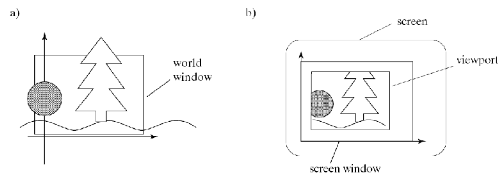
Clipping

- We only want to draw the objects that we can see in the viewport
- Need to calculate the intersection between the clipping window and lines, polygons etc.

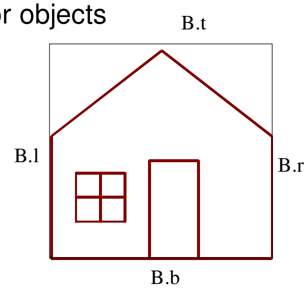


Clipping

- Should we clip against window or against the viewport?

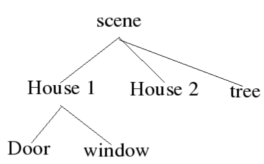
Bounding Boxes

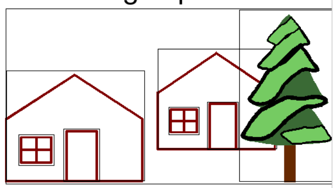
- To decide whether clipping is needed construct bounding boxes for objects



Hierarchical Bounding Boxes

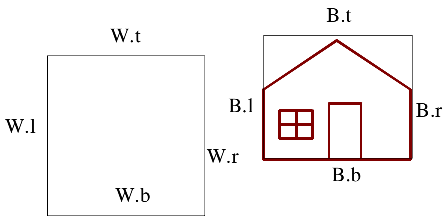
- Group objects together in scene graph and construct bounding boxes for the groups.





Trivial reject

- Nothing to draw if box is to right of window, i.e B.l > W.r



Trivial reject

- Or box is to left of window: B.r < W.l
- Or box is above window: B.b > W.t
- Or box is below window: B.t < W.b

Trivial Accept

- If box is completely inside window, no clipping is required, we can just draw the object
- B.l>W.l and B.r<W.r and B.t<W.t and B.b>W.b

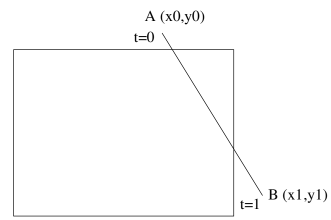
Clip pseudocode

```
Clip b against w {
  if b.l > w.r then return;
  if b.r < w.l then return;
  if b.b > w.t then return;
  if b.t < w.b then return;

  if b.l > w.l && b.r < w.r &&
     b.b > w.b && b.t < w.t
    then draw without clipping
    else clip each child of b against w;
}
```

Line clipping

- Liang-Barsky algorithm
- Work in parameter space (t coordinates in a parametric representation



Solving inequalities

$L(t) = A + Dt\,,\ 0 \le t \le 1, D = B - A$

The line must be below the top side of the window, so

$$L(t)_y < w_t$$
$$(A + Dt)_y < w_t$$
$$y_0 + (y_1 - y_0) t < w_t$$
$$t < (w_t - y_0)/(y_1 - y_0) = \alpha_{0,} \mathit{if}\ (y_1 - y_0) > 0$$
$$t > \alpha_{0,} \mathit{if}\ (y_1 - y_0) < 0$$

Solving inequalities

- If $t > \alpha_0$ we can combine the two inequalities $t > \alpha_0$ and $t > 0$ to get $t > max(\alpha_0, 0)$
- If $t < \alpha_0$ we get $t < min(\alpha_0, 1)$
- Each side of the window gives a new inequality. If α_0 and α_2 (say) are upper bounds for t, get
  $\alpha = max(0, \alpha_0, \alpha_2) < t < min(1, \alpha_1, \alpha_3) = \beta$
- If $\beta < \alpha$ line is completely outside window