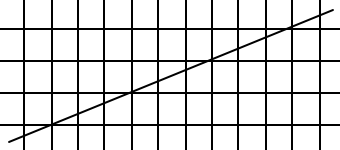
Computer Graphics

Z Sweedyk

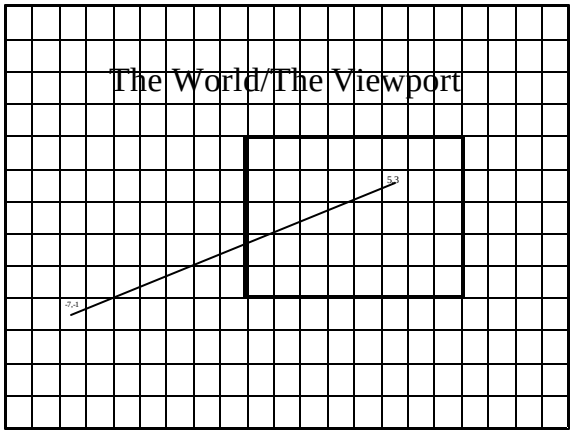
Lecture 3

9/4/00

The World



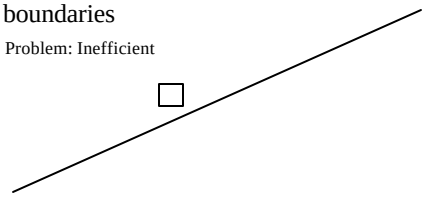
The World/The Viewport



Answer 1: Scissoring

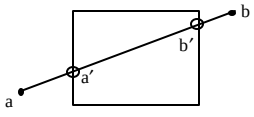
- Compute pixels in world grid
- Then check chosen pixels against viewport boundaries

Problem: Inefficient



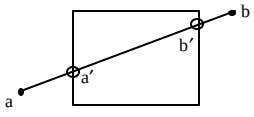
Answer 2: Analytical Clipping

- Compute intersection points
- Scan convert line segment between intersection points



But … a' and b' are not likely to have integer coordinates

1. We could go back to using floating point operations.
2. We could round the endpoint coordinates and scan convert.
3. We could do it the right way.

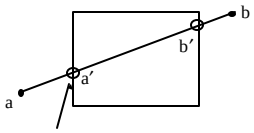


The right way

```
SpecialCaseBresenham's(x1,y1,xfirst,xlast)
   m=y1/x1
   i=xfirst, j=round(m*xfirst)
   d = x1(2*j+1)-2y1(i+1)
   while i<xlast
       write-pixel(i,j)
       if d<0
              i+=1, j+=1, d+=2(x1-y1)
       else
              i+=1, d-=2y1
```

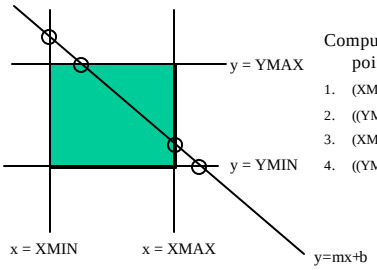
Answer 2: Analytical Clipping

- Compute intersection points
- Scan convert line segment between intersection points



Intersection of lines: y=mx and x=c

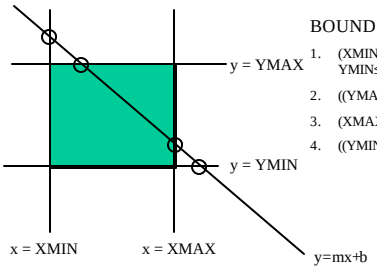
Naïve approach



Compute 4 intersection points:

1. (XMIN, mXMIN+b)
2. ((YMAX-b)/m, YMAX)
3. (XMAX,mXMAX+b)
4. ((YMIN-b)/m,YMIN)

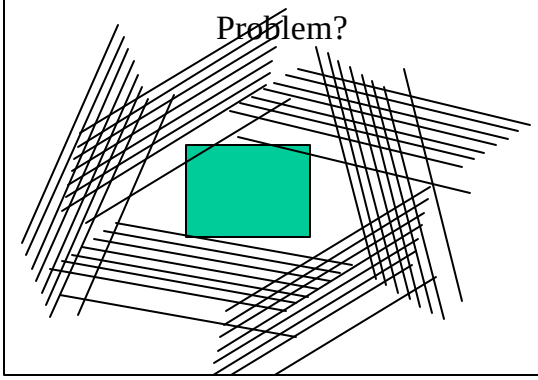
Naïve approach cont.



BOUND CHECK:

1. (XMIN, mXMIN+b): YMIN≤mXMIN+b≤YMAX?
2. ((YMAX-b) /m, YMAX)
3. (XMAX,mXMAX+b)
4. ((YMIN-b)/m,YMIN)

Problem?

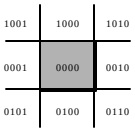


Step 1 - Cohen-Sutherland

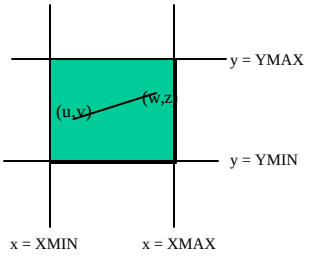
- Assign an "outcode" to each endpoint
- Example:

  Endpoint (u,v) and viewport boundaries: x= Xmin, x= Xmax, y= Ymin, y= Ymax:

  $(v>Y_{max})(v<Ymin)(u>X_{max})(u<Ymin)$



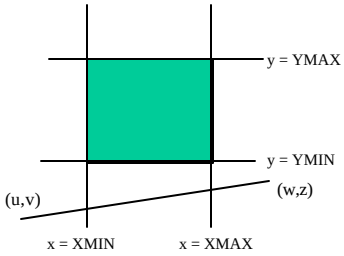
Outcode Example (1)



(u,v):0000

(w,z):0000

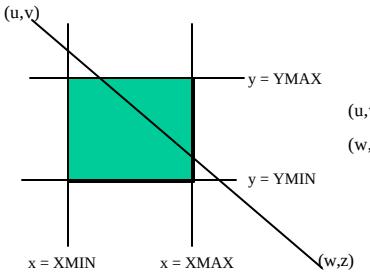
Outcode Example (2)



(u,v):0101

(w,z):0110

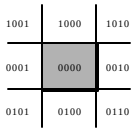
Outcode Example (3)

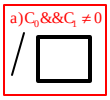


(u,v):1001

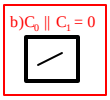
(w,z):0110

Step 1:
Endpoints p_0 and p_1, outcodes C_0 and C_1



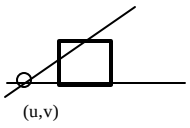


Trivial Reject



Trivial Accept

If Step 1 fails to resolve then Step 2:
Endpoints p_0 and p_1, outcodes C_0 and C_1

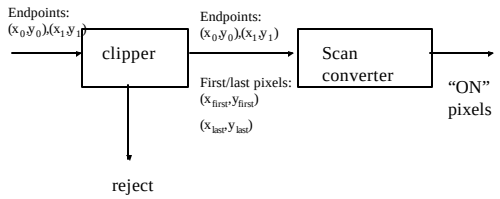


- Choose an "out" endpoint and clip
- Return to step 1 with new line segment
- Example: (u,v) outcode is 0101 so clip to y=YMIN

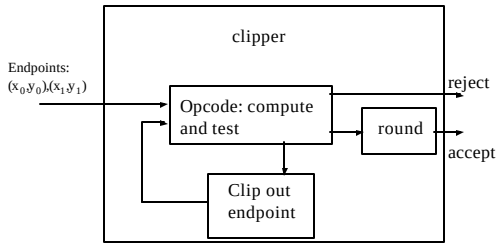
How many clips are needed

- Before reject?
- Before accept?

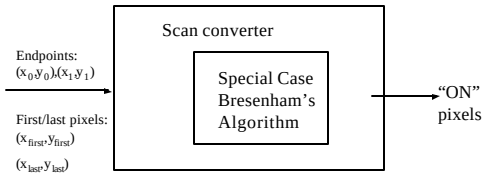
Overview of Scan Conversion



Overview of Clipper



Overview of Scan Converter

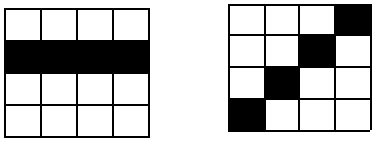


Assignment 1

- Implement Special Case Bresenham's 20
- Generalize to arbitrary lines 35
- Dashed lines obeying endpoint order 10
- Clip to viewport boundaries 15
- Use opcodes 10
- Use iterative opcode test 10

Anti-aliasing (Getting Rid of the Jaggies)

Fundamental Problem: pixel area/ line length



Lab exercise coming up!

Open GL

- OpenGL: Primitive graphics operations
- GLUT: Interactions with window environment

- Lab exercise coming up!