0.1 Introduction

0.1.1 Background and Motivation

Transitioning from non-renewable energy sources to renewable energy sources is one of the largest, if not the larges political challenge of today. Renewable energy is less polluting that non-renewable energy and should therefore be preferred. However, renewable energy sources make up only 17.05 percent of the worlds energy sources as of 26th of May 2015 (renewableenergyworld.com).

Wind turbine technology is a promising source of renewable energy. Wind turbine technology advances has led to wind turbines able to produce more energy to lower costs. However, wind turbines still produces less energy than predicted because of the wake effect. For wind energy to become a bigger player in the worlds energy sources, sophisticated methods for wind turbine placement in wind farms needs to be developed so that each turbine produces as much energy as possible.

Wind turbine positioning is hard to optimize analytically. Fortunately, use of genetic algorithms shows promising results. As more sophisticated approaches to evaluate layouts are developed, and more realistic constrains are introduced, more sophisticated genetic algorithms are required.

To come up with more sophisticated genetic algorithms for solving the wind farm layout optimization problem, the annual Genetic and Evolutionary Computation Conference (GECCO), launched a competition where different contestants provide their own implementation of a genetic algorithm. The goal of the competition is to bring more realistic problems to algorithm developers, and to create an open source library useful beyond the scope of the competition (http://www.irit.fr/wind-competition/).

Wind parameters and evaluation mechanism are provided by GECCO, therefore the goal of this project will be to optimize the genetic algorithm for solving the problem not wind farm parameters and models. However, some knowledge of wind turbines, wind farm layout and wake models are useful in understanding the project and is therefore introduced in the background section.

0.1.2 Goal and Research Questions

This section states the goal statement and research questions that will be investigated in this thesis.

Goal statement

> *The project goal is to investigate the advantages of using distributed genetic algorithms to optimizing wind farm layout, i.e. solving the wind farm layout optimization problem.*

The performance of distributed genetic algorithms will be studied and compared to the performance of a simple genetic algorithm (not distributed) as well as to each other, with the goal of answering the research questions stated below.

Research question 1

> *Can distributed genetic algorithms improve the quality of the solution to the wind farm layout optimization problem as compared to simple genetic algorithm.*

Research question 2

> *Which distributed genetic algorithm works best for the wind farm layout optimization problem? What properties are essential for its success?*