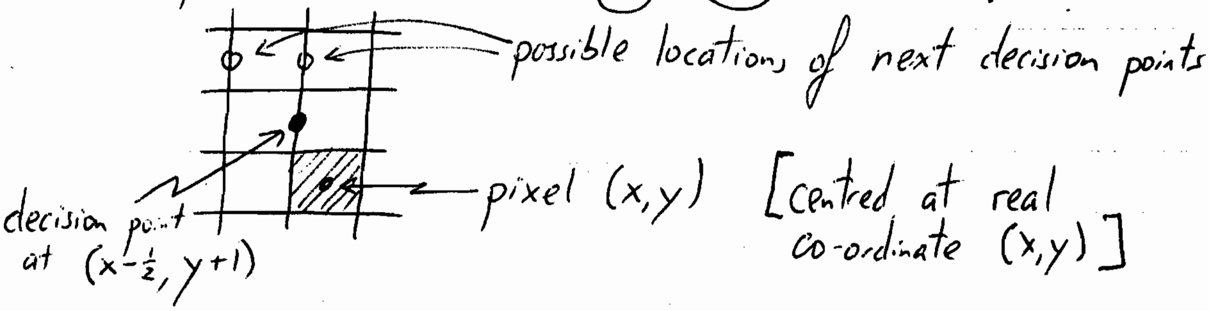
Computer Graphics and Image Processing

2000
p13q4

(a) use the midpoint circle drawing algorithm



possible locations of next decision points
pixel (x,y) [centred at real co-ordinate (x,y)]
decision point at $(x-\frac{1}{2}, y+1)$

given a turned on pixel (x,y), the next pixel up will either be (x-1, y+1) or (x, y+1). To decide which evaluate the decision variable at $(x-\frac{1}{2}, y+1)$.

$$d = (x-\tfrac{1}{2})^2 + (y+1)^2 - r^2$$

if $d > 0$ then move NW to $(x-1, y+1)$
and $d' = (x-\frac{3}{2})^2 + (y+2)^2 - r^2$
$= d - 2x + 2y + 5$

if $d \leq 0$ then move N to $(x, y+1)$
and $d' = (x-\frac{1}{2})^2 + (y+2)^2 - r^2$
$= d + 2y + 3$

starting condition is : $x = r$ (an integer)
$y = 0$

end condition is : $y > x$

Overall algorithm

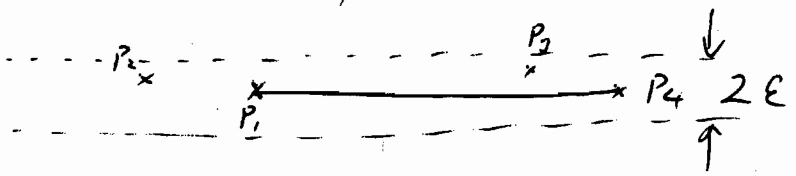
radius is sole parameter

```
function drawFirstOctant (r) {
    $x = r$
    $y = 0$
    $d = (x - 0.5)^2 + (y+1)^2 - r^2$
    ~~drawPixel (x,y~~)
    ~~repeat {~~
    ~~if (~~ while ($x \geq y$) {
      drawPixel (x,y)
      if ($d > 0$)
      then {
          $d = d - 2x + 2y + 5$
          $x = x - 1$
          $y = y - 1$
      }
      else {
          $d = d + 2y + 3$
          $y = y - 1$
      }
    }
}
```

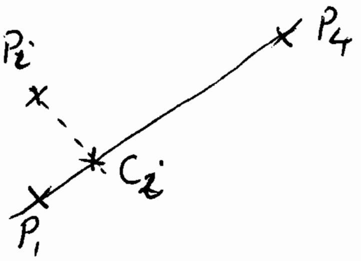
(b) translate to origin, rotate by θ, translate back

$$\begin{bmatrix} 1 & 0 & x_c \\ 0 & 1 & y_c \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} 1 & 0 & -x_c \\ 0 & 1 & -y_c \\ 0 & 0 & 1 \end{bmatrix}$$

(c) test the two middle control points to see if they lie within the tolerance, 'ε', of the straight line. If so, return 'true' else return false. you also must provide a check that they lie between the end point rather than like this:



So: the test for one point is this



$\boxed{A}$ $$C_i = (1-t_i)P_1 + t_i P_4$$

$\boxed{B}$ $$(P_i - C_i)\cdot(P_4 - P_1) = 0$$

Solving $\boxed{B}$ for t_i provides us with a value for t_i and hence for C_i in $\boxed{A}$

Return true if and only if:

$$0 \le t_2 \le 1 \quad \text{and} \quad |P_2 - C_2| \le \varepsilon$$
$$\text{and} \quad 0 \le t_3 \le 1 \quad \text{and} \quad |P_3 - C_3| \le \varepsilon$$