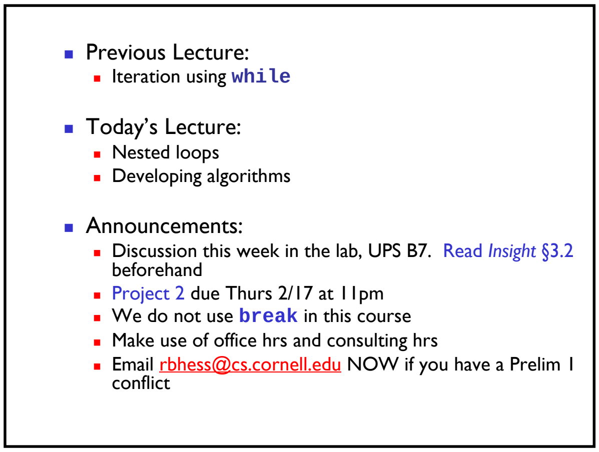
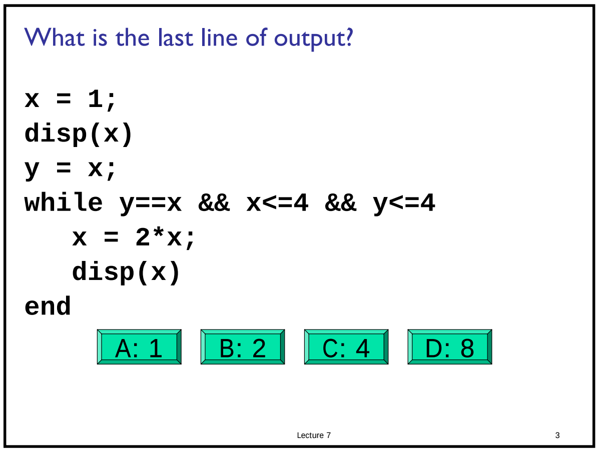


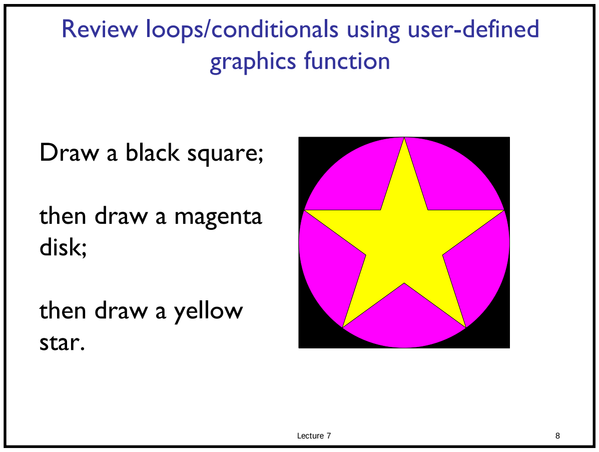
- Previous Lecture:
  - Iteration using `while`
- Today's Lecture:
  - Nested loops
  - Developing algorithms
- Announcements:
  - Discussion this week in the lab, UPS B7. Read *Insight* §3.2 beforehand
  - Project 2 due Thurs 2/17 at 11pm
  - We do not use `break` in this course
  - Make use of office hrs and consulting hrs
  - Email rbhess@cs.cornell.edu NOW if you have a Prelim I conflict



What is the last line of output?

```
x = 1;
disp(x)
y = x;
while y==x && x<=4 && y<=4
   x = 2*x;
   disp(x)
end
```

A: 1 B: 2 C: 4 D: 8

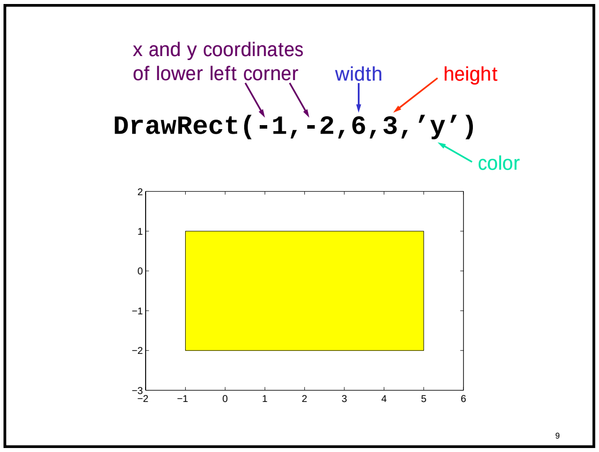


Review loops/conditionals using user-defined graphics function

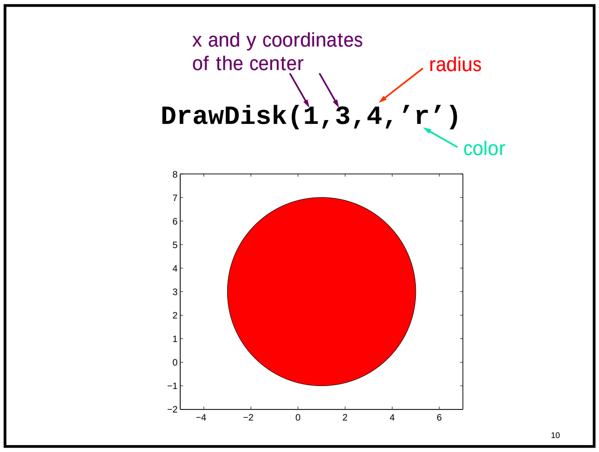
Draw a black square;

then draw a magenta disk;

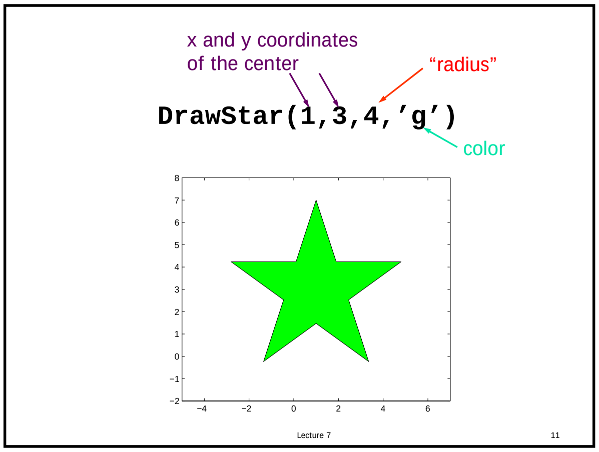
then draw a yellow star.



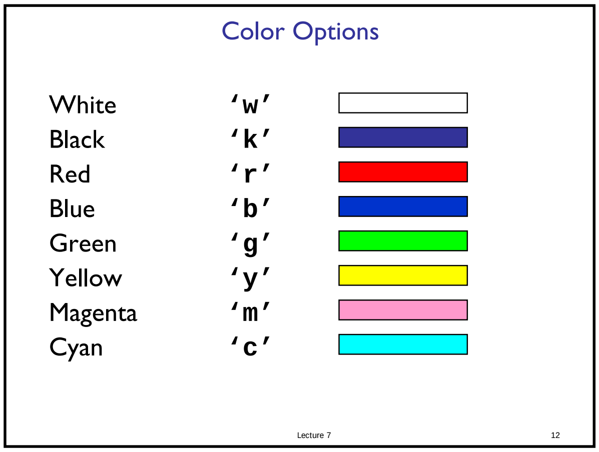
`DrawRect(-1,-2,6,3,'y')`



`DrawDisk(1,3,4,'r')`

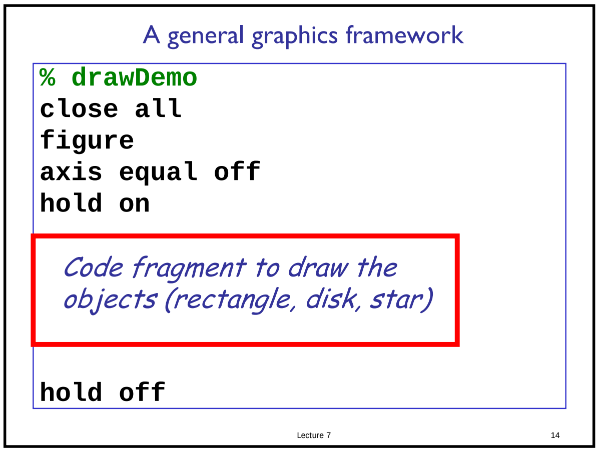


`DrawStar(1,3,4,'g')`



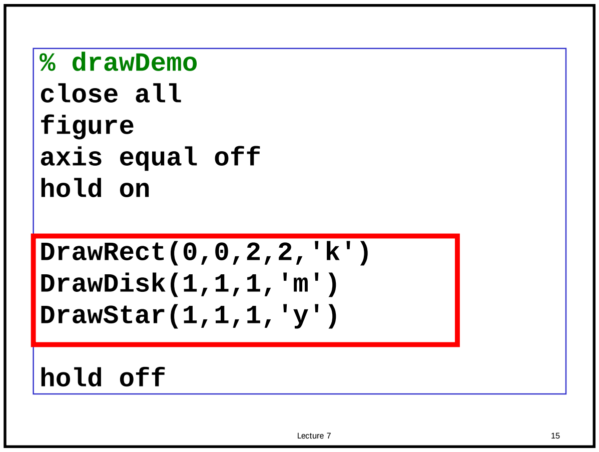
Color Options

White	'w'	⬜
Black	'k'	⬛
Red	'r'	🟥
Blue	'b'	🟦
Green	'g'	🟩
Yellow	'y'	🟨
Magenta	'm'	🟪
Cyan	'c'	🟦



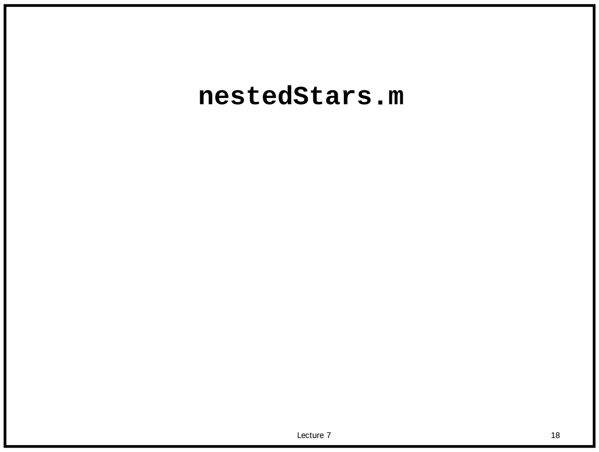
A general graphics framework

```
% drawDemo
close all
figure
axis equal off
hold on

    Code fragment to draw the
    objects (rectangle, disk, star)

hold off
```

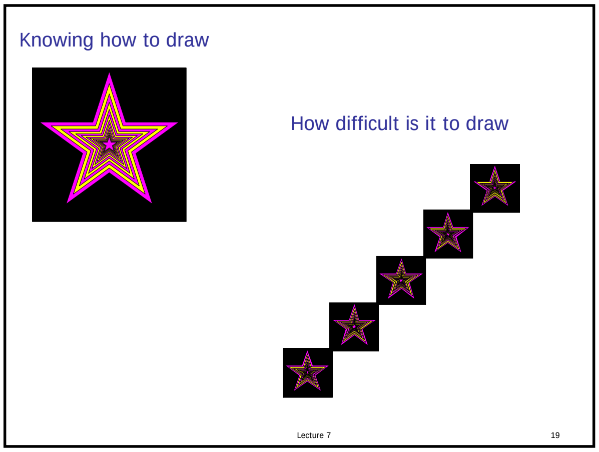


```
% drawDemo
close all
figure
axis equal off
hold on

DrawRect(0,0,2,2,'k')
DrawDisk(1,1,1,'m')
DrawStar(1,1,1,'y')

hold off
```

Example: Nested Stars

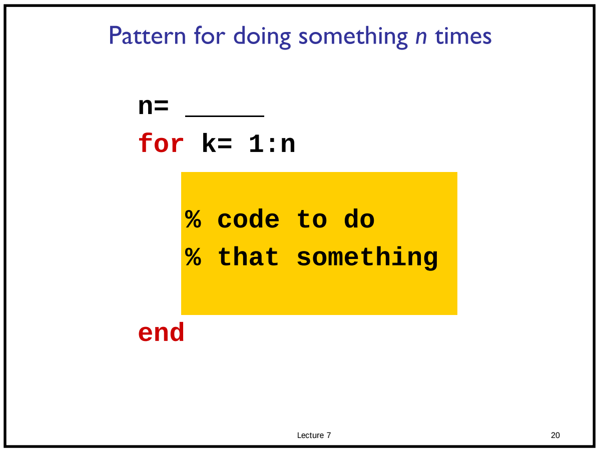


`nestedStars.m`



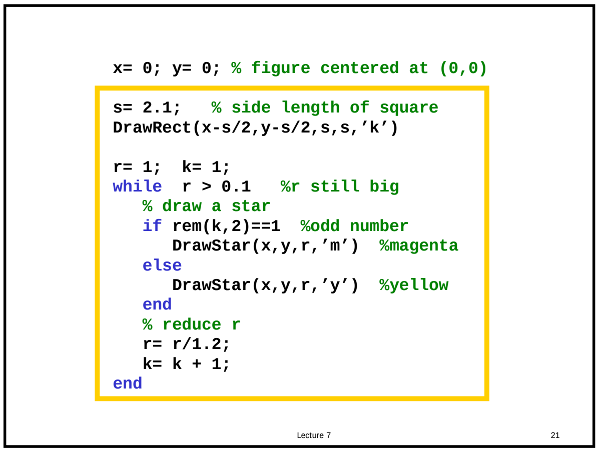
Knowing how to draw

How difficult is it to draw

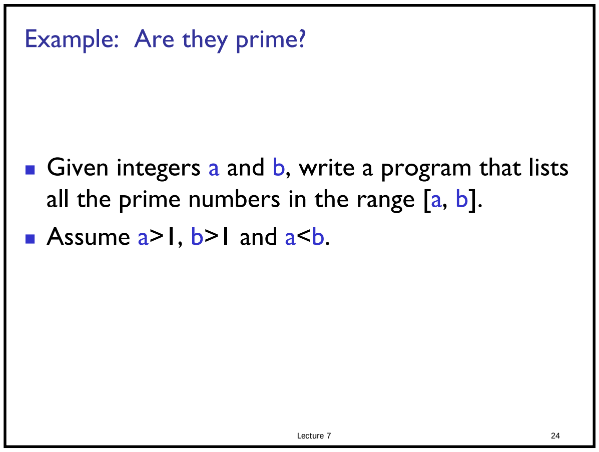


Pattern for doing something *n* times

```
n= ______
for k= 1:n

    % code to do
    % that something

end
```

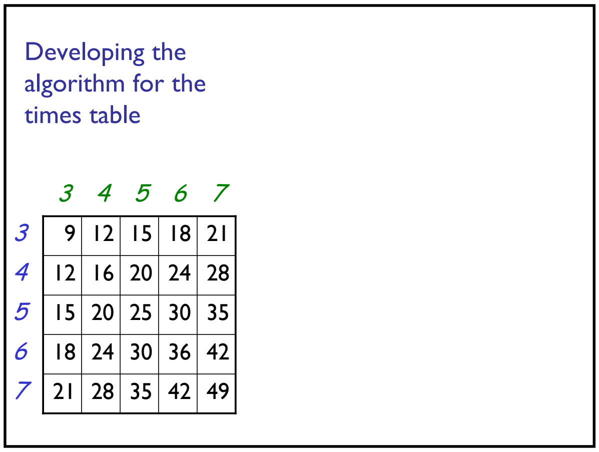


```
x= 0; y= 0; % figure centered at (0,0)

s= 2.1;   % side length of square
DrawRect(x-s/2,y-s/2,s,s,’k’)

r= 1;  k= 1;
while  r > 0.1   %r still big
   % draw a star
   if rem(k,2)==1  %odd number
      DrawStar(x,y,r,’m’)  %magenta
   else
      DrawStar(x,y,r,’y’)  %yellow
   end
   % reduce r
   r= r/1.2;
   k= k + 1;
end
```



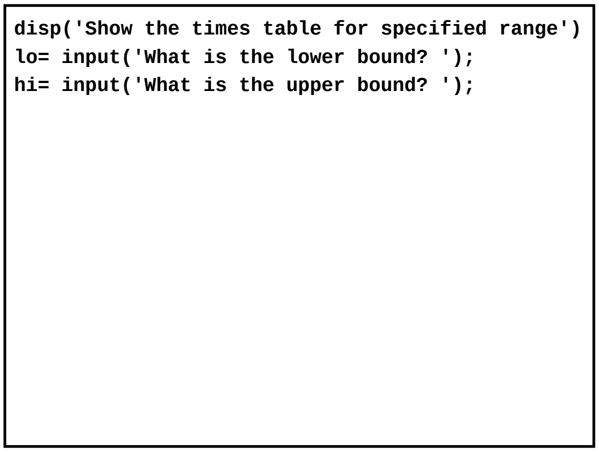
Example: Are they prime?

- Given integers a and b, write a program that lists all the prime numbers in the range [a, b].
- Assume a>1, b>1 and a<b.

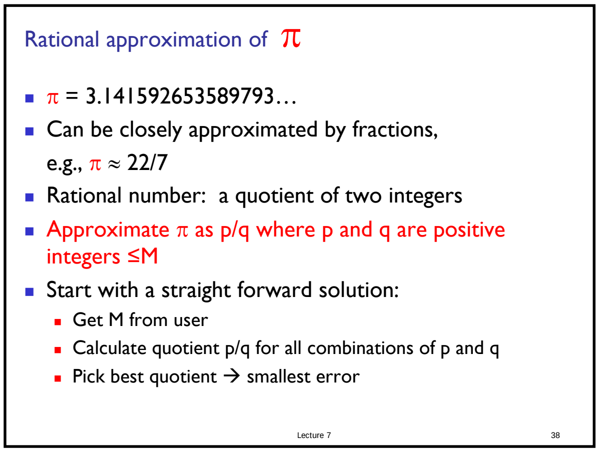


Developing the algorithm for the times table

	3	4	5	6	7
3	9	12	15	18	21
4	12	16	20	24	28
5	15	20	25	30	35
6	18	24	30	36	42
7	21	28	35	42	49



```
disp('Show the times table for specified range')
lo= input('What is the lower bound? ');
hi= input('What is the upper bound? ');
```



Rational approximation of π

- π = 3.141592653589793…
- Can be closely approximated by fractions, e.g., π ≈ 22/7
- Rational number: a quotient of two integers
- Approximate π as p/q where p and q are positive integers ≤M
- Start with a straight forward solution:
  - Get M from user
  - Calculate quotient p/q for all combinations of p and q
  - Pick best quotient → smallest error

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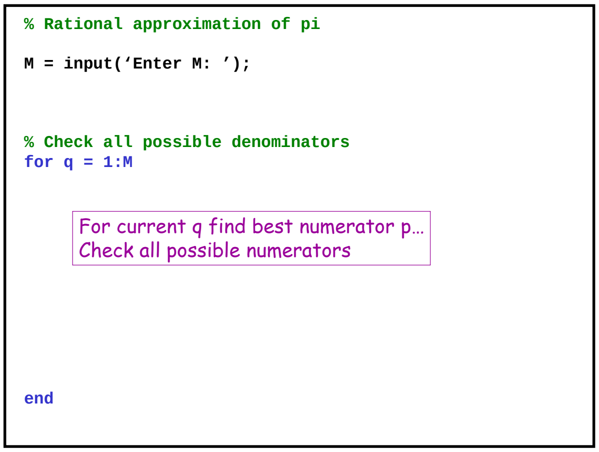
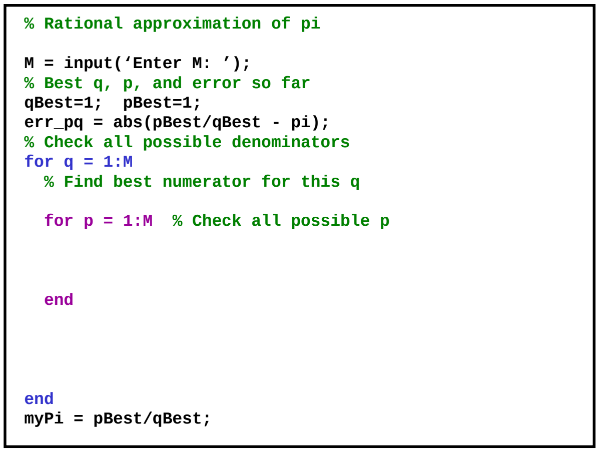
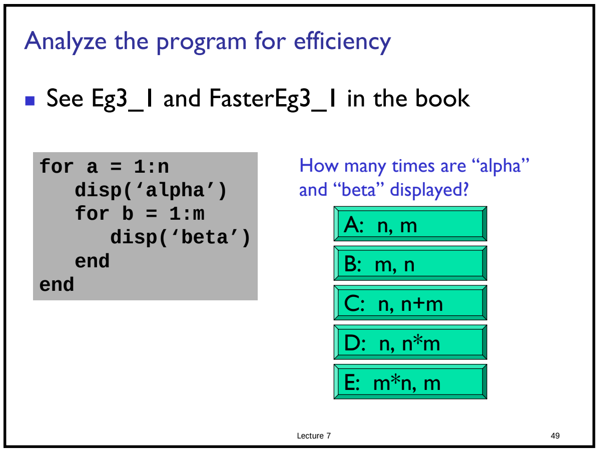


```
% Rational approximation of pi

M = input('Enter M: ');


% Check all possible denominators
for q = 1:M


     For current q find best numerator p…
     Check all possible numerators






end
```



```
% Rational approximation of pi

M = input('Enter M: ');
% Best q, p, and error so far
qBest=1;  pBest=1;
err_pq = abs(pBest/qBest - pi);
% Check all possible denominators
for q = 1:M
  % Find best numerator for this q

  for p = 1:M  % Check all possible p



  end




end
myPi = pBest/qBest;
```



Analyze the program for efficiency

- See Eg3_1 and FasterEg3_1 in the book

```
for a = 1:n
   disp('alpha')
   for b = 1:m
      disp('beta')
   end
end
```

How many times are "alpha" and "beta" displayed?

A: n, m

B: m, n

C: n, n+m

D: n, n*m

E: m*n, m

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