03

INTERACTION AND GUI

WHY INTERACTION?

PASSIVE INFORMATION DISPLAY

Few
functions

Presentation
purposes mostly

WHY INTERACTION?

ACTIVE INFORMATION DISPLAY

Queries on the data

Changing visualization parameters

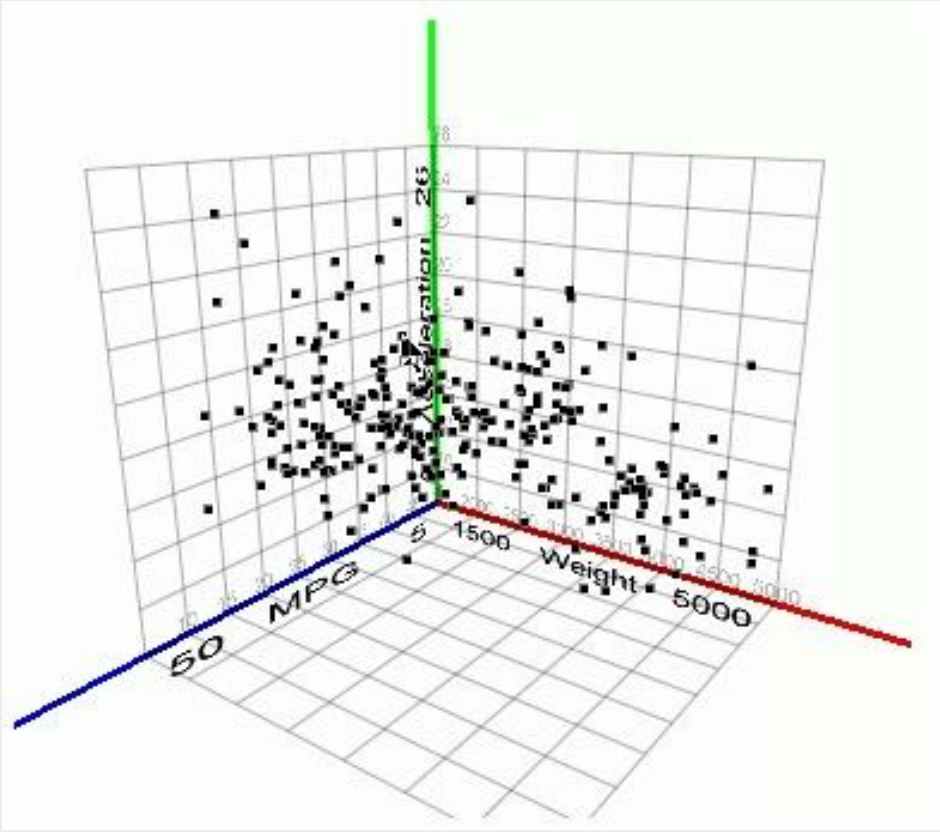
- Filtering
- Mapping
- Rendering

INTERACTIVE DISPLAY IMMERSES THE VIEWER

MENTAL MODEL OF THE DATA

BUILDING A MENTAL MODEL

INTERACTION WITH A 3D SCATTERPLOT



FAST RESPONSE = DIRECT MANIPULATION

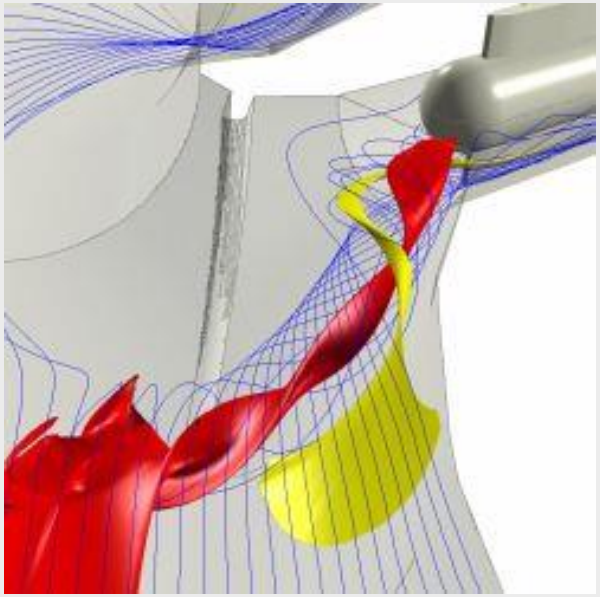
DIRECT MANIPULATION

QUICK RESPONSE = CAUSALITY LINK

SPEED ISSUES

What is ”real-time” ?

25 - 100 fps



5 - 30 fps

SLOW DISPLAYS

CHANGE BLINDNESS

Smooth changes too slow
Jumps and jerks

HOW TO FIX IT?

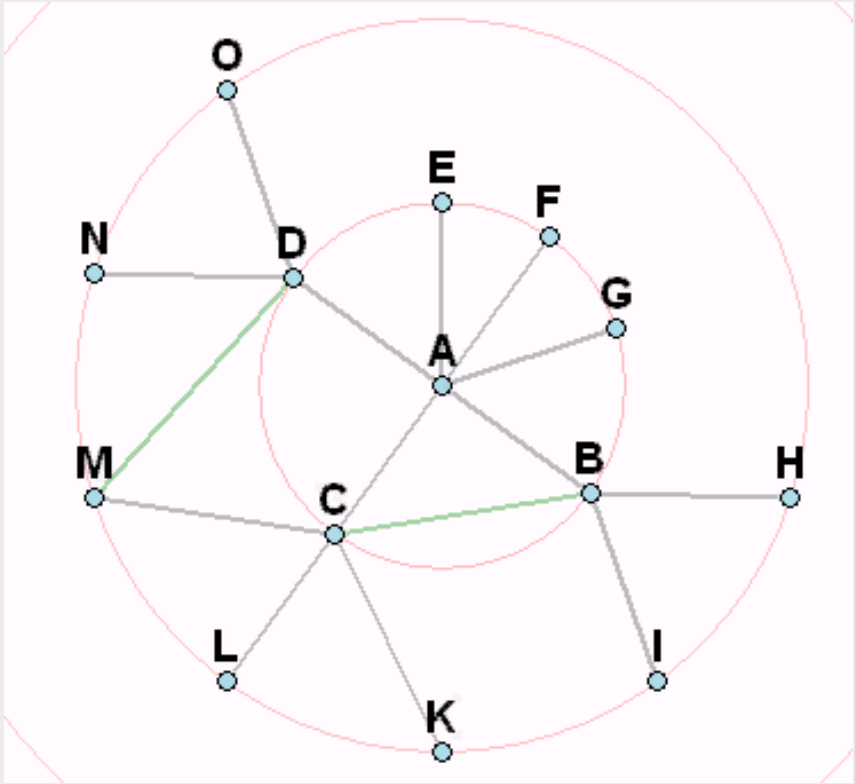
Less data
Level of detail techniques
Progressive rendering
Faster technologies (GPU, GPGPU,...)

INTERACTION AND ANIMATION

EVEN FAST DISPLAYS CAN OBSTRUCT BUILDING A MENTAL MODEL

EXAMPLE:

Animated Exploration of Graphs with Radial Layout
(Yee et al., Infovis'01)



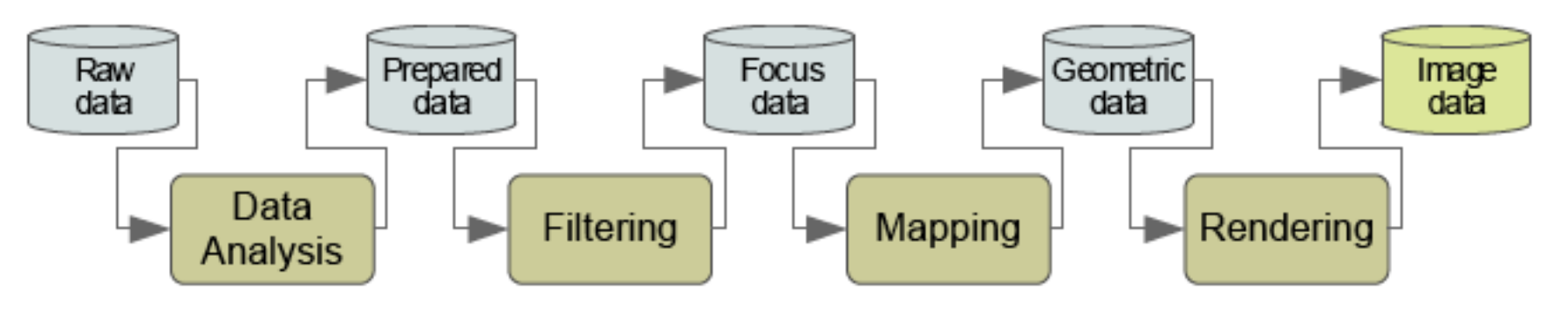
POINTS OF INTERACTION

DIFFERENT STAGES OF INTERACTION

FILTERING
Picking, brushing, interval queries,...

MAPPING
Axes manipulation, transfer function

RENDERING
View manipulation (rotate, zoom, pan)



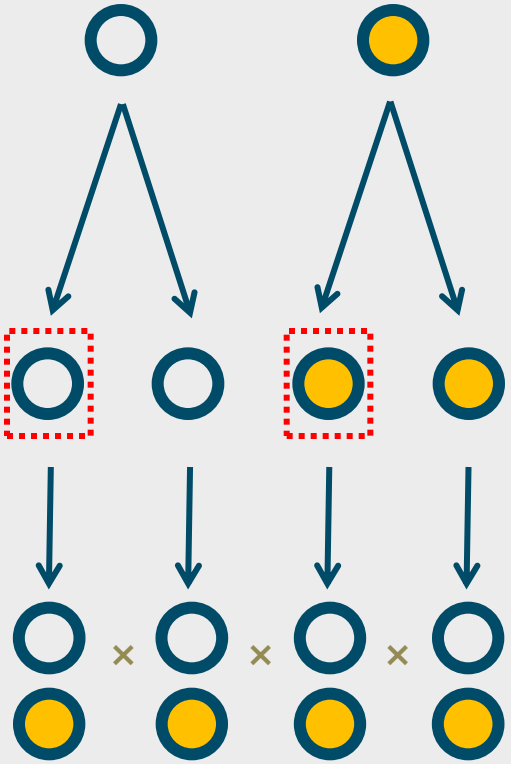
FILTERING: SELECT WHAT IS INTERESTING

STATE *N*:
What's selected and what not?

INTERACTION:
Which items are indicated

STATE *N+1*:
What should be the result?

TOTAL: 2^4 = 16 OPERATORS
Not all are useful



BASIC SELECTION OPERATORS

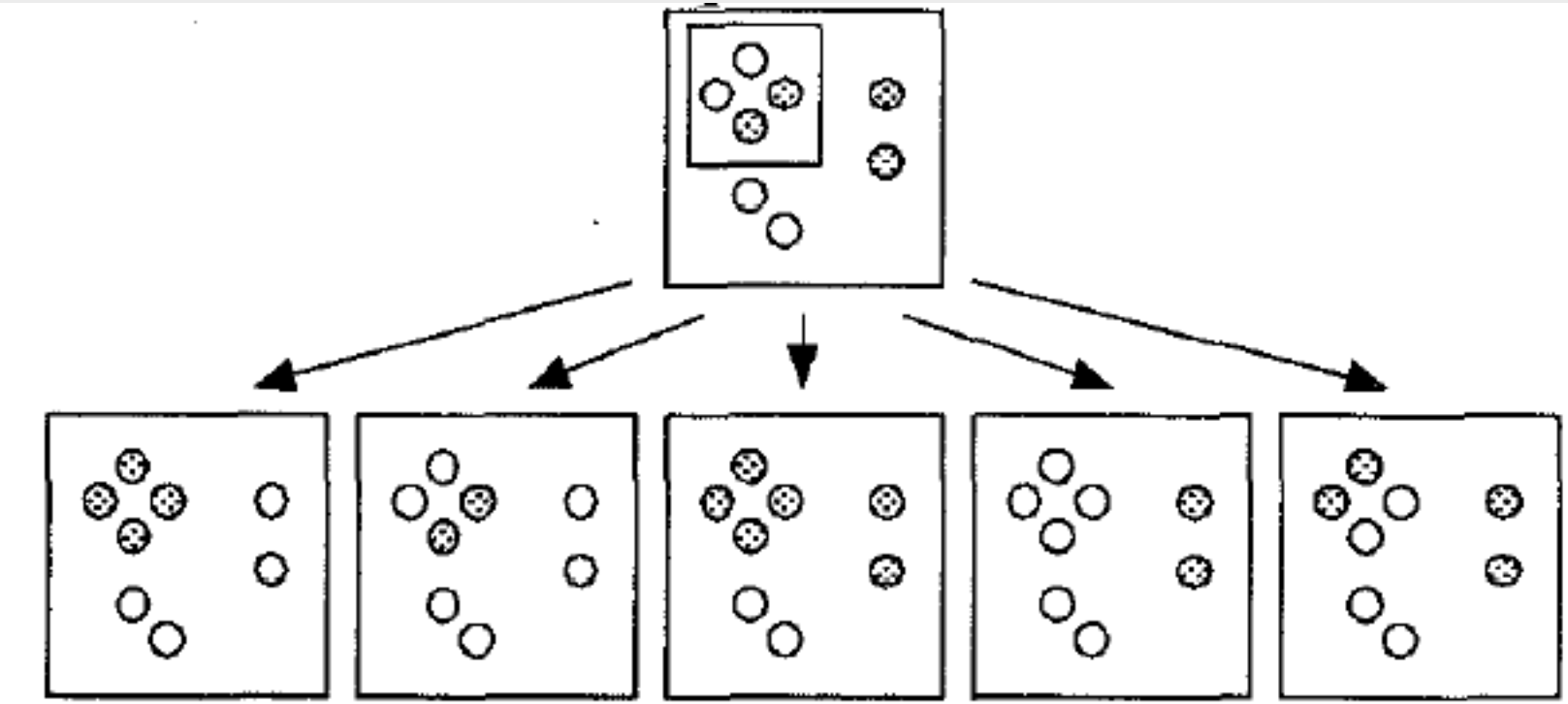


Figure 3. Basic Selection Operations

Graham J. Wills:
Selection: 524,288 Ways to Say “This is Interesting”

EXAMPLE SCENARIO

1. SELECT ALL MEN OUT OF ALL PEOPLE
   REPLACE operator, Attribute: sex

2. DESELECT MEN WHERE AGE > 70
   NOT operator, Attribute: age

3. SELECT ONLY THOSE WITH INCOME < 1000
   AND operator, Attribute: income

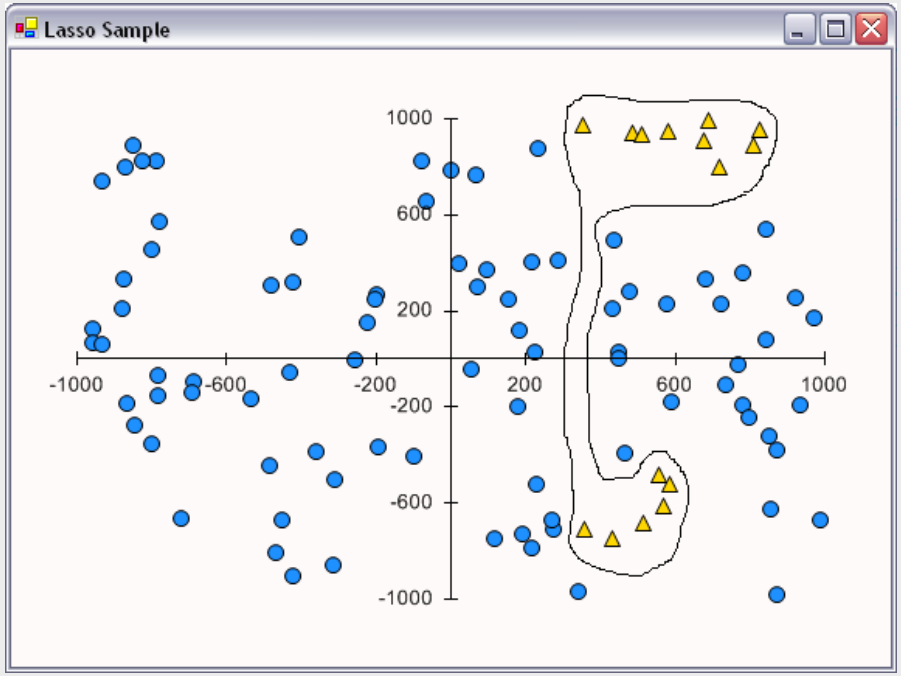
4. ADD ALL WOMEN OUT OF ALL PEOPLE
   OR operator, Attribute: sex

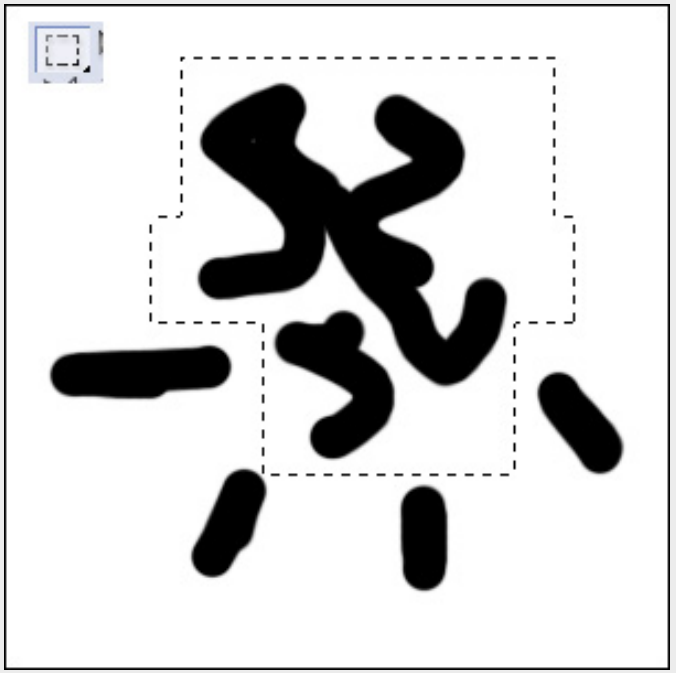
BRUSHING

WITH MEMORY / WITHOUT MEMORY

BRUSHES / LASSOS

DATA DEPENDENT / INDEPENDENT





SO IN TOTAL

16 POSSIBLE OPERATORS

65.536 POSSIBLE SETS OF OPERATORS (2^16)

WITH / WITHOUT MEMORY = *2
BRUSH / LASSO = *2
DATA DEPENDENT/INDEPENDENT = *2

65.536 * 2 * 2 * 2 =

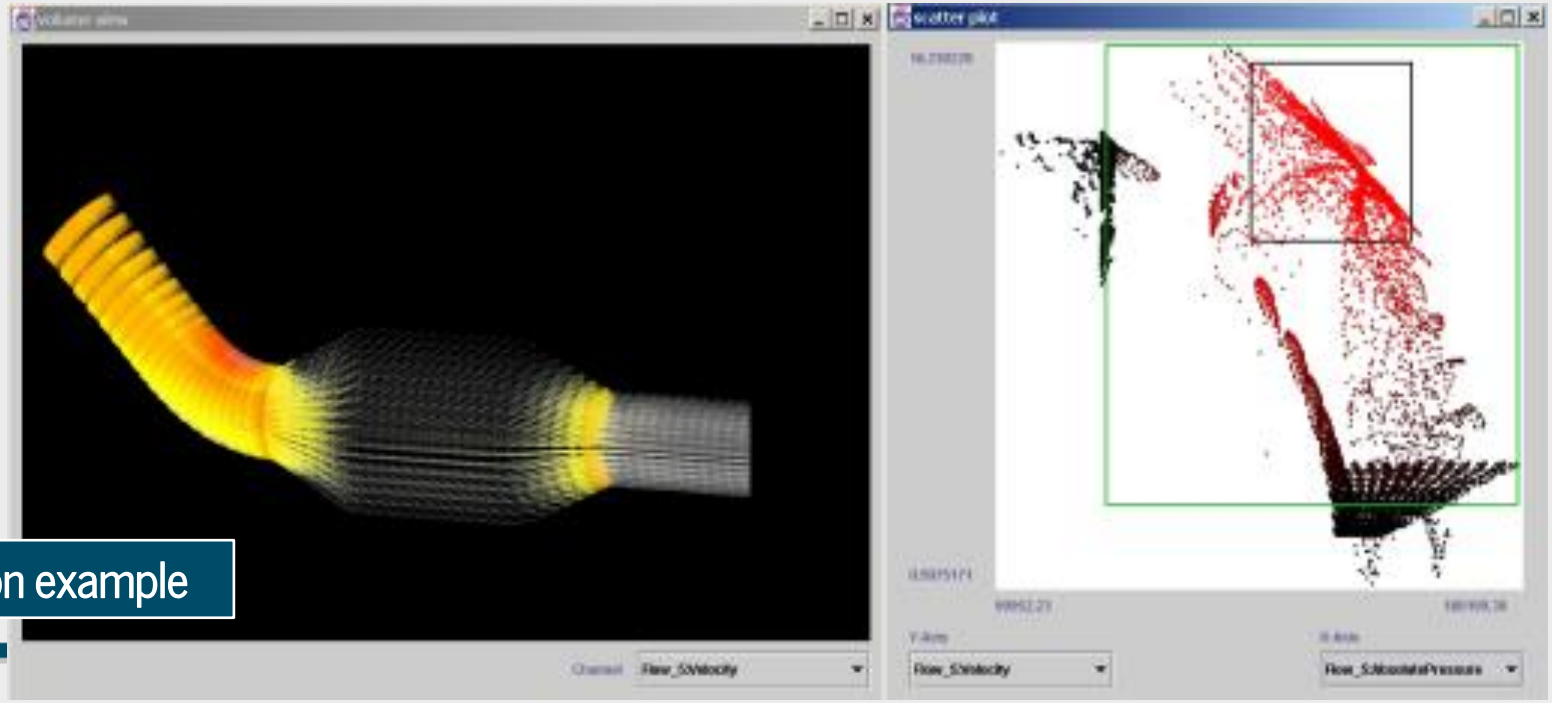
524.288 WAYS TO SAY ”THIS IS INTERESTING”

DEGREE OF INTEREST FUNCTION

RESULT OF SELECTION, BRUSHING, QUERIES...

DISCRETE SELECTION
Data index → { 0,1 }

SMOOTH SELECTION
Data index → < 0,1 >



Smooth selection example

MAPPING: AXES MANIPULATION

MAPPING FUNCTION (TRANSFER FUNCTION)

- Attribute C, Axis A
- $\langle C_{min}, C_{max} \rangle \rightarrow \langle A_{min}, A_{max} \rangle$
- Linear, logarithmic, hyperbolic, exponential...

COLOR MAPPING

SIMILAR TO ZOOMING, PANNING

VIEW MANIPULATION

ROTATE, PAN

ZOOM

Linear
Non-linear (fisheye)

OTHER DISPLAY PARAMETERS

Transparency, linking

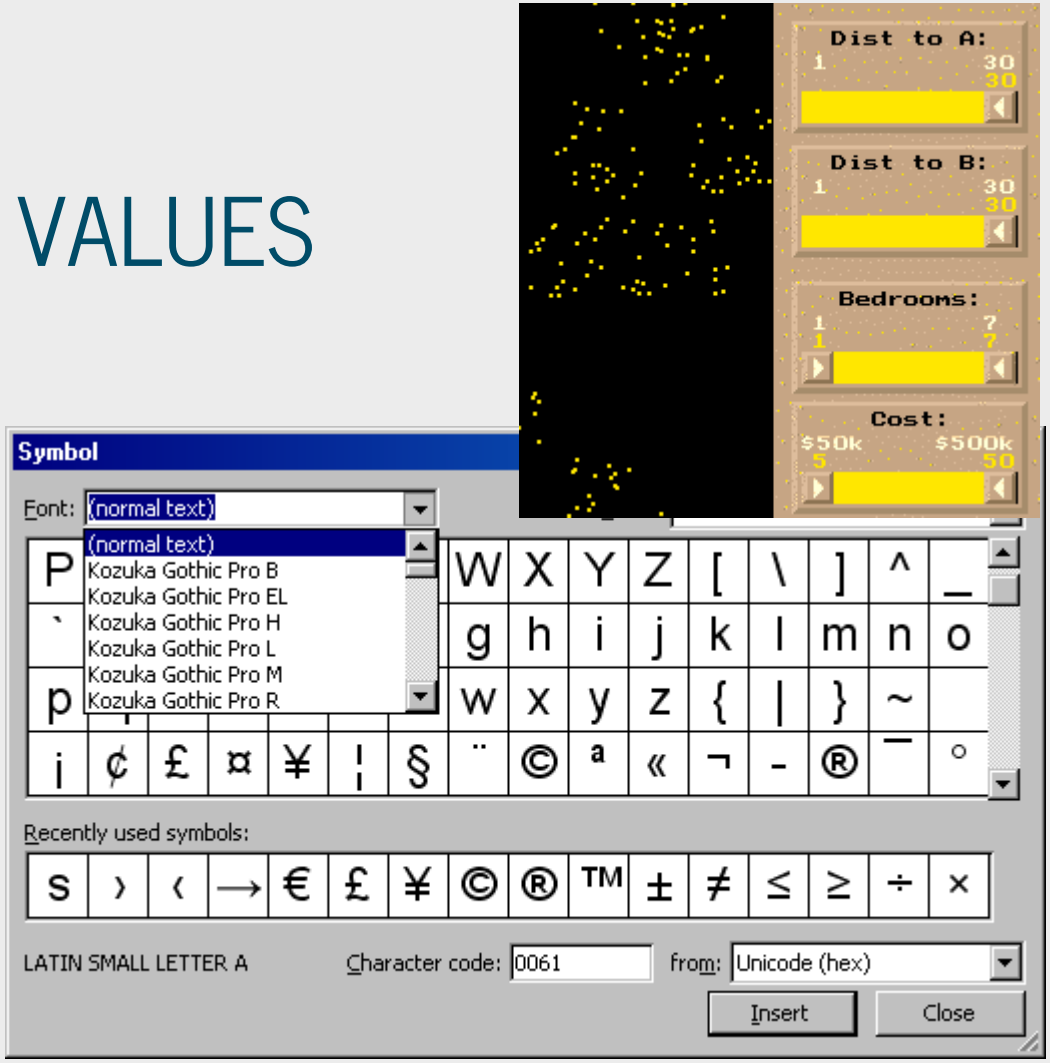
MEANS OF INTERACTION

SELECTORS

BRUSH
PICK
STRINGS, NUMERIC VALUES
INTERVALS

REMEMBER DATA TYPES

- Continuous
- Discrete
- Categorical ...



INTERACTION WIDGETS

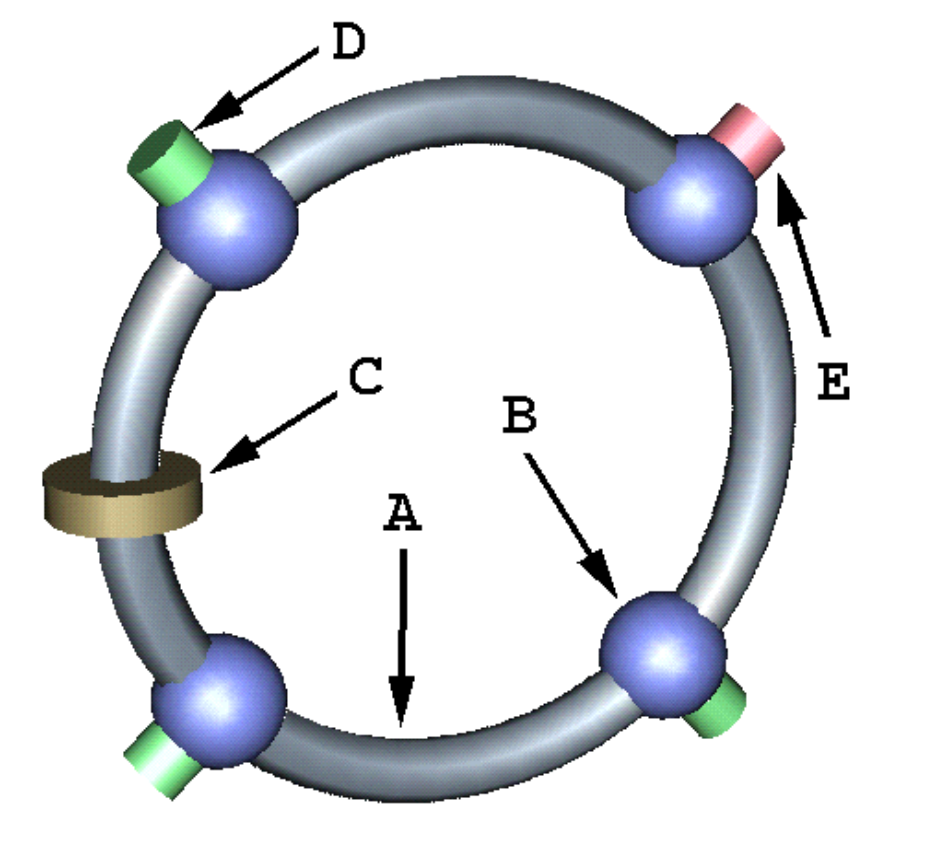
INTERNAL WIDGETS

3d icons
Handles, ...

EXTERNAL WIDGETS

Sliders
Spin-buttons, ...

SIMPLE / COMBINED



RULES FOR USING WIDGETS

AFFORDANCES
LABELS

- On demand
- Always visible

MIND THE TYPE OF DATA VALUES

Discrete values - picking
Nominal values - input boxes with completion
Continuous - sliders
Color values - combined widgets, HSV not RGB

INPUT DEVICES FOR HCI

KEYBOARD
MOUSE
(MULTI-)TOUCH-SENSITIVE DISPLAY

TANGIBLE INTERFACES
CAMERA
MOTION SENSORS (OPTICAL, PHYSICAL)

INTERACTION METAPHORS

METAPHORS

BEHAVIOR THAT'S BEEN EXPERIENCED BEFORE

ANALOGY TO REAL WORLD MANIPULATION

INTUITIVE

PREDICTABLE

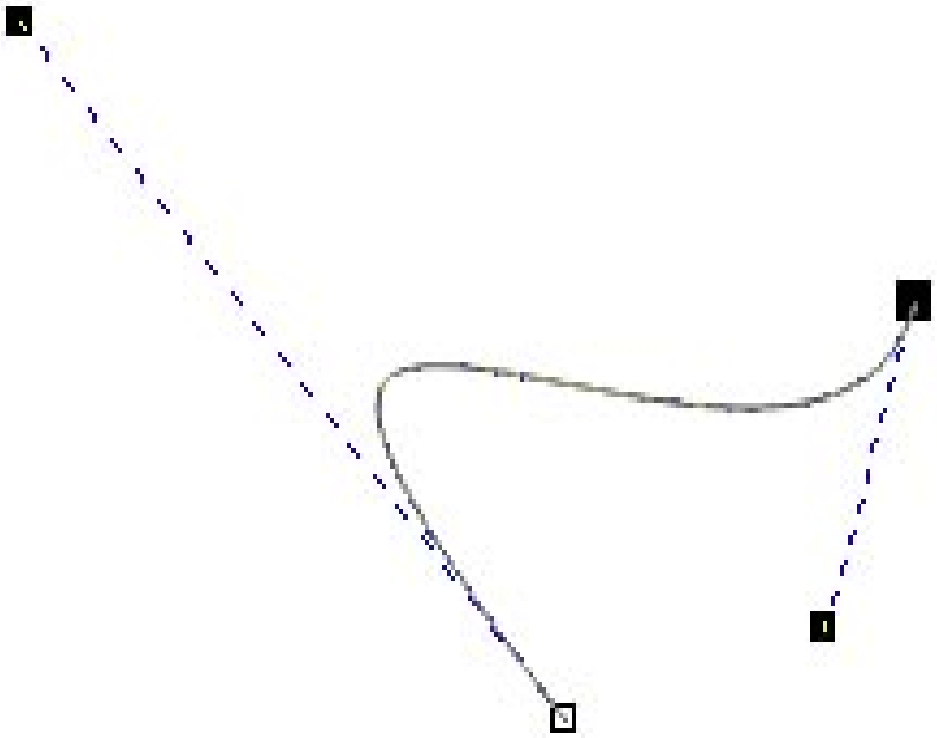
CONSISTENT

CONVENTIONAL

MAGIC LENS METAPHOR

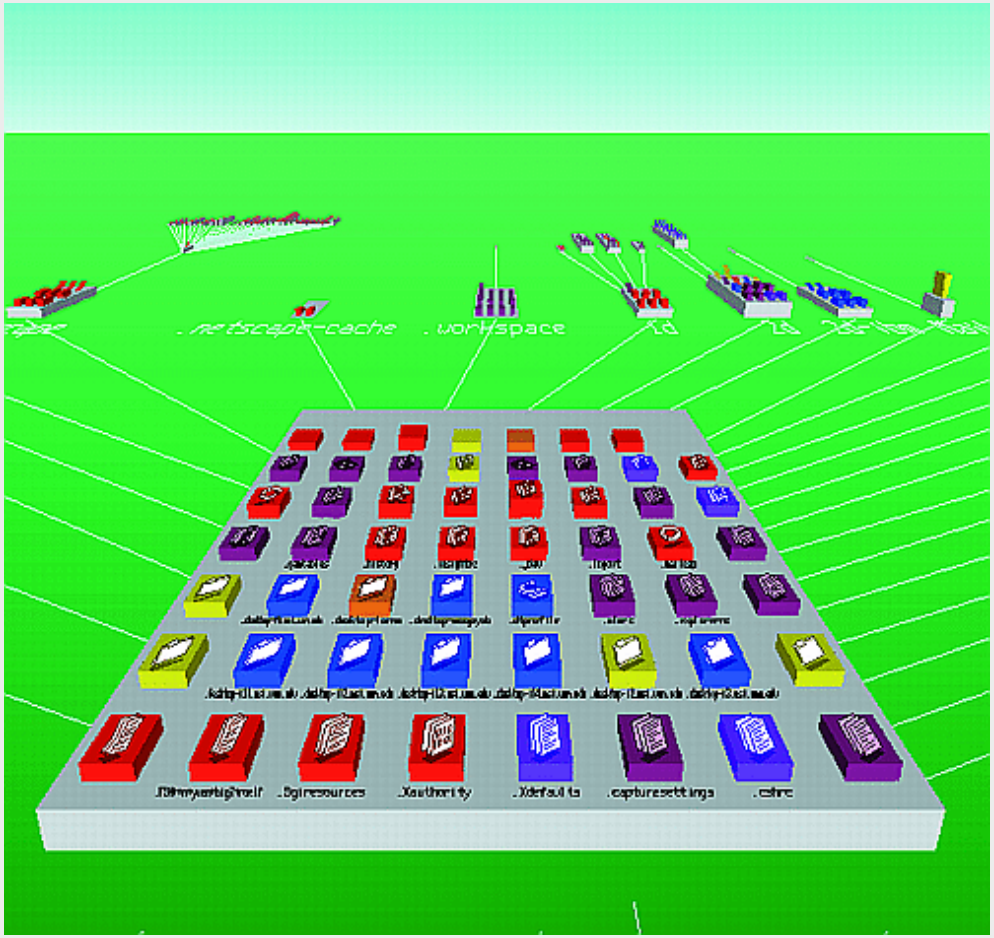
TABLE TOP METAPHOR

HANDLES, CONTROL POINTS



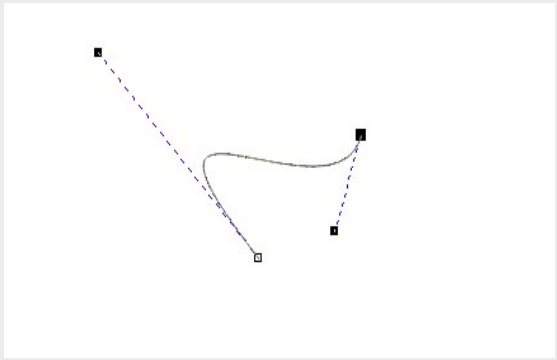
SGI FILE SYSTEM

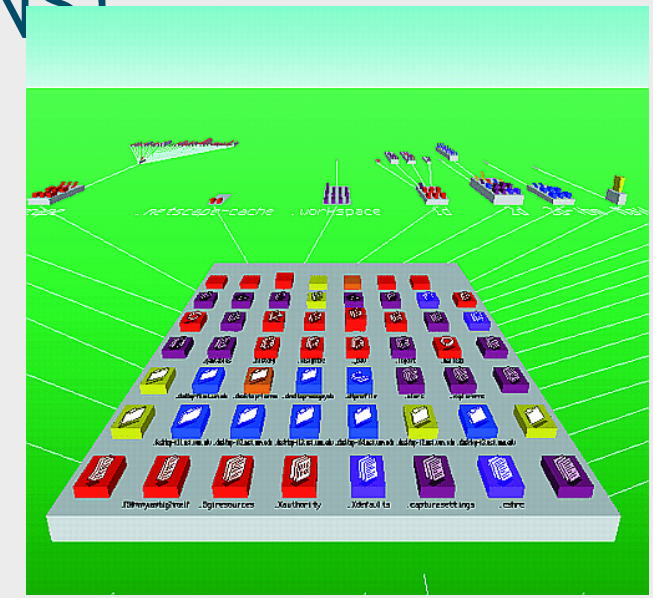
TOWN METAPHOR



EXAMPLE METAPHORS

DESKTOP / ROOM (OS)
HANDLES (DTP, GRAPHICS)
HOUSES (SGI FILE SYSTEM NAVIGATOR)
GESTURES (MOUSE GESTURES)
MAGNIFYING GLASS (MAGIC LENS)



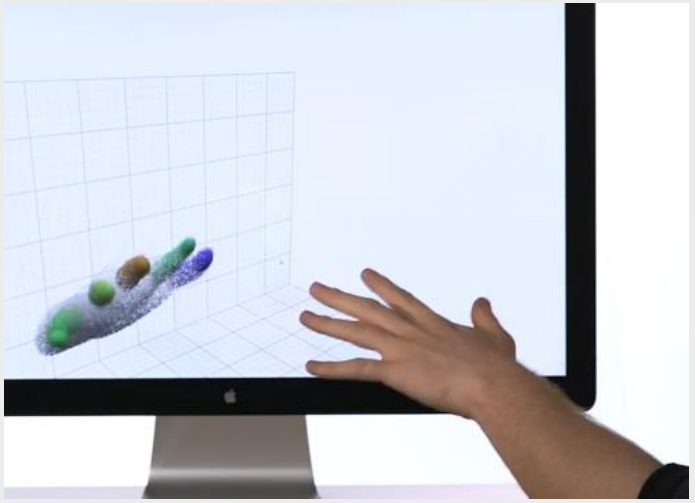


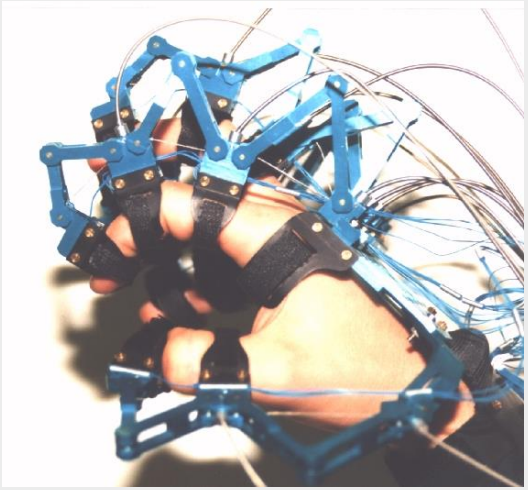
A METAPHOR GONE TOO FAR

MICROSOFT BOB

NATURAL USER INTERFACES

METAPHORS BECOME REAL
TANGIBLE UI
MOTION/KINETIC SENSORS
HAPTIC
FORCE FEEDBACK





NATURAL USER INTERFACES

SUMMARY

DIFFERENT STAGES OF VISUALIZATION

CORRECT INTERACTION METAPHOR / WIDGET
Depends on the nature of the action, type of data

CONVENTIONS ARE GOOD
TOO MUCH ORIGINALITY IS BAD ☺

DEVELOP FOR THE USER, NOT FOR YOURSELF!

USABILITY FIRST, TECHNOLOGY SECOND

MORE ABOUT HCI

HUMAN-COMPUTER INTERACTION

Pavol Fabo, 2-AIN-151

JACOB NIELSEN ON USABILITY AND WEB DESIGN

http://www.useit.com

HUMAN-COMPUTER INTERACTION RESOURCES

http://hcibib.org

KEYWORDS:

Usability

User experience (UX)

INTERACTION FOR INFOVIS

DATA SELECTION

Fast response = direct manipulation
Convenient selection system = queries

LINKING AND BRUSHING

Different views of the same data share the same selection

VIEWPORT MANIPULATION

Axis mapping

NEXT WEEK: MULTIDIMENSIONAL DATA