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Polluted Terrain Cleaning”
HURO/0802/100**

APPLICATION OF GENETIC ALGORITHMS FOR STUDYING THE EVOLUTION OF BACTERIA POPULATION. POPULATION MODELS

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- **The population models may be distinguished from each other by looking at the range of the selection strategies of the parents and the definition of the selection pool.**
- **Three population models can be defined:**
 - 1. *Global model.* In the global model the selection takes place inside the whole population. That means, any two or more individuals may be selected together for the production of offspring. No restrictions exist.**
 - 2. *Local model.* The local model constrains the selection of parents to a local neighborhood.**
 - 3. *Regional model.* The regional model constrains the selection of parents to parts of the population isolated from each other, called subpopulation. Inside the subpopulation the selection is unre-stricted (similar to the global model).**



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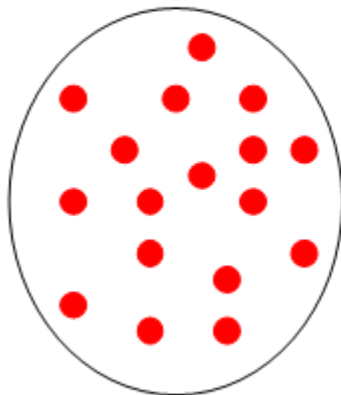
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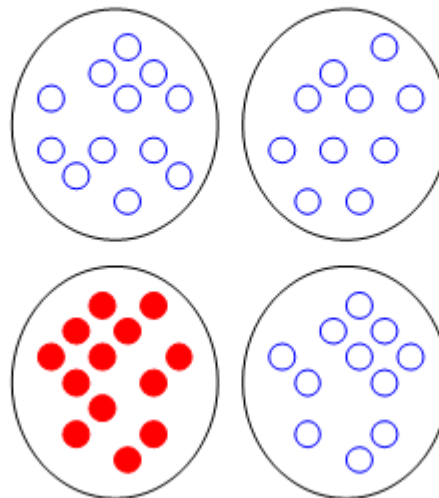
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Classification of population models by range of selection (selection pool)

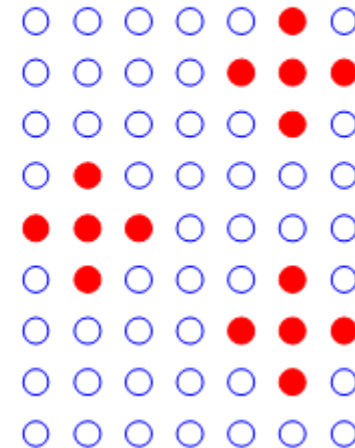
Globales Modell



Regionales Modell



Lokales Modell



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1. Global model - worker/farmer

- The global model does not divide the population.
- The global model corresponds to the classical evolutionary algorithm.
- The calculations where the whole population is needed - fitness assignment and selection - are performed by the master.
- All remaining calculations which are performed for one or two individuals each can be distributed to a number of slaves
- The slaves perform recombination, mutation and the evaluation of the objective function separately.
- This is known as synchronous master-slave-structure



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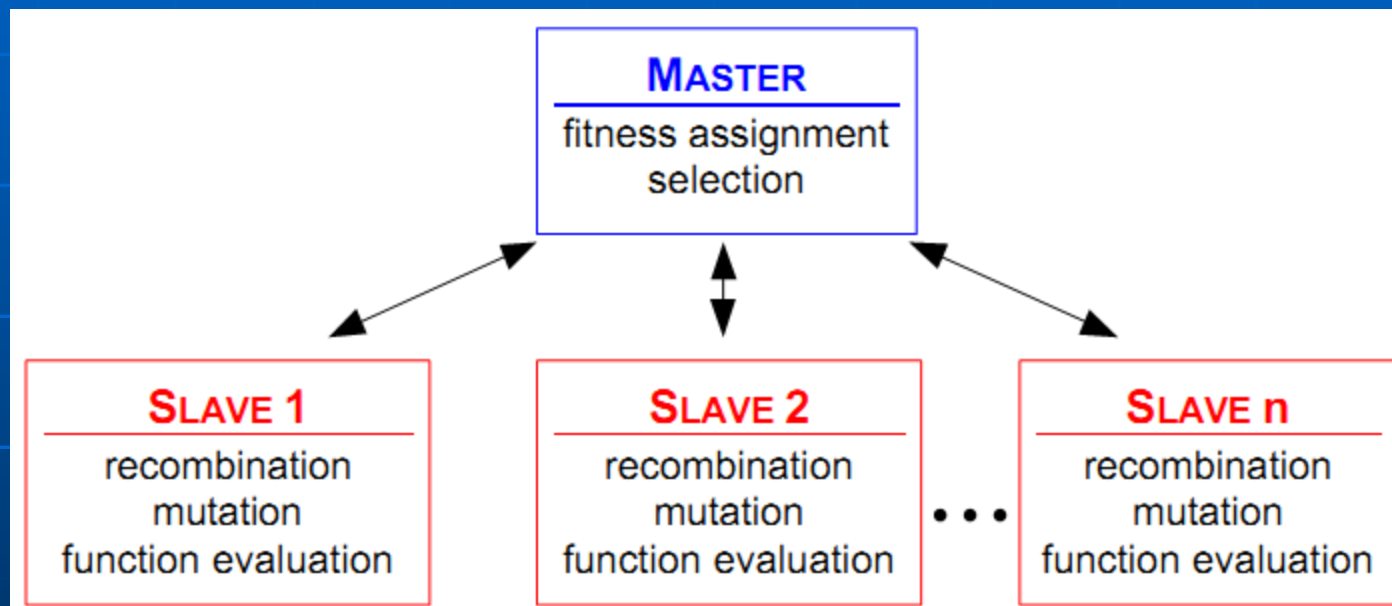
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Global population model (master-slave-structure)



- The slave calculations can be done in parallel.
- In this case, the whole evolutionary algorithm is calculated by the master and only the objective function evaluation is distributed to the slaves.

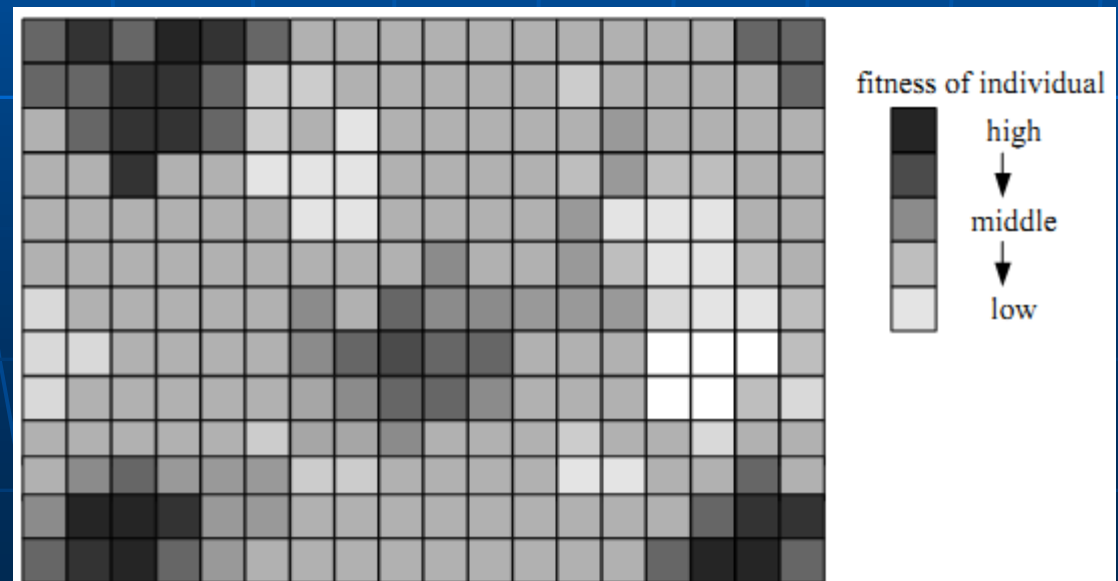


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2. Local model - Diffusion model

- The local model (diffusion model) handles every individual separately and selects the mating partner in a local neighborhood by local selection.
- Thus, a diffusion of information through the population takes place.

Local model (diffusion
evolutionary algorithm)



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3. Regional model - Migration

- **The regional model (migration model) divides the population into multiple subpopulations.**
- **These subpopulations evolve independently of each other for a certain number of generations (isolation time). After the isolation time a number of individuals is distributed between the subpopulation (migration).**
- **The number of exchanged individuals (migration rate), the selection method of the individuals for migration and the scheme of migration determines how much genetic diversity can occur in the subpopulation and the exchange of information between subpopulation.**

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The selection of the individuals for migration can take place:

- **uniformly at random (pick individuals for migration in a random manner);**
- **fitness-based (select the best individuals for migration).**

The migration can take place:

- **between all subpopulations (complete net topology - unrestricted);**
- **in a ring topology;**
- **in a neighborhood topology.**



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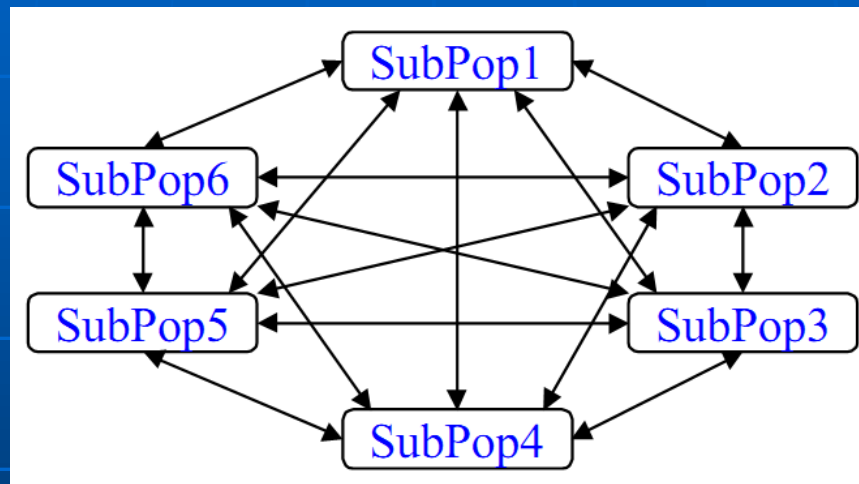
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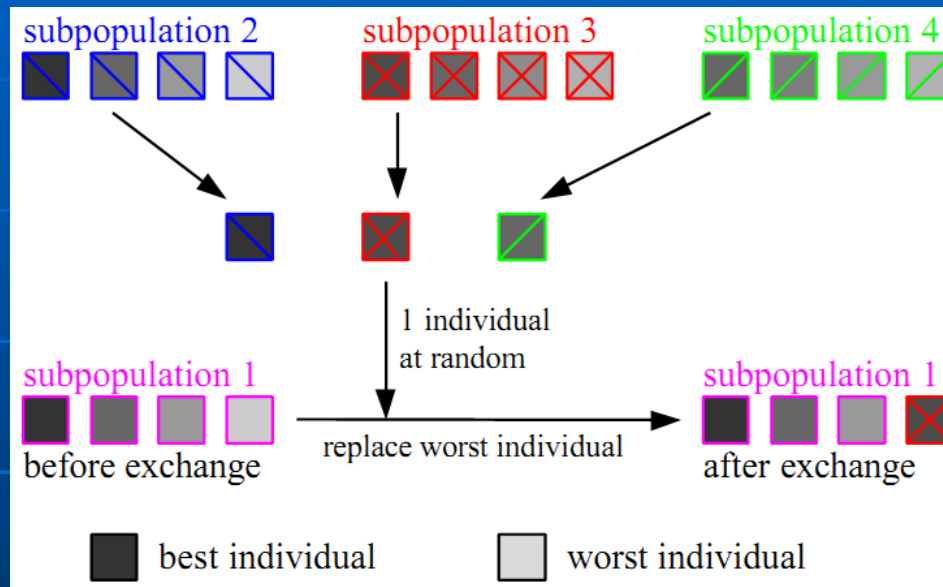
Unrestricted migration topology (Complete net topology)



- The most general migration strategy is that of unrestricted migration (complete net topology).
- The individuals may migrate from any subpopulation to another. For each subpopulation, a pool of potential immigrants is constructed from the other subpopulation.
- The individual migrants are then uniformly at random determined from this pool.

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Scheme for migration of individuals between subpopulation

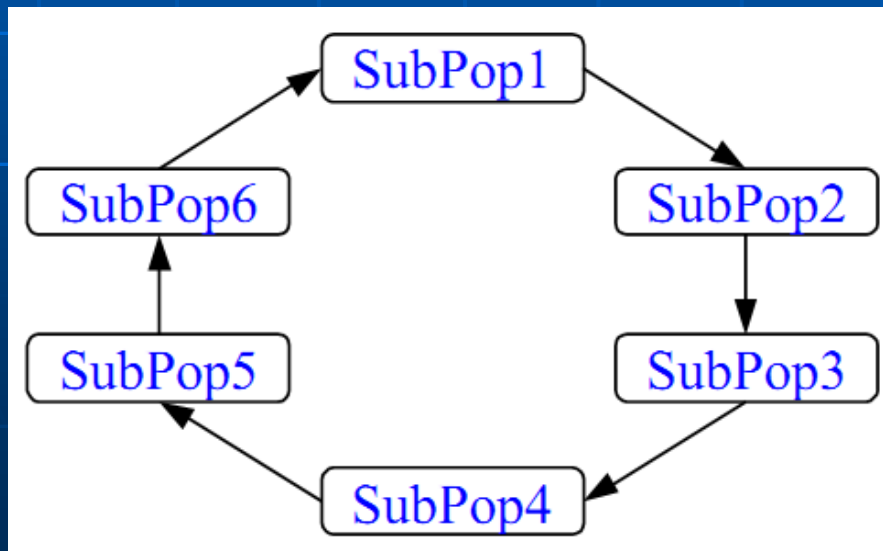


- Subpopulation 2, 3 and 4 construct a pool of their best individuals (fitness-based migration). 1 individual is uniformly at random chosen from this pool and replaces the worst individual in subpopulation 1.
- This cycle is performed for every subpopulation. Thus, it is ensured that no subpopulation will receive individuals from itself.

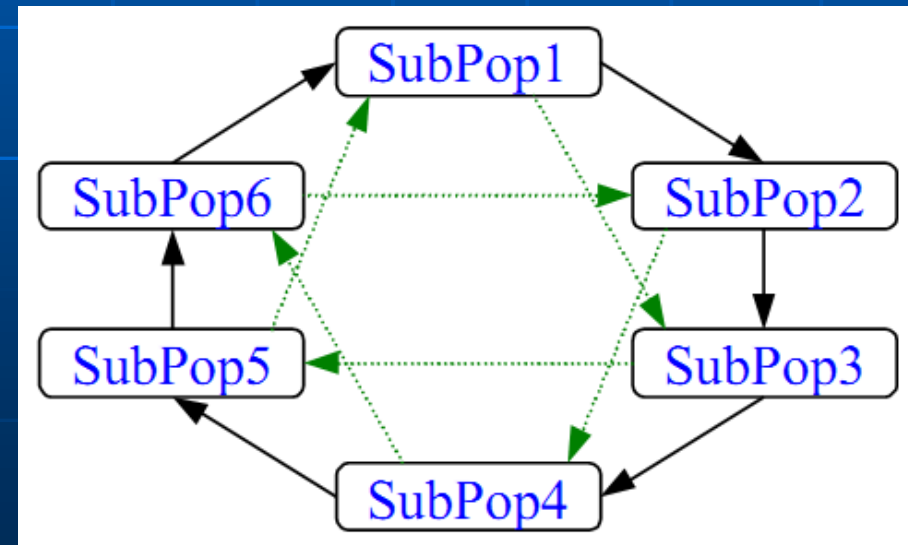
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- The most basic migration scheme is the *ring topology*.
- The individuals are transferred between directionally adjacent subpopulations.

Example: individuals from subpopulation 6 migrate only to subpopulation 1 and individuals from subpopulation 1 only migrate to subpopulation 2.



Ring migration topology: distance 1

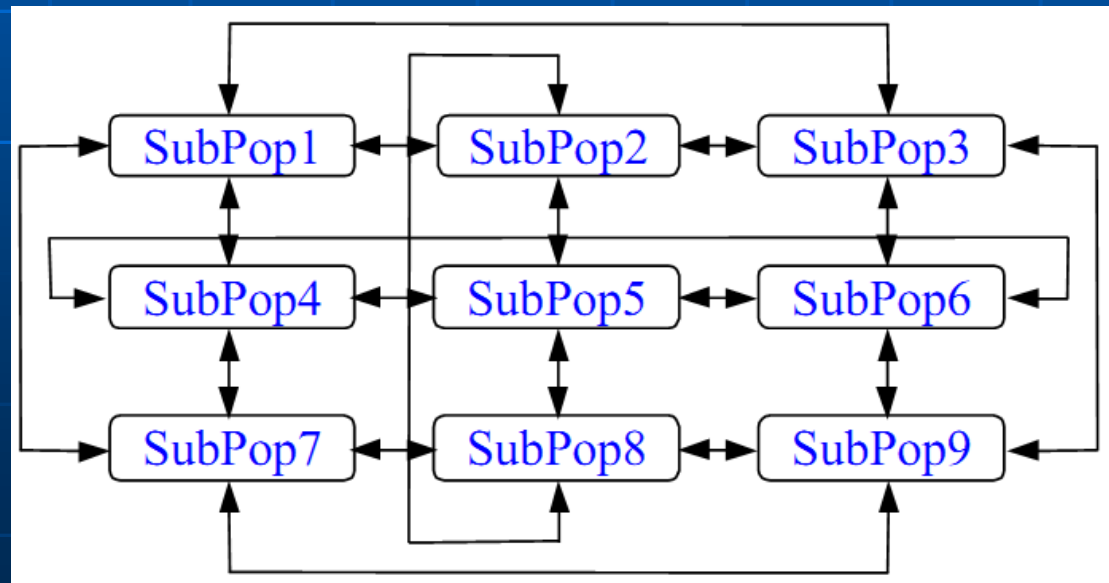


Ring migration topology:
distance 1 and 2

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- *The neighborhoods migration.* This migration is made only between the nearest neighbors.
- For each subpopulation, the possible immigrants are determined, according to the desired selection method, from the adjacent subpopulations and a final selection is made from this pool of individuals

Neighborhood migration
topology (2-D grid)





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Thank you !