Inheritance

```
classdef E0 < handle
    % An E0 object represents the ellipse
    %                (a*cos(t),b*sin(t))        0<=t<=2pi
    % Such an ellipse is centered at (0,0) and has no tilt

    properties (Access = protected)
        a                   % The major semiaxis
        b                   % The minor semi-axis (b<=a)
        F1 = Point.empty();  % Focus
        F2 = Point.empty();  % Focus
        s                   % string length
    end

    methods
        function E = E0(a,b)
        % Constructs an E0 object
          if a >= b
             E.a = a;
             E.b = b;
             E.F1 = Point(-sqrt(a^2-b^2),0);
             E.F2 = Point(sqrt(a^2-b^2),0);
             E.s = 2*a;
          else
             disp('a cannot be smaller than b')
          end
        end

        function A = Area(ThisE0)
        % The area of the ellipse referenced by ThisE0.
            A = pi*ThisE0.a*ThisE0.b;
        end

        function alfa = Enclose(ThisE0,P)
        % alfa is one if the point referenced by P is inside the
        %   ellipse referenced by ThisE0.
        % Otherwise, alfa is zero.
            alfa = P.Dist(ThisE0.F1)+P.Dist(ThisE0.F2) <= ThisE0.s;
        end

        function Show(ThisE0,c)
        % Displays the ellipse referenced by ThisE0 in the current figure window
        % with color c. The two focii are also displayed. Assumes hold is
        % on
        end
    end
end


% Show E0
% Illustrates the class E0.

% Construct and display an E0 object...
E = E0(4,3);
E.Show('m')

% Construct and display a Point object...
P = Point(-2,-2);
P.Show('b')

% Display a message that indocates whether or not the ellipse referenced
% by E encloses the point referenced by P...
if E.Enclose(P)
    title('P is inside E','Fontsize',14)
else
    title('P is not inside E','Fontsize',14)
end
xlabel(sprintf('Area = %6.2f',E.Area()),'Fontsize',14)
```

```
classdef E1 < E0
    % An E1 object represents the ellipse
    %                 (h+a*cos(t),kb*sin(t))        0<=t<=2pi
    % Such an ellipse is centered at (h,k) and has no tilt.
    % Terminology:
    %    E1 is a subclass of E0. E0 is the parent of E1
    %    E0 is a superclass of E0. E1 is a child of E0.

    properties (Access = protected)
        h  % the x-coordinate of the center
        k  % the y-coordinate of the center

    end

    methods
        function E = E1(a,b,h,k)
        % Constructs an E1 object
        % Call the superclass constructor...
           E@E0(a,b)
           E.h = h;
           E.k = k;
           E.F1.x = E.F1.x + h;
           E.F1.y = k;
           E.F2.x = E.F2.x + h;
           E.F2.y = k;
        end

        % Displays the ellipse referenced by ThisE1 in the current figure window
        % with color c. The focii are also displayed. Assumes hold is on.
        function Show(ThisE1,c)

        end

    end

end


% Show E1
% Illustrates the class E1.

% Construct and display an E1 object...
E = E1(4,3,5,6);
E.Show('m')

% Construct and display the untranslated version..
Eorig = E0(4,3);
Eorig.Show('r')

% Construct and display a Point object...
P = Point(-2,-2);
P.Show('b')

% Report on whether or not the ellipse referenced by E and the ellipse
% referenced by Eorig encloses the point referenced by P...

if E.Enclose(P) && Eorig.Enclose(P)
    title('P is inside E and Eorig','Fontsize',14)
elseif E.Enclose(P) && ~Eorig.Enclose(P)
    title('P is inside E but not inside Eorig','Fontsize',14)
elseif ~E.Enclose(P) && Eorig.Enclose(P)
    title('P is not inside E and is inside Eorig','Fontsize',14)
else
    title('P is not inside E and not inside Eorig','Fontsize',14)
end

% Report the area...
xlabel(sprintf('Area = %6.2f',E.Area()),'Fontsize',14)
```

```
classdef E2 < E1
    % An E2 object represents the ellipse
    %                 (h+a*cos(t),kb*sin(t))        0<=t<=2pi
    % rotated about its center.

    properties (Access = private)
        phi     % The counterclockwise rotation angle (degrees)
    end

    methods
        function E = E2(a,b,h,k,phi)
        % Constructs an E2 object
           E@E1(a,b,h,k)
           E.phi = phi;
           c = cos(phi*pi/180); s = sin(phi*pi/180);
           d = sqrt(a^2-b^2);
           E.F1.x =  h + c*d;
           E.F1.y =  k + s*d;
           E.F2.x =  h - c*d;
           E.F2.y =  k - s*d;
        end

        % Displays the ellipse referenced by ThisE2 in the current figure window
        % with color c. The two focii are also displayed. Assumes hold is on
        function Show(ThisE2,c)

        end

    end

end


% Show E2
% Illustrates the class E2.

close all
plot([-10 10],[0 0],':k',[0 0],[-10 10],':k')
axis equal
axis([-10 10 -10 10])
hold on

% Construct and display an E2 object...
E = E2(4,3,5,6,30);
E.Show('m')

% Construct and display its unrotated version centered at the origin..
Eorig = E0(4,3);
Eorig.Show('r')

% Construct and display a Point object..
P = Point(-2,-2);
P.Show('b')

% Report on whether or not the ellipse referenced by E and the ellipse
% referenced by Eorig encloses the point referenced by P...
if E.Enclose(P) && Eorig.Enclose(P)
    title('P is inside E and Eorig','Fontsize',14)
elseif E.Enclose(P) && ~Eorig.Enclose(P)
    title('P is inside E but not inside Eorig','Fontsize',14)
elseif ~E.Enclose(P) && Eorig.Enclose(P)
    title('P is not inside E and is inside Eorig','Fontsize',14)
else
    title('P is not inside E and not inside Eorig','Fontsize',14)
end

% Report the area...
xlabel(sprintf('Area = %6.2f',E.Area()),'Fontsize',14)
```