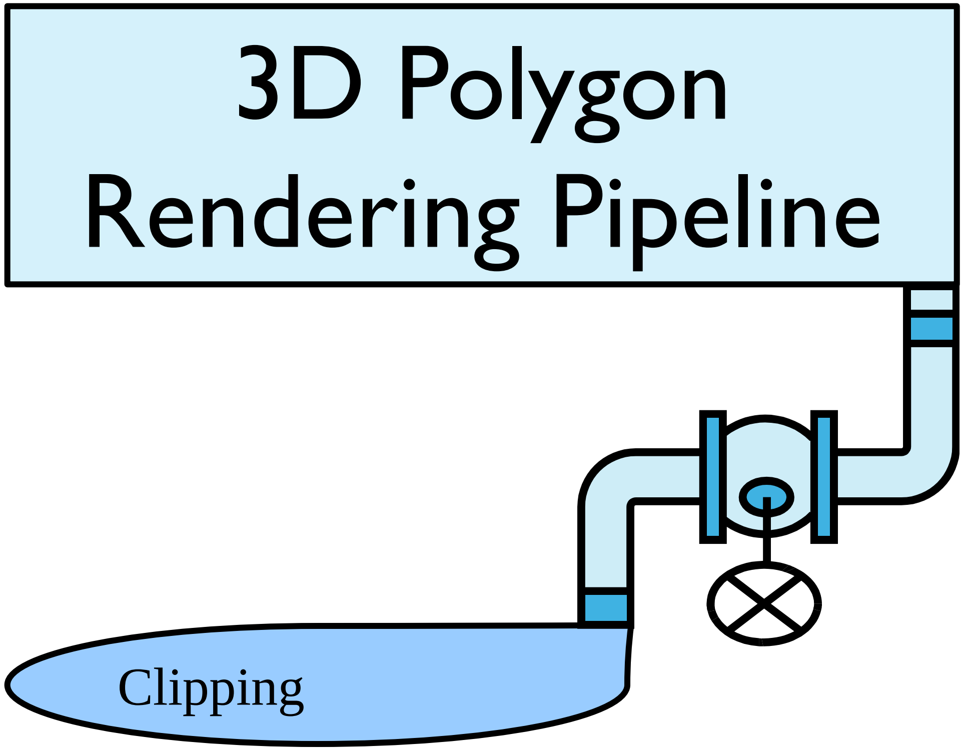
2009/2010 סמסטר א'

ליאור שפירא

קורס גרפיקה ממוחשבת

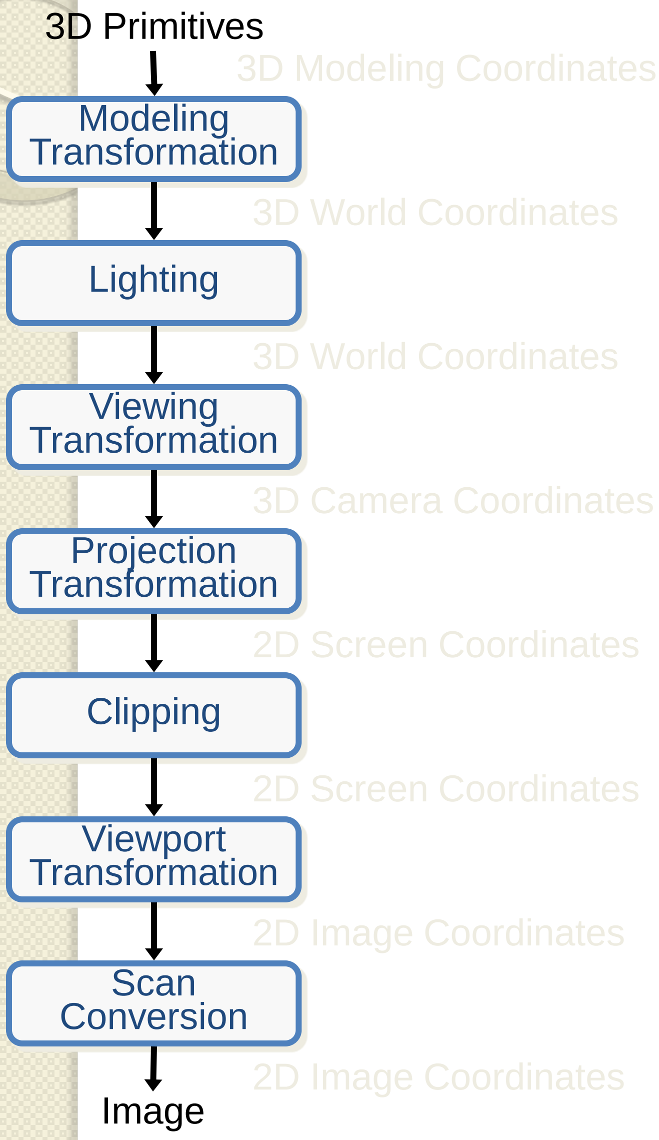
שיעור 6



3D Polygon Rendering Pipeline

Clipping

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

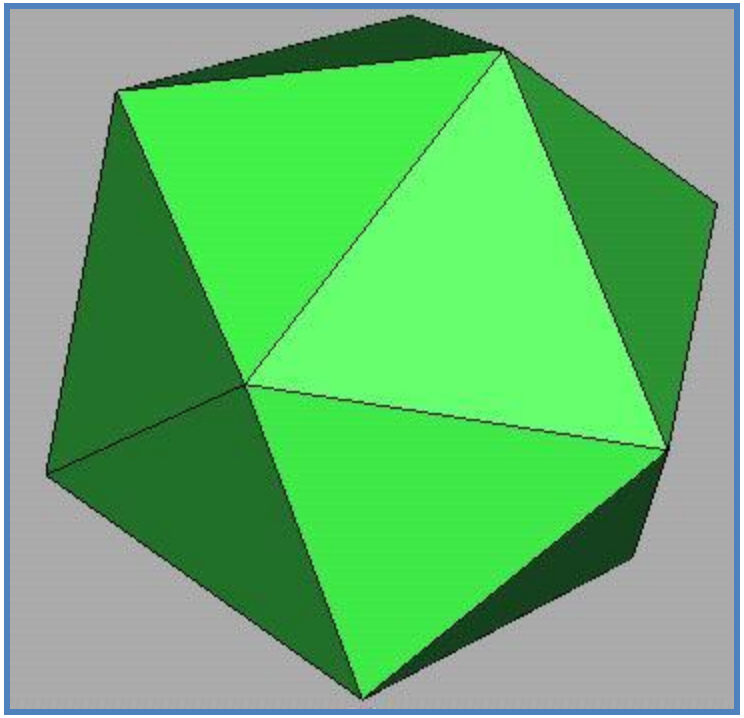
Viewport Transformation

2D Image Coordinates

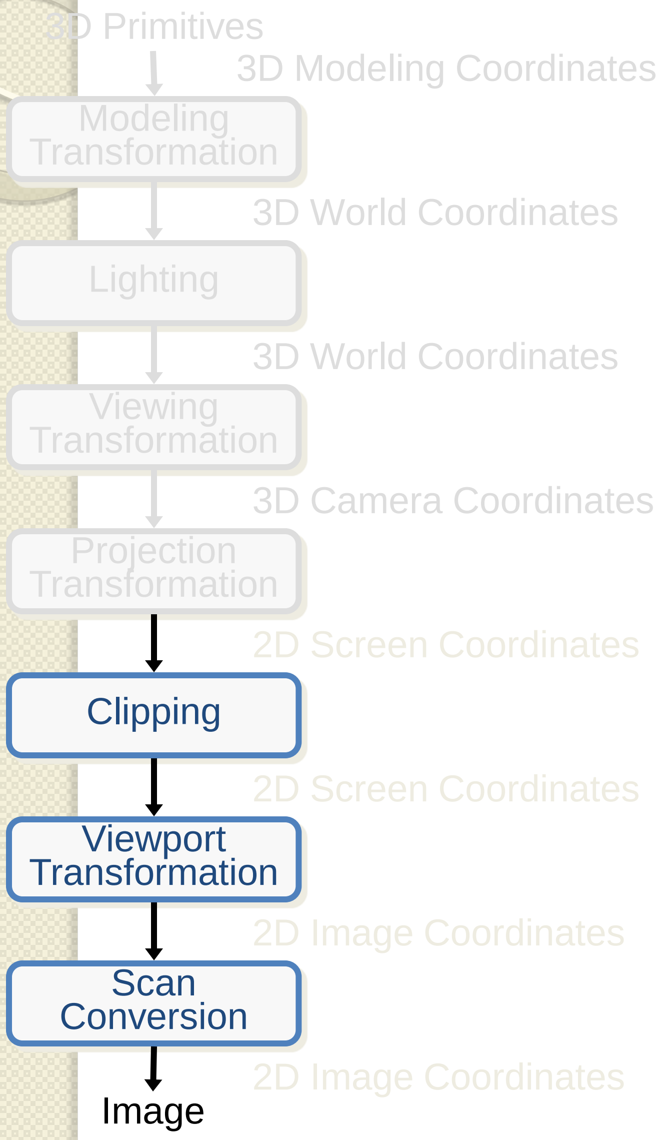
Scan Conversion

2D Image Coordinates

Image



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

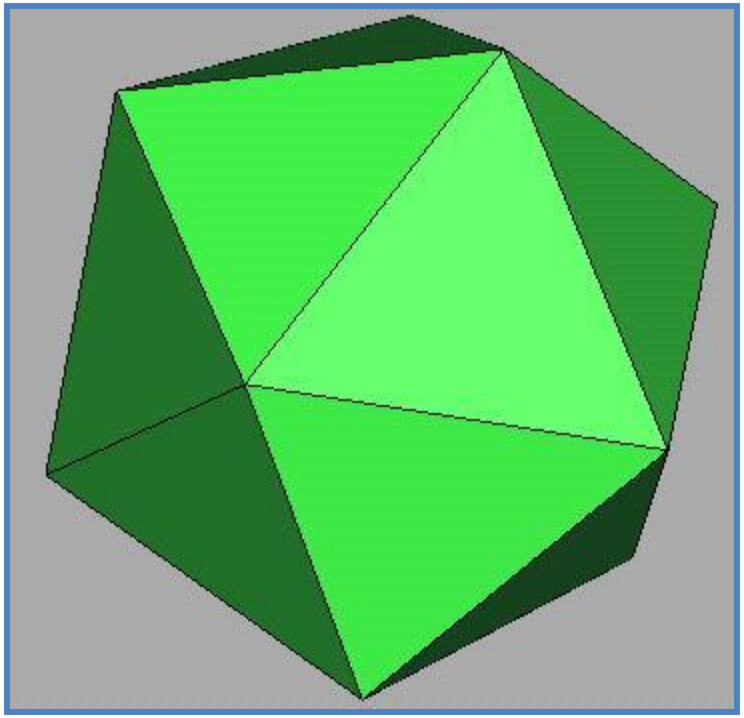
Viewport Transformation

2D Image Coordinates

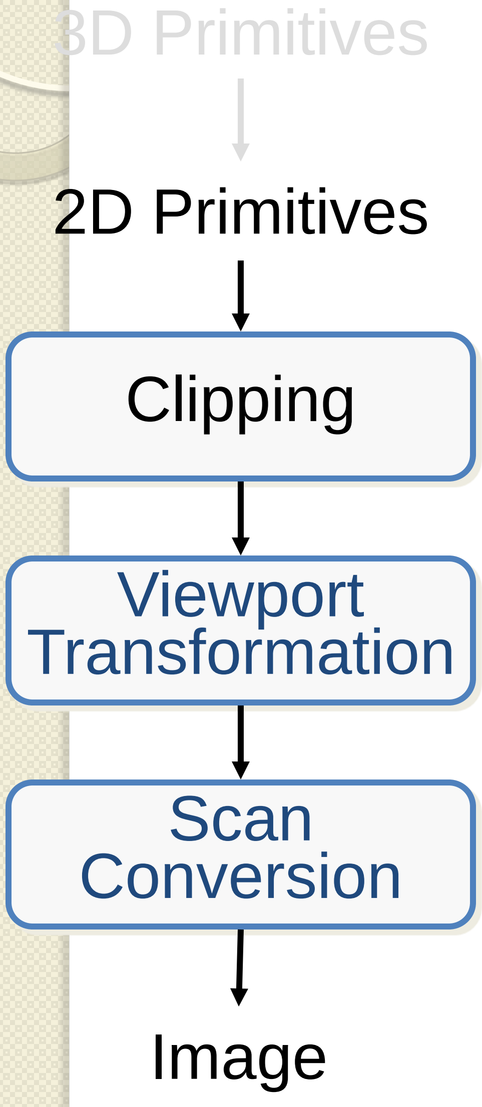
Scan Conversion

2D Image Coordinates

Image



2D Rendering Pipeline



3D Primitives

2D Primitives

Clipping

Viewport Transformation

Scan Conversion

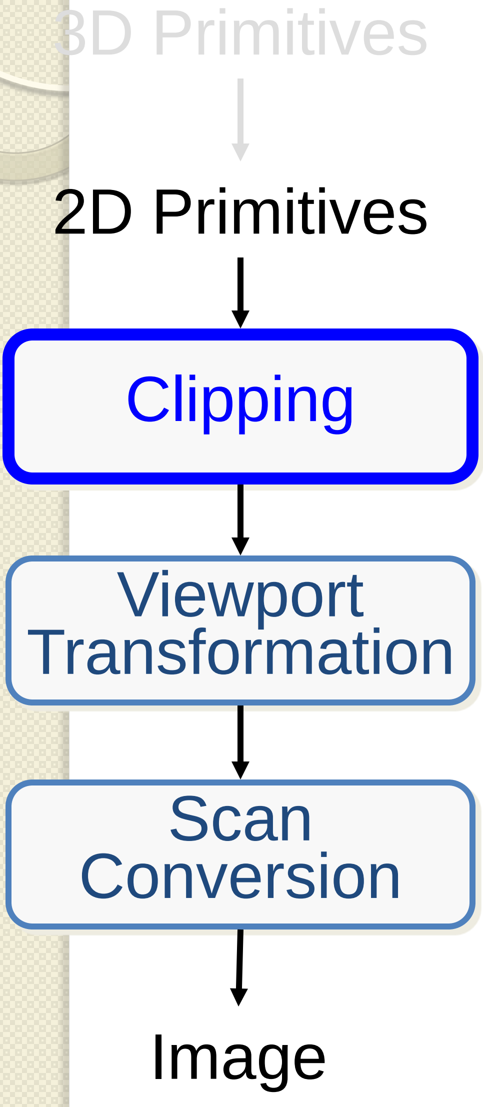
Image

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



3D Primitives

2D Primitives

Clipping

Viewport Transformation

Scan Conversion

Image

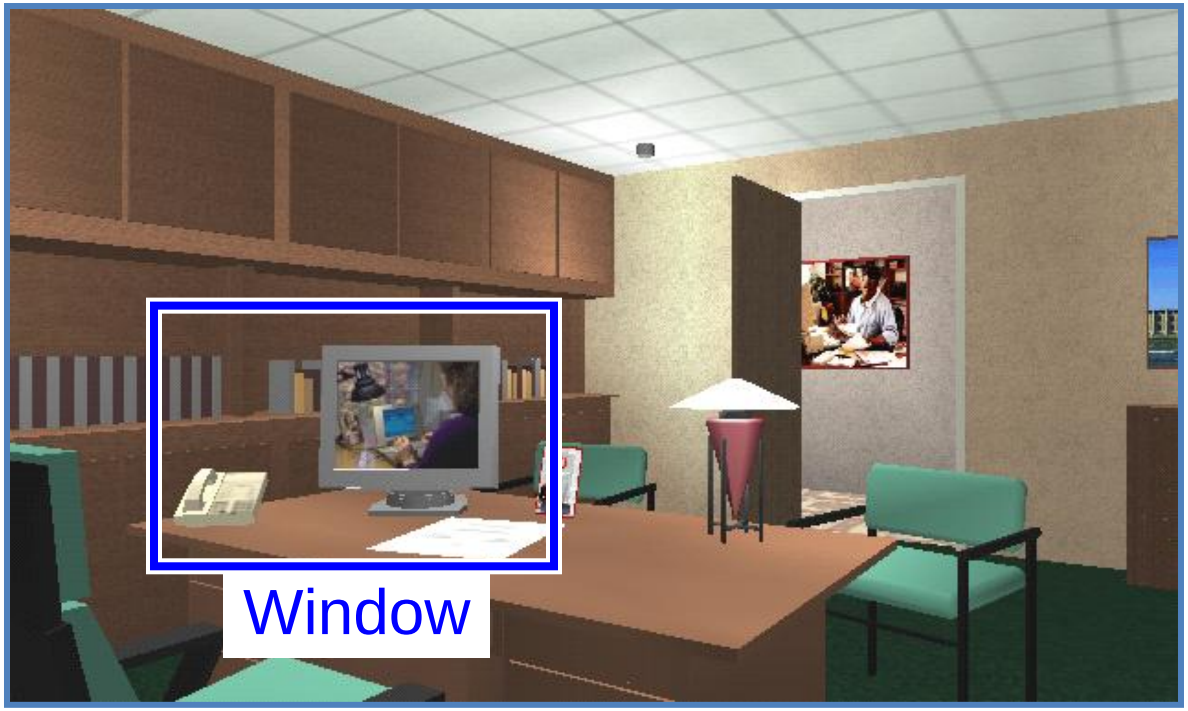
Clip portions of geometric primitives residing outside the window

Transform the clipped primitives from screen to image coordinates

Fill pixels representing primitives in screen coordinates

Clipping

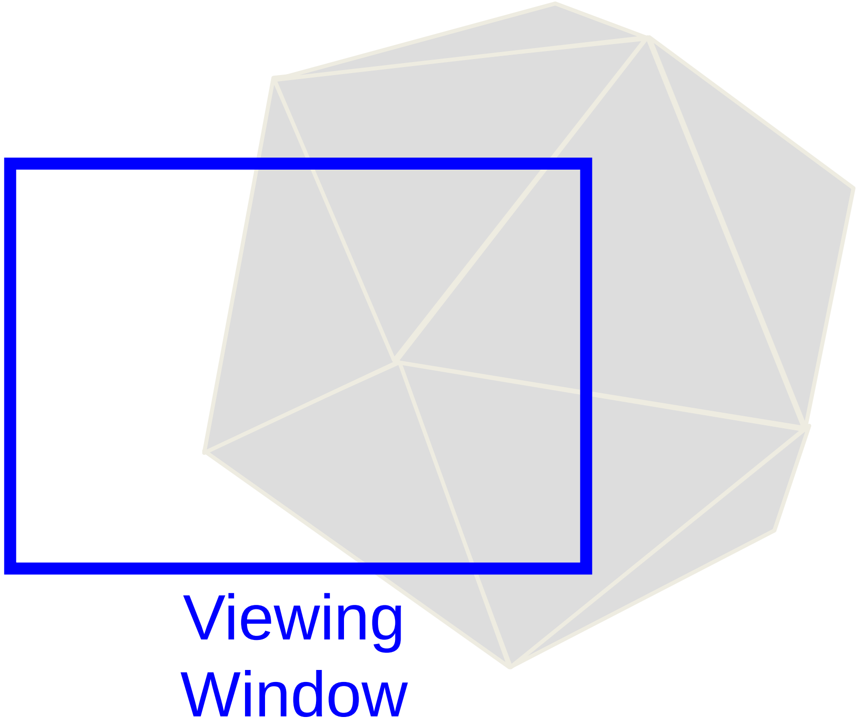
- Avoid drawing parts of primitives outside window
  - Window defines part of scene being viewed
  - Must draw geometric primitives only inside window



Screen Coordinates

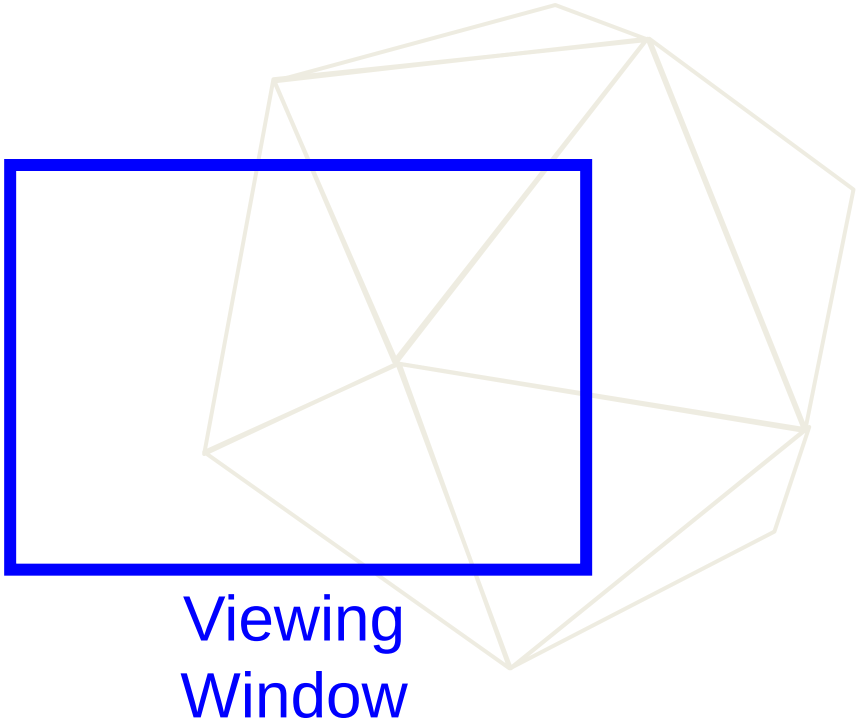
Clipping

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



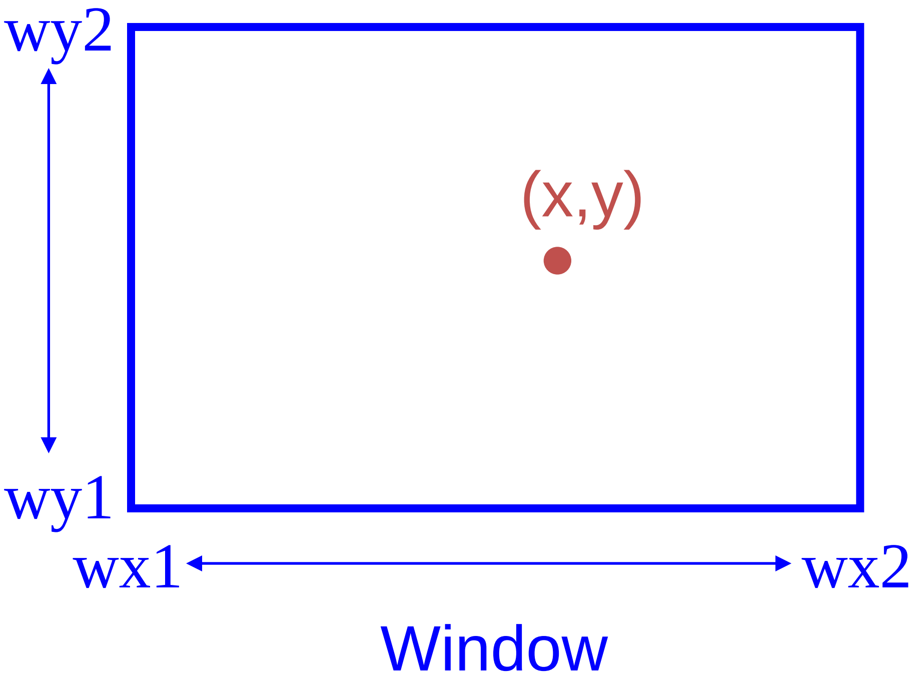
Clipping

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



Point Clipping

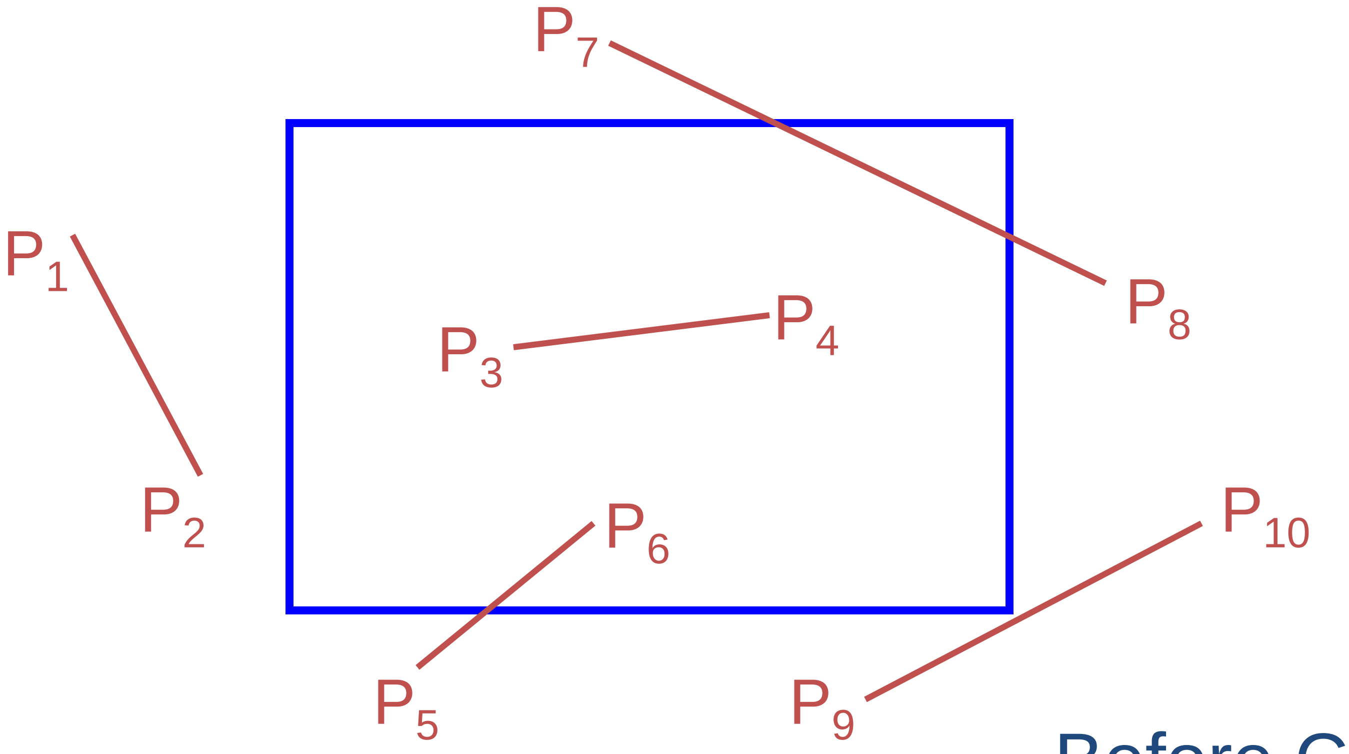
- Is point (x,y) inside the clip window?



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

Line Clipping

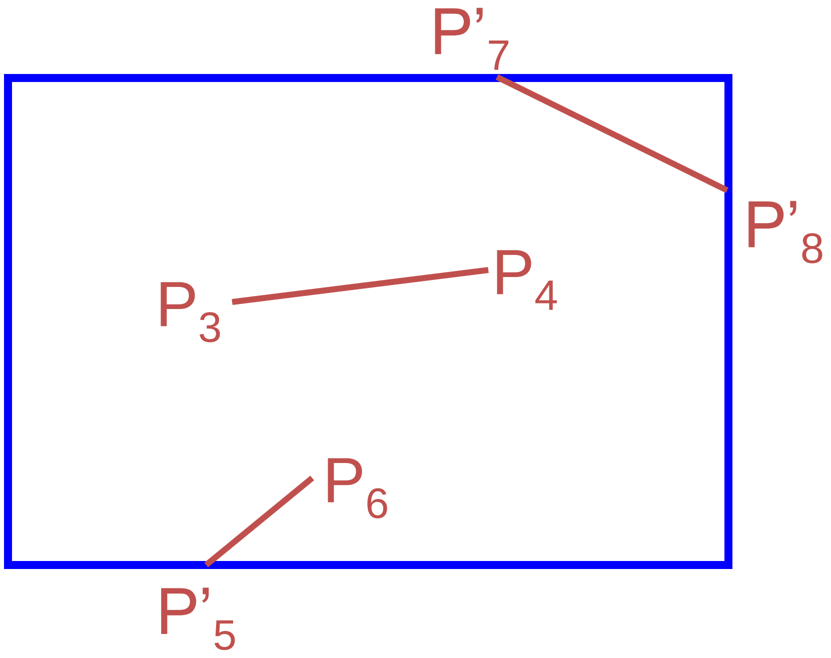
- Find the part of a line inside the clip window



Before Clipping

Line Clipping

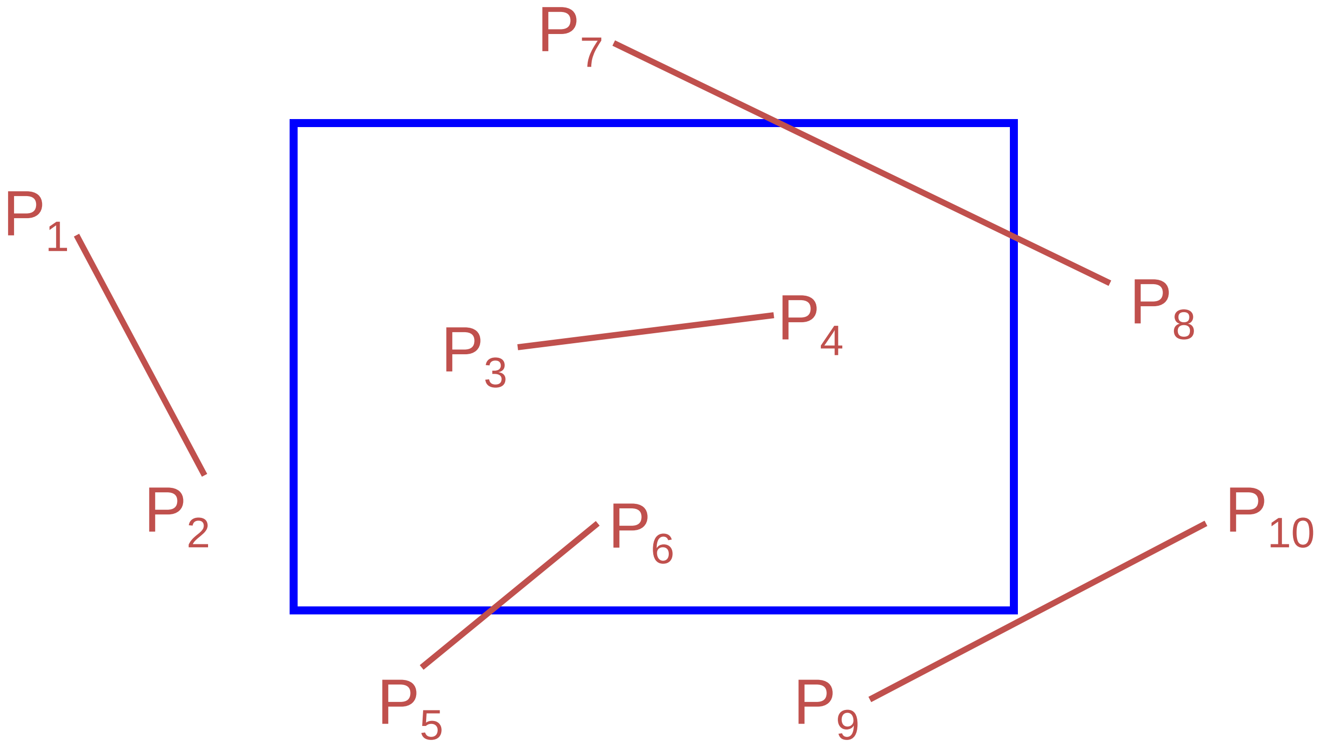
- Find the part of a line inside the clip window



After Clipping

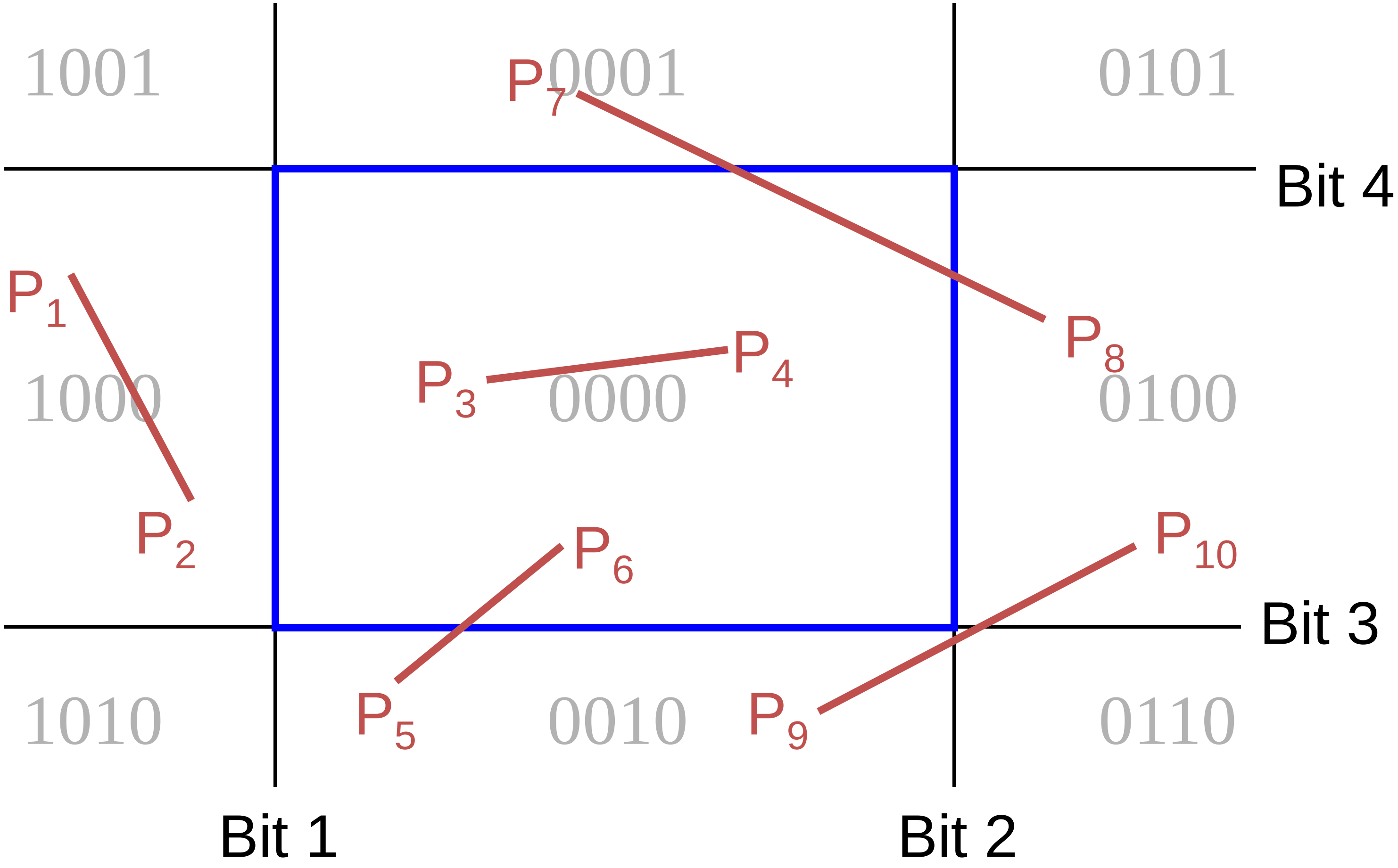
Cohen Sutherland Line Clipping

- Use simple tests to classify easy cases first



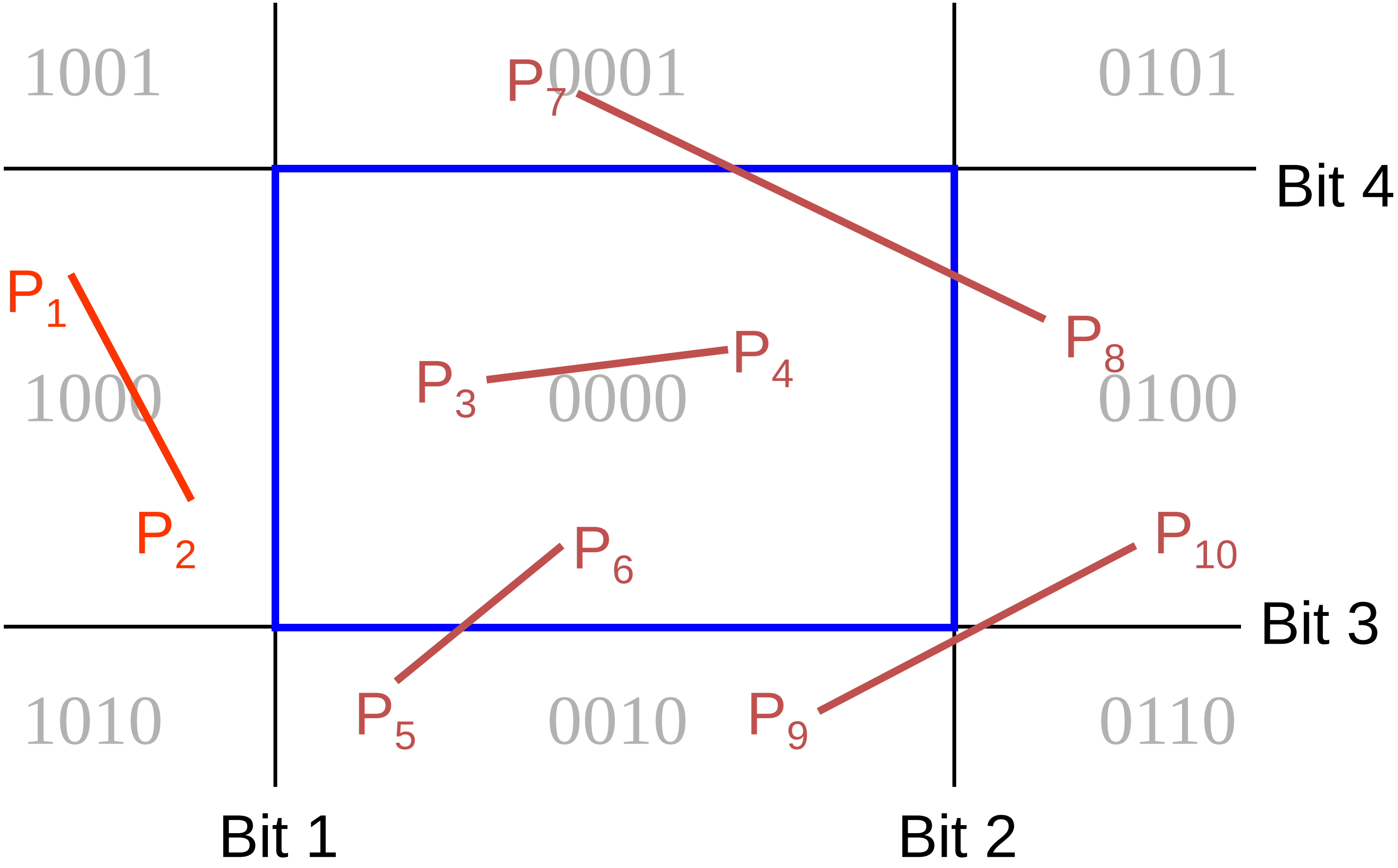
Cohen Sutherland Line Clipping

- 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

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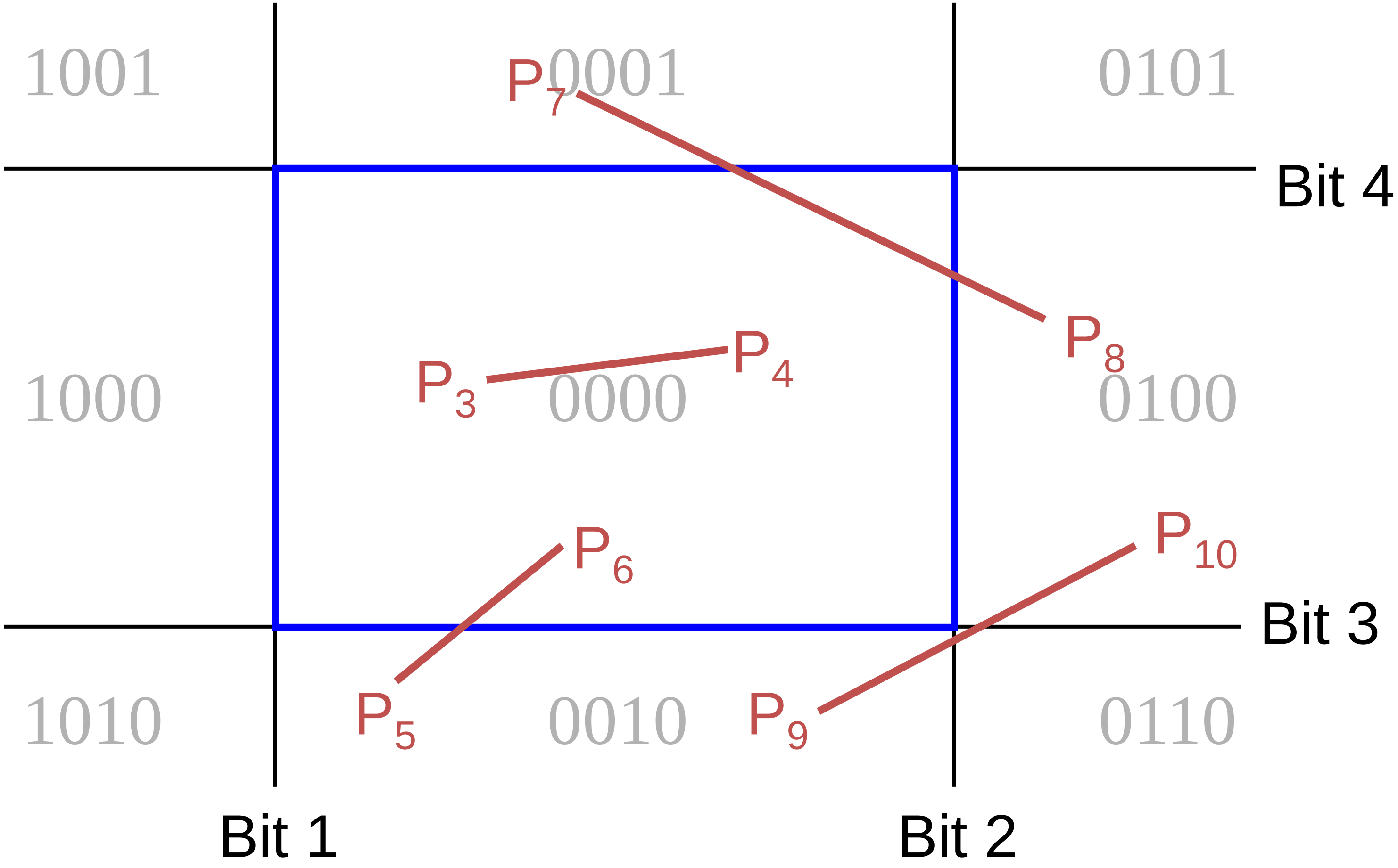
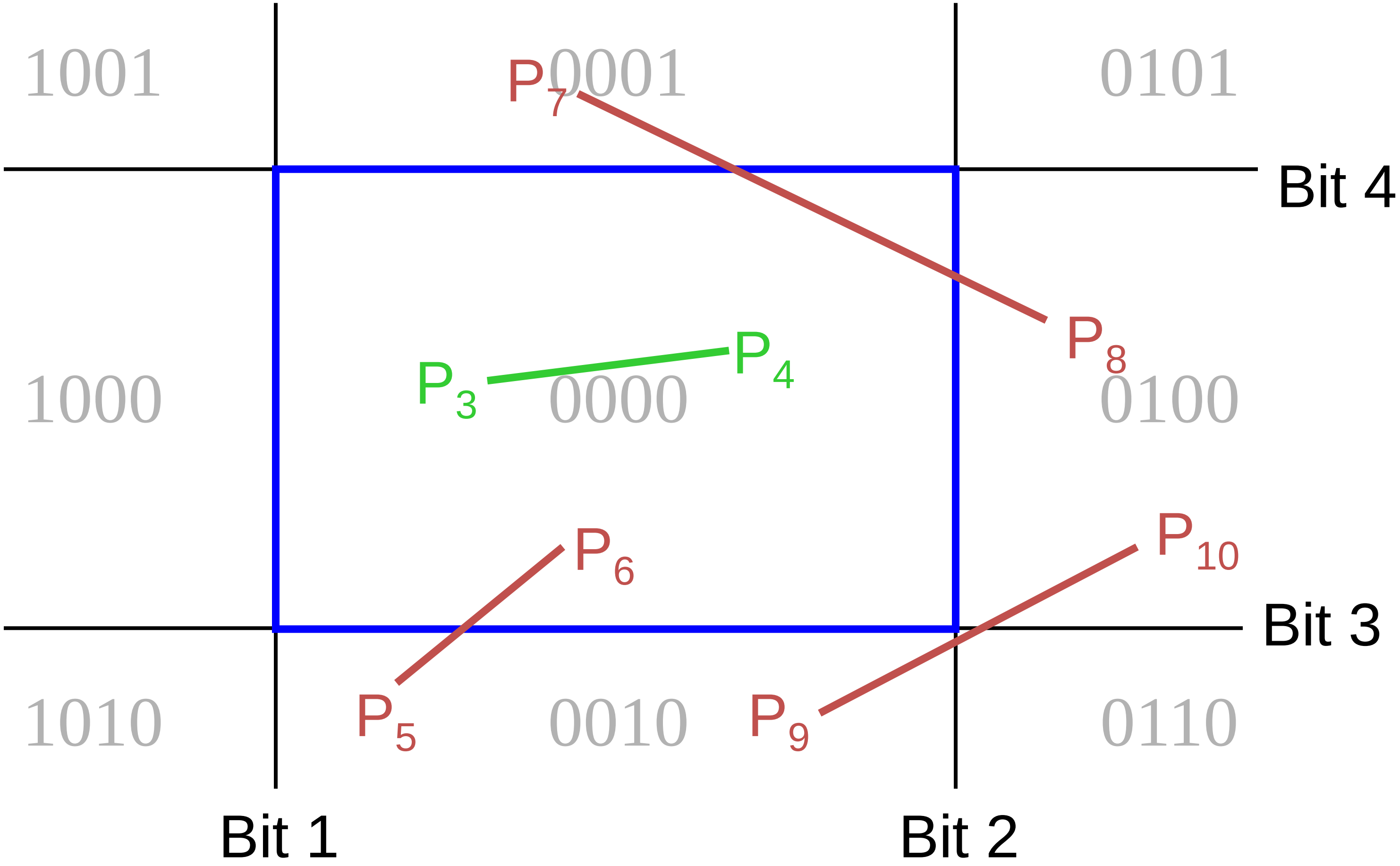


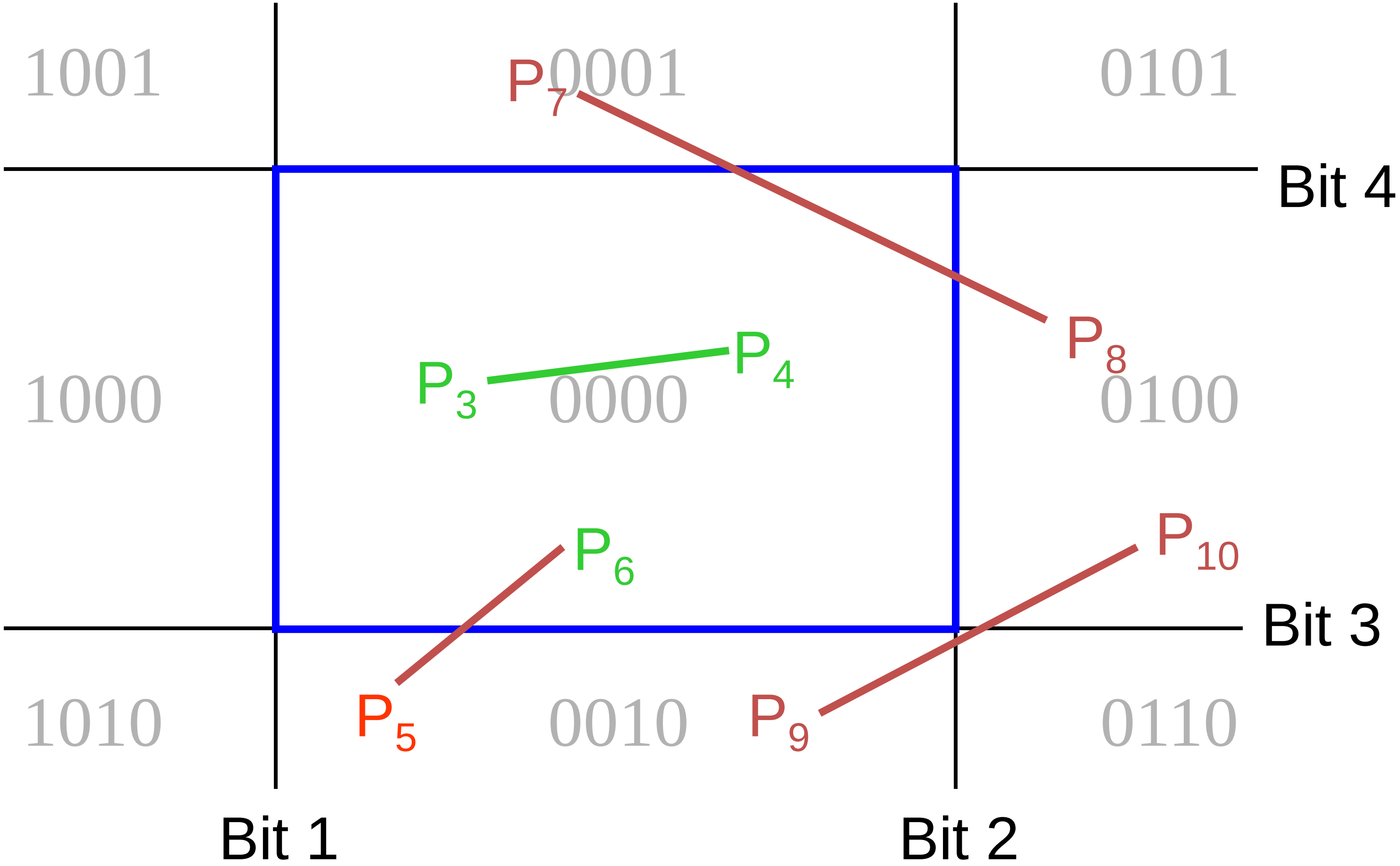
Cohen Sutherland Line Clipping

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



Cohen Sutherland Line Clipping

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



Cohen Sutherland Line Clipping

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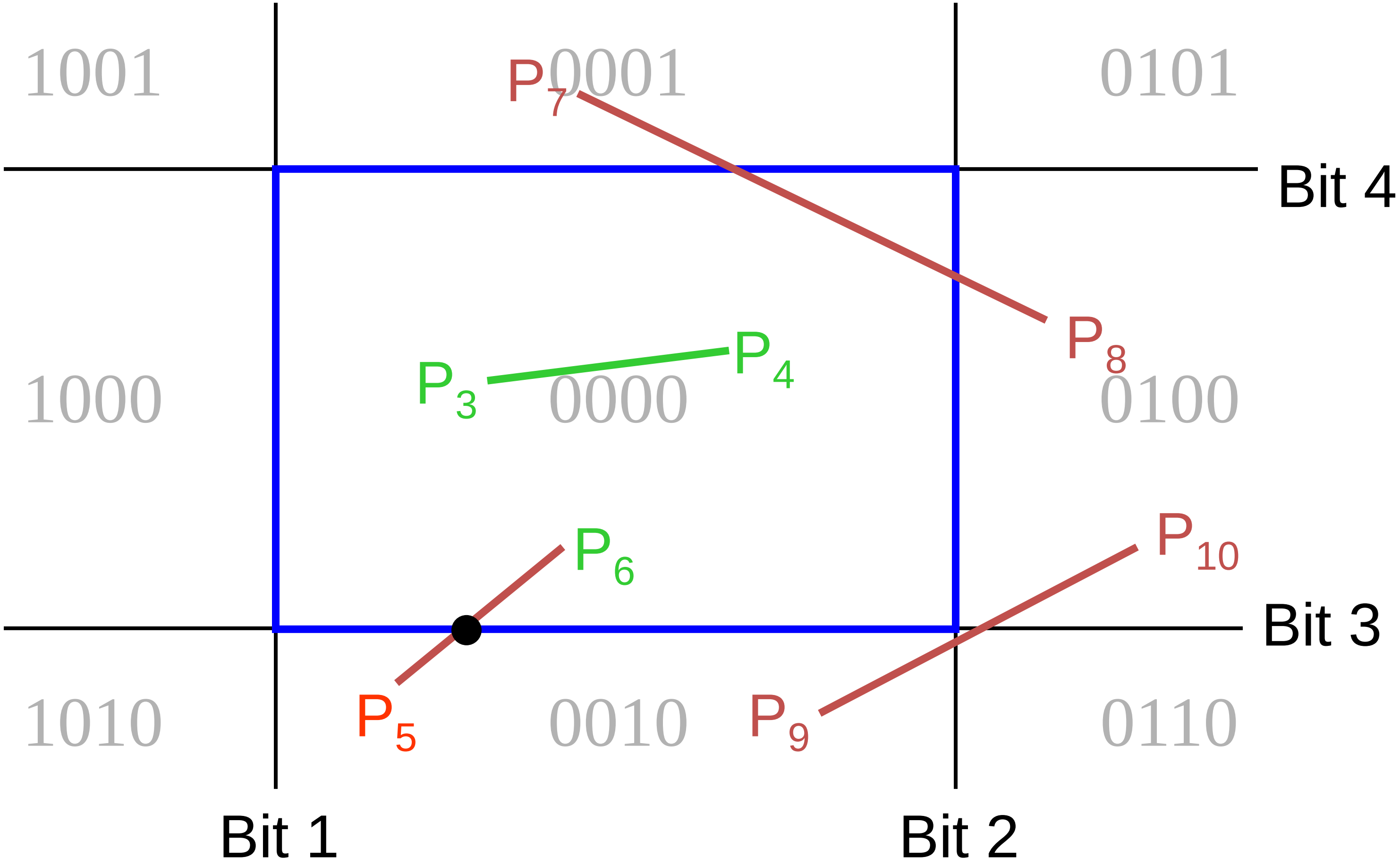

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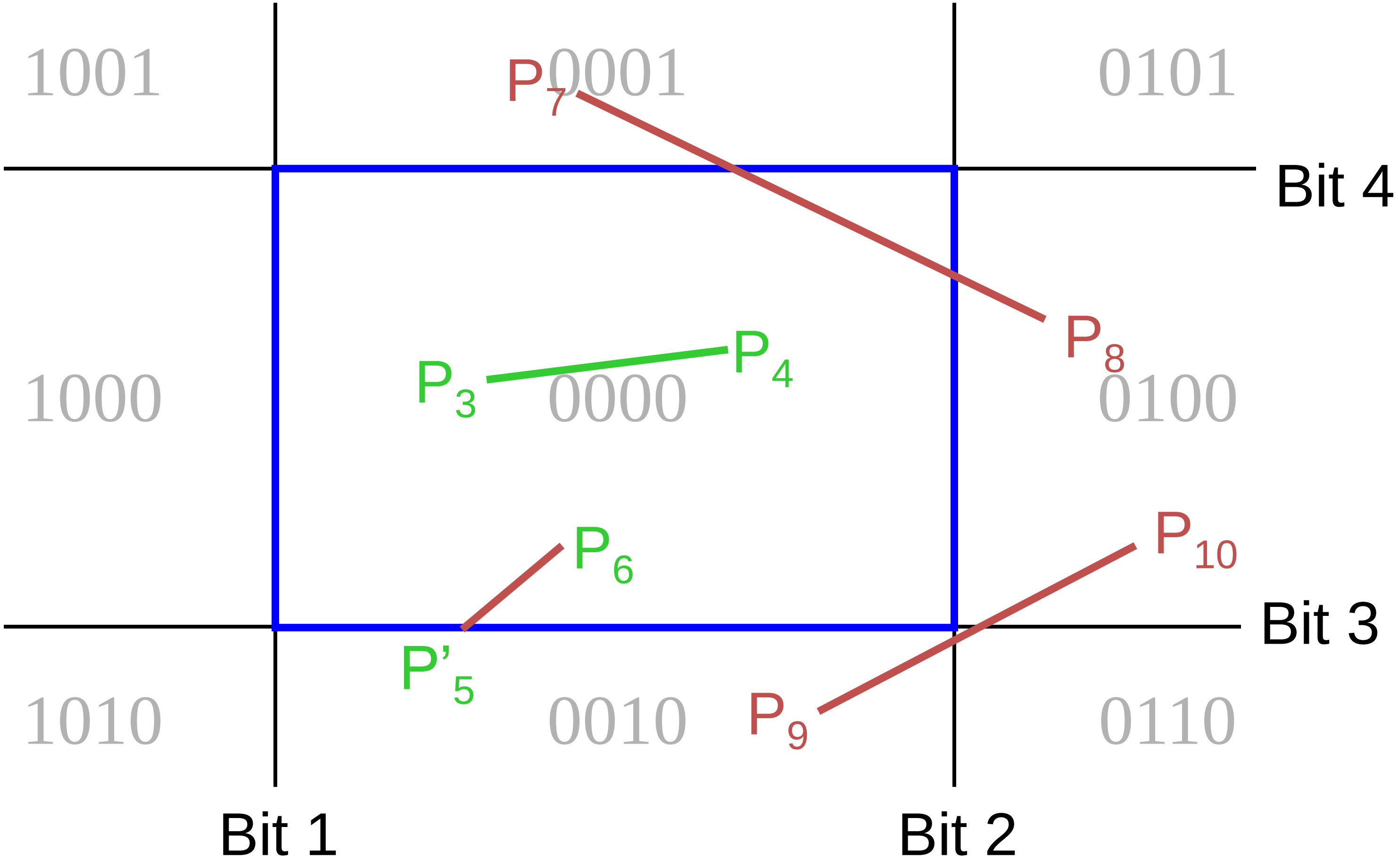
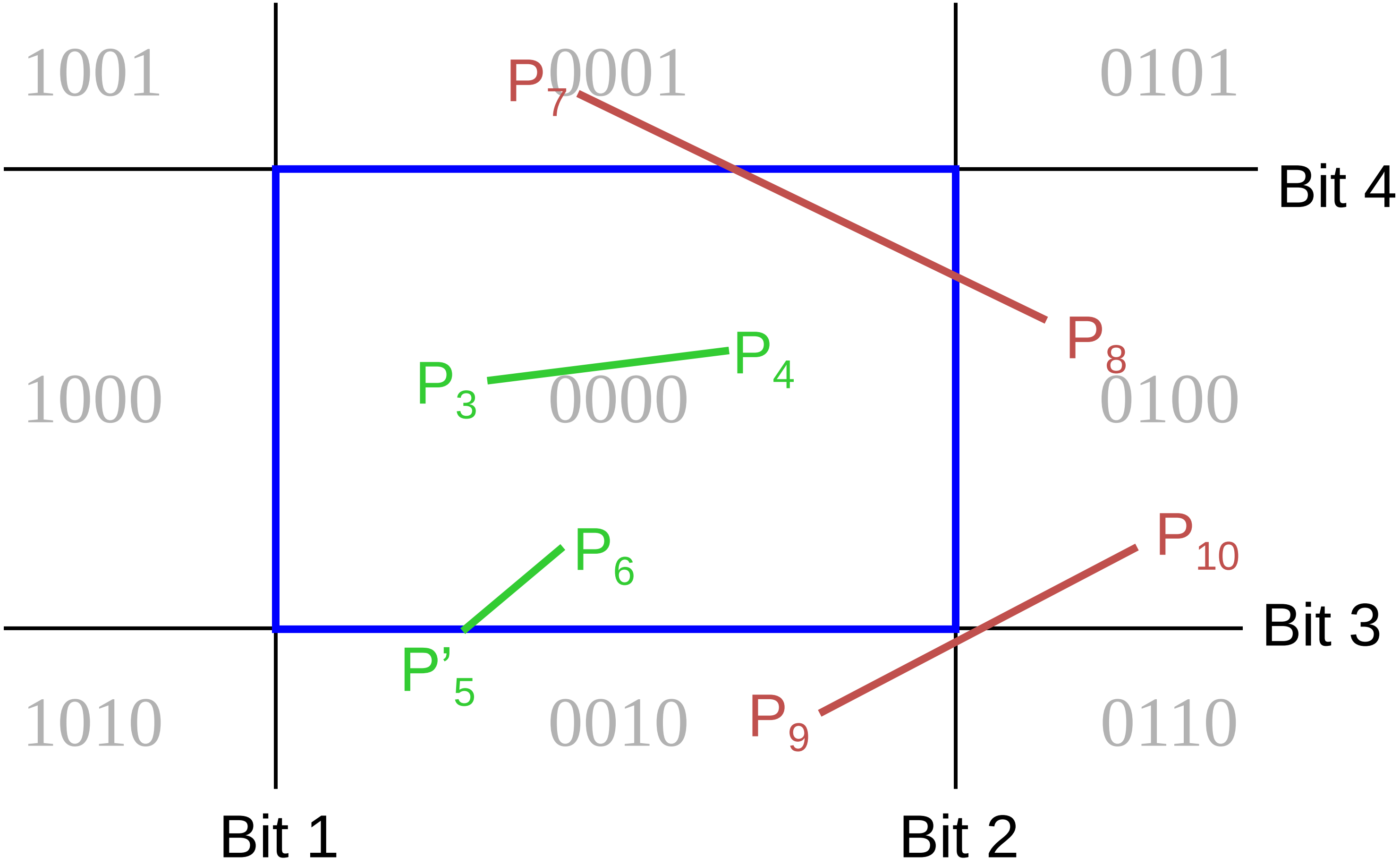


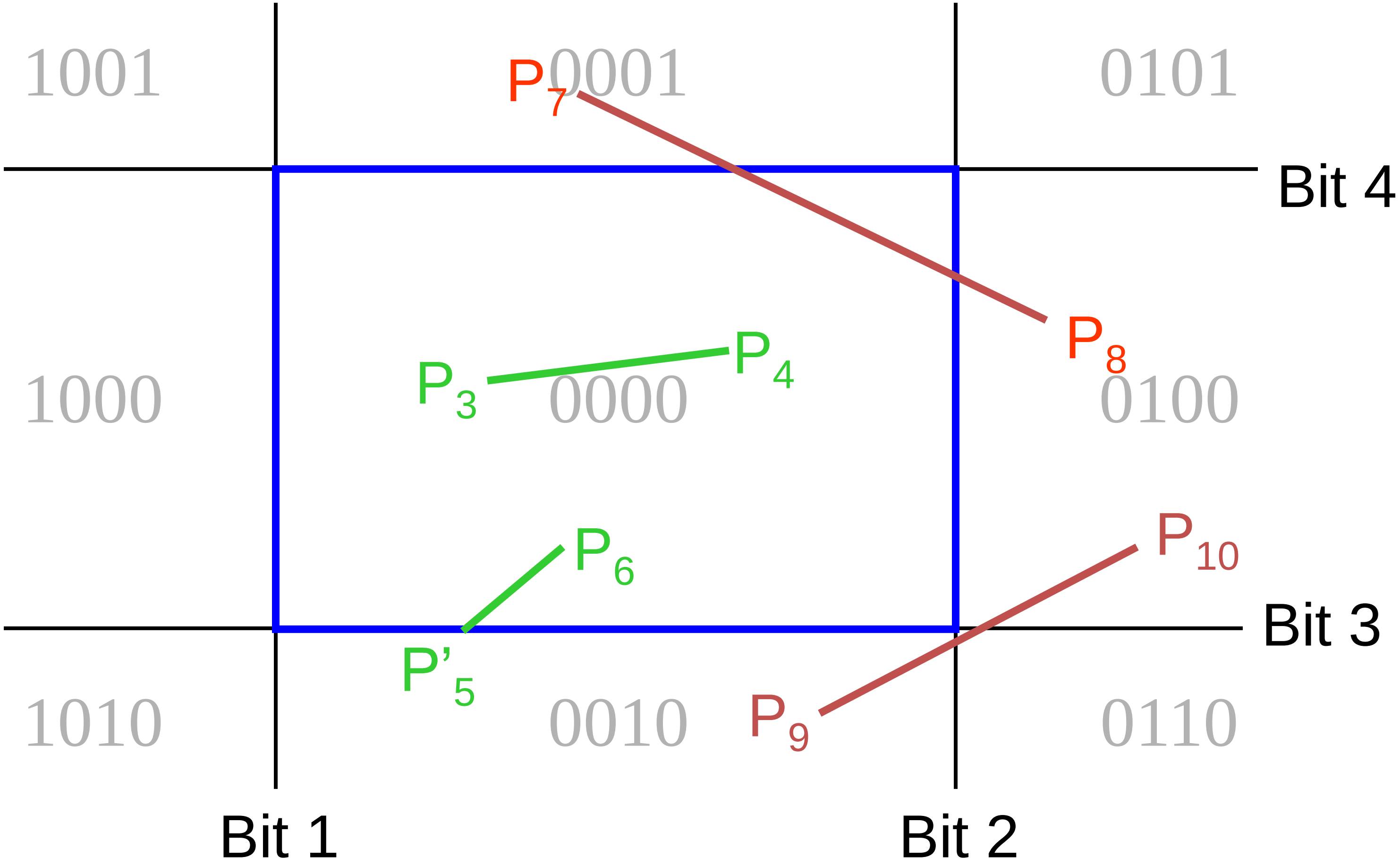
Cohen Sutherland Line Clipping

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



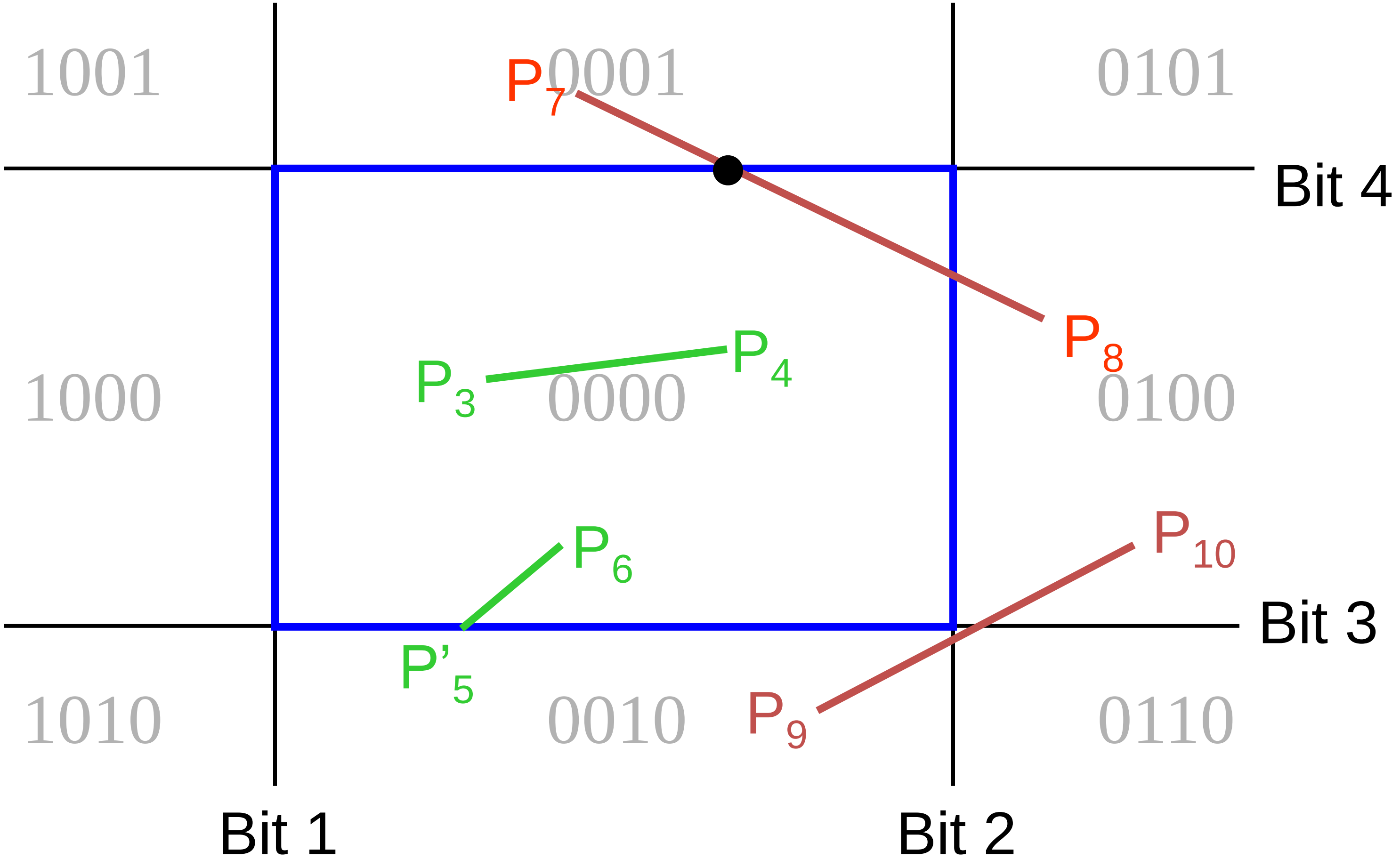
Cohen Sutherland Line Clipping

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



Cohen Sutherland Line Clipping

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



Cohen Sutherland Line Clipping

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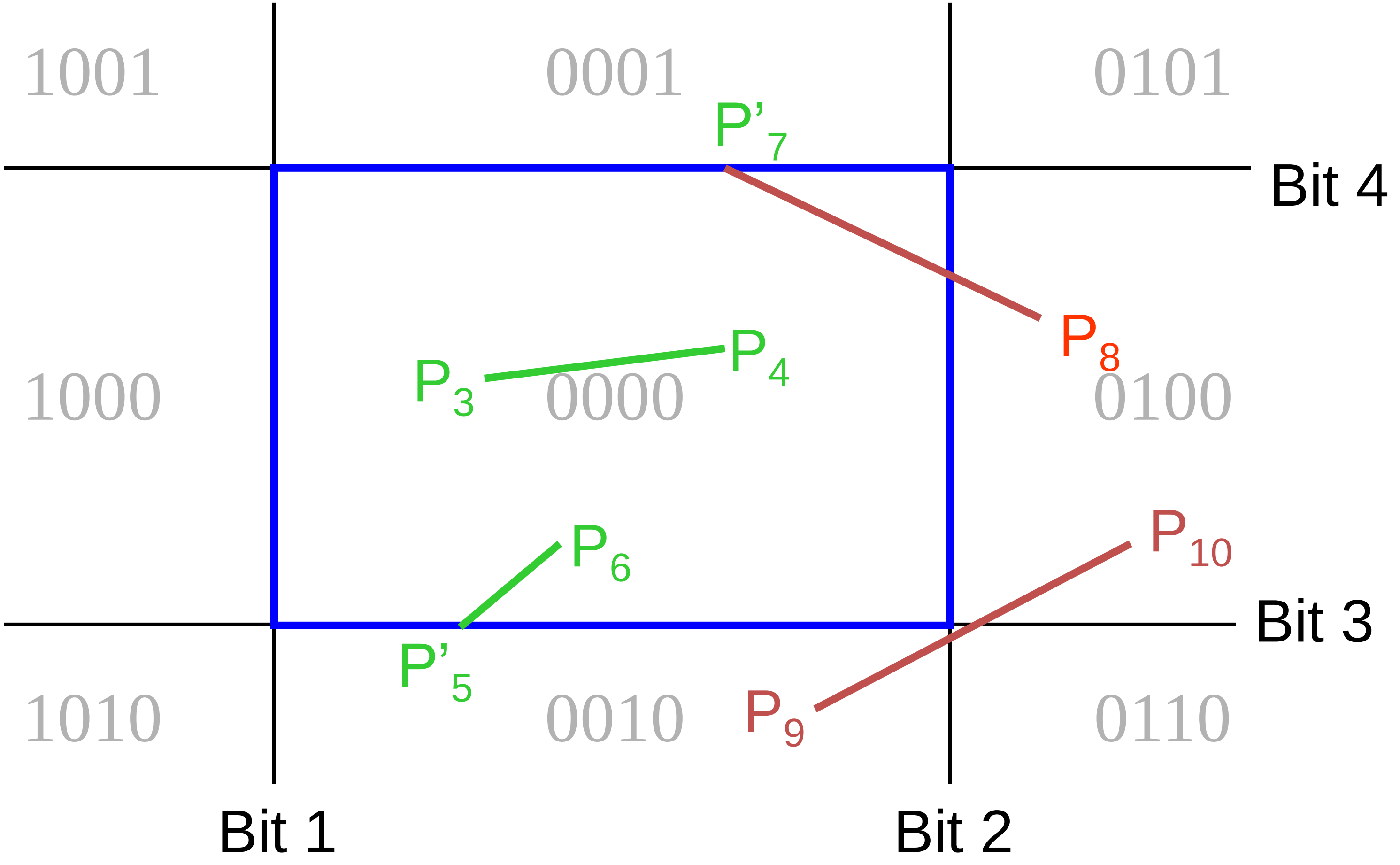

Cohen Sutherland Line Clipping

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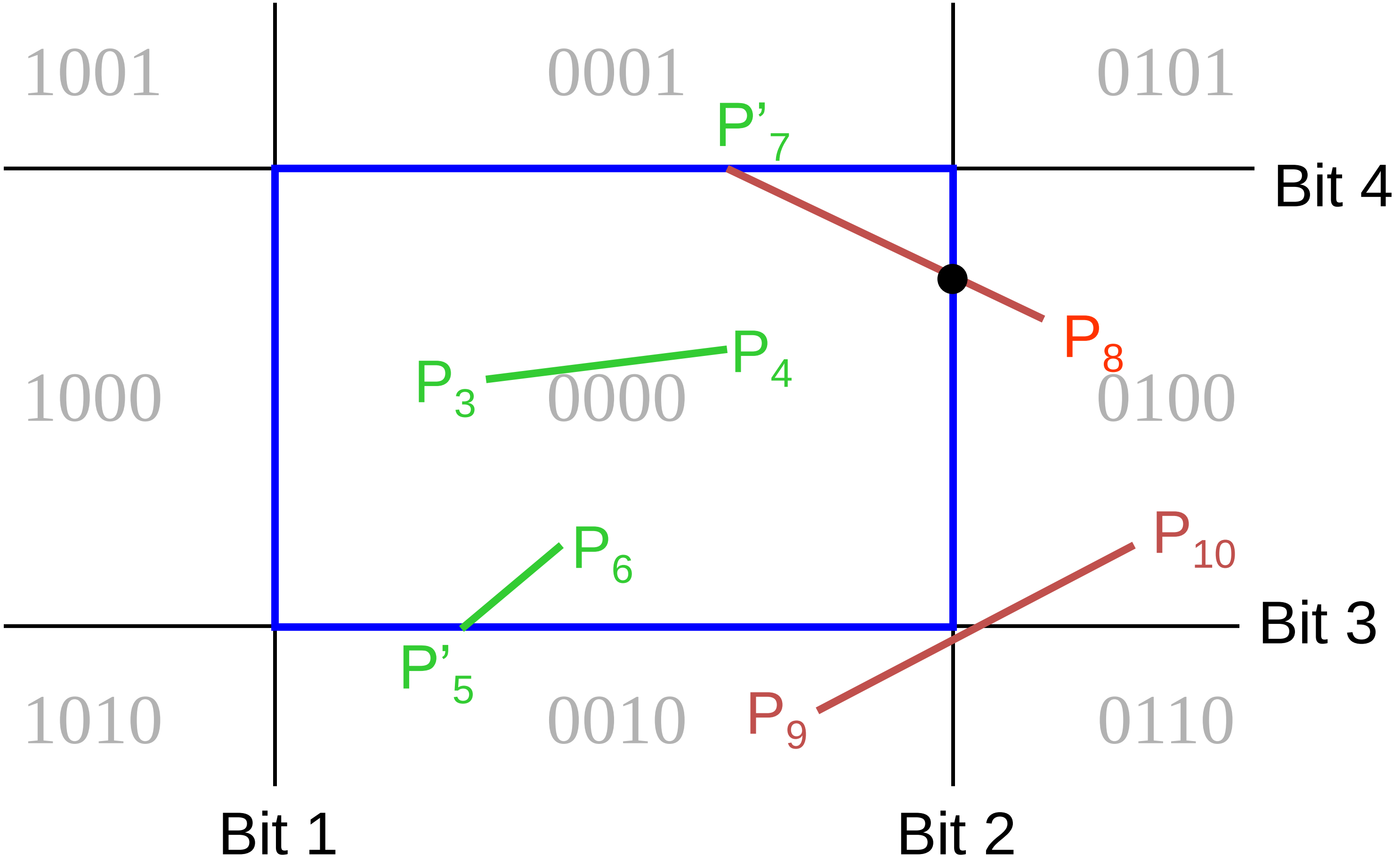

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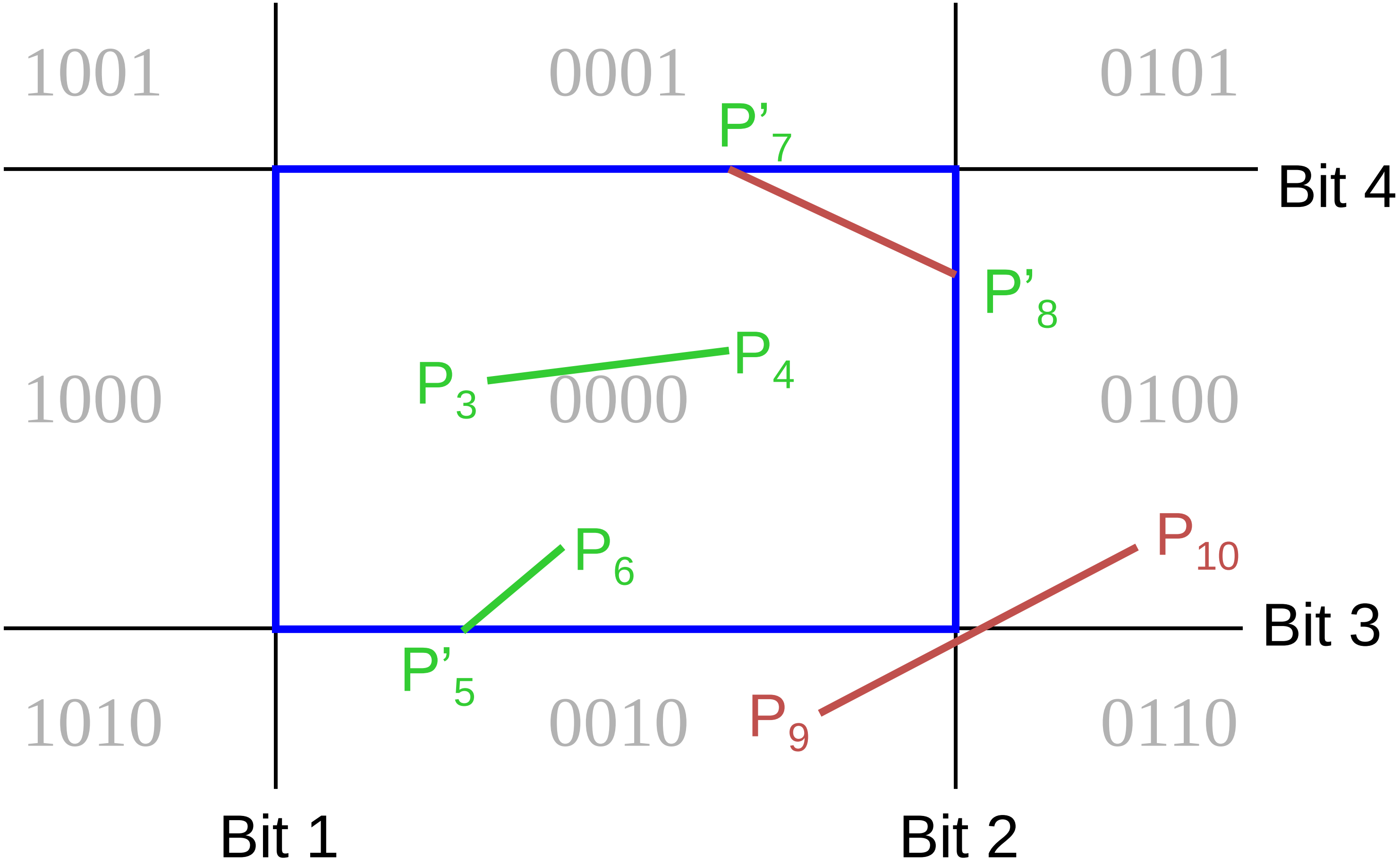

Cohen Sutherland Line Clipping

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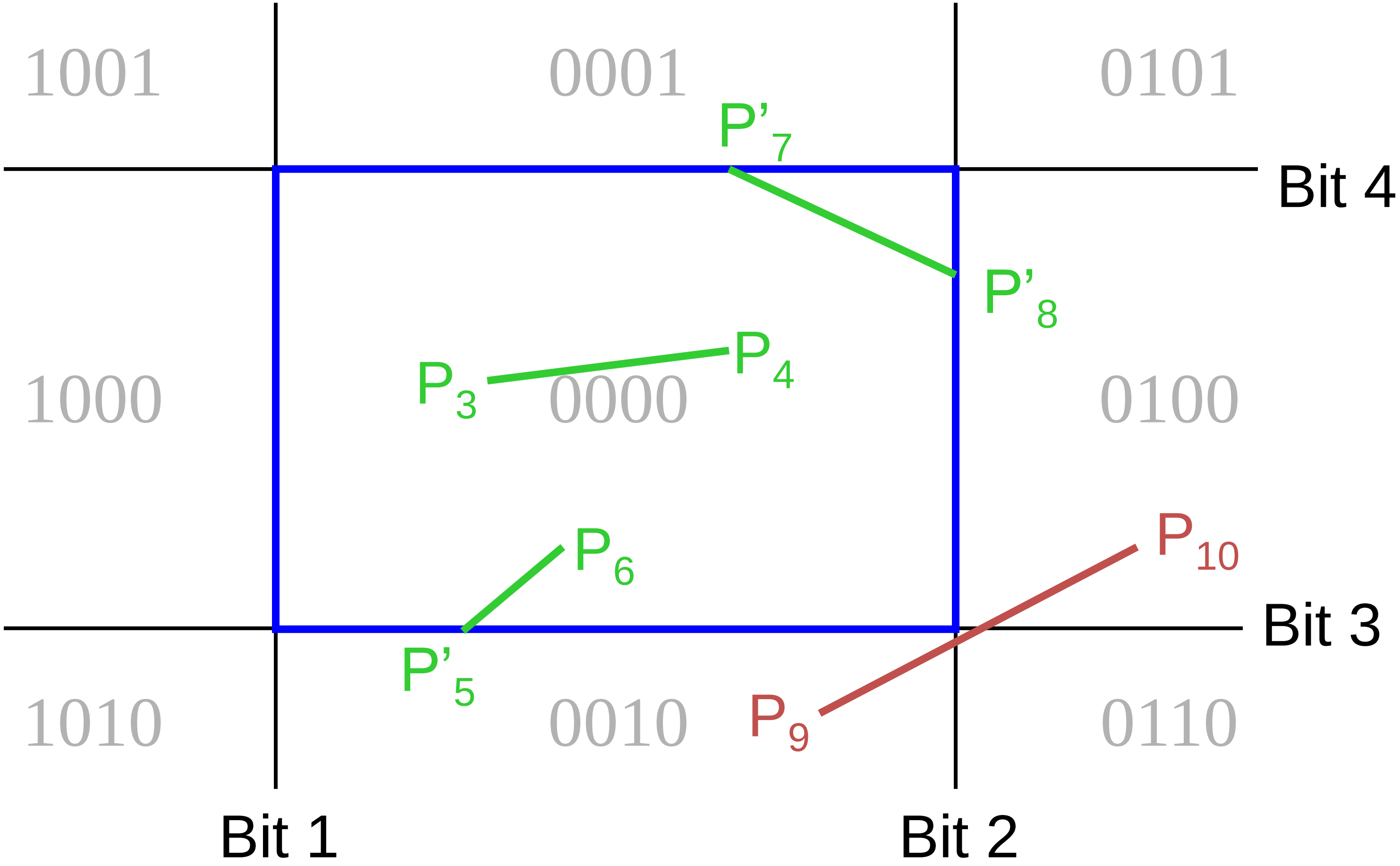

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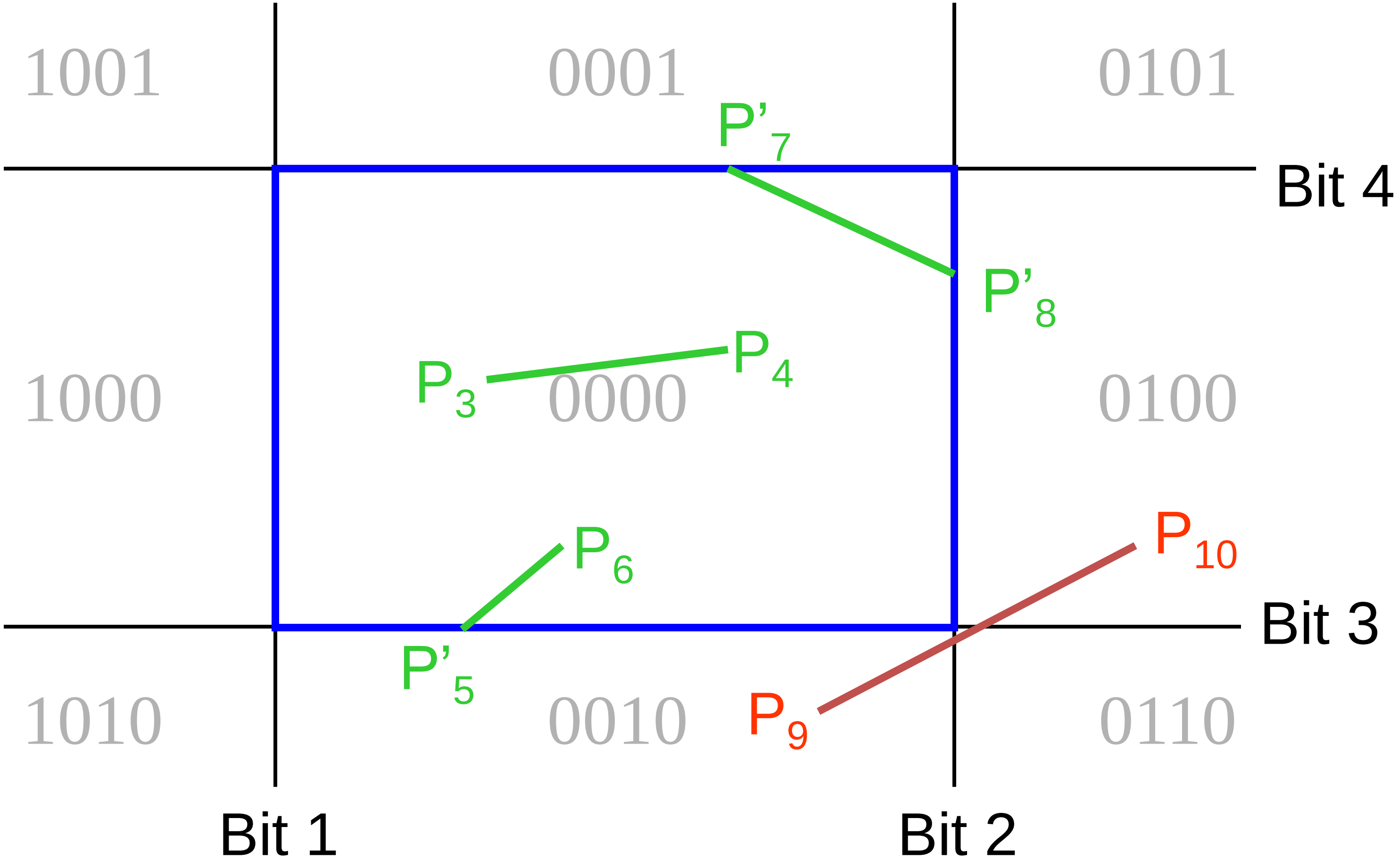
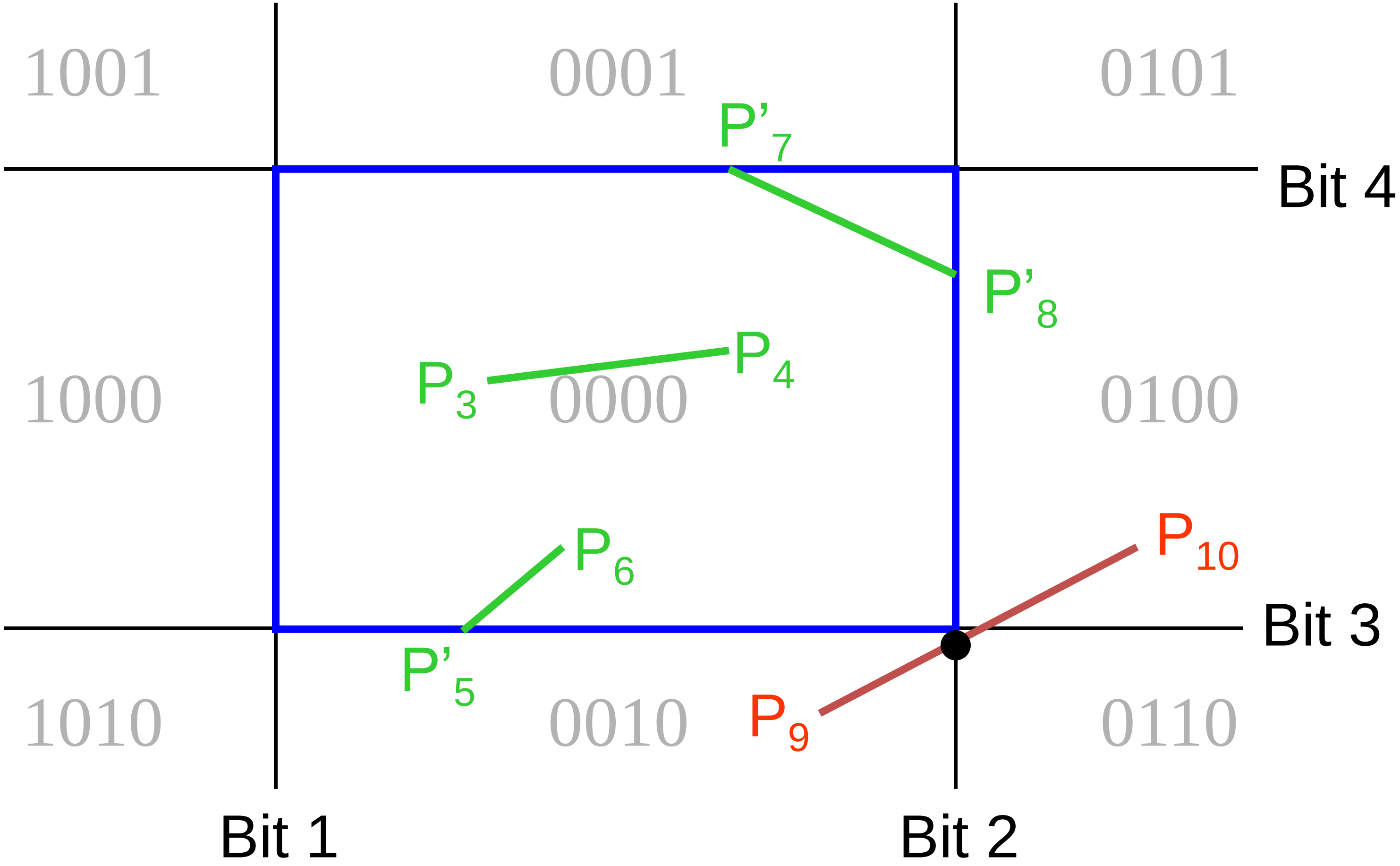


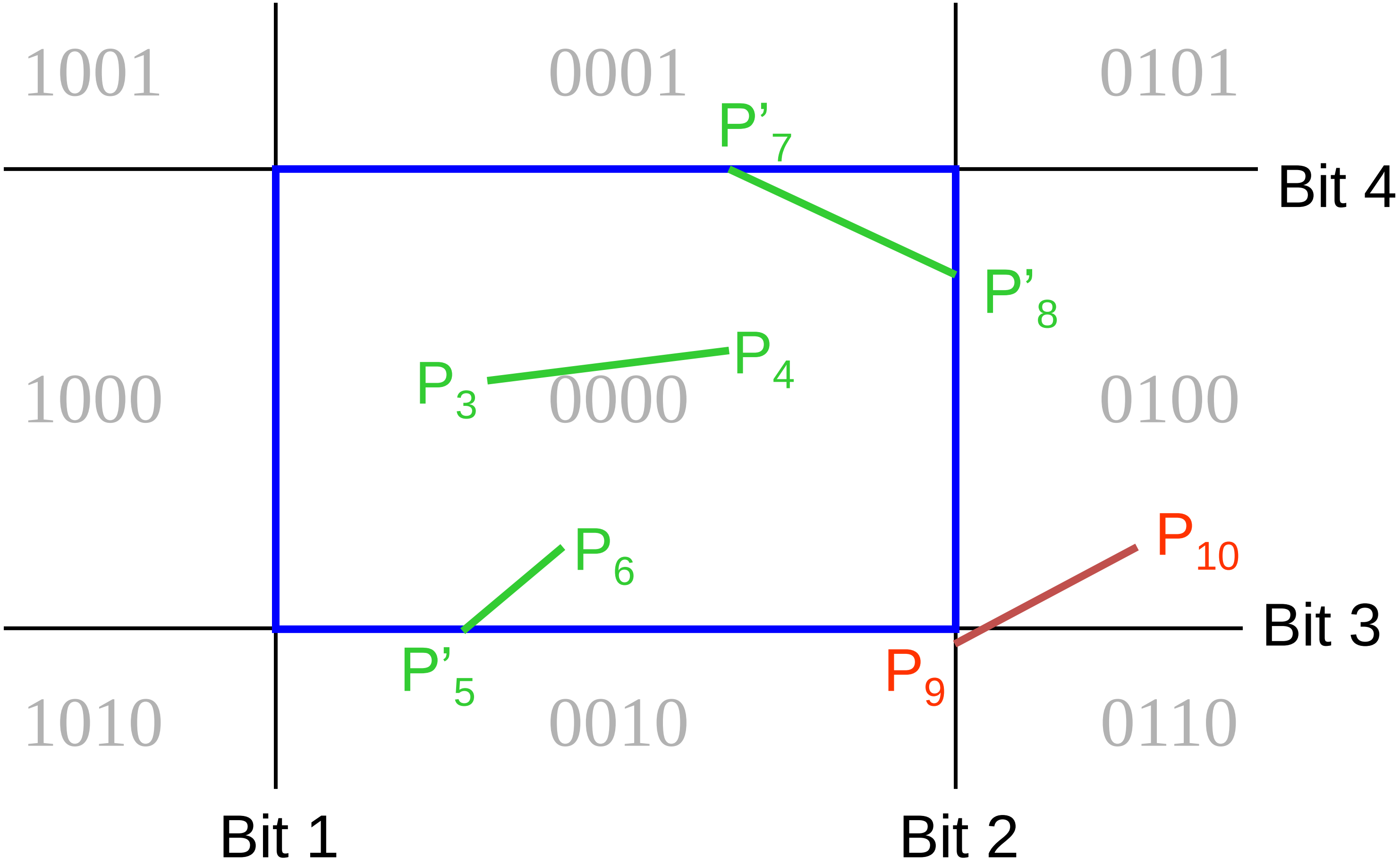
Cohen Sutherland Line Clipping

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



Cohen Sutherland Line Clipping

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



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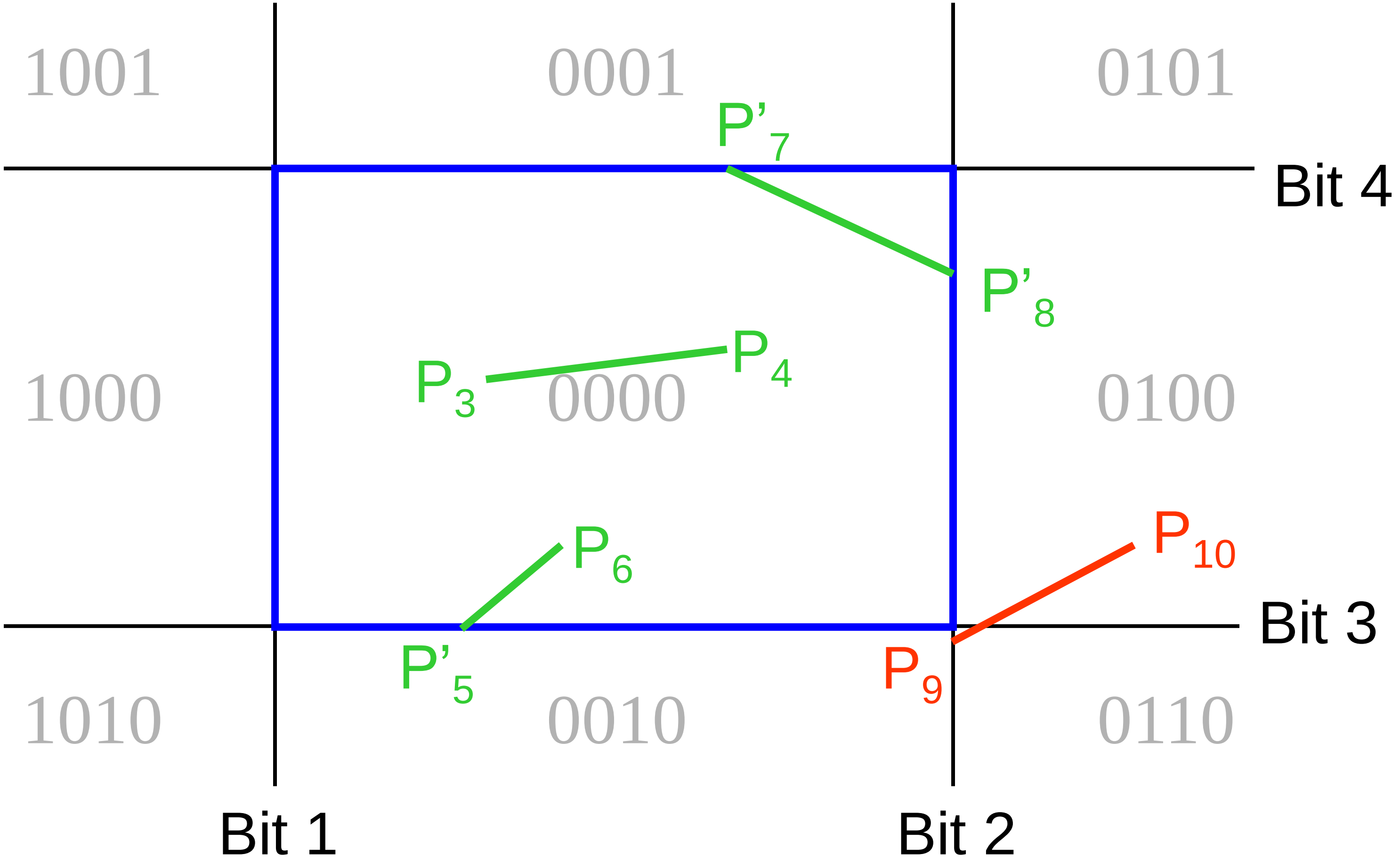
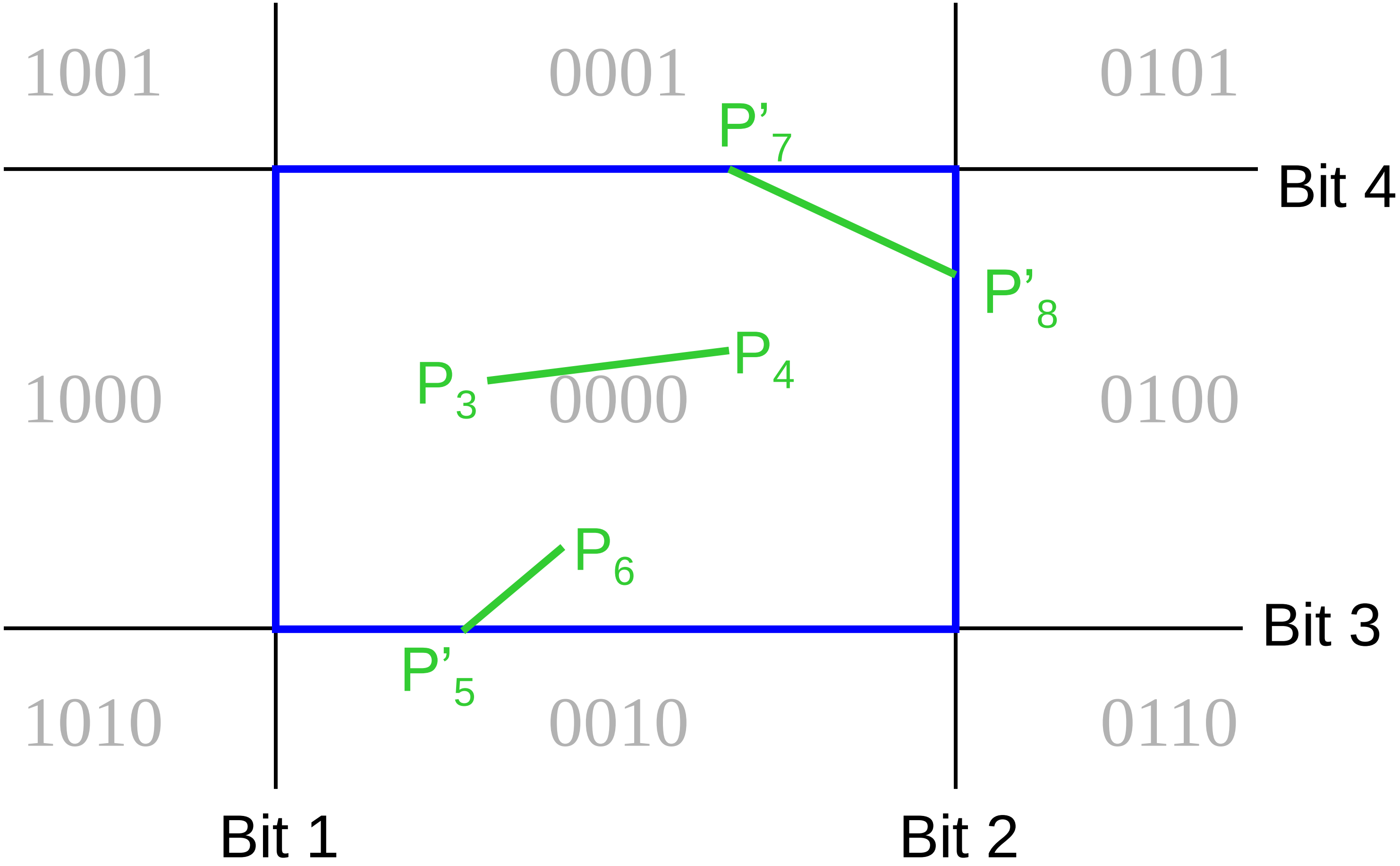
- Compute intersections with window boundary for lines that can't be classified quickly



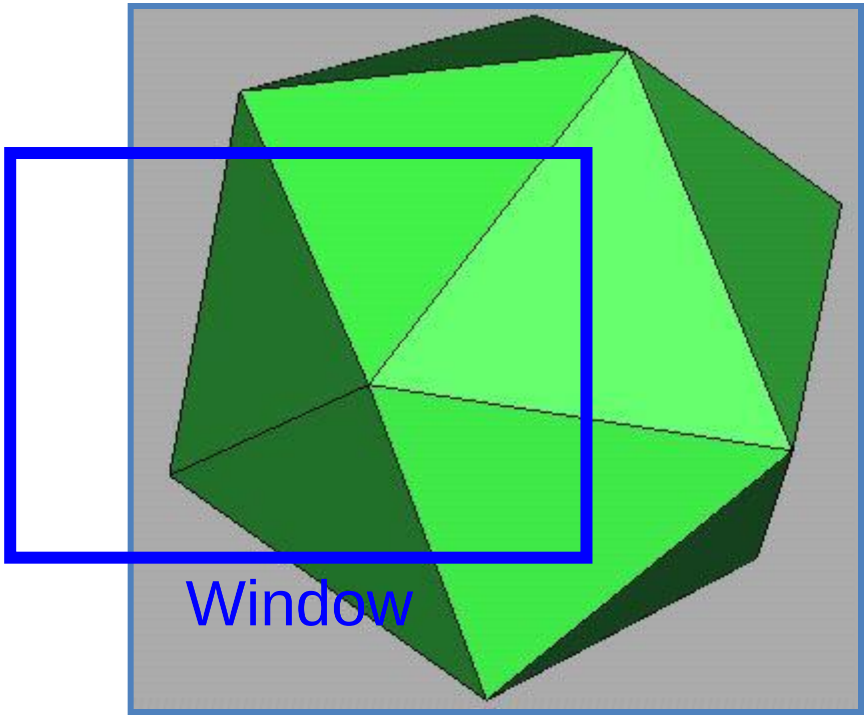
Cohen Sutherland Line Clipping

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



Clipping

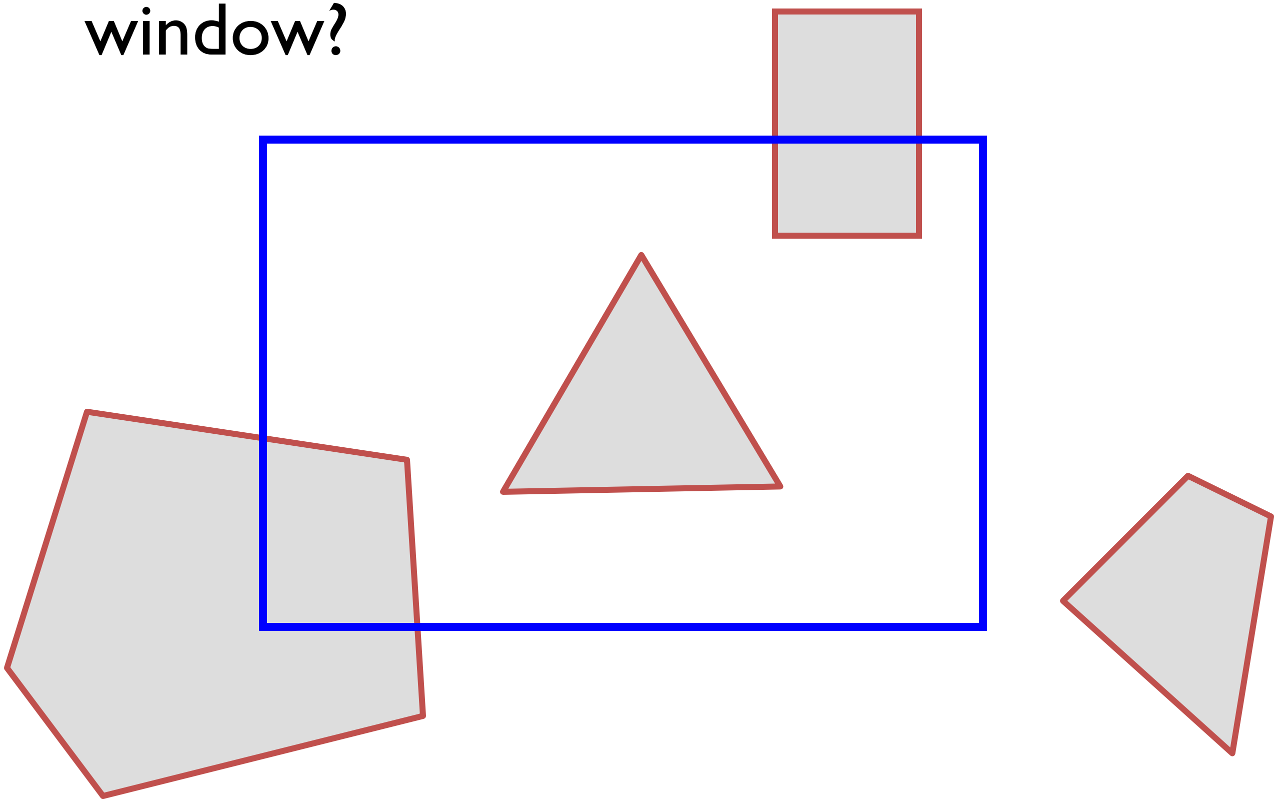
- Avoid drawing parts of primitives outside window
  - Points
  - Lines
  - Polygons
  - Circles
  - etc.



2D Screen Coordinates

Polygon Clipping

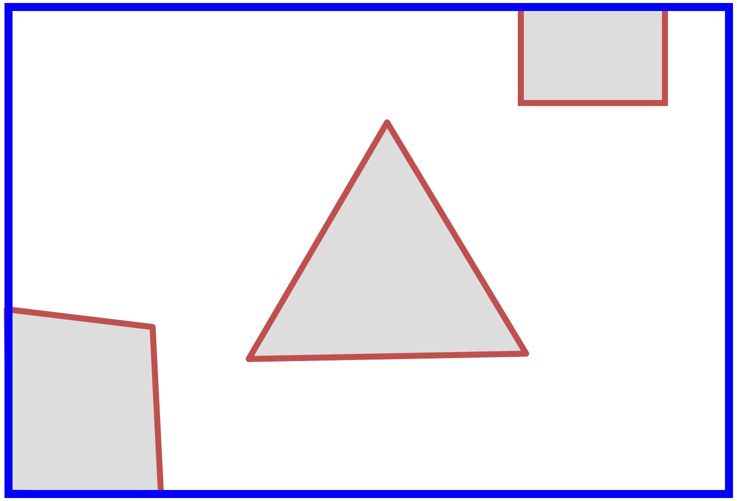
- Find the part of a polygon inside the clip window?



Before Clipping

Polygon Clipping

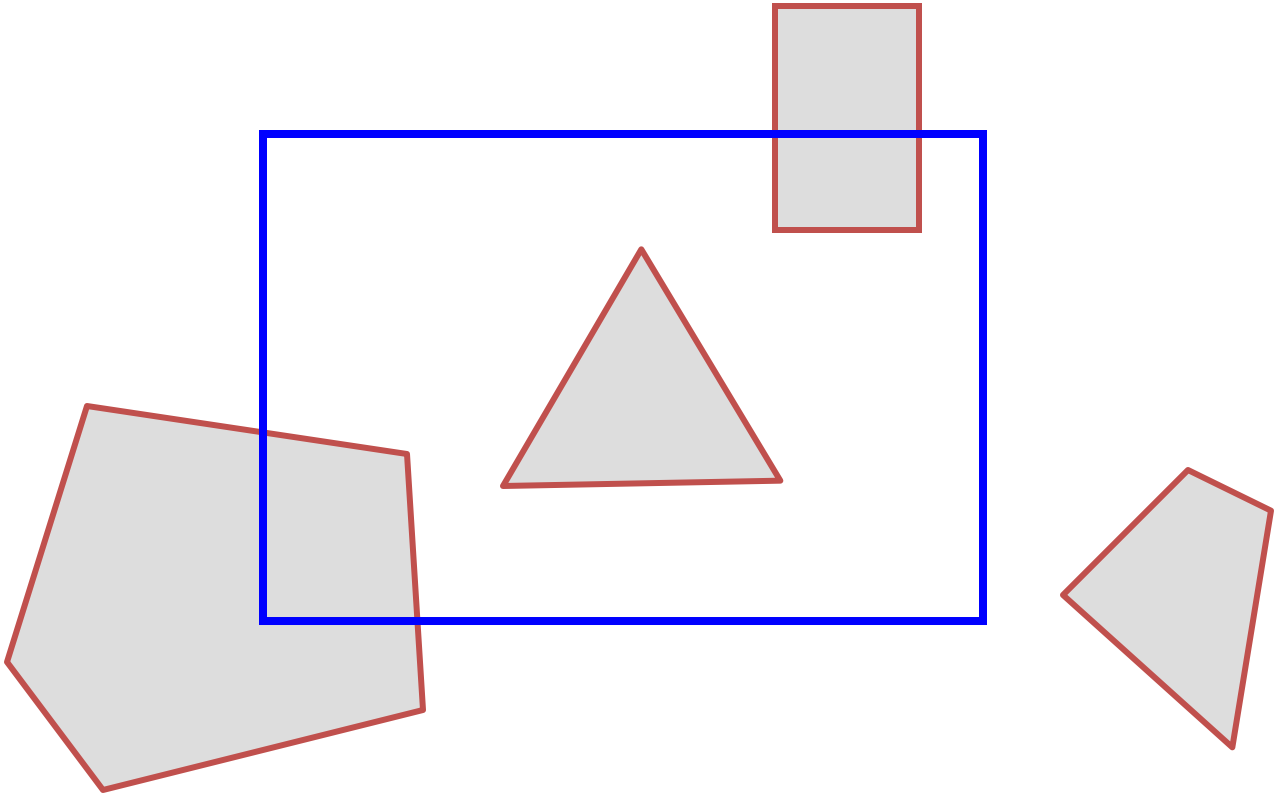
- Find the part of a polygon inside the clip window?



After Clipping

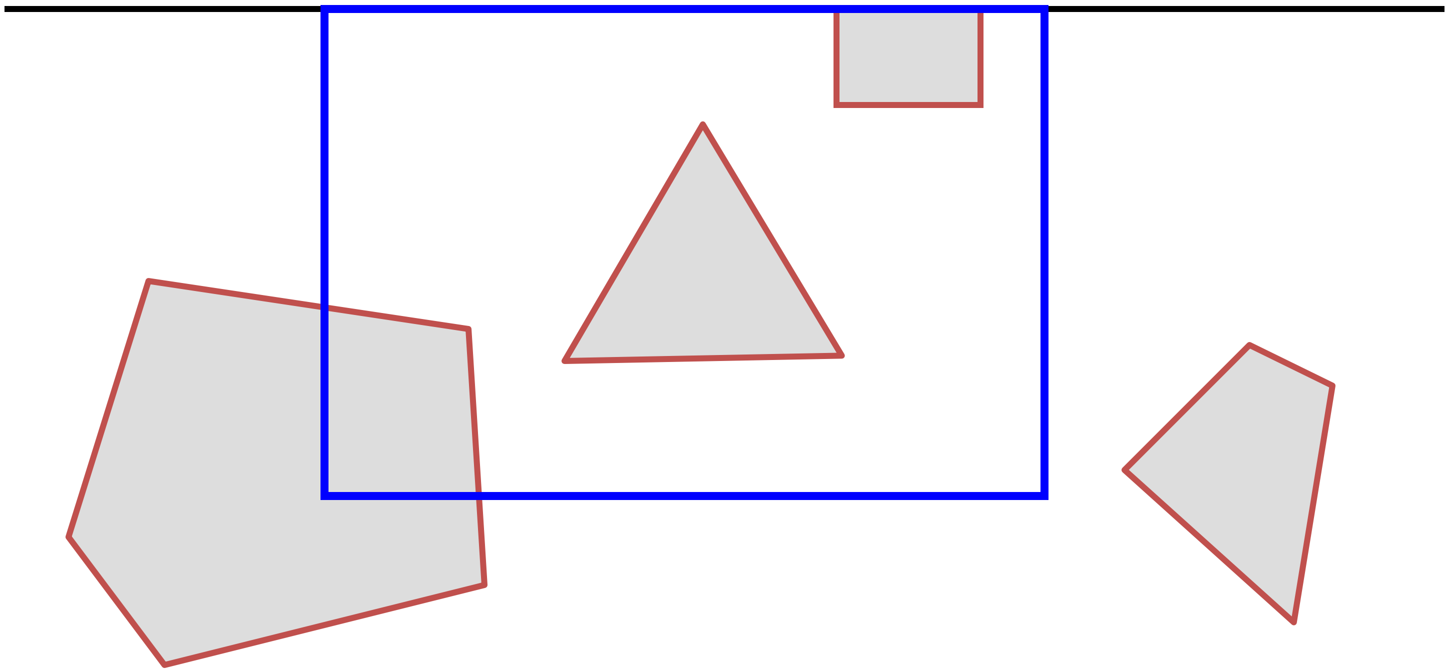
Sutherland Hodgeman Clipping

- Clip to each window boundary one at a time



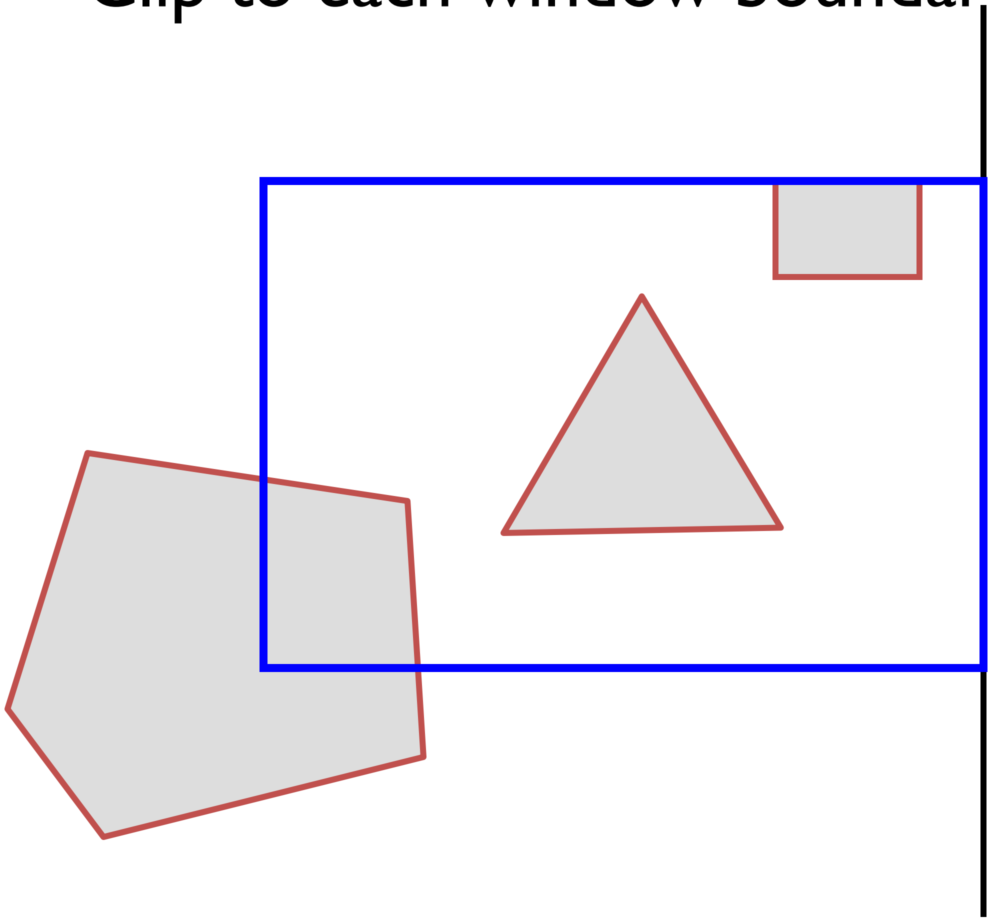
Sutherland Hodgeman Clipping

- Clip to each window boundary one at a time



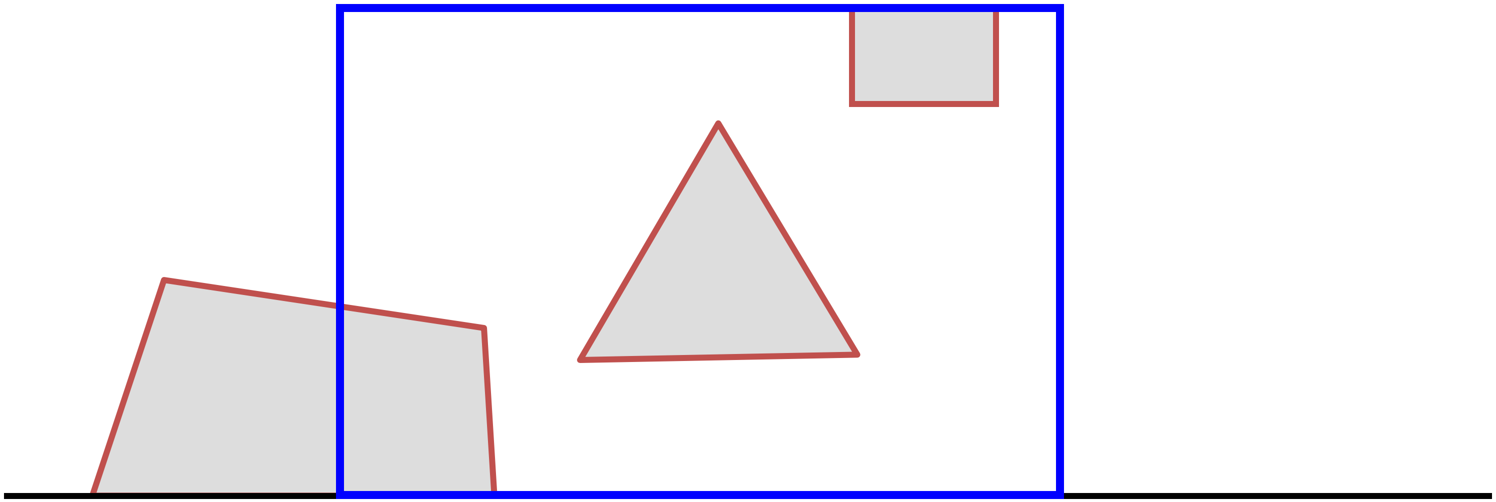
Sutherland Hodgeman Clipping

- Clip to each window boundary one at a time



Sutherland Hodgeman Clipping

- Clip to each window boundary one at a time



Sutherland Hodgeman Clipping

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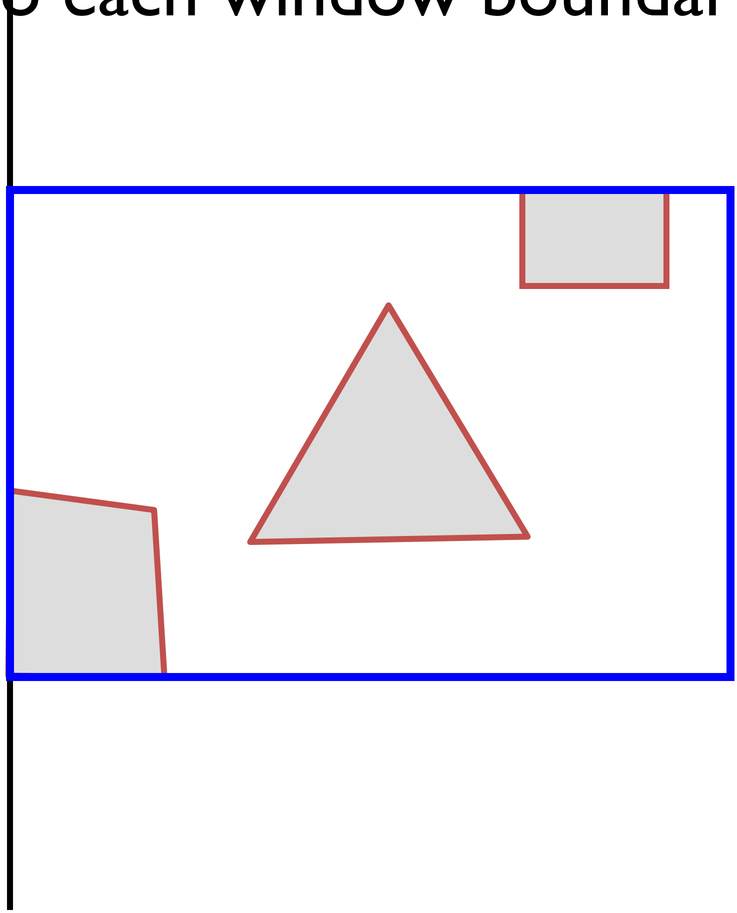
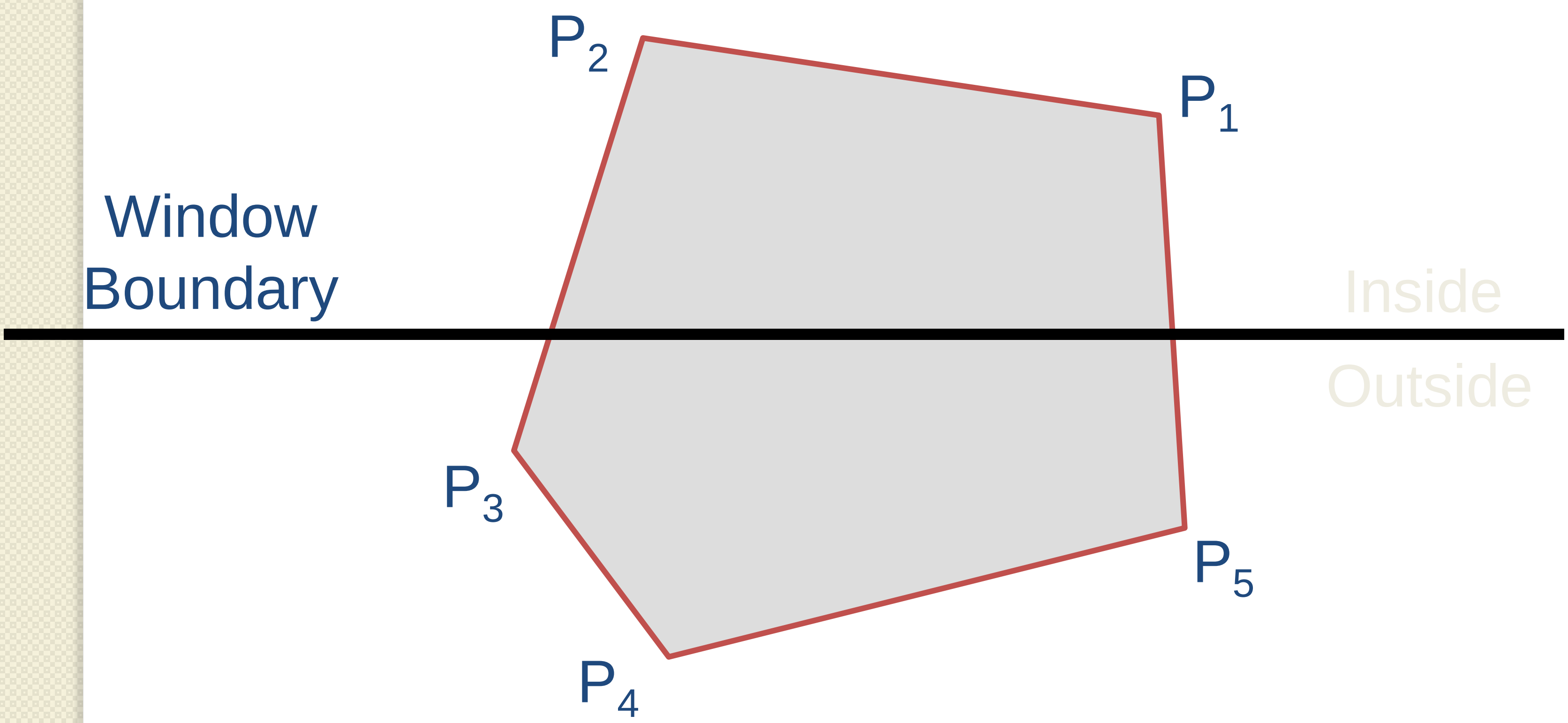


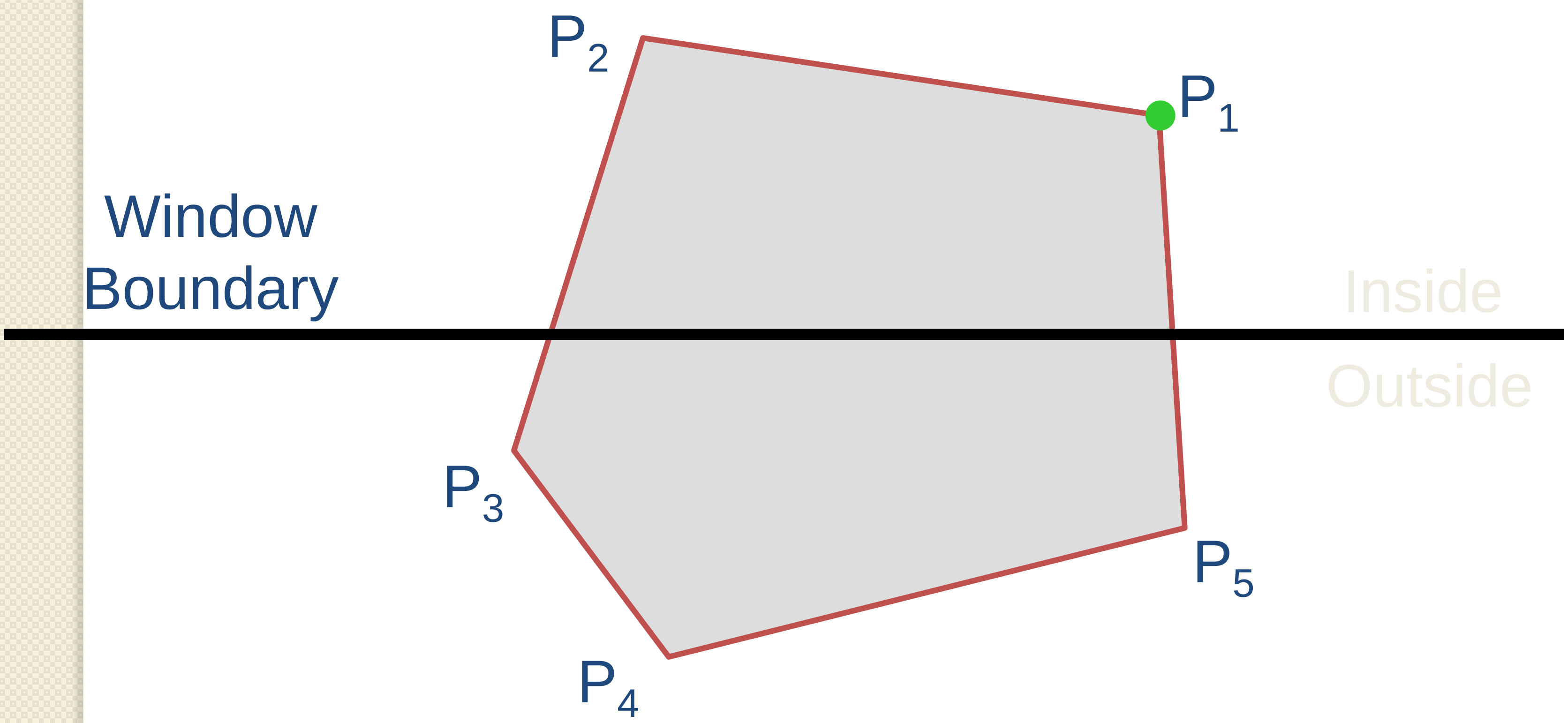
Clipping to a Boundary

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



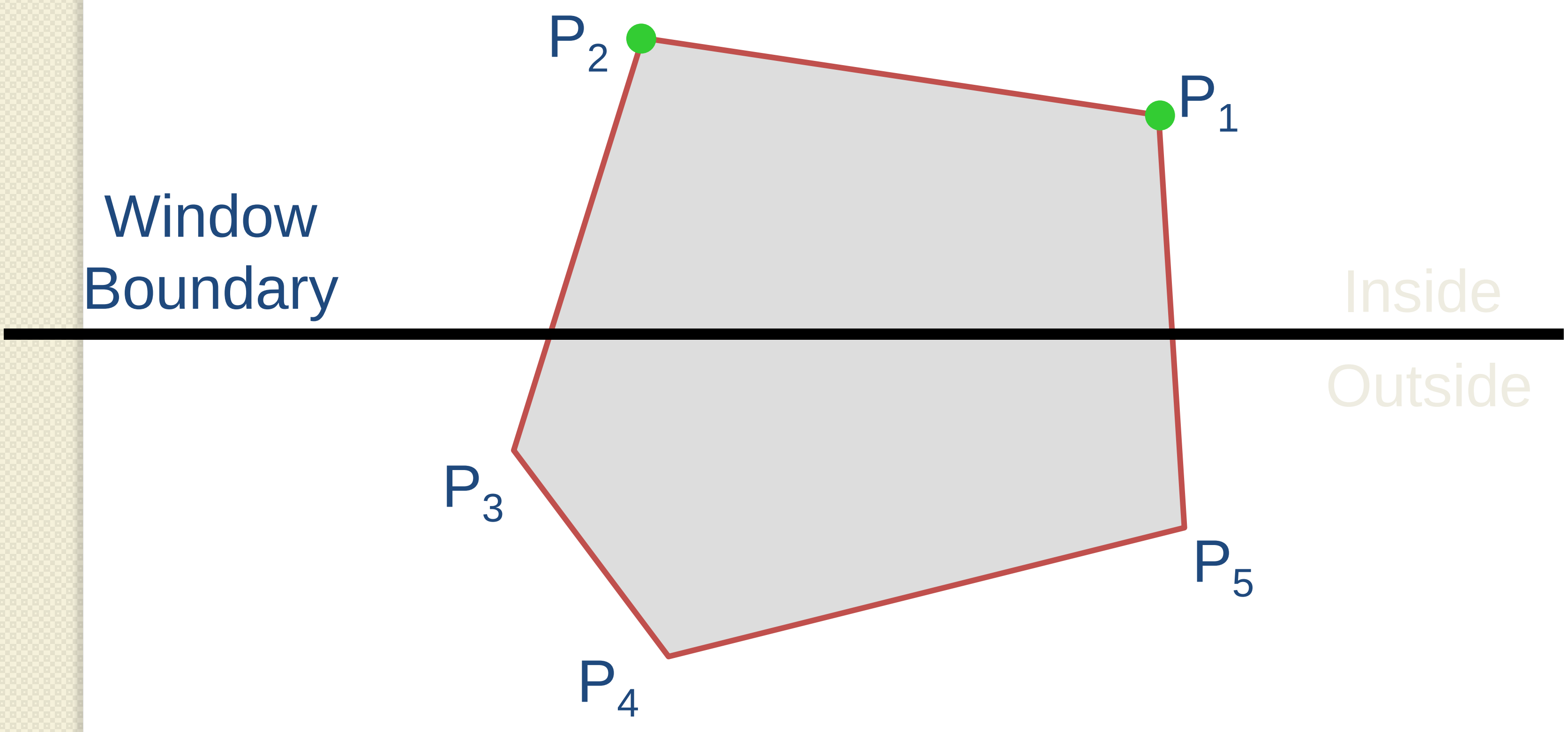
Clipping to a Boundary

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



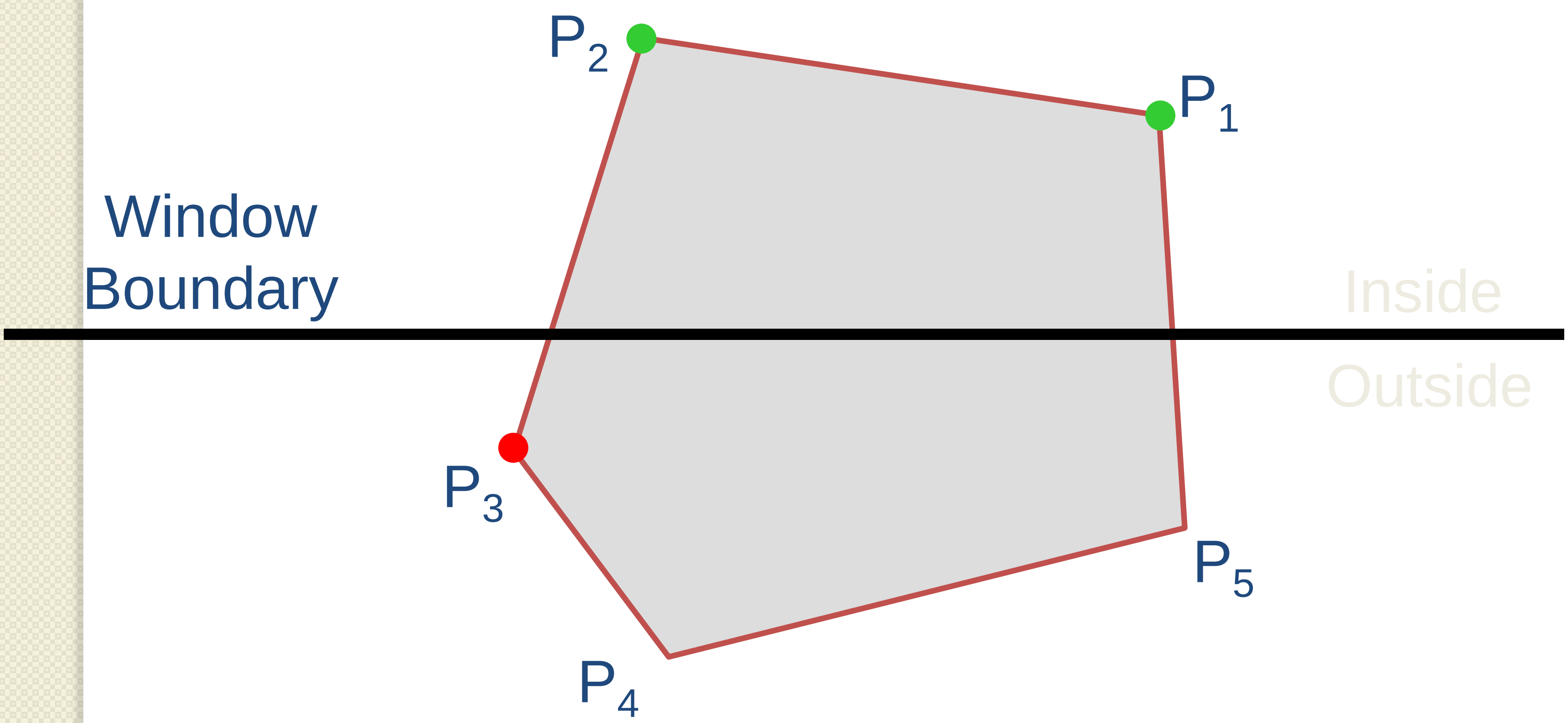
Clipping to a Boundary

- 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,
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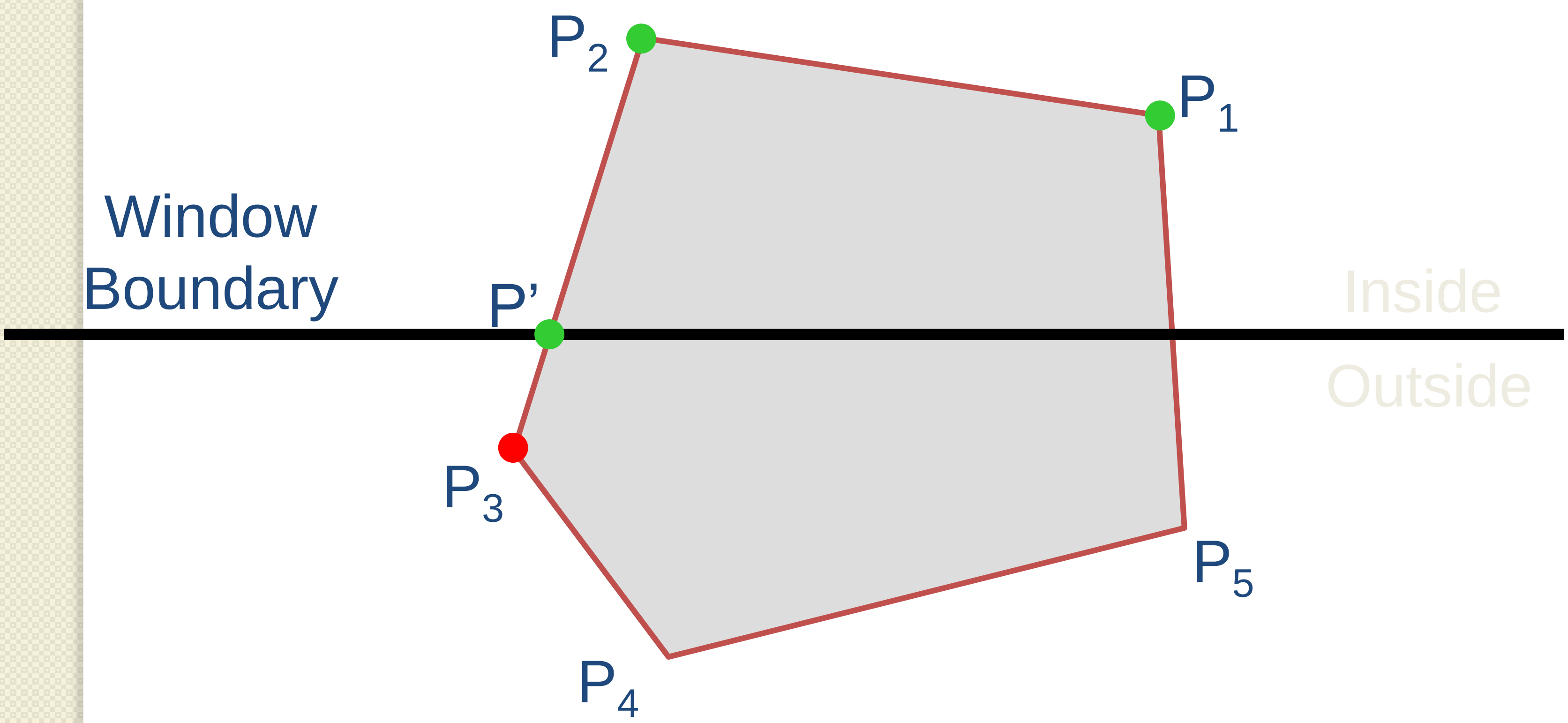
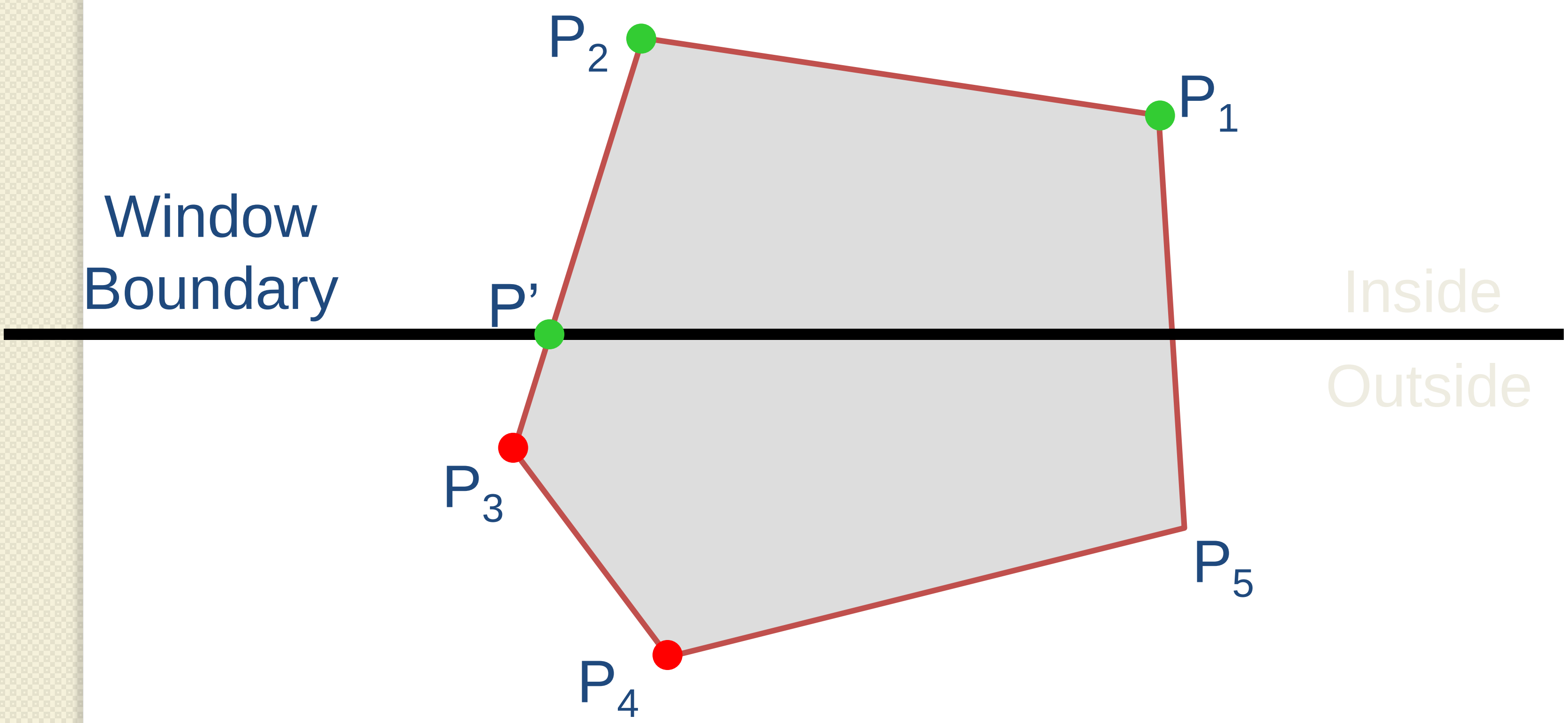
  Remove points outside window boundary



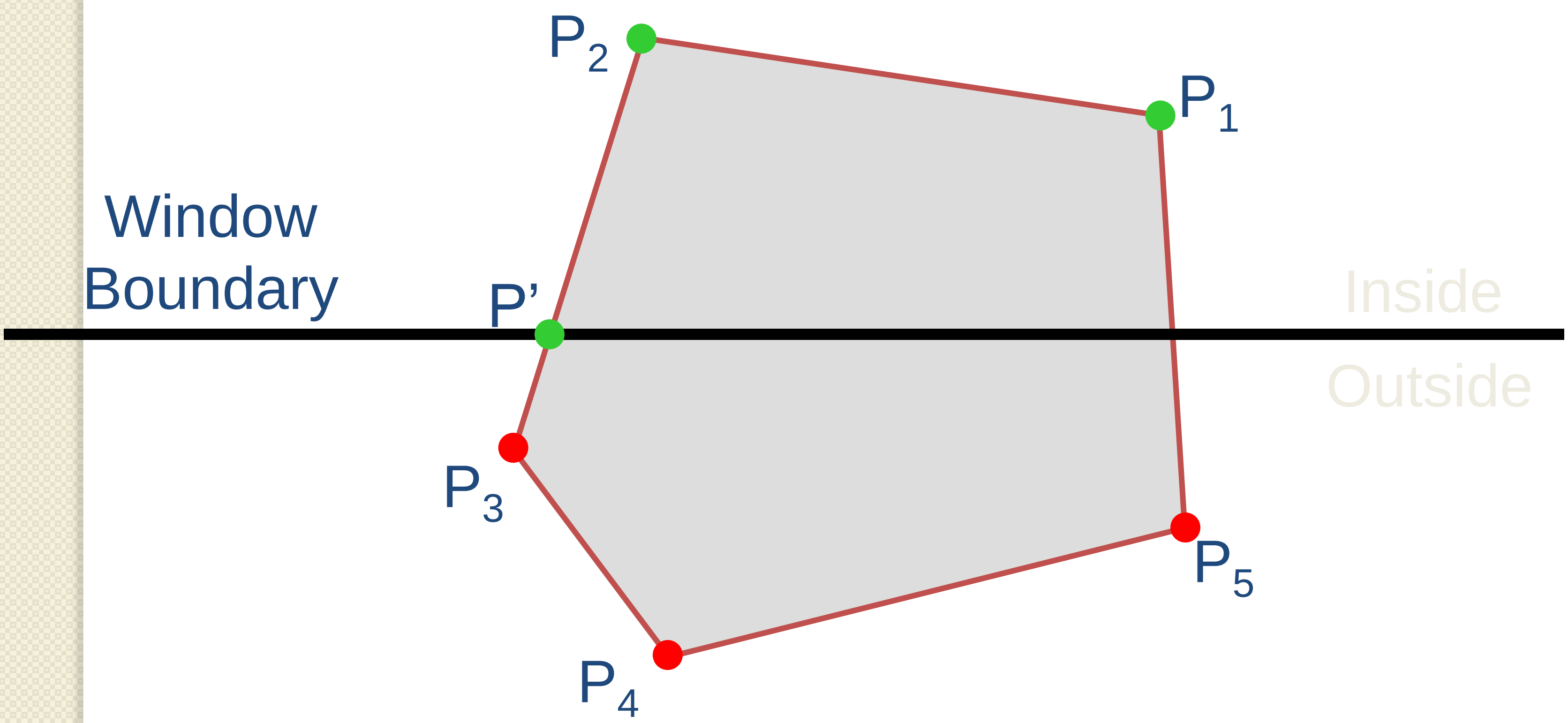
Clipping to a Boundary

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



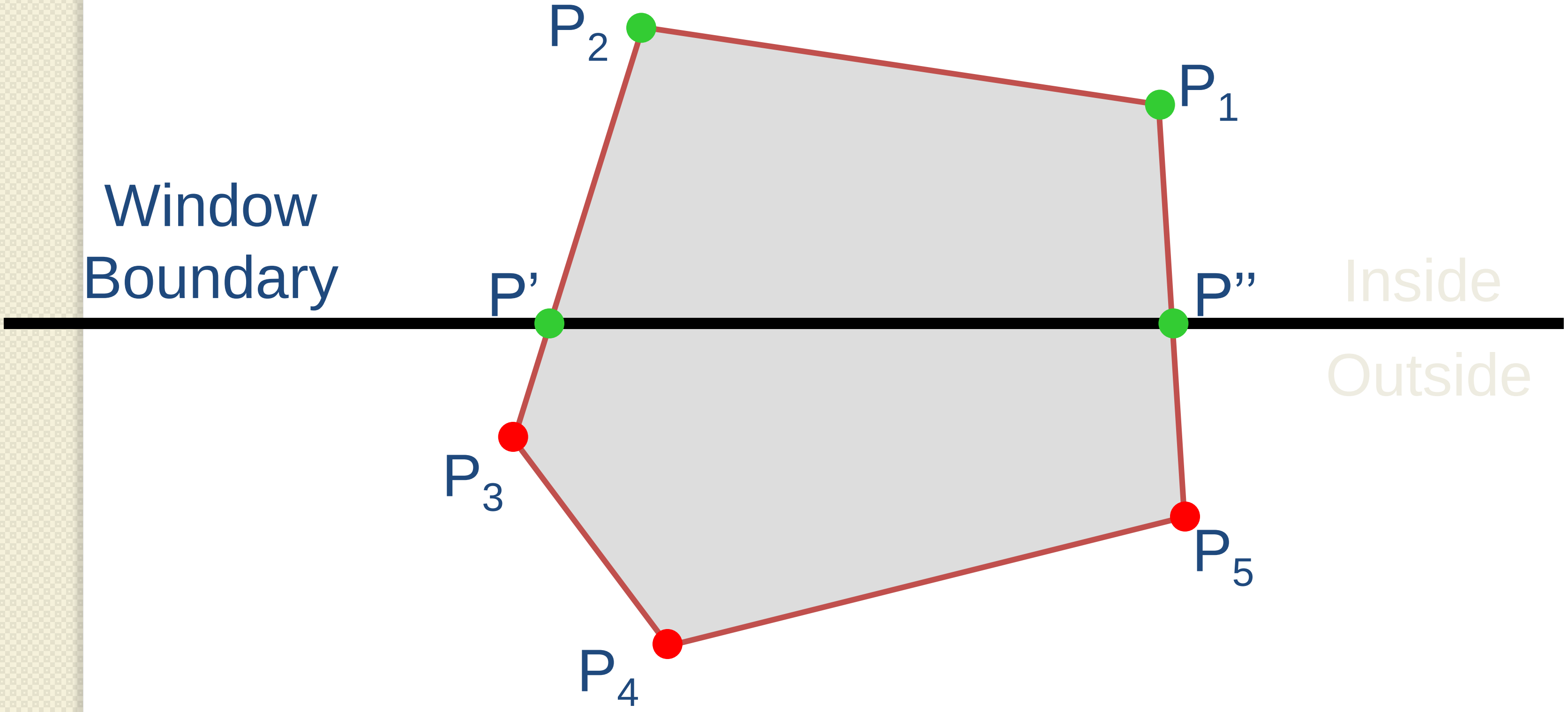
Clipping to a Boundary

- 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,
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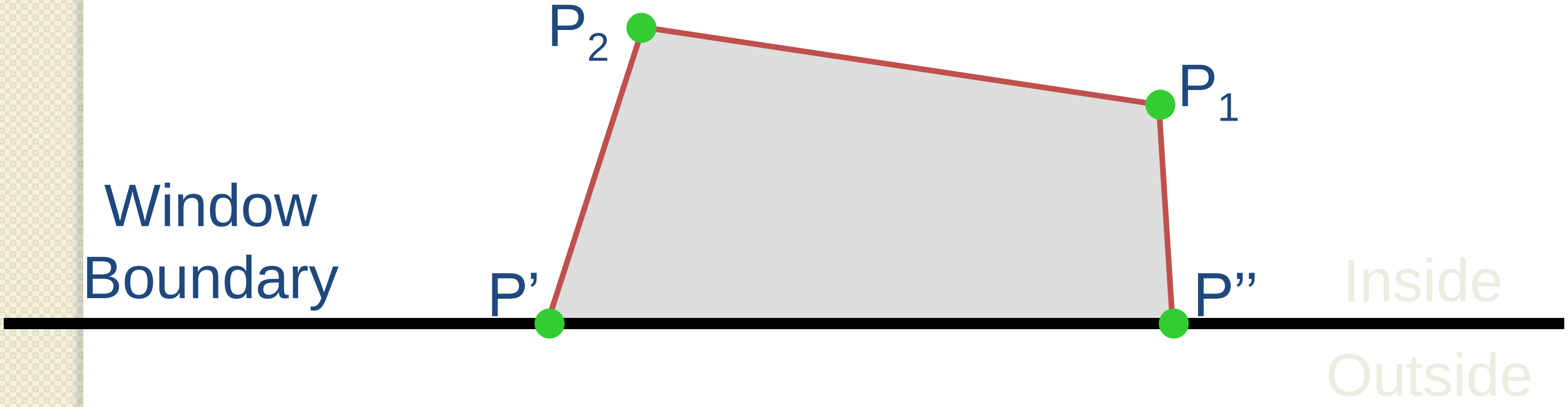
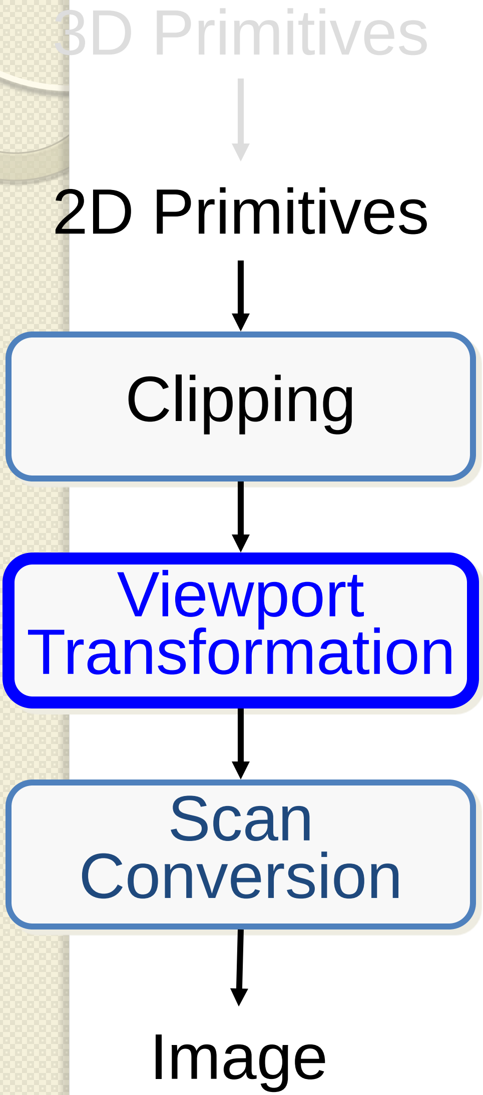
  Remove points outside window boundary



2D Rendering Pipeline



3D Primitives

2D Primitives

Clipping

Viewport Transformation

Scan Conversion

Image

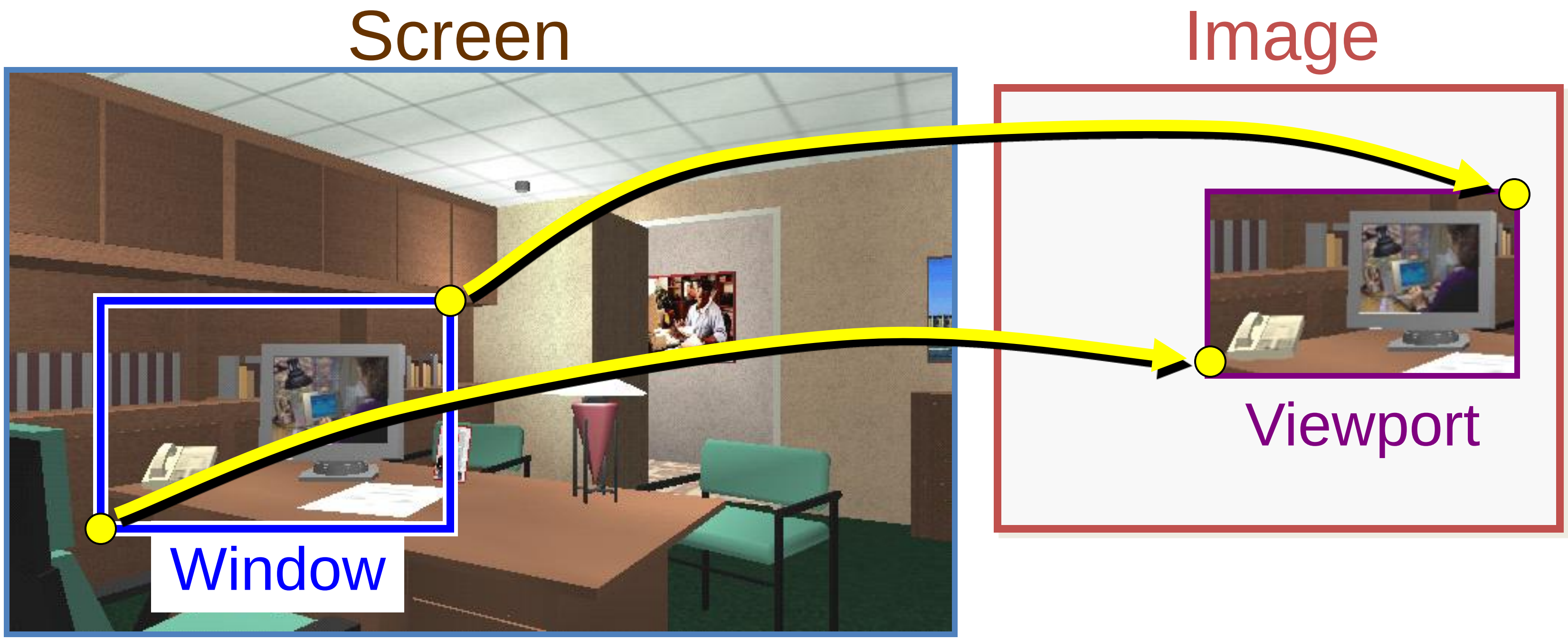
Clip portions of geometric primitives residing outside the window

Transform the clipped primitives from screen to image coordinates

Fill pixels representing primitives in screen coordinates

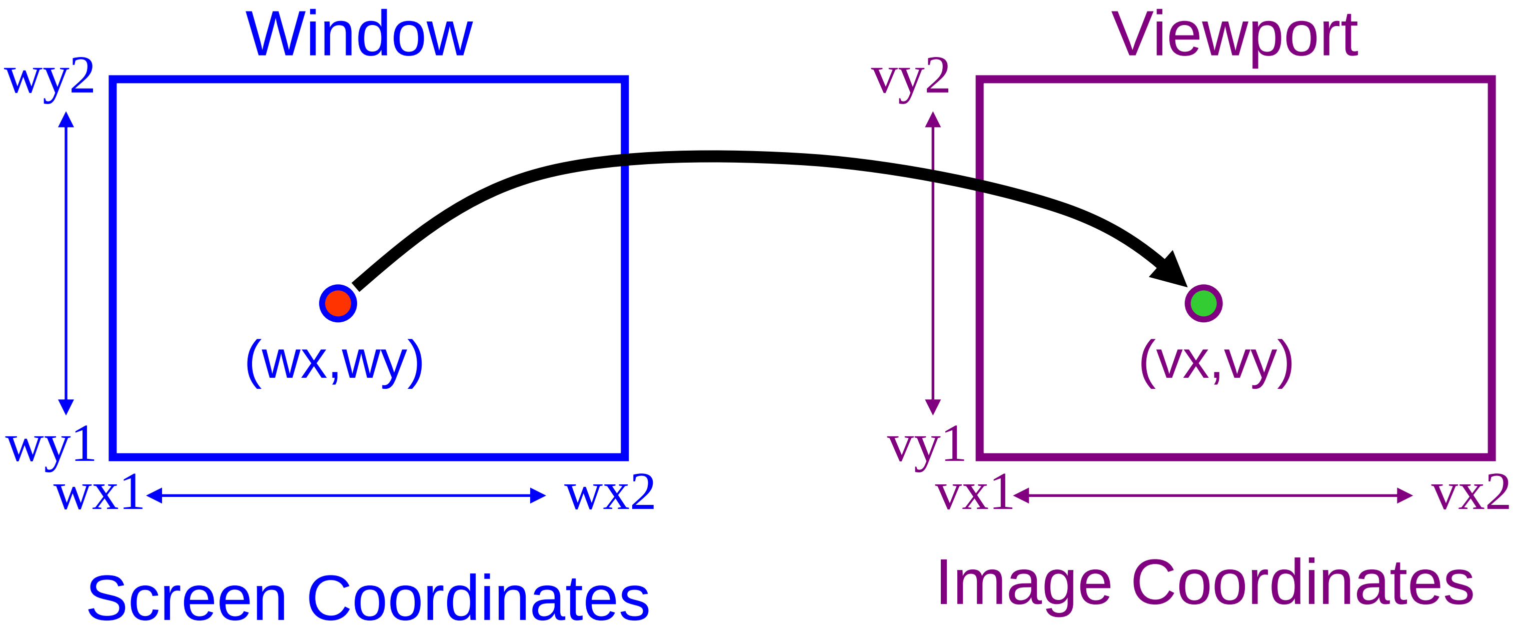
Viewport Transformation

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



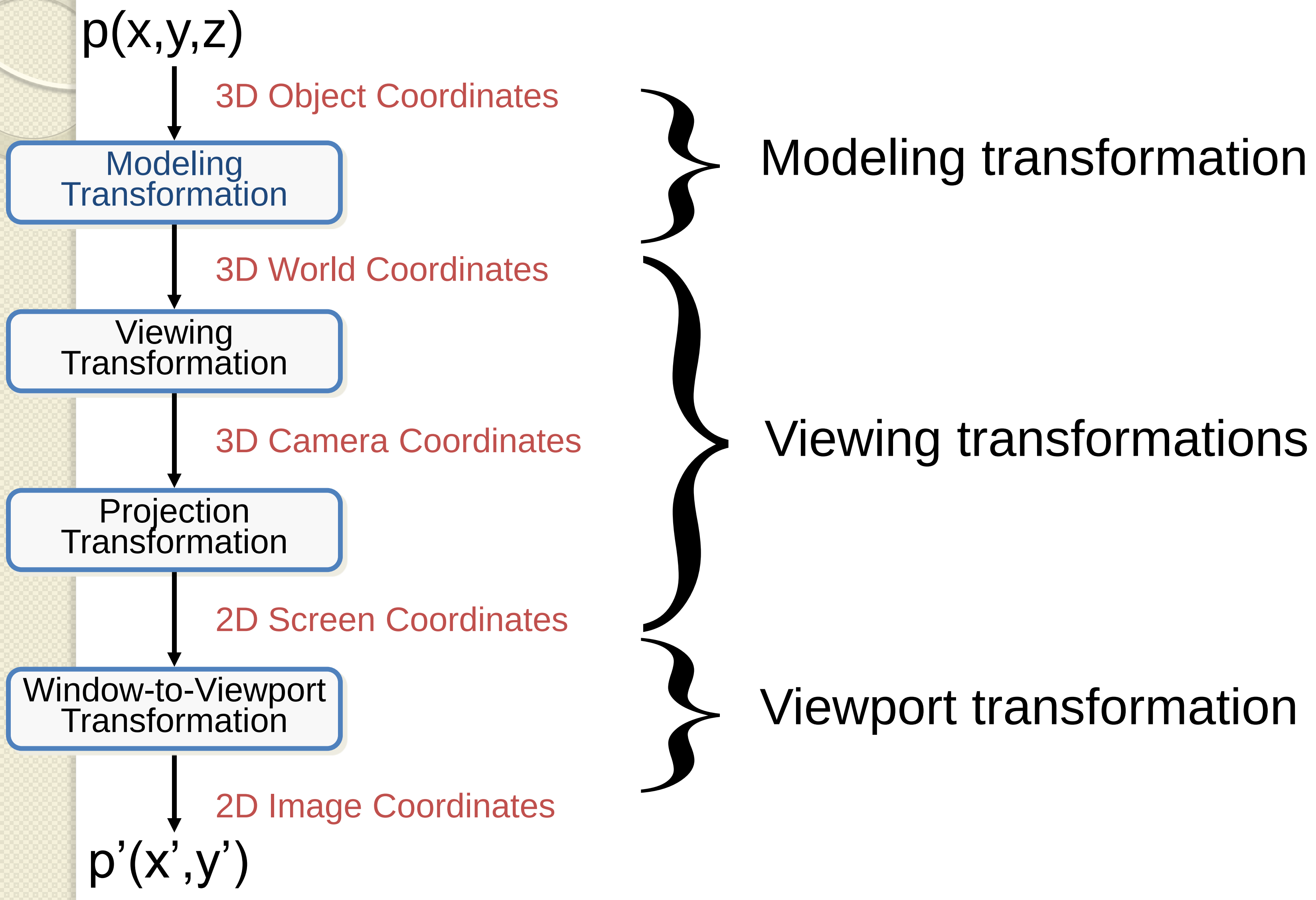
Viewport Transformation

- Window-to-viewport mapping



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

Summary of Transformations



p(x,y,z)

3D Object Coordinates

Modeling Transformation

3D World Coordinates

Viewing Transformation

3D Camera Coordinates

Projection Transformation

2D Screen Coordinates

Window-to-Viewport Transformation

2D Image Coordinates

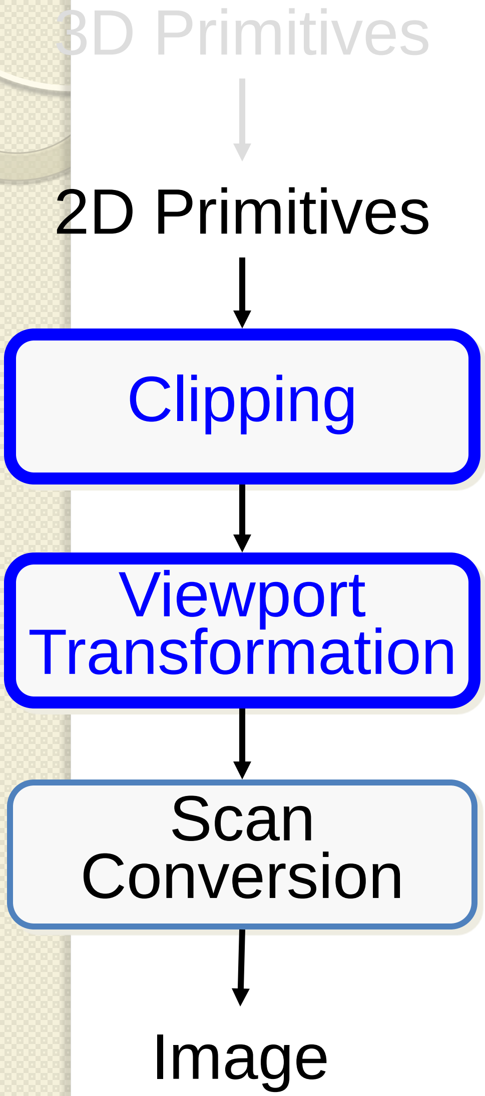
p’(x’,y’)

Modeling transformation

Viewing transformations

Viewport transformation

Summary



3D Primitives

2D Primitives

Clipping

Viewport Transformation

Scan Conversion

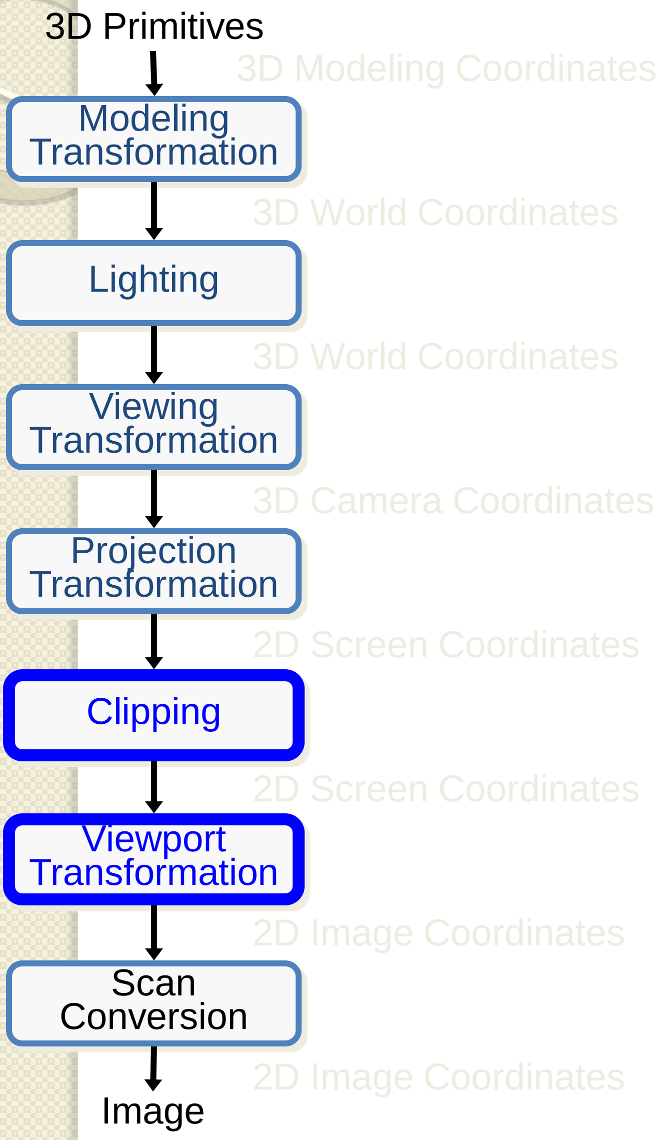
Image

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

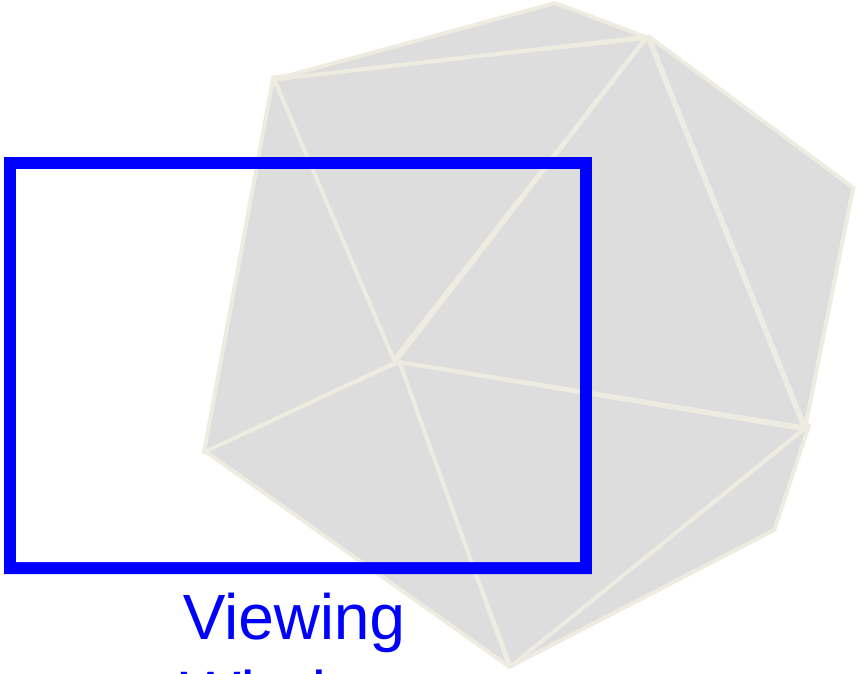
Viewport Transformation

2D Image Coordinates

Scan Conversion

2D Image Coordinates

Image



Viewing Window