

# Introduction to Optimization Techniques

# What is Operations Research?

## *Operations:*

The activities carried out in an organization.

## *Research:*

The process of observation and testing characterized by the scientific method. Situation, problem statement, model construction, validation, experimentation, candidate solutions.

Operations Research is a quantitative approach to decision making based on the scientific method of problem solving.

- OR consists of:
  - The art of *mathematical modeling* of complex situations
  - The science of the development of *solution techniques* used to solve these models
  - The ability to effectively *communicate* the results to the decision maker

# Introduction

- The first formal activities of OR were initiated in England during World War-II, when a team of British scientists set out to assess the best utilization of war material based on scientific principles rather than on an ad hoc rules. After the war, the ideas advanced in military operations were adapted to improve efficiency and productivity in civilian sector.

- OR professionals aim to provide rational bases for **decision making** by seeking to **understand** and structure complex situations and to use this understanding to **predict** system behavior and **improve** system performance.
- Much of this work is done using **analytical** and **numerical** techniques to develop and manipulate **mathematical and computer** models of organizational systems composed of people, machines, and procedures.

# Some Applications

- Manufacturing
  - Planning, Design, Scheduling, Dealing with Defects
- Service Industries
- Logistics
- Transportation
- Environment
- Health Care
- Situations with complexity
- Situations with uncertainty

- Optimization techniques are a powerful set of tools for solving complex real-world problems. The application domain has grown manifold in recent years, covering almost all engineering and science disciplines.
- On the technological front, many new algorithms are designed by taking inspirations from different natural phenomena, resulting in some of the popular algorithm such as Genetic Algorithm (GA).

# Applications in Computer Science

- As computers play a vital role in industrial production systems means Operational research is relevant in this area. Computer science and Operational Research are intertwined together since the origin of both. And also, both have contributed to the advancement of both disciplines.
- The main idea of operation research-based modeling in computer science applications is the systematic approach to deal with the problem and get the optimized solution
- The optimization models are very useful in computer science, especially in software engineering and computer network domains.
- The studies are optimized to gain solutions with minimum cost for a particular problem. Some applications in Operational research used in computer science are:



- Simulation
- Resource allocation
- Data mining
- Network routing
- Pattern Recognition
- Queuing theory
- Linear programming

# Some Operation Research Models

- Linear Programming
- Integer Programming
- Nonlinear Programming
- Dynamic programming
- Network Programming

These are a few among many available OR models.

# Linear Programming Problem (L.P.P.)

- It was L.V. Kantorovich, a Russian mathematician, who was first interested to apply mathematical models in solving business problems.
- He pointed out that there existed numerous production problems which could be formulated mathematically and solved numerically.

# What is L.P.P?

- Linear Programming problem deals with the **optimization** (maximization or minimization) of a function of variables known as **objective function** subject to a set of linear equalities and/or inequalities known as **constraints** satisfying the non-negative restrictions.

# Application areas of L.P.P

- This technique could be extensively used in
  - In problems of management
  - Planning
  - Food and Agriculture
  - Transportation Optimization
  - Efficient Manufacturing
  - Energy Industry
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- While some linear programming can be done manually, quite often the variables and calculations become too complex and require the use of computational software.