Nature-Inspired Localized Search

Genetic Algorithms
Ant Colony Algorithms
Swarm Algorithms

Constraint-Satisfaction Problems
Optimization Problems

All involve a goodness (fitness) function applied to individual states (proposed solutions).

All are based on using the results generated by populations progressing through a series of generations.

Basic idea is that a set of simple agents exploring a space of solutions and coordinating/combining their results can lead to effective search.

All reflect an analogy to naturally observed processes.
Genetic Algorithms

Representation

solutions are seen as genotypes of individuals
typically a linearized representation of a solution

fitness function.. as per hill climbing.. a measure of
solution goodness.

Given a population at generation i, to generate
the population at generation i+1

must select parents
generate offspring

To select parents

chance of being selected as a parent
increases with increasing fitness

fitness proportionate selection
tournament selection
Genetic Algorithms

to generate offspring

one parent

**mutation**
go through elements of solution
and modify each with some
mutation probability

two parent

**crossover**
select a location at random
swap two first parts
one-point, multipoint, uniform

**mutation**
Ant Colony Algorithms

ants explore randomly and slowly converge to a path that goes to a food source (the path is a solution)
ants communicate by depositing a pheromone along the path taken, with its strength related to what found many of the ants follow that, still wandering around a bit, perhaps stumbling on another food source

At each generation:

- each ant fills in parts of a proposed solution sequentially, selecting next part based upon weights of choices (weight proportionate selection)
- each proposed solution is evaluated
- each ant backs up along the path, updating weights in direct relation to goodness of proposed solution

need to specify
- fitness function
- sequence to build up solution and transitions
- weight updating function
  - reduce old weight (evaporation)
  - add in effects of solutions found
Swarm Algorithms

each particle is a proposed solution
each particle has an evaluation value of its solution
each particle has its velocity
determined by mix of
  past velocity
direction to best solution of the particle
  or of its neighbors
direction to best solution overall

At each generation:
each particle moves a bit according to its velocity
each particle is evaluated (new proposed solution)
each particle updates its velocity

parameters
determine weight of components of velocity
how fast are moving