Window to Viewport Mapping

This notebook introduces the transformation from window coordinates to the viewport coordinates.

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Definitions

World Coordinate - Is the space in which the objects are defined.

Screen Coordinate - The screen space in which the image is displayed.

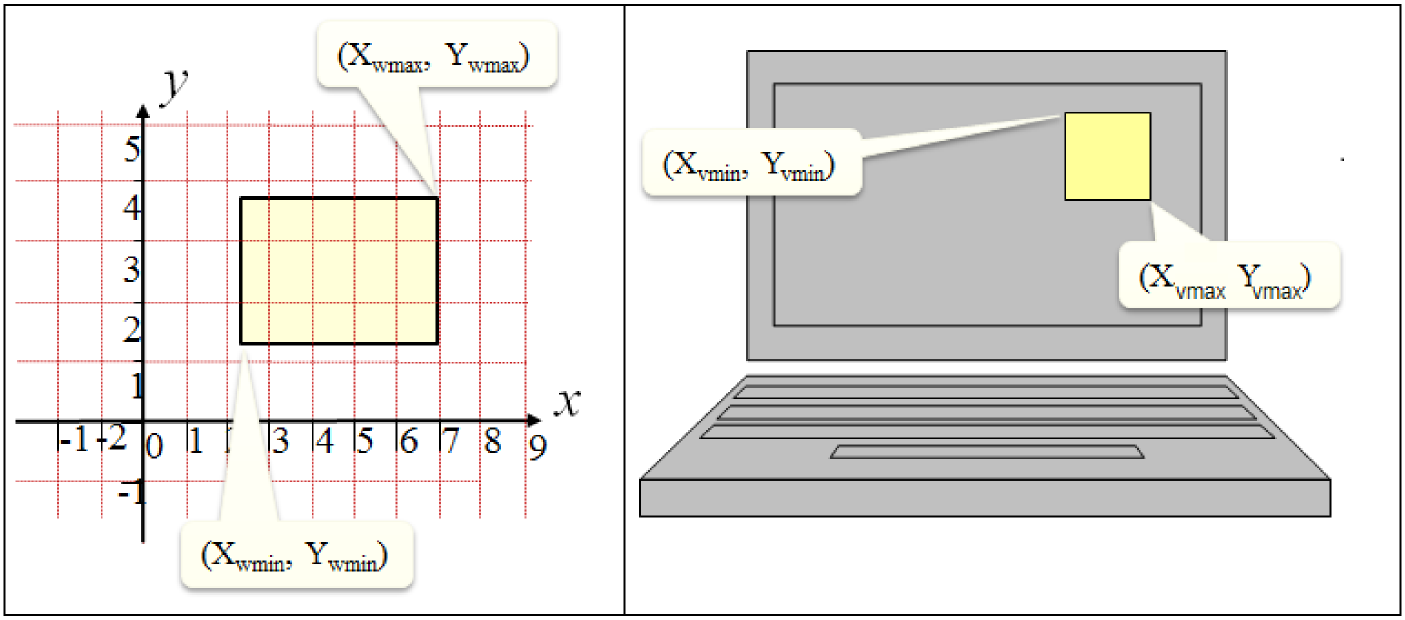
Window - Is the rectangle in the world coordinates defining the region that is to be displayed. This rectangle is also used for 2-dimensional clipping..

Viewport - The rectangular portion of the screen that defines where the image should appear.

Window to Viewport Mapping (Transformation)

The window to viewport mapping is the process of mapping a world window in World Coordinates to the Viewport coordinates which is in screen coordinates.

Window and viewport coordinates are usually specified by giving the minimums and maximums of x and y of the opposite corners.



Notes:

- Window coordinates are real numbers while viewport coordinates are integers (because they are pixels on screen).
- The origin of the device (screen) coordinate system is usually at the upper left corner (positive y axis is downward).
- Normalized viewport coordinates are defined as the ratio of the viewport coordinates to the resolution of the monitor.

Mathematics of Mapping Window to Viewport

Given:

(X_{wmin}, Y_{wmin}) and (X_{wmax}, Y_{wmax}), the coordinates of the two opposite corners of the window.

(X_{vmin}, Y_{vmin}) and (X_{vmax}, Y_{vmax}), the coordinates of the two opposite corners of the viewport.

2D world coordinates of point $P = \begin{bmatrix} x \\ y \end{bmatrix}$;

Find the coordinates of the corresponding point in the viewport $P' = \begin{bmatrix} x' \\ y' \end{bmatrix}$.

Solution:

- Find the distance between point p and left boundary of window $d_x = (x - X_{wmin})$
- Calculate the ratio of the viewport width to the window width $s_x = \frac{(X_{vmax} - X_{vmin})}{(X_{wmax} - X_{wmin})}$
- Scale d_x by s_x to find the distance of point p' from the left boundary of the viewport $d'_x = d_x s_x$
- Add d'_x to X_{vmin} to find the screen x coordinate of the point p' : $x' = X_{vmin} + d'_x$

In a similar manner, you can find y'. But it's critical to notice that in the screen coordinates, the y-component increases in the downward direction.

- Find the distance between point p and **top** boundary of window $d_y = (Y_{wmax} - y)$
- Calculate the ratio of the viewport height to the window height $s_y = \frac{(Y_{vmax} - Y_{vmin})}{(Y_{wmax} - Y_{wmin})}$
- Scale d_y by s_y to find the distance of point p' from the top boundary of the viewport $d'_y = d_y s_y$
- Add d'_y to Y_{vmin} to find the screen y coordinate of the point p' : $y' = Y_{vmin} + d'_y$

In [1]:
```
# Assuming a point in the world coordinate system
pwx=5.2
pwy=0.2
# Define window coordinates
xwmin=-1000.6
xwmax=20
ywmin=1.9
ywmax=10
# Define normalized viewport coordinates
nxvmin=.1
nxvmax=.5
nyvmin=.1
nyvmax=.6
# Define screen resolution
screen_width=1920
screen_height=1080
# Find actual viewport coordinates
xvmin=int(nxvmin*screen_width)
xvmax=int(nxvmax*screen_width)
yvmin=int(nyvmin*screen_height)
yvmax=int(nyvmax*screen_height)
# Calculate screen coordinates of point p
sx=(xvmax-xvmin)/(xwmax-xwmin)
psx=xvmin+int(sx*(pwx-xwmin))
sy=(yvmax-yvmin)/(ywmax-ywmin)
psy=yvmin+int(sy*(ywmax-pwy))

print("World coordinates of point p is = ", pwx," , ",pwy, " Screen coordinate
s of point p is = ",psx," , ",psy)
```

```
World coordinates of point p is =  5  ,  2  Screen coordinates of point p is
=  576  ,  588
```