Chapter 1

Introduction

1.1 Background

Scheduling is a necessary process for complex and distributed systems such as manufacturing, transportation, and networks systems. Scheduling is a decision-making process that deals with the allocation of resources to tasks over given time periods and its goal is to optimize one or more objectives. In research, many different approaches and techniques have been developed to solve the scheduling problems. The job-shop scheduling (JSSP) is one of the challenging scheduling problems. The JSSP has been addressed in many research papers along with many proposed approaches to tackle it. In this thesis, the standard JSSP to find a schedule with a minimum makespan is considered. A makespan is the maximum completion time of all the jobs in the shop. Obtaining the schedule with minimum makespan for the JSSP is not easy since the JSSP is NP-Hard problem. The meta-heuristic approaches are the most recent approaches that have been applied to solve the JSSP. This research work focus on the
population-based meta-heuristic approaches; i.e. the genetic algorithm (GA), the particle swarm optimization (PSO), and the ant colony optimization (ACO) to solve the JSSP. The research work also considers the powerful features of the multi-agent system (MAS) to be incorporated with the meta-heuristic approaches for developing models that are capable to tackle the JSSP. Nowadays, the MAS is one of the most attractive technologies that has been applied to diverse research domains.

1.2 Research objectives

The main goal of the research work is to develop a model using a multi-agent system to solve the Job-shop scheduling problem. Three population-based meta-heuristic approaches (GA, PSO, and ACO) have been chosen since they are suitable for the MAS structure where each solution of the population is carried by one agent. The agent cooperates with other agents in multi-agent environment to improve its JSSP solution. In order to meet the goal, a number of objectives are addressed as follows:

- Developing a MAS model that utilizes the genetic algorithm, testing its performance on some JSSP benchmark instances, comparing it with other related research work.

- Developing a MAS model that utilizes the particle swarm optimization, testing its performance on some JSSP benchmark instances, comparing it with other related research work.

- Developing a MAS model that utilizes the ant colony optimization, testing its performance on some JSSP benchmark instances, comparing it with other related research work.
Comparing the proposed models for the JSSP and recommending the best.

1.3 Thesis Structure

Chapter 2 describes the scheduling problems and the job-shop scheduling problem (JSSP). The JSSP is one of the most encounter scheduling problems in research. Some of the optimization approaches for the JSSP are classified and some of JSSP benchmark problems from OR Library and research papers have been listed with their references. The concepts of the agent and the multi-agent system (MAS) are featured in Chapter 3. The agent oriented programming (AOP) as new paradigm in software engineering has been compared with the object oriented programming (OOP). Some of the MAS tools are: JACK, JADE, ZEUS, SWARM, and REPAST. Some of the domain areas of the MAS have been enumerated in Chapter 3. Chapter 4 explains the genetic algorithm (GA) and presents the proposed Multi-Agent based Genetic Algorithm (MAGA) to solve the JSSP. The proposed MAGA is implemented on the REPAST toolkit. The results obtained from the proposed MAGA have been compared with another related model. Chapter 5 explains the standard PSO algorithm and the proposed Multi-agent based Particle Swarm Optimization (MAPSO). The proposed MAPSO has been implemented on the REPAST toolkit. The results of MAPSO have been compared with other related research work. The ant colony optimization (ACO) algorithm and its variants (ant system, elitist ant system, Rank-based ant system, max-min ant system, ant colony system) are presented in Chapter 6. Chapter 6 also presents the proposed ant colony system with Local Search (ACSLs) to solve the JSSP. The
ACSLs has been implemented in the REPAST toolkit. The results of the ACSLS have been compared with the results of other related models from a research paper. Chapter 7 compares the performance of the three proposed models (the MAGA, the MAPSO, and the ACSLS) on the set of the JSSP benchmark instances. Conclusions based on the positive points and limitations of the research work are highlighted in Chapter 7. Also, directions to the future work are mentioned at the end of Chapter 7.