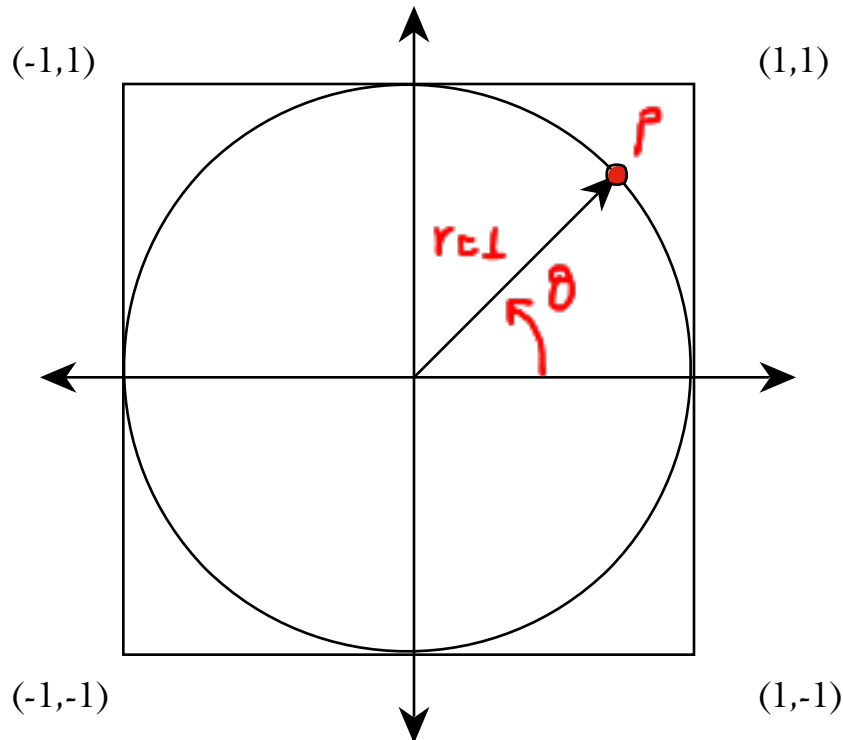


CAP 3027 – Lecture #11 – 201009.17

Administrivia

* HW 04 to be posted

Cartesian & polar coordinates



P is located at
 * (x, y) – Cartesian
 * (r, θ) – Polar

Polar \rightarrow Cartesian

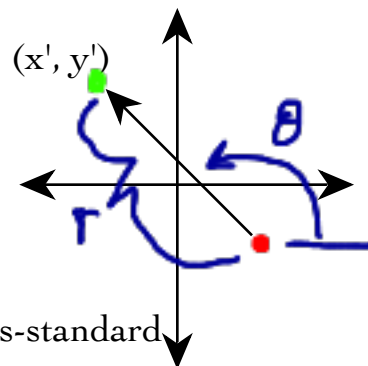
Given an arbitrary radius r and θ , what are the Cartesian coordinates?

Relative to the origin

$$\begin{aligned} x &= r * \cos(\theta) \\ y &= r * \sin(\theta) \end{aligned}$$

Relative to an arbitrary point (x, y)

$$\begin{aligned} x' &= x + r * \cos(\theta) \\ y' &= y + r * \sin(\theta) \end{aligned}$$



Note: this is the *standard Cartesian plane*

These formulae are *not* the ones to use of the graphics-standard inverted Y-axis style.

Directed random walk plant

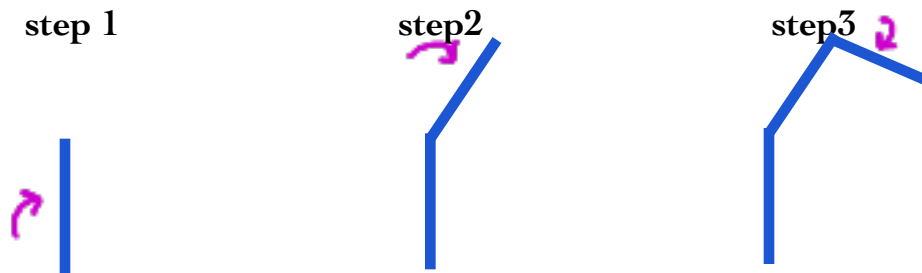
α = the transmission probability

β = the reflection probability

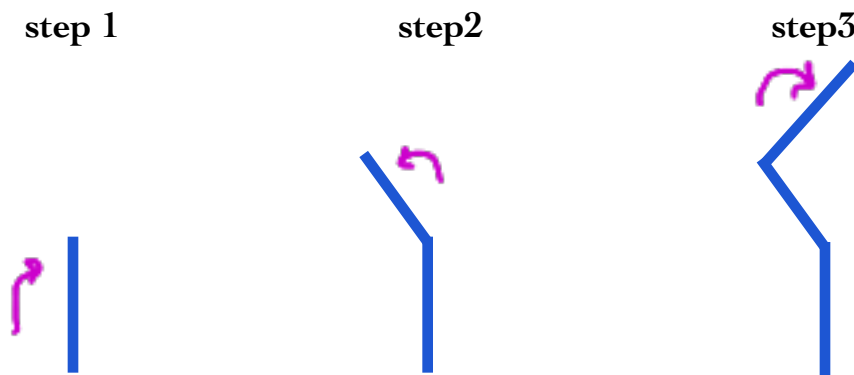
$$\alpha + \beta = 1$$



When $\alpha = 1$, the next step turns in the *same* direction as the previous step



When $\alpha = 0$, the next step turns in the *opposite* direction as the previous step



Inspiration

Clifford Pickover's *Computers, Chaos, Pattern, & Beauty*

Algorithm for a *single stem*

0) given the constants:

- α transmission probability [0.0.1.0]
- $\Delta\theta$ maximum change in rotation per step (in radians)
- Δr change in growth segment length per step (in pixels)

1) initialize variables

- $\theta := \pi/2$ start growing "upwards"
- $r := 1.0$ growth segment length
- $x := \text{imageWidth} / 2$ grow from point (x,y)
- $y := \text{imageHeight} / 2$
- $\beta := (1.0 - \alpha)$ reflection probability [0.0.1.0]
- $\text{direction} := +1 \text{ or } -1$ direction to turn (+1 = left | -1 = right)

2) plot the initial segment

3) determine τ , the virtual coin's *bias*

if the last turn was to the right

$\tau := \alpha$

else

$\tau := \beta$

4) flip the *biased coin* to determine which direction to turn next

if $\text{random}[0.0,1.0) > \tau$

$\text{direction} := +1.0$

else

$\text{direction} := -1.0$

5) compute offset from end of the old growth segment to the end of the new one

$(r, \theta) := (r + \Delta r, \theta + (\Delta\theta * \text{random}[0.0,1.0) * \text{direction}))$

the actual change in θ for this step

6) draw a growth segment from the old position to the new position

7) if this stem hasn't finished growing, goto step 3

Added after class:

Recall: $[x,y)$ denotes a range of values that INcludes x and EXcludes y.

```
beta = 1.0 - alpha;
tau = (direction < 0) ? alpha : beta;
direction = ( rand.nextDouble() > tau ) ? +1.0 : -1.0;
```

By plugging in values for alpha at the extremes we can see the effect that alpha has on the system:

when alpha == 0, beta == 1 *100% reflection probability*

```
if we were going right [direction is -1]
  tau := alpha == 0
  since rand [0.0,1.0) is (practically) always going to be > 0.0
  direction := +1 [turn left]
else we were going left [direction is +1]
  tau := beta == 1
  since rand [0.0,1.0) is always going to be < 1.0
  direction := -1 [turn right]
```

==> on each step, turn in *opposite* direction as before

==> makes paths that tend to be straight

when alpha == 1, beta == 0 *100% transmission probability*

```
if we were going right [direction is -1]
  tau := alpha == 1
  since rand [0.0,1.0) is always going to be < 1.0
  direction := -1 [turn right]
else we were going left [direction is +1]
  tau := beta == 0
  since rand [0.0,1.0) is practically always going to be > 0.0
  direction := +1 [turn left]
```

==> on each step turn in the *same* direction as before

==> makes curled paths