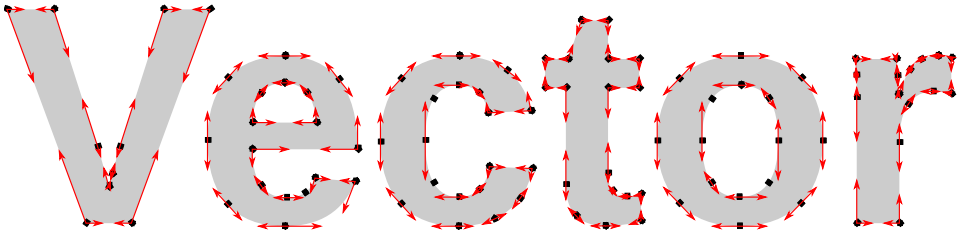
Unidad 5

Rasterización

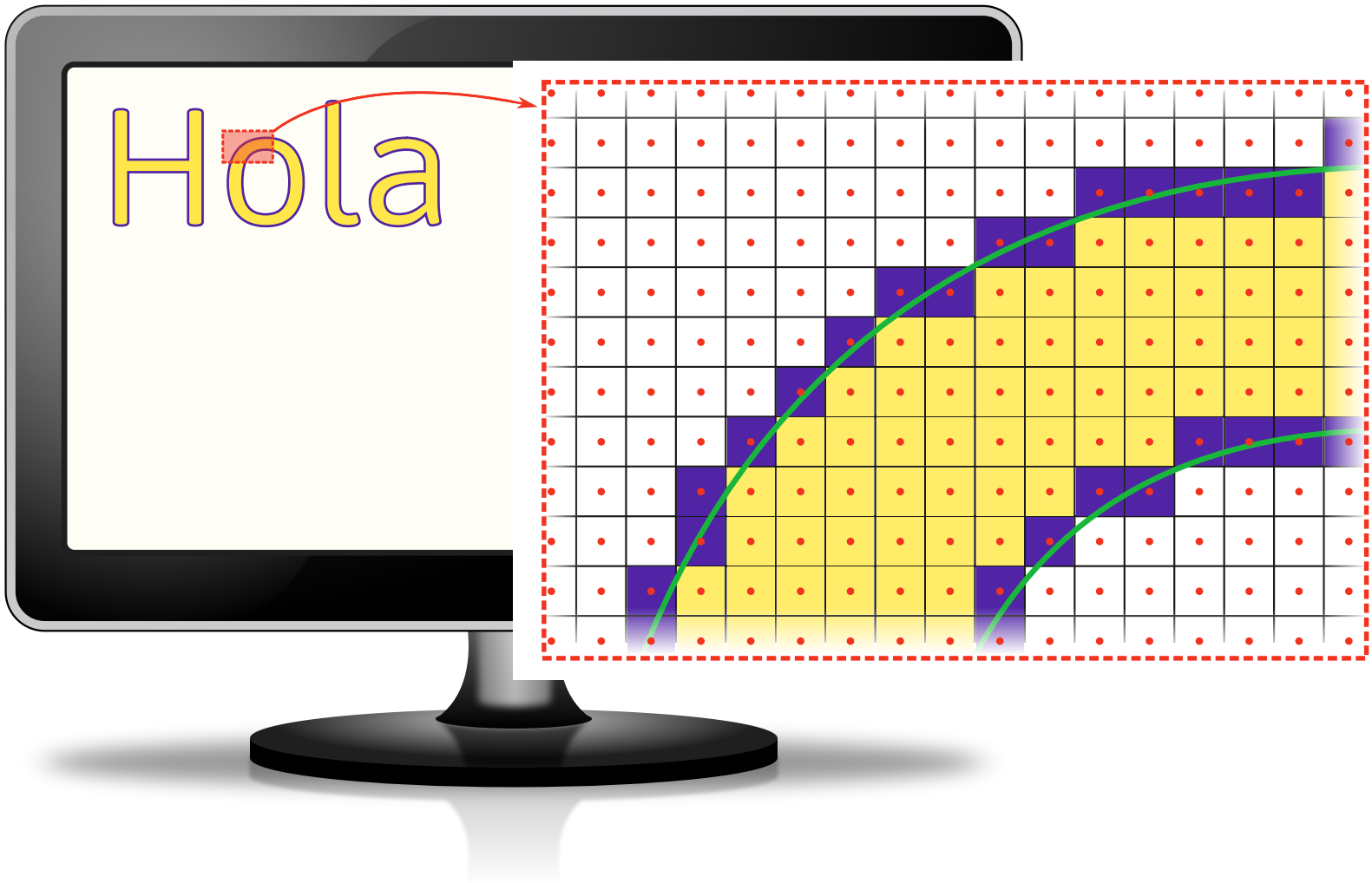
UNL FICH
Universidad Nacional del Litoral
Facultad de Ingeniería y Ciencias Hídricas

Raster

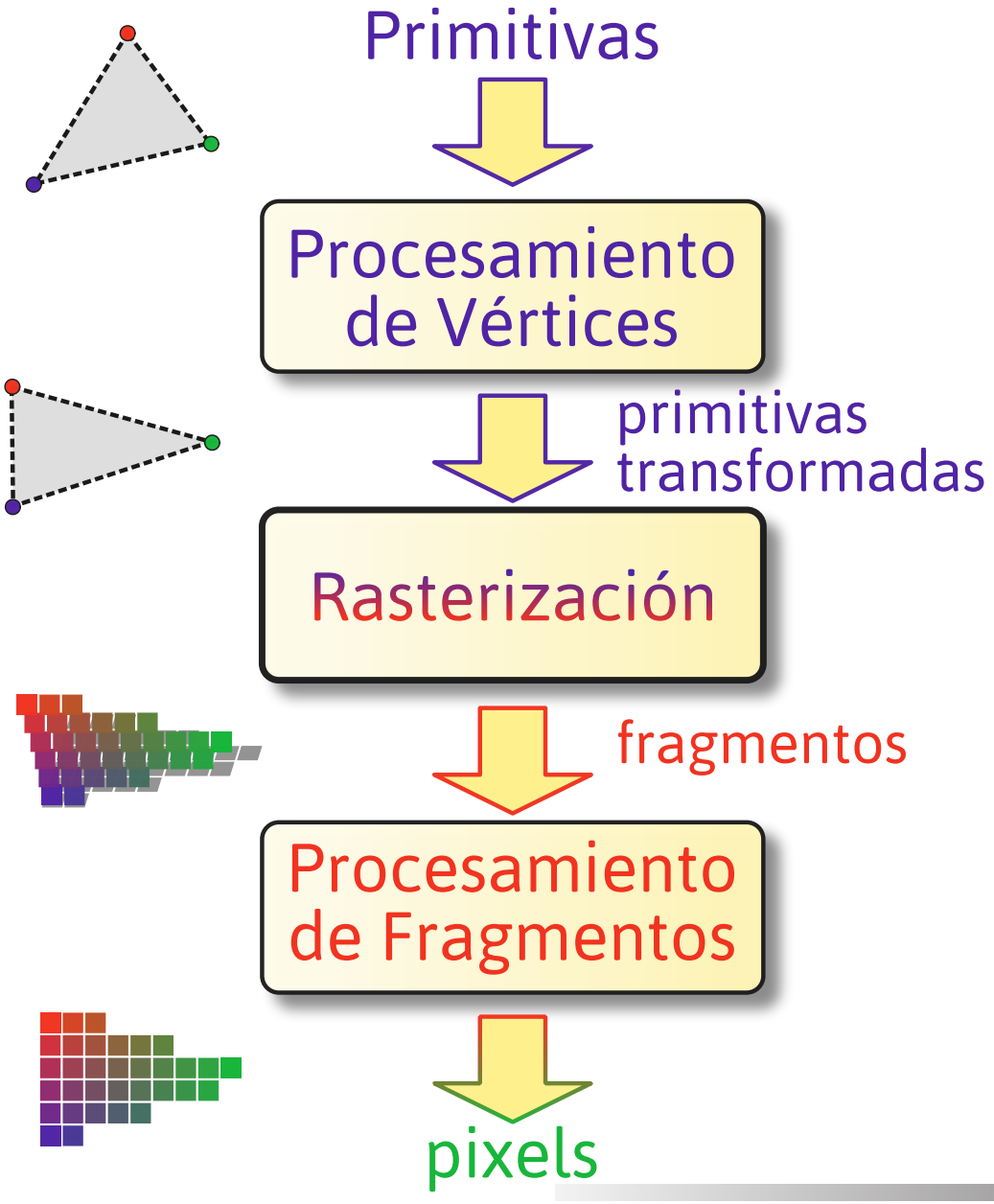
vs



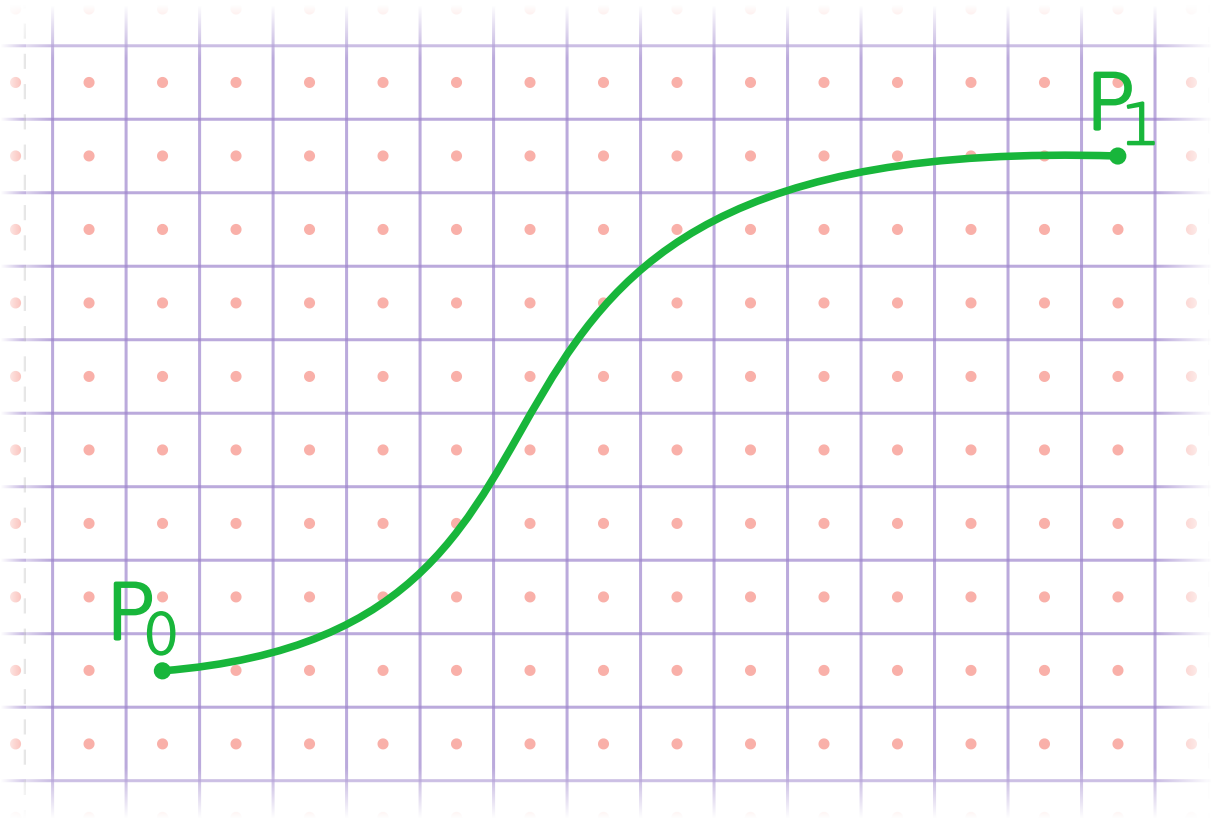
Rasterización o Scan-Conversion



La Rasterización en el Pipeline

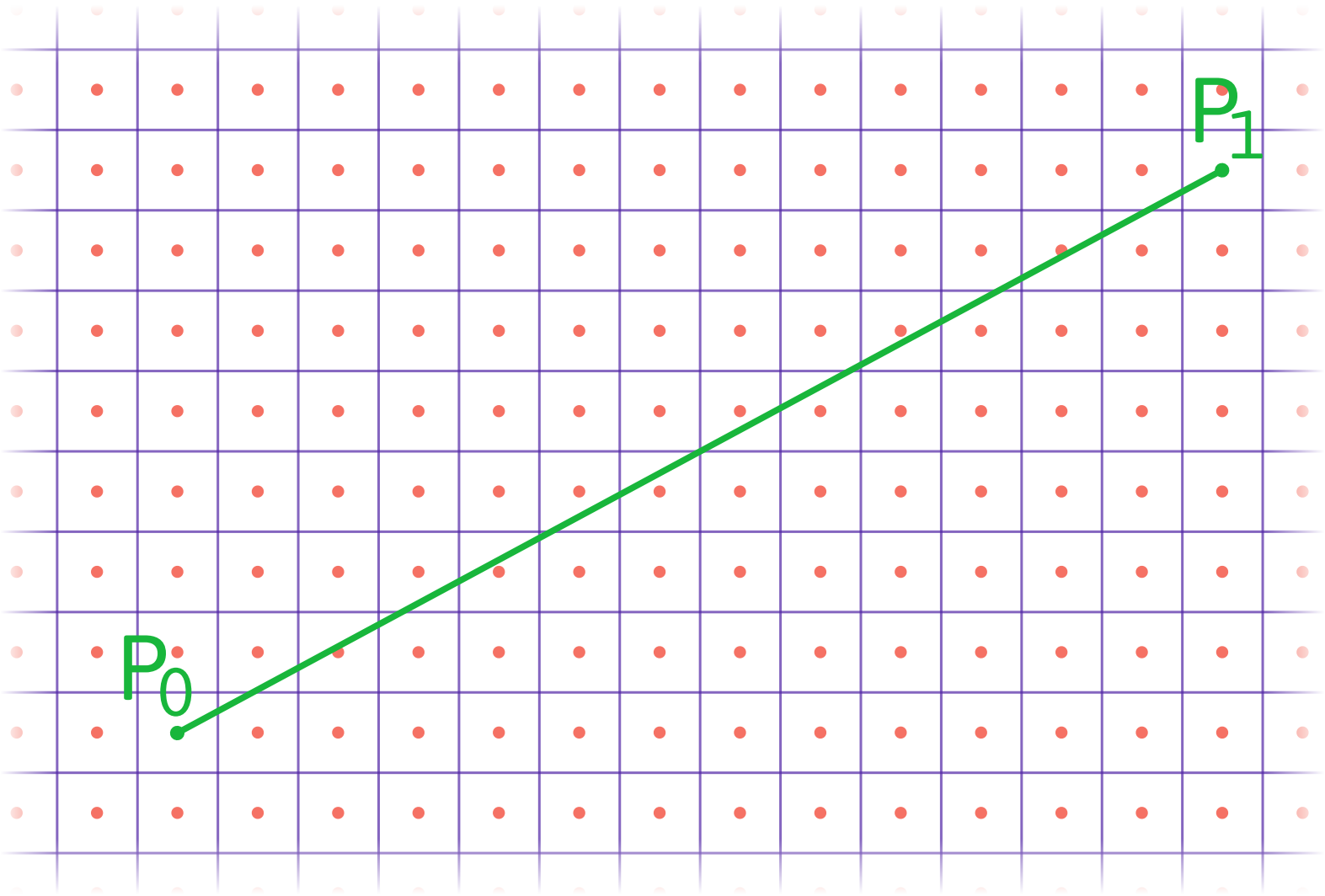


Requerimientos

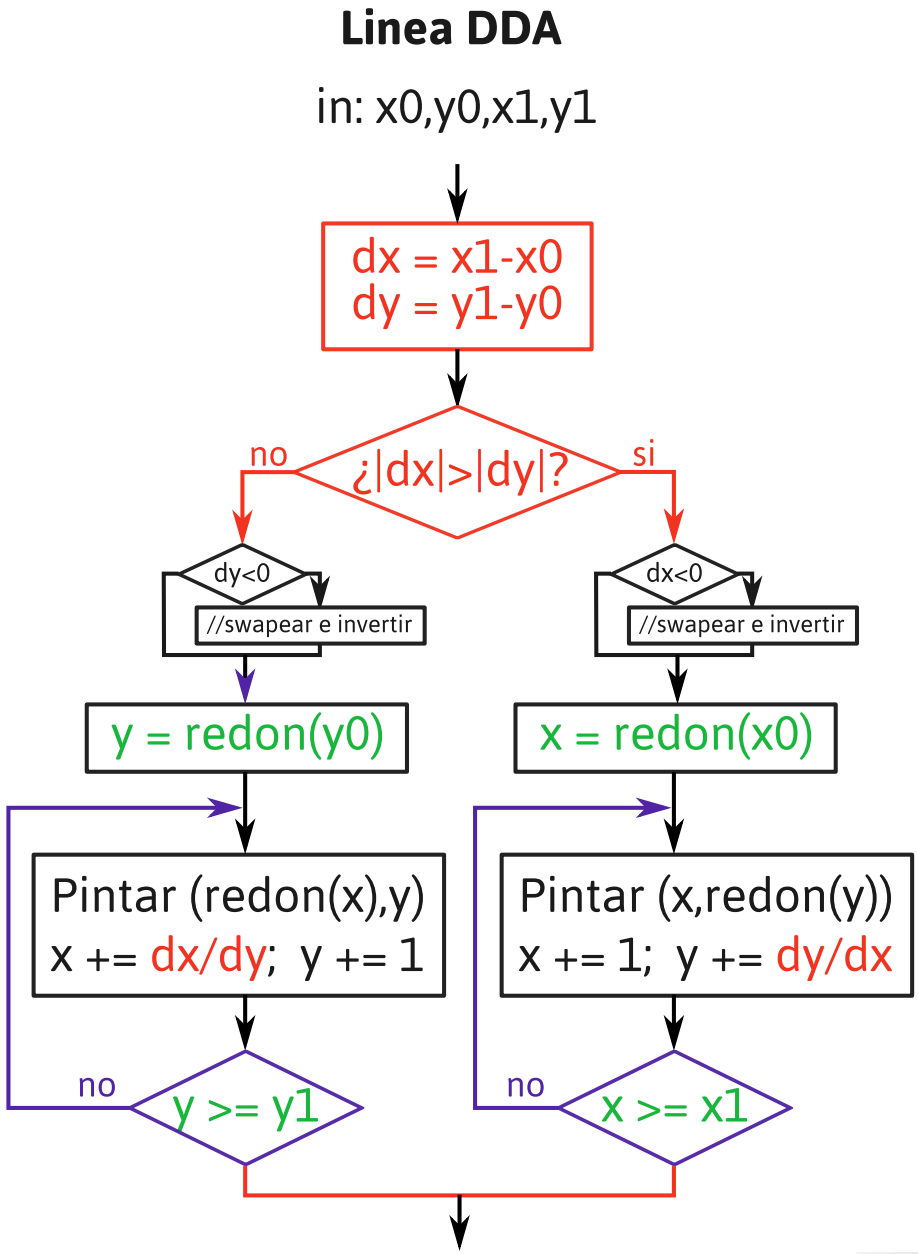


1. Representación Adecuada
2. Contigüidad (water-tight) $\max(\Delta x, \Delta y) \leq 1$
3. Eficiencia y Robustez

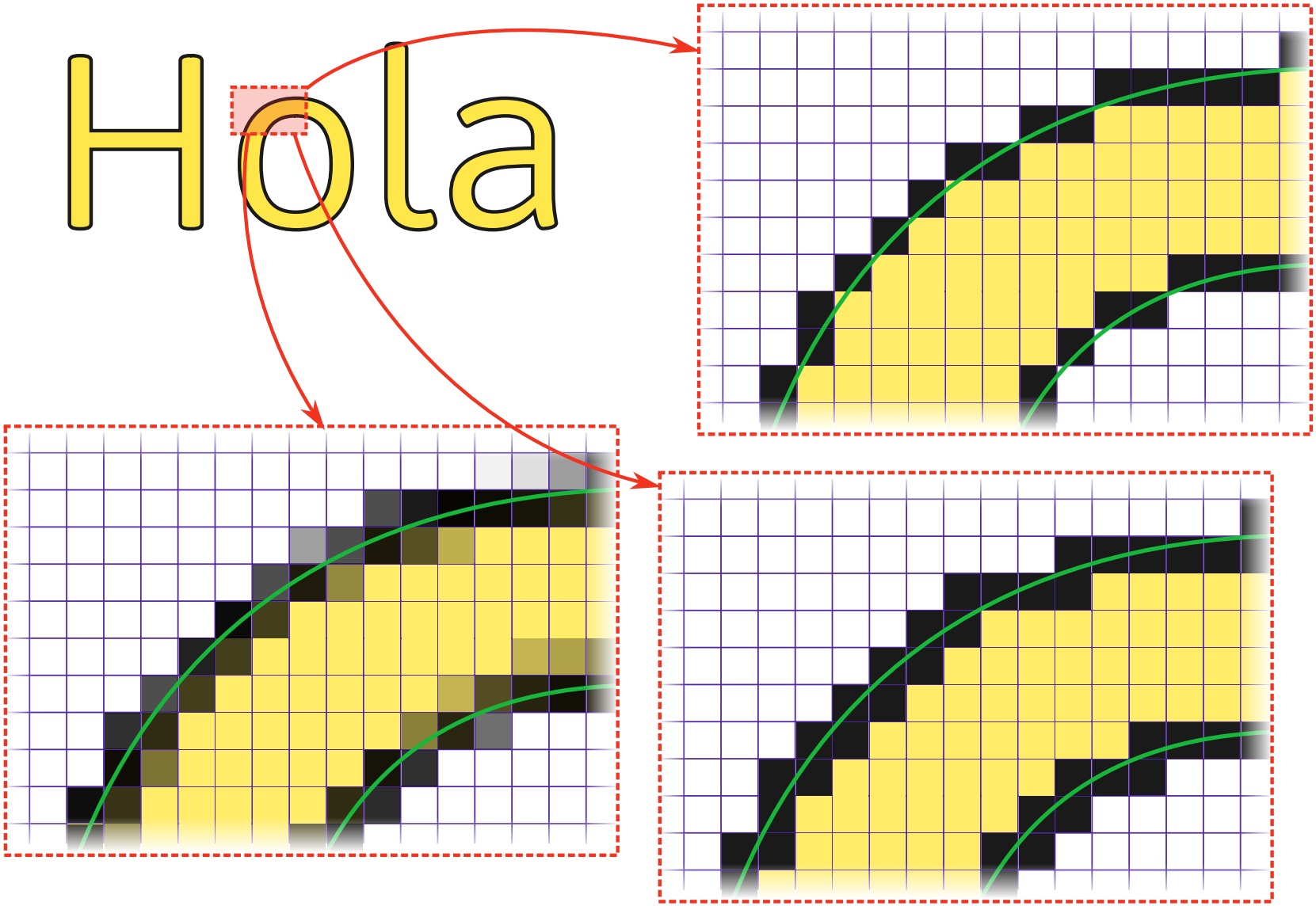
Rasterización o Scan-Conversion



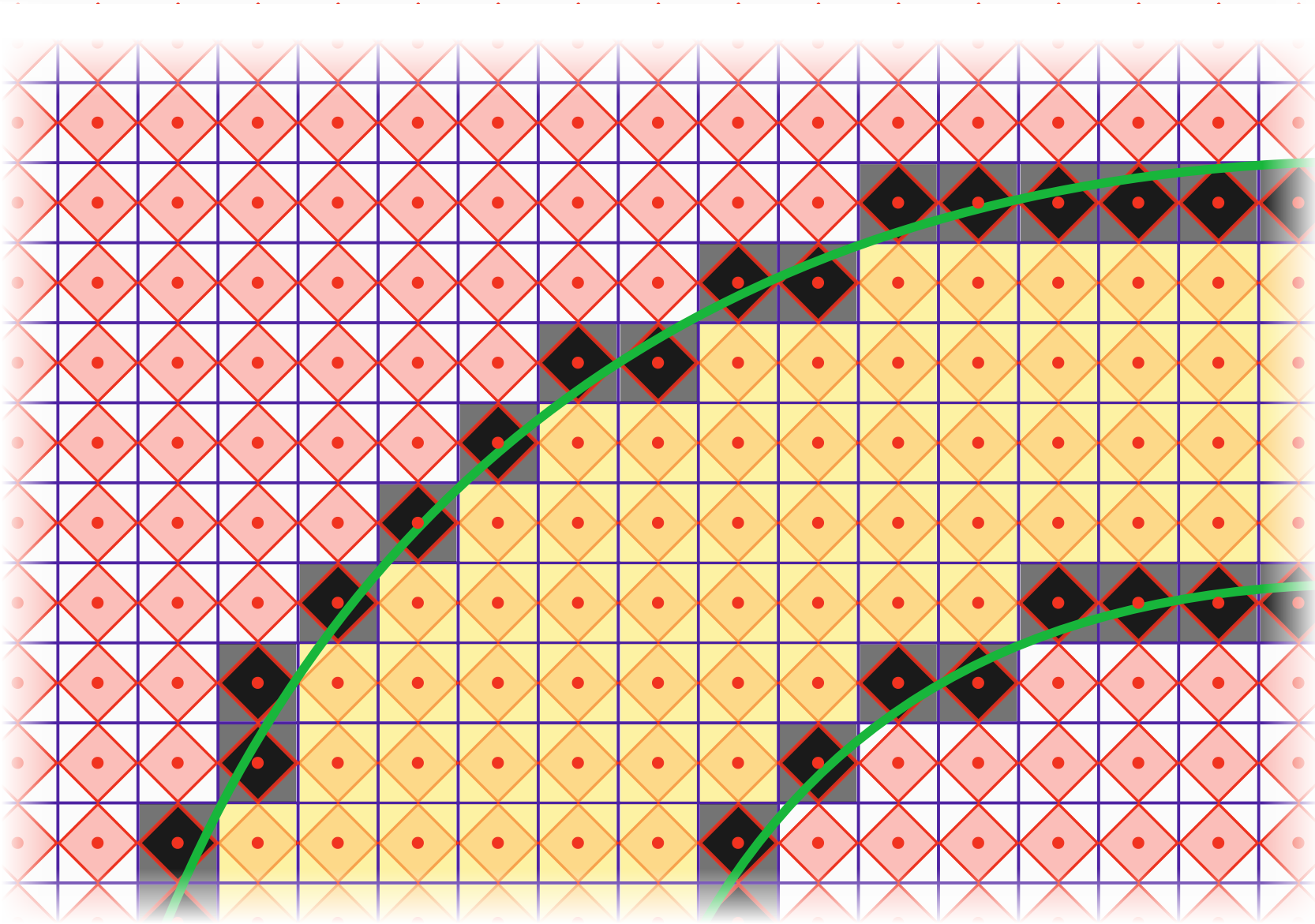
Linea DDA


Linea DDA
in: x0,y0,x1,y1
dx = x1-x0
dy = y1-y0
¿|dx|>|dy|?
no
si
dy<0
//swapear e invertir
dx<0
//swapear e invertir
y = redon(y0)
x = redon(x0)
Pintar (redon(x),y)
x += dx/dy; y += 1
Pintar (x,redon(y))
x += 1; y += dy/dx
no
y >= y1
no
x >= x1

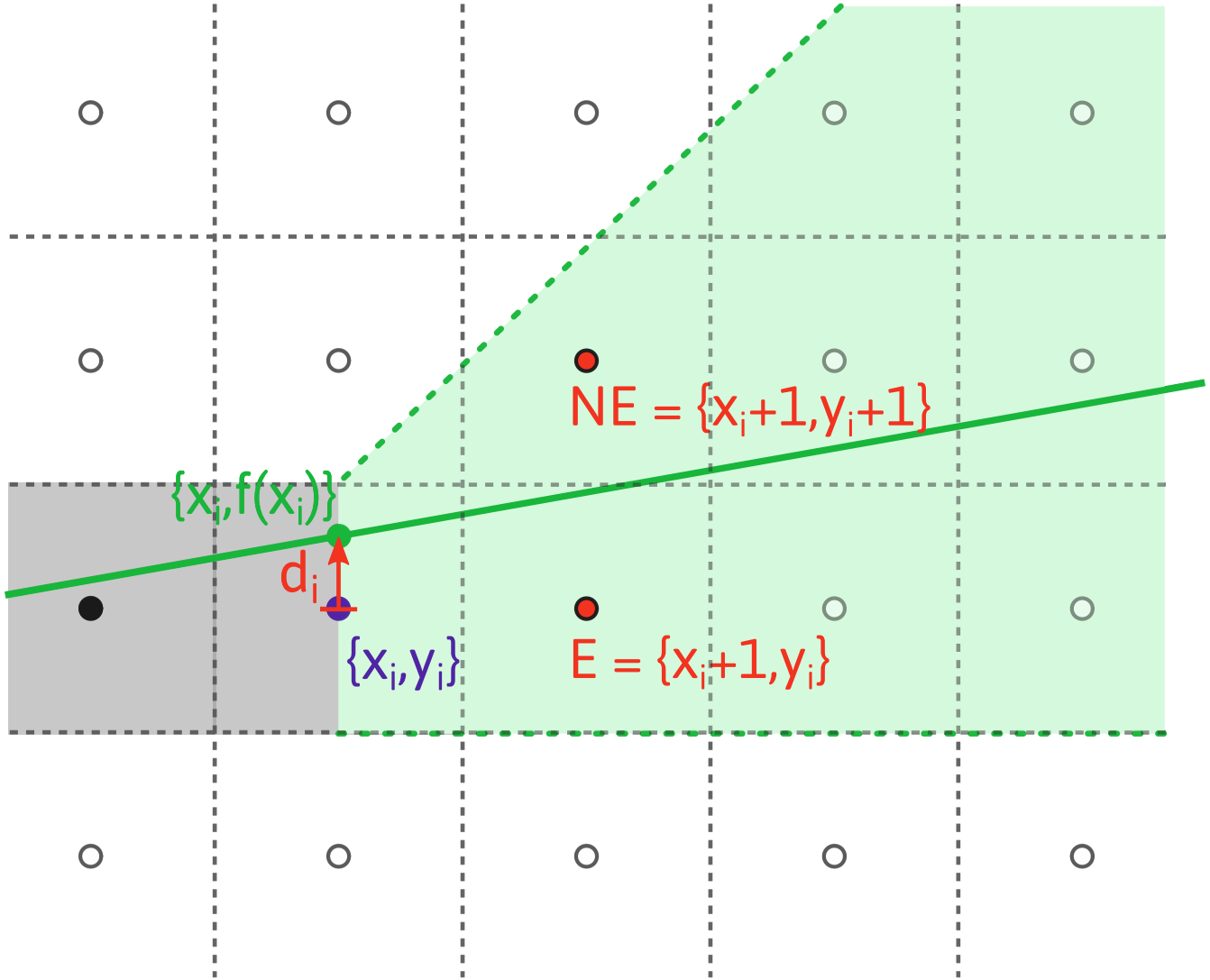
Rasterización o Scan-Conversion



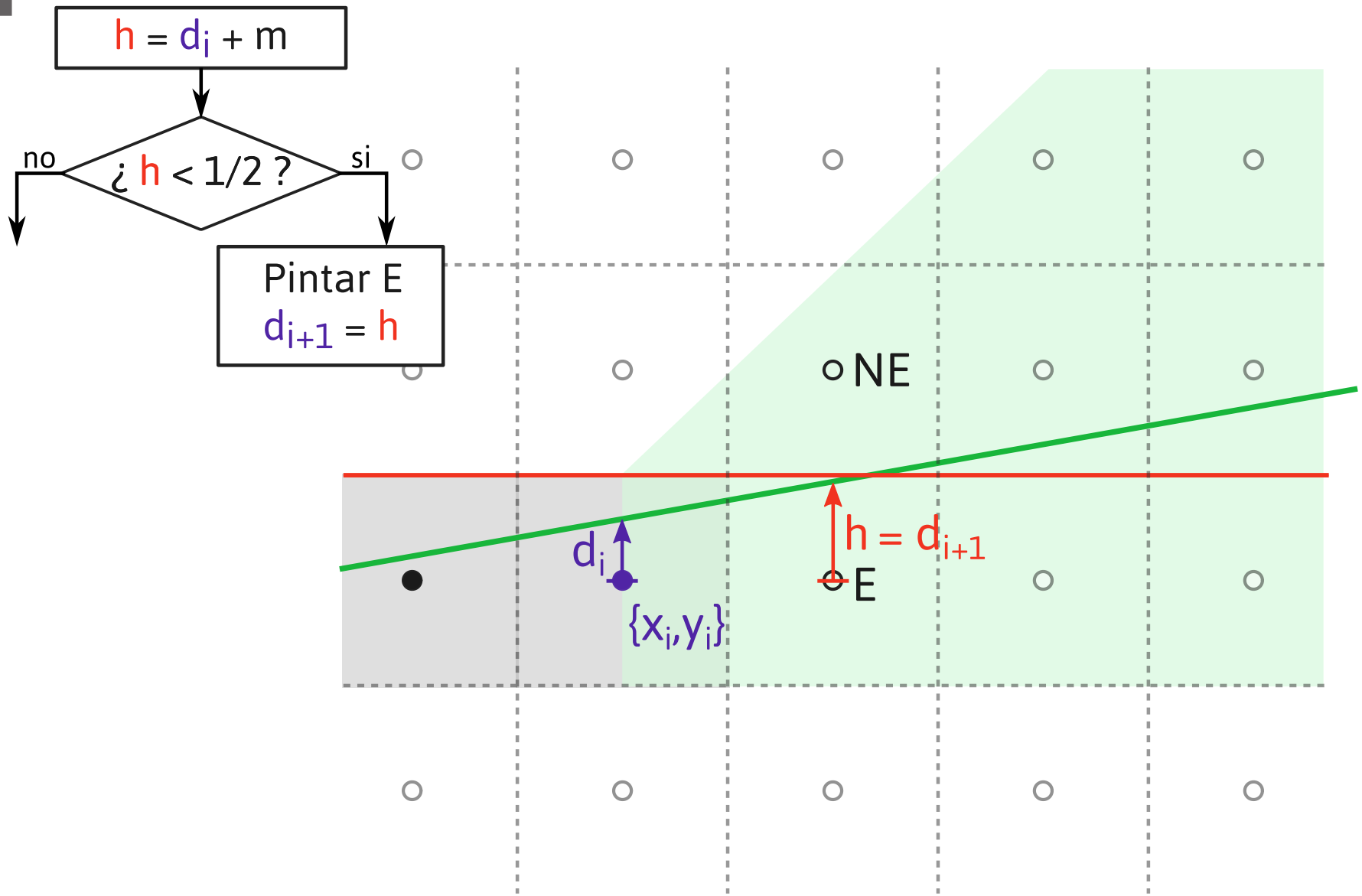
Rasterización o Scan-Conversion



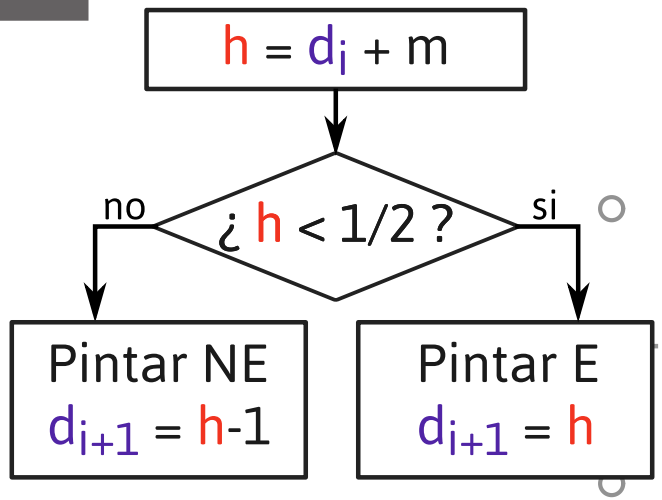
Algoritmo de linea de Bresenham

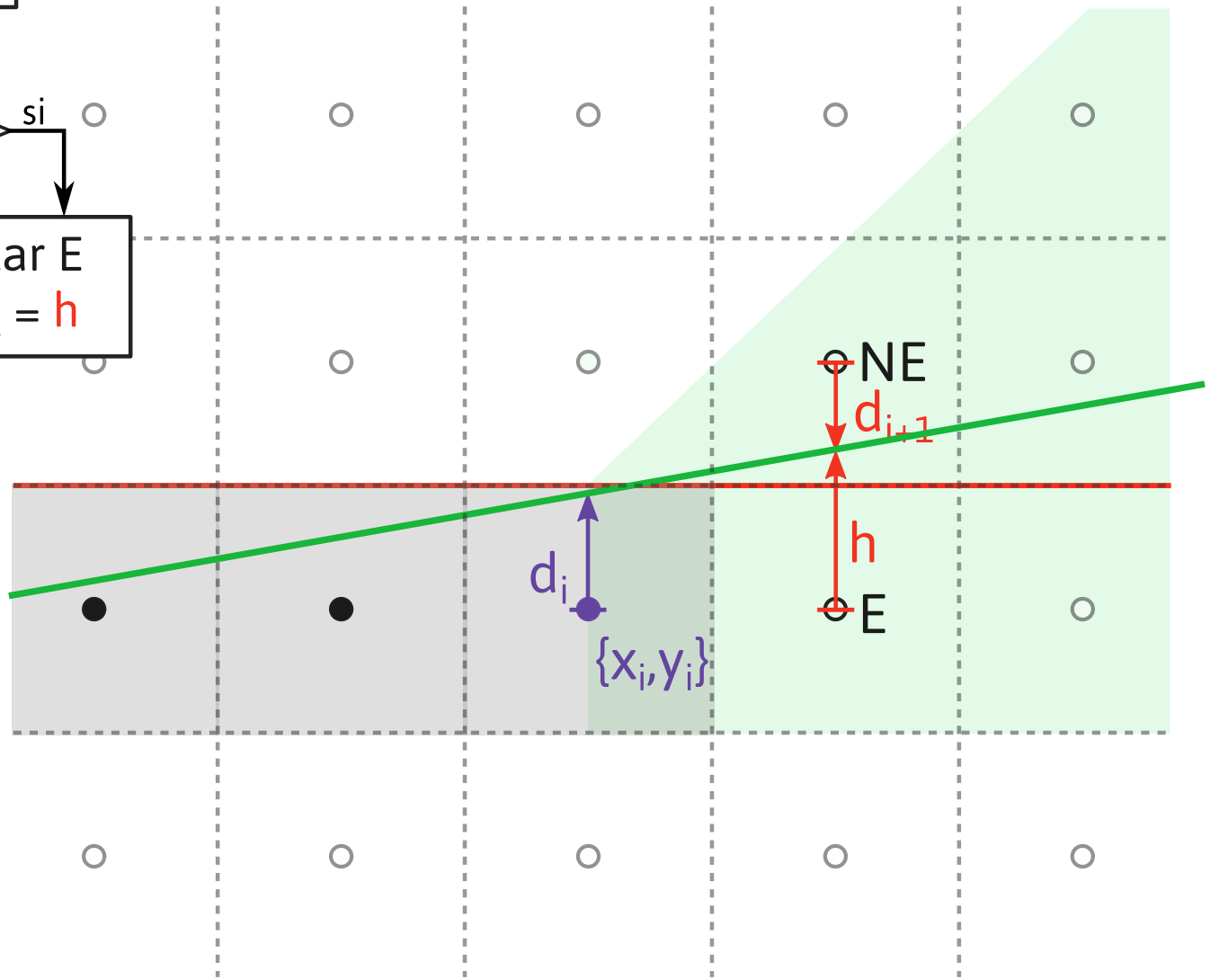


Algoritmo de linea de Bresenham

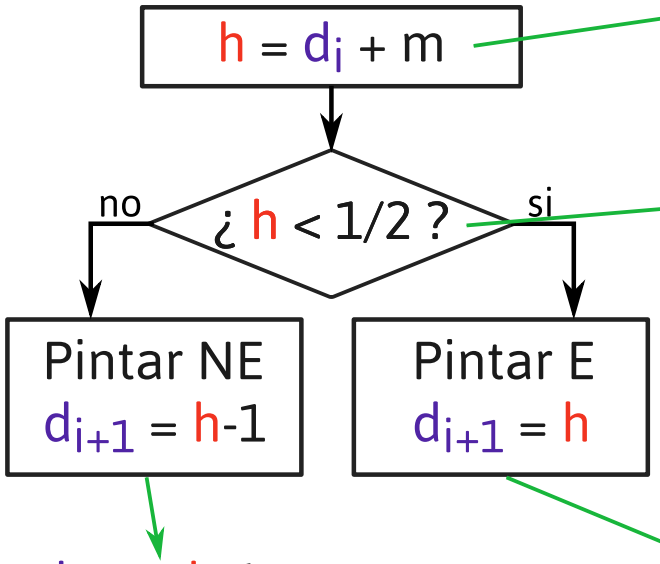


Algoritmo de linea de Bresenham





Algoritmo de linea de Bresenham



$h = d_i + m$

$h = d_i + dy/dx$

¿ $h < 1/2$?

¿ $d_i + dy/dx < 1/2$?

¿ $2*dx*(d_i + dy/dx) < 2*dx*1/2$?

¿ $2*dx*d_i + 2*dy < dx$?

¿ $2*dx*d_i + 2*dy - dx < 0$?

$d_{i+1} = h-1$

$d_{i+1} = d_i + dy/dx - 1$

$2*dx*d_{i+1} = 2*dx*(d_i + dy/dx - 1)$

$2*dx*d_{i+1} = 2*dx*d_i + 2*dy - 2*dx$

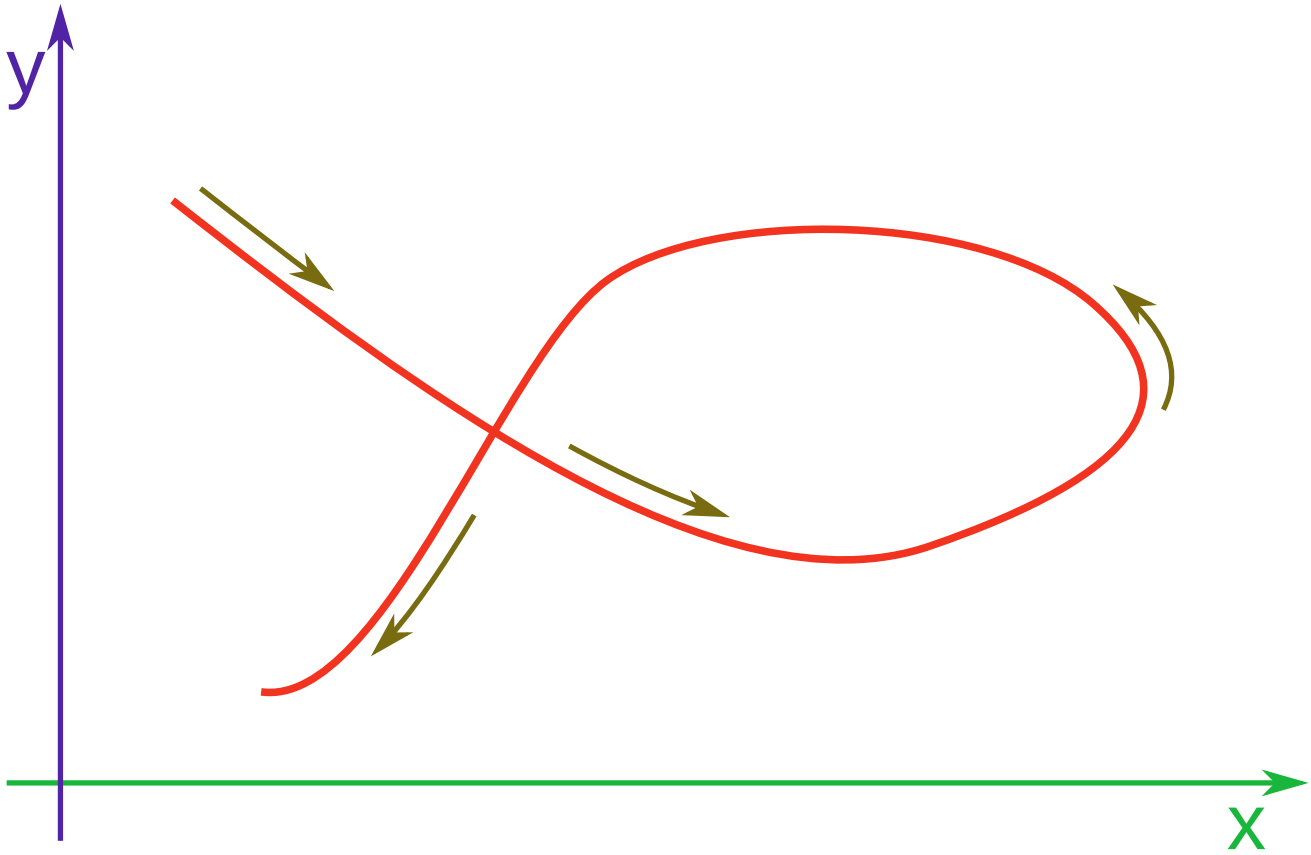
$d_{i+1} = h$

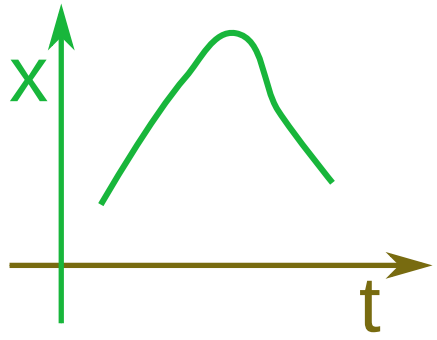
$d_{i+1} = d_i + dy/dx$

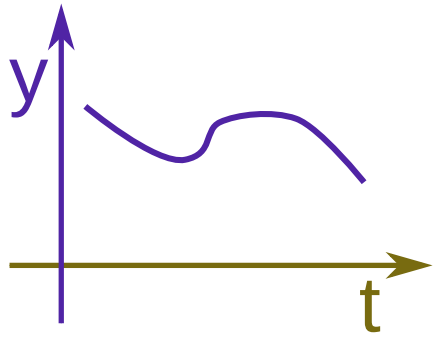
$2*dx*d_{i+1} = 2*dx*(d_i + dy/dx)$

$2*dx*d_{i+1} = 2*dx*d_i + 2*dy$

Curvas Paramétricas

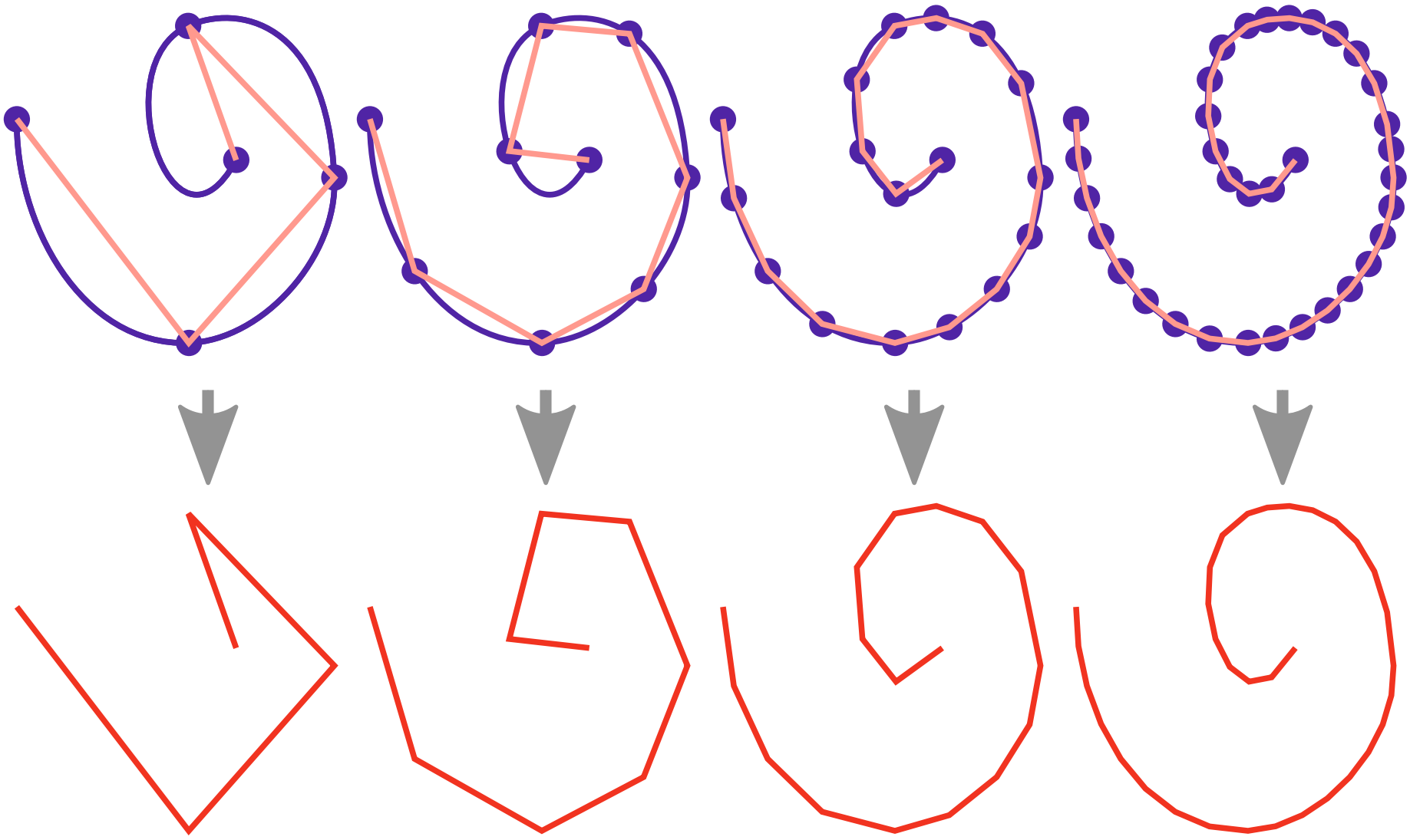




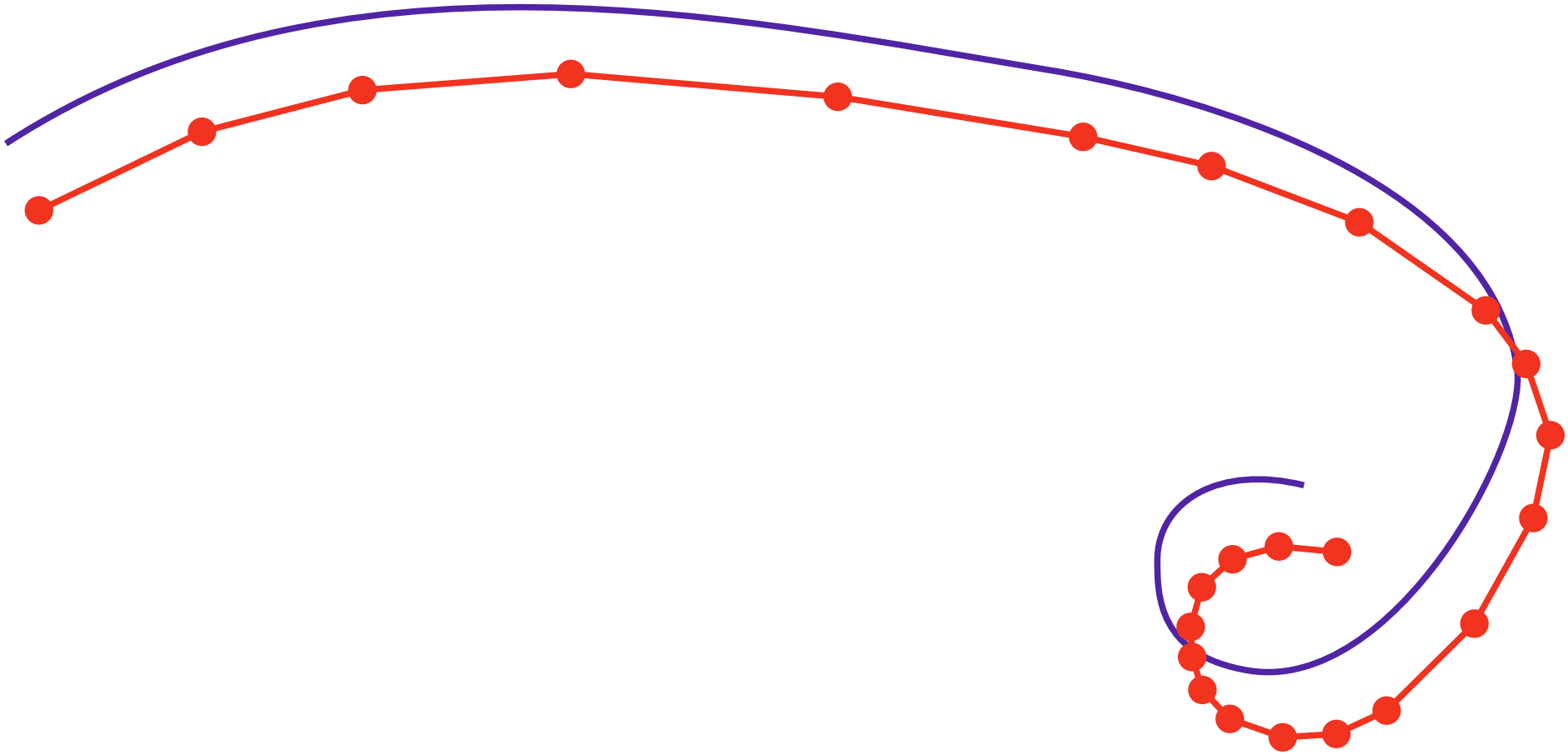


$y=f(t) \quad x = g(t) \quad t \in [t_0;t_1]$

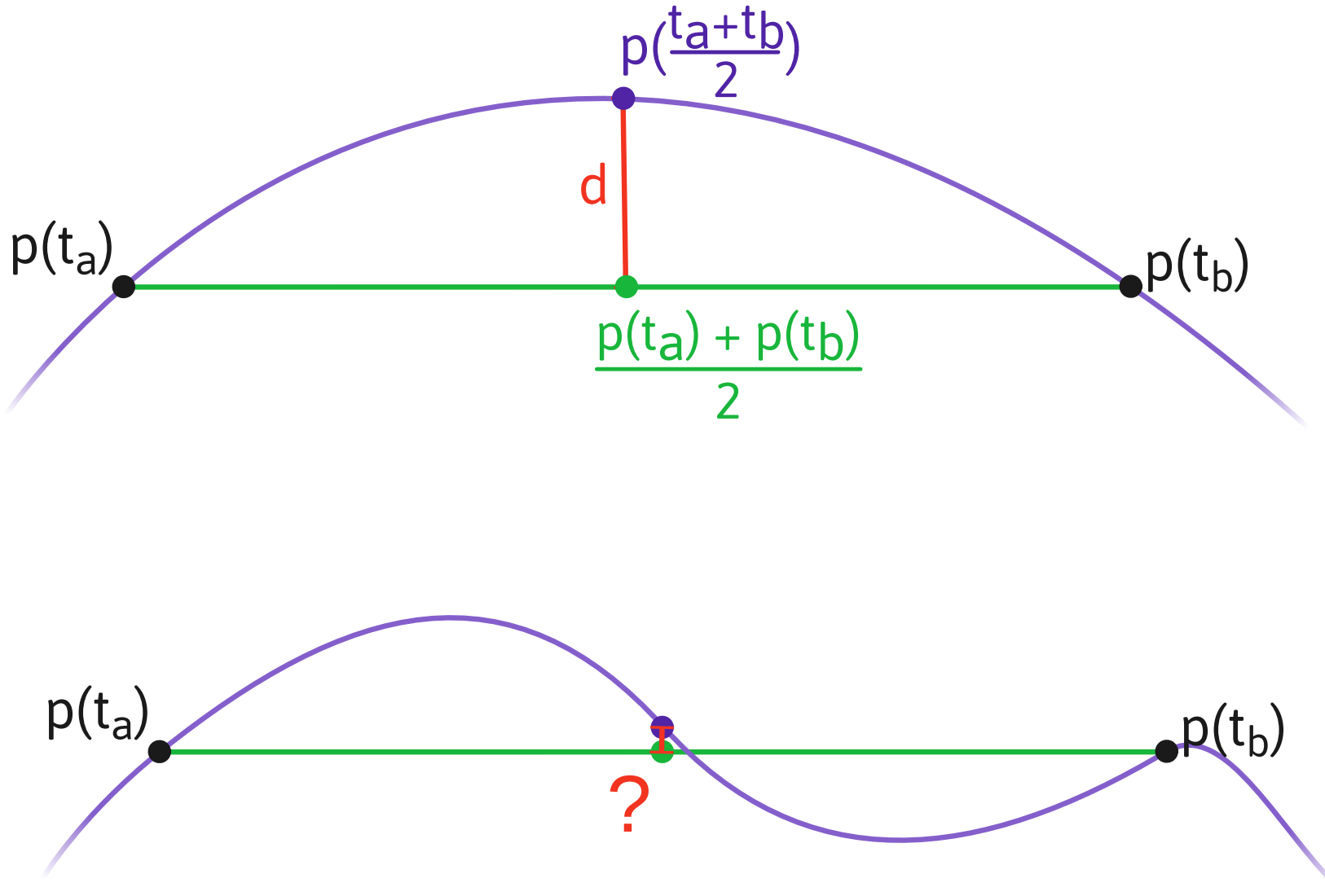
Rasterización por Subdivisiones



Rasterización por Subdivisiones



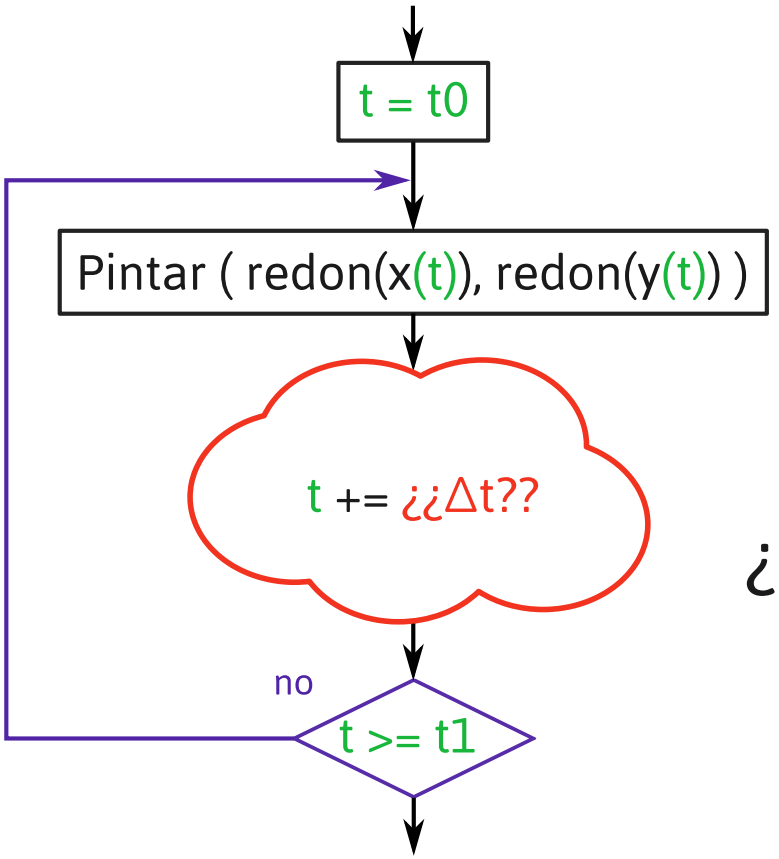
Rasterización por Subdivisiones



Rasterización de curvas por Derivadas

Curva DDA

in: x(t), y(t), dx(y), dy(t), t0, t1



contigüidad: $\max(\Delta x, \Delta y) \leq 1$

$\Delta t \mid \max(\Delta x, \Delta y) = 1$

$\Delta x = 1$ ó $\Delta y = 1$

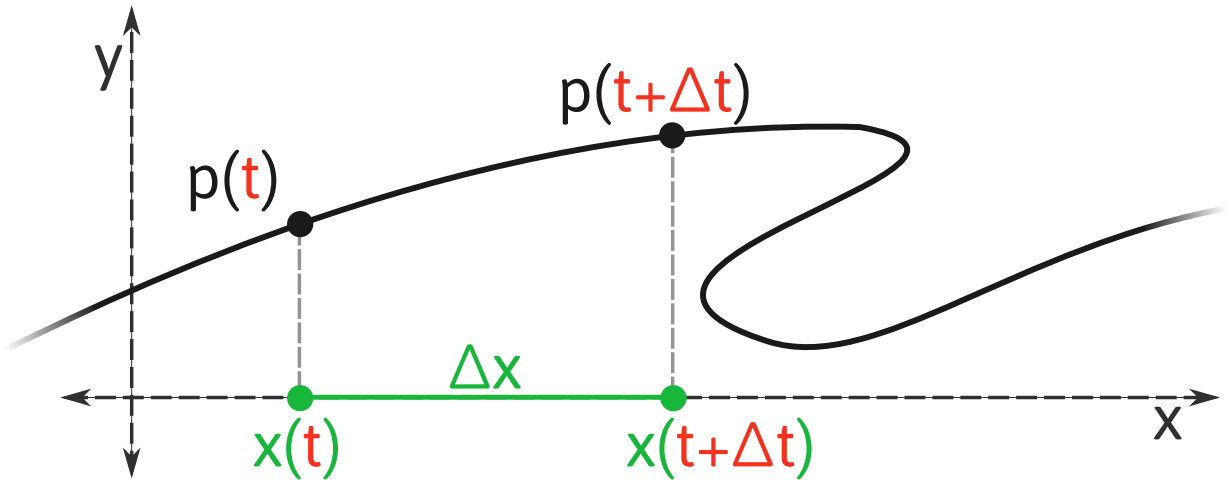
¿ $\Delta t_x = f(\Delta x)$? ¿ $\Delta t_y = g(\Delta y)$?

$\Delta t_x = f(1)$ $\Delta t_y = g(1)$

$\Delta t = \min(\Delta t_x, \Delta t_y)$

Rasterización de curvas por Derivadas

¿ $\Delta t \mid \Delta x = 1$?



$$\Delta x = x(t+\Delta t) - x(t)$$

$$x(t+\Delta t) \approx x(t) + \Delta t\, x'(t)$$

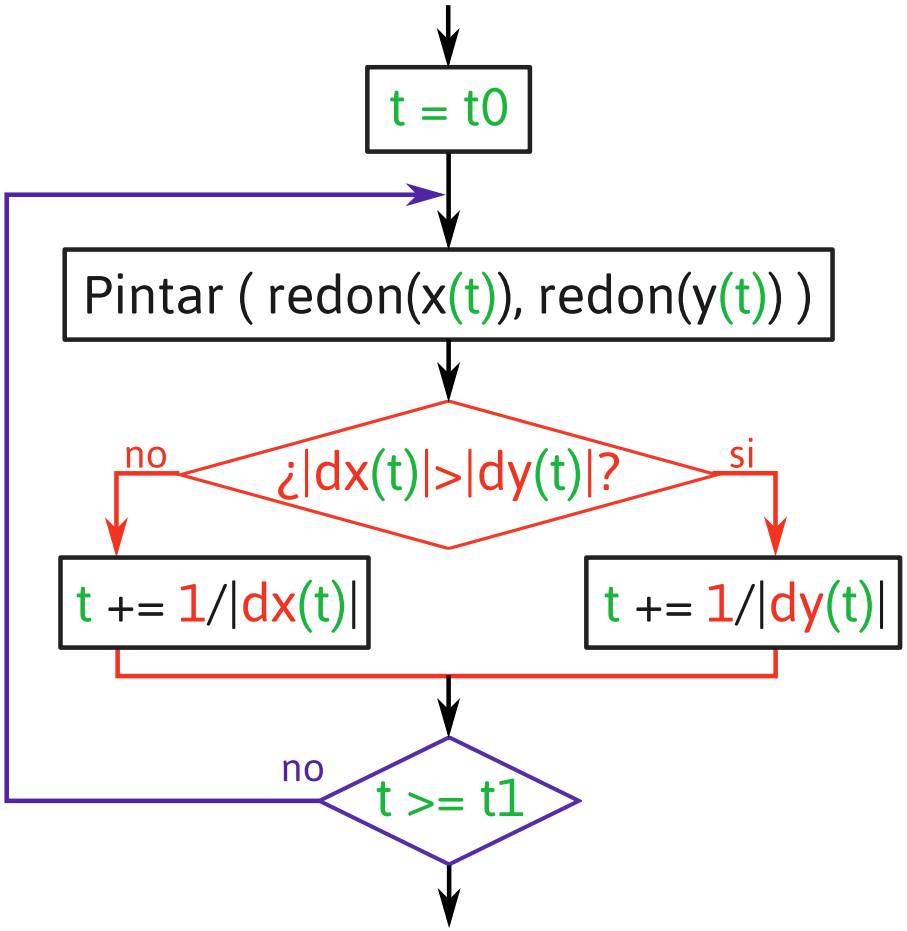
$$\Delta x \approx x(t) + \Delta t\, x'(t) - x(t)$$

$$\Delta x \approx \Delta t\, x'(t) \longrightarrow 1 \approx \Delta t\, x'(t) \longrightarrow \Delta t \approx 1 / x'(t)$$

Rasterización de curvas por Derivadas

Curva DDA

in: x(t),y(t),dx(y),dy(t),t0,t1

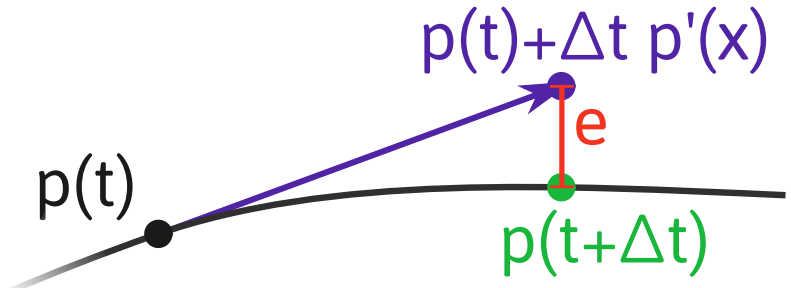


$$\Delta t = \min(\Delta t_x, \Delta t_y)$$

$$\Delta t_x \approx 1 / x'(t)$$

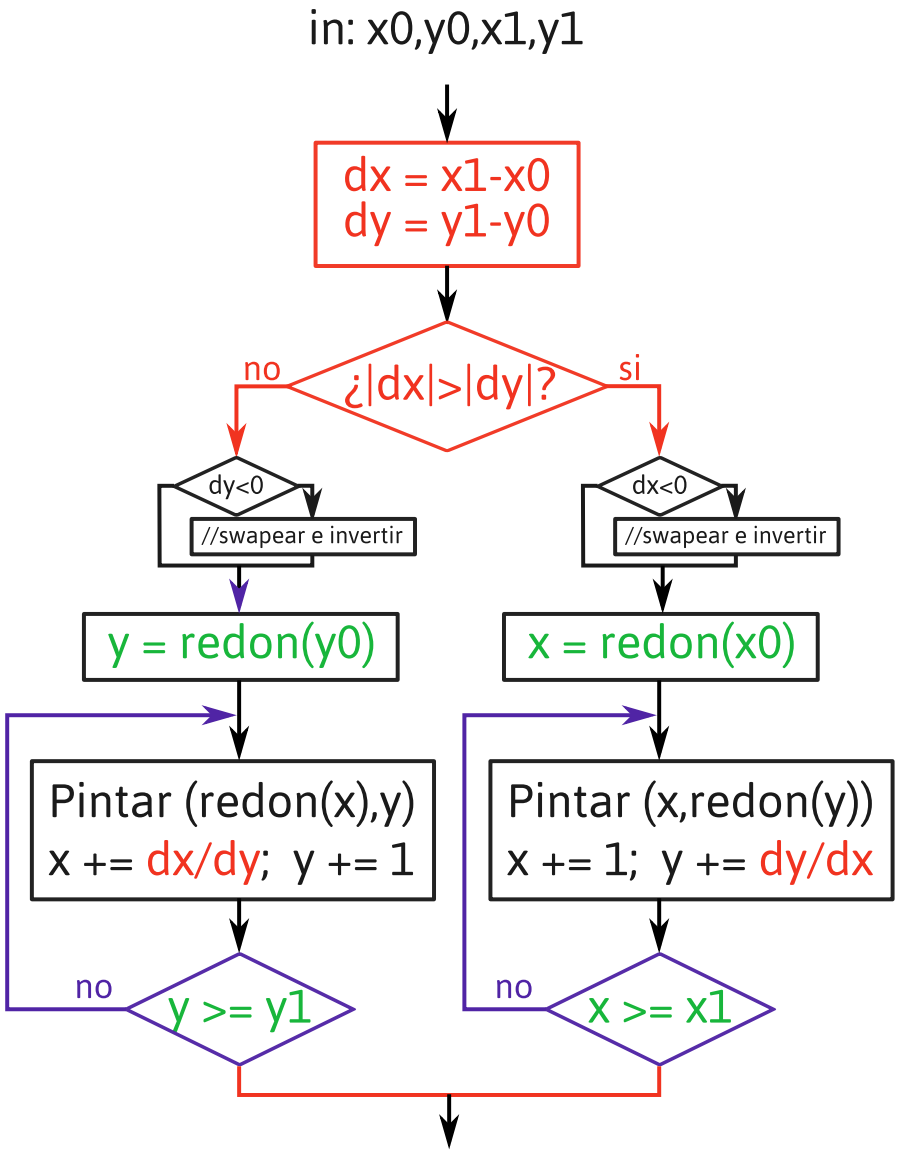
$$\Delta t = \min(1/|x'(t)|, 1/|y'(t)|)$$

$$\Delta t = 1 / \max(|x'(t)|, |y'(t)|)$$

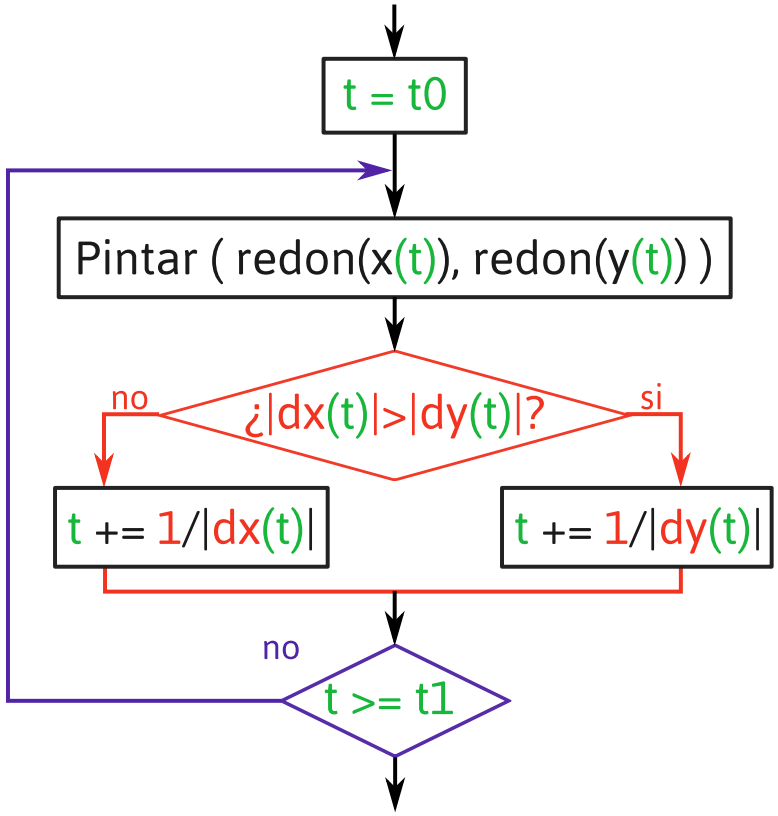


Rasterización por DDA: Linea vs Curva

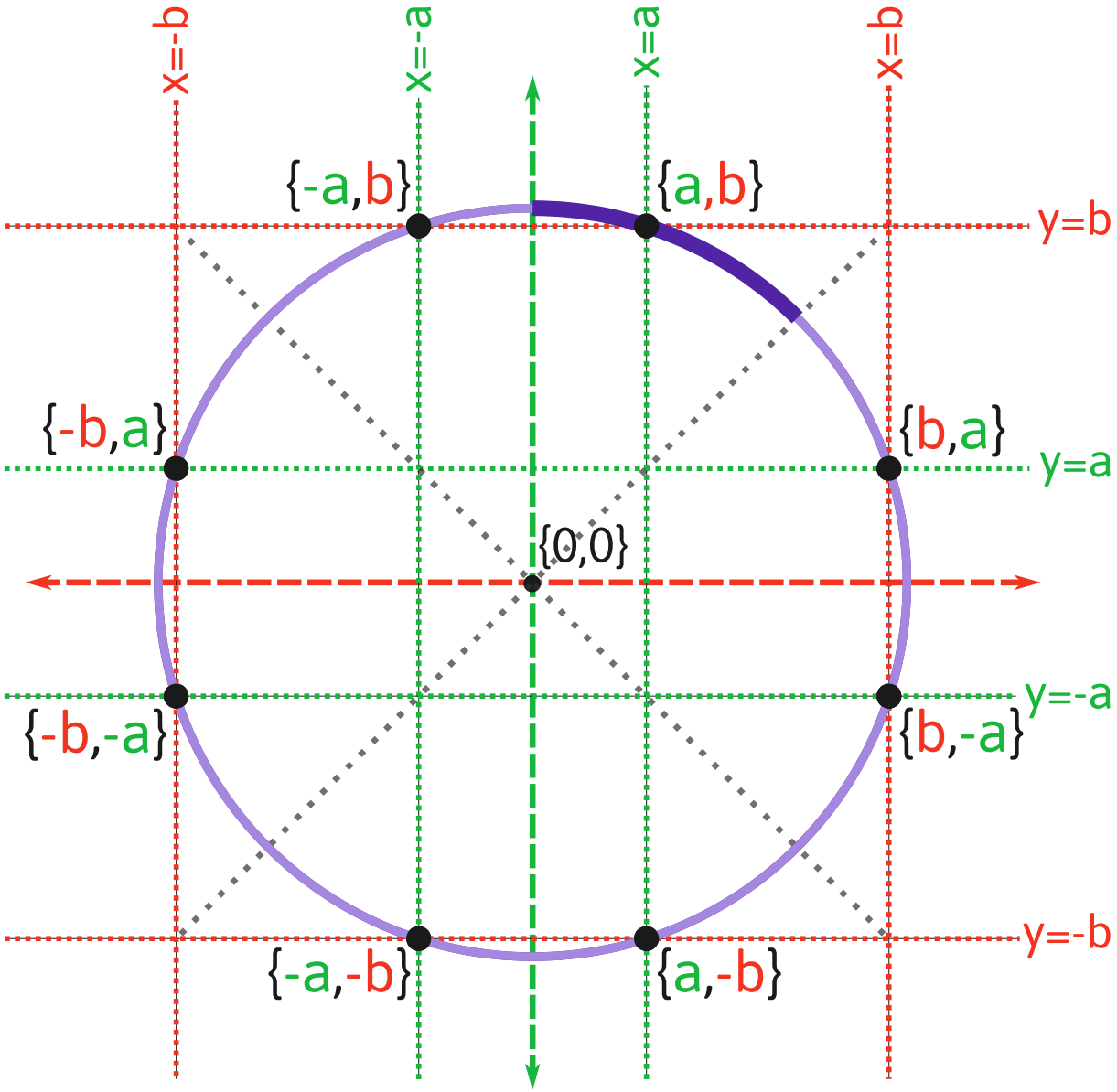
Linea DDA



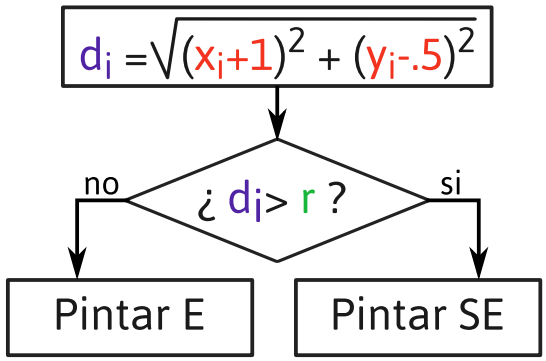
Curva DDA

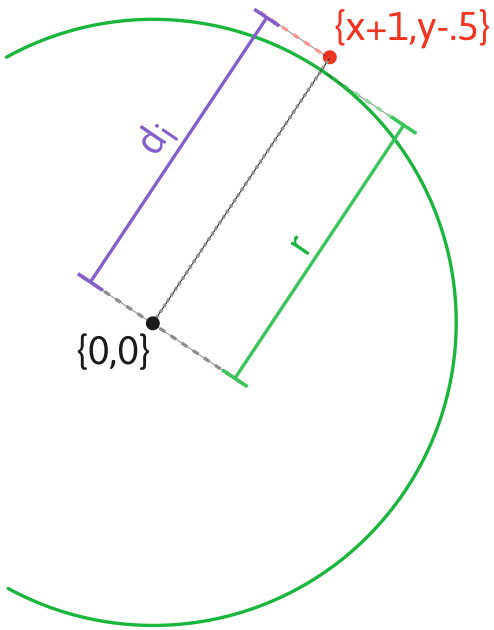


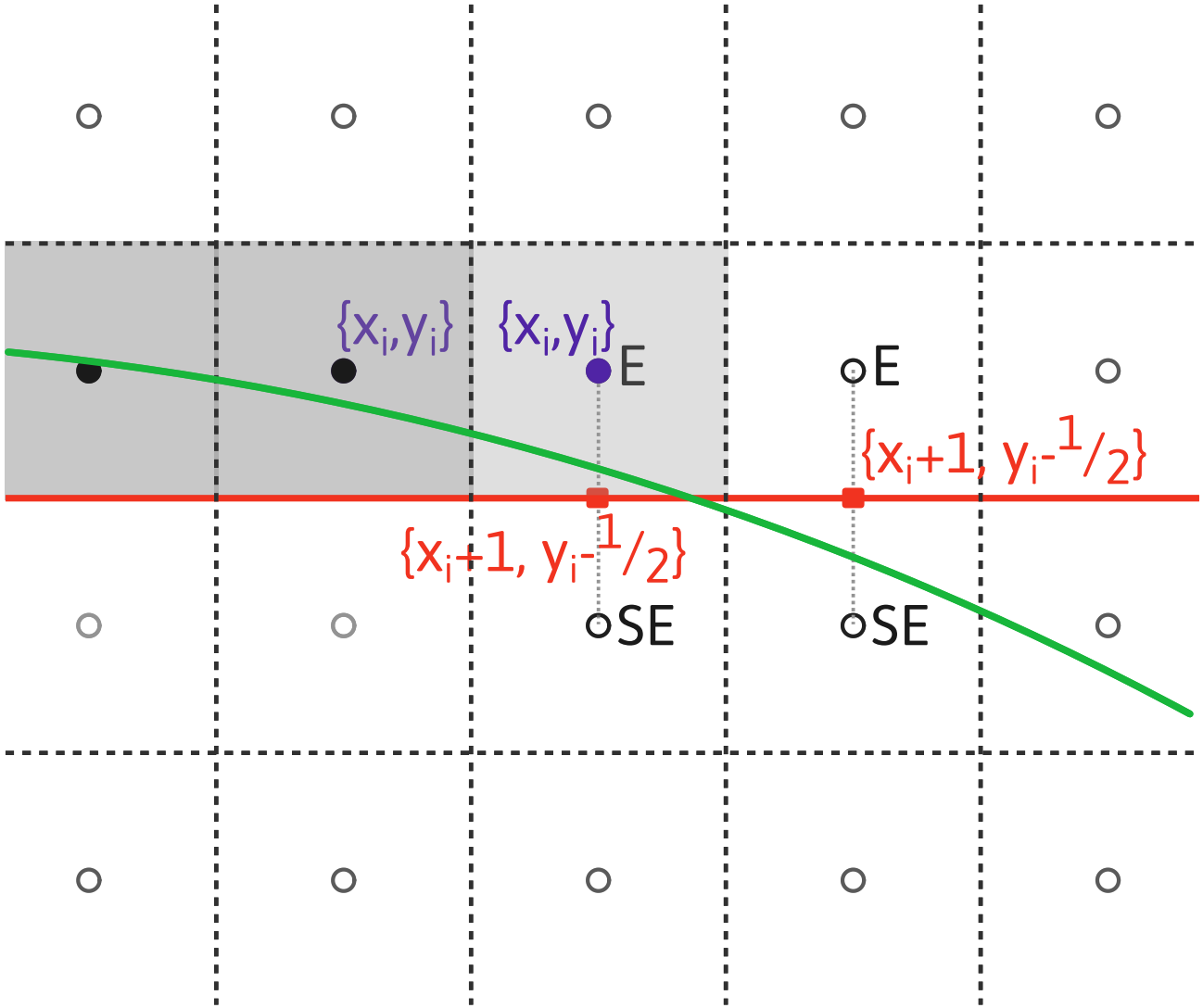
Rasterización de Circunferencias



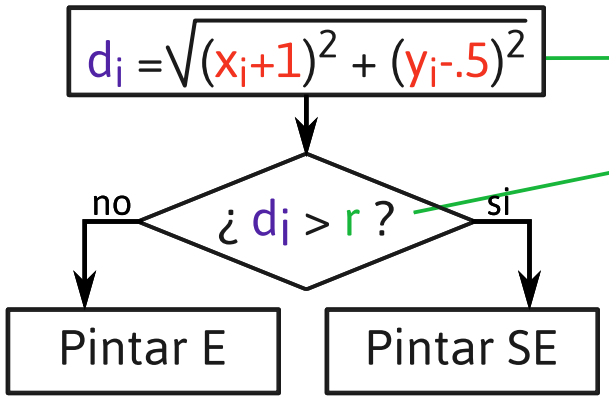
Algoritmo de Circunferencias de Bresenham







Algoritmo de Circunferencias de Bresenham



$$\sqrt{(x_i+1)^2 + (y_i-.5)^2} > r$$

$$(x_i+1)^2 + (y_i-.5)^2 > r^2$$

$$(x_i+1)^2 + (y_i-.5)^2 - r^2 > 0$$

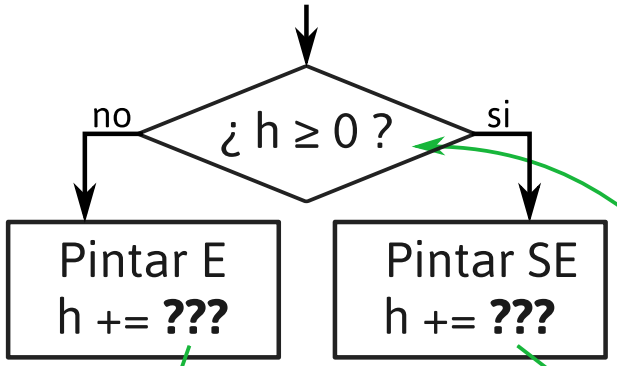
$$x_i^2+2x_i+1^2 + y_i^2+2y_i(-.5)+(-.5)^2 - r^2 > 0$$

$$x_i^2 + 2x_i + y_i^2 - y_i + 1.25 - r^2 > 0$$

$$x_i^2 + 2x_i + y_i^2 - y_i + 1 - r^2 > -0.25$$

$$\underbrace{x_i^2 + 2x_i + y_i^2 - y_i + 1 - r^2}_{h_i} \geq 0$$

Algoritmo de Circunferencias de Bresenham



$$\sqrt{(x_i+1)^2 + (y_i-.5)^2} > r$$

$$(x_i+1)^2 + (y_i-.5)^2 > r^2$$

$$(x_i+1)^2 + (y_i-.5)^2 - r^2 > 0$$

$$x_i^2+2x_i+1^2 + y_i^2+2y_i(-.5)+(-.5)^2 - r^2 > 0$$

$$x_i^2 + 2x_i + y_i^2 - y_i + 1.25 - r^2 > 0$$

$$x_i^2 + 2x_i + y_i^2 - y_i + 1 - r^2 > -0.25$$

$$\underbrace{x_i^2 + 2x_i + y_i^2 - y_i + 1 - r^2}_{h_i} \geq 0$$

$x_{i+1} = x_i+1$
$y_{i+1} = y_i$

$$h_{i+1}= (x_i+1)^2 +2(x_i+1) +y_i^2 -y_i +1 -r^2$$

$$h_{i+1}= x_i^2 +2x_i +1 +2x_i +2 +y_i^2 -y_i +1 -r^2$$

$$h_{i+1}= \underbrace{x_i^2+2x_i +y_i^2 -y_i +1 -r^2}_{h_i} \underbrace{+2x_i +3}_{E}$$

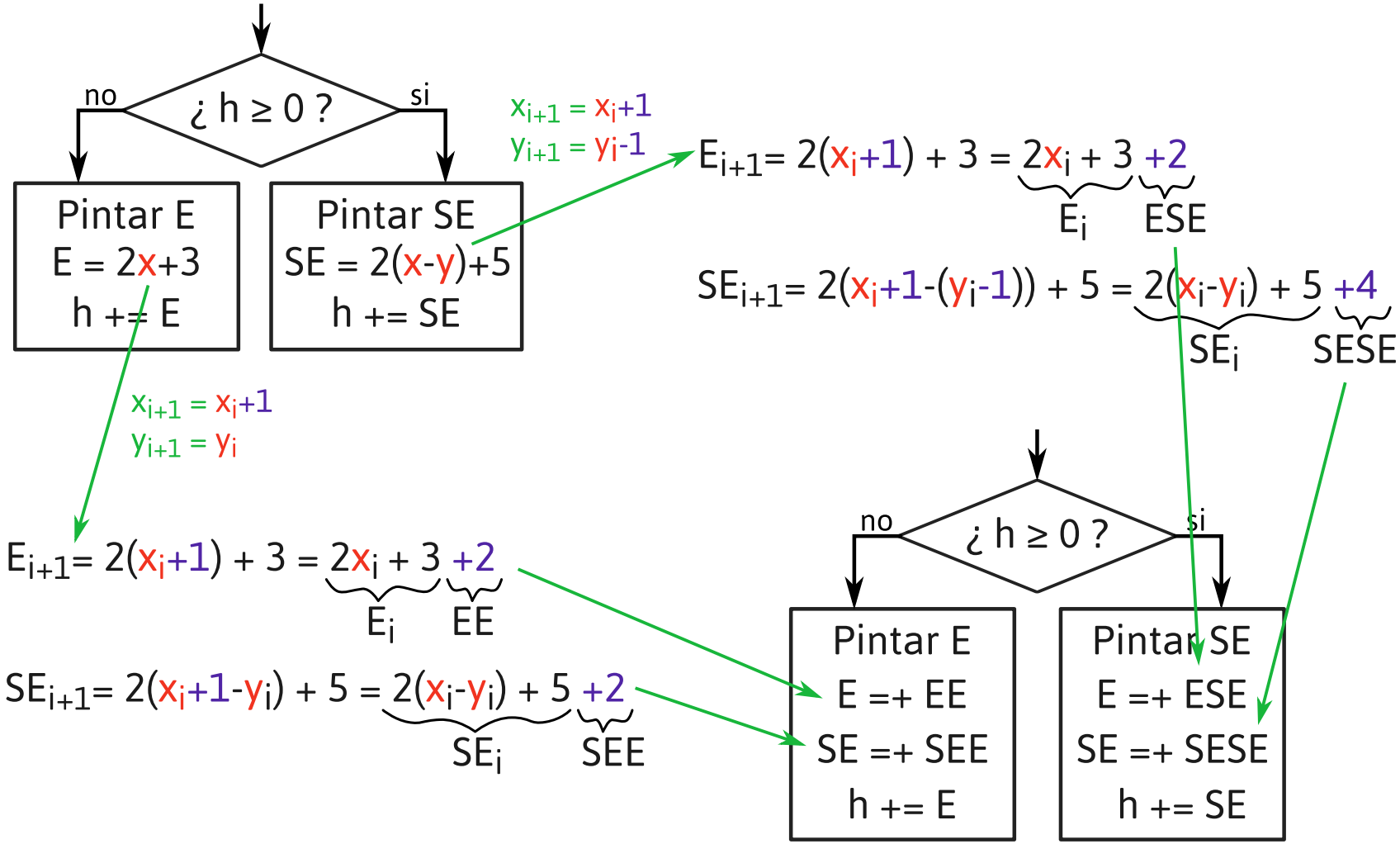
$x_{i+1} = x_i+1$
$y_{i+1} = y_i-1$

$$h_{i+1}= (x_i+1)^2 +2(x_i+1) +(y_i-1)^2 -(y_i-1) +1 -r^2$$

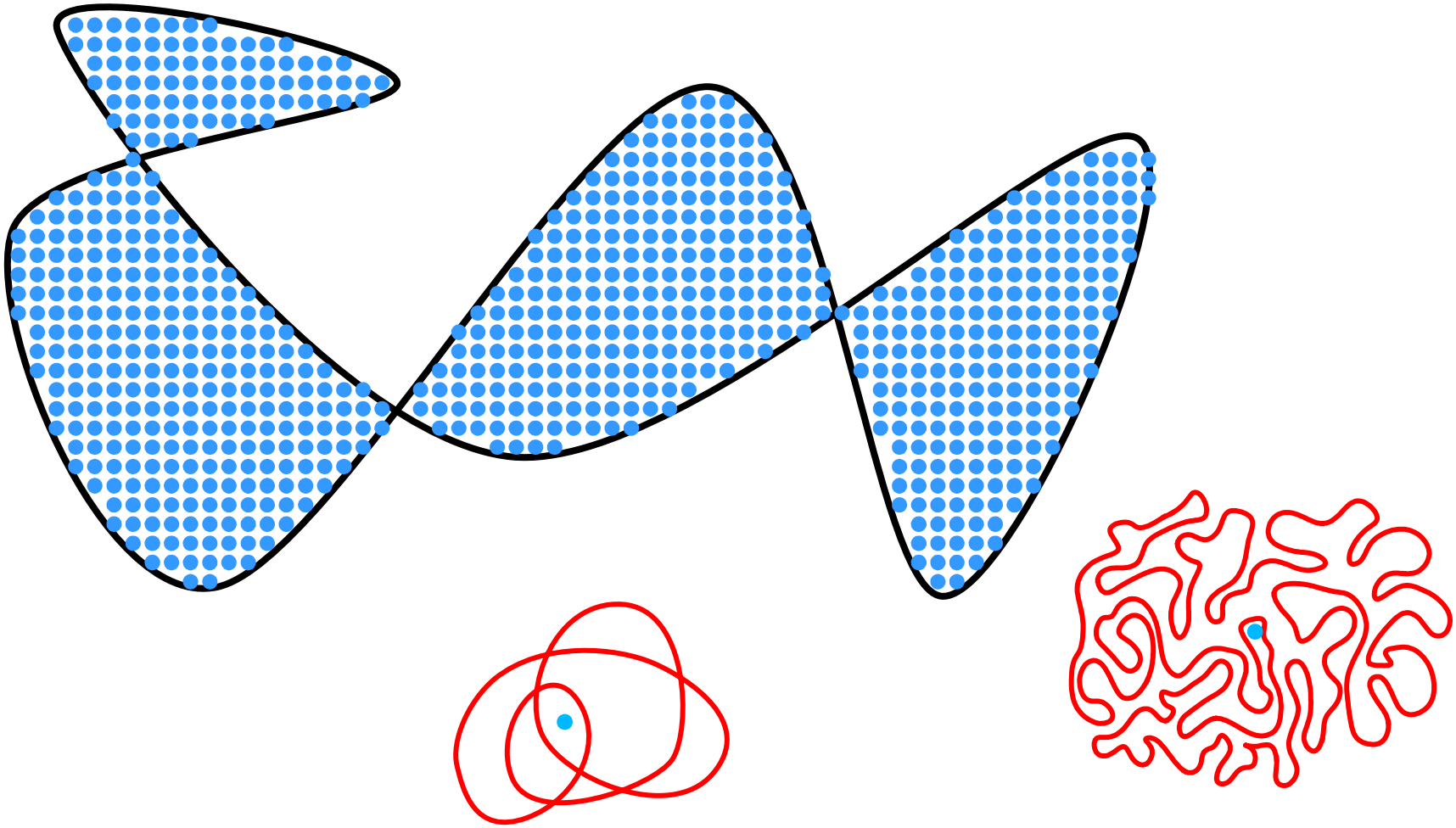
$$h_{i+1}= x_i^2+2x_i+1 + 2x_i+2 + y_i^2-2y_i^2+1 +y_i+1 +1 -r^2$$

$$h_{i+1}= \underbrace{x_i^2+2x_i +y_i^2 +y_i +1 -r^2}_{h_i} \underbrace{+ 2x_i -2y_i +5}_{SE}$$

Algoritmo de Circunferencias de Bresenham

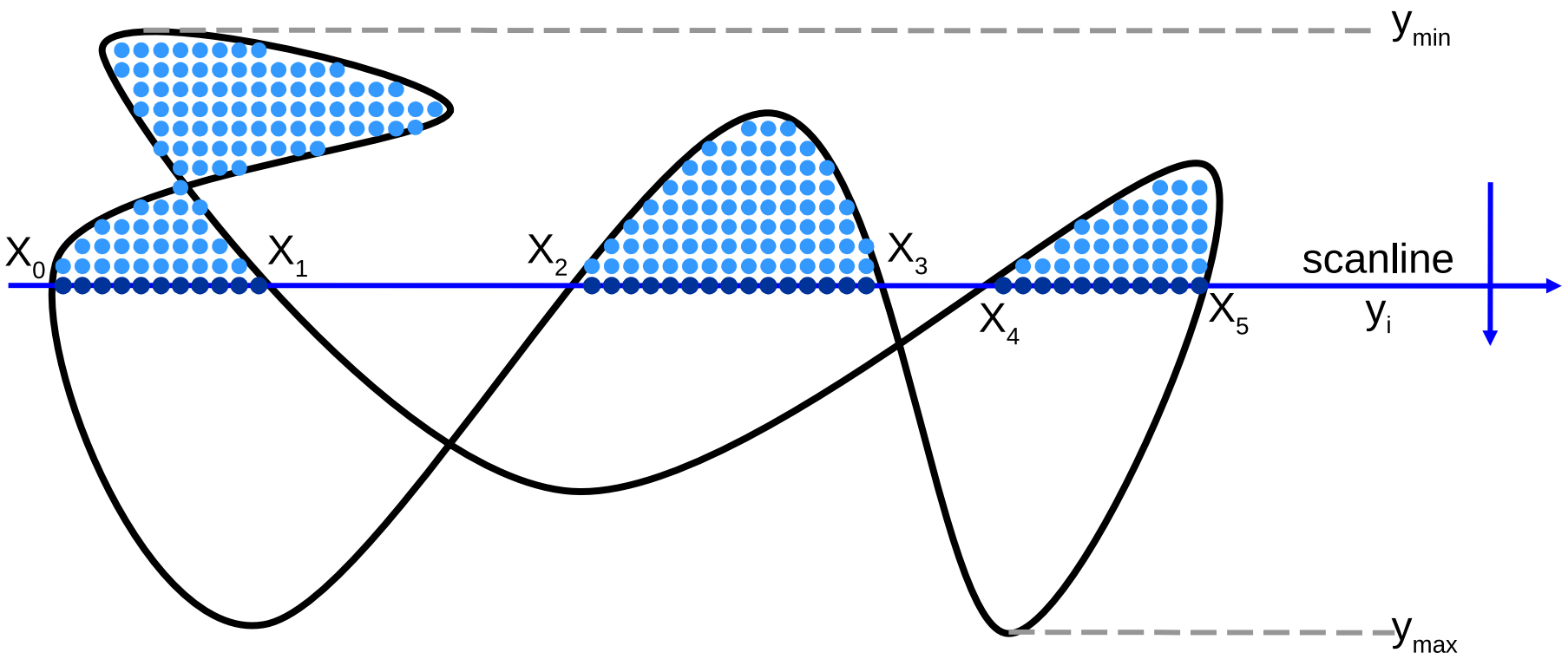


Rasterización de Figuras Cerradas



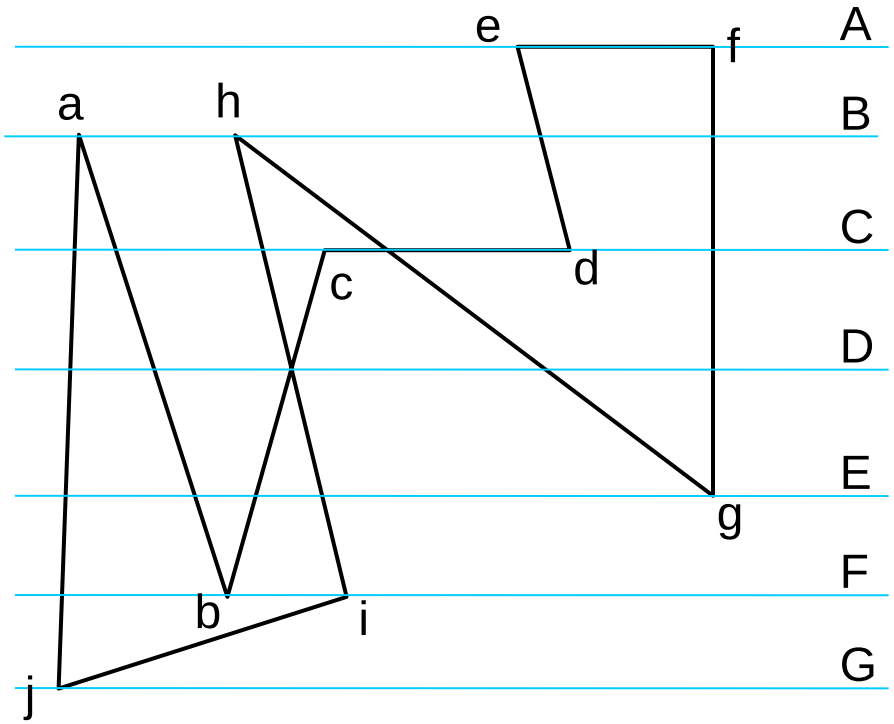
Rasterización de Figuras Cerradas

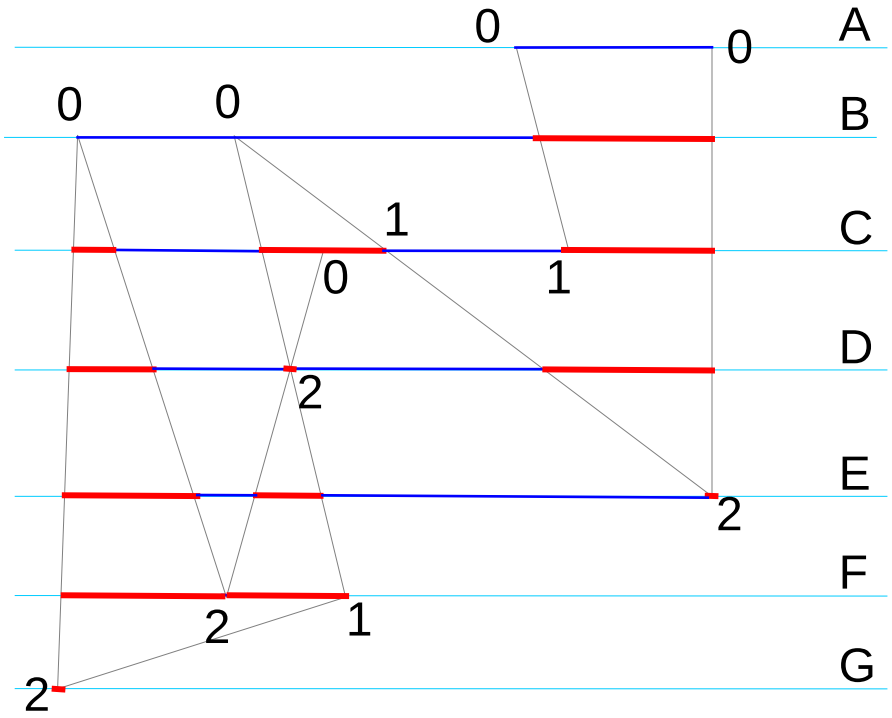
Igual que el *buffer* de color *cache friendly*




```
y=ymin+1; i=1; while(y<ymax) {
  j=0; while(j<n[i]-1) {
    x=X[i][j]+1; while(x<X[i][j+1]){pinta(x,y); x++;} j+=2;
  }
  y++; i++;
}
```

Rasterización de Poligonales





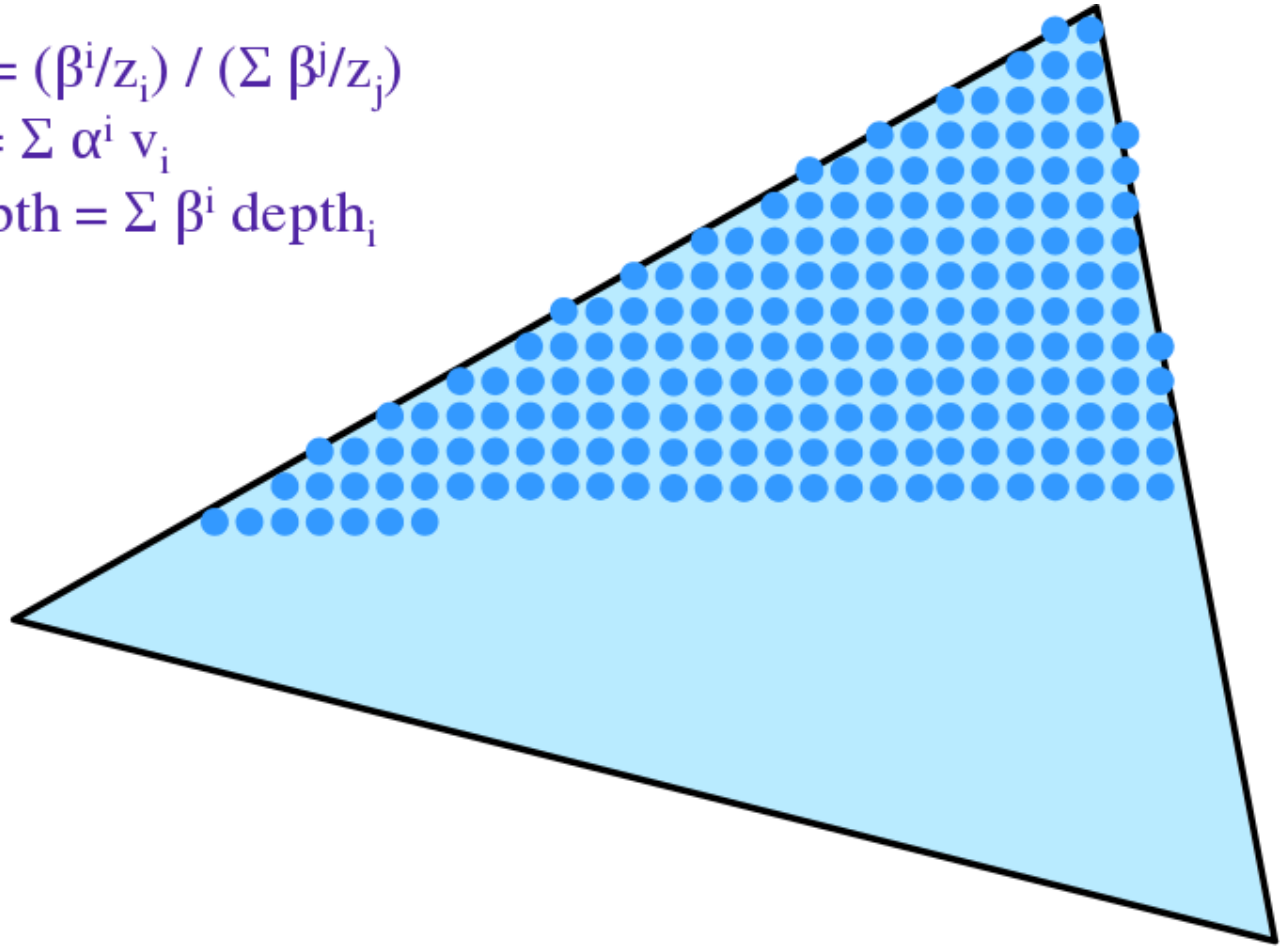
Pasos horizontales no se agregan a la lista.
Vértices: sólo los mínimos estrictos de su segmento.

Rasterización de Triángulos

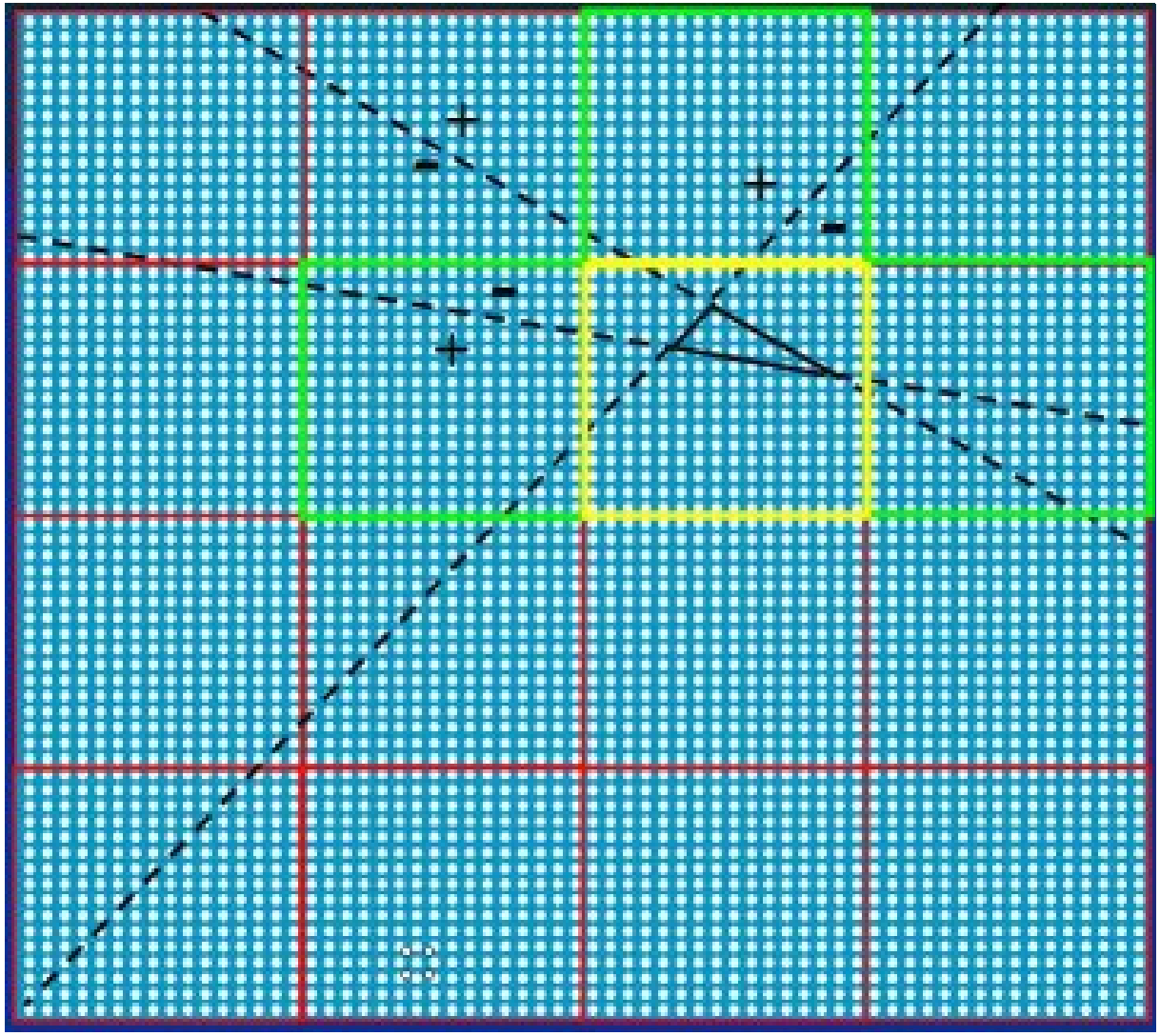
$\alpha^i = (\beta^i/z_i) / (\Sigma\ \beta^j/z_j)$

$v = \Sigma\ \alpha^i\ v_i$

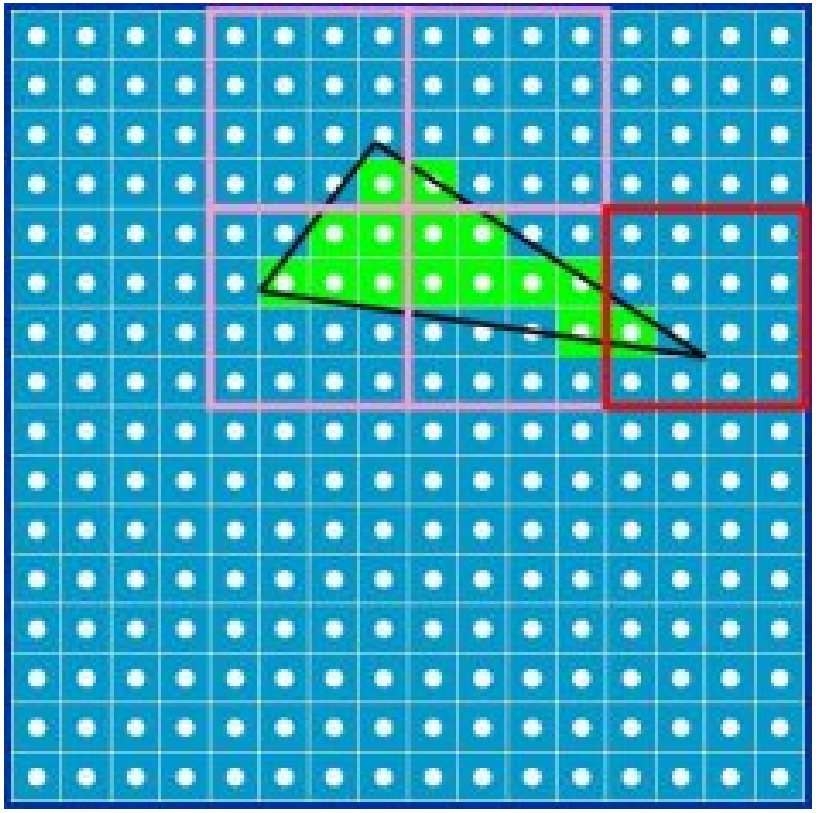
$depth = \Sigma\ \beta^i\ depth_i$



Rasterización de Triángulos

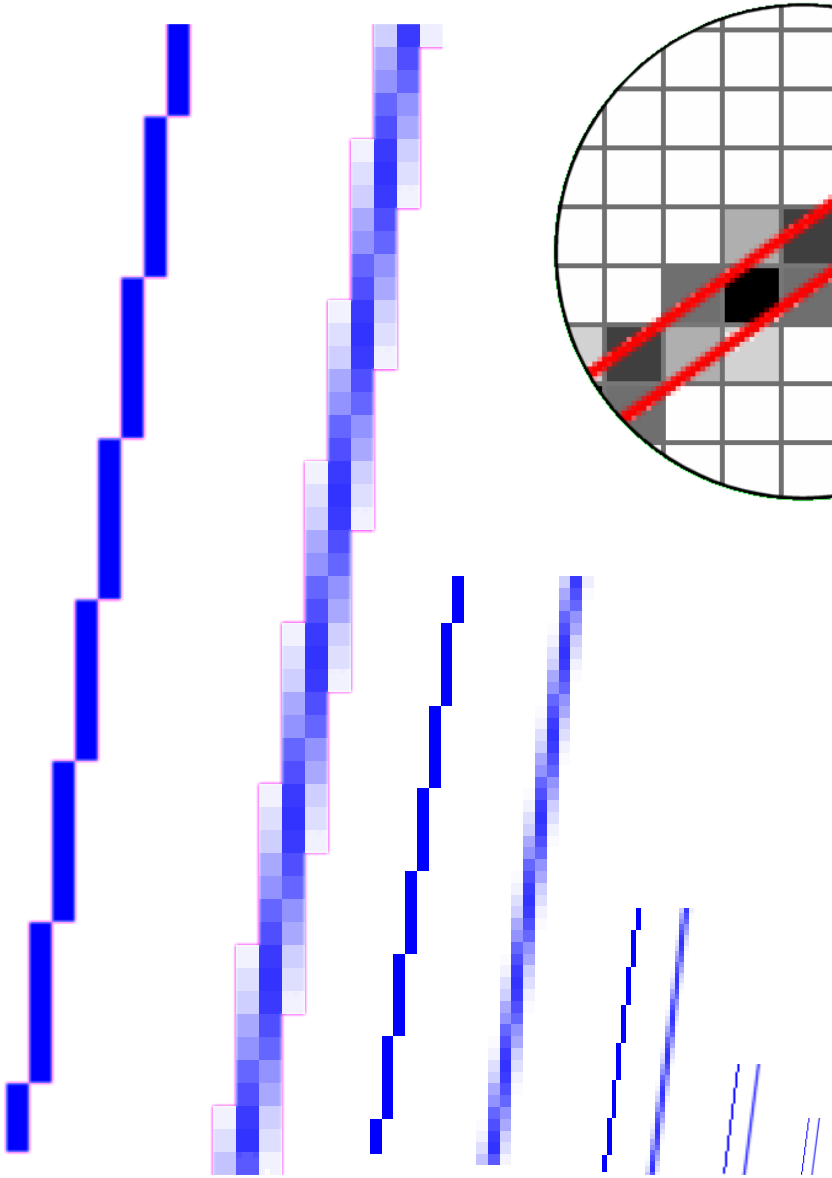


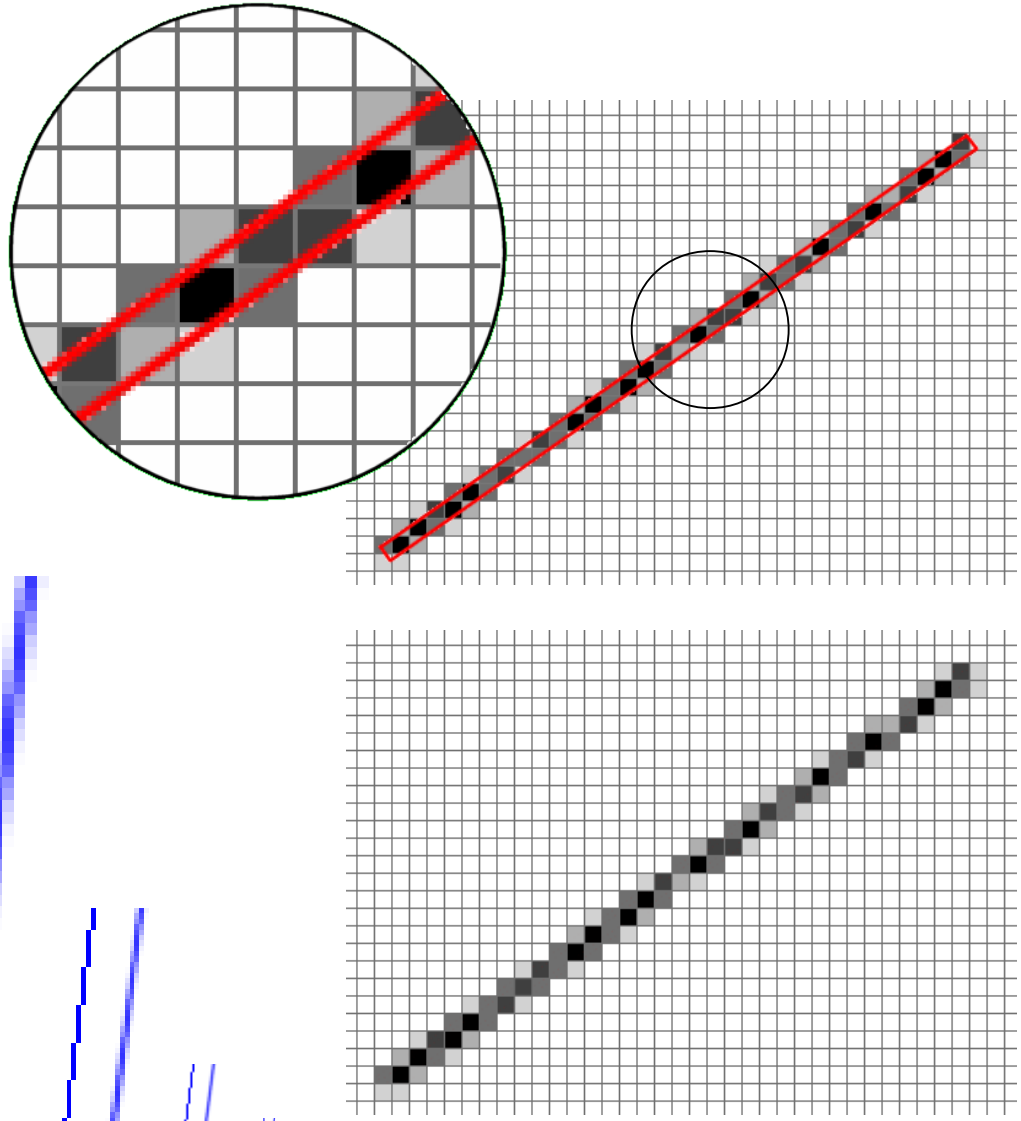
Rasterización de Triángulos



Anti-aliasing

Anti-aliasing





Anti-aliasing