

ay/bi199: methods of computational science

visualization

jumpstart + tools + techniques

santiago v lombeyda | center for advanced computing research | caltech



data



~~questions~~

new questions

analytical

 answers

visual inspection

 answers



what *includes* visualization

data



mo



ple

visualization =

science

+

computer graphics/hci

+

graphic design/art

finding solution(s) via purpose

for what purpose do we visualize?

quick view/demonstration

we want to look at/show something particular

analysis

we know what we are looking for

explore

we do not know what we are looking for

debugging

we want to assure there is nothing odd

...

process dictated by the data



A CLOSER **LOOK** AT THE "DATA"

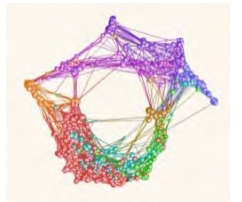
data: GEOMETRIC STRUCTURE

abstract

multi-dimensional data RECORDS

mapping + paradigms → *interaction*

infoviz

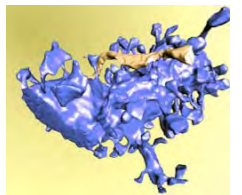


2d/3d data

scalar/vector/tensor + time

paradigms → *interaction*

the more main stream viz



ieee vis
ieee infovis
siggraph

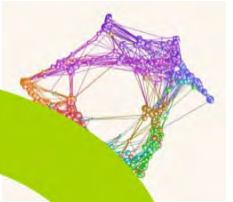
ieee xplore:
ieeexplore.ieee.org

acm digital library:
portal.acm.org/dl.cfm

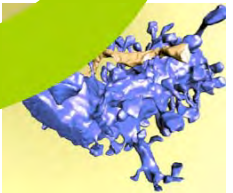
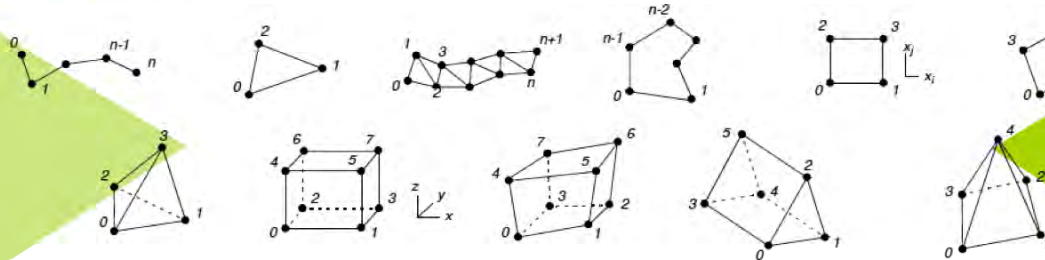
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| MPG | Cylinders | Horsepower | Weight | Acceleration | Year | Origin |
|-----------|-----------|------------|----------|--------------|-------------|-----------|
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| 70.000000 | 1.000000 | | | | | |



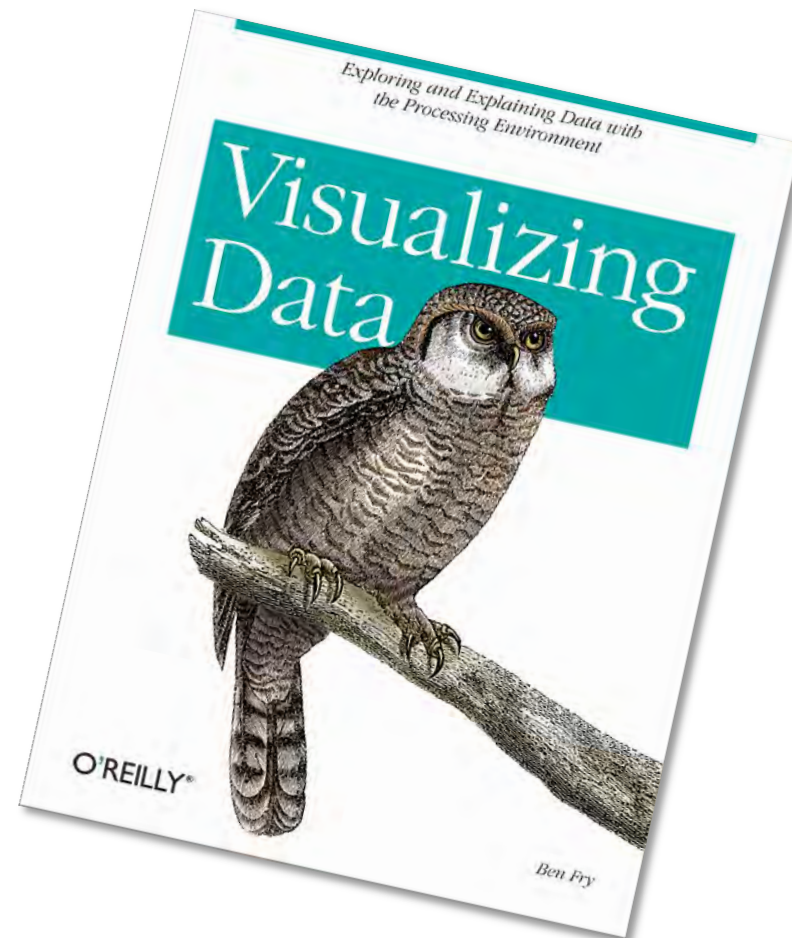
2d/3d data





understanding
✓

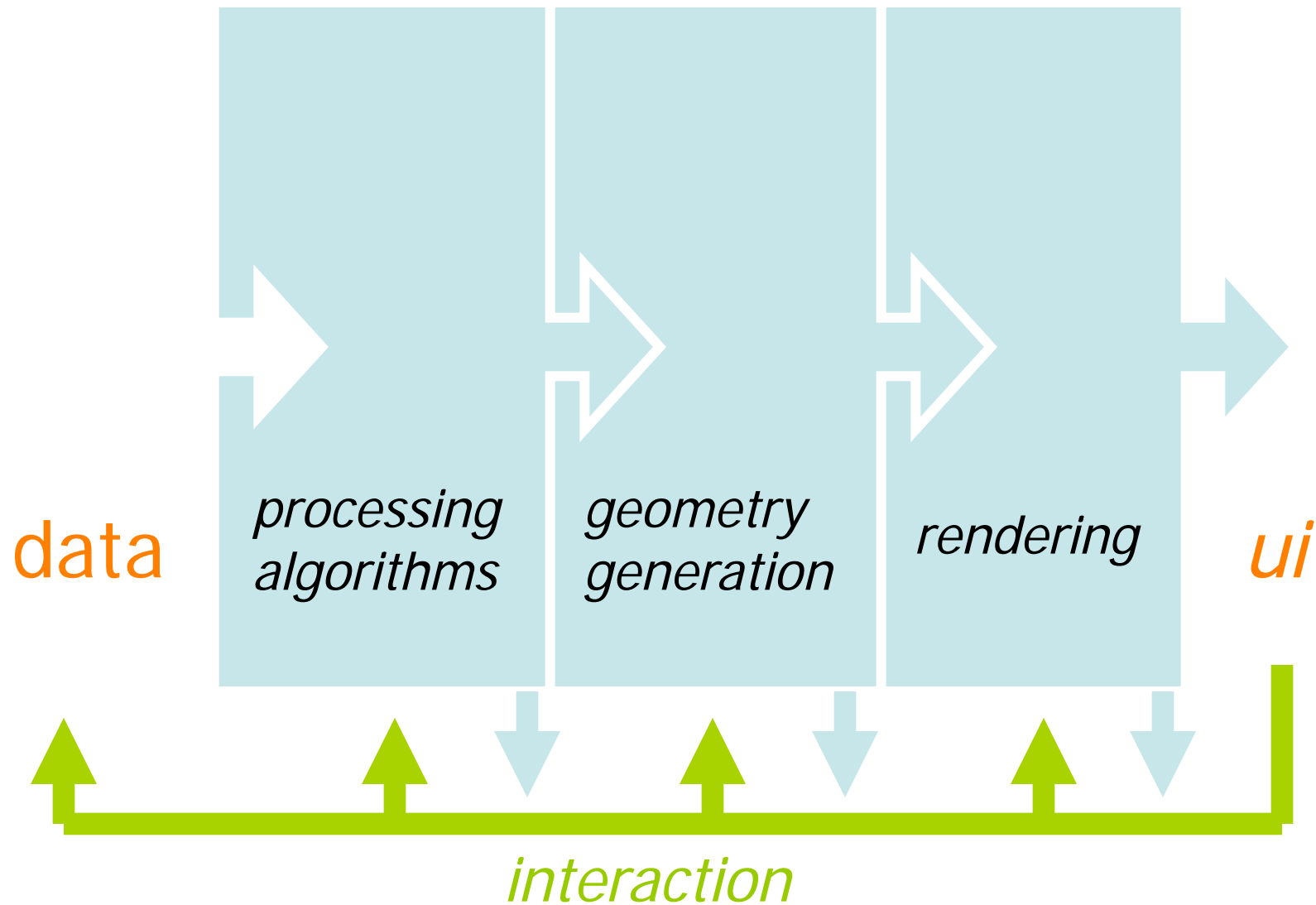
THE VISUALIZATION PROCESS



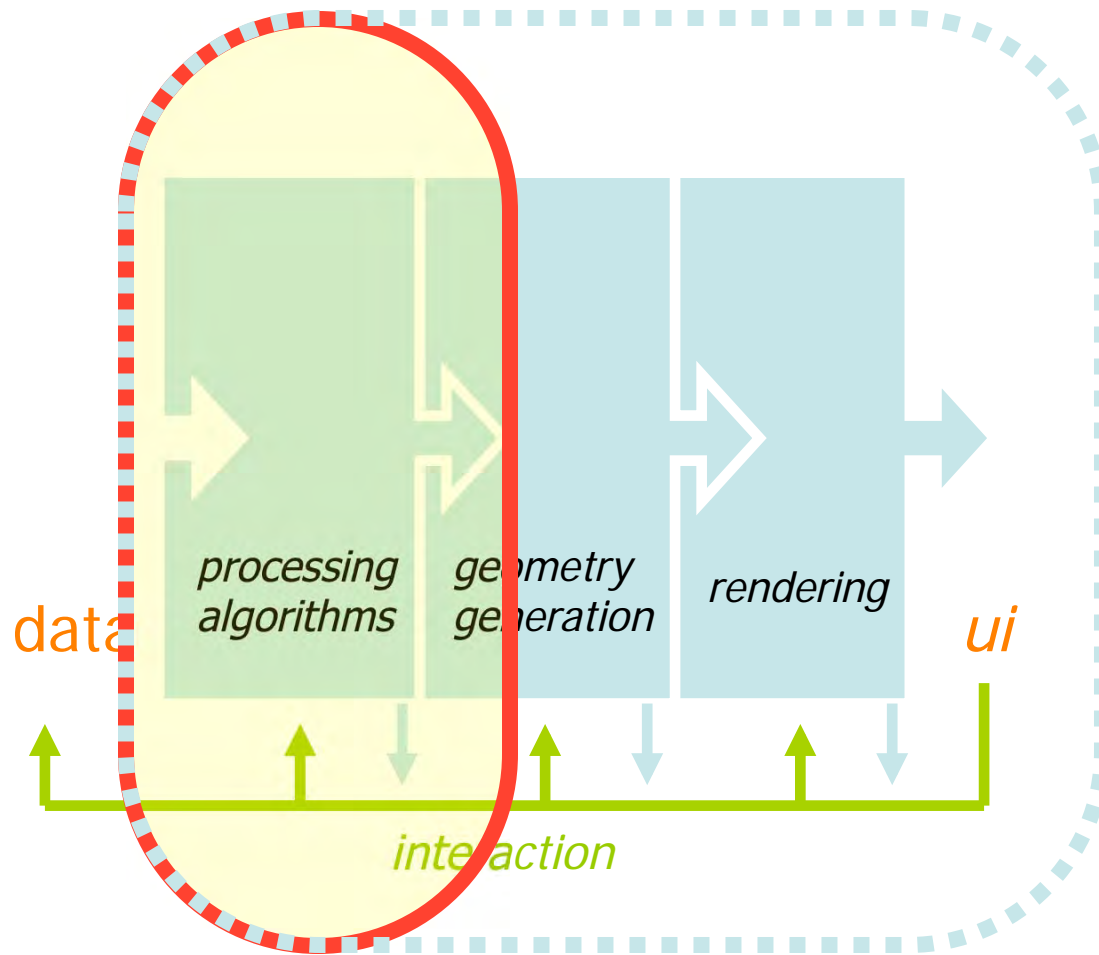
[Ben Fry, *Visualizing Data*, O'Reilly Media, 2008]

| Acquire | Parse | Filter | Mine | Represent | Refine | Interact |
|--|---|--------------------------------------|--|--|---|---|
| Obtain the data, whether from a file on a disk or a source over a network. | Provide some structure for the data's meaning, and order it into categories | Remove all but the data of interest. | Apply methods from statistics or data mining as a way to discern patterns or place data in mathematical context. | Choose a basic visual model, such as a bar graph, list, or tree. | Improve the basic representation to make it clearer and more visually engaging. | Add methods for manipulating the data or controlling what features are visible. |

usual visualization engine

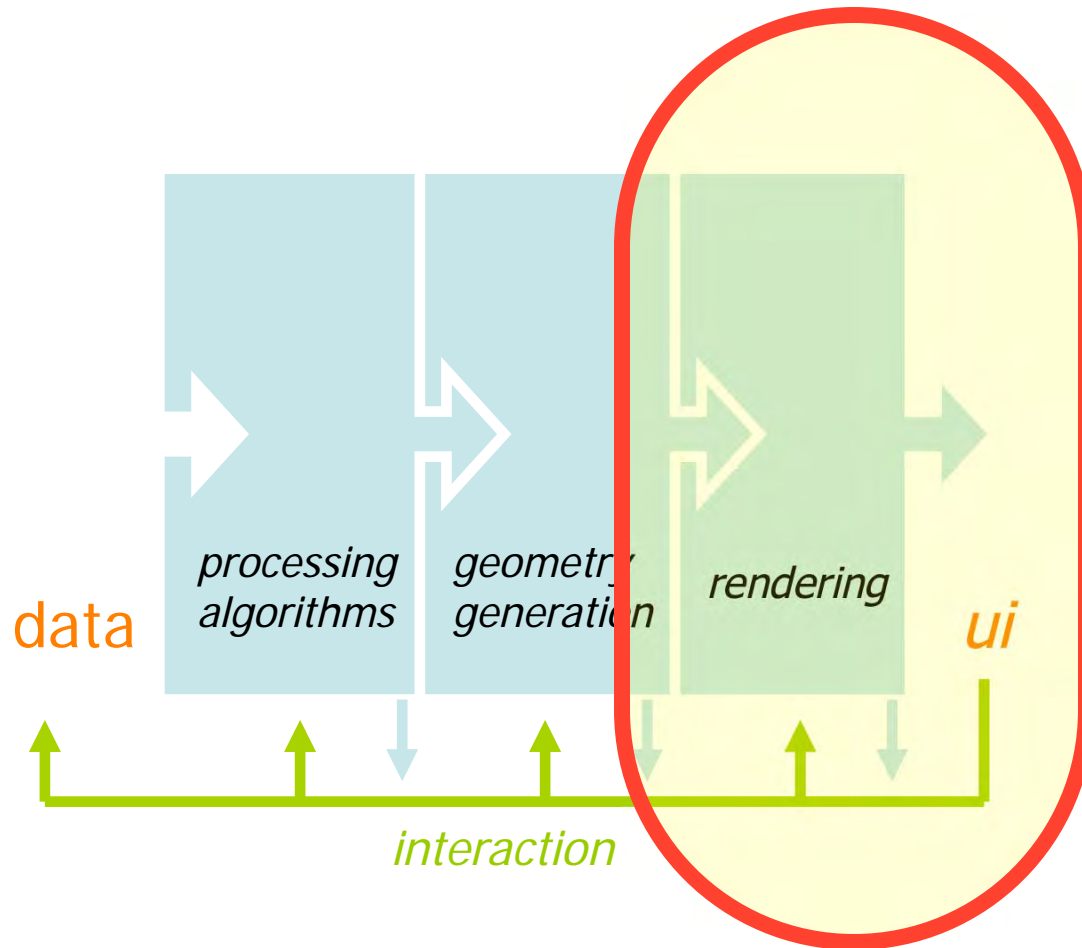


"the" visualization toolkit



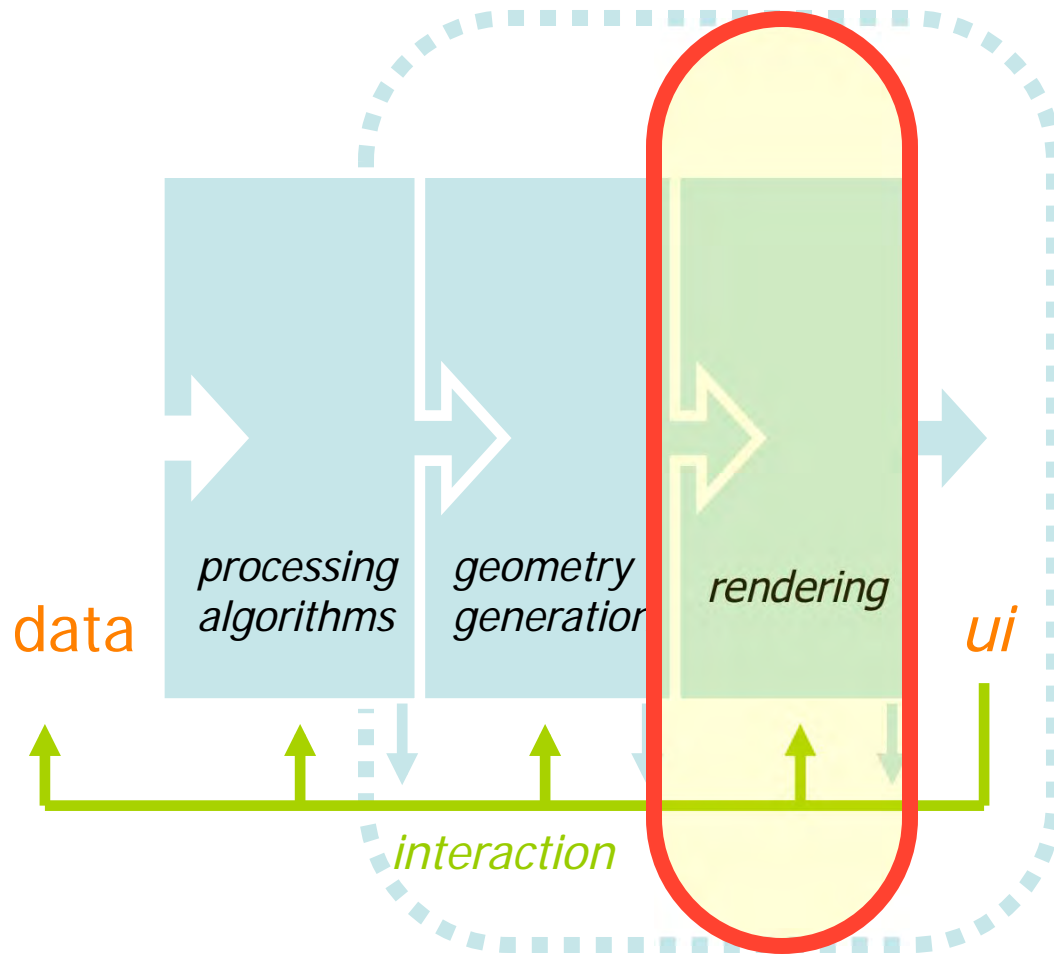
- * VTK
 - * c/c++
 - * tcl/tk
 - * python
 - * java
 - * R
-
-

interactive renderers



- * OpenGL mesaGL
HIGHER LEVEL: directX
- * OpenInventor
 - * C++/GL
 - * COIN
- * Java3D
 - * Java/GL
- * ~~O3D~~ *(by Google)*
 - WebGL

ray tracers



* POVRay

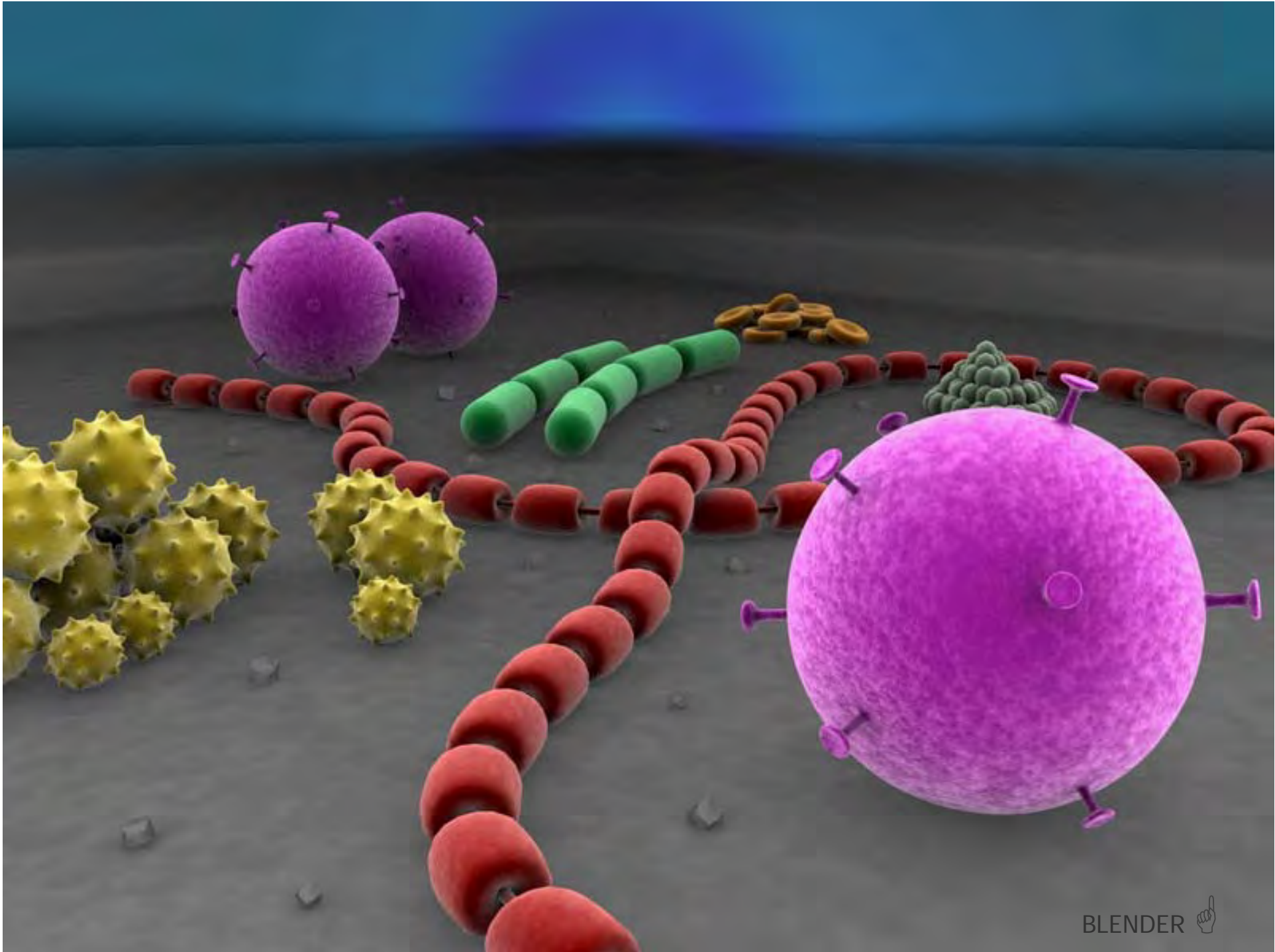
* RenderMan^{\$\$}

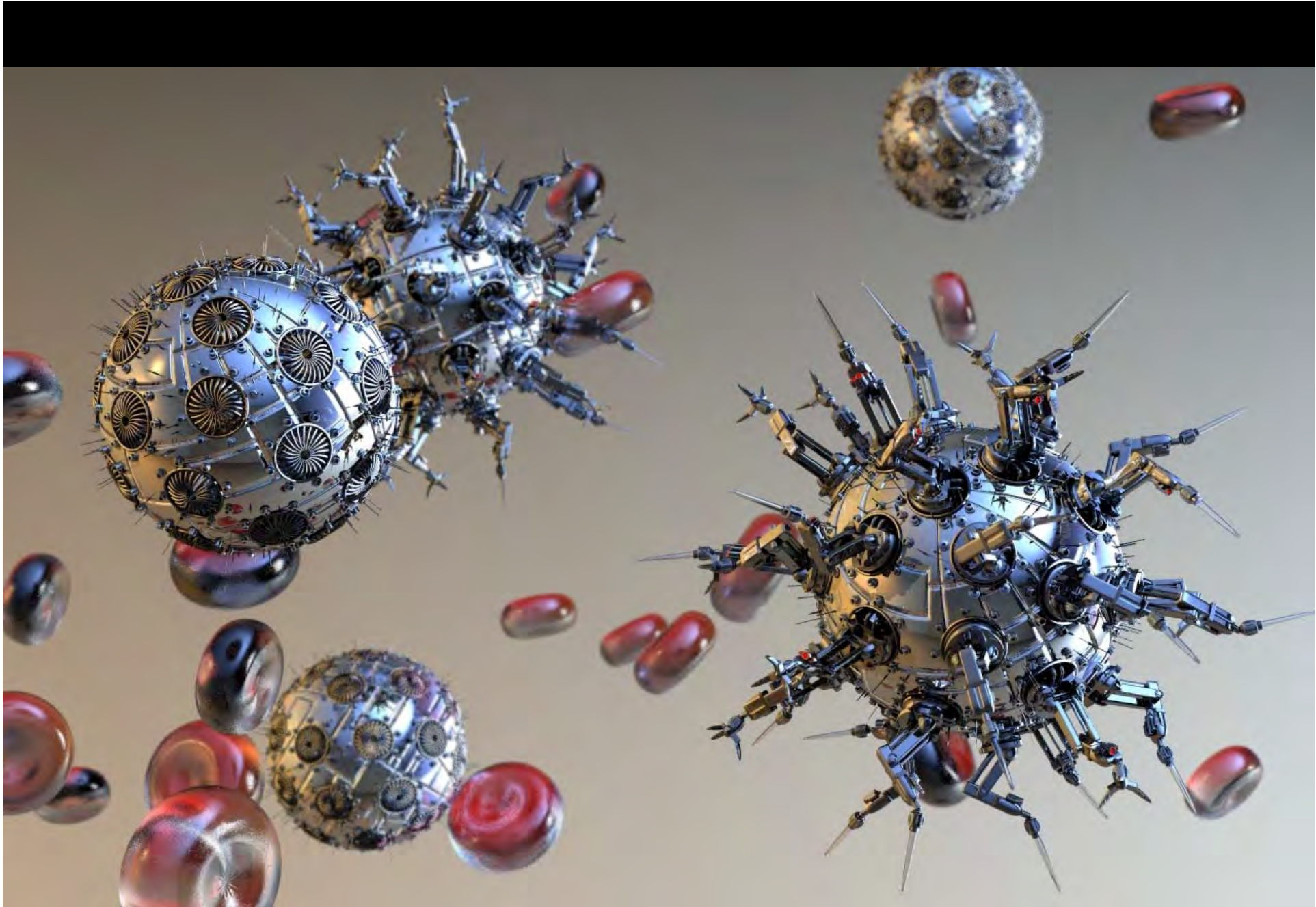
MODELLERS:

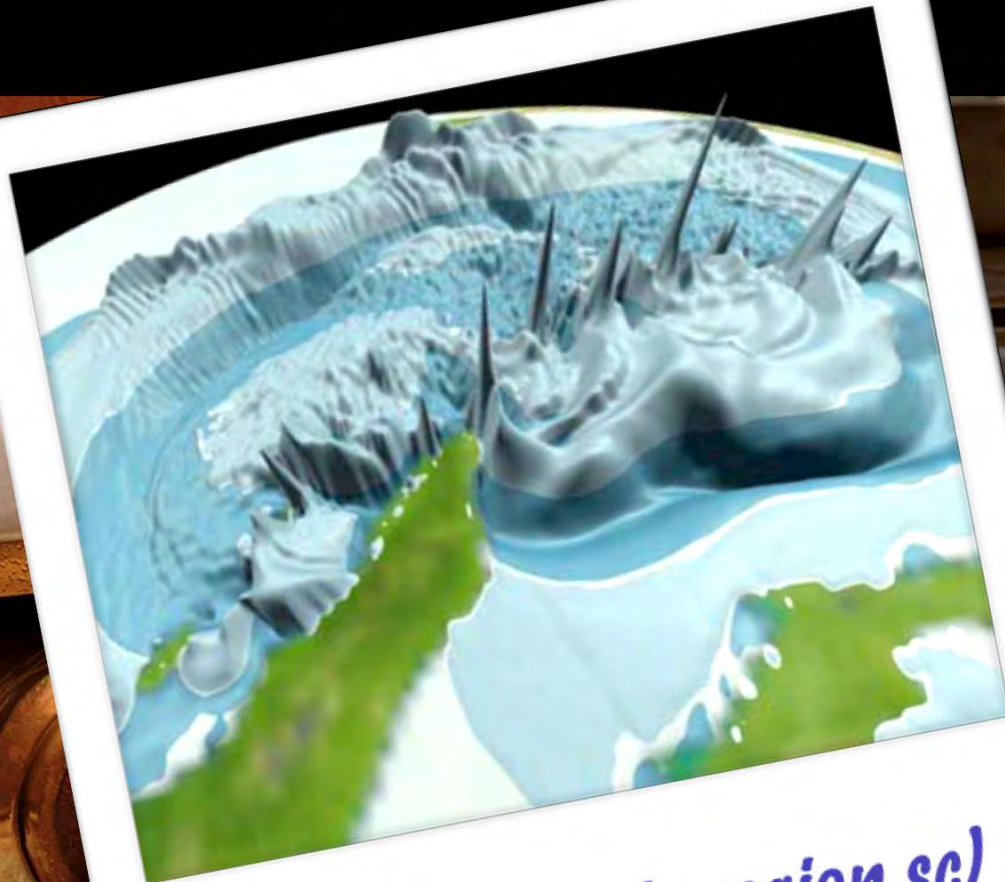
* Blender

* Maya^{\$\$}



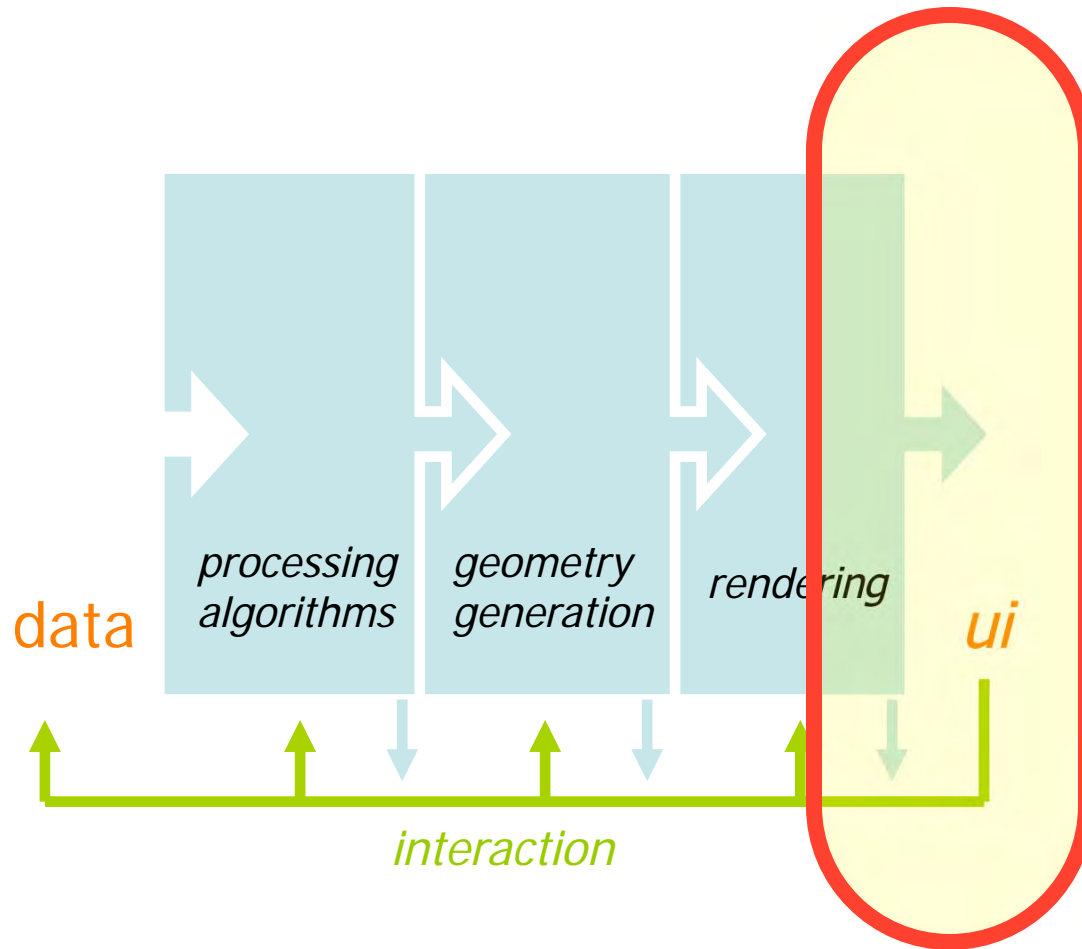






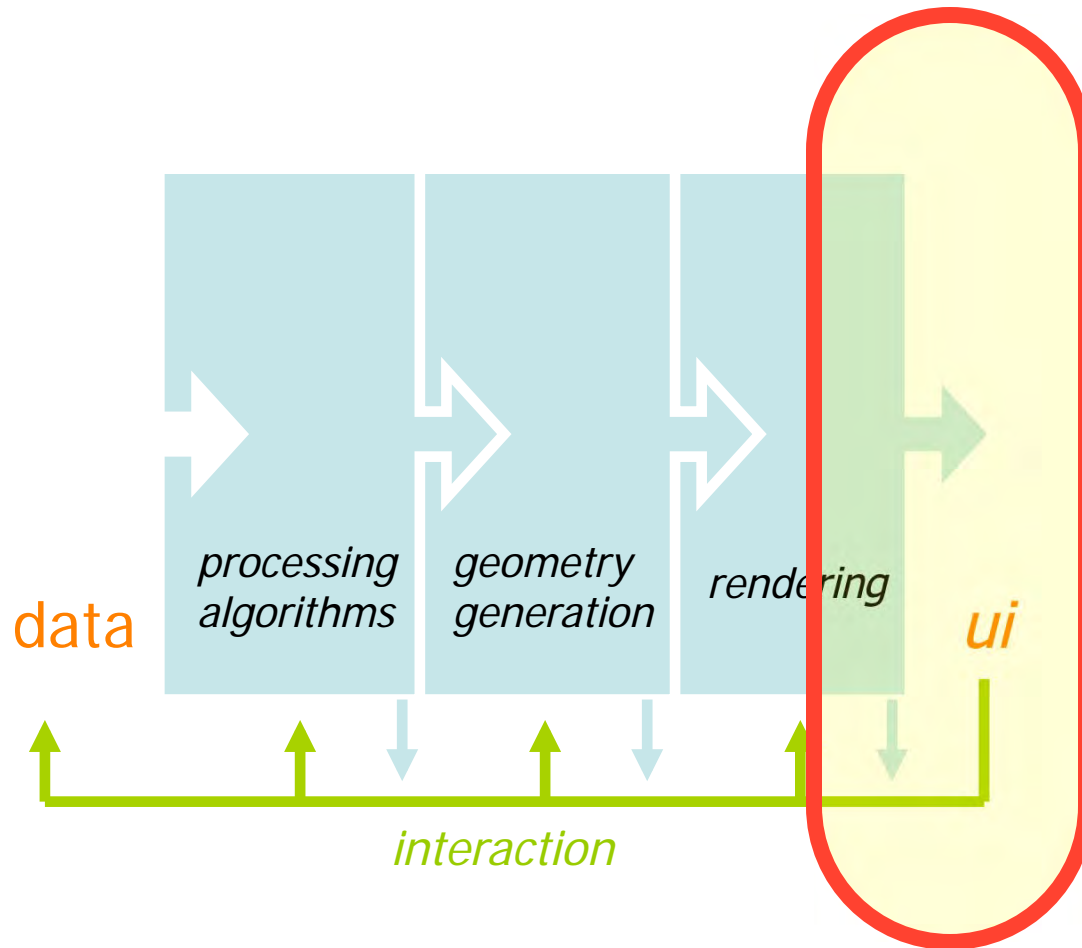
tsunami (artic region sc)

gui toolkits



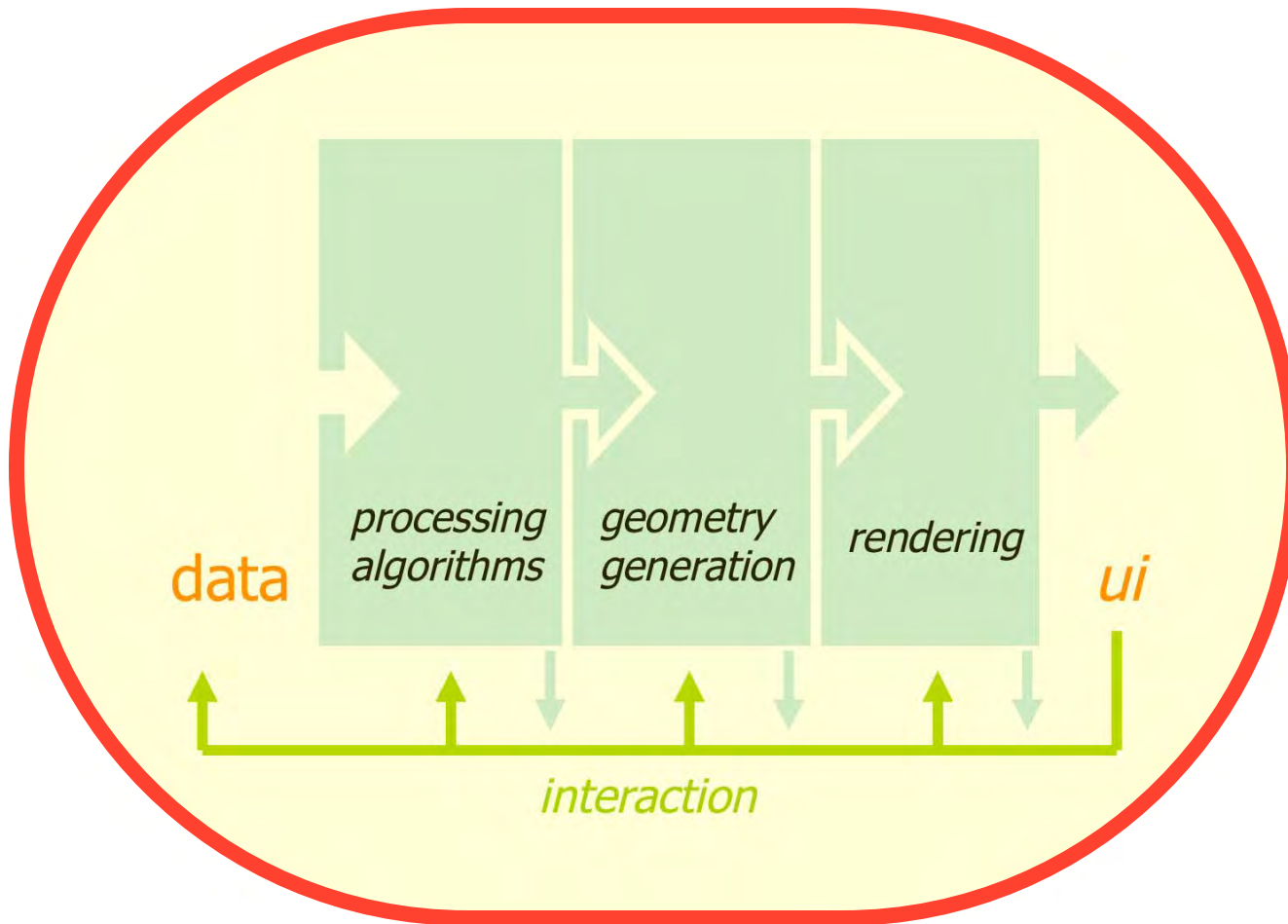
- * QT
 - * python
- * GTK+
 - * python
- * TK (TCL/TK)
- * Java Swing,
Cocoa,
Motiff...

web based ui



- * dHTML
(HTML5 or SVG)/
JavaScript
- * Processing
- * *Java*
- * *JProcessing*
- * Flash

visualization system



- * Paraview^{VTK}
- * LLNL VisIt^{VTK}
- * EnSight^{\$}
- * Protovis^{WWW}
- * Many Eyes^{WWW}
- * *Wiki based*
- * Modrian^R,
TopCat,
Mollegro, ...

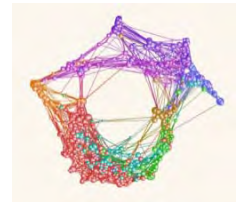


an overview: *tools & techniques*
INFOVIZ

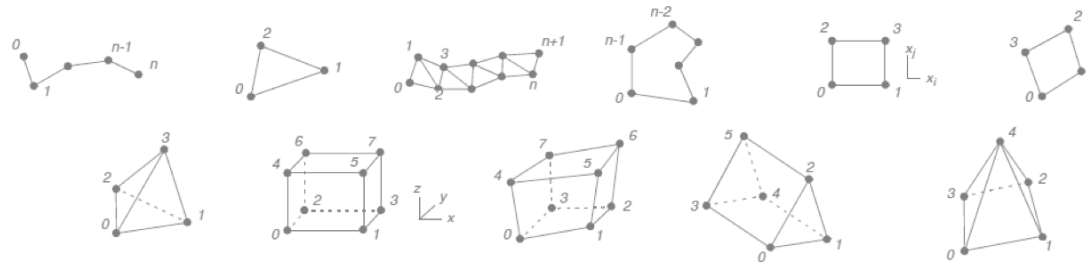
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| 70.000000 | 1.000000 | ... | ... | ... | ... | ... |



2d/3d data



basic infovis techniques:
N-DIMENSIONAL RECORD DATA

visual analytics goal:

(mapping data)

detect, classify, and measure

X

trends, outliers, patterns, clusters, correlations

principal component analysis:

pca = data transformation

n “correlated” variables

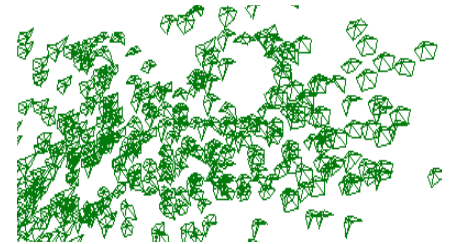
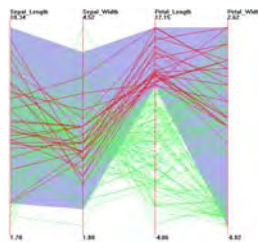
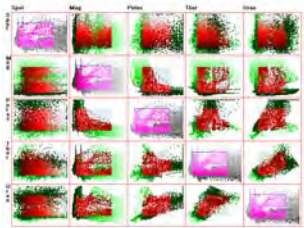


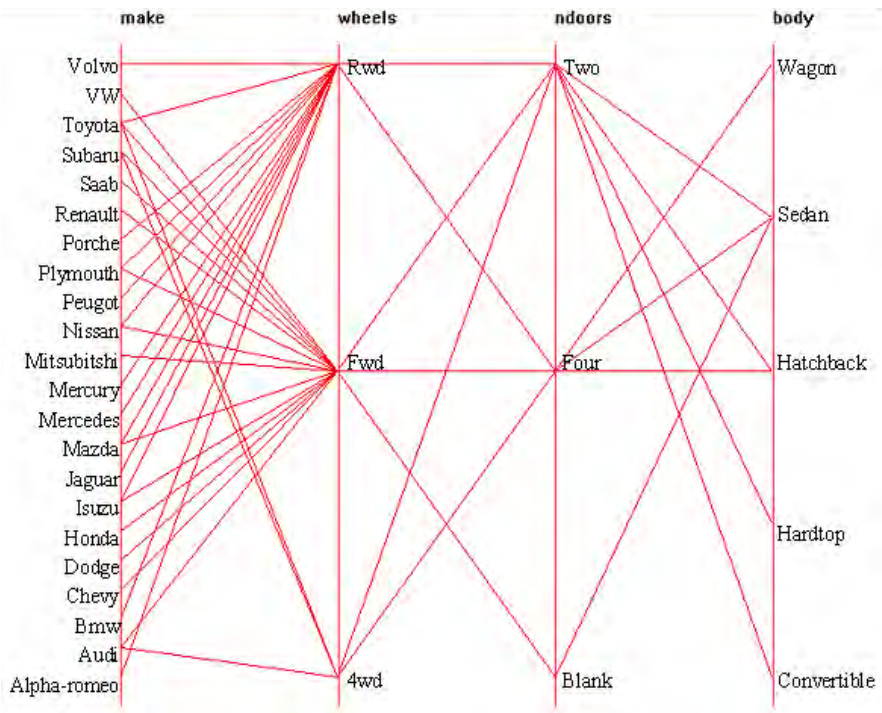
n uncorrelated variables

(akin decomposition into orthogonal element basis)

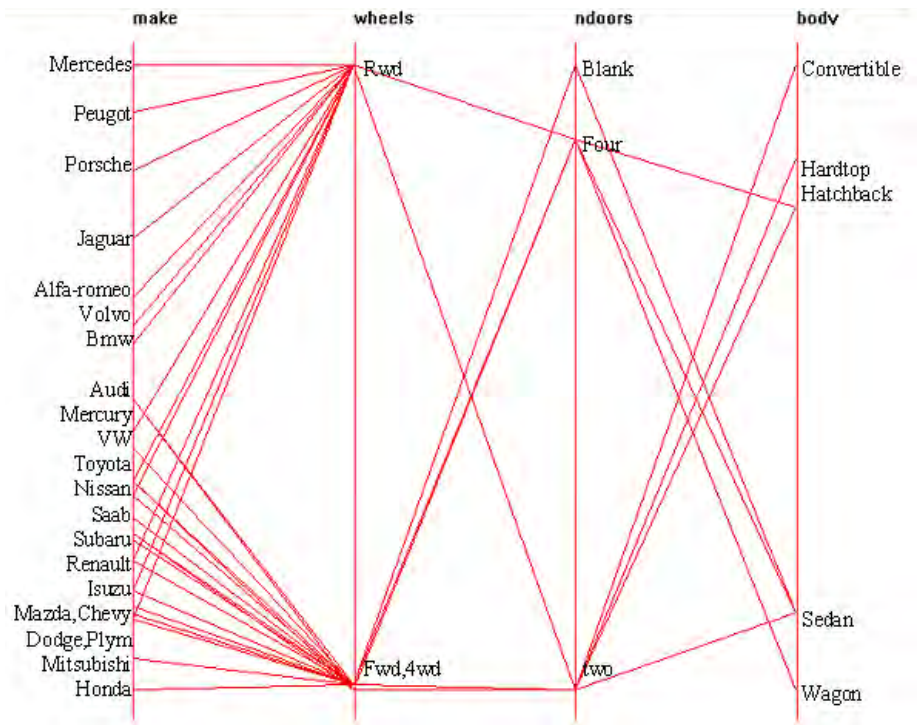


choose a layout strategy..

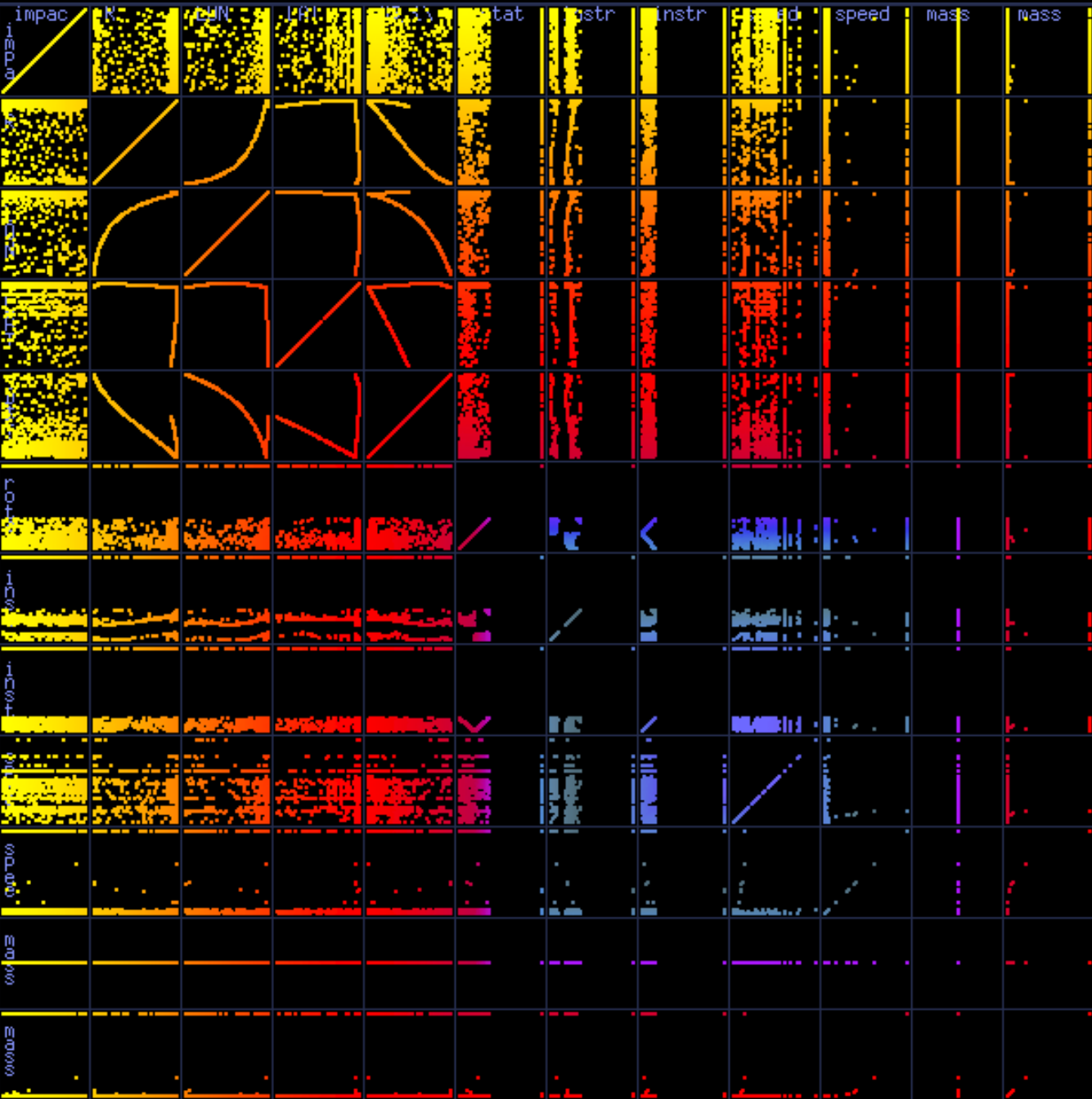




PARALLEL COORDINATES



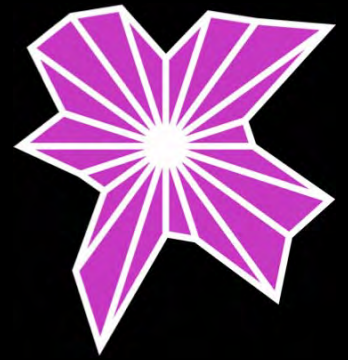
+ CLUSTERING



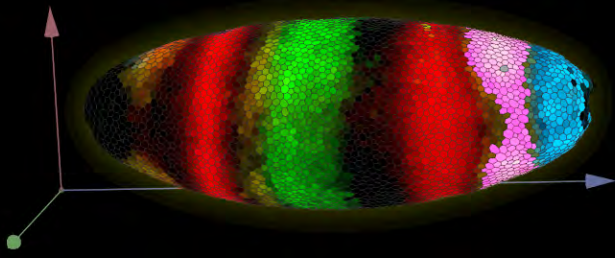
SCATTERPLOT MATRIX



STAR PLOT GLYPHS



Genes: Brusher
hb
kr
m
gt

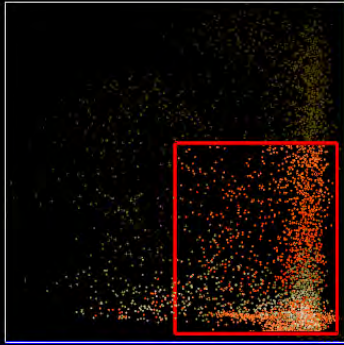


DROSOPHILIA



:DATA 48,383Z

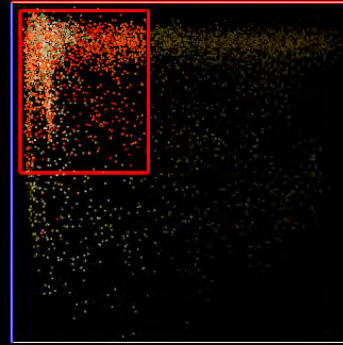
ftz



hb

:DATA 48,383Z

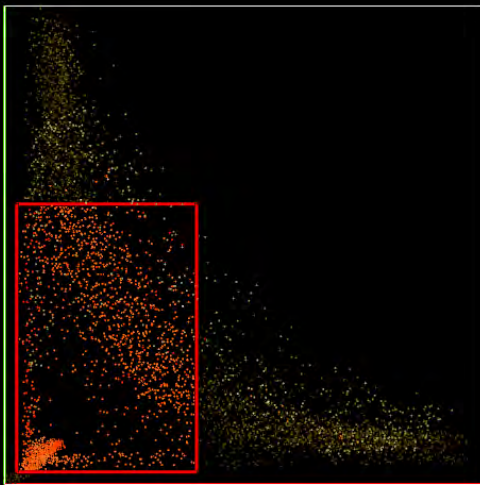
eve



hb

:DATA 48,383Z

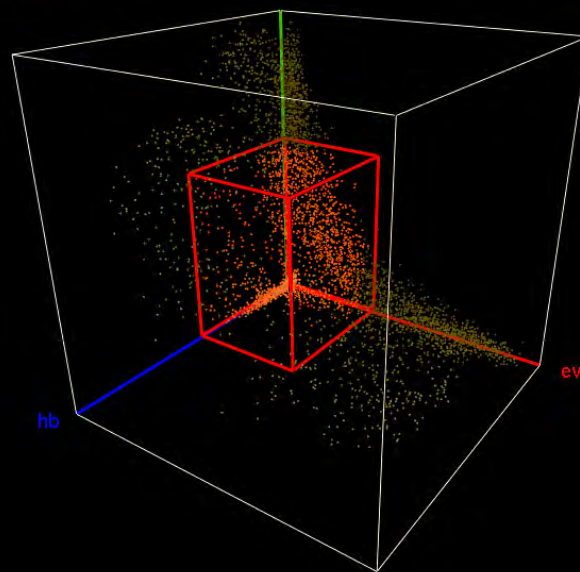
ftz



eve

:DATA 48,383Z

ftz



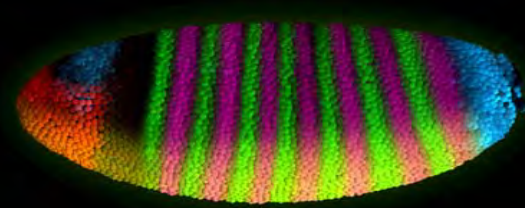
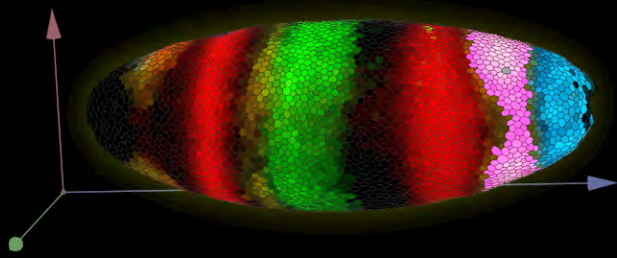
hb

eve

2D & 3D
SCATTERPLOTS



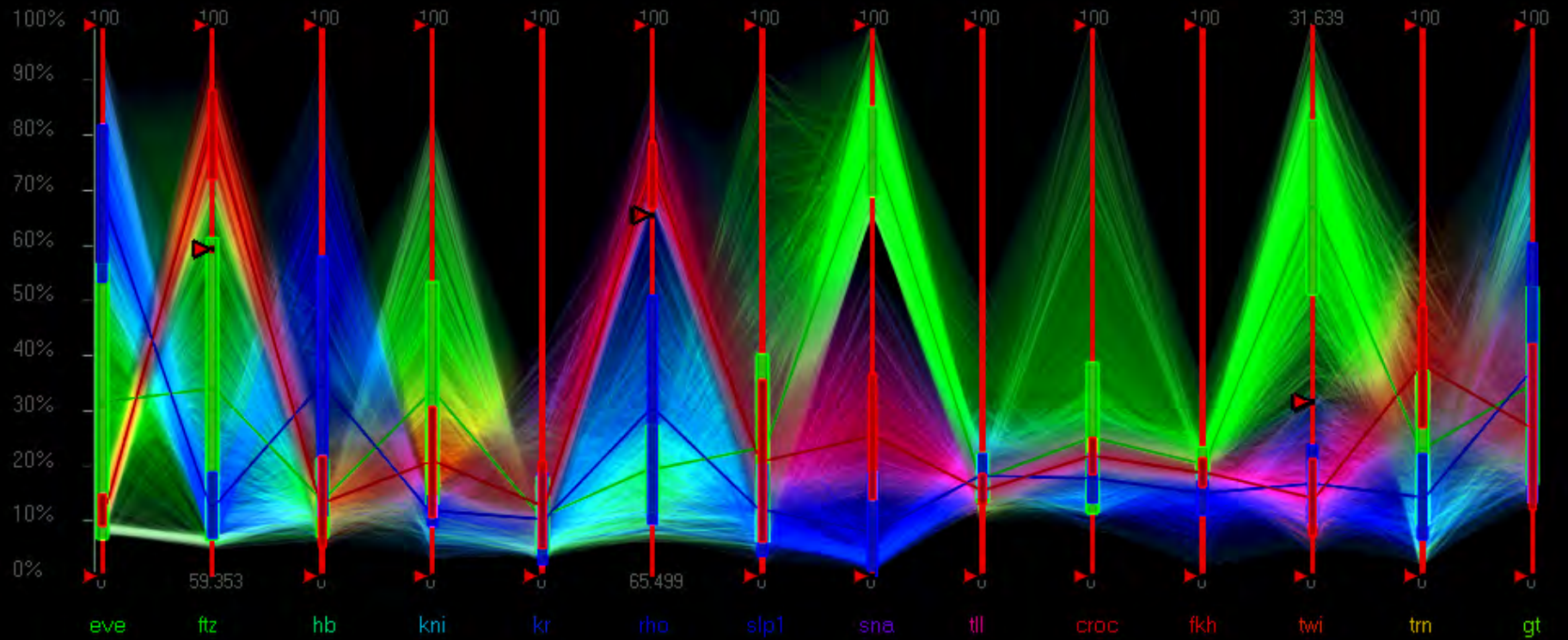
Genes: Bruches
hb
kr
m
gt



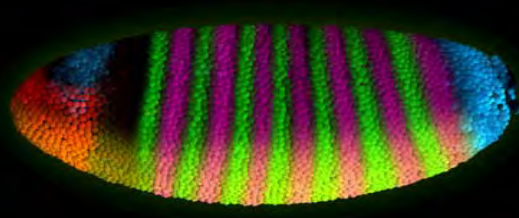
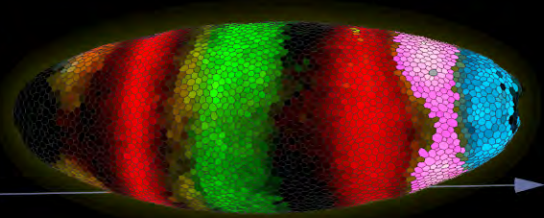
DROSOPHILIA



PARALLEL COORDINATES

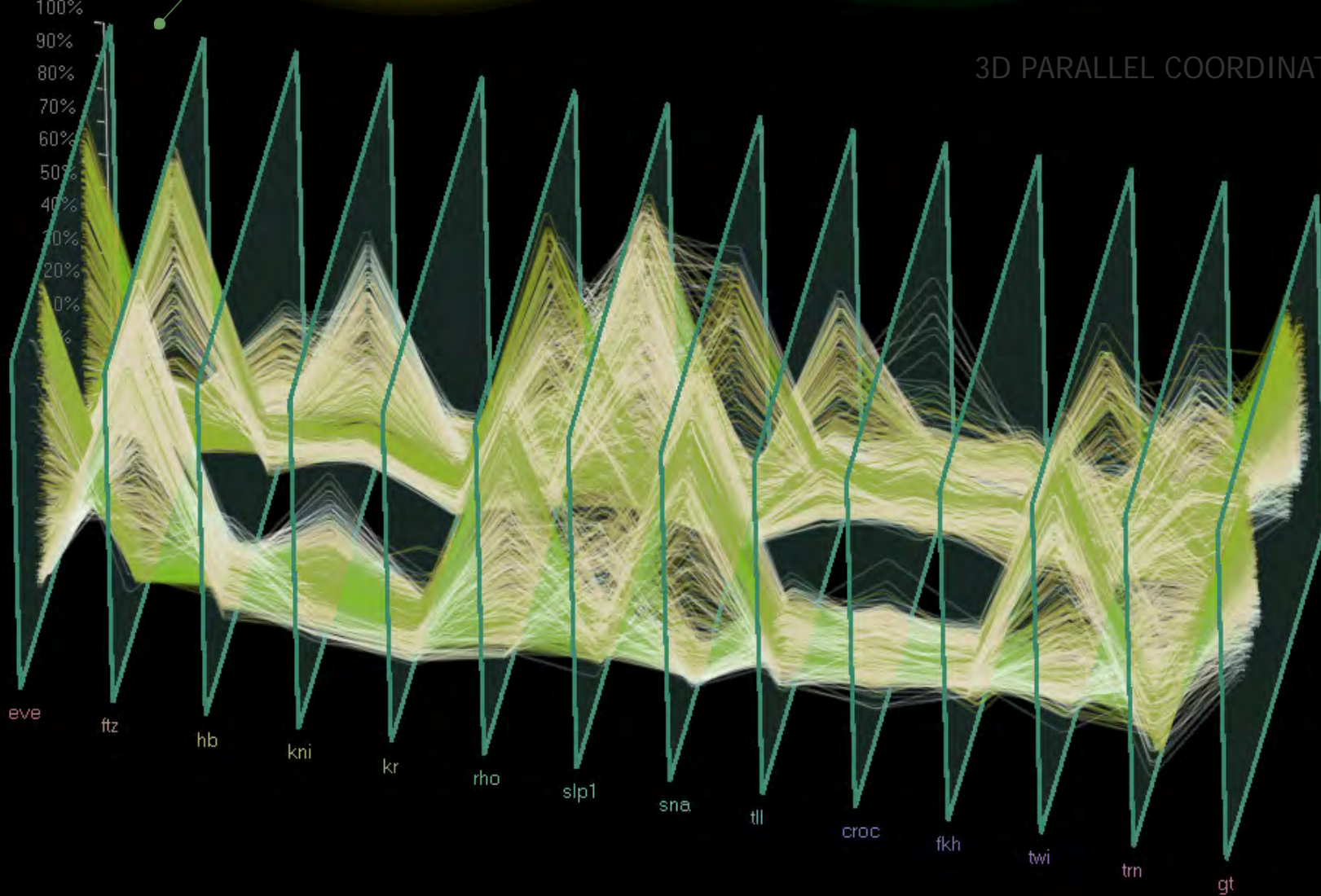


Genes Brushes
hb
kri
m
gt



100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

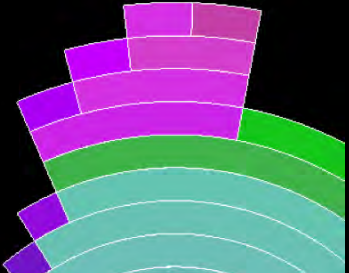
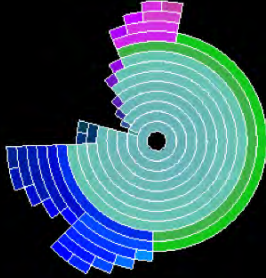
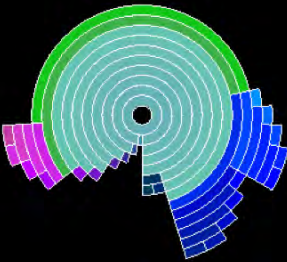
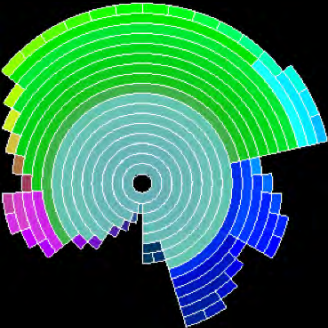
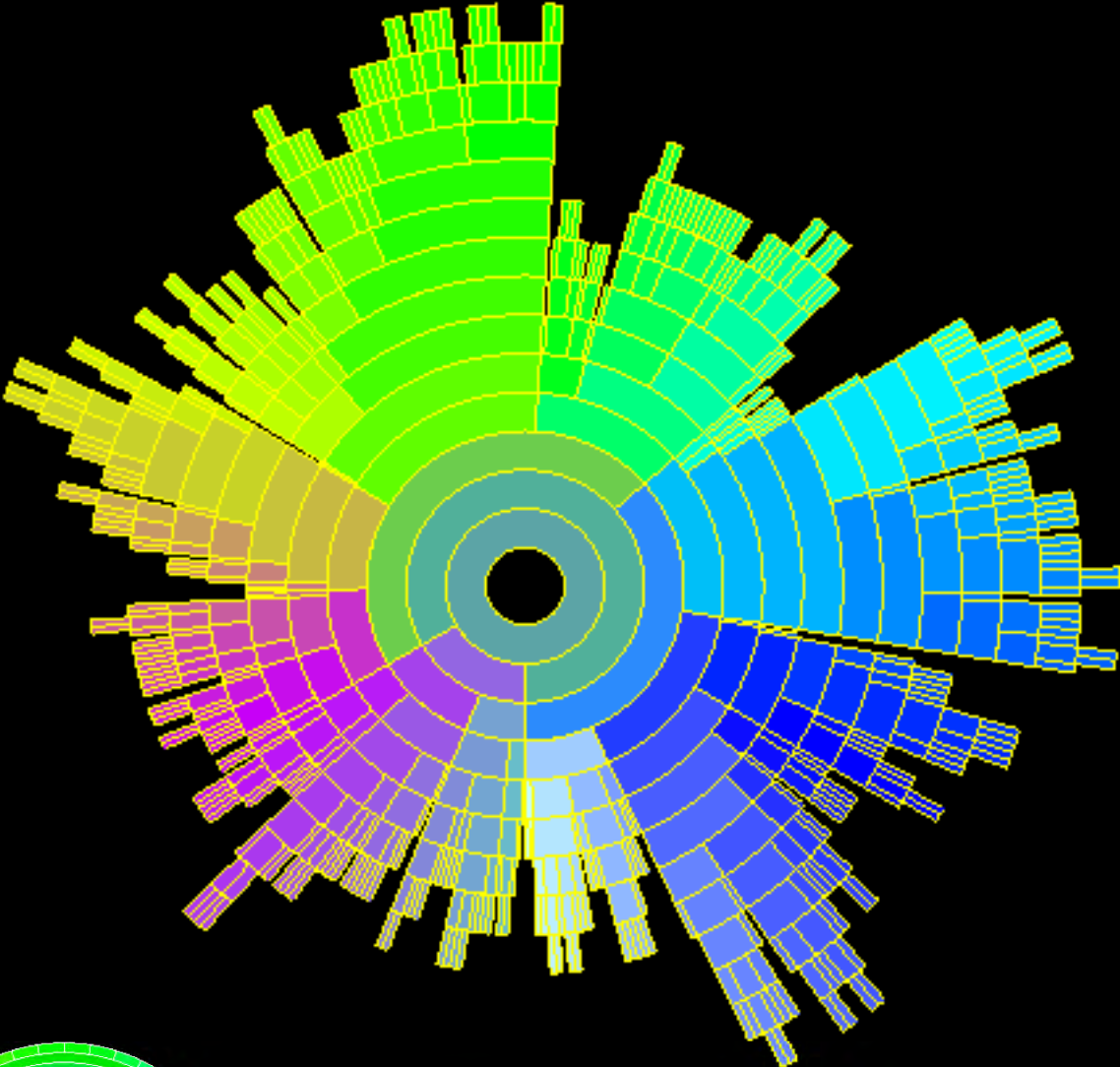
3D PARALLEL COORDINATES 



basic infovis techniques:
HEIRARCHICAL DATA



HEIRARCHICAL
RINGS





DPOSS & Fisher's Iris :
MONDRIAN+R



quick demo

infovis packages

mondrian (*R based*)

rosuda.org/Mondrian

xmdv

davis.wpi.edu/~xmdv

molegro data modeller (*bio*)

topcat (*astro*)

many eyes (*online wiki*)

protovis/polaris (+DATACUBES)

COMERCIAL: *tableau.com*

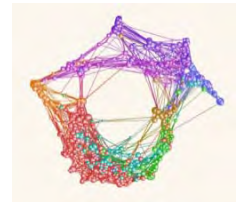
iVu (*local*)

www.infovis-wiki.net

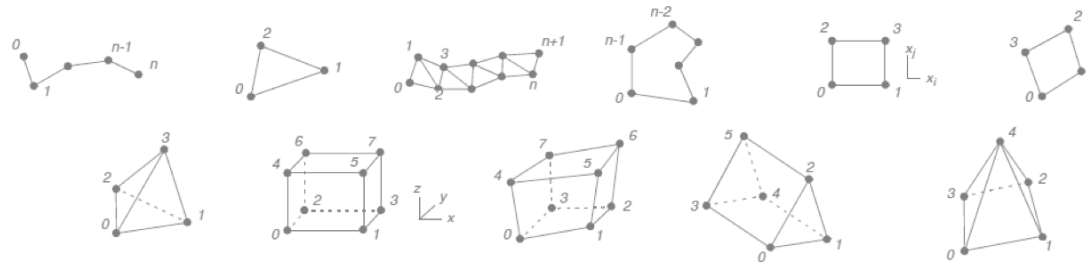
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| ... | ... | ... | ... | ... | ... | ... |



2d/3d data



multivariable visualization...

how many variables can you visualize?

as many as you want!

how many variables can you understand?

3? 4?

Collin Ware study:

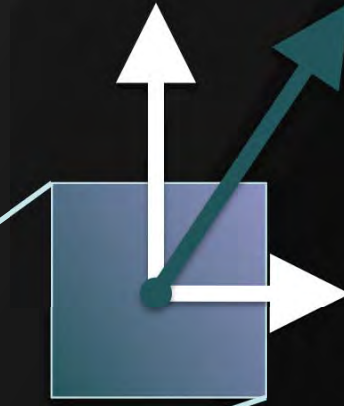
encoding 4 variables

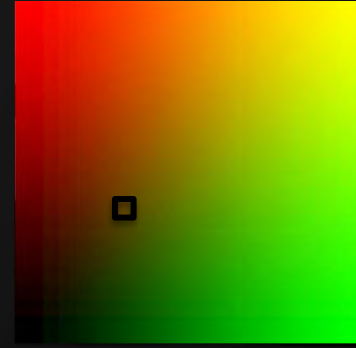
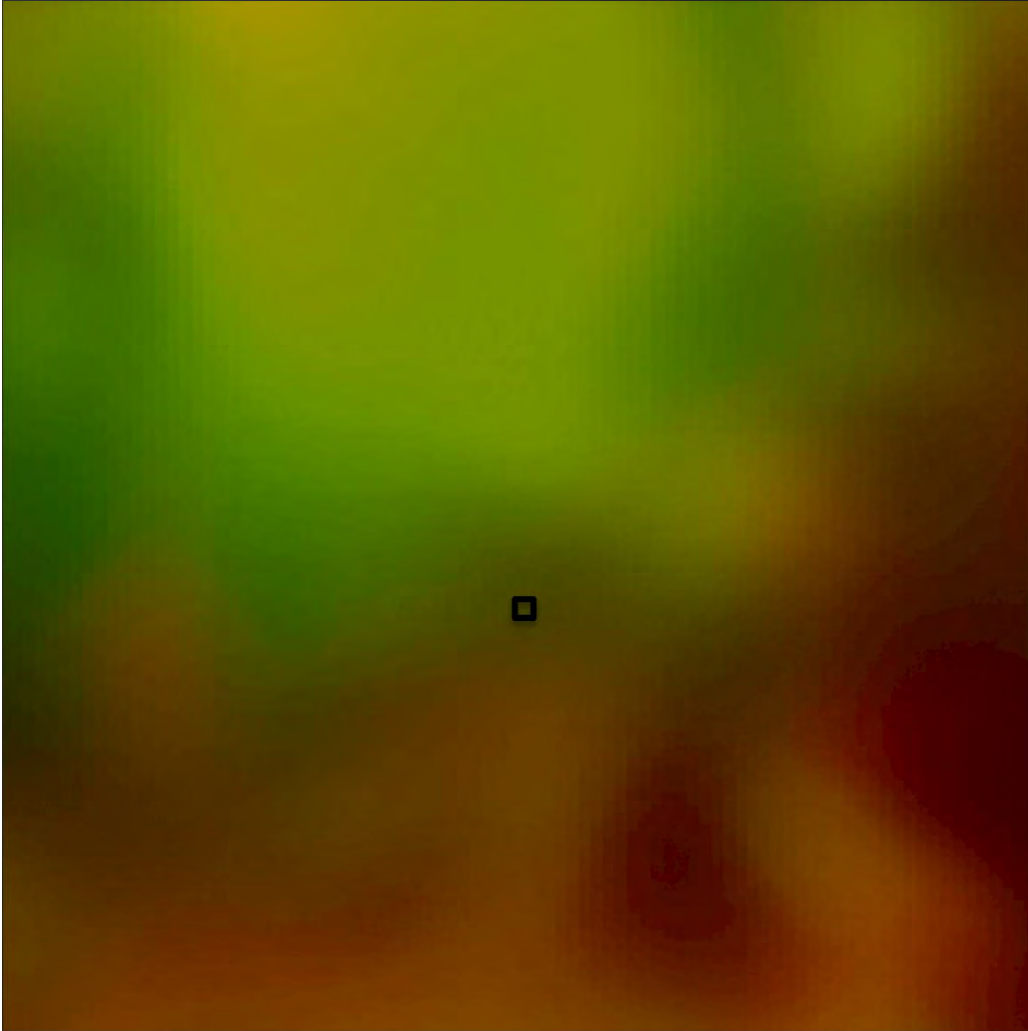
i.e. encoding 2 variables on map

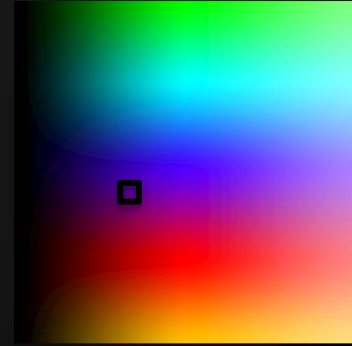
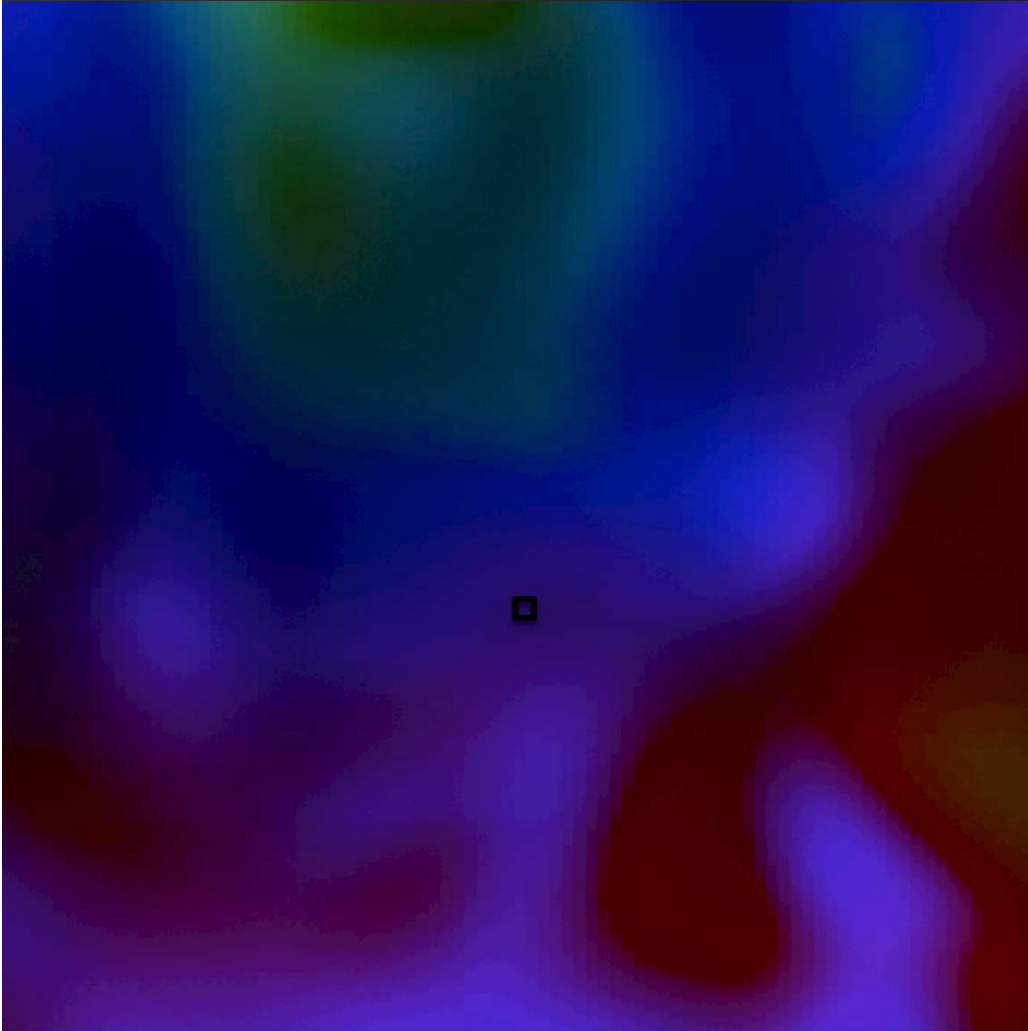
(x, y, u, v)

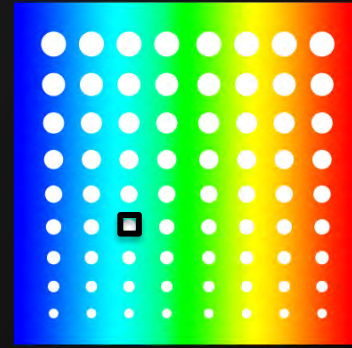
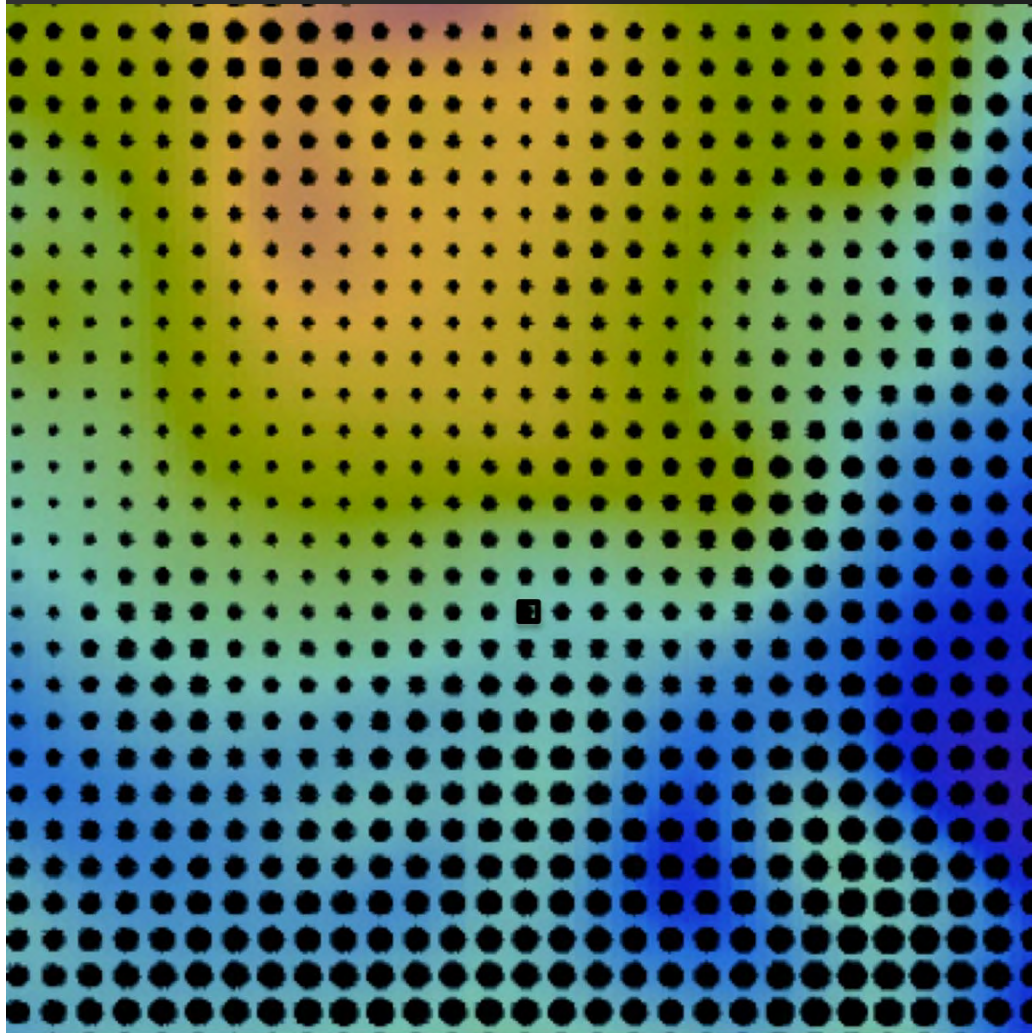
Qton:

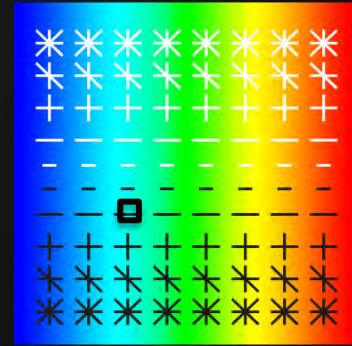
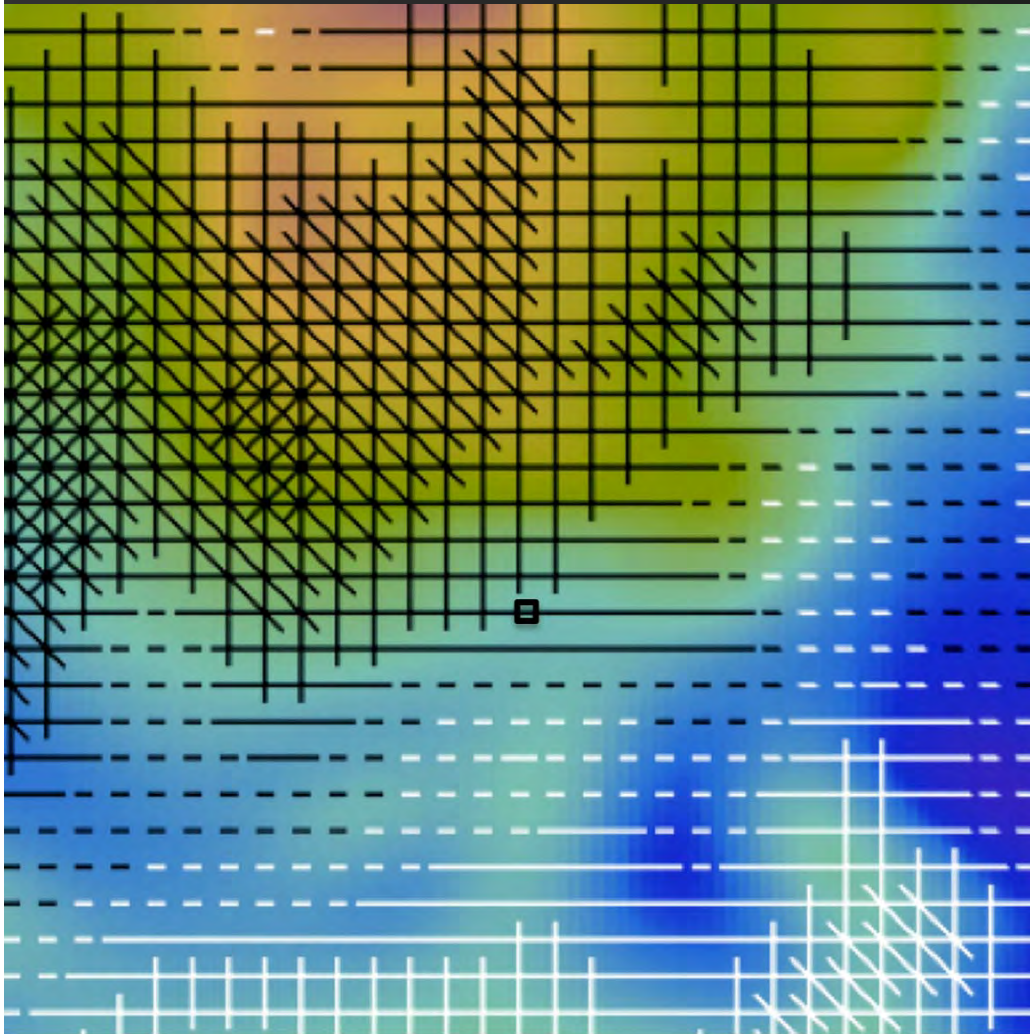
putative units of pre-attentive human
texture perception, analogous to a
phoneme in speech recognition

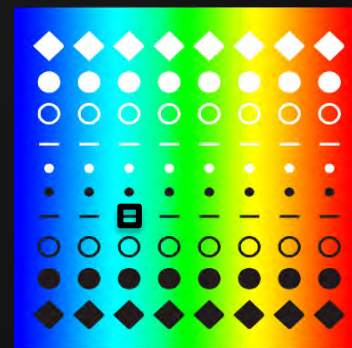
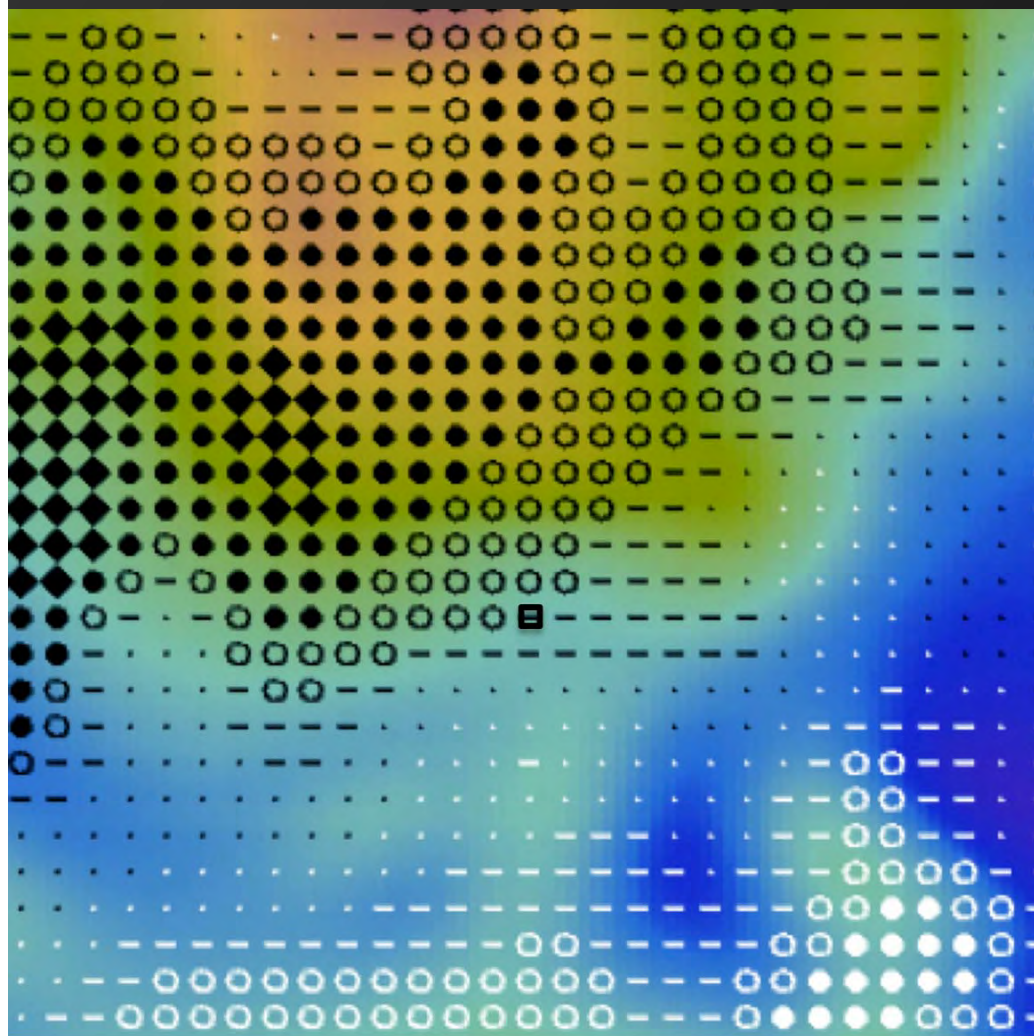










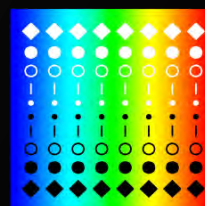
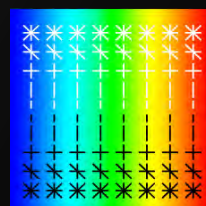
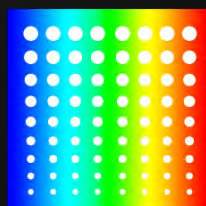
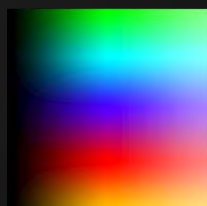
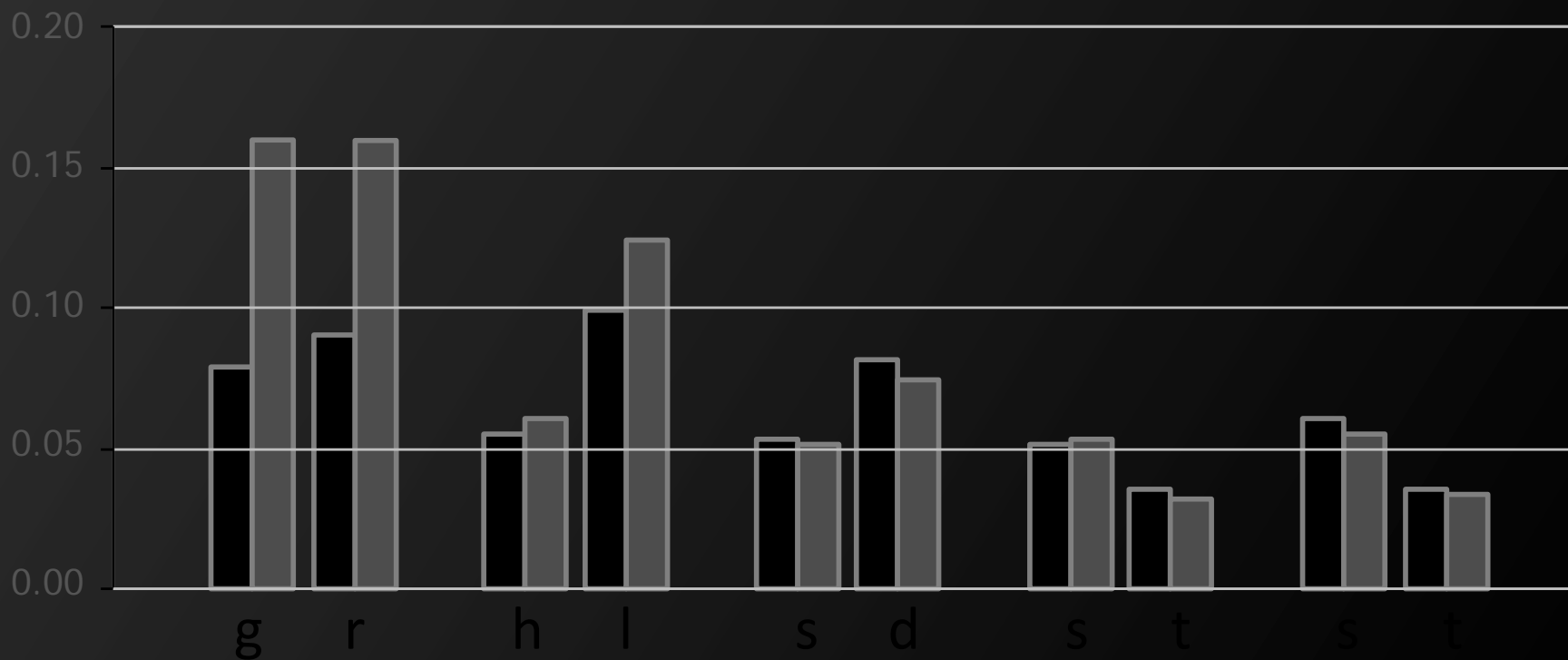
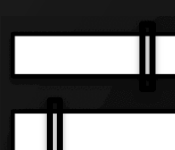


error:

integral



separable





reading order/focal flow



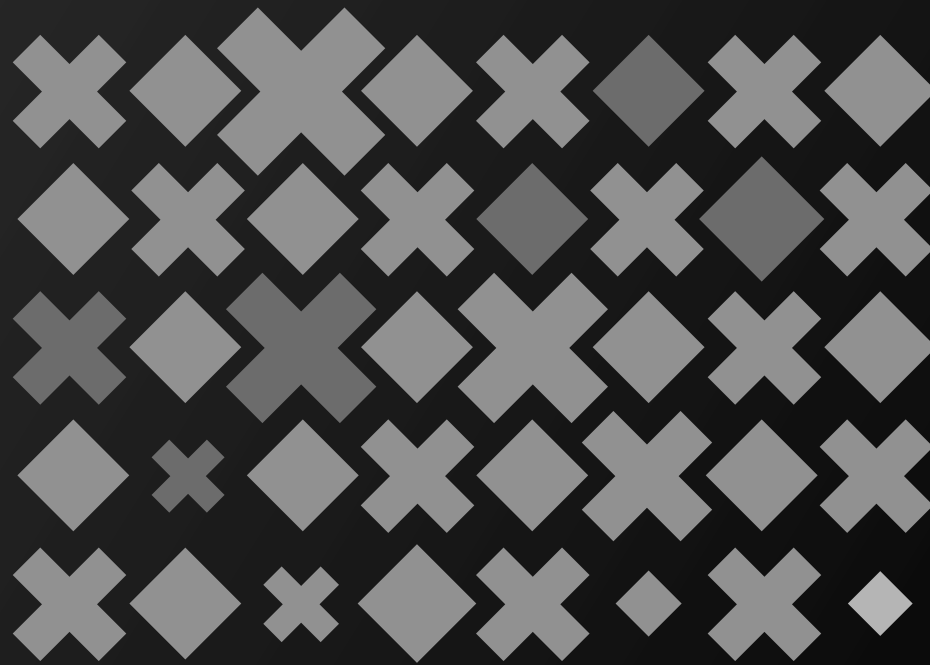
what do you see first? second?

why is it important?

what does unknown order create?







science
(data analysis, visual analytics)



graphics/hci



graphic design/art
(human perception, aesthetics)

visualization

visualization =

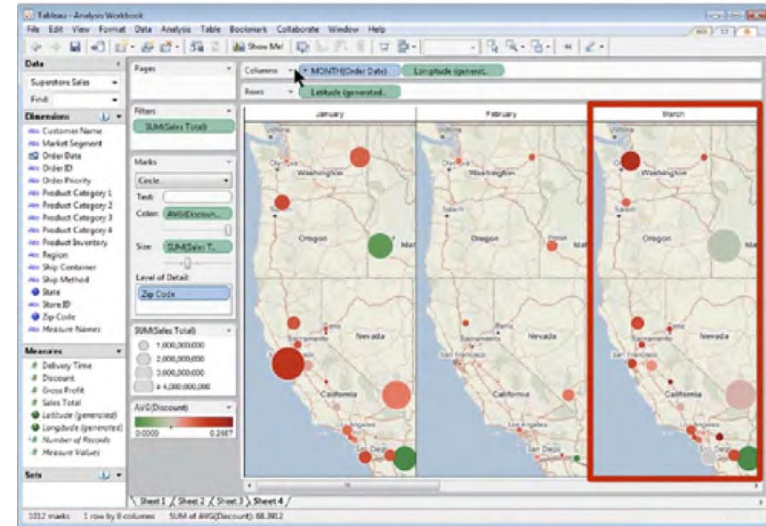
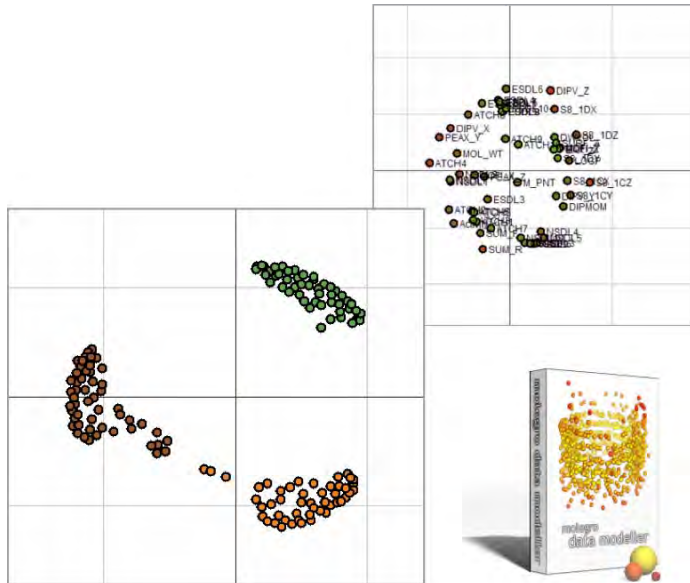
science

+

computer graphics/hci

+

graphic design/art



quick looks at...



ay/bi199: methods of computational science

visualization

jumpstart + tools + techniques

santiago v lombeyda | center for advanced computing research | caltech