

**Ellipse Algorithm:**

Ellipse is define by center (x1, y1) , first radius (r1) and second radius (r2). To draw ellipse we must:

1. Find initial point:

$$x = x1 + r1$$

$$y = y1$$

2. Find the increment value:

$$x = x1 + r1 * \cos (\Theta) \dots\dots\dots(1)$$

$$y = y1 + r2 * \sin (\Theta)$$

by find the differential of equations (1)

$$dx = -r1 * \sin (\Theta) * d(\Theta) \dots\dots\dots(2)$$

$$dy = r2 * \cos (\Theta) * d(\Theta)$$

and from equation (1)

$$\cos (\Theta) = ( x - x1) / r1 \dots\dots\dots(3)$$

$$\sin (\Theta) = ( y - y1) / r2$$

substitute equation (3) in (2)

$$dx = -r1 * ( y - y1) / r2 * d(\Theta) \rightarrow dx = -r1/r2 * ( y - y1) * d(\Theta)$$

$$dy = r2 * ( x - x1) / r1 * d(\Theta) \rightarrow dy = r2 / r1 * ( x - x1) * d(\Theta)$$

$$\text{where } d(\Theta) = 1 / \max (r1, r2)$$

3. The iterations ( number of points) are depend on angle rotation from 0 to 360.

**Ellipse Algorithm: center (x1,y1) , first radius (r1), second radius (r2)****Begin**

$$x = x1 + r1$$

$$y = y1$$

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theta = 0
dtheta = 1 / max (r1 , r2 )
while theta < 360
SetPixel ( x , y , color )
x = x - (r1 / r2) * (y - y1) * dtheta
y = y - (r2 / r1) * (y - y1) * dtheta
theta = theta + dtheta
end

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### **Arc Algorithm**

Arc is define by center (x1, y1) , radius (r), start angle ( $\Theta$ ) and endangle ( $\beta$ ). To draw Arc we must:

1. Find initial point:

$$x = x1 + r * \cos(\Theta) \dots \dots \dots (1)$$

$$y = y1 + r * \sin (\Theta)$$

2. Find the incremental value by find the differential of equations (1) :

$$dx = -r * \sin (\Theta) * d(\Theta) \dots \dots \dots (2)$$

$$dy = r * \cos (\Theta) * d(\Theta)$$

and from equation (1)

$$\cos (\Theta) = ( x - x1) / r \dots \dots \dots (3)$$

$$\sin (\Theta) = ( y - y1) / r$$

substitute equation (3) in (2)

$$dx = - ( y - y1) * d(\Theta) \rightarrow dx = ( y1 - y) * d(\Theta)$$

$$dy = ( x - x1) * d(\Theta)$$

$$\text{where } d(\Theta) = 1 / r$$

3. The iterations ( number of points) are begin from startangle( $\Theta$ ) to endangle( $\beta$ ).

**Arc Algorithm: center (x1 , y1) , radius (r),startangle( $\Theta$ ), endangle( $\beta$ )****Begin**

$$\Theta = \text{startangle} * 3.14 / 180$$

$$\beta = \text{endangle} * 3.14 / 180$$

$$d\theta = 1 / r$$

$$x = x1 + r * \cos (\Theta)$$

$$y = y1 + r * \sin (\Theta)$$

SetPixel(x ,y , color)

While  $\Theta < \beta$

$$x = x + (y1 - y) * d(\Theta)$$

$$y = y + (x - x1) * d(\Theta)$$

SetPixel(x ,y , color)

$$\Theta = \Theta + d(\Theta)$$

Endwhile

**End**