Tecnológico de Monterrey

Historia, Aplicaciones y Tendencias de la Investigación de Operaciones

Profesor

Optimización de Operaciones

Escuela de Ingeniería y Ciencias

Tecnológico de Monterrey

Jenny Díaz Ramírez PhD

Historia

Jenny Díaz Ramírez PhD

History of OR

Starts in late 1930s in UK just before World War II with the establishment of teams of scientists to study the strategic and tactical problems involved in military operations.

The objective: to **find the most effective utilization of limited military resources** by the use of quantitative techniques.

After war OR spread in different ways in the UK and USA.

Most OR involves carrying out a large number of numeric calculations. Without computers this would simply not be possible.

Jenny Díaz Ramírez PhD

History of OR …

Organization of flying maintenance and inspection

- **Problem**: in a squadron each aircraft, in a cycle of approximately 350 flying hours, required in terms of routine maintenance 7 minor inspections (lasting 2 to 5 days each) and a major inspection (lasting 14 days). How then was flying and maintenance to be organized to make best use of squadron resources?
- **Decision**: the current procedure, whereby an aircrew had their own aircraft, and that aircraft was serviced by a devoted ground crew, was inefficient .
- **Proposal**: A central garage system whereby aircraft were sent for maintenance when required and each aircrew drew a (different) aircraft when required.
- **Outcome**: In one trial (over 5 months) the daily operational flying hours were increased by 61% .

Jenny Díaz Ramírez PhD

History of OR ...

Organization of flying maintenance and inspection

- **Problem**: in a squadron each aircraft, in a cycle of approximately 350 flying hours, required in terms of routine maintenance 7 minor inspections (lasting 2 to 5 days each) and a major inspection (lasting 14 days). How then was flying and maintenance to be organized to make best use of squadron resources?
- **Decision**: the current procedure, whereby an aircrew had their own aircraft, and that aircraft was serviced by a devoted ground crew, was inefficient .
- **Proposal**: A central garage system whereby aircraft were sent for maintenance when required and each aircrew drew a (different) aircraft when required.
- **Outcome**: In one trial (over 5 months) the daily operational flying hours were increased by 61% .

Jenny Díaz Ramírez PhD

History of OR …

Improvement of attack kill probability

(the probability of attacking and killing a U-boat)

- **Problem**: Experience showed that it required some 170 man-hours by maintenance and ground staff to produce one hour of operational flying and more than 200 hours of flying to produce one attack on a surfaced U-boat. Hence over 34,000 man-hours of effort were necessary just to attack a U-boat. In early 1941 the attack kill probability was 2% to 3%. This low attack kill probability is what it really needs to be improved.
- **Decision**: on six variables considered as influencing the kill probability.
- **Outcome**: The overall effect of all the measures was such that by 1945 the attack kill probability had risen to over 40% (remember it started out at 2-3%).

Jenny Díaz Ramírez PhD

OR Definition

Jenny Díaz Ramírez PhD

OR Definition

OR is the discipline of applying advanced analytical methods to help **make better decisions.**

By using techniques such as mathematical modeling to analyze complex situations, OR gives executives the power to make more effective decisions and build more productive systems based on:

- More complete data
- Consideration of all available options
- Careful predictions of outcomes and estimates of risk
- The latest decision tools and techniques

(the Science of Better)

Jenny Díaz Ramírez PhD

Other OR Definition

OR is the application of the scientific method, by interdisciplinary teams, to problems related to the management and control of organizations or systems in order to produce solutions that help to reach the organization objectives.

- Organizational vision
- Gives conclusions to the decision maker
- Extense application: manufacturing, transportation, health, army, etc.

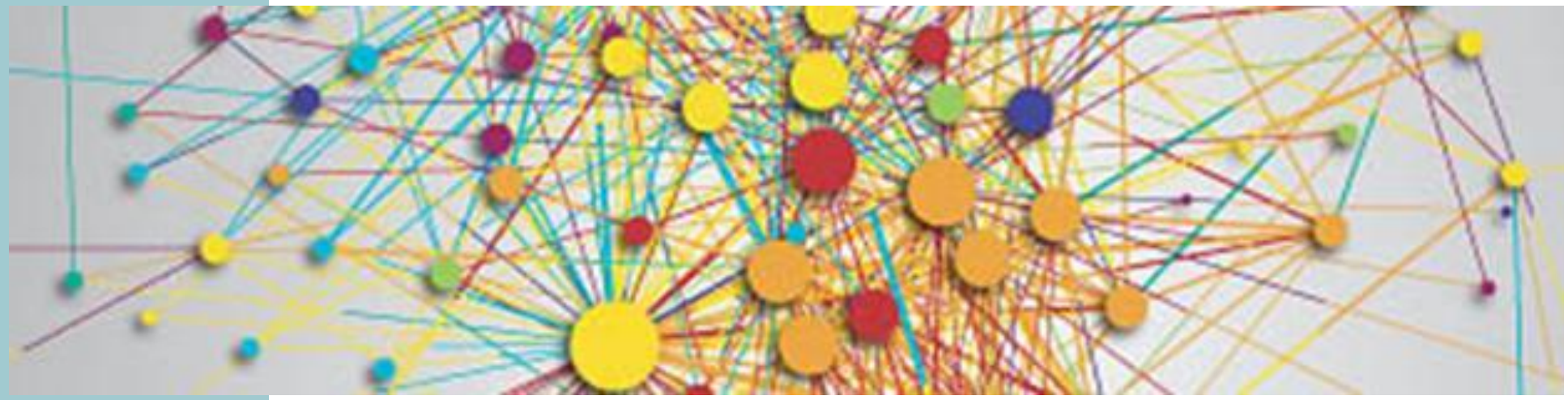
Jenny Díaz Ramírez PhD

One more …

Interdisciplinary branch of mathematics which uses methods like mathematical modeling, statistics, and algorithms to arrive at optimal or good decisions in complex problems which are concerned with optimizing.

- the maxima (profit, faster assembly line, greater crop yield, higher bandwidth, etc) or
- The minima (cost loss, lowering of risk, etc) of some objective function.

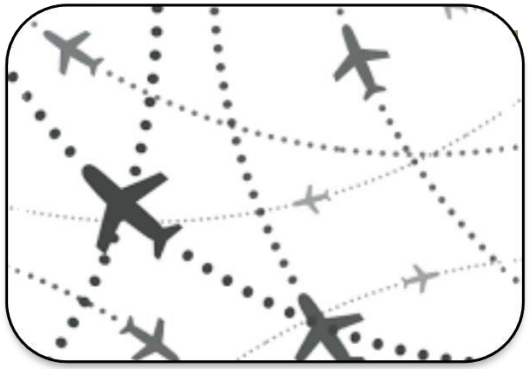
Jenny Díaz Ramírez PhD



Aplicaciones

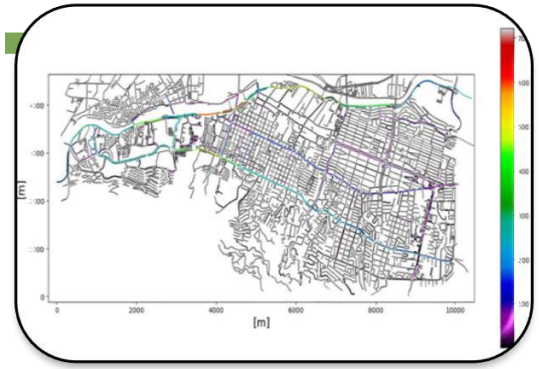
Jenny Díaz Ramírez PhD

OR Applications

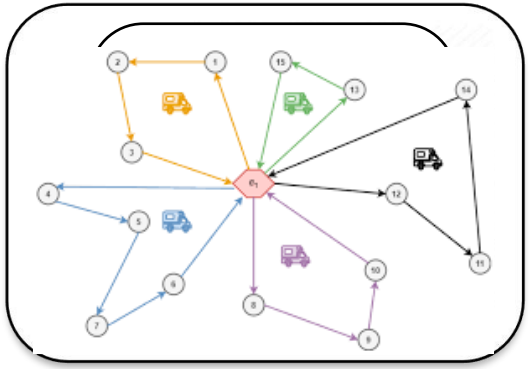


Ruteo y programación de tripulaciones de aviones integrado

Programación y secuenciación



Microsimulación de tráfico

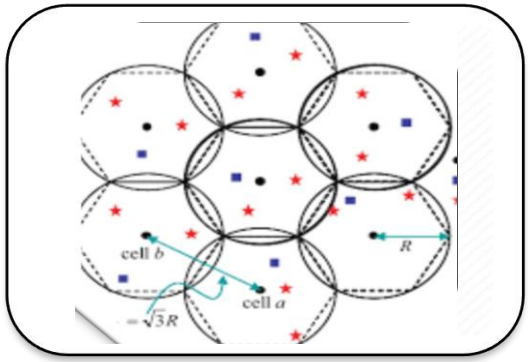


Ruteo de vehículos para distribución

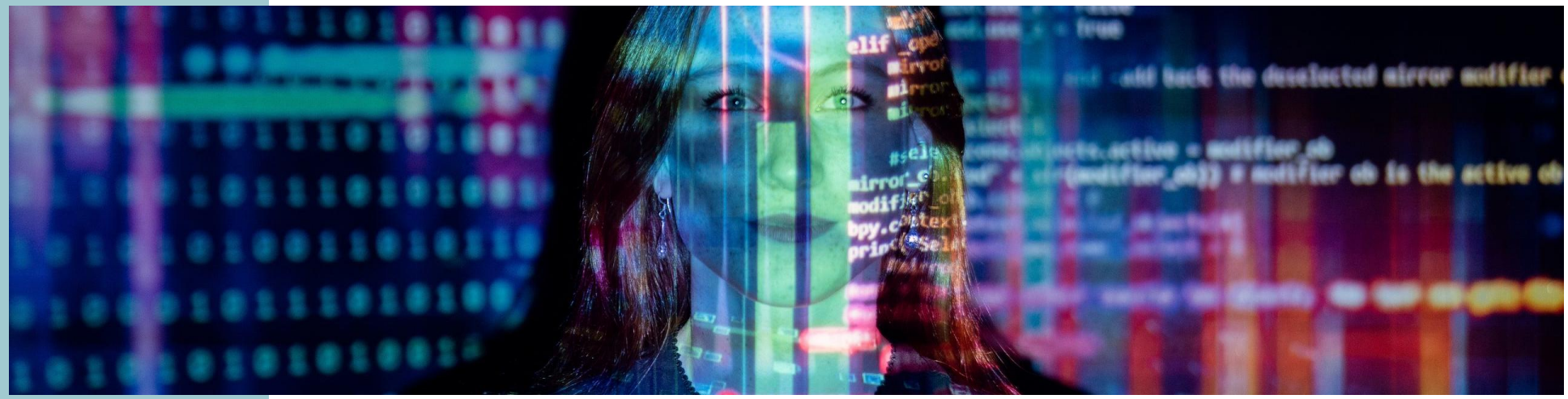
Distribución de almacenes

Distribución de última milla

Ruteo interunivesitario



Localización de instalaciones: e.g., antenas parabólicas

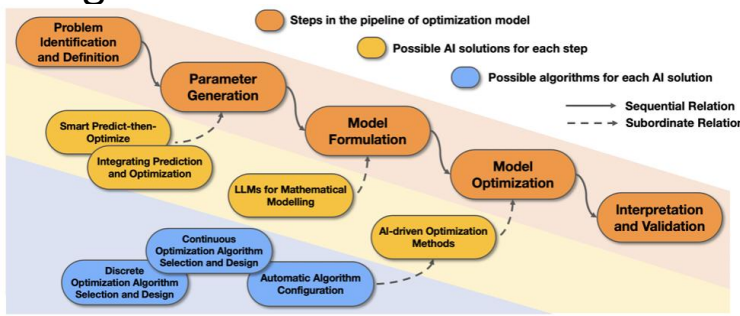


Tendencias

Jenny Díaz Ramírez PhD

Tendencias

Integración con la IA



Fan, Z., Ghaddar, B., Wang, X., Xing, L., Zhang, Y., & Zhou, Z. (2024). Artificial Intelligence for Operations Research: Revolutionizing the Operations Research Process.

Optimización computacional en paralelo

Desarrollo de algoritmos en paralelo, optimización híbrida, etc.

Métodos Heurísticos y Metaheurísticos

Avances en optimización combinatoria

Aplicaciones en campos emergentes

Sistemas autónomos, ciudades inteligentes, gemelos digitales, y otros sistemas complejos.

Jenny Díaz Ramírez PhD