CS 53000 Introduction to Scientific Visualization

Introduction to 

August 25, 2011

The Visualization Toolkit

- Open source software for
  - Imaging
  - Computer Graphics
  - Visualization
- Written in C++
- Supports scripting languages (*wrappers*)
  - Tcl/Tk
  - Python
  - Java

Outline

- Object-oriented design
- Visualization pipeline
- Data structure
- Rendering
- Examples

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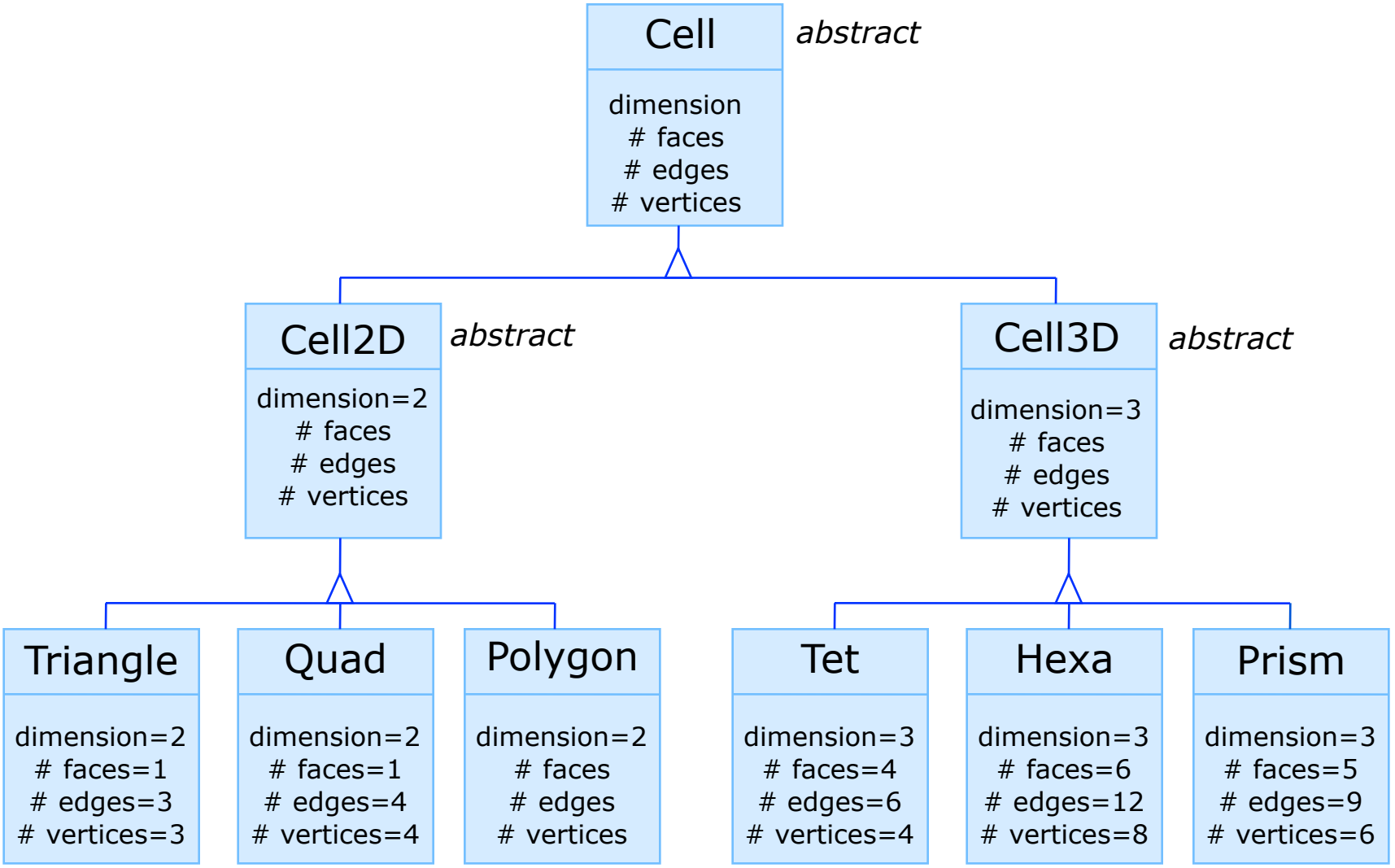
Object-Oriented Design



Outline

- Object-oriented design
- Visualization pipeline
- Data structure
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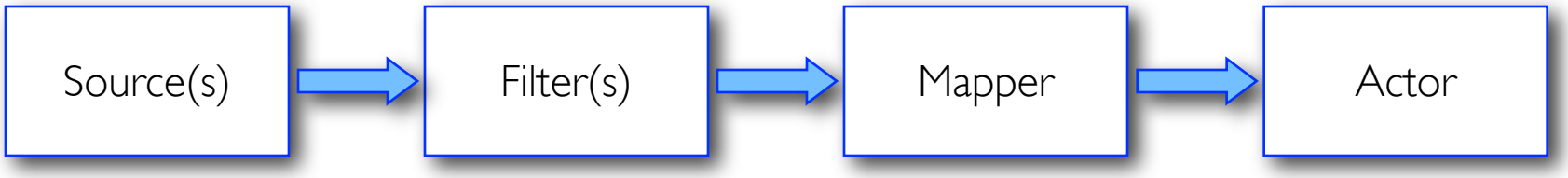
- Examples

Visualization Pipeline

- Process objects

Visualization Pipeline

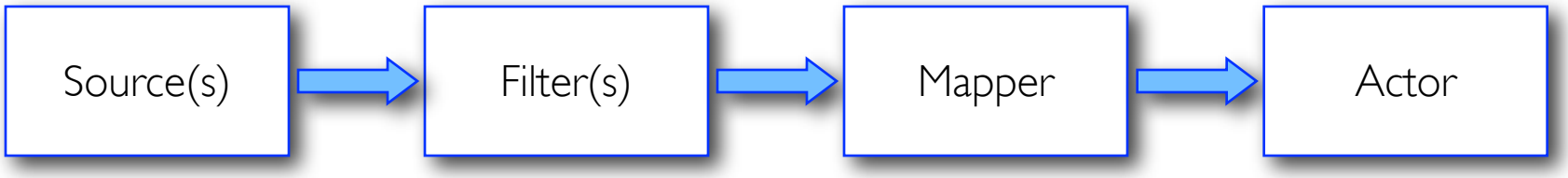
- Process objects



- Source: input data
  - Read data from file (reader)
  - Generate data from parameters (procedural)
  - Set up data structure

Visualization Pipeline

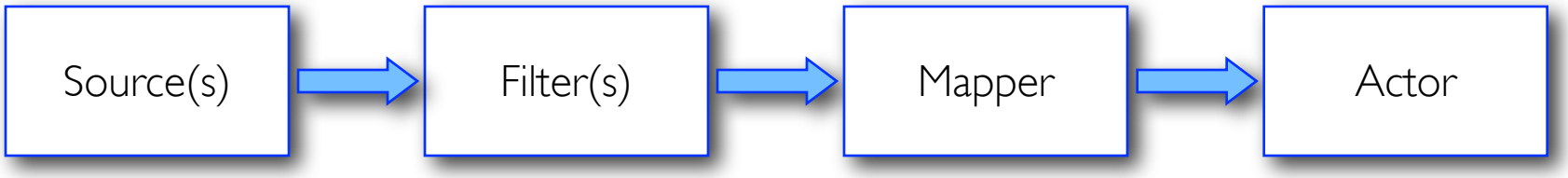
- Process objects



- Filter: visualization processing
  - Compute data
  - Transform data
  - Create representation

Visualization Pipeline

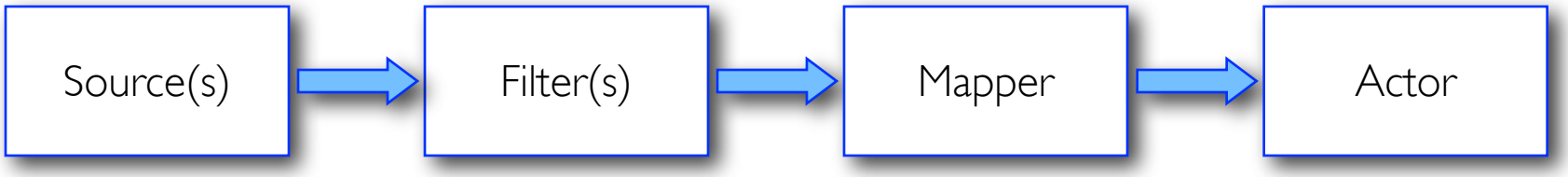
- Process objects

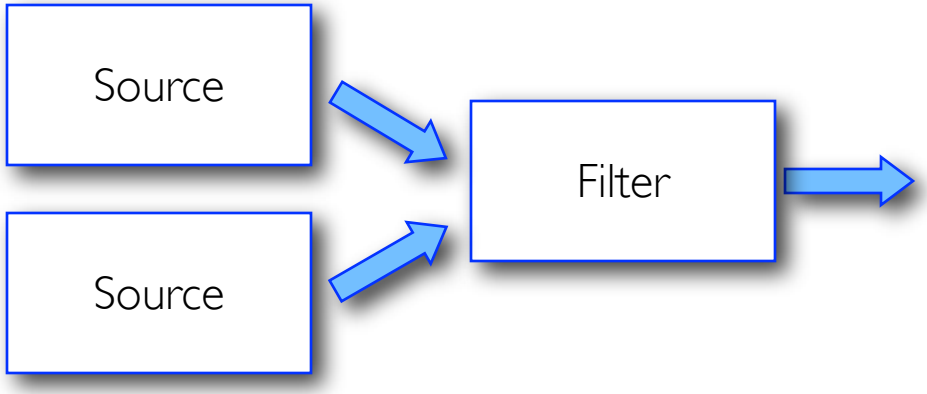


- Mapper: output data
  - Generate graphical primitives
  - Write data to file
  - Interface with another software or device

Visualization Pipeline

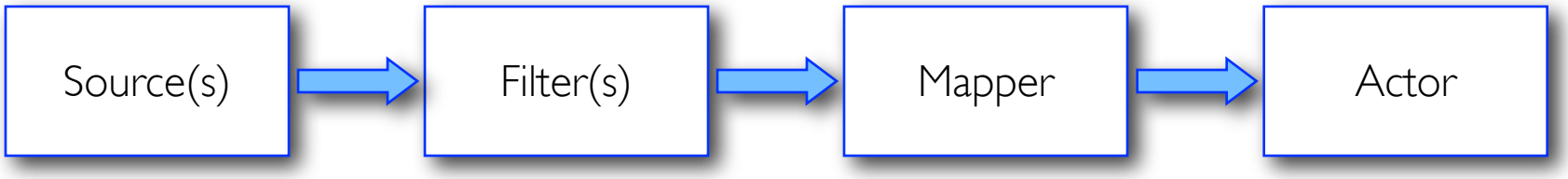
- Connections *(type checking)*





Visualization Pipeline

- Connections *(type checking)*



Visualization Pipeline

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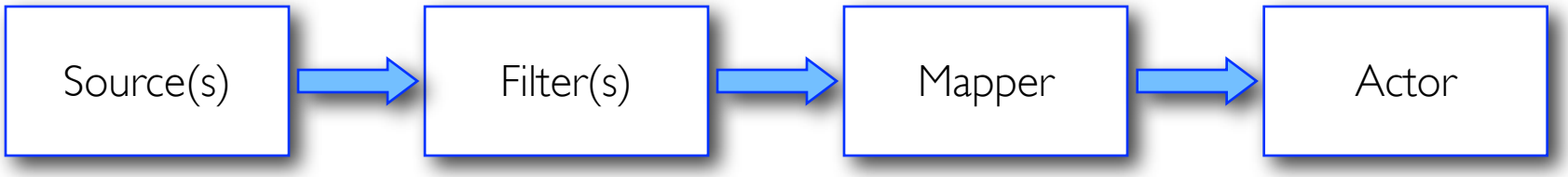
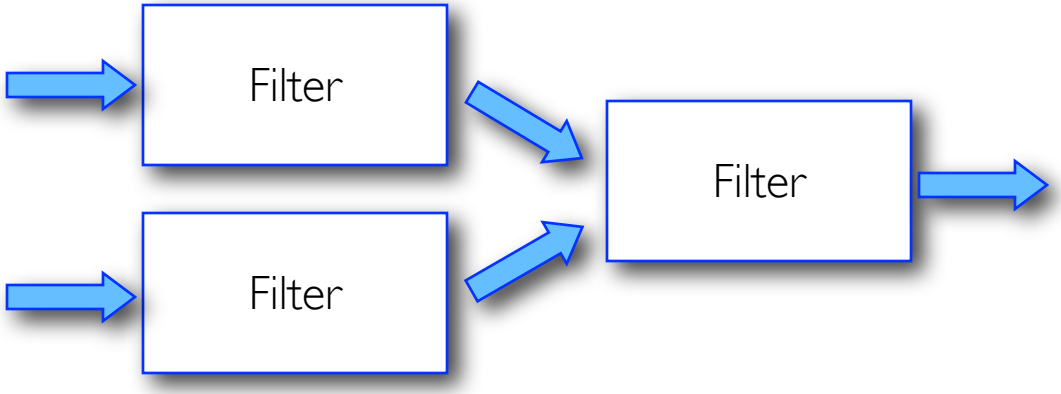
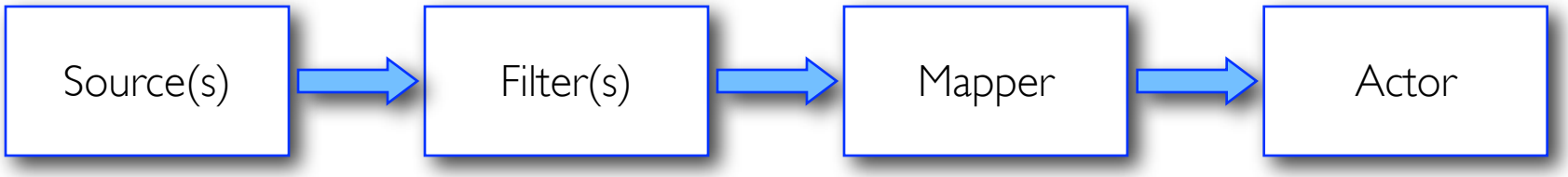
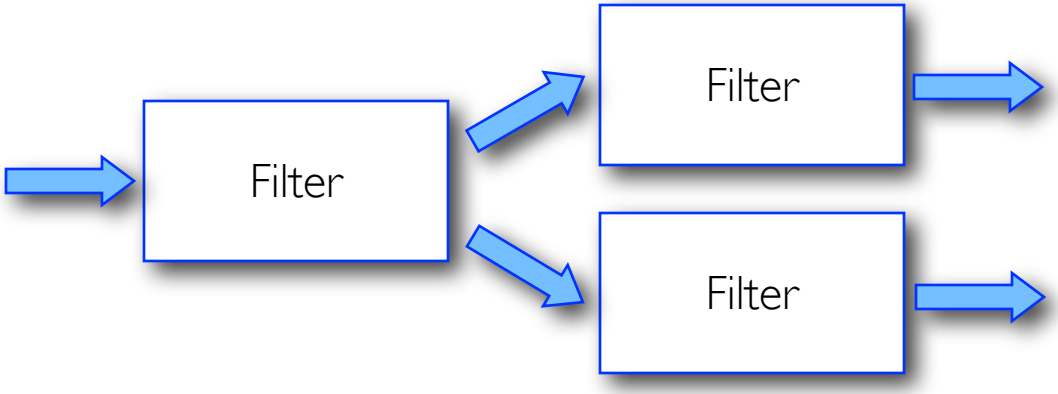




Visualization Pipeline

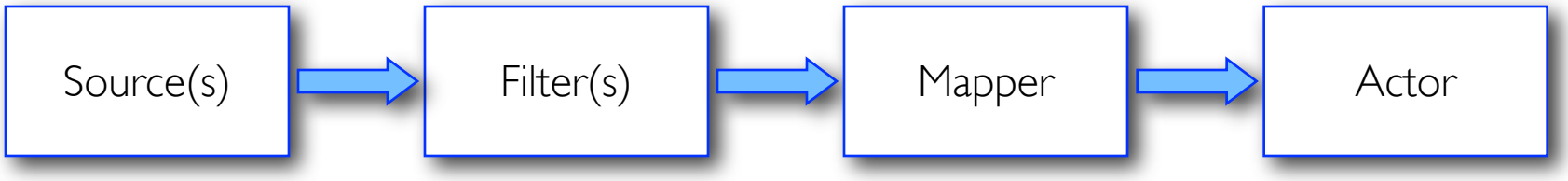
- Connections ***(type checking)***

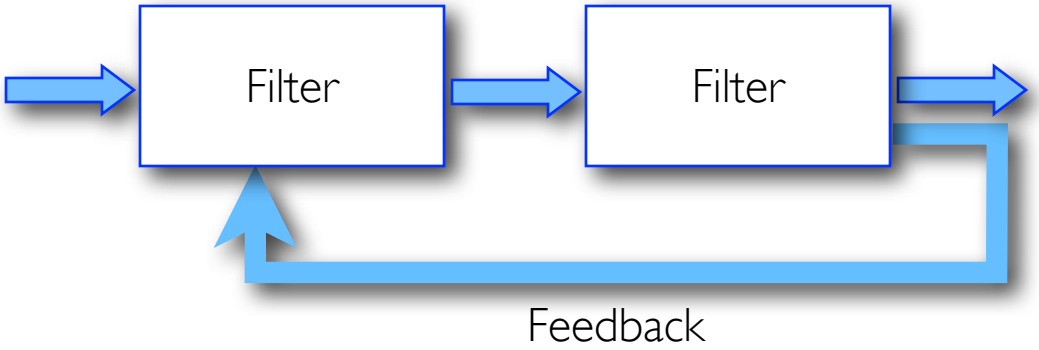




Visualization Pipeline

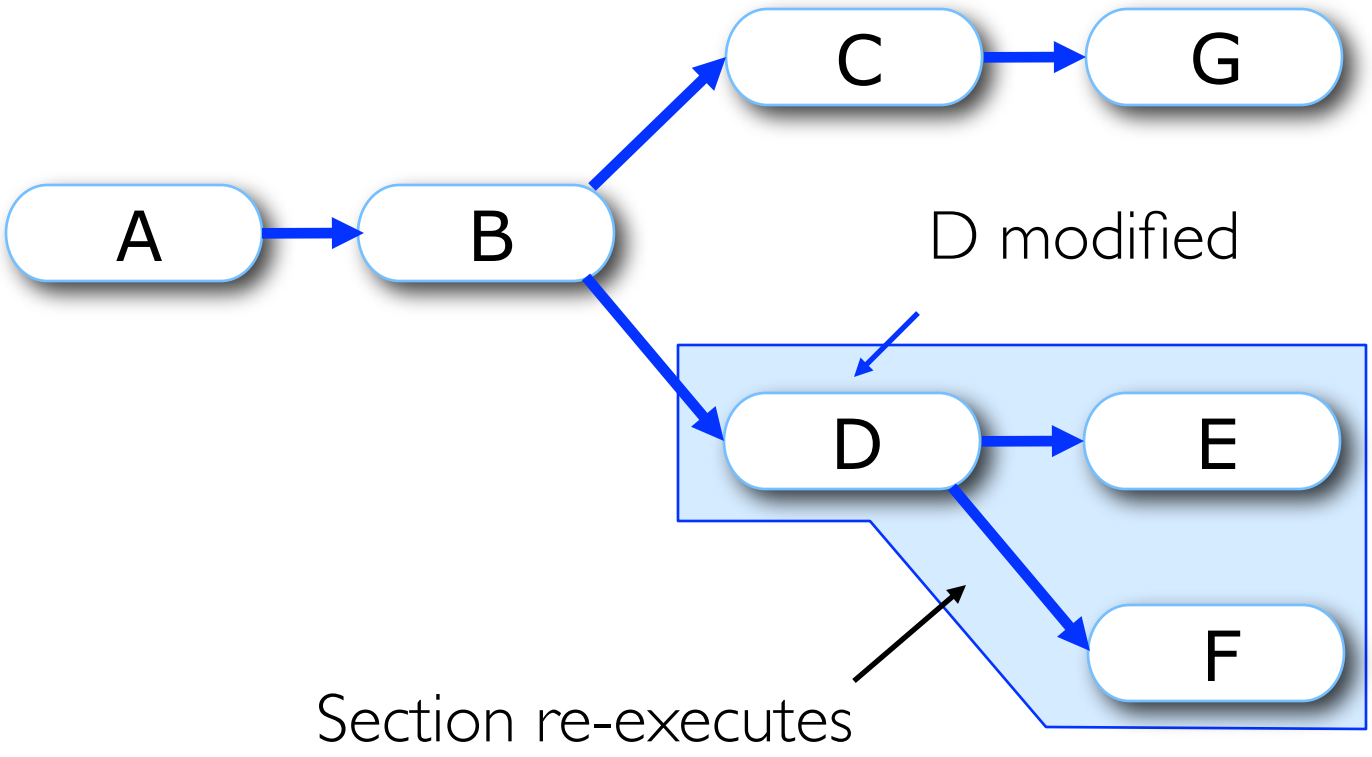
- Connections *(type checking)*





Visualization Pipeline

- Implicit control of execution *(lazy evaluation)*

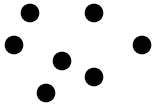


Outline

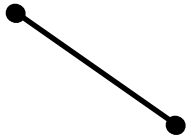
- Object-oriented design
- Visualization pipeline
- Data structure
- Rendering
- Examples

Cell Types

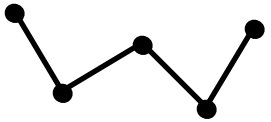
vertex



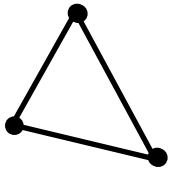
Polyvertex



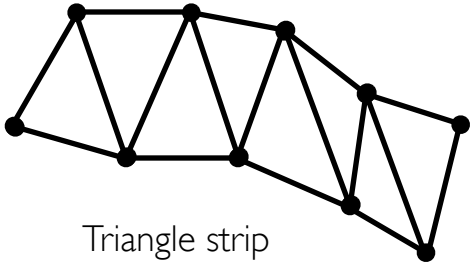
Line



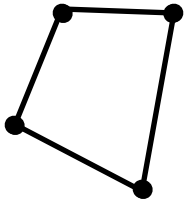
Polyline



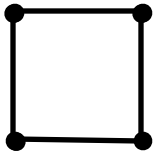
Triangle



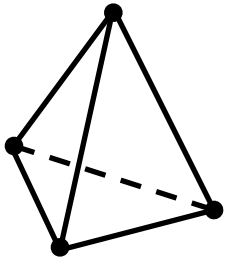
Triangle strip



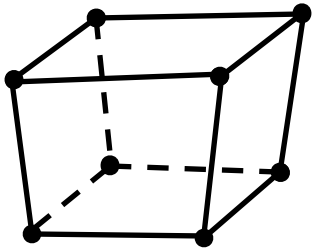
Quadrilateral



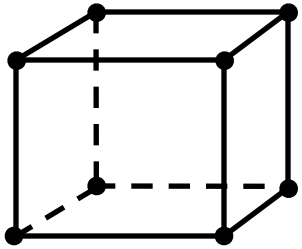
Pixel



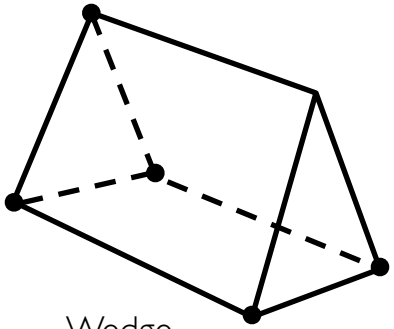
Tetrahedron



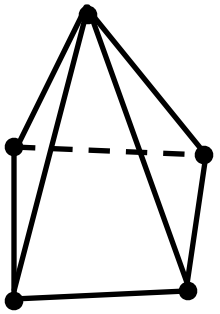
Hexahedron



Voxel

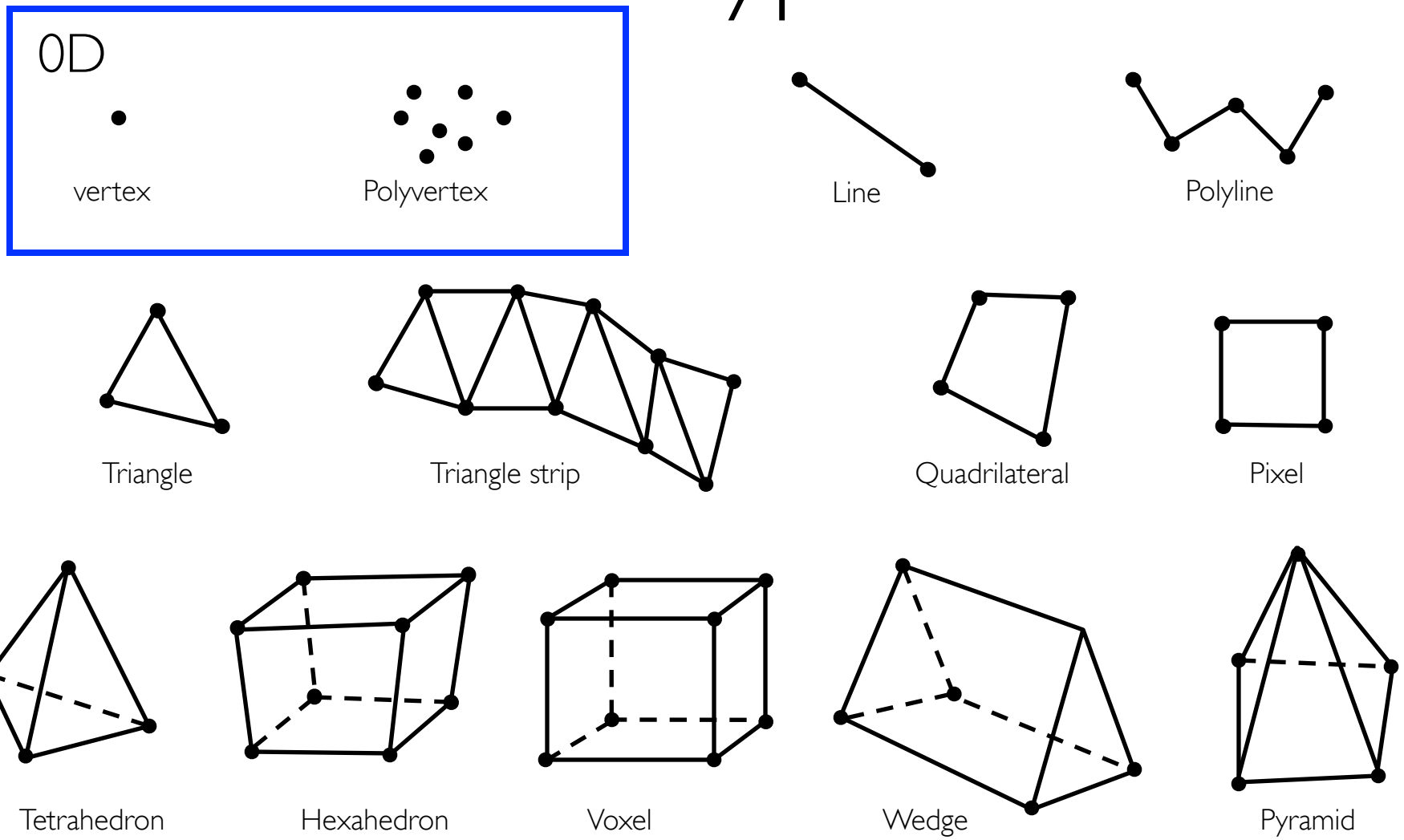


Wedge



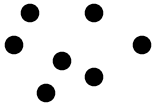
Pyramid

Cell Types


0D
vertex
Polyvertex
Line
Polyline
Triangle
Triangle strip
Quadrilateral
Pixel
Tetrahedron
Hexahedron
Voxel
Wedge
Pyramid

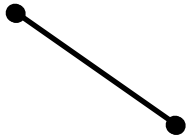
Cell Types

vertex

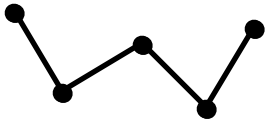


Polyvertex

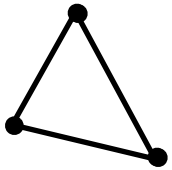
1D



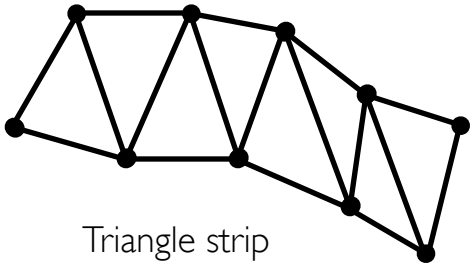
Line



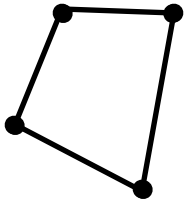
Polyline



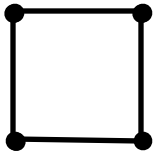
Triangle



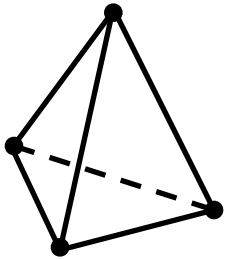
Triangle strip



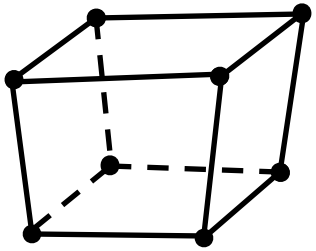
Quadrilateral



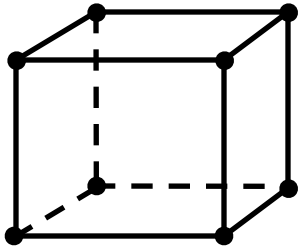
Pixel



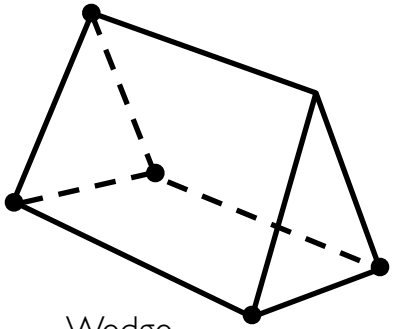
Tetrahedron



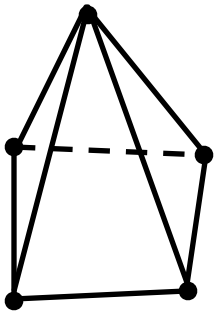
Hexahedron



Voxel



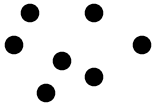
Wedge



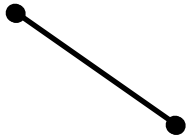
Pyramid

Cell Types

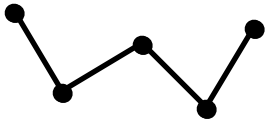
vertex



Polyvertex

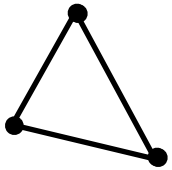


Line

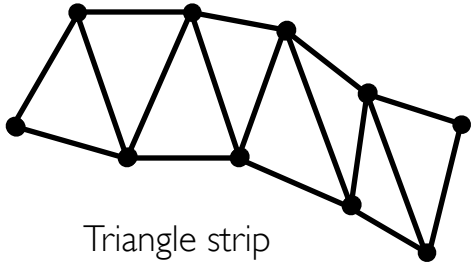


Polyline

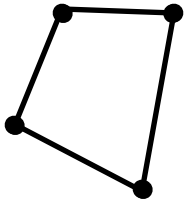
2D



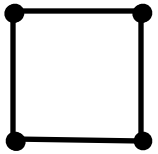
Triangle



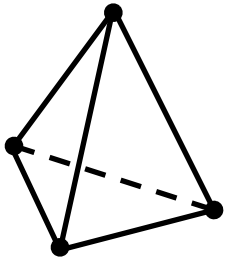
Triangle strip



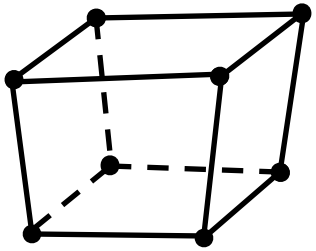
Quadrilateral



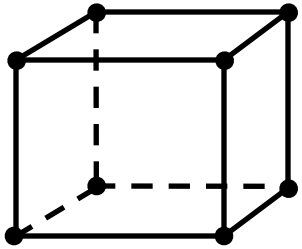
Pixel



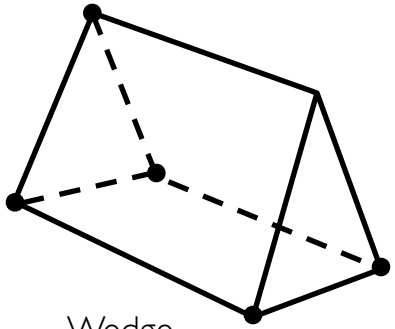
Tetrahedron



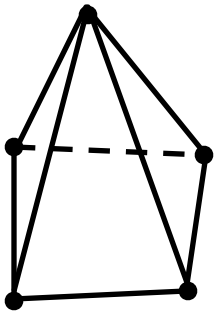
Hexahedron



Voxel

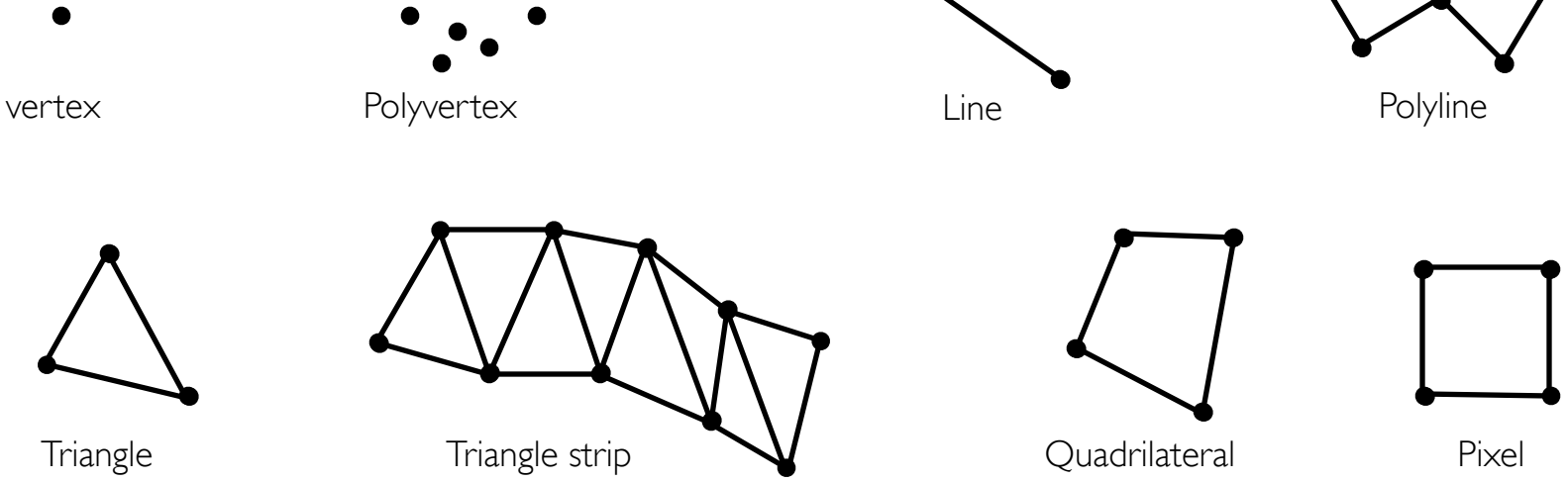


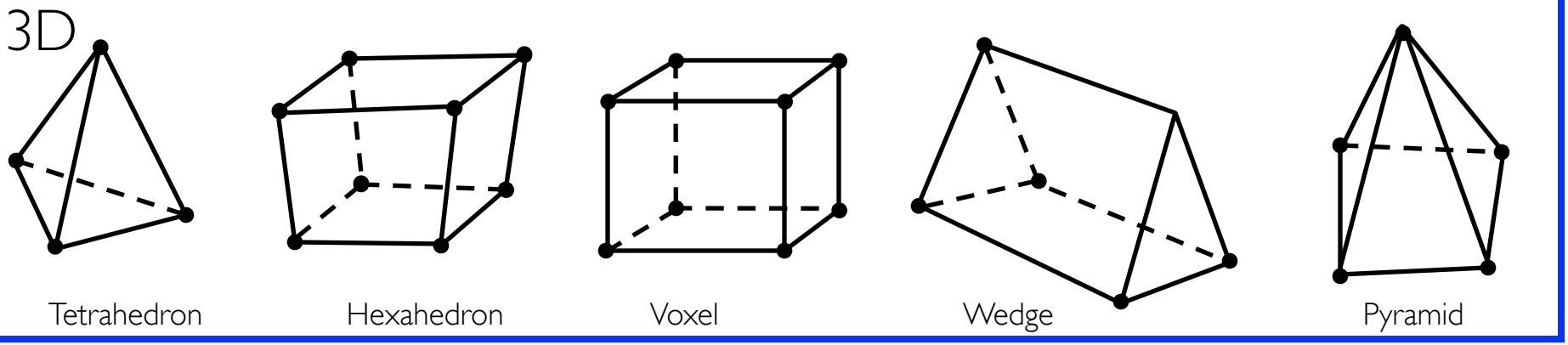
Wedge



Pyramid

Cell Types

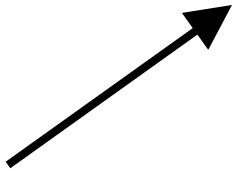

vertex
Polyvertex
Line
Polyline
Triangle
Triangle strip
Quadrilateral
Pixel


3D
Tetrahedron
Hexahedron
Voxel
Wedge
Pyramid

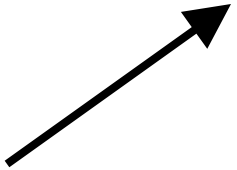
Data Attributes

Cell-wise / point-wise (*vtkDataSetAttribute*)

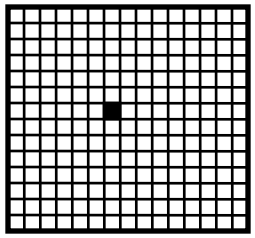
Scalar



3D vector (u,v,w)



normal (u,v,w) ||n||=1

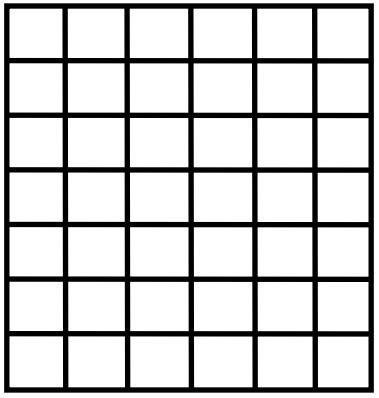


Texture coordinate (u,v) or (u,v,w)

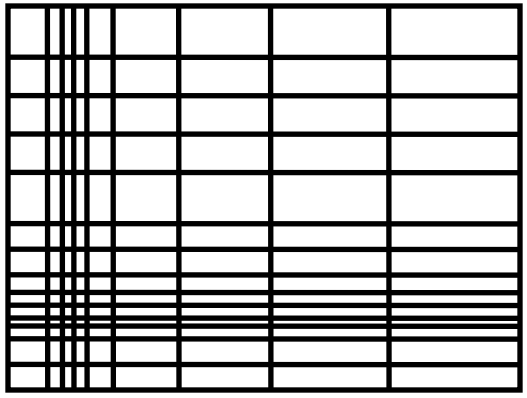
$$\begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix}$$

2nd order tensor (3x3 matrix)

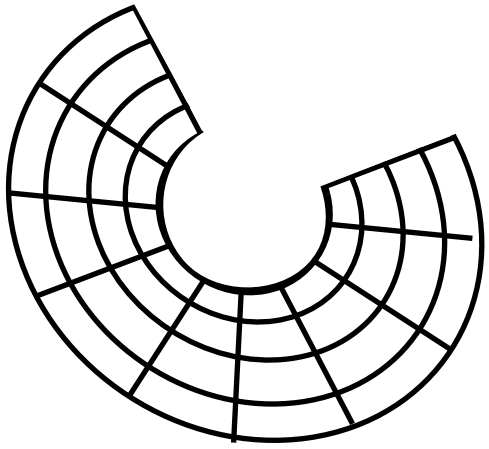
Dataset Types



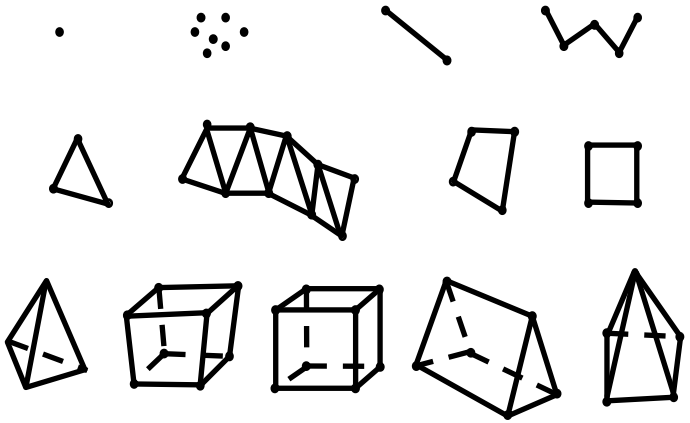
Image



Rectilinear grid

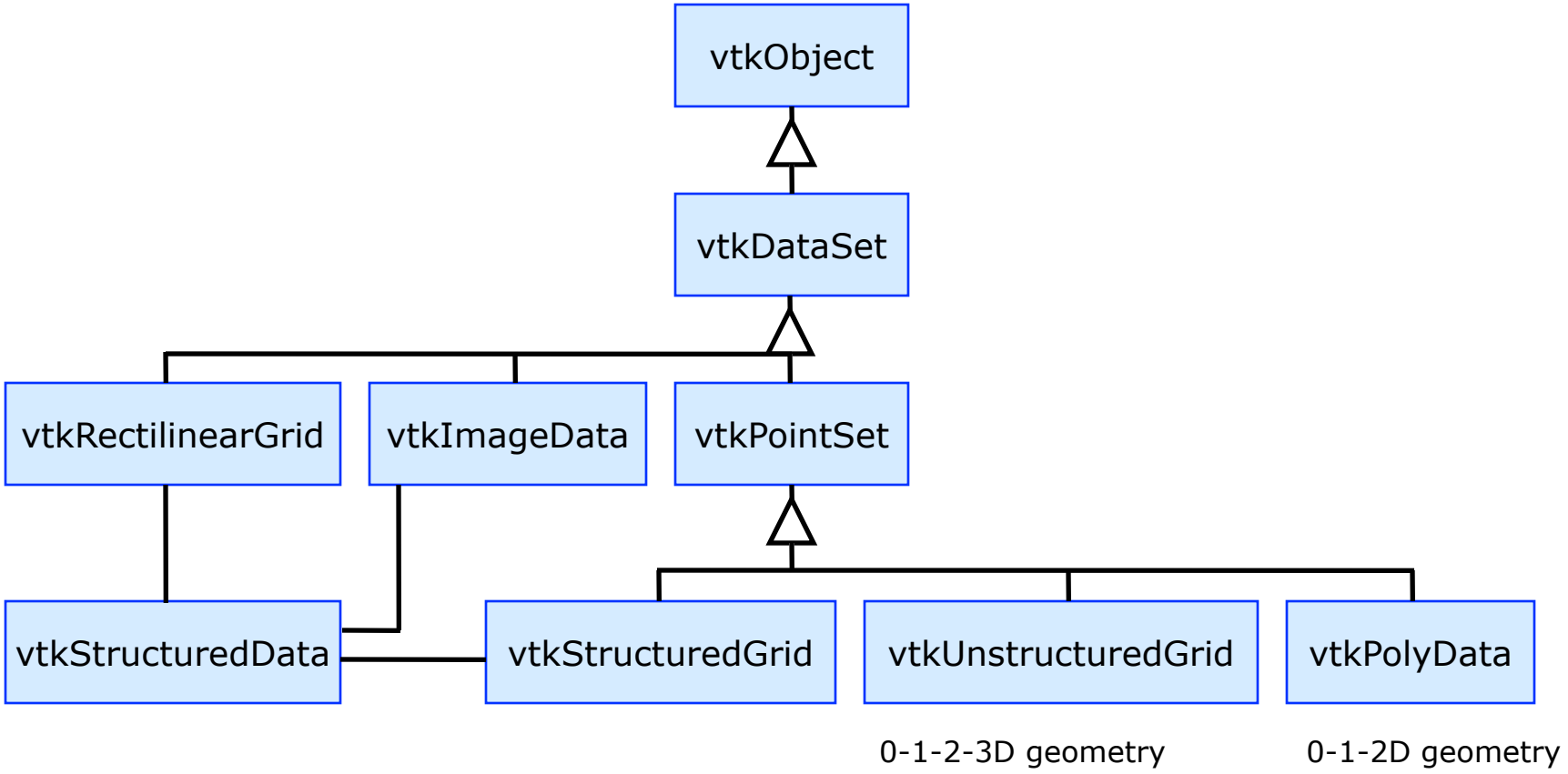


Structured (curvilinear) grid



Unstructured grid

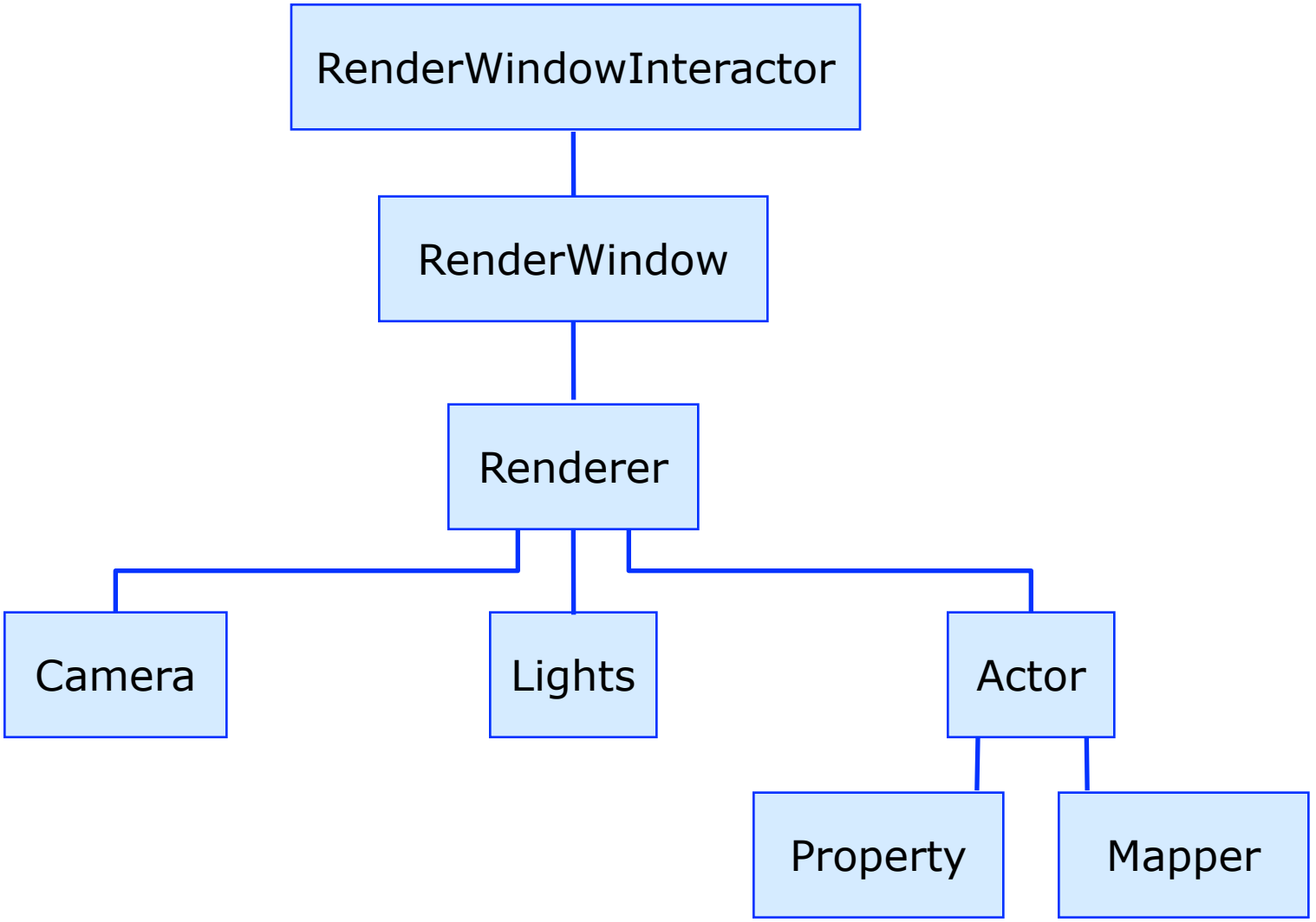
Dataset Types



Outline

- Object-oriented design
- Visualization pipeline
- Data structure
- Rendering
- Examples

Rendering in VTK



Outline

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Demos

Additional References

- VTK User's Guide
- VTK tutorial

http://www.cs.uic.edu/~jbell/CS526/Tutorial/Tutorial.html

- The Visualization Toolkit

An object-oriented Approach to 3D Graphics,

3rd edition, W. Schroeder, K. Martin, B. Lorensen, Kitware