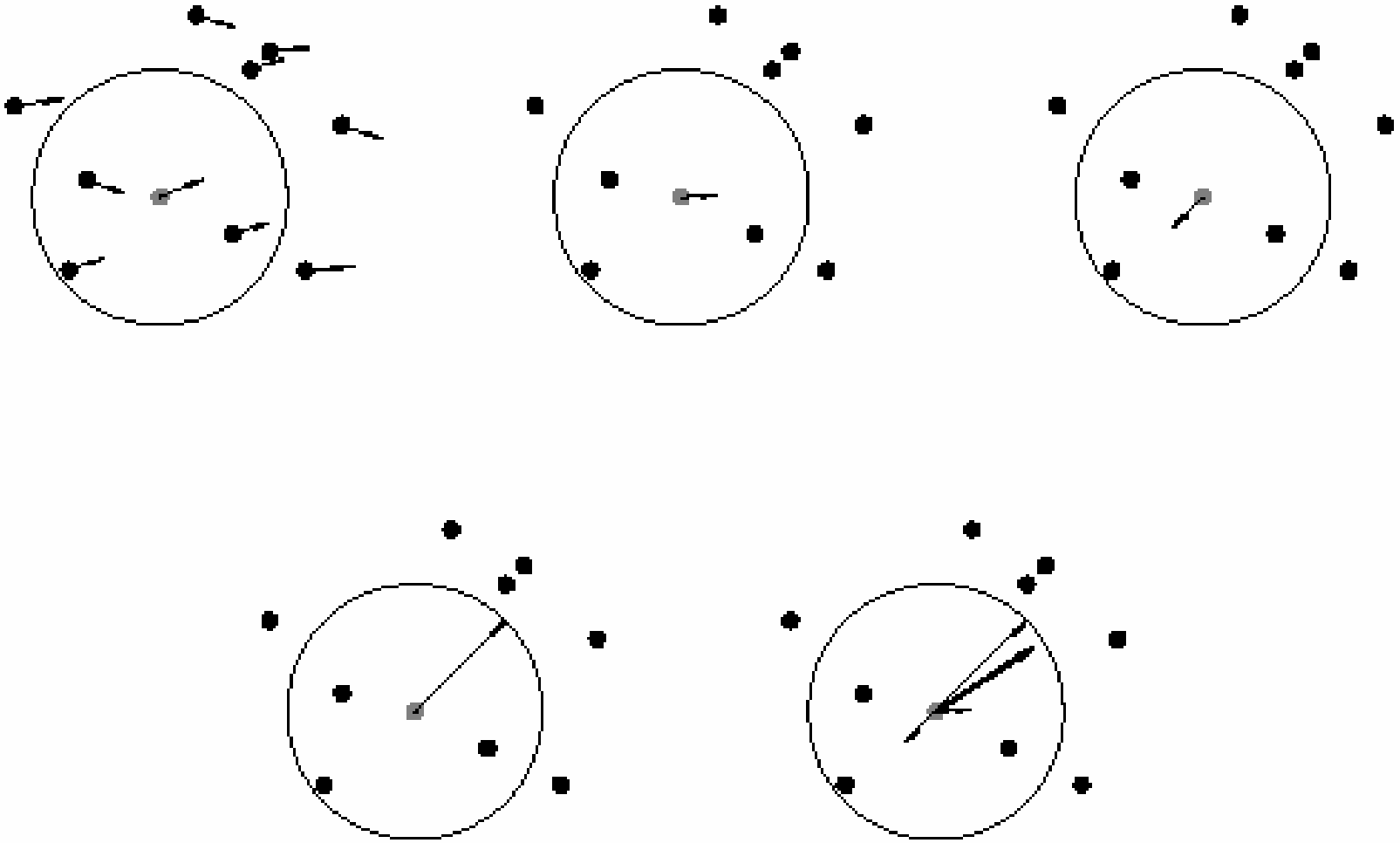
Boids

- General reference:
  - http://www.red3d.com/cwr/boids/



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Particle swarm optimization

- Like ACO, PSO is an example of *swarm intelligence*, loosely based on the properties of a flock of birds or a school of fish.

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1. Initialize positions and velocities of the particles p_i:

   1.1. $x_{i,j} = x_{\min} + r\,(x_{\max} - x_{\min})\,,\ i = 1, \ldots, N,\ j = 1, \ldots, n$

   1.2. $v_{i,j} = \alpha \frac{x_{\min} + r(x_{\max} - x_{\min})}{\Delta t},\ i = 1, \ldots, N,\ j = 1, \ldots, n$

2. Evaluate each particle in the swarm: $\mathbf{x}_i \rightarrow f(\mathbf{x}_i),\ i = 1, \ldots, N.$

3. Update the best position of each particle, and the global best position. Thus, for all particles $p_i\ i = 1, \ldots, N$:

   3.1. if $f(\mathbf{x}_i) < f(\mathbf{x}_i^{\mathrm{pb}})$ then $\mathbf{x}_i^{\mathrm{pb}} \leftarrow \mathbf{x}_i.$

   3.2. if $f(\mathbf{x}_i) < f(\mathbf{x}^{\mathrm{sb}})$ then $\mathbf{x}^{\mathrm{sb}} \leftarrow \mathbf{x}_i.$

4. Update particle velocities and positions:

   4.1. $v_{i,j} \leftarrow v_{i,j} + c_1 q \left(\frac{x_{i,j}^{\mathrm{pb}} - x_{i,j}}{\Delta t} \right) + c_2 r \left(\frac{x_j^{sb} - x_{i,j}}{\Delta t} \right),\ i = 1, \ldots, N,\ j = 1, \ldots, n$

   4.2. $x_{i,j} \leftarrow x_{i,j} + v_{i,j} \Delta t,\ i = 1, \ldots, N,\ j = 1, \ldots, n.$

5. Return to step 2, unless the termination criterion has been reached.

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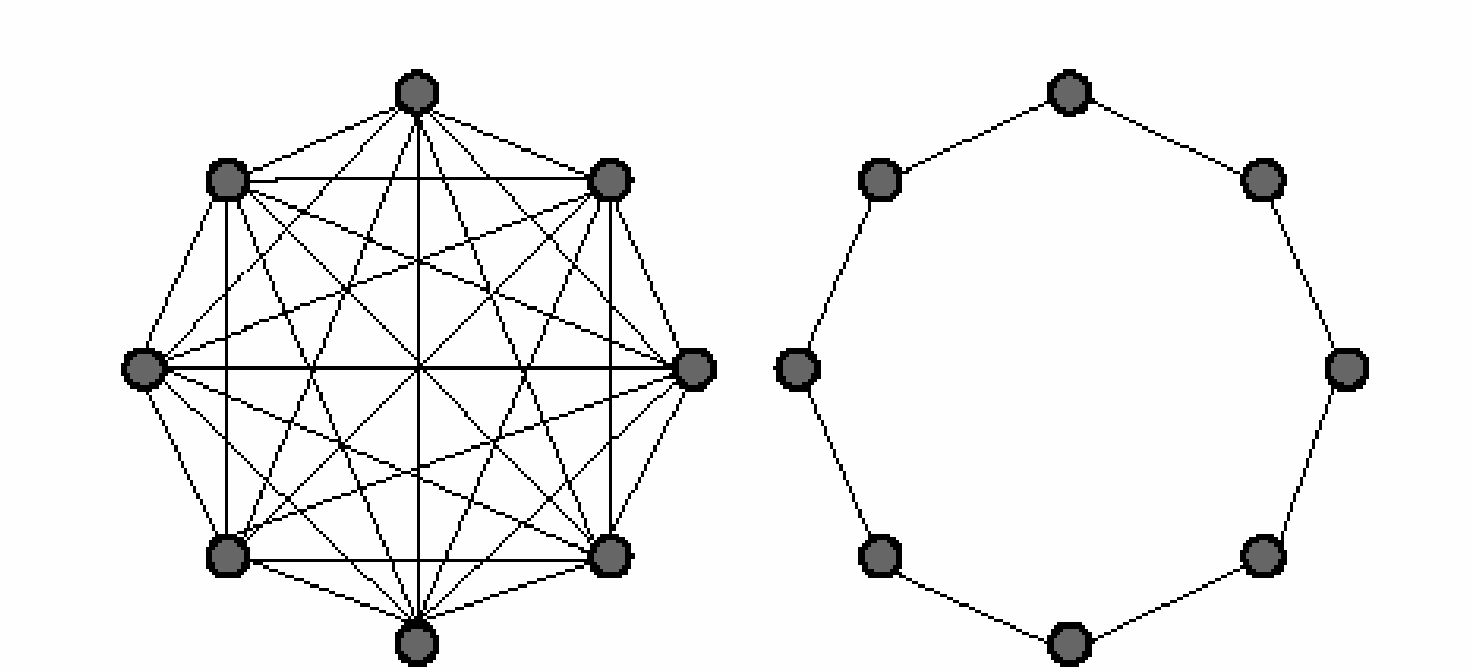

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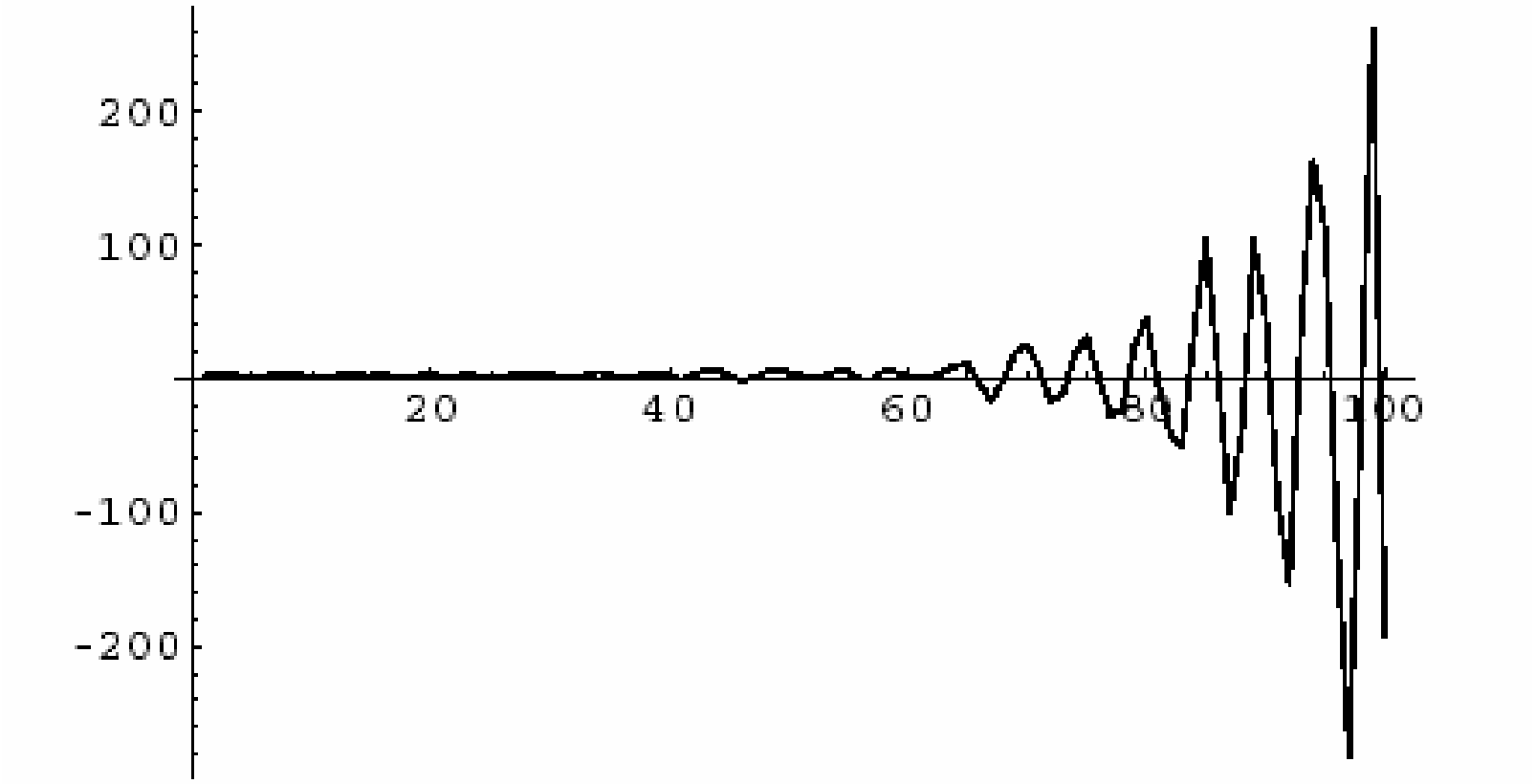

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