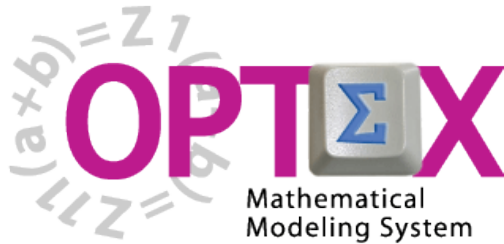


TUTORIAL – SESSION 6

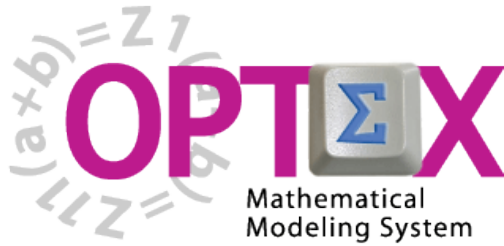
IMPLEMENTATION OF THE VRP PROBLEM (VEHICLE ROUTING PROBLEM)





TUTORIAL BASIC

1. **SESSION 1: INTRODUCTION**
 - Introduction to OPTEX (Section 1)
 - OPTEX-EXCEL-MMS (Section 2)
2. **SESSION 2: VRP MODELING IN EXCEL**
 - VRP: Vehicle Routing Problem (Section 3)
 - Implementing VRP Model using EXCEL (Section 4)
3. **SESSION 3: USING EXCEL TO LOAD DATA**
 - Industrial Data Information Systems –IDIS- (Section 5)
4. **SESSION 4: OPTEX-GUI – LOADING MODELS**
 - Loading the Model in OPTEX-MMIS (Section 6)
 - Verification of the Model in OPTEX-MMIS (Section 7)
5. **SESSION 5: Loading and Checking Industrial Data**
 - Implementation and Validation of IDIS- (Section 8)
6. **SESSION 6: Solving Mathematical Models**
 - Scenarios and Families of Scenarios (Section 9)
 - Solution of Mathematical Problems (Section 10)
 - Results Information System (Section 11)
7. **SESSION 7: SQL Servers**
 - Using SQL Servers for IDIS (Section 12)
8. **SESSION 8: Optimization Technologies**
 - Solving Problems using C (Section 13.1)
 - Solving Problems using GAMS (Section 13.2)
 - Solving Problems using IBM OPL (Section 13.3)



TUTORIAL IMPLEMENTATION OF THE VRP PROBLEM (VEHICLE ROUTING PROBLEM)

TUTORIAL BASIC

6. SESSION 6: Solving Mathematical Models

- **Scenarios and Families of Scenarios (Section 9)**
- **Solution of Mathematical Problems (Section 10)**
- **Results Information System (Section 11)**

SCENARIOS AND FAMILIES OF SCENARIOS

In this moment the modeler has a right model and a set of correct data, therefore, it has a proper environment for “run” the mathematical model with the data stored in the IDIS.

When the user works only with OPTEX-EXCEL-MMS without access OPTEX-GUI, he must consider only the concept of scenario as there is not a way to group the cases, because in EXCEL does not exist the family of scenarios concept, then it is equal to consider a system with family of scenarios that have only one scenario.

OPTEX always meet the specified model for a scenario/case.

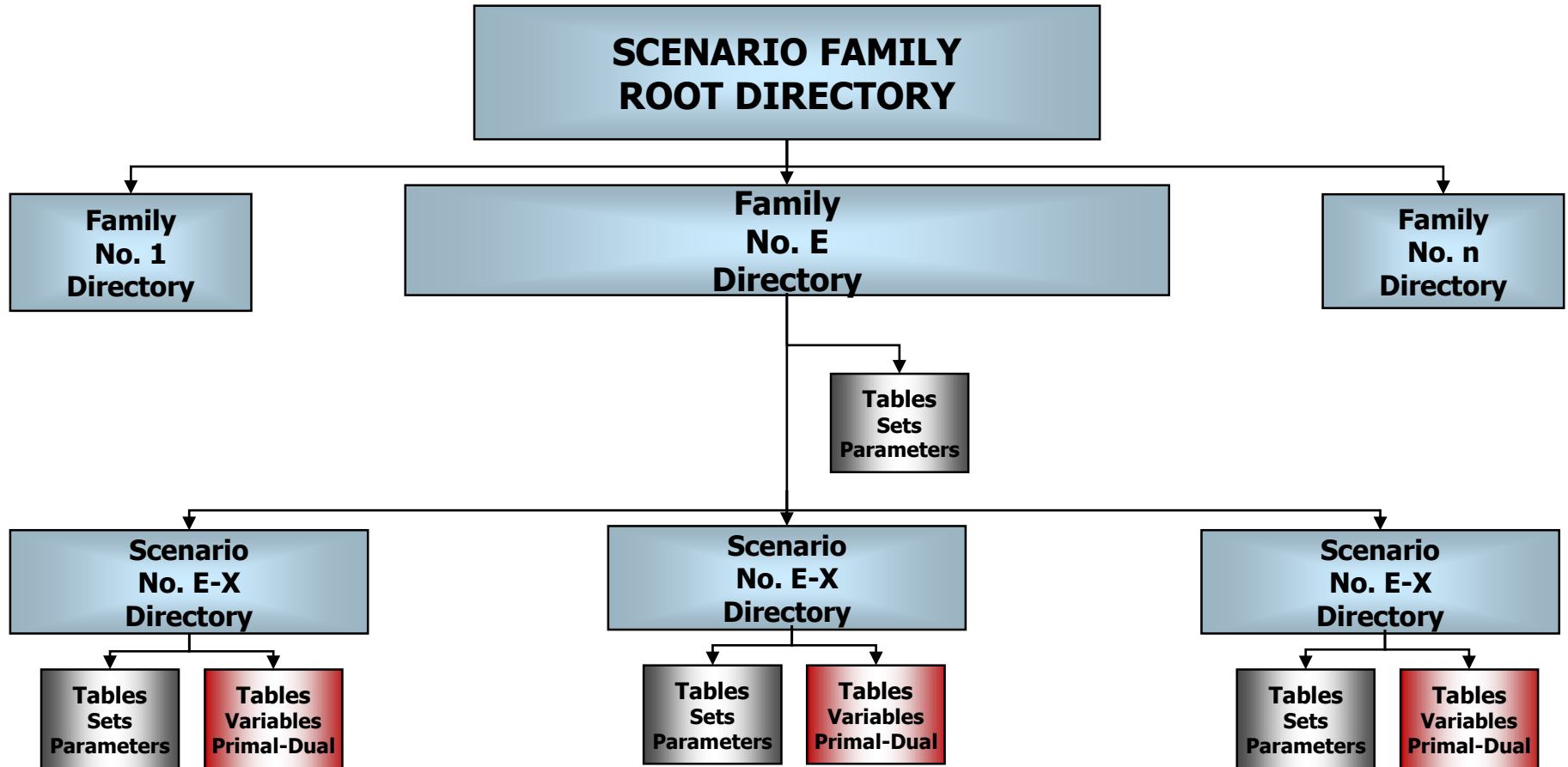
SCENARIOS AND FAMILIES OF SCENARIOS CONCEPTUALIZATION

The concept of **Family of Scenarios** and **Scenarios** can group the runs of the mathematical models according to common criteria, deemed appropriate by the user, preferably in mathematical terms that take advantages of this fact; however, this is not needed and families can just be associated with cases that are run using a mathematical model available in the decision support system.

In OPTEX-GUI, a scenario has its own information system. This means that two families of scenarios can have two different information systems, each designed according to the decision supported by the specific model/problem.

The information system of a scenario is divided between the common information for all scenarios that make up the family, and data from each specific scenario. The administrator is responsible for the coordination of integrated information system. The definition of these information systems is made in OPTEX-GUI when the modeler configures the IDIS. The part of the information system that is located in the area of scenarios it is assumed symmetric for all scenarios within a family.

HIERARCHIC INFORMATION SYSTEM FOR MODELS RESULTS



OPT Σ X AUTOMATICALLY GENERATES A HIERARCHIC INFORMATION SYSTEM TO STORE THE RESULTS OF THE MODELS USING THE CONCEPTS OF SCENARIOS AND FAMILY OF SCENARIOS.

SCENARIOS AND FAMILIES OF SCENARIOS

DEFINITION

The first step to define a family of scenarios, or a scenario, is to have clear the mathematical model and the objective function to use, that delimit the problem that modeler wish to associate with the family; to do this the user must determine:

- **ID/Code:** Code given to the scenario family, or to the scenario. This code will be used by OPT Σ X for the location data-tables as it determines the directory that is located from the root directory of scenarios.
- **Description**
- **Model ID:** mathematical model associated
- **Planning Horizon ID:** the planning horizon associated with the scenarios family. It is required to discrete time models.
- **Objective Function:** objective function ID
- **Type of Optimization:** maximize, minimize, minimax or maximin.
- **Start Date:** date for which time is considered zero. ($t = 0$). Valid for models with discrete time periods.
- **Start Time:** Start time for time zero. ($t = 0$)

SCENARIOS AND FAMILIES OF SCENARIOS

DEFINITION

To parameterize families of scenarios at OPTEX-GUI it is required to access the window of Families of Scenarios that includes tools that are activated with the right click of the mouse:

- Automatically create the tables needed for the family of scenarios, and
- Enable the control window OPTEX-EXE

In the case of the VRP to define a family of scenarios, or scenario, it should be specifying:

- Mathematical Model
- Objective Function
- Scenario Control Tables; tables **ESC_XXX** where **XXX** is associated with the physical entity of the information system. In this case **VEH**, **NOD**, **CAJ** and **PED**.

SCENARIOS AND FAMILIES OF SCENARIOS DEFINITION

The following figure shows the definition of two families of scenarios (scenarios in case OPTEX-EXCEL-MMS).

OPTEX-VRP - Family of Scenarios

Archivo Edición Ver Análisis Ver Ayuda

Code: VRP

Spanish Description: Modelo VRP

English Description: Vehicle Routing Problem

Decision Support System Code: [Dropdown]

Model Code: Ruteo Vehiculos (VRP)

Planning Horizon Code: [Dropdown]

Horizon Start Date: 16/12/2015

Initial Time/Hour: [Text Box]

Objective Function Code: Costo Total de Funcionamiento

Type Code Optimization: Minimizar

Type Code Optimization 12:24:35 p. m.

| | A | B | C | D | E | F | G |
|---|---------|--|--|------------|------------------------------|-------------------------|------------------------|
| 1 | COD_ESC | DES_ESC | DN_ESC | COD_MOD | COD_DSS | COD_FOB | COD_TOP |
| 2 | Code | Spanish Description | English Description | Model Code | Decision Support System Code | Objective Function Code | Type Code Optimization |
| 3 | VRP | Modelo VRP | Vehicle Routing Problem | VRP | DSSVRP | CTOT | MIN |
| 4 | VRP2C | Ruteo Vehiculos (VRP) - Peso + Volumen | Vehicle Routing Problem - Weigh + Volume | VRP2C | DSSVRP | CTOT | MIN |

| Code | Spanish Desc. | English Desc. | Model | DSS | Objective Func. | Type Opt |
|-------|--|--|-------|--------|-----------------|----------|
| VRP | Modelo VRP | Vehicle Routing Problem | VRP | DSSVRP | CTOT | MIN |
| VRP2C | Ruteo Vehiculos (VRP) - Peso + Volumen | Vehicle Routing Problem - Weigh + Volume | VRP2C | DSSVRP | CTOT | MIN |

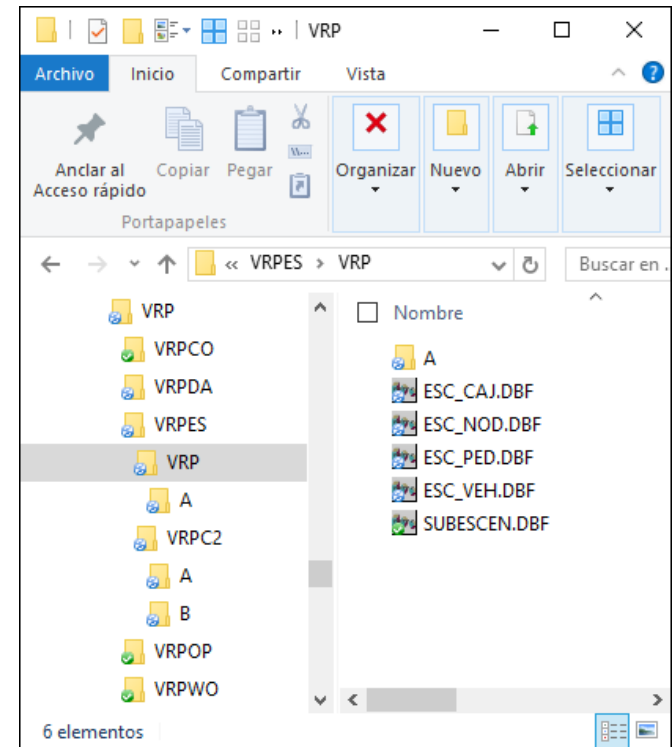
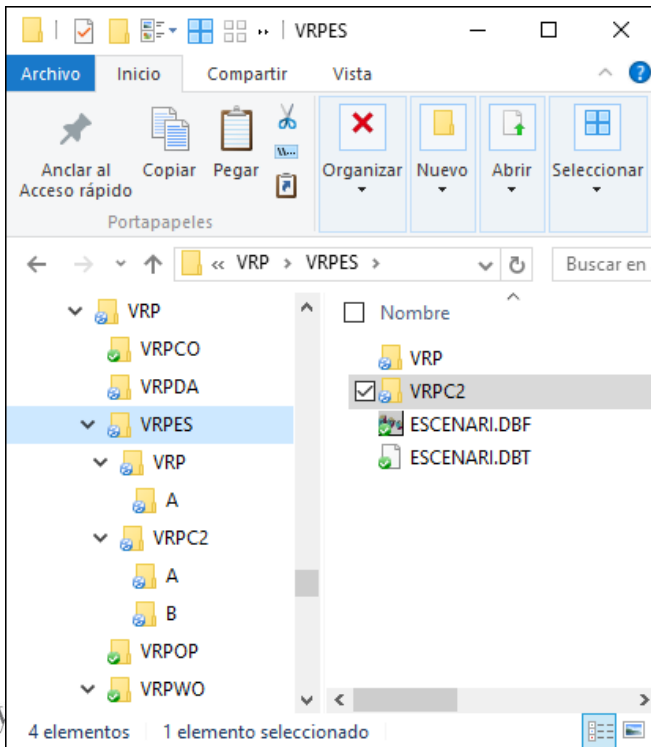
01:17:17 p. m.

SCENARIOS AND FAMILIES OF SCENARIOS

SCENARIO TABLES : LOCATION

The first step in locating tables that define the configuration of industrial database, which will consider the mathematical models, is related to the understanding of the possible locations of the tables within the areas of the application. In the images that are presented below are designed two families of scenarios, **VRP** (with a scenario **A**) and **VRPC2** (with a scenario **A** and one **B**); families scenarios differ in the mathematical models, VRP and VRPC2.

In the root directory of the families of scenarios (**VRPES**) must be located **ESCENARI** table containing the families of scenarios and in the root directory of each scenario family **SUBESCEN** must locate the table containing the family scenario.



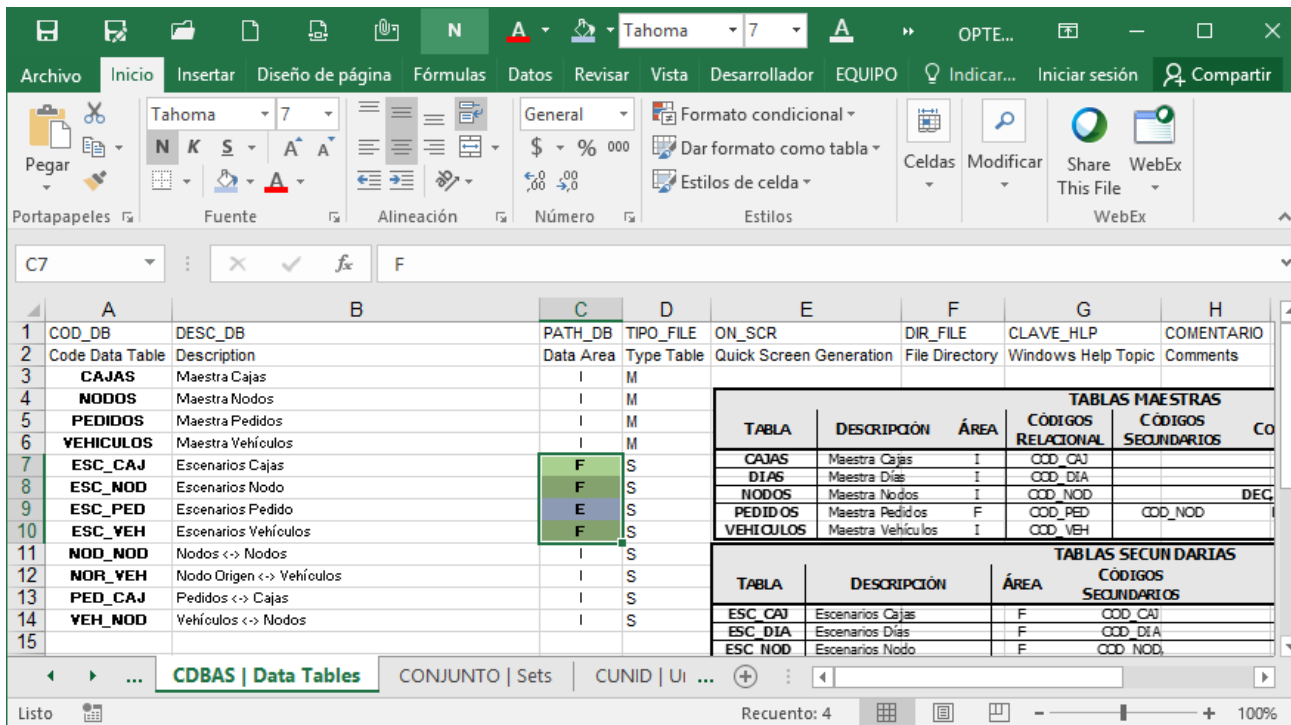
SCENARIOS AND FAMILIES OF SCENARIOS

SCENARIO TABLES : LOCATION

The configuration of the family is to define its topology, means, those entities of IDIS to be included in the mathematical model, which define the relationships between entities that will be taken into account. "Normally", to do this a set of tables at the level of the family of scenarios is defined.

In this case, scenarios are differentiated by the number of vehicles, orders, customers and boxes involved in the scenario. For this reason, the scenario tables are relocated in the in the root of the families of scenarios (**ESC_VEH**, **ESC_CLI** and **ESC_CAJ**) and (**ESC_PED**) in the scenario. **It should be noted that the subset of physical entities in the scenarios must comply with the rules of integrity of the information system.**

The following figure presents in EXCEL table **CDBAS** with the new locations.



| COD_DB | DESC_DB | PATH_DB | TIPO_FILE | ON_SCR | DIR_FILE | CLAVE_HLP | COMENTARIO |
|-----------------|---------------------------|-----------|------------|-------------------------|----------------|--------------------|------------|
| Code Data Table | Description | Data Area | Type Table | Quick Screen Generation | File Directory | Windows Help Topic | Comments |
| CAJAS | Maestra Cajas | I | M | | | | |
| NODOS | Maestra Nodos | I | M | | | | |
| PEDIDOS | Maestra Pedidos | I | M | | | | |
| VEHICULOS | Maestra Vehículos | I | M | | | | |
| ESC_CAJ | Escenarios Cajas | F | S | | | | |
| ESC_NOD | Escenarios Nodos | F | S | | | | |
| ESC_PED | Escenarios Pedido | E | S | | | | |
| ESC_VEH | Escenarios Vehículos | F | S | | | | |
| NOD_NOD | Nodos <-> Nodos | I | S | | | | |
| NOR_VEH | Nodo Origen <-> Vehículos | I | S | | | | |
| PED_CAJ | Pedidos <-> Cajas | I | S | | | | |
| VEH_NOD | Vehículos <-> Nodos | I | S | | | | |

| TABLA | DESCRIPCIÓN | ÁREA | CÓDIGOS RELACIONAL | CÓDIGOS SECUNDARIOS | CO |
|-----------|-------------------|------|--------------------|---------------------|-----|
| CAJAS | Maestra Cajas | I | COD_CAJ | | |
| DIAS | Maestra Días | I | COD_DIA | | |
| NODOS | Maestra Nodos | I | COD_NOD | | DEC |
| PEDIDOS | Maestra Pedidos | F | COD_PED | COD_NOD | |
| VEHICULOS | Maestra Vehículos | I | COD_VEH | | |

| TABLA | DESCRIPCIÓN | ÁREA | CÓDIGOS SECUNDARIOS |
|---------|------------------|------|---------------------|
| ESC_CAJ | Escenarios Cajas | F | COD_CAJ |
| ESC_DIA | Escenarios Días | F | COD_DIA |
| ESC_NOD | Escenarios Nodos | F | COD_NOD |

SOLUTION OF THE MATHEMATICAL MODELS

SOLUTION VIA REMOTE OPTEX-WEB

OPTIMIZATION SERVER Powered by **OPT Σ X** Mathematical Modeling System

Output File: GAMS

Library: CPLEX

LP Algorithm: Default

Feasibility: NO Relajacion

Objective F: Activa

Emphasis: Optimalidad+Facilit

Load, check model

Check data

Load data

Execute Model

Deterministic Mode

Parallel Optimization

Tuning

Parallel Problems

Parametric Optimization: Regular optimizati

Initial Solution

Subrogation

SOS Sets

PreFix Variables

No Error

Disjuntive Programming

Cores Solver: Default

Time (seg): []

MIP Gap (%): []

Iterations: []

Output Language: English

Selective Variables

Only Results

Constrains

Filter Results

Detail Log

Entities Tables

GIS Tables

GANTT Tables

EXCEL-GUI

EXCEL-Tables

EXCEL Book

OLAP Cubes

Tableau

QLIK View

XML File

MPS File

Inputs File: [] [Examinar...](#)

Model File: [] [Examinar...](#)

Server: DW Server 16 Cor

IP: 4.31.168.188

Connections: 120

Process: 1800

Socket: 5000

Action: Solver Remote

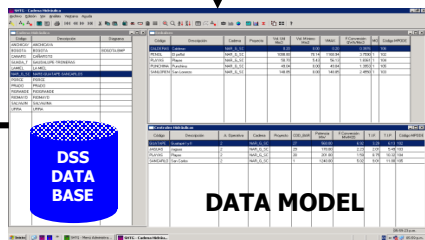
User: optexmms

Password: []

[Send](#) [Clear](#)



SOLUTION OF THE MATHEMATICAL MODELS SOLUTION VIA OPTEX-EXCEL-MMS



ALGEBRAIC MODEL

$$\text{Min } \Psi = \sum_{t=1}^T \sum_{j=1}^{N_j} \Psi_{(t,j)}$$

s.a.

$$\Psi_{(t,j)} = \frac{e_{(t,j)}}{2} \cdot P_{(t,j)}^2 + e_{(t,j)} \cdot P_{(t,j)}$$

$$V_{(t,j+1)} = V_{(t,j)} + \tau \cdot (A_{(t,j)} - Q_{(t,j)} - S_{(t,j)})$$

$$P_{(t,j)} = \rho_{(j)} \cdot Q_{(t,j)}$$

OPTEX-EXCEL-MMS
OPTEX-EXCEL-MATHEMATICAL MODELING SYSTEM

Control

User Code: JWB
OPTEX Key: []
Input Data: C:\GENEX\userexcel\input_OPTEX_EXCEL

Scenario

Code: VRSPT
Description: VRSPT
Model: Ruffino Urbano con Ventanas de Tiempo
Obj Function: VRSPTW
Optimization direction: MIN
Decision Tree: []
Planning Horizon: 12,000.00 a. m.
Horizon Start Date: []
Initial Time/hour: []

Optimization

Output file: GAMS
Library: CPLEX 64 bits v12.2
Date: Archivo texto

Feasibility: NO Relaxacion
Objective F: Activa

Run Optex: Run Solver Parallel Solution Tuning

Phases

Load, Check Model Load Data
 Check Data Execute Model

Initial Solution Prefixed Variables
 Subrogation No Error validation

Export CSV

Mathematical Model
 Data Model
 CSV Data Directory

Export Files

Results Recover

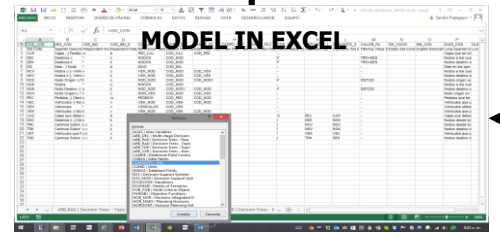
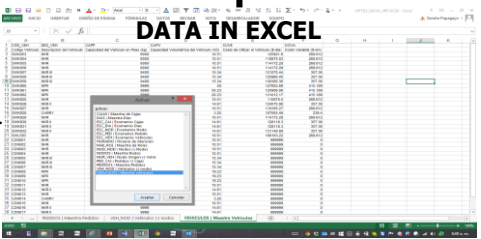
Selective
 Variables
 Only Results
 Constraints

Recover Results

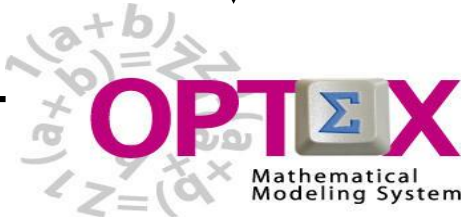
Excel New Books

Mathematical Model
 Data Model

optexmodel.opx *.CSV FILES



FILLING THE BLANKS



CODE GENERATION

OPTIMIZATION TECHNOLOGY

C++

GAMS

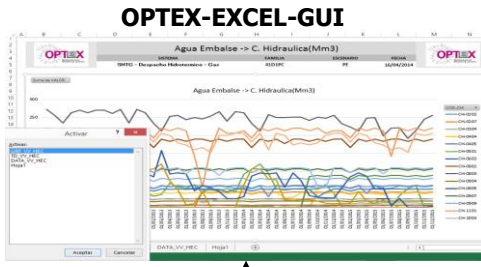
ILOG
An IBM Company

**FICO™
MOSEL**

AIMMS

OPL

AMPL



PRIMAL - DUAL VARIABLES

SOLUTION OF THE MATHEMATICAL MODELS

SOLUTION VIA OPTEX-EXCEL-MMS

OPTEX-EXCEL-MMS is an application developed in Visual Basic using EXCEL functionality.

OPTEX-EXCEL-MMS collects two files in EXCEL, the first mathematical models (MMIS) and the second the input data (IDIS), and generates CSV files for each sheet of EXCEL workbooks and generates the OPTEX initialization file (optexmodel.opx) that defines the process to be performed, which is oriented to generate a code in a particular technology optimization and use it to solve the mathematical problems that are part of the model.

SOLUTION OF THE MATHEMATICAL MODELS

SOLUTION VIA OPTEX-EXCEL-MMS

Upon entering the OPTEX-EXCEL-MMS application the next screen, that integrates several areas related to control of OPTEX, is observed.

OPTEX-EXCEL-MATHEMATICAL MODELING SYSTEM ✕

Inicio

Control

User Code:

OPTEX Key:

Input Data: ?

Scenario

Code:

Scenario:

Description:

Model:

Obj Function:

Optimization direction:

Decision Tree:

Planning Horizon:

Horizon Start Date:

Initial Time/Hour:

CONTROL

Optimization

Output file: Feasibility:

Library: Objective F:

Data: Disjunctive programming SOS

Run Solver Parallel Solution Tuning

Phases

Load, Check Model Load Data

Check Data Execute Model

Initial Solution Prefixed Variables

Subrogation No Error validation

Export CSV

Mathematical Model

Data Model

CSV Data Directory

Optimization Server

Activate Server Server: IP:

User: Clave: Socket:

Results Recover

Selective

Variables

Only Results

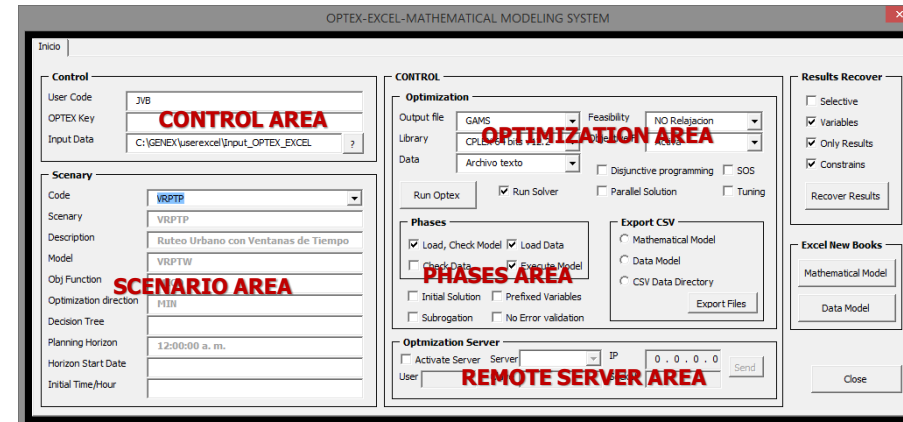
Constrains

Excel New Books

SOLUTION OF THE MATHEMATICAL MODELS

SOLUTION VIA OPTEX-EXCEL-MMS

- **Control Area** in which the user must enter its data and select the folder (directory) containing the CSV files, for the mathematical model and the data model.
- **Optimization Area** allows to select the options that are used to solve the mathematical model, the main selection is related to the optimization platform to use.
- **Phases Area** is part of the optimization area and lets to select what actions will perform OPTEX. These possibilities have already been described previously and determine whether:
 - Load and check the model
 - Load industrial data and if the data integrity is verified
 - Run the program that solves the mathematical model
- **Scenario Area** that allows the user to characterize and select the scenario and the model that will solve by OPTEX. These options are taken from the ESCENARI.csv table that must be included in the selected directory.
- **Remote Server Area** contains the data of the remote server on which the problem will be solved, when the user uses this option.



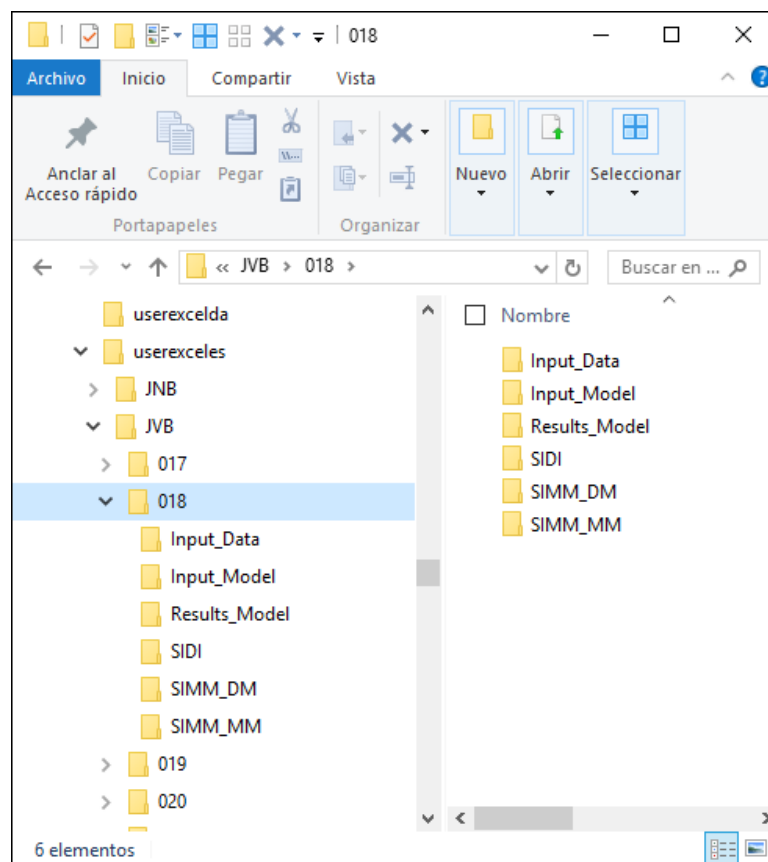
Annex A contains the component installation procedure to be followed by the user to control the execution of OPTEX-EXCEL-MMS on a remote server OPTEX.

SOLUTION OF THE MATHEMATICAL MODELS

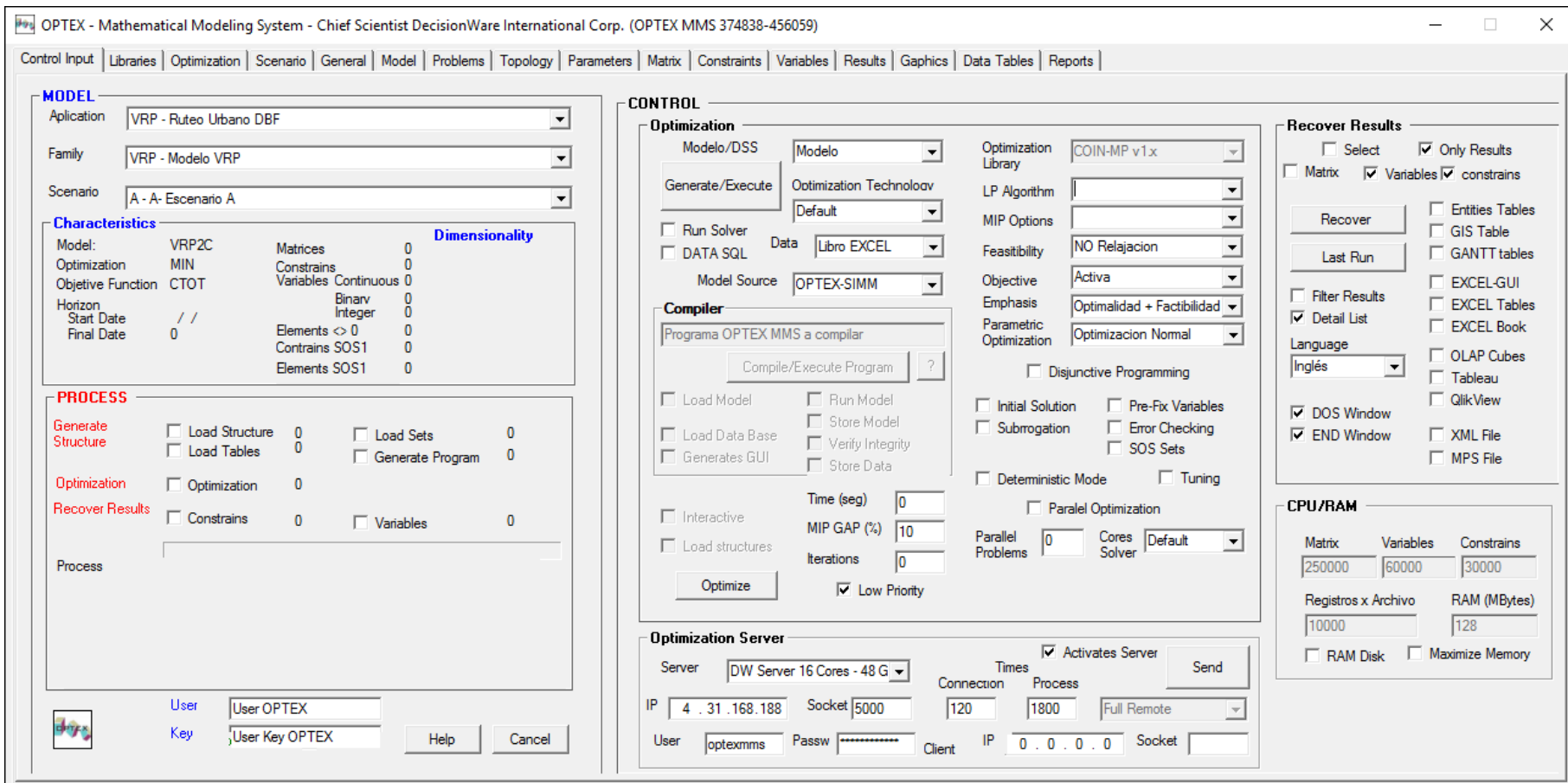
SOLUTION VIA OPTEX-EXCEL-MMS

The results of the process are stored in a directory nnn (a numerical code assigned by OPTEX, considering user code) which contains six (6) subdirectories with the following contents.

- **Input_Model:** CSV files used to load the mathematical model and the data model of the application
- **Input_Data:** CSV files used to load industrial data to the data tables described in the data model of the application.
- **Input_Model:** CSV files used to load the mathematical model and the data model of the application.
- **IDIS:** DBF format tables that contain the data used to solve the mathematical model
- **MMIS_MM:** tables in DBF format containing the formulation of the mathematical model.
- **MMIS_DM:** tables in DBF format containing the structure of IDIS data model IDIS and all tables that are required to handle the user interface using OPTEX-GUI.
- **Results_Model:** OPTEX processing results, include all the files used as input to computer programs and mathematical models and results tables in CSV format. The results are the same as those obtained when the OPTEX-EXE is used.



SOLUTION OF THE MATHEMATICAL MODELS SOLUTION VIA OPTeX-EXE



The screenshot displays the OPTeX - Mathematical Modeling System interface, showing various configuration panels for solving mathematical models.

MODEL Panel:

- Application: VRP - Ruteo Urbano DBF
- Family: VRP - Modelo VRP
- Scenario: A - A - Escenario A

Characteristics Panel:

| Model: | VRP2C | Matrices | 0 | Dimensionality |
|--------------------|-------|-----------------|--------------|----------------|
| Optimization | MIN | Constrains | 0 | |
| Objective Function | CTOT | Variables | Continuous 0 | |
| Horizon | | Binav | 0 | |
| Start Date | / / | Integer | 0 | |
| Final Date | 0 | Elements > 0 | 0 | |
| | | Constrains SOS1 | 0 | |
| | | Elements SOS1 | 0 | |

PROCESS Panel:

- Generate Structure: Load Structure 0, Load Sets 0, Load Tables 0, Generate Program 0
- Optimization: Optimization 0
- Recover Results: Constrains 0, Variables 0

CONTROL Panel:

- Modelo/DSS: Modelo
- Optimization Library: COIN-MP v1.x
- Optimization Technology: Default
- Data: Libro EXCEL
- Model Source: OPTeX-SIMM
- Compiler: Programa OPTeX MMS a compilar
- Optimize: Load Model, Run Model, Load Data Base, Store Model, Generates GUI, Verify Integrity, Store Data
- Time (seg): 0, MIP GAP (%): 10, Iterations: 0, Low Priority
- Optimization Server: DW Server 16 Cores - 48 G, Activates Server:

Recover Results Panel:

- Select, Only Results
- Matrix, Variables, constrains
- Recover, Last Run buttons
- Entities Tables, GIS Table, GANTT tables, EXCEL-GUI, EXCEL Tables, EXCEL Book, OLAP Cubes, Tableau, QlikView
- Language: Inglés
- DOS Window, END Window, XML File, MPS File

CPU/RAM Panel:

| Matrix | Variables | Constrains |
|---------------------|--------------|------------|
| 250000 | 60000 | 30000 |
| Registros x Archivo | RAM (MBytes) | |
| 10000 | 128 | |

User/Key Panel:

- User: User OPTeX
- Key: User Key OPTeX

Control is exercised defining parameters that are placed in various areas which are described in detail in the Manual OPTeX User; then, the window is partially presented:

SOLUTION OF THE MATHEMATICAL MODELS

OPTEX-EXE - MODEL AREA

Oriented selection of the case to be solved, the user must select:

- **OPTEX Application**
- **Scenario Family**
- **Sscenario**

MODEL

Application: VRP - Ruteo Urbano DBF

Family: Ruteo Urbano con Ventanas de Tiempo (Pequeño)

Scenario: A - Escenario

The screenshot shows the OPTEX Mathematical Modeling System interface. The 'MODEL' section is highlighted with a red circle, showing the following settings:

- Application: VRP - Ruteo Urbano DBF
- Family: VRP - Modelo VRP
- Scenario: A - Escenario A

The 'CONTROL' section includes the following settings:

- Modelo/DSS: Modelo
- Optimization Library: COIN-MP v1.x
- Optimization Technology: LP Algorithms
- MP Options: NO Relaxation
- Feasibility: Active
- Objective: Optimized + Feasibilidad
- Parametric Optimization: Optimization Normal
- Compiler: Programs OPTEX MMS a compiler
- Optimization Server: DW Server 16 Cores - 48 G

The 'PROCESS' section includes the following settings:

- Generate Structure: Load Structure 0, Load Sets 0
- Optimization: Optimization 0, Generate Program 0
- Recover Results: Constraits 0, Variables 0

The 'RECOVER RESULTS' section includes the following settings:

- Select: Only Results
- Recover: Entities Tables, GANT Tables, EXCEL Tables, EXCEL Book, OLAP Cubes, Tableau, QlikView, XML File, MPS File

The 'CPU/RAM' section includes the following settings:

- Matrix: 250000, Variables: 60000, Constraints: 30000
- Registro x Archivo: 10000, RAM (Mbytes): 128
- RAM Dak: Maximize Memory

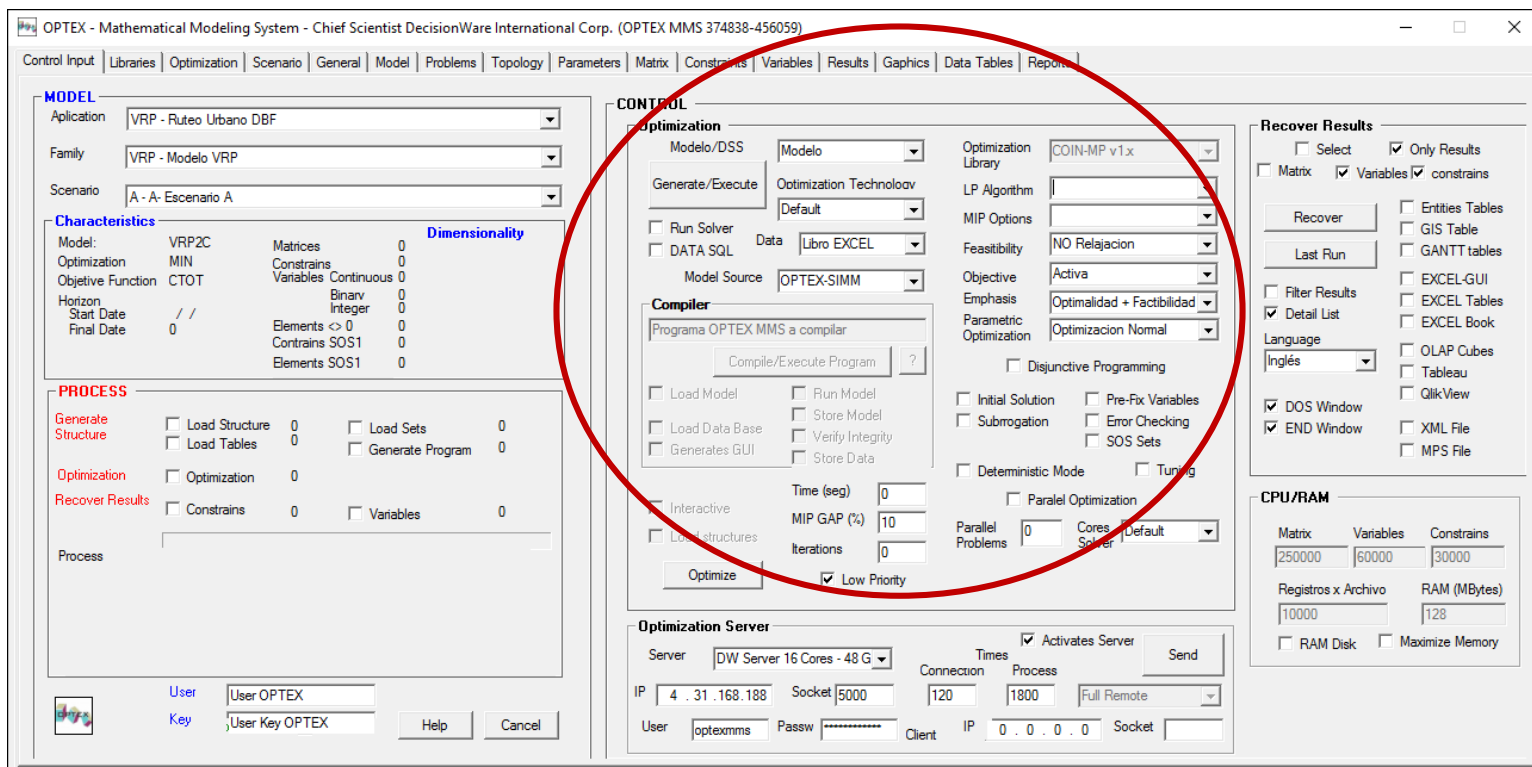
SOLUTION OF THE MATHEMATICAL MODELS

OPTEX-EXE - CONTROL AREA

Oriented to specify the actions, and the setting of such actions, under which will operate OPTEX-EXE.

It consists of several sub-areas.

- Optimization
- Data Recovery
- Optimization Server
- CPU/RAM



MODEL

Application: VRP - Ruteo Urbano DBF
 Family: VRP - Modelo VRP
 Scenario: A - A - Escenario A

Characteristics

| Model: | VRP2C | Matrices | 0 | Dimensionality |
|--------------------|-------|-----------------|--------------|----------------|
| Optimization | MIN | Constrains | 0 | |
| Objective Function | CTOT | Variables | Continuous 0 | |
| Horizon | | Binav | Integer 0 | |
| Start Date | // | Elements <> 0 | 0 | |
| Final Date | 0 | Constrains SOS1 | 0 | |
| | | Elements SOS1 | 0 | |

PROCESS

Generate Structure: Load Structure 0 Load Sets 0
 Load Tables 0 Generate Program 0

Optimization: Optimization 0

Recover Results: Constrains 0 Variables 0

CONTROL

Optimization

Modelo/DSS: Modelo
 Generate/Execute: Optimization Technology: Default
 Run Solver
 DATA SQL Data: Libro EXCEL
 Model Source: OPTEX-SIMM

Compiler

Programa OPTEX MMS a compiler
 Load Model Run Model
 Load Data Base Store Model
 Generates GUI Verify Integrity
 Store Data

Time (seg): 0
 MIP GAP (%): 10
 Iterations: 0
 Low Priority

Optimization Server

Server: DW Server 16 Cores - 48 G
 Times: Activates Server
 Connection: 120
 Process: 1800
 IP: 4 . 31 . 168 . 188 Socket: 5000 Full Remote:

Recover Results

Matrix Variables constrains
 Only Results
 Entities Tables
 GIS Table
 GANTT tables
 EXCEL-GUI
 EXCEL Tables
 EXCEL Book
 OLAP Cubes
 Tableau
 QlikView
 DOS Window
 END Window
 XML File
 MPS File

CPU/RAM

| Matrix | Variables | Constrains |
|---------------------|--------------|------------|
| 250000 | 60000 | 30000 |
| Registros x Archivo | RAM (MBytes) | |
| 10000 | 128 | |

RAM Disk Maximize Memory

SOLUTION OF THE MATHEMATICAL MODELS

OPTEX-EXE - OPTIMIZATION SUB-AREA

Oriented to specify the parameters to be considered when performing the optimization. It is organized by several "sub-sections" related to different aspects of the process.

Optimization

| | |
|---|---|
| Modelo/DSS: <input type="text" value="Modelo"/> | Optimization Library: <input type="text" value="COIN-MP v1.x"/> |
| <input type="button" value="Generate/Execute"/> | LP Algorithm: <input type="text"/> |
| <input type="checkbox"/> Run Solver | MIP Options: <input type="text"/> |
| <input type="checkbox"/> DATA SQL | Feasibility: <input type="text" value="NO Relajacion"/> |
| Data: <input type="text" value="Archivo Texto"/> | Objective: <input type="text" value="Activa"/> |
| Model Source: <input type="text" value="OPTEX-SIMM"/> | Emphasis: <input type="text" value="Optimalidad + Factibilidad"/> |
| <h3>Compiler</h3> | |
| <input type="text" value="Programa OPTEX MMS a compilar"/> | |
| <input type="button" value="Compile/Execute Program"/> <input type="button" value="?"/> | |
| <input type="checkbox"/> Load Model | <input type="checkbox"/> Run Model |
| <input type="checkbox"/> Load Data Base | <input type="checkbox"/> Store Model |
| <input type="checkbox"/> Generates GUI | <input type="checkbox"/> Verify Integrity |
| | <input type="checkbox"/> Store Data |
| <input type="checkbox"/> Interactive | Time (seg): <input type="text" value="0"/> |
| <input type="checkbox"/> Load structures | MIP GAP (%): <input type="text" value="10"/> |
| | Iterations: <input type="text" value="0"/> |
| <input type="button" value="Optimize"/> | <input checked="" type="checkbox"/> Low Priority |

| |
|--|
| <input type="checkbox"/> Disjunctive Programming |
| <input type="checkbox"/> Initial Solution |
| <input type="checkbox"/> Subrogation |
| <input type="checkbox"/> Deterministic Mode |
| <input type="checkbox"/> Paralel Optimization |
| Parallel Problems: <input type="text" value="0"/> |
| Cores Solver: <input type="text" value="Default"/> |
| <input type="checkbox"/> Pre-Fix Variables |
| <input type="checkbox"/> Error Checking |
| <input type="checkbox"/> SOS Sets |
| <input type="checkbox"/> Tuning |

SOLUTION OF THE MATHEMATICAL MODELS

OPTEX-EXE - OPTIMIZATION TECHNOLOGY SECTION

Model/DSS: Specifies whether the process is related with a model or with a set of models that integrate a DSS.

Optimization Technology: Specifies the type of program to be generated. The options available depend of the type of license that the user has and on the technologies that have installed his PC or in the OPTEX-OPTIMIZATION-SERVER.

Source Model: Determines the source of the mathematical model. The options are:

- OPTEX-MMIS
- OPTEX-EXCEL.MMS
- OPTEX Program

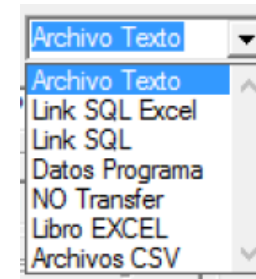
SOLUTION OF THE MATHEMATICAL MODELS

OPTEX-EXE - OPTIMIZATION TECHNOLOGY SECTION

| | |
|-------------------------------------|-------------------------|
| Modelo/DSS | Modelo |
| Generate/Execute | Optimization Technology |
| | GAMS |
| <input type="checkbox"/> Run Solver | Data |
| <input type="checkbox"/> DATA SQL | Archivo Texto |
| Model Source | OPTEX-SIMM |

Data Source: determines the data source to be used for optimization. The options are:

- **Text File:** Data tables, DBF or SQL, will become text files.
- **Link EXCEL SQL:** Data is read from a book EXCEL using an ODBC link type (used in GAMS).
- **SQL Link:** Data is read from server using an ODBC associated to the application.
- **Program Data:** Data tables, DBF or SQL are included as part of the generated program (when it applied).
- **NO Transfer:** No file transfer process is performed.
- **EXCEL Book:** The data is in an Excel workbook type OPTEX (XML) located in the directory associated with the scenario.
- **CSV files:** The data is in CSV files located in the directory associated with the scenario.



Archivo Texto

- Archivo Texto
- Link SQL Excel
- Link SQL
- Datos Programa
- NO Transfer
- Libro EXCEL
- Archivos CSV

SOLUTION OF THE MATHEMATICAL MODELS

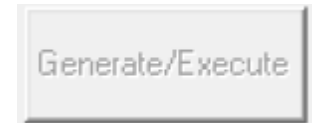
OPTEX-EXE - OPTIMIZATION TECHNOLOGY SECTION

| | |
|-------------------------------------|-------------------------|
| Modelo/DSS | Modelo |
| Generate/Execute | Optimization Technoloov |
| | GAMS |
| <input type="checkbox"/> Run Solver | Data |
| <input type="checkbox"/> DATA SQL | Archivo Texto |
| Model Source | OPTEX-SIMM |

Run Solver: Activates the process of solving the mathematical model. If unchecked, the process stops and ends by opening the IDE (Integrated Development Environment) interface of the selected optimization technology.

DATA SQL: Indicates that the data collection should access a SQL data source type, using an ODBC that the user specified during the optimization process

Generate/Execute: Button that activates the process of generating and executing the process associated with the model/DSS.



SOLUTION OF THE MATHEMATICAL MODELS

OPTEX-EXE - PARAMETER OPTIMIZATION SECTION

| | |
|--|--|
| Optimization Library | COIN-MP v1.x |
| LP Algorithm | |
| MIP Options | |
| Feasibility | NO Relajacion |
| Objective | Activa |
| Emphasis | Optimalidad + Factibilidad |
| Parametric Optimization | Optimizacion Normal |
| <input type="checkbox"/> Disjunctive Programming | |
| <input type="checkbox"/> Initial Solution | <input type="checkbox"/> Pre-Fix Variables |
| <input type="checkbox"/> Subrogation | <input type="checkbox"/> Error Checking |
| | <input type="checkbox"/> SOS Sets |
| <input type="checkbox"/> Deterministic Mode | <input type="checkbox"/> Tuning |
| <input type="checkbox"/> Paralel Optimization | |
| Parallel Problems | 0 |
| Cores Solver | Default |

SOLUTION OF THE MATHEMATICAL MODELS

OPTeX-EXE - PARAMETER OPTIMIZATION SECTION

Optimization Library: COIN-MP v1.x

LP Algorithm: []

MIP Options: []

Feasibility: NO Relajacion

Objective: Activa

Emphasis: Optimalidad + Factibilidad

Parametric Optimization: Optimizacion Normal

Disjunctive Programming

Initial Solution Pre-Fix Variables

Subrogation Error Checking

SOS Sets

Deterministic Mode Tuning

Paralel Optimization

Parallel Problems: 0 Cores Solver: Default

Optimization Library: With programs in C ANSI, it indicates the optimization library that must use OPTeX-EXE.

CPLEX 64 bits v12.2

COIN-MP v1.x

CPLEX 64 bits v12.2

GLPK v4.9

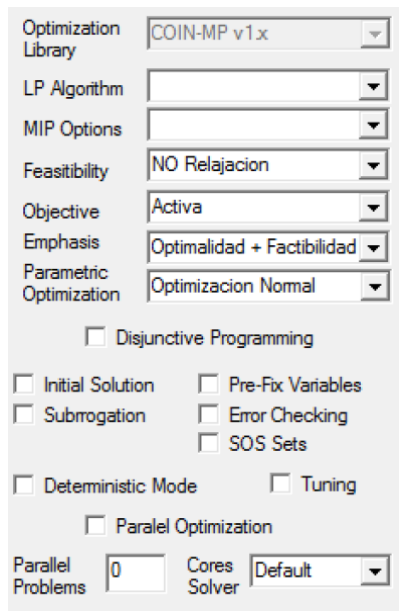
GUROBI Server 64 bits v5

LP Algorithm: Not used

MIP Options: Not used

SOLUTION OF THE MATHEMATICAL MODELS

OPTeX-EXE - PARAMETER OPTIMIZATION SECTION



Optimization Library: COIN-MP v1.x

LP Algorithm: []

MIP Options: []

Feasibility: NO Relajacion

Objective: Activa

Emphasis: Optimalidad + Factibilidad

Parametric Optimization: Optimizacion Normal

Disjunctive Programming

Initial Solution Pre-Fix Variables

Subrogation Error Checking

SOS Sets

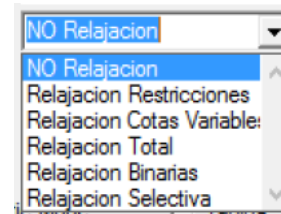
Deterministic Mode Tuning

Paralel Optimization

Parallel Problems: 0 Cores Solver: Default

Feasibility: Allows relax the constraints model to analyze the feasibility. Four options considered:

- **NO Relaxation:** it is the normal option, in which all functional and variable bounds of constraints are active.
- **Constraints Relaxation:** Indicates that all functional constraints must be relaxed, including artificial variables with "infinite" cost in the objective function; so as to detect constraints that present feasibility problems.
- **Relaxation Bounds Variables:** Indicates that all bounds of the relaxed variables must be relaxed, including artificial variables with infinite cost in the objective function, so as to detect bounds of the variables that present feasibility problems.
- **Total Relaxation:** Indicates relaxation of all functional constraints and all bounds of the variables.
- **Selective Relaxation:** being implemented.



NO Relajacion

NO Relajacion

Relajacion Restricciones

Relajacion Cotas Variable:

Relajacion Total

Relajacion Binarias

Relajacion Selectiva

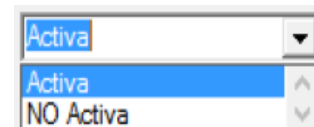
The results of the violation of the constraints are included in the **VV_vvv.opt** and **RR_rrr.opt** tables in the **ERROR** field.

SOLUTION OF THE MATHEMATICAL MODELS

OPTeX-EXE - PARAMETER OPTIMIZATION SECTION

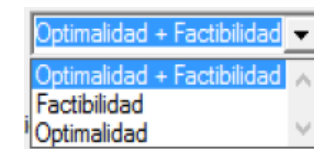
| | |
|--|--|
| Optimization Library | COIN-MP v1.x |
| LP Algorithm | |
| MIP Options | |
| Feasibility | NO Relajacion |
| Objective | Activa |
| Emphasis | Optimalidad + Factibilidad |
| Parametric Optimization | Optimizacion Normal |
| <input type="checkbox"/> Disjunctive Programming | |
| <input type="checkbox"/> Initial Solution | <input type="checkbox"/> Pre-Fix Variables |
| <input type="checkbox"/> Subrogation | <input type="checkbox"/> Error Checking |
| | <input type="checkbox"/> SOS Sets |
| <input type="checkbox"/> Deterministic Mode | <input type="checkbox"/> Tuning |
| <input type="checkbox"/> Paralel Optimization | |
| Parallel Problems | 0 |
| Cores Solver | Default |

Objective Function: Activate or ignore the purpose of the model function. Two possibilities are considered:

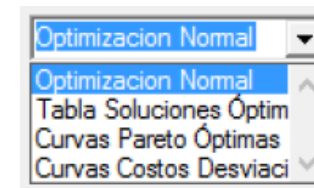


- **Active:** it corresponds to the normal option, which is considered the defined target for the model function. When the options of feasibility are activated implemented, OPTeX optimization process involves two phases: first, the feasibility is minimized and subsequently, if the problem is feasible, the user given objective function is optimized.
- **NO Active:** Indicates that the objective function of the model is ignored. This parameter must be used when required to analyze the feasibility of the problem alone.

Emphasis: indicates the type of emphasis used in the optimization process



Parametric Optimization:



SOLUTION OF THE MATHEMATICAL MODELS

OPTeX-EXE - PARAMETER OPTIMIZATION SECTION

| | |
|--|--|
| Optimization Library | COIN-MP v1.x |
| LP Algorithm | |
| MIP Options | |
| Feasibility | NO Relajacion |
| Objective | Activa |
| Emphasis | Optimalidad + Factibilidad |
| Parametric Optimization | Optimizacion Normal |
| <input type="checkbox"/> Disjunctive Programming | |
| <input type="checkbox"/> Initial Solution | <input type="checkbox"/> Pre-Fix Variables |
| <input type="checkbox"/> Subrogation | <input type="checkbox"/> Error Checking |
| | <input type="checkbox"/> SOS Sets |
| <input type="checkbox"/> Deterministic Mode | <input type="checkbox"/> Tuning |
| <input type="checkbox"/> Paralel Optimization | |
| Parallel Problems | 0 |
| Cores Solver | Default |

Disjunctive Programming: Indicates that the binary model is formulated to be resolved in accordance with the principles of the Disjunctive Programming (Grossmann, I. [1]). It is implemented for GAMS and C using CPLEX solver.

Initial Solution: Indicates that initial starting must be included in the process. This solution must be a result of a previous run.

Subrogation: Not used

Preset Variables: Indicates that fixed values for the variables must consider in the optimization process.

Error Checking: Indicates that, during the optimization process, or at the end, information relevant to validation errors should be generated for sets and parameters

SOS: It depends on the solver and indicates that the binary model should be solved including constraints SOS (Special Ordered Sets) type.

Deterministic Mode: Included in the solution process the instructions necessary for the mathematical models are solved in deterministic mode; the alternative is opportunistic.

Tuning: Enables the option of tuning algorithms if it is available. It depends on the optimization technology used.

SOLUTION OF THE MATHEMATICAL MODELS

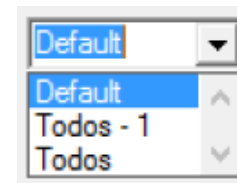
OPTEX-EXE - PARAMETER OPTIMIZATION SECTION

| | |
|--|--|
| Optimization Library | COIN-MP v1.x |
| LP Algorithm | |
| MIP Options | |
| Feasibility | NO Relajacion |
| Objective | Activa |
| Emphasis | Optimalidad + Factibilidad |
| Parametric Optimization | Optimizacion Normal |
| <input type="checkbox"/> Disjunctive Programming | |
| <input type="checkbox"/> Initial Solution | <input type="checkbox"/> Pre-Fix Variables |
| <input type="checkbox"/> Subrogation | <input type="checkbox"/> Error Checking |
| | <input type="checkbox"/> SOS Sets |
| <input type="checkbox"/> Deterministic Mode | <input type="checkbox"/> Tuning |
| <input type="checkbox"/> Paralel Optimization | |
| Parallel Problems | 0 |
| Cores Solver | Default |

Parallel Optimization: Indicates that the generated code should include the option of parallel for multi-problem optimization models.

Parallel problems: Limit the number of parallel problems were handled simultaneously under the parallel optimization option.

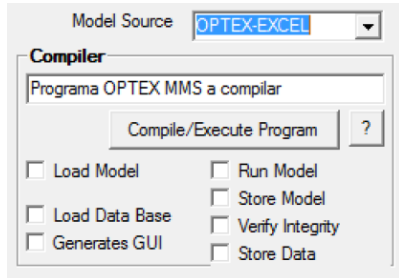
Cores Solver: Limits the number of cores that can use the solver in the optimization process.



Default
Default
Todos - 1
Todos

SOLUTION OF THE MATHEMATICAL MODELS

OPTEX-EXE - PROCESSING MODELS EXCEL SECTION



Related process control optimization for models handled in OPTEX-EXCEL-MMS or in OPTEX algebraic language, which is determined by selecting the Source Model.

SOLUTION OF THE MATHEMATICAL MODELS

OPTEX-EXE - OPTIMIZATION CONTROL MISCELLANEOUS SECTION

| | | |
|--|--|---------------------------------|
| <input type="checkbox"/> Interactive | Time (seg) | <input type="text" value="0"/> |
| <input type="checkbox"/> Load structures | MIP GAP (%) | <input type="text" value="10"/> |
| <input type="button" value="Optimize"/> | Iterations | <input type="text" value="0"/> |
| | <input checked="" type="checkbox"/> Low Priority | |

The parameters to define are:

Time Limit: Time limit (in seconds); zero or a negative number indicates **NO** limit.

MIP GAP: Percentage for difference (GAP) between primal solution (possible) and dual solution (limit not reached) to be assigned to stop the solution process. Valid numbers between 0 and 100 (%).

Iterations Limit: iteration limit to apply to the solver to solve the problem. Zero or a negative number indicates no limit.

Interactive: Indicates that the optimization process will be make interactively, is only usable for models generated in C.

Load Structures: Indicates that the matrix and vectors of costs and resources are stored to be analyzed with OPTEX-GUI; it is usable only for models that were generated in C.

Optimize: Make the optimization process without generating a new program for the model.

SOLUTION OF THE MATHEMATICAL MODELS

OPT Σ X-EXE - RECOVERY OF RESULTS SUB-AREA

Related to the control of the recovery of the results process.

Recover Results

Select Only Results
 Matrix Variables Constrains

 Entities Tables
 GIS Table
 Filter Results GANTT tables
 Detail List EXCEL-GUI
 Language EXCEL Tables
 Inglés EXCEL Book
 OLAP Cubes
 DOS Window Tableau
 END Window QlikView
 XML File
 MPS File

SOLUTION OF THE MATHEMATICAL MODELS

OPTeX-EXE - CONTROL REPORTS SECTION

Recover Results

Select Only Results
 Matrix Variables Constrains

 Entities Tables
 GIS Table
 GANTT tables
 EXCEL-GUI
 Filter Results EXCEL Tables
 Detail List EXCEL Book
 Language OLAP Cubes
 Tableau
 QlikView
 DOS Window XML File
 END Window MPS File

Selective: Only the variables and constraints specified for family of scenario are recovered.

Only Results: Activate the option to recover only the value of the primal variables.

Variables: Recovery of variables, generating tables VV_vvv

Constraints: Recovery of constrains, generating tables RR_rrr

Filter Results: Indicates that only zero values are recovered.

Detailed List: Indicates that generates a detailed listing of all calculations.

SOLUTION OF THE MATHEMATICAL MODELS

OPT Σ X-EXE - SELECTION REPORTS SECTION

Recover Results

Select Only Results

Matrix Variables Constrains

Recover Last Run

Filter Results Entities Tables

Detail List GIS Table

Language: Inglés

DOS Window GANTT tables

END Window EXCEL-GUI

EXCEL Tables

EXCEL Book

OLAP Cubes

Tableau

QlikView

XML File

MPS File

Entities Table: Generates table type EE_eee

GIS Tables: Creating tables connectivity to a GIS system.

GANTT charts: Generates files connectivity to Gantt diagrams in JViews.

EXCEL-GUI: Generate interconnection with OPT Σ X-EXCEL-GUI.

Tables EXCEL: Produces tables EXCEL-XML

OLAP Cubes: generates connectivity with a server OLAP-MONDRIAN.

TABLEAU: Generates connectivity with TABLEAU (under development)

QLIKVIEW: Generates connectivity with QLIKVIEW (under development)

XML Files: Generate files XML

MPS: Generates a file in format MPS

- Entities Tables
- GIS Table
- GANTT tables
- EXCEL-GUI
- EXCEL Tables
- EXCEL Book
- OLAP Cubes
- Tableau
- QlikView
- XML File
- MPS File

SOLUTION OF THE MATHEMATICAL MODELS

OPTeX-EXE - CONTROL WINDOWS SECTION

Recover Results

Select Only Results

Matrix Variables Constrains

Recover

Last Run

Filter Results

Detail List

Language
Inglés

DOS Window

END Window

Entities Tables

GIS Table

GANTT tables

EXCEL-GUI

EXCEL Tables

EXCEL Book

OLAP Cubes

Tableau

QlikView

XML File

MPS File

DOS Window: indicates that running the solver the DOS window with the report will be displayed. Hide this window produces significant reductions in time.

END Window: Indicates whether the end of the process with OPTeX is visible or is automatically terminated

SOLUTION OF THE MATHEMATICAL MODELS **OPTEX-EXE - CONTROL WINDOWS SECTION**

Optimization Server

Server Activates Server

IP Socket Connection Times Process

User Passw Client IP Socket

It explained below in section related to such services.

SOLUTION OF THE MATHEMATICAL MODELS OPTEX-EXE - MEMORY RAM SUB-AREA

It corresponds to parameters that determine the initial memory allocation to be implemented in the C program generated OPTEX-EXE.

| CPU/RAM | | |
|-----------------------------------|--|------------|
| Matrix | Variables | Constrains |
| 250000 | 60000 | 30000 |
| Registros x Archivo | RAM (MBytes) | |
| 10000 | 128 | |
| <input type="checkbox"/> RAM Disk | <input type="checkbox"/> Maximize Memory | |

SOLUTION OF THE MATHEMATICAL MODELS

OPTEX-EXE

When the selection process is successful, and if it is instructed in OPTEX-EXE, at the end of the process the user will see the results in an explorer window.

OPTEX - Mathematical Modeling System - Chief Scientist DecisionWare International Corp. (OPTEX MMS 374838-456059)

Control Input | Libraries | Optimization | Scenario | General | Model | Problems | Topology | Parameters | Matrix | Constraints | Variables | Results | Graphics | Data Tables | Reports

Explore Results
See Tables
Cancel

Escenario: d:\Dropbox\genex\vrp\vrpes\VRP\

- WV_AVL | Uso del vehículo v
- WV_VCL | Vehículo v viaja del nodo c al nodo k
- RR_ENSA | Entrada y Salida de un Nodo
- RR_SANO | Salida del Nodo Origen
- RR_UTVE | Utilización de Vehículos
- RR_VCLI | Visita de Destino
- FF_CFIT | Costo Fijo
- FF_CTOT | Costo Total de Funcionamiento
- FF_CVAT | Costo Variable
- CC_DEC | Destinos c
- CC_NCV | Nodos c <- Vehículos
- CC_NKV | Nodos k <- Vehículos
- CC_NOC | Nodo Origen -> Nodo Destino
- CC_NOK | Nodo Destino -> Nodo Origen
- CC_NOV | Nodo Origen <- Vehículos
- CC_TRC | Caminos Sobre los Cuales Puede Transita
- CC_TRK | Caminos Sobre los Cuales Puede Transita
- CC_VEC | Vehículos -> Nodos
- CC_VEH | Vehículos
- PP_CFIJ | Costo Fijo de Utilizar el Vehículo v
- PP_COVA | Costo Variable de Utilizar un Vehículo
- PP_CVIA | Costo de Viaje Entre Nodos
- PP_DIST | Distancia Nodos

| COD_VEH | COD_NOD | COD_NOD1 | VALOR | OK_HIS |
|---------|-------------|-------------|-------|--------|
| SWK060 | 83002514... | 83002563... | 0.000 | .F. |
| SWK060 | 83002514... | 83002563... | 0.000 | .F. |
| SWK060 | 83002514... | 83002563... | 0.000 | .F. |
| SWK060 | 83002514... | 83002563... | 0.000 | .F. |
| SWK060 | 83002514... | 83002563... | 0.000 | .F. |
| SWK060 | 83002514... | 83002563... | 0.000 | .F. |
| SWK060 | 83002514... | 86000209... | 0.000 | .F. |
| SWK060 | 83002563... | 83002514... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002514... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 86000209... | 0.000 | .F. |
| SWK060 | 83002563... | 83002514... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |
| SWK060 | 83002563... | 83002563... | 0.000 | .F. |

RESULTS INFORMATION SYSTEM

OPTeX generates information that allows the administrator and/or the user to consult, with the level of detail that he wants, the data tables generated in the process of solving a model.

It is available from the coefficients of a variable, or the general structure of an assembled within a matrix, to information that summarizes the activity levels of a variable or its economic assessment in terms of dual variables, and the sets and parameters used by the "solver" to solve mathematical problems.

OPTeX organizes all results of a mathematical model run in an information system that can be explored using the OPTeX-GUI.

TABLES OF RESULTS

The following types of tables of results are generated automatically by OPTeX according to recovery criteria set by the user. The user can get results for:

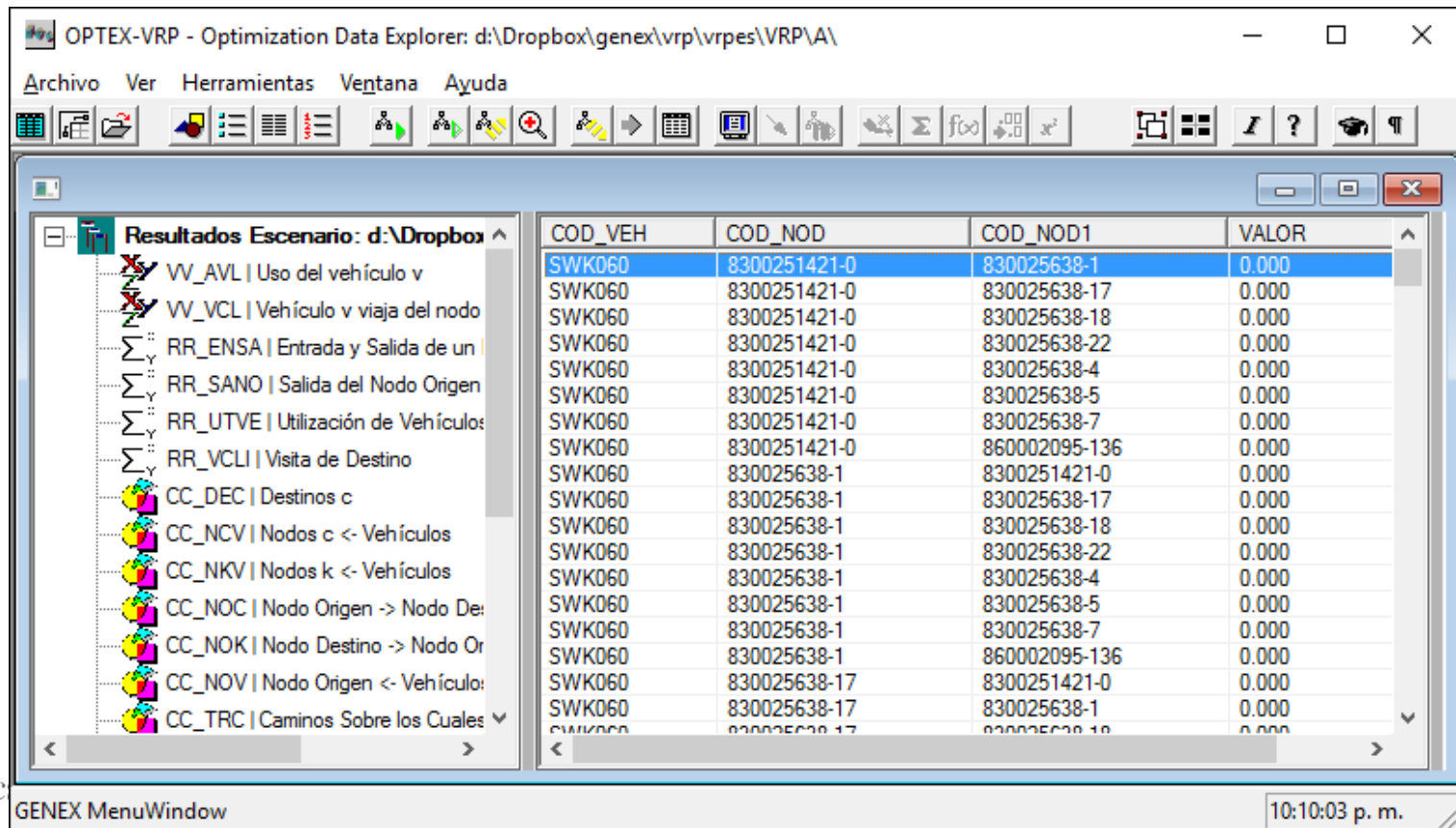
- **Variables**
- **Constraints**
- **Objective Functions**
- **Indexes**
- **Sets**
- **Parameters**

Additional to the relational fields/keys associated with the indexes of variables and constraints (COD_eee** and **FECHA**), the information stored in the tables presented below (the structure should depend on the type of technology):**

RESULTS INFORMATION SYSTEM VARIABLES

VV_vvv tables where **vvv** is the code variable. Additional to the relational fields this tables include:

- **VALOR:** Value of the variable.
- **FECHA_HORA:** Date-time, for type T variables (continuous time)
- **COSTO_RED:** reduced cost (dual) variable.
- **COTA_SUP:** Upper bound.
- **COSTO_OBJ:** Cost in the objective function



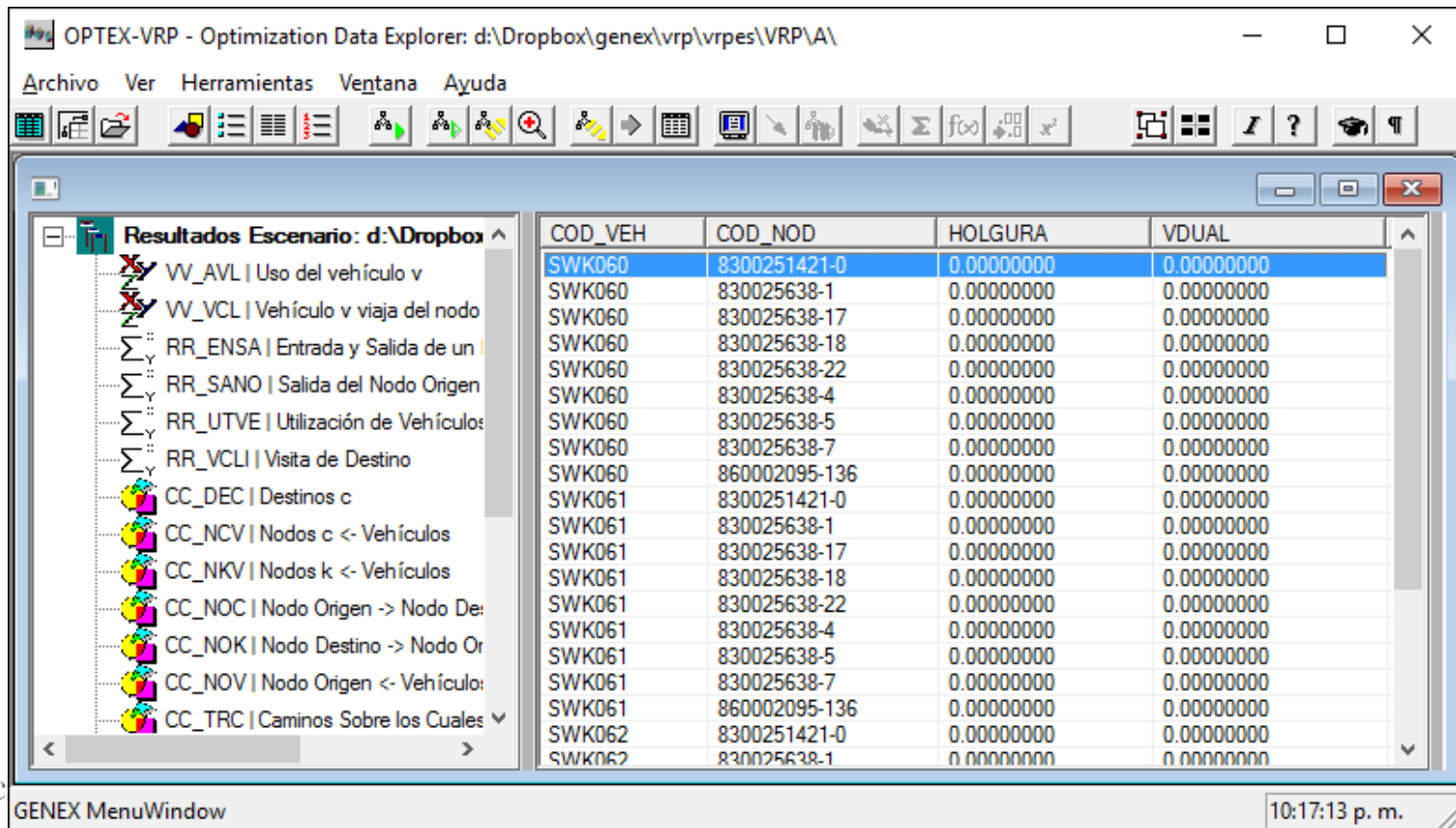
The screenshot shows the OPTEX-VRP - Optimization Data Explorer window. The main area displays a table of results for the scenario 'd:\Dropbox\genex\vrp\vrpes\VRP\A\'. The table has four columns: COD_VEH, COD_NOD, COD_NOD1, and VALOR. The left sidebar shows a tree view of variables, including VV_AVL, VV_VCL, RR_ENSA, RR_SANO, RR_UTVE, RR_VCLI, CC_DEC, CC_NCV, CC_NKV, CC_NOC, CC_NOK, CC_NOV, and CC_TRC.

| COD_VEH | COD_NOD | COD_NOD1 | VALOR |
|---------|--------------|---------------|-------|
| SWK060 | 8300251421-0 | 830025638-1 | 0.000 |
| SWK060 | 8300251421-0 | 830025638-17 | 0.000 |
| SWK060 | 8300251421-0 | 830025638-18 | 0.000 |
| SWK060 | 8300251421-0 | 830025638-22 | 0.000 |
| SWK060 | 8300251421-0 | 830025638-4 | 0.000 |
| SWK060 | 8300251421-0 | 830025638-5 | 0.000 |
| SWK060 | 8300251421-0 | 830025638-7 | 0.000 |
| SWK060 | 8300251421-0 | 860002095-136 | 0.000 |
| SWK060 | 830025638-1 | 8300251421-0 | 0.000 |
| SWK060 | 830025638-1 | 830025638-17 | 0.000 |
| SWK060 | 830025638-1 | 830025638-18 | 0.000 |
| SWK060 | 830025638-1 | 830025638-22 | 0.000 |
| SWK060 | 830025638-1 | 830025638-4 | 0.000 |
| SWK060 | 830025638-1 | 830025638-5 | 0.000 |
| SWK060 | 830025638-1 | 830025638-7 | 0.000 |
| SWK060 | 830025638-1 | 860002095-136 | 0.000 |
| SWK060 | 830025638-17 | 8300251421-0 | 0.000 |
| SWK060 | 830025638-17 | 830025638-1 | 0.000 |
| SWK060 | 830025638-17 | 830025638-18 | 0.000 |

RESULTS INFORMATION SYSTEM CONSTRAINTS

RR **rrr** tables where **rrr** is the constraint code. Additional to the relational fields this tables include:

- **VDUAL:** Value of the dual variable (marginal cost or opportunity cost).
- **HOLGURA:** value of the slack variable.
- **RECURSO:** value of the right side (RHS) of the constraint



The screenshot shows the 'Resultados Escenario' window in the OPTEX-VRP software. The table displays the following data:

| COD_VEH | COD_NOD | HOLGURA | VDUAL |
|---------|---------------|------------|------------|
| SWK060 | 8300251421-0 | 0.00000000 | 0.00000000 |
| SWK060 | 830025638-1 | 0.00000000 | 0.00000000 |
| SWK060 | 830025638-17 | 0.00000000 | 0.00000000 |
| SWK060 | 830025638-18 | 0.00000000 | 0.00000000 |
| SWK060 | 830025638-22 | 0.00000000 | 0.00000000 |
| SWK060 | 830025638-4 | 0.00000000 | 0.00000000 |
| SWK060 | 830025638-5 | 0.00000000 | 0.00000000 |
| SWK060 | 830025638-7 | 0.00000000 | 0.00000000 |
| SWK060 | 860002095-136 | 0.00000000 | 0.00000000 |
| SWK061 | 8300251421-0 | 0.00000000 | 0.00000000 |
| SWK061 | 830025638-1 | 0.00000000 | 0.00000000 |
| SWK061 | 830025638-17 | 0.00000000 | 0.00000000 |
| SWK061 | 830025638-18 | 0.00000000 | 0.00000000 |
| SWK061 | 830025638-22 | 0.00000000 | 0.00000000 |
| SWK061 | 830025638-4 | 0.00000000 | 0.00000000 |
| SWK061 | 830025638-5 | 0.00000000 | 0.00000000 |
| SWK061 | 830025638-7 | 0.00000000 | 0.00000000 |
| SWK061 | 860002095-136 | 0.00000000 | 0.00000000 |
| SWK062 | 8300251421-0 | 0.00000000 | 0.00000000 |
| SWK062 | 830025638-1 | 0.00000000 | 0.00000000 |

The left sidebar lists various constraint types such as 'WV_AVL | Uso del vehículo v', 'WV_VCL | Vehículo v | viaje del nodo', and 'RR_ENSA | Entrada y Salida de un...'. The bottom status bar shows 'GENEX MenuWindow' and the time '10:17:13 p. m.'.

RESULTS INFORMATION SYSTEM

OBJECTIVE FUNTIONS

FF_fff tables where **fff** is the code of the objective function. Additional to the relational fields this tables include:

- **VALUE:** Value of the objective function for all FO.

For the main FO, additional fields are:

- **PROBLEMA:** Code Problem
- **BEST_BOUND:** Bound for FO for MIP problems.
- **MOD_STA:** Type Solution (TSO).
- **TMOD_STA:** Description TSO
- **SOL_STA:** Finish Solver Code (FSC).
- **TSOL_STA:** Description FSC.

| | A | B | C | D | E | F | G | H |
|---|----------|-------------|-------------|---------|------------------|---------|-------------------|---|
| 1 | PROBLEMA | VALOR | BEST_BOUND | MOD_STA | TMOD_STA | SOL_STA | TSOL_STA | |
| 2 | VRP | 149933.0474 | 135922.2644 | 8 8 | Integer Solution | 1 1 | Normal Completion | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |

FF_OPTEX

Lista Promedio: 71466.07797 Recuento: 14 Suma: 285864.3119 100%

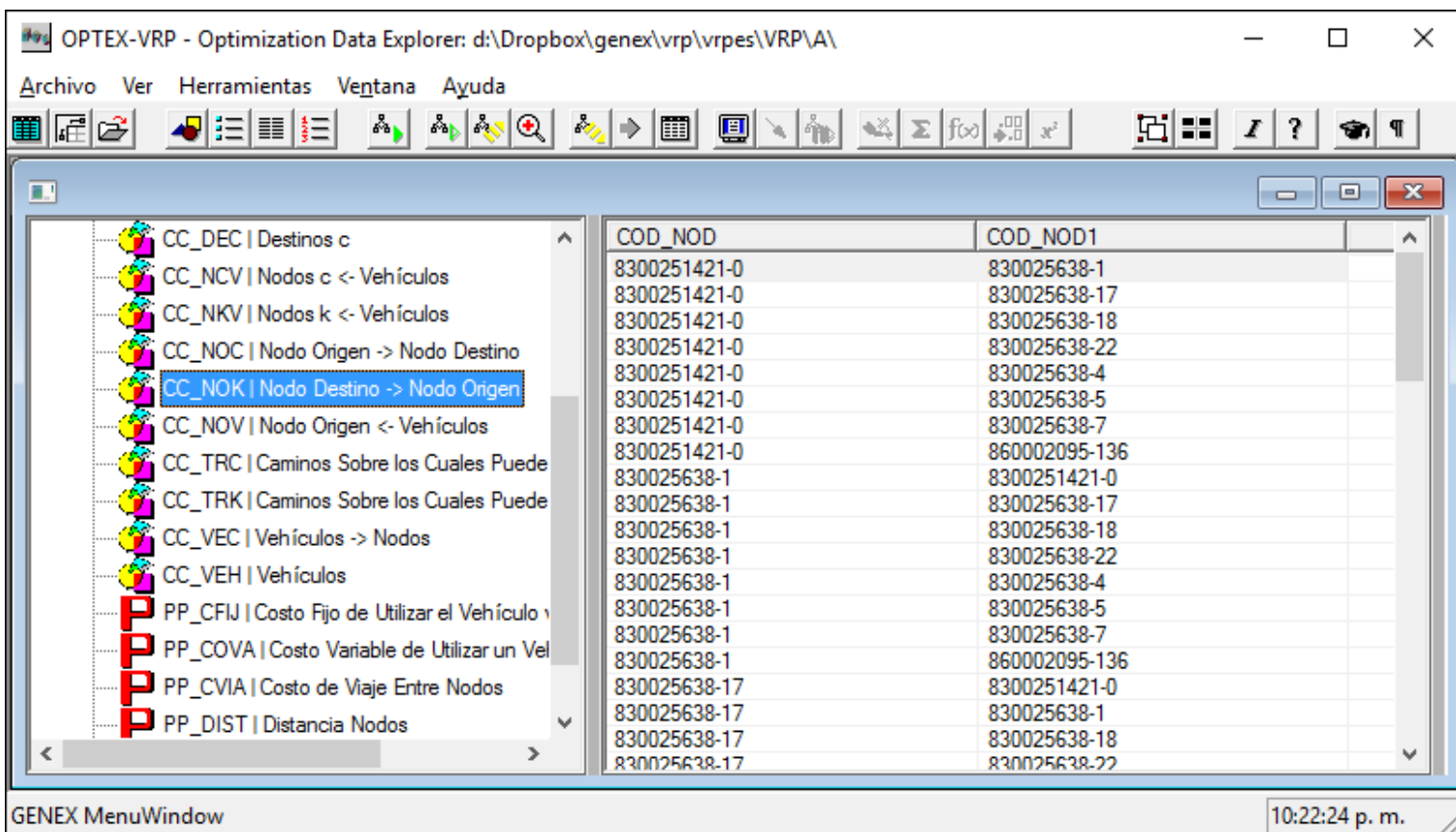
RESULTS INFORMATION SYSTEM INDEXES

II_ii tables where **ii** is the index.

Contains the codes of the entities associated with the indices included in model. Contains only one column **COD_eee** associated with the index.

RESULTS INFORMATION SYSTEM SETS

CC_ccc tables where **ccc** is the code of the set, calculated or read. It contains only fields **COD_eee** related indexes set.

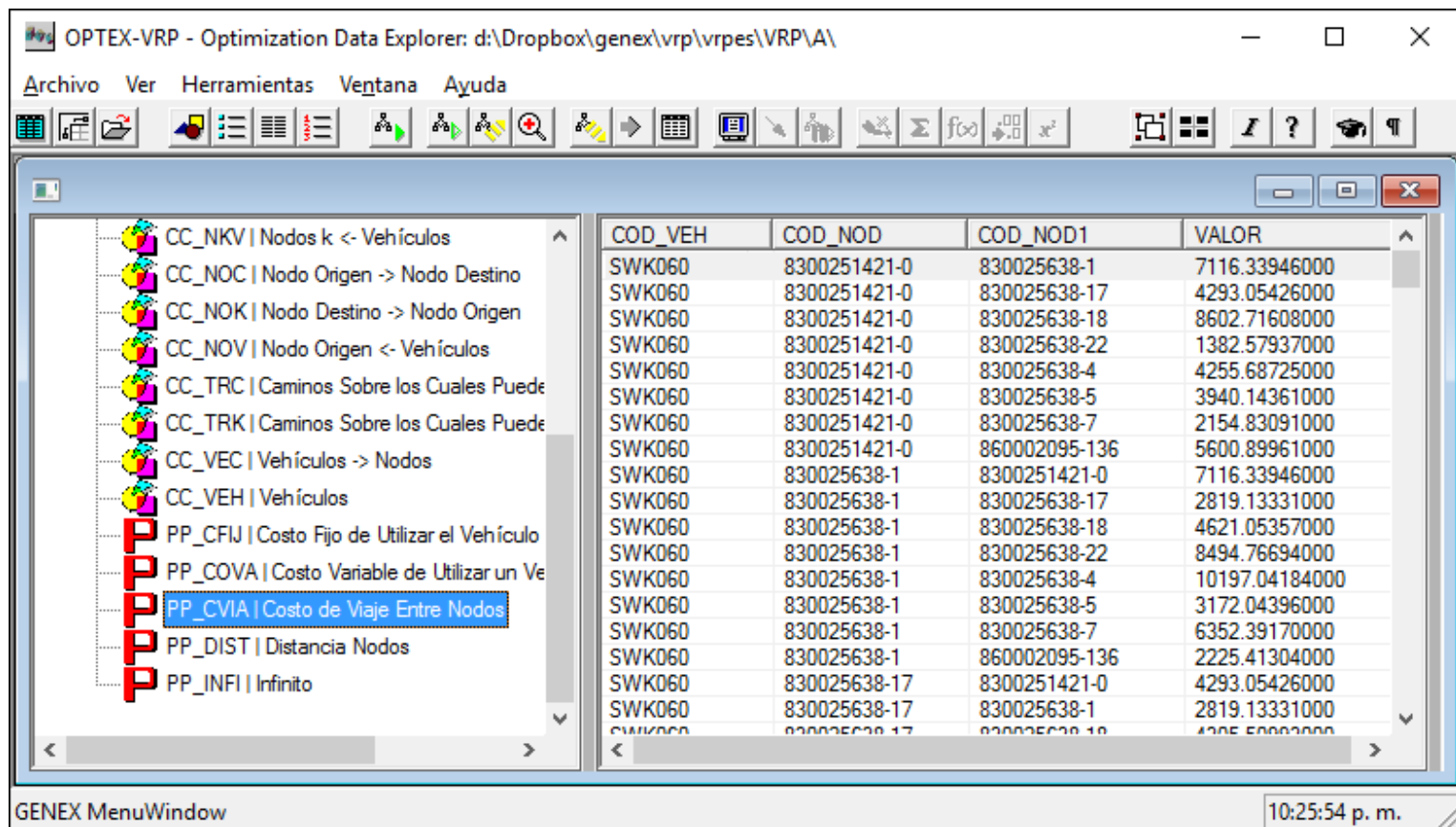


| COD_NOD | COD_NOD1 |
|--------------|---------------|
| 8300251421-0 | 830025638-1 |
| 8300251421-0 | 830025638-17 |
| 8300251421-0 | 830025638-18 |
| 8300251421-0 | 830025638-22 |
| 8300251421-0 | 830025638-4 |
| 8300251421-0 | 830025638-5 |
| 8300251421-0 | 830025638-7 |
| 8300251421-0 | 860002095-136 |
| 830025638-1 | 8300251421-0 |
| 830025638-1 | 830025638-17 |
| 830025638-1 | 830025638-18 |
| 830025638-1 | 830025638-22 |
| 830025638-1 | 830025638-4 |
| 830025638-1 | 830025638-5 |
| 830025638-1 | 830025638-7 |
| 830025638-1 | 860002095-136 |
| 830025638-17 | 8300251421-0 |
| 830025638-17 | 830025638-1 |
| 830025638-17 | 830025638-18 |
| 830025638-17 | 830025638-22 |

RESULTS INFORMATION SYSTEM PARAMETERS

PP_*** tables where *** is the parameter code. Additional to the relational fields this tables include:

- **VALOR:** Value of the parameter read or calculated.



| COD_VEH | COD_NOD | COD_NOD1 | VALOR |
|---------|--------------|---------------|----------------|
| SWK060 | 8300251421-0 | 830025638-1 | 7116.33946000 |
| SWK060 | 8300251421-0 | 830025638-17 | 4293.05426000 |
| SWK060 | 8300251421-0 | 830025638-18 | 8602.71608000 |
| SWK060 | 8300251421-0 | 830025638-22 | 1382.57937000 |
| SWK060 | 8300251421-0 | 830025638-4 | 4255.68725000 |
| SWK060 | 8300251421-0 | 830025638-5 | 3940.14361000 |
| SWK060 | 8300251421-0 | 830025638-7 | 2154.83091000 |
| SWK060 | 8300251421-0 | 860002095-136 | 5600.89961000 |
| SWK060 | 830025638-1 | 8300251421-0 | 7116.33946000 |
| SWK060 | 830025638-1 | 830025638-17 | 2819.13331000 |
| SWK060 | 830025638-1 | 830025638-18 | 4621.05357000 |
| SWK060 | 830025638-1 | 830025638-22 | 8494.76694000 |
| SWK060 | 830025638-1 | 830025638-4 | 10197.04184000 |
| SWK060 | 830025638-1 | 830025638-5 | 3172.04396000 |
| SWK060 | 830025638-1 | 830025638-7 | 6352.39170000 |
| SWK060 | 830025638-1 | 860002095-136 | 2225.41304000 |
| SWK060 | 830025638-17 | 8300251421-0 | 4293.05426000 |
| SWK060 | 830025638-17 | 830025638-1 | 2819.13331000 |
| SWK060 | 830025638-17 | 830025638-18 | 4293.05426000 |

RESULTS INFORMATION SYSTEM

RELATIONAL TABLES (EE_eee)

Additionally, OPTeX organizes information according to the relationships between entities (indexes) derived from the set of variables and constraints that have been considered in the model.

This information is stored in tables EE_ii1_ii2_ii3 ... where ii1 corresponds to the index (entity) 1, ii2 index 2, ii3 index 3 and so on to describe all entities that are part of the relationship.

This files including the results for all the variables and constraint associated with the relation (a combination of indexes)

Additional to the relational fields associated with the indexes (COD_eee and FECHA), the information stored in the tables are presented below.

| VARIABLES (vvv) | CONSTRAINTS (rrr) |
|---|--|
| <ul style="list-style-type: none"> ▪ VA_vvv: Variable value (primal). ▪ FH_vvv: Date-time associated with the value for variable type T (continuous-time) ▪ CR_vvv: Reduced cost for the variable (dual) ▪ LO_vvv: Lower Bound ▪ UP_vvv: Upper Bound ▪ CO_vvv: Objective Function Cost | <ul style="list-style-type: none"> ▪ VD_rrr: Value of the dual. ▪ VH_rrr: Value of the slack variable ▪ RS_rrr: Value of Right Hand Side (RHS) |

If IDIS is supported in DBase tables, these are stored in the directories specified in the application settings; alternatively, if the application drive tables in SQL format, the tables will be stored using an ODBC that controls the access to a TABLESPACE where all tables in the application are defined, in this case to all results tables the fff_eee_ prefix is added, fff which corresponds to the family code and eee to the scenario code.

RESULTS INFORMATION SYSTEM

RELATIONAL TABLES (EE_eee)

OPTEX-VRP - Optimization Data Explorer: d:\Dropbox\genex\vrp\vrpes\VRP\A

Archivo Ver Herramientas Ventana Ayuda

| | COD_VEH | COD_NOD | VD_ENSA | VH_ENSA | VD_SANO | VH_SANO |
|---------------------------------------|---------|---------------|------------|------------|------------|------------|
| CC_DEC Destinos c | SWK060 | 8300251421-0 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| CC_NCV Nodos c <- Vehículos | SWK060 | 830025638-1 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| CC_NKV Nodos k <- Vehículos | SWK060 | 830025638-17 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| CC_NOC Nodo Origen -> Nodo C | SWK060 | 830025638-18 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| CC_NOK Nodo Destino -> Nodo | SWK060 | 830025638-22 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| CC_NOV Nodo Origen <- Vehículo | SWK060 | 830025638-4 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| CC_TRC Caminos Sobre los Cual | SWK060 | 830025638-5 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| CC_TRK Caminos Sobre los Cual | SWK060 | 830025638-7 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| CC_VEC Vehículos -> Nodos | SWK060 | 860002095-136 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| CC_VEH Vehículos | SWK061 | 8300251421-0 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| PP_CFIJ Costo Fijo de Utilizar el V | SWK061 | 830025638-1 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| PP_COVA Costo Variable de Utili | SWK061 | 830025638-17 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| PP_CVIA Costo de Viaje Entre N | SWK061 | 830025638-18 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| PP_DIST Distancia Nodos | SWK061 | 830025638-22 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| PP_INFI Infinito | SWK061 | 830025638-4 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| EE_NOD Nodo - | SWK061 | 830025638-5 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| EE_VEH Vehículo - | SWK061 | 830025638-7 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| EE_VEH_NOD Vehículo - Nodo | SWK061 | 860002095-136 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| EE_VEH_NOD_NOD1 Vehículo | SWK062 | 8300251421-0 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| | SWK062 | 830025638-1 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| | SWK062 | 830025638-17 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| | SWK062 | 830025638-18 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| | SWK062 | 830025638-22 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| | SWK062 | 830025638-4 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| | SWK062 | 830025638-5 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| | SWK062 | 830025638-7 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| | SWK062 | 860002095-136 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |

GENEX MenuWindow 10:33:48 p. m.

RESULTS INFORMATION SYSTEM DISPLAY RESULTS VIA OPTEX-GUI

The optimization results are available for any scenario through OPTEX-GUI browser, following the menu the user can access to Scenario Family's Information System, whose consultation is guided by OPTEX-GUI.

The screenshot displays the OPTEX-GUI interface. The window title is "VRP - Modelo de Datos - [OPTEX_GUI - Menu Explorer]". The menu bar includes "Archivo", "Ver", "Herramientas", "Ventana", and "Ayuda". The left pane shows a hierarchical tree structure under "Modelo de Datos", with "Información Familias de Escenarios" expanded to show "Modelo VRP" and "Ruteo Vehículos (VRP) - Peso + Volumen". Under "Ruteo Vehículos (VRP) - Peso + Volumen", "Escenarios Familia VRP2C" is expanded, and "B- Escenario B" is selected. The right pane displays three icons: "Estructuras Matriciales Escenario VRP2C:B", "Tablas Resultados Escenario VRP2C:B" (circled in red), and "Resultados EXCEL Escenario VRP2C:B". The status bar at the bottom indicates "GENEX MenuWindow" and the time "08:34:55 p. m."

RESULTS INFORMATION SYSTEM DISPLAY RESULTS VIA OPTEX-GUI

The user can view all the results tables of a scenario accessing the **Result Scenario Tables** option, as shown in the following figure.

OPTEX-VRP - Optimization Data Explorer: d:\Dropbox\genex\vrp\vrpes\VRP\A\

Archivo Ver Herramientas Ventana Ayuda

Resultados Escenario: d:\Dropbox\genex\vrp\vrpes\VRP\A\

| | COD_VEH | COD_NOD | COD_NOD1 | VA_VCL |
|---|---------|--------------|---------------|------------|
| VV_AVL Uso del vehículo v | SWK060 | 8300251421-0 | 830025638-1 | 0.00000000 |
| VV_VCL Vehículo v viaja del nodo c al nodo k | SWK060 | 8300251421-0 | 830025638-17 | 0.00000000 |
| RR_ENSA Entrada y Salida de un Nodo | SWK060 | 8300251421-0 | 830025638-18 | 0.00000000 |
| RR_SANO Salida del Nodo Origen | SWK060 | 8300251421-0 | 830025638-22 | 0.00000000 |
| RR_UTVE Utilización de Vehículos | SWK060 | 8300251421-0 | 830025638-4 | 0.00000000 |
| RR_VCLI Visita de Destino | SWK060 | 8300251421-0 | 830025638-5 | 0.00000000 |
| CC_DEC Destinos c | SWK060 | 830025638-1 | 830025638-7 | 0.00000000 |
| CC_NCV Nodos c <- Vehículos | SWK060 | 830025638-1 | 860002095-136 | 0.00000000 |
| CC_NKV Nodos k <- Vehículos | SWK060 | 830025638-1 | 8300251421-0 | 0.00000000 |
| CC_NOC Nodo Origen -> Nodo Destino | SWK060 | 830025638-1 | 830025638-17 | 0.00000000 |
| CC_NOK Nodo Destino -> Nodo Origen | SWK060 | 830025638-1 | 830025638-18 | 0.00000000 |
| CC_NOV Nodo Origen <- Vehículos | SWK060 | 830025638-1 | 830025638-22 | 0.00000000 |
| CC_TRC Caminos Sobre los Cuales Puede Transitar el Vehículo | SWK060 | 830025638-1 | 830025638-4 | 0.00000000 |
| CC_TRK Caminos Sobre los Cuales Puede Transitar el Vehículo | SWK060 | 830025638-1 | 830025638-5 | 0.00000000 |
| CC_VEC Vehículos -> Nodos | SWK060 | 830025638-17 | 830025638-7 | 0.00000000 |
| CC_VEH Vehículos | SWK060 | 830025638-17 | 860002095-136 | 0.00000000 |
| PP_CFIJ Costo Fijo de Utilizar el Vehículo v | SWK060 | 830025638-17 | 8300251421-0 | 0.00000000 |
| PP_COVA Costo Variable de Utilizar un Vehículo | SWK060 | 830025638-18 | 830025638-1 | 0.00000000 |
| PP_CVIA Costo de Viaje Entre Nodos | SWK060 | 830025638-18 | 830025638-17 | 0.00000000 |
| PP_DIST Distancia Nodos | SWK060 | 830025638-18 | 830025638-22 | 0.00000000 |
| PP_INF1 Infinito | SWK060 | 830025638-18 | 830025638-4 | 0.00000000 |
| EE_NOD Nodo - | SWK060 | 830025638-18 | 830025638-5 | 0.00000000 |
| EE_VEH Vehículo - | SWK060 | 830025638-18 | 860002095-136 | 0.00000000 |
| EE_VEH_NOD Vehículo - Nodo - | SWK060 | 830025638-22 | 8300251421-0 | 0.00000000 |
| EE_VEH_NOD_NOD1 Vehículo - Nodo - Nodo (Alias) - | SWK060 | 830025638-22 | 830025638-1 | 0.00000000 |
| | SWK060 | 830025638-22 | 830025638-17 | 0.00000000 |
| | SWK060 | 830025638-22 | 830025638-18 | 0.00000000 |
| | SWK060 | 830025638-22 | 830025638-4 | 0.00000000 |
| | SWK060 | 830025638-22 | 830025638-5 | 0.00000000 |
| | SWK060 | 830025638-22 | 830025638-7 | 0.00000000 |
| | SWK060 | 830025638-22 | 860002095-136 | 0.00000000 |
| | SWK060 | 830025638-4 | 8300251421-0 | 0.00000000 |
| | SWK060 | 830025638-4 | 830025638-1 | 0.00000000 |
| | SWK060 | 830025638-4 | 830025638-17 | 0.00000000 |
| | SWK060 | 830025638-4 | 830025638-18 | 0.00000000 |

RESULTS INFORMATION SYSTEM DISPLAY RESULTS VIA OPT_ΣX-GUI

Alternatively, the user can view the results from the master tables and tables of scenarios; to do this, the user selects the Open Table(s) Result(s) option from the menu of data window that displays all result tables related to the entity, for it must select the family and the scenario that the user want to explore.

The screenshot displays the 'VRP - Maestra Vehículos - [Maestra Vehículos]' window. The main data table lists various vehicle types with their respective capacities and costs. An 'OPTEX - Results Exploration' dialog box is open, allowing the user to select a 'Familia' (Family) and an 'Escenario' (Scenario) to view specific result tables.

| Código | Descripcion | Capacidad kg | Peso | Capacidad Volum m3 | Costo Fijo \$/día | Costo Variable \$/km |
|--------|------------------|-----------------|------|-----------------------|----------------------|-------------------------|
| SWK053 | SWK053 - NHR | 6000.00 | | 10.51 | 125921.60 | 268.612 |
| SWK054 | SWK054 - NHR | 6000.00 | | 10.51 | 118875.03 | 268.612 |
| SWK055 | SWK055 - NHR | 6000.00 | | 10.51 | 114172.28 | |
| SWK056 | SWK056 - NHR | 6000.00 | | 10.51 | 114172.28 | |
| SWK057 | SWK057 - NKR III | 8400.00 | | 15.34 | 121070.44 | |
| SWK058 | SWK058 - NKR III | 8400.00 | | 15.34 | 125980.45 | |
| SWK059 | SWK059 - NKR III | 8400.00 | | 15.34 | 130385.36 | |
| SWK060 | SWK060 - NPR | 9999.00 | | 50.00 | 127652.89 | |
| SWK061 | SWK061 - NPR | 9999.00 | | 50.23 | 125906.06 | |
| SWK062 | SWK062 - NPR | 9999.00 | | 20.23 | 131012.17 | |
| SWK925 | SWK925 - NHR | 6000.00 | | 10.51 | 115870.50 | |
| SWK926 | SWK926 - NKR II | 9999.00 | | 14.61 | 124575.98 | |
| SWK927 | SWK927 - NHR | 6000.00 | | 10.51 | 119165.27 | |
| SWK928 | SWK928 - CARRY | 2400.00 | | 3.25 | 107005.49 | |
| SWK929 | SWK929 - NHR | 6000.00 | | 10.51 | 114172.28 | |
| SWK930 | SWK930 - NKR II | 9999.00 | | 14.61 | 128118.30 | |
| SWK931 | SWK931 - NKR II | 9999.00 | | 14.61 | 128118.30 | |
| SWK932 | SWK932 - NKR II | 9999.00 | | 14.61 | 131148.88 | |
| SWL583 | SWL583 - NHR | 6000.00 | | 10.51 | 108163.22 | |

OPTEX - Results Exploration

Familia: VRP - Modelo VRP
Escenario: A - A - Escenario A

Available Tables:

- CC_NCV - Nodos c <- Vehículos
- CC_NKV - Nodos k <- Vehículos
- CC_NOV - Nodos Origen <- Vehículos
- CC_TRC - Caminos Sobre los Cuales Puede Transtar el Vehi
- CC_TRK - Caminos Sobre los Cuales Puede Transtar el Vehi
- CC_VEC - Vehículos -> Nodos
- CC_VEH - Vehículos
- EE_VEH - Relation: Vehículo -
- EE_VEH_NOD - Relation: Vehículo - Nodo -
- EE_VEH_NOD_NOD1 - Relation: Vehículo - Nodo - Nodo (A
- PP_CFIJ - Costo Fijo de Utilizar el Vehículo v
- PP_COVA - Costo Variable de Utilizar un Vehículo
- PP_CVIA - Costo de Viaje Entre Nodos
- RR_ENSA - Entrada y Salida de un Nodo
- RR_SANO - Salida del Nodo Origen
- RR_UTVE - Utilización de Vehículos
- W_AVL - Uso del vehículo v
- W_VCL - Vehículo v viaje del nodo c al nodo k

Buttons: Abrir Tabla, Abrir Todas, Ayuda, Cancelar

GENEX Super Data Window | 08:36:19 p. m. | 8:36 p. m.

RESULTS INFORMATION SYSTEM DISPLAY RESULTS VIA OPTeX-GUI

The following figure presents an example of the query results for specific physical entity.

VRP - Maestra Vehículos

Archivo Edición Ver Análisis Ver Ayuda

Maestra Vehículos

| Código | Descripcion | Capa |
|--------|------------------|------|
| SWK053 | SWK053 - NHR | |
| SWK054 | SWK054 - NHR | |
| SWK055 | SWK055 - NHR | |
| SWK056 | SWK056 - NHR | |
| SWK057 | SWK057 - NKR III | |
| SWK058 | SWK058 - NKR III | |
| SWK059 | SWK059 - NKR III | |
| SWK060 | SWK060 - NPR | |
| SWK061 | SWK061 - NPR | |
| SWK062 | SWK062 - NPR | |
| SWK925 | SWK925 - NHR | |
| SWK926 | SWK926 - NKR II | |

VV_AVL - Uso del vehículo v

| Cod_Veh: | Valor: | Ok_His: |
|----------|--------|---------|
| SWK060 | 0.000 | .F. |

PP_CFU - Costo Fijo de Utilizar el Ve...

| Cod_Veh: | Valor: |
|----------|-----------------|
| SWK060 | 127652.89000000 |

CC_NOV - Nodo Origen <- Vehiculos

| Cod_Veh: | Cod_Nod: |
|----------|--------------|
| SWK060 | 8300251421-0 |

VV_VCL - Vehículo v viaje del nodo ...

| Cod_Veh: | Cod_Nod: | Cod_Nod1: | Valor: |
|----------|--------------|---------------|--------|
| SWK060 | 8300251421-0 | 830025638-1 | 0.0 |
| SWK060 | 8300251421-0 | 830025638-17 | 0.0 |
| SWK060 | 8300251421-0 | 830025638-18 | 0.0 |
| SWK060 | 8300251421-0 | 830025638-22 | 0.0 |
| SWK060 | 8300251421-0 | 830025638-4 | 0.0 |
| SWK060 | 8300251421-0 | 830025638-5 | 0.0 |
| SWK060 | 8300251421-0 | 830025638-7 | 0.0 |
| SWK060 | 8300251421-0 | 860002095-136 | 0.0 |
| SWK060 | 830025638-1 | 8300251421-0 | 0.0 |
| SWK060 | 830025638-1 | 830025638-17 | 0.0 |
| SWK060 | 830025638-1 | 830025638-18 | 0.0 |
| SWK060 | 830025638-1 | 830025638-22 | 0.0 |

Σ RR_ENSA - Entrada y Salida de un N...

| Cod_Veh: | Cod_Nod: | Holgura: |
|----------|---------------|------------|
| SWK060 | 8300251421-0 | 0.00000000 |
| SWK060 | 830025638-1 | 0.00000000 |
| SWK060 | 830025638-17 | 0.00000000 |
| SWK060 | 830025638-18 | 0.00000000 |
| SWK060 | 830025638-22 | 0.00000000 |
| SWK060 | 830025638-4 | 0.00000000 |
| SWK060 | 830025638-5 | 0.00000000 |
| SWK060 | 830025638-7 | 0.00000000 |
| SWK060 | 830025638-7 | 0.00000000 |
| SWK060 | 860002095-136 | 0.00000000 |

EE_VEH_NOD_NOD1 - Relation: Veh...

| Cod_Veh: | Cod_Nod: | Cod_Nod1: |
|----------|--------------|---------------|
| SWK060 | 8300251421-0 | 830025638-1 |
| SWK060 | 8300251421-0 | 830025638-17 |
| SWK060 | 8300251421-0 | 830025638-18 |
| SWK060 | 8300251421-0 | 830025638-22 |
| SWK060 | 8300251421-0 | 830025638-4 |
| SWK060 | 8300251421-0 | 830025638-5 |
| SWK060 | 8300251421-0 | 830025638-7 |
| SWK060 | 8300251421-0 | 860002095-136 |
| SWK060 | 830025638-1 | 8300251421-0 |
| SWK060 | 830025638-1 | 830025638-17 |
| SWK060 | 830025638-1 | 830025638-18 |
| SWK060 | 830025638-1 | 830025638-22 |

CC_NCV - Nodos c <- Vehiculos

| Cod_Veh: | Cod_Nod: |
|----------|---------------|
| SWK060 | 8300251421-0 |
| SWK060 | 830025638-1 |
| SWK060 | 830025638-17 |
| SWK060 | 830025638-18 |
| SWK060 | 830025638-22 |
| SWK060 | 830025638-4 |
| SWK060 | 830025638-5 |
| SWK060 | 830025638-7 |
| SWK060 | 860002095-136 |

RESULTS INFORMATION SYSTEM DISPLAY RESULTS VIA OPTEX-EXCEL-GUI

All results of mathematical models can be viewed and analyzed in OPTEX-EXCEL-GUI that corresponding to a graphical interface based on EXCEL using dynamics tables and dynamics graphs. The interested reader is invited to consult the Manual OPTEX-EXCEL-GUI User.

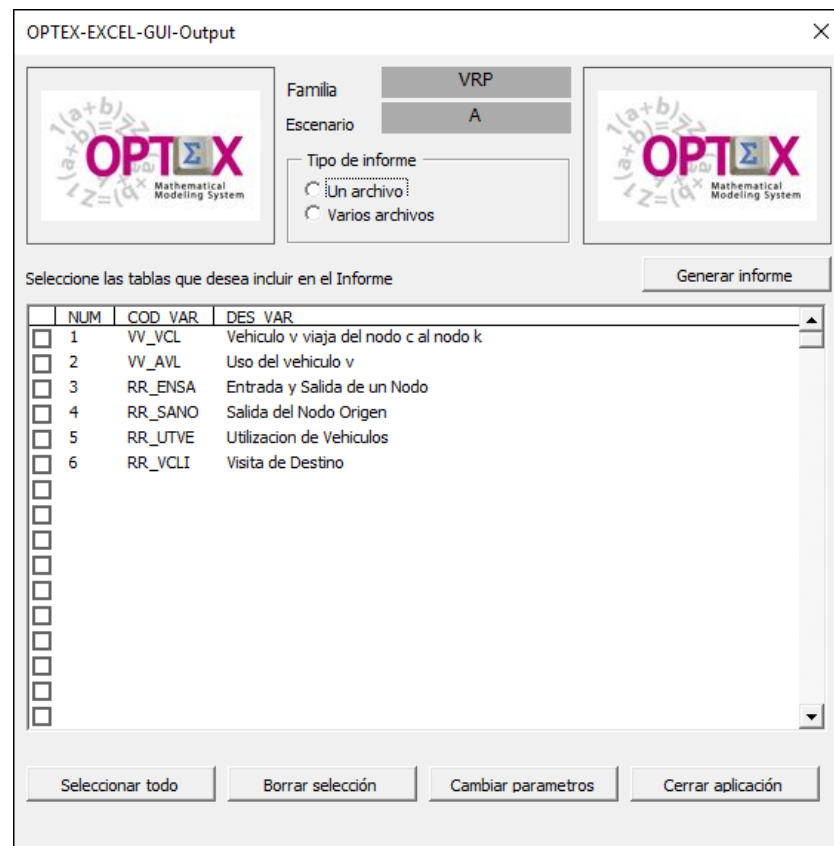
OPTEX-EXCEL-GUI is handled by a control window that is accessed by the user to define the report required.

For each variable, or constraint, three sheets are generated with the following information:

- **DATA:** Raw Data (CSV)
- **TD:** Pivot Table
- **GRF:** Pivot Graph (Dynamic Graphics)

The sheet will be named by concatenating the following codes:

- Type of sheet (**DATA**, **TD** or **GRF**);
- Type of item (**VV** or **RR**) and iii) the variable code or the constraints code.



The screenshot shows the 'OPTEX-EXCEL-GUI-Output' window. It features a header with the OPTΣX logo and the text 'Mathematical Modeling System'. Below the logo, there are two input fields: 'Familia' with the value 'VRP' and 'Escenario' with the value 'A'. There are also two radio buttons for 'Tipo de informe': 'Un archivo' (selected) and 'Varios archivos'. A 'Generar informe' button is located to the right of these options. Below this, a section titled 'Seleccione las tablas que desea incluir en el Informe' contains a table with columns 'NUM', 'COD VAR', and 'DES VAR'. The table lists six items, each with a checkbox in the 'NUM' column. At the bottom of the window, there are four buttons: 'Seleccionar todo', 'Borrar selección', 'Cambiar parametros', and 'Cerrar aplicación'.

| NUM | COD VAR | DES VAR |
|--------------------------|-----------|---------------------------------------|
| <input type="checkbox"/> | 1 VV_VCL | Vehiculo v viaja del nodo c al nodo k |
| <input type="checkbox"/> | 2 VV_AVL | Uso del vehiculo v |
| <input type="checkbox"/> | 3 RR_ENSA | Entrada y Salida de un Nodo |
| <input type="checkbox"/> | 4 RR_SANO | Salida del Nodo Origen |
| <input type="checkbox"/> | 5 RR_UTVE | Utilizacion de Vehiculos |
| <input type="checkbox"/> | 6 RR_VCLI | Visita de Destino |

RESULTS INFORMATION SYSTEM

DISPLAY RESULTS VIA OPTEX-EXCEL-GUI

CSV (RAW) TABLE

| | A | B | C | D | E | F | G | H |
|-----|---------|---------------|---------------|-------|------------|---|---|---|
| 1 | COD_VEH | COD_NOD | COD_NOD1 | VALOR | COSTO_RED | | | |
| 77 | SWK061 | 8300251421-0 | 830025638-22 | 1 | 1382.57937 | | | |
| 89 | SWK061 | 830025638-1 | 860002095-136 | 1 | 2225.41304 | | | |
| 95 | SWK061 | 830025638-17 | 830025638-5 | 1 | 1864.19861 | | | |
| 99 | SWK061 | 830025638-18 | 830025638-1 | 1 | 4621.05357 | | | |
| 106 | SWK061 | 830025638-22 | 8300251421-0 | 1 | 1382.57937 | | | |
| 120 | SWK061 | 830025638-4 | 830025638-7 | 1 | 3844.65014 | | | |
| 124 | SWK061 | 830025638-5 | 830025638-17 | 1 | 1864.19861 | | | |
| 135 | SWK061 | 830025638-7 | 830025638-4 | 1 | 3844.65014 | | | |
| 141 | SWK061 | 860002095-136 | 830025638-18 | 1 | 2997.66458 | | | |
| 218 | | | | | | | | |
| 219 | | | | | | | | |

Grupos de datos: GRF_VV_AVL | TD_VV_AVL | DATA_VV_AVL | GRF_VV ...

Listo Se encontraron 9 de 216 registros

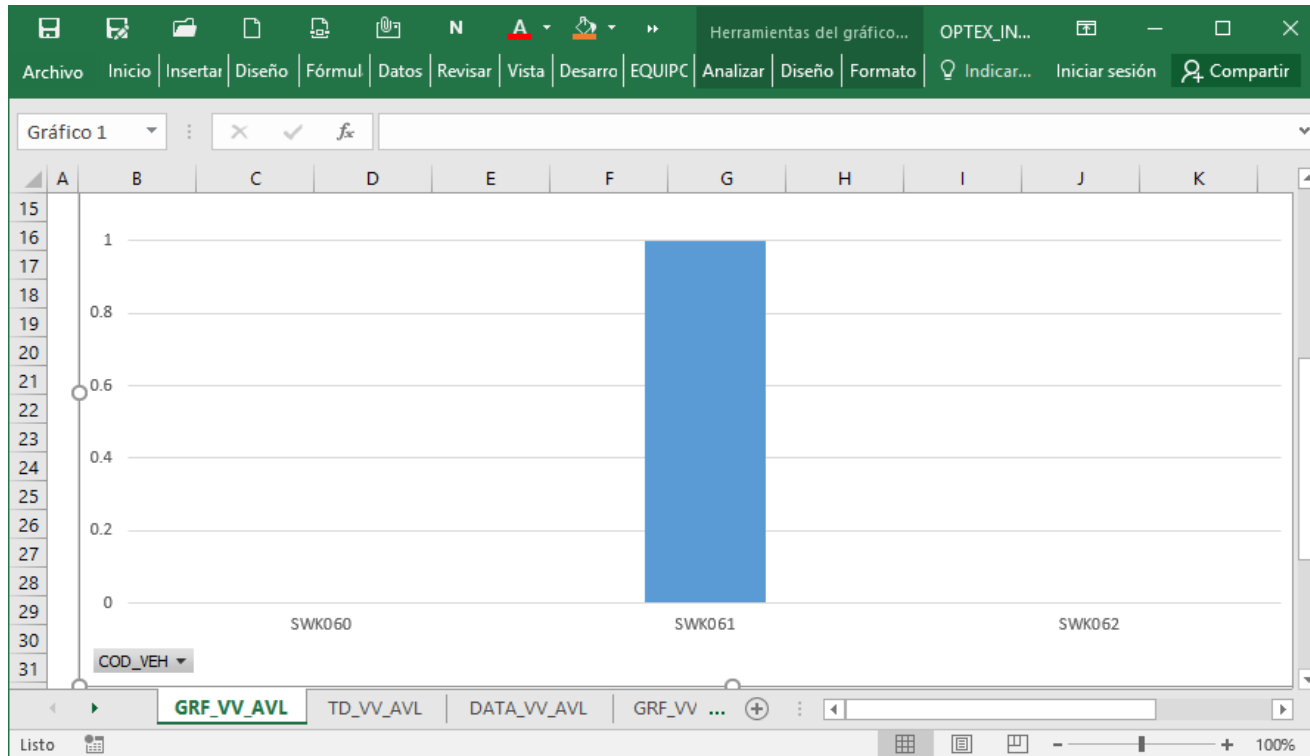
RESULTS INFORMATION SYSTEM

DISPLAY RESULTS VIA OPTEX-EXCEL-GUI

PIVOT TABLE

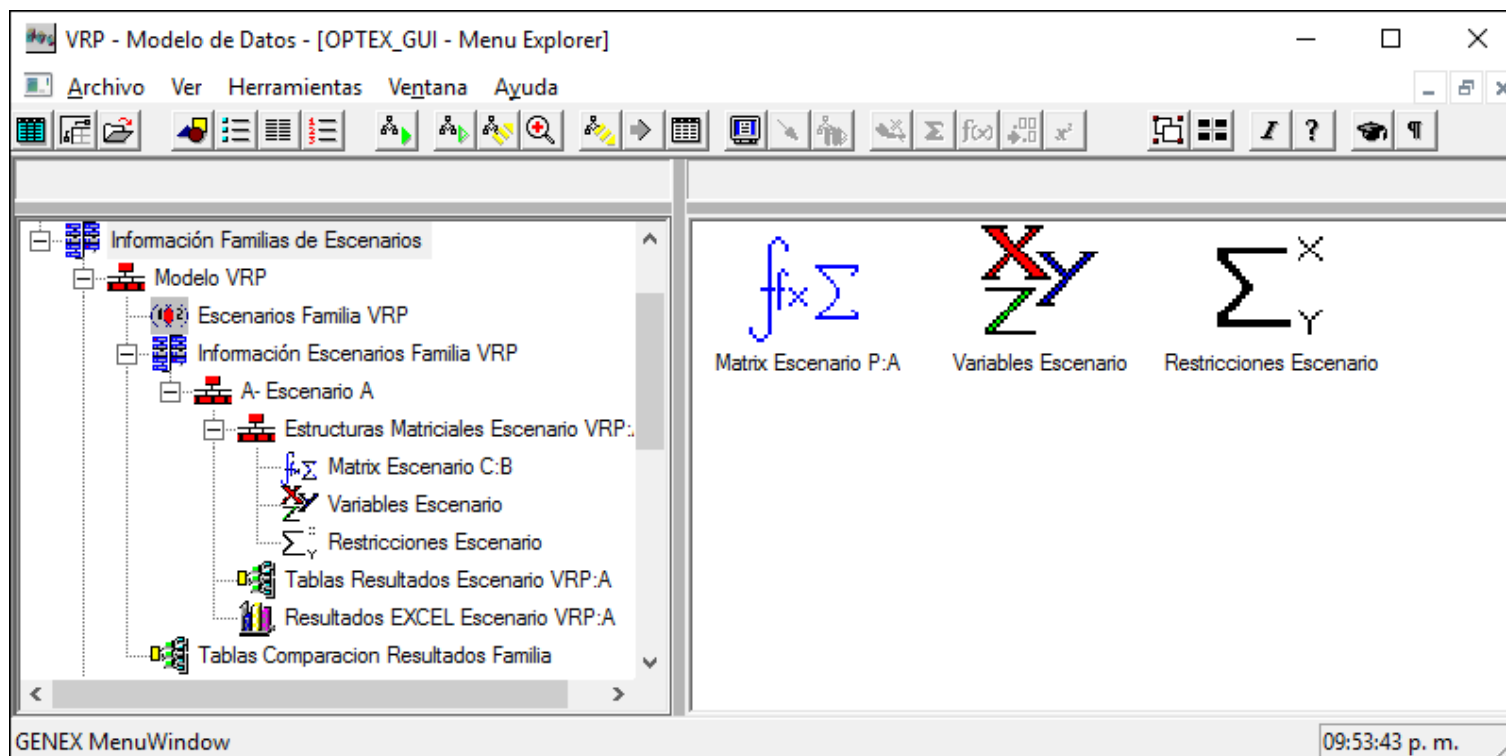
| Etiquetas de fila | 8300251421-0 | 830025638-1 | 830025638-17 | 830025638-18 | 830025638-22 | 830025638-4 | 830025638-5 | 830025638-7 | 860002095-136 | Total general |
|----------------------|--------------|-------------|--------------|--------------|--------------|-------------|-------------|-------------|---------------|---------------|
| SWK061 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 |
| 8300251421-0 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| 830025638-1 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 830025638-17 | 0 | 0 | | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 830025638-18 | 0 | 1 | 0 | | 0 | 0 | 0 | 0 | 0 | 1 |
| 830025638-22 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 1 |
| 830025638-4 | 0 | 0 | 0 | 0 | 0 | | 0 | 1 | 0 | 1 |
| 830025638-5 | 0 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 1 |
| 830025638-7 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | | 0 | 1 |
| 860002095-136 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | | 1 |
| Total general | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 |

RESULTS INFORMATION SYSTEM DISPLAY RESULTS VIA OPTEX-EXCEL-GUI PIVOT (DYNAMIC) GRAPH



RESULTS INFORMATION SYSTEM TABLES WITH MATRIX STRUCTURES

When available (depend of optimization technology), OPTeX matrix structures stored in tables of the information system to allow consultation through OPTeX-GUI. When available, and the user requests, OPTeX stores matrix structures related to the model in three tables located in the directory of the scenario.



RESULTS INFORMATION SYSTEM TABLES WITH MATRIX STRUCTURES

MAT_ESC: Expanded Matrix. It allows the user to review the matrix used in the mathematical model. Apply for problems with linear constraints.

VRP - Expanded Matrix - [Expanded Matrix]

Archivo Edición Ver Análisis Ver Ayuda


| ID Expand.Constraint | ID Expanded Variable | Coefficient | Problem | ID Restriccion | ID Variable | Serial Constraint | Serial Variable |
|--------------------------|---------------------------------------|-------------|---------|----------------|-------------|-------------------|-----------------|
| ENSA_SWK060_8300251421-0 | VCL_SWK060_8300251421-0_830025638-1 | 1. | | | | 1 | 1 |
| ENSA_SWK060_8300251421-0 | VCL_SWK060_830025638-17_8300251421-0 | -1. | | | | 1 | 10 |
| ENSA_SWK060_8300251421-0 | VCL_SWK060_830025638-18_8300251421-0 | -1. | | | | 1 | 11 |
| ENSA_SWK060_8300251421-0 | VCL_SWK060_830025638-22_8300251421-0 | -1. | | | | 1 | 12 |
| ENSA_SWK060_8300251421-0 | VCL_SWK060_830025638-4_8300251421-0 | -1. | | | | 1 | 13 |
| ENSA_SWK060_8300251421-0 | VCL_SWK060_830025638-5_8300251421-0 | -1. | | | | 1 | 14 |
| ENSA_SWK060_8300251421-0 | VCL_SWK060_830025638-7_8300251421-0 | -1. | | | | 1 | 15 |
| ENSA_SWK060_8300251421-0 | VCL_SWK060_860002095-136_8300251421-0 | -1. | | | | 1 | 16 |
| ENSA_SWK060_8300251421-0 | VCL_SWK060_8300251421-0_830025638-17 | 1. | | | | 1 | 2 |
| ENSA_SWK060_8300251421-0 | VCL_SWK060_8300251421-0_830025638-18 | 1. | | | | 1 | 3 |
| ENSA_SWK060_8300251421-0 | VCL_SWK060_8300251421-0_830025638-22 | 1. | | | | 1 | 4 |
| ENSA_SWK060_8300251421-0 | VCL_SWK060_8300251421-0_830025638-4 | 1. | | | | 1 | 5 |
| ENSA_SWK060_8300251421-0 | VCL_SWK060_8300251421-0_830025638-5 | 1. | | | | 1 | 6 |
| ENSA_SWK060_8300251421-0 | VCL_SWK060_8300251421-0_830025638-7 | 1. | | | | 1 | 7 |
| ENSA_SWK060_8300251421-0 | VCL_SWK060_8300251421-0_860002095-136 | 1. | | | | 1 | 8 |
| ENSA_SWK060_8300251421-0 | VCL_SWK060_830025638-1_8300251421-0 | -1. | | | | 1 | 9 |
| ENSA_SWK061_8300251421-0 | VCL_SWK061_8300251421-0_830025638-1 | 1. | | | | 10 | 73 |
| ENSA_SWK061_8300251421-0 | VCL_SWK061_8300251421-0_830025638-17 | 1. | | | | 10 | 74 |
| ENSA_SWK061_8300251421-0 | VCL_SWK061_8300251421-0_830025638-18 | 1. | | | | 10 | 75 |
| ENSA_SWK061_8300251421-0 | VCL_SWK061_8300251421-0_830025638-22 | 1. | | | | 10 | 76 |
| ENSA_SWK061_8300251421-0 | VCL_SWK061_8300251421-0_830025638-4 | 1. | | | | 10 | 77 |
| ENSA_SWK061_8300251421-0 | VCL_SWK061_8300251421-0_830025638-5 | 1. | | | | 10 | 78 |
| ENSA_SWK061_8300251421-0 | VCL_SWK061_8300251421-0_830025638-7 | 1. | | | | 10 | 79 |
| ENSA_SWK061_8300251421-0 | VCL_SWK061_8300251421-0_860002095-136 | 1. | | | | 10 | 80 |
| ENSA_SWK061_8300251421-0 | VCL_SWK061_830025638-1_8300251421-0 | -1. | | | | 10 | 81 |
| ENSA_SWK061_8300251421-0 | VCL_SWK061_830025638-17_8300251421-0 | -1. | | | | 10 | 82 |
| ENSA_SWK061_8300251421-0 | VCL_SWK061_830025638-18_8300251421-0 | -1. | | | | 10 | 83 |
| ENSA_SWK061_8300251421-0 | VCL_SWK061_830025638-22_8300251421-0 | -1. | | | | 10 | 84 |
| ENSA_SWK061_8300251421-0 | VCL_SWK061_830025638-4_8300251421-0 | -1. | | | | 10 | 85 |
| ENSA_SWK061_8300251421-0 | VCL_SWK061_830025638-5_8300251421-0 | -1. | | | | 10 | 86 |
| ENSA_SWK061_8300251421-0 | VCL_SWK061_830025638-7_8300251421-0 | -1. | | | | 10 | 87 |

RESULTS INFORMATION SYSTEM TABLES WITH MATRIX STRUCTURES

VAR_ESC: Expanded Variables. It allows the user to review the matrix structures from the point of view of the variables indicating in which constraints is included a specific variable. This requires access **MAT_ESC** tables from the Open Table (s) Related (s) option.

VRP - Expanded Variable - Scenario-

Archivo Edición Ver Análisis Ver Ayuda



| ID Expanded Variable | Value Solution | C. Reduced | Cost F.Obj | Lc |
|---------------------------------------|----------------|------------|------------|----|
| VCL_SWK060_8300251421-0_830025638-1 | | | 0. | 0. |
| VCL_SWK060_830025638-17_8300251421-0 | | | 0. | 0. |
| VCL_SWK061_830025638-5_830025638-1 | | | 0. | 0. |
| VCL_SWK061_830025638-7_830025638-1 | | | 0. | 0. |
| VCL_SWK061_860002095-136_830025638-1 | | | 0. | 0. |
| VCL_SWK061_830025638-17_830025638-18 | | | 0. | 0. |
| VCL_SWK061_830025638-17_830025638-22 | | | 0. | 0. |
| VCL_SWK061_830025638-17_830025638-4 | | | 0. | 0. |
| VCL_SWK061_830025638-17_830025638-5 | | | 0. | 0. |
| VCL_SWK061_830025638-17_830025638-7 | | | 0. | 0. |
| VCL_SWK061_830025638-17_860002095-136 | | | 0. | 0. |
| VCL_SWK061_830025638-18_830025638-17 | | | 0. | 0. |
| VCL_SWK060_830025638-18_8300251421-0 | | | 0. | 0. |
| VCL_SWK061_830025638-22_830025638-17 | | | 0. | 0. |
| VCL_SWK061_830025638-4_830025638-17 | | | 0. | 0. |
| VCL_SWK061_830025638-5_830025638-17 | | | 0. | 0. |
| VCL_SWK061_830025638-7_830025638-17 | | | 0. | 0. |
| VCL_SWK061_860002095-136_830025638-17 | | | 0. | 0. |
| VCL_SWK061_830025638-18_830025638-22 | | | 0. | 0. |
| VCL_SWK061_830025638-18_830025638-4 | | | 0. | 0. |
| VCL_SWK061_830025638-18_830025638-5 | | | 0. | 0. |
| VCL_SWK061_830025638-18_830025638-7 | | | 0. | 0. |
| VCL_SWK061_830025638-18_860002095-136 | | | 0. | 0. |
| VCL_SWK060_830025638-22_8300251421-0 | | | 0. | 0. |
| VCL_SWK061_830025638-22_830025638-18 | | | 0. | 0. |
| VCL_SWK061_830025638-4_830025638-18 | | | 0. | 0. |
| VCL_SWK061_830025638-5_830025638-18 | | | 0. | 0. |
| VCL_SWK061_830025638-7_830025638-18 | | | 0. | 0. |

| ID Expand.Constraint | Coefficient | ID Expanded Variable |
|--------------------------|-------------|-------------------------------------|
| ENSA_SWK060_8300251421-0 | 1. | VCL_SWK060_8300251421-0_830025638-1 |
| ENSA_SWK060_830025638-1 | -1. | VCL_SWK060_8300251421-0_830025638-1 |
| SANO_SWK060_8300251421-0 | 1. | VCL_SWK060_8300251421-0_830025638-1 |
| UTVE_SWK060 | 1. | VCL_SWK060_8300251421-0_830025638-1 |

RESULTS INFORMATION SYSTEM TABLES WITH MATRIX STRUCTURES

RES_ESC: Expanded Constraints. It allows the user to review the matrix structures from the point of view of the constraints, indicating which variables are included in a specific constraint. This requires access **MAT_ESC** tables from the Open Table (s) Related (s) option.

VRP - Expanded Constraints - Scenario

Archivo Edición Ver Análisis Ver Ayuda

| ID Expand.Constraint | Cost Dual | Type | RHS | LHS | Problem |
|---------------------------|-----------|------|-----|-----|---------|
| ENSA_SWK060_8300251421-0 | | = | 0. | | |
| ENSA_SWK061_8300251421-0 | | = | 0. | | |
| ENSA_SWK061_830025638-1 | | = | 0. | | |
| ENSA_SWK061_830025638-17 | | = | 0. | | |
| ENSA_SWK061_830025638-18 | | = | 0. | | |
| ENSA_SWK061_830025638-22 | | = | 0. | | |
| ENSA_SWK061_830025638-4 | | = | 0. | | |
| ENSA_SWK061_830025638-5 | | = | 0. | | |
| ENSA_SWK061_830025638-7 | | = | 0. | | |
| ENSA_SWK061_860002095-136 | | = | 0. | | |
| ENSA_SWK062_8300251421-0 | | = | 0. | | |
| ENSA_SWK060_830025638-1 | | = | 0. | | |
| ENSA_SWK062_830025638-1 | | = | 0. | | |
| ENSA_SWK062_830025638-17 | | = | 0. | | |
| ENSA_SWK062_830025638-18 | | = | 0. | | |
| ENSA_SWK062_830025638-22 | | = | 0. | | |
| ENSA_SWK062_830025638-4 | | = | 0. | | |
| ENSA_SWK062_830025638-5 | | = | 0. | | |
| ENSA_SWK062_830025638-7 | | = | 0. | | |
| ENSA_SWK062_860002095-136 | | = | 0. | | |
| SANO_SWK060_8300251421-0 | | = | 0. | | |
| SANO_SWK061_8300251421-0 | | = | 0. | | |
| ENSA_SWK060_830025638-17 | | = | 0. | | |
| SANO_SWK062_8300251421-0 | | = | 0. | | |
| UTVE_SWK060 | | < | 0. | | |
| UTVE_SWK061 | | < | 0. | | |
| UTVE_SWK062 | | < | 0. | | |
| VCLI_830025638-1 | | = | 1. | | |

| ID Expanded Variable | Coefficient | ID Expand.Constraint |
|---------------------------------------|-------------|--------------------------|
| VCL_SWK060_8300251421-0_830025638-1 | 1. | ENSA_SWK060_8300251421-0 |
| VCL_SWK060_830025638-17_8300251421-0 | -1. | ENSA_SWK060_8300251421-0 |
| VCL_SWK060_830025638-18_8300251421-0 | -1. | ENSA_SWK060_8300251421-0 |
| VCL_SWK060_830025638-22_8300251421-0 | -1. | ENSA_SWK060_8300251421-0 |
| VCL_SWK060_830025638-4_8300251421-0 | -1. | ENSA_SWK060_8300251421-0 |
| VCL_SWK060_830025638-5_8300251421-0 | -1. | ENSA_SWK060_8300251421-0 |
| VCL_SWK060_830025638-7_8300251421-0 | -1. | ENSA_SWK060_8300251421-0 |
| VCL_SWK060_860002095-136_8300251421-0 | -1. | ENSA_SWK060_8300251421-0 |
| VCL_SWK060_8300251421-0_830025638-17 | 1. | ENSA_SWK060_8300251421-0 |
| VCL_SWK060_8300251421-0_830025638-18 | 1. | ENSA_SWK060_8300251421-0 |
| VCL_SWK060_8300251421-0_830025638-22 | 1. | ENSA_SWK060_8300251421-0 |
| VCL_SWK060_8300251421-0_830025638-4 | 1. | ENSA_SWK060_8300251421-0 |
| VCL_SWK060_8300251421-0_830025638-5 | 1. | ENSA_SWK060_8300251421-0 |
| VCL_SWK060_8300251421-0_830025638-7 | 1. | ENSA_SWK060_8300251421-0 |
| VCL_SWK060_8300251421-0_860002095-136 | 1. | ENSA_SWK060_8300251421-0 |
| VCL_SWK060_830025638-1_8300251421-0 | -1. | ENSA_SWK060_8300251421-0 |



"the computer-based mathematical modeling is the greatest invention of all times"

**Herbert Simon
First Winner of Nobel Prize in Economics (1978)**

"for his pioneering research into the decision-making process within economic organizations"