CS401 Assignment 1

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Notion:

- Given position: $\vec{P}$ = (x, y)
- GIven field scaling: *K*
- The velocity: $\vec{V}$
- The maximum distance of influence: *R*
- The minimum distance of influence: *r*

Part 1 – Analysis

How to generate uniform, perpendicular, attractive, repulse, tangential forces for a robot and obstacles with known positions?

1. **Uniform**

> $$\vec{V} = V_0$$

2. **Perpendicular**

> $$\vec{V} = \vec{B}_0, where\ \vec{B}_0 * \vec{P} = 0$$

3. **Attractive**

> $$\vec{V} = \begin{cases} 0 & \vec{P} < \vec{r} \\ -K * \vec{P} & \vec{r} \leqslant \vec{P} \leqslant \vec{R} \\ 0 & \vec{P} > \vec{R} \end{cases}$$

4. **Repulse**

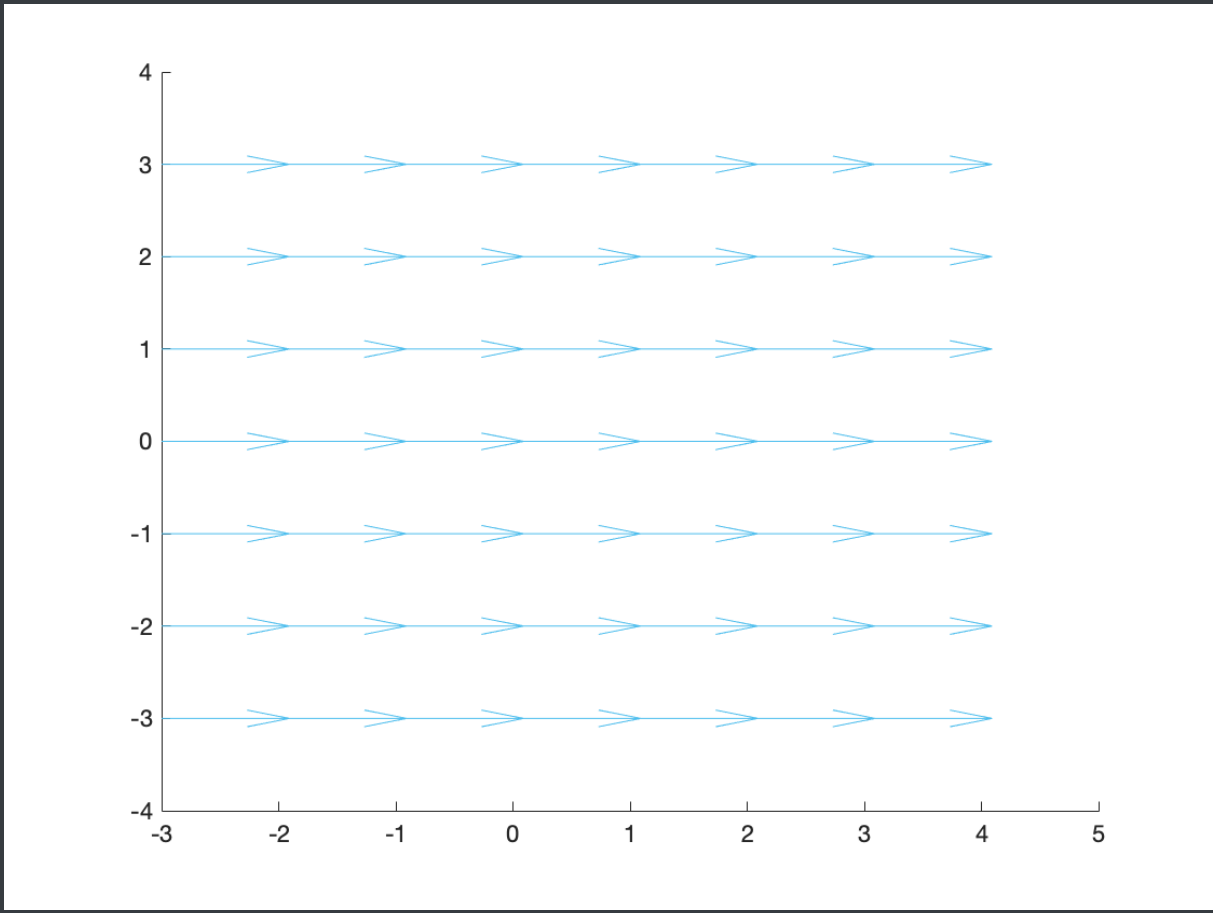
> $$\vec{V} = \begin{cases} 0 & \vec{P} < \vec{r} \\ K * (\vec{R} - \vec{P}) & \vec{r} \leqslant \vec{P} \leqslant \vec{R} \\ 0 & \vec{P} > \vec{R} \end{cases}$$

5. **Tangential**

> $\vec{V} = \vec{\omega} \times \vec{P}$

Part 2 – Draw the Field

1. **Uniform**



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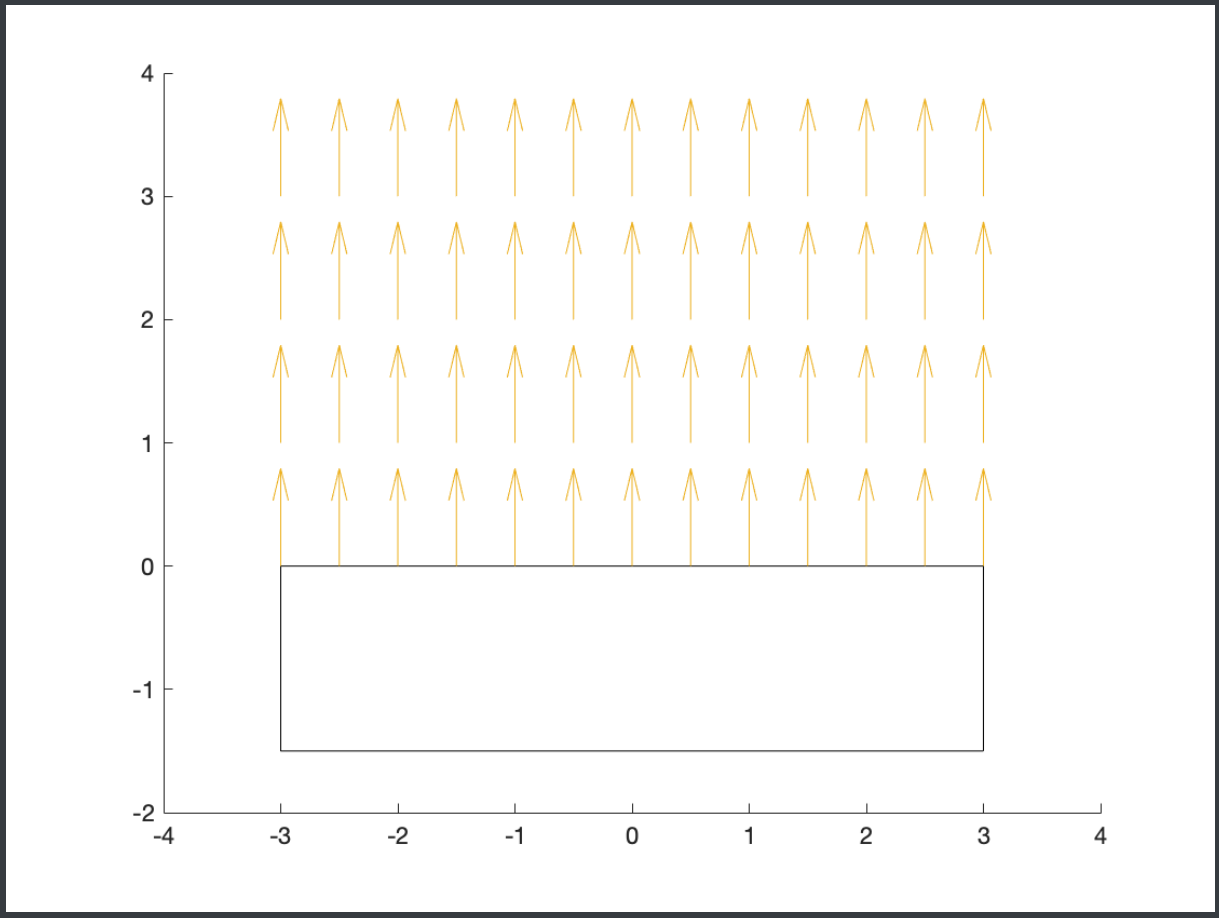
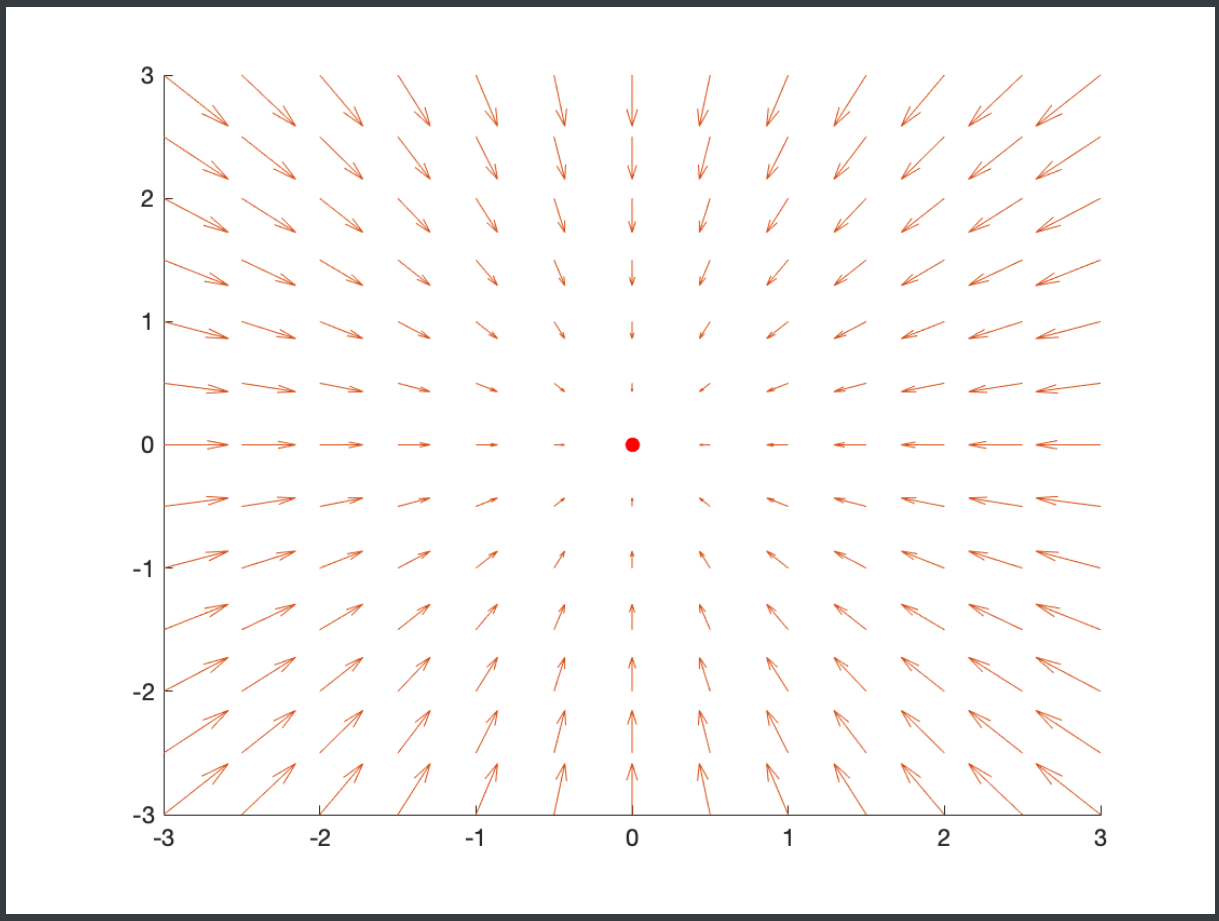
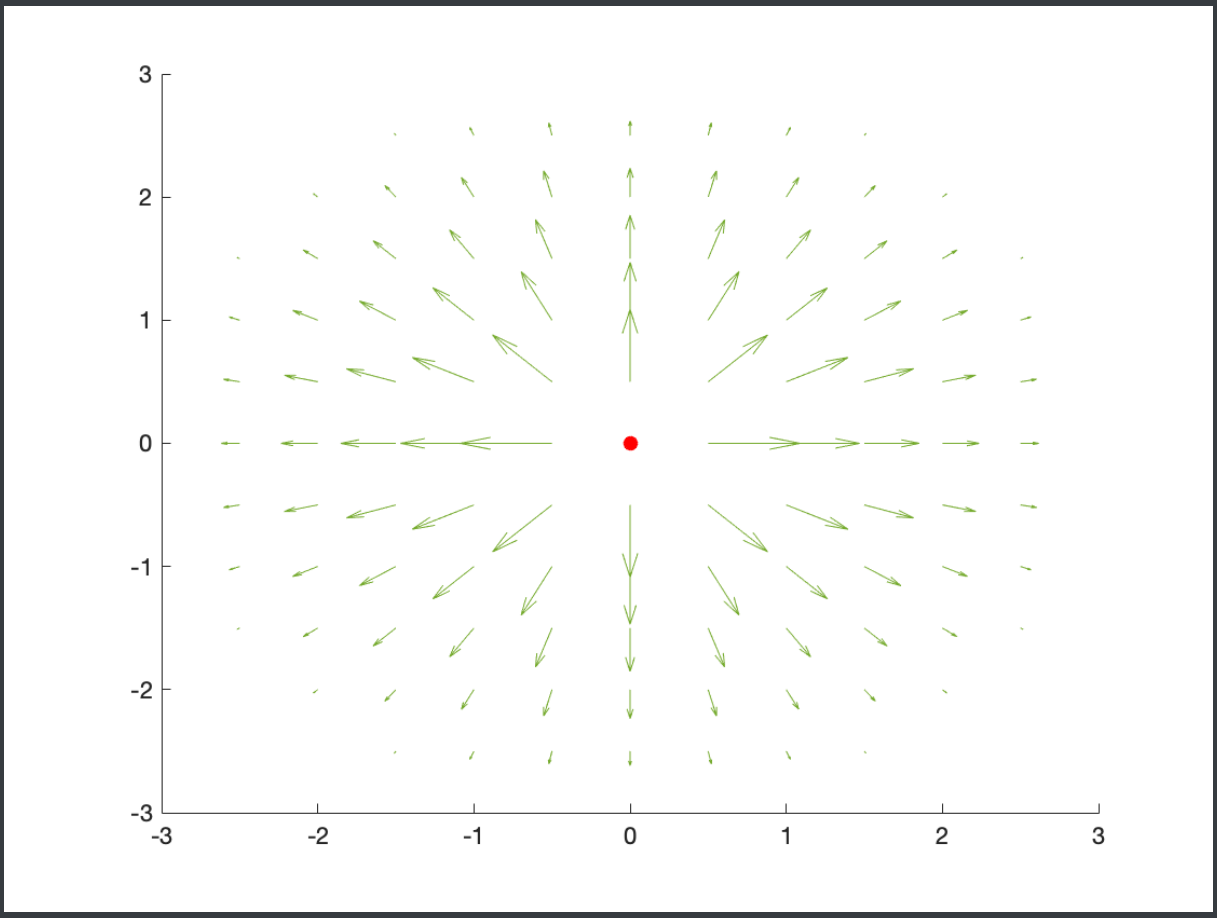
2. **Perparticular**



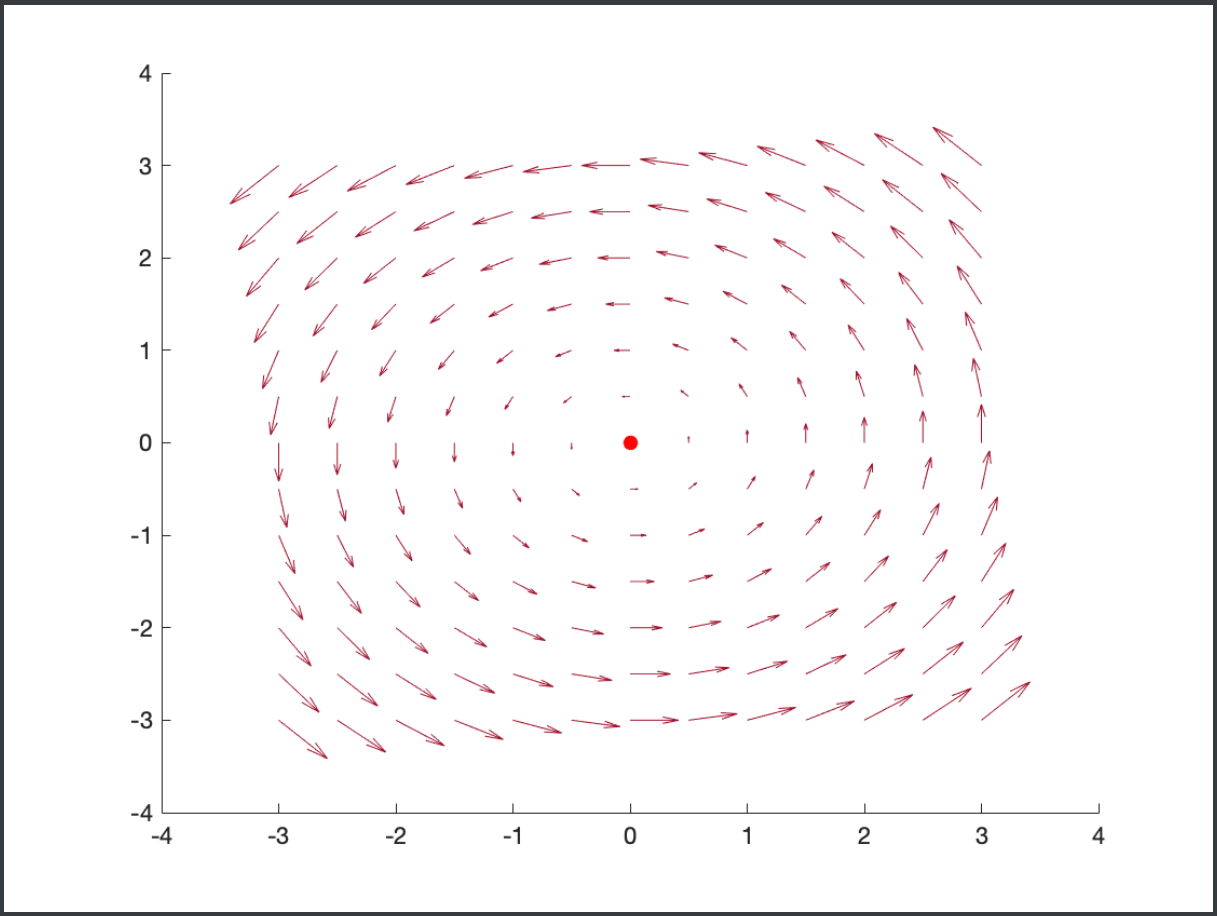
3. **Attractive**



4. **Repulse**

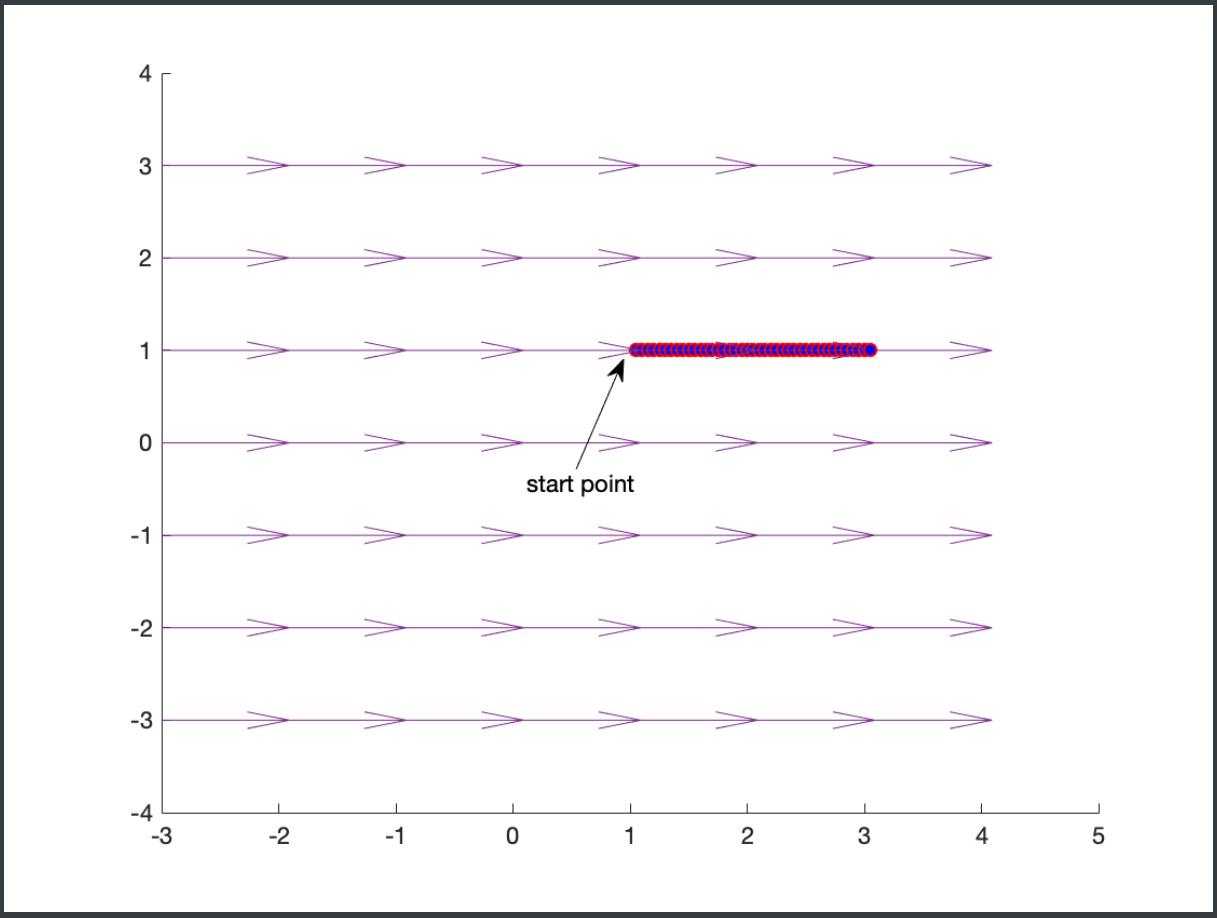


5. **Tangential**

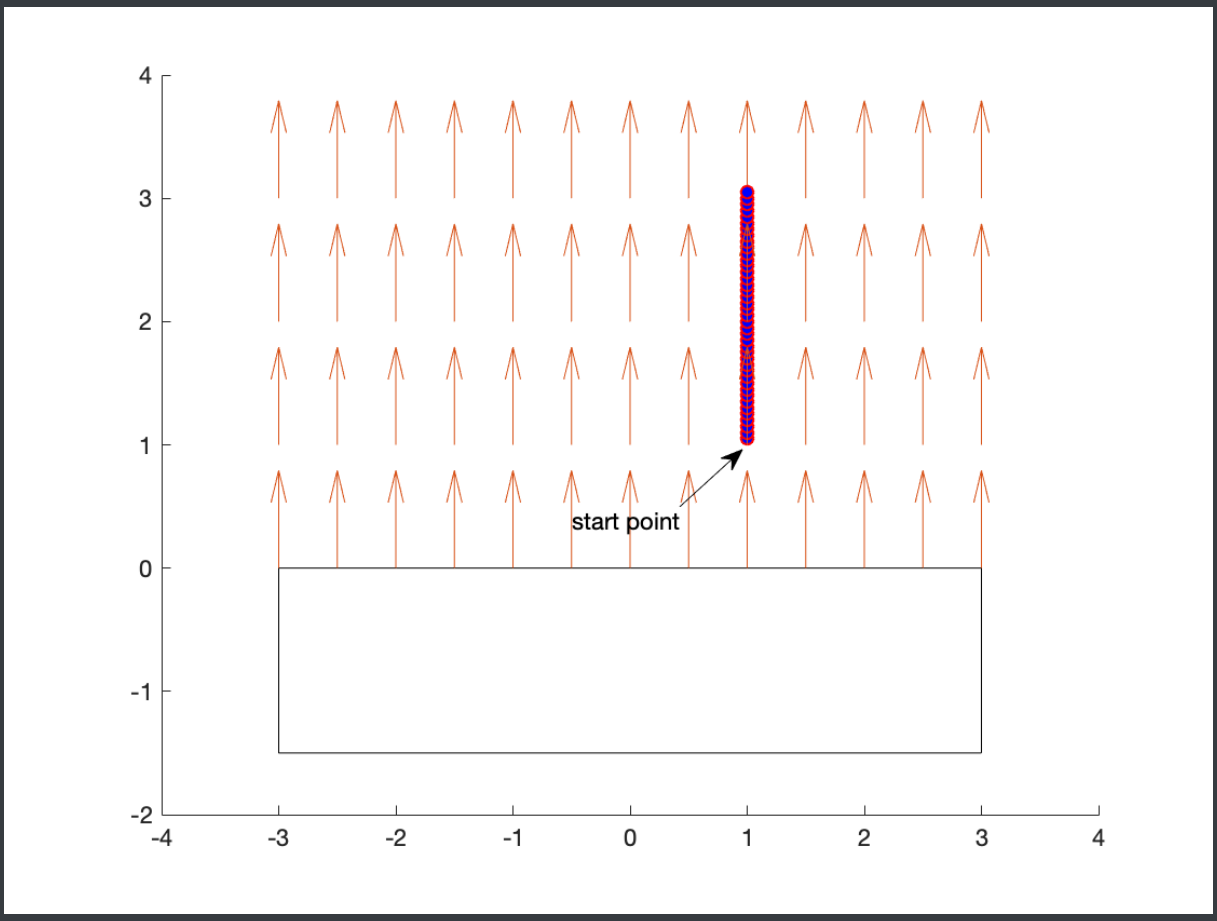


Part 3 – Put the Robot In It!

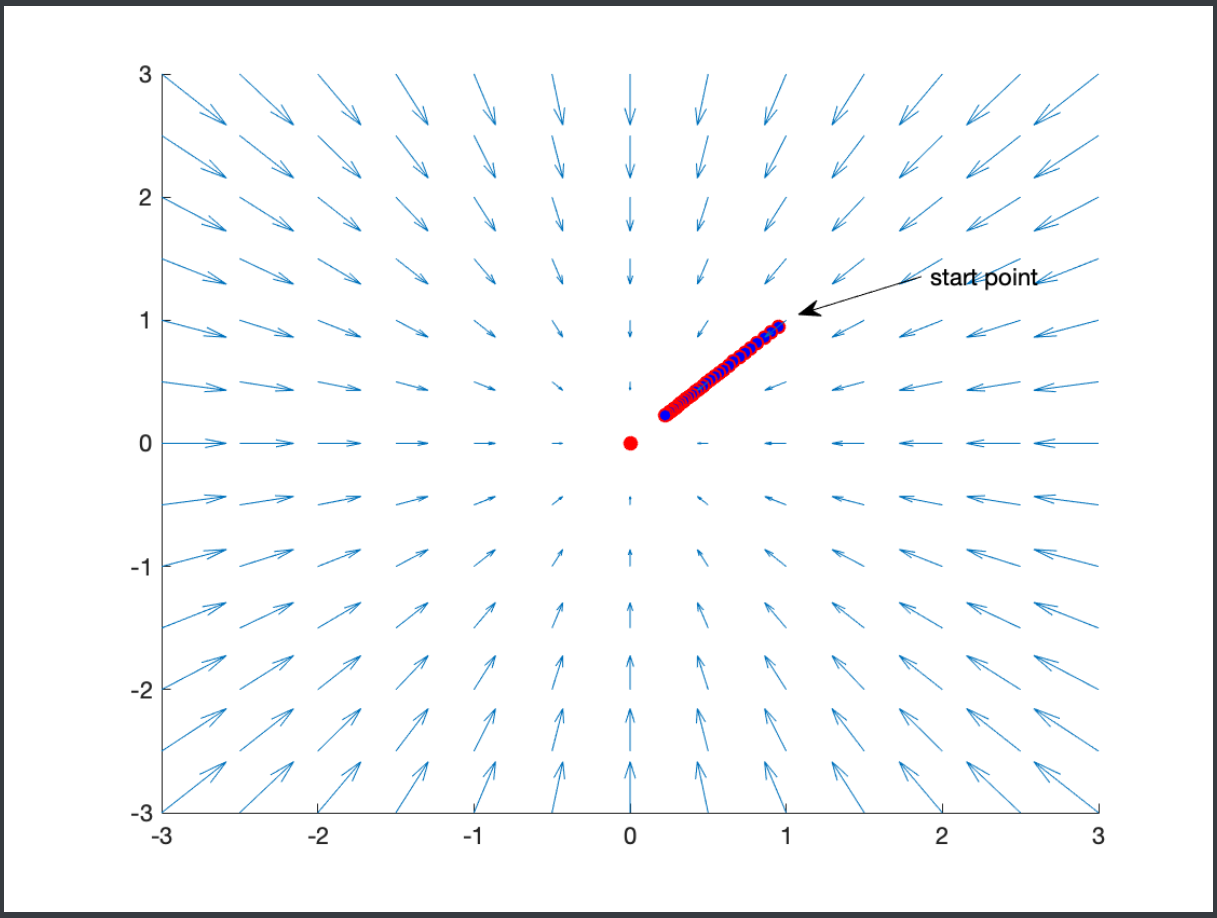
1. **Uniform**



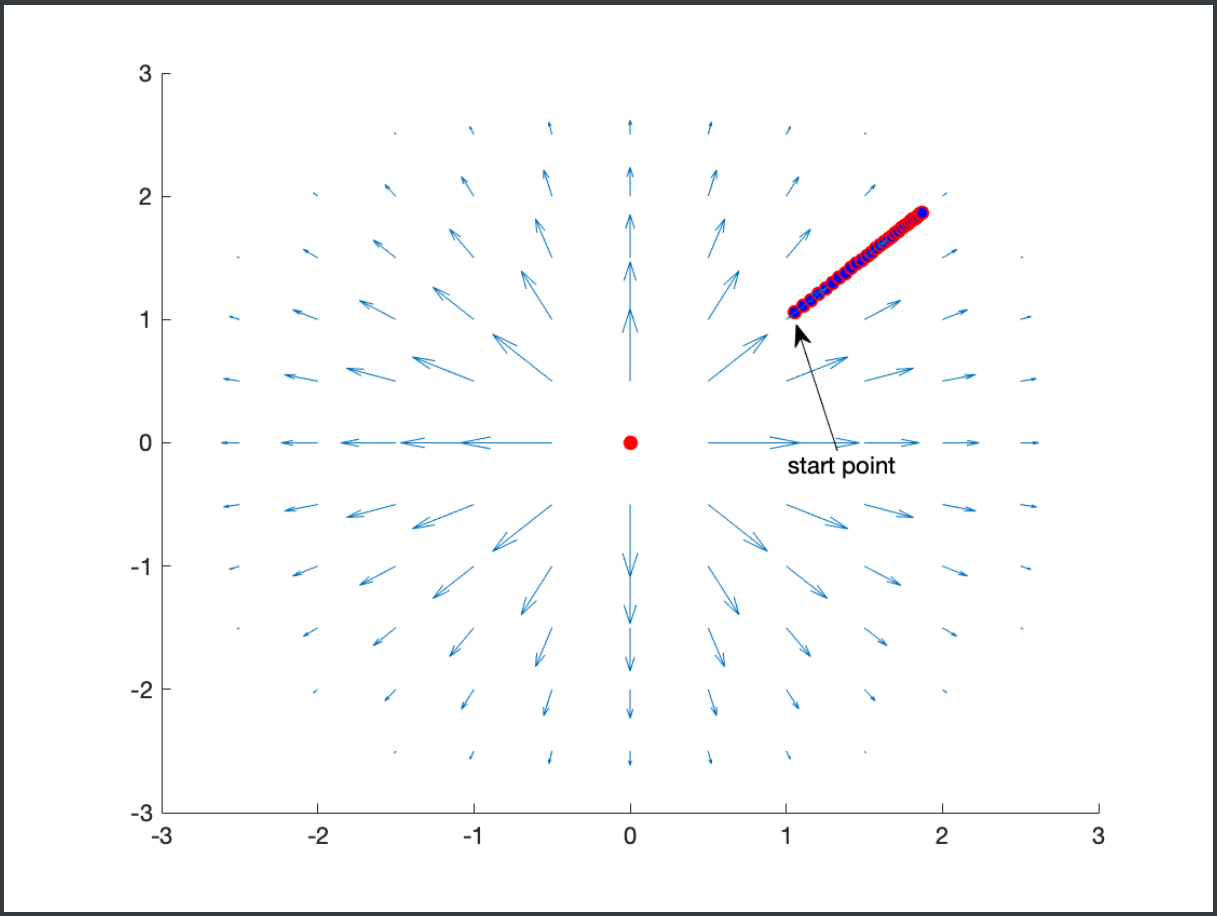
2. **Perparticular**



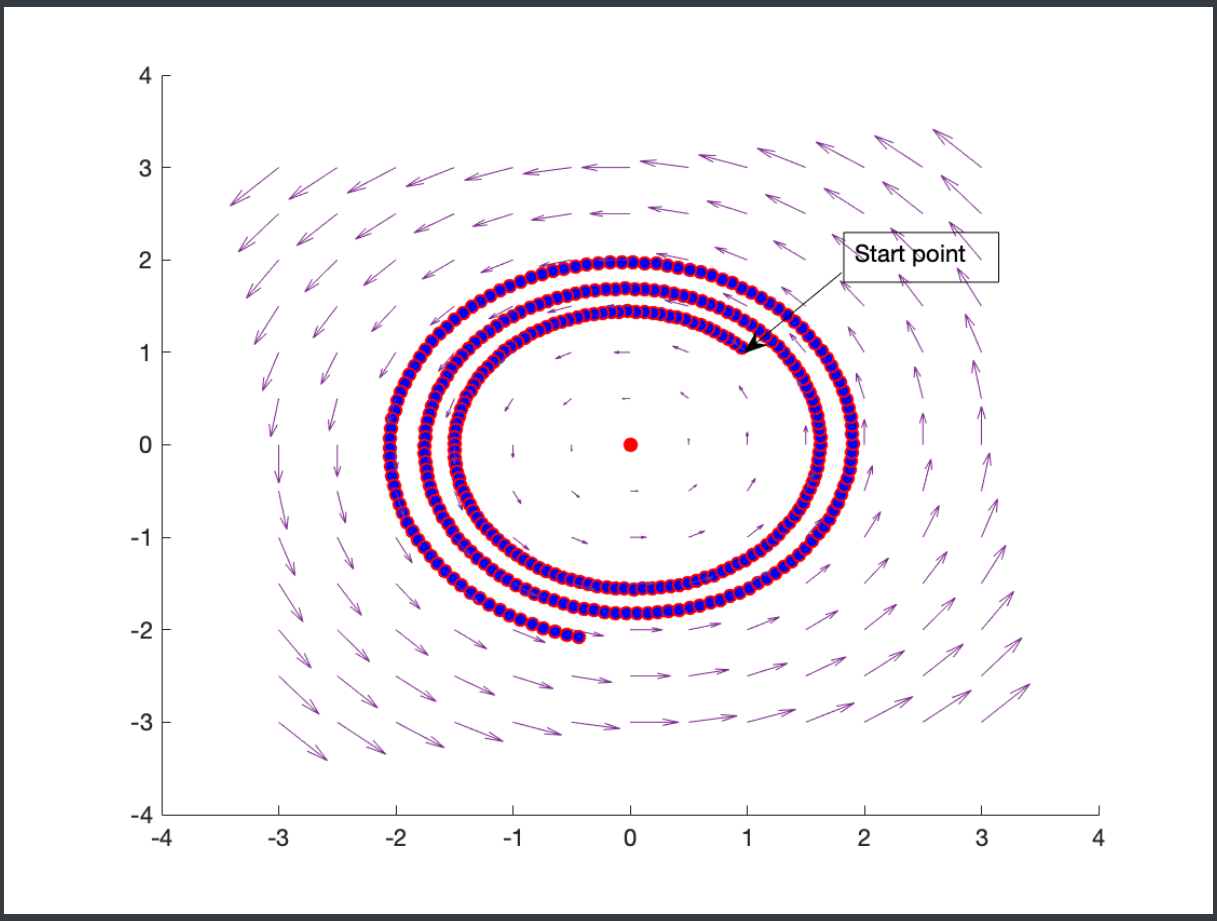
3. **Attractive**



4. **Repulse**



5. **Tangential**



Part 4 – The CODE

```
function test()
clc
close all
clear all
%% ============ Set the paramters =======
R = 3;
r = 0.5;


T=0.01; % Sampling Time
k=2; % Sampling counter
X(k-1)=1; % initilize the state x
Y(k-1)=1; % initilize the state y

tfinal=100; % final simulation time
t=0; % intilize the time
%=====================================
%% ============ Main function =======
while(t<=tfinal)
    t=t+T; % increase the time
    V=5;

    % you can change the function here to test different fields.
    result = perparticular(X(k-1),Y(k-1));

    X(k)=V*result(1)*T+X(k-1); % calculating x
    Y(k)=V*result(2)*T+Y(k-1); % calculating y

    % you can change the function here to draw different fields.
    draw_perparticular(X(k),Y(k));
    k=k+1; % increase the sampling counter
end
%=====================================
%% ============ Function defination =======

    function result = attractive(x,y)
        if(x<=R && x>=-R&&y<=R&&y>=-R)
            result = [-x,-y];
        else
            result = [0,0];
        end
```

```
end

function result = uniform(x,y)
    if(x<=R && x>=-R&&y<=R&&y>=-R)
        result = [1,0];
    else
        result = [0,0];
    end
end

function result = perparticular(x,y)
    if(x<=R && x>=-R&&y>=0&&y<=R)
        result = [0,1];
    else
        result = [0,0];
    end
end

function result = repulse(x,y)
    if(x^2+y^2<r^2)
        result = [sign(x)*Inf,sign(y)*Inf];
    elseif(x^2+y^2>R^2)
        result = [0,0];
    elseif(x==0)
        result = [0,sign(y)*(R-abs(y))];
    else
        slop = y/x;
        x2 = R/sqrt(slop^2+1)*sign(x);
        y2 = abs(slop)*R/sqrt(slop^2+1)*sign(y);
        result = [x2-x,y2-y];
    end
end

function result = tangential(x,y)
    if(x<=R && x>=-R&&y<=R&&y>=-R)
        l = sqrt(y^2+x^2);
        sita = atan(abs(y)/abs(x));
        if(x>=0&&y<0)
            sita = 2*pi - sita;
        elseif(x<=0&&y<0)
            sita = pi + sita;
        elseif(x<=0&&y>=0)
            sita = pi - sita;
        end
        sita = sita +pi/4;
```

```
        x2 = sqrt(2)*l*cos(sita);
        y2 = sqrt(2)*l*sin(sita);
        result = [x2-x,y2-y];
    else
        result = [0,0];
    end
end

function draw_attractive(a,b)
    hold on
    plot(0,0,'ro','MarkerFaceColor','r');
    [x,y] = meshgrid(-R:.5:R,-R:.5:R);
    u = -x;
    v = -y;
    quiver(x,y,u,v);
    plot(a,b,'ro','MarkerFaceColor','b');
    drawnow
    hold off
end

function draw_uniform(a,b)
    hold on
    [x,y] = meshgrid(-R:1:R,-R:1:R);
    u = ones(size(x));
    v = zeros(size(y));
    quiver(x,y,u,v);
    plot(a,b,'ro','MarkerFaceColor','b');
    drawnow
    hold off
end

function draw_perparticular(a,b)
    hold on
    rectangle('position',[-R,-R/2,2*R,R/2]);
    [x,y] = meshgrid(-R:.5:R,0:1:R);
    u = zeros(size(x));
    v = ones(size(y));
    quiver(x,y,u,v);
    plot(a,b,'ro','MarkerFaceColor','b');
    drawnow
    hold off
end
function draw_repulse(a,b)
    hold on
    plot(0,0,'ro','MarkerFaceColor','r');
```

```
    [x,y] = meshgrid(-R:.5:R,-R:.5:R);
    [m,n] = size(x);
    for ii = 1:m
        for jj = 1:n
            result = repulse(x(ii,jj),y(ii,jj));
            u(ii,jj) = result(1);
            v(ii,jj) = result(2);
        end
    end

    quiver(x,y,u,v);
    plot(a,b,'ro','MarkerFaceColor','b');
    drawnow
    hold off
end

function draw_tangential(a,b)
    hold on
    plot(0,0,'ro','MarkerFaceColor','r');
    [x,y] = meshgrid(-R:.5:R,R:-.5:-R);
    [m,n] = size(x);
    l = sqrt(y.^2+x.^2);
    sita = atan(abs(y)./abs(x));
    for ii = 1:m
        for jj = 1:n
            x1 = x(ii,jj);
            y1 = y(ii,jj);
            if(x1>=0&&y1<0)
                sita(ii,jj) = 2*pi - sita(ii,jj);
            elseif(x1<=0&&y1<0)
                sita(ii,jj) = pi + sita(ii,jj);
            elseif(x1<=0&&y1>=0)
                sita(ii,jj) = pi - sita(ii,jj);
            end
        end
    end
    sita = sita +pi/4;
    x2 = sqrt(2)*l.*cos(sita);
    y2 = sqrt(2)*l.*sin(sita);

    u = x2-x;
    v = y2-y;
    quiver(x,y,u,v);
    plot(a,b,'ro','MarkerFaceColor','b');
    drawnow
```

```
            hold off
        end


    %==================================

    end
```