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Decomposition of Spectral Contour into Gaussian Bands using Gender Genetic Algorithms

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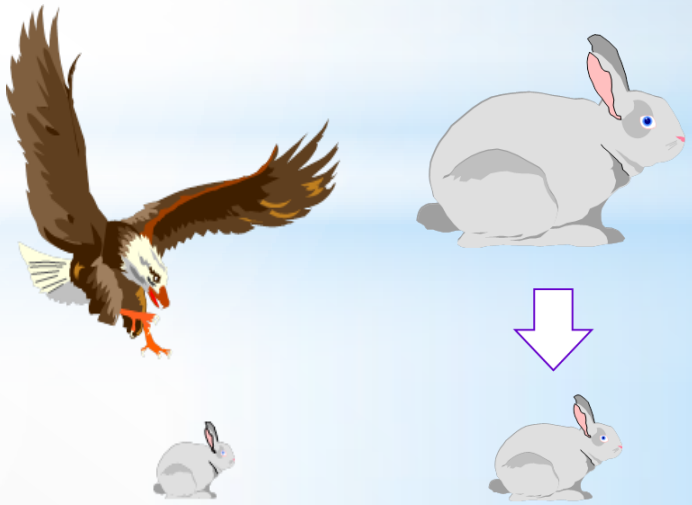
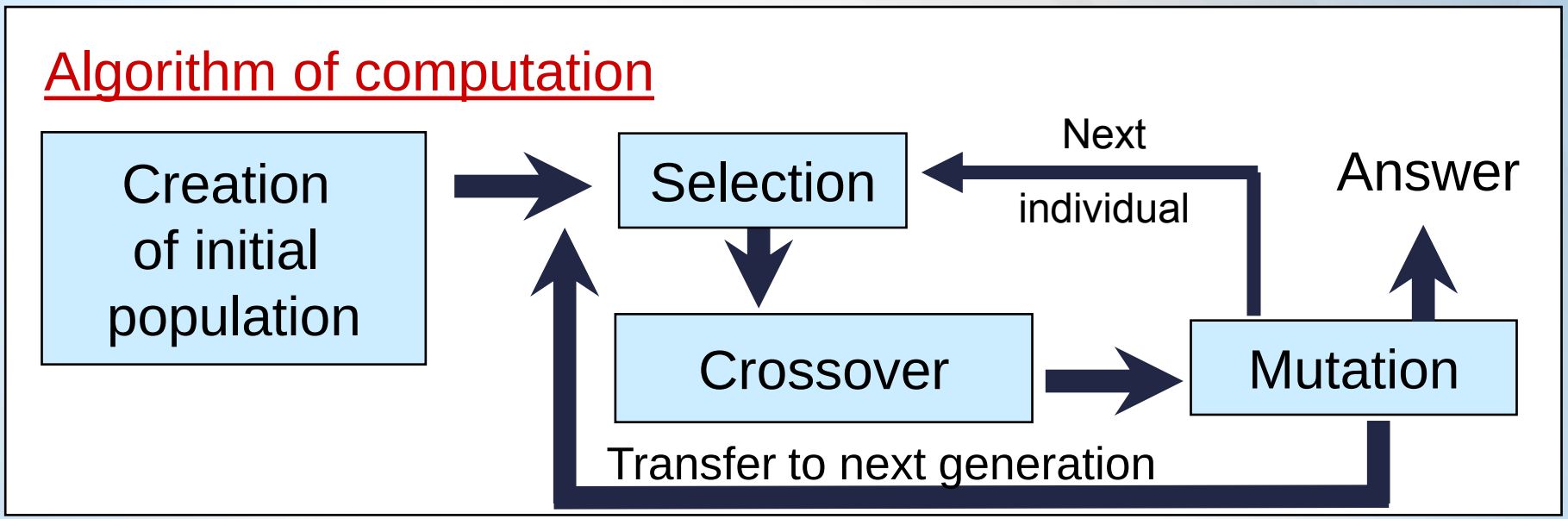
Genetic Algorithms (GA)

- 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



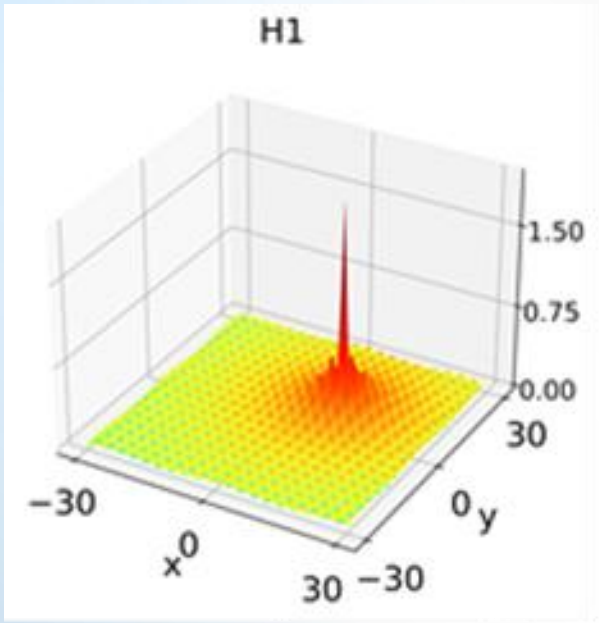
The main aspects of an implementation of GA are:

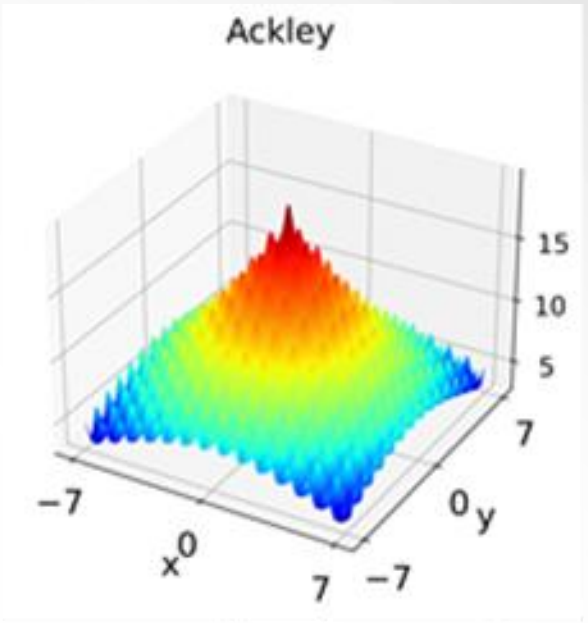
- Type of coding of information in an individual
- The method of selection
- The crossover operator providing inheritance and exchange of information between parents
- The mutation operator providing search of new areas

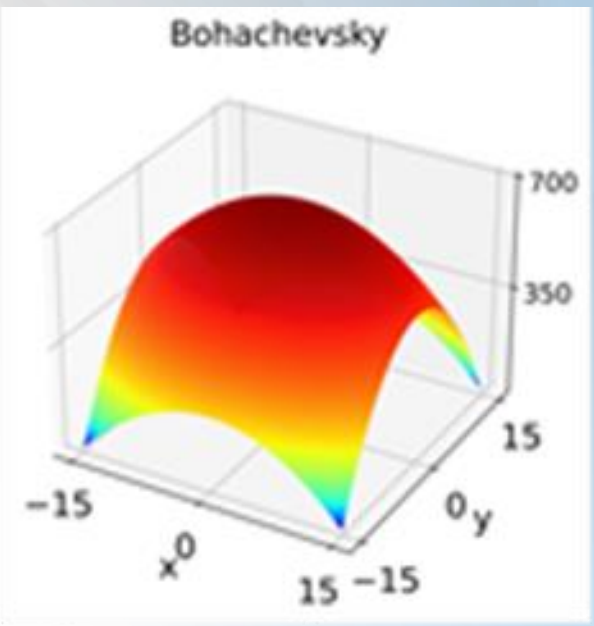
Conventional GA and Gender GA (GGA)

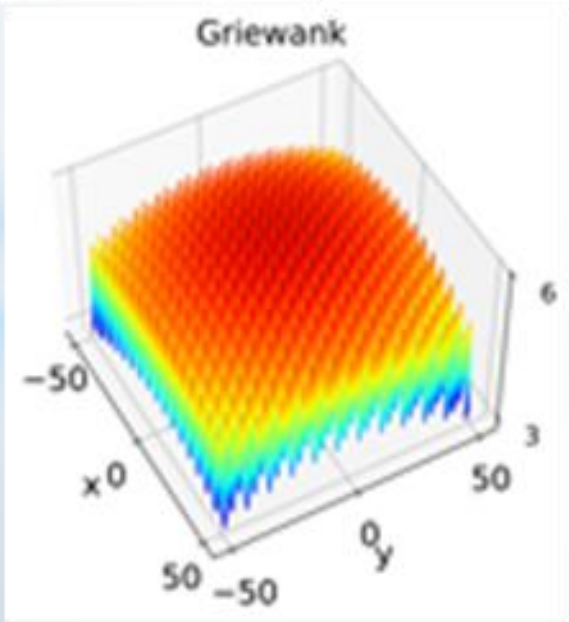
- In conventional GA, all individuals are equal in respect to genetic operators
- In nature, higher mammals use sexual selection
- The female gender is responsible for preserving useful features found by the evolution
- The male gender is responsible for variability. Among males, geniuses and freaks 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
- The females have a limit on the number of crossovers *N*

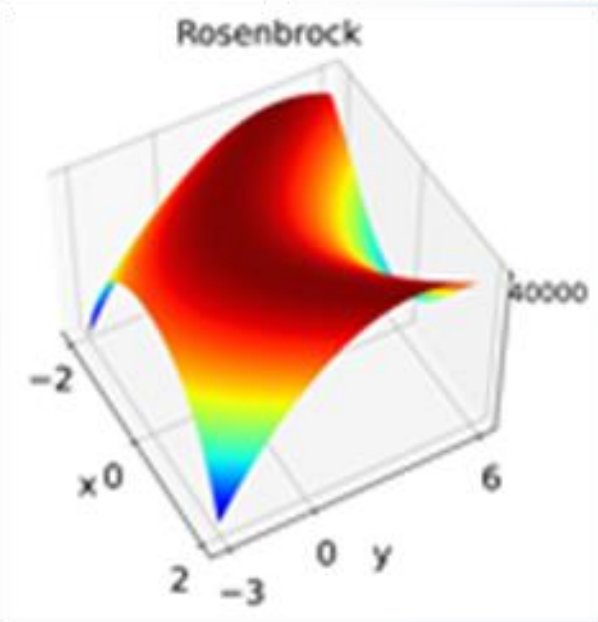
Testing on 2D Model Functions: Func Types











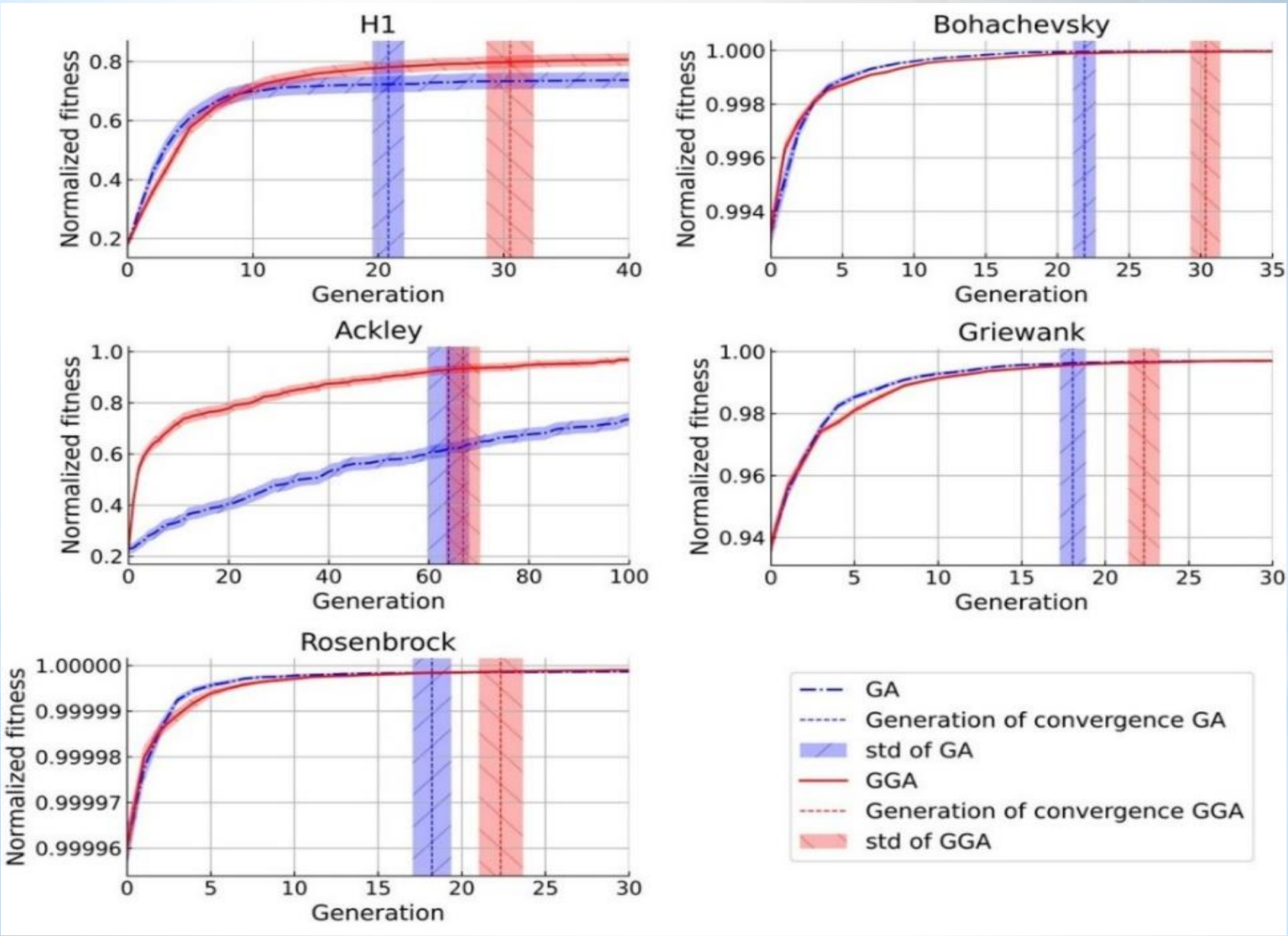
Testing on 2D Model Functions: Parameters

- 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

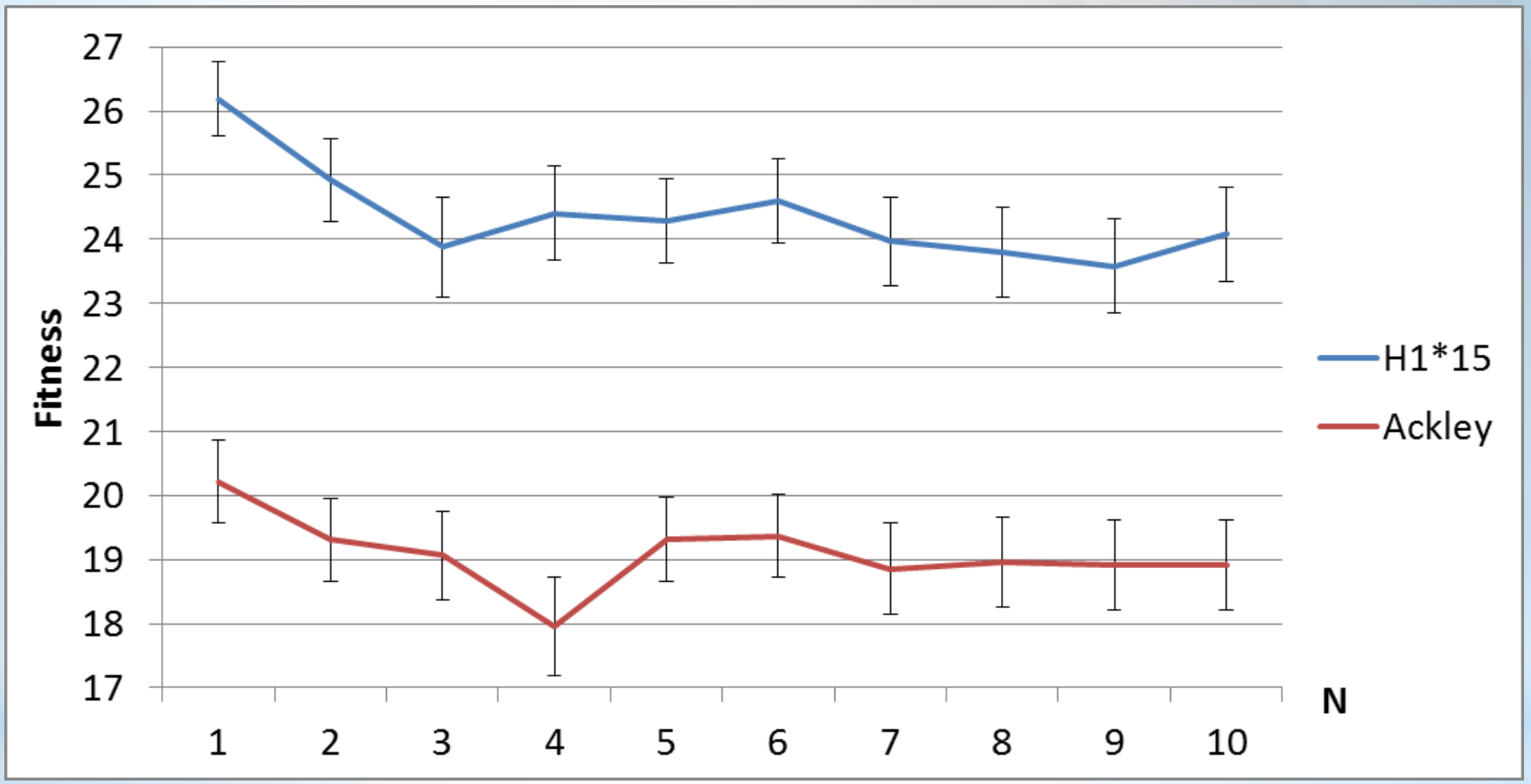
Testing on 2D Model Functions: Parameters

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
Maximum number of times each female may be selected	-	5

Testing on 2D Model Functions: Results

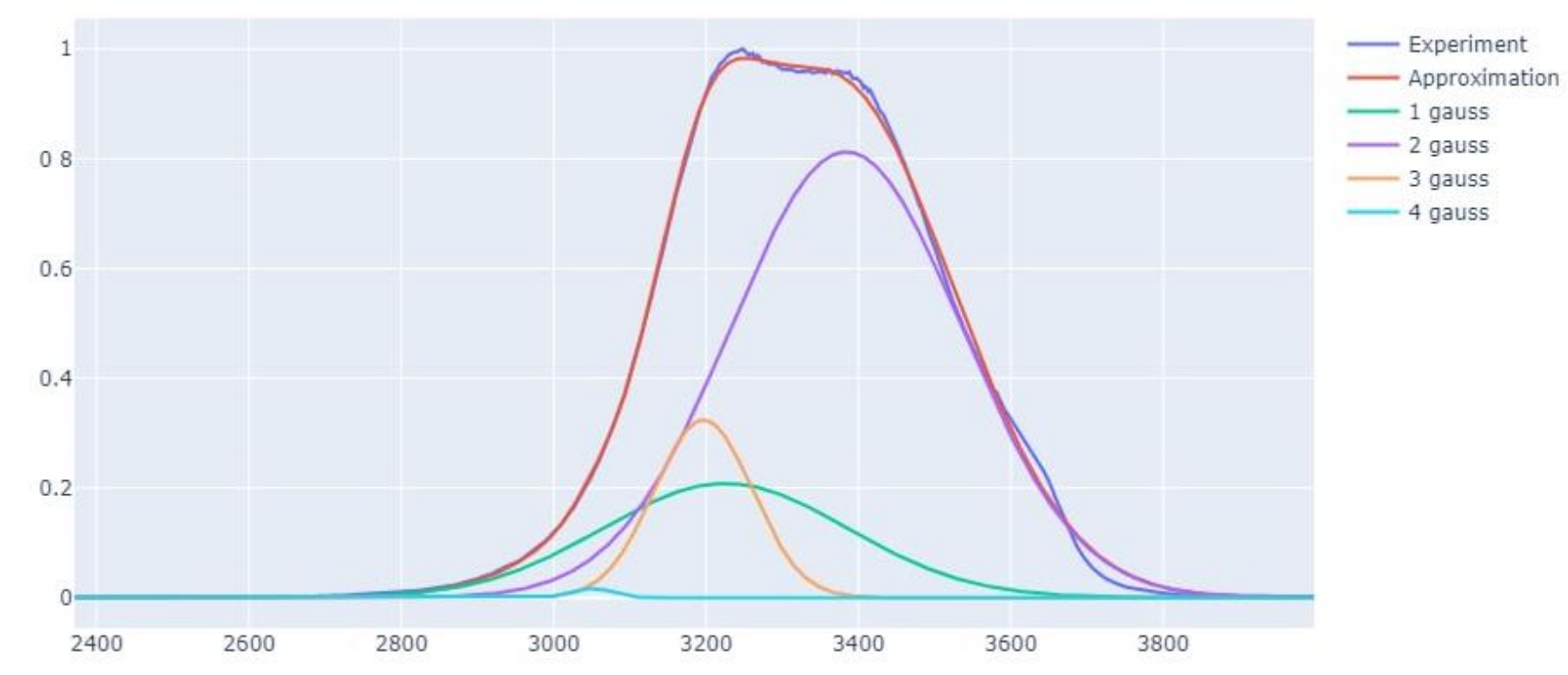


Dependence on the Number of Selections of a Female



- Starting from N=3, there is no dependence
- The best results are for the strongest limitation (N=1)

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

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
- Strong limitation on the number of crossovers per female improves the results of optimization
- 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!