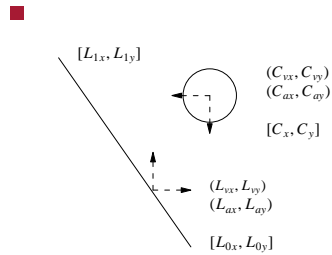


## Circle line collision

- assumes that we have a robust solution to the circle circle problem which is fully debugged and ready to be used :-)

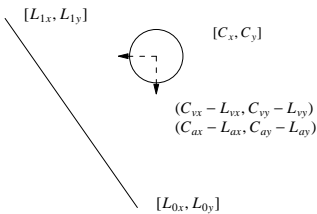


- at what time is the earliest collision between the line and circle?

slide 3  
gaius

### Step one

- is to consider the line as stationary and only the circle as moving:



- hence we now have the relative velocity, acceleration
  - the radius of the circle is  $r$

slide 4  
gaius

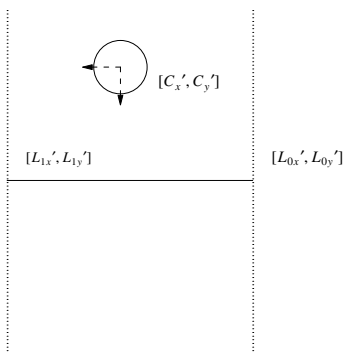
### Step two

- consider the line to be lying on the X axis, say, with  $[L_{1x}, L_{1y}]$  on the point  $[0, 0]$ 
  - and  $[L_{0x}, L_{0y}]$  at  $[\text{length}(L), 0]$
- this involves translating the line and circle by  $[-L_{1x}, -L_{1y}]$
- it also involves rotating the line, circle and the relative velocity and acceleration by

$$\theta = \arcsin\left(\frac{L_{0y} - L_{1y}}{\sqrt{(L_{0x} - L_{1x})^2 + (L_{0y} - L_{1y})^2}}\right)$$

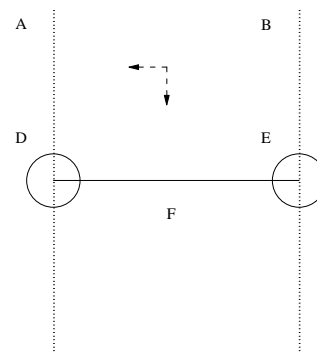
### Step two

- we can redraw our diagram as:



### Step 3

- redraw the diagram as:



- the radius of the circle is  $r$

- now we can ask three questions:

### Step 3

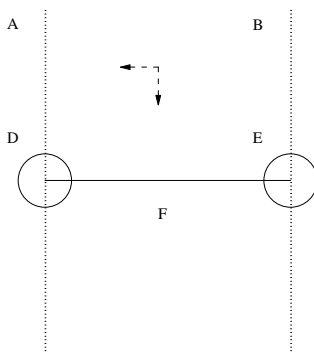
- (i) does the point  $C_x', C_y'$  hit the left circle?
  - in which case the circle will hit the left edge of the line
- (ii) does the point  $C_x', C_y'$  hit the right circle?
  - in which case the circle will hit the right edge of the line
- (iii) does the point  $C_x', C_y - r'$  hit inbetween the left and right end points of the line?

### Step 4

- to answer both (i) and (ii) we notice that:
- all we need to do is call our circle circle algorithm and ask this question as whether the new circle hits point (a circle with a radius of 0)

**Step 4**

- to answer (iii) we return to the diagram:

**Step 4**

- we need to know at what time,  $t$ , our point hits the X axis
- we only need to consider the Y values of the velocity, position, acceleration vectors
- so:  $0 = s_0 + ut + \frac{a}{2} t^2$
- and solve for  $t$

**Step 4**

- now we have a value for  $t$  we can find where about on the X axis the point will hit using the same formula, but we plug in the X values of the velocity, position, acceleration vectors
- let  $s_x$  be the new position
- if  $s_x \geq 0$  and  $s_x \leq \text{length}(\text{line})$ 
  - then we have a hit!
- from answering questions (i), (ii), (iii) we ignore any negative time values, only remember the smallest time value  $\geq 0$  which tells us the next time of a collision

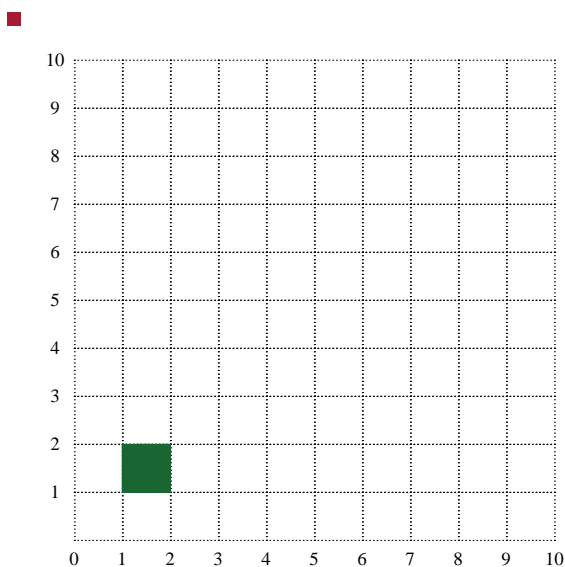
## Calculating the Centre of Gravity of a polygon (centroid of polygon)

- clearly the centre of gravity for a linear mass circle is its centre
- how do we calculate the centre of gravity for a linear mass polygon?
- centroid of a non-self-intersecting closed polygon defined by a number of points (or vertices):
  - $(x_0, y_0), (x_1, y_1), \dots, (x_{n-1}, y_{n-1})$
  - each point or vertice **must** be presented in a clockwise or anticlockwise order
  - we need to find position  $(c_x, c_y)$  which is the centre of gravity of this polygon

## Calculating the Centre of Gravity of a polygon (centroid of polygon)

- firstly we need to find the polygons area
- $A = \frac{1}{2} \sum_{i=0}^{n-1} x_i y_{i+1} - x_{i+1} y_i$

## Calculating the Centre of Gravity of a polygon (centroid of polygon)



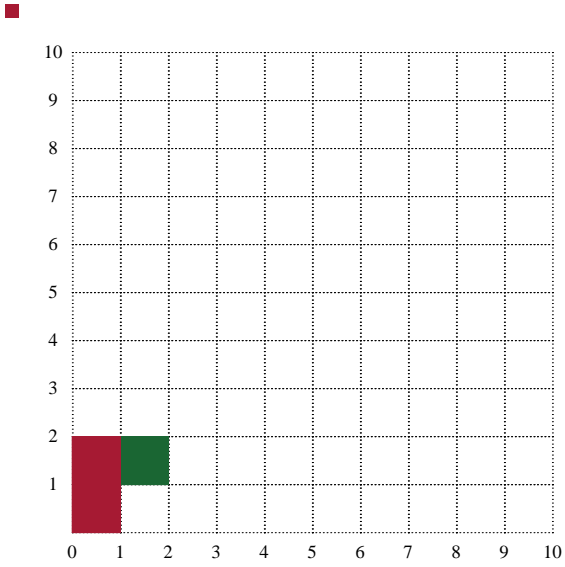
## Calculating the Centre of Gravity of a polygon (centroid of polygon)

- area of box is:

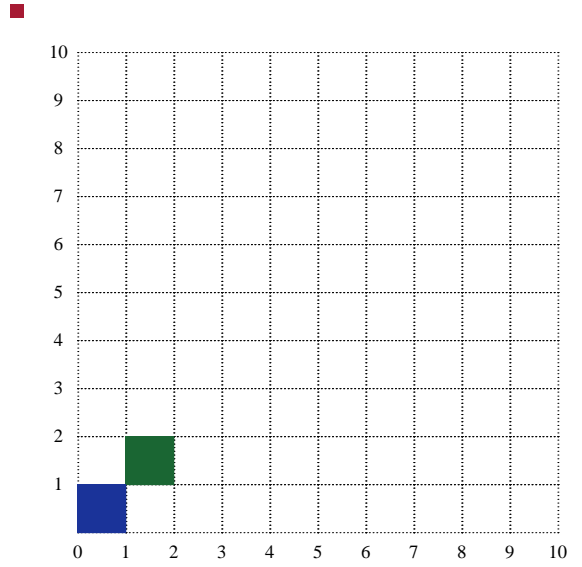
- | i | $x_i y_{i+1} - x_{i+1} y_i$ | total |
|---|-----------------------------|-------|
| 0 | $1 \times 2 - 1 \times 1$   | 1     |
| 1 | $1 \times 2 - 2 \times 2$   | -2    |
| 2 | $2 \times 1 - 2 \times 2$   | -2    |
| 3 | $2 \times 1 - 1 \times 1$   | 1     |
|   |                             | -2    |

- $area = \frac{-2}{2} = -1$

### Iteration 0.a of the area calculation



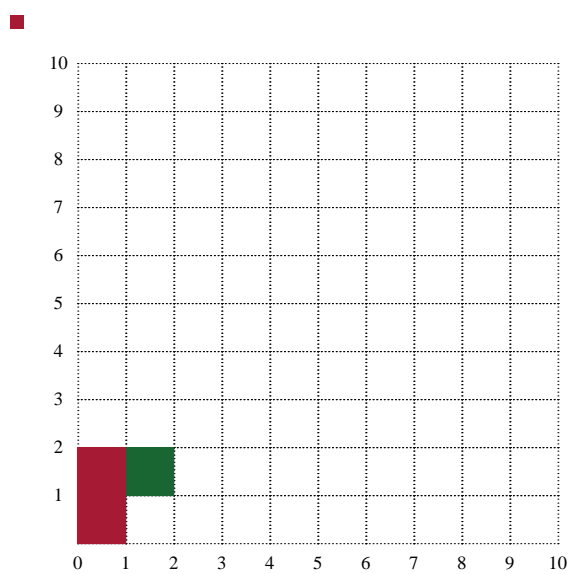
### Iteration 0.b of the area calculation



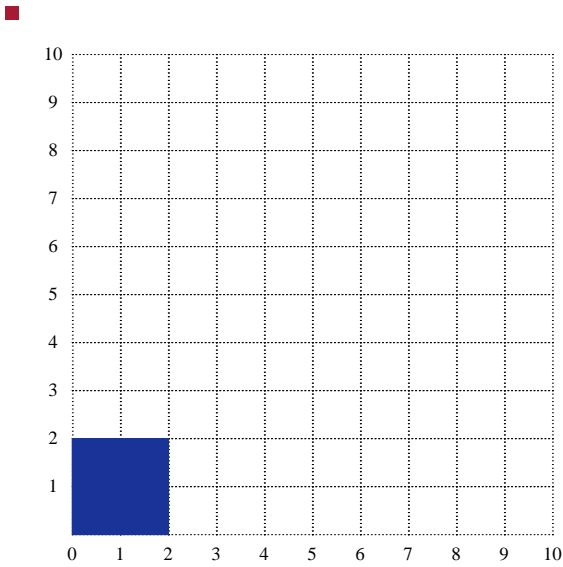
### Iteration 0.b of the area calculation

■ area of red box - blue box = 1

### Iteration 1.a of the area calculation



## Iteration 1.b of the area calculation



## Iteration 1.b of the area calculation

- red box - blue box = -2
- exercise for the reader, complete the diagrams for the remaining iterations

## Calculating the centre of gravity of a polygon

- $C_x$  is calculated via:

- $$C_x = \frac{1}{6A} \sum_{i=0}^{n-1} (x_i + x_{i+1})(x_i y_{i+1} - x_{i+1} y_i)$$

- $C_y$  is calculated via:

- $$C_y = \frac{1}{6A} \sum_{i=0}^{n-1} (y_i + y_{i+1})(x_i y_{i+1} - x_{i+1} y_i)$$

## Calculating C of G in pge

- please see `c/twoDsim.c` and the functions `calculateCofG` and `calcArea`