Object Oriented Programming

Lecture 2

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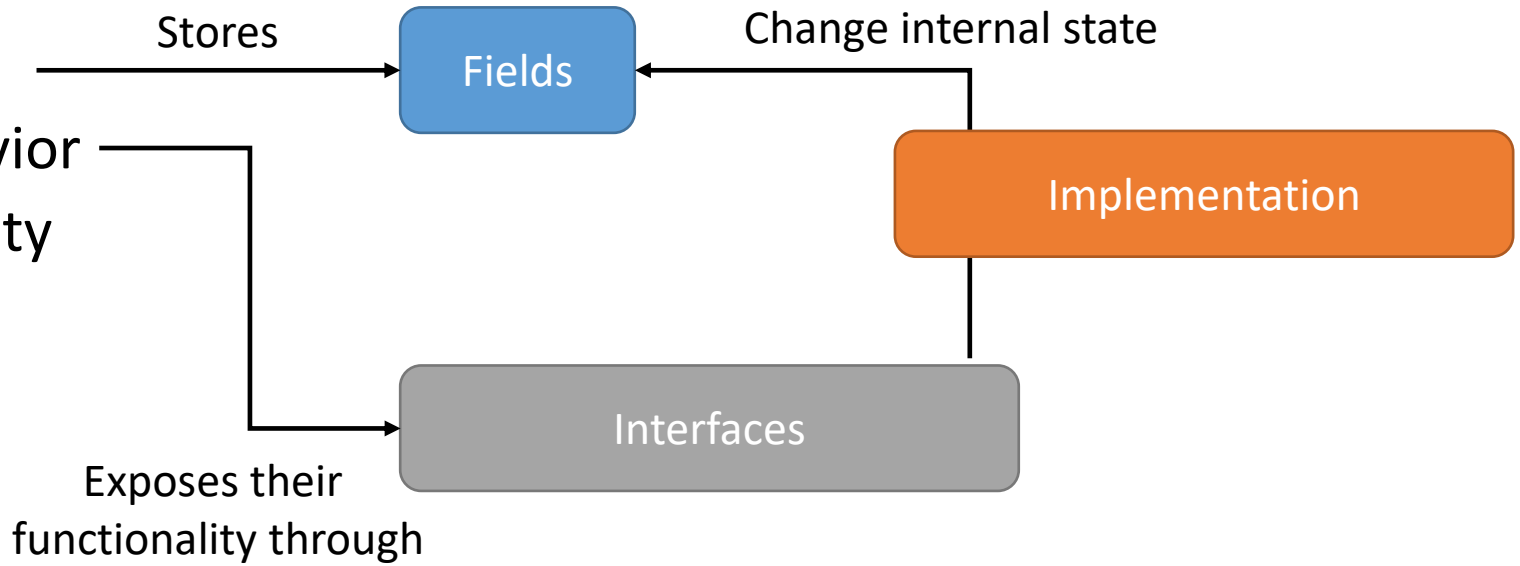
Object Oriented Modeling
Concepts

Last Class

- Model
- Object Oriented Model
- Object
  - State
  - Behavior
  - Identity



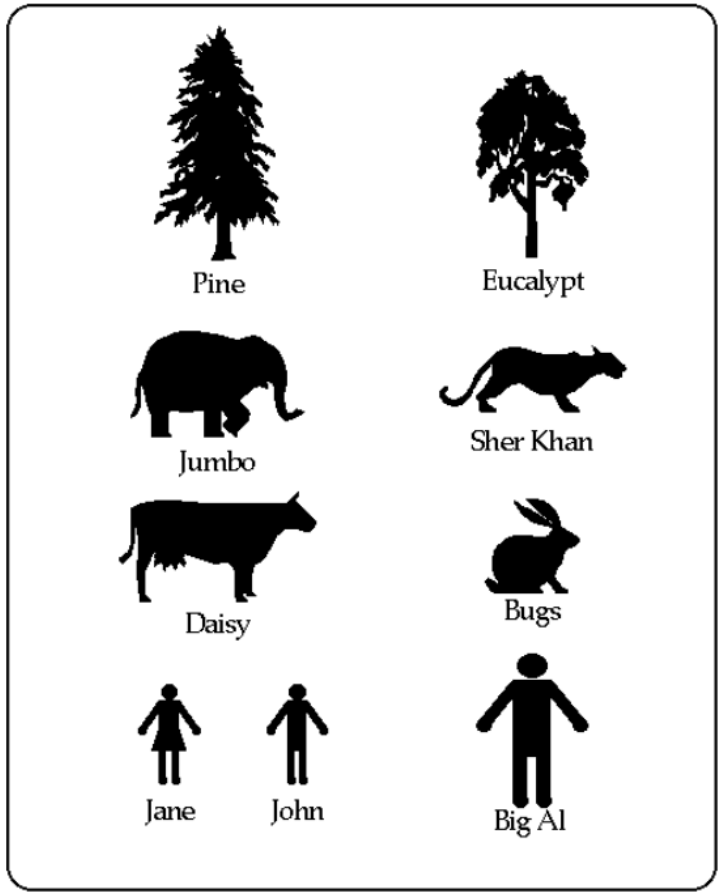
Abstraction (Revised)

- Abstraction is a way to cope with complexity.

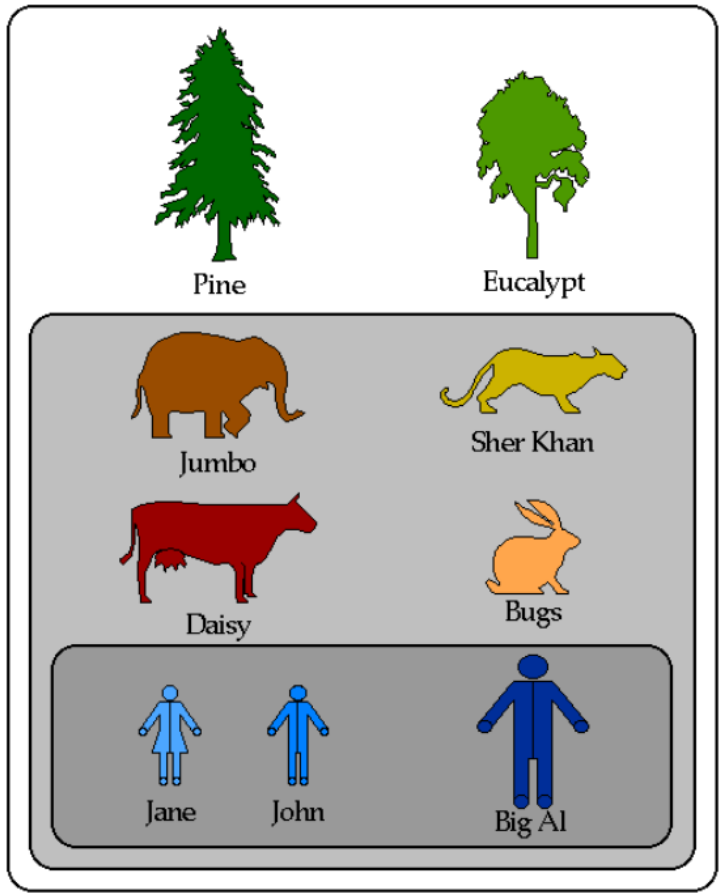
- Principle of abstraction:

“ Capture only those details about an object that are relevant to current perspective ”

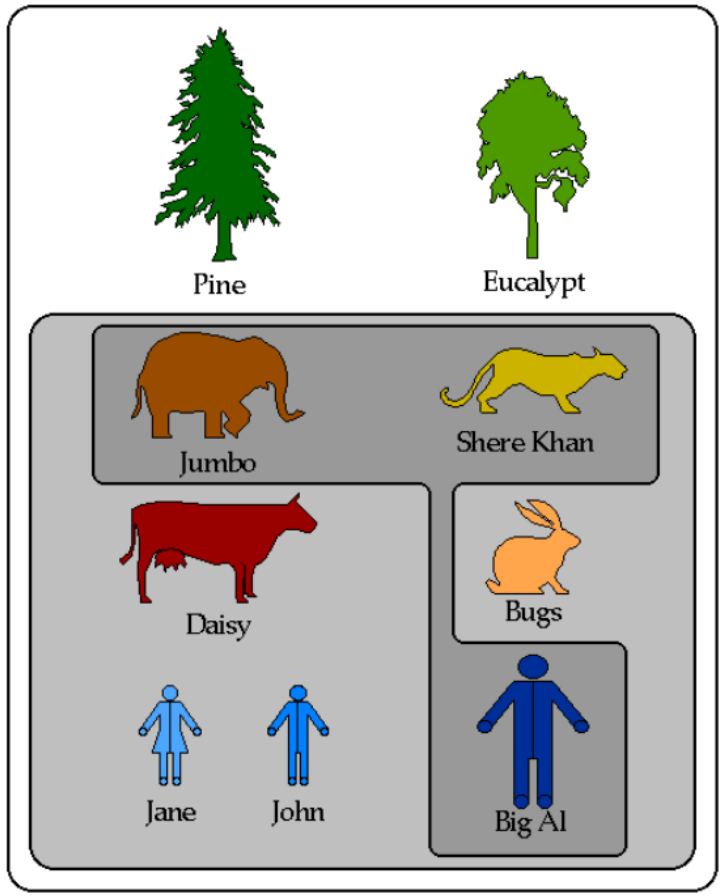
Abstraction - Example



unclassified “organisms"

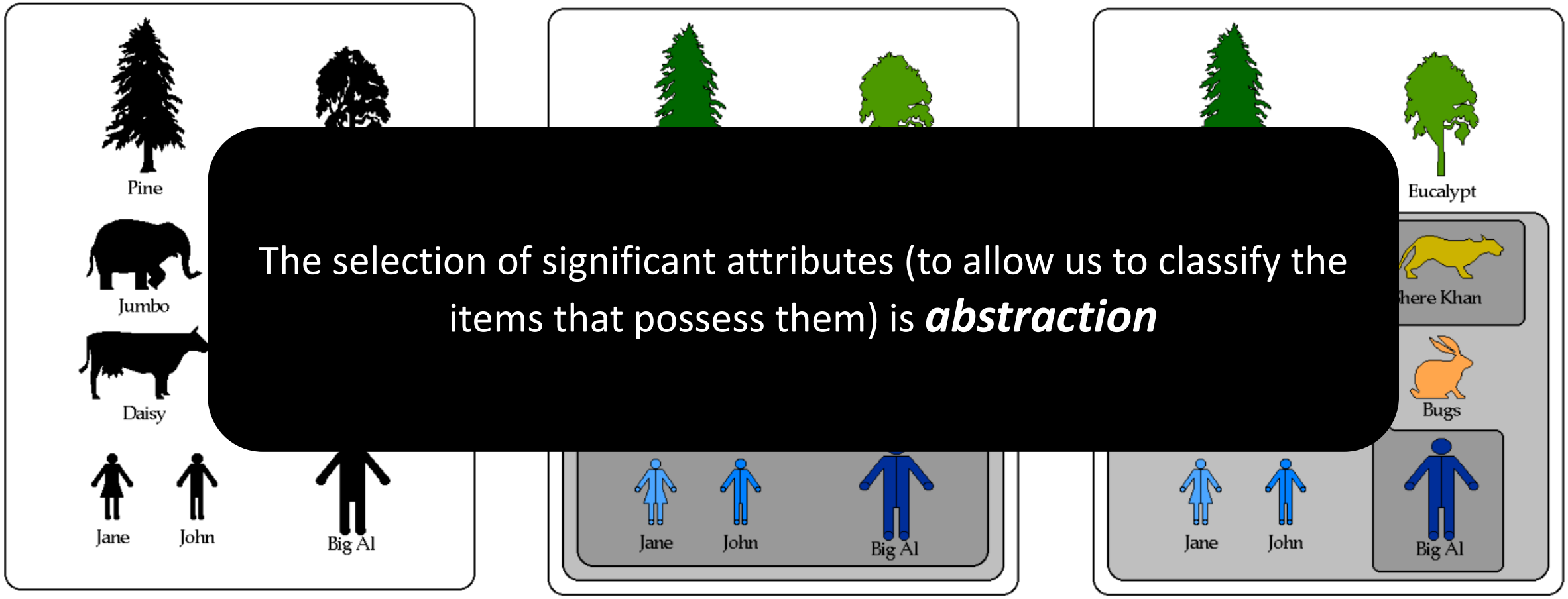


organisms, mammals, humans



organisms, mammals, dangerous mammals

Abstraction - Example



The selection of significant attributes (to allow us to classify the items that possess them) is ***abstraction***

unclassified "things"

organisms, mammals, humans

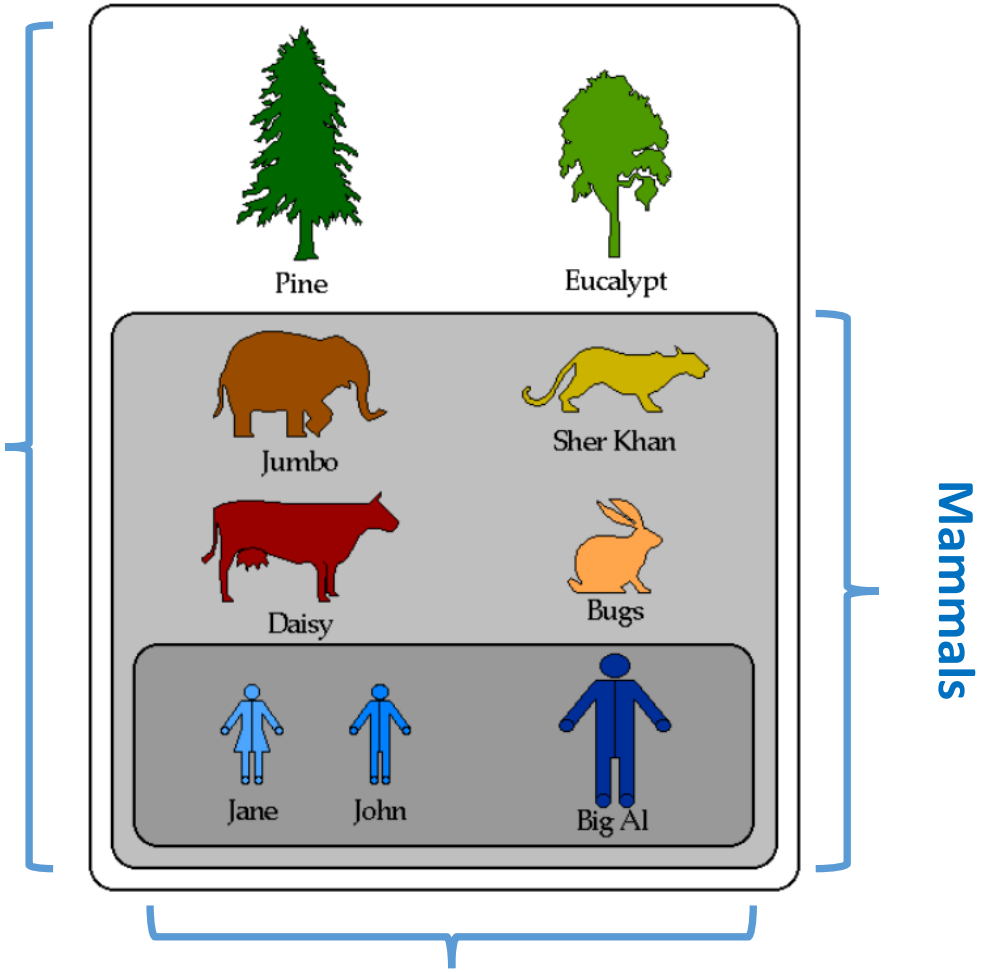
organisms, mammals, dangerous mammals

Abstraction – Advantages

- Simplifies the model by hiding irrelevant details
- Abstraction provides the freedom to defer implementation decisions by avoiding commitment to details

Classes

- In an OO model, some of the objects exhibit identical characteristics (information structure and behavior)
- We say that they belong to the same class



Few More Examples – Class

- **Ali** studies mathematics
- **Anam** studies physics
- **Sohail** studies chemistry

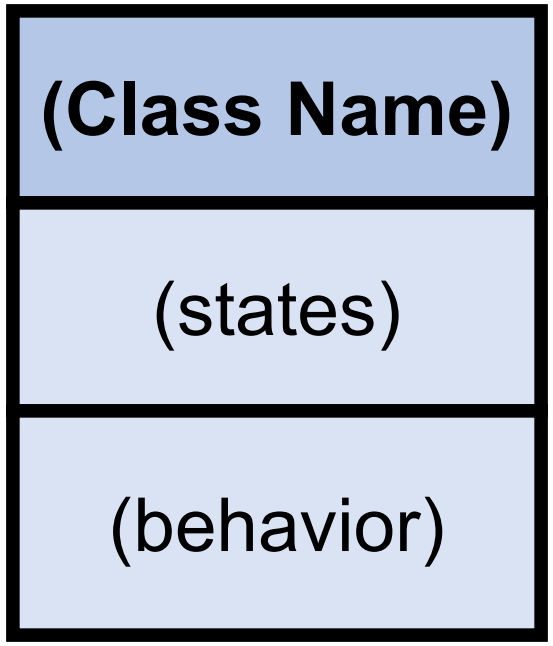
- Each one is a **Student**
- We say these **objects** are ***instances*** of the **Student** class

Few More Examples – Class

- **Ahsan** teaches mathematics
- **Aamir** teaches computer science
- **Atif** teaches physics

- Each one is a **Teacher**
- We say these **objects** are ***instances*** of the **Teacher** class

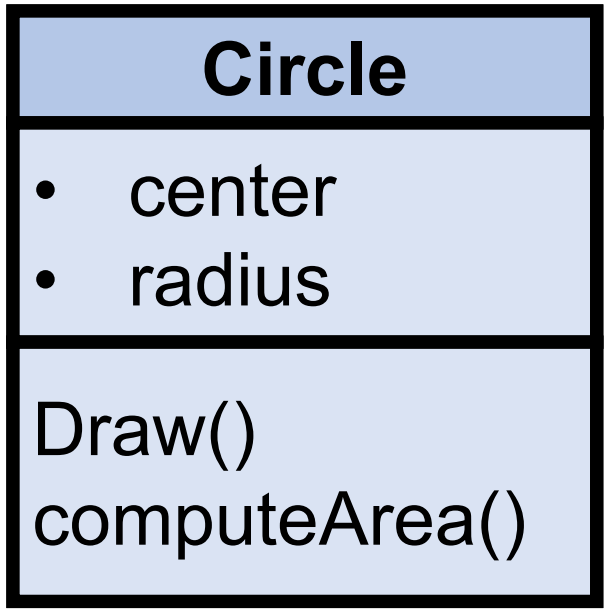
Graphical Representation of Classes



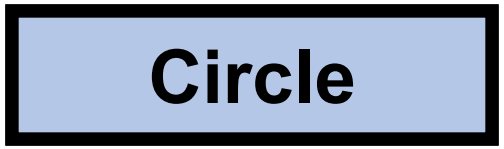
Normal Form

Suppressed Form

Example - Graphical Representation of Classes

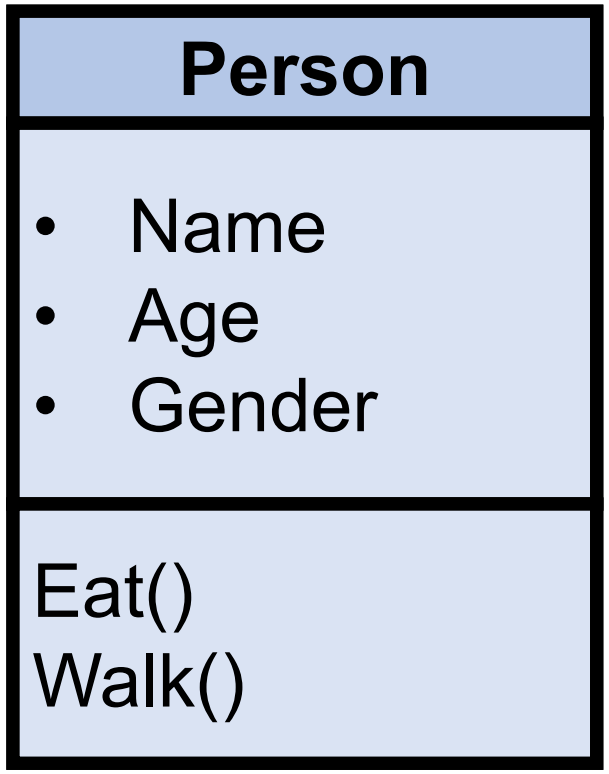


Normal Form



Suppressed Form

Example - Graphical Representation of Classes



Normal Form

Suppressed Form

This leads us to:

User-defined data types

Lets get into programming!

User defined data types

- The data types that are defined by the user are called:
  - ***derived datatype*** or
  - ***user-defined derived data type*** or
  - ***user-defined data type)***

- These types include:

  - ❑ Enum
  - ❑ Typedef
  - ❑ Structure
  - ❑ Union
  - ❑ Class

User defined data types

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  - ❑ **Typedef**
  - ❑ Structure
  - ❑ Union
  - ❑ Class

Typedef

- Allows you to define explicitly new data type names by using the keyword typedef
- Does not actually create a new data class, rather it defines a name for an existing type

```
#include <iostream>
using namespace std;
typedef  char BYTE;

int main()
{
    BYTE b1, b2;
    b1 = 'Y';
    b2 = 'O';
    cout << b1 << " " << b2;
    return 0;
}
```

Output: Y O

Structures

- A ***struct*** (structure) is a collection of information of different data types (heterogeneous). The fields of a struct are referred to as ***members***.

- Defining a Structure:

```
struct StructName
{
    dataType memberName;
    ...
    ...
};
```

Example:

```
struct StudentRecord
{
    string Name;
    int       id;
    float   CGPA;
};
```

Structures

- Two ways to create instance of Structure and accessing the Data Members

Option 1

```
struct StudentRecord
{
    string Name;
    int      id;
    float   CGPA;
}student_1;

int main()
{
    student_1.Name = "Ali";
    student_1.id = 007;
    student_1.CGPA = 3.9;

    return 0;
}
```

Structure definition must be followed either by a semicolon or a list of declarations

Option 2

```
struct StudentRecord
{
    string Name;
    int      id;
    float   CGPA;
};

int main()
{
    StudentRecord student_1;

    student_1.Name = "Ali";
    student_1.id = 007;
    student_1.CGPA = 3.9;

    return 0;
}
```

Passing structure to function

- Exercise: Find the output of the following program

```
struct MyBox
{
    int length, breadth, height;
};

void dimension(MyBox M)
{
    cout << M.length << "x" << M.breadth << "x";
    cout << M.height << endl;
}
```

```
int main()
{
    MyBox B1 = { 10, 15, 5 }, B2, B3;
    ++B1.height;
    dimension(B1);
    B3 = B1;
    ++B3.length;
    B3.breadth++;
    dimension(B3);
    B2 = B3;
    B2.height += 5;
    B2.length--;
    dimension(B2);

    return 0;
}
```

Output:

```
10x15x6
11x16x6
10x16x11
```

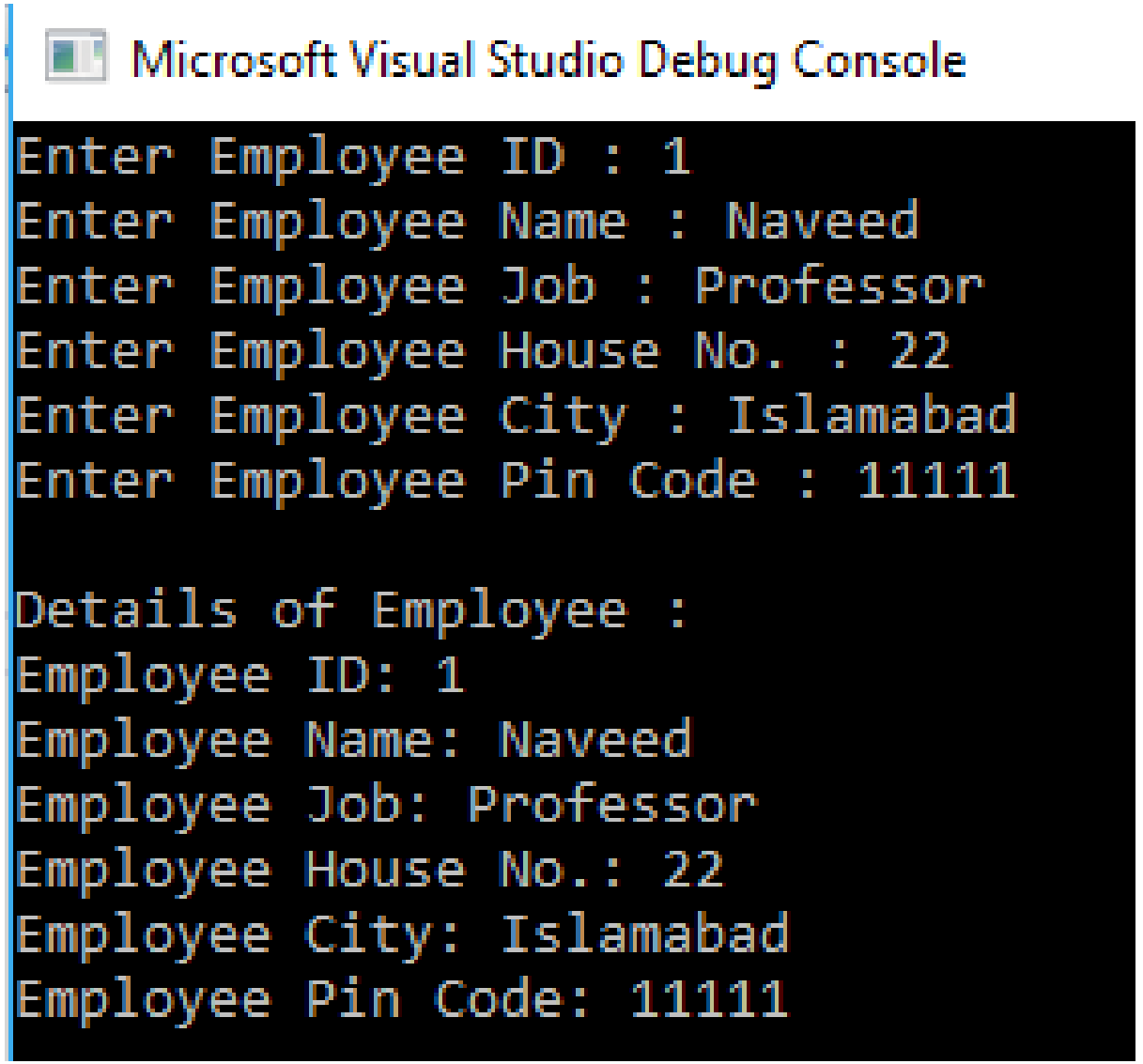
Nested Structures

- Example

```
#include <iostream>
using namespace std;

struct Address
{
    int HouseNo;
    char City[25];
    int PinCode;

};

struct Employee
{
    int Id;
    char Name[25];
    char Job[25];
    Address Add;

};

int main()
{
    Employee E;

    cout << "Enter Employee ID : ";
    cin >> E.Id;

    cout << "Enter Employee Name : ";
    cin >> E.Name;

    cout << "Enter Employee Job : ";
    cin >> E.Job;

    cout << "Enter Employee House No. : ";
    cin >> E.Add.HouseNo;

    cout << "Enter Employee City : ";
    cin >> E.Add.City;

    cout << "Enter Employee Pin Code : ";
    cin >> E.Add.PinCode;


    cout << endl << "Details of Employee : ";
    cout << endl << "Employee ID: "<< E.Id;
    cout << endl << "Employee Name: " << E.Name;
    cout << endl << "Employee Job: " << E.Job;
    cout << endl << "Employee House No.: " << E.Add.HouseNo;
    cout << endl << "Employee City: " << E.Add.City;
    cout << endl << "Employee Pin Code: " << E.Add.PinCode;
    cout << endl;

    return(0);
}
```

Structures

- Example (continued…)



Structures (Recap)

- Some important points to remember:

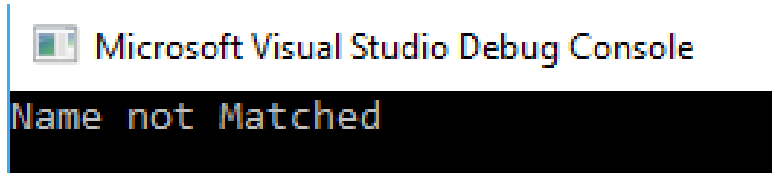
  - Aggregate I/O is **not allowed**. I/O must be performed on a member by member basis.
  - Aggregate assignment is allowed. All data members (fields) are copied (**if both structure variables are of same type**)
  - Aggregate arithmetic is **not allowed**.
  - Aggregate comparison is **not allowed**. Comparisons must be performed on a member by member basis.
  - A struct is a valid return type for a value returning function.

Passing structure to function

- Example of comparison:

```cpp
#include <iostream>
#include <string>
using namespace std;

struct StudentRecord
{
    string Name;
    int      id;
    float   CGPA;
};

bool compare_name(StudentRecord a, StudentRecord b)
{
    if (a.Name == b.Name)
        return true;
    else
        return false;
}
```

```cpp
int main()
{
    StudentRecord Students[2];

    Students[0].Name ="Naveed";
    Students[0].id = 7;
    Students[0].CGPA =3.9;

    Students[1].Name = "Ali";
    Students[1].id = 8;
    Students[1].CGPA = 4;

    if (compare_name(Students[0], Students[1]))
        cout << "Name Matched" << endl;
    else
        cout << "Name not Matched" << endl;

    return 0;
}
```



Passing structure to function

- Example of addition:

```
struct Fraction
{
    float numerator;
    float denominator;
};
```

```
Fraction add(Fraction a, Fraction b)
{
     Fraction temp;
     temp.numerator = a.numerator * b.denominator
                  + a.denominator * b.numerator;
     temp.denominator = a.denominator *
     b.denominator;

     return temp;
}
```

```
int main()
{
    Fraction num1, num2, result;

    cout << "For 1st fraction," << endl;
    cout << "Enter numerator and denominator:" << endl;
    cin >> num1.numerator >> num1.denominator;

    cout << endl << "For 2nd fraction," << endl;
    cout << "Enter numerator and denominator:" << endl;
    cin >> num2.numerator >> num2.denominator;

    result = add(num1, num2);
    cout << "Sum = "<<result.numerator<<'/'<< result.denominator<<endl;

    return 0;
}
```

Output:

```
For 1st fraction,
Enter numerator and denominator:
1
2

For 2nd fraction,
Enter numerator and denominator:
1
2
Sum = 2/2
```

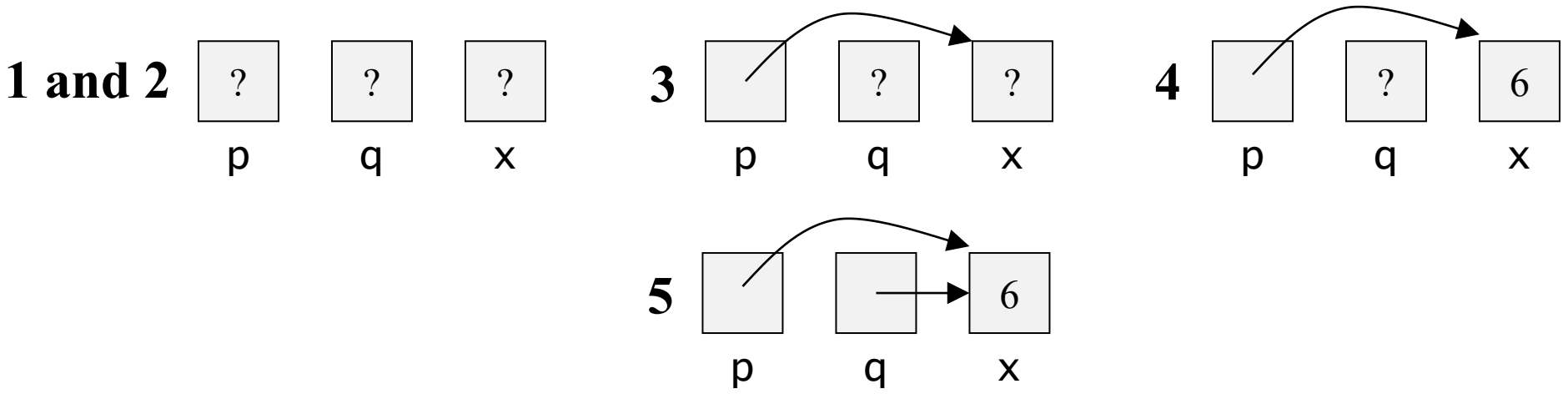
Pointers to Structure

Here is how you can create pointer for structures:

```
#include <iostream>
using namespace std;
struct temp {
    int i;
    float f;
};
int main() {
    temp *ptr;
    return 0;
}
```

Pointers (Recap)

1.	Pointer variables	int *p, *q;
2.	Static allocation	int x;
3.	Address-of operator	p = &x;
4.	Memory cell to which P points	*p = 6;
5.	Pointer operations	q = p;



Memory Allocation

- Dynamic memory allocation is necessary because, during compile time, we may not know the exact memory needs to run the program.

new **malloc()**

- C++ also does not have automatic garbage collection. Therefore a programmer must manage all dynamic memory used during the program execution

delete[] **free()**

Memory Allocation

new / delete[]

```
int main()
{
    int *x;
    x = new int[11];

    for (int i = 0; i <= 10; i++)
        x[i] = 0.1*i;

    delete[] x;
}
```

Return same pointer type

Is a operator

Allocate memory and
calls constructor
for initialization

malloc() / free() / realloc()

```
int main()
{
    int *x;
    x = (int*) malloc(11 * sizeof(int));

    for (int i = 0; i <= 10; i++)
        x[i] = 0.1*i;

    free(x);
}
```

return void *

stdlib function

Allocate memory and
Does not calls constructor

Memory Allocation (2D array)

new / delete[]

```
int main()
{
    int rowCount = 10;
    int colCount = 10;

    int** a = new int*[rowCount];
    for (int i = 0; i < rowCount; ++i)
        a[i] = new int[colCount];

    for (int i = 0; i < rowCount; ++i)
        delete[] a[i];
    delete[] a;
}
```

malloc() / free()

YOUR TURN

Pointers to Structure

Here is how you can create pointer for structures:

```
#include <iostream>
using namespace std;
struct temp {
    int i;
    float f;
};
int main() {
    temp *ptr;
    return 0;
}
```

Pointers to Structure

- Example

```
#include <iostream>
using namespace std;

struct Distance
{
    int feet;
    float inch;
};
int main()
{
    Distance *ptr, d;
    ptr = &d;

    cout << "Enter feet: ";
    cin >> (*ptr).feet;
    cout << "Enter inch: ";
    cin >> (*ptr).inch;

    cout << "Displaying information." << endl;
    cout << "Distance = " << (*ptr).feet << " feet " << (*ptr).inch << " inches"<<endl;
    return 0;
}
```

Note: Since pointer ptr is pointing to variable d in this program, (*ptr).inch and d.inch is exact same cell. Similarly, **(*ptr).feet** and **d.feet** is exact same cell.

The syntax to access member function using pointer is ugly and there is alternative notation -> which is more common..

ptr->feet is same as (*ptr).feet

ptr->inch is same as (*ptr).inch

Pointers to Structure

- Example

```
#include <iostream>
using namespace std;

struct Distance
{
    int feet;
    float inch;
};
int main()
{
    Distance *ptr, d;
    ptr = &d;

    cout << "Enter feet: ";
    cin >> (*ptr).feet;
    cout << "Enter inch: ";
    cin >> (*ptr).inch;

    cout << "Displaying information." << endl;
    cout << "Distance = " << (*ptr).feet << " feet " << (*ptr).inch << " inches"<<endl;
    return 0;
}
```

Can you tell me the sizeof(ptr)?

Passing Structure Array to Function

Option 1

```
void myFunction(StudentRecord Student[10])
{
   .
   .
   .
}
```

Option 1

```
void myFunction(StudentRecord Student[], int size)
{
   .
   .
   .
}
```

Unions

- A union is comprised of two or more variables that share the **same memory location**.

- A union declaration is similar to that of a structure, as shown below:

```
union example
{
    int     a;
    double  b;
    char    c;
};
```

Unions

- Example

```
#include <iostream>
using namespace std;

union example_test
{
    short int       count;
    char            ch[2];
};
example_test test;


int main()
{
    test.ch[0] = 'X';
    test.ch[1] = 'Y';
    cout << "union as chars: " << test.ch[0] << test.ch[1] << endl;
    cout << "union as integer: " << test.count << endl;
    return(0);
}
```

Output:

```
union as chars: XY
union as integer: 22872
```

- **Be clear on one point: It is not possible to have this union hold both an integer and a character at the same time, because *count* and *ch* overlay each other.**
- **Advantage of union?**

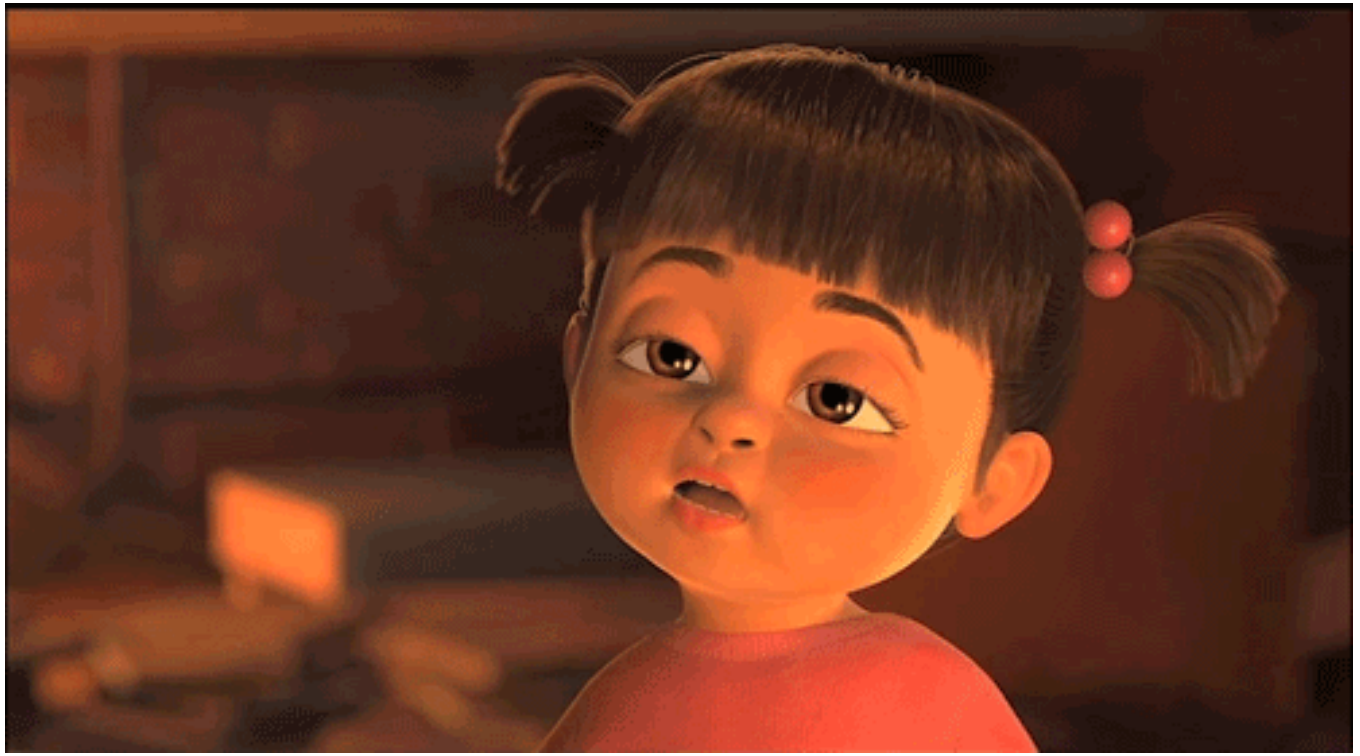
Unions

- Example

```
#include <iostream>
using namespace std;

union example1 {
    int a;
    float b;
    char *c;
}U;

struct example2 {
    int a;
    float b;
    char *c;
}S;

int main()
{
    cout<< sizeof(U)<< endl;
    cout << sizeof(S) << endl;

    return 0;
}
```

Can you tell me the output?

Thanks a lot



If you are taking a Nap, **wake up**.....Lecture Over