Object-Oriented Programming

CSCI 334
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Growing A Language

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Operator Overloading

```
class Vector {
  int data[10];
  int size;

  // overload * to be dot-product on vectors
  int operator*(Vector other) {
    int result = 0;
    for (int i = 0; i < size; i++) {
      result += data[i] * other.data[i];
    }
    return result;
  }
}

Vector v1;
Vector v2;
...
int dot_prod = v1 * v2;
```

Object-oriented programming

- Programming methodology
  - organize concepts into objects and classes
  - build extensible systems
- Language concepts
  - encapsulate data and functions into objects
  - subtyping allows extensions of data types
  - inheritance allows reuse of implementation

Object-oriented Method [Booch]

- Four steps
  - Identify the objects at a given level of abstraction
  - Identify the semantics (intended behavior) of objects
  - Identify the relationships among the objects
  - Implement these objects
- Iterative process
  - Implement objects by repeating these steps
- Not necessarily top-down
  - "Level of abstraction" could start anywhere

This Method

- Based on associating objects with components or concepts in a system
- Why iterative?
  - An object is typically implemented using a number of constituent objects
  - Apply same methodology to subsystems, underlying concepts

Comparison to top-down design

- Similarity:
  - Iterative process of refinement
- Differences:
  - Focus of top-down design is on data structure
  - OO methods are based on modeling ideas
  - Combining functions and data into objects makes data refinement more natural

Subtyping and Substitutivity

```
class Rectangle {
  private int x,y,w,h;
  void moveTo(int x, int y);
  void setSize(int width, int height);
  void show();
  void hide();
}

class FilledRectangle {
  private int x,y,w,h;
  private Color c;
  void moveTo(int x, int y);
  void setSize(int width, int height);
  void show();
  void hide();
  void setFillColor(Color color);
  Color getFillColor();
}
```

Subtyping and Substitutivity

```
void f() {
  Rectangle r =
    new Rectangle();
  r.moveTo(100,100);
  r.hide();
}
```

```
void f() {
  Rectangle r =
    new FilledRectangle();
  r.moveTo(100,100);
  r.hide();
}
```

```
void g() {
  FilledRectangle r =
    new FilledRectangle();
  r.moveTo(100,100);
  r.setFillColor(Color.red);
  r.hide();
}
```

```
void g() {
  FilledRectangle r =
    new Rectangle();
  r.moveTo(100,100);
  r.setFillColor(Color.red);
  r.hide();
}
```

Rectangles Revisited

```
class Rectangle {
  int x,y,w,h;
  void moveTo(int x, int y);
  void setSize(int width, int height);
  void show();
  void hide();
}

class FilledRectangle extends Rectangle {
  Color c;
  void setFillColor(Color color);
  Color getFillColor();
}
```

Java Subtyping (Sneak Preview...)

```
interface MouseListener {
  void onMousePress(MouseEvent e);
  void onMouseRelease(MouseEvent e);
  void onMouseMove(MouseEvent e);
  void onMouseClick(MouseEvent e);
  ...
}

class StockTicker extends Applet implements MouseListener {
  ...
  void onMousePress(MouseEvent e) { ... }
  void onMouseRelease(MouseEvent e) { ... }
  void onMouseMove(MouseEvent e) { ... }
  void onMouseClick(MouseEvent e) { ... }
  ...
}
```

OO Program Structure

- Group data and functions
- Class
  - Defines behavior of all objects that are instances of the class
- Subtyping
  - Place similar data in related classes
- Inheritance
  - Avoid reimplementing functions that are already defined

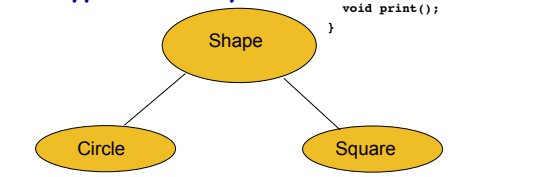
Example: Geometry Library

- Define general concept: Shape
- Implement two shapes: Circle, Square
- Functions on implemented shapes
  center, move, rotate, draw
- Anticipate additions to library

Shapes

- Interface of every Shape must include
  center, move, rotate, draw
- Different kinds of shapes are implemented differently
  - Square: two points, representing corners
  - Circle: center point and radius

Subtype Hierarchy




```
interface Shape {
  Point center();
  void move(int dx, int dy);
  void rotate(double theta);
  void print();
}
```

```
class Circle implements Shape {
    Point center() { ... }
    ...
}
```

```
class Square implements Shape {
    Point center() { ... }
    ...
}
```

- General interface defined in the Shape class
- Implementations defined in Circle, Square
- Extend hierarchy with additional shapes

Code Placed In Classes

	center	move	rotate	print
Circle	c_center	c_move	c_rotate	c_draw
Square	s_center	s_move	s_rotate	s_draw

- Dynamic lookup
  - circle.move(x,y) calls function c_move

Example Use: Processing Loop

```
Vector<Shape> shapes =
    new Vector<Shape>();
...
for (i = 0; i < shapes.size(); i++) {
  Shape s = shapes.get(i);
  s.move(10, 10);
}
```

Control loop does not know the type of each shape