Introduction to Programming

Lecture Six

N.R.Aravind

I.I.T. Hyderabad

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Topics in this lecture

- Structures
- Review
- Passing addresses
- Recursion
- Binary search

Structures

Structures: Example 1

```
struct Book
{
    char bookName[30];
    char author[20];
    float price;
};

struct Book book1,book2;
strcpy(book1.bookName,"Timeline");
strcpy(book1.author,"Michael Crichton");
book1.price=400;
```

Structures: Example 2

```
struct polynomial
{
    unsigned int degree;
    float coefficients[30];
};
```

Structures: Example 3

```
struct Circle
{
    double centerX;
    double centerY;
    double radius;
};
struct Circle c[10];
c[1].centerX=2.3;
c[1].centerY=-2.1;
c[1].radius=3.0;
```

Structures: Example 4

```
struct Point
{
    double x;
    double y;
};
struct Circle
{
    struct Point center;
    double radius;
};
```

Divide-and-Conquer

- Compute x^{80}.
- Method 1: Compute $x^2, x^3, \ldots, x^{79}, x^{80}$.
- Method 2: Compute $y = x^{40}$; then $x^{80} = y * y$.
- Method 2 (Bottom-up): Compute $x, x^2, x^4, x^8, x^{16}, x^{32}, x^{64}$.
- Write $x^{80} = x^{64} * x^{16}$.
- Write $x^{83} = x^{64} * x^{16} * x^2 * x$.
- $x^{105} = x^{64} * x^{32} * x^8 * x^1$.

Divide-and-Conquer: Top-down

- Compute x^{164}.
- Compute x^{82}.
- Compute x^{41}.
- Compute $y = x^{20}$; write $x^{41} = y * y * x$.
- Compute x^n.
- If n is even, square $x^{n/2}$.
- If n is odd, square $x^{(n-1)/2}$ and multiply by x.

Recursive solution

```
double power (double x, unsigned int n)
{
  double y;
  if (n==0) return 1;
  y=power(x,n/2);
  y=y*y;
  if (n%2==1) {y=y*x;}
  return y;
}
```

Binary search

Binary search

- $X \in [1, 100]$. Find X using Y/N questions.
- Is $X >= 50$?

Binary search

- $X \in [1, 100]$. Find X using Y/N questions.
- Is $X >= 50$? No.
  $X \in [1, 50]$.
- Is $X >= 25$?

Binary search

- $X \in [1, 100]$. Find X using Y/N questions.
- Is $X >= 50$? No.
  $X \in [1, 50]$.
- Is $X >= 25$? Yes.
  $X \in [25, 50]$.
- Is $X >= 37$?

Binary search

- $X \in [1, 100]$. Find X using Y/N questions.
- Is $X >= 50$? No.
  $X \in [1, 50]$.
- Is $X >= 25$? Yes.
  $X \in [25, 50]$.
- Is $X >= 37$? Yes.
  $X \in [37, 50]$.
- Is $X >= 43$?

Binary Search

```
int binarySearch(int value,int left,int right);
//
```

Binary Search

```
left=0; right=n-1;
while(right> left)
{
    mid =(left+right)/2;
    if (X<=a[mid])
        right=mid;
    else
        left=mid;
}
```

Binary Search

Finding square-root of X; X>=1.

```
left=1; right=X;
while (right-left>0.001)
{
    mid=(left+right)/2;
    if (mid*mid>X) right=mid;
    else left=mid;
}
```