Object-Oriented Programming

- Object-oriented programming (OOP) is a ***methodology***

  = abstract data types (ADTs)

  + inheritance

  + dynamic binding

- OO programming languages (OOPLs) have features to ***support*** this methodology

Simula	1967	static inheritance and dynamic binding
CLU	1980	abstract datatypes
Smalltalk	1980	
ZetaLisp	1984	(along with other OO Lisps)
C++	1985	
Objective-C	1988	
Oberon	1988	
SELF	1989	
Modula-3	1990	
Oberon-2	1991	

  and many more...

C++ vs Modula-3 (A View)

feature	C++	Modula-3
safe	no	yes
efficient	yes	yes
garbage collection	any day now	yes
static typechecking	mostly	yes
enforced interfaces	yes	yes
concurrency	no	yes
widely available	yes	no
everyone knows it	so they claim	no
software tools	yes	some
good for a summer job	probably	no

A Brief History of Modula-3

Algol-60	1960	procedures, parameters, arrays, BEGIN-END, WHILE-DO, FOR-DO
Simula-67	1967	Algol-60 plus pointers, records, inheritance
Pascal	1971	Simula-67 cleaned up minus inheritance
Modula	1978	Pascal plus abstract data types
Modula-2	1980	Modula cleaned up plus interfaces
Modula-2+	1985	Modula-2 plus concurrency and exceptions
Oberon	1988	Modula-2 stripped down plus inheritance
Modula-3	1990	Module-2+ cleaned up plus objects, inherit-ance, and dynamic binding (influenced by Oberon)
Oberon-2	1991	Oberon plus methods

Abstract Data Types

- ADTs support *data abstraction*

  hides representation details
  reduces *coupling*
  promotes *reuse*

- Procedures help make code representation independent, e.g., interface `line.h`

```
#ifndef LINE_INCLUDED
#define LINE_INCLUDED
#define MAX_LINE_SIZE 256
typedef struct Line_T *Line_T;
extern Line_T Line_New( char *text );
extern char *Line_Text( Line_T line );
extern void Line_Insert( Line_T current, Line_T new );
extern void Line_Delete( Line_T line );
extern Line_T Line_Split( Line_T line, int col );
        ...
```

- ADTs are a programming ***methodology***:

  applicable in any language, e.g., C
  easy to *preach*, hard to *do*

- ADT languages have features to ***support*** this methodology

Inheritance

- Example: shapes in a graphics system
- Interface: `shape.h`

```
#ifndef SHAPE_INCLUDED
#define SHAPE_INCLUDED

#include "point.h"

typedef enum { circle, square, triangle, ... } Kind_T;

typedef struct Shape_T {
    Kind_T tag;
    Point_T center;
    union {
        float radius;  /* circle */
        float side;    /* square */
        ...
    } u;
} *Shape_T;

extern Point_T Shape_where(Shape_T s);
extern void Shape_move(Shape_T s, Point_T to);
extern void Shape_draw(Shape_T s);

#endif
```

Inheritance, cont'd

- Implementation: **`shape.c`**

```
#include "assert.h"
#include "shape.h"

#define T Shape_T

Point_T Shape_where(T s) {
    return s->center;
}

void Shape_move(T s, Point_T to) {
    s->center = to;
    Shape_draw(s);
}

void Shape_draw(T s) {
    switch (s->tag) {
    case circle: ...
    case square: ...
    case triangle: ...
    ...
    default: assert(0);
    }
}
```

Problems with ADTs

- Problems

  `Shape_draw` must know about ***all*** shapes

  new shapes require inspecting/modifying ***all*** functions

- ADTs don't distinguish between ***general*** and ***specific*** properties

  e.g., between all shapes and just circles

- OOPLs support this distinction

  ADT is a ***class***

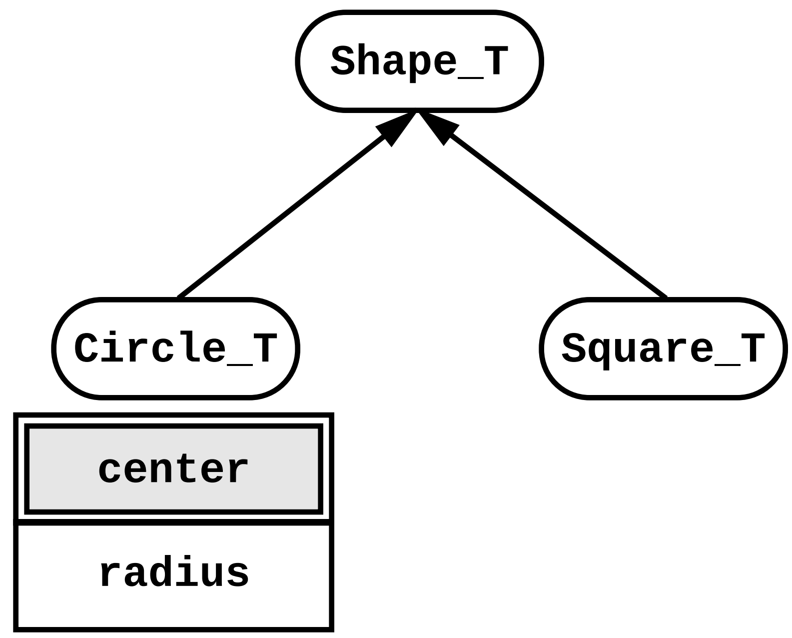
  a class ***inherits*** the fields and functions of its ***superclass***

  objects are ***instances*** of a class

Using Inheritance

- Revised interface: **`shape.h`**

```
#ifndef SHAPE_INCLUDED
#define SHAPE_INCLUDED

#include "point.h"

typedef struct Shape_T {
    Point_T center;
} *Shape_T;

typedef struct Circle_T {
    struct Shape_T super;
    float radius;
} *Circle_T;

typedef struct Square_T {
    struct Shape_T super;
    float side;
} *Square_T;

...
#endif
```



Note: a **`Circle_T`** is also a **`Shape_T`**, etc. **`Circle_T`** is a ***<u>subtype</u>*** of **`Shape_T`**, and **`Shape_T`** is a ***<u>supertype</u>*** of **`Circle_T`**; ditto for **`Square_T`**

- What about **`Shape_draw`**, etc?