Supplementary file: AI-AEFA

IOP's problem formulation

Beef cattle case [1]

$$\text{Minimize } f=\sum_{j=1}^{N}\alpha_j cost_j,$$

$$\text{Subject to } \sum_{j=1}^{N}\alpha_j D_j-a=0,\ b-\sum_{j=1}^{N}\alpha_j P_j\le 0,\ \sum_{j=1}^{N}\alpha_j P_j-c\le 0,\ d-\sum_{j=1}^{N}\alpha_j t_j\le 0,\ \sum_{j=1}^{N}\alpha_j T_j-e\le 0,$$

$$f-\sum_{j=1}^{N}\alpha_j C_j\le 0,\ \sum_{j=1}^{N}\alpha_j C_j-g\le 0,\ h-\sum_{j=1}^{N}\alpha_j Q_j\le 0,\ \sum_{j=1}^{N}\alpha_j Q_j-i\le 0, k-\sum_{j=1}^{N}\alpha_j R_j\le 0,$$

$$\sum_{j=1}^{N}\alpha_j R_j-l\le 0,\ m-\sum_{j=1}^{N}\alpha_j M_j\le 0,\ \sum_{j=1}^{N}\alpha_j M_j-o\le 0,\ p-\sum_{j=1}^{N}\alpha_j Co_j\le 0,\ \sum_{j=1}^{N}\alpha_j Co_j-q\le 0,$$

where D, T, C, P, R, and Q represent the dry matter intake, total digestible nutrients, calcium, crude protein, roughages, and phosphorus, respectively, in kg. The known fitness values of LF1, LF2, LF3, and LF4 are $4.5508511497E+03$, $3.3489821493E+03$, $4.9976069290E+03$, and $4.2405482538E+03$, respectively.

Dairy cattle case [1]

$$\text{Minimize } f=\sum_{j=1}^{N}\alpha_j cost_j,$$

$$\text{Subject to } \sum_{j=1}^{N}\alpha_j M_j-r=0,\ \sum_{j=1}^{N}\alpha_j L_j-s=0,\ \sum_{j=1}^{N}\alpha_j C_j-t=0,$$

$$\sum_{j=1}^{N}\alpha_j Q_j-u=0,\ \sum_{j=1}^{N}\alpha_j E_j-v=0,\ \sum_{j=1}^{N}\alpha_j ET_j-z=0,$$

where, L, M, Q, C, ET, and E represent the lysine, metabolizable protein, phosphorus, calcium, methionine, and metabolizable energy, respectively in kg.

Topology optimization

$$\text{Minimize } f=D^{'}SD=\sum_{i=1}^{N}\alpha_i d_i^p s_o d_o,$$

$$\text{Subject to } \frac{V}{V_o}=f,\ SD=F,$$

$$\text{Bounds } 0\le\overline{\alpha}_{min}<\alpha\le 1.$$

where, F denotes force, S, s_0 are global stiffness matrix and stiffness matrix, D, d_o are the global, and element displacement, V, V_o represents the material and designed volume, N denotes the number of elements used to discretize the designed domain, and $p=3$ penalized power.

Mathematical model of SOPM

$$\text{Minimize } f = \frac{\sqrt{\sum_i (i^{-4})(\sum_j^r A(r)\cos(i\beta_j))^2}}{\sqrt{\sum_i (i^{-4})}},$$

$$\text{Subject to } \beta_{j+1} - \beta_j > 10^{-5},\ j = 1, 2, \cdots, r-1,\ \&\ cn - \sum_j^r \cos(i\beta_j) = 0,$$

$$\text{Bounds } 0 < \beta_j < \frac{\pi}{2},\ j = 1, 2, \cdots, r, \text{where, } i = 5, 7, \cdots, 97, \text{ and } r = \lfloor \frac{cf_{A,max}}{fn} \rfloor.$$

(i) *3-level Inverters [2]:*
$c = 1$, and $A(r) = (-1)^{r+1}$.
n=0.32, dimension=25.
The known objective value is $3.8029250566E-02$.

(ii) *5-level Inverters [3]:*
$c = 2$, and $A(r) = [1, -1, 1, 1, -1, 1, -1, 1, -1, -1, 1, -1, 1, 1, -1, 1, -1, 1, -1, -1, 1, -1, 1, 1, -1]$.
n=0.32, dimension=25.
The known objective value is $2.1215000000E-02$.

(iii) *7-level Inverters [4]:*
$c = 3$, and $A(r) = [1, -1, 1, 1, 1, -1, -1, -1, 1, 1, -1, -1, 1, 1, 1, -1, -1, -1, 1, 1, -1, -1, 1, 1, 1]$.
n=0.36, dimension=25.
The known objective value is $1.5164538375E-02$.

(iv) *9-level Inverters [5]:*
$c = 4$, and $A(r) = [1, 1, 1, 1, -1, 1, -1, -1, -1, 1, -1, -1, 1, 1, 1, 1, -1, 1, -1, -1, -1, 1, -1, -1, 1, 1, 1, 1, -1, 1]$.
n=0.32, dimension=30.
The known objective value is $1.6787535766E-02$.

(v) *13-level Inverters [6]:*
$c = 6$, and $A(r) = [1, 1, 1, -1, 1, -1, 1, -1, 1, 1, 1, 1, -1, -1, -1, -1, 1, -1, 1, -1, 1, 1, 1, 1, -1, -1, -1, 1, -1, 1]$.
n=0.32, dimension=30.
The known objective value is $1.5096451396E-02$.

Case .1: Heat Exchanger Network Design Optimization Problem [7]

The problem contains six linear and two non-linear equality constrained with one non-linear objective.

$$\begin{aligned}
&\text{Minimize } f = 35\alpha_1^{0.6} + 35\alpha_2^{0.6}\\
&\text{Subject to } 200\alpha_1\alpha_4 - \alpha_3 = 0,\ 200\alpha_2\alpha_6 - \alpha_5 = 0,\ \alpha_3 - 10^4(\alpha_7 - 100) = 0,\\
&\qquad \alpha_5 - 10^4(300 - \alpha_7) = 0,\ \alpha_3 - 10^4(600 - \alpha_8) = 0,\ \alpha_5 - 10^4(900 - \alpha_9) = 0,\\
&\qquad \alpha_4 \ln(\alpha_8 - 100) - \alpha_4 \ln(600 - \alpha_7) - \alpha_8 + \alpha_7 + 500 = 0,\\
&\qquad \alpha_6 \ln(\alpha_9 - \alpha_7) - \alpha_6 \ln(600) - \alpha_9 + \alpha_7 + 600 = 0,\\
&\text{Bounds } 0 \le \alpha_1 \le 10,\ 0 \le \alpha_2 \le 200,\ 0 \le \alpha_3 \le 100,\ 0 \le \alpha_4 \le 200,\ 10^3 \le \alpha_5 \le 2\times 10^6,\\
&\qquad 0 \le \alpha_6 \le 600,\ 100 \le \alpha_7 \le 600,\ 100 \le \alpha_8 \le 600,\ 100 \le \alpha_9 \le 900.
\end{aligned}$$

The known objective value is $1.8931162966E+02$.

Case .2: Heat Exchanger Network Design Optimization Problem [8]

The problem contains six linear and three non-linear equality constrained with one non-linear objective.

$$
\begin{aligned}
&\text{Minimize } f = \left(\frac{\alpha_1}{120\alpha_4}\right)^{0.6} + \left(\frac{\alpha_2}{80\alpha_5}\right)^{0.6} + \left(\frac{\alpha_3}{40\alpha_6}\right)^{0.6} \\
&\text{Subject to } \alpha_1 - 10^4(\alpha_7 - 100) = 0,\ \alpha_2 - 10^4(\alpha_8 - \alpha_7) = 0,\ \alpha_3 - 10^4(500 - \alpha_8) = 0, \\
&\qquad \alpha_1 - 10^4(300 - \alpha_7) = 0,\ \alpha_2 - 10^4(400 - \alpha_7) = 0,\ \alpha_3 - 10^4(600 - \alpha_7) = 0, \\
&\qquad \alpha_4 \ln(\alpha_9 - 100) - \alpha_4 \ln(300 - \alpha_7) - \alpha_9 - \alpha_7 + 400 = 0, \\
&\qquad \alpha_5 \ln(\alpha_{10} - \alpha_7) - \alpha_5 \ln(300 - \alpha_8) - \alpha_{10} + \alpha_7 - \alpha_8 + 400 = 0, \\
&\qquad \alpha_6 \ln(\alpha_{11} - \alpha_7) - \alpha_6 \ln(100) - \alpha_{11} + \alpha_8 + 100 = 0, \\
&\text{Bounds } a \le \alpha_1 \le 81.9 \times a,\ a \le \alpha_2 \le 113.1 \times a,\ a \le \alpha_3 \le 205 \times a,\ 0 \le \alpha_4, \alpha_5, \alpha_6 \le 0.05074, \\
&\qquad 100 \le \alpha_7 \le 200,\ 100 \le \alpha_8 \alpha_9, \alpha_{10} \le 300,\ 100 \le \alpha_{11} \le 400, \\
&\qquad \text{where } a = 10^4.
\end{aligned}
$$

The known objective value is $7.0490369540E+03$.

RRA's problem formulation

The demand for highly reliable products and equipment is increasing daily in the modern world. As a result, the demand for reliability analysis to assess the performance of products, equipment, and various engineering systems has grown. Reliability optimization is capable of identifying these difficulties and identifying a high-quality system that works efficiently and securely within a specified time frame. We define the following assumptions before introducing the RRA problems:

(i) The failure of one element of any circuit is unrelated to the unaffected others.
(ii) The components and the system can only be in one of two states: failure or operating.
(iii) All redundancy is treated as "active redundancy", which means it is not repaired.
(iv) Reliability, weight, cost, volume, and other component attributes are fixed.

The basic mathematical expression for RRA problems is given as follows:

$$
\begin{aligned}
&\text{Maximize } \mathbf{f}(\mathbf{x},\mathbf{y}) = 1 - (1-\mathbf{x})^{\mathbf{y}}, \\
&\text{Subject to } g(\mathbf{x},\mathbf{y}) \le p, \\
&\qquad x_{min} \le \mathbf{x} \le x_{max}, \text{ and } y_{min} \le \mathbf{y} \le y_{max}, \\
&\qquad y_{min}, y_{max}, \mathbf{y} \in \mathbb{Z}^+,
\end{aligned}
\tag{1}
$$

where $\mathbf{x} = \{x_1, x_2, \cdots, x_m\}$ and $\mathbf{y} = \{y_1, y_2, \cdots, y_m\}$ are the number of components and reliability in each system. $\mathbf{f}(\mathbf{x},\mathbf{y})$ is the system reliability. Each RRA problem aims to maximize system reliability by determining the optimal values for the number of redundant components $\mathbf{y}_j$ and the reliability of each component $\mathbf{x}_j$ for j^{th} subsystem. In the evolution process, the integer variables $\mathbf{y}_j$ are initially treated as real variables, and their real values are later rounded to the nearest integers upon completion of the optimization process. The subsequent section defines seven benchmark RRA problems, which are commonly utilized to evaluate the optimization performance of newly developed algorithms.

Series system RRA problem (R1): It is an integer programming non-linear RRA problem and has been solved by a variety of optimization algorithms in literature [9, 10, 11]. The general mathematical expression is defined as follows:

$$\text{Maximize } \mathbf{f}(\mathbf{x},\mathbf{y}) = \prod_{j=1}^{m} 1-(1-\mathbf{x}_j)^{\mathbf{y}_j}, \tag{2}$$

$$\text{Subject to } \sum_{j=1}^{m} vol_j \mathbf{y}_j^2 - Vol \le 0, \quad \text{(Volume constrained)} \tag{3}$$

$$\sum_{j=1}^{m} cst_j \left[\mathbf{y}_j + \exp(\mathbf{y}_j/4)\right] - Cst \le 0, \quad \text{(Cost constrained)} \tag{4}$$

$$\sum_{j=1}^{m} wgt_j \mathbf{y}_j^2 \exp(\mathbf{y}_j/4) - Wgt \le 0, \quad \text{(Weight constrained)} \tag{5}$$

$$0.5 \le \mathbf{x}_j \le 1,\ 1 \le \mathbf{y}_j \le m,\ \mathbf{y}_j \in \mathbb{Z}^+,\ j=1,2,\cdots m,$$

$$\alpha_j = [2.330, 1.450, 0.541, 8.050, 1.950] \times 10^5,\ \beta_j = [1.5, 1.5, 1.5, 1.5, 1.5],\ vol_j = [1,2,3,4,2],$$

$$wgt_j = [7,8,8,6,9],\ Cst = 175, Wgt = 200, Vol = 110,$$

where $cst_j = \alpha_j \left(-1000/ln(\mathbf{x}_j)\right)^{\beta_j}$, $j = 1,2,\cdots,m$, $m = 5$. vol_j, wgt_j and cst_j are the predefined volume, weight, and cost of each component in j^{th} subsystem, Vol, Wgt, and Cst are the upper limits of volume, weight, and cost, and α_j and β_j are the physical parameters. The diagrammatic representation of this RRA problem is depicted in Fig. S1.

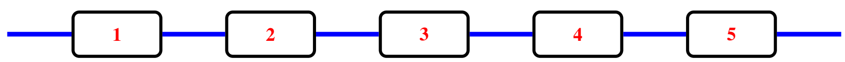

Figure S1: *Series system RRA problem (R1).*

Series parallel system RRA problem (R2): This system has been studied in several studies [9, 10, 11], and the its mathematical expression are given as follows:

$$\text{Maximize } \mathbf{f}(\mathbf{x},\mathbf{y}) = 1-(1-(1-\mathbf{x}_1)^{\mathbf{y}_1}(1-\mathbf{x}_2)^{\mathbf{y}_2})\,(1-(1-(1-\mathbf{x}_3)^{\mathbf{y}_3})(1-(1-\mathbf{x}_4)^{\mathbf{y}_4})(1-\mathbf{x}_5)^{\mathbf{y}_5}), \tag{6}$$

Constraints same as Eqs. (3)– (5),

$$\alpha_j = [2.5, 1.45, .541, .541, 2.100] \times 10^5,\ \beta_j = [1.5, 1.5, 1.5, 1.5, 1.5],\ vol_j = [2,4,5,8,4],$$

$$wgt_j = [3.5, 4, 4, 3.5, 3.5],\ Cst = 175, Wgt = 100, Vol = 180.$$

The diagrammatic representation of this RRA problem is depicted in Fig. S2.

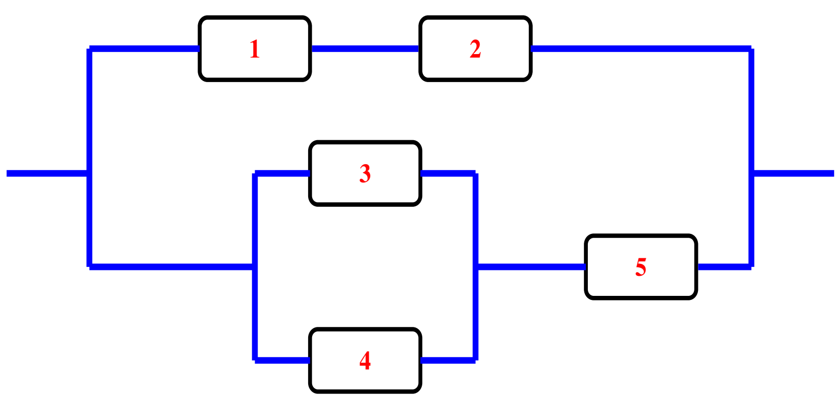

Figure S2: *Series-parallel system RRA problem (R2).*

Bridge system RRA problem (R3): This system has five subsystems of classical RRA problem and studied by [9, 10, 11]. The mathematical formulation is given as follows:

$$\begin{aligned}
&\text{Maximize } \mathbf{f}(\mathbf{x},\mathbf{y}) = (1-\mathbf{x}_1)^{\mathbf{y}_1}(1-\mathbf{x}_2)^{\mathbf{y}_2} + (1-\mathbf{x}_3)^{\mathbf{y}_3}(1-\mathbf{x}_4)^{\mathbf{y}_4} + (1-\mathbf{x}_1)^{\mathbf{y}_1}(1-\mathbf{x}_4)^{\mathbf{y}_4}(1-\mathbf{x}_5)^{\mathbf{y}_5} \\
&+(1-\mathbf{x}_2)^{\mathbf{y}_2}(1-\mathbf{x}_3)^{\mathbf{y}_3}(1-\mathbf{x}_5)^{\mathbf{y}_5} - (1-\mathbf{x}_1)^{\mathbf{y}_1}(1-\mathbf{x}_2)^{\mathbf{y}_2}(1-\mathbf{x}_3)^{\mathbf{y}_3}(1-\mathbf{x}_4)^{\mathbf{y}_4} \\
&-(1-\mathbf{x}_1)^{\mathbf{y}_1}(1-\mathbf{x}_2)^{\mathbf{y}_2}(1-\mathbf{x}_3)^{\mathbf{y}_3}(1-\mathbf{x}_5)^{\mathbf{y}_5} - (1-\mathbf{x}_1)^{\mathbf{y}_1}(1-\mathbf{x}_2)^{\mathbf{y}_2}(1-\mathbf{x}_4)^{\mathbf{y}_4}(1-\mathbf{x}_5)^{\mathbf{y}_5} \qquad (7) \\
&-(1-\mathbf{x}_2)^{\mathbf{y}_2}(1-\mathbf{x}_3)^{\mathbf{y}_3}(1-\mathbf{x}_4)^{\mathbf{y}_4}(1-\mathbf{x}_5)^{\mathbf{y}_5} + 2(1-\mathbf{x}_1)^{\mathbf{y}_1}(1-\mathbf{x}_2)^{\mathbf{y}_2}(1-\mathbf{x}_3)^{\mathbf{y}_3}(1-\mathbf{x}_4)^{\mathbf{y}_4}(1-\mathbf{x}_5)^{\mathbf{y}_5},
\end{aligned}$$

Constraints same as Eqs. (3)$-$ (5),

$\alpha_j = [2.33, 1.45, 0.541, 8.05, 1.95] \times 10^5$, $\beta_j = [1.5, 1.5, 1.5, 1.5, 1.5]$, $vol_j = [1, 2, 3, 4, 2]$,
$wgt_j = [7, 8, 8, 6, 9]$, $Cst = 175, Wgt = 200, Vol = 110$.

The diagrammatic representation of this RRA problem is depicted in Fig. S3.

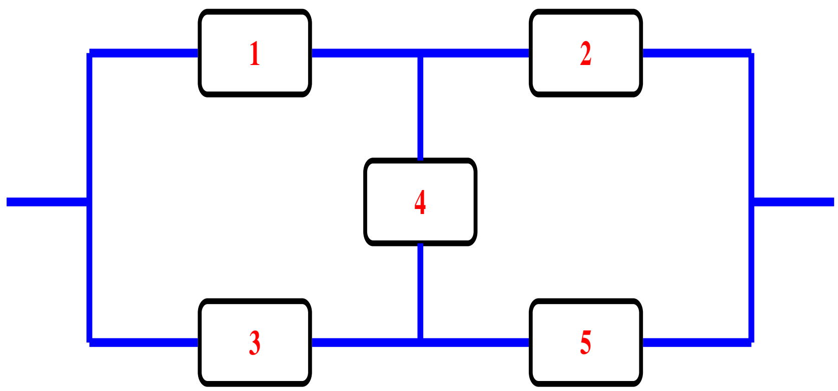

Figure S3: *Bridge system RRA problem (R3).*

Gas turbine RRA problem (R4): This RRA problem corresponds to an overspeed protection system designed for gas turbines. It incorporates both electrical and mechanical systems to ensure continuous overspeed detection. The system involves four control valves (Val1$-$Val4) that must be nearly closed to halt the fuel supply in the event of an overspeed condition. The control system is organized in a four-stage series configuration. The objective is to determine the optimal values of $\mathbf{x}_j$ and $\mathbf{y}_j$ at j^{th} stage to maximize the system reliability. This particular RRA problem has been investigated by various researchers [9, 10, 11], and its mathematical formulation is presented as follows:

$$\text{Maximize } \mathbf{f}(\mathbf{x},\mathbf{y}) = \prod_{j=1}^{m} 1-(1-\mathbf{x}_j)^{\mathbf{y}_j}, \qquad (8)$$

Constraints same as Eqs. (3)$-$ (5),

$\alpha_j = [1.0, 2.3, 0.3, 2.3] \times 10^5$, $\beta_j = [1.5, 1.5, 1.5, 1.5, 1.5]$, $vol_j = [1, 2, 3, 2]$,
$wgt_j = [6, 6, 8, 7]$, $Cst = 400$, $Wgt = 500$, $Vol = 250$, $m = 4$.

The diagrammatic representation of this RRA problem is depicted in Fig. S4.

Convex quadratic RRA problem (R5): This RRA problem is an integer programming with convex quadratic constraints and has been studied by several researchers [9, 10, 11]. The mathematical expression

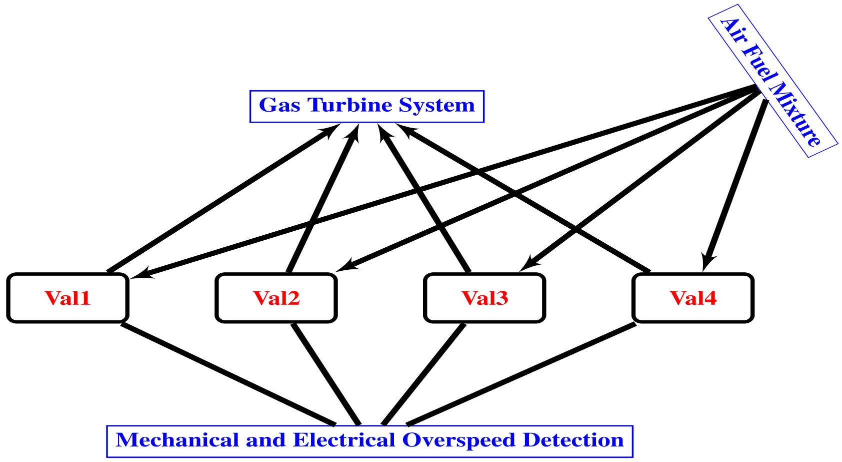

Figure S4: *Gas turbine system RRA problem (R4).*

is given as follows:

$$\text{Maximize } \mathbf{f}(\mathbf{x},\mathbf{y}) = \prod_{j=1}^{m} 1-(1-\mathbf{x}_j)^{\mathbf{y}_j}, \tag{9}$$

$$\text{Subject to } \prod_{j}^{m}(ud1_{ij}\mathbf{y}_j^2 + ud2_{ij}\mathbf{y}_j) - c_i \leq 0,$$
$$1 \leq \mathbf{y}_j \leq 6,\ i=1,2,3,4;\ \mathbf{x}_j = [.81,.93,.92,.96,.99,.89,.85,.83,.94,.92];$$
$$c_j = (2.0\times a, 3.1\times b, 5.7\times a, 9.3\times b);\ a=10^{13},\ b=10^{12};\ m=10;$$
$$ud1 = [2,7,3,0,5,6,9,4,8,1;4,9,2,7,1,0,8,3,5,6;5,1,7,4,3,6,0,9,8,2;8,3,5,6,9,7,2,4,0,1];$$
$$ud2 = [7,1,4,6,8,2,5,9,3,3;4,6,5,7,2,6,9,1,0,8;1,10,3,5,4,7,8,9,4,6;2,3,2,5,7,8,6,10,9,1].$$

Mixed series-parallel system RRA problem (R6): This RRA problem has been studied by several researchers [9, 10, 11]. The mathematical expression is given as follows:

$$\text{Maximize } \mathbf{f}(\mathbf{x},\mathbf{y}) = \prod_{j=1}^{m} 1-(1-\mathbf{x}_j)^{\mathbf{y}_j}, \tag{10}$$

$$\text{Subject to } \sum_{j}^{m} cst_j\mathbf{y}_j - 400 \leq 0,\ \& \sum_{j}^{m} wgt_j\mathbf{y}_j - 414 \leq 0,$$
$$\mathbf{y}_j \geq 1,\ \mathbf{y}_j \in \mathbb{Z}^+;\ m=15$$
$$\mathbf{x}_j = [.9,.75,.65,.8,.85,.93,.78,.66,.78,.91,.79,.77,.67,.79,.67];$$
$$cst_j = [5,4,9,7,7,5,6,9,4,5,6,7,9,8,6];\ wgt_j = [8,9,6,7,8,8,9,6,7,8,9,7,6,5,7].$$

Large-scale system RRA problem (R7): This RRA problem has been studied by several researchers [9,

Table S1: *Constrained real-parameter optimization IEEE CEC* 2017 *test problems.*

Functions	Nature	Search range	No. of Equality Constraints	No. of Inequality Constraints
CE1, CE3, CE13, CE14, CE17, CE20	NS	$[-100, 100]^D$	1, S; 1, S; 3, S; 1, S; 1, S; 2	0; 1, S ;0; 0; 1, NS; 0
CE2	NS, R	$[-100, 100]^D$	1,NS, R	0
CE4, CE9	S	$[-10, 10]^D$	2, S; 0	0; 2, NS
CE5	NS	$[-10, 10]^D$	2, NS, R	0
CE6	S	$[-20, 20]^D$	0, S	6
CE7	S	$[-50, 50]^D$	0	2, S
CE8, CE10−CE12, CE16, CE18	S	$[-100, 100]^D$	0; 0; 1, NS, 2, S; 1, S; 2, NS	2, NS; 2, NS; 1, NS; 0; 1, NS; 1
CE15−CE16	S	$[-100, 100]^D$	1; 1, S	1; 1, NS
CE19	S	$[-50, 50]^D$	2, NS	0
CE21−CE28	R	$[-100, 100]^D$	2, R; 3, R; 1, R; 1, R; 1, R; 1, R; 2, R; 2, R	0; 0; 1, R; 1, R; 1, R; 1, R; 1, R; 0

D = Number of decision variables

10, 11]. The mathematical expression is given as follows:

$$\text{Maximize } \mathbf{f}(\mathbf{x},\mathbf{y}) = \prod_{j=1}^{m} 1-(1-\mathbf{x}_j)^{\mathbf{y}_j}, \tag{11}$$

$$\text{Subject to } \sum_{j=1}^{m} a_j \mathbf{y}_j^2 - \left(1+\theta\times 10^{-2}\right)\sum_{j=1}^{m} a_j lb_j^2 \leq 0,\ \sum_{j}^{m} b_j \exp(\mathbf{y}_j/2) - \left(1+\theta\times 10^{-2}\right)\sum_{j}^{m} b_j \exp(lb_j/2) \leq 0,$$
$$\sum_{j}^{m} c_j \mathbf{y}_j - \left(1+\theta\times 10^{-2}\right)\sum_{j}^{m} c_j lb_j \leq 0,\ \sum_{j}^{m} c_j \sqrt{\mathbf{y}_j} - \left(1+\theta\times 10^{-2}\right)\sum_{j}^{m} c_j \sqrt{lb_j} \leq 0,$$
$$1 \leq \mathbf{y}_j \leq 10,\ \mathbf{y}_j \in \mathbb{Z}^+;\ m=36,\ lb_j = \text{lower limit of } \mathbf{y}_j;\ \theta = 0.33 lb_j$$

the other factors values are provided in [9].

Table S2: *Experimental results of all comparison algorithm along with feasibility rate, 10 D.*

Functions	Metrices	COA	CSA	GSA	RSO	TSA	ChOA	BWOA	AEFA	AEFA-C	CPSOGSA	E-AEFA
CE1	Mean	4.180E-01	1.470E+02	2.497E+01	1.919E+03	1.244E+03	4.353E+02	7.260E+03	2.272E+02	2.367E+02	1.593E+03	7.631E-04
	Std	1.508E-01	7.023E+01	2.334E+01	8.737E+02	8.722E+02	0.000E+00	4.072E+03	1.230E+02	1.599E+02	5.592E+02	5.434E-04
	FR	1.000E+02	1.000E+02	1.000E+02	5.000E+01	6.000E+01	7.500E+01	6.000E+01	1.000E+02	1.000E+02	1.000E+02	1.000E+02
CE2	Mean	4.010E-01	1.480E+02	2.503E+01	1.786E+03	1.069E+03	1.319E+03	8.123E+03	2.188E+02	2.161E+02	2.028E+03	7.980E-04
	Std	1.424E-01	1.199E+02	1.941E+01	1.039E+03	5.883E+02	0.000E+00	5.360E+03	1.344E+02	2.084E+02	7.399E+02	6.577E-04
	FR	9.000E+01	1.000E+02	1.000E+02	1.000E+02	1.000E+02	1.000E+02	1.000E+02	1.000E+02	1.000E+02	0.000E+00	1.000E+02
CE3	Mean	3.530E-01	1.406E+02	7.539E+01	1.364E+03	1.590E+03	8.770E+02	4.957E+03	3.854E+02	3.515E+02	1.877E+03	9.811E-04
	Std	6.912E-02	9.113E+01	4.887E+01	4.539E+02	1.234E+03	0.000E+00	2.142E+03	2.082E+02	2.032E+02	6.119E+02	6.615E-04
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.000E+00	0.000E+00	3.000E+01
CE4	Mean	1.233E+01	4.128E+01	6.766E+00	1.258E+02	7.697E+01	1.206E+02	9.430E+01	8.258E+00	6.218E+00	1.989E+02	1.547E+01
	Std	3.101E+00	4.881E+00	2.534E+00	1.212E+01	2.259E+01	0.000E+00	2.362E+01	6.384E+00	2.698E+00	2.761E+01	8.816E+00
	FR	1.000E+02	1.000E+02	1.000E+02	1.000E+02	1.000E+02	1.000E+02	1.000E+02	1.000E+02	1.000E+02	1.000E+02	1.000E+02
CE5	Mean	1.511E+07	1.511E+07	1.511E+07	1.511E+07	1.511E+07	1.511E+07	1.511E+07	1.511E+07	1.511E+07	1.511E+07	1.511E+07
	Std	1.911E-09	1.911E-09	1.911E-09	1.911E-09	1.911E-09	0.000E+00	1.911E-09	1.911E-09	1.911E-09	1.911E-09	1.911E-09
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE6	Mean	1.631E+01	5.376E+01	6.965E+00	2.950E+02	1.599E+02	1.949E+02	2.396E+02	6.865E+00	6.069E+00	3.626E+02	1.402E+01
	Std	2.323E+00	1.145E+01	3.292E+00	4.143E+01	7.222E+01	0.000E+00	8.164E+01	2.392E+00	3.338E+00	1.045E+02	5.959E+00
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE7	Mean	-4.858E+02	-2.753E+02	-2.558E+01	-3.024E+02	-2.492E+02	-2.092E+02	-2.375E+02	-1.527E+02	-1.640E+02	-3.665E+02	-2.263E+02
	Std	1.083E+01	2.504E+01	6.978E+01	4.499E+01	2.945E+01	0.000E+00	5.704E+01	9.186E+01	6.345E+01	1.567E+01	4.279E+01
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE8	Mean	-9.037E+01	-7.204E+01	-3.181E+01	-9.037E+01	-5.040E+01	-9.037E+01	-7.673E+01	-6.821E+01	-6.968E+01	-9.037E+01	-9.037E+01
	Std	4.374E-14	6.834E+00	5.249E+00	4.374E-14	4.339E+01	0.000E+00	3.338E+01	1.307E+01	7.789E+00	4.374E-14	4.374E-14
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE9	Mean	-6.092E-01	-5.179E-01	1.166E+00	-6.092E-01	-5.178E-01	-6.092E-01	1.936E+00	2.162E+00	1.954E+00	-6.092E-01	-6.092E-01
	Std	0.000E+00	9.823E-02	2.106E+00	0.000E+00	2.813E-01	0.000E+00	2.108E+00	2.744E+00	2.754E+00	0.000E+00	0.000E+00
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE10	Mean	-5.975E+01	-5.656E+01	-3.948E+01	-5.975E+01	-4.574E+01	-5.975E+01	-1.931E+01	-5.884E+01	-5.786E+01	-5.975E+01	-5.975E+01
	Std	7.290E-15	2.116E+00	5.487E+00	7.290E-15	7.953E+00	0.000E+00	1.940E+01	1.113E+00	2.111E+00	7.290E-15	7.290E-15
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE11	Mean	-9.861E+02	-7.596E+02	-8.063E+02	-9.861E+02	-8.208E+02	-9.861E+02	-8.431E+02	-9.860E+02	-9.860E+02	-9.861E+02	-9.861E+02
	Std	0.000E+00	5.901E+01	5.557E+01	0.000E+00	1.138E+02	0.000E+00	1.584E+02	2.107E-01	3.604E-01	0.000E+00	0.000E+00
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE12	Mean	2.751E+01	1.209E+02	5.671E+00	1.504E+03	1.383E+03	1.516E+03	2.442E+03	5.771E+00	6.766E+00	6.402E+02	1.139E+01
	Std	3.558E+00	2.799E+01	2.285E+00	3.896E+02	8.418E+02	0.000E+00	1.058E+03	2.693E+00	3.689E+00	2.508E+02	4.574E+00
	FR	0.000E+00	0.000E+00	5.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.500E+01	9.500E+01	0.000E+00	9.500E+01
CE13	Mean	8.170E+01	4.179E+04	1.691E+02	6.000E+07	1.338E+08	8.522E+07	9.610E+07	2.697E+03	1.008E+04	8.786E+06	6.264E+00
	Std	6.042E+01	4.169E+04	2.713E+02	2.870E+07	2.000E+08	0.000E+00	7.146E+07	5.734E+03	4.344E+04	9.064E+06	5.150E-01
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.500E+01	0.000E+00	9.500E+01
CE14	Mean	2.005E+01	1.779E+01	1.254E+01	2.016E+01	2.029E+01	2.058E+01	2.003E+01	4.993E+00	3.993E+00	2.040E+01	1.818E-02
	Std	1.535E-02	4.834E+00	9.070E+00	4.120E-01	8.211E-01	0.000E+00	7.407E-01	8.873E+00	8.193E+00	7.411E-02	5.861E-03
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE15	Mean	7.900E-01	4.233E+00	2.137E-01	2.328E+01	1.037E+01	2.472E+01	2.411E+01	1.611E-12	1.888E-12	1.118E+01	1.231E-02
	Std	1.472E-01	1.048E+00	6.590E-01	3.292E+00	8.934E+00	0.000E+00	6.541E+00	4.863E-13	9.326E-13	1.933E+00	4.832E-03
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.000E+00
CE16	Mean	4.038E-01	1.649E+01	2.387E-08	8.560E+01	6.041E+01	5.538E+01	1.166E+02	5.840E-12	6.139E-12	6.682E+01	4.103E-02
	Std	8.042E-02	4.917E+00	1.007E-08	1.613E+01	3.283E+01	0.000E+00	3.006E+01	2.989E-12	1.514E-12	1.374E+01	1.176E-02
	FR	0.000E+00	0.000E+00	5.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.000E+02	1.000E+02	0.000E+00	1.000E+02
CE17	Mean	3.270E-01	7.174E-01	7.877E-03	1.274E+00	1.010E+00	1.101E+00	1.433E+00	5.663E-03	6.646E-03	1.134E+00	6.671E-03
	Std	5.942E-02	1.300E-01	1.170E-02	1.010E-01	3.171E-01	0.000E+00	2.894E-01	7.701E-03	1.098E-02	9.005E-02	7.993E-03
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.000E+01

Table S3: Experimental results of all comparison algorithm along with feasibility rate, 10 *D*

Functions	Metrices	COA	CSA	GSA	RSO	TSA	ChOA	BWOA	AEFA	AEFA-C	CPSOGSA	E-AEFA
CE18	Mean	1.612E+01	9.975E+01	9.150E+00	1.535E+03	1.255E+03	1.030E+03	2.379E+03	1.045E+01	7.450E+00	6.808E+02	1.801E+01
	Std	2.747E+00	3.380E+01	4.120E+00	3.504E+02	8.007E+02	0.000E+00	1.262E+03	3.395E+00	3.634E+00	2.599E+02	7.308E+00
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE19	Mean	-3.848E+00	9.042E+00	3.206E+00	2.010E+01	1.799E+01	9.779E+00	1.978E+01	-5.326E+00	-5.513E+00	1.955E+01	-7.261E+00
	Std	9.710E-01	2.233E+00	3.784E+00	3.104E+00	6.811E+00	0.000E+00	4.877E+00	2.471E+00	2.477E+00	3.585E+00	2.264E+00
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE20	Mean	1.086E+00	1.433E+00	5.319E-01	1.166E+00	1.429E+00	1.662E+00	1.303E+00	6.726E-01	9.135E-01	1.517E+00	6.611E-01
	Std	1.314E-01	2.090E-01	1.767E-01	3.753E-01	2.473E-01	0.000E+00	3.153E-01	2.677E-01	4.007E-01	2.357E-01	1.756E-01
	FR	1.000E+02	4.000E+00	5.000E+00	5.000E+00	5.000E+00	5.000E+00	5.000E+00	1.000E+02	9.500E+01	5.000E+00	1.000E+02
CE21	Mean	4.785E+01	2.442E+02	7.363E+00	4.611E+03	5.569E+03	4.882E+03	7.078E+03	9.950E+00	9.800E+00	2.396E+03	1.625E+01
	Std	5.519E+00	1.067E+02	3.345E+00	1.523E+03	2.830E+03	0.000E+00	3.322E+03	4.799E+00	6.712E+00	6.871E+02	6.121E+00
	FR	0.000E+00	0.000E+00	5.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.000E+01	5.000E+01	0.000E+00	6.000E+01
CE22	Mean	5.184E+02	8.262E+05	3.808E+03	5.241E+07	2.366E+08	2.000E+07	6.552E+08	1.399E+04	7.839E+04	7.112E+07	5.488E+02
	Std	3.282E+02	1.416E+06	8.771E+03	1.589E+08	5.056E+08	0.000E+00	6.200E+08	3.443E+04	2.020E+05	6.708E+07	1.765E+03
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.000E+01	1.000E+01	0.000E+00	1.000E+01
CE23	Mean	2.036E+01	2.049E+01	1.999E+01	2.044E+01	2.047E+01	2.041E+01	2.051E+01	2.000E+01	1.900E+01	2.048E+01	1.202E+01
	Std	8.209E-02	7.687E-02	2.345E-02	1.357E-01	1.033E-01	0.000E+00	1.025E-01	9.160E-04	4.472E+00	1.039E-01	1.004E+01
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE24	Mean	9.077E+00	1.999E+00	3.394E+01	3.191E+01	2.831E+01	4.348E+01	4.417E-01	2.846E-01	3.304E+01	1.972E-02	1.972E-02
	Std	3.197E+00	2.809E+00	5.151E+00	1.057E+01	0.000E+00	9.401E+00	1.312E+00	6.159E-01	1.045E+01	5.811E-03	5.811E-03
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.000E+00	5.000E+00
CE25	Mean	1.752E+00	3.405E+01	7.710E+00	1.713E+02	1.344E+02	1.309E+02	2.137E+02	9.906E-01	3.002E-01	1.212E+02	7.721E-02
	Std	3.231E-01	1.195E+01	1.144E+01	2.312E+01	4.620E+01	0.000E+00	4.628E+01	3.077E+00	1.343E+00	3.108E+01	2.387E-02
	FR	0.000E+00	0.000E+00	5.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.500E+01	9.500E+01	0.000E+00	1.000E+02
CE26	Mean	4.682E-01	8.848E-01	1.575E-02	2.089E+00	1.787E+00	2.022E+00	2.536E+00	1.096E-02	1.251E-02	1.592E+00	6.390E-03
	Std	6.197E-02	1.156E-01	1.422E-02	4.133E-01	7.253E-01	0.000E+00	8.426E-01	1.343E-02	1.259E-02	2.607E-01	8.300E-03
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE27	Mean	3.261E+01	2.701E+02	9.300E+00	4.935E+03	5.728E+03	3.037E+03	8.174E+03	1.205E+01	1.740E+01	2.318E+03	1.155E+01
	Std	6.683E+00	8.829E+01	3.813E+00	1.039E+03	3.398E+03	0.000E+00	3.667E+03	7.598E+00	1.337E+01	1.068E+03	4.308E+00
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE28	Mean	8.163E+00	1.342E+01	3.354E+00	2.925E+01	2.922E+01	2.954E+01	2.817E+01	-3.422E+00	-2.842E+00	2.689E+01	-3.666E+00
	Std	1.540E+00	3.845E+00	3.996E+00	1.863E+00	7.608E+00	0.000E+00	5.429E+00	3.302E+00	4.044E+00	4.448E+00	3.040E+00
	FR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table S4: *T-test p−values results of all algorithms for CEC-17 constrained problems, D =10, E-AEFA vs.*

Funcs	COA	CSA	GSA	RSO	TSA	BWOA	AEFA	AEFA-C	CPSOGSA
CE1	6.80E-15	2.04E-11	2.61E-05	5.64E-12	1.72E-07	1.24E-09	5.22E-10	8.14E-08	4.63E-30
CE2	4.08E-15	2.59E-06	1.19E-06	2.90E-09	7.97E-10	4.94E-08	1.04E-08	4.08E-05	2.55E-31
CE3	8.97E-24	3.35E-08	3.41E-08	5.25E-16	1.20E-06	1.33E-12	5.02E-10	2.56E-09	4.84E-36
CE4	1.45E-01	6.97E-14	1.40E-04	1.59E-29	9.82E-14	1.51E-16	5.30E-03	6.70E-05	2.11E-01
CE6	1.21E-01	2.41E-16	3.94E-05	4.35E-28	5.85E-11	7.35E-15	1.33E-05	6.76E-06	3.74E-19
CE7	5.12E-26	7.79E-05	2.43E-13	2.94E-06	5.55E-02	4.89E-01	2.45E-03	7.99E-04	3.09E-34
CE8	1.00E+00	1.70E-14	2.77E-36	1.00E+00	1.97E-04	7.55E-02	3.84E-09	2.15E-14	1.00E+00
CE9	NA	1.80E-04	5.58E-04	NA	1.54E-01	3.78E-06	5.91E-05	1.74E-04	NA
CE10	1.00E+00	3.89E-08	5.70E-19	1.00E+00	1.60E-09	2.30E-11	5.91E-04	2.24E-04	1.00E+00
CE11	NA	1.68E-19	4.87E-17	NA	1.19E-07	2.53E-04	3.24E-01	3.24E-01	NA
CE12	5.28E-15	1.36E-19	1.31E-05	1.78E-19	1.02E-08	1.65E-12	3.02E-05	1.13E-03	2.28E-32
CE13	2.13E-06	6.59E-05	1.06E-02	2.15E-11	4.82E-03	5.42E-07	4.25E-02	3.06E-01	1.03E-14
CE14	8.99E-95	7.27E-19	3.29E-07	4.63E-60	4.05E-49	1.23E-50	1.66E-02	3.64E-02	7.00E-107
CE15	2.97E-24	3.40E-20	1.80E-01	6.34E-29	7.58E-06	6.77E-19	8.25E-14	8.25E-14	4.90E-28
CE16	9.72E-22	1.67E-17	4.15E-18	2.31E-24	5.95E-10	1.24E-19	4.15E-18	4.15E-18	7.06E-36
CE17	1.81E-24	7.88E-25	7.06E-01	5.11E-38	9.52E-17	3.49E-23	6.88E-01	9.93E-01	7.19E-36
CE18	2.85E-01	7.17E-13	3.13E-05	2.55E-21	3.33E-08	3.77E-10	1.57E-04	1.11E-06	9.62E-26
CE19	3.08E-07	7.45E-24	6.33E-13	5.06E-29	3.18E-18	1.48E-23	1.38E-02	2.53E-02	9.38E-08
CE20	1.61E-10	3.40E-15	2.62E-02	3.29E-06	9.23E-14	1.38E-09	8.75E-01	1.39E-02	2.16E-24
CE21	1.86E-19	1.26E-11	1.38E-06	4.56E-16	1.10E-10	1.33E-11	8.14E-04	2.83E-03	2.10E-36
CE22	9.40E-01	1.30E-02	1.12E-01	1.48E-01	4.31E-02	3.12E-05	8.93E-02	9.31E-02	1.69E-04
CE23	6.43E-04	5.51E-04	1.03E-03	5.84E-04	5.62E-04	5.30E-04	1.02E-03	7.14E-03	2.14E-40
CE24	1.87E-20	3.40E-15	3.17E-03	8.52E-28	4.51E-16	2.89E-22	1.58E-01	6.20E-02	3.50E-28
CE25	5.13E-24	2.90E-15	4.97E-03	1.44E-29	1.49E-15	3.04E-22	1.92E-01	4.62E-01	5.54E-28
CE26	1.31E-29	5.47E-30	1.52E-02	1.31E-23	2.34E-13	5.11E-16	2.04E-01	7.75E-02	3.24E-71
CE27	1.78E-05	4.09E-15	1.30E-05	1.24E-22	5.03E-09	4.00E-12	3.46E-03	4.29E-01	5.26E-31
CE28	4.96E-18	4.07E-18	2.57E-07	3.38E-33	3.76E-20	7.43E-24	8.10E-01	4.71E-01	2.93E-28

Table S5: *p−values results of all algorithms for CEC-17 constrained problems, D =30, E-AEFA vs.*

Funcs	COA	CSA	GSA	RSO	TSA	BWOA	AEFA	AEFA-C	CPSOGSA
CE1	4.63E-30	6.25E-05	1.90E-22	9.00E-34	6.20E-17	5.06E-16	1.01E-17	2.44E-13	1.34E-20
CE2	2.55E-31	3.81E-06	6.47E-22	2.18E-28	5.91E-17	1.49E-13	2.06E-15	7.30E-22	5.75E-26
CE3	4.84E-36	2.53E-05	1.40E-18	5.46E-17	1.11E-17	5.39E-13	2.27E-16	2.18E-20	6.69E-21
CE4	2.11E-01	2.26E-10	4.41E-10	6.37E-35	1.33E-27	2.15E-31	1.71E-06	3.72E-08	2.92E-30
CE6	3.74E-19	1.50E-03	3.63E-10	4.33E-37	5.30E-27	9.26E-34	2.06E-03	4.38E-07	9.17E-36
CE7	3.09E-34	2.26E-20	2.56E-16	7.57E-01	7.87E-09	5.31E-07	1.07E-08	9.93E-11	1.38E-03
CE8	1.00E+00	6.24E-08	1.19E-51	1.00E+00	2.73E-62	1.25E-72	8.67E-39	2.26E-39	4.55E-20
CE9	NA	5.08E-04	9.18E-03	NA	4.35E-10	1.04E-30	6.92E-03	2.13E-18	5.00E-14
CE10	1.00E+00	1.55E-53	6.43E-37	1.00E+00	1.18E-12	3.57E-43	5.51E-25	3.14E-46	2.23E-07
CE11	NA	2.01E-59	1.34E-40	NA	1.27E-31	1.65E-23	2.71E-08	2.03E-40	5.74E-19
CE12	2.28E-32	3.80E-05	6.33E-04	2.51E-28	1.61E-22	2.59E-31	7.46E-02	1.46E-01	4.93E-19
CE13	1.03E-14	2.43E-02	1.88E-06	1.37E-16	2.92E-13	4.47E-18	7.84E-02	1.96E-03	1.59E-18
CE14	7.00E-107	1.57E-09	1.61E-62	8.66E-76	1.23E-92	9.38E-80	6.48E-06	6.36E-07	8.17E-91
CE15	4.90E-28	9.29E-15	3.71E-23	1.54E-78	8.53E-28	2.66E-43	6.35E-10	3.12E-08	5.64E-30
CE16	7.06E-36	1.65E-13	6.54E-02	1.42E-38	1.98E-24	1.18E-39	4.71E-02	6.32E-02	3.52E-33
CE17	7.19E-36	5.27E-16	4.28E-04	4.32E-40	2.56E-27	5.11E-33	1.91E-02	5.71E-02	2.62E-24
CE18	9.62E-26	6.01E-03	1.41E-02	4.17E-13	3.94E-19	3.45E-28	3.05E-01	1.47E-01	1.56E-23
CE19	9.38E-08	3.54E-13	1.39E-28	6.38E-15	8.35E-32	9.27E-37	4.78E-11	6.67E-10	5.03E-37
CE20	2.16E-24	1.16E-06	3.43E-01	9.78E-23	9.52E-34	1.34E-33	7.49E-03	2.78E-03	5.08E-39
CE21	2.10E-36	1.42E-07	9.42E-06	2.06E-12	3.16E-15	5.32E-21	7.80E-07	7.26E-07	2.12E-23
CE22	1.69E-04	3.93E-04	9.92E-02	1.48E-01	9.43E-08	3.02E-12	9.55E-06	8.30E-02	1.41E-13
CE23	2.14E-40	2.13E-26	NA	9.22E-31	6.25E-49	7.39E-35	NA	NA	3.50E-46
CE24	3.50E-28	2.14E-14	1.21E-21	1.92E-34	5.32E-29	3.03E-31	4.11E-14	1.80E-14	2.57E-32
CE25	5.54E-28	8.13E-10	4.76E-20	7.50E-23	4.99E-26	3.47E-32	3.35E-11	1.04E-10	4.83E-33
CE26	3.24E-71	8.28E-25	1.03E-01	5.98E-28	1.04E-22	5.06E-26	3.46E-09	7.17E-09	7.84E-23
CE27	5.26E-31	4.62E-01	3.23E-07	4.49E-14	2.97E-26	8.93E-27	5.45E-04	4.25E-05	2.39E-24
CE28	2.93E-28	3.17E-02	1.08E-19	2.07E-19	6.19E-29	3.36E-33	2.12E-03	1.39E-02	1.38E-33

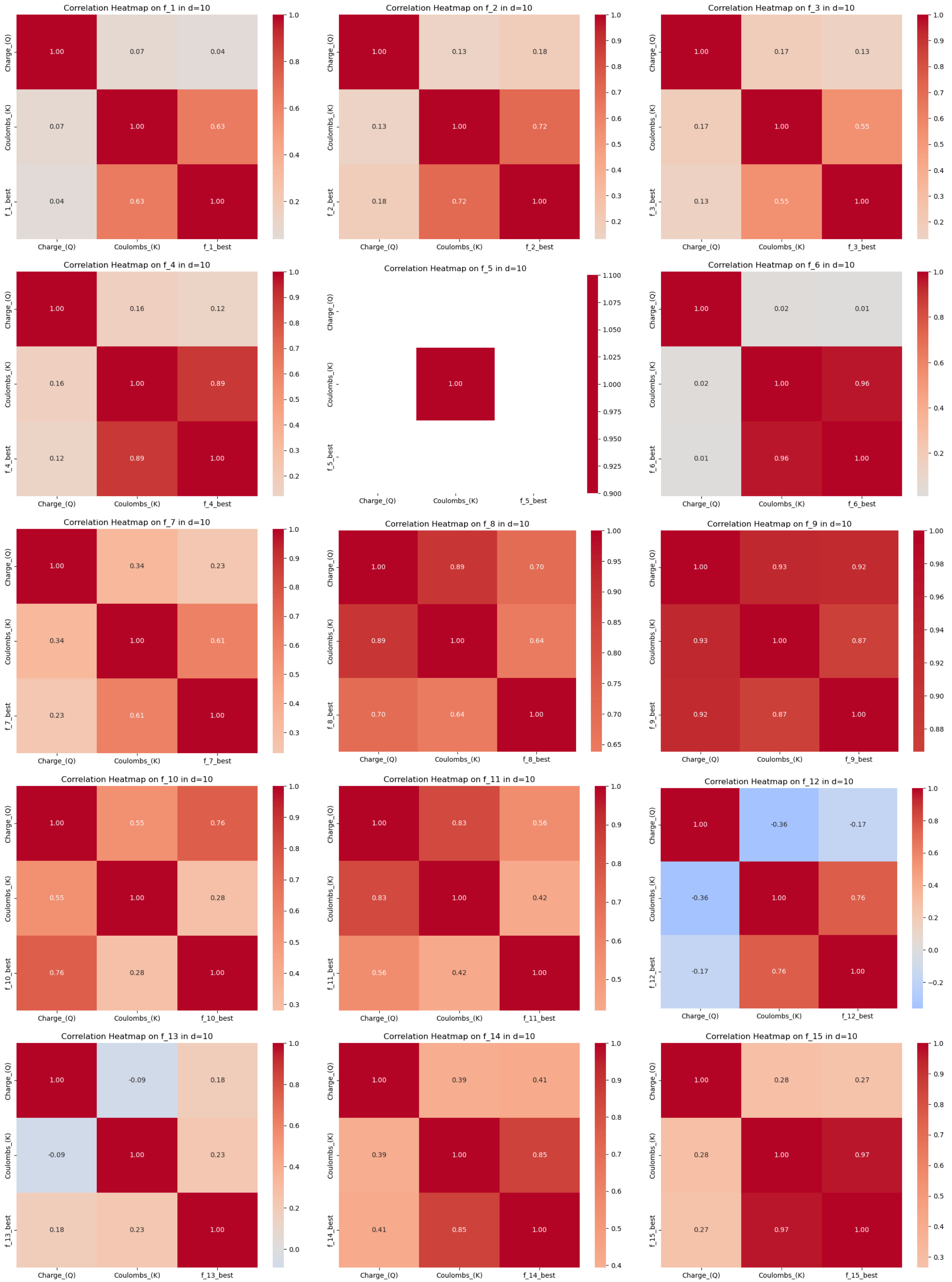

Figure S5: Correlation heatmap on 1st dataset across all functions with d = 10.

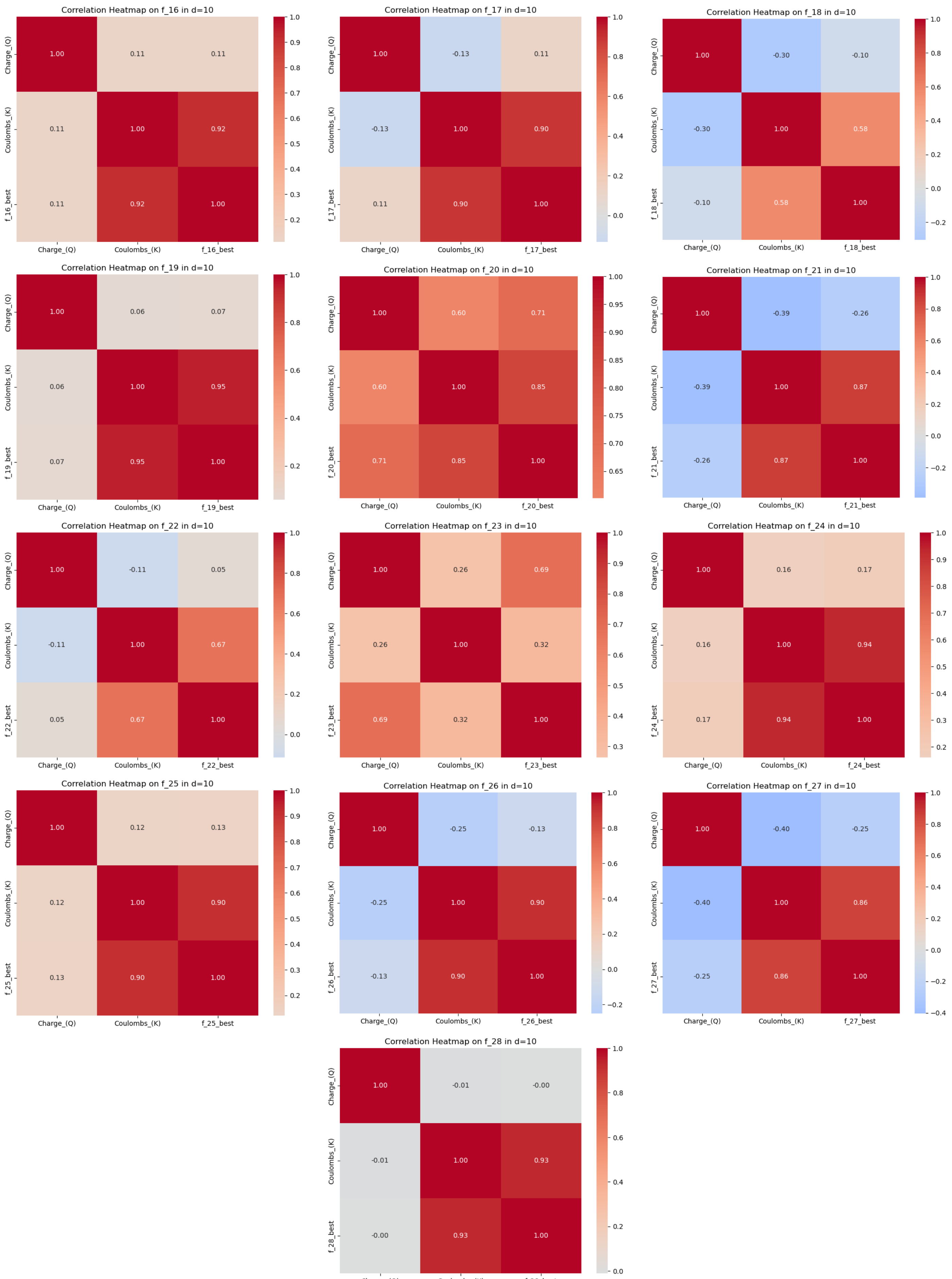

Figure S6: Correlation heatmap on 1st dataset across all functions with d = 10.

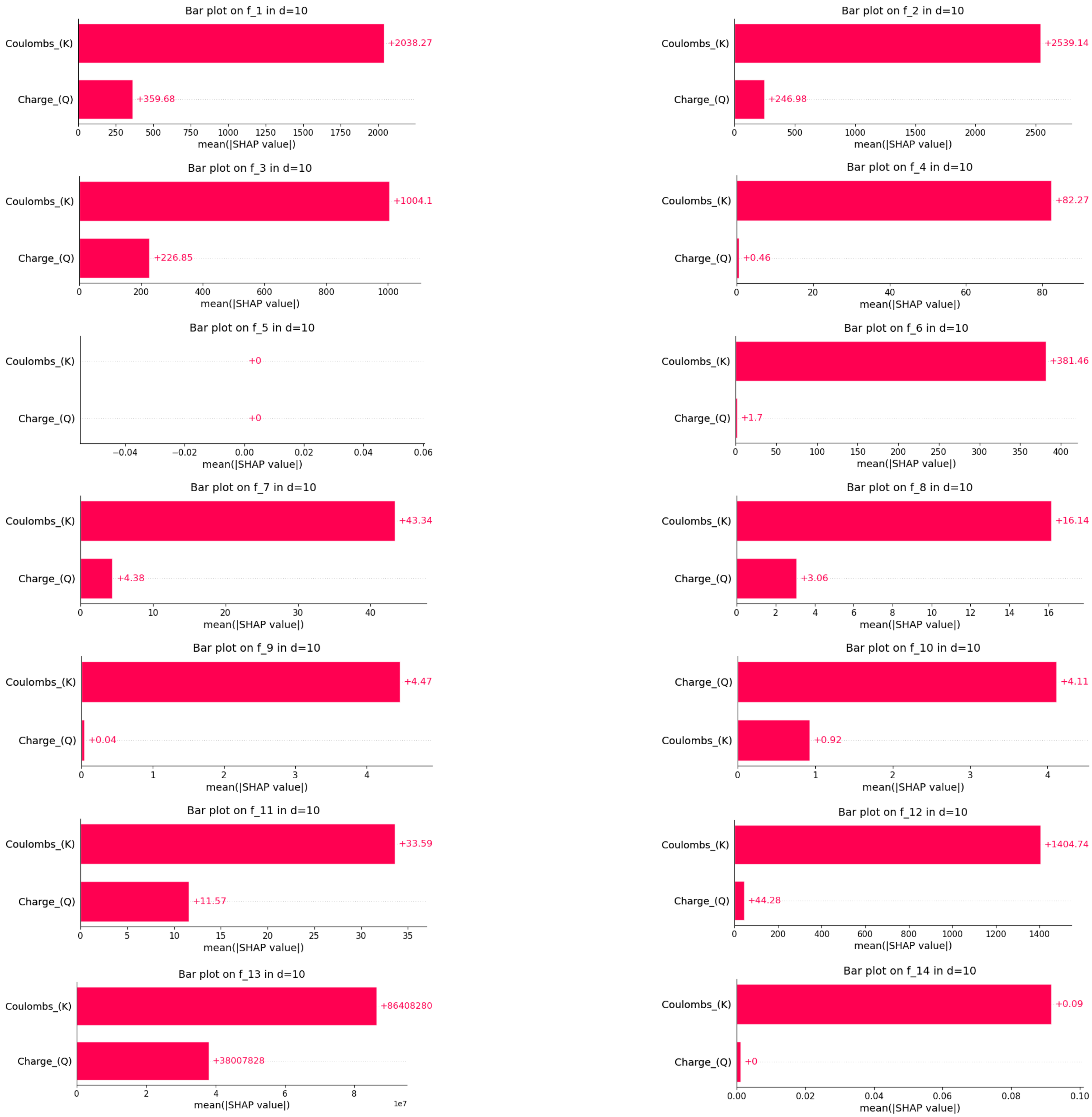

Figure S7: Bar plots on 1st dataset across all function with d=10.

Figure S8: Bar plots on 1st dataset across all function with d=10.

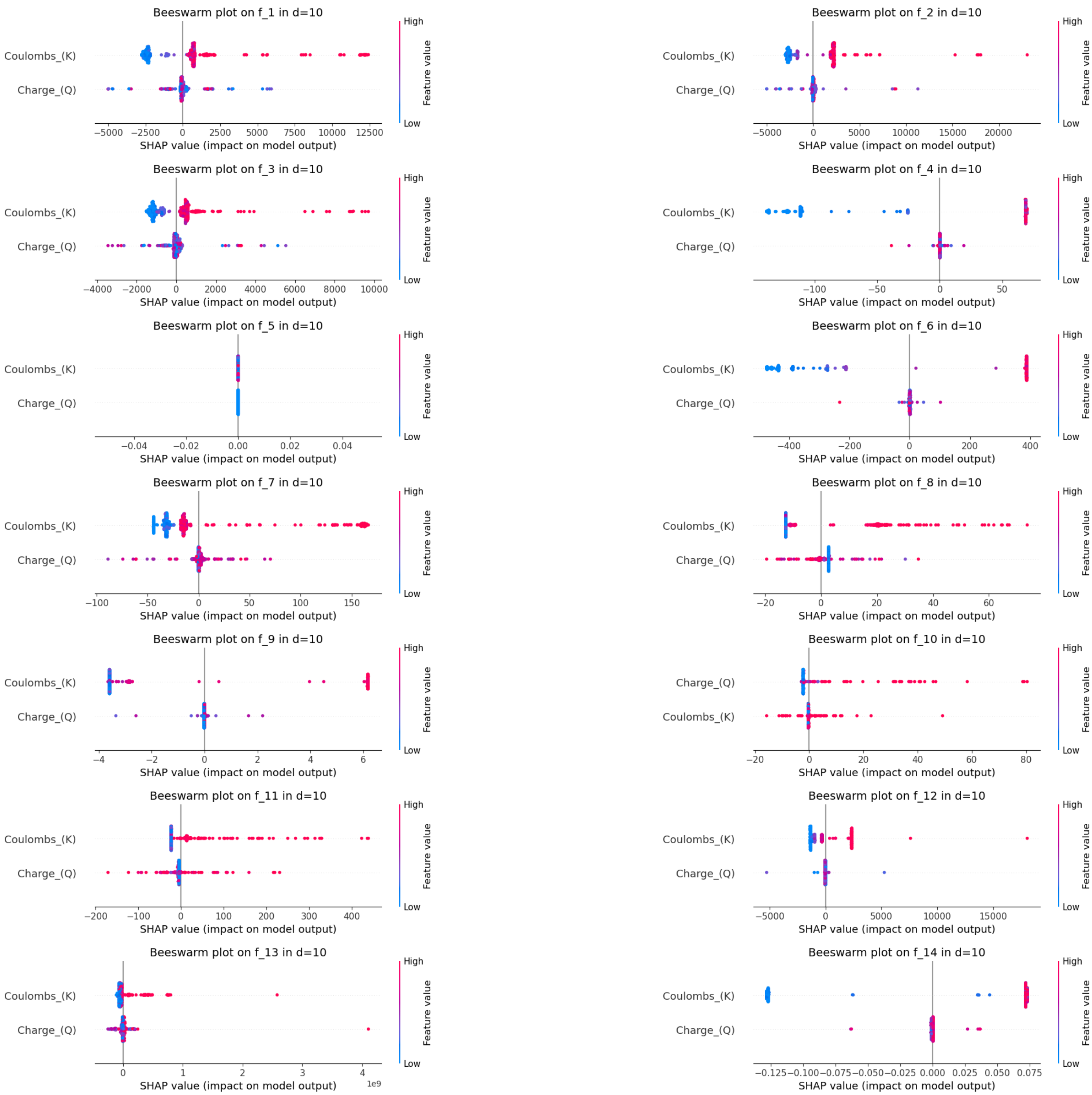

Figure S9: Beeswarm plots on 1st dataset across all function with d=10.

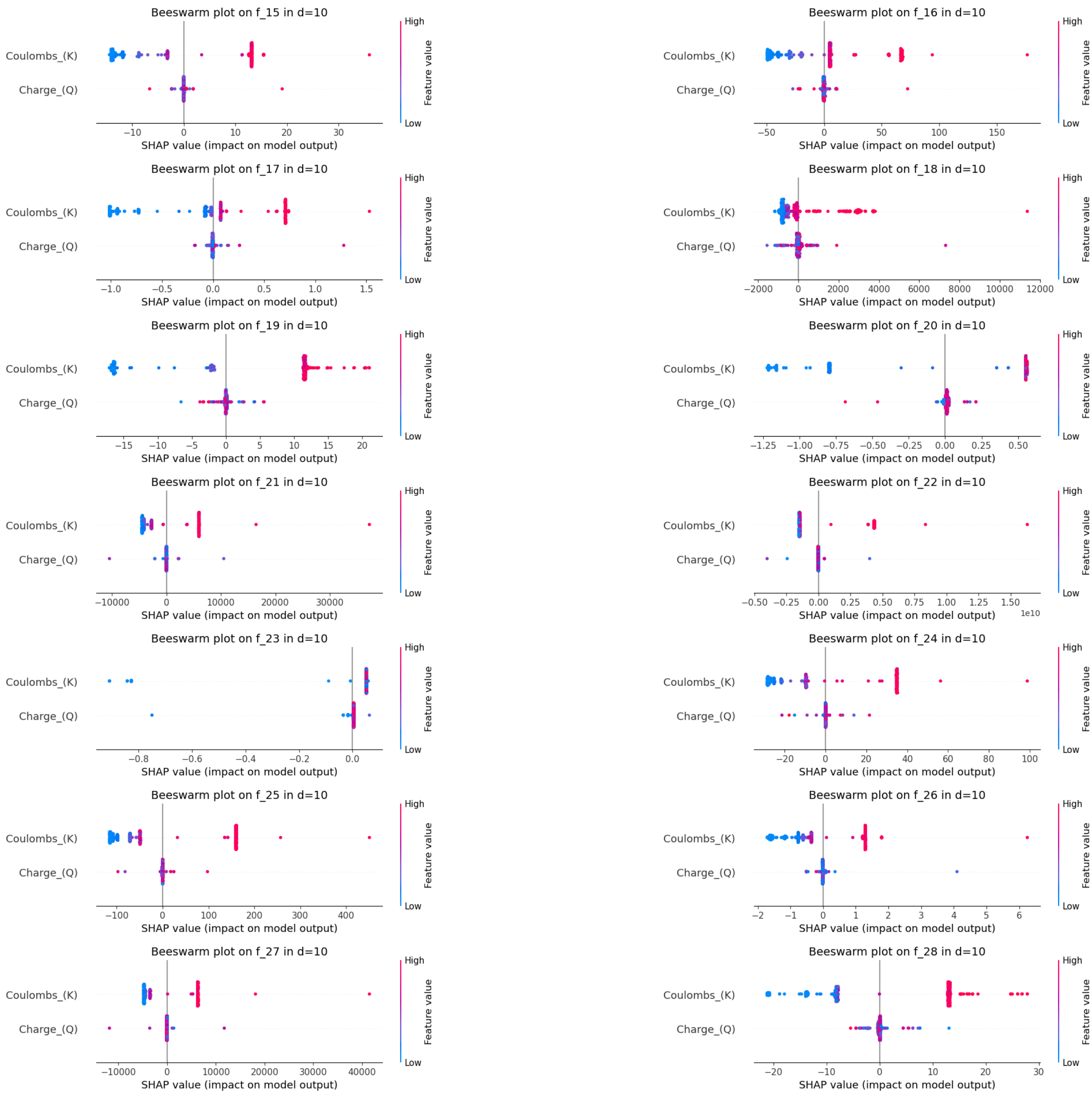

Figure S10: Beeswarm plots on 1st dataset across all function with d=10.

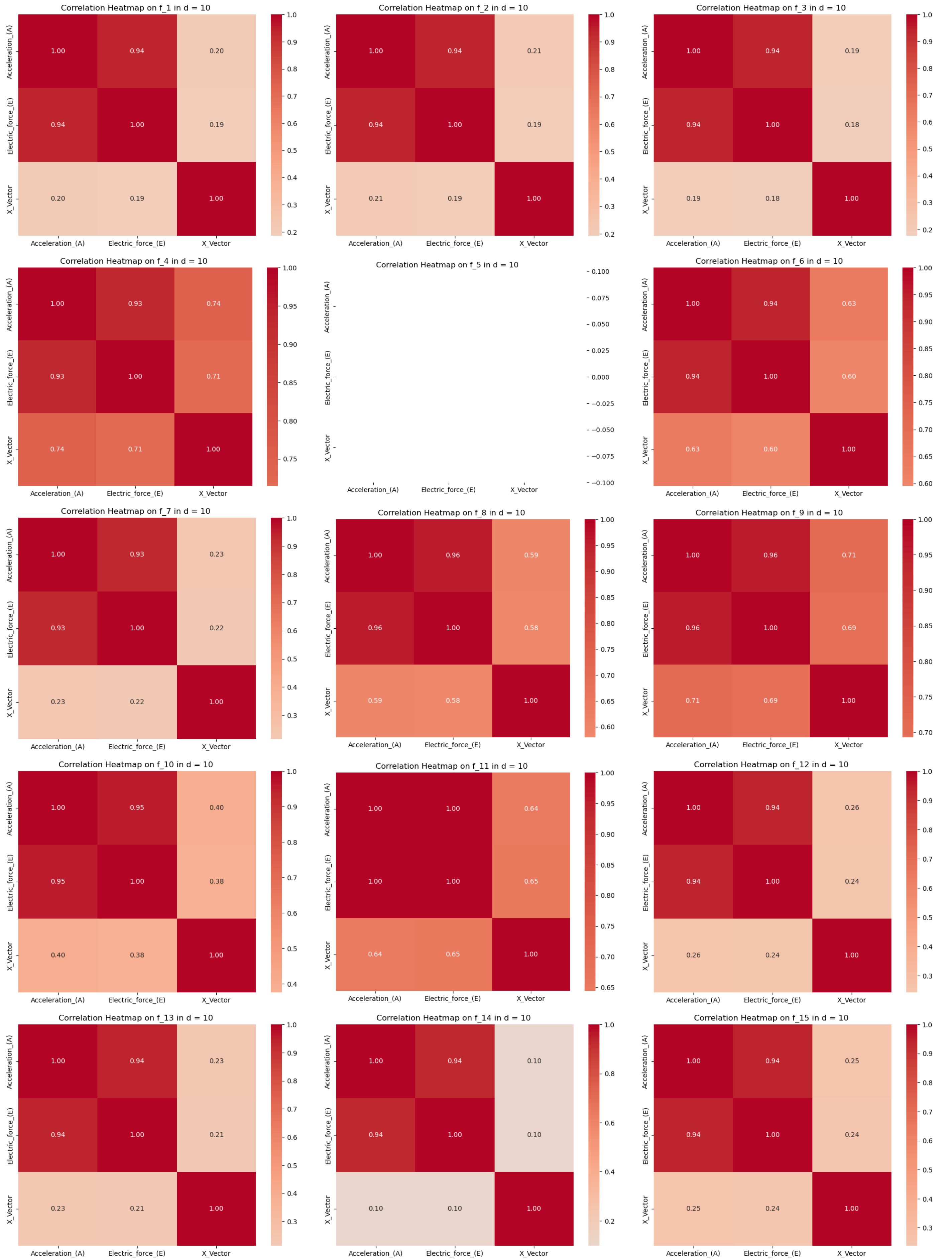

Figure S11: Correlation heatmap on 2nd dataset across all functions with d = 10.

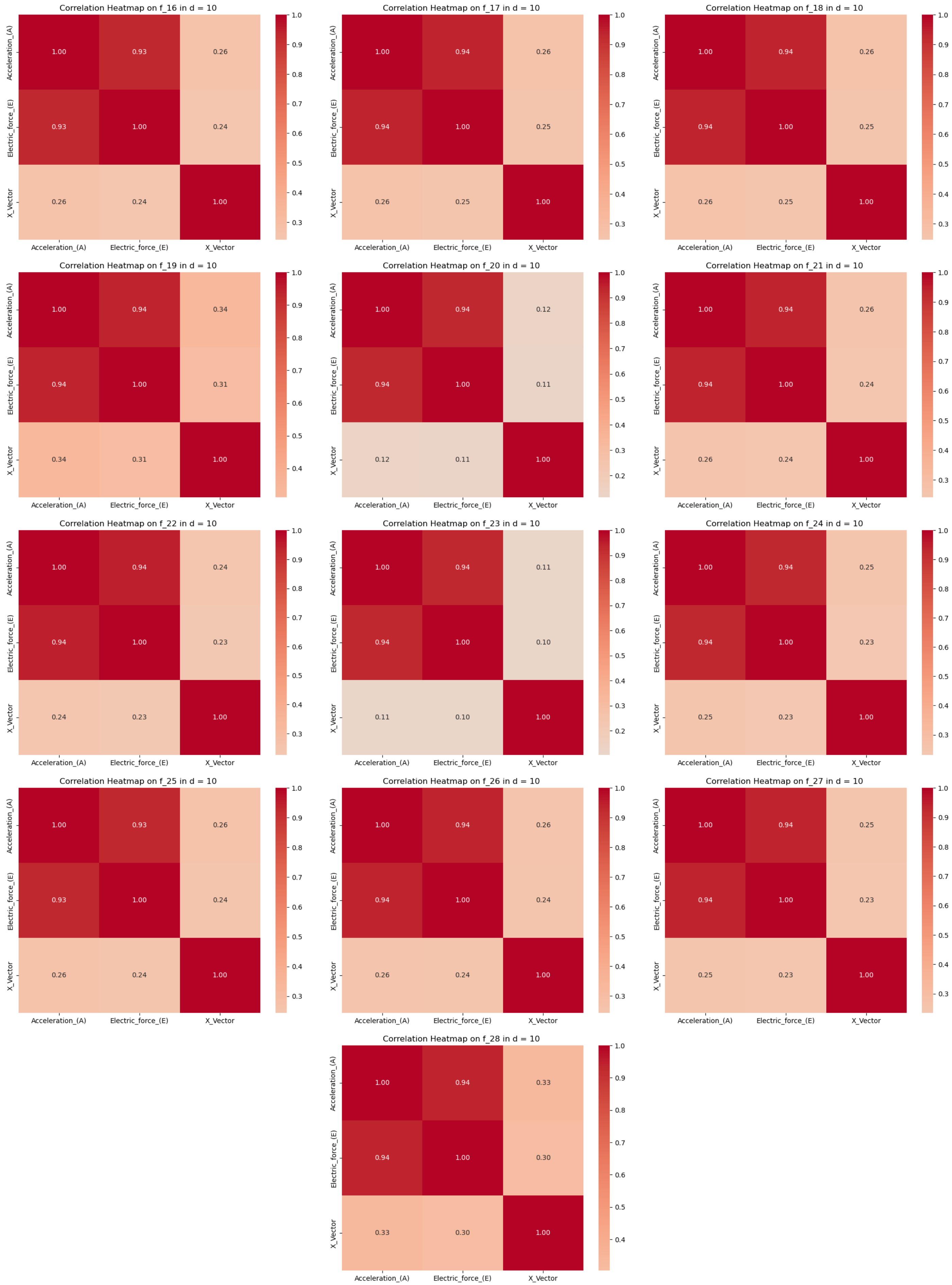

Figure S12: Correlation heatmap on 2nd dataset across all functions with d = 10.

Figure S13: Bar plots on 2nd dataset across all function with d=10.

Figure S14: Bar plots on 2nd dataset across all function with d=10.

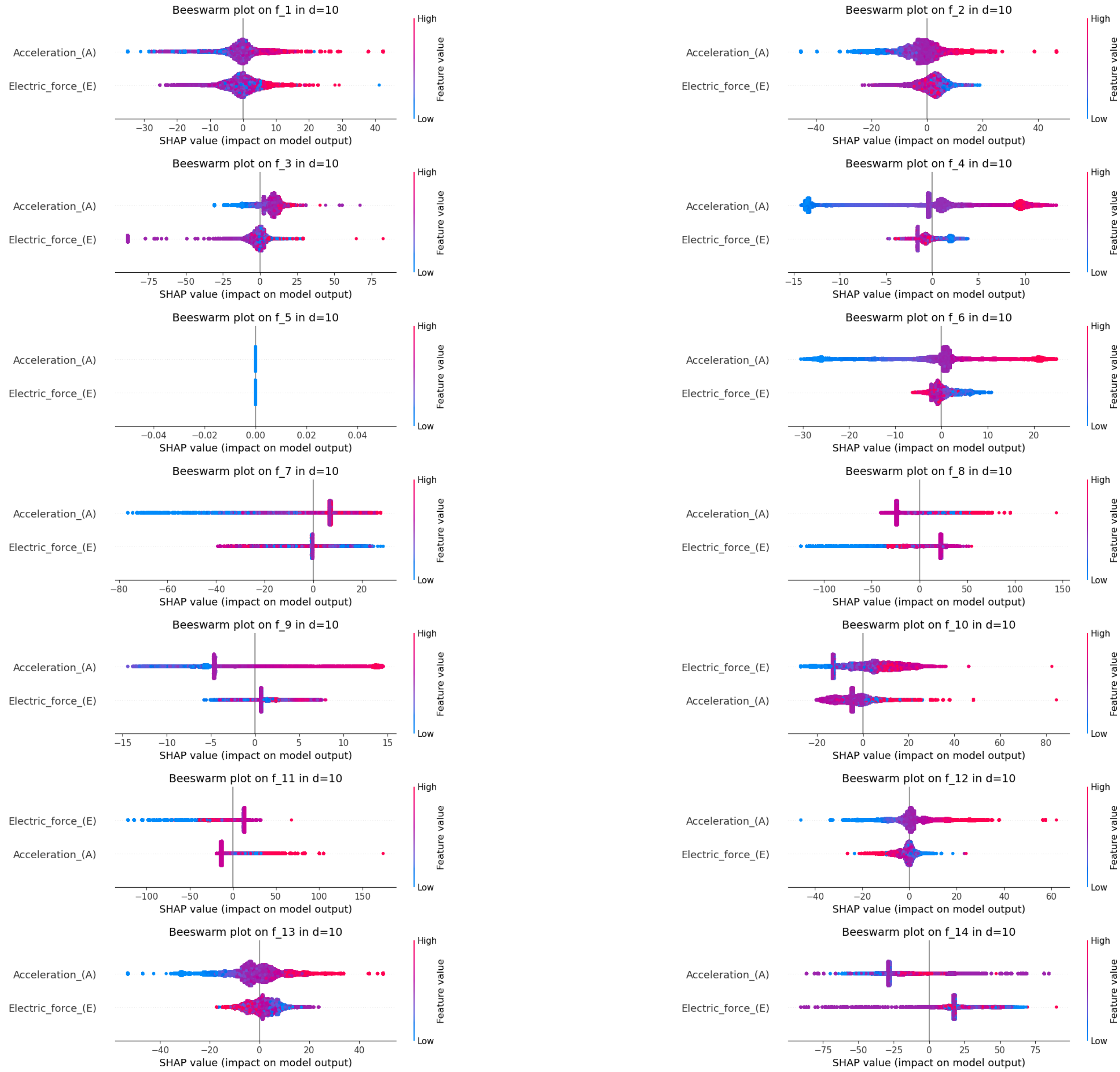

Figure S15: Beeswarm plots on 2nd dataset across all function with d=10.

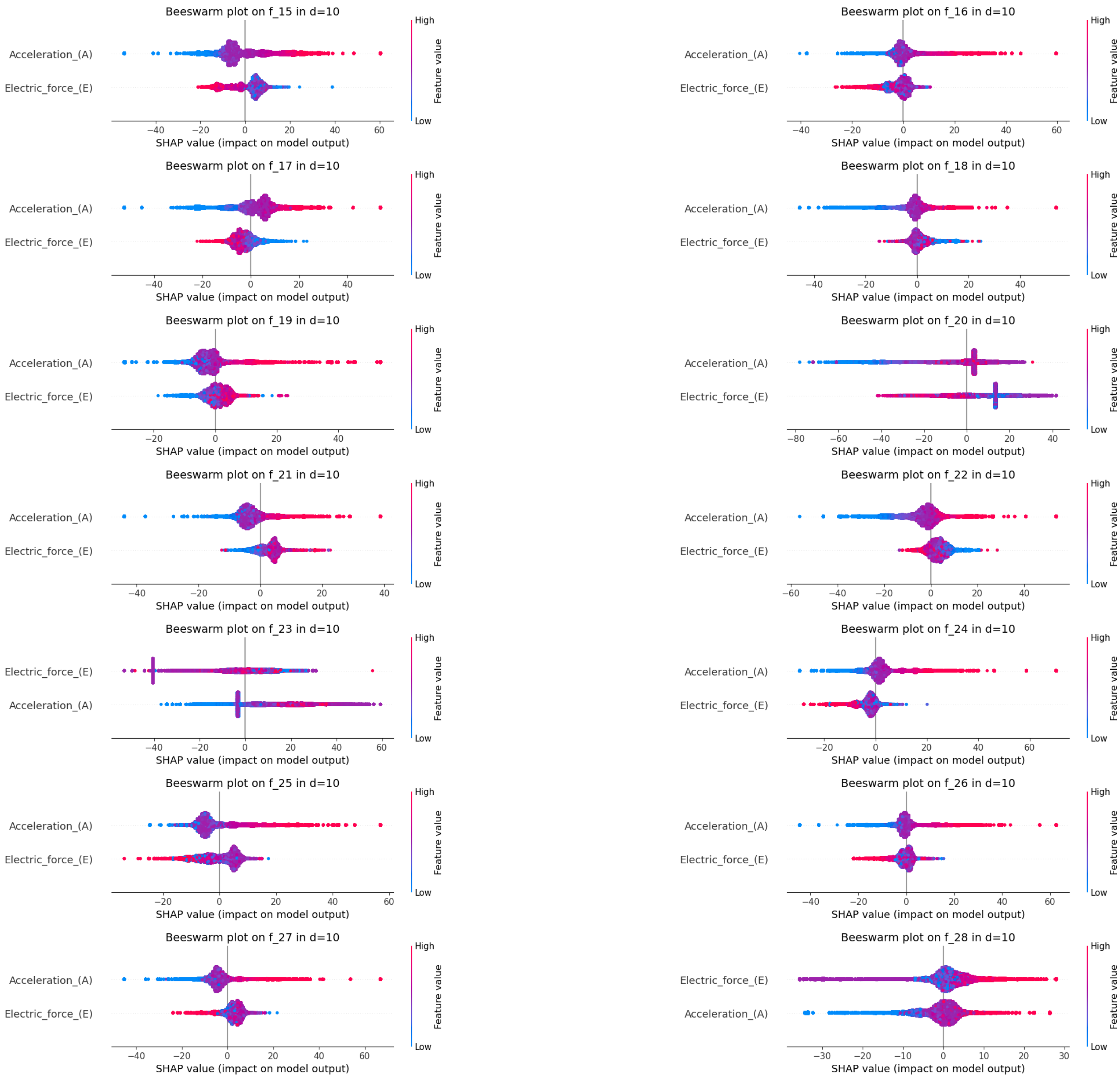

Figure S16: Beeswarm plots on 2nd dataset across all function with d=10.

Figure S17: Correlation heatmap on 1st dataset across all functions with d = 30.

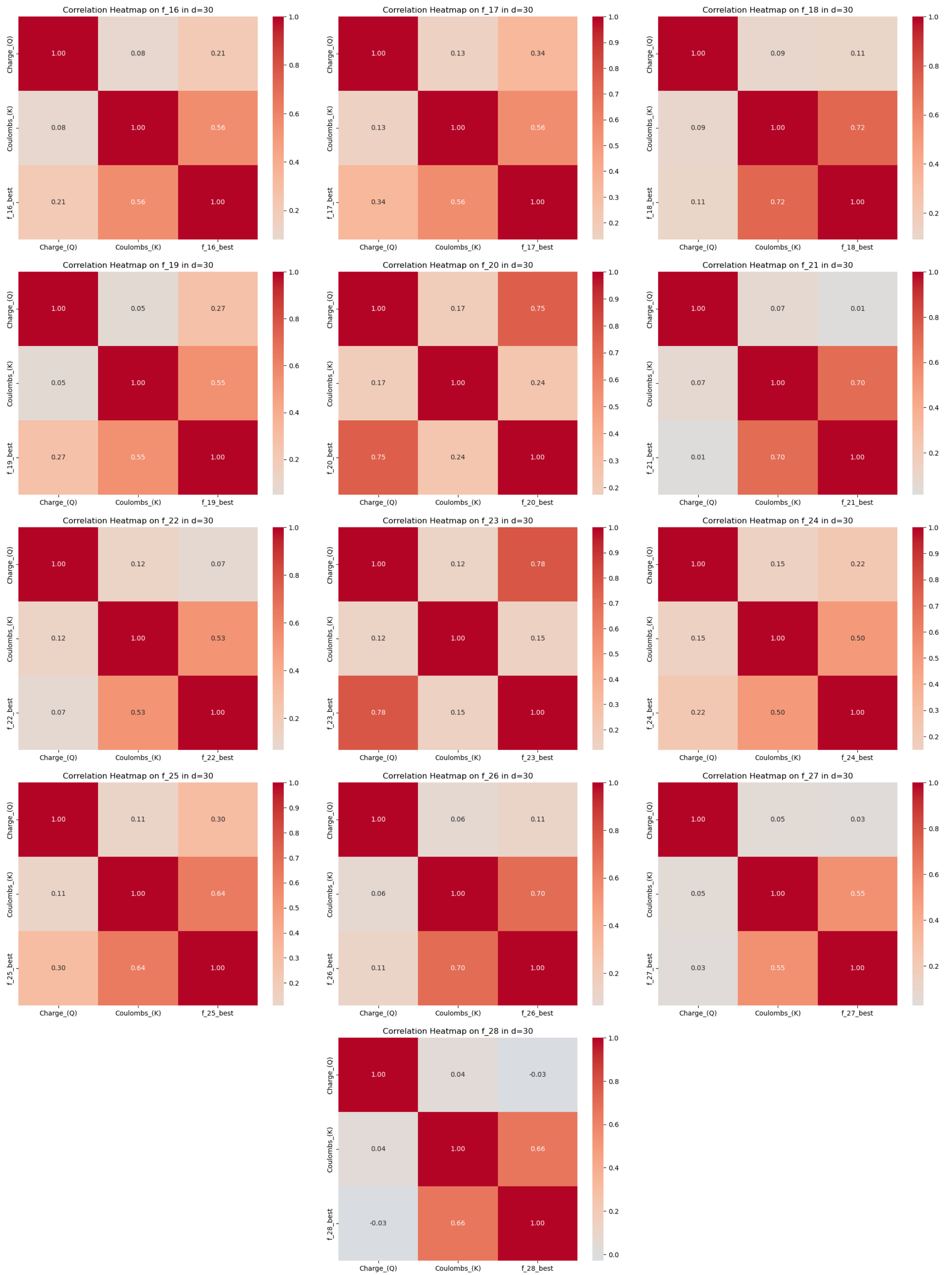

Figure S18: Correlation heatmap on 1st dataset across all functions with d = 30.

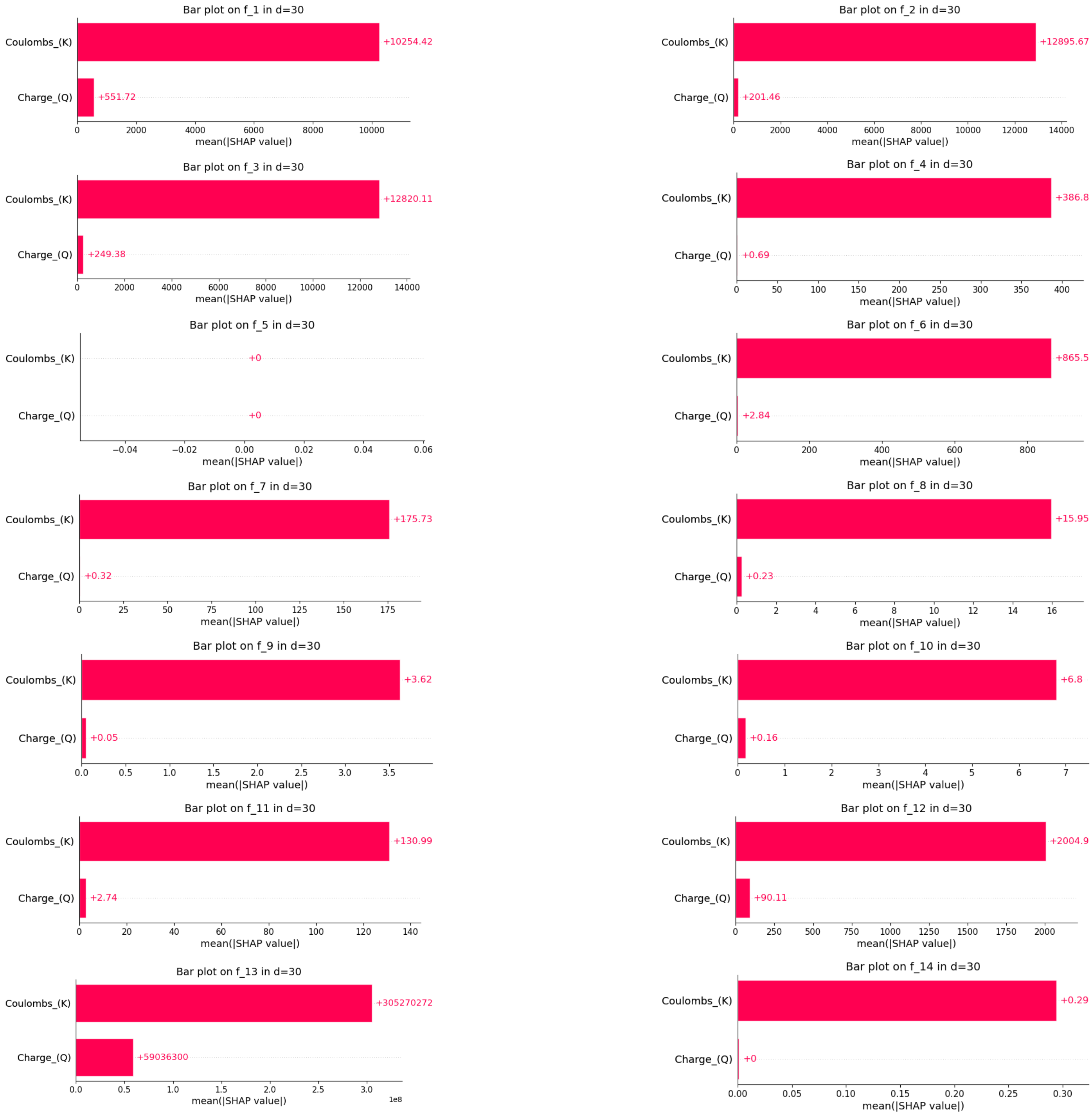

Figure S19: Bar plots on 1st dataset across all function with d=30.

Figure S20: Bar plots on 1st dataset across all function with d=30.

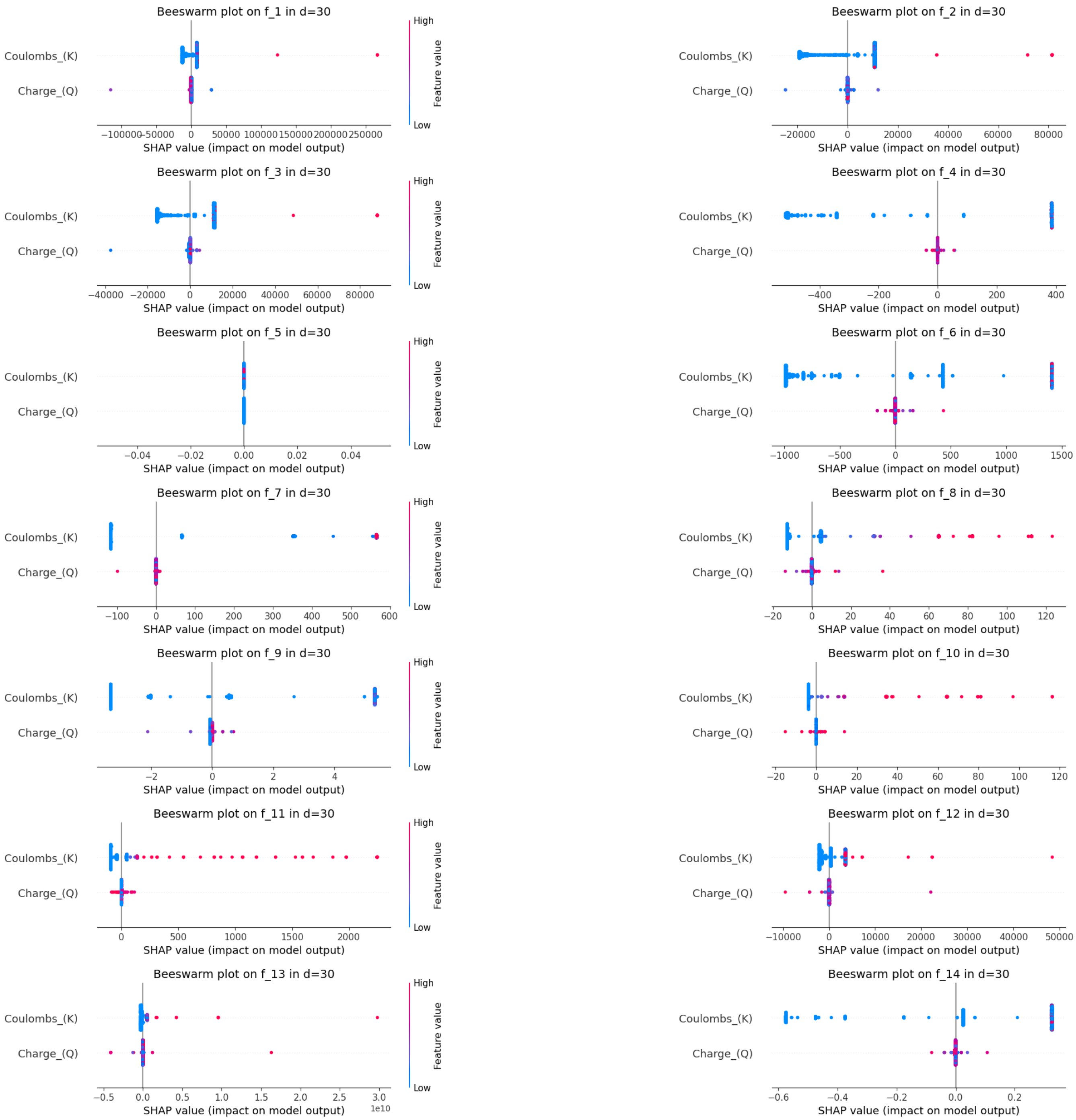

Figure S21: Beeswarm plots on 1st dataset across all function with d=30.

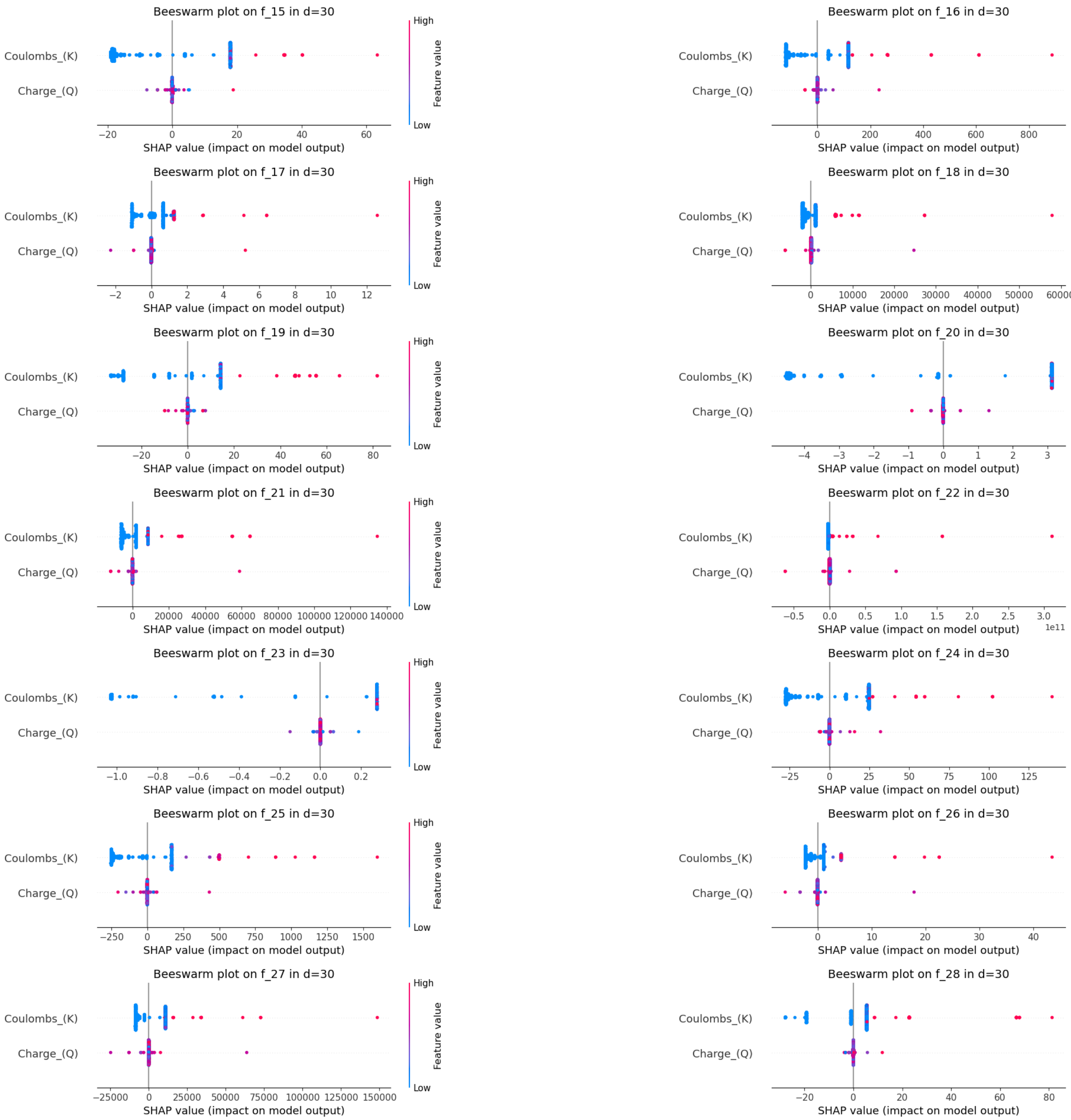

Figure S22: Beeswarm plots on 1st dataset across all function with d=30.

Figure S23: Correlation heatmap on 2nd dataset across all functions with d = 30.

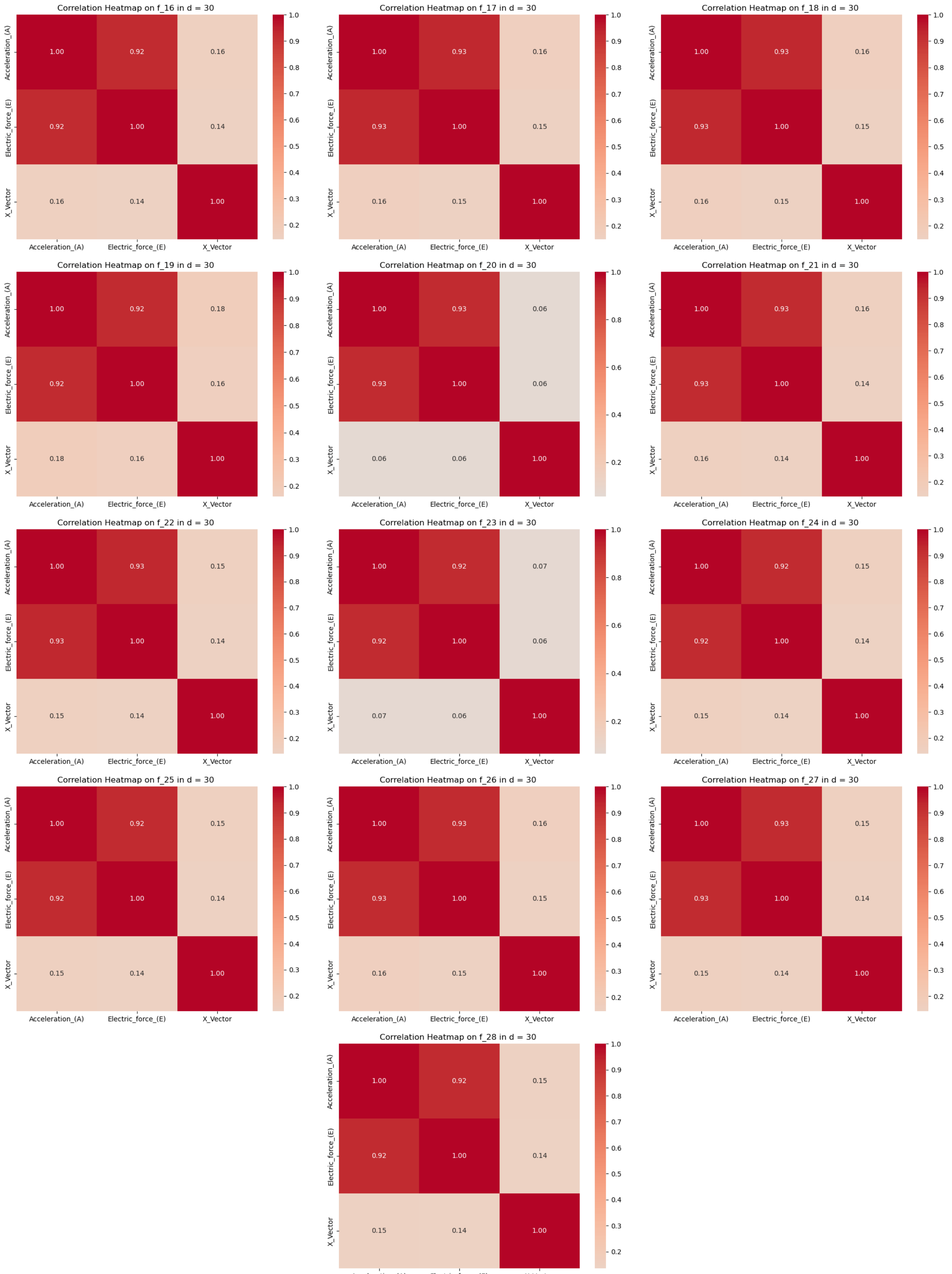

Figure S24: Correlation heatmap on 2nd dataset across all functions with d = 30.

Figure S25: Bar plots on 2nd dataset across all function with d=30.

Figure S26: Bar plots on 2nd dataset across all function with d=30.

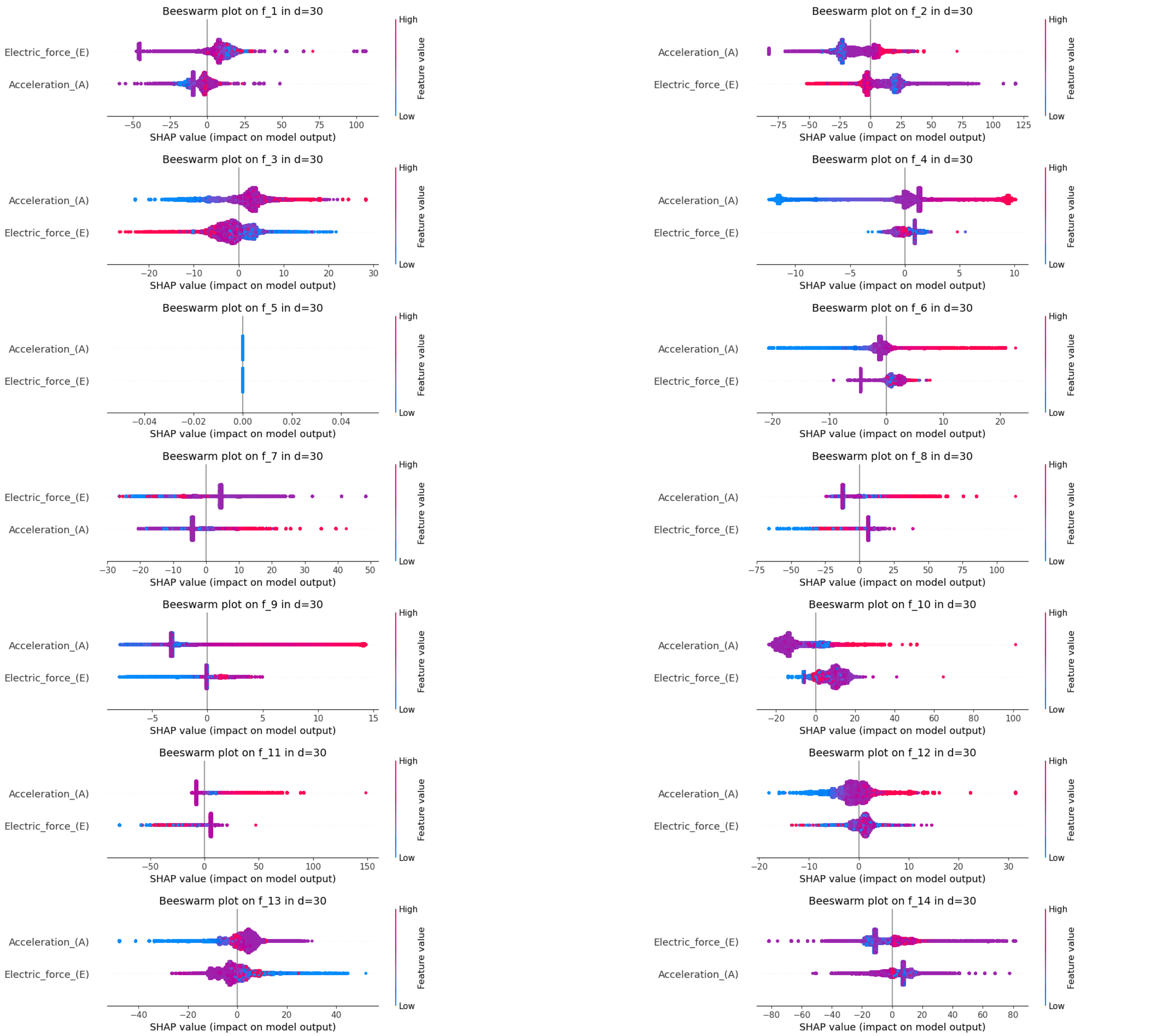

Figure S27: Beeswarm plots on 2nd dataset across all function with d=30.

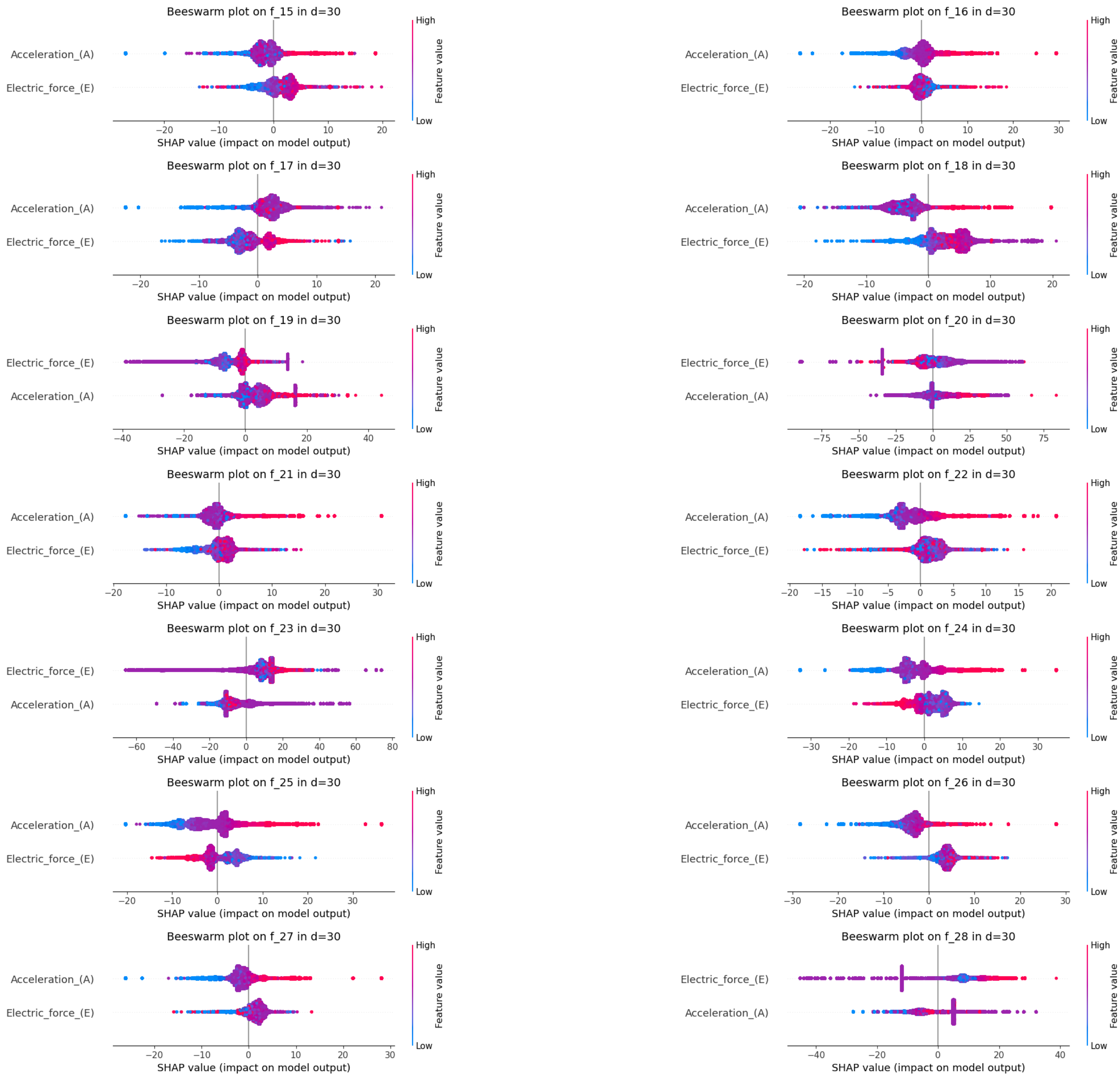

Figure S28: Beeswarm plots on 2nd dataset across all function with d=30.

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