Programming with VTK --- A High-level Visualization Toolkit

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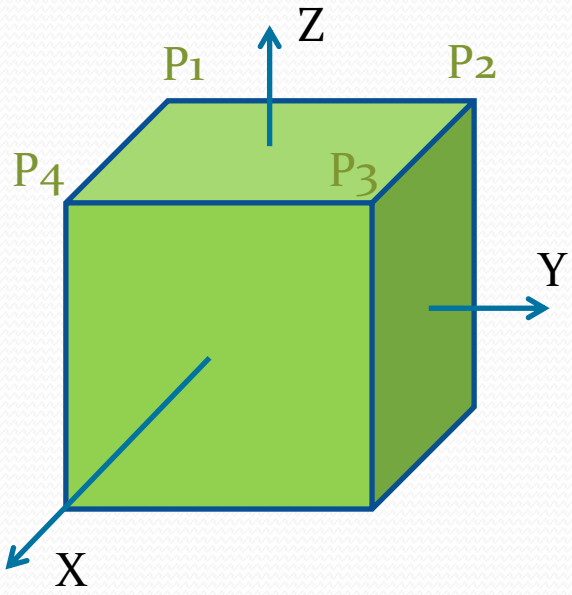
Draw a cube using OpenGL

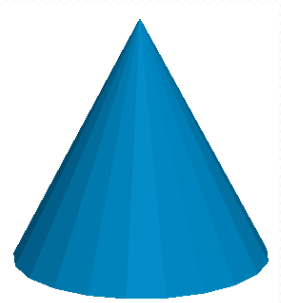
Top face:

```
glBegin(GL_POLYGON);
    glVertex3f( -0.5, -0.5, 0.5); // P1
    glVertex3f( -0.5, 0.5, 0.5); // P2
    glVertex3f( 0.5, 0.5, 0.5); // P3
    glVertex3f( 0.5, -0.5, 0.5); // P4
glEnd();
```



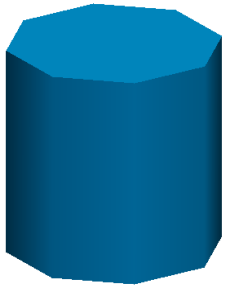
More Primitives

- Cone



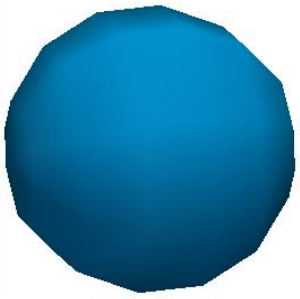
(Radius, Height, Resolution) ?

- Cylinder



(Radius, Height, Resolution) ?

- Sphere



(Radius, Resolution) ?

Outline

- Overview of VTK
- Basics of VTK
- A “hello world” application
- VTK architecture
- VTK’s main classes
- More applications
- Advanced topics
- Resources

Overview of VTK

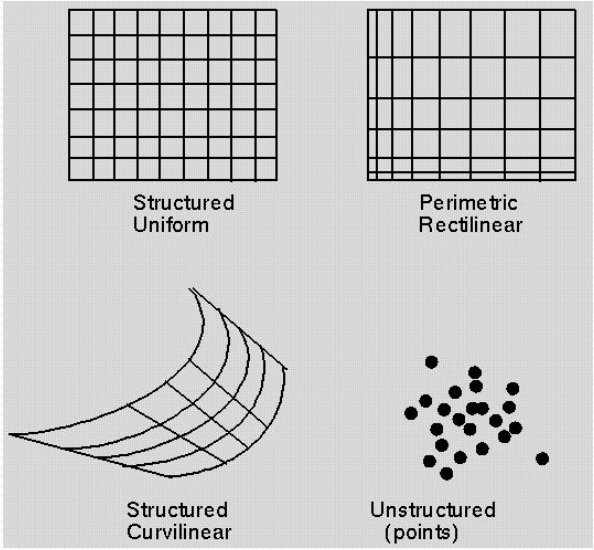
- Created in 1993
- Open Source maintained by Kitware Inc
- Powerful high-level visualization library
  - 3D graphics
  - Image processing
  - Visualization
- Cross platform (Linux, Unix, Windows, MacOS)
- 2627 C++ classes (version 6.1)
- Tcl, Java, Python wrappers

Overview of VTK (cont.)

- Shorter code/more effecient
- Many users/code contributors
- Active development
- Visualization of large-scale data
- Well-documented and resources

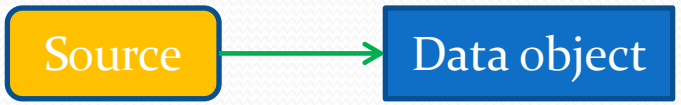
Basics of VTK

- vtkDataObject
  - vtkImageData
  - vtkRectilinearGrid
  - vtkStructuredGrid
  - vtkPolydata
  - vtkUnstructuredGrid



Basics of VTK (cont.)

- vtkAlgorithm
  - Source
    - Procedural sources
    - Reader sources
  - Filter



Basics of VTK (cont.)

- Connection of sources/filters

filter1->SetInputConnection(source->GetOutputPort())

filter2->SetInputConnection(filter1->GetOutputPort())

Basics of VTK (cont.)

- Main directories of source tree
  - VTK/Common --- Core classes
  - VTK/Filtering --- Data processing in pipeline
  - VTK/Graphics --- Filters that process 3D data
  - VTK/Hybrid --- complex classes
  - VTK/Imaging --- Image processing filters
  - VTK/IO --- data file reading/writing
  - VTK/Parallel --- Parallel processing support
  - VTK/Rendering --- various rendering techniques
  - VTK/Widgets --- 3D widgets

A “hello world” app

```
# define source
cone = vtk.vtkConeSource()
cone.SetHeight( 3.0 )
cone.SetRadius( 1.0 )
cone.SetResolution( 10 )

# define mapper
coneMapper = vtk.vtkPolyDataMapper()
coneMapper.SetInputConnection( cone.GetOutputPort() )

#define actor
coneActor = vtk.vtkActor()
coneActor.SetMapper( coneMapper )
```

A “hello world” app (cont.)

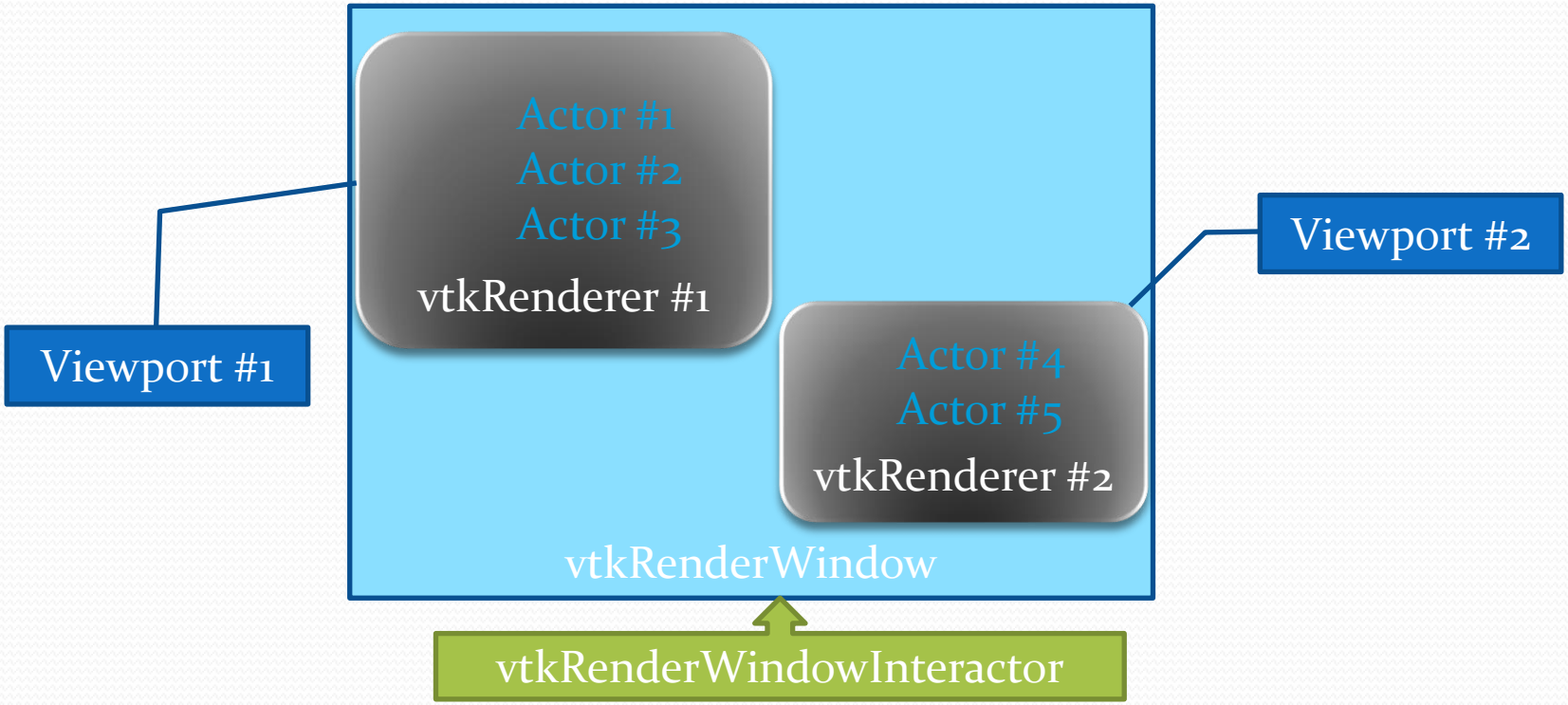
```
# define renderer
ren= vtk.vtkRenderer()
ren.AddActor( coneActor )
ren.SetBackground( 0.1, 0.2, 0.4 )

# define rendering window
renWin = vtk.vtkRenderWindow()
renWin.AddRenderer( ren )
renWin.SetSize( 300, 300 )

# define interactor
iren = vtk.vtkRenderWindowInteractor()
iren.SetRenderWindow(renWin)
iren.Initialize()
iren.Start()
```

A “hello world” app (cont.)

- Add another primitive
- Set color
- Set position
- Set orientation

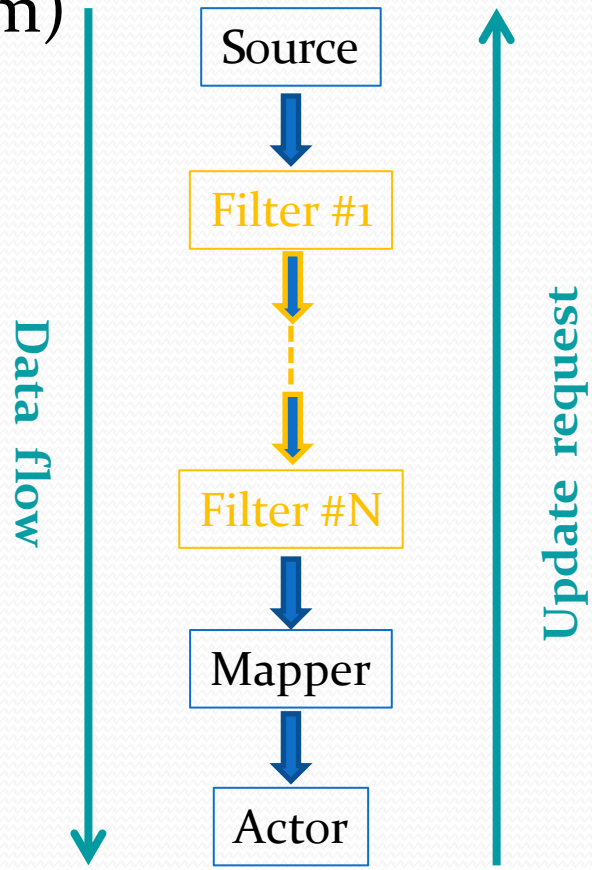
http://www.vtk.org/doc/nightly/html/classvtkConeSource.html

VTK architecture



VTK architecture (cont.)

- VTK processing unit (vtkAlgorithm)
  - Time stamp of latest update
  - Time stamp of latest modification
- VTK “lazy-update” scheme
  - Up-stream Update()
  - Down-stream RequestData()



VTK's main classes

- vtkProp (vtkActor, vtkVolume, vtkActor2D): position, scaling, orientation
- vtkAbstractMapper (vtkPolyDataMapper, vtkFixedPointVolumeRayCastMapper): rendering
- vtkProperty: appearance such as color, opacity, surface optical property
- vtkCamera: eye position, focal point, clipping planes, view frustum
- vtkLight: specification of lights
- vtkRenderer: holds props, camera, lights
- vtkRenderWindow: windowing
- vtkRenderWindowInteractor: rotating, moving, scaling

More applications

- Load and render STL data
- Load and render 3DS data
- Load and render medical image data

Advanced topics

- Event observers and callback methods

  AddObserver(Event, Callback)

  - StartEvent
  - EndEvent
  - ProgressEvent
  - ErrorEvent
  - WarningEvent
  - Other events (picking, dragging, selecting, keyboard/mouse, or user-defined events)

Advanced topics

- I/O
  - Readers/Writers (load/save a specific dataset. e.g., vtkMultiBlockPLOT3DReader, vtkIVWriter)
  - Importers/Exporters (import/export whole scene. e.g., vtk3DSImporter, vtkIVExporter)
  - Screenshots (bmp, png, jpeg, tiff, etc)
  - Movies (vtkMPEG2Writer)

Advanced topics (cont.)

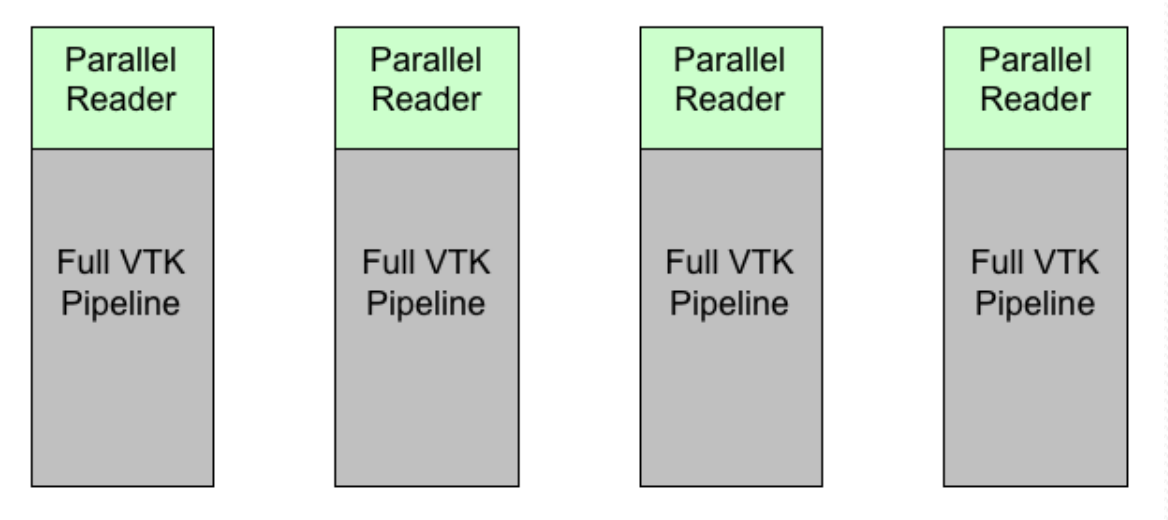
- Widgets
  - vtkScalarBarWidget
  - vtkPointWidget
  - vtkLineWidget
  - **vtkPlaneWidget**
  - **vtkBoxWidget**
  - vtkImagePlaneWidget
  - vtkSphereWidget
  - vtkSplineWidget

Advanced topics (cont.)

- Animation
  - vtkAnimationScene
  - vtkAnimationCue

Advanced topics (cont.)

- Parallel visualization
  - Multi-threading
  - MPI-based Parallelism



Resources

- Official web www.vtk.org
- Documentation http://www.vtk.org/VTK/help/documentation.html
- Wiki http://www.vtk.org/Wiki/VTK
- Mailing lists
  - vtkusers@vtk.org
  - vtk-developers@vtk.org
- Examples

Resources

- Textbook “Visualization Toolkit: An Object-Oriented Approach to 3D Graphics”
- “VTK User’s Guide”

Qestions?