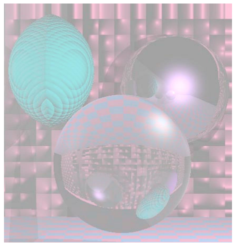
2D Clipping

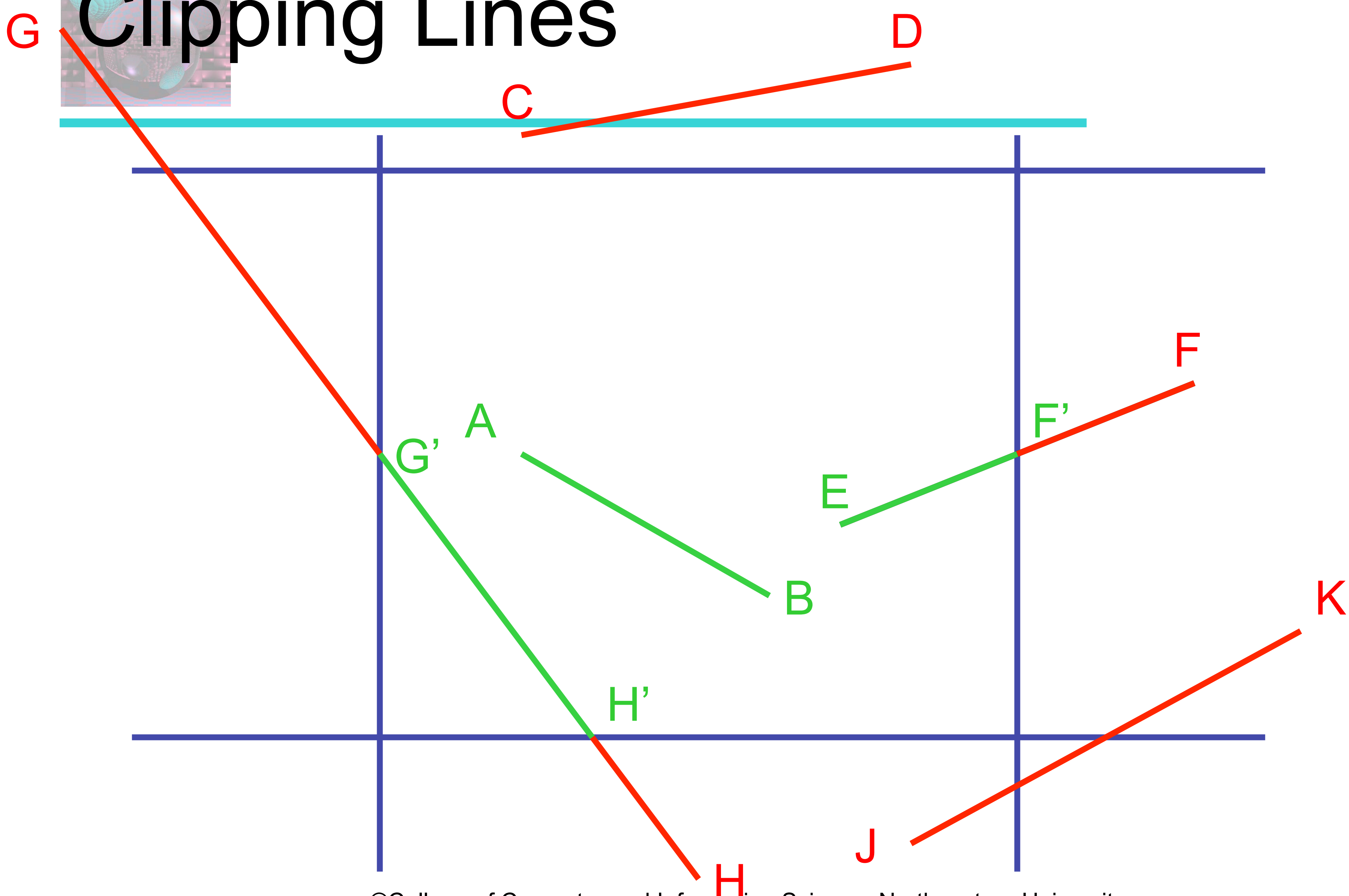


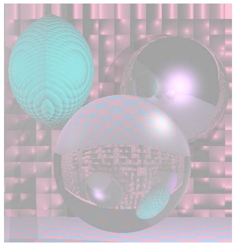
CS 4300
Computer Graphics

Professor Fell

October 18, 2012

Clipping Lines





Intersections

We know how to find the intersections of a line segment

$$P + t(Q-P)$$

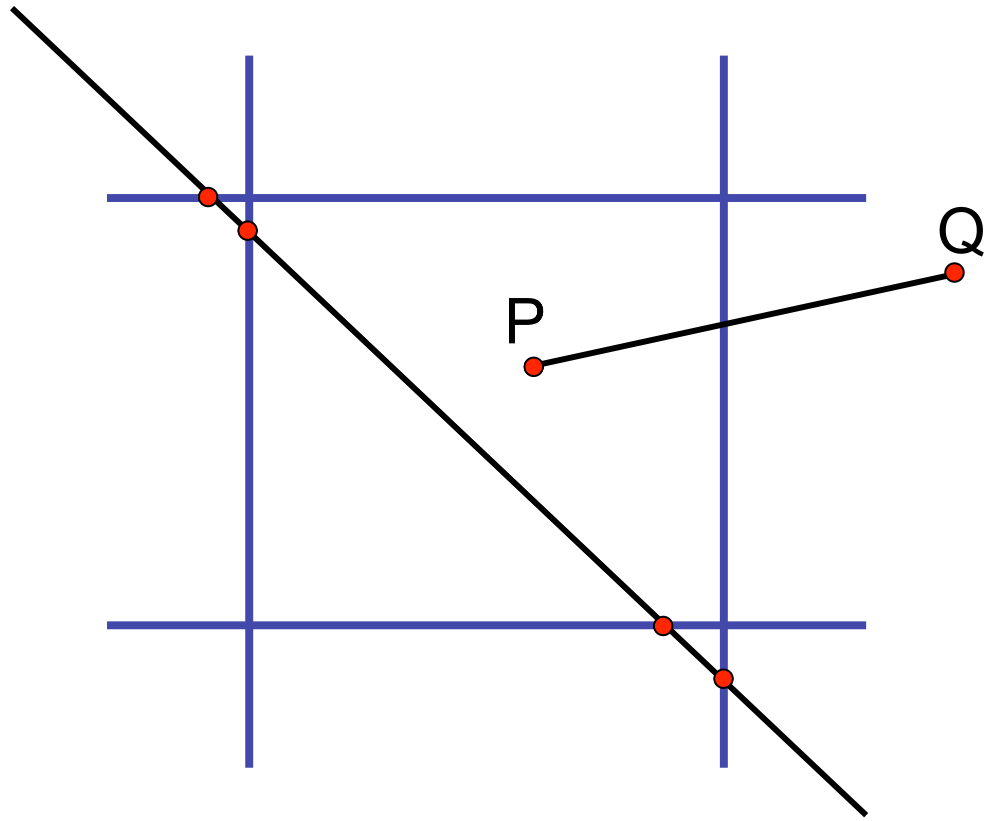
with the 4 boundaries

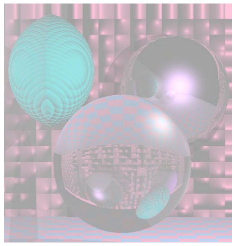
$x = xmin$

$x = xmax$

$y = ymin$

$y = ymax$





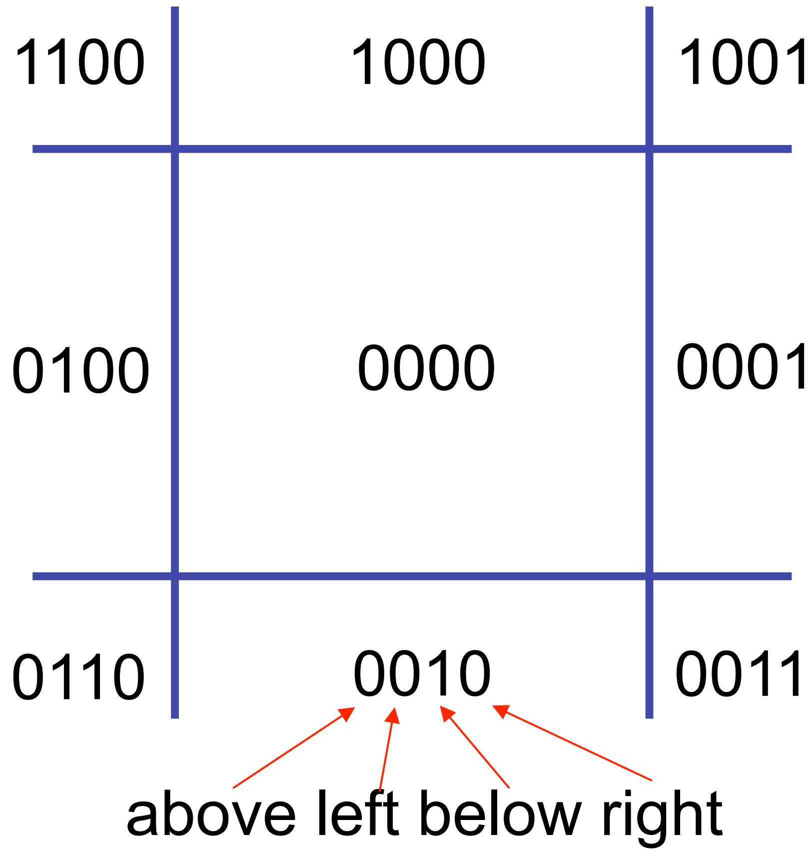
Cohen-Sutherland Clipping

1. Assign a 4 bit *outcode* to each endpoint.
2. Identify lines that are trivially accepted or trivially rejected.

if (outcode(P) = outcode(Q) = 0)
    accept

else if (outcode(P) & outcode(Q)) ≠ 0) reject

else test further



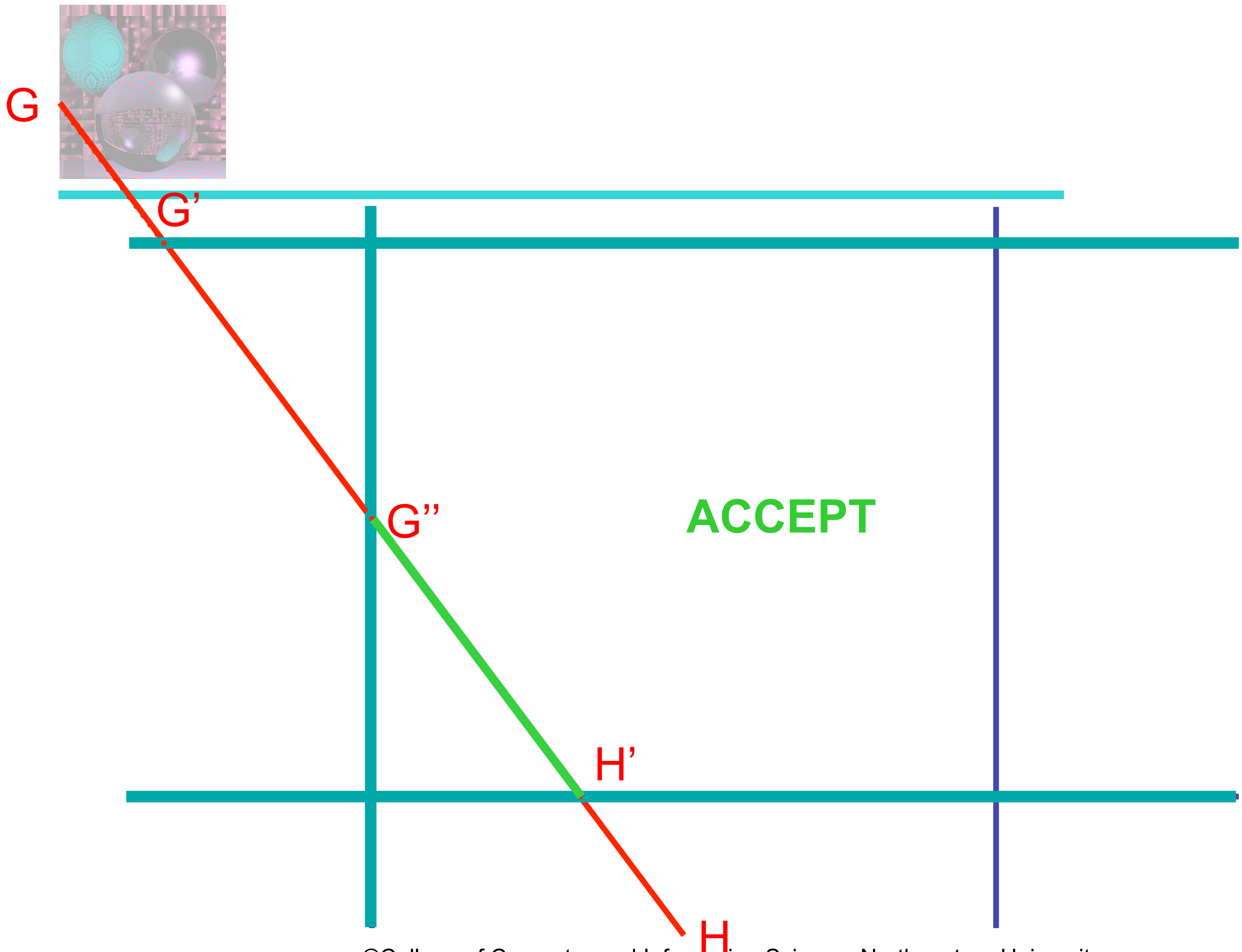
Cohen-Sutherland continued

Clip against one boundary at a time, **top**, left, bottom, right.

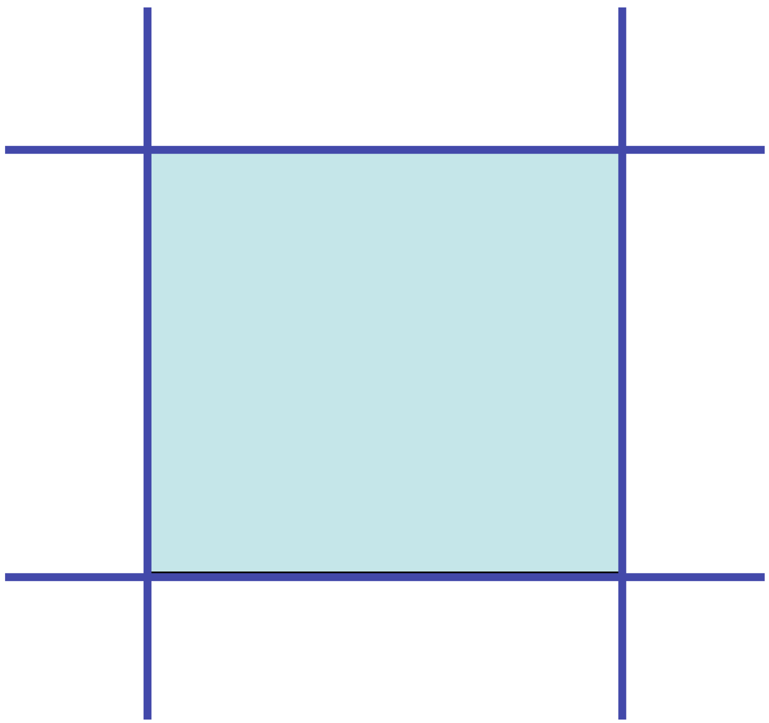
Check for trivial accept or reject.

If a line segment PQ falls into the "test further" category then

```
if (outcode(P) & 1000 ≠ 0)
        replace P with PQ intersect y = top
else if (outcode(Q) & 1000 ≠ 0)
        replace Q with PQ intersect y = top
go on to next boundary
```


G
G'
G''
ACCEPT
H'
H

Liang-Barsky Clipping

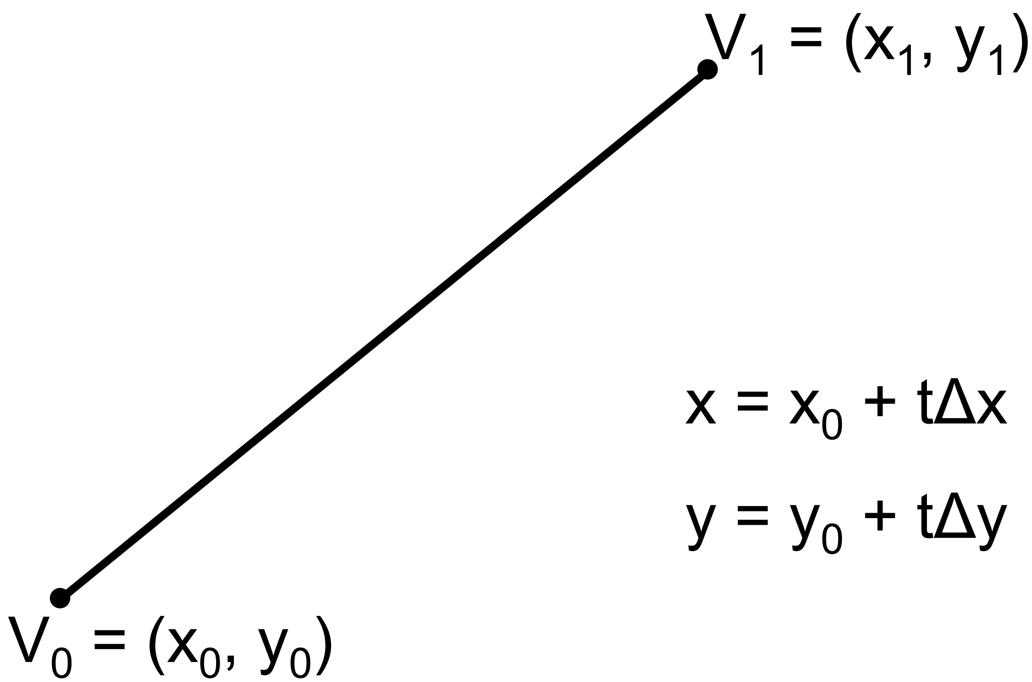


Clip window interior is defined by:

$$xleft \le x \le xright$$

$$ybottom \le y \le ytop$$

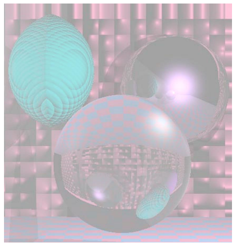
Liang-Barsky continued



$x = x_0 + t\Delta x$ $\Delta x = x_1 - x_0$

$y = y_0 + t\Delta y$ $\Delta y = y_1 - y_0$

$t = 0$ at V_0 $t = 1$ at V_1



Liang-Barsky continued

Put the parametric equations into the inequalities:

$xleft \leq x_0 + t\Delta x \leq xright$

$ybottom \leq y_0 + t\Delta y \leq ytop$

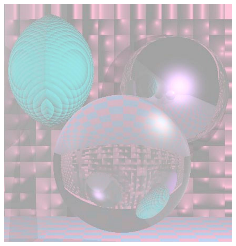
$-t\Delta x \leq x_0 - xleft$

$-t\Delta y \leq y_0 - ybottom$

$t\Delta x \leq xright - x_0$

$t\Delta y \leq ytop - y_0$

These decribe the interior of the clip window in terms of t.



Liang-Barsky continued

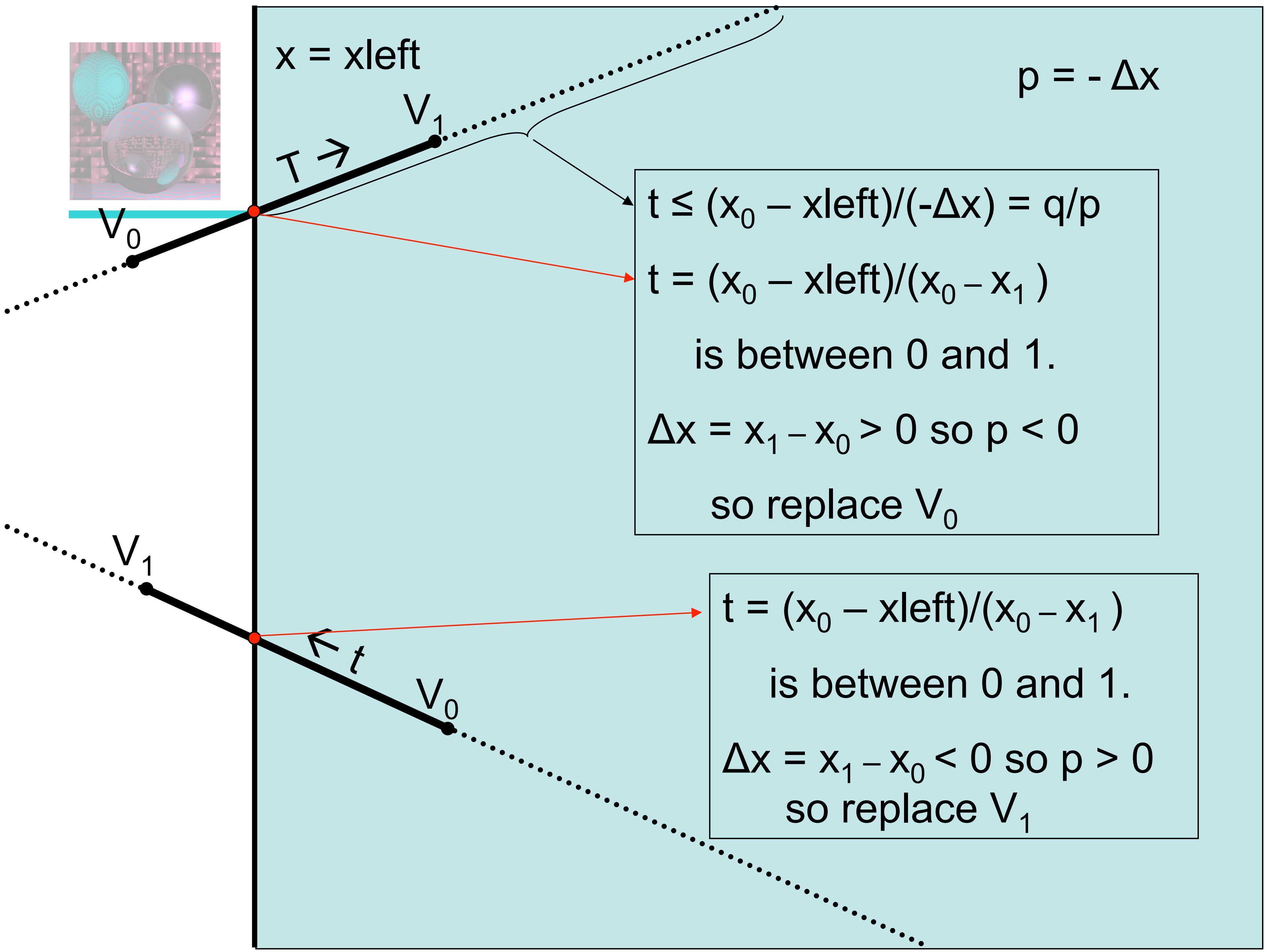
$-t\Delta x \le x_0$ - xleft $\quad$ $t\Delta x \le$ xright $- x_0$

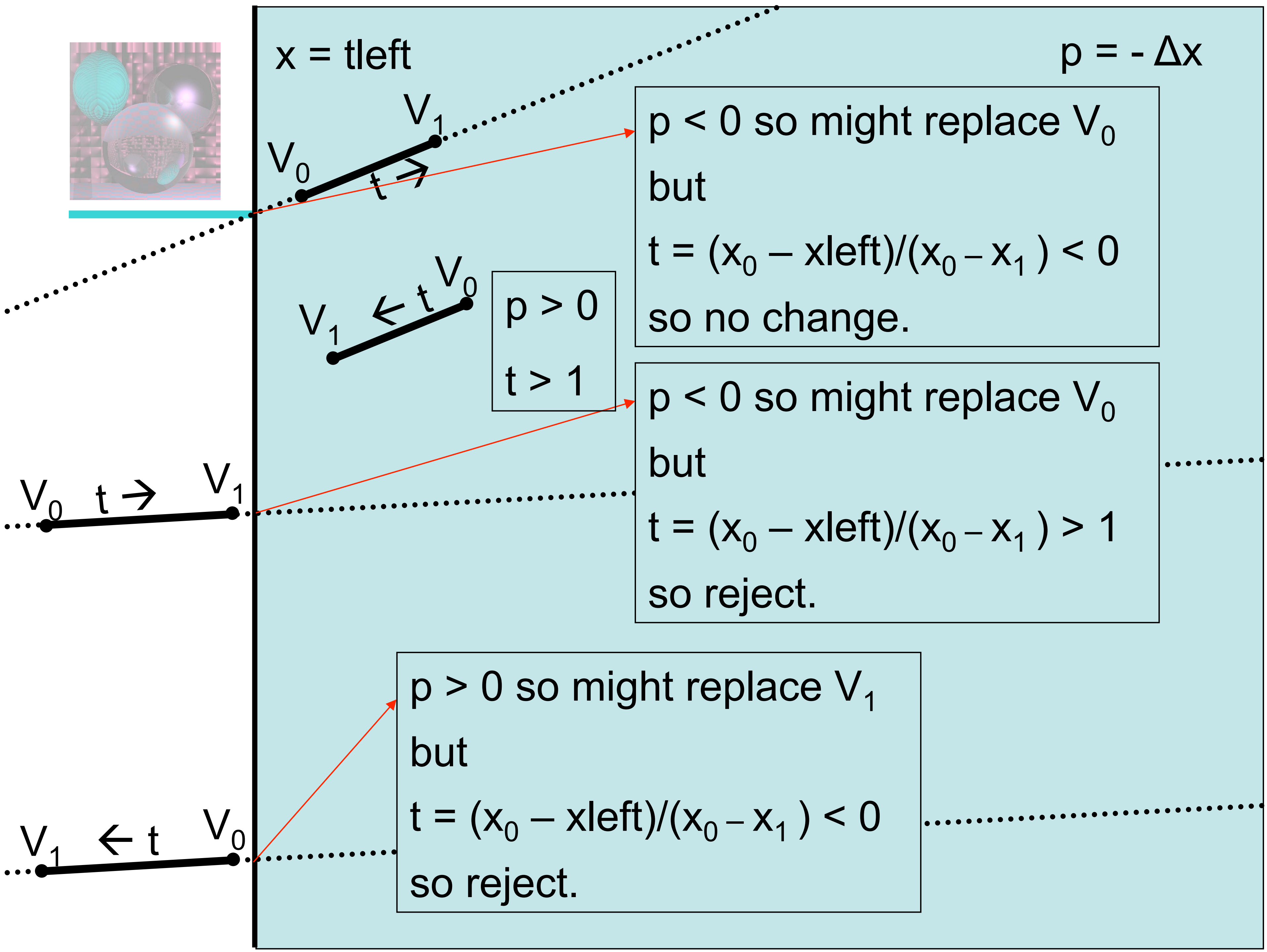
$-t\Delta y \le y_0$ - ybottom $\quad$ $t\Delta y \le$ ytop $- y_0$

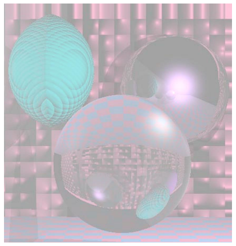
- These are all of the form

  $tp \le q$

- For each boundary, we decide whether to accept, reject, or which point to change depending on the sign of p and the value of t at the intersection of the line with the boundary.


x = xleft
p = - Δx
V_1
T →
V_0
t ≤ (x_0 – xleft)/(-Δx) = q/p
t = (x_0 – xleft)/(x_0 – x_1)
is between 0 and 1.
Δx = x_1 – x_0 > 0 so p < 0
so replace V_0
V_1
← t
V_0
t = (x_0 – xleft)/(x_0 – x_1)
is between 0 and 1.
Δx = x_1 – x_0 < 0 so p > 0
so replace V_1


x = tleft
p = - Δx
V0
V1
t →
p < 0 so might replace V0
but
t = (x0 – xleft)/(x0 – x1) < 0
so no change.
V1
← t
V0
p > 0
t > 1
V0
t →
V1
p < 0 so might replace V0
but
t = (x0 – xleft)/(x0 – x1) > 1
so reject.
V1
← t
V0
p > 0 so might replace V1
but
t = (x0 – xleft)/(x0 – x1) < 0
so reject.



Liang-Barsky Rules

- $0 < t < 1$, $p < 0$ replace V_0
- $0 < t < 1$, $p > 0$ replace V_1

- $t < 0$, $p < 0$ no change
- $t < 0$, $p > 0$ reject

- $t > 1$, $p > 0$ no change
- $t > 1$, $p < 0$ reject