

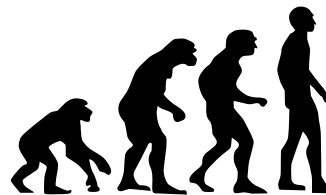
# GPU Parallelization of Evolutionary Algorithms

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OF MATHEMATICS  
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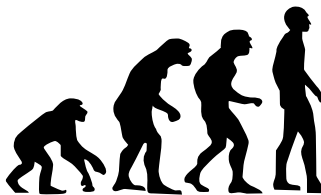
# Evolutionary Algorithms

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Evolutionary Algorithms (EVA) are population-based stochastic global optimization technique inspired by the evolution of species in the nature.

Individual (candidate solution) survives based on the solution quality and reproduces.

Resulting individuals form new generation and the process repeats.



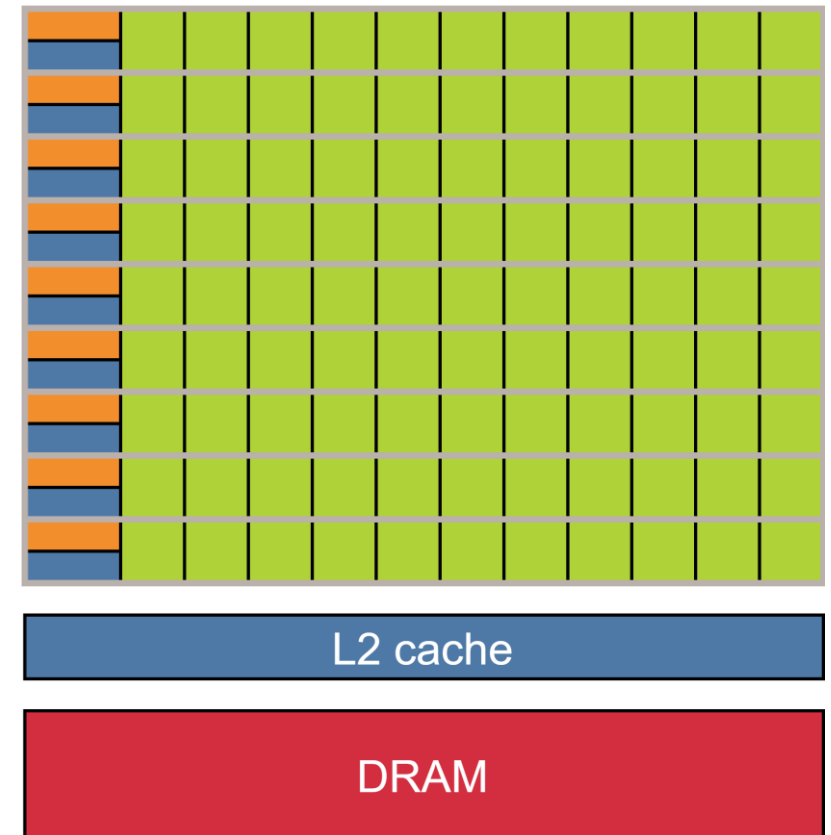
# Graphical Processing Unit

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Highly parallel and distributed hardware build for performance.

Stands behind recent achievements of Artificial Neural Networks.

Would be possible to use it for EVA?



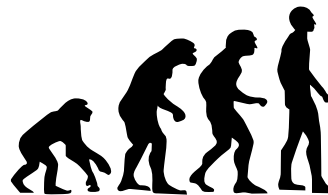
# FFEAT

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Framework for Evolutionary Algorithms in Torch

Implements

- Genetic Algorithms
- Real-Coded Evolutionary Algorithms
- Differential Evolution
- Particle Swarm Optimization

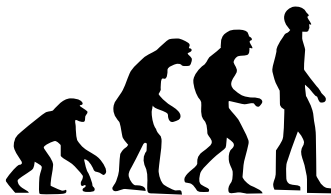


# Example

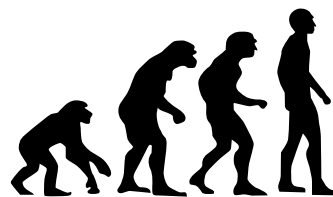
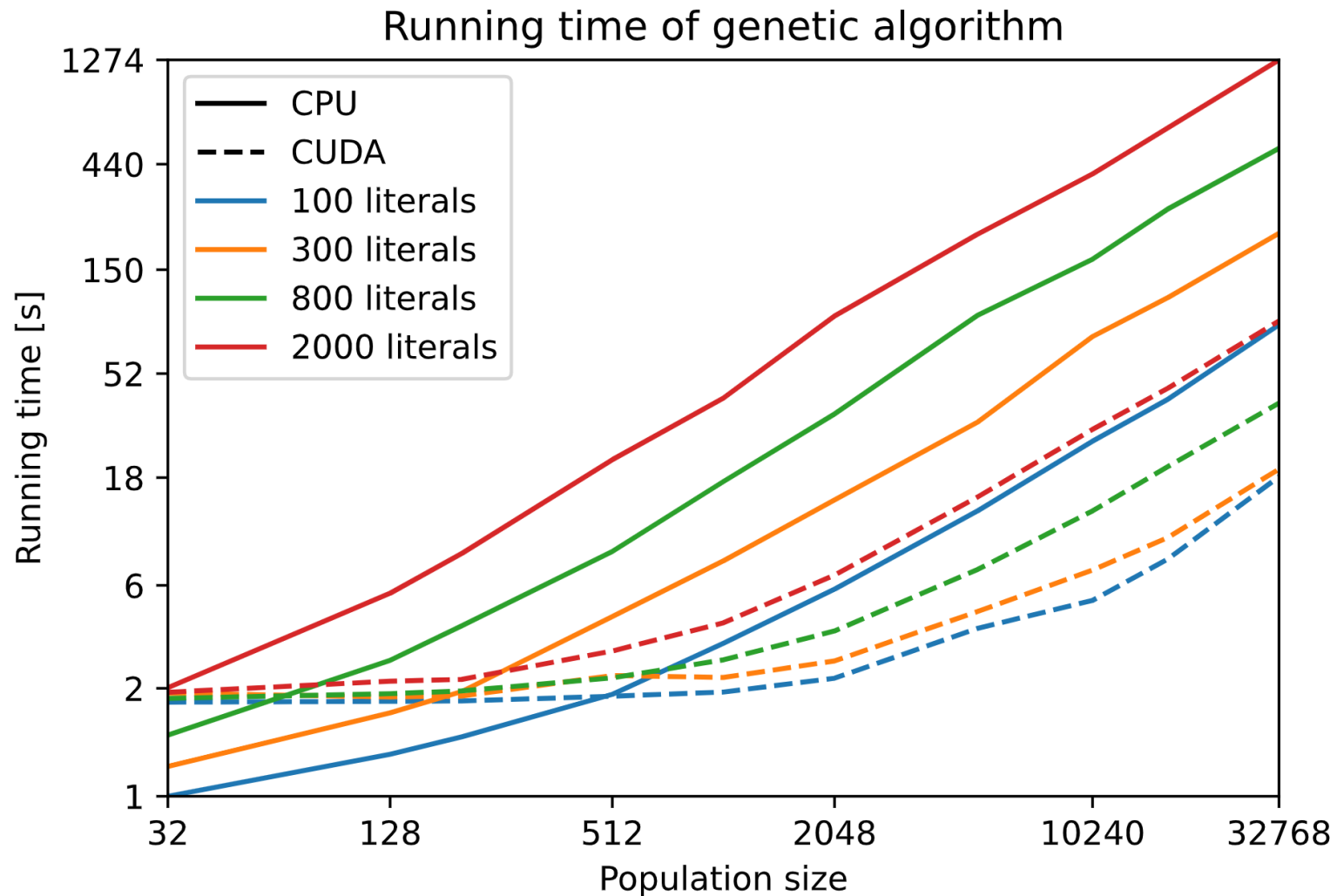
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```
problem = SATProblem.from_cnf_file("uf250-017.cnf")

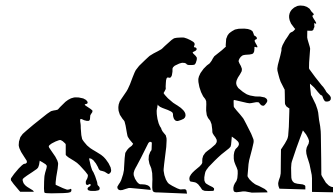
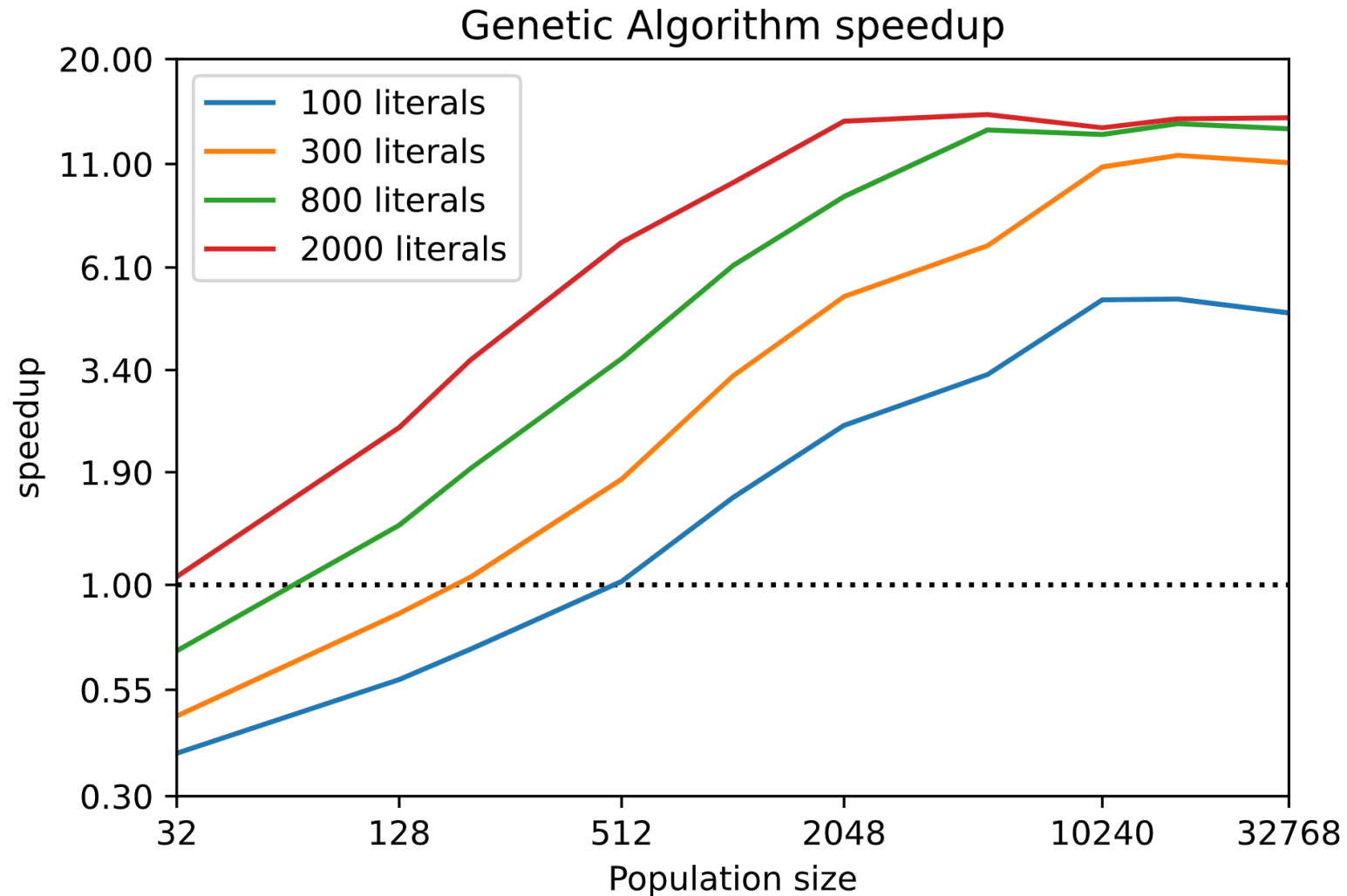
alg = GA.GeneticAlgorithm(
    GA.initialization.Uniform(100, problem.nvars),
    GA.evaluation.Evaluation(problem.fitness_count_unsatisfied),
    GA.selection.Tournament(100),
    GA.crossover.TwoPoint1D(0.6),
    GA.mutation.FlipBit(0.4, 0.001),
    iterations=500,
)
alg()
```



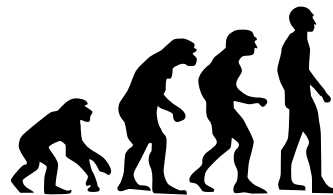
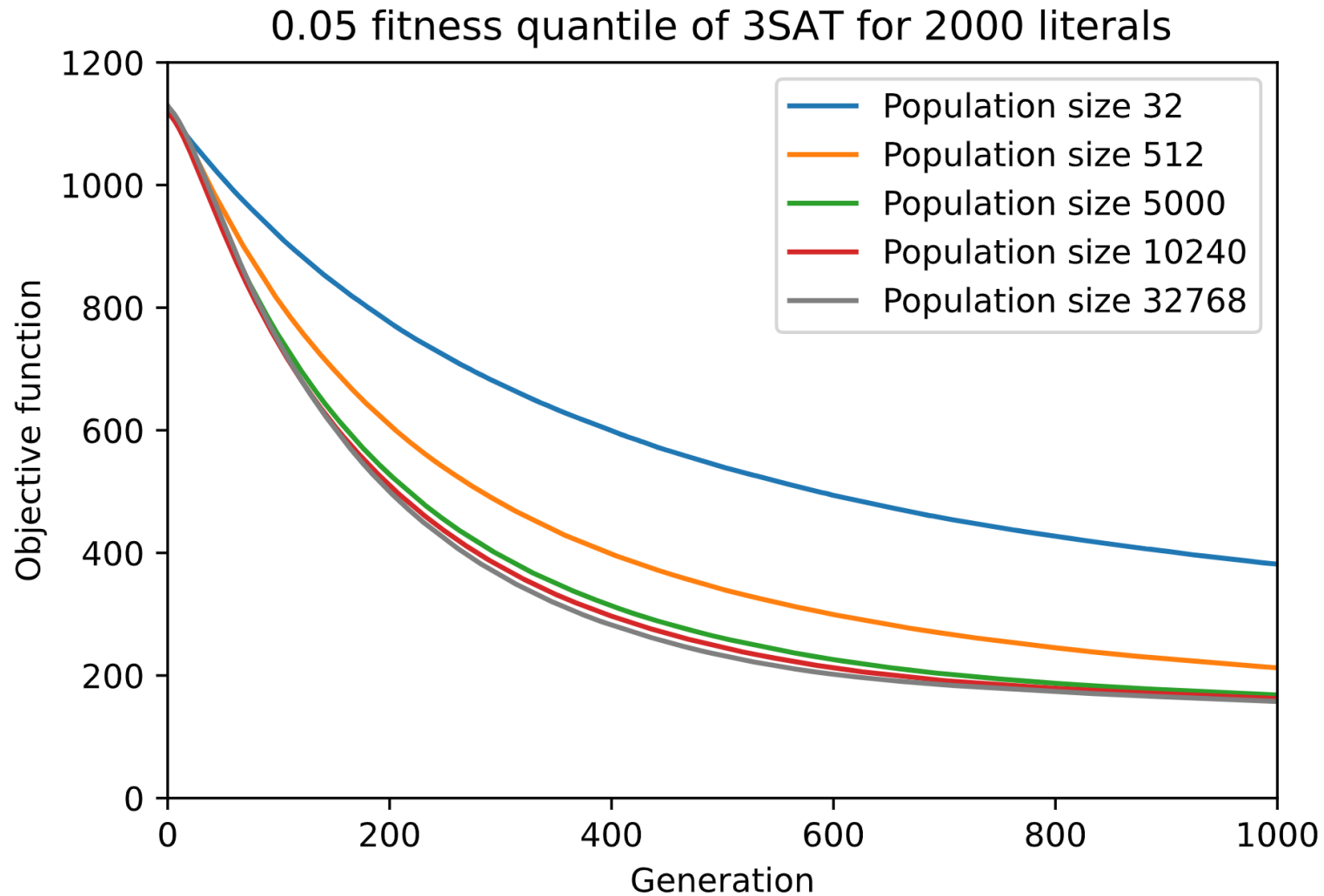
# Results for Genetic Algorithms



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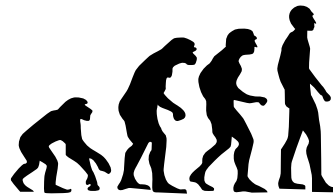
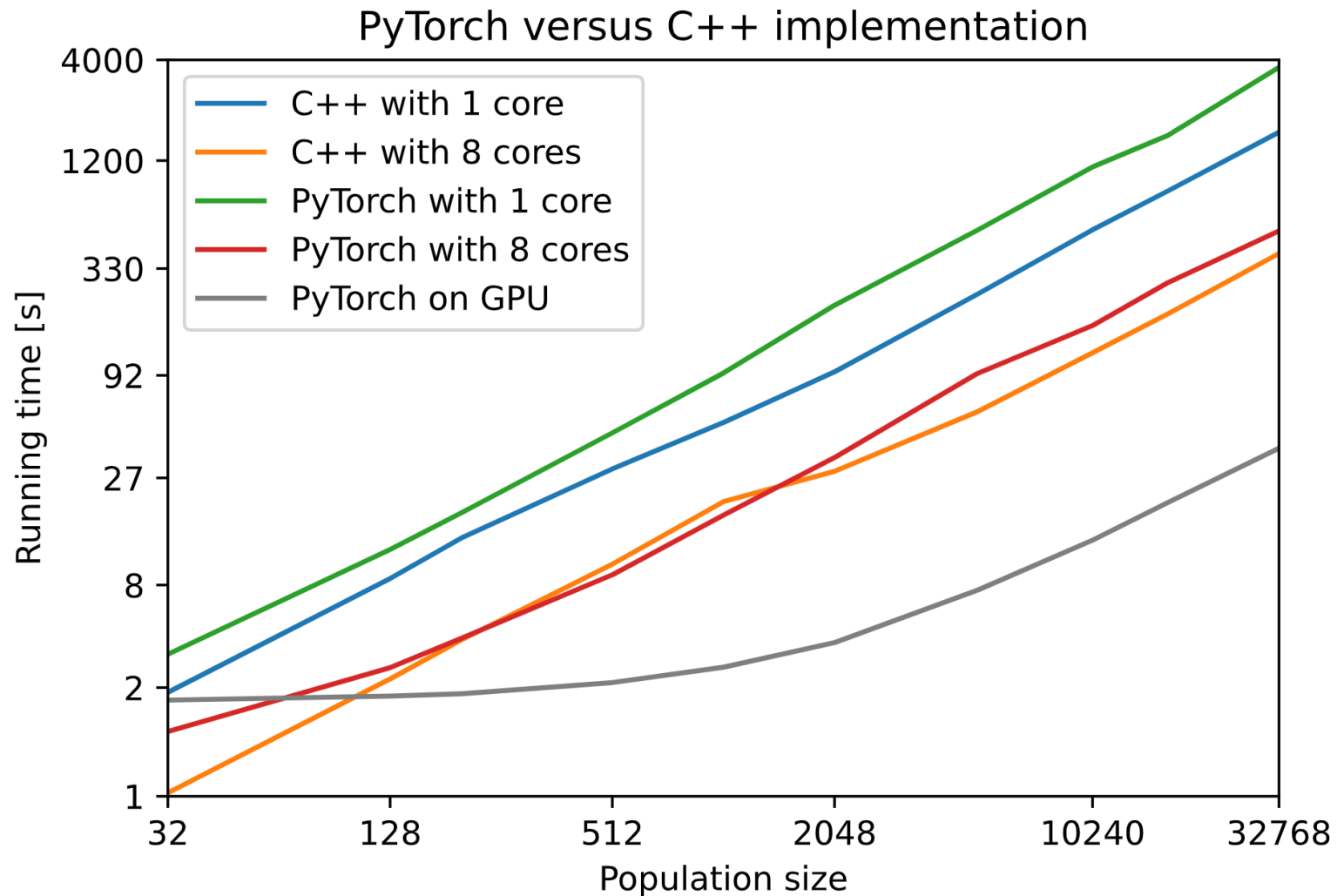


# Results for Genetic Algorithms

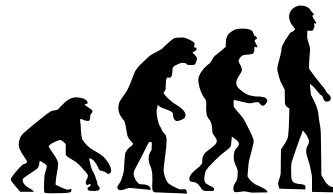
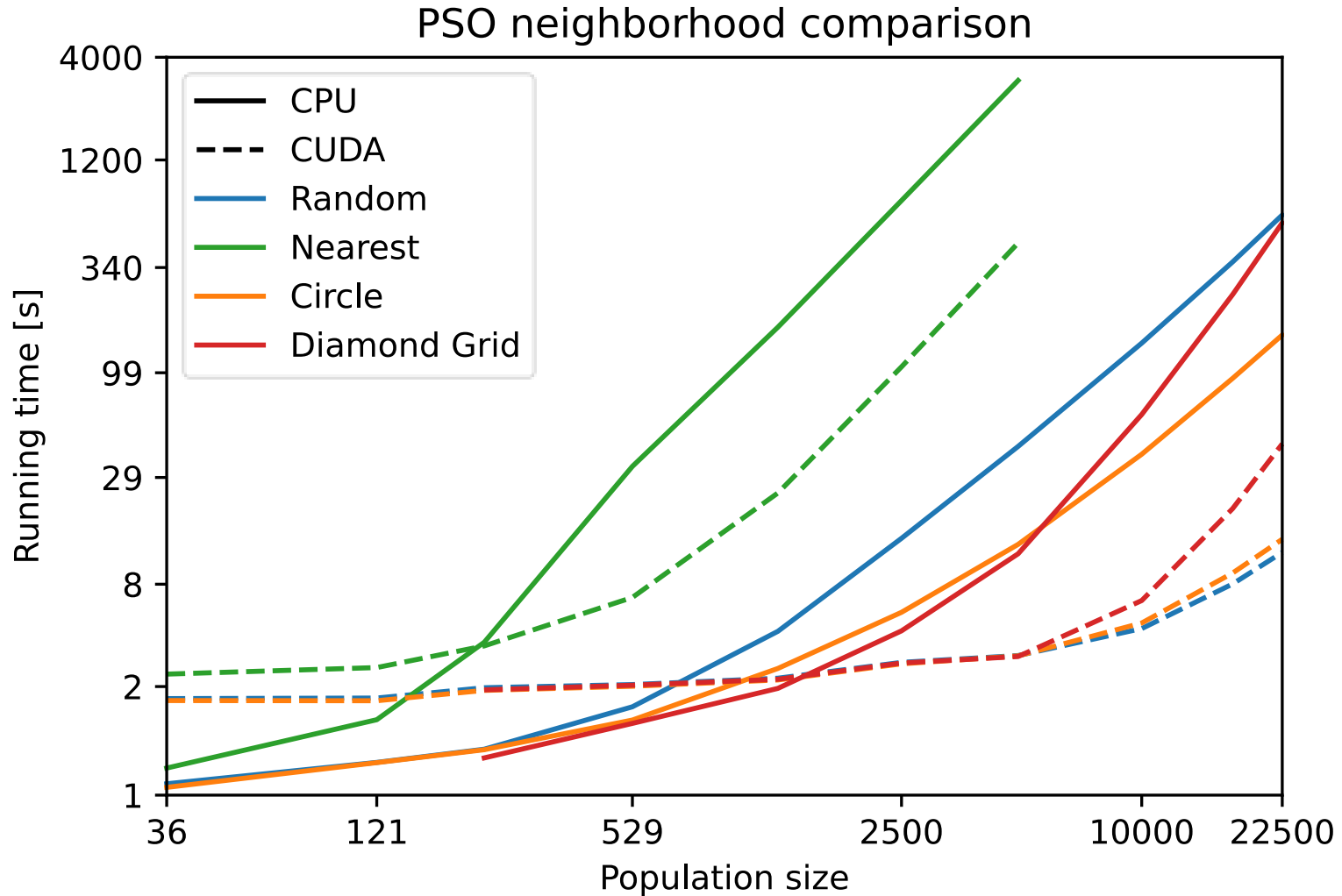




# Comparison to C



# Pairwise operation



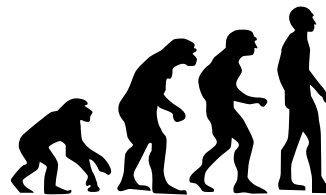
# Results

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Faster evolutions for medium and big-sized problems and populations.

Comparable to native C implementation with a little overhead of Python runtime.

I have shown that all the operations may be vectorized and run on the GPU without much knowledge of its internal mechanisms.



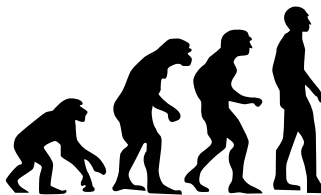
# My contribution

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Comprehensive overview of the field of evolutionary algorithms and their possible parallelization.

Design and implementation of the FFEAT library and its publication on the PyPI package manager.

Extensive testing showing superiority of the GPU implementation for big enough problems and populations.



# Thank you for your attention

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[github.com/PatrikValkovic/MasterThesis](https://github.com/PatrikValkovic/MasterThesis)

Patrik Valkovič

2021/06/22

Supervisor: Mgr. Martin Pilát, Ph.D.

Reviewer: Mgr. Roman Neruda, CSc.

