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

Supplementary Material

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The supplementary material includes

- A thorough illustration of the settings for each evaluated method, including their predictors, responses, hyperparameters.
- All the ranking results (36 in total) with the mean and maximal relative errors of all 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