CS 530 Visualization

Introduction to VTK

January 9, 2013

The Visualization Toolkit

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

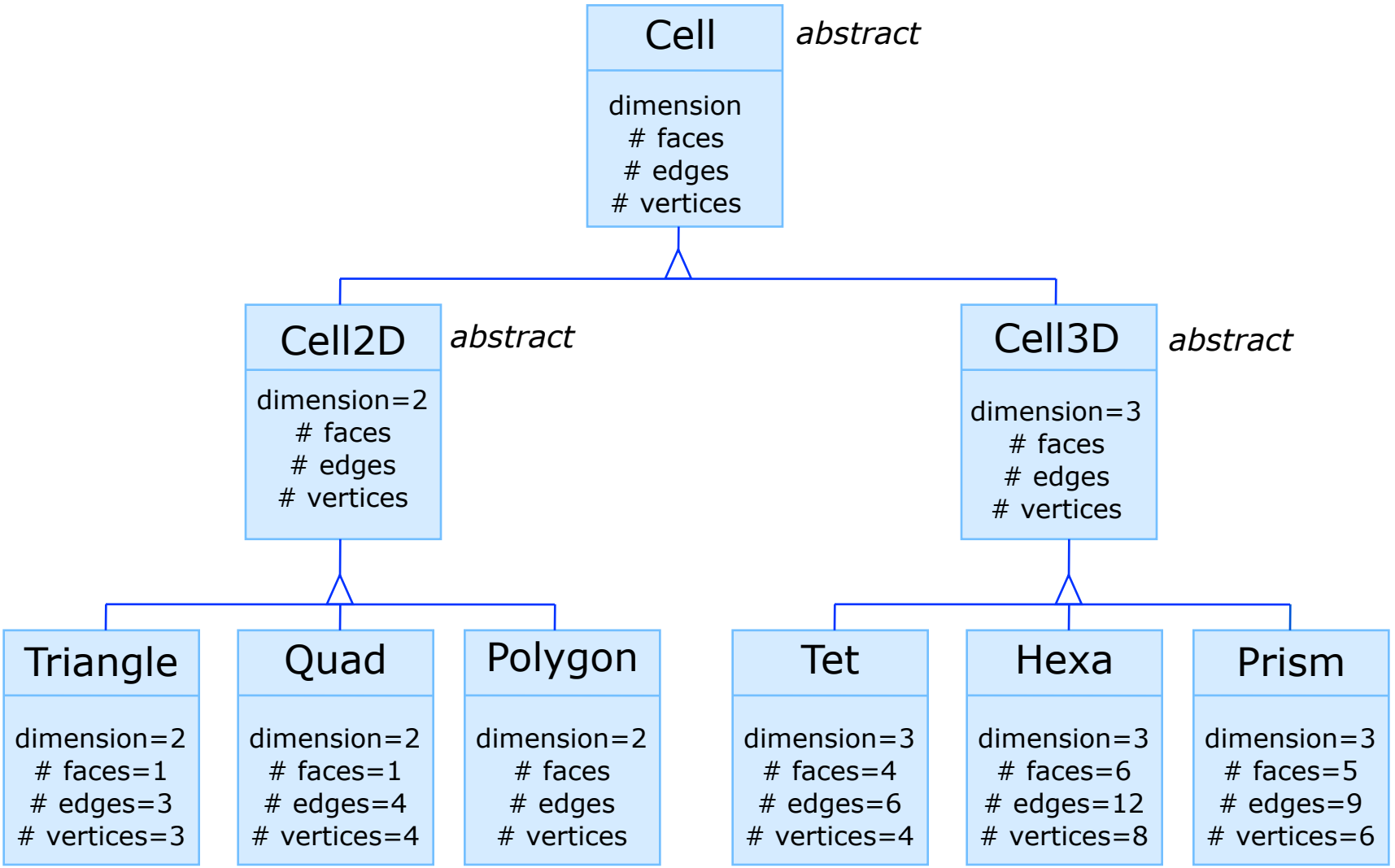
Outline

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

Outline

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

Object-Oriented Design



Outline

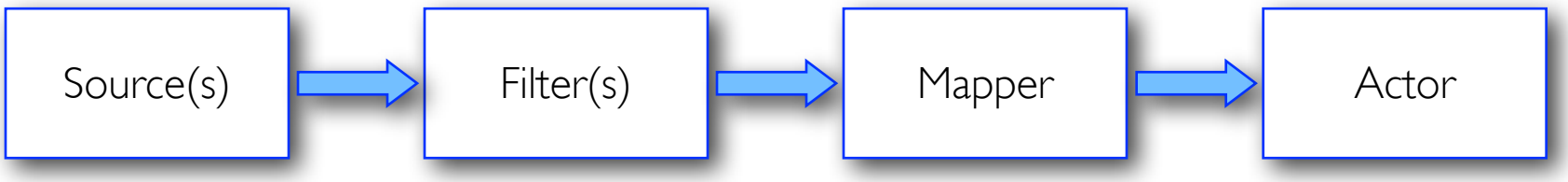
- Object-oriented design
- Visualization pipeline
- Data structure
- Rendering
- Examples

Visualization Pipeline

- Process objects

Visualization Pipeline

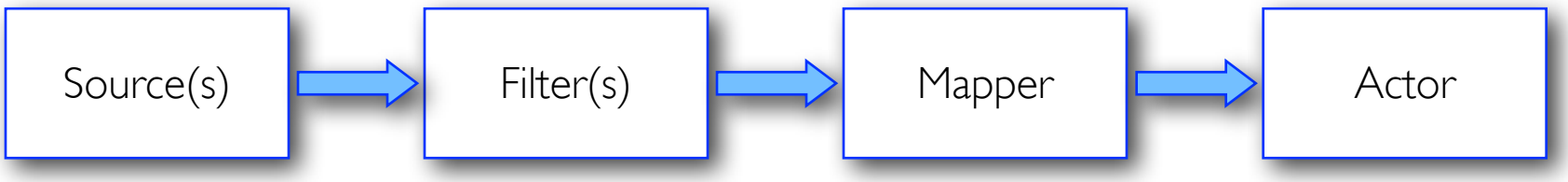
- Process objects



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

Visualization Pipeline

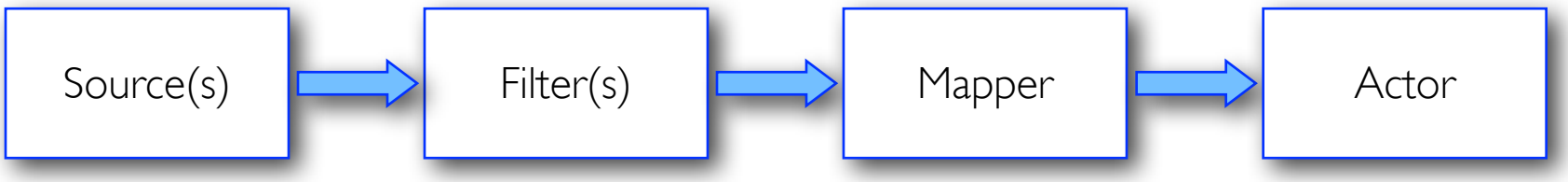
- Process objects



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

Visualization Pipeline

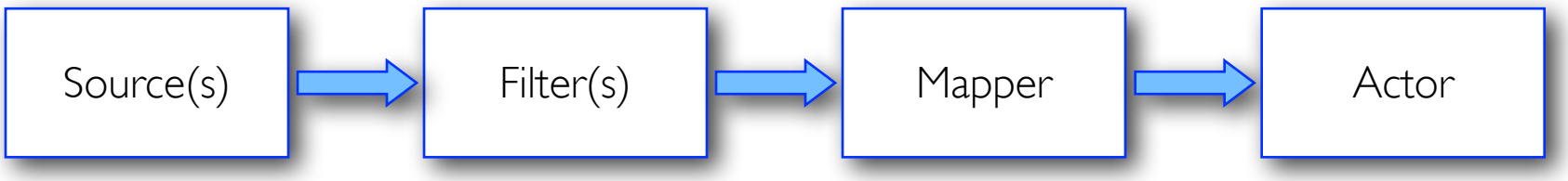
- Process objects

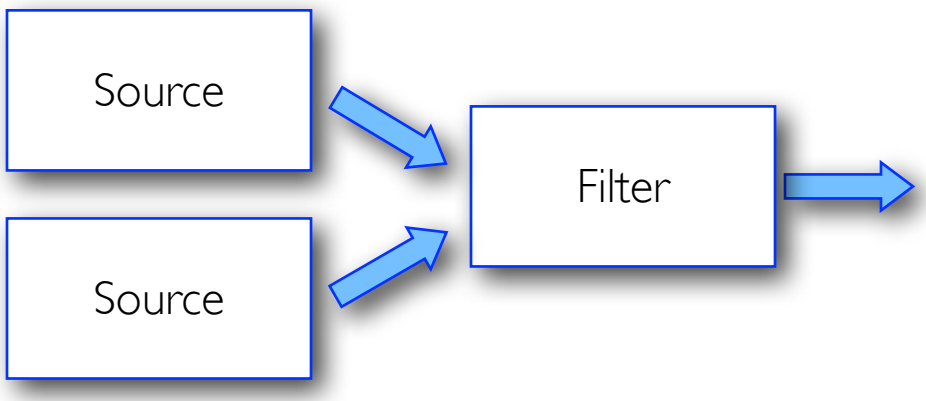


- Mapper: output data
  - Generate graphical primitives
  - Write data to file
  - Interface with another software or device

Visualization Pipeline

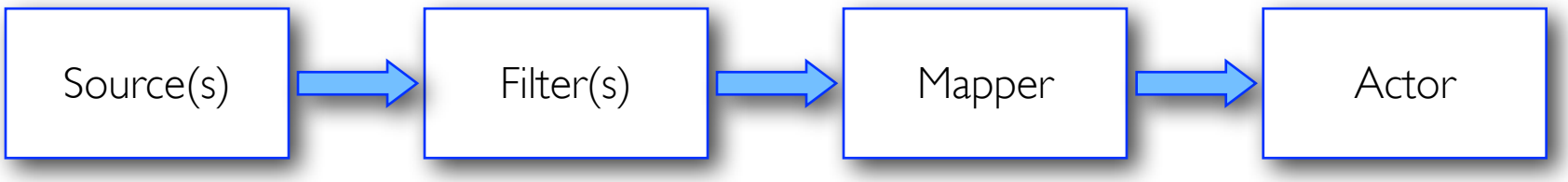
- Connections *(type checking)*





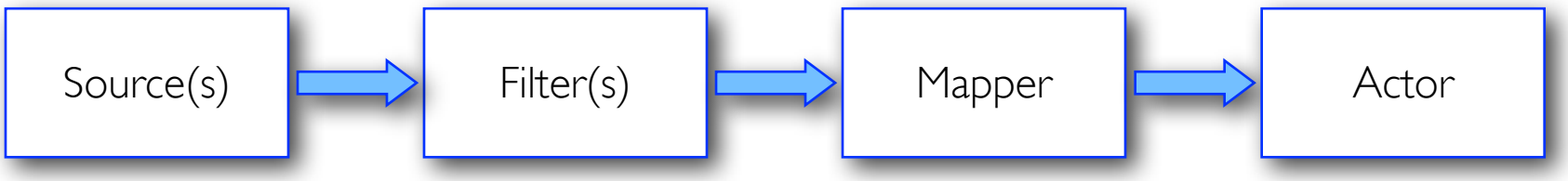
Visualization Pipeline

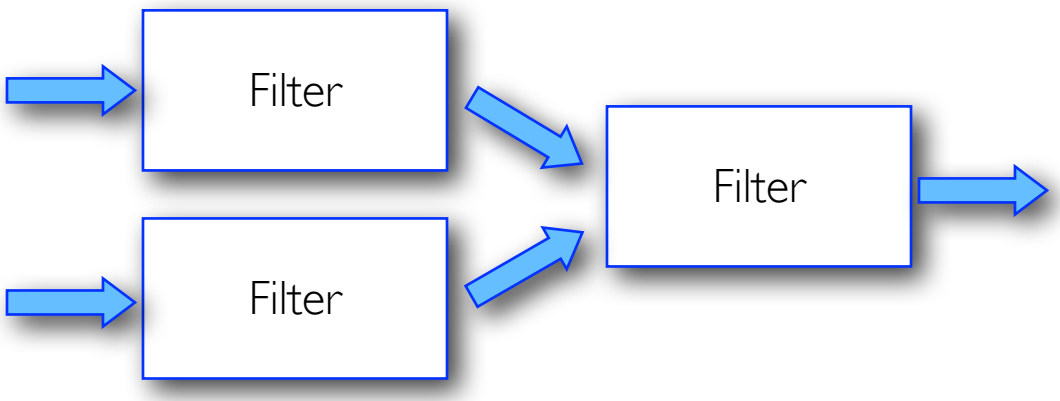
- Connections *(type checking)*



Visualization Pipeline

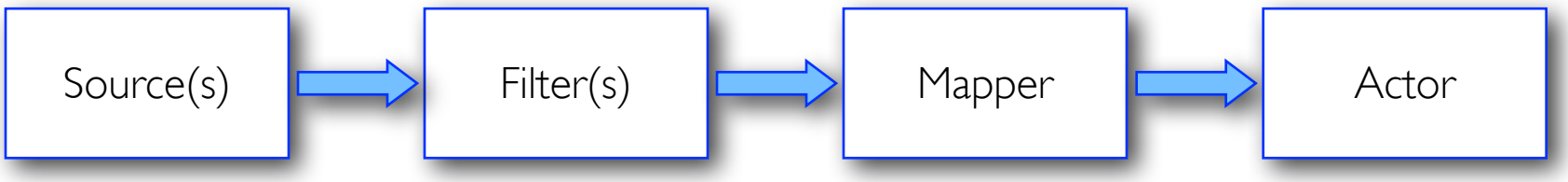
- Connections *(type checking)*

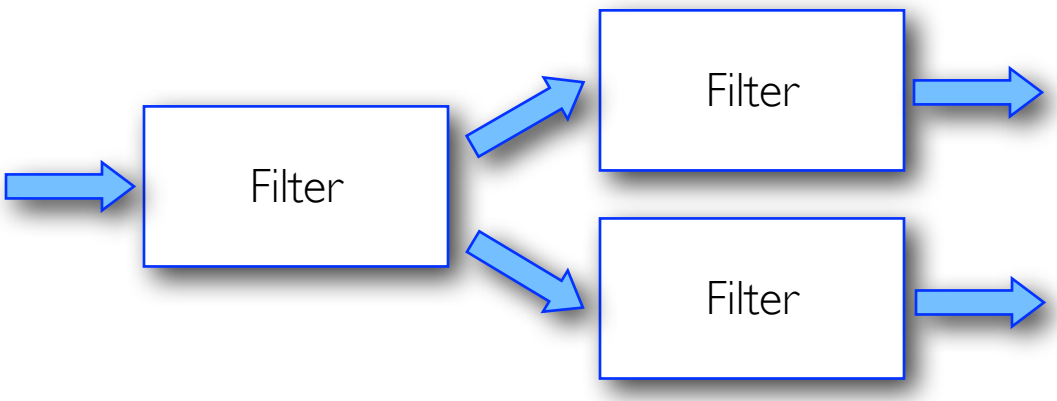




Visualization Pipeline

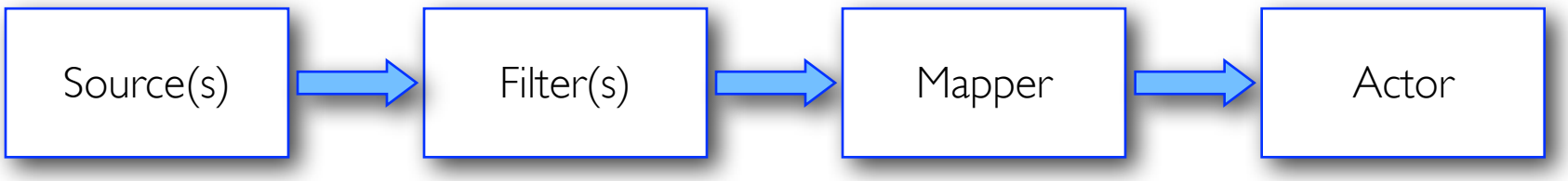
- Connections *(type checking)*

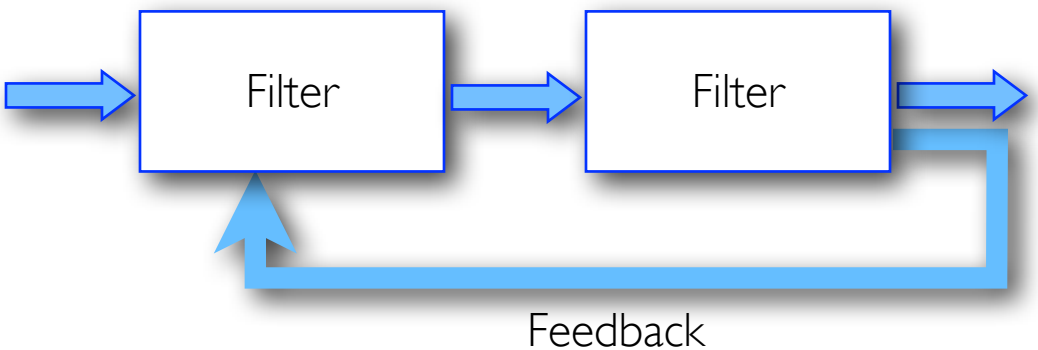




Visualization Pipeline

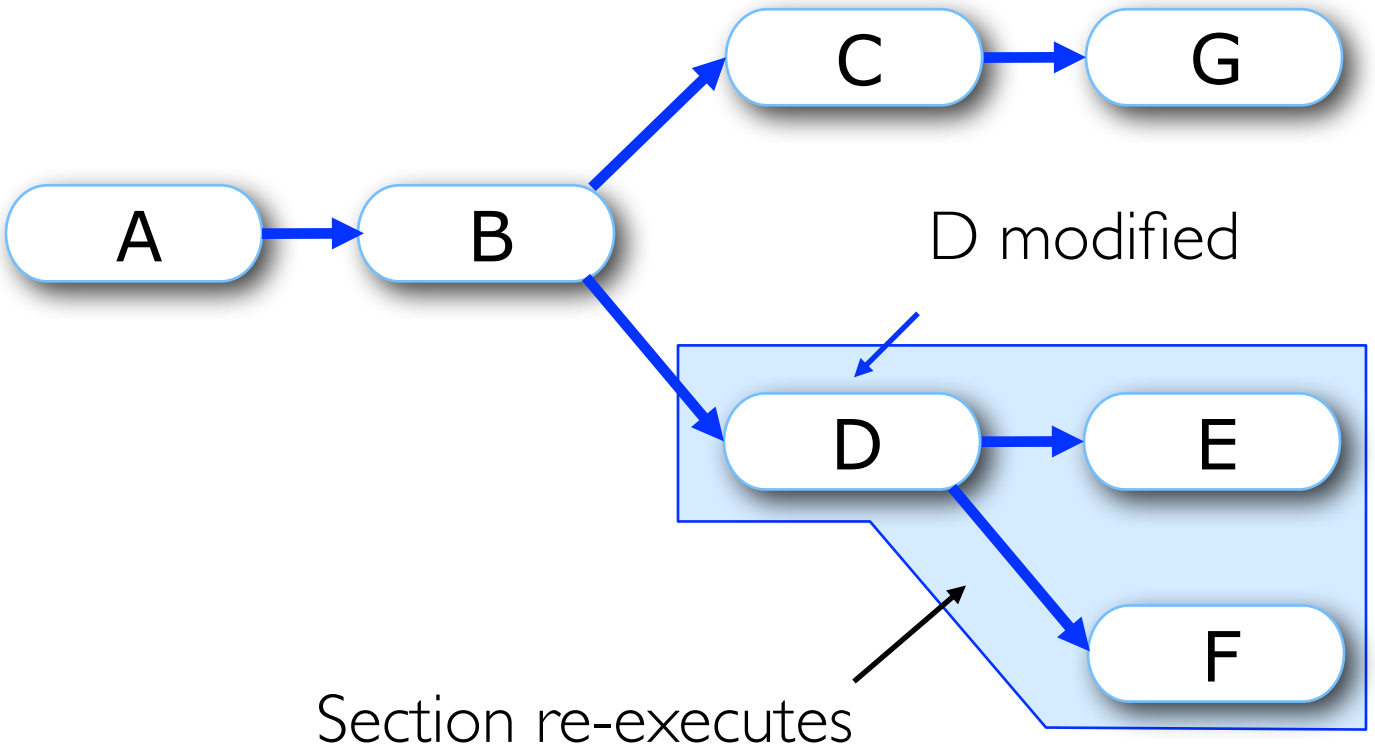
- Connections *(type checking)*





Visualization Pipeline

- Implicit control of execution *(lazy evaluation)*

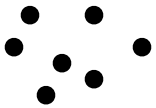


Outline

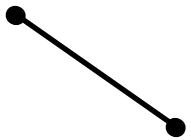
- Object-oriented design
- Visualization pipeline
- Data structure
- Rendering
- Examples

Cell Types

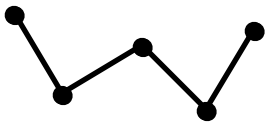
vertex



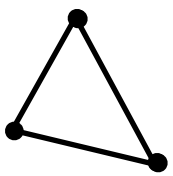
Polyvertex



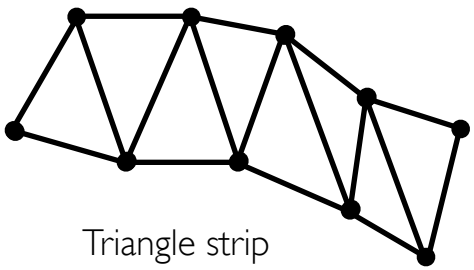
Line



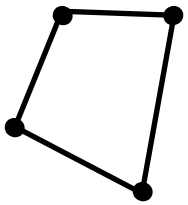
Polyline



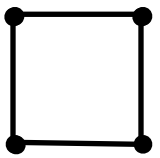
Triangle



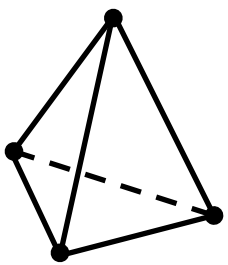
Triangle strip



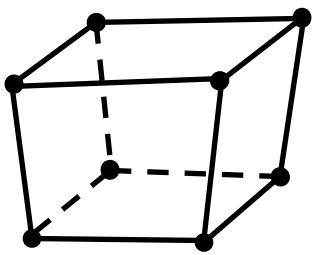
Quadrilateral



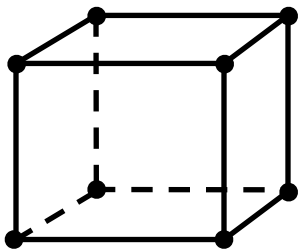
Pixel



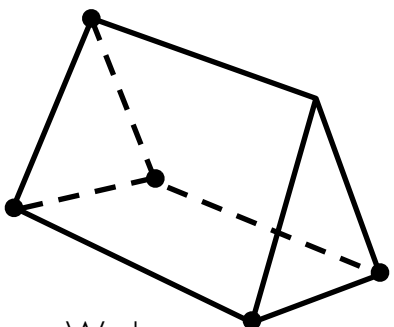
Tetrahedron



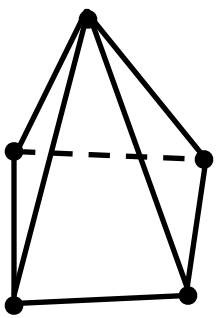
Hexahedron



Voxel

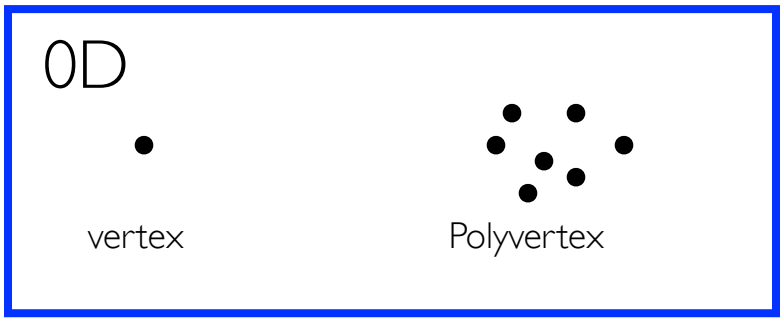


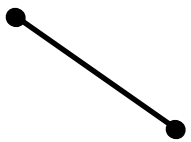
Wedge

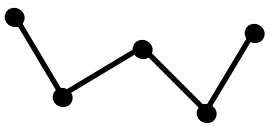


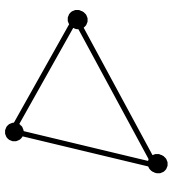
Pyramid

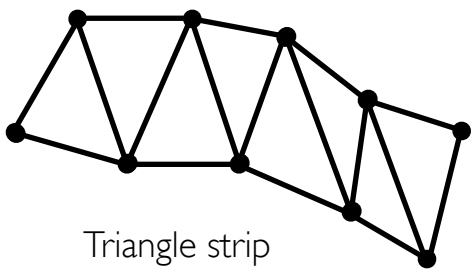
Cell Types

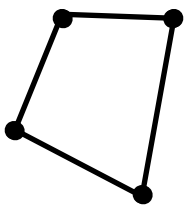


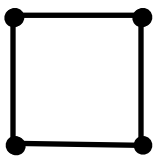

Line

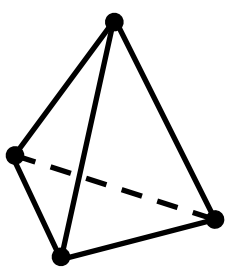

Polyline

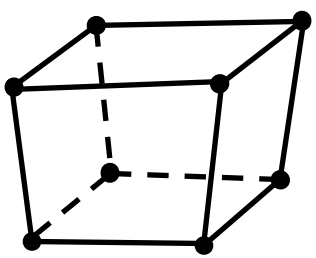

Triangle

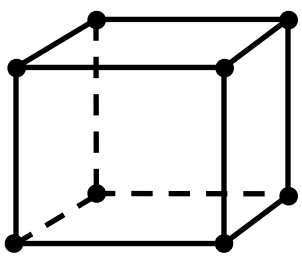

Triangle strip

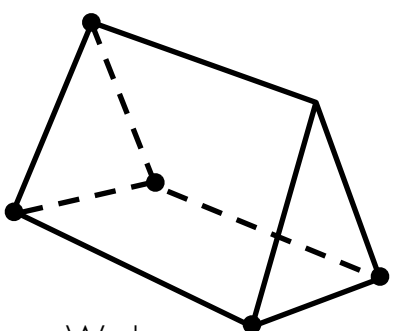

Quadrilateral

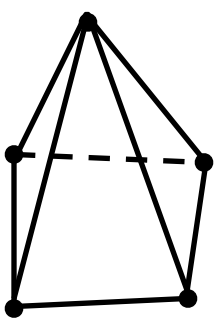

Pixel


Tetrahedron

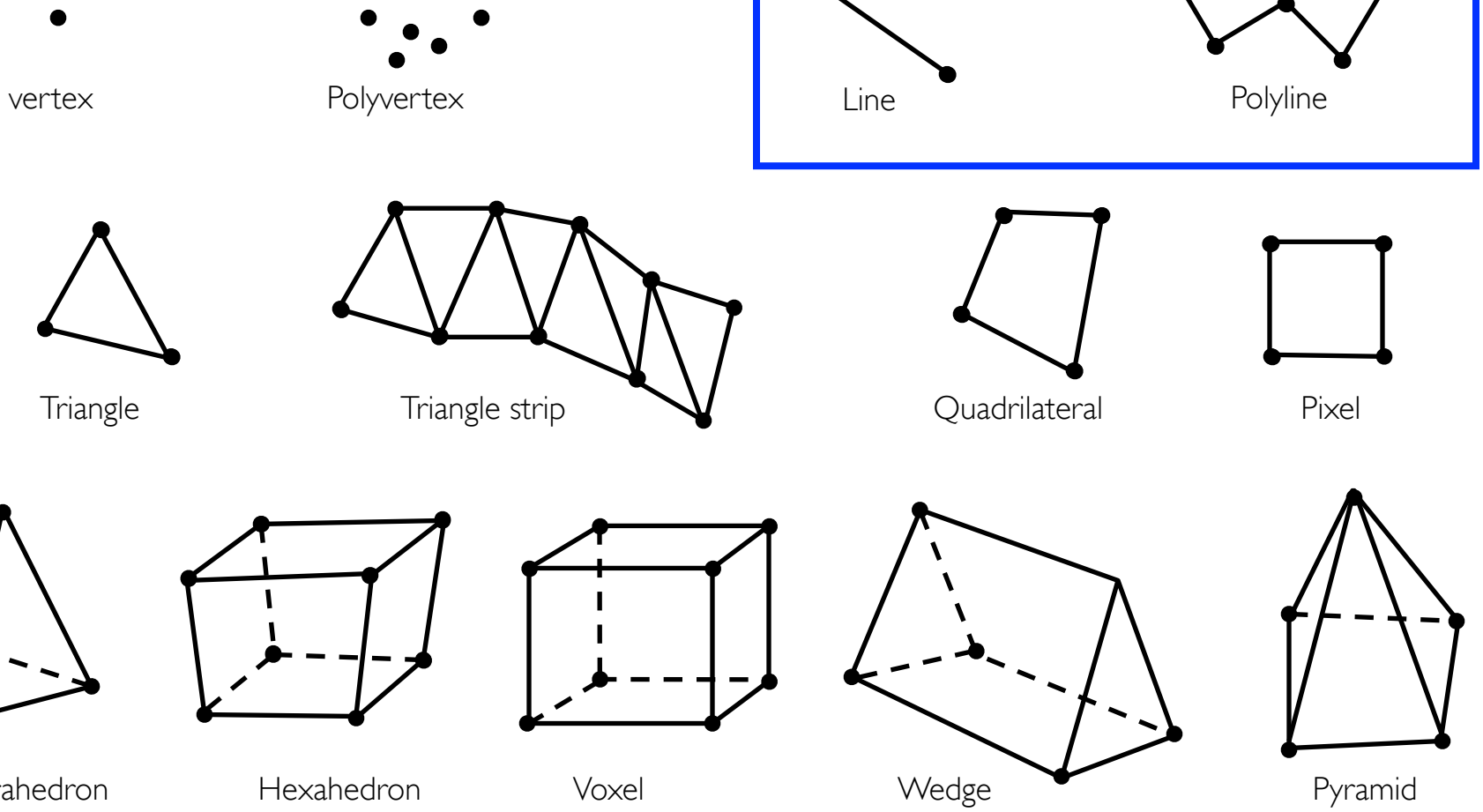

Hexahedron


Voxel


Wedge

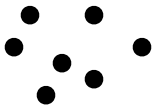

Pyramid

Cell Types

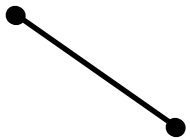

1D
vertex
Polyvertex
Line
Polyline
Triangle
Triangle strip
Quadrilateral
Pixel
Tetrahedron
Hexahedron
Voxel
Wedge
Pyramid

Cell Types

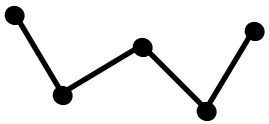
vertex



Polyvertex

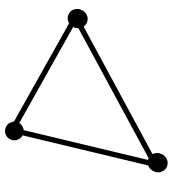


Line

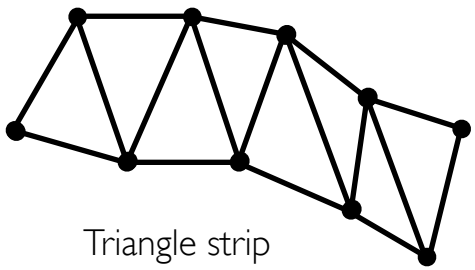


Polyline

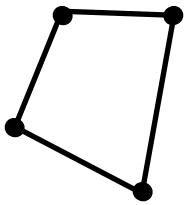
2D



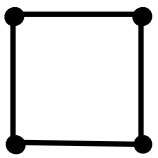
Triangle



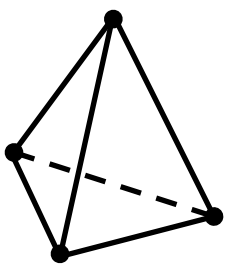
Triangle strip



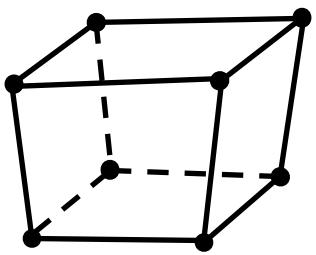
Quadrilateral



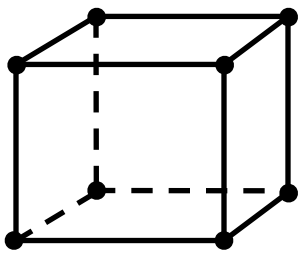
Pixel



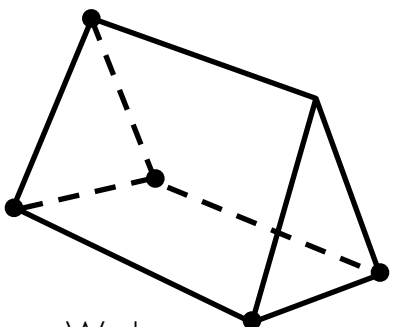
Tetrahedron



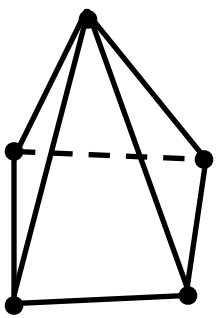
Hexahedron



Voxel

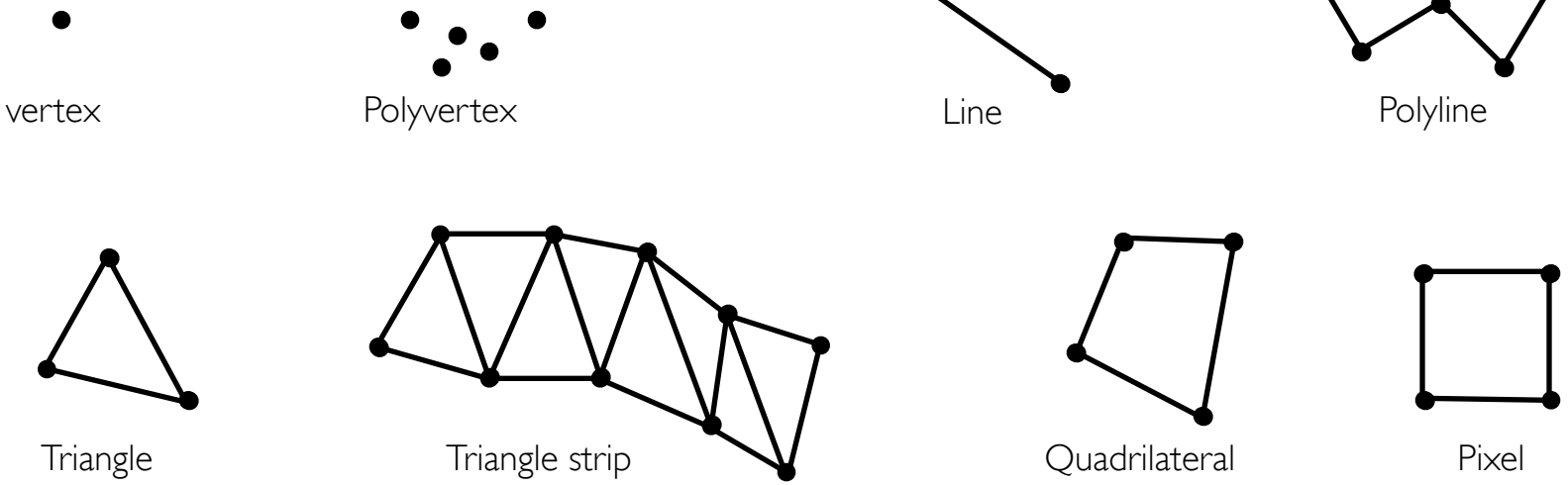


Wedge



Pyramid

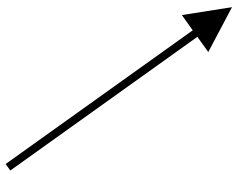
Cell Types


vertex
Polyvertex
Line
Polyline
Triangle
Triangle strip
Quadrilateral
Pixel
3D
Tetrahedron
Hexahedron
Voxel
Wedge
Pyramid

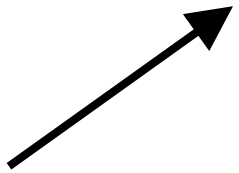
Data Attributes

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

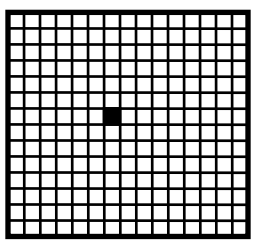
Scalar



3D vector (u,v,w)



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

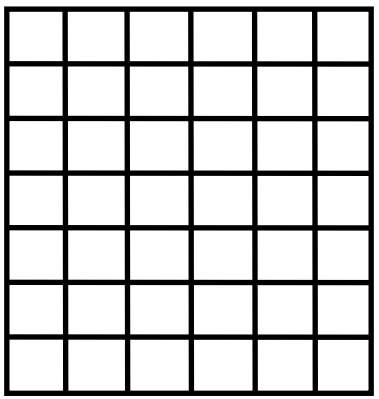


Texture coordinate (u,v) or (u,v,w)

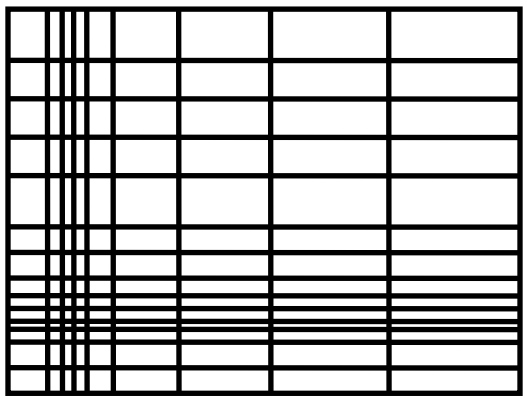
$$\begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix}$$

2nd order tensor (3x3 matrix)

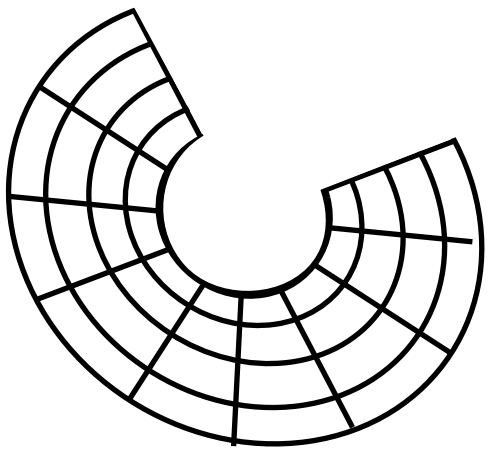
Dataset Types



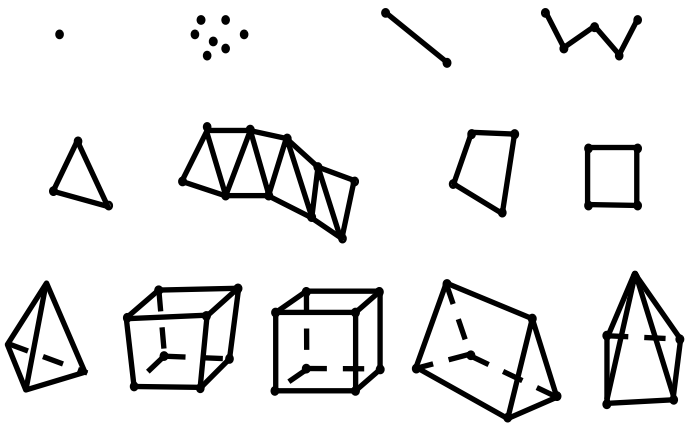
Image



Rectilinear grid

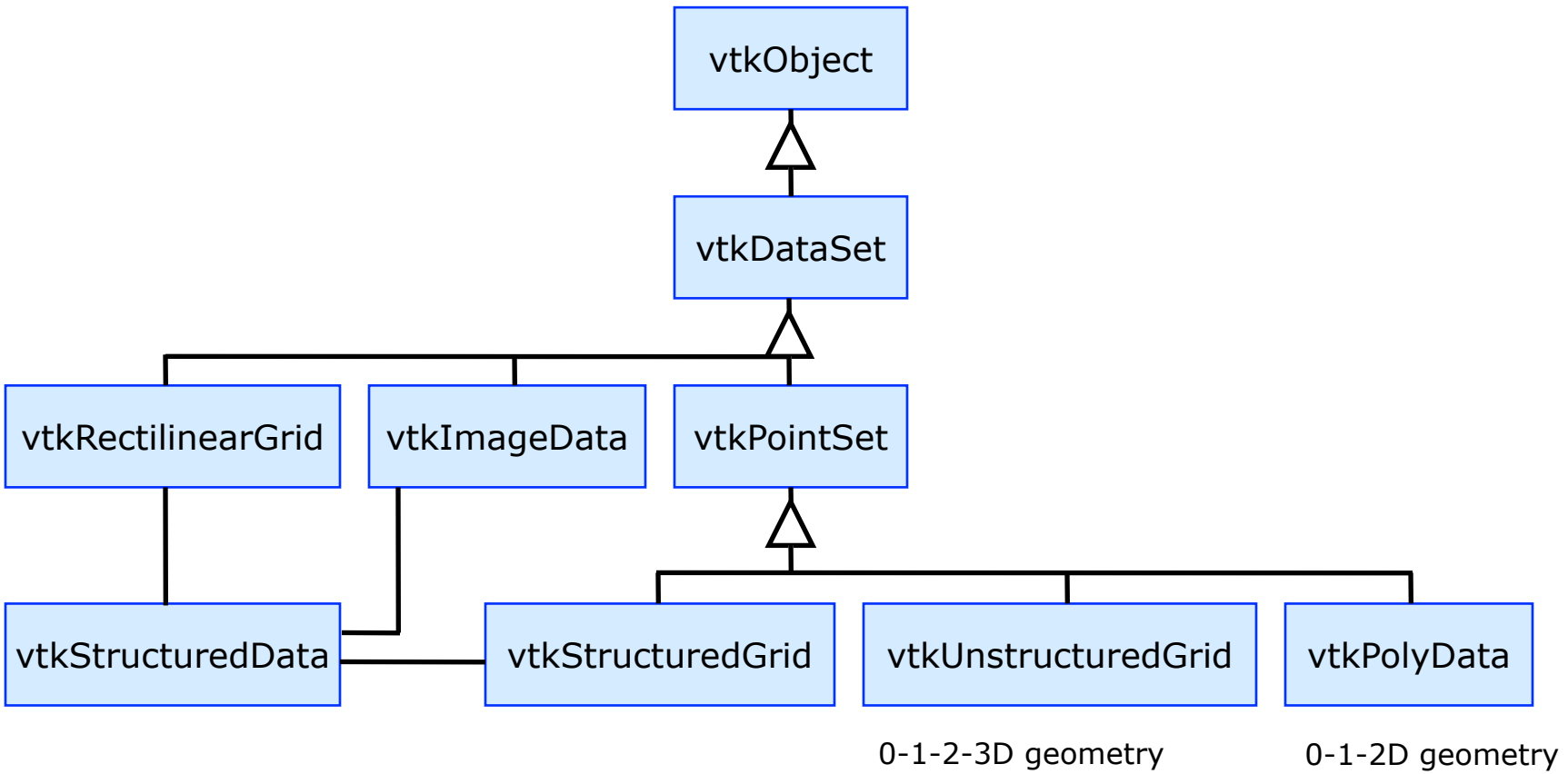


Structured (curvilinear) grid



Unstructured grid

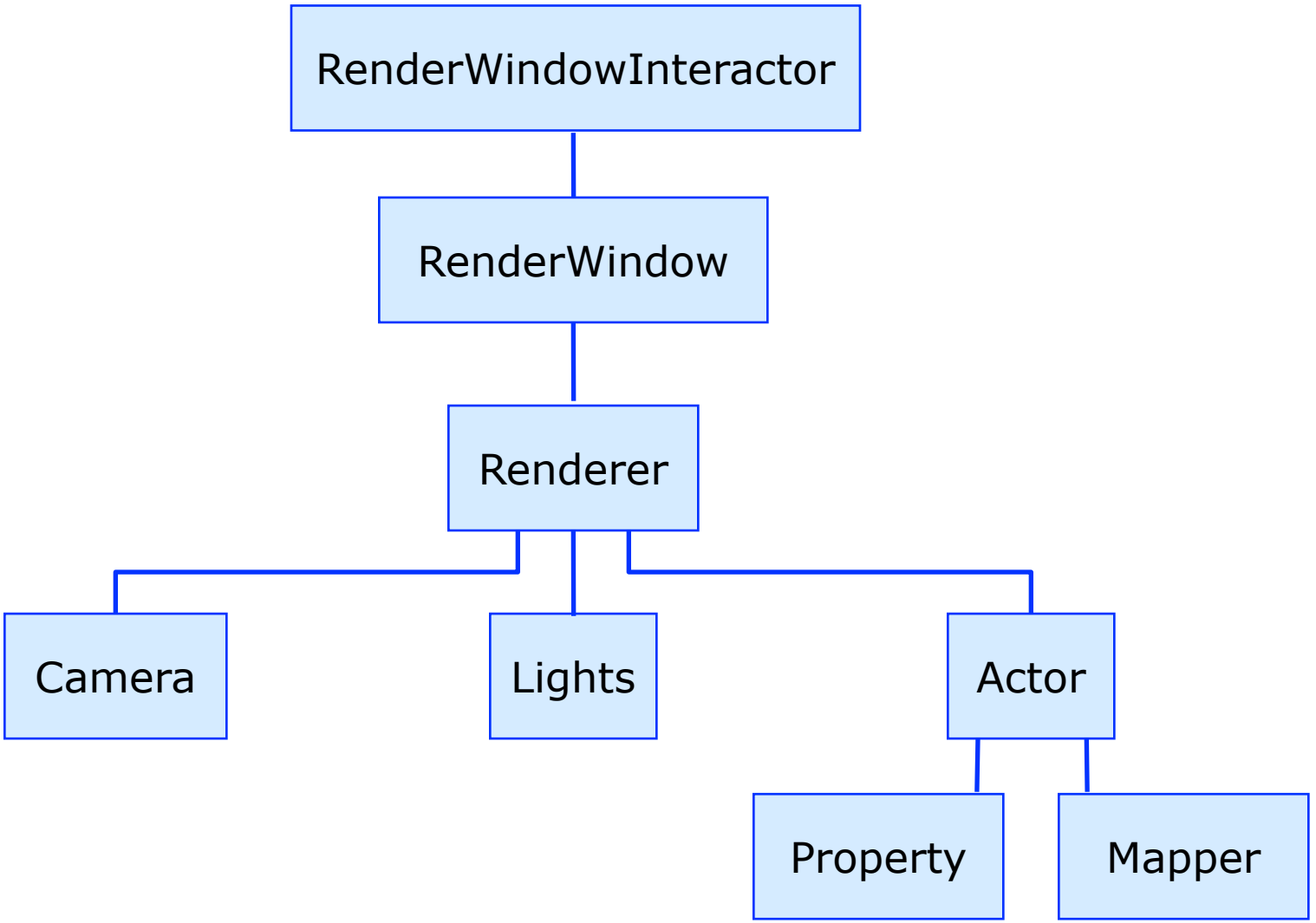
Dataset Types



Outline

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

Rendering in VTK



Outline

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

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