Lawrence Technological University

Other Evolutionary Algorithms and EA Applications

GA, ES, EP, CA, …

Evolutionary Algorithms

- GA (Genetic Algorithms)
- ES (Evolutionary Strategies)
- EP (Evolutionary Programming)

Evolutionary Algorithms Symbols [Rechenberg]

- μ: Number of Individuals in a Population
- λ: Number of Offspring
- ρ: Number of Parents for a child. Recombination Parameter
- **+** strategy: Both parents and offspring are possible parents of the next generation
- **,** strategy: Parents of the next generation are selected from the offspring. Parents cannot survive in the next generation. For empirical experiments, this strategy is often recommended [Rechenberg, 1994].

Genetic Algorithms

$(\mu / 2 , \lambda)$, where $\mu = \lambda$

$t = 0$;
initialize μ_t
evaluate μ_t by the objective function *f*
repeat
    repeat
        select a pair (2) from μ_t parents for reproduction
        crossover and mutation (mutation is embedded within crossover)
        evaluate offspring by the objective function *f*
    until λ offspring is generated (new population is filled);
    $t = t + 1$;
    $\mu_t = \lambda$;
until termination condition reached;

ES Algorithm

$(\mu / \rho +, \lambda)$

t = 0;
initialize μ_t
evaluate μ_t by the objective function *f*
repeat
    repeat
        select ρ parents from μ_t parents for reproduction (parent selection)
        recombine selected parents (recombination)
        mutate combined offspring (mutation)
        evaluate offspring (evaluate) by the objective function *f*
    until λ offspring is generated;
    t = t + 1;
    if comma(,) strategy
        select μ_t parents from λ offspring (offspring selection)
    elsif plus(+) strategy
        select μ_t parents from μ_{t-1} and λ offspring (offspring selection)
    fi;
until termination condition reached;

Examples of ES(μ / ρ +, λ) Algorithms

- ES(1+1)
- ES(1,1)
- ES(4+4)
- ES(4,4)
- ES(8/2+8)

- ES(4+5): 4 parents, 5 offspring → best 4 survive

- ES(4,5): 4 parents, 5 offspring → next gen: best 4 from 5

EP algorithm

1. Generate an initial population of μ candidate solutions at random
2. Assess the performance for each parent solution using the given objective(performance, fitness) function *f*.
3. Generate λ ($= \mu$) new offspring solutions from by applying the variation operator. Now there are 2μ solutions in the population.
4. Assess the performance score of each offspring using the given objective function f.
5. For each individual, select c competitors at random from the population of 2μ size. Next, conduct pair-wise competitions between the individual and the competitors.
6. Select the μ solutions that have the greatest number of wins to be the parents for the next generation.
7. The process proceeds back to step (3) unless the available execution time is exhausted or an acceptable solution has been discovered.

Comparisons

	GA	ES	EP
Rechenberg's notation	$(\mu / 2 , \lambda)$, where $\mu = \lambda$	$(\mu / \rho +, \lambda)$	$(\mu / 1 + \lambda)$, where $\mu = \lambda$
Representation of individuals	Genotype level of individuals	Coding structure of individuals (Phenotype).	Coding structure of individuals (Phenotype).
Focuses on	Genotype	Individual	Population (Species)
Re-combination (crossover)	Recombination(crossover) serves as the main search operator	Recombination operators may be possible.	Recombination operators is not possible
Mutation	Secondary role of mutation	Mutation serves as the main search operator	Mutation serves as the main search operator
Selection	Roulette wheel selection (proportional selection),	Strict deterministic selection (static extinctive)	Stochastic tournament

Darwinian Evolutionary Algorithms

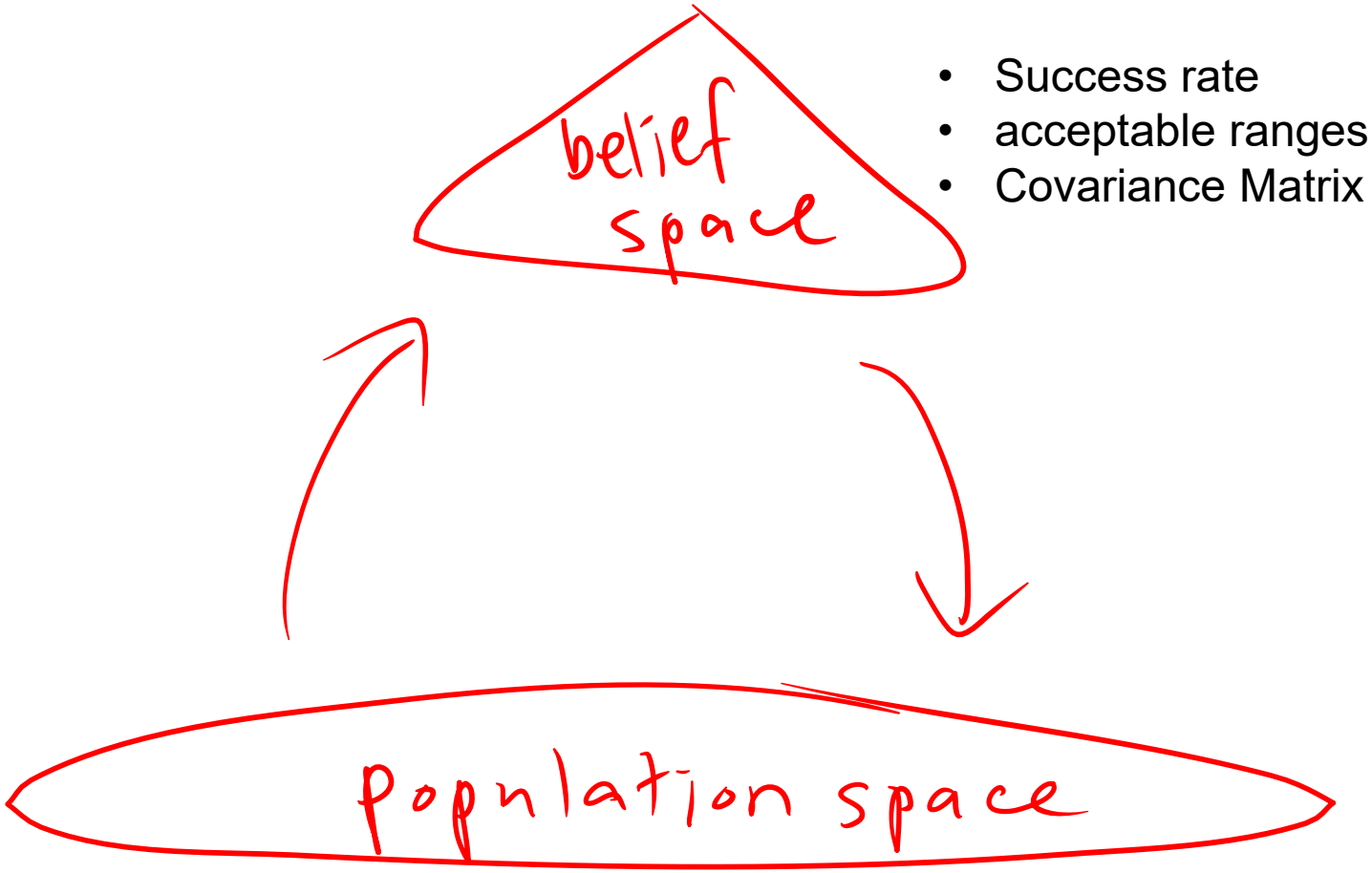
- Binary GA

- EP?
- ES?
- GP?

Non-Darwinian Evolutionary Algorithms

- Cultural Algorithms
- Learnable Evolution Model
- Memetic Algorithms
- …

Cultural Algorithms



- Success rate
- acceptable ranges for each variable
- Covariance Matrix

Applications of EC

- Search & Optimization
- 2D & 3D design optimization
- Scheduling
- Automatic Programming – GP
- Evolving Hardware
- Forecasting & Prediction
- Discovery of new drugs: docking a small molecule of potential drug into target protein's biding site
- EDL
- …