





GRwHS: Group Ridge within Horseshoe

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Synthetic Scenarios

- Design: $n=1300$, Train/test: 300/1000, 5-fold CV, $p=200$, $G=8$ groups [5,10,15,20,30,40,40,40]
- Correlation: group block ($\rho_{in}=0.7$, $\rho_{out}=0.1$); Signal-to-noise ratio(SNR) $\in \{0.1, 0.5, 1, 3\}$

Legend:  strong dense  medium  weak / sparse  null

Each bar represents $p=200$ features grouped as [5,10,15,20,30,40,40,40].



Group-sparse strong signals: two active groups; others ideally shrunk.



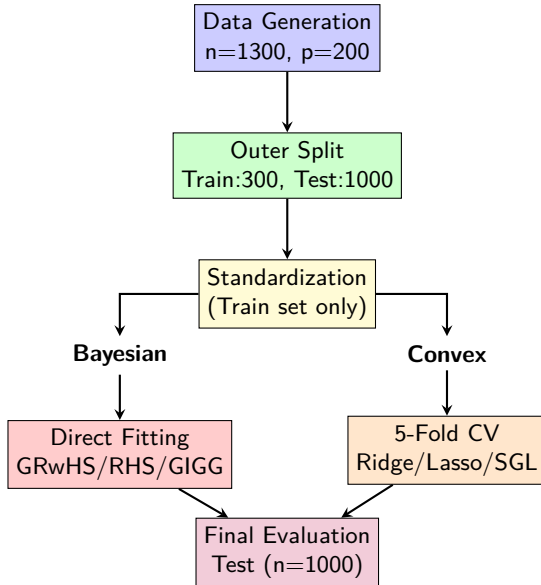
Dense weak signals: all groups slightly active; tests robustness to over-shrinkage.



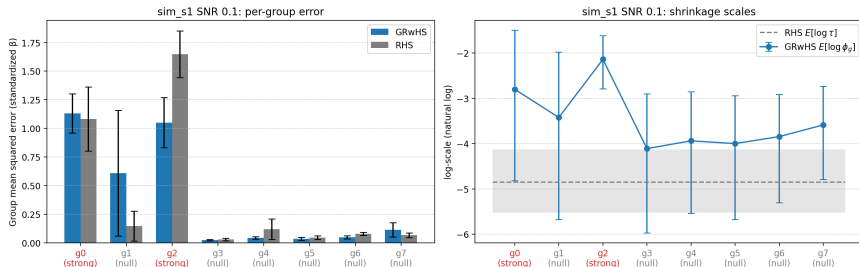
Mixed hierarchy: strong G_0 , medium G_3 , sparse weak tails in G_5-7 .

All share identical design, standardization, and evaluation pipeline (RMSE, group edf, posterior shrinkage).

Experimental Design: Nested Data Splitting



Results: sim_s1



Left: GRwHS lowers error in the strong (g2) groups while matching RHS on weak/null groups.

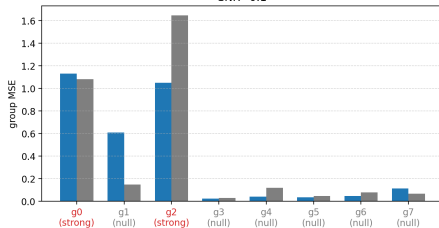
Right: GRwHS learns larger $E[\log \phi_g]$ for signal groups, whereas RHS uses one global τ (dashed).

This group-aware shrinkage releases true signal and preserves shrinkage on noise, explaining the error gains.

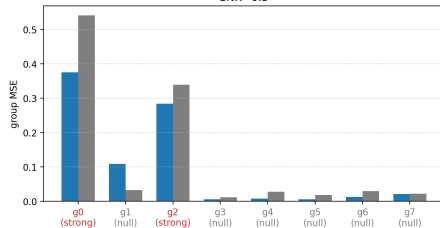
Results: sim_s1

sim_s1: Per-group error across SNR

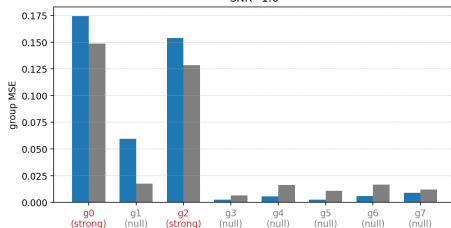
SNR=0.1



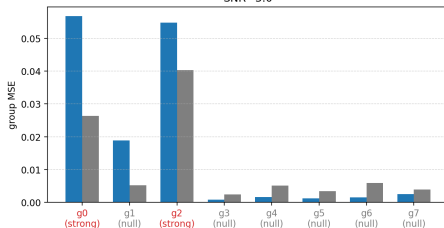
SNR=0.5



SNR=1.0

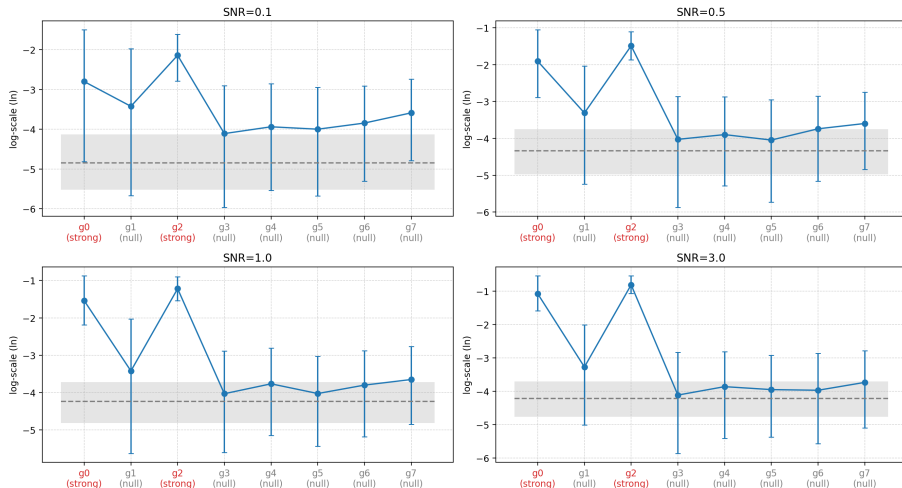


SNR=3.0



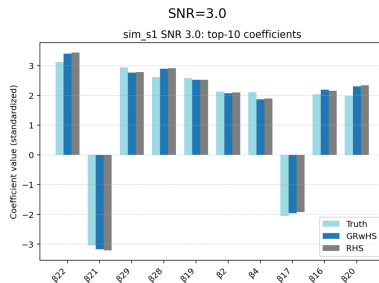
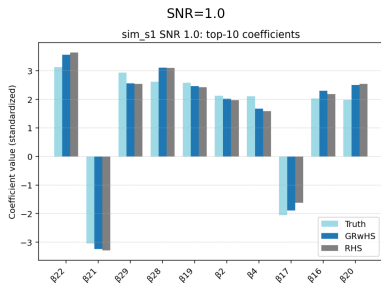
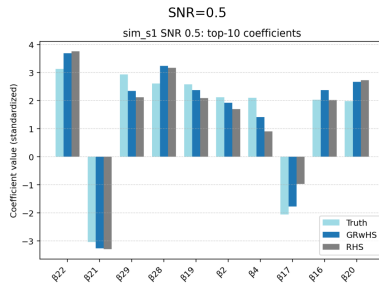
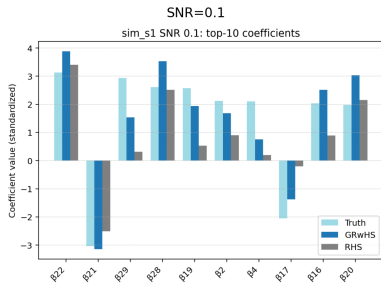
Results: sim_s1

sim_s1: Group shrinkage scales across SNR



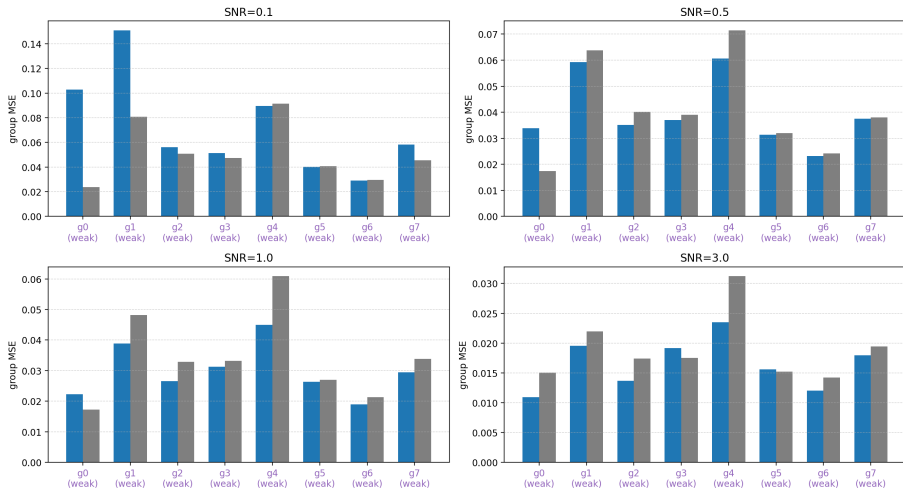
Results: sim_s1

sim_s1: Top-10 coefficients (Truth vs GRwHS vs RHS)



Results: sim_s2

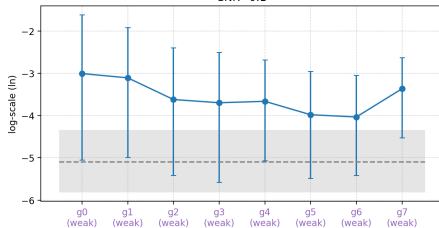
sim_s2: Per-group error across SNR



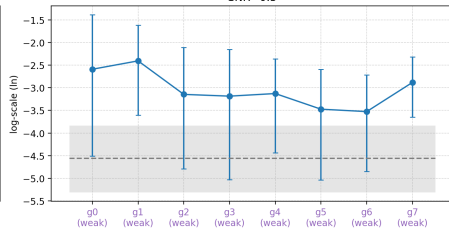
Results: sim_s2

sim_s2: Group shrinkage scales across SNR

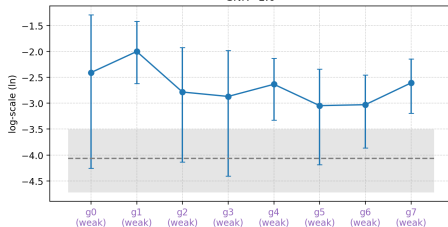
SNR=0.1



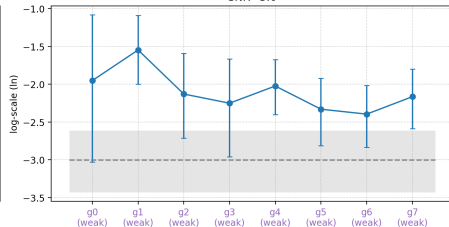
SNR=0.5



SNR=1.0

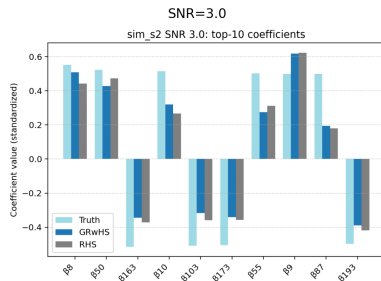
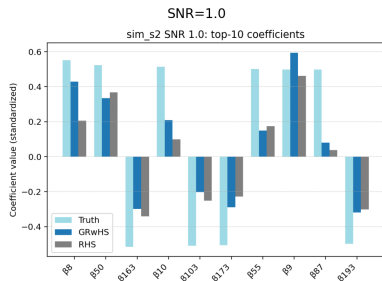
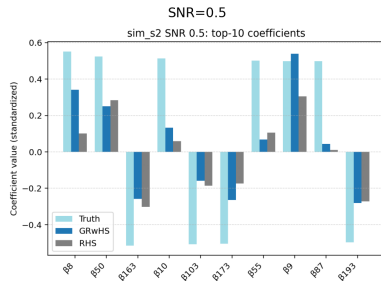
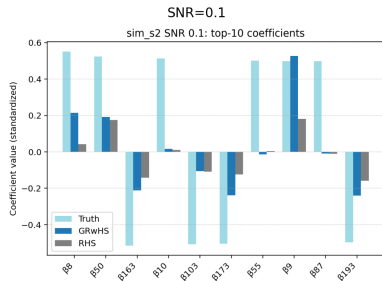


SNR=3.0



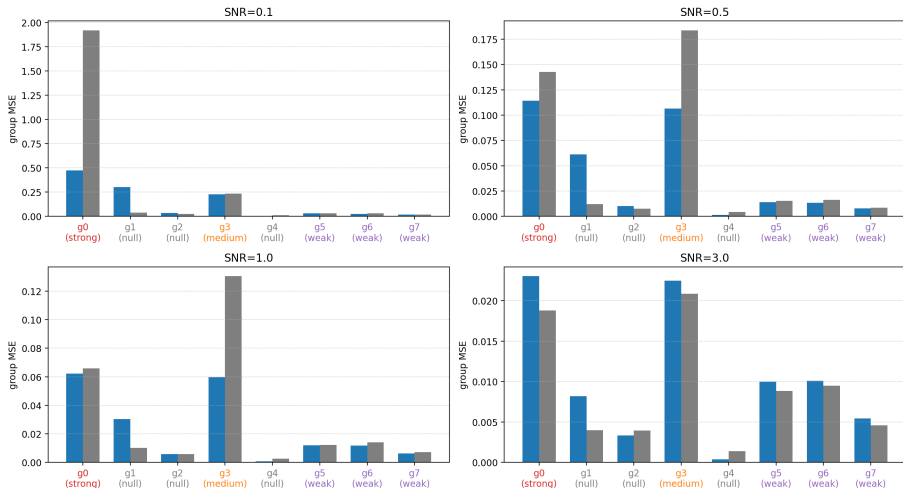
Results: sim_s2

sim_s2: Top-10 coefficients (Truth vs GRwHS vs RHS)



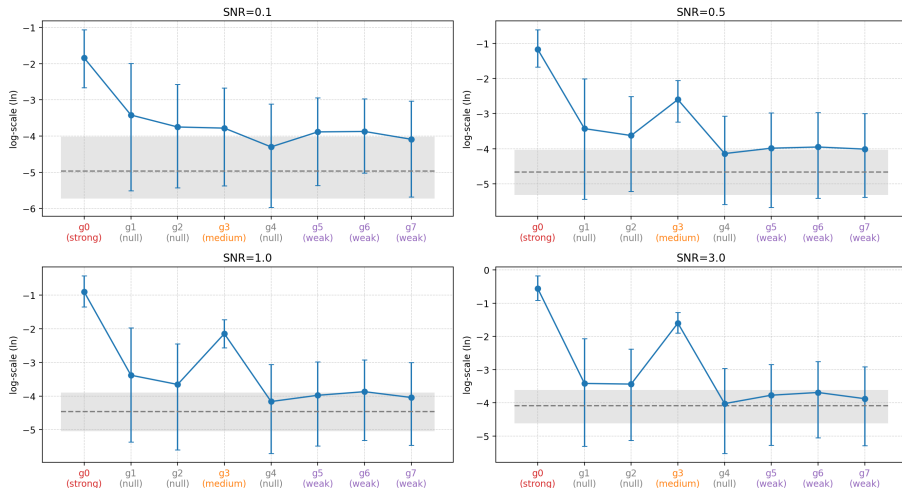
Results: sim_s3

sim_s3: Per-group error across SNR



Results: sim_s3

sim_s3: Group shrinkage scales across SNR



Results: sim_s3

sim_s3: Top-10 coefficients (Truth vs GRwHS vs RHS)

