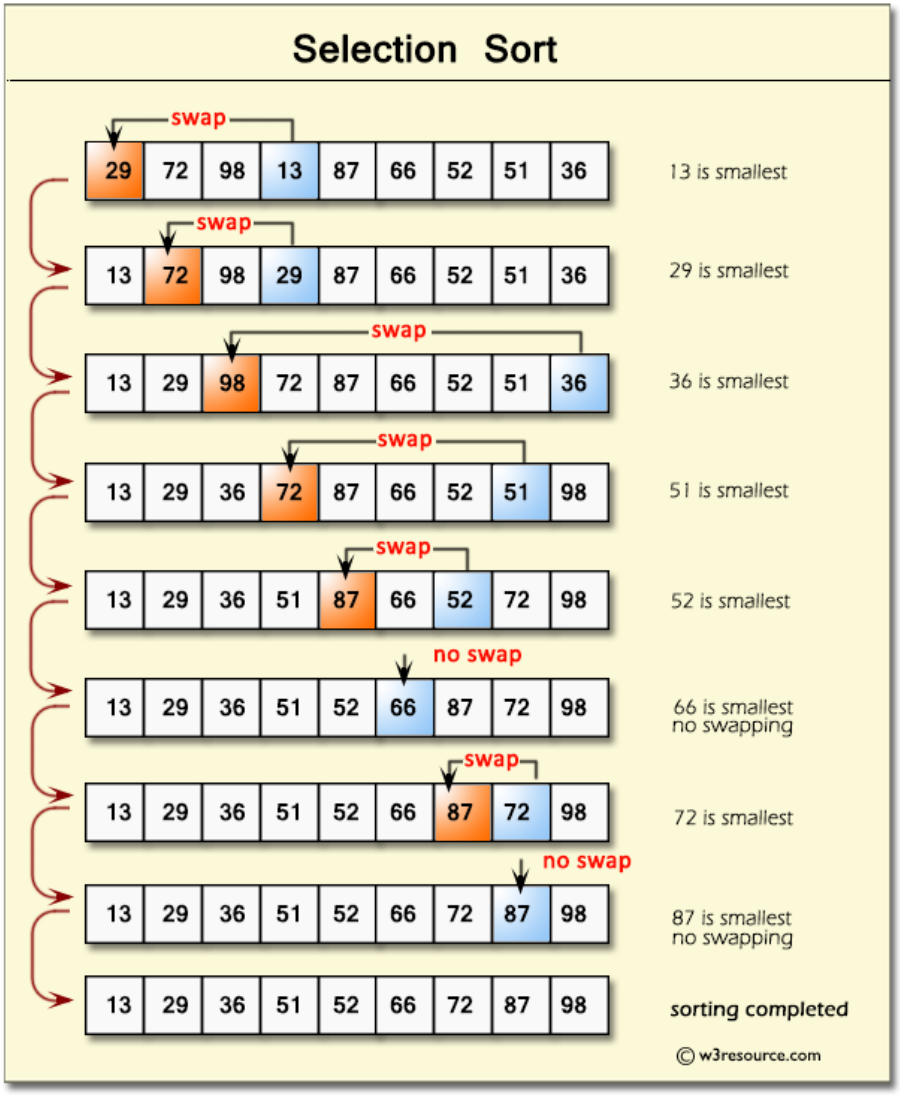
Selection Sort

- Repeatedly **find the minimum element** and swap with the element at the index where it is supposed to be (from the beginning of the array).



https://www.w3resource.com/php-exercises/searching-and-sorting-algorithm/searching-and-sorting-algorithm-exercise-4.php

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Selection Sort (2)

```
for(i = 0; i < n - 1; i++)
{
        position=i;
        for(j = i + 1; j < n; j++)
        {
                if(a[position] > a[j])
                        position=j;
        }
        if(position != i)
        {
                temp=a[i];
                a[i]=a[position];
                a[position]=temp;
        }
}

printf("Sorted Array\n");
for(i = 0; i < n; i++)
        printf("%d\n", a[i]);
```

Outer Loop

Inner Loop

swap

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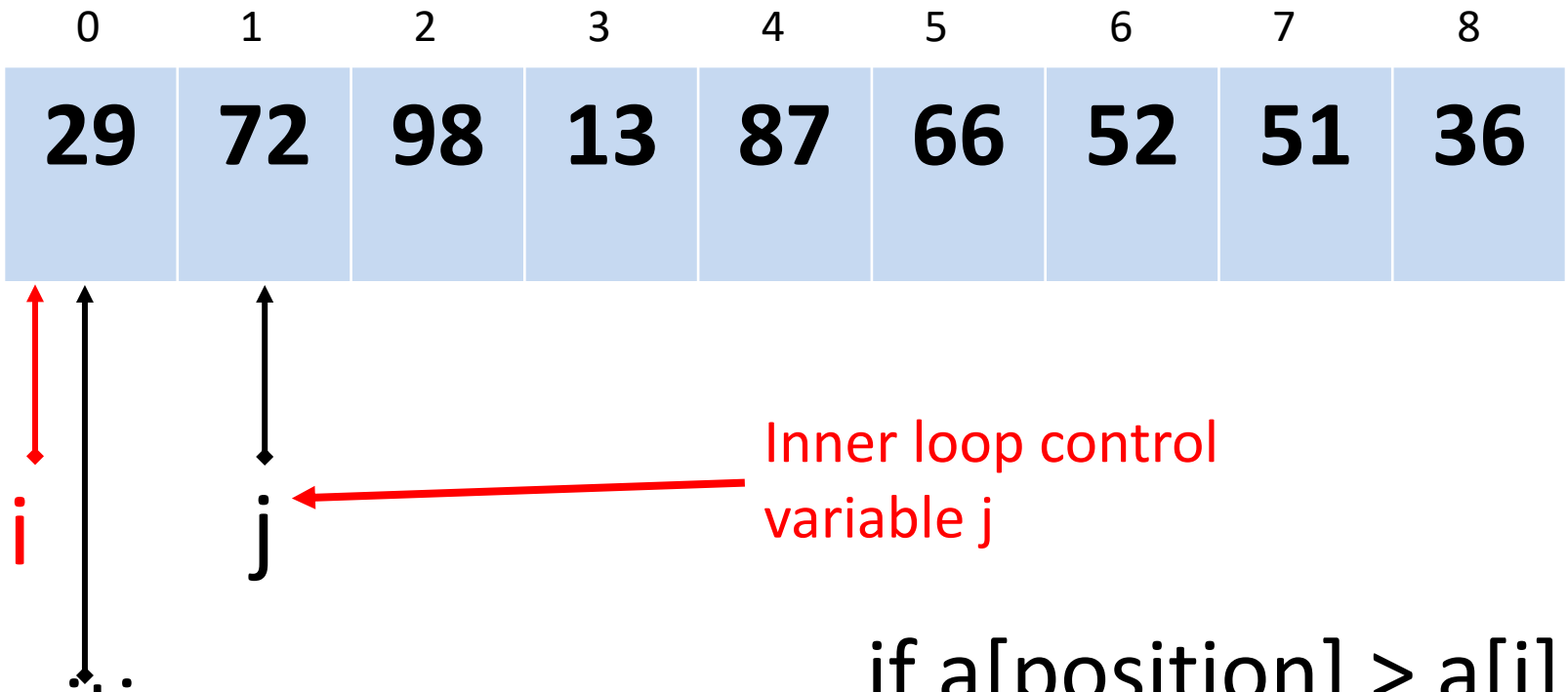


```
if a[position] > a[j];
    position = j;
```

Outer loop control variable i

```
i = 0;
position = i;
```

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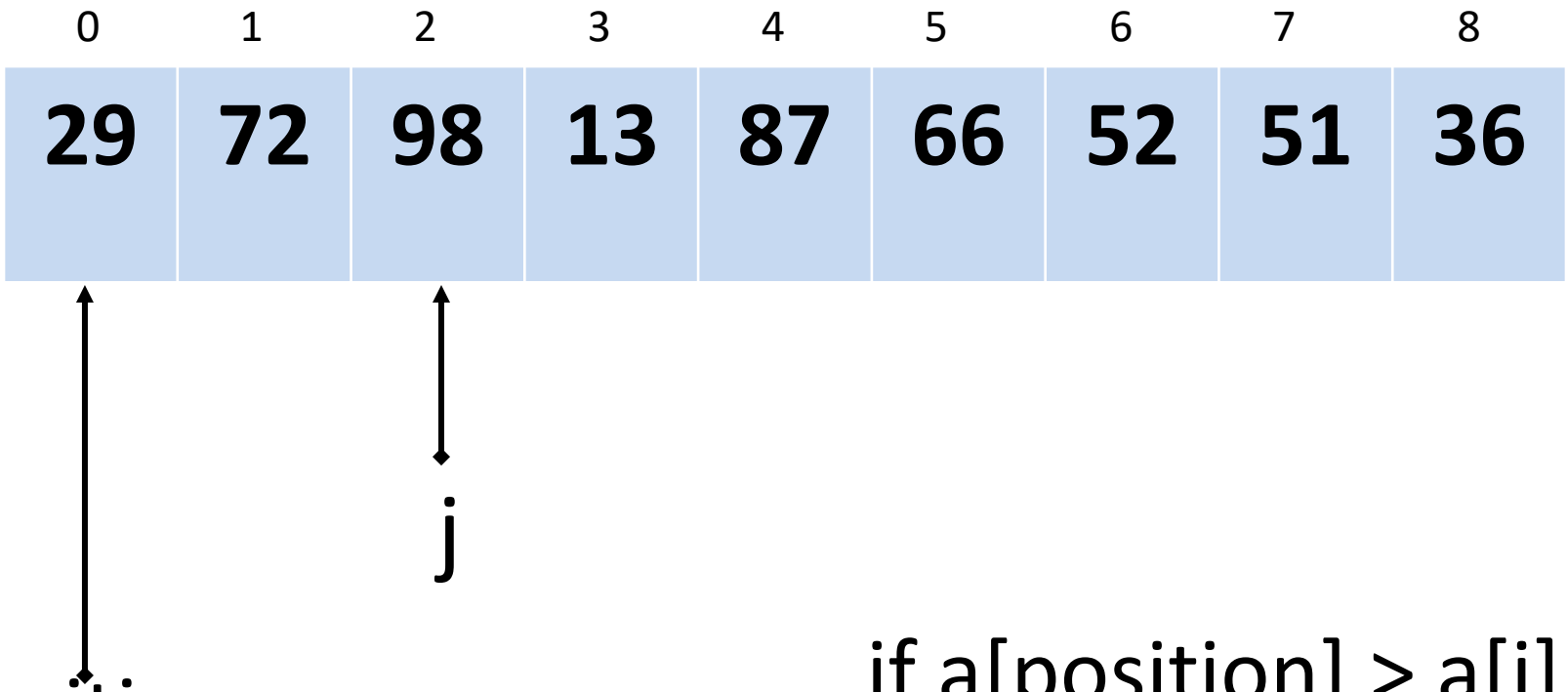

if a[position] > a[j];
position = j;

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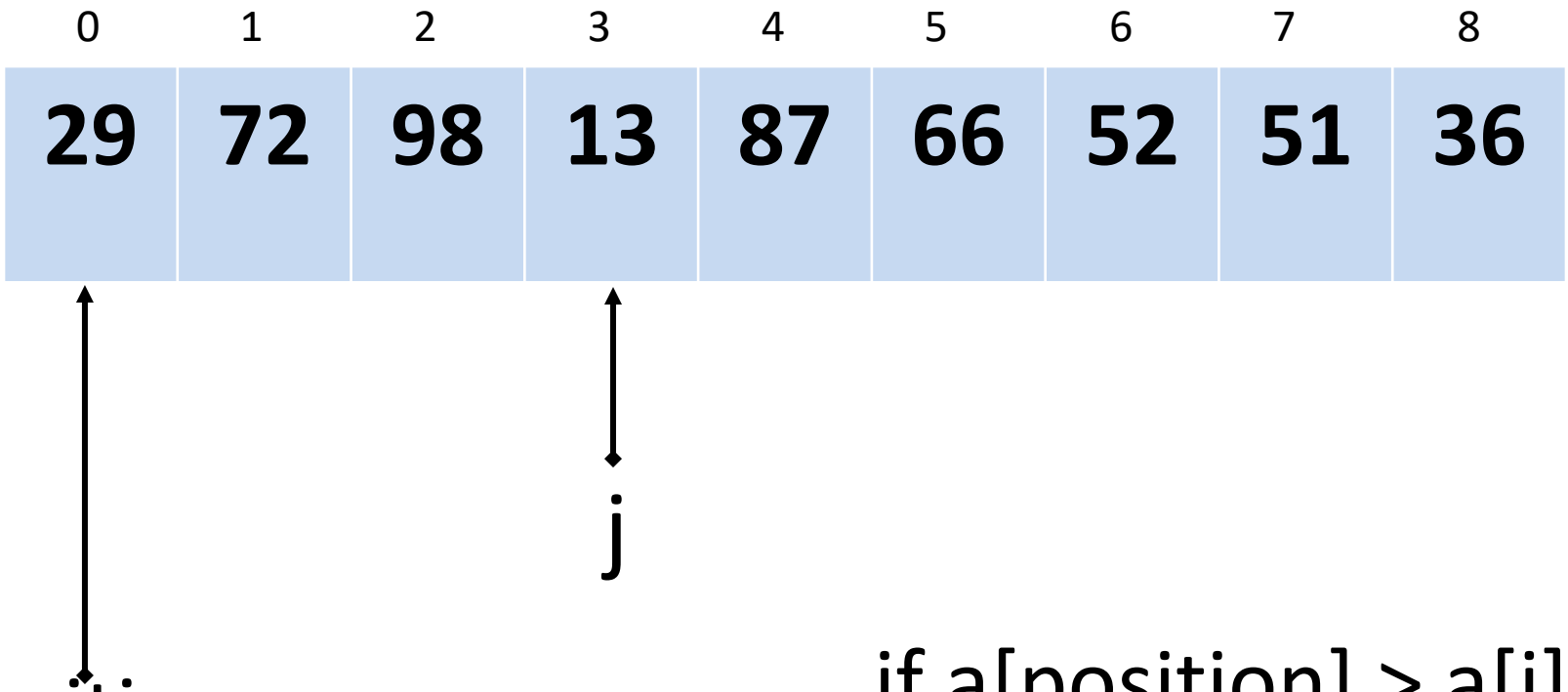


```
if a[position] > a[j];
    position = j;
```

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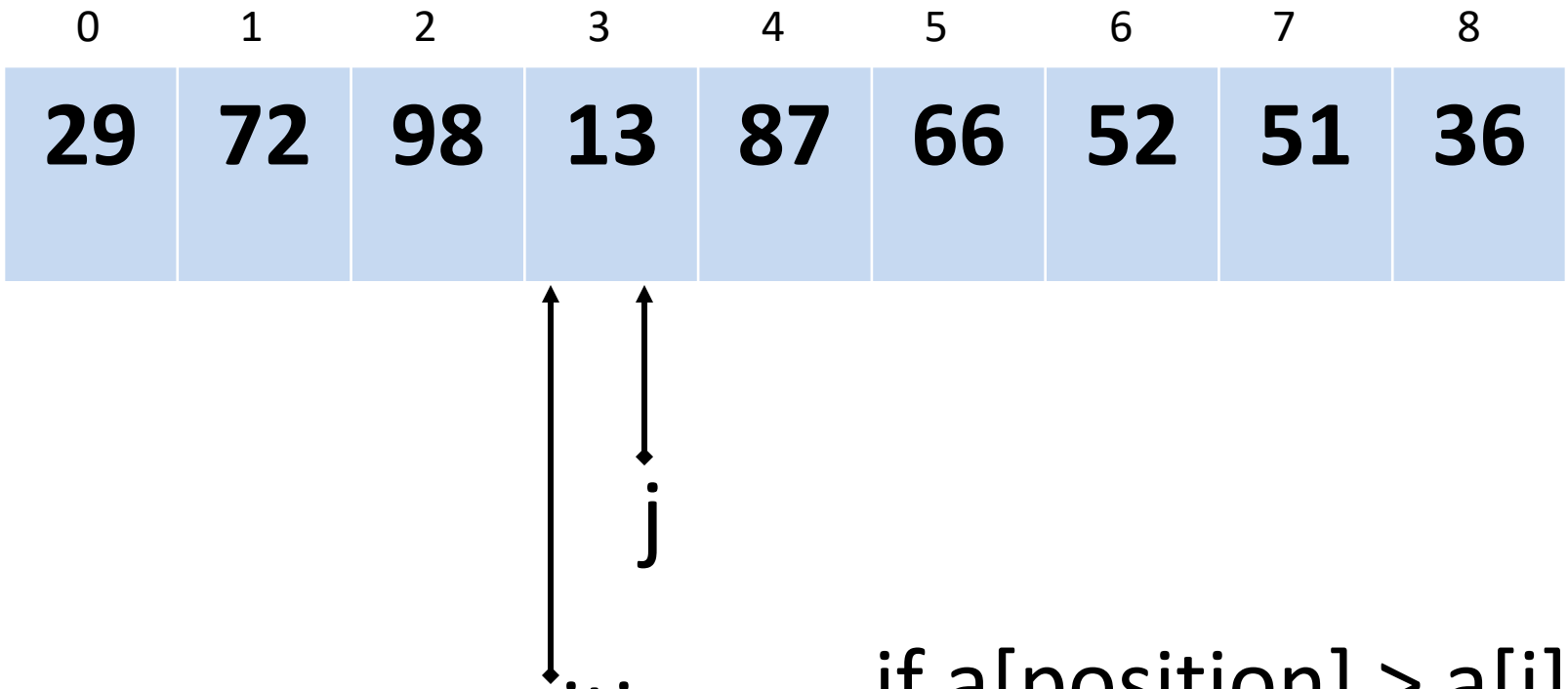


```
if a[position] > a[j];
    position = j;
```

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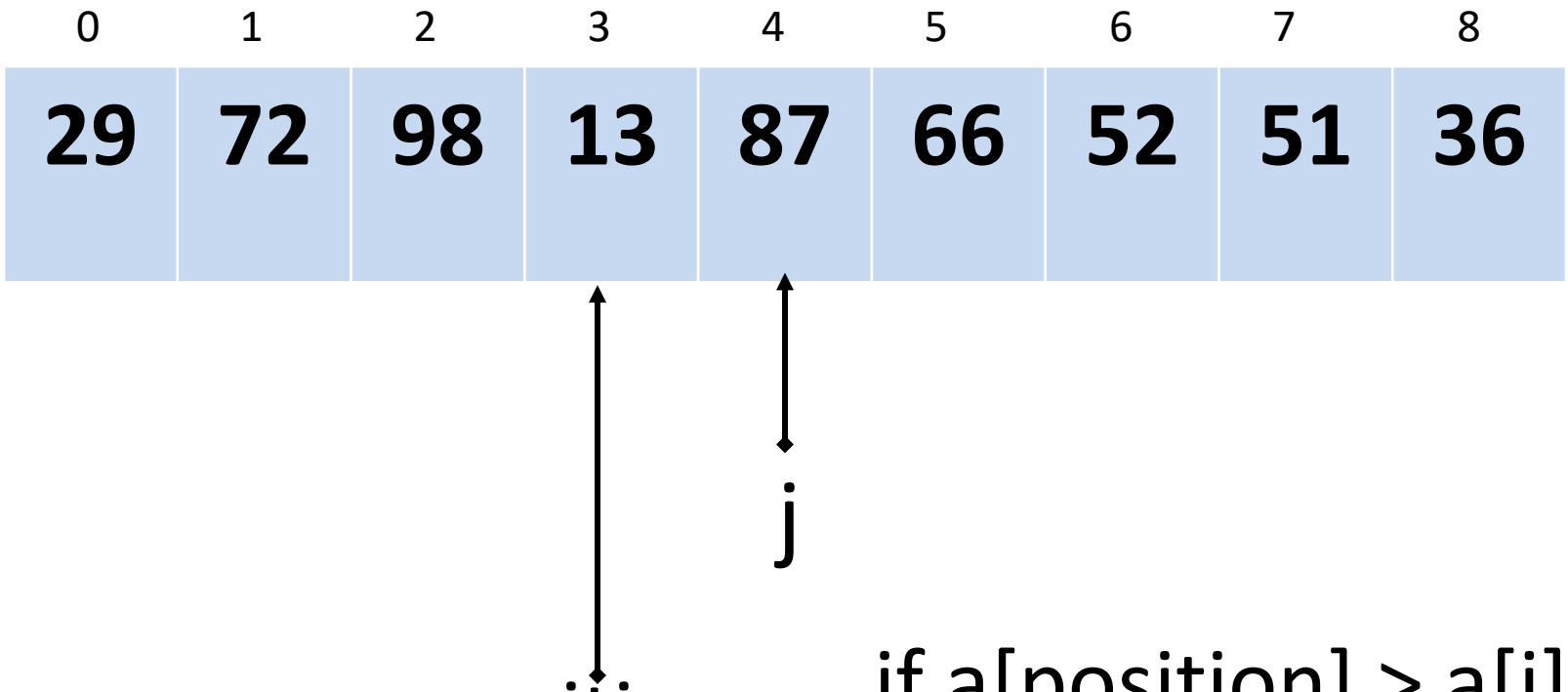

if a[position] > a[j];
position = j;

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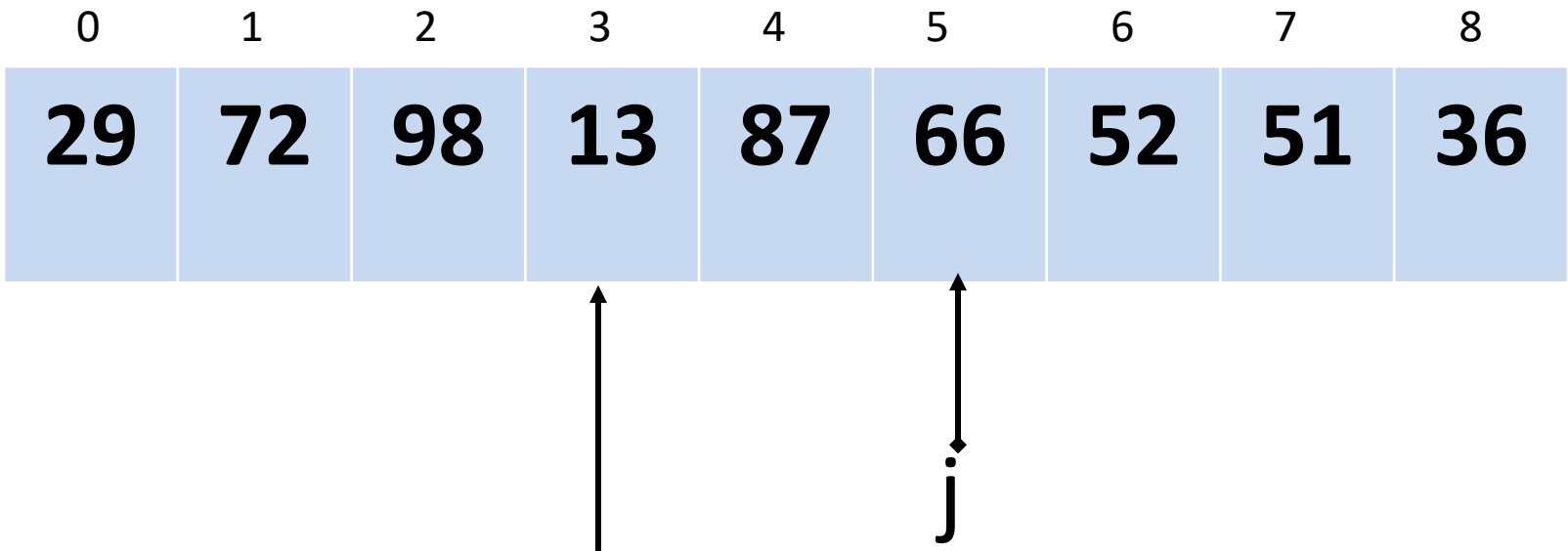

if a[position] > a[j];
position = j;

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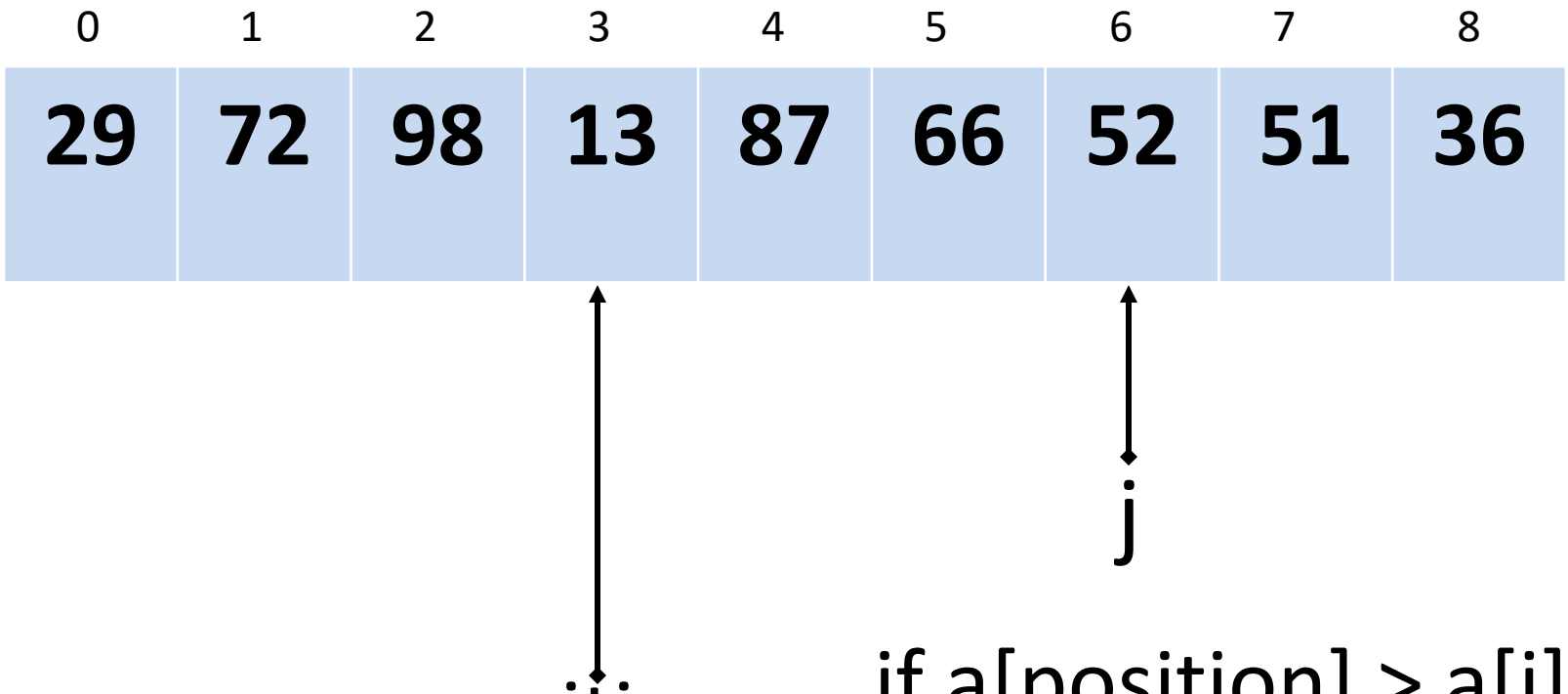

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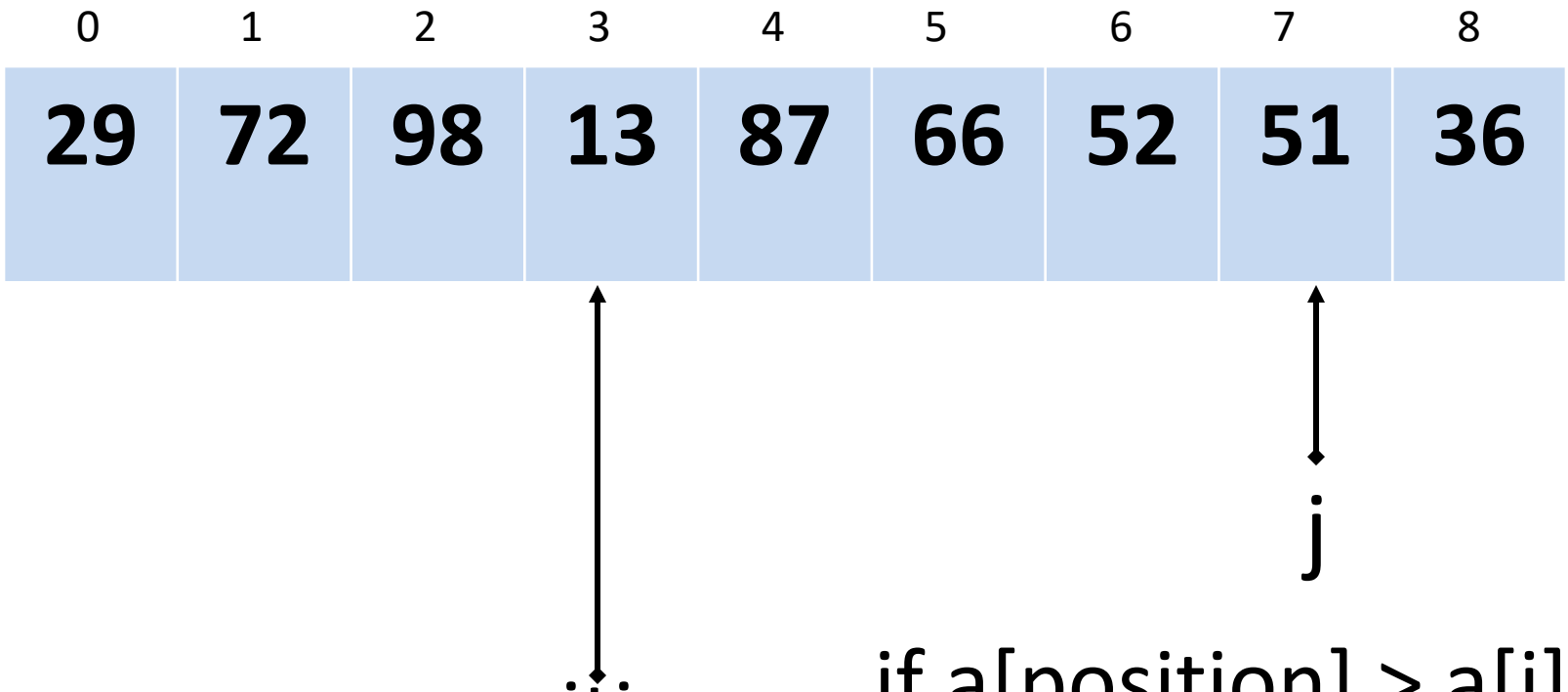

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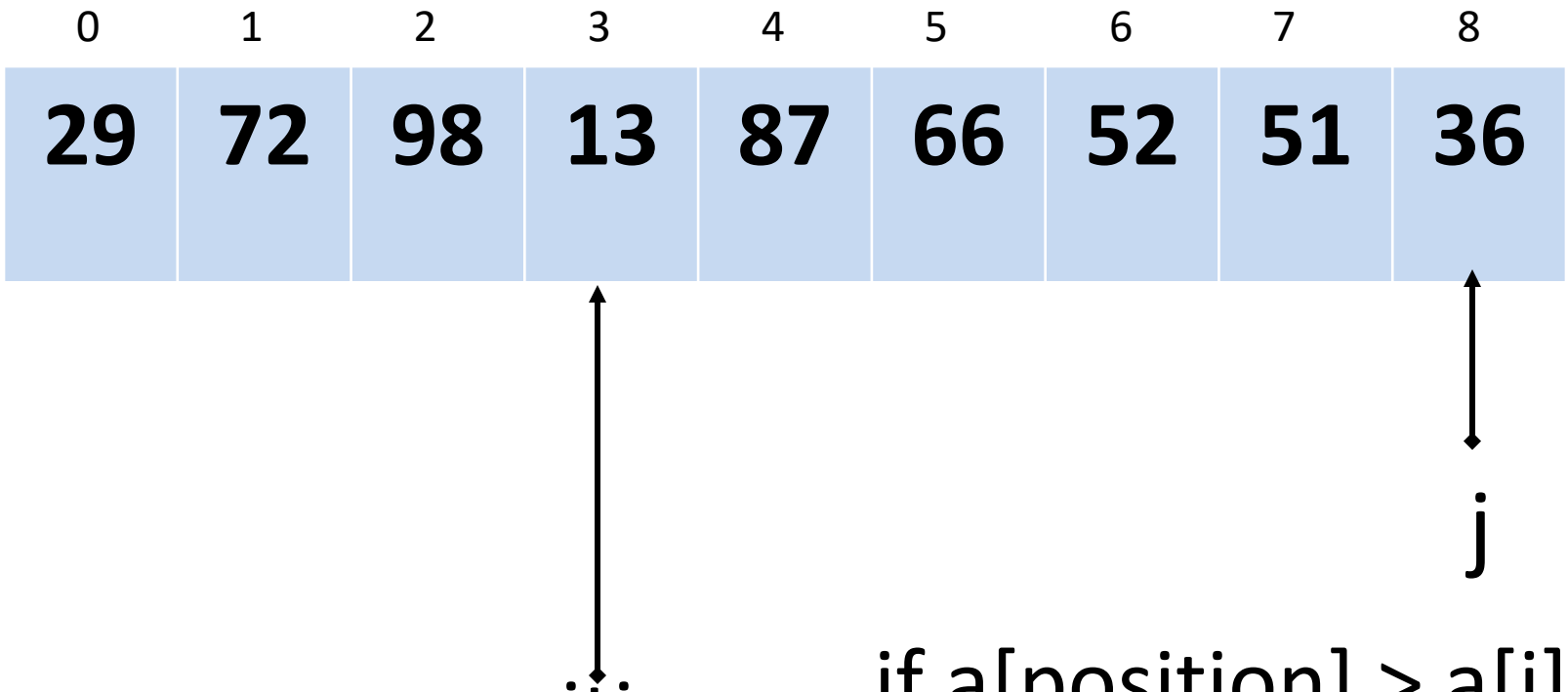

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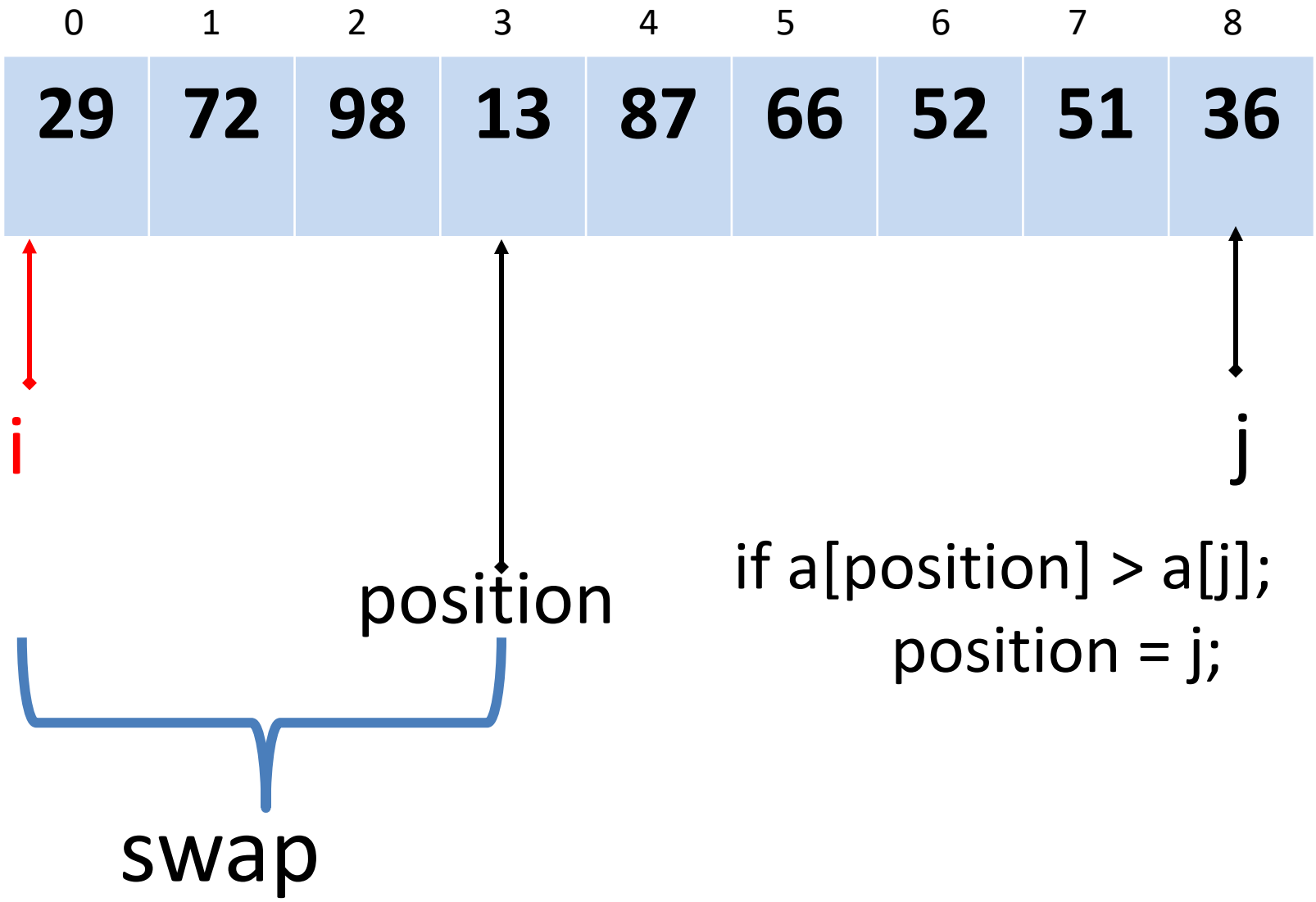

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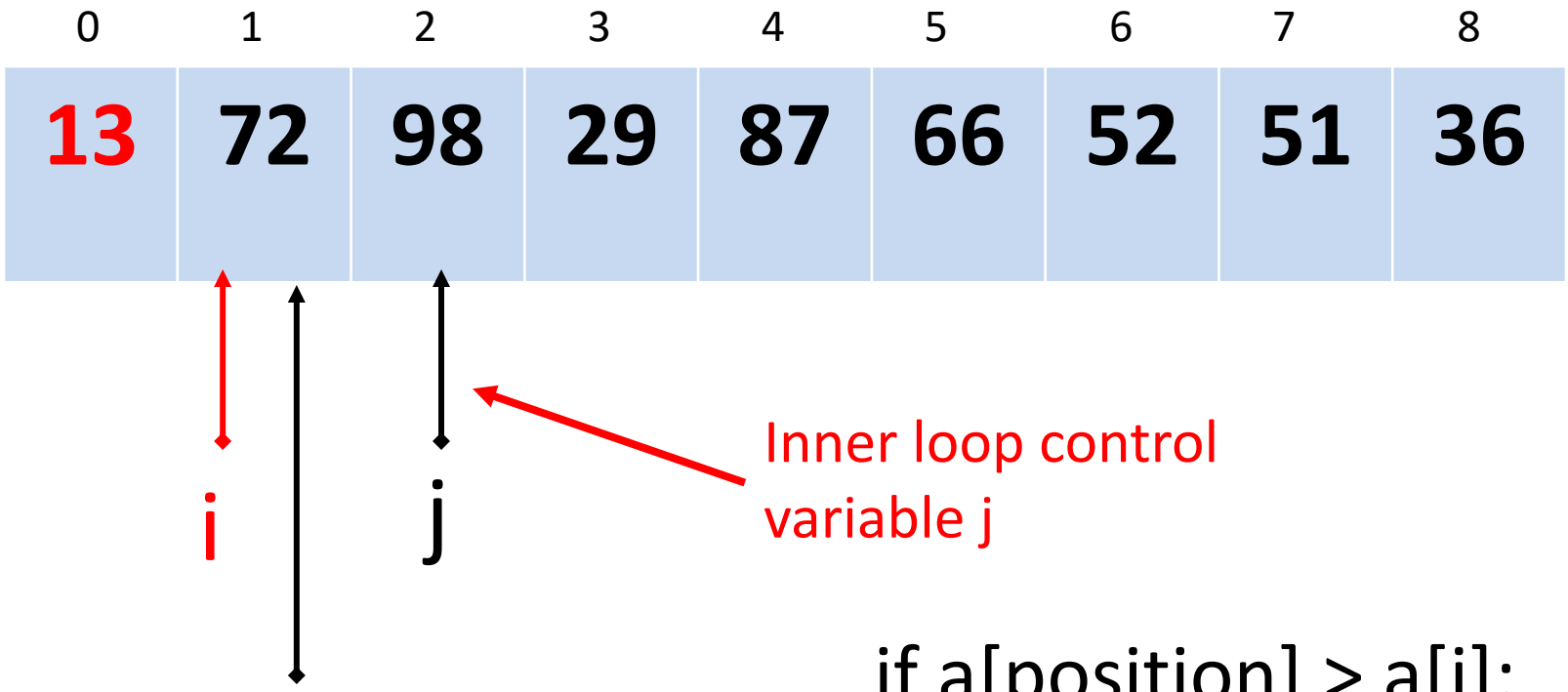


```
if a[position] > a[j];
    position = j;
```

Outer loop control variable i

```
i = 1;
position = i;
```

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Bubble Sort

Bubble sort or the sinking sort: the smaller values gradually "bubble" their way upward to the top of the array like air bubbles rising in water, while the larger values sink to the bottom of the array.

https://www.coderarticles.com/bubble-sort-algorithm/

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Bubble Sort (2)

```
int temp = 0;
int i = 0;
int j = 0;

for(i = 0; i< length; i++){

   for(j = 0; j < length-1; j++){

           if(arr[j] > arr[j+1]){
                   temp = arr[j];
                   arr[j] = arr[j+1];
                   arr[j+1] = temp;
           }

   }

}
```

swap

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Animation of Bubble Sort

https://www.cc.gatech.edu/~bleahy/cs1311/cs1311lecture16wdl.ppt Slides 24-96

https://visualgo.net/en

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Overview

- Sorting Algorithms
- **Searching Algorithms**
- Type Casting
- Array of Pointers

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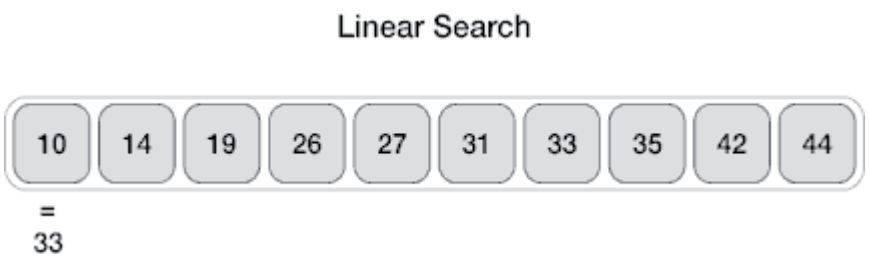
Linear Search

A sequential search, every item is checked until the end of the data collection or the item is found.




```
450     int index = -1;
451     for(i = 0; i < count; i++)
452     {
453         if(hunt == myInt[i])
454         {
455             index = i;
456             break;
457         }
458     }
```

Source: https://www.tutorialspoint.com/data_structures_algorithms/linear_search_algorithm.htm

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Binary Search

- The linear searching method works well for *small* or *unsorted* arrays.
- However, for large arrays linear searching is *inefficient*.
- *If the array is sorted*, the high-speed binary search technique can be used.
- The binary search algorithm eliminates from consideration *one-half* of the elements in a sorted array after each comparison.

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Binary Search (2)

- An array of 1,048,576 (2^{20}) elements takes a maximum of only 20 comparisons to find the search key.

- This is a tremendous increase in performance over the linear search that required comparing the search key to an average of half of the array elements.

- Binary search, focuses on “Divide and Conquer”, requires *sorted array*.

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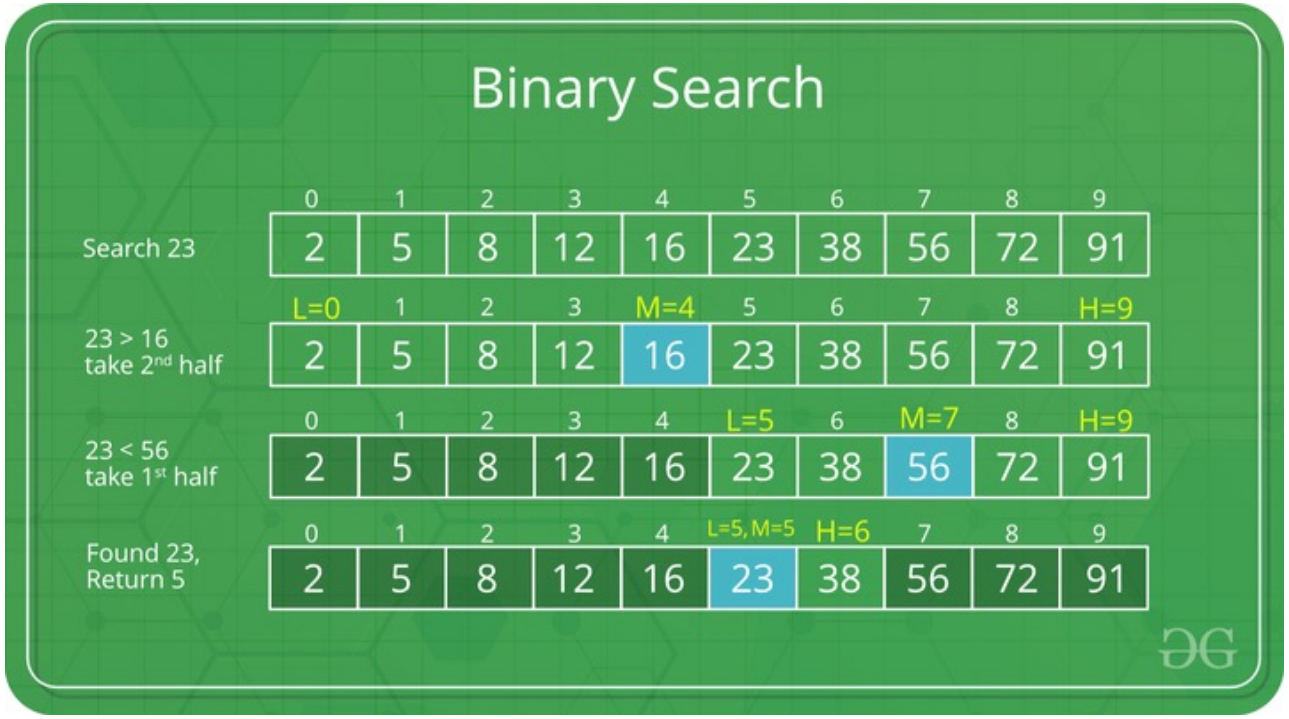
Binary Search



Source: https://www.geeksforgeeks.org/binary-search/

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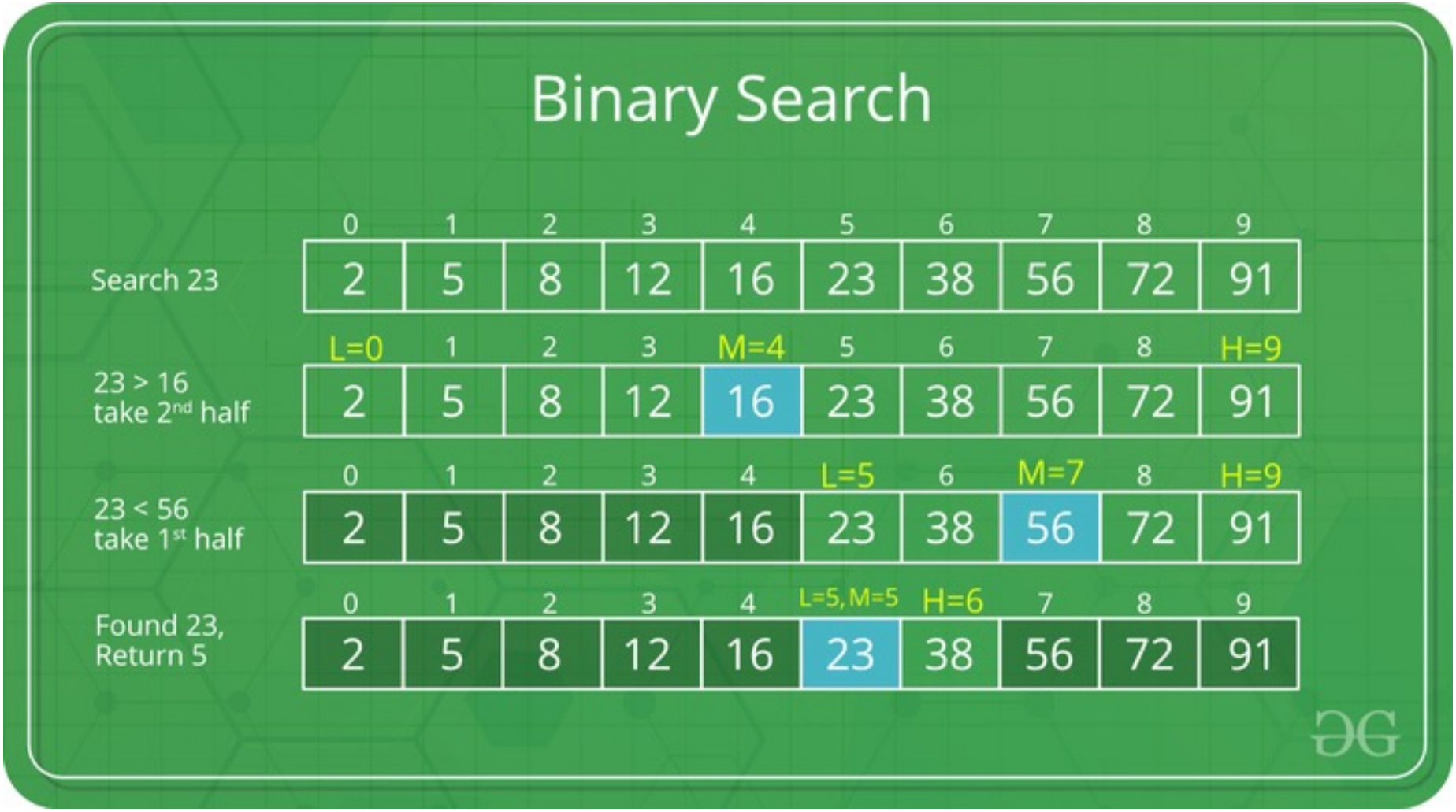

Source: https://www.geeksforgeeks.org/binary-search/

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Animation of Binary Search:

https://www.cc.gatech.edu/~bleahy/cs1311/cs1311lecture15wdl.ppt Slides 130-136

https://algorithm-visualizer.org/branch-and-bound/binary-search

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Binary Search: code sample

```
#include <stdio.h>
int main()
{
  int c, first, last, middle, n, search,
array[100];

  printf("Enter number of elements\n");
  scanf("%d", &n);
  printf("Enter %d integers\n", n);

  for (c = 0; c < n; c++)
    scanf("%d", &array[c]);

  printf("Enter value to find\n");
  scanf("%d", &search);

  first = 0;
  last = n - 1;
  middle = (first+last)/2;
  while (first <= last) {
    if (array[middle] < search)
      first = middle + 1;
    else if (array[middle] == search) {
      printf("%d found at location %d.\n", search,
middle+1);
      break;
    }
    else
      last = middle - 1;

    middle = (first + last)/2;
  }
  if (first > last)
    printf("Not found! %d isn't present in the list.\n",
search);

  return 0;
}
```

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```
#include <stdio.h>
int main()
{
  int c, first, last, middle, n, search,  array[100];

  printf("Enter number of elements\n");
  scanf("%d", &n);
  printf("Enter %d integers\n", n);

  for (c = 0; c < n; c++)
    scanf("%d", &array[c]);

  printf("Enter value to find\n");
  scanf("%d", &search);

  first = 0;
  last = n - 1;
  middle = (first+last)/2;
```

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```
  while (first <= last) {
      if (array[middle] < search)
          first = middle + 1;
      else if (array[middle] == search) {
          printf("%d found at location %d.\n", search, middle+1);
          break;
      }
      else
          last = middle - 1;
      middle = (first + last)/2;
  }

  if (first > last)
      printf("Not found! %d isn't present in the list.\n", search);

  return 0;
}
```

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Binary Search: new solution, what do you think?

```
#include <stdio.h>
int binarySearch(int a[], int s, int e, int f);

int main()
{
  int c, first, last, n, search, array[100], index;

  printf("Enter number of elements\n");
  scanf("%d", &n);

  printf("Enter %d integers\n", n);

  for (c = 0; c < n; c++)
    scanf("%d", &array[c]);

  printf("Enter value to find\n");
  scanf("%d", &search);

  first = 0;
  last = n - 1;

  index = binarySearch(array, first, last, search);

  if (index == -1)
    printf("Not found! %d isn't present in the list.\n", search);
  else
    printf("%d is present at location %d.\n", search, index +
1);

  return 0;
}

int binarySearch(int a[], int s, int e, int f) {
  int m;

  if (s > e) // Not found
    return -1;

  m = (s + e)/2;

  if (a[m] == f)  // element found
    return m;
  else if (f > a[m])
    return binarySearch(a, m+1, e, f);
  else
    return binarySearch(a, s, m-1, f);
}
```

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Type Casting

- Convert the type of an expression to another type

- (data_type) expression

- float a, b, c = 2.34;
  b = (int)(c+4.6)

b is 6

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Explicit Type Conversions

- Implicit type conversion

```
float f;
int i;
i = f;
```

- Explicit type conversion

```
float f;
int i;
i = (int) f;
```

Same result, but for explicit type conversion the reader knows for sure that it was intentional!!

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Initialisation

Example: variable initialized where declared

```
int max = 0;
/* use of max is within a page of where it is declared */
for (i=0; i<n; i++)
    if (vec[i] > max)
        max = vec[i];
```

Example: variable initialized where used

Use an assignment statement just before the for loop:

```
int max;
...
/* several pages between declaration and use */
...
max = 0;
for (i=0 ; i<n ; i++)
    if (vec[i] > max)
        max = vec[i];
```

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Overview

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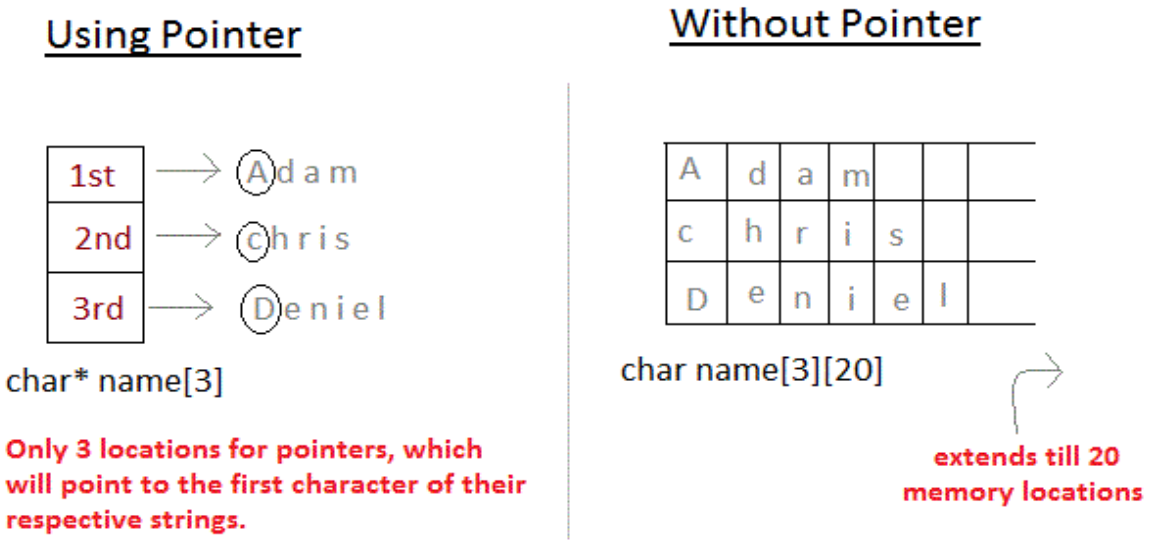
2D Array and Array of Pointers

- Array of pointers can be helpful in handling character array with varying length.

```
char *name[3] = {
    "Adam",
    "chris",
    "Deniel"
};
//Now lets see same array without using pointer
char name[3][20] = {
    "Adam",
    "chris",
    "Deniel"
};
```



Source: https://www.studytonight.com/c/pointers-with-array.php

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Summary

- Sorting Algorithms
- Searching Algorithms
- Type Casting
- Array of Pointers

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