Morphic

- **A highly unusual graphical toolkit!**
- **Originates in the Self project at Sun**
  - Self: a prototype-based programming language
  - No classes---objects inherit/instantiate by “cloning”
- **Self design strongly reflected in Morphic**
  - Can create Morphic objects, add properties & behavior without defining classes
  - All Morphic objects have uniform, “concrete” feel---e.g., “shadows” when dragging

Morphic, Smalltalk-style

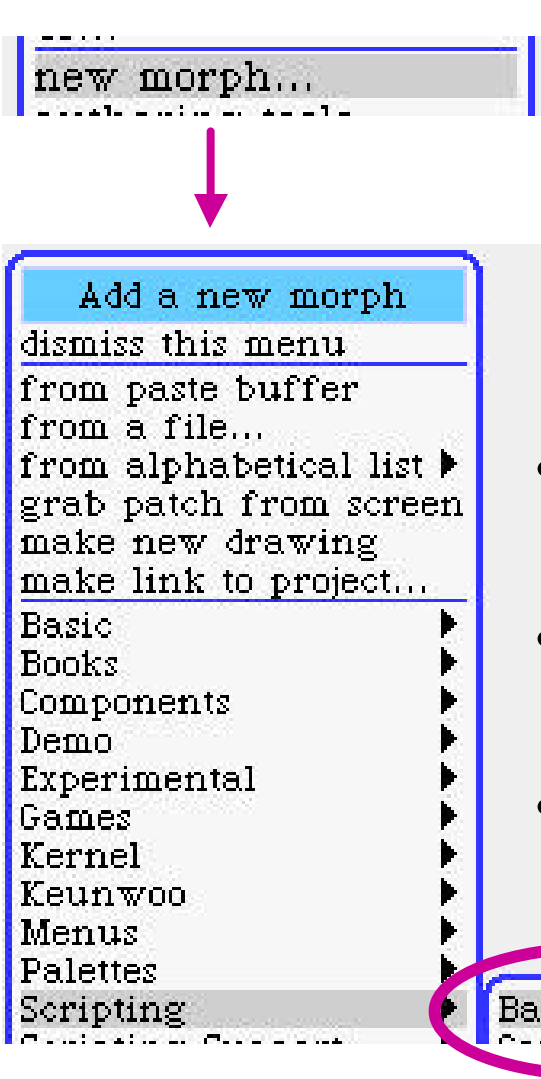
- Smalltalk is class-based, so Squeak Morphic generates classes “under the hood”
- You can also use Morphic in traditional (non-prototype-based) style.

- This tutorial will use a traditional class-based programming style.

Squeak Morphic programming

- **Goal:** to get you coding something "interesting" as quickly as possible.
- Steps:
  - (Enter a Morphic world)
  1. Define & instantiate your own Morph
  2. Customizing your Morph
  3. Animating Morphs
  4. Toolkits and hierarchical composition

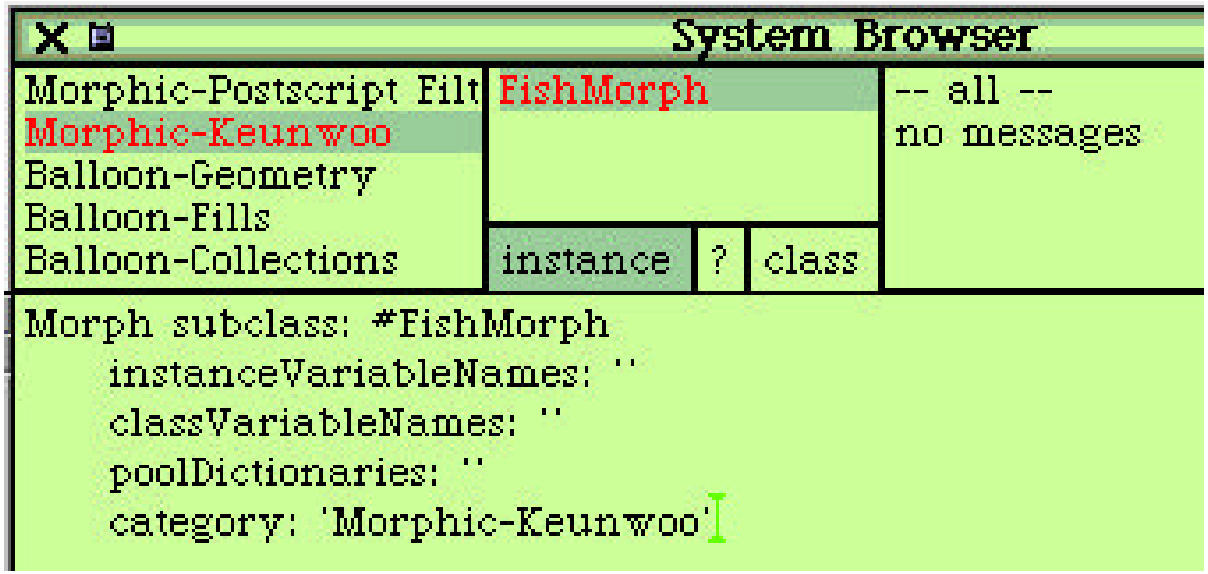
Morphs in the class browser



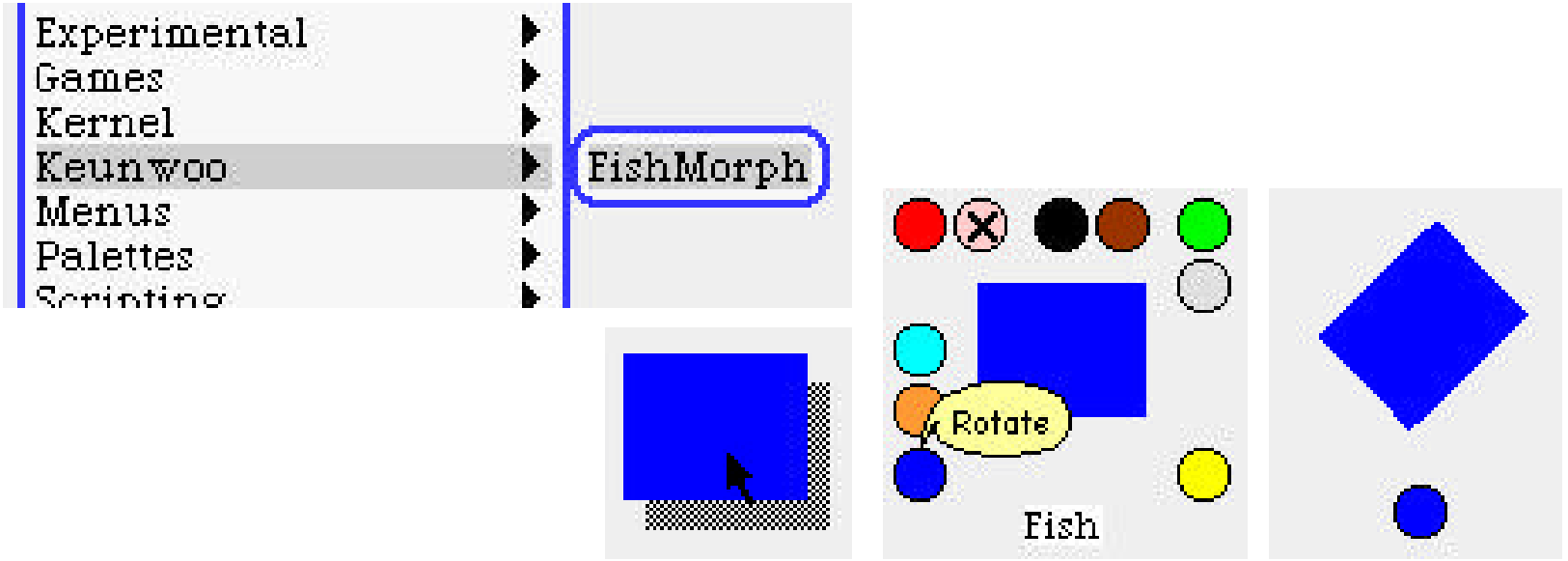
- All Morphic objects are instances of subclasses of **Morph**.
- Squeak looks for Morph subclasses in class categories starting with **Morphic-**
- Morphs found in these packages will be shown in the **new morph...** submenu

1. Defining your own Morph

- You can add Morph subclasses anywhere.
- But, you will probably want to create a new class category for your Morphs, e.g. **Morphic-Keunwoo**
- In this category, define a new subclass of **Morph**:



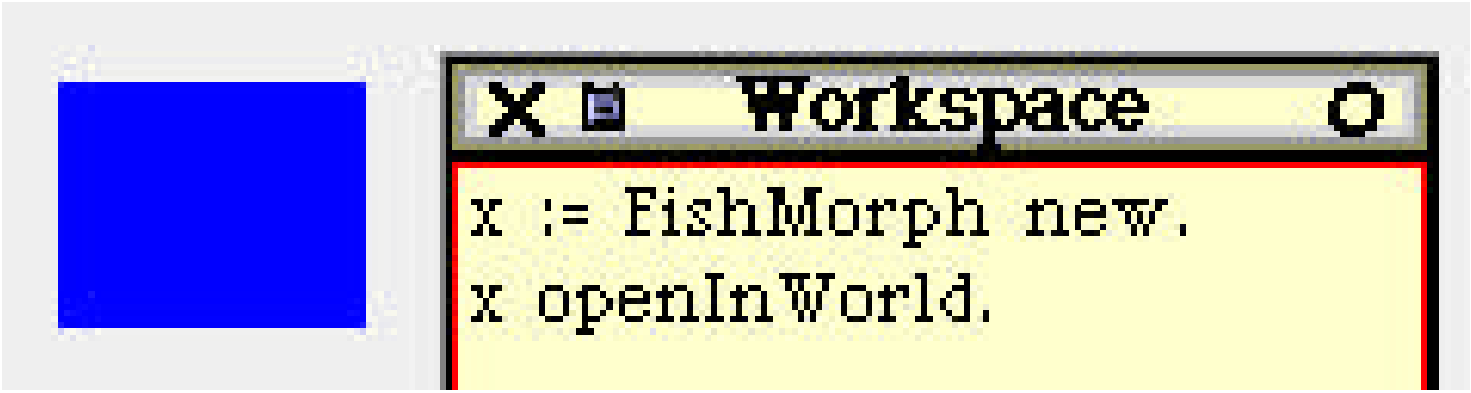
You're done! But...



- Your new morph category, and morph, should appear in the **new morph...** submenu.
- You inherit all the default Morph behaviors. (The default rendering is a blue rectangle.)
- Default behaviors are nice, but they're not *yours*...
- (Important: See various online tutorials for information on **halos**, direct manipulation of Morphs, etc.)

Alternate way to show instances

1. Open a workspace
2. Create an instance with **new**
3. Send the **openInWorld** message



What's the "world"?

- The global namespace* contains a variable named **World.**
- When you enter a Morphic "world", **World** is set to point to the current "world"
- When you send the **openInWorld** message to a Morph, it gets the current World and adds itself.

* For the curious, the global namespace is a dictionary named **Smalltalk**. Do **Smalltalk inspect** in any Workspace to get a look at it.

Okay, but what's *a* "world"?

Q: What's a "world"?

A: An instance of a subclass of PasteUpMorph

Q: What's a PasteUpMorph?

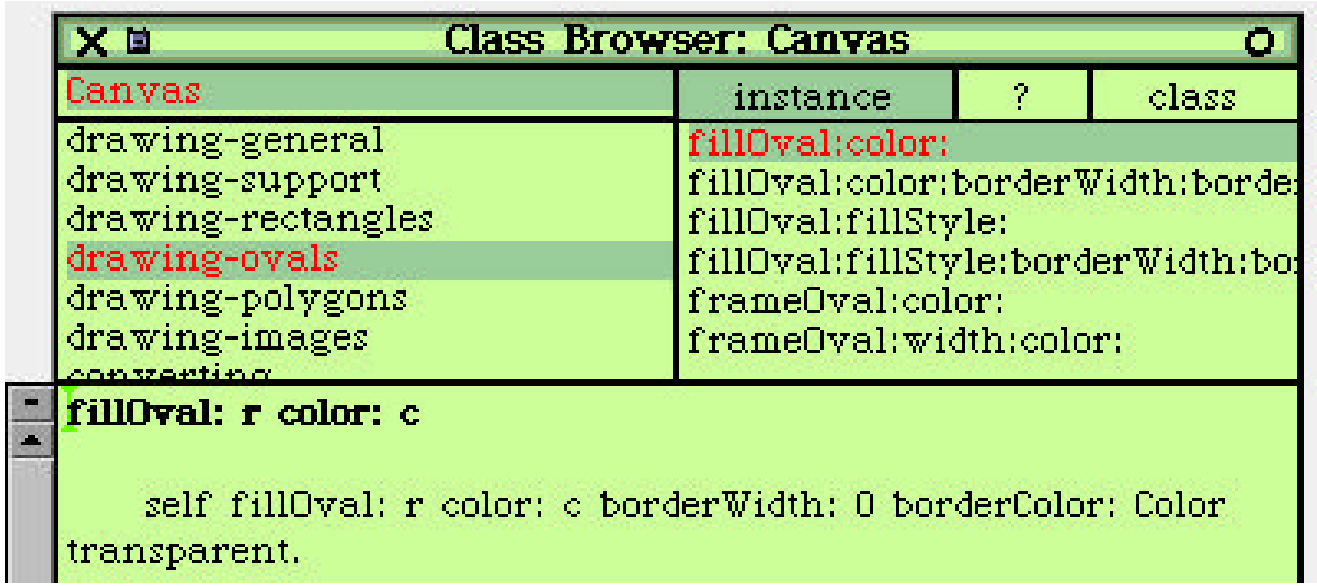
A: A Morph where you can drop other morphs, and they stick---think of it as a "desktop-like" morph.

2. Customizing your Morph

- Morphs are almost endlessly flexible
- For brevity, we will begin by customizing only two aspects:
  - Appearance (“look”)
  - Response to mouse input (“feel”)

2(a). Morph drawing [2]

- Like most graphics toolkits, components paint themselves onto a **graphics context** provided by the system.
- In Squeak, graphics contexts are instances of **Canvas**
- **Canvas** defines many methods for drawing...



Graphical environments: A question

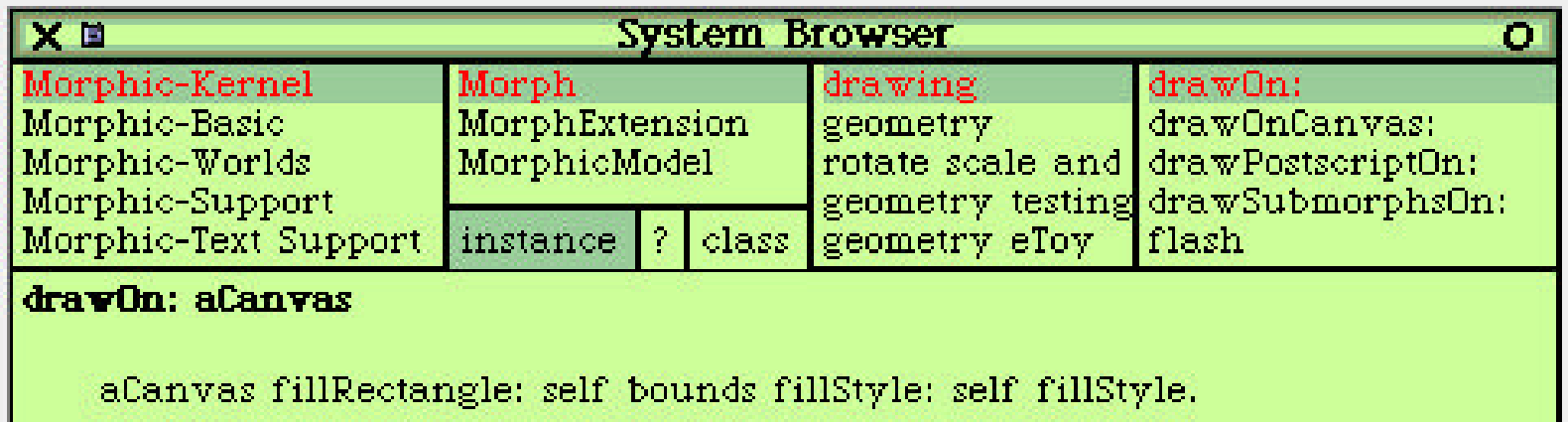
Q: When should components paint themselves?

A: **Often. It's complicated...**

- When created
- Whenever onscreen area is covered, then uncovered
- Whenever it receives input that changes its state
  - (e.g., pressed button must change appearance)
- Whenever the state of the thing it represents changes
  - (e.g., an animation of a physics simulation)
- ...and more...

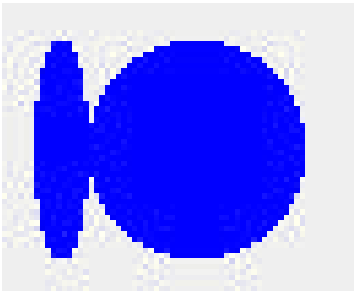
2(a) Drawing components [2]

- Therefore, components draw when asked by the system, onto the Canvas provided.
- When object needs a repaint, it will be sent the **drawOn:** message, which takes a **Canvas:**



2(a) Customized drawing [3]

- To customize drawing, simply override the **drawOn:** message



System Browser

Morphic-Postscript Canv	FishMorph	-- all --	drawOn:
Morphic-Postscript Filter		drawing	
Morphic-Keunwoo			
Balloon-Geometry			
Balloon-Fills			
Balloon-Collections	instance ? class		

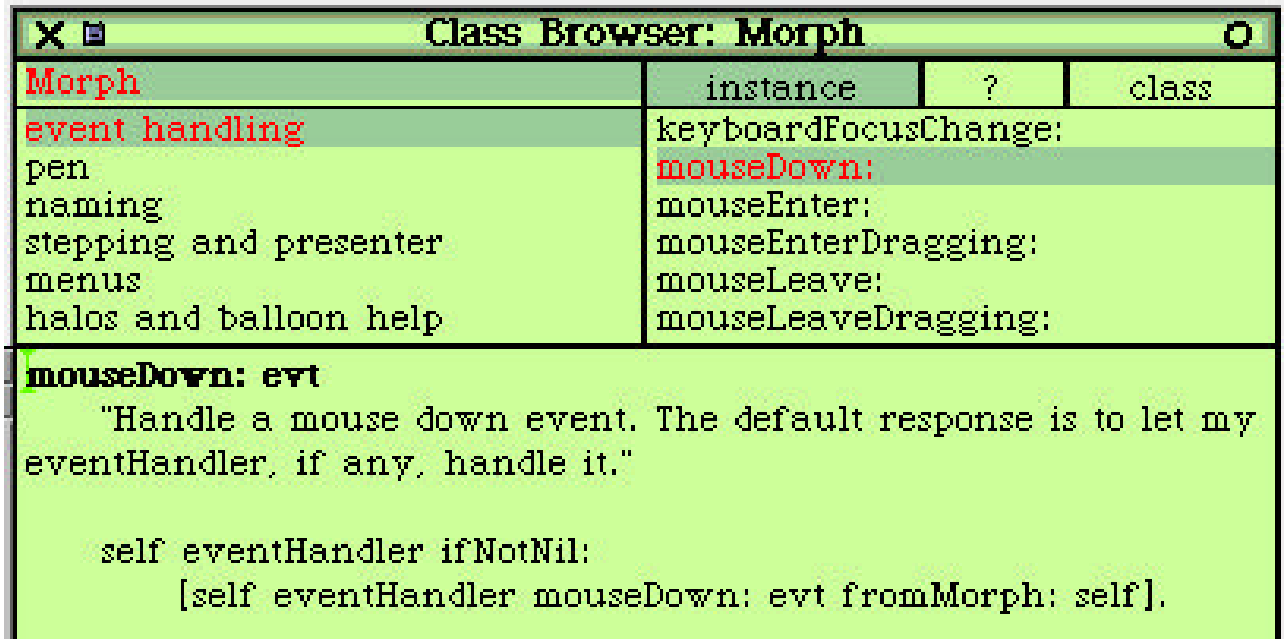
```
drawOn: aCanvas
    | myBounds bodyBounds tailBounds |
    myBounds := self bounds.
    bodyBounds := (myBounds origin translateBy: 10@0) corner: myBounds corner.
    aCanvas fillOval: bodyBounds fillStyle: self fillStyle.
    tailBounds := myBounds origin corner: (myBounds left + 10)@(myBounds bottom).
    aCanvas fillOval: tailBounds fillStyle: self fillStyle.
```

Aside: a word about geometry

- Two natural screen coordinate systems:
  - "Text-like": top left corner is (0, 0)
    - Y coordinate increases as you go down screen
  - "Math-like": bottom left corner is (0, 0)
    - Y coordinate increases as you go up screen
- Morphic has both…
  - **x/x: and y/y: methods use math-like**
  - **position/position: methods use text-like**

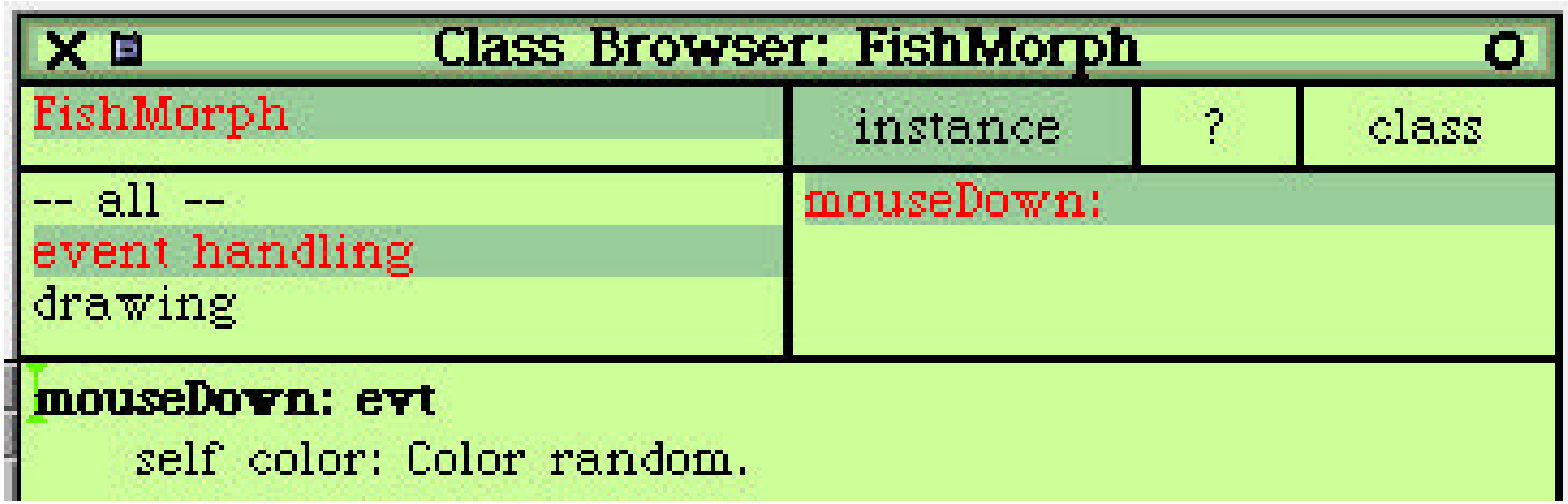
2(b) Custom event handling [1]

- Input events are similar to painting events
- To define your own event action, override a message that handles the event, e.g. **mouseDown**:



2(b) Custom event handling [2]

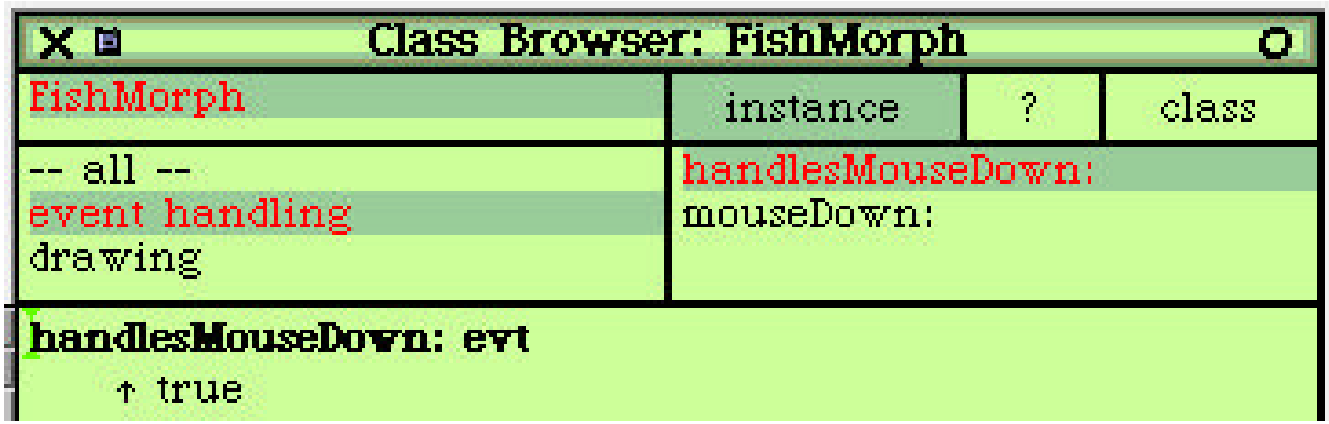
- An example of handling mouseDown event:



- However, this is not enough...

2(b) Custom event handling [3]

- Squeak does not want to dispatch all events to every Morph in the world (inefficient)
- To register interest in an event, you may have to override a **handlesXXX:** method, e.g.:



More about events...

- Event-driven programming is a big idea
- Good graphical toolkits provide a rich interface to send/receive/register interest in various events.
- Examine the “event handling” method category in the **Morph** base class for event handling methods.
- **MorphicEvent** (in class category Morphic-Support) is the class of the “evt” parameter received by the event handling methods.

3. Animating Morphs

- **Morph** defines a bunch of methods related to time-varying properties. Among the most important:
  - **step**
  - **stepTime**
  - **startStepping**
  - **stopStepping**
- These have the intuitively obvious meanings...
- As usual, override to make stuff happen

4. Hierarchical composition

- Most toolkits have a notion of “containers”, embodied in a class.
- **Container** is itself usually a subclass of the base **Component** class, so that Containers can recursively contain Containers.
  - (“Composite” design pattern – Gamma et al.)
- In this fashion, arbitrarily complex trees of components can be created.

Hierarchical composition in Morphic

- Morphic allows *all* Morphs to be containers
  - (some are better suited than others)
- Morph method **addMorph:** can be used to add any morph to any other.

- Note that **addMorph** alone does not constrain the position of submorphs!
  - A submorph may live outside its parent's physical area.
  - But, when this happens, painting often malfunctions

Composition, ct’d

- If you create your own specialized container (e.g., BouncingAtomsMorph in Morphic-Demos), you probably should not call addMorph directly
- Instead, create your own method, with a logical name, that calls **self addMorph**
  - (e.g., **addAtom:**)

Composition and delegation

- Adding components to containers allows the container to **delegate** responsibility for certain actions to its child objects
  - BouncingAtomsMorph need not explicitly define behavior of all atoms
- A fundamental principle of OOD: use hierarchical composition to build objects out of other objects.