PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC

MOHAMED BOUDIAF UNIVERSITY - M'SILA
FACULTY OF MATHEMATICS AND COMPUTER SCIENCE

DEPARTEMENT OF COMPUTER SCIENCE

End of studies DISSERTATION

Presented to obtain the MASTER'S Degree

Domain: Mathematics and Computer Science

Branch: Computer Science

Specialty: Advanced Information Systems

By: ZEMMIT Rebiha

SUBJECT

Optimization of container movements in a terminal container

Publicly supported on: / /2016 in front of the jury composed of:

………………………………	University of M'sila	President
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Promotion: 2015 /2016

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GENERAL INTRODUCTION

Transportation via sea is an age old and cost effective mode and forms a symbiotic relationship with land and air transport. Port management is the process of loading and unloading containers from ships (vessels) thus forming an essential link in the supply chain network of any and all (almost) businesses.

1 Problematic:

Ports are essential simply due to the fact that very expensive and specialized equipment are needed to handle the containers in a ship.

Because of fact are very expensive, transport via sea is very important time is the most important thing in the port, for this to minimize time is the best goal in the port. Now the question posed is: how to move container from court to ship in a minimum time? Which is our problematic in this dissertation.

For answer to our problematic there some questions must be posed also which are the subset problems for our problematic:

1- What’s the total time to move containers?
2- What’s the list of container must be moved?
3- Which quay used to move containers?
4- How organize container to minimize time?
5- Which algorithm must use to solve this problem?

We can resume our problematic in: How develop a method or an algorithm capable to model, simulate, solve, optimize and minimize the time of movement container process?

2 Objective of study and methodology:

We can distinguish tow problems to solve for reach our objective, the first is which list of container existing in the court of port must be moved help to get the decision, whether the second is to minimize the time of container movement from court to ship.

Thereby, we chose the movement container process as a terrain for application which seems to see one of the famous optimization algorithms which is the genetic algorithm, this last may be the effective algorithm to solve one of the problems of port (problem of minimization time of container movement).

The methodology use to win our goal is as follow ; in first time a presentation of the port problem and its characters and a selection for the objectives and constraint of the problem , then in analyze of the problem which allow to relief the port problem compared of other problems in the same domain. Especially those included in the container movement problem therefore it is possible to relate the problem by minimization time of container movement. A lot of studies has been do in this domain since 1977 to now days which permit to formulate the problem in a deferent forms ; as the problem of established of number of ISO containers affected by a full containership from several ports of departure to several ports of destination at the minimum distance or at minimum costs [21] , the problem of dynamic deployment of the portals of court [22], optimization of the space of storage available to handle departures and arrived containers in a maritime port[23], the problem of optimization of movement of containers in the case of exportation[14], the problem of storage of containers [24] … etc. According to this studies it be possible to find an interesting link to develop a suitable approach to solve the particular problem of the port.

In order to give back the more realistic resolution approach, incorporating specific constraints problem of container movement, has been the most important problem. So its necessaire to develop an approach for the resolution of the problem. This includes the construction of a genetic algorithm appropriate, and a software implement the proposed algorithm by using NetBeans 8.1 and the DB4O data base, finally a test of the proposed software.

3 Structure of document:

Our dissertation divided on three important parts, general introduction, general conclusion and three annexes.

So our document is structured as flow:

- General introduction:

In this part we define our problematic and the aim of study and the methodology used to solve the problematic, also the structure of document.

- Chapter1: generality on port traffic and state of the art review.

In this chapter we give a general idea about the port (definition of the important notion) where the goal is to make readers not familiar with the domain of port in it, then we study the state of review where the goal is to see what others do and select what we can do.

- Chapter 2: mathematical formulation and the proposed algorithm.

This chapter divided on three parts; in the first part we present the problem and the mathematical model its assumptions and its constraints. In the second part of this chapter we give a general idea for the algorithm used (genetic algorithm) and why we use it. In the last part the proposed genetic algorithm used to solve the problem of movement of container is existing.

- Chapter 3: Presentation of software and test of result.

In the beginning of this chapter we present Computer tool used in the programing of the software proposed: NetBeans 8.1 and the data base DB4O after that a presentation of the software proposed and an example solve (concerned SKIKDA port) finally discussion of results.

- General conclusion and future perspectives:

In this part we answer in the problematic posed in the general introduction by given our personal contribution and present some future perspective for person how want to continuous in this domain of problems.

- Annexes:

According to the continent of this dissertation we give four annexes which help to more understanding the problem posed and the method of resolution.

Annex A: Optimization methods.

Annex B: DB4O data base.

Annex C: SKIKDA port.

Annex D: Examples and result of GA execution.

CHAPTER 1
GENERALITY ON THE PORTIERE TRAFFIC AND STATE OF THE ART REVIEW

Summary of chapter:

In the first part of this chapter we present some definitions and we present the useful concepts related to the port problem; to help the understanding of the rest of this document for the readers not familiar with the world of port then we present the CNAN and its role. In the second part we described the previous studies which can help us to determine what we must do in our study, so a presentation of works related to the port problem and existing used methods.

1Generality

1.1 Port: definition and role:

1.1.1 Definition of port:

Ports play multiple roles in the maritime industry and they are a part of big and complex network. Ports are an interfaces between the sea and the land transport. For this, there are a lot of definitions for the port, the most important definitions are:

- Definition 1: A place where ships may ride secure from storms. [22]
- Definition 2: A harbor town or city where ships may take on or discharge cargo. [22]
- Definition 3: This term is used both for the harbor area where ships are docked and for the agency (port authority), which administers use of public wharves and port properties. [17]

1.1.2 Role of port:

According to definitions of port we can see an overview on the fundamental role of a port. So it is important to understand the role of a port, Nowadays ports have a lot of function which we can resume generally in for points:

- A port is a key business in cities economy. It provides the link between sea transportation and land freight.
- A port provides storage areas on land, sheds, wharfs, piers, ship channels and arrangements for ships to dock. It has the correct equipment for ships to load and unload their cargoes safely.
- Provides fast connectivity in order to transport the products to its consignees we handle the inventory and our job is to move the goods out, resulting in quicker turnaround time.
- A port ensure the passage of a marine mode of transportation to a mode of ground transportation.
- Port reflect national heritage, local commercial attitudes, practices, and laws that differ widely between nations.

1.2 Container and terminal container definition and role:

1.2.1 Definition of container:

- Definition 1: A large box that goods are placed in so that they can be moved from one place to another on a ship, airplane, train, or truck [22]. A portable compartment in which freight is placed (as on a train or ship) for convenience of movement [22]
- Definition 2: Steel or aluminum frame forming a box in which cargo can be stowed meeting International Standard Organization (ISO)-specified measurements, fitted with special castings on the corners for securing to lifting equipment, vessels, chassis, rail cars, or stacking on other containers. Containers come in many forms and types, including: ventilated, insulated, refrigerated, flat rack, vehicle rack, open top, bulk liquid, dry bulk, or other special configurations. Typical containers may be 10 feet, 20 feet, 30 feet, 40 feet, 45 feet, 48 feet, or 53 feet in length, 8 feet or 8.5 feet in width, and 8.5 feet or 9.5 feet in height. [1]

1.2.2 Container numbering:

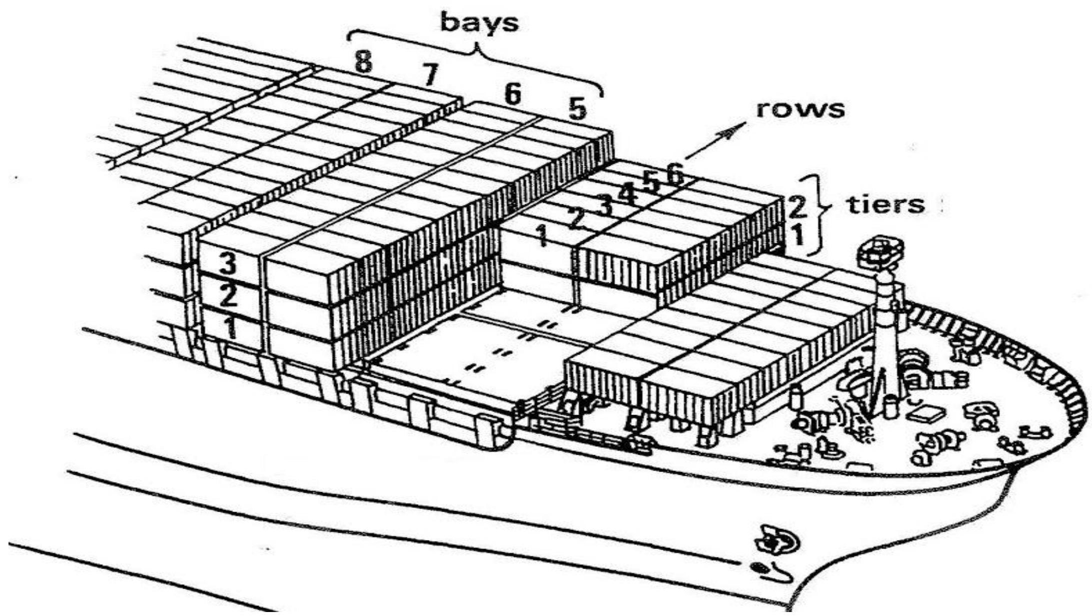


Figure1.1 Container numbering [20]

- **Bay:** Each container vessel is split into compartments which are termed as Bay and depending on the size of the ship it will proceed from 01 to 40 (for example) where Bay 01 is the bay towards the Bow (the front) of the ship and Bay 40 is the Stern (the back) of the ship. Odd numbered bays (1, 3, 5 etc.) means that it is a 20' stow and Even numbered bay (2, 4, 6 etc.) means that it is a 40' stow.[21]

- **Row**: A row is the position where the container is placed across the width of the ship. It starts with 01 in the center and progresses outwards with odd numbers on the right and even numbers on the left.[21]
- **Tier:** Denotes at which level the container is placed – basically how high the container is stacked on board. [21]

1 .2 .3 Type and property of container:

According to the type of products be shipped or served containers have a lot of sheeps with deferent dimensions, structure, materials… so the most common types of containers are:

- Dry storage container: The most commonly used shipping containers; they come in various dimensions standardized by ISO. They are used for shipping of dry materials and come in size of 20ft, 40 ft and 10ft.

- Flat rack container: With collapsible sides, these are like simple storage shipping containers where the sides can be folded so as to make a flat rack for shipping of wide variety of goods.

- Open top container: With a convertible top that can be completely removed to make an open top so that materials of any height can be shipped easily.

- Tunnel container: Container storage units provided with doors on both ends of the container, they are extremely helpful in quick loading and unloading of materials.

- Open side storage container: These storage units are provided with doors that can change into completely open sides providing a much wider room for loading of materials.

- Double doors container: They are kind of storage units that are provided with double doors, making a wider room for loading and unloading of materials. Construction materials include steel, iron etc in standardized sizes of 20ft and 40ft.

- Refrigerated ISO containers: These are temperature regulated shipping containers that always have a carefully controlled low temperature. They are exclusively used for shipment of perishable substances like fruits and vegetables over long distances.

- Insulated or thermal containers: These are the shipping storage containers that come with a regulated temperature control allowing them to maintain a higher temperature.

- Tanks: Container storage units used mostly for transportation of liquid materials, they are used by a huge proportion of entire shipping industry. They are mostly made of strong steel or other anti-corrosive materials providing them with long life and protection to the materials.

- Cargo storage roll container: A foldable container, this is one of the specialized container units made for purpose of transporting sets or stacks of materials. They are made of thick and strong wire mesh along with rollers that allows their easy movement. Availability in a range of colored wire meshes make these shipping container units a little more cheerful.

- Half height containers: Another kind of shipping containers includes half height containers. Made mostly of steel, these containers are half the height of full sized containers.

- Car carriers: Car carriers are container storage units made especially for shipment of cars over long distances. They come with collapsible sides that help a car fit snugly inside the containers without the risk of being damaged or moving from the spot.

- Intermediate bulk shift containers: These are specialized storage shipping containers made solely for the purpose of intermediate shipping of goods. They are designed to handle large amounts of materials and made for purpose of shipping materials to a destination where they can be further packed and sent off to final spot.

- Drums: As the name suggests, circular shipping containers, made from a choice of materials like steel, light weight metals, fiber, hard plastic etc. they are most suitable for bulk transport of liquid materials. They are smaller in size but due to their shape, may need extra space.

- Special purpose containers: Not the ordinary containers, these are the container units, custom made for specialized purposes. Mostly, they are used for high profile services like shipment of weapons and arson. As such, their construction and material composition depends on the special purpose they need to cater to. But in most cases, security remains the top priority.

- Swap bodies: They are a special kind of containers used mostly in Europe. Not made according to the ISO standards, they are not standardized shipping container units but extremely useful all the same. They are provided with a strong bottom and a convertible top making them suitable for shipping of many types of products. [21]

Figure1.2some type of container

1.2.2 Terminal container:

- Definition 1: A container terminal is a facility where large cargo containers are loaded or unloaded from ships to land vehicles, for further transport. The landside transportation at these facilities is usually trains or trucks. These tend to be individual parts of a larger port, and situated near either a river or a harbor. [25]

- Definition2: An area designated for the handling, storage, and possibly loading or unloading of cargo into or out of containers, and where containers can be picked up, dropped off, maintained, stored, or loaded or unloaded from one mode of transport to another (that is, vessel, truck, barge, or rail). [1]

Figure1.3 Terminal container

1.2.2 Role of terminal container:

Every maritime terminal performs four basic functions: receiving, storage, staging, and loading for both import (entering the terminal by sea and usually leaving by land modes) and export (usually entering the terminal by land and leaving by sea modes) containers.

- Receiving involves container arrival at the terminal, either as an import or export, recording its arrival, retrieving relevant logistics data and adding it to the current inventory.

- Storage is the function of placing the container in a known and recorded location so it may be retrieved when it is needed.

- Staging is the function of preparing a container to leave the terminal. In other words the containers that are to be exported are identified and organized so as to optimize the loading process. Import containers follow similar processes, although staging is not always performed. An exception is a group of containers leaving the terminal via rail.

- Finally, the loading function involves placing the correct container on the ship, truck, or other mode of transportation. In this work the emphasis will be put on internal logistics chain of container terminal (i.e. vessel-truck-yard and opposite direction respectively).

1.2.3 Structure of terminal container:

Generally, the terminal container can be described as a systems where operations of loading and unloading containers are existing. This system divided in three parts (loading area of trains and trucks, storage yard, area mooring vessels); a simple representation of a container terminal is given in the figure 1.4.

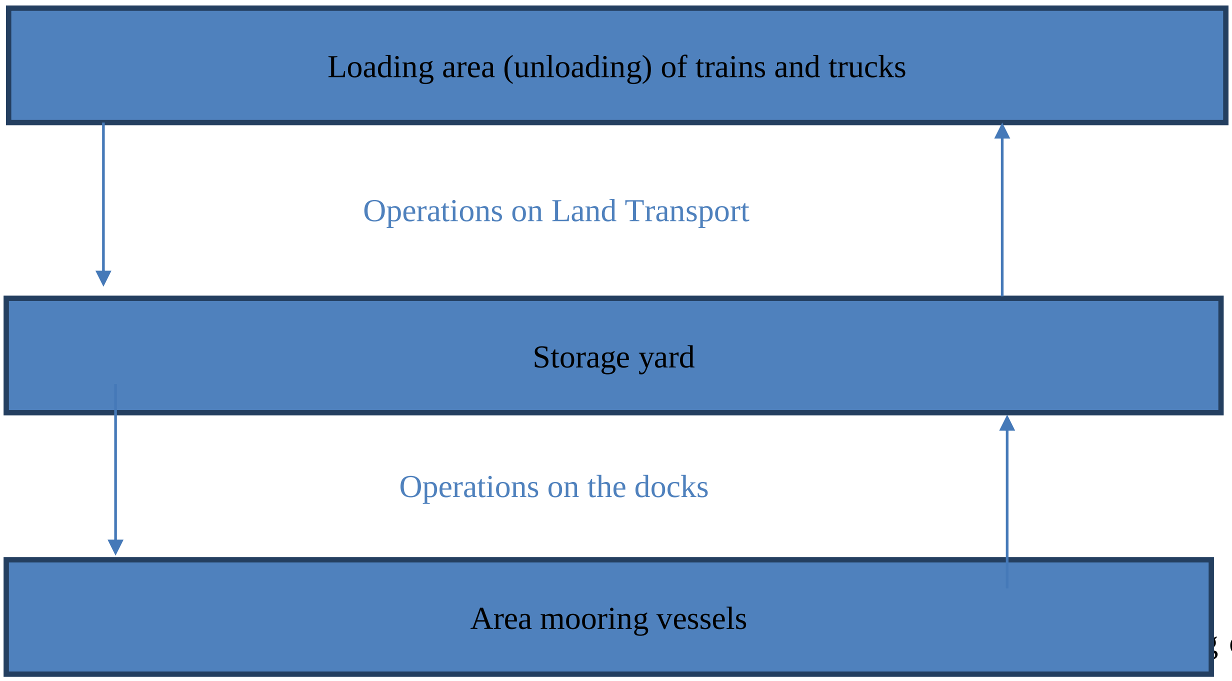


Figure1.4 Structure of terminal container

of ships. The first type of equipment used. [9]

- Storage yard: they are a key factor in the organization of terminals even the quality of port service. [9]

- Area mooring vessels: plays a key role in the port service. The service port hinterlands mainly based on rail and road transport containers. [9]

1.3 Container Ships:

1.3.1 Definition:

A ship specially constructed and equipped to carry only containers without associated equipment, in all available cargo spaces, either below or above deck. Containerships are usually non-self-staining, do not have built-in capability to loader off-load containers, and require port crane service. A containership with shipboard-installed cranes capable of loading containers without assistance of port crane service is considered self-sustaining. [27]

Figure1.5 A container ship

1.3.2 General structure of a container ship:

1. Bridge castle front.	4. Forecastle.	7. Double hull.
2. Deck containers.	5. Insulated containers in holds.	8. Passageway.
3. Foremast and mast top.	6. Container refrigeration ducts.	

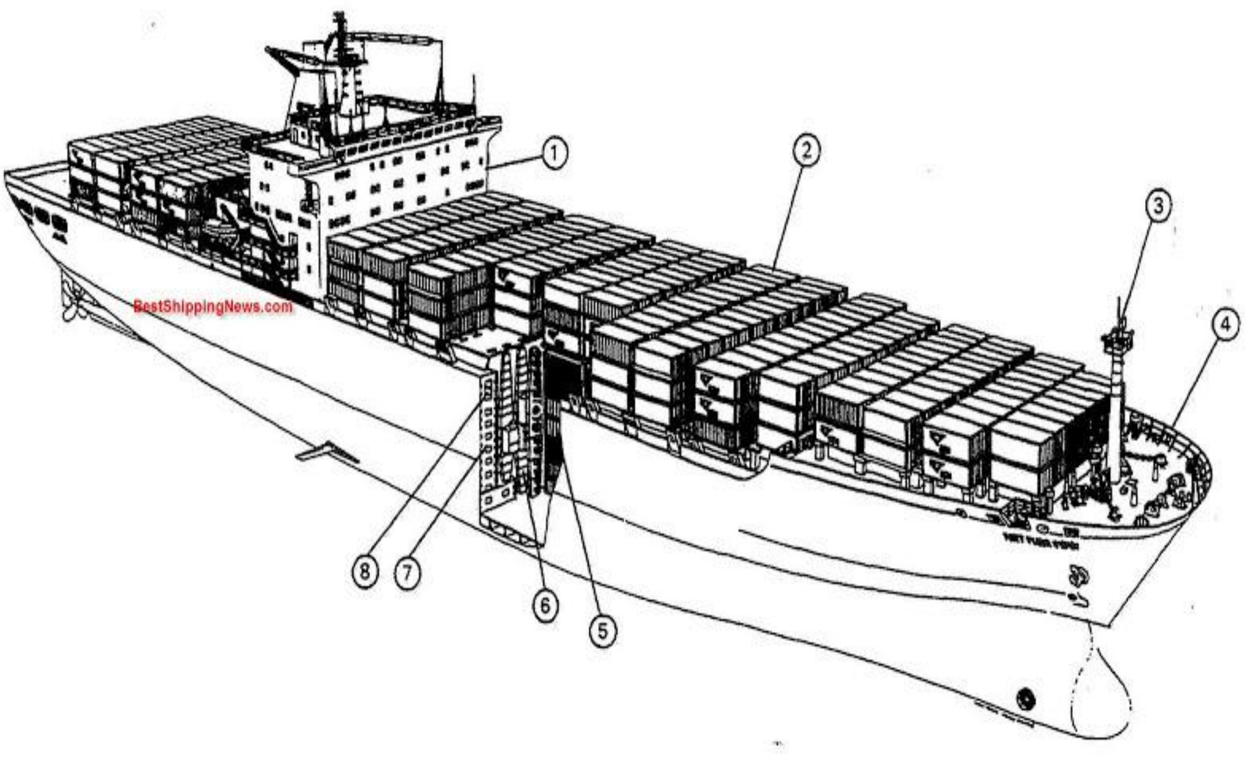


Figure1.6 Structure of a container ship [20]

1.4 General process in terminal container:

The general process of a container terminal can be divided in two parts the first is the operation of export containers:

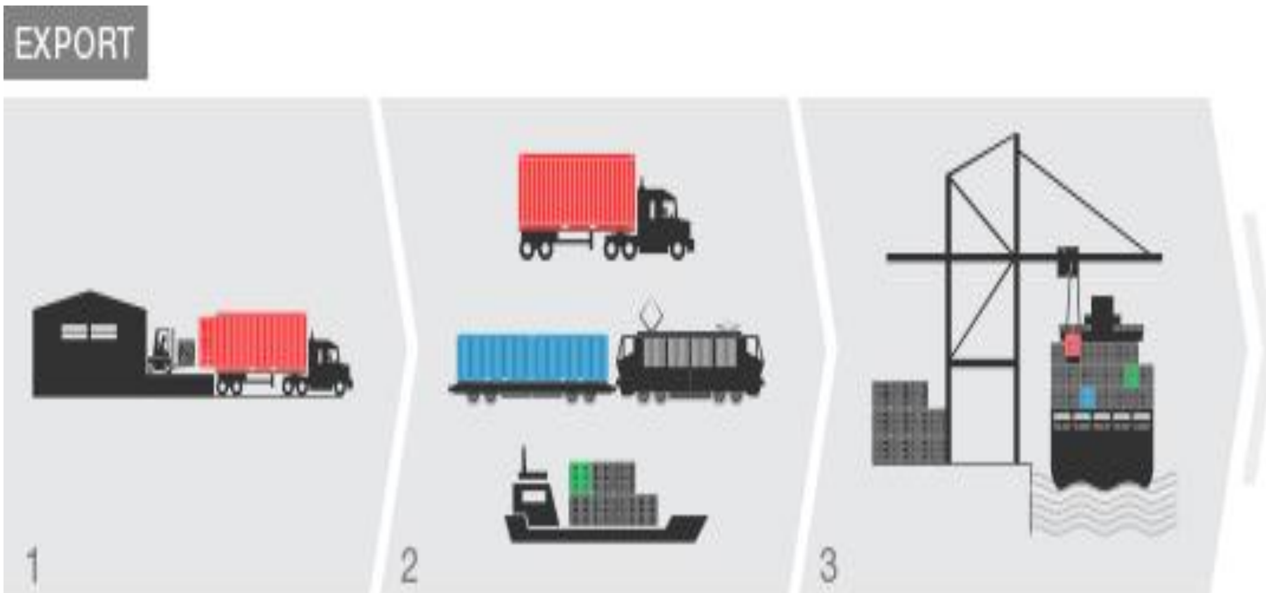


Figure1.7 Steps of export operation [18]

- Charger the container: departure of a container
- Transport Intermodal container service to the loading port
- Loading the container on the ship

The second is the operation of import containers:

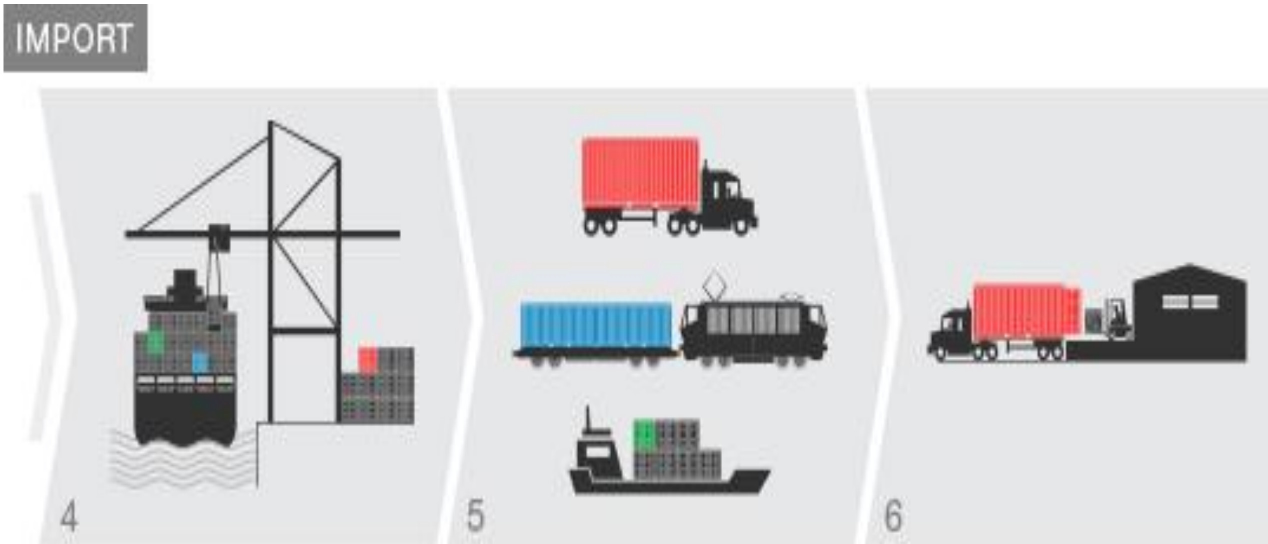


Figure1.8 Steps of import operation [18]

- Unloading the container at the discharge port
- Transport of the container multimodal service
- Unloading the container to the factory of the recipient.

1.5 Handling Equipment containers

- **Unit of port operation:** tow gantry container capacity: 40 tonnes under spreader and 45 tonnes under hook. They are mainly used to load and unload containers on ships.

- **Units of land operation:** the **reach stacker** to load and unload containers on trucks: there are a total of 14 KONECRANES brand. The empties anders, as their names suggest, are used to handling empty containers.29 terminal tractors (21 and 8 are 4x4 4x2) of Terberg brand, allow towing loaded trailers or not within the terminal.

Trailers of various types are used according to need; they can transport containers, wood or different within the terminal (they number 54 including: 12 container ships, 12 skeletons, 7 bass trailers 40 'Roro, 5 bass trailers 20' Roro).

The ranges are mainly used to handle non-containerized goods. They number 25 with 02 32 tonnes, 01 to 28 tonnes, 4 tonnes of 5, 4 of 4 tonnes, 2 tonnes of 4-5-cotton pliers.[19]

Figure1.9 Somme Handling Equipment containers.

For example the terminal container of SKIKDA has **Handling Equipment containers** in its park presented in the table as follows:

Table 1.1 Handling Equipment containers in the port of SKIKDA [24]

1.6 Containers transport equipment:

- **AGV** is a vehicle that is loaded and unloaded by equipment at a handling center and can travel from the loading point to its destination to its destination under its own power.[4]
- **ALV** is a vehicle that can both load and unload containers and travel from the loading point to its destination under its own power. [4]
- **MTS** is a train of coupled trailers that can be loaded or unloaded with one or more containers by handling center equipment. An MTS is pulled by a manned traction unit (FTF) from its point of origin to its destination. An MTS object cannot carry out any process itself. [4]
- **SC :** the main function of these trucks is the connection between the storage area and the docks by the transport of containers for export or import. [10]

Figure1.10 Somme containers transport equipment

The terminal container of SKIKDA has **Containers transport equipment** in its park presented in the table as follows:

Table 1.2 Containers transport equipment in the port of SKIKDA [24]

2 CNAN

2.1 Presentation of CNAN:

The Algerian National Navigation Company (CNAN) and the National Shipping Company of travelers are involved in maritime transport in Algeria. Several ferry (ferry boat) liaise passengers to European shores as well as the transport of goods around the world.

The almost all of international trade is carried by sea, through eleven commercial ports as follows: Algiers, Oran, Annaba, SKIKDA, ARZIEW / BETHIOUA, BEJAIA, MOSTAGANEM, GHAZNI, DJIJEL, TENES and DELLYS. [15]

2.2 Role of CNAN:

Role of CNAN in Algeria can be resume in the following point:

- *Maritime transport of goods in Eastern Mediterranean, Northern Europe, Americas, middle and far East and Inter-port,*
- *Brokering, transit and commission in customs,*
- Ship chartering,
- *Management and port warehouses under customs,*
- In General, all operations legal, industrial, commercial or financial, securities and real estate, that may relate directly or indirectly to the social or object which may facilitate the construction, extension or development.

3 State of the art review

3.1 History of container:

Container was created in 1956 by American Malcolm MacLean, haulier born in North Carolina in 1913 in a middle class family. In 1953, this entrepreneur realizes that the highways connecting the various ports on the west coast are completely saturated and the idea of taking truck trailers directly on boats. He then sold his trucking company and invests in a small shipping company to transport the trailers. He quickly realizes that the space used is too high. From there, the idea came to him to remove the frame and embark only the top of the trailer or the "box" itself. The container was born.

After the birth of container there some date where containers are developed presented as flow:

- 1958-1961: Standardization of container sizes: the "box" is beginning to conquer the world.
- In 1961 appear ISO, 20 '(6m) and 40' (12m) as standard containers dimensions.
- 2014: On 1 January, the world fleet were 4,976 container ships capable of carrying 17.3 million TEUs simultaneously boxes (20-foot equivalent).

3.2 Works related to the port problem (containerization problem):

Before seeing the history of container we see that they have a big importance in our days for this The problem of port formed a one of the most problem according to this a lot of studied consisting to this problem are existing from 1997 to our days.in 1997 [7] Discusses the planning of sequences of loading the containers to export in a marine terminal; for this, they have suggested an optimum algorithm routing of "optimal routing algorithm". The objective is to minimize the total time of the handling of containers by the portals of court. The contributions of

this work are: the determination of the optimal number of containers to pick up in each bay as well as the optimal route that a porch of court will browse.

They develop them study in 1999[6] by Solved the problem of planning for the operations of a single porch of court during the loading of export containers, while proposing a linear programming model mixed to determine the number of containers to be loaded and the order.

Now we going to 2005 where [14] solving the problem of planning of porticoes of court in order to minimize the sum of the waiting time.

In 2007 [29 are solve the problem of container loading problem (CLP) with multi-drop constraints, by using a heuristic based on a tree framework. In the same year [8] have dealt with the problem of planning of two porticoes of court used for the loading of export containers on the trucks. This planning has led to simultaneously determine the order of visit of the Bays of containers as well as the number of containers to remove each visit by the two porticoes. The mathematical model is based on certain assumptions.

[11] Have put the emphasis on the problem of management of pathways of the portals of court in real time in 2008. The integration of real-time data in the management system of the portals of court allows a better use of the resources of the sea port and consequently to improve the overall productivity of this port.

In 2009 [32]Study the problem of storage of containers in a port ,it proposes an approach to distribute resolution through a distribution of a model of heuristic optimization distribute , it solve the problem of optimization of the space of storage available to handle departures and arrived containers in a maritime port.

[24] Study the problem of optimization of movement of containers in the case of exportation , she examines the problem of movement nonproductive and the possible interference between this type of simultaneously portal using a heuristic approach of type adaptive search to neighborhood wide in 2011.

In 2012 [5] studied the container drayage problem in ISO container distribution and collecting process which are oriented to container sea ports when the sizes of container are 20 ft. or 40ft they examine the problem related to vehicle routing problem with the time windows where the goal is to found the optimal routes visiting deliveries and pickups costumers.

[13] In 2013 examine the problem of the terminal trucks queuing at terminal gates, the inter-block yard crane scheduling, the storage allocation problem when the objective is minimizing turn of drayage trucks, reducing congestion and emission and enhancing productivity of terminals by using agent based approaches. In 2014 [16]Study the problem of the allocation of the positions of the Pier in a terminal has container it resolve the problem according to several factors (the type of function of port, the type of contractual agreements with the maritime frames) it proposes two model to aid the decision for the problem in both cases static and dynamic.

Finally in 2015 [37] study the problem of storage of containers, exactly the problem to find a plan for optimal storage which precise the storage location ideal for each container it respects the two cases static and dynamic.

3.3 Methods used to solve the port problem:

We see in this part of this chapter that there a lot of studded examine the problem of port conciquencelly we can see that there are a lot of methods use to solve it.

For example an **optimal routing algorithm** used by [12] in 1997 to contribute and determining the optimal number of containers to be collected in each bay and the optimal route of yard cranes. But in 1999 [26]use a **mixed linear program** and them results was Determination of the number of containers to load and order of visits berries by the court gantries. In 2003 [27]: use a **mixed linear program** and **Heuristic Algorithm**, the results was Determine the loading/ unloading frequency and optimal yard gantry to minimize the workload of surplus. Mak in the same year use the **Branch & Bound algorithm** to minimize the amount of wait times. In the same year [14] Determining the order of visitation berries and the number of containers to collect at each visit to the two yard gantry cranes by using a **simulated annealing algorithm (recuit simulé)** .

[11] Determine the Best use of resources and improving the overall productivity of the port, the Method used is simulation model. In 2011[12] use an **heuristic approach of type adaptive search to neighborhood wide (ALNS)** to minimize the movement nonproductive of containers.[13] In 2013 use **agent based approaches** the result is a minimizing turn of drayage trucks in the operation of storage of container.

Branch_and_cut and other **meta-heuristic are used by** [37], its results was finding a plan for optimal storage of container.

CHAPTER3
PRESENTATION OF SOFTWARE AND TEST OF RESULT

Summary of chapter:

In this chapter we present Computer tool used in the construction of the software; NetBeans 8.1 and the data base DB4O, then we present our software and how it works, then we illustrate an example of SKIKDA port .Finally discussion of results by compare our results with result given by ALNS algorithm.

---

1 Computer Tool used.

2 Description of the software proposed.

3 Illustration of an example

4 Discussion of results.

1 Computer Tool used:

1.1 NetBeans:

1.1.1 Definition of NetBeans:

NetBeans is an open-source integrated development environment (IDE) for developing with Java, PHP, C++, and other programming languages. NetBeans is also referred to as a platform of modular components used for developing Java desktop applications.[25]

Figure 0.1 NetBeans 8.1

1.1.2 Current versions:

NetBeans IDE 6.0 introduced support for developing IDE modules and rich client applications based on the NetBeans platform, a Java Swing GUI builder (formerly known as "Project Matisse"), improved CVS support, WebLogic 9 and JBoss 4 support, and many editor enhancements. NetBeans 6 is available in official repositories of major Linux distributions.

NetBeans IDE 6.5, released in November 2008, extended the existing Java EE features (including Java Persistence support, EJB 3 and JAX-WS). Additionally, the NetBeans Enterprise Pack supports the development of Java EE 5 enterprise applications, including SOA visual design tools, XML schema tools, web services orchestration (for BPEL), and UML modeling. The NetBeans IDE Bundle for C/C++ supports C/C++ and FORTRAN development.

NetBeans IDE 6.8 is the first IDE to provide complete support of Java EE 6 and the GlassFish Enterprise Server v3. Developers hosting their open-source projects on kenai.com additionally benefit from instant messaging and issue tracking integration and navigation right in the IDE, support for web application development with PHP 5.3 and the Symfony framework, and improved code completion, layouts, hints and navigation in JavaFX projects.

NetBeans IDE 6.9, released in June 2010, added support for OSGi, Spring Framework 3.0, Java EE dependency injection (JSR-299), Zend Framework forPHP, and easier code navigation (such as "Is Overridden/Implemented" annotations), formatting, hints, and refactoring across several languages.

NetBeans IDE 7.0 was released in April 2011. On August 1, 2011, the NetBeans Team released NetBeans IDE 7.0.1, which has full support for the official release of the Java SE 7 platform.

NetBeans IDE 7.3 was released in February 2013 which added support for HTML5 and web technologies.

NetBeans IDE 7.4 was released on October 15, 2013.

NetBeans IDE 8.0 was released on March 18, 2014.

NetBeans IDE 8.1 was released on November 4, 2015. [19] This last version which is used to develop our software.

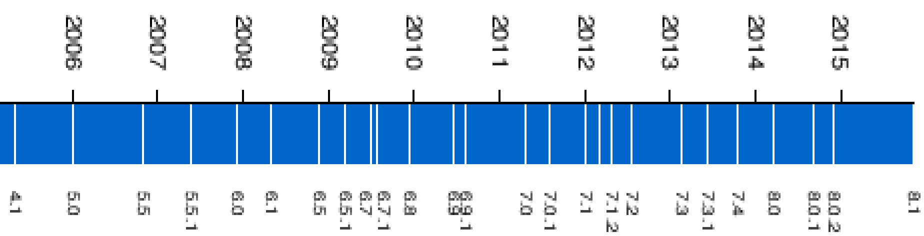


Figure 3.0.2 History of NetBeans

1.1.2 Why NetBeans?

NetBeans have a lot of importance we can resume it in the following:

- NetBeans is simple to download and to install.
- **Free and Open Source.**
- **Support for Java Standards and Platforms.**
- **Dynamic Language Support.**
- **Have a JVM (java virtually machine)**.

1.2 DB4O data base:

db4o represents an object-oriented database model. One of its main goals is to provide an easy and native interface to persistence for object oriented programming languages. Development with db4o database does not require a separate data model creation, the application's class model defines the structure of the data. db4o attempts to avoid the object/relational impedance mismatch by eliminating the relational layer from a software project. For more information see db4o features.

Developers using relational databases can view db40 as a complementary tool. The db4o-RDBMS data exchange can be implemented using db4o Replication System (dRS). dRS can also be used for migration between object (db4o) and relational (RDBMS) technologies.

As an embedded database db4o can be run in application process. It is distributed as a library (jar/dll).[19]

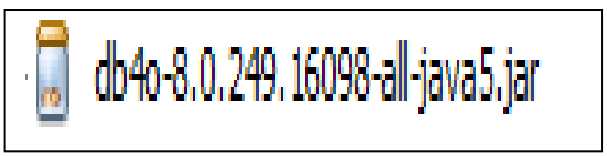


Figure 0.3 DB4O data base jar folder.

2 Description of the proposed software:

The software proposed is givan to solve the container movement problem; calculation of time and affectation of the outil to mouve container truck and portiquo. So we can devided our software in three type of frames.

1 welcome frames: this frames is generally to help user to select its goal (create user, save information in data base or go to solve container movement problem).

First frame of our software presented in fig 3.4 this frame can be give us tow probabilitis frame the firset wich is creat user frame presented in fig 3.5 if the user is not created before but if user is created it give us the login frame presented in fig 3.6.

Figure3.0.1start frame for the software proposed

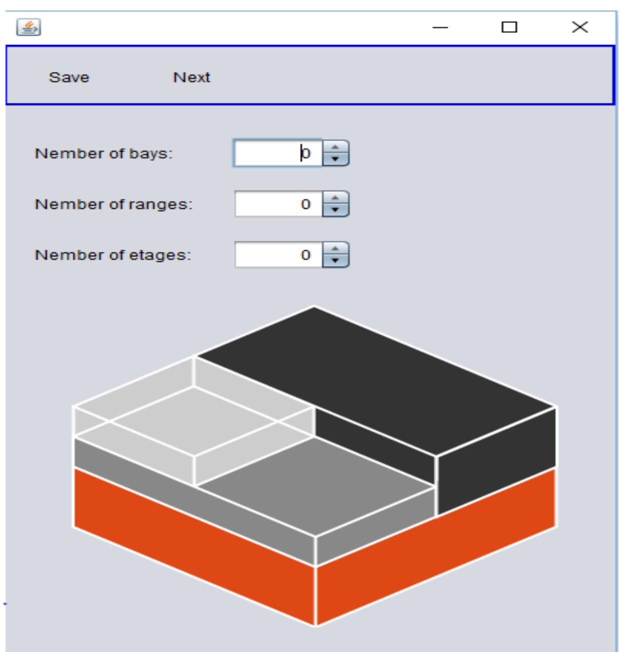
User of our software must create a new user in the first step, frame to create a new user is as following:

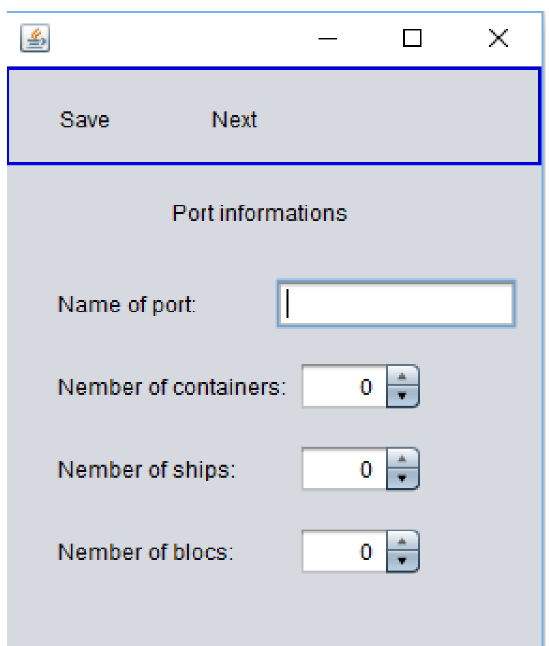
Figure 0.4 insert user frame

If user is created the frame given is:

Figure3.5 frame to login to the software

2 Data base frames : they are for the save data use in software calculations, frome them our software tick informations to start they are fore frames (data of port, data of bloc, data of ship and data of container), in this frames user give the importaint information wich can helpe us to solve the container mouvment problem. Data base frames presente in fig 3.5.





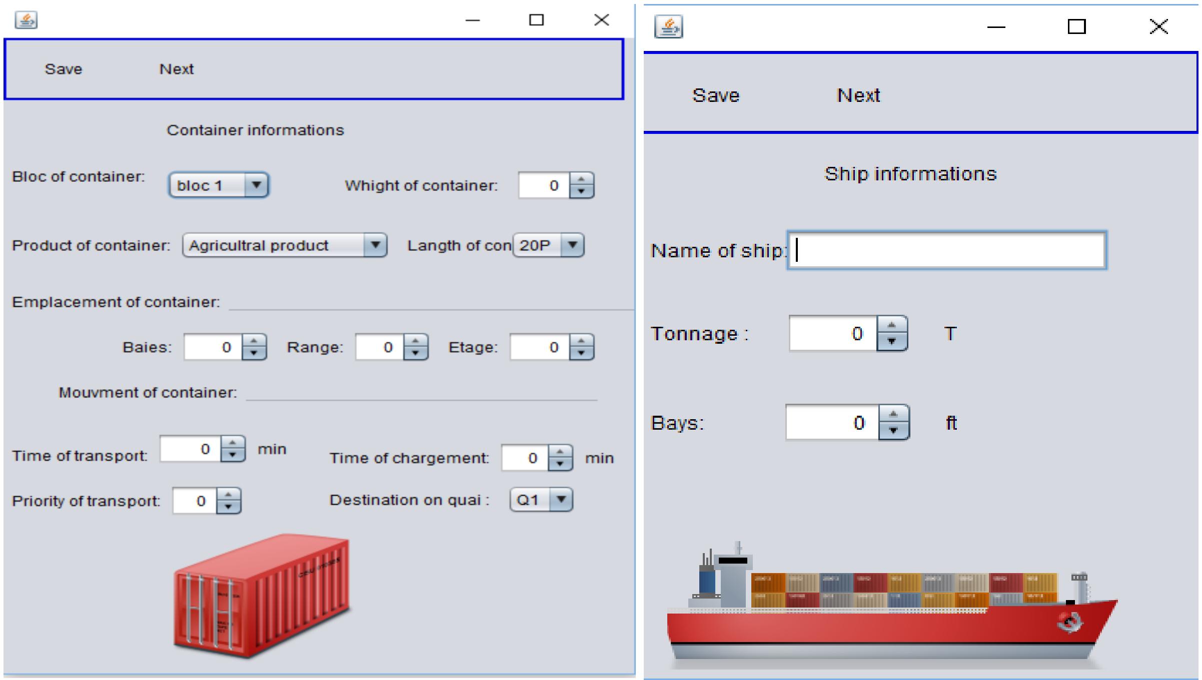


Figure 0.6 Data base frames

3 Solving the container movement problem frames: this frames present by two frames the first for given the number of container to move and the ship using in movement operation present in the following frame:

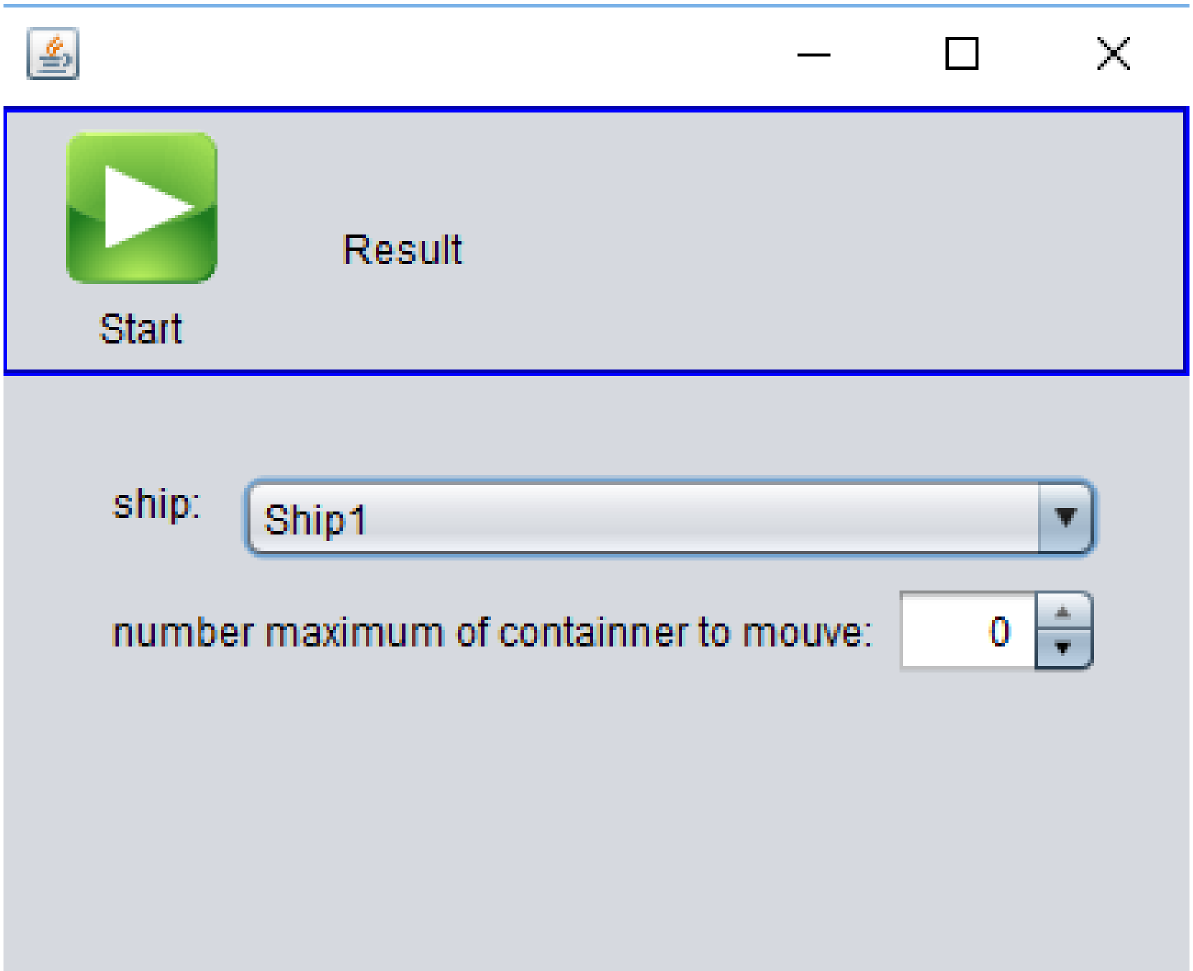


Figure3.7 frame to start execution

The second is about the result of software presented in fig3.7; in this frame we can see characters of container to move (emplacement in bloc, truck and crane using to move it) and total time of container movement.

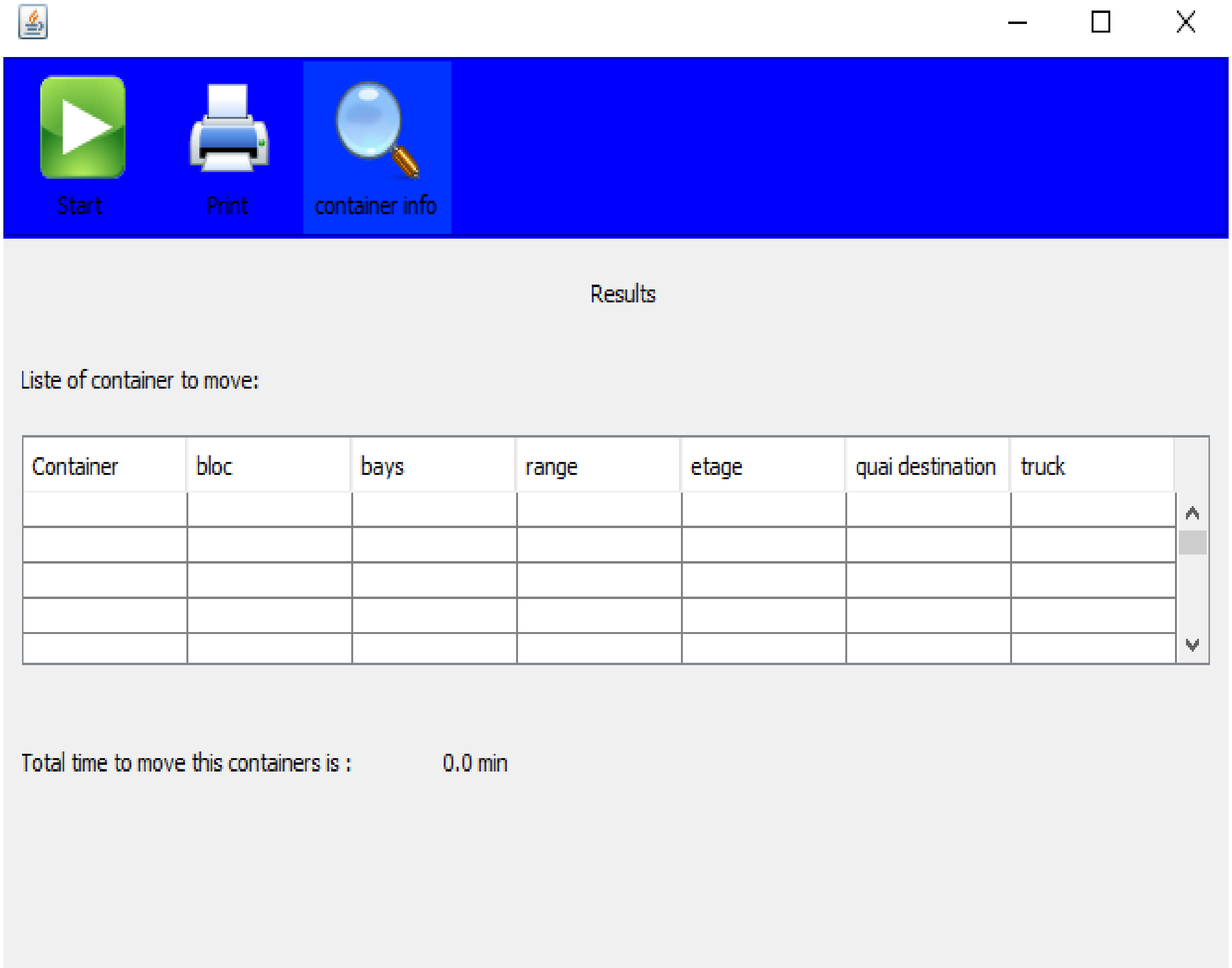
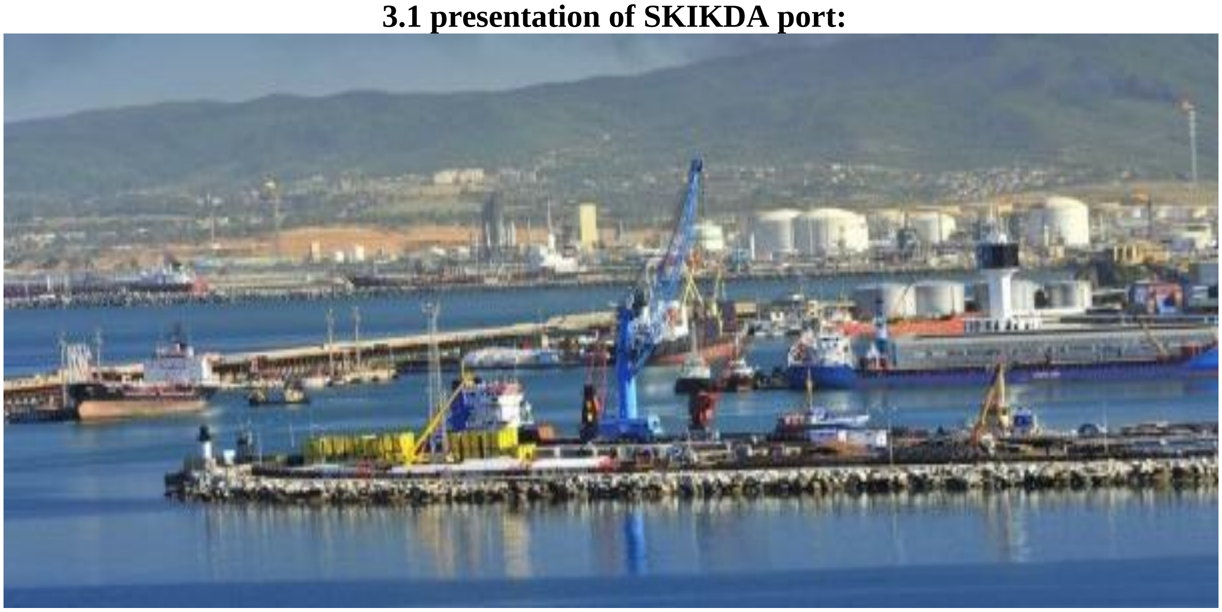


Figure3.8 frame of software result

3 Illistration of an example (SKIKDA port)

3.1 presentation of SKIKDA port:



Name: Port Company Skikda abbreviated E.P Skikda.

Legal form: EPE, Stock Company under the laws and regulations relating to the business autonomy.

Capital: 9,000,000,000 DA held by a single shareholder, the Group of Port-SERPORT- Services.

Management Organization: Company organized in single-unit DG

Creation date: Decree No. 82-284 dated 14 August 1982 and amendment of company statutes per share on 21 March 1989.

instance	number of container	nbr of bloc	number of court portiquo	number of trucks

jurisdictions: Mixed Skikda port, the New port of Skikda (oil port)

Fishing ports: STORA, LA MARSA, COLLO. [25]

Activities and tasks:

• The management and operation of the plant and port facilities.

• Exercise towing operations, pilotage and mooring.

• The exercise of stevedoring and handling operations.

• The exercise of police missions and port security.

• The execution of the maintenance, development and renewal of port superstructure.

• The development, in conjunction with other relevant authorities, development of maintenance programs and creating port infrastructure.[25]

3.2 Data used:

3.3 Result of execution:

4 Discussion of results:

To discuss our result we must compare it by other result for this we want to compare our genetic algorithm proposed by the ALNS algorithm proposed by K.CHEBLI in 2011. For this we illustrate some of examples organized in table 3.1 and presented in ANNEX D.

To

INS 1	10	2	2	2
INS 2	10	2	2	3
INS 3	20	2	2	3
INS 4	20	4	4	2
INS 5	20	4	4	3

compare between two algorithms we must compare tow big thing which are value of objective function and execution time.

Table3.1 Character of instances use in comparison between GA and ALNS

4.1 Compare the objective function results:

To compare the objective function we use the first and second instance where we have same number of containers, bloc, crane and a deferent number of trucks results present in table 3.2

instance	method	objective function
1	GA	600 sec
1	ALNS	860 sec
2	GA	480 sec
2	ALNS	560 sec

Table 3.2 Comparison between objective function given by GA and ALNS

For the first instance we see that the value of objective function is 680 second and in GA is 600 second, and in the second instance objective function is 560 second for ALNS and 480 for GA. So we can conclude that the objective function given by GA is best then other given by ALNS.

The deference between objective function in the first instance and the second is related to the number of trucks.

4.2 Compare the time of execution:

instance	method	time of execution
4	GA	60 sec – 80 sec
4	ALNS	43-74 sec
6	GA	60 sec- 120 sec
6	ALNS	43-41 sec
7	GA	76 sec – 110 sec
7	ALNS	44-78 sec

Table 3.3 Comparison between time of execution of GA and ALNS

We see that time of execution in GA can be the same or more then the time of execution of ALNS algorithm, because it's in the fourth instance take 60 sec to 80 sec in GA and 43 sec to 74 so we have a common interval between 60 to 74 ,in instance six there are no common interval where see that GA changed between 60 sec as minimum value to 110 as a maximum one; for the last instance we see that its existing common interval from 76 sec to 78 sec but GA can take few minutes more than ALNS. We conclude that ALNS method is the best for the execution time.

4.3 Conclusion of comparison:

After comparing objective function in 3.2 and time of execution in 3.3 we can conclude that genetic algorithm proposed in our dissertation is more efficacy for solving the container movement problem but it can take few time to give the result according to its complexity and operations of evaluation, selection, crossover, mutation and the selection of the best individual in the population than, it can take time in operation of calculation of real time of movement.

GENERAL CONCLUSION AND FUTERE PRESPECTIVES

In this dissertation we present a genetic algorithm to solve the problem of container movement from blocs to the container ship.

The presented work examines one of the important problems of port which is the minimization of total time to move containers and the scheduling of container to move.

Our personal contribution in this dissertation is to present the genetic algorithm to move containers, and to generate a software for this algorithm this last which is simple to use of the port management and its result is effective to help them to take them decision concerning the container movement.

This dissertation allows executing a number of objectives which are:

- Minimize time of container movement
- Select chain of container to move.
- Select scheduling of container to move.
- Minimization of number of movements of court portico in the port in indirect way.
- Executed software to help in the decision where we respect the presented mathematical model and its constraints and assumptions.

To present our software we illustrate an exemple in the port of SKIKDA with a real value extracted from [12].

To evaluate the effective of our software and proposed algorithm we solve in problem of container movement proposed by khaoula chebli in its dissertation then we compare our results by the result of ALNS algorithm, in time of execution and value of the objective function.

The test give that genetic algorithm proposed in our dissertation is more efficacy for solving the container movement problem but it can take few time to give the result according to its complexity and operations of evaluation, selection, crossover, mutation and the selection of the best individual in the population than, it can take time in operation of calculation of real time of movement.

This search domain is very large; for this we want to conclude by given some future perspectives for the future searches:

- Studied the problem with more than 2 portico of court in the bloc.
- Studied the same problem where the speed of portico of court is dynamic.

1 What's an optimization problem?

An optimization problem is a pair (S, f) where S is a generic set of solutions and $f: S \to R$ is a function that associates a cost to each solution. The problem is to find a $\bar{s} \in S$ for which:

$$f(\bar{s}) \leq f(s) \text{ for all } s \in S.$$

2 Exact optimization algorithms:

2.1 Definition:

Exact algorithms are algorithms that always solve an optimization problem to optimality. Unless P = NP, such an algorithm cannot run in worst-case polynomial time but there has been extensive research on finding exact algorithms whose running time is exponential with a low base.

2.2 Exact optimization algorithms:

2.2.1 Cutting plane method:

cutting-plane method is an umbrella term for optimization methods which iteratively refine a feasible set or objective function by means of linear inequalities, termed cuts. Such procedures are commonly used to find integer solutions to mixed integer linear programming (MILP) problems, as well as to solve general, not necessarily differentiable convex optimization problems. The use of cutting planes to solve MILP was introduced by Ralph E. Gomory and Václav Chvátal.

Cutting plane methods for MILP work by solving a non-integer linear program, the linear relaxation of the given integer program. The theory of Linear Programming dictates that under mild assumptions (if the linear program has an optimal solution, and if the feasible region does not contain a line), one can always find an extreme point or a corner point that is optimal. The obtained optimum is tested for being an integer solution. If it is not, there is guaranteed to exist a linear inequality that separates the optimum from the convex hull of the true feasible set. Finding such an inequality is the separation problem, and such an inequality is a cut. A cut can be added to the relaxed linear program. Then, the current non-integer solution is no longer feasible to the relaxation. This process is repeated until an optimal integer solution is found.

Cutting-plane methods for general convex continuous optimization and variants are known under various names: Kelley's method, Kelley-Cheney-Goldstein method, and bundle methods. They are popularly used for non-differentiable convex minimization, where a convex objective function and its sub gradient can be evaluated efficiently but usual gradient methods for differentiable optimization can't be used. This situation is most typical for the concave maximization of Lagrangian dual functions. Another common situation is the application of the Dantzig-Wolfe decomposition to a structured optimization problem in which formulations with an exponential number of variables are obtained. Generating these variables on demand by means of delayed column generation is identical to performing a cutting plane on the respective dual problem.

2.2.2 Branch and bound:

Branch and bound (BB or B&B) is an algorithm design paradigm for discrete and combinatorial optimization problems, as well as general real valued problems. A branch-and-bound algorithm consists of a systematic enumeration of candidate solutions by means of state space search: the set of candidate solutions is thought of as forming a rooted tree with the full set at the root. The algorithm explores branches of this tree, which represent subsets of the solution set. Before enumerating the candidate solutions of a branch, the branch is checked against upper and lower estimated bounds on the optimal solution, and is discarded if it cannot produce a better solution than the best one found so far by the algorithm.

The algorithm depends on the efficient estimation of the lower and upper bounds of a region/branch of the search space and approaches exhaustive enumeration as the size (n-dimensional volume) of the region tends to zero.

The method was first proposed by A. H. Land and A. G. Doig[1] in 1960 for discrete programming, and has become the most commonly used tool for solving NP-hard optimization problems.[2] The name "branch and bound" first occurred in the work of Little et al. on the traveling salesman problem.

2.2.3 Column generation :

Column generation or delayed column generation is an efficient algorithm for solving larger linear programs.

The overarching idea is that many linear programs are too large to consider all the variables explicitly. Since most of the variables will be non-basic and assume a value of zero in the optimal solution, only a subset of variables need to be considered in theory when solving the problem. Column generation leverages this idea to generate only the variables which have the potential to improve the objective function—that is, to find variables with negative reduced cost (assuming without loss of generality that the problem is a minimization problem).

The problem being solved is split into two problems: the master problem and the subproblem. The master problem is the original problem with only a subset of variables being considered. The subproblem is a new problem created to identify a new variable. The objective function of the subproblem is the reduced cost of the new variable with respect to the current dual variables, and the constraints require that the variable obey the naturally occurring constraints.

The process works as follows. The master problem is solved—from this solution, we are able to obtain dual prices for each of the constraints in the master problem. This information is then utilized in the objective function of the subproblem. The subproblem is solved. If the objective value of the subproblem is negative, a variable with negative reduced cost has been identified. This variable is then added to the master problem, and the master problem is re-solved. Re-solving the master problem will generate a new set of dual values, and the process is repeated until no negative reduced cost variables are identified. The subproblem returns a solution with non-negative reduced cost, we can conclude that the solution to the master problem is optimal.

In many cases, this allows large linear programs that had been previously considered intractable to be solved. The classical example of a problem where this is successfully used is the cutting stock problem. One particular technique in linear programming which uses this kind of approach is the Dantzig–Wolfe decomposition algorithm. Additionally, column generation has been applied to many problems such as crew scheduling,vehicle routing, and the capacitated p-median problem.

3 Metaheuristic optimization algorithms:

3.1 Definition:

A metaheuristic is a higher-level procedure or heuristic designed to find, generate, or select a heuristic (partial search algorithm) that may provide a sufficiently good solution to an optimization problem, especially with incomplete or imperfect information or limited computation capacity. Metaheuristics sample a set of solutions which is too large to be completely sampled. Metaheuristics may make few assumptions about the optimization problem being solved, and so they may be usable for a variety of problems.

3.2 Metaheuristic optimization algorithms:

3.2.1 Tabu search:

Tabu search is nowadays among the most cited metaheuristics. In its basic implementation, tabu search adopts a device called tabu list for trying to escape from local minima and avoid cycles. The tabu list is a first-in first-out queue of previously visited solutions. It is used within a search approach that is somehow similar to the best improvement strategy of local search: A neighborhood structure is defined on the set S of solutions; the search starts from an initial solution s1 and proceeds iteratively; at the generic step j, when the current solution is sj , the tabu list TLj contains sj, sj−1, . . . , sj−L+1, that is, the last k solutions visited, where the length of the tabu list L is a parameter of the algorithm. The new current solution is set to sj+1 = s_ _∈ TLj, where f(s_) ≤ f(s), ∀s ∈ N(sj) \ TLj . The process is then iterated.

In words, tabu search keeps memory of the previously visited solutions and moves from solution to solution selecting at each step the best option out of those in the neighborhood, yet avoiding some tabu moves.

3.2.2 Ant colony optimization:

Ant colony optimization is a metaheuristic inspired by the foraging behavior of ant colonies: It can be observed that, in order to find the shortest path from a nest to a food source, ant colonies exploit a positive feedback mechanism by using a form of indirect communication called stigmergy ,based on the laying and detection of pheromone trails.

The goal of ant colony optimization is to find a path of minimum cost on a weighted graph. To this end, a number of paths are generated in a Monte Carlo fashion, and the cost of these paths is used to bias the generation of further paths. This process is iterated with the aim of gathering more and more information on the graph and eventually produce a path of minimum cost.

Each path is generated sequentially. In the pictorial description of ant colony optimization, the generation of a path is described as the walk of an ant on the graph. At each node the ant randomly selects which edge to traverse on the basis of a set of parameters, called pheromone, which are associated to each edge: A high value of the pheromone for an edge increases its probability of being traversed. Once a walk is concluded and a solution is obtained, the ant traces back its path and deposits further pheromone on the traversed edges. The amount of pheromone released is some appropriate decreasing function of the cost of the solution so that edges composing low cost solutions get reinforced the most and increase their probability of being selected by future ants.

The performance of ant colony optimization can be significantly improved by using local search for refining the solution found by an ant before updating the pheromone trail.

3.2.3 Genetic Algorithms:

Genetic algorithms (GAs) are probably the most popular evolutionary algorithms with a diverse range of applications. A vast majority of well-known optimization problems have been solved by genetic algorithms. In addition, genetic algorithms are population-based and many modern evolutionary algorithms are directly based on, or have strong similarities to, genetic algorithms.

Genetic algorithms, developed by John Holland and his collaborators in the 1960s and 1970s, are a model or abstraction of biological evolution based on Charles Darwin's theory of natural selection. Holland was the first to use crossover, recombination, mutation and selection in the study of adaptive and artificial systems. These genetic operators are the essential components of genetic algorithms as a problem-solving strategy. Since then, many variants of genetic algorithms have been developed and applied to a wide range of optimization problems, from graph colouring to pattern recognition, from discrete systems (such as the travelling salesman problem) to continuous systems (e.g., the efficient design of airfoil in aerospace engineering), and from financial markets to multiobjective engineering optimization.

The essence of genetic algorithms involves the encoding of solutions as arrays of bits or character strings (chromosomes), the manipulation of these strings by genetic operators and a selection based on their fitness to find a solution to a given problem. This is often done through the following procedure: 1) definition of an encoding scheme; 2) definition of a fitness function or selection criterion; 3) creation of a population of chromosomes; 4) evaluation of the fitness of every chromosome in the population; 5) creation of a new population by performing fitness-proportionate selection, crossover and mutation; 6) replacement of the old population by the new one. Steps 4), 5) and 6) are then repeated for a number of generations. At the end, the best chromosome is decoded to obtain a solution to the problem.

Each iteration, which leads to a new population, is called a generation. The fixed-length character strings are used in most genetic algorithms at each generation although there is substantial research on variable-length strings and coding structures. The coding of the objective function is usually in the form of binary arrays or real-valued arrays in adaptive genetic algorithms. An important issue is the formulation or choice of an appropriate fitness function that determines the selection criterion in a particular problem. For the minimization of a function using genetic algorithms, one simple way of constructing a fitness function is to use the simplest form $F=A-y$ with A being a large constant (though $A=0$ will do if the fitness does not need to be non negative) and $y=f(x)$. Thus the objective is to maximize the fitness function and subsequently to minimize the objective function $f(x)$. However, there are many different ways of defining a fitness function. For example, we can assign an individual fitness relative to the whole population

$$F(x_i)=\frac{f(\xi_i)}{\sum_{i=1}^{N} f(\xi_i)},$$

Where ξ_i is the phenotypic value of individual i , and N is the population size. The form of the fitness function should make sure that chromosomes with higher fitness are selected more often than those with lower fitness. Poor fitness functions may result in incorrect or meaningless solutions.

Another important issue is the choice of various parameter values. The crossover probability p_c is usually very high, typically in the interval [0.7,1.0] . On the other hand, the mutation probability p_m is usually small (typically, in the interval [0.001,0.05]). If p_c is too small, then crossover is applied sparsely, which is not desirable. If the mutation probability is too high, the algorithm could still `jump around' even if the optimal solution is close.

Selection of the fittest is carried out according to the fitness of the chromosomes. Sometimes, in order to make sure that the best chromosomes remain in the population, they are transferred to the next generation without much change, which is called elitism. A proper criterion for selecting the best chromosomes is also important, because it determines how chromosomes with higher fitness are preserved and transferred to the next generation. This is often carried out in association with a certain form of elitism. The basic form is to select the best chromosome (in each generation) which will be carried over to the new generation without being modified by the genetic operators. This ensures that a good solution is attained more quickly.

Other issues include multiple sites for mutation and the use of various population sizes. The mutation at a single site is not very efficient, so mutation at multiple sites typically increases the evolution of the search. On the other hand, too many mutants will make it difficult for the system to converge or even lead the system toward wrong solutions. In real ecological systems, if the mutation rate is too high under high selection pressure, then the whole population might become extinct.

In addition, the choice of the right population size is also very important. If the population size is too small, there will not be enough evolution, and there is a risk for the whole population to converge prematurely. In the real world, ecological theory suggests that a species with a small population is in real danger of extinction. In a small population, if a chromosome with a fitness substantially larger than the fitness of the other chromosomes in the population appears too early, it may produce enough offspring to overwhelm the whole (small) population. This will eventually drive the system to a local optimum (not the global optimum). On the other hand, if the population is too large, more evaluations of the objective function are needed, which will require extensive computing time.

2.3.4 Bee Algorithms:

Bee algorithms are another class of metaheuristic algorithms, inspired by the foraging behaviour of bees. A few variants exist in the literature, including honeybee algorithm, artificial bee colony, bee algorithm, virtual bee algorithm, and honeybee mating algorithms.

Honey bees live in a colony and they forage and store honey in their constructed colony. Honey bees can communicate by pheromone and `waggle dance'. For example, an alarming bee may release a chemical message (pheromone) to stimulate attack response in other bees. Furthermore, when bees find a good food source and bring some nectar back to the hive, they will communicate the location of the food source by performing the so-called waggle dance as a signaling system. Such signaling dances vary from species to species, however, they are aimed at recruiting more bees by using directional dancing with varying strength so as to communicate the direction and distance of the food source.

For multiple food sources such as flower patches, studies show that a bee colony seems to be able to allocate forager bees among different flower patches so as to maximize their total nectar intake (Moritz and Southwick 1992).

It seems that the Honey Bee Algorithm (HBA) was first formulated around 2004 by Craig A Tovey at Georgia Tech in collaboration with Sunil Nakrani then at Oxford University as a method to allocate computers among different clients and web-hosting servers. Later in 2004 and in early 2005, Xin-She Yang at

Cambridge University developed a Virtual Bee Algorithm (VBA) to solve continuous optimization problems. At about the same time, Pham et al. (2005) developed the bee algorithms. Slightly later in 2005, Haddad and Afshar and their colleagues presented a Honey-bee mating optimization (HBMO) algorithm which was subsequently applied to reservoir modelling and clustering. Around the same time, D Karabogo in Turkey developed an Artificial Bee Colony (ABC) algorithm for numerical function optimization.

Ant and bee algorithms are more suitable for discrete and combinatorial optimization and have been applied in a wide range of applications.

2.3.5 Cuckoo Search:

Cuckoo search (CS) is one of the latest nature-inspired metaheuristic algorithms, developed by Xin-She Yang and Suash Deb in 2009. CS is based on the brood parasitism of some cuckoo species (Yang and Deb 2009). In addition, this algorithm is enhanced by the so-called Lévy flights, rather than by simple isotropic random walks (Pavlyukevich 2007). Recent studies show that CS is potentially far more efficient than PSO and genetic algorithms (Yang and Deb 2010).

Cuckoos are fascinating birds, not only because of the beautiful sounds they make, but also because of their aggressive reproduction strategy. Some species named ani and Guira lay their eggs in communal nests, though they may remove others' eggs to increase the hatching probability of their own eggs. Quite a number of species engage in the mandatory brood parasitism by laying their eggs in the nests of other host birds (often other species).

- Each cuckoo lays one egg at a time, and dumps it in a randomly chosen nest;
- The best nests with high-quality eggs are carried over to the next generations;
- The number of available host nests is fixed, and the egg laid by a cuckoo is discovered by the host bird with a probability $pa \in [0,1]$, depending on the similarity of a cuckoo egg to its host eggs. In this case, the host bird can either get rid of the egg, or simply abandon the nest and build a completely new nest.

When generating new solutions x(t+1) for, say, a cuckoo i , a Lévy flight is performed

$$x(t+1)i=x(t)i+\alpha L(s,\lambda),$$

where $\alpha>0$ is the step size which should be scaled to the problem of interest. The above equation is essentially the stochastic equation for a random walk. In general, a random walk is a Markov chain whose next status/location only depends on the current location (the first term in the above equation) and the transition probability (the second term). Here the random walk via Lévy flight is more efficient in exploring the search space, as its step length is much longer in the long run.

The Lévy flight essentially provides a random walk whose random step length (s) is drawn from a Lévy distribution

$$L(s,\lambda)\sim s-\lambda,(1<\lambda\leq 3),$$

which has an infinite variance and infinite mean. Here the steps essentially form a random walk process with a power-law step-length distribution with a heavy tail. Some of the new solutions should be generated by the Lévy walk around the best solution obtained so far to speed up the local search. However, a substantial fraction of the new solutions should be generated by far field randomization, that is, the locations should be far enough from the current best solution to make sure that the system will not get trapped in a local optimum.