Optimizing a Model for Siting Offshore Wind Farms using a Genetic Algorithm

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Background

- Generating electricity using offshore wind farms can assist coastal regions to meet growing electricity demands supported by a renewable source [4].
- However modeling wind farm siting must account for the interactions between wind farm sites in terms of economic value and cumulative environmental impacts [4].
- Genetic Algorithms have been used for numerous state of the art modeling for individual wind turbine placement, in which this research attempts to recreate the algorithm for Wind farm placements as a portfolio.

Goals and Objective

- Apply a Genetic Algorithm to the existing model to analyze the optimal or near optimal solutions, wind farm layout arrangement, and overall performance.
- Compare the Genetic Algorithm to a mixed integer linear program created to facilitate a quantitative understanding of the trade-offs between the objectives by comparing the optimal arrangement of wind farms.
- The network flow model captures the nonlinear interdependency between the power output and wind speed. Ensuring that the flow into each node equals the flow out of the node.

A Genetic Algorithm is a heuristic search and optimization technique developed by John Holland in which search algorithms are based on the mechanics of the Darwinian theory natural selection and natural genetics [2]. The algorithm must use a different fundamental approach to solving the problem as opposed to other optimization and search techniques [1].

- Genetic Algorithms are Blind.
- Genetic Algorithms search from a population and not a single point.
- Genetic Algorithms use randomized operators and not deterministic rules.

A Genetic Algorithm that yields good results in many applications compose of three significant operators [1].

- Reproduction- Individuals contribute to a gene pool in proportion to their relative fitness (evaluate of the function being optimized).
- Objective function - \( \max \{P(x) | \sum_{i=1}^{N} C_{i} x_{i} \} \)
- Crossover- Two parents at random from the gene pool as well as a crossover point within the binary encoding. The parents exchange tails, that is the portion of the string to the right of the crossover point to generate two new offspring’s.
- Mutation- Bit alteration of a string’s position with a low probability. Mutation is used to preserve the population density.

Results

![Image](image-url)

Future Work

- Further analysis of the results to check statistical trends in the variation of all parameters.
- Implementing the concept of Multi-objective optimization using the Genetic algorithm.
- Multi-objective optimization allows the approach to investigate a set of solutions known as a Pareto set, using multi criteria to optimize the profit values, tradeoffs, and outcomes.

References /Acknowledgments

[1] D.E. Goldberg

Genetic Algorithms for Modelling and Optimization


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