Introduction to VTK

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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Visualization Pipeline

- Process objects

![Visualization pipeline diagram]

- Source(s) → Filter(s) → Mapper
Visualization Pipeline

• Process objects

Source(s)  Filter(s)  Mapper  Actor

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

- Process objects

  Source(s) ➔ Filter(s) ➔ Mapper ➔ Actor

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

• Process objects

Source(s)  ➔  Filter(s)  ➔  Mapper  ➔  Actor

• 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*)

Source(s) → Filter(s) → Mapper → Actor

Filter → Filter → Filter
Visualization Pipeline

- Connections (*type checking*)

```
Source(s) -> Filter(s) -> Mapper -> Actor
```

```
Filter

Filter -> Filter

Filter

Filter
```
Visualization Pipeline

- Connections *(type checking)*
Visualization Pipeline

- Connections *(type checking)*

Source(s) → Filter(s) → Mapper → Actor

Filter → Filter

Feedback
Visualization Pipeline

- Implicit control of execution (*lazy evaluation*)
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Cell Types

0D
- vertex
- Polyvertex

- Line
- Polyline

- Triangle
- Triangle strip
- Quadrilateral
- Pixel

- Tetrahedron
- Hexahedron
- Voxel
- Wedge
- Pyramid
Cell Types

- **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

3D

- Tetrahedron
- Hexahedron
- Voxel
- Wedge
- Pyramid
Cell Types

vertex
Polyvertex
Line
Polyline
Triangle
Triangle strip
Quadrilateral
Pixel
Tetrahedron
Hexahedron
Voxel
Wedge
Pyramid
Data Attributes

Cell-wise / point-wise (\textit{vtkDataSetAttribute})

- Scalar
- 3D vector \((u,v,w)\)
- normal \((u,v,w)\) \(||n||=1\)
- Texture coordinate \((u,v)\) or \((u,v,w)\)
- 2\textsuperscript{nd} order tensor (3x3 matrix)
Dataset Types

- Image
- Rectilinear grid
- Structured (curvilinear) grid
- Unstructured grid
Dataset Types

- vtkObject
- vtkDataSet
  - vtkRectilinearGrid
  - vtkImageData
  - vtkPointSet
    - vtkStructuredData
    - vtkStructuredGrid
      - vtkUnstructuredGrid
      - vtkPolyData

0-1-2-3D geometry
0-1-2D geometry
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Rendering in VTK

RenderWindowInteractor

RenderWindow

Renderer

Camera

Lights

Actor

Property

Mapper
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Demos
Additional References

• VTK User’s Guide
• VTK tutorial
  

• The Visualization Toolkit
  An object-oriented Approach to 3D Graphics,
  3rd edition, W. Schroeder, K. Martin, B. Lorensen, Kitware