Generalized Data-driven Power Flow Linearization: Methodologies, Evaluations, and Challenges

Supplementary Material

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This supplementary material includes

- A thorough illustration of the settings for each evaluated method, including their predictors, responses, and hyperparameters.
- All the ranking results reported in Fig. 4-5, with the mean and maximal relative errors of the evaluated methods,

I. Experiment Settings

The reader is referred to the following table for a thorough illustration of the settings for each method, including their predictors, responses, hyperparameters, cross-validation ranges (in this study, cross-validation is employed for hyperparameter tuning only in cases where the literature does not specify the hyperparameter values), datasets, solvers (when applicable), and additional relevant information.

Approach	Predictor$^{\diamond}$	Response$^{\diamond}$	Miscellaneous	Solver
LS	P, Q, V^2, θ_{ref}	V, PF	Data: Normalized¶	-
LS_SVD	P, Q, V^2, θ_{ref}	V, PF	Data: Normalized	-
LS_COD	P, Q, V^2, θ_{ref}	V, PF	Data: Normalized	-
LS_HBLD	P, Q, V^2, θ_{ref}	V, PF	$\delta^{HUB} \in \{0.01, 0.02, \cdots, 0.05\}$; $N_{cv} = 5^{\dagger}$; Data: Normalized	FMINUNC
LS_HBLE	P, Q, V^2, θ_{ref}	V, PF	$\delta^{HUB} \in \{0.01, 0.02, \cdots, 0.05\}$; $N_{cv} = 5$; Data: Normalized	MOSEK
LS_TOL	P, Q, V^2, θ_{ref}	V, PF	Data: Normalized	-
LS_CLS	P, Q, V^2, θ_{ref}	V, PF	$k \in \{2, 3, \cdots, 10\}$; $N_{cv} = 5$; Data: Normalized	-
LS_LIFX	P, Q, V^2, θ_{ref}	V, PF	f_{lift}: Gauss; Data: Normalized	-
LS_LIFXi	P, Q, V^2, θ_{ref}	V, PF	f_{lift}: Gauss; Data: Normalized	-
LS_WEI	P, Q, V^2, θ_{ref}	V, PF	ϖ: 0.6; Data: Normalized	MOSEK
LS_REC	P, Q, V^2, θ_{ref}	V, PF	New Data Share = 40%‡; $\kappa = 0.99$; Data: Normalized	-
PLS_SIMRX	P, Q, V^2, θ_{ref}	V, PF	$N_p = \text{Rank}(\boldsymbol{X})$; Data: Normalized	-
PLS_BDL	P, Q, V^2	V, PF	$N_p = \text{Rank}(\boldsymbol{X})$; Data: Normalized	-
PLS_BDLY2	P, Q, V^2	V, PF	$N_p = \text{Rank}(\boldsymbol{X})$; Data: Normalized	-
PLS_REC	P, Q, V^2, θ_{ref}	V, PF	New Data Share = 40%; Data: Normalized	-
PLS_RECW	P, Q, V^2, θ_{ref}	V, PF	New Data Share = 40%; $\varpi = 0.6$; Data: Normalized	-
RR	P, Q, V^2, θ_{ref}	V, PF	$\lambda = 10^{-10}$; Data: Normalized	-
RR_VCS	P, Q, V^2	V^2, R_{ij}, C_{ij}	$\lambda = 10^{-10}$; Data: Original¶	-
RR_KPC	P, Q, V^2, θ_{ref}	V, PF	$\lambda = 10^{-10}$; $k \in \{2, 3, \cdots, 10\}$; $\eta \in \{10^2, 10^3, \cdots, 10^5\}$; $N_{cv} = 5$; Data: Normalized	-
RR_WEI	P, Q, V^2, θ_{ref}	V, PF	$\lambda = 10^{-10}$; $\tau \in \{0.1, 0.11, \cdots, 0.35\}$; $N_{cv} = 5$; Data: Normalized	-
SVR	P, Q, V^2, θ_{ref}	V, PF	$\epsilon = 10^{-4}$; $\omega = 10$; Data: Normalized	GUROBI
SVR_CCP	P, Q, V^2, θ_{ref}	V, PF	$\epsilon = 10^{-4}$; $\omega = 10$; $M = 10^6$; $\zeta_j^{CCP} = 95\%$; Data: Normalized	GUROBI
SVR_POL	P, Q, V^2, θ_{ref}	V, PF	$\epsilon = 10^{-4}$; Kernel Model: 3rd-order Polynomial; Data: Normalized	FITRSVM
SVR_RR	P, Q, V^2, θ_{ref}	V, PF	$\epsilon = 10^{-4}$; $\omega = 10$; $\lambda = 10^{-4}$; Data: Normalized	GUROBI
LCP_BOX	P, Q	V, θ	Bound: min/max coefficients of the 1st-order Taylor Approximation Model§; Data: Original	MOSEK
LCP_BOXN	P, Q	V, θ	Data: Original	MOSEK
LCP_COU	V, θ	PF	$\delta^{LIN} = 10^{-2}$; Data: Original	MOSEK
LCP_COUN	V, θ	PF	Data: Original	MOSEK
LCP_JGD	P, Q	V, θ	Structure: 1st-order Taylor Approximation Model; Data: Original	SDPT3
LCP_JGDN	P, Q	V, θ	Data: Original	SDPT3
DRC_XM	P, Q, V^2, θ_{ref}	V, PF	$\epsilon_j = 10^{-4}$; $\zeta_j^{DRC} = 95\%$; Data: Normalized	MOSEK
DRC_XYM	P, Q, V^2, θ_{ref}	V, PF	$\epsilon_j = 10^{-4}$; $\zeta_j^{DRC} = 95\%$; Data: Normalized	MOSEK
DRC_XYD	P, Q, V^2, θ_{ref}	V, PF	$\epsilon_j = 10^{-4}$; $\zeta_j^{DRC} = 95\%$; Data: Normalized	GUROBI
OI	P, Q, V^2, θ_{ref}	V, PF	$M = 10^6$; $\theta^{OI} = 0.9$; $p = 8\%$; Data: Normalized	GUROBI
DC_LS	P	θ	Data: Original	-
DLPF_C	P, Q, V, θ_{ref}	V, PF	Data: Original	-
LS_PIN	P, Q, V^2, θ_{ref}	V, PF	Data: Normalized	-
LS_PCA	P, Q, V^2, θ_{ref}	V, PF	$N_p \in \{40, 50, \cdots, 80\}$; $N_{cv} = 5$; Data: Normalized	-
LS_GEN	P, Q, V^2, θ_{ref}	V, PF	Covariance Estimation Model: ARIMA; Data: Normalized	FGLS$^{\&}$
PLS_NIP	P, Q, V^2, θ_{ref}	V, PF	Data: Normalized	-
PLS_CLS	P, Q, V^2, θ_{ref}	V, PF	$k \in \{2, 3, \cdots, 10\}$; $N_{cv} = 5$; Data: Normalized	-
DC	P	θ	Data: Original	-
PTDF	P	PF	Data: Original	-
TAY	P, Q	V, θ	Data: Original	-
DLPF	P, Q, V, θ_{ref}	V, PF	Data: Original	-

$^{\diamond}$: The default predictors and responses are $\{P, Q, V^2, \theta_{ref}\}$ and $\{V, \text{PF}\}$, respectively, unless they do not apply to the approach (see Table **??**).
¶ : The unit energy normalization is used for training and testing datasets by default, unless the approach is not applicable (see Table **??**).
† : N_{cv} is the fold number for cross-validation, used for auto-tuning the parameter based on the given parameter set and the training dataset.
‡ : "New Data Share" is the fraction of new data in the training set, used for recursive DPFL methods to update models in a point-wise manner.
§ : Every training data point has been used as a tangent point to find the min/max coefficients among all data points.
$^{\&}$: FGLS in MATLAB has been modified by replacing the ordinary least squares with the least squares with Pseudoinverse, as previously mentioned.

9-bus-L: Relative Error of PF (log-scale)

9-bus-L: Relative Error of Vm (log-scale)

9-bus-S: Relative Error of PF (log-scale)

9-bus-S: Relative Error of Vm (log-scale)

14-bus-L: Relative Error of PF (log-scale)
RR_KPC mean: 9.2x10^-6 max: 2.4x10^-4
PLS_CLS mean: 5.8x10^-5 max: 4.5x10^-4
LS_LIFX mean: 5.9x10^-5 max: 5.7x10^-4
LS_CLS mean: 1.4x10^-4 max: 1.0x10^-3
LS_LIFXi mean: 3.1x10^-4 max: 2.6x10^-3
LS_GEN mean: 5.2x10^-4 max: 3.0x10^-3
RR_WEI mean: 5.2x10^-4 max: 3.0x10^-3
LS_COD mean: 5.2x10^-4 max: 3.0x10^-3
DLPF_C mean: 5.2x10^-4 max: 3.0x10^-3
PLS_REC mean: 5.2x10^-4 max: 3.0x10^-3
PLS_NIP mean: 5.2x10^-4 max: 3.0x10^-3
LS_PIN mean: 5.2x10^-4 max: 3.0x10^-3
LS_PCA mean: 5.2x10^-4 max: 3.0x10^-3
RR_VCS mean: 5.2x10^-4 max: 3.0x10^-3
RR mean: 5.2x10^-4 max: 3.0x10^-3
LS_HBLE mean: 5.2x10^-4 max: 3.0x10^-3
LS_HBLD mean: 5.2x10^-4 max: 3.0x10^-3
DRC_XYM mean: 5.2x10^-4 max: 3.0x10^-3
OI mean: 5.6x10^-4 max: 3.7x10^-3
LS_WEI mean: 6.5x10^-4 max: 4.1x10^-3
PLS_RECW mean: 6.5x10^-4 max: 4.1x10^-3
SVR mean: 9.5x10^-4 max: 2.9x10^-3
SVR_RR mean: 9.5x10^-4 max: 2.9x10^-3
LS_REC mean: 1.4x10^-3 max: 8.4x10^-3
LCP_COU mean: 6.4x10^-3 max: 1.2x10^-1
LCP_COUN mean: 6.5x10^-3 max: 1.1x10^-1
SVR_POL mean: 8.3x10^-3 max: 2.3x10^-2
PTDF mean: 4.2x10^-2 max: 1.9x10^-1
DC mean: 4.2x10^-2 max: 1.9x10^-1
LS_SVD mean: 5.8x10^-2 max: 2.2x10^-1
PLS_SIMRX mean: 6.7x10^-2 max: 3.1x10^-1
DRC_XM mean: 1.2x10^-1 max: 4.4x10^-1
DLPF mean: 1.6x10^-1 max: 2.2x10^0
SVR_CCP mean: 1.7x10^-1 max: 3.9x10^-1
DC_LS mean: 1.7x10^-1 max: 6.3x10^-1
DRC_XYD mean: 2.5x10^-1 max: 1.0x10^0
PLS_BDL mean: 7.2x10^1 max: 3.0x10^2
PLS_BDLY2 mean: 3.1x10^2 max: 3.2x10^3
LS_TOL mean: 6.7x10^4 max: 2.3x10^5
LS mean: 2.3x10^15 max: 2.4x10^16
TAY failure
LCP_JGDN failure
LCP_JGD failure
LCP_BOXN failure
LCP_BOX failure

14-bus-L: Relative Error of Vm (log-scale)

14-bus-S: Relative Error of PF (log-scale)
RR_KPC mean: 4.0x10^-6 max: 9.4x10^-5
LS_LIFX mean: 5.9x10^-6 max: 7.3x10^-5
LS_CLS mean: 1.0x10^-5 max: 1.7x10^-4
LS_WEI mean: 4.6x10^-5 max: 3.9x10^-4
PLS_RECW mean: 4.6x10^-5 max: 3.9x10^-4
LS_LIFXi mean: 6.6x10^-5 max: 5.4x10^-4
DRC_XYD mean: 6.7x10^-5 max: 5.4x10^-4
LS_GEN mean: 6.9x10^-5 max: 5.7x10^-4
RR_WEI mean: 6.9x10^-5 max: 5.7x10^-4
LS_PCA mean: 6.9x10^-5 max: 5.7x10^-4
LS_COD mean: 6.9x10^-5 max: 5.7x10^-4
PLS_REC mean: 6.9x10^-5 max: 5.7x10^-4
DLPF_C mean: 6.9x10^-5 max: 5.7x10^-4
PLS_NIP mean: 6.9x10^-5 max: 5.7x10^-4
LS_PIN mean: 6.9x10^-5 max: 5.7x10^-4
LS mean: 6.9x10^-5 max: 5.7x10^-4
RR_VCS mean: 6.9x10^-5 max: 5.7x10^-4
RR mean: 6.9x10^-5 max: 5.7x10^-4
LS_HBLE mean: 6.9x10^-5 max: 5.6x10^-4
DRC_XYM mean: 7.0x10^-5 max: 5.8x10^-4
LS_HBLD mean: 7.2x10^-5 max: 5.8x10^-4
OI mean: 7.5x10^-5 max: 6.4x10^-4
SVR mean: 8.0x10^-4 max: 2.2x10^-3
SVR_RR mean: 8.1x10^-4 max: 2.3x10^-3
PLS_CLS mean: 1.8x10^-3 max: 1.6x10^-2
SVR_POL mean: 2.2x10^-3 max: 6.8x10^-3
LCP_COUN mean: 5.3x10^-3 max: 9.8x10^-2
LCP_COU mean: 6.3x10^-3 max: 10.0x10^-2
PLS_SIMRX mean: 1.1x10^-2 max: 9.7x10^-2
DRC_XM mean: 2.9x10^-2 max: 9.9x10^-2
PTDF mean: 4.3x10^-2 max: 1.6x10^-1
DC mean: 4.3x10^-2 max: 1.6x10^-1
SVR_CCP mean: 6.1x10^-2 max: 1.4x10^-1
LS_SVD mean: 9.5x10^-2 max: 2.4x10^-1
DLPF mean: 1.6x10^-1 max: 1.9x10^0
PLS_BDL mean: 1.7x10^-1 max: 5.9x10^-1
DC_LS mean: 1.7x10^-1 max: 5.8x10^-1
PLS_BDLY2 mean: 2.8x10^1 max: 2.1x10^2
LS_TOL mean: 4.1x10^4 max: 1.7x10^5
TAY failure
LCP_JGDN failure
LCP_JGD failure
LCP_BOXN failure
LCP_BOX failure
LS_REC failure

14-bus-S: Relative Error of Vm (log-scale)

33-bus-L: Relative Error of PF (log-scale)

33-bus-L: Relative Error of Vm (log-scale)

33-bus-S-NI: Relative Error of PF (log-scale)

33-bus-S-NI: Relative Error of Vm (log-scale)

33-bus-S-OI: Relative Error of PF (log-scale)

33-bus-S-OI: Relative Error of Vm (log-scale)

33-bus-S: Relative Error of PF (log-scale)

33-bus-S: Relative Error of Vm (log-scale)

39-bus-L: Relative Error of PF (log-scale)
RR_KPC mean: 1.4x10^-5 max: 1.5x10^-3
LS_LIFX mean: 5.2x10^-5 max: 2.2x10^-3
PLS_CLS mean: 6.8x10^-5 max: 3.9x10^-3
LS_LIFXi mean: 3.5x10^-4 max: 9.1x10^-3
OI mean: 8.5x10^-4 max: 2.3x10^-2
RR_WEI mean: 8.7x10^-4 max: 2.2x10^-2
DLPF_C mean: 8.7x10^-4 max: 2.2x10^-2
PLS_NIP mean: 8.7x10^-4 max: 2.2x10^-2
PLS_REC mean: 8.7x10^-4 max: 2.2x10^-2
LS_PIN mean: 8.7x10^-4 max: 2.2x10^-2
LS_PCA mean: 8.7x10^-4 max: 2.2x10^-2
LS_COD mean: 8.7x10^-4 max: 2.2x10^-2
RR_VCS mean: 8.7x10^-4 max: 2.2x10^-2
RR mean: 8.7x10^-4 max: 2.2x10^-2
LS_HBLD mean: 8.7x10^-4 max: 2.2x10^-2
LS_HBLE mean: 8.7x10^-4 max: 2.2x10^-2
LS_GEN mean: 8.7x10^-4 max: 2.2x10^-2
PLS_RECW mean: 1.1x10^-3 max: 3.4x10^-2
SVR mean: 1.5x10^-3 max: 2.3x10^-2
SVR_RR mean: 1.5x10^-3 max: 2.3x10^-2
SVR_POL mean: 8.1x10^-3 max: 2.7x10^-2
LS_WEI mean: 8.8x10^-3 max: 4.3x10^-1
LCP_COU mean: 2.0x10^-2 max: 2.0x10^-1
PLS_SIMRX mean: 4.0x10^-2 max: 1.7x10^-1
DRC_XYM mean: 4.4x10^-2 max: 10.0x10^-1
LS_SVD mean: 6.1x10^-2 max: 2.3x10^-1
DC mean: 6.3x10^-2 max: 6.1x10^-1
PTDF mean: 6.3x10^-2 max: 6.1x10^-1
DC_LS mean: 8.6x10^-2 max: 4.5x10^-1
DLPF mean: 8.8x10^-2 max: 1.3x10^0
DRC_XM mean: 1.1x10^-1 max: 4.4x10^-1
SVR_CCP mean: 1.3x10^-1 max: 3.6x10^-1
DRC_XYD mean: 2.0x10^-1 max: 1.0x10^0
LCP_COUN mean: 10.0x10^-1 max: 10.0x10^-1
PLS_BDLY2 mean: 3.0x10^1 max: 2.1x10^2
LS_TOL mean: 3.8x10^1 max: 3.3x10^2
PLS_BDL mean: 3.2x10^4 max: 1.6x10^5
TAY failure
LCP_JGDN failure
LCP_JGD failure
LCP_BOXN failure
LCP_BOX failure
LS_REC failure
LS_CLS failure
LS failure

39-bus-L: Relative Error of Vm (log-scale)

39-bus-S: Relative Error of PF (log-scale)

39-bus-S: Relative Error of Vm (log-scale)

118-bus-L-NI: Relative Error of PF (log-scale)
PLS_CLS mean: 1.2x10^-3 max: 6.0x10^-1
RR_KPC mean: 1.2x10^-3 max: 6.6x10^-1
SVR_POL mean: 3.4x10^-3 max: 4.5x10^0
LS_PCA mean: 4.1x10^-3 max: 1.3x10^1
LS_HBLD mean: 4.1x10^-3 max: 1.3x10^1
DLPF_C mean: 4.1x10^-3 max: 1.3x10^1
RR_WEI mean: 4.2x10^-3 max: 1.3x10^1
RR mean: 4.2x10^-3 max: 1.3x10^1
LS_HBLE mean: 4.2x10^-3 max: 1.3x10^1
LS_COD mean: 4.2x10^-3 max: 1.3x10^1
LS_PIN mean: 4.2x10^-3 max: 1.3x10^1
PLS_SIMRX mean: 4.2x10^-3 max: 1.3x10^1
PLS_NIP mean: 4.2x10^-3 max: 1.3x10^1
PLS_REC mean: 4.2x10^-3 max: 1.3x10^1
LS mean: 4.2x10^-3 max: 1.3x10^1
LS_SVD mean: 4.2x10^-3 max: 1.3x10^1
LS_REC mean: 4.2x10^-3 max: 1.3x10^1
LS_GEN mean: 4.2x10^-3 max: 1.3x10^1
SVR_RR mean: 4.2x10^-3 max: 1.4x10^1
SVR mean: 4.2x10^-3 max: 1.4x10^1
LS_WEI mean: 4.9x10^-3 max: 9.2x10^0
LS_TOL mean: 5.8x10^-3 max: 1.2x10^1
PLS_BDLY2 mean: 8.8x10^-3 max: 5.8x10^0
LS_LIFXi mean: 9.0x10^-3 max: 3.6x10^0
LCP_COUN mean: 1.0x10^-2 max: 1.2x10^1
LS_LIFX mean: 1.1x10^-2 max: 5.1x10^-1
PLS_BDL mean: 3.3x10^-2 max: 1.4x10^1
LS_CLS mean: 4.5x10^-2 max: 1.4x10^0
LCP_COU mean: 6.4x10^-2 max: 4.8x10^1
RR_VCS mean: 6.7x10^-2 max: 8.5x10^0
DRC_XYD mean: 1.2x10^-1 max: 5.0x10^1
SVR_CCP mean: 1.5x10^-1 max: 2.9x10^1
PTDF mean: 3.1x10^-1 max: 3.4x10^2
DC mean: 3.1x10^-1 max: 3.4x10^2
DC_LS mean: 3.4x10^-1 max: 5.3x10^1
DLPF mean: 5.5x10^-1 max: 3.6x10^2
OI failure
TAY failure
LCP_BOXN failure
LCP_BOX failure
PLS_RECW failure

118-bus-L-NI: Relative Error of Vm (log-scale)
LCP_BOX mean: 3.1x10^-4 max: 2.0x10^-3
LS_HBLD mean: 3.4x10^-4 max: 2.0x10^-3
LS_PCA mean: 3.7x10^-4 max: 2.1x10^-3
SVR mean: 4.1x10^-4 max: 2.3x10^-3
SVR_RR mean: 4.1x10^-4 max: 2.2x10^-3
LCP_BOXN mean: 4.7x10^-4 max: 2.8x10^-3
RR_VCS mean: 5.1x10^-4 max: 2.9x10^-3
DLPF_C mean: 5.2x10^-4 max: 2.8x10^-3
RR mean: 5.3x10^-4 max: 2.9x10^-3
LS_GEN mean: 5.3x10^-4 max: 3.1x10^-3
LS_HBLE mean: 5.3x10^-4 max: 3.1x10^-3
RR_WEI mean: 5.3x10^-4 max: 2.9x10^-3
LS_SVD mean: 5.3x10^-4 max: 3.1x10^-3
LS_COD mean: 5.3x10^-4 max: 3.1x10^-3
LS_PIN mean: 5.3x10^-4 max: 3.1x10^-3
PLS_SIMRX mean: 5.3x10^-4 max: 3.1x10^-3
PLS_NIP mean: 5.3x10^-4 max: 3.1x10^-3
PLS_REC mean: 5.3x10^-4 max: 3.1x10^-3
LS mean: 5.3x10^-4 max: 3.1x10^-3
LS_REC mean: 5.3x10^-4 max: 3.3x10^-3
SVR_POL mean: 5.8x10^-4 max: 5.4x10^-3
PLS_CLS mean: 1.2x10^-3 max: 1.5x10^-2
RR_KPC mean: 1.2x10^-3 max: 1.5x10^-2
LS_WEI mean: 1.4x10^-3 max: 6.0x10^-3
DLPF mean: 2.0x10^-3 max: 1.4x10^-2
LS_TOL mean: 2.7x10^-3 max: 2.0x10^-2
PLS_BDLY2 mean: 4.7x10^-3 max: 2.3x10^-2
TAY mean: 4.8x10^-3 max: 1.7x10^-2
DRC_XYD mean: 5.2x10^-3 max: 2.3x10^-2
LS_LIFXi mean: 8.6x10^-3 max: 5.5x10^-2
LS_LIFX mean: 1.1x10^-2 max: 8.3x10^-2
PLS_BDL mean: 2.1x10^-2 max: 9.0x10^-2
DC mean: 2.3x10^-2 max: 6.4x10^-2
DC_LS mean: 2.3x10^-2 max: 6.4x10^-2
LS_CLS mean: 5.0x10^-2 max: 1.5x10^0
SVR_CCP mean: 5.1x10^-2 max: 1.3x10^-1
OI failure
PTDF failure
LCP_COUN failure
LCP_COU failure
PLS_RECW failure

118-bus-L-OI: Relative Error of PF (log-scale)

118-bus-L-OI: Relative Error of Vm (log-scale)
SVR mean: 5.7x10^-4 max: 2.5x10^-3
SVR_POL mean: 6.7x10^-4 max: 6.0x10^-3
DLPF mean: 2.0x10^-3 max: 1.4x10^-2
DRC_XYD mean: 2.4x10^-3 max: 8.7x10^-2
DLPF_C mean: 8.2x10^-3 max: 8.3x10^-2
RR_WEI mean: 8.6x10^-3 max: 6.8x10^-2
RR mean: 8.6x10^-3 max: 6.8x10^-2
LS_PCA mean: 9.8x10^-3 max: 5.5x10^-2
LS_HBLD mean: 1.0x10^-2 max: 4.3x10^-2
LS_HBLE mean: 1.1x10^-2 max: 4.4x10^-2
LS_WEI mean: 1.3x10^-2 max: 1.9x10^-1
SVR_RR mean: 1.6x10^-2 max: 2.9x10^-2
TAY mean: 1.6x10^-2 max: 1.0x10^0
LCP_BOXN mean: 2.0x10^-2 max: 7.2x10^-2
LCP_BOX mean: 2.0x10^-2 max: 5.3x10^-2
RR_VCS mean: 2.1x10^-2 max: 1.2x10^-1
LS_REC mean: 2.1x10^-2 max: 8.9x10^-2
LS mean: 2.1x10^-2 max: 8.4x10^-2
PLS_REC mean: 2.1x10^-2 max: 8.4x10^-2
PLS_SIMRX mean: 2.1x10^-2 max: 8.4x10^-2
PLS_NIP mean: 2.1x10^-2 max: 8.4x10^-2
LS_COD mean: 2.1x10^-2 max: 8.4x10^-2
LS_SVD mean: 2.1x10^-2 max: 8.4x10^-2
LS_PIN mean: 2.1x10^-2 max: 8.4x10^-2
LS_GEN mean: 2.1x10^-2 max: 8.3x10^-2
DC mean: 2.3x10^-2 max: 6.4x10^-2
DC_LS mean: 2.3x10^-2 max: 6.4x10^-2
RR_KPC mean: 2.3x10^-2 max: 2.0x10^0
PLS_CLS mean: 2.4x10^-2 max: 1.6x10^0
SVR_CCP mean: 7.1x10^-2 max: 1.4x10^-1
PLS_BDLY2 mean: 1.7x10^-1 max: 6.9x10^-1
LS_LIFXi mean: 1.7x10^-1 max: 9.5x10^-1
LS_LIFX mean: 2.0x10^-1 max: 1.4x10^0
PLS_BDL mean: 2.0x10^-1 max: 9.1x10^-1
LS_TOL mean: 3.4x10^-1 max: 2.7x10^0
LS_CLS mean: 5.3x10^-1 max: 1.6x10^1
OI failure
PTDF failure
LCP_COUN failure
LCP_COU failure
PLS_RECW failure

118-bus-L: Relative Error of PF (log-scale)

118-bus-L: Relative Error of Vm (log-scale)

118-bus-S: Relative Error of PF (log-scale)
LS_LIFX mean: 6.1x10^-6 max: 1.7x10^-3
RR_KPC mean: 8.3x10^-6 max: 6.4x10^-3
PLS_CLS mean: 3.7x10^-5 max: 1.7x10^-2
LS_LIFXi mean: 1.6x10^-4 max: 2.3x10^-2
LS_HBLE mean: 3.2x10^-4 max: 6.0x10^-2
RR_VCS mean: 3.2x10^-4 max: 6.0x10^-2
DLPF_C mean: 3.2x10^-4 max: 6.0x10^-2
PLS_NIP mean: 3.2x10^-4 max: 6.0x10^-2
PLS_REC mean: 3.2x10^-4 max: 6.0x10^-2
LS_COD mean: 3.2x10^-4 max: 6.0x10^-2
LS_PIN mean: 3.2x10^-4 max: 6.0x10^-2
LS_PCA mean: 3.2x10^-4 max: 6.0x10^-2
RR mean: 3.2x10^-4 max: 6.0x10^-2
RR_WEI mean: 3.2x10^-4 max: 6.0x10^-2
LS_GEN mean: 3.2x10^-4 max: 6.0x10^-2
LS_HBLD mean: 3.2x10^-4 max: 6.0x10^-2
OI mean: 3.3x10^-4 max: 6.4x10^-2
PLS_RECW mean: 3.5x10^-4 max: 6.4x10^-2
LS_WEI mean: 3.5x10^-4 max: 6.4x10^-2
SVR mean: 1.1x10^-3 max: 6.4x10^-2
SVR_RR mean: 1.1x10^-3 max: 6.4x10^-2
PLS_SIMRX mean: 1.5x10^-3 max: 5.5x10^-2
SVR_POL mean: 2.2x10^-3 max: 4.5x10^-2
DRC_XYD mean: 1.7x10^-2 max: 4.6x10^-1
SVR_CCP mean: 5.0x10^-2 max: 4.6x10^-1
LS_SVD mean: 9.8x10^-2 max: 3.5x10^-1
LCP_COU mean: 2.2x10^-1 max: 1.2x10^1
PTDF mean: 2.6x10^-1 max: 6.7x10^0
DC mean: 2.6x10^-1 max: 6.7x10^0
DC_LS mean: 3.3x10^-1 max: 2.8x10^1
DLPF mean: 5.0x10^-1 max: 1.8x10^1
LS_TOL mean: 7.4x10^-1 max: 2.1x10^0
LCP_COUN mean: 10.0x10^-1 max: 1.0x10^0
PLS_BDL mean: 8.6x10^1 max: 1.9x10^3
PLS_BDLY2 mean: 1.6x10^2 max: 2.8x10^3
LS_REC mean: 3.0x10^32 max: 1.9x10^34
TAY failure
LCP_BOXN failure
LCP_BOX failure
LS_CLS failure
LS failure

118-bus-S: Relative Error of Vm (log-scale)

RR_KPC	mean: 6.7×10^{-8}	max: 8.4×10^{-6}
PLS_CLS	mean: 3.0×10^{-7}	max: 2.2×10^{-5}
LS_LIFX	mean: 3.1×10^{-7}	max: 2.2×10^{-6}
LS_LIFXi	mean: 1.3×10^{-6}	max: 2.9×10^{-5}
RR_VCS	mean: 2.3×10^{-6}	max: 7.7×10^{-5}
LS_PCA	mean: 2.6×10^{-6}	max: 7.9×10^{-5}
LS_PIN	mean: 2.6×10^{-6}	max: 7.9×10^{-5}
DLPF_C	mean: 2.6×10^{-6}	max: 7.9×10^{-5}
PLS_NIP	mean: 2.6×10^{-6}	max: 7.9×10^{-5}
PLS_REC	mean: 2.6×10^{-6}	max: 7.9×10^{-5}
LS_COD	mean: 2.6×10^{-6}	max: 7.9×10^{-5}
RR	mean: 2.6×10^{-6}	max: 7.9×10^{-5}
LCP_BOXN	mean: 2.6×10^{-6}	max: 7.9×10^{-5}
RR_WEI	mean: 2.6×10^{-6}	max: 7.9×10^{-5}
LS_GEN	mean: 2.6×10^{-6}	max: 7.9×10^{-5}
OI	mean: 2.8×10^{-6}	max: 7.9×10^{-5}
PLS_RECW	mean: 2.8×10^{-6}	max: 8.5×10^{-5}
LCP_BOX	mean: 2.9×10^{-6}	max: 7.9×10^{-5}
LS_WEI	mean: 2.9×10^{-6}	max: 8.5×10^{-5}
LS_HBLE	mean: 3.1×10^{-6}	max: 8.1×10^{-5}
TAY	mean: 4.4×10^{-6}	max: 1.1×10^{-4}
LS_HBLD	mean: 4.9×10^{-6}	max: 8.6×10^{-5}
PLS_SIMRX	mean: 1.8×10^{-5}	max: 1.4×10^{-4}
SVR_POL	mean: 2.8×10^{-5}	max: 2.4×10^{-4}
DRC_XYD	mean: 4.8×10^{-4}	max: 2.7×10^{-3}
SVR	mean: 9.0×10^{-4}	max: 2.6×10^{-3}
SVR_RR	mean: 9.0×10^{-4}	max: 2.6×10^{-3}
DLPF	mean: 1.9×10^{-3}	max: 1.0×10^{-2}
SVR_CCP	mean: 9.5×10^{-3}	max: 3.0×10^{-2}
DC	mean: 2.3×10^{-2}	max: 5.9×10^{-2}
DC_LS	mean: 2.3×10^{-2}	max: 5.9×10^{-2}
LS_TOL	mean: 2.5×10^{-2}	max: 9.4×10^{-2}
LS_SVD	mean: 9.5×10^{-2}	max: 3.3×10^{-1}
PLS_BDL	mean: 1.2×10^{0}	max: 1.7×10^{1}
PLS_BDLY2	mean: 2.3×10^{0}	max: 3.8×10^{1}
LS_REC	mean: 3.8×10^{32}	max: 9.4×10^{33}
PTDF		failure
LCP_COUN		failure
LCP_COU		failure
LS_CLS		failure
LS		failure

141-bus-L: Relative Error of PF (log-scale)

141-bus-L: Relative Error of Vm (log-scale)

141-bus-S: Relative Error of PF (log-scale)

141-bus-S: Relative Error of Vm (log-scale)

1354-bus-L: Relative Error of PF (log-scale)
PLS_CLS mean: 3.0x10^-5 max: 3.8x10^0
RR_KPC mean: 3.0x10^-5 max: 3.8x10^0
RR mean: 2.6x10^-3 max: 3.6x10^2
PLS_NIP mean: 2.6x10^-3 max: 3.6x10^2
LS_COD mean: 2.6x10^-3 max: 3.6x10^2
DLPF_C mean: 2.6x10^-3 max: 3.6x10^2
PLS_REC mean: 2.6x10^-3 max: 3.6x10^2
LS_PIN mean: 2.6x10^-3 max: 3.6x10^2
LS_PCA mean: 2.6x10^-3 max: 3.6x10^2
RR_WEI mean: 2.6x10^-3 max: 3.7x10^2
RR_VCS mean: 2.8x10^-3 max: 3.6x10^2
PLS_RECW mean: 3.4x10^-3 max: 2.2x10^2
PLS_SIMRX mean: 4.9x10^-2 max: 1.7x10^3
LS_SVD mean: 5.9x10^-2 max: 9.1x10^2
DC mean: 1.6x10^-1 max: 1.5x10^4
PTDF mean: 1.6x10^-1 max: 1.5x10^4
DLPF mean: 1.7x10^-1 max: 1.6x10^4
LS_TOL mean: 8.1x10^-1 max: 9.4x10^2
DC_LS mean: 9.9x10^-1 max: 4.8x10^3
PLS_BDL mean: 1.4x10^2 max: 4.3x10^6
PLS_BDLY2 mean: 2.9x10^3 max: 1.1x10^8
TAY failure
LS_REC failure
LS_CLS failure
LS failure

1354-bus-L: Relative Error of Vm (log-scale)
RR_KPC
mean: 2.2x10^-6
max: 1.2x10^-4
PLS_CLS
mean: 2.2x10^-6
max: 1.2x10^-4
RR_VCS
mean: 1.6x10^-4
max: 5.4x10^-3
RR_WEI
mean: 1.8x10^-4
max: 6.2x10^-3
PLS_REC
mean: 1.8x10^-4
max: 6.1x10^-3
DLPF_C
mean: 1.8x10^-4
max: 6.1x10^-3
PLS_NIP
mean: 1.8x10^-4
max: 6.1x10^-3
LS_PIN
mean: 1.8x10^-4
max: 6.1x10^-3
LS_COD
mean: 1.8x10^-4
max: 6.1x10^-3
RR
mean: 1.8x10^-4
max: 6.1x10^-3
LS_PCA
mean: 1.8x10^-4
max: 6.1x10^-3
TAY
mean: 2.4x10^-4
max: 8.7x10^-3
PLS_RECW
mean: 2.7x10^-4
max: 1.3x10^-2
PLS_SIMRX
mean: 1.7x10^-3
max: 3.1x10^-2
DLPF
mean: 9.3x10^-3
max: 1.0x10^-1
DC
mean: 4.0x10^-2
max: 1.0x10^-1
DC_LS
mean: 4.0x10^-2
max: 1.0x10^-1
LS_SVD
mean: 6.0x10^-2
max: 2.8x10^-1
LS_TOL
mean: 5.3x10^-1
max: 1.9x10^0
PLS_BDL
mean: 5.5x10^0
max: 1.3x10^2
PLS_BDLY2
mean: 1.2x10^2
max: 3.3x10^3
PTDF
failure
LS_REC
failure
LS_CLS
failure
LS
failure

1354-bus-S: Relative Error of PF (log-scale)
RR_KPC
mean: 2.5x10^-6
max: 9.9x10^-2
PLS_CLS
mean: 2.5x10^-6
max: 9.9x10^-2
RR
mean: 1.9x10^-4
max: 2.8x10^1
LS_PIN
mean: 1.9x10^-4
max: 2.8x10^1
PLS_NIP
mean: 1.9x10^-4
max: 2.8x10^1
DLPF_C
mean: 1.9x10^-4
max: 2.8x10^1
PLS_REC
mean: 1.9x10^-4
max: 2.8x10^1
LS_COD
mean: 1.9x10^-4
max: 2.8x10^1
RR_WEI
mean: 1.9x10^-4
max: 2.8x10^1
RR_VCS
mean: 3.3x10^-4
max: 2.8x10^1
PLS_RECW
mean: 3.4x10^-4
max: 5.7x10^1
LS_PCA
mean: 3.8x10^-4
max: 7.5x10^1
LS_SVD
mean: 8.3x10^-2
max: 7.8x10^1
DC
mean: 1.7x10^-1
max: 2.4x10^4
PTDF
mean: 1.7x10^-1
max: 2.4x10^4
DLPF
mean: 1.8x10^-1
max: 2.7x10^4
LS_TOL
mean: 7.9x10^-1
max: 5.9x10^1
DC_LS
mean: 1.0x10^0
max: 7.3x10^3
PLS_SIMRX
mean: 1.1x10^0
max: 4.9x10^4
PLS_BDLY2
mean: 6.3x10^0
max: 2.3x10^5
PLS_BDL
mean: 8.7x10^0
max: 2.5x10^5
TAY
failure
LS_REC
failure
LS_CLS
failure
LS
failure

1354-bus-S: Relative Error of Vm (log-scale)
PLS_CLS mean: 2.3x10^-7 max: 9.4x10^-6
RR_KPC mean: 2.3x10^-7 max: 9.4x10^-6
RR_VCS mean: 1.2x10^-5 max: 3.2x10^-4
RR_WEI mean: 1.3x10^-5 max: 3.6x10^-4
RR mean: 1.3x10^-5 max: 3.6x10^-4
PLS_REC mean: 1.3x10^-5 max: 3.6x10^-4
DLPF_C mean: 1.3x10^-5 max: 3.6x10^-4
PLS_NIP mean: 1.3x10^-5 max: 3.6x10^-4
LS_COD mean: 1.3x10^-5 max: 3.6x10^-4
LS_PIN mean: 1.3x10^-5 max: 3.6x10^-4
LS_PCA mean: 2.2x10^-5 max: 5.4x10^-4
PLS_RECW mean: 2.3x10^-5 max: 6.6x10^-4
TAY mean: 9.4x10^-5 max: 2.3x10^-3
DLPF mean: 8.9x10^-3 max: 6.9x10^-2
DC mean: 4.0x10^-2 max: 8.7x10^-2
DC_LS mean: 4.0x10^-2 max: 8.7x10^-2
PLS_SIMRX mean: 5.3x10^-2 max: 5.8x10^-1
LS_SVD mean: 8.2x10^-2 max: 3.1x10^-1
PLS_BDLY2 mean: 2.4x10^-1 max: 6.1x10^0
PLS_BDL mean: 3.4x10^-1 max: 8.4x10^0
LS_TOL mean: 5.1x10^-1 max: 2.2x10^0
PTDF failure
LS_REC failure
LS_CLS failure
LS failure