Predator-Prey Swarm Colloqium Demo

This code was written during a University of Toronto Mathematics Department Colloquium on Feb 8th, 2016. The talk was given by Theodore Kolokolnikov titled, *Swarms: from molecular dynamics to biological aggregations.* The talk described results from his paper:

Chen, Y., & Kolokolnikov, T. (2014). A minimal model of predator-swarm interactions. Journal of the Royal Society, Interface / the Royal Society, 11(94), 20131208. http://doi.org/10.1098/rsif.2013.1208

For this *Mathematica* demonstration I implement the predator-prey swarm dynamic system that Kolokolnikov describes.

```
(* Equations for system of ODEs for predeator and prey movement *)
(* Paper gives naming convention z for predator and x for prey *)
dpred := c / numprey Sum[Normalize[x[k][t] - z[t], Norm[#]^3 &], {k, 1, numprey}]

dprey[j_] :=
 1 / numprey Sum[Normalize[x[j][t] - x[k][t], Norm[#]^2 &] - a (x[j][t] - x[k][t]) +
    b Normalize[x[j][t] - z[t], Norm[#]^2 &], {k, Delete[Range[numprey], j]}]

numprey = 150;

(*Random Initial Positions for prey*)
prey0 = RandomReal[{-10, 10}, {numprey, 2}];

(*Swarm Parameters as Described in Paper*)
a = 1;
b = 0.3;
c = 1.5;

(*Create ODE System*)
odesys = Append[Table[{
      x[j]'[t] == dprey[j],
      x[j][0] == prey0[[j]]},
     {j, numprey}], {z'[t] == dpred, z[0] == {0, 0}}];

depvars = Flatten[{z, Table[x[j], {j, numprey}]}];
```

```
(*Solve System of ODEs with NDSolve*)
tfinal = 40;
sol = NDSolve[odesys, depvars,
   {t, 0, tfinal}(*,PrecisionGoal→2,AccuracyGoal→2*)][[1]];
predpos = z /. sol;
preypos = Array[x, {numprey}] /. sol;
```

```
(*Visualize Swarm with Manipulate*)
Manipulate[
 Graphics[{PointSize[0.05], Point[{#@t & /@preypos}], Red, Point[predpos[t]]}],
 {t, 0, tfinal}]
```