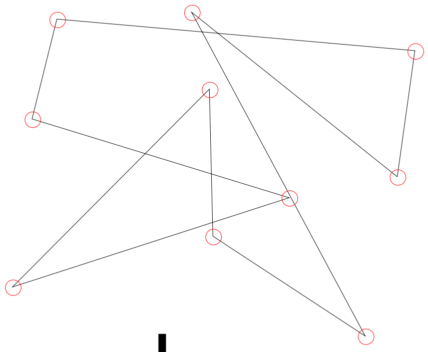
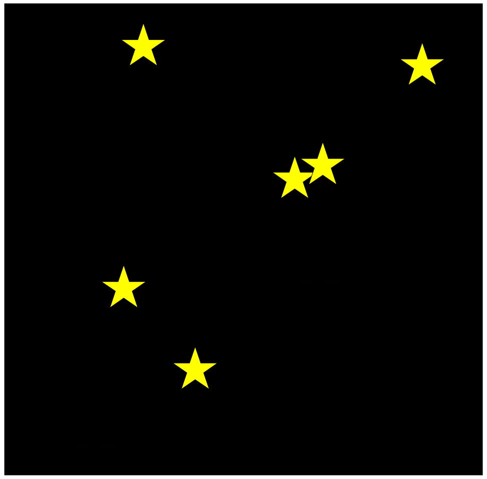
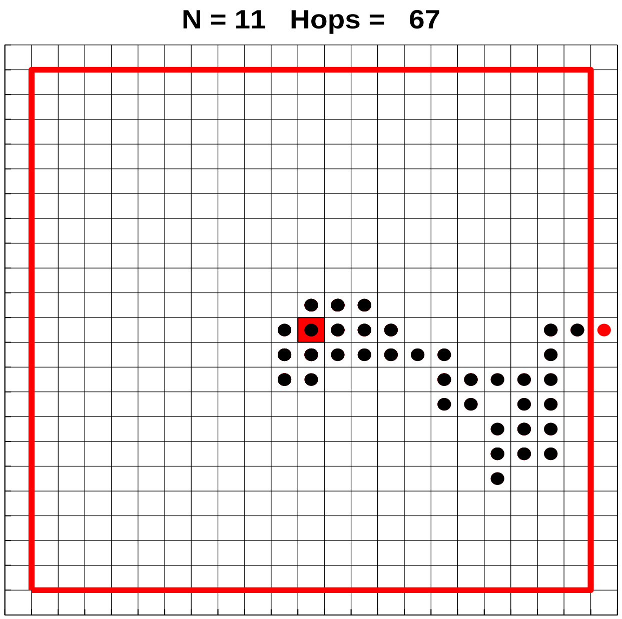
- Previous Lecture:
  - Probability and random numbers
  - 1-d array—vector
- Today's Lecture:
  - More examples on vectors
  - Simulation
- Announcement:
  - Project 3 due on Monday 10/1
  - Prelim 1 on Thurs 10/4 at 7:30pm

Simulation



- Imitates real system
- Requires judicious use of random numbers
- Requires many trials
- → opportunity to practice working with vectors!





L

Loop patterns for working with a vector

```
% Given a vector v

for k = 1:length(v)

   % Work with v(k)
   % E.g.,  disp(v(k))

end
```

```
% Given a vector v
k = 1;
while k <= length(v)

   % Work with v(k)
   % E.g.,  disp(v(k))

   k = k+1;

end
```

Simulate twinkling stars

- Get 10 user mouse clicks as locations of 10 stars—our constellation
- Simulate twinkling
  - Loop through all the stars; each has equal likelihood of being bright or dark
  - Repeat many times

- Can use DrawStar, DrawRect

```
% No. of stars and star radius
  N=10;  r=.5;
% Get mouse clicks, store coords in vectors x,y
  [x,y] = ginput(N);
% Twinkle!
  for k= 1:20  % 20 rounds of twinkling







  end
```

```
% No. of stars and star radius
  N=10;  r=.5;
% Get mouse clicks, store coords In vectors x,y
  [x,y] = ginput(N);
% Twinkle!
  for k= 1:20  % 20 rounds of twinkling
```

Loop through all stars.
Each has 50% chance of being
“lit”—draw in yellow.
Otherwise draw in black.

```
  end
```

Twinkle.m

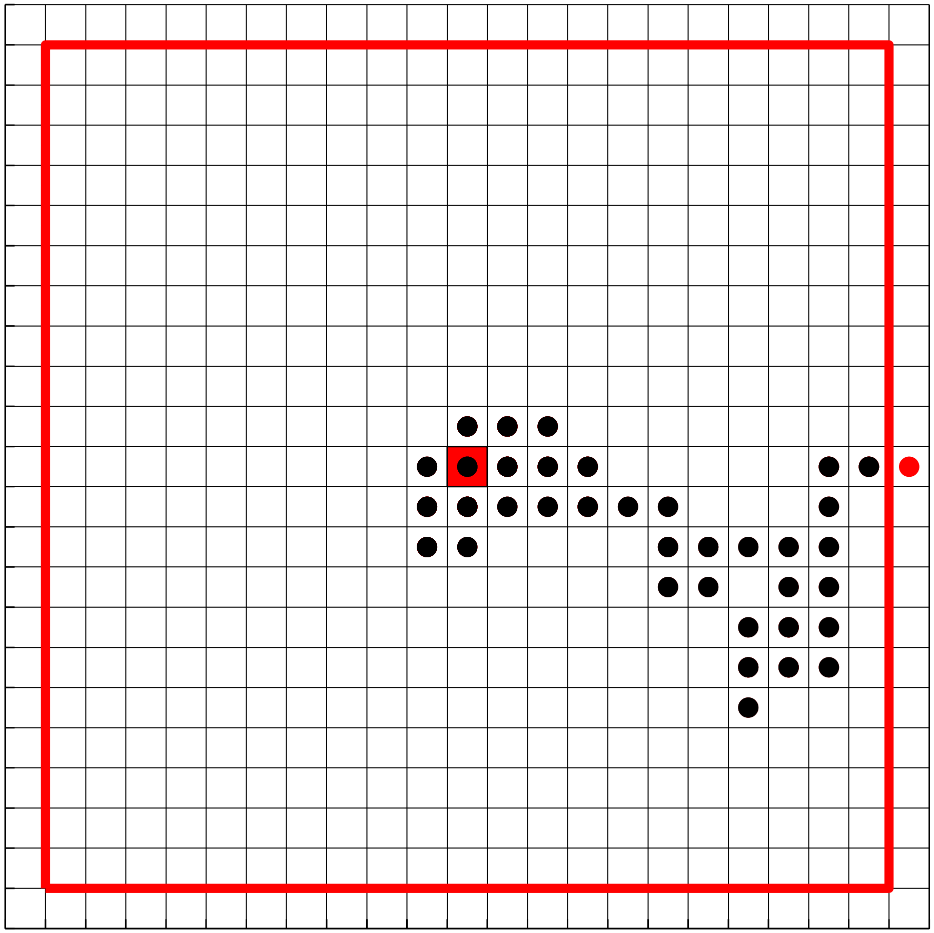
2-dimensional random walk

Start in the middle tile, (0,0).

For each step, randomly choose between N,E,S,W and then walk one tile. Each tile is 1×1.

Walk until you reach the boundary.

N = 11 Hops = 67



```
function [x, y] = RandomWalk2D(N)
% 2D random walk in 2N-1 by 2N-1 grid.
% Walk randomly from (0,0) to an edge.
% Vectors x,y represent the path.
```

```
function [x, y] = RandomWalk2D(N)

k=0;  xc=0;  yc=0;

while   not at an edge
   % Choose random dir, update xc,yc



   % Record new location in x, y

end
```

```
function [x, y] = RandomWalk2D(N)

k=0;  xc=0;  yc=0;

while  abs(xc)<N && abs(yc)<N
   % Choose random dir, update xc,yc



   % Record new location in x, y

end
```

```
function [x, y] = RandomWalk2D(N)

k=0;  xc=0;  yc=0;

while  abs(xc)<N && abs(yc)<N
   % Choose random dir, update xc,yc



   % Record new location in x, y
   k=k+1;  x(k)=xc;  y(k)=yc;
end
```

```
% Standing at (xc,yc)
% Randomly select a step
    r= rand(1);
    if r < .25
        yc= yc + 1;  % north
    elseif r < .5
        xc= xc + 1;  % east
    elseif r < .75
        yc= yc -1;   % south
    else
        xc= xc -1;   % west
    end
```

RandomWalk2D.m

Another representation for the random step

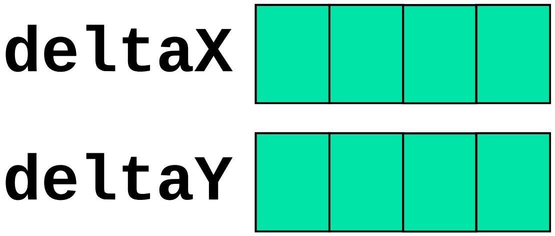
- Observe that each update has the form

$$xc = xc + \Delta x$$

$$yc = yc + \Delta y$$

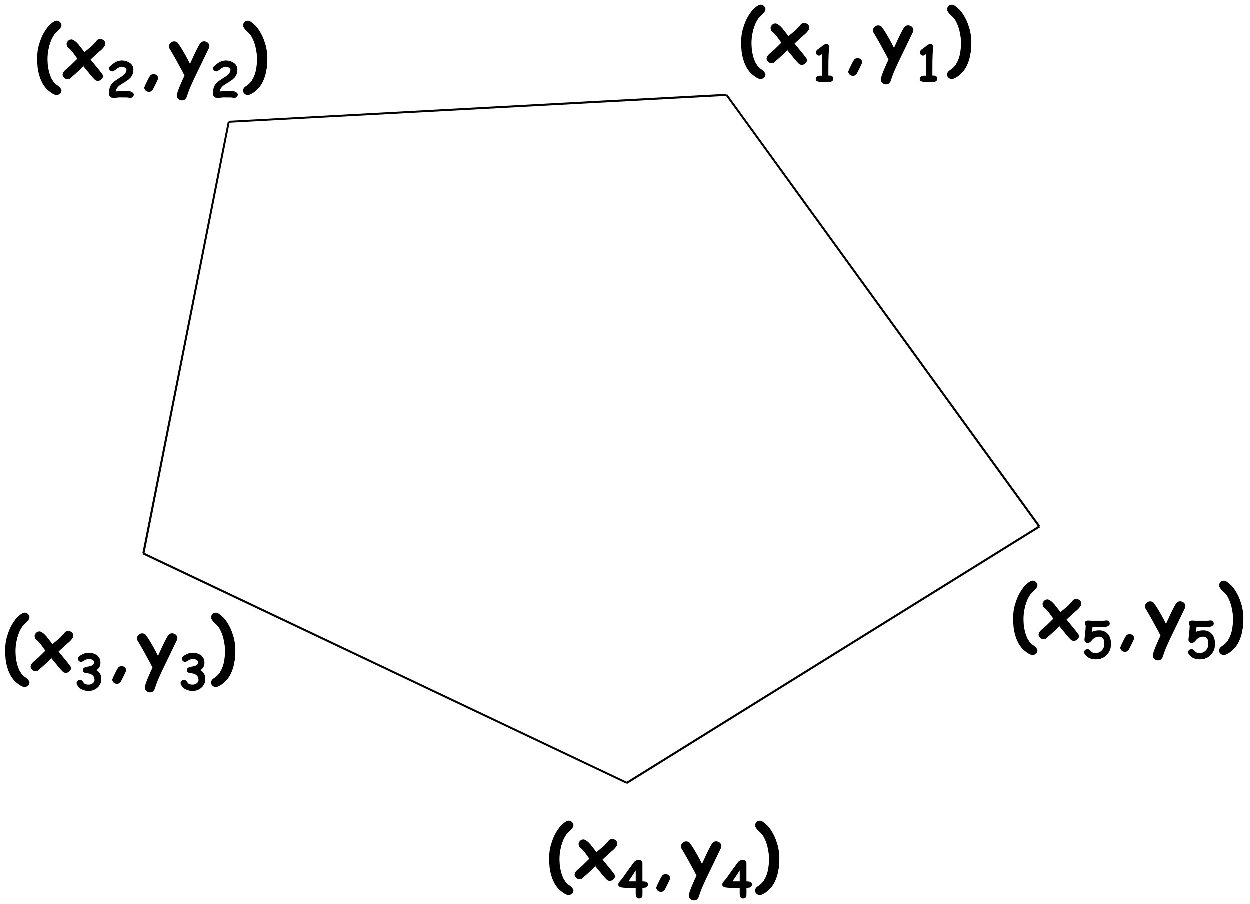
no matter which direction is taken.

- So let’s get rid of the if statement!
- Need to create two “change vectors” deltaX and deltaY

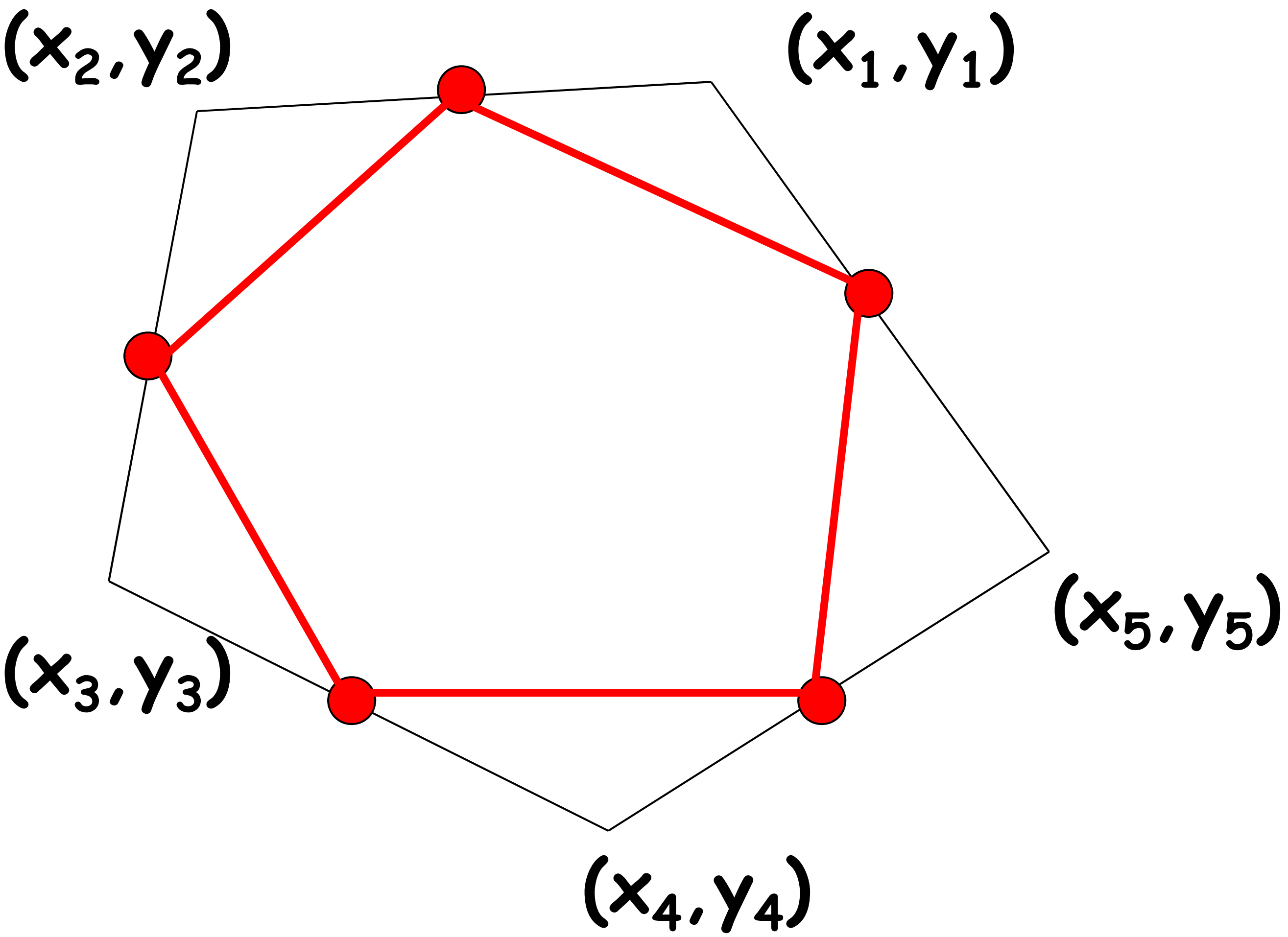


RandomWalk2D_v2.m

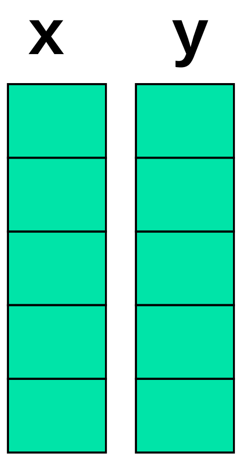
Example: polygon smoothing



Example: polygon smoothing

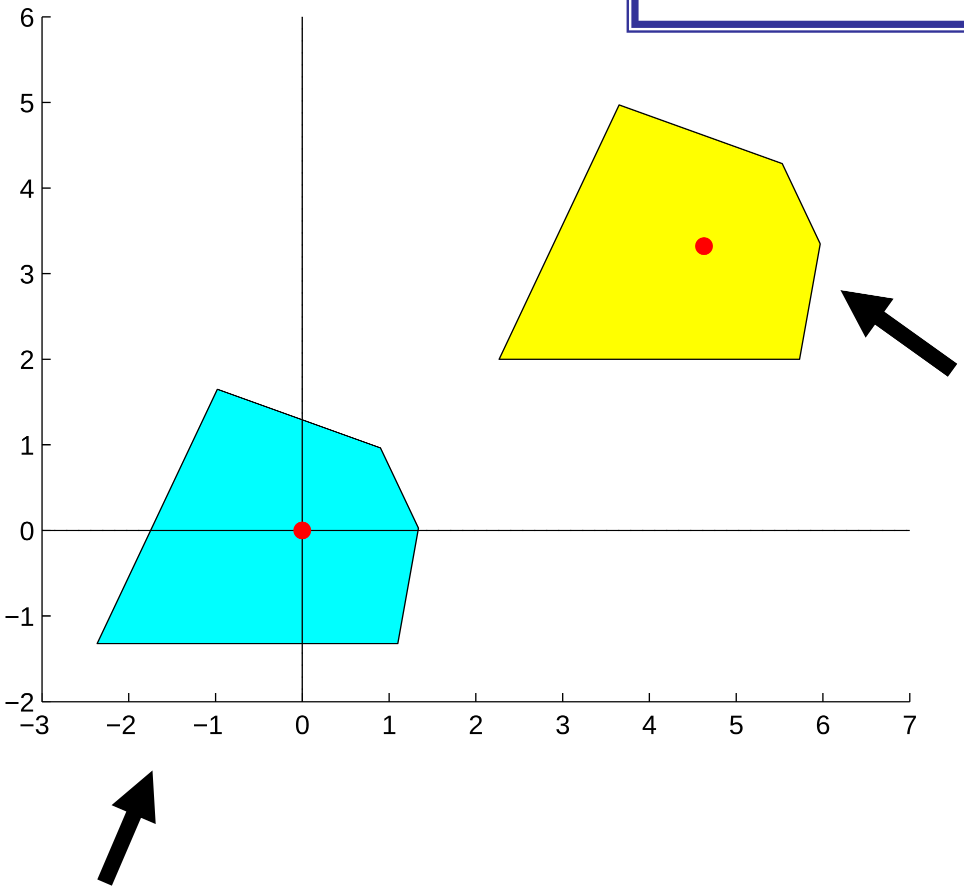


Can store the x-y coordinates in vectors x and y



First operation: centralize

Move a polygon so that the centroid of its vertices is at the origin



Before

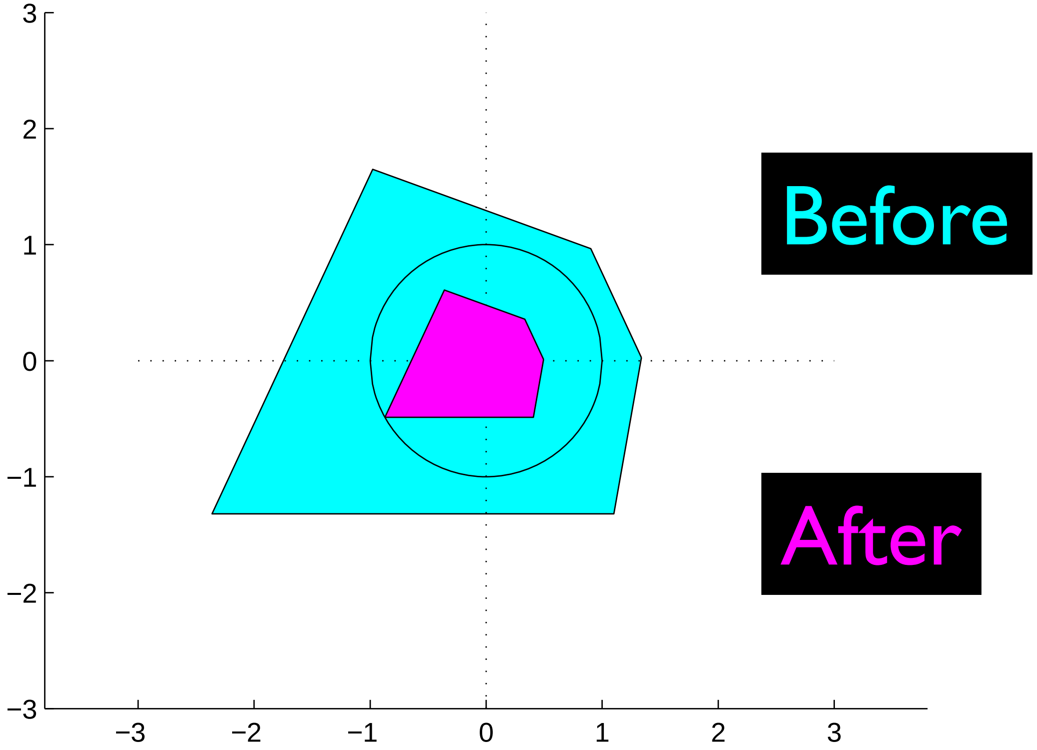
After

```
function [xNew,yNew] = Centralize(x,y)
% Translate polygon defined by vectors
% x,y such that the centroid is on the
% origin. New polygon defined by vectors
% xNew,yNew.

n = length(x);
xBar = sum(x)/n;   yBar = sum(y)/n;
xNew = zeros(n,1); yNew = zeros(n,1);
for k = 1:n
    xNew(k) = x(k)-xBar;
    yNew(k) = y(k)-yBar;
end
```

`sum` returns the sum of all values in the vector

Second operation: normalize

Shrink (enlarge) the polygon so that the vertex furthest from the (0,0) is on the unit circle

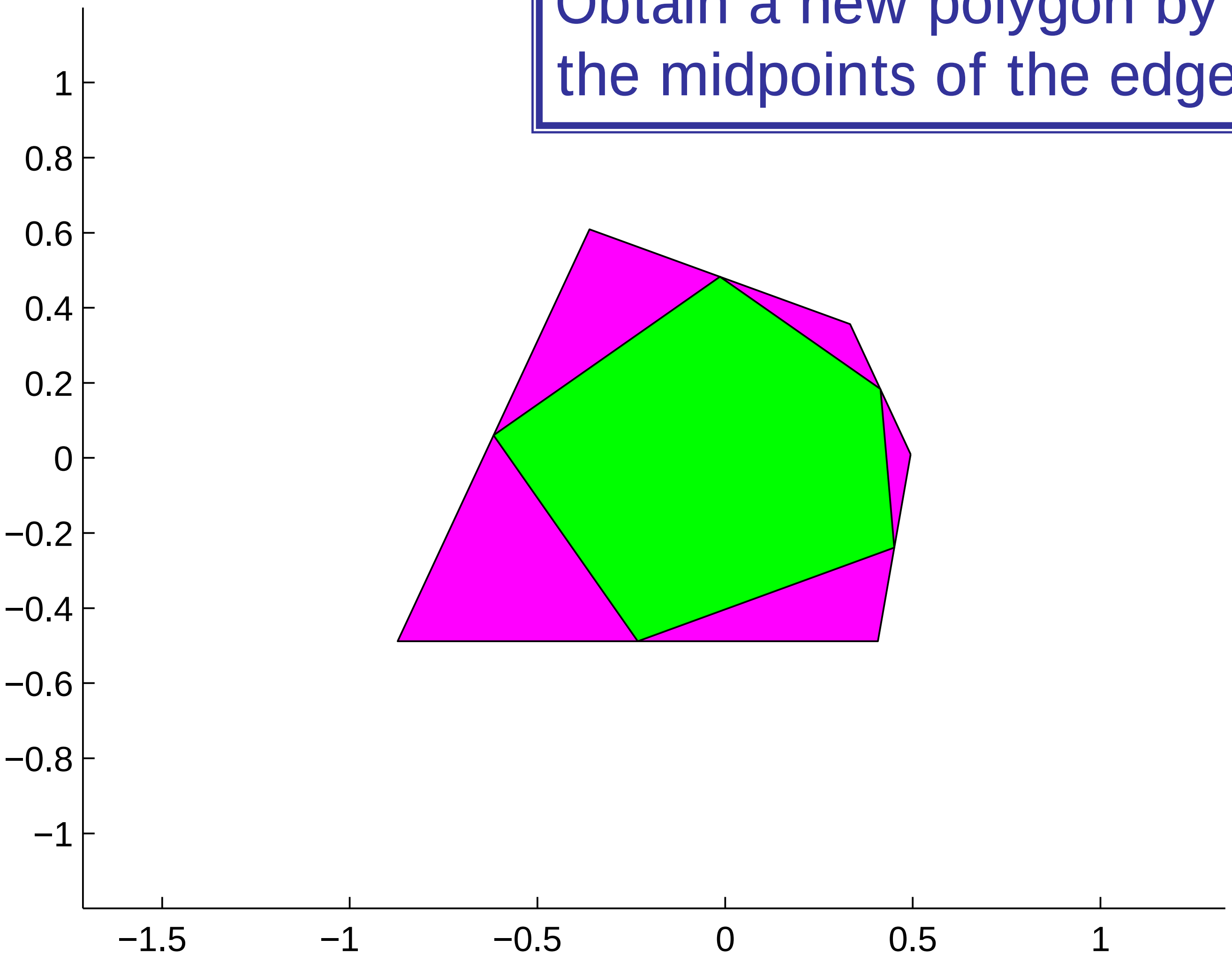


```
function [xNew,yNew] = Normalize(x,y)
% Resize polygon defined by vectors x,y
% such that distance of the vertex
% furthest from origin is 1

n = length(x);
for k = 1:n
   d(k) = sqrt(x(k)^2 + y(k)^2);
end
maxD = max(d);
xNew = zeros(n,1);  yNew = zeros(n,1);
for k = 1:n
   xNew(k)=x(k)/maxD; yNew(k)=y(k)/maxD;
end
```

Applied to a vector, `max` returns the largest value in the vector

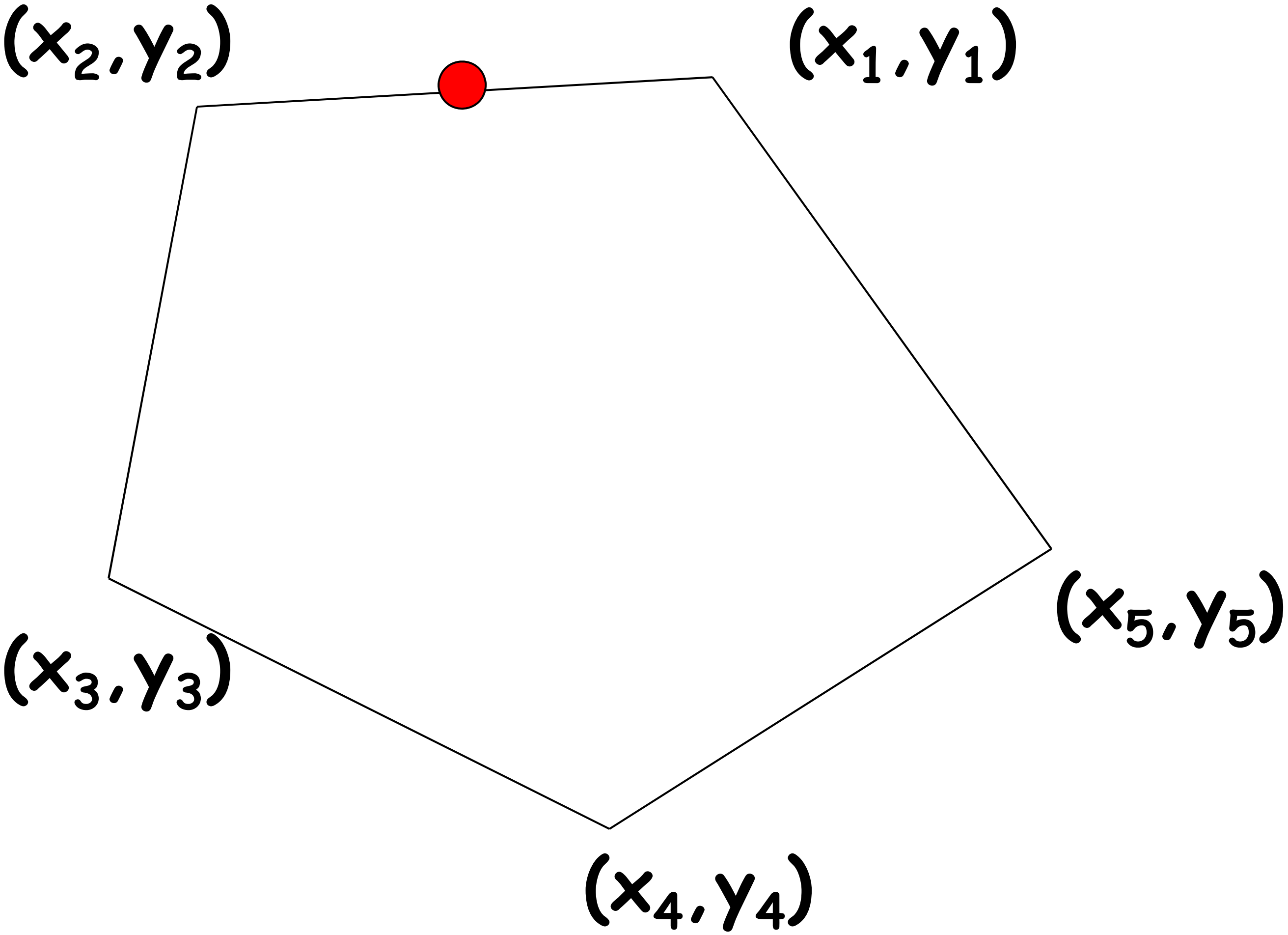
Third operation: smooth

Obtain a new polygon by connecting the midpoints of the edges

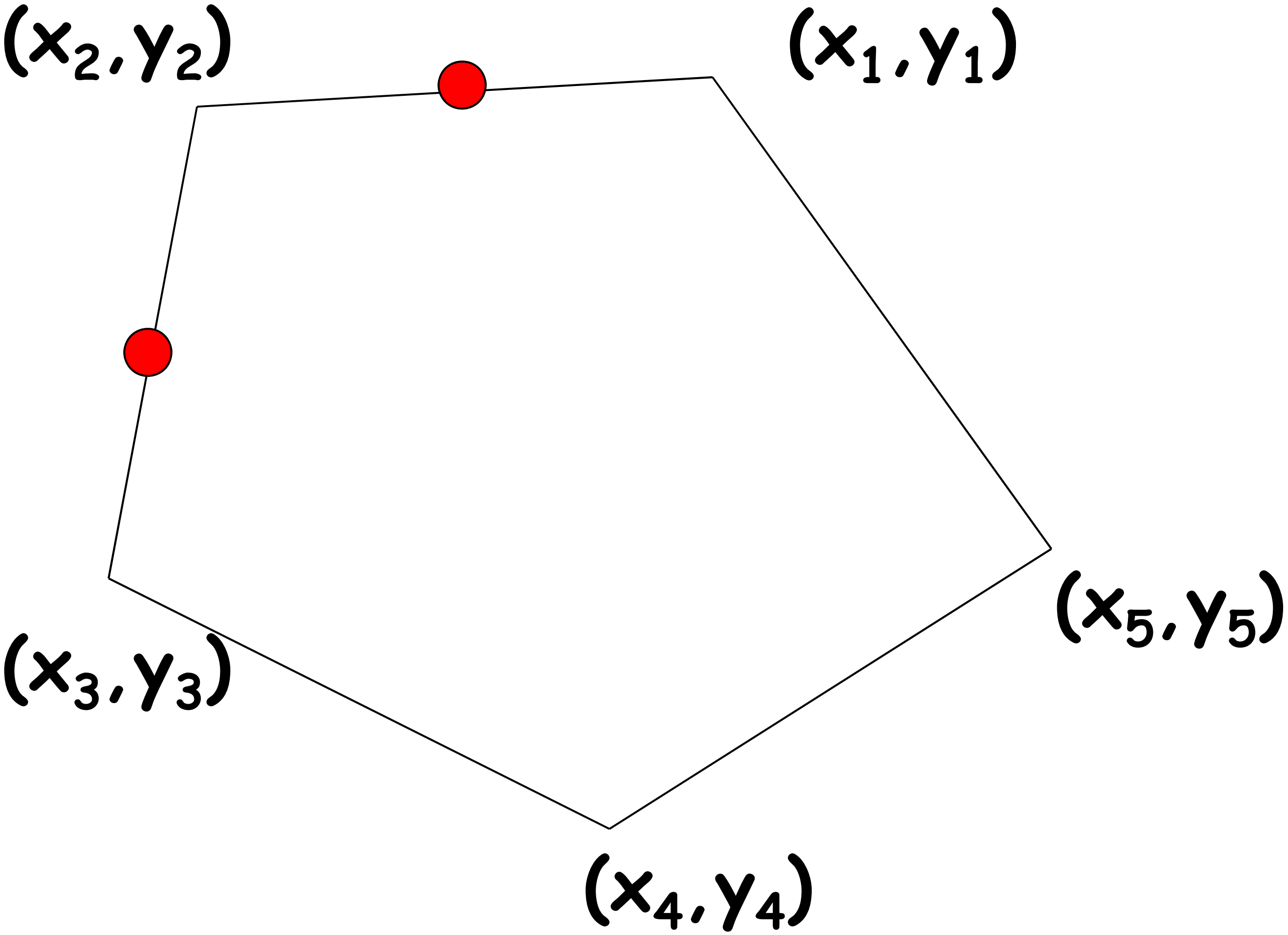


```
function [xNew,yNew] = Smooth(x,y)
% Smooth polygon defined by vectors x,y
% by connecting the midpoints of
% adjacent edges

n = length(x);
xNew = zeros(n,1);
yNew = zeros(n,1);

for i=1:n
   Compute the midpt of ith edge.
   Store in xNew(i) and yNew(i)
end
```

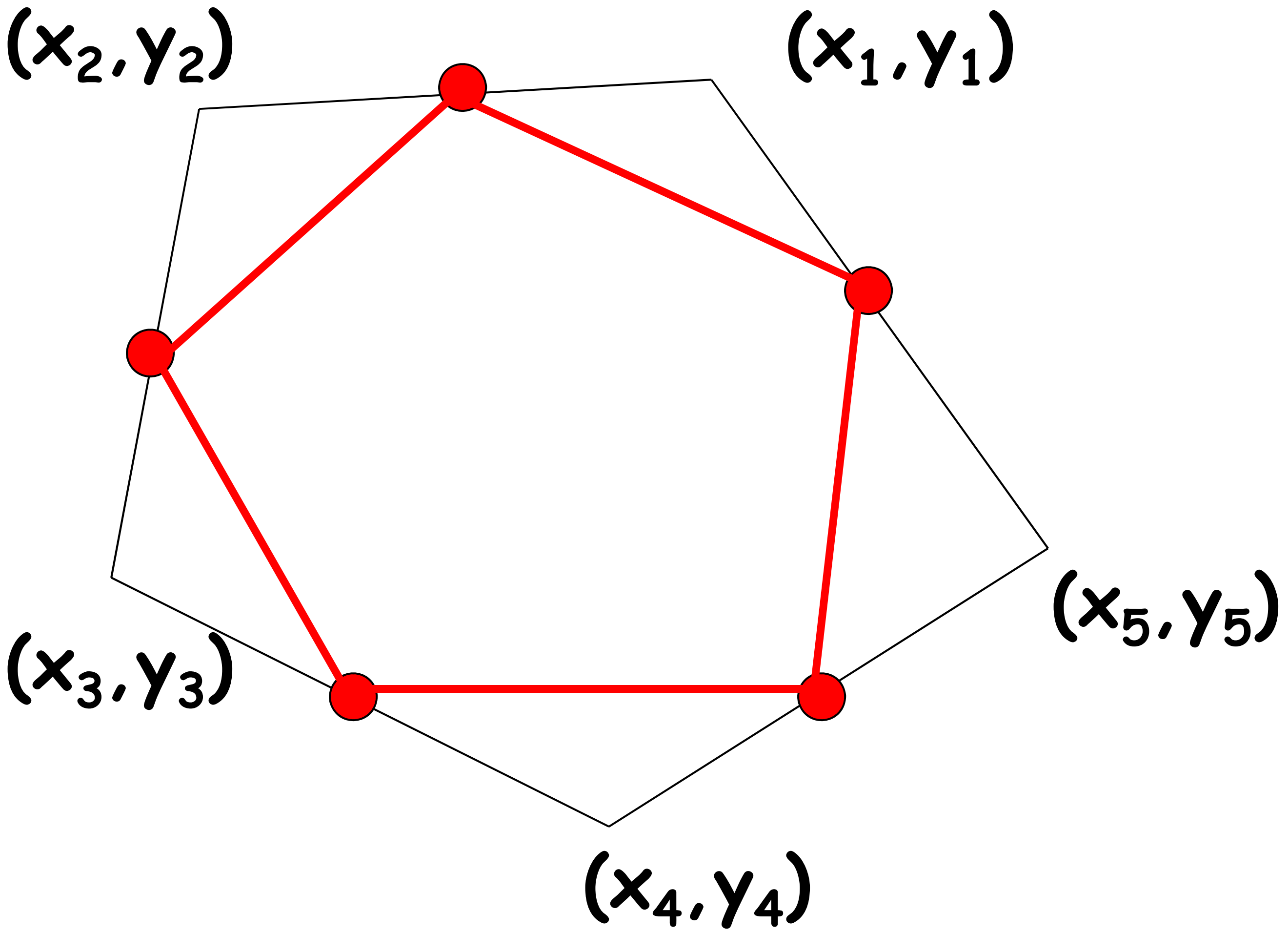
```
xNew(1) = (x(1)+x(2))/2
yNew(1) = (y(1)+y(2))/2
```



```
xNew(2) = (x(2)+x(3))/2
yNew(2) = (y(2)+y(3))/2
```



```
xNew(5) = (x(5)+x(1))/2
yNew(5) = (y(5)+y(1))/2
```



Show a simulation of polygon smoothing

Create a polygon with randomly located vertices.

Repeat:

- Centralize
- Normalize
- Smooth