Direct Manipulation

Interaction versus Interface

- Recall: What is the difference between user interaction and the user interface?
  - Interaction is the dialog between user and computer
    - At the I/O threshold
  - Interface is the vehicle for dialog
    - Fully contained in the computer
- We seek a common language for:
  - Defining the interface objects users interact with
  - The way we map these objects onto manipulations of data within the interactive system/application

Concepts for Describing Interfaces

- Instrumental Interaction
  - Definition
  - Applications
- Direct Manipulation
  - Definition/Analogies
  - Direct Manipulation Issues
  - Representing "Special Locations"

Instrumental Interaction

- Coined and described by Michel Beaudouin-Lafon in 2000
- Interface can be decomposed into instruments and objects
  - Instruments are the manipulable components that act on objects
  - Objects are the domain concepts, the knowledge or information, being manipulated by the user through the instruments
    - The information content of the application
    - The purpose BEHIND the interaction

Instrumental Interaction (2)

- Goals
  - Describe state of the art interaction techniques
  - Provide metrics (qualitative and quantitative for comparing interaction techniques within a UI)
  - Present a design space to explore new ideas
  - Provide guidance for how to integrate new techniques into GUIs
- He defined Instrumental Interaction as an interaction model
  - Paraphrased from CHI 2000 paper: "A set of rules, principles, and properties that guide the define of an interface. It describes how to combine techniques, the "look and feel", and provides guidance for evaluating specific interaction designs."
- By definitions in this course, not an "interaction model"

Instruments

- WIMP interfaces present a set of instruments to user
  - Activated two ways: spatially and temporally
  - Examples?
- Instruments can also act on other instruments
  - Reification (becoming objects)
  - Meta-instruments (instruments designed to act on other instruments)
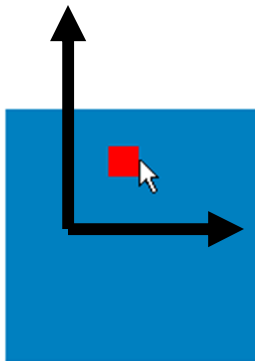 - Examples?

Instruments (2)

- Evaluating instruments
  - Degree of indirection
    - Spatial or temporal offset between instrument and action on object
    - Spatial
      - Close = handles on rectangle to resize
      - Far = dialog boxes
      - Is far always bad?
    - Temporal
      - Real time response versus clicking OK in dialog
  - Degree of integration
    - Ratio of degrees of freedom of instrument to degrees of freedom of input device
  - Degree of compatibility
    - Similarity of action on control device/instrument to action on object
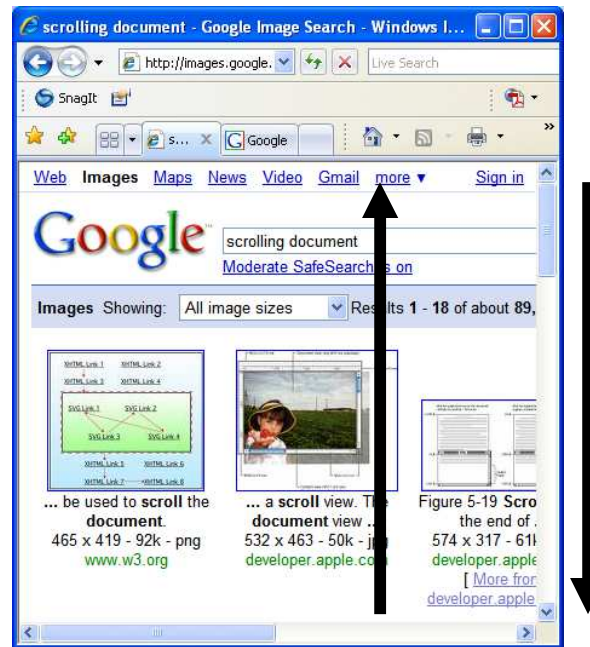
Degree of Integration

1D

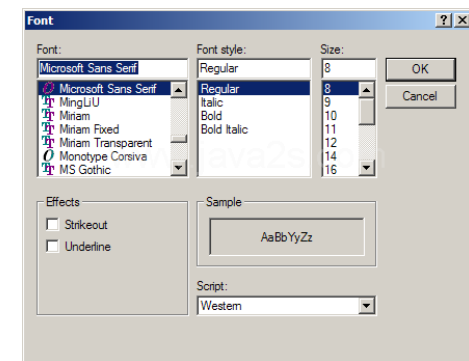2D

3D

2D

6D
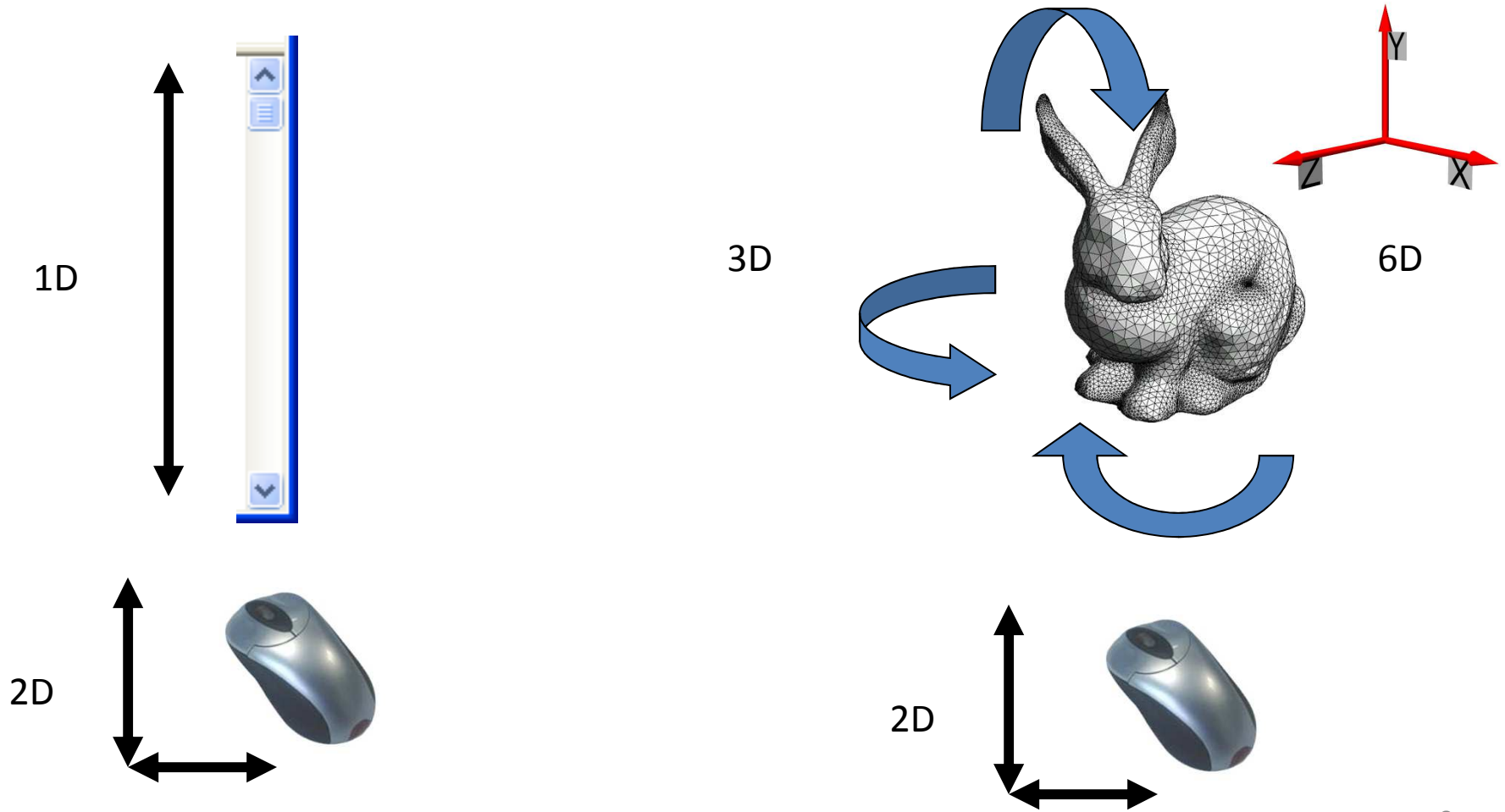
Degree of Compatibility

Dragging = high

Scrolling = medium

Dialog = low

Influences Leading to II

- Heavily influenced by Shneiderman's *principles of direct manipulation*
  - Examples of direct manipulation
    - Drag and drop
    - Resizing via handles

What is Direct Manipulation?

- By Definition:
A *direct manipulation interface* allows a user to directly act on a set of objects (instruments) in the interface.
  - The instruments are indistinguishable visually from the objects they represent.
  - The actions on instrument/object entities are analogous to actions on similar objects in the real world.
  - The actions on instrument/object entities preserve the conceptual linkage between instrument and object.

What is Direct Manipulation?

- By Example:
  - dragging a document to the trash
  - changing the size of a triangle by interacting with a visual representation of a triangle
  - inserting characters in a document by pointing to where they should go (with a mouse/cursor/insertion point) and then typing
  - "dialing" a phone number by pushing numbers on a keypad
  - playing a song using controls like a physical tape deck or CD/DVD player

What is Direct Manipulation?

- By Decomposition:
  - an analogy (including appropriate presentation of interface objects)
  - an implementation
- By Contrast: It is one of several interaction styles
  - menu selection
  - fill-in forms
  - command language
  - natural language
  - direct manipulation

What is Direct Manipulation?

- **By Characteristics:** (from User Interface Design & Evaluation, p. 213-214)
  - There is a visible and continuous representation of the task objects and their actions. Consequently, there is little syntax to remember.
  - The task objects are manipulated by physical actions, such as clicking or dragging, rather than by entering complex syntax.
  - Operations are rapid and incremental
  - Their effects on task objects are immediately visible.
  - Reversibility of (almost) all actions
  - Users can explore without severe consequences
  - Syntactic correctness – every operation is legal
- **What (is/is not) direct manipulation in modern interfaces?**

What is Direct Manipulation?

- By Benefits:
  While interacting with DM interfaces, users feel as if they are *interacting with the domain* rather than with the interface, so they *focus on the task rather than on the technology*. There is a feeling of *direct involvement with a world of task objects* rather than communication with an intermediary.

DM Issues (1/2)

- Setback for impaired users
  - visually impaired users can't see the graphics; no linear flow for screen readers
  - physically impaired may have difficulty with actions
- Meanings are indirect
  - Users need to learn meaning of visual representations
  - Visual representations may be misleading
- Often consume valuable screen space, forcing valuable information off-screen.
- Switching modes, from keyboard to tracker, is time consuming.

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DM Issues (2/2)

- Many commands are invoked indirectly
  - Menus, dialog boxes, toolbars
    - Not direct manipulation
    - They are mediators that pull users away from objects of interest
- Many objects of interest are hidden
  - Style sheets
  - Alignment constraints are often fleeting
- Lots of object in the interface are not objects of interest
  - Toolbar pallets

(From Beaudoin-Lafon [2000])

Analogies

- "attempting to make affordances in the interface like affordances for analogous actions in the real world"

  – Build on the user's existing experiences and intuitions to aid learning.

  – But… Not every analogy results in a DM interface. Example: shopping analogy for on-line retailers.

Analogies

- Analysis of analogies, in an attempt to come up with a more concrete paradigm:
  - Identify components of the description of the real-world action
  - Identify corresponding components of the direct manipulation action
  - Try to create a more generalized description of each pair.

Analyzing an Analogy

Real World	Common Language	DM Interface
Object to be discarded	Grammatical Object	Icon of object to be discarded
Move hand to object	Move to object location	Move pointer to object
Pick up object with hand	Acquire object	Click to aquire object
Waste basket	Waste Basket location	Waste basket icon
Move to waste basket	Move to waste basket location	Drag to waste basket icon
Release object from hand	Release object	Release button to discard object

Analyzing an Analogy

- A location with special meaning (the object)
- Another location with special meaning (the waste basket)
- Movement between locations

Other Analogies

- Graphics Editors
  - analogy of drawing surface and tools to paper and tools
  - every location has a special meaning
  - locations often have multiple meanings
- Word Processors
  - analogy of screen to paper
  - locations between letters have special meanings
- Desktop
  - analogy to office: documents, folders, waste basket
  - all of these have special meanings
- Drag 'n Drop
- Spreadsheets

Representing Special Locations

- Icons often represent a "special location"; they require:
  - a location
  - a visible boundary
  - enough visual information for users to make a precise identification
- Many other special locations are similar
- Need to perform many inside tests to implement DM:

```
for (Item item : displayList)
{    if    (item.contains(m.x, m.y))
    {    …
    }
}
```

- Easy for rectangles, but not for many other shapes. We need a more general strategy…