Clipping

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Abstract

This document will outline how you can do line clipping quickly using Cohen-Sutherlands algorithm.

The idea behin Cohen-Sutherland algorithm is how we can clip a line to the screen in an efficient manner. The method is really focused on making use of simple logical operations so that we can figure out what plan to clip against as quickly as possible reducing the amount of compares that we need to do.

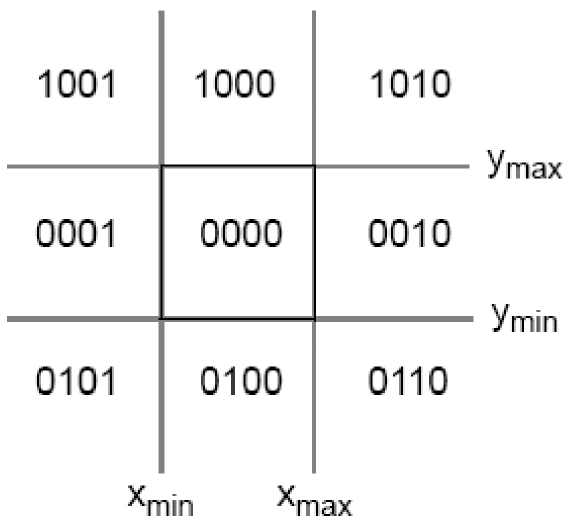

Figure 1: The outcodes for the different regions.

The idea underpinning the method is to assign each end-point of the line with an outcode, each outcode depends on which region the end-point lies in. As there are 4 different "edges" to a screen we will use a `nibble` to represent the outcodes. The nibble is structured as follows,

$$[\mathrm{TOP}, \mathrm{BOTTOM}, \mathrm{RIGHT}, \mathrm{LEFT}].$$

Now we will assign the corresponding nibble to the end-points of the line. The nice thing is that this allows us to quickly figure out which planes we need to clip against. We do this by following this algorithm,

- Compute `outcode` for each endpoint
- `OR` the outcodes
  - if the result is `0` we know that the whole line is contained on screen so nothing more to do
- `AND` the outcodes

- if the result is **not** `0` we know that there is one plane the line is always outside which means it will not pass through the screen

- now we have done the trivial rejects and we can deal with the remaining parts
- for each planes `AND` the planes code with the end-points code
  - if `0` no need to clip
  - if **not** `0` clip to this plane

1 Example

- Compute outcodes of end-points

$$\text{outcode}([x_0, y_0]) = 1001 \quad \text{outcode}([x_1, y_1]) = 0000$$

- Check if on screen

$$1001 \vee 0000 = 1001$$

- Check if completely outside

$$1001 \wedge 0000 = 0000$$

- Check `TOP` plane

$$1001 \wedge 1000 = 1000$$

- Need to clip to `TOP`

$$\frac{x_0 - x_1}{y_0 - y_1} = \frac{x - x_1}{y_{\max} - y_1} \quad \rightarrow \quad x = x_1 + (x_0 - x_1)\frac{y_{\max} - y_1}{y_0 - y_1}$$

- Compute new outcode

$$1001 \veebar 1000 = 0001$$

- Need to clip to `LEFT`

$$\frac{y_{\max} - y_1}{x - x_1} = \frac{y - y_1}{x_{\min} - x_1} \quad \rightarrow \quad y = y_1 + \frac{y_{\max} - y_1}{x - x_1}(x_{\min} - x_1)$$

- We can be a little bit clever with the last computation, as it is a line the slope will not change and we have already compute this previousl, we can therefore re-write the above as follows,

$$y = y_1 + \frac{y_0 - y_1}{x_0 - x_1}(x_{\min} - x_1)$$