

- Global Optimization (Benchmark Only)
 - v_x
 - v_x_Matrix
 - v_energy_variation
- Local / MPC Optimization (Actual Simulation)
 - Rate_Matrix
 - energy_variation
 - EV_Matrix
 - EV_Mapping
 - E_Charged
- Support Structures
 - F

Diagram illustrating a matrix F with columns indexed from 0 to N . The matrix is shown as a 3x6 grid of cells. The first column is labeled $\#Evs$. A bracket under the first three columns is labeled "Intervals".

0	0	1	...	0	0
0	1	1	...	1	0
1	1	0	...	0	0

The diagram illustrates the input data for the EV charging problem, organized into three main components:

- Power Consumption and Charging Power:** A horizontal bar represents the timeline from $t=1$ to $t=N$. The first part, labeled "total_load", consists of purple blocks representing power consumption. The second part, labeled "charging power", consists of yellow blocks representing power available for charging. An arrow points from the end of the timeline to the set $D = \{-5, 5\}$, which is also indicated by arrows from $-P_{\max}$ and P_{\max} .
- EVs Matrix:** A matrix showing the number of EVs (#Evs) at different time intervals. The matrix is divided into two sections: "0" and "N". The "0" section contains a 3x3 grid of values: $\begin{bmatrix} 0 & 0 & 3.5 \\ 0 & -2.1 & -4.3 \\ 0 & 0 & -2.3 \end{bmatrix}$. The "N" section contains a 3x3 grid of values: $\begin{bmatrix} \dots & 5 & 0 \\ \dots & 5 & 0 \\ \dots & +3.4 & 0 \end{bmatrix}$. The "Intervals" label is placed below the "N" section.
- v_energy_variation:** A matrix showing the energy variation for different EVs (#Evs) at different time intervals. The matrix is divided into two sections: "0" and "N+1". The "0" section contains a 3x3 grid of values: $\begin{bmatrix} 7k & 7k & 7k \\ 5k & 7k & 0 \\ 3k & 7k & 7k \end{bmatrix}$. The "N+1" section contains a 3x3 grid of values: $\begin{bmatrix} \dots & 12k & 14k \\ 9k & 14k \\ 10k & 14k \end{bmatrix}$. The "Intervals" label is placed below the "N+1" section, and an arrow points from the "0" section to the "Initial_energy" label.

The diagram illustrates the data flow and processing steps for EV charging data. It shows how raw data matrices are processed to generate energy variation and mapping information.

EV_Matrix (Input Matrix):

ID	INTS	CURR(E)	ARRIVE(S)	DEPARTURE(S)	STATUS	TYPE	GROUP_ID
42	6.5	12.3	10	18	1	1	3
43	6.5	12.3	10	18	1	1	3

Annotations for EV_Matrix:

- 0 : not charging
- 1: charging
- 2: charge complete
- 0 : CHG
- 1. V2G

Rate_Matrix (Input Matrix):

Intervals	0	0	3.5	...	5	0
0	0	-2.1	-4.3	...	5	0
0	0	-2.3	...	+3.4	0	

energy_variation (Output Matrix):

Intervals	0	7k	7k	...	12k	14k
7k	7k	7k	...	12k	14k	
5k	7k	0	...	9k	14k	
3k	7k	7k	...	10k	14k	

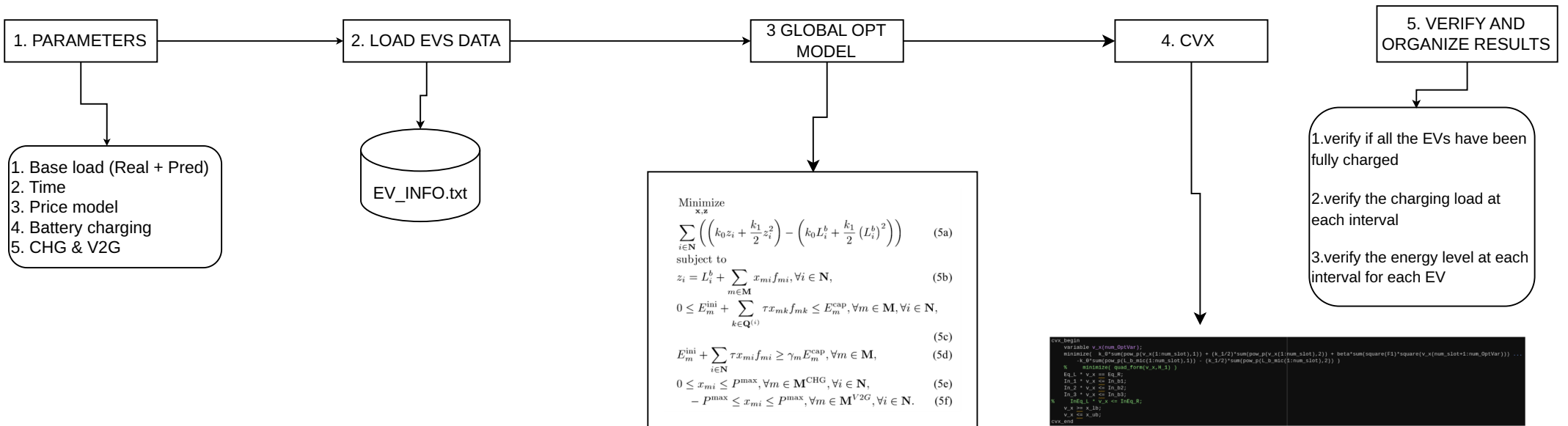
E_charged (Output Matrix):

INTS	CURR(E)	TRAVEL(S)
5.2	10.8	14
...
...

EV_Mapping (Output Matrix):

ID	INTS	STATUS
1	56	
2	1	
...	...	
200	2	

GLOBAL



The flowchart illustrates the proposed algorithm's steps:

- 6. DISCRETE OPTIMIZATION GROUP**
 - 1. Init. $E_Charged$
 - 2. Init. $Rate_Matrix$
 - 3. EV_Matrix
- 7 GROUP LEVEL**
 - For each time slot compute optimization for all the vehicle into the sliding window ($Current_EV$)
- 8. VERIFY THE RESULT**
- 9. PLOT THE RESULTS**

A sample plot of EV charging power is shown, comparing three schemes over 350 time slots:

- Globally optimal scheme** (Blue line): Shows the highest charging power, fluctuating between approximately 280 and 340.
- Locally optimal scheme** (Orange line): Shows intermediate charging power, fluctuating between approximately 260 and 320.
- Equal allocation scheme** (Green line): Shows the lowest charging power, fluctuating between approximately 240 and 300.

