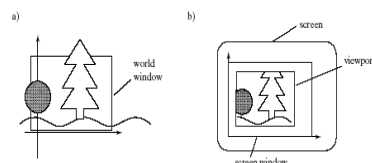


Computer Graphics

Drawing Tools

Window to Viewport Mapping

- [WinToViewMap page](#)



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Coordinate Systems Example

- We want to graph $\text{sinc}(x) = \frac{\sin(\pi x)}{\pi x}$
- $\text{Sinc}(0) = 1$ by definition. Interesting parts of the function are in $-4.0 \leq x \leq 4.0$.
- What should be the world coordinates?
- What should be the viewport?



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GL Functions To Create the Map

- World window:
`void gluOrtho2D(GLdouble left, GLdouble right, GLdouble bottom, GLdouble top);`
- Viewport:
`void glViewport(GLint x, GLint y, GLint width, GLint height);`

This sets the lower left corner of the viewport, along with its width and height.

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GL Functions To Create the Map

- Because OpenGL uses matrices to set up all its transformations, the call to `gluOrtho2D()` must be preceded by two setup functions:

```
glMatrixMode(GL_PROJECTION);
glLoadIdentity();
```

```
gluOrtho2D(-10, 10, -6, 6);
glViewport(0, 0, 600, 400);
```

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setWindow and setViewport

- For a uniform set of parameters, the `setWindow` and `setViewport` functions can be defined:

```
void setWindow(GLdouble left, GLdouble right, GLdouble bottom, GLdouble top)
{
    glMatrixMode(GL_PROJECTION);
    glLoadIdentity();
    gluOrtho2D(left, right, bottom, top);
}

void setViewport(GLint left, GLint right, GLint bottom, GLint top)
{
    glViewport(left, bottom, right - left, top - bottom);
}
```

- Calls: `setWindow(-5.0, 5.0, -0.3, 1.0);`
`setViewport(0, 640, 0, 480);`

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Scaling and Translating

Window to viewport

mapping :

$$v_x = s_x w_x + t_x$$

$$v_y = s_y w_y + t_y$$

Translation factor :

$$t_x = \frac{w_{right} v_{left} - w_{left} v_{right}}{w_{right} - w_{left}} = v_{left} - s_x * w_{left}$$

$$t_y = \frac{w_{top} v_{bottom} - w_{bottom} v_{top}}{w_{top} - w_{bottom}} = v_{bottom} - s_y * w_{bottom}$$

Scaling factor :

$$s_x = \frac{v_{right} - v_{left}}{w_{right} - w_{left}}$$

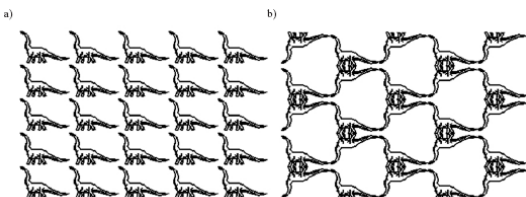
$$s_y = \frac{v_{top} - v_{bottom}}{w_{top} - w_{bottom}}$$

Window-to-Viewport Mapping

- Find the values for A, B, C, and D for the given setup
 - World Window (-10,10,-6,6)
 - Viewport (0,600,0,400) (left, right, bottom, top)
 - Is the aspect ratio in the world preserved in the viewport?
 - Aspect ratio = width/height
- For a point (5, 2) in the world window, what are the corresponding coordinates (x_v , y_v) in the viewport?

Application: Tiling with Viewports

- With a draw function that draws one dinosaur, how to produce the following these tiling picture?



Applications (continued)

```
// set a fixed window
setWindow(0, 640.0, 0, 440.0);
for (int i = 0; i < 5; i++) // for each column
    for (int j = 0; j < 5; j++)
    {
        // for each row
        glViewport (i*128, j*88, 128, 88);

        // set the next viewport
        drawPolylineFile("dino.dat"); // draw it again
    }
```

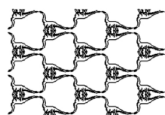


Applications (continued)

```
for (int i = 0; i < 5; i++)
    for (int j = 0; j < 5; j++)
    {
        // for each row
        if ((i + j) % 2 == 1)
            setWindow(0.0, 640.0, 0.0, 440.0);
        else
            setWindow(0.0, 640.0, 440.0, 0.0); // turn the window
            // upside-down

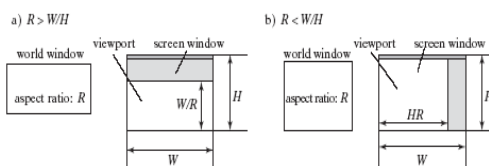
        glViewport (i*128, j*88, 128, 88);

        // no distortion
        drawPolylineFile("dino.dat");
    }
```



Automatic Aspect Ratio Preservation for Viewports

$$\text{aspect ratio } (R) = \frac{\text{Width}}{\text{Height}}$$



We want the largest viewport which preserves the aspect ratio R of the world window.

Resizing the Screen Window

- Users are free to alter the size and aspect ratio of the screen window.
- You may want GL to handle this event so that your drawing does not get distorted.
- Register the reshape callback function:
 - `glutReshapeFunc (myReshape);`
- `void myReshape (GLsizei W, GLsizei H);` collects the new width and height for the window.
 - Should you modify the window or viewport?

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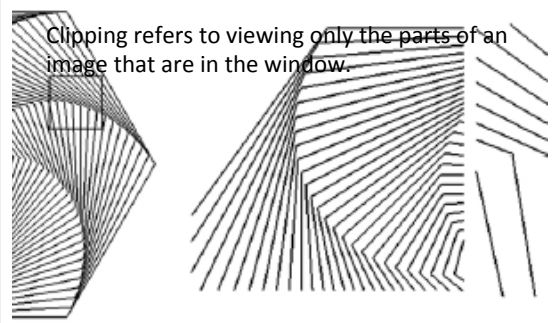
Preserving Aspect Ratio

- We want the largest viewport which **preserves the aspect ratio R of the world window**.
- Suppose the screen window has width W and height H :
 - If $R > W/H$, the viewport should be width W and height W/R
 - If $R < W/H$, the viewport should be width $H*R$ and height H
 - What happens if $R = W/H$?

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Application: Clip, Zoom and Pan

Clipping refers to viewing only the parts of an image that are in the window.



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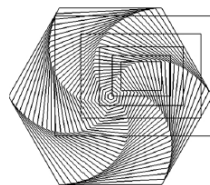
Application (continued)

- The figure is a collection of concentric hexagons of various sizes, each rotated slightly with respect to the previous one. It is drawn by a function called `hexSwirl ();`
- The figure showed 2 choices of world windows.
- We can also use world windows for zooming and roaming (panning).
- How to change the windows to zoom?
- How to change the windows to pan?

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Zooming and Panning

- To zoom, we pick a concentric set of windows of decreasing size and display them from outside in.




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Zooming and Roaming

- The animation of the zoom will probably not be very smooth.
- We want to look at one drawing while the next one is drawn
 - then switch to the new drawing.
- We use `glutInitDisplayMode (GLUT_DOUBLE | GLUT_RGB);`
 - gives us 2 buffers, one to look at and one to draw in
- We add `glutSwapBuffers();` after the call to `hexSwirl ();` // change to the new drawing

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Roaming (Panning)

- To roam, or pan, we move a viewport through various portions of the world. This is easily accomplished by translating the world window to a new position.

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