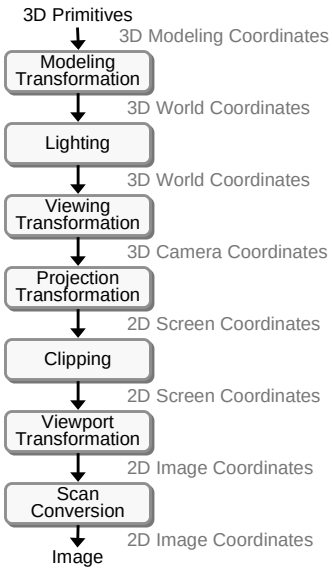
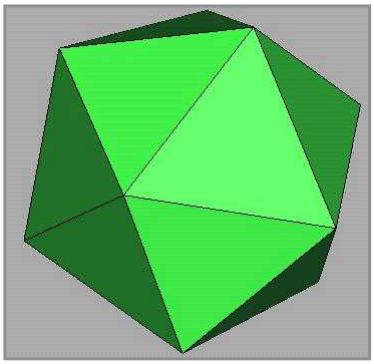
Clipping

Thomas Funkhouser
Princeton University
C0S 426, Fall 2000

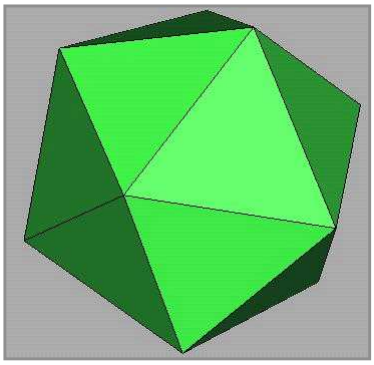
3D Rendering Pipeline (for direct illumination)





3D Rendering Pipeline (for direct illumination)

3D Primitives
↓
3D Modeling Coordinates
Modeling Transformation
↓
3D World Coordinates
Lighting
↓
3D World Coordinates
Viewing Transformation
↓
3D Camera Coordinates
Projection Transformation
↓
2D Screen Coordinates
Clipping
↓
2D Screen Coordinates
Viewport Transformation
↓
2D Image Coordinates
Scan Conversion
↓
2D Image Coordinates
Image



2D Rendering Pipeline

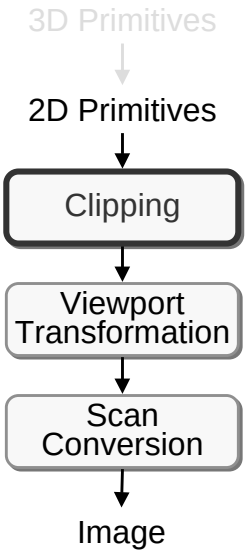
3D Primitives
↓
2D Primitives
↓
Clipping
↓
Viewport Transformation
↓
Scan Conversion
↓
Image

Clip portions of geometric primitives residing outside the window

Transform the clipped primitives from screen to image coordinates

Fill pixels representing primitives in screen coordinates

2D Rendering Pipeline



Clip portions of geometric primitives residing outside the window

Transform the clipped primitives from screen to image coordinates

Fill pixels representing primitives in screen coordinates

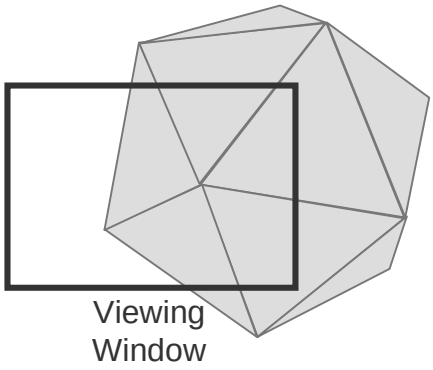
Clipping

- Avoid drawing parts of primitives outside window
  - Window defines part of scene being viewed
  - Must draw geometric primitives only inside window

Screen Coordinates

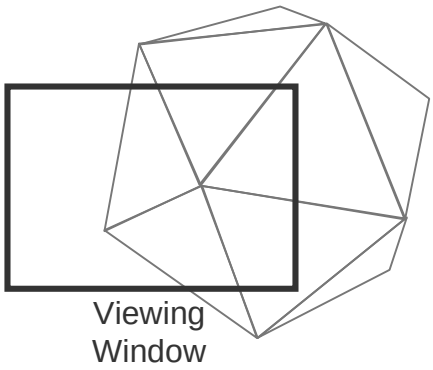
Clipping

- Avoid drawing parts of primitives outside window
  - Window defines part of scene being viewed
  - Must draw geometric primitives only inside window



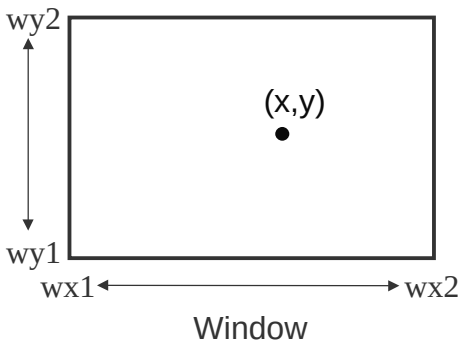
Clipping

- Avoid drawing parts of primitives outside window
  - Points
  - Lines
  - Polygons
  - Circles
  - etc.



Point Clipping

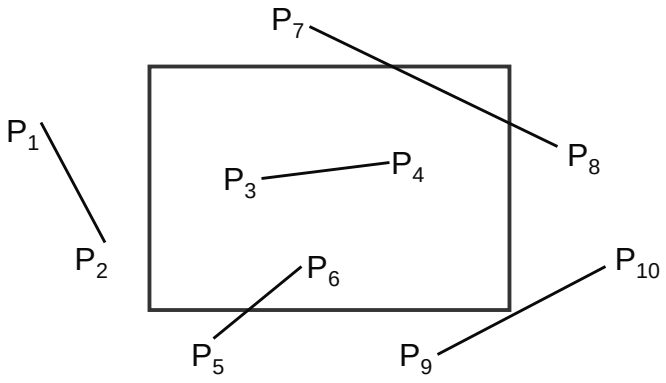
- Is point (x,y) inside the clip window?




```
inside =
  (x >= wx1) &&
  (x <= wx2) &&
  (y >= wy1) &&
  (y <= wy2);
```

Line Clipping

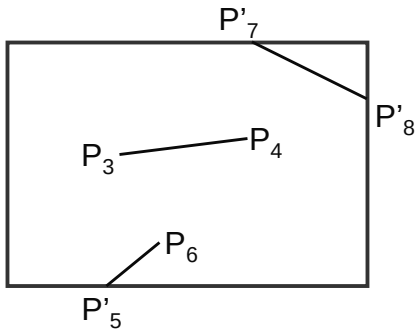
- Find the part of a line inside the clip window



Before Clipping

Line Clipping

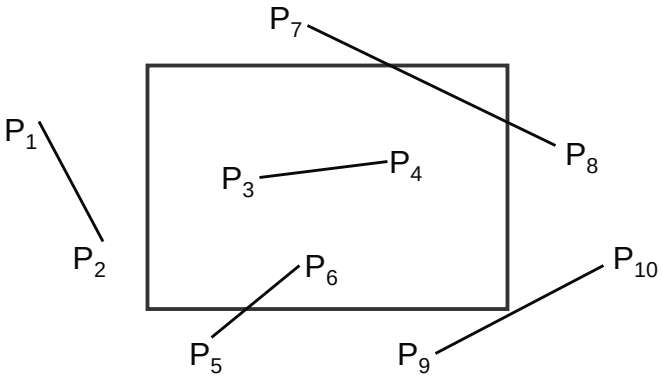
- Find the part of a line inside the clip window



After Clipping

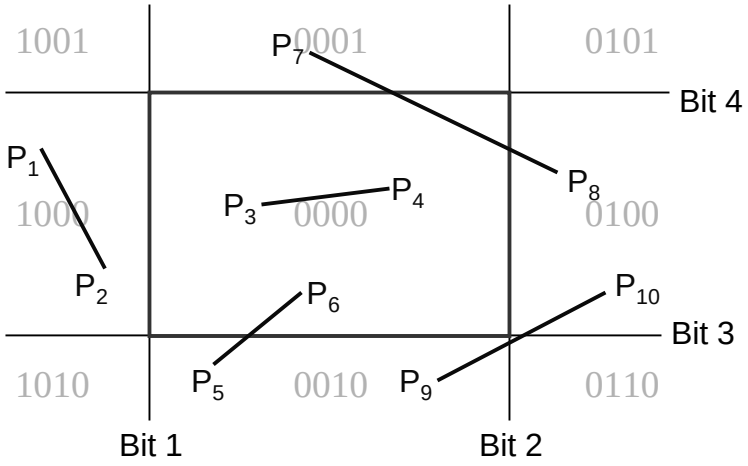
Cohen Sutherland Line Clipping

- Use simple tests to classify easy cases first



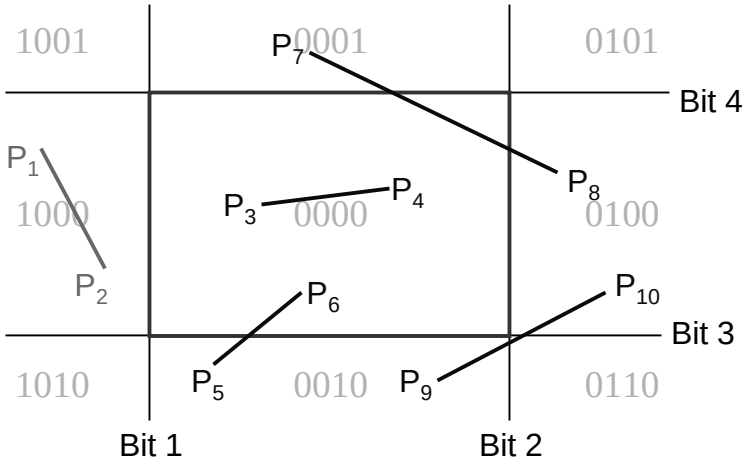
Cohen Sutherland Line Clipping

- Classify some lines quickly by AND of bit codes representing regions of two endpoints (must be 0)



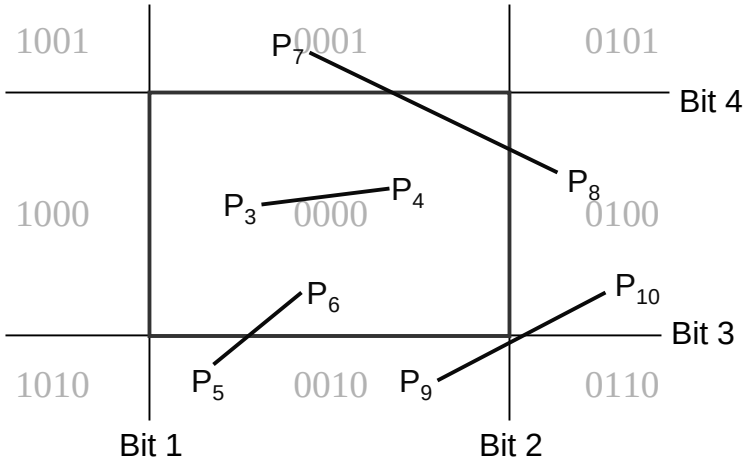
Cohen Sutherland Line Clipping

- Classify some lines quickly by AND of bit codes representing regions of two endpoints (must be 0)



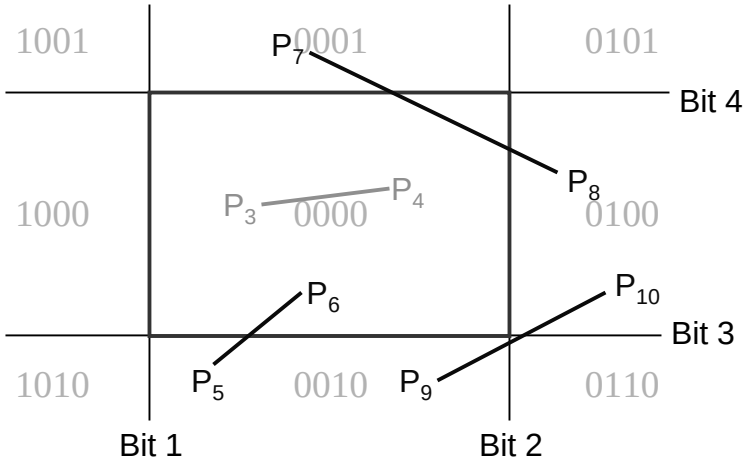
Cohen Sutherland Line Clipping

- Classify some lines quickly by AND of bit codes representing regions of two endpoints (must be 0)



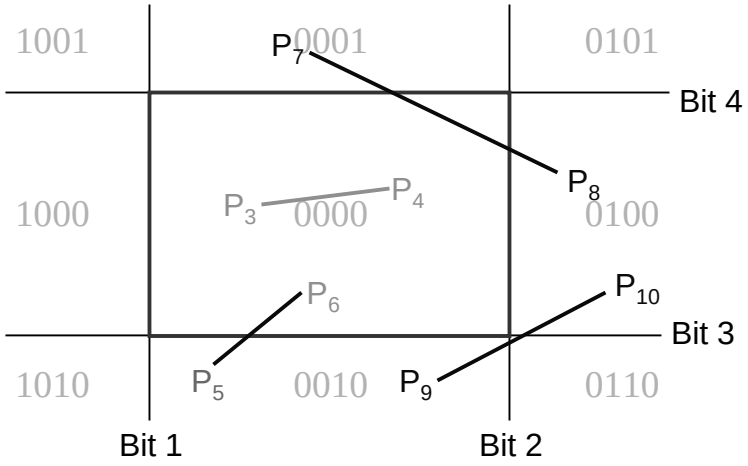
Cohen Sutherland Line Clipping

- Classify some lines quickly by AND of bit codes representing regions of two endpoints (must be 0)



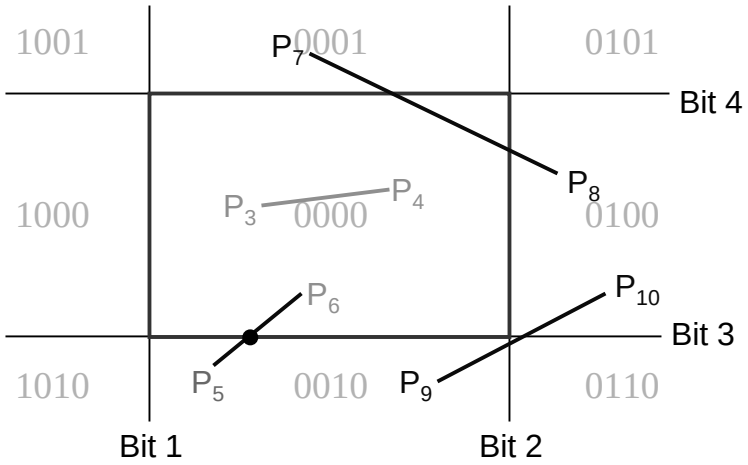
Cohen-Sutherland Line Clipping

- Compute interesections with window boundary for lines that can't be classified quickly



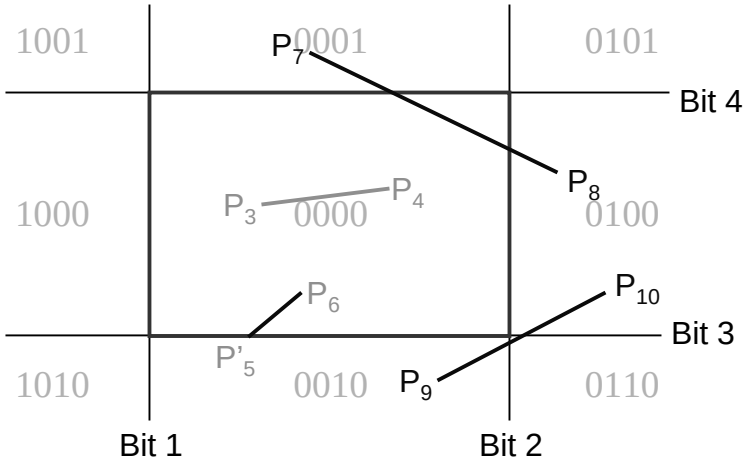
Cohen-Sutherland Line Clipping

- Compute interesections with window boundary for lines that can't be classified quickly



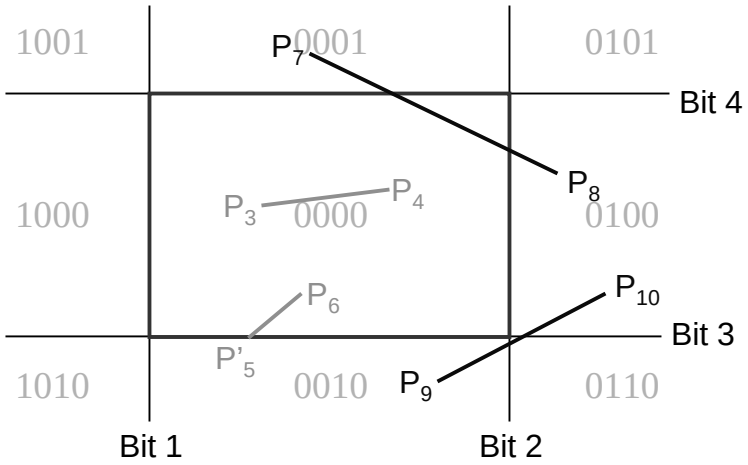
Cohen-Sutherland Line Clipping

- Compute interesections with window boundary for lines that can't be classified quickly



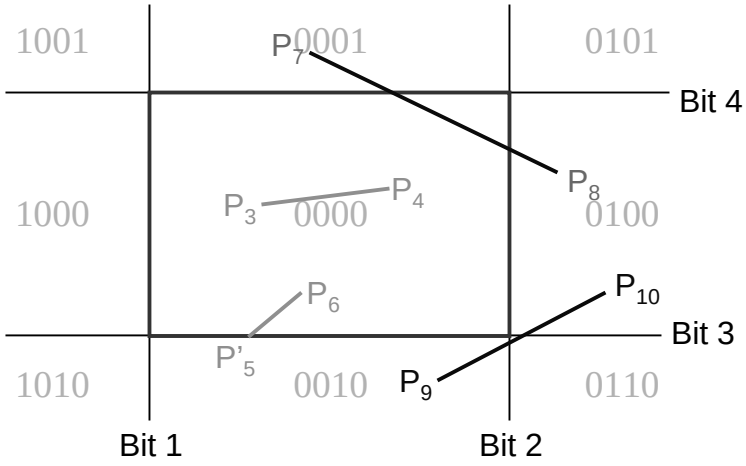
Cohen-Sutherland Line Clipping

- Compute interesections with window boundary for lines that can't be classified quickly



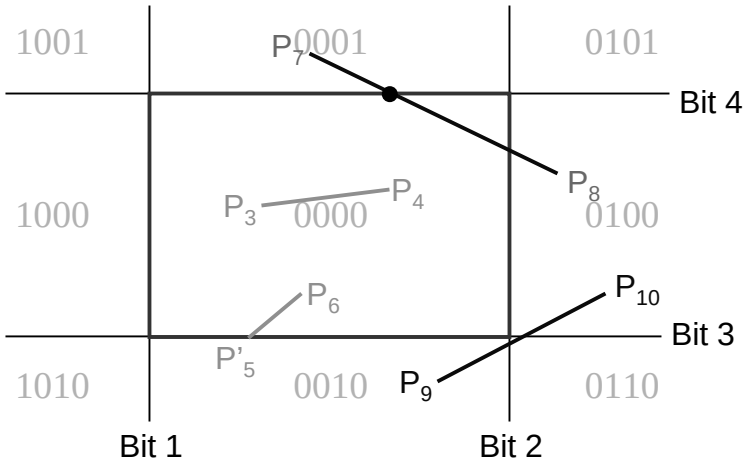
Cohen-Sutherland Line Clipping

- Compute interesections with window boundary for lines that can't be classified quickly



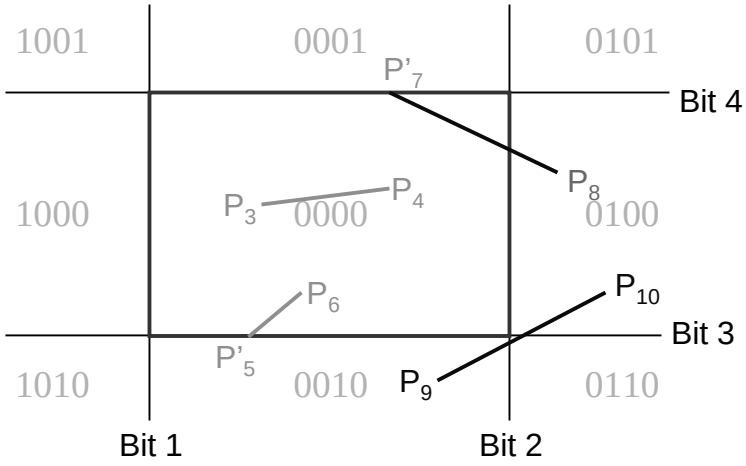
Cohen-Sutherland Line Clipping

- Compute interesections with window boundary for lines that can't be classified quickly



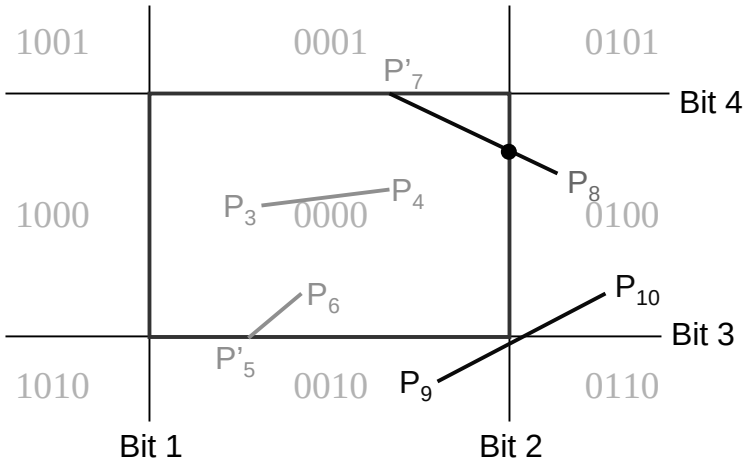
Cohen-Sutherland Line Clipping

- Compute interesections with window boundary for lines that can't be classified quickly



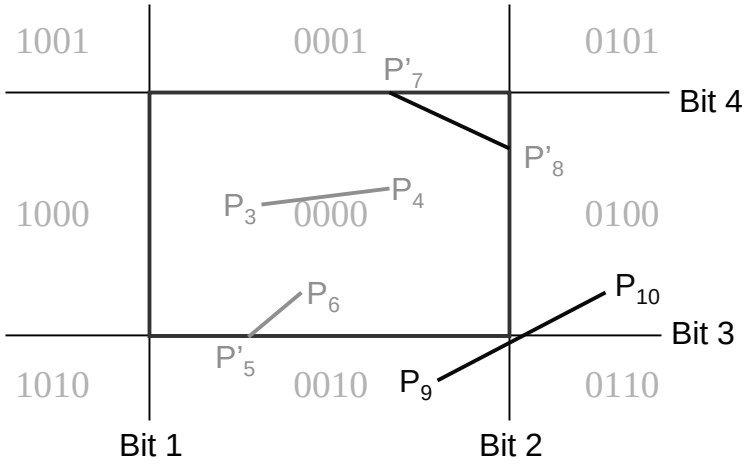
Cohen-Sutherland Line Clipping

- Compute interesections with window boundary for lines that can't be classified quickly



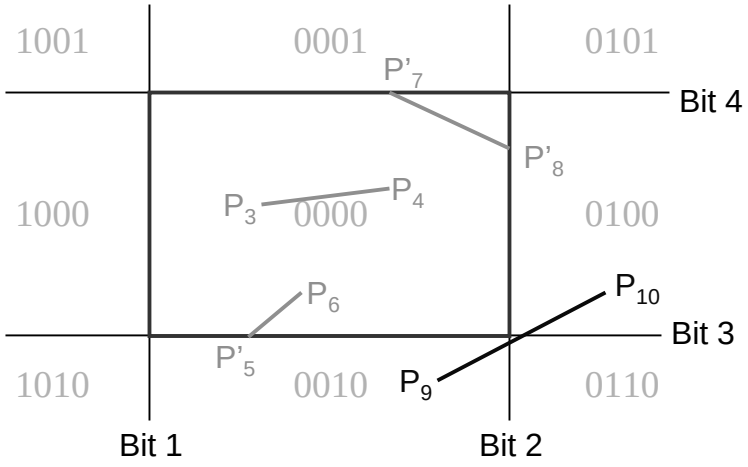
Cohen-Sutherland Line Clipping

- Compute interesections with window boundary for lines that can't be classified quickly



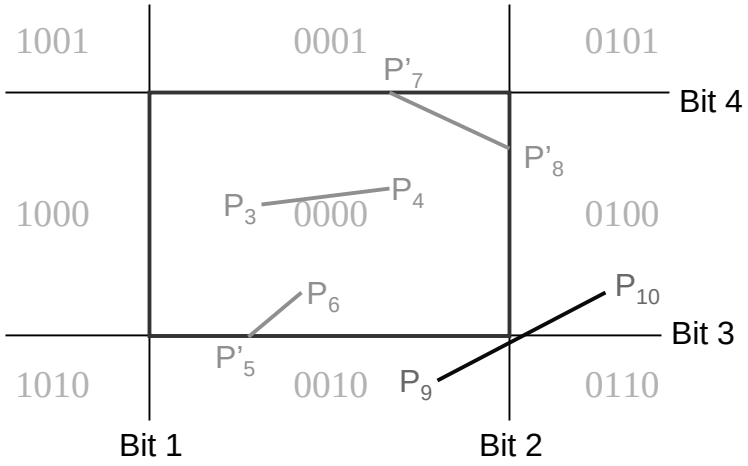
Cohen-Sutherland Line Clipping

- Compute interesections with window boundary for lines that can't be classified quickly



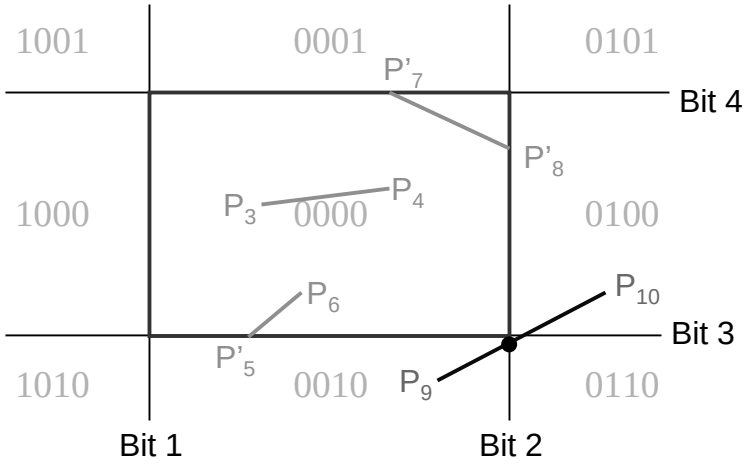
Cohen-Sutherland Line Clipping

- Compute interesections with window boundary for lines that can't be classified quickly



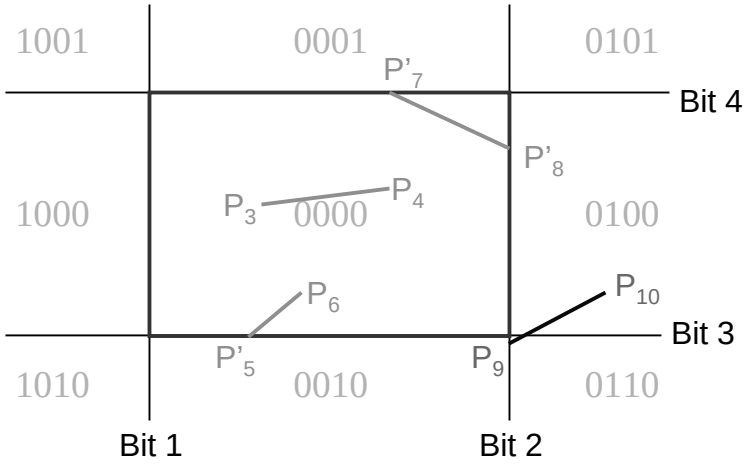
Cohen-Sutherland Line Clipping

- Compute interesections with window boundary for lines that can't be classified quickly



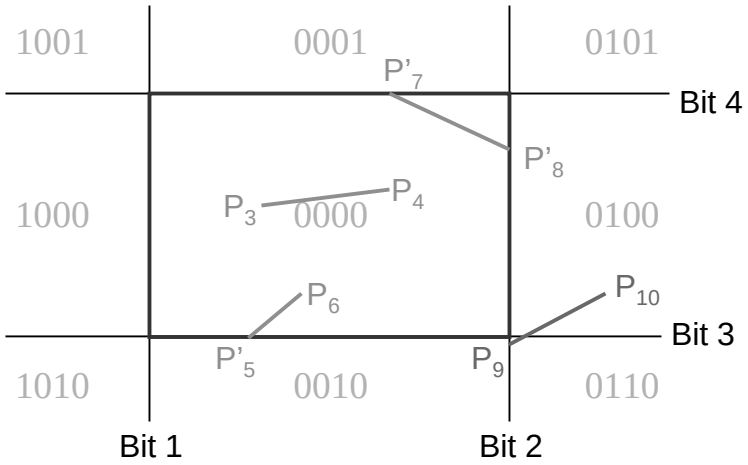
Cohen-Sutherland Line Clipping

- Compute interesections with window boundary for lines that can't be classified quickly



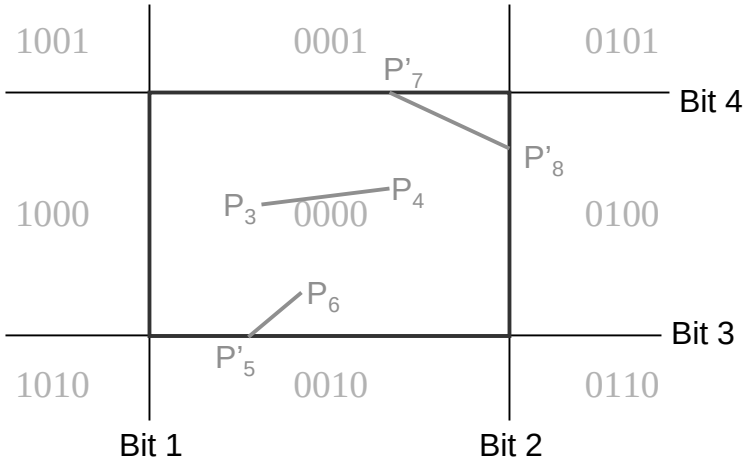
Cohen-Sutherland Line Clipping

- Compute interesections with window boundary for lines that can't be classified quickly



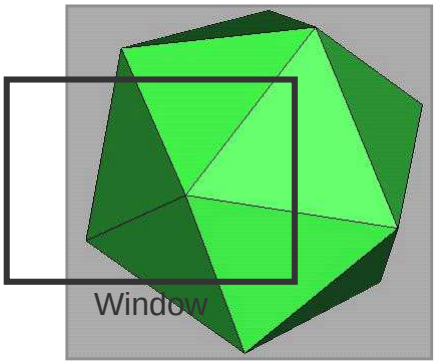
Cohen-Sutherland Line Clipping

- Compute interesections with window boundary for lines that can't be classified quickly



Clipping

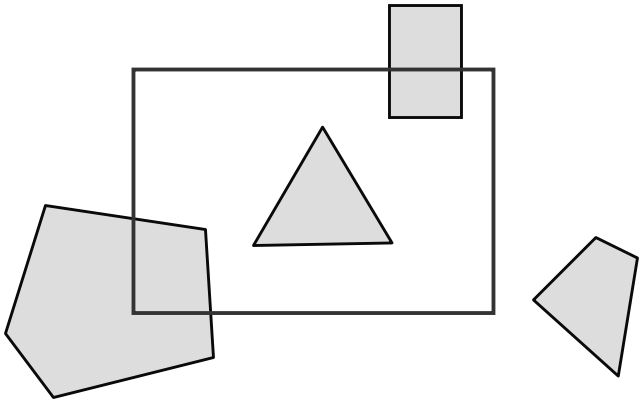
- Avoid drawing parts of primitives outside window
  - Points
  - Lines
  - Polygons
  - Circles
  - etc.



2D Screen Coordinates

Polygon Clipping

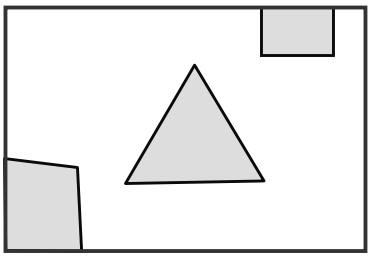
- Find the part of a polygon inside the clip window?



Before Clipping

Polygon Clipping

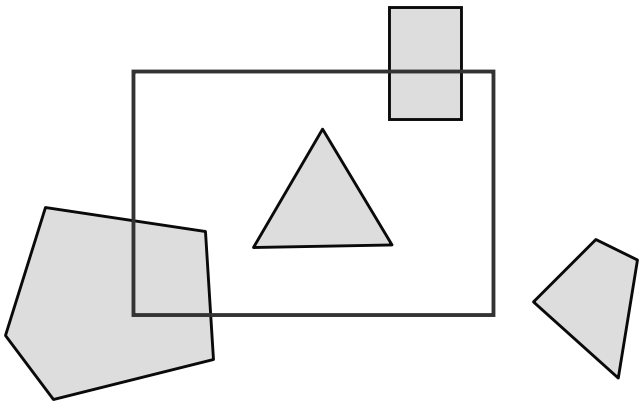
- Find the part of a polygon inside the clip window?



After Clipping

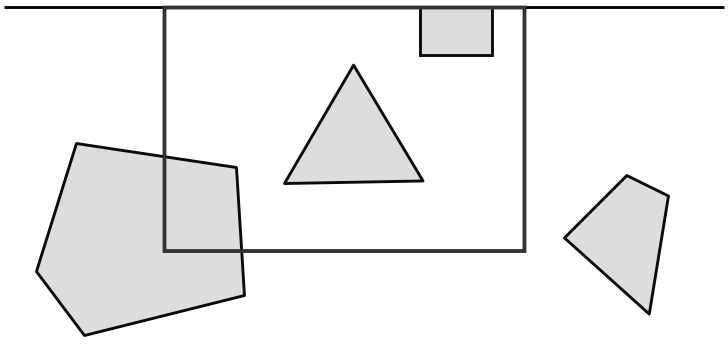
Sutherland Hodgeman Clipping

- Clip to each window boundary one at a time



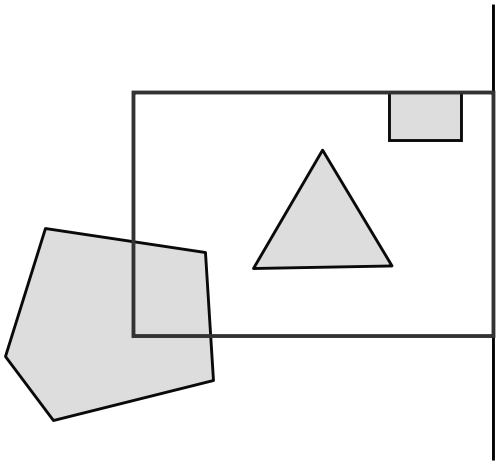
Sutherland Hodgeman Clipping

- Clip to each window boundary one at a time



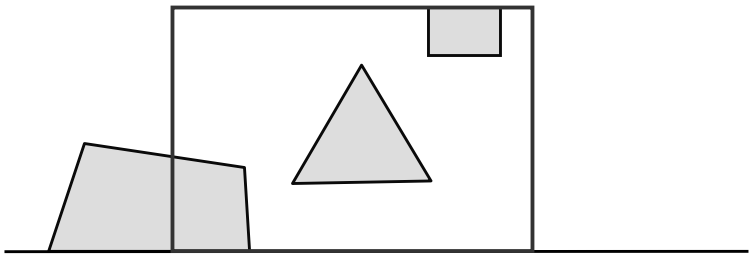
Sutherland Hodgeman Clipping

- Clip to each window boundary one at a time



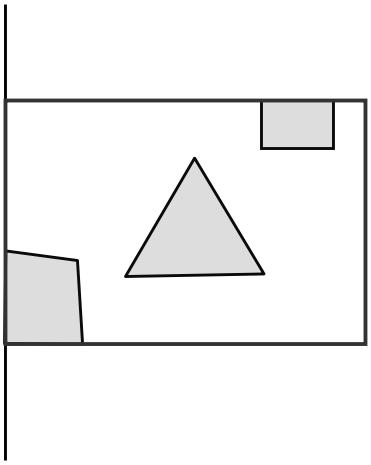
Sutherland Hodgeman Clipping

- Clip to each window boundary one at a time



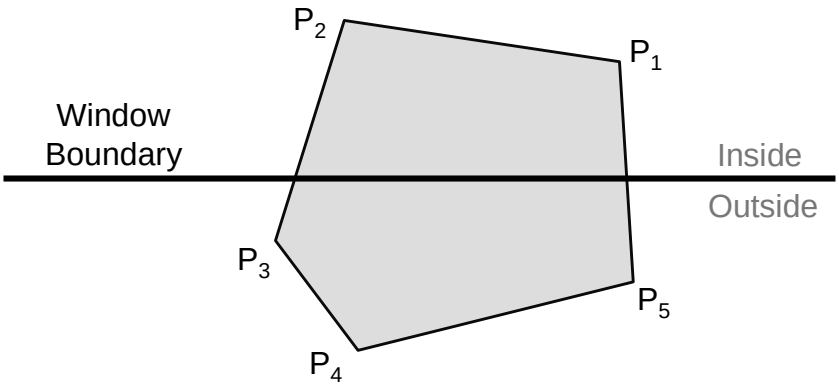
Sutherland Hodgeman Clipping

- Clip to each window boundary one at a time



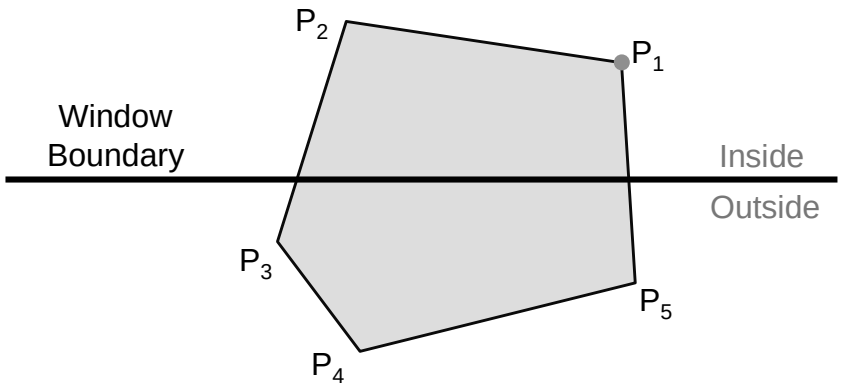
Clipping to a Boundary

- Do inside test for each point in sequence,
  Insert new points when cross window boundary,
  Remove points outside window boundary



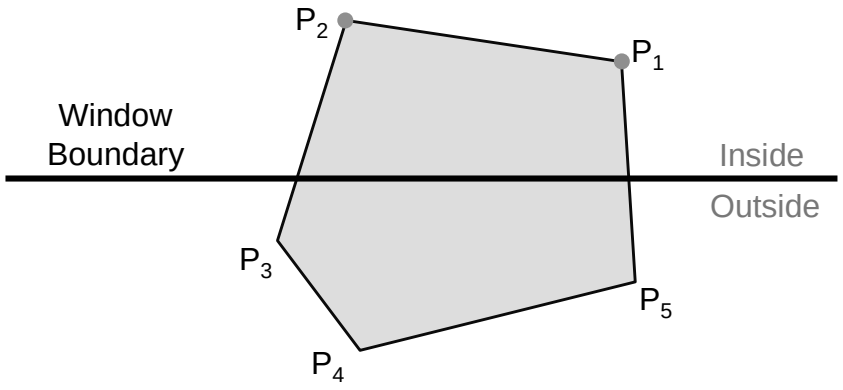
Clipping to a Boundary

- Do inside test for each point in sequence,
  Insert new points when cross window boundary,
  Remove points outside window boundary



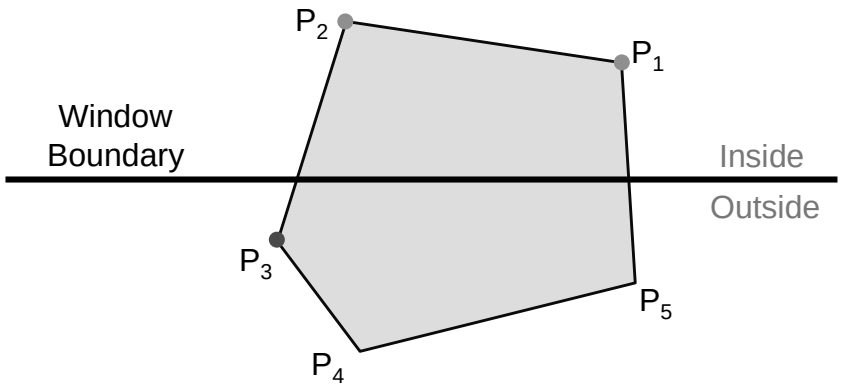
Clipping to a Boundary

- Do inside test for each point in sequence,
  Insert new points when cross window boundary,
  Remove points outside window boundary



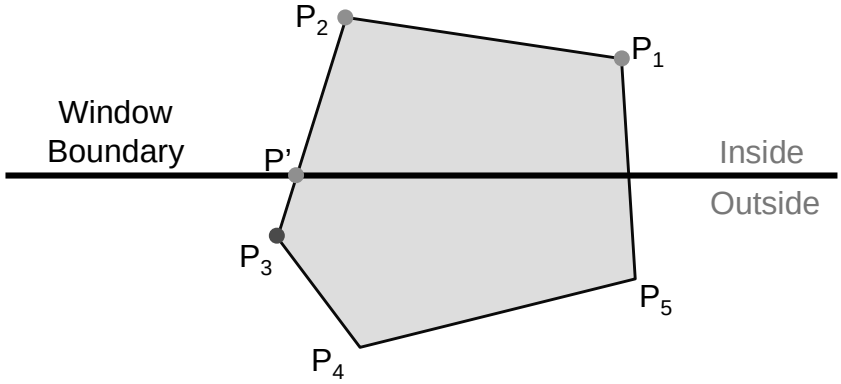
Clipping to a Boundary

- Do inside test for each point in sequence,
  Insert new points when cross window boundary,
  Remove points outside window boundary



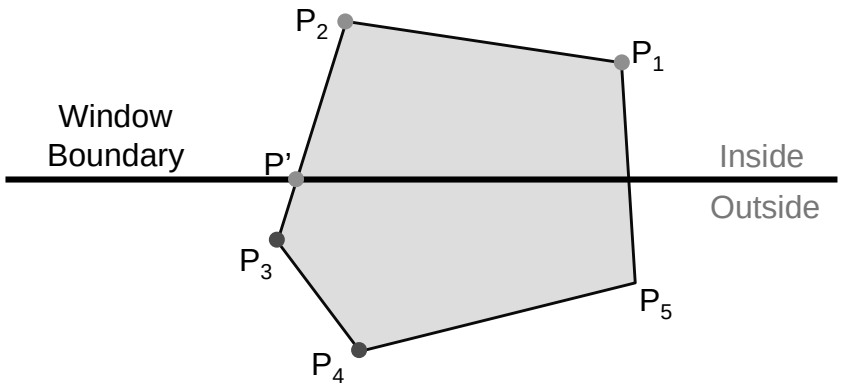
Clipping to a Boundary

- Do inside test for each point in sequence,
  Insert new points when cross window boundary,
  Remove points outside window boundary



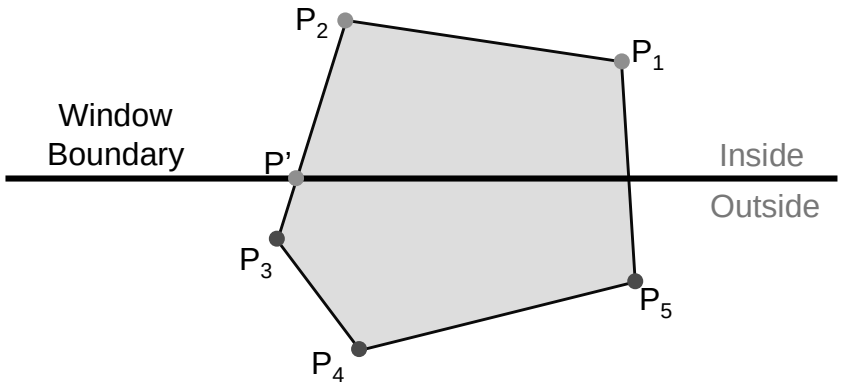
Clipping to a Boundary

- Do inside test for each point in sequence,
  Insert new points when cross window boundary,
  Remove points outside window boundary



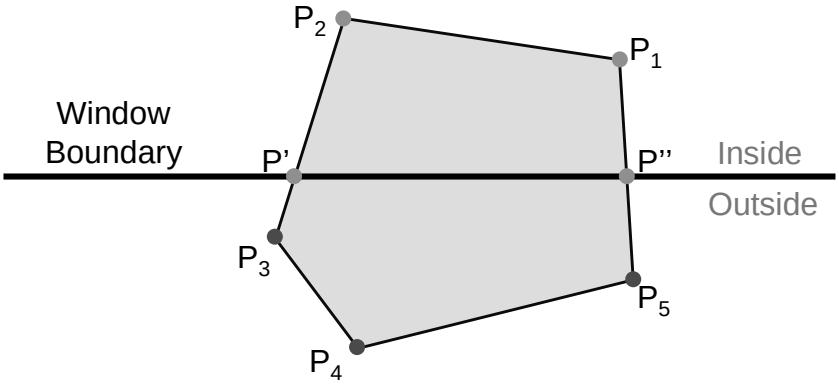
Clipping to a Boundary

- Do inside test for each point in sequence,
  Insert new points when cross window boundary,
  Remove points outside window boundary



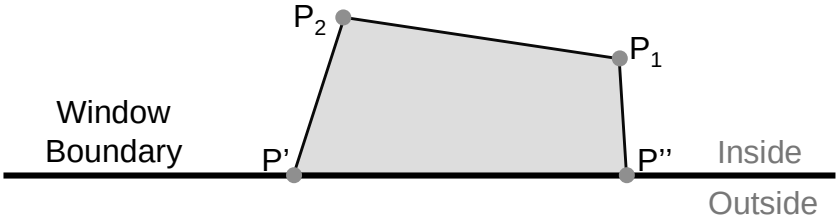
Clipping to a Boundary

- Do inside test for each point in sequence,
  Insert new points when cross window boundary,
  Remove points outside window boundary

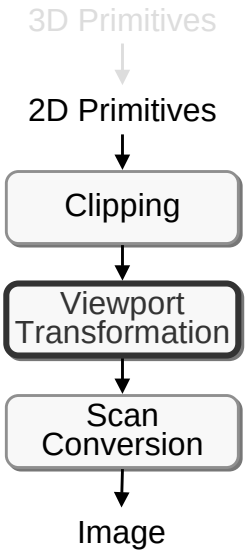


Clipping to a Boundary

- Do inside test for each point in sequence,
  Insert new points when cross window boundary,
  Remove points outside window boundary



2D Rendering Pipeline



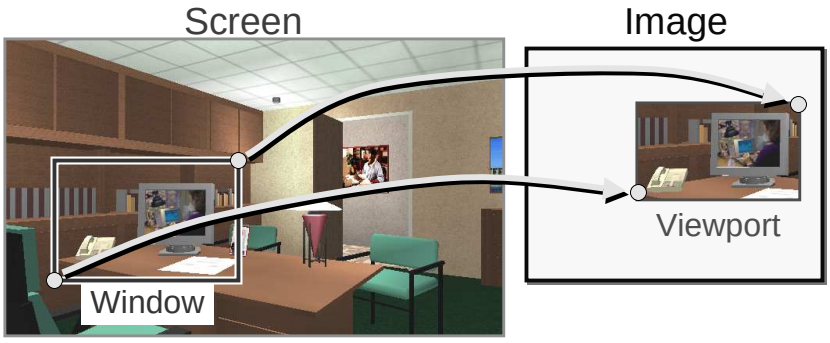
Clip portions of geometric primitives residing outside the window

Transform the clipped primitives from screen to image coordinates

Fill pixels representing primitives in screen coordinates

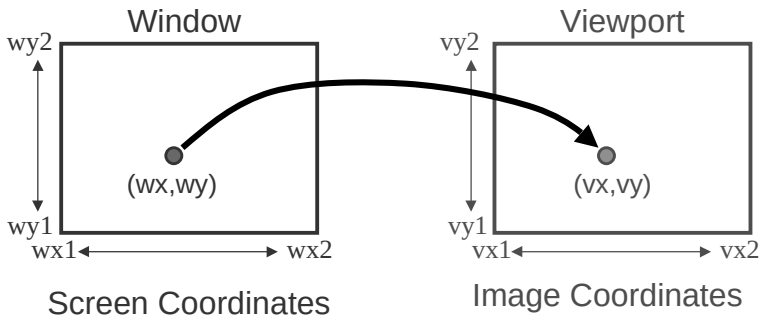
Viewport Transformation

- Transform 2D geometric primitives from screen coordinate system (normalized device coordinates) to image coordinate system (pixels)



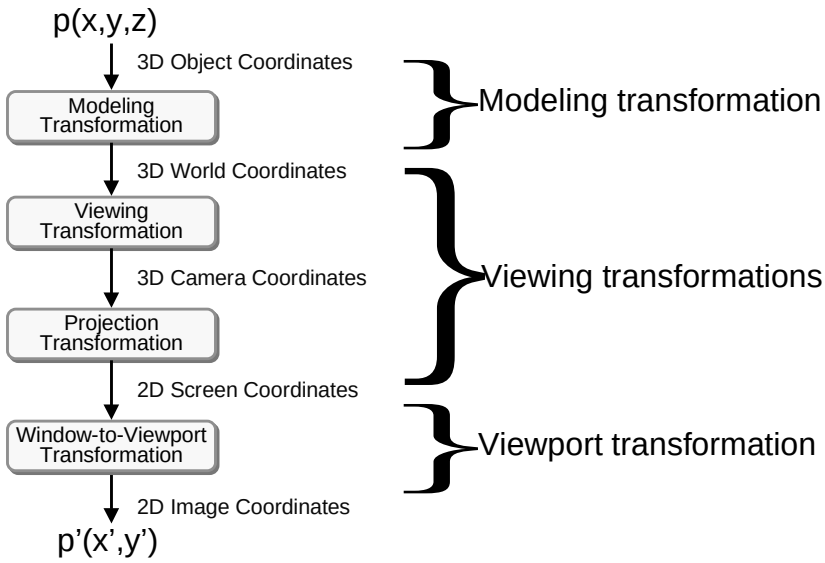
Viewport Transformation

- Window-to-viewport mapping




```
vx = vx1 + (wx - wx1) * (vx2 - vx1) / (wx2 - wx1);
vy = vy1 + (wy - wy1) * (vy2 - vy1) / (wy2 - wy1);
```

Summary of Transformations



Summary

3D Primitives

↓

2D Primitives

↓

Clipping

↓

Viewport Transformation

↓

Scan Conversion

↓

Image

Clip portions of geometric primitives residing outside the window

Transform the clipped primitives from screen to image coordinates

Fill pixels representing primitives in screen coordinates

Summary

3D Primitives

↓ 3D Modeling Coordinates

Modeling Transformation

↓ 3D World Coordinates

Lighting

↓ 3D World Coordinates

Viewing Transformation

↓ 3D Camera Coordinates

Projection Transformation

↓ 2D Screen Coordinates

Clipping

↓ 2D Screen Coordinates

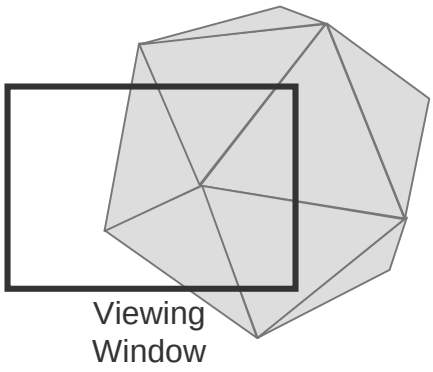
Viewport Transformation

↓ 2D Image Coordinates

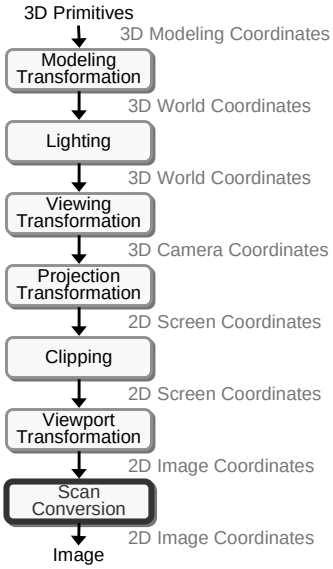
Scan Conversion

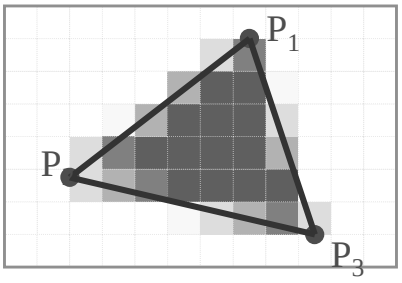
↓ 2D Image Coordinates

Image



Next Time





Scan Conversion!