



**7th International Conference
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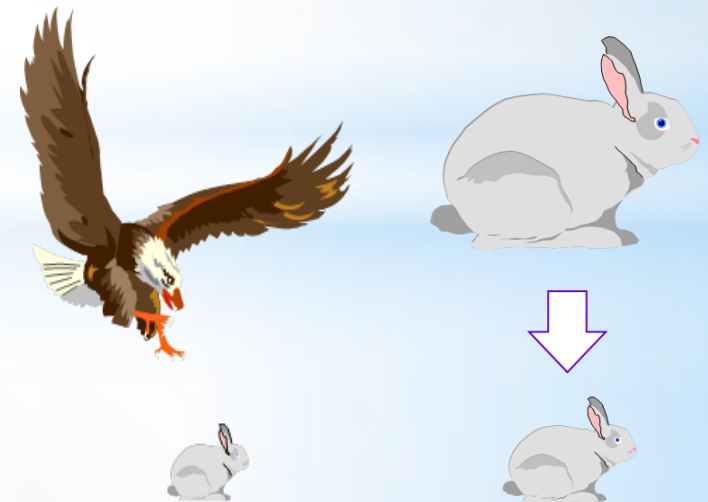
Decomposition of Spectral Contour into Gaussian Bands using Improved Modification of Gender Genetic Algorithms

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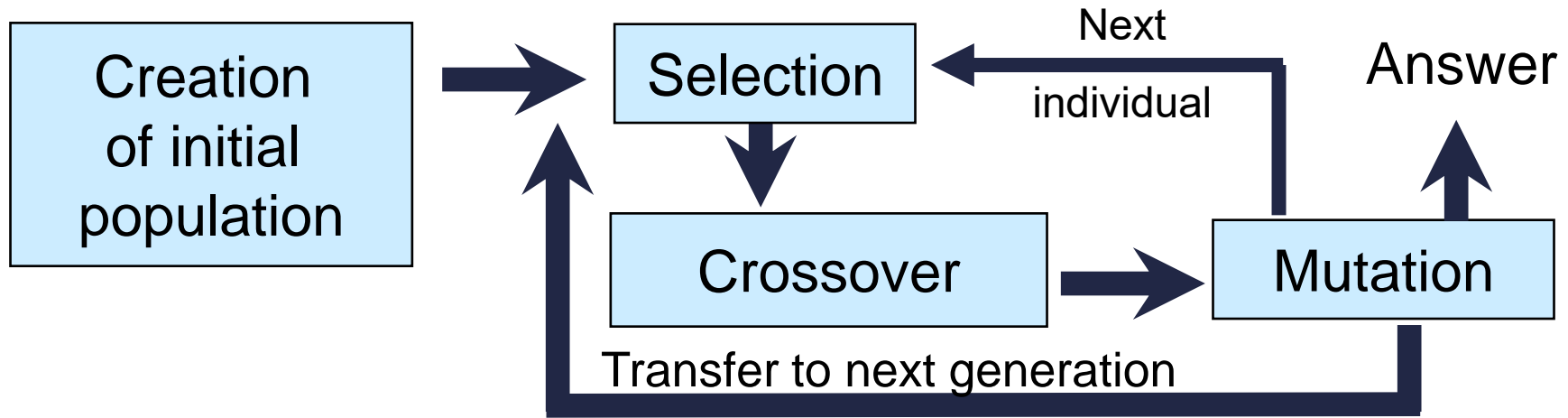
Genetic Algorithms (GA)

- An effective class of **optimization** algorithms based on ideas of **evolution** in nature
- A number (**population**) of candidate solutions (individuals) are considered **simultaneously**
- The quality of a solution is estimated by its **fitness function**
- Two basic **principles** applied are **selection** and **inheritance**
- **Selection** of the fittest provides survival of better individuals
- **Inheritance** brings information contained in selected individuals to next generations



Genetic Operators

Algorithm of computation

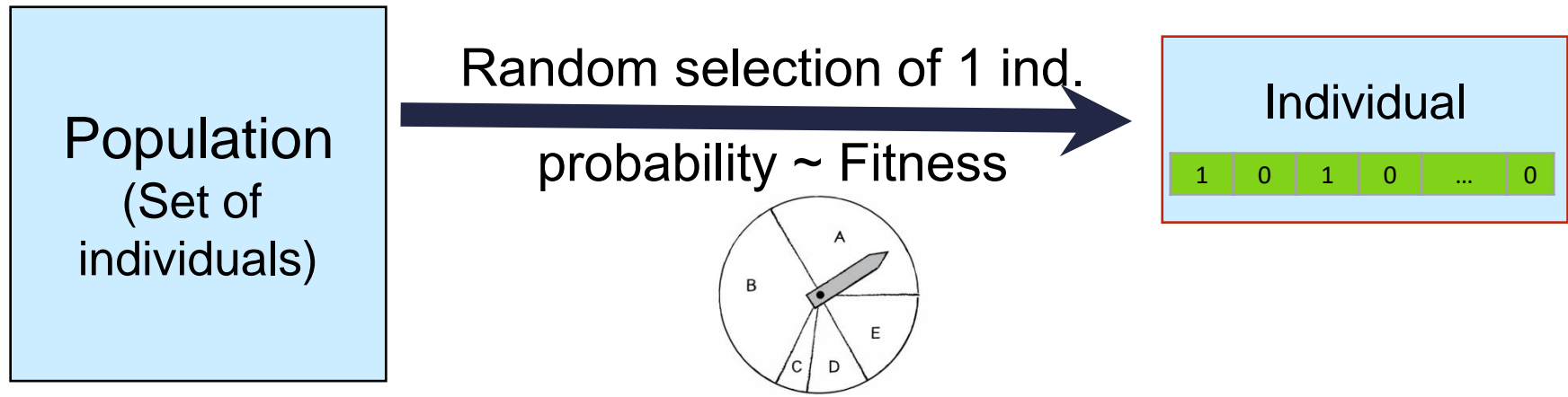


The **main aspects** of an implementation of GA are:

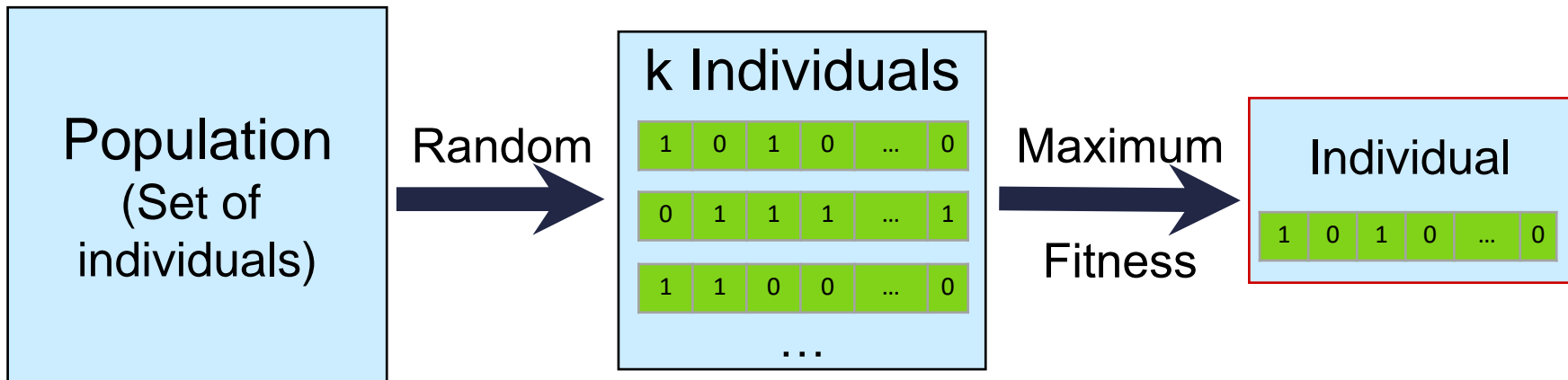
- **Type of coding** of information in an individual
- The method of **selection**
- The **crossover** operator providing inheritance and exchange of information between parents
- The **mutation** operator providing search of new areas

Selection

1. Roulette Wheel

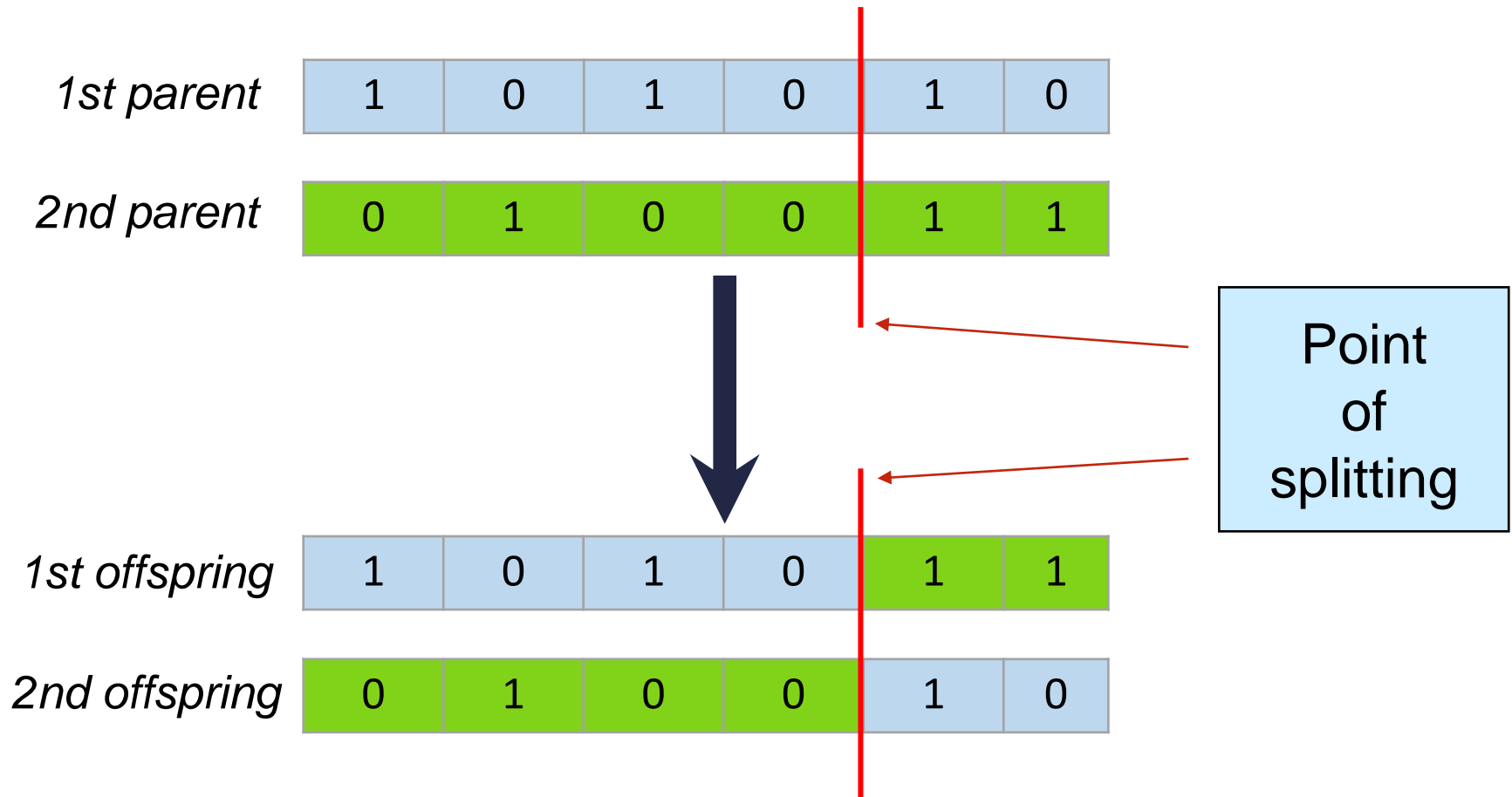


2. Tournament



Crossover

One-point crossover

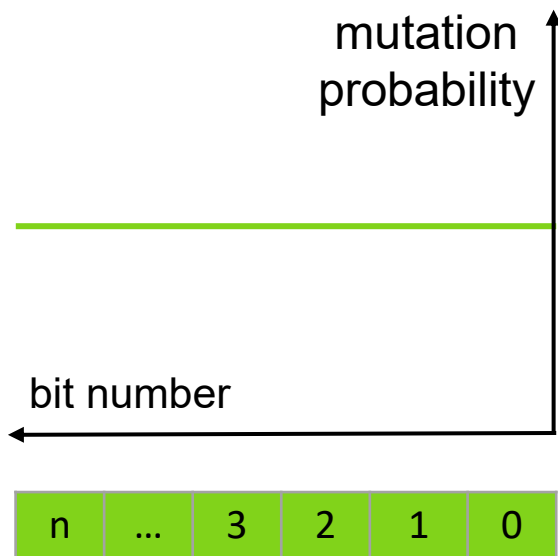


Mutation

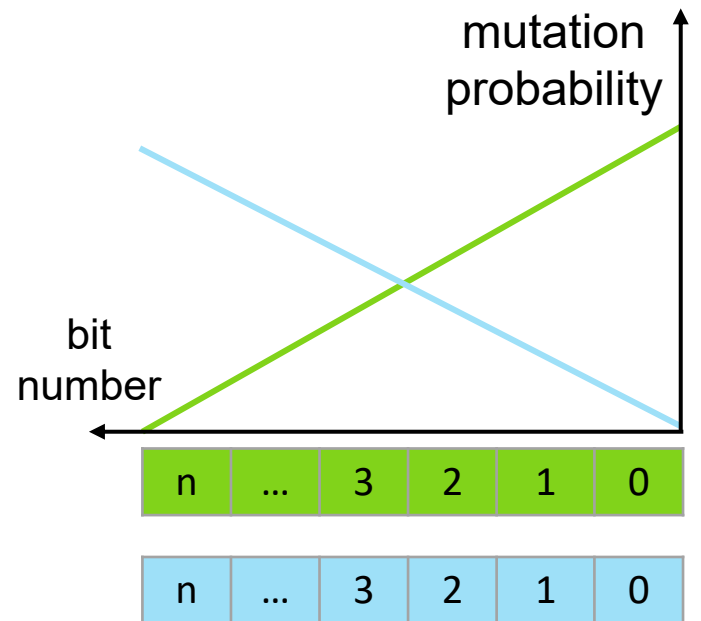
One-bit mutation



1. Uniform distribution



2. Linear distribution



Conventional GA and Gender GA (GGA)

- In conventional GA, **all individuals are equal** in respect to genetic operators
- In nature, higher mammals use **sexual** selection
- The ♀ **female** gender is responsible for **preserving useful features** found by the evolution
- The ♂ **male** gender is responsible for **variability**.
Among ♂ males, geniuses and freaks are more common than among ♀ females
- **In this study**, we divide the population in what we call GGA into ♂ males and ♀ females half by half
- The **mutation rate for ♂ males** is several fold higher

GA and GGA operators

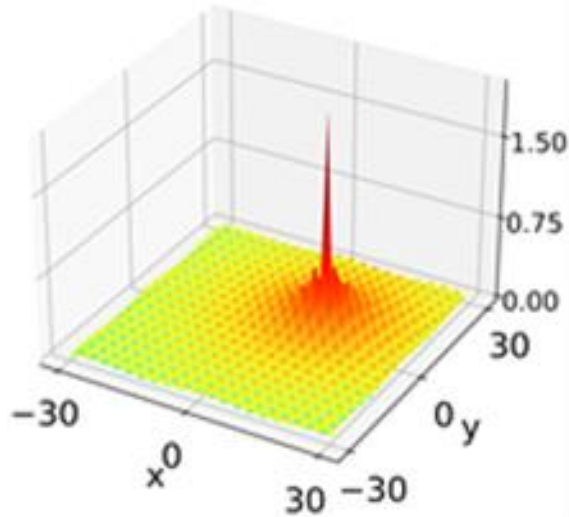
Operators	GA	GGA
Selection	Roulette Wheel	♂ male - Roulette Wheel ♀ female - Roulette Wheel
One-bit mutation	Uniform distribution	♂ male - Uniform distribution, higher rate ♀ female - Uniform distribution, lower rate

Modifications of GGA

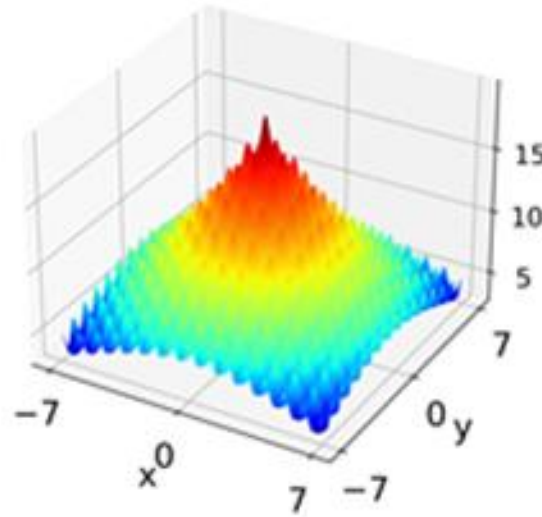
Operators	GGA-1	GGA-2	GGA-3
Selection: ♂ Male	Roulette Wheel	Tournament	Tournament
Selection: ♀ Female	Roulette Wheel	Roulette Wheel	Roulette Wheel
Mutation: ♂ Male	Linear distribution	Uniform distribution	Linear distribution
Mutation: ♀ Female	Linear distribution	Uniform distribution	Linear distribution

Testing on 2D Model Functions: Func Types

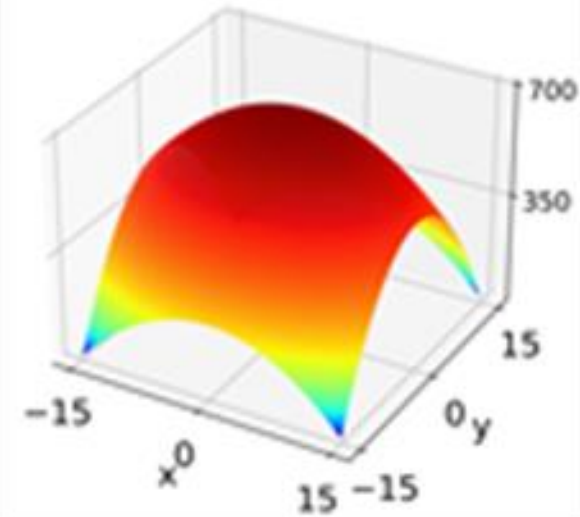
H1



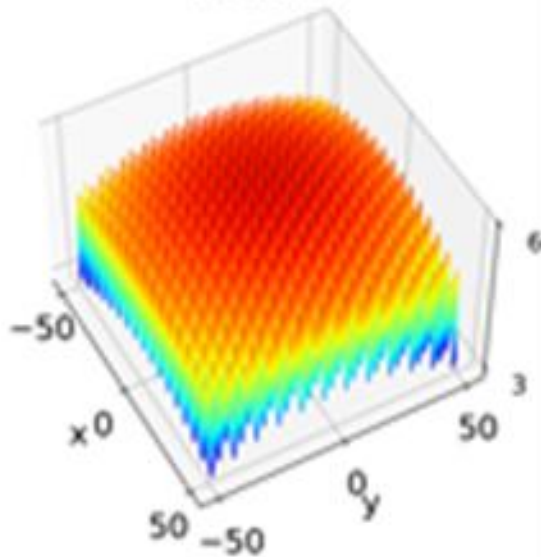
Ackley



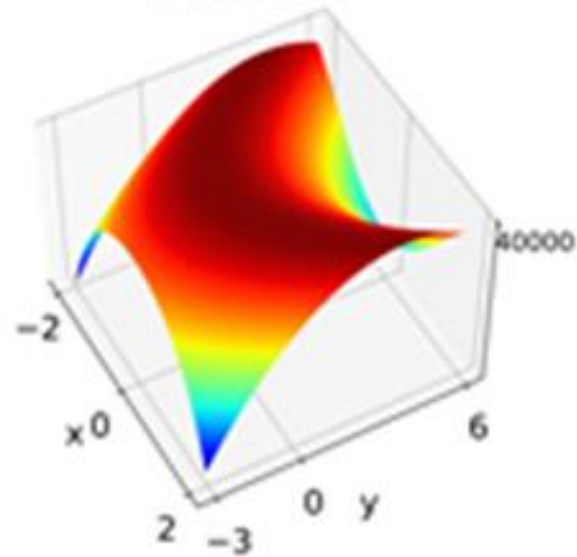
Bohachevsky



Griewank



Rosenbrock



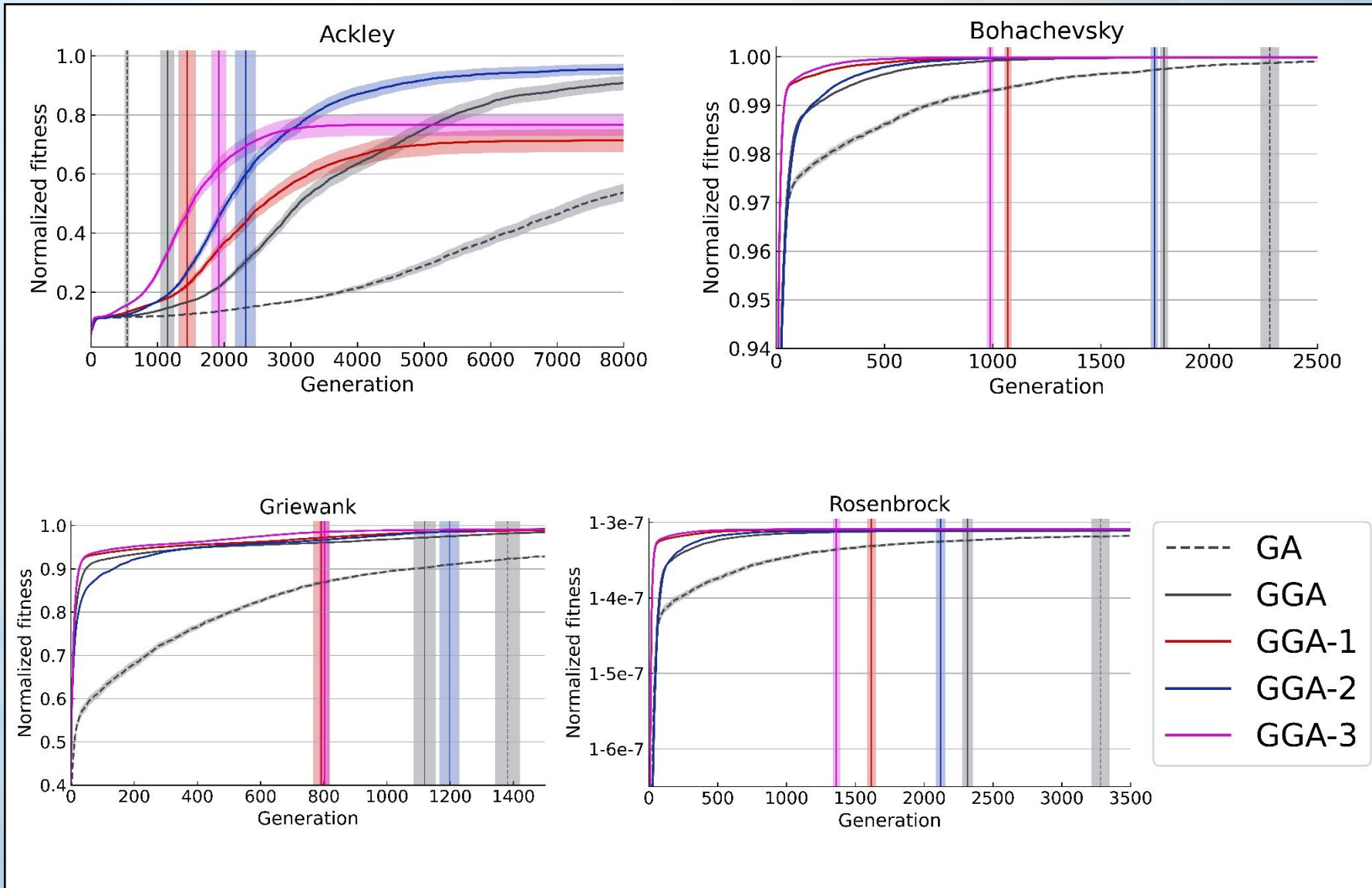
Testing on 2D Model Functions: Parameters

- **Stopping criterion:** less than 10^{-6} increase in fitness function maximum in the population during last 20 generations
- 100 **independent runs**
- Continuous chromosomes with **binary encoding**
- **Roulette wheel** selection method
- **Single-point** crossover operator
- **Single-bit** mutation operator
- **Fixed population size** in all generations
- Equal number of ♂ **males** and ♀ **females** in each generation

Testing on 2D Model Functions: Parameters

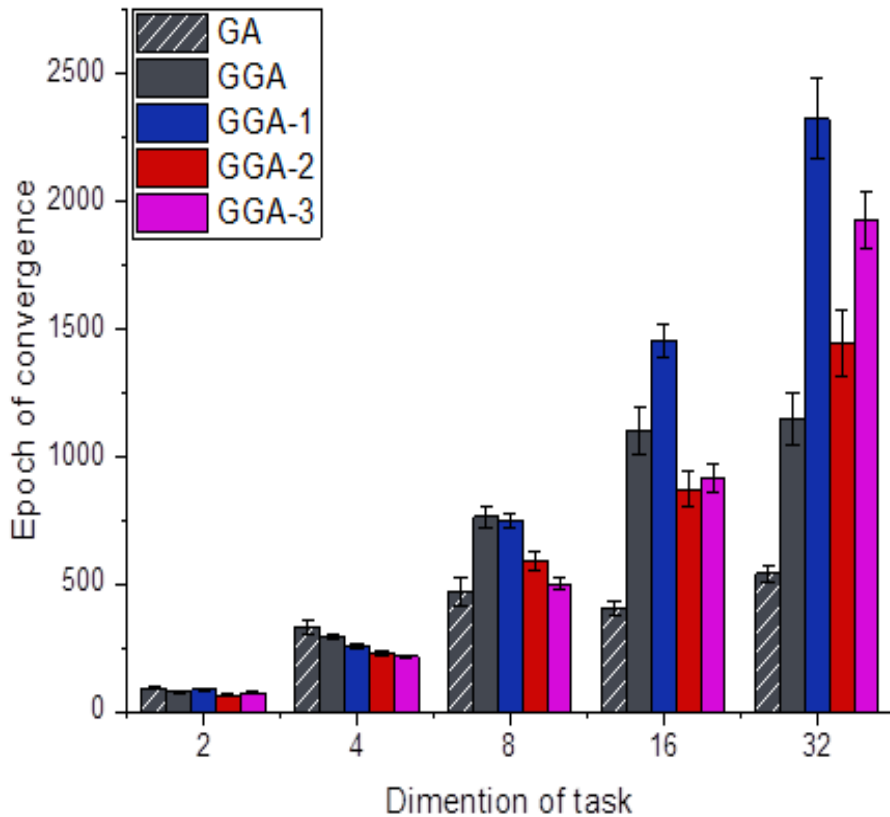
Parameters	GA	GGA
Dimension of chromosomes, bits	25	25
Individuals in the population	100	100
Share of elite individuals	6%	6%
Probability of mutation	1%	5% - ♂ males 0.1% - ♀ females

Testing on Model Functions: Results

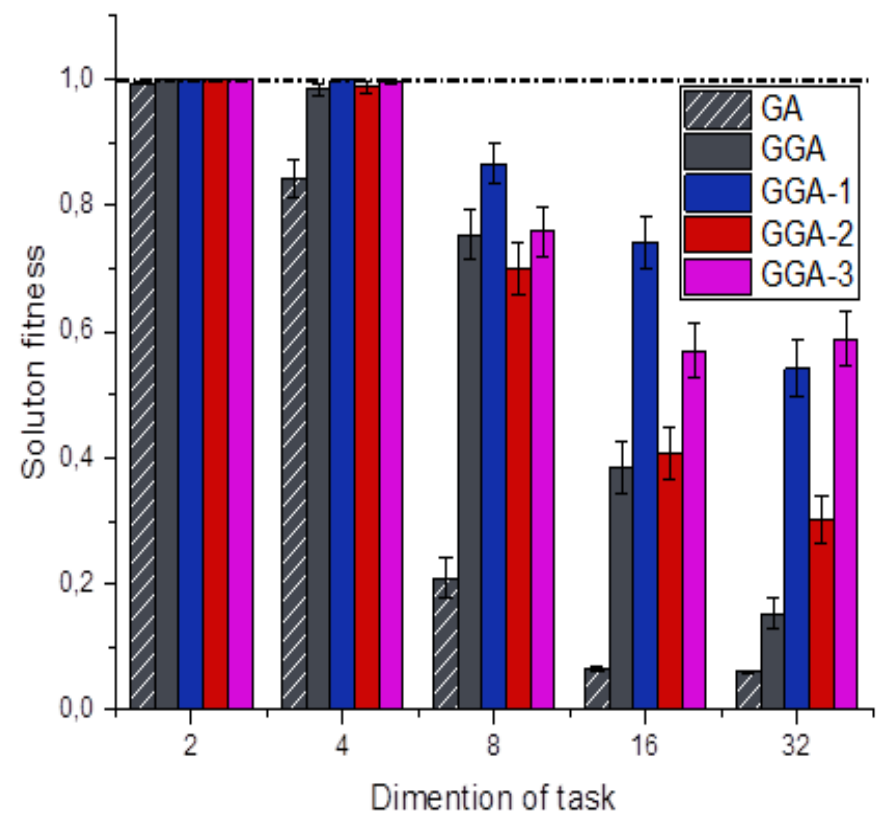


Testing on Ackley Model Function: Results

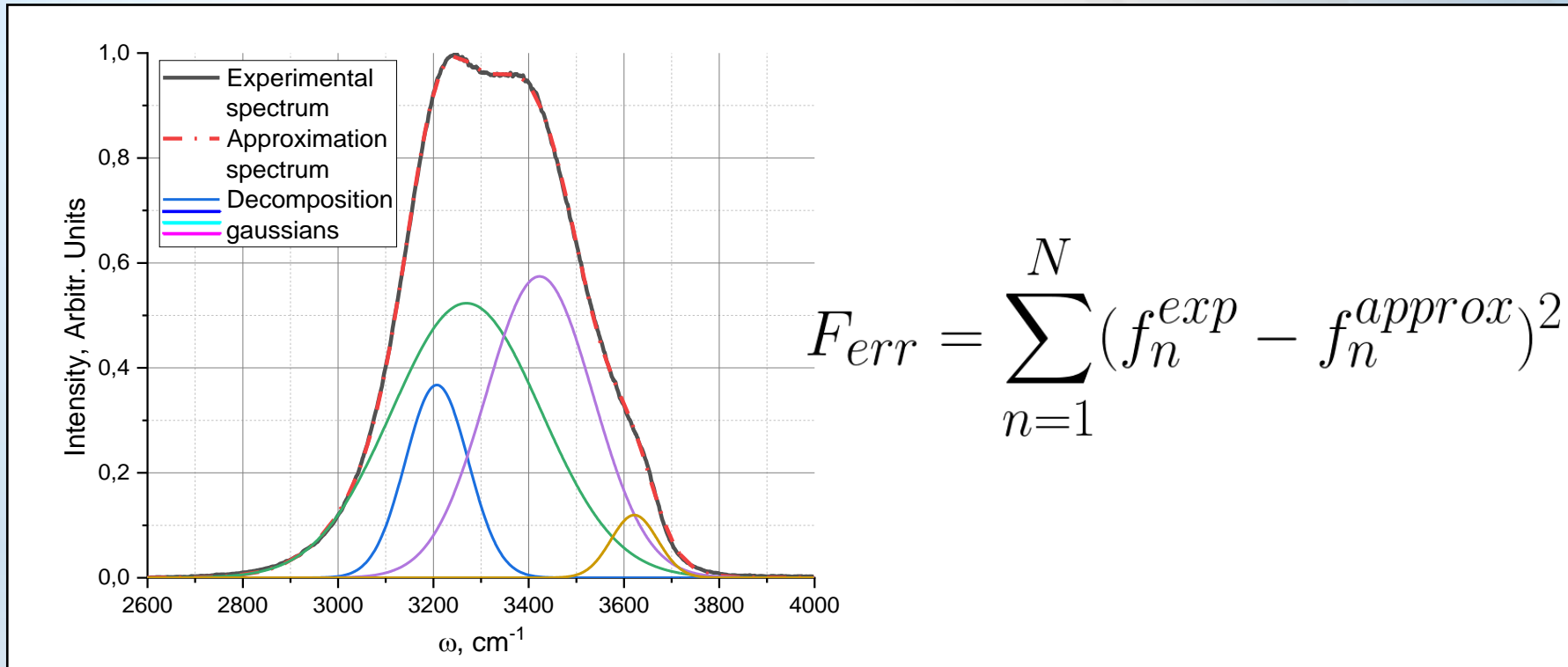
Ackley function



Ackley function

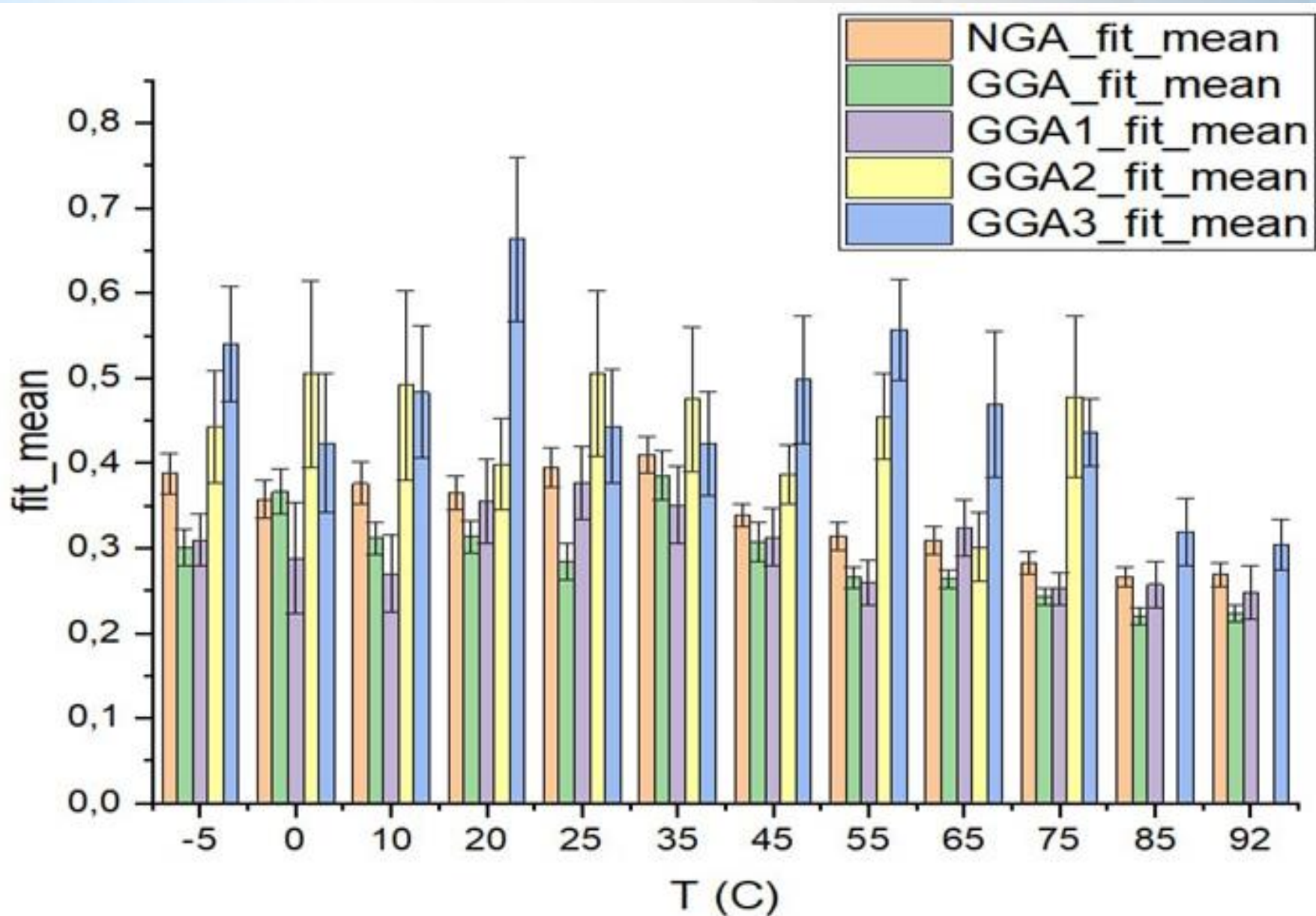


Decomposition of Spectral Contour



- Raman **valence band** of liquid water
- Decomposition of spectral contour into **Gaussian shapes**
- This is an **incorrect inverse problem** solved with various error values for various numbers of Gaussians
- 3 parameters per Gaussian; **multiple fitness minima**

Decomposition at Various Temperatures



Conclusion

- Gender modification of GA is **more efficient** than conventional GA for **complex multi-extremum** problems
- It prevents **premature degradation** of the population and stop of the evolution, providing **better solution**
- Our new modifications of selection and mutation provide **improvement of GGA performance** for complex problems
- The algorithm has been tested on **several model problems** and on **one real-world problem**.

Further tests on a **wider variety** of problems are needed

- **Other differences** between genders may be introduced



Thank you for your attention!

