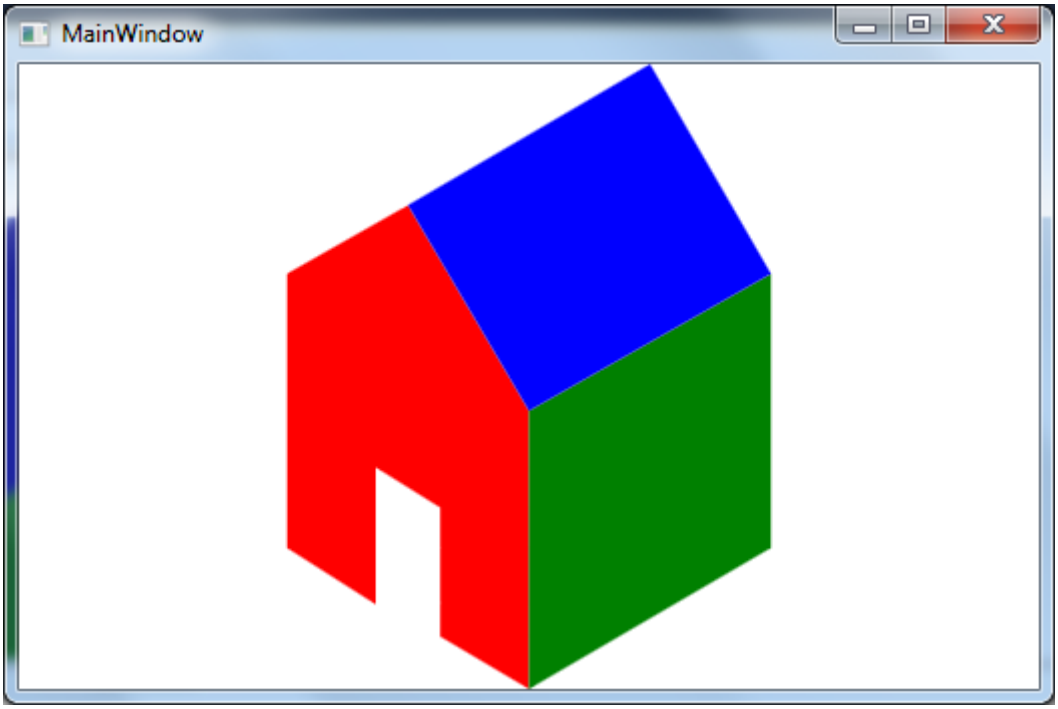
3D Graphics in WPF

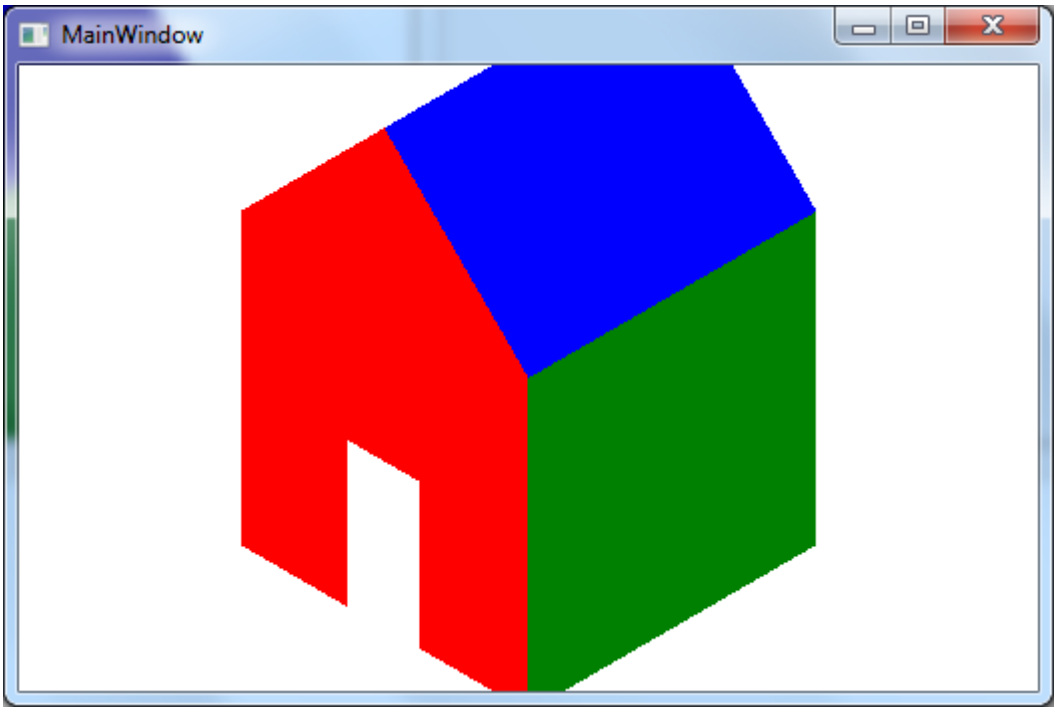
- You CAN create 3D illusions using 2D graphics




```
  <Image>
            <Image.Source>
                <DrawingImage>
                    <DrawingImage.Drawing>
                        <DrawingGroup x:Name="House">
                            <GeometryDrawing x:Name="Front" Brush="Red"
Geometry="M0,260 L0,600 L110,670 L110,500 L190,550 L190,710 L300,775
L300,430 L150,175"/>
                            <GeometryDrawing x:Name="Side" Brush="Green"
Geometry="M300,430 L300,775 L600,600 L600,260"/>
                            <GeometryDrawing x:Name="Roof" Brush="Blue"
Geometry="M150,175 L300,430 L600,260 L450,0"/>
                        </DrawingGroup>
                    </DrawingImage.Drawing>
                </DrawingImage>
            </Image.Source>
        </Image>
```

Real 3D graphics

- Uses camera (and look direction)



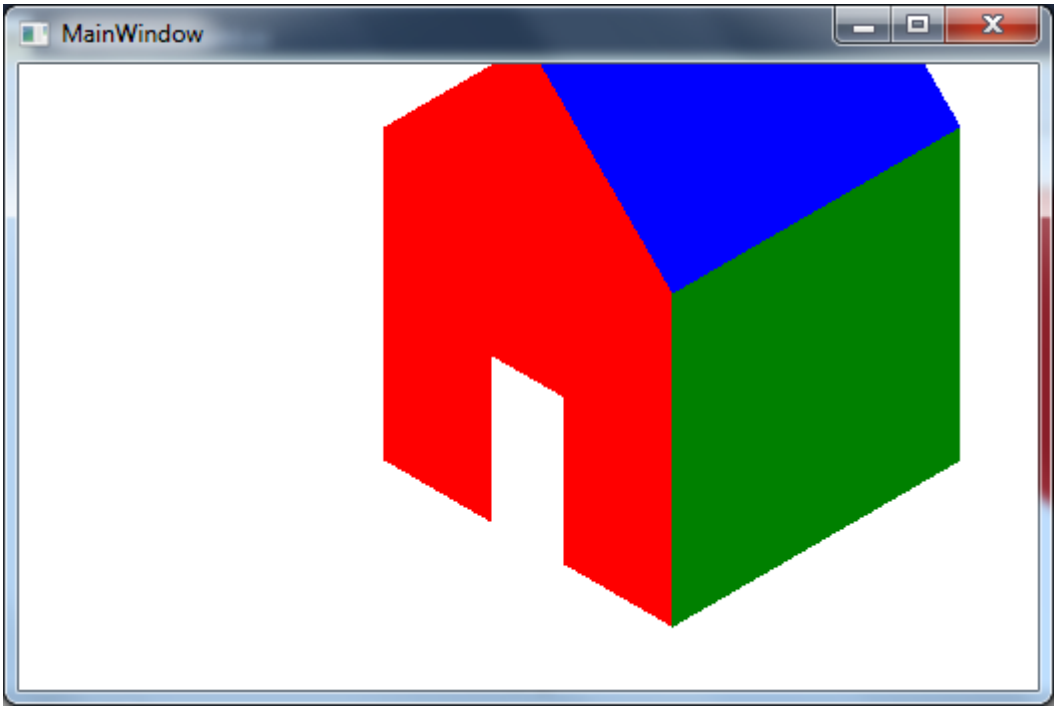

```
<Viewport3D>
            <Viewport3D.Camera>
                <OrthographicCamera Position="5,5,5" LookDirection="-1,-1,-1" Width="5"/>
            </Viewport3D.Camera>
            <Viewport3D.Children>
                <ModelVisual3D x:Name="Light">
                    <ModelVisual3D.Content>
                        <AmbientLight/>
                    </ModelVisual3D.Content>
                </ModelVisual3D>
                <ModelVisual3D>
                    <ModelVisual3D.Content>
                        <Model3DGroup x:Name="House">
                            <GeometryModel3D x:Name="Roof">
                                <GeometryModel3D.Material>
                                    <DiffuseMaterial Brush="Blue"/>
                                </GeometryModel3D.Material>
                                <GeometryModel3D.Geometry>
                                    <MeshGeometry3D Positions="-1,1,1 0,2,1 0,2,-1 -1,1,-1
0,2,1 1,1,1
1,1,-1 0,2,-1"
TriangleIndices="0 1 2 0 2 3 4 5 6 4 6 7"/>
                                </GeometryModel3D.Geometry>
                            </GeometryModel3D>
```

```
                            <GeometryModel3D x:Name="Sides">
                                <GeometryModel3D.Material>
                                    <DiffuseMaterial Brush="Green"/>
                                </GeometryModel3D.Material>
                                <GeometryModel3D.Geometry>
                                    <MeshGeometry3D Positions="-1,1,1 -1,1,-1 -1,-1,-1 -1,-
1,1 1,1,-1
1,1,1 1,-1,1 1,-1,-1"
TriangleIndices="0 1 2 0 2 3 4 5 6 4 6 7"/>
                                </GeometryModel3D.Geometry>
                            </GeometryModel3D>
                            <GeometryModel3D x:Name="Ends">
                                <GeometryModel3D.Material>
                                    <DiffuseMaterial Brush="Red"/>
                                </GeometryModel3D.Material>
                                <GeometryModel3D.Geometry>
                                    <MeshGeometry3D
Positions="-0.25,0,1 -1,1,1 -1,-1,1 -0.25,-1,1 -0.25,0,1
-1,-1,1 0.25,0,1 1,-1,1 1,1,1 0.25,0,1 0.25,-1,1 1,-1,1
1,1,1 0,2,1 -1,1,1 -1,1,1 -0.25,0,1 0.25,0,1 1,1,1 1,1,-1
1,-1,-1 -1,-1,-1 -1,1,-1 1,1,-1 -1,1,-1 0,2,-1"
TriangleIndices="0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 15
17 18 19 20 21 19 21 22 23 24 25"/>
                                </GeometryModel3D.Geometry>
                            </GeometryModel3D>
                        </Model3DGroup>
                    </ModelVisual3D.Content>
                </ModelVisual3D>
            </Viewport3D.Children>
        </Viewport3D>
```

Camera positions

- Changed to:

```
<Viewport3D.Camera>
                <OrthographicCamera Position="6,6,7" LookDirection="-1,-1,-1" Width="5"/>
            </Viewport3D.Camera>
```



3D types

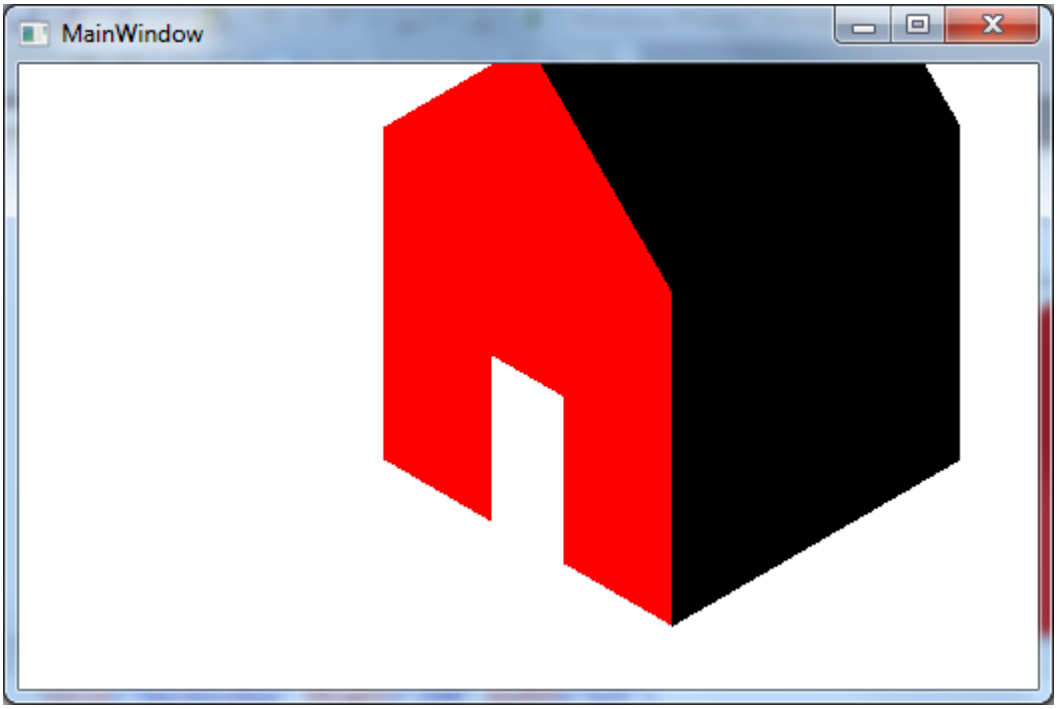
2D Type	3D Type	Description
`Drawing`	`Model3D`	`Drawings` represent pieces of 2D content, such as clip art, which may be rendered by a `Visual`. `Model3Ds` represent pieces of 3D models, which may be rendered by a `Visual3D`.
`Geometry`	`Geometry3D`	A `Geometry` represents a 2D shape. Geometries can answer questions about bounds and intersections. By itself, a `Geometry` cannot be rendered. A `GeometryDrawing` combines a `Geometry` with a `Brush` to give it an appearance. A `Geometry3D` represents a 3D surface. To render a `Geometry3D`, you combine it with a `Material` using a `GeometryModel3D`.
`Visual`	`Visual3D`	`Visual` is the base class for elements that render 2D content. This includes `DrawingVisual` and all `FrameworkElements` such as `Controls` and `Shapes`. `Visual3D` is the base class for elements that render 3D content. `ModelVisual3D` is a concrete `Visual3D` that renders 3D content represented as `Model3Ds`.
`UIElement`	`UIElement3D`	`UIElement`, a derivative of the Visual class, adds much of the core functionality associated with many of WPF's framework-level concepts. It is often said that the `UIElement` class introduces LIFE (layout, input, focus, and eventing) to the 2D class hierarchy. `UIElement3D`, as the 3D analog to the 2D `UIElement` class, adds IFE (input, focus, and eventing) to the 3D world. It allows 3D objects to directly participate in application behavior rather than act as purely visual representations of 3D content.
`Transform`	`Transform3D`	Subclasses of the 2D `Transform` class are used to position, rotate, and size 2D `Drawings` and `Visuals`. There are no `Transform3Ds` in Listing 16.2, but when you encounter the 3D transform objects later in this chapter, you will see that they perform the same function for `Model3Ds` and `Visual3Ds`.

Kilde: WPF4.Unleashed

Notice:

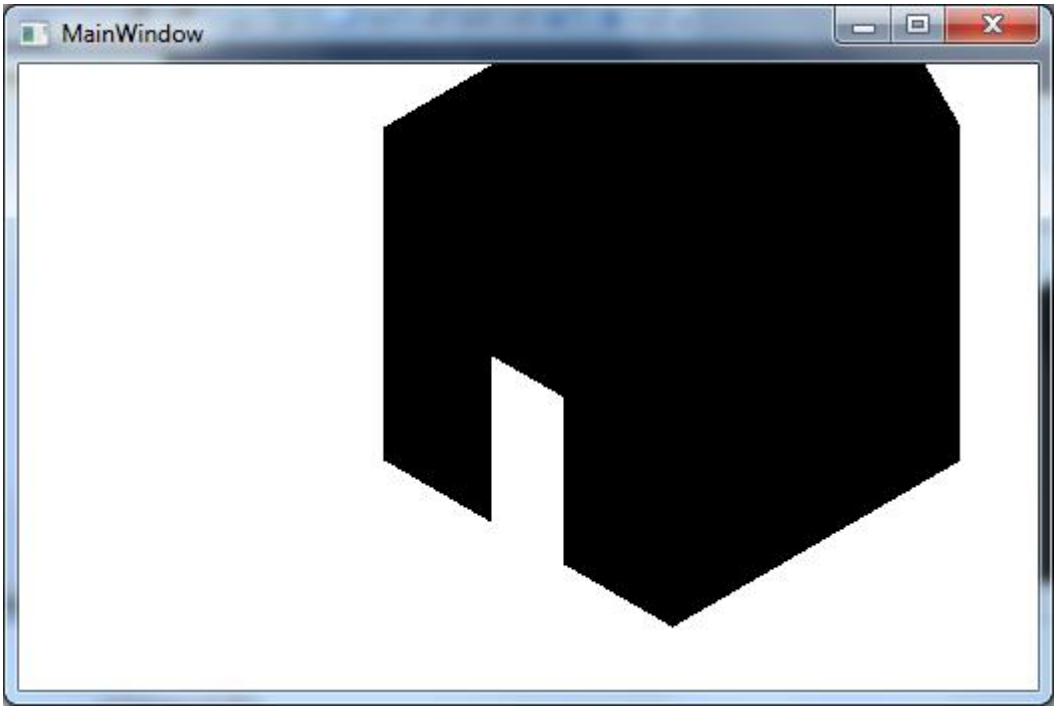
- A virtual camera is used
- 3D uses brushes and light
- Here: DirectionalLight instead of AmbientLight

```
<Viewport3D.Camera>
                <OrthographicCamera Position="6,6,7" LookDirection="-1,-1,-1" Width="5"/>
            </Viewport3D.Camera>
            <Viewport3D.Children>
                <ModelVisual3D x:Name="Light">
                    <ModelVisual3D.Content>
                        <DirectionalLight></DirectionalLight>

                    </ModelVisual3D.Content>
```



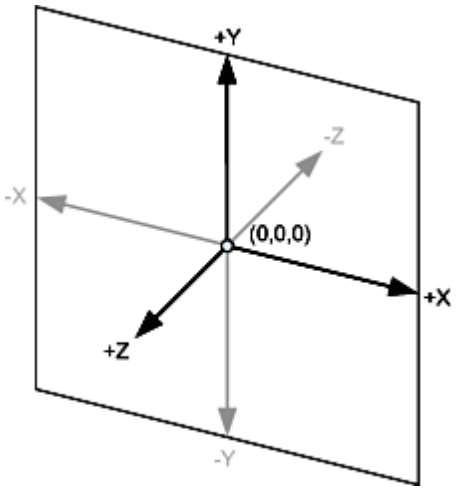
- Here: PointLight

```
<Viewport3D.Camera>
                <OrthographicCamera Position="6,6,7" LookDirection="-1,-1,-1" Width="5"/>
            </Viewport3D.Camera>
            <Viewport3D.Children>
                <ModelVisual3D x:Name="Light">
                    <ModelVisual3D.Content>
                        <PointLight></PointLight>


                    </ModelVisual3D.Content>
```

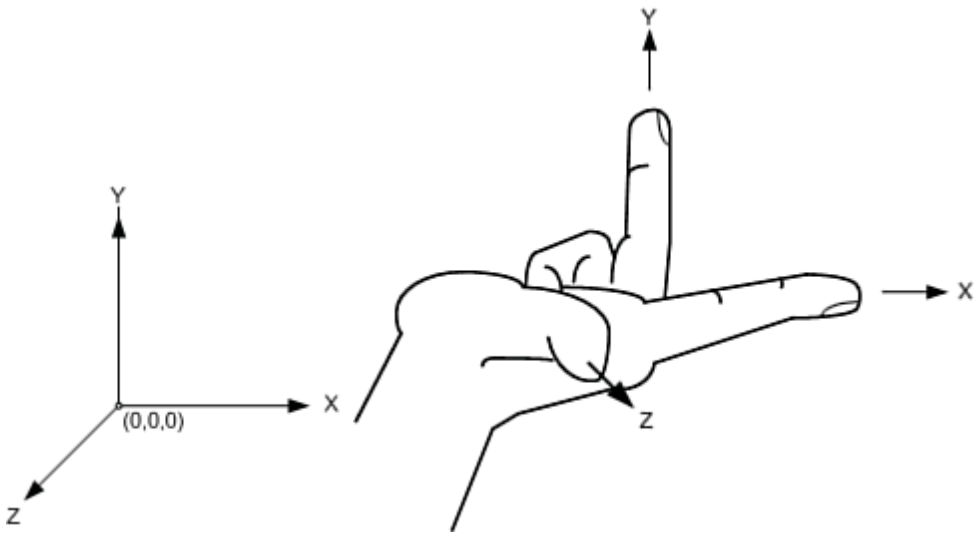


- SpotLight is also existing (not shown here)

The Coordinate system in 3D graphics



Right-hand coordinate system



Placement of the camera

- Measurements in ”units” (units can be changed)

```
<Viewport3D.Camera>
                <OrthographicCamera Position="6,6,7" LookDirection="-1,-1,-1" Width="5"/>
            </Viewport3D.Camera>
```

- A new position:

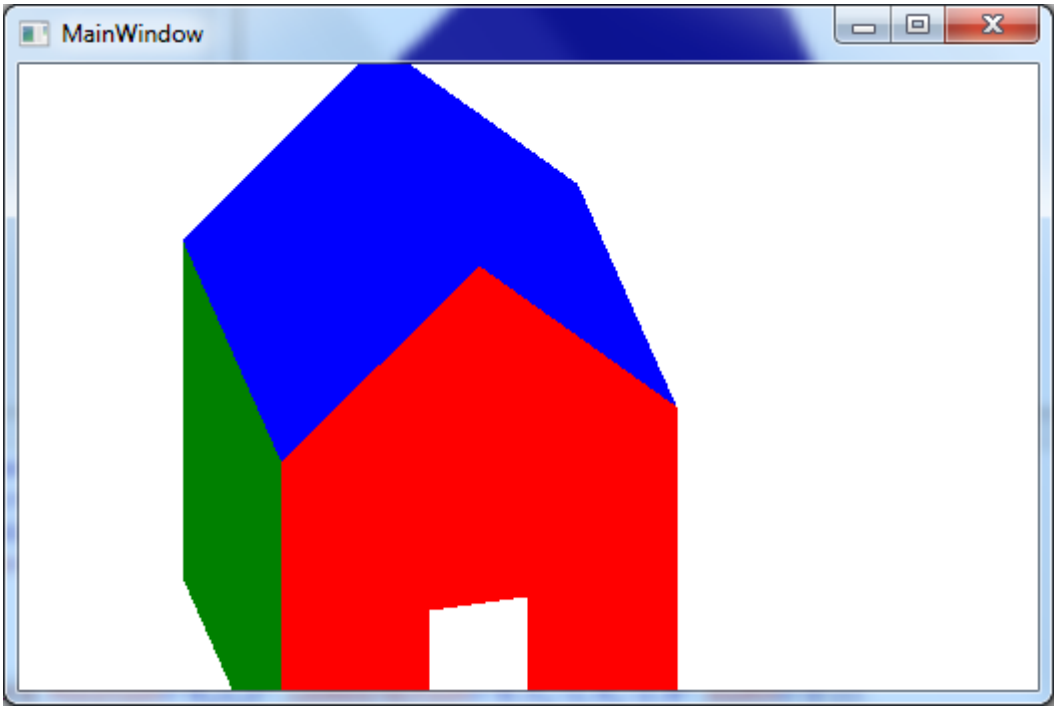
```
   <Viewport3D.Camera>
                <OrthographicCamera Position="0,2,2" LookDirection="-1,-1,-1" Width="5"/>
            </Viewport3D.Camera>
```

The look direction of the camera

```
    <Viewport3D.Camera>
                <OrthographicCamera Position="0,2,2" LookDirection="-1,-1,-1" Width="5"/>
            </Viewport3D.Camera>
```

- Now changed to:

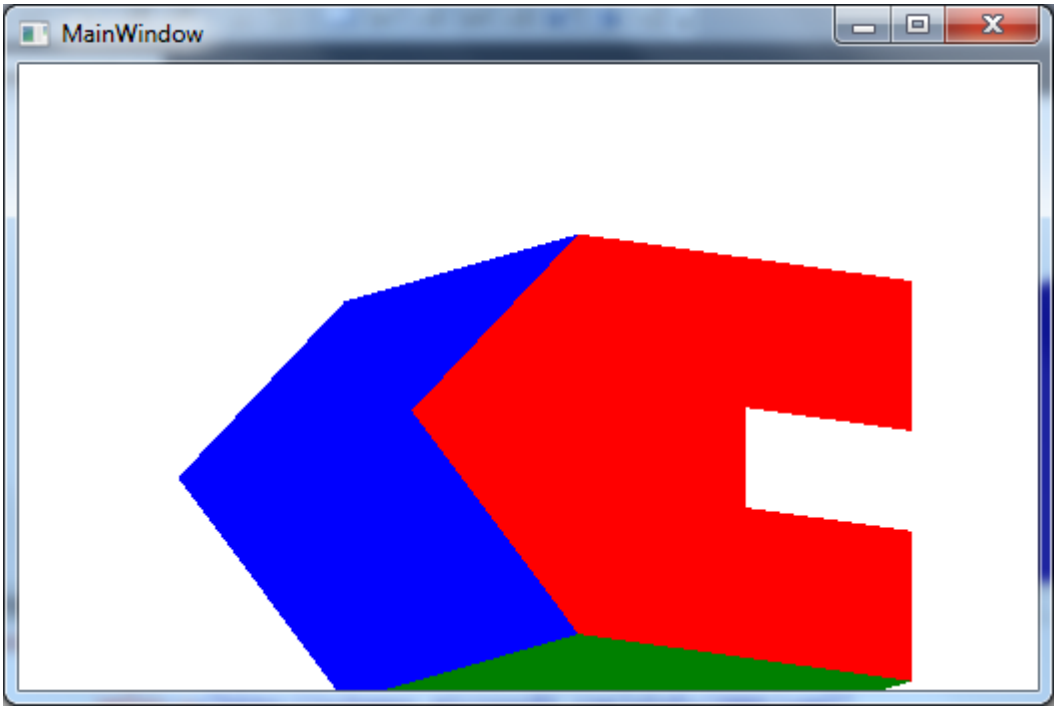
```
            <Viewport3D.Camera>
                <OrthographicCamera Position="0,2,2" LookDirection="0.5,-1.4,-2.0"
Width="5"/>
            </Viewport3D.Camera>
```



Set camera from landscape to portrait position

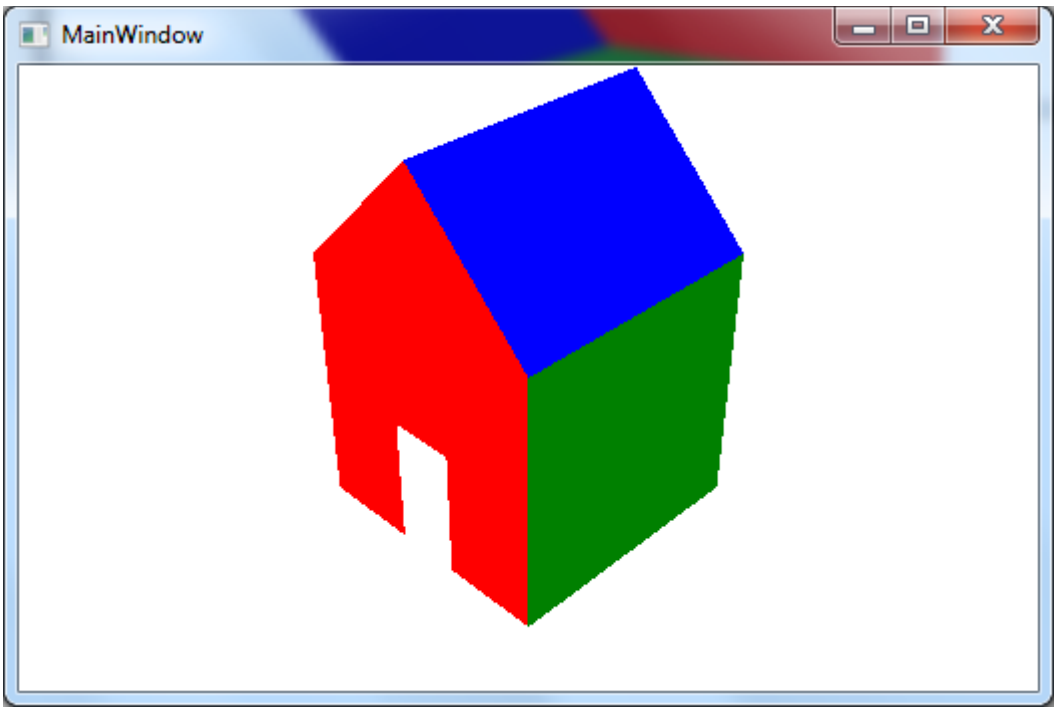
- Use UpDirection:

```
   <Viewport3D.Camera>
                <OrthographicCamera Position="0,2,2" LookDirection="0.5,-1.4,-2.0"
UpDirection="1,0,0" Width="5"/>
            </Viewport3D.Camera>
```



Perspektive camera

```
<Viewport3D.Camera>
                <PerspectiveCamera Position="5,5,5" LookDirection="-1,-1,-1"
FieldOfView="45"/>
            </Viewport3D.Camera>
```



Transform3D

- Repositioning of objects
- Buliding blocks:
  - House
    - Roof
    - Sides
    - Ends

```
        <Viewport3D>
            <Viewport3D.Camera>
                <OrthographicCamera Position="5,5,5" LookDirection="-1,-1,-1" Width="10"/>
            </Viewport3D.Camera>
            <Viewport3D.Children>
                <ModelVisual3D x:Name="Light">
                    <ModelVisual3D.Content>
                        <AmbientLight/>
                    </ModelVisual3D.Content>
                </ModelVisual3D>
                <ModelVisual3D>
                    <ModelVisual3D.Transform>
                        <x:Static Member="Transform3D.Identity"/>
                    </ModelVisual3D.Transform>
                    <ModelVisual3D.Content>
                        <Model3DGroup x:Name="House">
                            <GeometryModel3D x:Name="Roof">
                                <GeometryModel3D.Material>
                                    <DiffuseMaterial Brush="Blue"/>
                                </GeometryModel3D.Material>
                                <GeometryModel3D.Geometry>
                                    <MeshGeometry3D Positions="-1,1,1 0,2,1 0,2,-1 -1,1,-1
0,2,1 1,1,1
1,1,-1 0,2,-1"
TriangleIndices="0 1 2 0 2 3 4 5 6 4 6 7"/>
                                </GeometryModel3D.Geometry>
                            </GeometryModel3D>
                            <GeometryModel3D x:Name="Sides">
                                <GeometryModel3D.Material>
                                    <DiffuseMaterial Brush="Green"/>
                                </GeometryModel3D.Material>
                                <GeometryModel3D.Geometry>
                                    <MeshGeometry3D Positions="-1,1,1 -1,1,-1 -1,-1,-1 -1,-
1,1 1,1,-1
1,1,1 1,-1,1 1,-1,-1"
TriangleIndices="0 1 2 0 2 3 4 5 6 4 6 7"/>
                                </GeometryModel3D.Geometry>
                            </GeometryModel3D>
                            <GeometryModel3D x:Name="Ends">
                                <GeometryModel3D.Material>
```

```
                                    <DiffuseMaterial Brush="Red"/>
                                </GeometryModel3D.Material>
                                <GeometryModel3D.Geometry>
                                    <MeshGeometry3D
Positions="-0.25,0,1 -1,1,1 -1,-1,1 -0.25,-1,1 -0.25,0,1
-1,-1,1 0.25,0,1 1,-1,1 1,1,1 0.25,0,1 0.25,-1,1 1,-1,1
1,1,1 0,2,1 -1,1,1 -1,1,1 -0.25,0,1 0.25,0,1 1,1,1 1,1,-1
1,-1,-1 -1,-1,-1 -1,1,-1 1,1,-1 -1,1,-1 0,2,-1"
TriangleIndices="0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 15
17 18 19 20 21 19 21 22 23 24 25"/>
                                </GeometryModel3D.Geometry>
                            </GeometryModel3D>
                        </Model3DGroup>
                    </ModelVisual3D.Content>
                </ModelVisual3D>
            </Viewport3D.Children>
        </Viewport3D>
    </Grid>
</Window>
```

TranslateTransform3D

```
<ModelVisual3D.Transform>
                        <TranslateTransform3D OffsetZ="3"/>
                    </ModelVisual3D.Transform>
```

- Plus many other Transforms...