Population Diversity as a Selection Factor: Improving Fitness by Increasing Diversity

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Introduction

Preview

- What is diversity in a GA
- How we measure and use diversity in selection
- Experiments and results
- Conclusion

Diversity in a Genetic Algorithm

What is diversity?

- Diversity is a population measure
  - Guide the algorithm
  - Supports breadth of search
  - Avoid local optimum
- Distinctiveness is an individual's contribution
  - Influence individual selection
  - Global optimum is one best individual

Diversity in a Genetic Algorithm

Types of diversity

- Genetic diversity
  - Estimated Hamming distinctiveness
  - Close approximation of Hamming distance
  - Individual's distance from genetic mean
- Behavior or performance diversity
  - Phenotype distinctiveness
  - Weighted contribution to population's performance

Measuring and Using Diversity

Estimated Hamming distinctiveness

- Total of individual's distance from population's genetic mean
- Individuals receive their own distinctiveness value
- Order of n, the population size

$$D_i = \sum_{j=1}^{g} \left| I_{ij} - A_j \right|$$

Measuring and Using Diversity

Phenotype distinctiveness

- Weighted contribution to population's performance on training set
- Most difficult problems weighted most heavily
- Order of n, the population size

$$D_i = \sum_{j=1}^{t} \left(V_{ij} \times w_j \right)$$

Using distinctiveness in selection

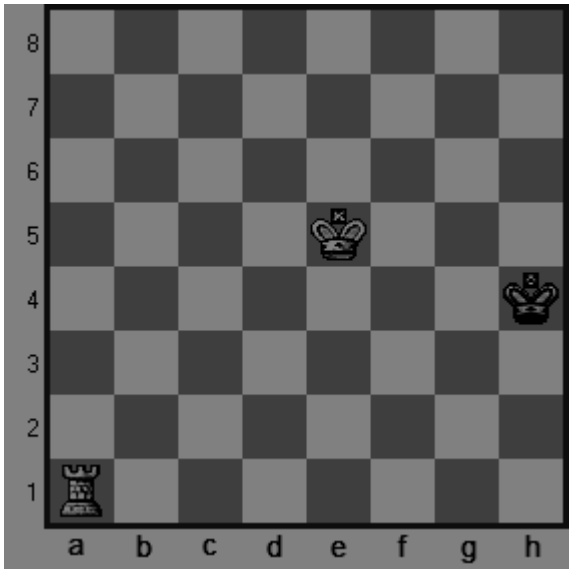
- Combine distinctiveness with accuracy to create fitness
- Weight value between 0 and 1 emphasizes accuracy or diversity
- Fitness value used for selection

$$F_i = \left(w \times D_i \right) + \left(\left(1 - w \right) \times A_i \right)$$

Experiments and Results

King-Rook-King chess endgame

- Domain includes 28,056 problems
  - Rank & file of three chess pieces: white-white-black
  - Number of moves to checkmate, draw to sixteen
- Example: e,5,a,1,h,4,three



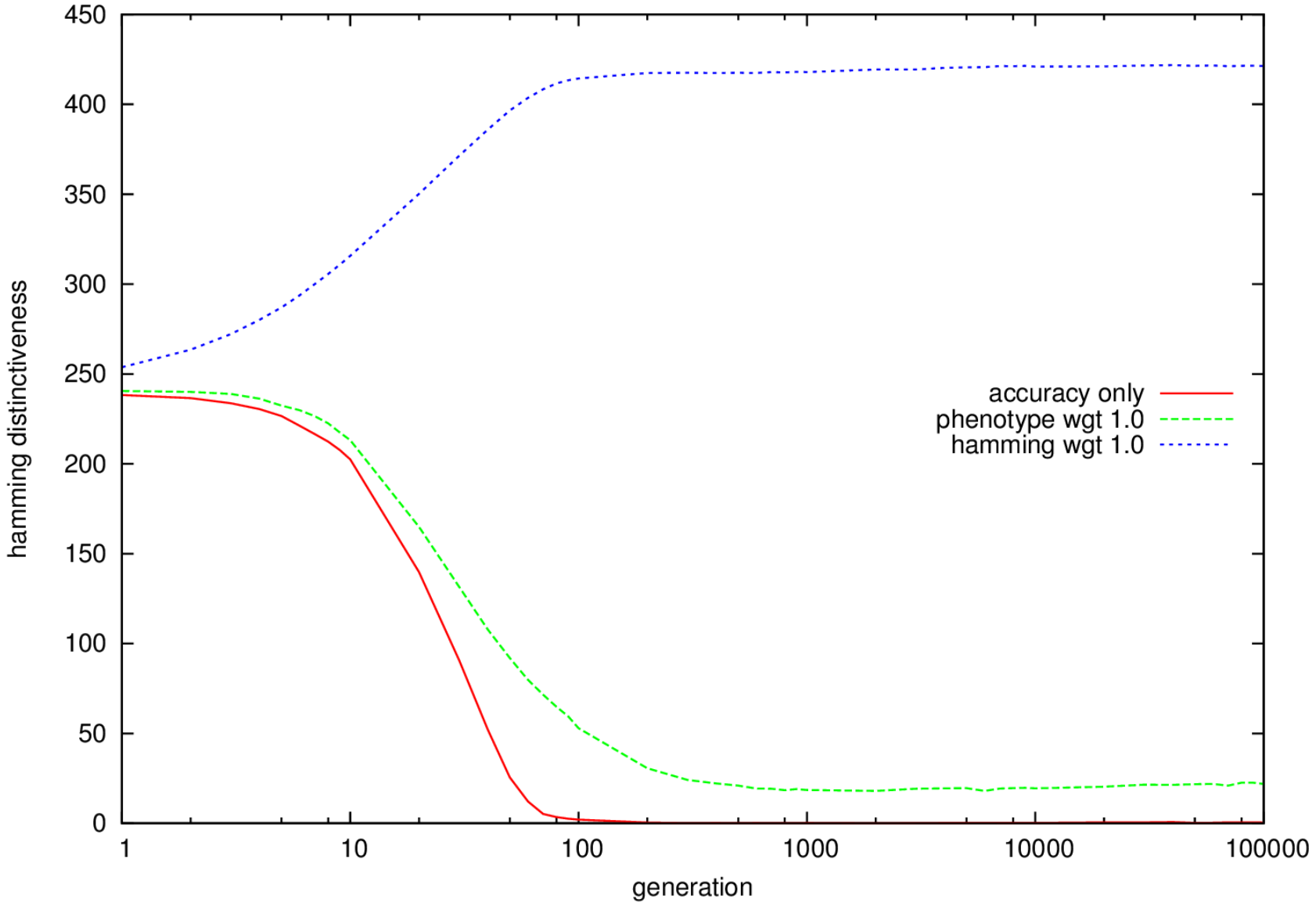
Experiments and Results

Algorithm setup

- 1,000 problems in training set
- Tournament size of five
- 400 individuals in population
- 100,000 generations
- 20% chance of survival
- Distinctiveness weight varies from 0.0 to 1.0
- Results from average of nine simulations

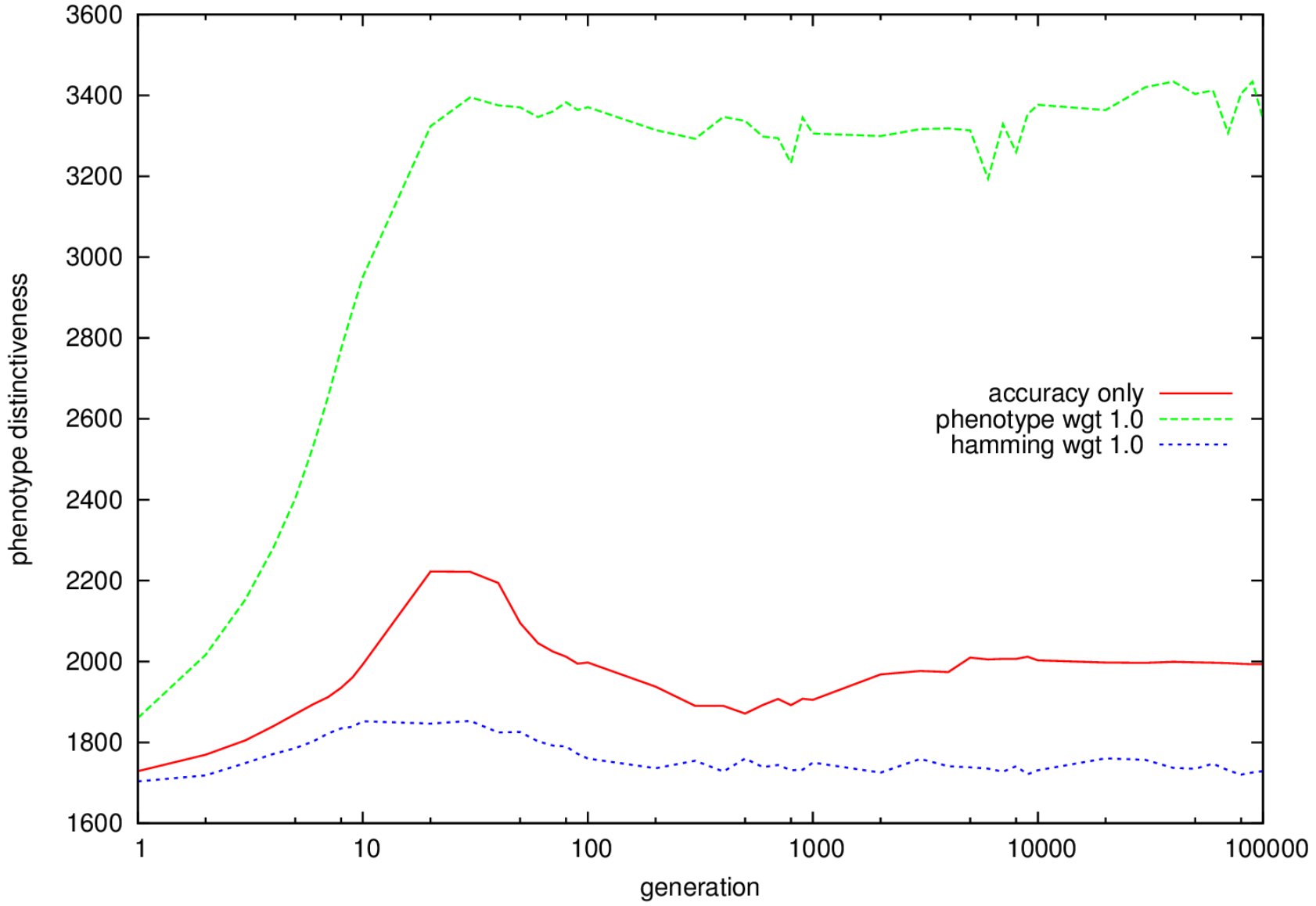
Experiments and Results

Estimated hamming distinctiveness



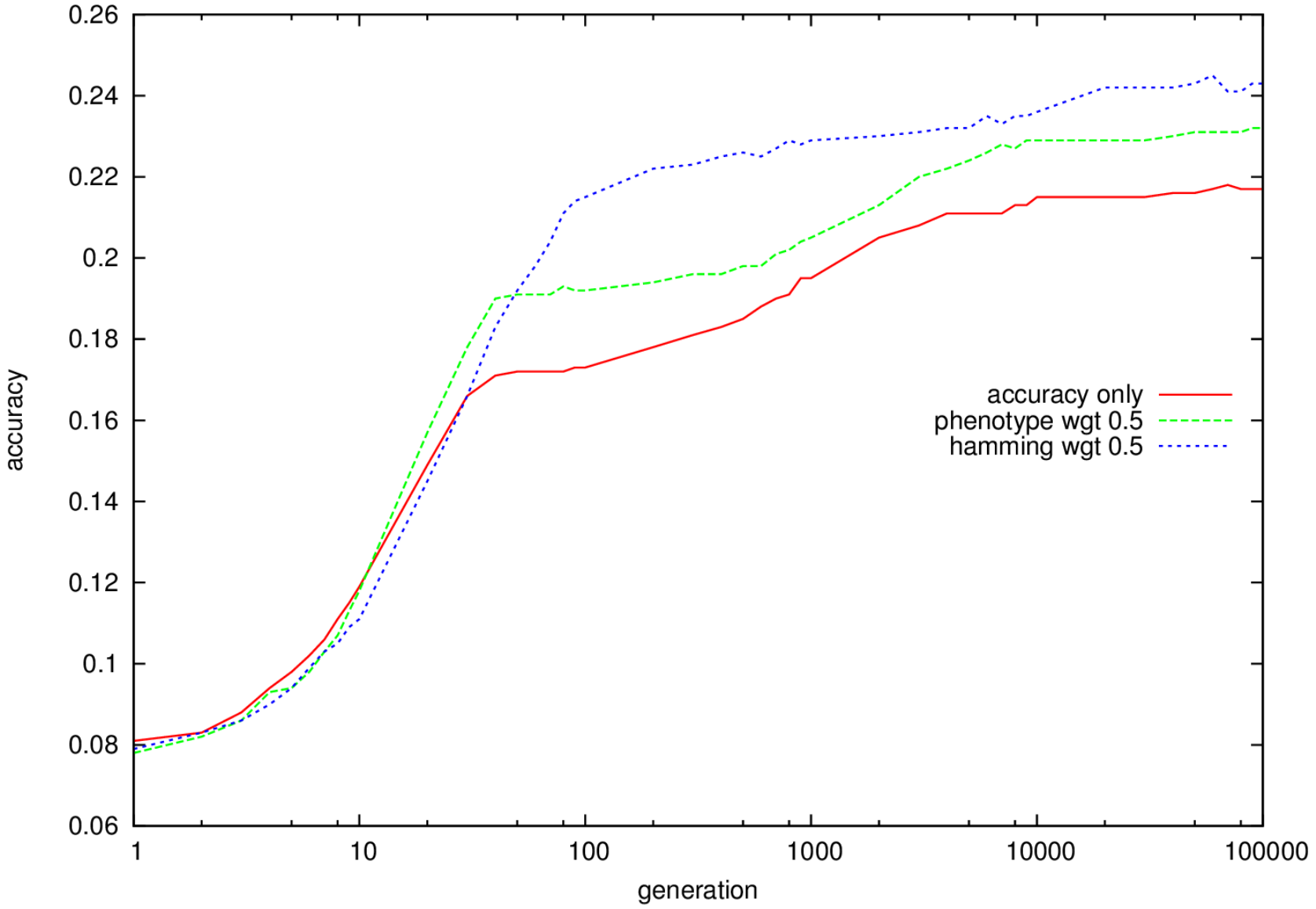
Experiments and Results

Phenotype distinctiveness



Experiments and Results

Accuracy on full test set



Conclusion

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