Appendix of Exploiting disagreement between high-dimensional variable selectors for uncertainty visualization

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A Appendix

A.1 Proof of Proposition 1

Proof.

$$
\begin{aligned}
& \arg\min_{M} \frac{1}{|\mathcal{M}|} \sum_{\{k|M_k \in \mathcal{M}\}} Hamming(M_k, M) \\
\iff & \arg\min_{M} \frac{1}{|\mathcal{M}|} \sum_{\{k|M_k \in \mathcal{M}\}} \sum_{j=1}^{p} (\mathbb{1}_{\beta_j^k = 0} \mathbb{1}_{j \in M} + \mathbb{1}_{\ beta_j^k \neq 0} \mathbb{1}_{j \notin M}) \\
\iff & \arg\min_{M} \frac{1}{|\mathcal{M}|} \sum_{j=1}^{p} \sum_{\{k|M_k \in \mathcal{M}\}} [(1 - \mathbb{1}_{\beta_j^k \neq 0}) \mathbb{1}_{j \in M} + \mathbb{1}_{\beta_j^k \neq 0} (1 - \mathbb{1}_{j \in M})] \\
\iff & \arg\min_{M} \frac{1}{|\mathcal{M}|} \sum_{j=1}^{p} \sum_{\{k|M_k \in \mathcal{M}\}} [\mathbb{1}_{j \in M} (1 - 2\mathbb{1}_{\beta_j^k \neq 0})] \\
\iff & \arg\min_{M} \sum_{j=1}^{P} \mathbb{1}_{j \in M} (1 - 2 \frac{\sum_{\{k|M_k \in \mathcal{M}\}} \mathbb{1}_{\beta_j^k \neq 0}}{|\mathcal{M}|}) \\
\iff & \arg\min_{M} \sum_{j=1}^{P} \mathbb{1}_{j \in M} (1 - 2\tau_j)
\end{aligned}
$$

□

A.2 Proof of Proposition 2

Proof. Let the number of fitted models for covariance j to be estimated with positive sign to be n_j^+ and those estimated with negative sign to be n_j^-.

$$
\begin{aligned}
&\arg\min_{M} \frac{1}{|\mathcal{M}|} \sum_{\{k|M_k \in \mathcal{M}\}} dist(M_k, M) \\
\iff &\frac{1}{|\mathcal{M}|} \arg\min_{\{s_j^M | j=1,\ldots,p\}} \sum_{\{k|M_k \in \mathcal{M}\}} |s_j^M - sign(\beta_j^k)| \\
\iff &\frac{1}{|\mathcal{M}|} \arg\min_{\{s_j^M | j=1,\ldots,p\}} \sum_{\{k|M_k \in \mathcal{M}\}} [(|\mathcal{M}| - n_j^+ + n_j^-)\mathbb{1}_{s_j^M=+1} + (n_j^+ + n_j^-)\mathbb{1}_{s_j^M=0} + (|\mathcal{M}| + n_j^+ - n_j^-)\mathbb{1}_{s_j^M=-1}] \\
\iff &\arg\min_{\{s_j^M | j=1,\ldots,p\}} \sum_{\{k|M_k \in \mathcal{M}\}} [(1 - \tau_j^+ + \tau_j^-)\mathbb{1}_{s_j^M=+1} + (\tau_j^+ + \tau_j^-)\mathbb{1}_{s_j^M=0} + (1 - \tau_j^- + \tau_j^+)\mathbb{1}_{s_j^M=-1}]
\end{aligned}
$$

which is equivalent to setting

$$
s_j^M = \begin{cases} +1 \text{ if } \tau_j^+ \geq 1/2 \\ -1 \text{ if } \tau_j^- \geq 1/2 \\ 0 \text{ otherwise} \end{cases}
$$

□

A.3 Illustration of selection disagreement via Jaccard distance heatmap

The heat maps in Figure 1-5 show the average Jaccard distance ($dist_{Jaccard}(A, B) = \frac{|A \triangle B|}{|A \cup B|}$, where $A \triangle B = (A \cup B) - (A \cap B)$) among selected sets from five different variable selection methods under simulation setting 1-5 (see Section 5 more details). The Jaccard distance shows the relative size of selection disagreement. It ranges from 0 to 1 and larger distance means larger dissimilarity between two selected sets. The Jaccard distance among some selection methods can be quite large, showing that relatively large number of covariates are selected by one method but not by another. Even for methods that are relatively similar like the Lasso and elastic Lasso, the difference among them is still not negligible for most settings.

Figure 1: Average Jaccard distance among fitted models from different methods using simulated data from model 1

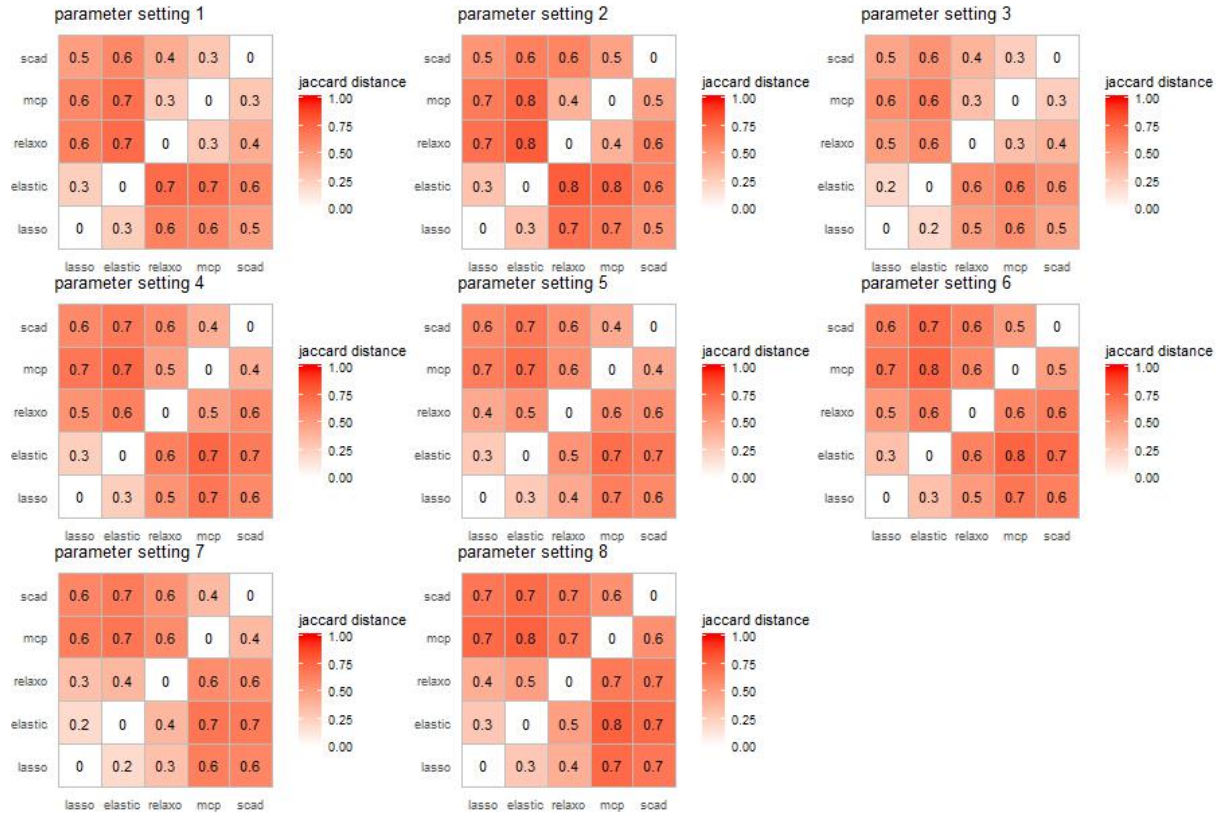

Figure 2: Average Jaccard distance among fitted models from different methods using simulated data from model 2

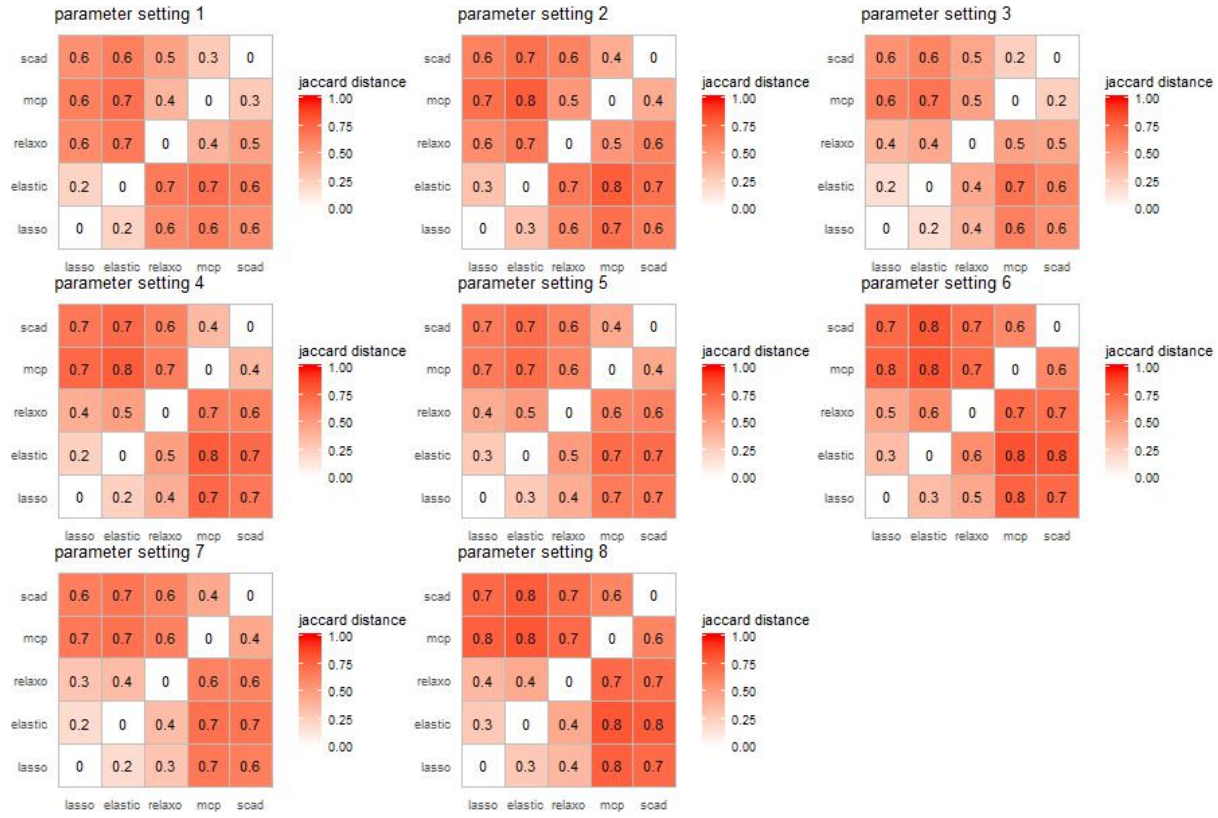

Figure 3: Average Jaccard distance among fitted models from different methods using simulated data from model 3

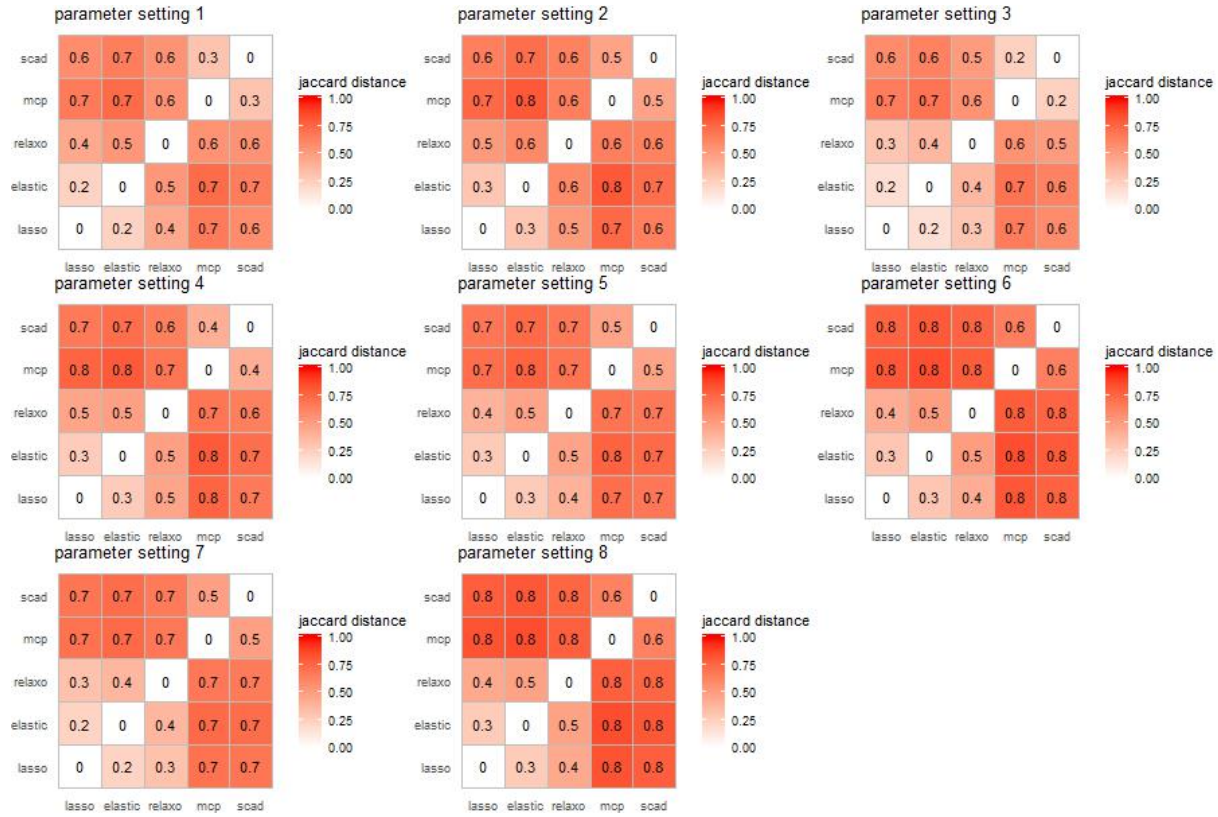

Figure 4: Average Jaccard distance among fitted models from different methods using simulated data from model 4

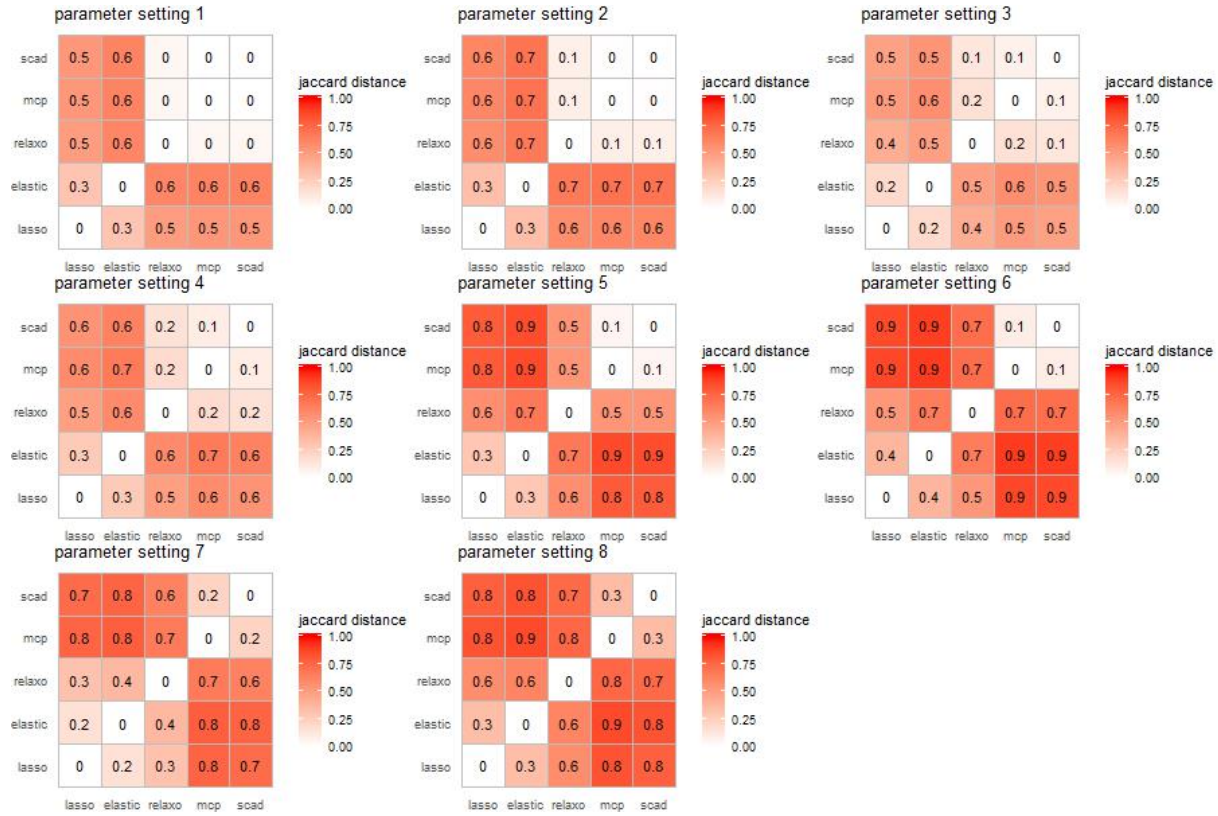

Figure 5: Average Jaccard distance among fitted models from different methods using simulated data from model 5

A.4 Tables of the simulation results

parameters	methods	f	FP+FN	FP	FN	pred.err	l1.diff	l2.diff	size
setting 1	lasso	0.76 (0.01)	2.11 (0.14)	2.11	0	1.13 (0.02)	0.75 (0.04)	0.39 (0.02)	5.11 (0.14)
	elastic net	0.71 (0.01)	2.67 (0.14)	2.67	0	1.15 (0.03)	0.85 (0.04)	0.42 (0.02)	5.67 (0.14)
rho = 0.5	relaxed lasso	0.91 (0.01)	0.7 (0.1)	0.7	0	1.11 (0.03)	0.6 (0.04)	0.34 (0.02)	3.7 (0.1)
s = 3	mcp	0.94 (0.01)	0.47 (0.1)	0.47	0	1.1 (0.02)	0.53 (0.04)	0.32 (0.02)	3.47 (0.1)
p = 8	scad	0.94 (0.01)	0.53 (0.11)	0.53	0	1.09 (0.02)	0.51 (0.04)	0.31 (0.02)	3.53 (0.11)
	vsd	0.98 (0)	0.11 (0.03)	0.11	0	1.08 (0.02)	0.43 (0.02)	0.28 (0.01)	3.11 (0.03)
	bic	0.96 (0.01)	0.35 (0.08)	0.35	0	1.09 (0.02)	0.5 (0.03)	0.31 (0.02)	3.35 (0.08)
	ebic	**0.96** (0.01)	0.35 (0.08)	0.35	0	**1.09** (0.02)	**0.5** (0.03)	**0.31** (0.02)	3.35 (0.08)
	cv	0.94 (0.01)	0.48 (0.11)	0.48	0	**1.09** (0.03)	0.51 (0.04)	**0.31** (0.02)	3.48 (0.11)
	csuv.m.0	**0.96** (0.01)	**0.27** (0.06)	**0.27**	0	**1.09** (0.02)	**0.5** (0.03)	**0.31** (0.02)	3.27 (0.06)
	csuv.s.0	0.94 (0.01)	0.42 (0.06)	0.42	0	1.1 (0.02)	0.55 (0.03)	0.33 (0.02)	3.42 (0.06)
	csuv.m.5	0.96 (0.01)	0.27 (0.06)	0.27	0	1.09 (0.02)	0.5 (0.03)	0.31 (0.02)	3.27 (0.06)
	csuv.s.5	0.94 (0.01)	0.42 (0.06)	0.42	0	1.1 (0.02)	0.55 (0.03)	0.33 (0.02)	3.42 (0.06)
	csuv.m.0.all	0.95 (0.01)	0.38 (0.07)	0.38	0	1.1 (0.02)	0.53 (0.03)	0.33 (0.02)	3.38 (0.07)
	csuv.s.0.all	0.92 (0.01)	0.56 (0.06)	0.56	0	1.11 (0.02)	0.59 (0.03)	0.35 (0.02)	3.56 (0.06)
	csuv.m.0.mcp	0.97 (0.01)	0.21 (0.06)	0.21	0	1.09 (0.02)	0.47 (0.03)	0.29 (0.02)	3.21 (0.06)
	csuv.s.0.mcp	0.97 (0.01)	0.2 (0.05)	0.2	0	1.08 (0.02)	0.46 (0.03)	0.29 (0.02)	3.2 (0.05)
setting 2	lasso	0.76 (0.01)	2.13 (0.14)	2.11	0.02	10.12 (0.21)	2.26 (0.11)	1.17 (0.05)	5.09 (0.14)
	elastic net	0.73 (0.01)	2.49 (0.14)	2.48	0.01	10.25 (0.23)	2.39 (0.11)	1.2 (0.04)	5.47 (0.14)
rho = 0.5	relaxed lasso	0.87 (0.01)	1.01 (0.12)	0.96	0.05	10.11 (0.23)	1.99 (0.12)	1.12 (0.05)	3.91 (0.12)
s = 3	mcp	0.84 (0.01)	1.29 (0.13)	1.15	0.14	10.38 (0.23)	2.3 (0.14)	1.28 (0.06)	4.01 (0.15)
p = 8	scad	0.82 (0.01)	1.53 (0.13)	1.48	0.05	10.31 (0.23)	2.26 (0.13)	1.26 (0.06)	4.43 (0.14)
	vsd	0.87 (0.01)	0.65 (0.07)	0.08	0.57	10.79 (0.27)	2.18 (0.13)	1.42 (0.08)	2.51 (0.06)
	bic	0.86 (0.01)	1.04 (0.11)	0.92	0.12	10.24 (0.22)	2.11 (0.12)	1.22 (0.06)	3.8 (0.12)
	ebic	0.86 (0.01)	1.06 (0.11)	0.94	0.12	10.22 (0.22)	2.11 (0.12)	1.22 (0.06)	3.82 (0.13)
	cv	0.76 (0.01)	2.12 (0.14)	2.09	**0.03**	10.13 (0.22)	2.28 (0.11)	1.18 (0.05)	5.06 (0.14)
	csuv.m.0	**0.91** (0.01)	**0.65** (0.09)	**0.56**	0.09	10.09 (0.22)	**1.83** (0.11)	**1.09** (0.06)	3.47 (0.08)
	csuv.s.0	0.9 (0.01)	0.72 (0.08)	0.64	0.08	**10.08** (0.21)	1.88 (0.1)	1.11 (0.05)	3.56 (0.08)
	csuv.m.5	0.91 (0.01)	0.65 (0.09)	0.56	0.09	10.09 (0.22)	1.83 (0.11)	1.09 (0.06)	3.47 (0.08)
	csuv.s.5	0.9 (0.01)	0.72 (0.08)	0.64	0.08	10.08 (0.21)	1.88 (0.1)	1.11 (0.05)	3.56 (0.08)
	csuv.m.0.all	0.91 (0.01)	0.63 (0.09)	0.57	0.06	10.09 (0.22)	1.83 (0.11)	1.09 (0.06)	3.51 (0.08)
	csuv.s.0.all	0.9 (0.01)	0.73 (0.08)	0.67	0.06	10 (0.21)	1.86 (0.1)	1.1 (0.05)	3.61 (0.07)
	csuv.m.0.mcp	0.9 (0.01)	0.74 (0.1)	0.57	0.17	10.25 (0.23)	1.99 (0.13)	1.18 (0.07)	3.4 (0.11)
	csuv.s.0.mcp	0.9 (0.01)	0.69 (0.09)	0.55	0.14	10.15 (0.22)	1.9 (0.12)	1.14 (0.06)	3.41 (0.08)
setting 3	lasso	0.73 (0.02)	2.16 (0.14)	1.86	0.3	40.51 (0.85)	4.33 (0.21)	2.28 (0.09)	4.56 (0.16)
	elastic net	0.71 (0.01)	2.39 (0.14)	2.14	0.25	40.66 (0.9)	4.37 (0.2)	2.25 (0.08)	4.89 (0.16)
rho = 0.5	relaxed lasso	0.73 (0.02)	1.78 (0.12)	1.13	0.65	41.41 (0.91)	4.52 (0.21)	2.51 (0.1)	3.48 (0.16)
s = 3	mcp	0.66 (0.02)	2.26 (0.13)	1.41	0.85	42.76 (0.98)	5.54 (0.23)	2.97 (0.1)	3.56 (0.2)
p = 8	scad	0.7 (0.02)	2.22 (0.14)	1.67	0.55	42.47 (0.92)	5.51 (0.22)	2.94 (0.1)	4.12 (0.17)
	vsd	0.54 (0.01)	2.24 (0.06)	0.01	2.23	48.66 (1.21)	5.94 (0.14)	3.53 (0.08)	0.78 (0.06)
	bic	0.69 (0.02)	1.9 (0.12)	1.03	0.87	42.24 (0.95)	4.87 (0.21)	2.72 (0.1)	3.16 (0.16)
	ebic	0.69 (0.02)	1.9 (0.12)	1.03	0.87	42.24 (0.95)	4.87 (0.21)	2.72 (0.1)	3.16 (0.16)
	cv	**0.73** (0.02)	2.16 (0.14)	1.86	**0.3**	**40.51** (0.85)	**4.33** (0.21)	**2.28** (0.09)	4.56 (0.16)
	csuv.m.0	**0.73** (0.02)	**1.45** (0.09)	**0.43**	1.02	42.38 (0.91)	4.47 (0.21)	2.69 (0.1)	2.41 (0.11)
	csuv.s.0	**0.73** (0.02)	1.53 (0.11)	0.63	0.9	42.16 (0.9)	4.46 (0.22)	2.6 (0.1)	2.73 (0.1)
	csuv.m.5	0.73 (0.02)	1.45 (0.09)	0.43	1.02	42.38 (0.91)	4.47 (0.21)	2.69 (0.1)	2.41 (0.11)
	csuv.s.5	0.73 (0.02)	1.53 (0.11)	0.63	0.9	42.16 (0.9)	4.46 (0.22)	2.6 (0.1)	2.73 (0.1)
	csuv.m.0.all	0.74 (0.02)	1.41 (0.1)	0.44	0.97	42.15 (0.89)	4.39 (0.21)	2.65 (0.1)	2.47 (0.11)
	csuv.s.0.all	0.74 (0.02)	1.51 (0.1)	0.65	0.86	41.99 (0.87)	4.4 (0.2)	2.6 (0.1)	2.79 (0.1)
	csuv.m.0.mcp	0.69 (0.02)	1.59 (0.09)	0.36	1.23	43.2 (0.96)	4.77 (0.21)	2.85 (0.1)	2.13 (0.11)
	csuv.s.0.mcp	0.7 (0.02)	1.6 (0.09)	0.45	1.15	42.74 (0.95)	4.77 (0.22)	2.8 (0.1)	2.3 (0.1)

Table 1: Model 1: performance of CSUV and methods it compares with. Variable selection performance in terms of F-measure (f), total error (FP+FN), false positives (FP) and false negatives (FN), prediction error in terms of mse (pred.err) and estimation error in terms of l1 and l2 distance (l1.diff and l2.diff) and are shown. The numbers are based on 100 simulations. The last 8 rows are the performance of CSUV with different parameters (e.g. csuv.m.0.mcp corresponds to CSUV with MCP as constituent method and r = 0). A bold number represents the best result among delete-n/2 cross validation, eBIC and CSUV using Lasso, MCP and SCAD while a underlined number represents the worst among them. Standard errors are shown inside the parentheses.

parameters	methods	f	FP+FN	FP	FN	pred.err	l1.diff	l2.diff	size
setting 1	lasso	0.43 (0.01)	15.7 (0.89)	15.7	0	1.28 (0.02)	1.76 (0.07)	0.53 (0.01)	20.7 (0.89)
	elastic net	0.35 (0.01)	21.2 (0.91)	21.2	0	1.36 (0.02)	2.22 (0.07)	0.6 (0.01)	26.2 (0.91)
rho = 0	relaxed lasso	0.88 (0.02)	2.1 (0.47)	2.05	0.05	1.14 (0.02)	0.81 (0.07)	0.35 (0.02)	7 (0.47)
s = 5	mcp	0.85 (0.02)	2.3 (0.32)	2.3	0	1.1 (0.02)	0.68 (0.04)	0.3 (0.01)	7.3 (0.32)
p = 100	scad	0.66 (0.02)	6.16 (0.4)	6.16	0	1.09 (0.02)	0.75 (0.03)	0.3 (0.01)	11.16 (0.4)
	vsd	0.99 (0)	0.09 (0.03)	0.02	0.07	1.07 (0.02)	0.44 (0.02)	0.24 (0.01)	4.95 (0.03)
	bic	0.77 (0.02)	3.6 (0.33)	3.6	0	1.09 (0.02)	0.7 (0.03)	0.3 (0.01)	8.6 (0.33)
	ebic	0.85 (0.02)	2.31 (0.31)	2.31	**0**	1.09 (0.02)	0.67 (0.04)	0.3 (0.01)	7.31 (0.31)
	cv	0.76 (0.02)	4.28 (0.46)	4.28	**0**	1.09 (0.02)	0.7 (0.03)	0.29 (0.01)	9.28 (0.46)
	csuv.m.0	**0.98** (0)	**0.2** (0.04)	**0.18**	0.02	**1.06** (0.02)	**0.47** (0.02)	**0.25** (0.01)	5.16 (0.04)
	csuv.s.0	0.93 (0.01)	0.81 (0.09)	0.79	0.02	1.1 (0.02)	0.62 (0.03)	0.32 (0.01)	5.77 (0.09)
	csuv.m.5	0.99 (0)	0.15 (0.04)	0.12	0.03	1.06 (0.02)	0.45 (0.02)	0.25 (0.01)	5.09 (0.04)
	csuv.s.5	0.86 (0.01)	1.63 (0.1)	1.62	0.01	1.14 (0.02)	0.81 (0.03)	0.38 (0.01)	6.61 (0.1)
	csuv.m.0.all	0.98 (0)	0.21 (0.04)	0.19	0.02	1.06 (0.02)	0.47 (0.02)	0.25 (0.01)	5.17 (0.04)
	csuv.s.0.all	0.92 (0.01)	0.92 (0.09)	0.9	0.02	1.11 (0.02)	0.65 (0.03)	0.33 (0.01)	5.88 (0.09)
	csuv.m.0.mcp	0.99 (0)	0.09 (0.03)	0.04	0.05	1.06 (0.02)	0.43 (0.02)	0.24 (0.01)	4.99 (0.03)
	csuv.s.0.mcp	0.97 (0)	0.29 (0.05)	0.28	0.01	1.07 (0.02)	0.49 (0.02)	0.26 (0.01)	5.27 (0.05)
setting 2	lasso	0.33 (0.01)	24.65 (1.43)	24.64	0.01	1.43 (0.03)	2.41 (0.1)	0.65 (0.02)	29.63 (1.44)
	elastic net	0.26 (0.01)	32.75 (1.44)	32.74	0.01	1.59 (0.03)	3.05 (0.1)	0.75 (0.02)	37.73 (1.44)
rho = 0	relaxed lasso	0.78 (0.02)	4.25 (0.81)	4.12	0.13	1.28 (0.03)	1.3 (0.09)	0.49 (0.02)	8.99 (0.81)
s = 5	mcp	0.75 (0.02)	4.24 (0.39)	4.23	0.01	1.13 (0.02)	0.87 (0.04)	0.36 (0.01)	9.22 (0.39)
p = 300	scad	0.5 (0.02)	12.21 (0.72)	12.2	0.01	1.14 (0.02)	1.1 (0.04)	0.37 (0.01)	17.19 (0.72)
	vsd	0.94 (0.01)	0.5 (0.09)	0	0.5	1.28 (0.05)	0.76 (0.06)	0.43 (0.03)	4.5 (0.09)
	bic	0.55 (0.02)	12.38 (1.43)	12.37	0.01	1.19 (0.02)	1.32 (0.11)	0.41 (0.02)	17.36 (1.43)
	ebic	0.74 (0.02)	5.84 (1.22)	5.83	**0.01**	1.15 (0.02)	0.98 (0.09)	0.37 (0.01)	10.82 (1.22)
	cv	0.61 (0.02)	8.92 (0.75)	8.91	**0.01**	1.13 (0.02)	1.01 (0.05)	0.36 (0.01)	13.9 (0.75)
	csuv.m.0	**0.97** (0.01)	**0.28** (0.06)	**0.13**	0.15	**1.11** (0.02)	**0.58** (0.03)	**0.31** (0.02)	4.98 (0.06)
	csuv.s.0	0.86 (0.01)	1.71 (0.12)	1.65	0.06	1.19 (0.02)	0.95 (0.04)	0.44 (0.01)	6.59 (0.13)
	csuv.m.5	0.97 (0.01)	0.3 (0.05)	0.11	0.19	1.12 (0.02)	0.6 (0.04)	0.33 (0.02)	4.92 (0.05)
	csuv.s.5	0.78 (0.01)	3.02 (0.15)	3	0.02	1.25 (0.02)	1.24 (0.04)	0.51 (0.01)	7.98 (0.15)
	csuv.m.0.all	0.97 (0.01)	0.31 (0.06)	0.15	0.16	1.12 (0.02)	0.59 (0.04)	0.32 (0.02)	4.99 (0.05)
	csuv.s.0.all	0.85 (0.01)	1.87 (0.14)	1.81	0.06	1.19 (0.02)	1 (0.04)	0.46 (0.01)	6.75 (0.14)
	csuv.m.0.mcp	0.97 (0.01)	0.24 (0.05)	0.01	0.23	1.13 (0.03)	0.58 (0.03)	0.33 (0.02)	4.78 (0.05)
	csuv.s.0.mcp	0.92 (0.01)	0.83 (0.07)	0.72	0.11	1.15 (0.02)	0.74 (0.03)	0.38 (0.01)	5.61 (0.09)
setting 3	lasso	0.46 (0.01)	24.88 (0.93)	24.88	0	1.55 (0.03)	3.23 (0.1)	0.73 (0.01)	34.88 (0.93)
	elastic net	0.42 (0.01)	29.6 (0.89)	29.6	0	1.65 (0.03)	3.74 (0.1)	0.79 (0.01)	39.6 (0.89)
rho = 0	relaxed lasso	0.8 (0.01)	5.53 (0.46)	5.49	0.04	1.36 (0.03)	1.95 (0.08)	0.58 (0.02)	15.45 (0.46)
s = 10	mcp	0.88 (0.01)	3.1 (0.31)	3.1	0	1.19 (0.02)	1.23 (0.05)	0.42 (0.01)	13.1 (0.31)
p = 100	scad	0.7 (0.01)	8.98 (0.41)	8.98	0	1.2 (0.02)	1.4 (0.05)	0.43 (0.01)	18.98 (0.41)
	vsd	0.98 (0.01)	0.4 (0.09)	0.1	0.3	1.25 (0.05)	1.06 (0.06)	0.43 (0.03)	9.8 (0.08)
	bic	0.83 (0.01)	5.28 (0.72)	5.28	0	1.22 (0.03)	1.41 (0.1)	0.44 (0.02)	15.28 (0.72)
	ebic	0.87 (0.01)	3.27 (0.33)	3.27	**0**	**1.19** (0.02)	1.24 (0.05)	**0.42** (0.01)	13.27 (0.33)
	cv	0.63 (0.02)	14.87 (1.16)	14.87	**0**	1.38 (0.03)	2.25 (0.14)	0.58 (0.02)	24.87 (1.16)
	csuv.m.0	**0.97** (0)	**0.49** (0.08)	**0.27**	0.22	1.23 (0.04)	**1.07** (0.05)	0.43 (0.02)	10.05 (0.09)
	csuv.s.0	0.87 (0.01)	3.19 (0.16)	3.16	0.03	1.31 (0.03)	1.64 (0.05)	0.54 (0.01)	13.13 (0.16)
	csuv.m.5	0.98 (0)	0.46 (0.08)	0.25	0.21	1.22 (0.04)	1.06 (0.05)	0.42 (0.02)	10.04 (0.08)
	csuv.s.5	0.83 (0)	4.29 (0.15)	4.27	0.02	1.35 (0.03)	1.86 (0.05)	0.58 (0.01)	14.25 (0.15)
	csuv.m.0.all	0.98 (0)	0.47 (0.07)	0.3	0.17	1.21 (0.03)	1.05 (0.04)	0.42 (0.02)	10.13 (0.08)
	csuv.s.0.all	0.86 (0.01)	3.47 (0.16)	3.44	0.03	1.32 (0.03)	1.7 (0.05)	0.55 (0.01)	13.41 (0.17)
	csuv.m.0.mcp	0.98 (0)	0.36 (0.07)	0.03	0.33	1.25 (0.04)	1.05 (0.05)	0.43 (0.02)	9.7 (0.07)
	csuv.s.0.mcp	0.94 (0)	1.26 (0.08)	1.19	0.07	1.24 (0.04)	1.25 (0.04)	0.47 (0.02)	11.12 (0.08)

Table 2: Model 2: performance of CSUV and methods it compares with. Variable selection performance in terms of F-measure (f), total error (FP+FN), false positives (FP) and false negatives (FN), prediction error in terms of mse (pred.err) and estimation error in terms of l1 and l2 distance (l1.diff and l2.diff) and are shown. The numbers are based on 100 simulations. The last 8 rows are the performance of CSUV with different parameters (e.g. csuv.m.0.mcp corresponds to CSUV with MCP as constituent method and r = 0). A bold number represents the best result among delete-n/2 cross validation, eBIC and CSUV using Lasso, MCP and SCAD while a underlined number represents the worst among them. Standard errors are shown inside the parentheses.

parameters	methods	f	FP+FN	FP	FN	pred.err	l1.diff	l2.diff	size
setting 4	lasso	0.38 (0.01)	36.64 (1.56)	36.6	0.04	1.88 (0.05)	4.49 (0.14)	0.94 (0.02)	46.56 (1.56)
	elastic net	0.31 (0.01)	47.38 (1.54)	47.34	0.04	2.15 (0.05)	5.62 (0.14)	1.08 (0.02)	57.3 (1.55)
rho = 0	relaxed lasso	0.66 (0.01)	11.84 (0.9)	11.61	0.23	1.7 (0.05)	3.2 (0.13)	0.81 (0.02)	21.38 (0.93)
s = 10	mcp	0.81 (0.01)	5.19 (0.35)	5.16	0.03	1.24 (0.03)	1.46 (0.06)	0.48 (0.02)	15.13 (0.35)
p = 300	scad	0.57 (0.01)	15.88 (0.53)	15.86	0.02	1.23 (0.03)	1.74 (0.06)	0.48 (0.02)	25.84 (0.53)
	vsd	0.88 (0.02)	2.08 (0.28)	0.03	2.05	2.36 (0.24)	2.33 (0.22)	0.9 (0.08)	7.98 (0.29)
	bic	0.6 (0.02)	19.21 (2)	19.19	0.02	1.39 (0.05)	2.44 (0.2)	0.58 (0.03)	29.17 (2.01)
	ebic	0.78 (0.02)	8.05 (1.42)	8.02	**0.03**	**1.28** (0.03)	**1.75** (0.15)	**0.51** (0.02)	17.99 (1.42)
	cv	0.41 (0.01)	33.78 (1.67)	33.74	0.04	1.8 (0.05)	4.18 (0.16)	0.88 (0.02)	43.7 (1.67)
	csuv.m.0	**0.91** (0.01)	**1.51** (0.15)	**0.1**	1.41	1.77 (0.08)	1.84 (0.1)	0.8 (0.04)	8.69 (0.13)
	csuv.s.0	0.76 (0.01)	6.53 (0.25)	6.29	0.24	1.5 (0.04)	2.35 (0.07)	0.7 (0.02)	16.05 (0.27)
	csuv.m.5	0.91 (0.01)	1.59 (0.15)	0.08	1.51	1.82 (0.08)	1.89 (0.11)	0.82 (0.04)	8.57 (0.14)
	csuv.s.5	0.72 (0.01)	7.75 (0.23)	7.51	0.24	1.55 (0.04)	2.57 (0.07)	0.73 (0.02)	17.27 (0.26)
	csuv.m.0.all	0.92 (0.01)	1.48 (0.15)	0.14	1.34	1.75 (0.08)	1.81 (0.11)	0.79 (0.04)	8.8 (0.12)
	csuv.s.0.all	0.74 (0.01)	7.26 (0.27)	7.03	0.23	1.53 (0.04)	2.47 (0.07)	0.72 (0.02)	16.8 (0.29)
	csuv.m.0.mcp	0.78 (0.01)	3.37 (0.18)	0.01	3.36	2.86 (0.13)	3.21 (0.14)	1.31 (0.04)	6.65 (0.18)
	csuv.s.0.mcp	0.91 (0.01)	1.65 (0.14)	0.45	1.2	1.73 (0.09)	1.84 (0.11)	0.77 (0.04)	9.25 (0.14)
setting 5	lasso	0.39 (0.01)	16.4 (0.67)	16.19	0.21	1.28 (0.02)	3.51 (0.11)	1.04 (0.03)	20.98 (0.68)
	elastic net	0.33 (0.01)	21.14 (0.69)	20.99	0.15	1.31 (0.02)	4.21 (0.11)	1.15 (0.02)	25.84 (0.69)
rho = 0.9	relaxed lasso	0.49 (0.01)	10.58 (0.65)	10	0.58	1.31 (0.02)	3.31 (0.13)	1.07 (0.03)	14.42 (0.7)
s = 5	mcp	0.67 (0.02)	4.26 (0.31)	3.17	1.09	1.29 (0.03)	2.48 (0.17)	1.09 (0.06)	7.08 (0.24)
p = 100	scad	0.65 (0.02)	4.91 (0.28)	4.06	0.85	1.24 (0.03)	2.01 (0.14)	0.91 (0.06)	8.21 (0.22)
	vsd	0.76 (0.02)	2.1 (0.16)	0.5	1.6	1.38 (0.03)	1.93 (0.13)	1.01 (0.05)	3.9 (0.08)
	bic	0.69 (0.02)	4.15 (0.32)	3.26	0.89	1.26 (0.03)	2.22 (0.17)	0.96 (0.06)	7.37 (0.24)
	ebic	0.71 (0.02)	3.67 (0.27)	2.77	0.9	**1.24** (0.03)	2.07 (0.15)	0.94 (0.06)	6.87 (0.2)
	cv	0.47 (0.02)	13.01 (0.75)	12.64	**0.37**	1.27 (0.02)	3.14 (0.14)	1.01 (0.04)	17.27 (0.79)
	csuv.m.0	**0.77** (0.02)	**2.25** (0.17)	**0.97**	1.28	1.33 (0.03)	**1.9** (0.11)	**0.93** (0.05)	4.69 (0.11)
	csuv.s.0	0.68 (0.01)	4.21 (0.18)	3.5	0.71	1.26 (0.02)	2.31 (0.1)	0.95 (0.04)	7.79 (0.18)
	csuv.m.5	0.77 (0.02)	2.16 (0.16)	0.8	1.36	1.35 (0.03)	1.88 (0.11)	0.95 (0.04)	4.44 (0.11)
	csuv.s.5	0.66 (0.01)	4.45 (0.17)	3.77	0.68	1.26 (0.02)	2.37 (0.1)	0.95 (0.03)	8.09 (0.17)
	csuv.m.0.all	0.76 (0.02)	2.43 (0.17)	1.23	1.2	1.31 (0.03)	1.96 (0.11)	0.94 (0.04)	5.03 (0.14)
	csuv.s.0.all	0.65 (0.01)	4.94 (0.21)	4.28	0.66	1.26 (0.03)	2.48 (0.1)	0.97 (0.03)	8.62 (0.22)
	csuv.m.0.mcp	0.69 (0.02)	2.53 (0.14)	0.36	2.17	1.87 (0.07)	2.37 (0.12)	1.24 (0.05)	3.19 (0.09)
	csuv.s.0.mcp	0.72 (0.02)	2.88 (0.18)	1.55	1.33	1.34 (0.03)	2.24 (0.14)	1.03 (0.05)	5.22 (0.08)
setting 6	lasso	0.3 (0.01)	24.79 (1.08)	24.6	0.19	1.42 (0.03)	3.81 (0.15)	1.04 (0.03)	29.41 (1.09)
	elastic net	0.23 (0.01)	34.73 (1.22)	34.6	0.13	1.51 (0.03)	4.91 (0.14)	1.21 (0.02)	39.47 (1.21)
rho = 0.9	relaxed lasso	0.51 (0.02)	10.84 (0.88)	10.37	0.47	1.35 (0.03)	3.13 (0.15)	0.99 (0.03)	14.9 (0.9)
s = 5	mcp	0.59 (0.02)	5.52 (0.33)	4.24	1.28	1.33 (0.03)	2.66 (0.16)	1.16 (0.06)	7.96 (0.24)
p = 300	scad	0.57 (0.02)	7.54 (0.42)	6.94	0.6	1.21 (0.02)	1.78 (0.12)	0.79 (0.05)	11.34 (0.36)
	vsd	0.75 (0.02)	2.47 (0.2)	0.58	1.89	1.87 (0.1)	2.28 (0.16)	1.12 (0.07)	3.69 (0.19)
	bic	0.59 (0.02)	8.1 (1.1)	7.33	0.77	1.27 (0.03)	2.3 (0.19)	0.92 (0.05)	11.56 (1.12)
	ebic	0.63 (0.02)	5.69 (0.73)	4.65	1.04	1.29 (0.03)	2.32 (0.17)	1 (0.06)	8.61 (0.72)
	cv	0.44 (0.02)	16.75 (1.32)	16.32	0.43	1.33 (0.03)	2.89 (0.19)	0.93 (0.04)	20.89 (1.34)
	csuv.m.0	**0.79** (0.02)	**2.01** (0.16)	**0.91**	1.1	1.4 (0.04)	**1.81** (0.12)	0.92 (0.05)	4.81 (0.1)
	csuv.s.0	0.64 (0.01)	5.53 (0.24)	5.19	**0.34**	**1.24** (0.02)	2.31 (0.1)	**0.87** (0.03)	9.85 (0.21)
	csuv.m.5	0.8 (0.02)	1.87 (0.15)	0.76	1.11	1.43 (0.04)	1.75 (0.11)	0.9 (0.05)	4.65 (0.1)
	csuv.s.5	0.61 (0.01)	6.14 (0.19)	5.84	0.3	1.25 (0.02)	2.43 (0.09)	0.88 (0.03)	10.54 (0.16)
	csuv.m.0.all	0.8 (0.02)	2 (0.16)	1	1	1.38 (0.04)	1.74 (0.11)	0.87 (0.05)	5 (0.11)
	csuv.s.0.all	0.61 (0.01)	6.31 (0.27)	5.98	0.33	1.26 (0.03)	2.49 (0.11)	0.89 (0.03)	10.65 (0.25)
	csuv.m.0.mcp	0.68 (0.02)	2.56 (0.15)	0.39	2.17	2.11 (0.07)	2.46 (0.12)	1.25 (0.05)	3.22 (0.11)
	csuv.s.0.mcp	0.73 (0.01)	2.98 (0.17)	2.05	0.93	1.3 (0.03)	2.13 (0.13)	0.97 (0.05)	6.12 (0.07)

Table 3: Model 2: performance of CSUV and methods it compares with (continue). Variable selection performance in terms of F-measure (f), total error (FP+FN), false positives (FP) and false negatives (FN), prediction error in terms of mse (pred.err) and estimation error in terms of l1 and l2 distance (l1.diff and l2.diff) and are shown. The numbers are based on 100 simulations. The last 8 rows are the performance of CSUV with different parameters (e.g. csuv.m.0.mcp corresponds to CSUV with MCP as constituent method and r = 0). A bold number represents the best result among delete-n/2 cross validation, eBIC and CSUV using Lasso, MCP and SCAD while a underlined number represents the worst among them. Standard errors are shown inside the parentheses.

parameters	methods	f	FP+FN	FP	FN	pred.err	l1.diff	l2.diff	size
setting 7	lasso	0.47 (0.01)	22.4 (0.7)	21.74	0.66	1.49 (0.03)	6.3 (0.17)	1.49 (0.03)	31.08 (0.73)
	elastic net	0.42 (0.01)	27.11 (0.73)	26.68	0.43	1.54 (0.03)	7.11 (0.17)	1.57 (0.03)	36.25 (0.73)
rho = 0.9	relaxed lasso	0.54 (0.01)	17.19 (0.83)	16.23	0.96	1.53 (0.03)	6.31 (0.22)	1.55 (0.03)	25.27 (0.91)
s = 10	mcp	0.64 (0.01)	7.8 (0.32)	4.56	3.24	1.66 (0.05)	6.15 (0.23)	1.98 (0.06)	11.32 (0.27)
p = 100	scad	0.66 (0.01)	8.03 (0.35)	5.54	2.49	1.48 (0.04)	4.97 (0.21)	1.71 (0.06)	13.05 (0.3)
	vsd	0.7 (0.02)	5.13 (0.24)	1.36	3.77	1.86 (0.08)	5.3 (0.22)	1.89 (0.06)	7.59 (0.15)
	bic	0.67 (0.01)	7.44 (0.33)	4.84	2.6	1.55 (0.04)	5.35 (0.22)	1.78 (0.05)	12.24 (0.29)
	ebic	0.68 (0.01)	6.73 (0.29)	3.94	2.79	1.55 (0.04)	5.21 (0.21)	1.77 (0.06)	11.15 (0.23)
	cv	0.47 (0.01)	22.4 (0.7)	21.74	**0.66**	1.49 (0.03)	6.3 (0.17)	1.49 (0.03)	31.08 (0.73)
	csuv.m.0	**0.76** (0.01)	**4.57** (0.2)	**1.84**	2.73	1.66 (0.04)	**4.35** (0.14)	1.53 (0.04)	9.11 (0.15)
	csuv.s.0	0.67 (0.01)	8.65 (0.24)	7.19	1.46	**1.45** (0.03)	4.87 (0.13)	**1.44** (0.03)	15.73 (0.23)
	csuv.m.5	0.76 (0.01)	4.54 (0.19)	1.74	2.8	1.69 (0.04)	4.37 (0.14)	1.54 (0.04)	8.94 (0.15)
	csuv.s.5	0.66 (0.01)	9 (0.23)	7.54	1.46	1.45 (0.03)	4.96 (0.12)	1.45 (0.03)	16.08 (0.22)
	csuv.m.0.all	0.76 (0.01)	4.76 (0.22)	2.31	2.45	1.6 (0.04)	4.25 (0.15)	1.46 (0.04)	9.86 (0.16)
	csuv.s.0.all	0.64 (0.01)	9.97 (0.25)	8.62	1.35	1.45 (0.03)	5.14 (0.11)	1.46 (0.03)	17.27 (0.27)
	csuv.m.0.mcp	0.59 (0.01)	5.95 (0.18)	0.47	5.48	3.22 (0.11)	6.16 (0.18)	2.19 (0.05)	4.99 (0.12)
	csuv.s.0.mcp	0.72 (0.01)	5.48 (0.21)	2.39	3.09	1.74 (0.04)	5.04 (0.17)	1.74 (0.04)	9.3 (0.09)
setting 8	lasso	0.39 (0.01)	32.18 (1.08)	31.63	0.55	1.72 (0.04)	6.9 (0.19)	1.5 (0.03)	41.08 (1.06)
	elastic net	0.32 (0.01)	41.56 (0.99)	41.13	0.43	1.83 (0.04)	8.36 (0.16)	1.68 (0.03)	50.7 (0.97)
rho = 0.9	relaxed lasso	0.51 (0.01)	18.39 (0.75)	17.43	0.96	1.64 (0.04)	6.25 (0.18)	1.5 (0.03)	26.47 (0.79)
s = 10	mcp	0.53 (0.02)	11.72 (0.57)	7.88	3.84	2.09 (0.07)	7.45 (0.36)	2.2 (0.08)	14.04 (0.3)
p = 300	scad	0.54 (0.01)	14.05 (0.51)	11.82	2.23	1.71 (0.06)	5.27 (0.26)	1.7 (0.07)	19.59 (0.35)
	vsd	0.6 (0.02)	6.71 (0.33)	1.82	4.89	3.24 (0.23)	6.5 (0.31)	2.21 (0.09)	6.93 (0.25)
	bic	0.55 (0.02)	13.84 (1.12)	11.25	2.59	1.79 (0.06)	5.95 (0.31)	1.81 (0.07)	18.66 (1.15)
	ebic	0.57 (0.02)	10.93 (0.5)	7.81	3.12	1.86 (0.05)	6.22 (0.3)	1.94 (0.07)	14.69 (0.36)
	cv	0.39 (0.01)	32.18 (1.08)	31.63	**0.55**	1.72 (0.04)	6.9 (0.19)	**1.5** (0.03)	41.08 (1.06)
	csuv.m.0	**0.69** (0.01)	**5.8** (0.23)	**2.27**	3.53	2.37 (0.08)	**5.28** (0.19)	1.82 (0.05)	8.74 (0.16)
	csuv.s.0	0.55 (0.01)	14.1 (0.32)	12.73	1.37	**1.65** (0.04)	5.87 (0.16)	1.52 (0.03)	21.36 (0.34)
	csuv.m.5	0.69 (0.01)	5.68 (0.22)	1.96	3.72	2.57 (0.1)	5.25 (0.17)	1.83 (0.05)	8.24 (0.16)
	csuv.s.5	0.55 (0.01)	14.24 (0.33)	12.87	1.37	1.64 (0.04)	5.92 (0.16)	1.54 (0.04)	21.5 (0.34)
	csuv.m.0.all	0.69 (0.01)	5.99 (0.24)	2.68	3.31	2.26 (0.08)	5.17 (0.18)	1.76 (0.05)	9.37 (0.17)
	csuv.s.0.all	0.53 (0.01)	15.93 (0.35)	14.69	1.24	1.64 (0.04)	6.12 (0.16)	1.53 (0.03)	23.45 (0.36)
	csuv.m.0.mcp	0.38 (0.01)	7.95 (0.16)	0.32	7.63	7.18 (0.21)	7.43 (0.16)	2.53 (0.04)	2.69 (0.13)
	csuv.s.0.mcp	0.59 (0.01)	8.07 (0.26)	3.9	4.17	2.53 (0.08)	6.56 (0.21)	2.08 (0.05)	9.73 (0.11)

Table 4: Model 2: performance of CSUV and methods it compares with (continue). Variable selection performance in terms of F-measure (f), total error (FP+FN), false positives (FP) and false negatives (FN), prediction error in terms of mse (pred.err) and estimation error in terms of l1 and l2 distance (l1.diff and l2.diff) and are shown. The numbers are based on 100 simulations. The last 8 rows are the performance of CSUV with different parameters (e.g. csuv.m.0.mcp corresponds to CSUV with MCP as constituent method and r = 0). A bold number represents the best result among delete-n/2 cross validation, eBIC and CSUV using Lasso, MCP and SCAD while a underlined number represents the worst among them. Standard errors are shown inside the parentheses.

parameters	methods	f	FP+FN	FP	FN	pred.err	l1.diff	l2.diff	size
setting 1	lasso	0.38 (0.01)	17.85 (0.75)	17.84	0.01	1.31 (0.02)	2.35 (0.07)	0.68 (0.01)	22.83 (0.75)
	elastic net	0.32 (0.01)	23.17 (0.81)	23.17	0	1.38 (0.02)	2.91 (0.08)	0.77 (0.01)	28.17 (0.81)
block.cor = 0.5	relaxed lasso	0.62 (0.02)	7.16 (0.63)	6.79	0.37	1.3 (0.03)	1.76 (0.07)	0.63 (0.02)	11.42 (0.69)
s = 5	mcp	0.85 (0.01)	2.15 (0.26)	2.07	0.08	1.12 (0.03)	0.77 (0.07)	0.34 (0.02)	6.99 (0.26)
p = 100	scad	0.63 (0.01)	6.61 (0.37)	6.58	0.03	1.13 (0.03)	0.9 (0.06)	0.36 (0.02)	11.55 (0.38)
	vsd	0.92 (0.01)	0.7 (0.08)	0.05	0.65	1.21 (0.03)	0.87 (0.06)	0.5 (0.03)	4.4 (0.08)
	bic	0.81 (0.01)	2.79 (0.3)	2.73	0.06	1.13 (0.03)	0.82 (0.08)	0.35 (0.02)	7.67 (0.31)
	ebic	0.85 (0.01)	2.15 (0.26)	2.07	0.08	**1.12** (0.03)	**0.77** (0.07)	**0.34** (0.02)	6.99 (0.26)
	cv	0.69 (0.02)	5.62 (0.52)	5.56	**0.06**	1.13 (0.03)	0.9 (0.07)	0.36 (0.02)	10.5 (0.53)
	csuv.m.0	**0.92** (0.01)	**0.76** (0.08)	**0.23**	0.53	1.2 (0.03)	0.87 (0.06)	0.48 (0.03)	4.7 (0.09)
	csuv.s.0	0.85 (0.01)	1.72 (0.13)	1.42	0.3	1.21 (0.03)	1.06 (0.05)	0.51 (0.02)	6.12 (0.15)
	csuv.m.5	0.92 (0.01)	0.75 (0.08)	0.17	0.58	1.2 (0.03)	0.88 (0.05)	0.5 (0.03)	4.59 (0.08)
	csuv.s.5	0.81 (0.01)	2.35 (0.12)	2.08	0.27	1.22 (0.03)	1.17 (0.05)	0.53 (0.02)	6.81 (0.16)
	csuv.m.0.all	0.91 (0.01)	0.83 (0.09)	0.31	0.52	1.2 (0.03)	0.89 (0.06)	0.49 (0.03)	4.79 (0.1)
	csuv.s.0.all	0.83 (0.01)	1.98 (0.14)	1.7	0.28	1.21 (0.03)	1.1 (0.05)	0.51 (0.02)	6.42 (0.16)
	csuv.m.0.mcp	0.92 (0.01)	0.72 (0.08)	0.07	0.65	1.21 (0.03)	0.89 (0.05)	0.51 (0.03)	4.42 (0.07)
	csuv.s.0.mcp	0.9 (0.01)	0.99 (0.08)	0.5	0.49	1.2 (0.03)	0.92 (0.05)	0.5 (0.03)	5.01 (0.12)
setting 2	lasso	0.29 (0.01)	26.37 (1.1)	26.32	0.05	1.49 (0.03)	3.19 (0.1)	0.85 (0.02)	31.27 (1.1)
	elastic net	0.23 (0.01)	35.16 (1.2)	35.1	0.06	1.62 (0.03)	3.94 (0.11)	0.98 (0.02)	40.04 (1.2)
block.cor = 0.5	relaxed lasso	0.49 (0.01)	12.49 (0.9)	12.23	0.26	1.48 (0.03)	2.68 (0.12)	0.8 (0.03)	16.97 (0.94)
s = 5	mcp	0.79 (0.01)	2.99 (0.25)	2.9	0.09	1.15 (0.02)	0.93 (0.06)	0.41 (0.02)	7.81 (0.24)
p = 300	scad	0.54 (0.01)	9.86 (0.51)	9.83	0.03	1.15 (0.02)	1.13 (0.05)	0.41 (0.02)	14.8 (0.5)
	vsd	0.9 (0.01)	1.06 (0.14)	0.05	1.01	1.56 (0.09)	1.26 (0.12)	0.67 (0.06)	4.04 (0.14)
	bic	0.65 (0.02)	8.15 (1.17)	8.08	0.07	1.18 (0.03)	1.3 (0.12)	0.45 (0.02)	13.01 (1.18)
	ebic	0.79 (0.02)	3.75 (0.85)	3.66	0.09	**1.16** (0.02)	1.01 (0.1)	**0.42** (0.02)	8.57 (0.85)
	cv	0.5 (0.02)	14.67 (1.34)	14.61	**0.06**	1.28 (0.03)	1.85 (0.15)	0.57 (0.03)	19.55 (1.34)
	csuv.m.0	**0.92** (0.01)	**0.72** (0.1)	**0.18**	0.54	1.3 (0.05)	**0.96** (0.08)	0.52 (0.04)	4.64 (0.07)
	csuv.s.0	0.73 (0.01)	3.8 (0.21)	3.67	0.13	1.28 (0.03)	1.55 (0.07)	0.6 (0.02)	8.54 (0.2)
	csuv.m.5	0.92 (0.01)	0.71 (0.1)	0.16	0.55	1.3 (0.05)	0.97 (0.08)	0.53 (0.04)	4.61 (0.08)
	csuv.s.5	0.67 (0.01)	5.08 (0.17)	4.96	0.12	1.32 (0.02)	1.8 (0.06)	0.65 (0.02)	9.84 (0.18)
	csuv.m.0.all	0.92 (0.01)	0.72 (0.11)	0.18	0.54	1.29 (0.05)	0.96 (0.08)	0.52 (0.04)	4.64 (0.07)
	csuv.s.0.all	0.72 (0.01)	4.13 (0.23)	4.01	0.12	1.28 (0.02)	1.6 (0.07)	0.6 (0.02)	8.89 (0.22)
	csuv.m.0.mcp	0.9 (0.01)	0.84 (0.09)	0.04	0.8	1.4 (0.05)	1.09 (0.07)	0.62 (0.04)	4.24 (0.09)
	csuv.s.0.mcp	0.87 (0.01)	1.38 (0.1)	1.12	0.26	1.23 (0.04)	1.04 (0.07)	0.5 (0.03)	5.86 (0.08)
setting 3	lasso	0.48 (0.01)	22.55 (0.82)	22.53	0.02	1.52 (0.03)	3.77 (0.1)	0.88 (0.01)	32.51 (0.83)
	elastic net	0.44 (0.01)	26.43 (0.83)	26.41	0.02	1.58 (0.03)	4.22 (0.1)	0.94 (0.01)	36.39 (0.83)
block.cor = 0.5	relaxed lasso	0.66 (0.01)	11.12 (0.69)	10.68	0.44	1.49 (0.02)	3.17 (0.1)	0.87 (0.02)	20.24 (0.75)
s = 10	mcp	0.89 (0.01)	2.62 (0.21)	2.44	0.18	1.22 (0.02)	1.5 (0.07)	0.54 (0.02)	12.26 (0.23)
p = 100	scad	0.76 (0.01)	6.64 (0.3)	6.5	0.14	1.21 (0.02)	1.55 (0.06)	0.52 (0.02)	16.36 (0.3)
	vsd	0.94 (0.01)	1.17 (0.11)	0.15	1.02	1.39 (0.03)	1.77 (0.08)	0.73 (0.03)	9.13 (0.1)
	bic	0.87 (0.01)	3.28 (0.27)	3.12	0.16	1.22 (0.02)	1.52 (0.07)	0.54 (0.02)	12.96 (0.27)
	ebic	0.89 (0.01)	2.63 (0.21)	2.45	0.18	**1.22** (0.02)	**1.5** (0.07)	**0.54** (0.02)	12.27 (0.23)
	cv	0.5 (0.01)	21.91 (0.89)	21.86	**0.05**	1.52 (0.03)	3.72 (0.11)	0.88 (0.02)	31.81 (0.9)
	csuv.m.0	**0.93** (0.01)	**1.39** (0.11)	**0.54**	0.85	1.36 (0.03)	1.8 (0.07)	0.73 (0.03)	9.69 (0.11)
	csuv.s.0	0.82 (0.01)	4.47 (0.18)	4.11	0.36	1.36 (0.03)	2.25 (0.07)	0.73 (0.02)	13.75 (0.19)
	csuv.m.5	0.93 (0.01)	1.42 (0.12)	0.47	0.95	1.39 (0.03)	1.86 (0.07)	0.76 (0.03)	9.52 (0.1)
	csuv.s.5	0.8 (0.01)	4.86 (0.15)	4.54	0.32	1.37 (0.03)	2.29 (0.07)	0.73 (0.02)	14.22 (0.16)
	csuv.m.0.all	0.93 (0.01)	1.46 (0.12)	0.66	0.8	1.35 (0.03)	1.81 (0.07)	0.73 (0.03)	9.86 (0.11)
	csuv.s.0.all	0.8 (0.01)	5.02 (0.19)	4.69	0.33	1.37 (0.03)	2.32 (0.07)	0.74 (0.02)	14.36 (0.2)
	csuv.m.0.mcp	0.89 (0.01)	1.87 (0.12)	0.05	1.82	1.63 (0.04)	2.34 (0.09)	0.97 (0.03)	8.23 (0.11)
	csuv.s.0.mcp	0.93 (0.01)	1.43 (0.1)	0.59	0.84	1.35 (0.03)	1.8 (0.07)	0.73 (0.03)	9.75 (0.1)

Table 5: Model 3: performance of CSUV and methods it compares with. Variable selection performance in terms of F-measure (f), total error (FP+FN), false positives (FP) and false negatives (FN), prediction error in terms of mse (pred.err) and estimation error in terms of l1 and l2 distance (l1.diff and l2.diff) and are shown. The numbers are based on 100 simulations. The last 8 rows are the performance of CSUV with different parameters (e.g. csuv.m.0.mcp corresponds to CSUV with MCP as constituent method and r = 0). A bold number represents the best result among delete-n/2 cross validation, eBIC and CSUV using Lasso, MCP and SCAD while a underlined number represents the worst among them. Standard errors are shown inside the parentheses.

parameters	methods	f	FP+FN	FP	FN	pred.err	l1.diff	l2.diff	size
setting 4	lasso	0.37 (0.01)	35.15 (1.15)	35.03	0.12	1.77 (0.04)	5.29 (0.13)	1.11 (0.02)	44.91 (1.15)
	elastic net	0.31 (0.01)	45.8 (1.39)	45.65	0.15	1.97 (0.05)	6.59 (0.17)	1.27 (0.02)	55.5 (1.39)
block.cor = 0.5	relaxed lasso	0.51 (0.01)	20.03 (0.83)	19.75	0.28	1.73 (0.04)	4.62 (0.15)	1.04 (0.03)	29.47 (0.86)
s = 10	mcp	0.84 (0.01)	3.71 (0.27)	3.31	0.4	1.39 (0.06)	1.96 (0.14)	0.67 (0.04)	12.91 (0.21)
p = 300	scad	0.68 (0.01)	9.88 (0.44)	9.75	0.13	1.3 (0.04)	1.96 (0.11)	0.62 (0.03)	19.62 (0.41)
	vsd	0.91 (0.01)	1.83 (0.2)	0.21	1.62	1.88 (0.17)	2.31 (0.16)	0.92 (0.06)	8.59 (0.18)
	bic	0.73 (0.02)	10.55 (1.62)	10.37	0.18	1.37 (0.04)	2.35 (0.19)	0.68 (0.04)	20.19 (1.62)
	ebic	**0.85** (0.01)	4.28 (0.81)	3.97	0.31	**1.33** (0.04)	**1.9** (0.13)	**0.64** (0.03)	13.66 (0.81)
	cv	0.37 (0.01)	35.15 (1.15)	35.03	**0.12**	1.77 (0.04)	5.29 (0.13)	1.11 (0.02)	44.91 (1.15)
	csuv.m.0	**0.85** (0.01)	**2.77** (0.17)	**0.88**	1.89	1.92 (0.07)	2.73 (0.12)	1.08 (0.04)	8.99 (0.13)
	csuv.s.0	0.61 (0.01)	12.58 (0.35)	12.06	0.52	1.64 (0.04)	3.82 (0.11)	1 (0.02)	21.54 (0.37)
	csuv.m.5	0.85 (0.01)	2.78 (0.17)	0.73	2.05	2.01 (0.08)	2.79 (0.13)	1.11 (0.04)	8.68 (0.13)
	csuv.s.5	0.6 (0.01)	13 (0.35)	12.45	0.55	1.66 (0.04)	3.89 (0.12)	1 (0.03)	21.9 (0.37)
	csuv.m.0.all	0.85 (0.01)	2.85 (0.18)	1.12	1.73	1.87 (0.07)	2.65 (0.12)	1.04 (0.04)	9.39 (0.14)
	csuv.s.0.all	0.58 (0.01)	14.46 (0.41)	13.95	0.51	1.68 (0.04)	4.11 (0.12)	1.02 (0.03)	23.44 (0.44)
	csuv.m.0.mcp	0.6 (0.02)	5.53 (0.16)	0.04	5.49	4.62 (0.2)	5.23 (0.13)	1.9 (0.04)	4.55 (0.16)
	csuv.s.0.mcp	0.82 (0.01)	3.47 (0.21)	1.37	2.1	2.07 (0.08)	3.14 (0.15)	1.18 (0.04)	9.27 (0.07)
setting 5	lasso	0.38 (0.01)	14.34 (0.77)	13.22	1.12	1.27 (0.02)	4.03 (0.14)	1.28 (0.02)	17.1 (0.85)
	elastic net	0.31 (0.01)	19.43 (0.84)	18.45	0.98	1.3 (0.02)	4.77 (0.15)	1.38 (0.02)	22.47 (0.91)
block.cor = 0.9	relaxed lasso	0.48 (0.01)	8.15 (0.5)	6.46	1.69	1.26 (0.02)	3.42 (0.11)	1.26 (0.03)	9.77 (0.6)
s = 5	mcp	0.58 (0.02)	4.88 (0.22)	3.03	1.85	1.28 (0.02)	2.99 (0.15)	1.34 (0.05)	6.18 (0.26)
p = 100	scad	0.6 (0.02)	4.7 (0.27)	3.04	1.66	1.25 (0.02)	2.7 (0.15)	1.26 (0.05)	6.38 (0.32)
	vsd	0.65 (0.02)	2.86 (0.14)	0.46	2.4	1.25 (0.03)	2.41 (0.13)	1.25 (0.04)	3.06 (0.03)
	bic	0.61 (0.02)	4.35 (0.21)	2.7	1.65	1.26 (0.03)	2.74 (0.15)	1.26 (0.05)	6.05 (0.29)
	ebic	0.62 (0.02)	4.13 (0.2)	2.39	1.74	1.26 (0.03)	2.66 (0.14)	1.24 (0.05)	5.65 (0.28)
	cv	0.47 (0.02)	10.44 (0.76)	9.07	**1.37**	1.26 (0.02)	3.53 (0.16)	1.28 (0.03)	12.7 (0.86)
	csuv.m.0	**0.66** (0.01)	**2.99** (0.12)	**0.85**	2.14	1.25 (0.03)	**2.41** (0.09)	**1.19** (0.03)	3.71 (0.09)
	csuv.s.0	0.58 (0.01)	4.72 (0.16)	2.89	1.83	**1.22** (0.02)	2.95 (0.09)	1.22 (0.03)	6.06 (0.14)
	csuv.m.5	0.66 (0.01)	2.93 (0.12)	0.74	2.19	1.25 (0.03)	2.37 (0.09)	1.19 (0.03)	3.55 (0.09)
	csuv.s.5	0.57 (0.01)	4.88 (0.14)	3.03	1.85	1.23 (0.02)	2.98 (0.09)	1.23 (0.03)	6.18 (0.13)
	csuv.m.0.all	0.63 (0.01)	3.42 (0.16)	1.28	2.14	1.25 (0.03)	2.6 (0.1)	1.22 (0.03)	4.14 (0.11)
	csuv.s.0.all	0.53 (0.01)	5.71 (0.17)	3.91	1.8	1.23 (0.02)	3.16 (0.09)	1.25 (0.03)	7.11 (0.16)
	csuv.m.0.mcp	0.53 (0.02)	3.51 (0.12)	0.18	3.33	2.42 (0.1)	3.1 (0.11)	1.56 (0.04)	1.85 (0.09)
	csuv.s.0.mcp	0.61 (0.02)	3.45 (0.18)	0.99	2.46	1.39 (0.04)	2.91 (0.15)	1.39 (0.05)	3.53 (0.08)
setting 6	lasso	0.28 (0.01)	21.2 (1.05)	19.8	1.4	1.4 (0.02)	5.37 (0.15)	1.6 (0.02)	23.4 (1.1)
	elastic net	0.21 (0.01)	30.54 (1.35)	29.32	1.22	1.41 (0.02)	6.18 (0.2)	1.66 (0.02)	33.1 (1.41)
block.cor = 0.9	relaxed lasso	0.34 (0.01)	14.1 (0.77)	12.28	1.82	1.41 (0.03)	5.18 (0.17)	1.65 (0.03)	15.46 (0.83)
s = 5	mcp	0.42 (0.02)	7.21 (0.26)	4.52	2.69	1.45 (0.03)	4.8 (0.16)	1.85 (0.04)	6.83 (0.25)
p = 300	scad	0.4 (0.02)	8.83 (0.35)	6.53	2.3	1.42 (0.03)	4.42 (0.19)	1.74 (0.05)	9.23 (0.32)
	vsd	0.45 (0.02)	4.8 (0.14)	1.14	3.66	2 (0.06)	4.4 (0.11)	1.94 (0.03)	2.48 (0.12)
	bic	0.42 (0.02)	9.21 (0.91)	6.9	2.31	1.44 (0.03)	4.76 (0.21)	1.77 (0.05)	9.59 (0.95)
	ebic	0.44 (0.02)	6.91 (0.27)	4.39	2.52	1.43 (0.03)	4.59 (0.17)	1.79 (0.05)	6.87 (0.26)
	cv	0.29 (0.01)	20.18 (1.01)	18.7	**1.48**	1.39 (0.02)	5.31 (0.15)	**1.62** (0.02)	22.22 (1.06)
	csuv.m.0	**0.51** (0.02)	**3.97** (0.12)	**0.81**	3.16	2.06 (0.06)	**3.78** (0.1)	1.72 (0.03)	2.65 (0.12)
	csuv.s.0	0.44 (0.01)	7.26 (0.19)	5.08	2.18	**1.38** (0.03)	4.45 (0.11)	1.65 (0.03)	7.9 (0.13)
	csuv.m.5	0.51 (0.02)	3.86 (0.12)	0.65	3.21	2.1 (0.06)	3.71 (0.1)	1.71 (0.03)	2.44 (0.11)
	csuv.s.5	0.44 (0.01)	7.46 (0.19)	5.32	2.14	1.38 (0.03)	4.45 (0.1)	1.64 (0.03)	8.18 (0.13)
	csuv.m.0.all	0.51 (0.02)	4.02 (0.13)	1.02	3	1.94 (0.06)	3.8 (0.1)	1.7 (0.03)	3.02 (0.13)
	csuv.s.0.all	0.42 (0.01)	8.34 (0.2)	6.34	2	1.37 (0.03)	4.51 (0.1)	1.62 (0.03)	9.34 (0.17)
	csuv.m.0.mcp	0.42 (0.01)	4.26 (0.09)	0.14	4.12	2.89 (0.06)	3.93 (0.07)	1.84 (0.02)	1.02 (0.09)
	csuv.s.0.mcp	0.47 (0.02)	5.21 (0.17)	2.35	2.86	1.65 (0.05)	4.39 (0.11)	1.78 (0.03)	4.49 (0.08)

Table 6: Model 3: performance of CSUV and methods it compares with (continue). Variable selection performance in terms of F-measure (f), total error (FP+FN), false positives (FP) and false negatives (FN), prediction error in terms of mse (pred.err) and estimation error in terms of l1 and l2 distance (l1.diff and l2.diff) and are shown. The numbers are based on 100 simulations. The last 8 rows are the performance of CSUV with different parameters (e.g. csuv.m.0.mcp corresponds to CSUV with MCP as constituent method and r = 0). A bold number represents the best result among delete-n/2 cross validation, eBIC and CSUV using Lasso, MCP and SCAD while a underlined number represents the worst among them. Standard errors are shown inside the parentheses.

parameters	methods	f	FP+FN	FP	FN	pred.err	l1.diff	l2.diff	size
setting 7	lasso	0.5 (0.01)	18.54 (0.66)	17.19	1.35	1.42 (0.02)	6.55 (0.16)	1.65 (0.03)	25.84 (0.69)
	elastic net	0.44 (0.01)	22.85 (0.63)	21.67	1.18	1.43 (0.02)	7.18 (0.15)	1.7 (0.02)	30.49 (0.67)
block.cor = 0.9	relaxed lasso	0.56 (0.01)	13.74 (0.64)	11.91	1.83	1.42 (0.03)	6.37 (0.18)	1.68 (0.03)	20.08 (0.72)
s = 10	mcp	0.53 (0.01)	8.51 (0.29)	3.35	5.16	1.73 (0.04)	7.19 (0.25)	2.34 (0.06)	8.19 (0.13)
p = 100	scad	0.59 (0.01)	7.76 (0.28)	3.23	4.53	1.61 (0.04)	6.23 (0.21)	2.17 (0.06)	8.7 (0.16)
	vsd	0.6 (0.01)	6.52 (0.23)	1.53	4.99	1.8 (0.06)	6.56 (0.22)	2.3 (0.06)	6.54 (0.1)
	bic	0.6 (0.01)	7.5 (0.28)	3.04	4.46	1.59 (0.04)	6.11 (0.21)	2.11 (0.06)	8.58 (0.21)
	ebic	0.6 (0.01)	7.27 (0.27)	2.77	4.5	1.6 (0.04)	6.12 (0.22)	2.12 (0.06)	8.27 (0.14)
	cv	0.5 (0.01)	18.54 (0.66)	17.19	**1.35**	1.42 (0.02)	6.55 (0.16)	**1.65** (0.03)	25.84 (0.69)
	csuv.m.0	**0.69** (0.01)	**5.88** (0.23)	**2.47**	3.41	1.66 (0.05)	**5.24** (0.16)	1.77 (0.04)	9.06 (0.18)
	csuv.s.0	0.62 (0.01)	9.49 (0.27)	7.22	2.27	**1.38** (0.02)	5.69 (0.14)	**1.65** (0.03)	14.95 (0.22)
	csuv.m.5	0.68 (0.01)	5.92 (0.23)	2.38	3.54	1.71 (0.06)	5.34 (0.16)	1.8 (0.04)	8.84 (0.18)
	csuv.s.5	0.62 (0.01)	9.76 (0.26)	7.54	2.22	1.38 (0.02)	5.67 (0.13)	1.64 (0.03)	15.32 (0.21)
	csuv.m.0.all	0.7 (0.01)	5.99 (0.25)	2.86	3.13	1.58 (0.04)	5.21 (0.17)	1.73 (0.04)	9.73 (0.18)
	csuv.s.0.all	0.6 (0.01)	10.58 (0.28)	8.54	2.04	1.38 (0.02)	5.79 (0.13)	1.64 (0.03)	16.5 (0.25)
	csuv.m.0.mcp	0.4 (0.01)	7.64 (0.13)	0.31	7.33	5.38 (0.28)	7.79 (0.14)	2.71 (0.04)	2.98 (0.12)
	csuv.s.0.mcp	0.6 (0.01)	7.01 (0.21)	2.25	4.76	1.98 (0.06)	6.57 (0.19)	2.22 (0.05)	7.49 (0.08)
setting 8	lasso	0.33 (0.01)	34.07 (0.92)	32.27	1.8	1.59 (0.03)	10.03 (0.23)	2.1 (0.03)	40.47 (0.9)
	elastic net	0.29 (0.01)	42.66 (0.87)	41.11	1.55	1.62 (0.03)	10.86 (0.21)	2.15 (0.03)	49.56 (0.84)
block.cor = 0.9	relaxed lasso	0.35 (0.01)	28.37 (0.78)	25.88	2.49	1.63 (0.03)	10.14 (0.22)	2.19 (0.04)	33.39 (0.88)
s = 10	mcp	0.38 (0.02)	12.94 (0.35)	6.81	6.13	2.2 (0.06)	11.21 (0.31)	3.09 (0.06)	10.68 (0.18)
p = 300	scad	0.43 (0.02)	12.2 (0.39)	6.8	5.4	2.01 (0.05)	9.94 (0.32)	2.89 (0.07)	11.4 (0.21)
	vsd	0.44 (0.02)	10 (0.31)	3.78	6.22	2.73 (0.17)	9.8 (0.29)	2.97 (0.06)	7.56 (0.14)
	bic	0.42 (0.02)	14 (1)	8.7	5.3	2.05 (0.05)	10.53 (0.34)	2.92 (0.07)	13.4 (1.09)
	ebic	0.44 (0.02)	11.7 (0.35)	6.29	5.41	2.03 (0.05)	10.05 (0.31)	2.9 (0.06)	10.88 (0.18)
	cv	0.33 (0.01)	34.07 (0.92)	32.27	**1.8**	**1.59** (0.03)	10.03 (0.23)	**2.1** (0.03)	40.47 (0.9)
	csuv.m.0	**0.52** (0.01)	**7.84** (0.22)	**2.15**	5.69	3.96 (0.16)	**7.74** (0.21)	2.52 (0.05)	6.46 (0.16)
	csuv.s.0	0.42 (0.01)	20.14 (0.32)	17.25	2.89	1.65 (0.03)	9.4 (0.2)	2.21 (0.04)	24.36 (0.25)
	csuv.m.5	0.52 (0.01)	7.69 (0.21)	1.87	5.82	4.29 (0.16)	7.61 (0.2)	2.5 (0.05)	6.05 (0.15)
	csuv.s.5	0.41 (0.01)	20.32 (0.32)	17.36	2.96	1.67 (0.03)	9.45 (0.2)	2.21 (0.04)	24.4 (0.23)
	csuv.m.0.all	0.53 (0.01)	7.91 (0.21)	2.46	5.45	3.55 (0.15)	7.77 (0.19)	2.53 (0.05)	7.01 (0.16)
	csuv.s.0.all	0.41 (0.01)	21.06 (0.34)	18.27	2.79	1.65 (0.03)	9.47 (0.2)	2.19 (0.04)	25.48 (0.26)
	csuv.m.0.mcp	0.23 (0.01)	9.67 (0.09)	0.22	9.45	10.76 (0.22)	8.96 (0.1)	2.97 (0.03)	0.77 (0.09)
	csuv.s.0.mcp	0.36 (0.02)	11.97 (0.28)	5.33	6.64	3.41 (0.12)	10.68 (0.25)	3.08 (0.05)	8.69 (0.05)

Table 7: Model 3: performance of CSUV and methods it compares with (continue). Variable selection performance in terms of F-measure (f), total error (FP+FN), false positives (FP) and false negatives (FN), prediction error in terms of mse (pred.err) and estimation error in terms of l1 and l2 distance (l1.diff and l2.diff) and are shown. The numbers are based on 100 simulations. The last 8 rows are the performance of CSUV with different parameters (e.g. csuv.m.0.mcp corresponds to CSUV with MCP as constituent method and r = 0). A bold number represents the best result among delete-n/2 cross validation, eBIC and CSUV using Lasso, MCP and SCAD while a underlined number represents the worst among them. Standard errors are shown inside the parentheses.

parameters	methods	f	FP+FN	FP	FN	pred.err	l1.diff	l2.diff	size
setting 1	lasso	0.37 (0.01)	18.19 (0.89)	17.98	0.21	1.85 (0.09)	3.02 (0.13)	0.9 (0.03)	22.77 (0.89)
	elastic net	0.32 (0.01)	23.2 (0.97)	23.01	0.19	1.98 (0.08)	3.57 (0.13)	0.98 (0.03)	27.82 (0.98)
num.factor = 2	relaxed lasso	0.5 (0.02)	11.16 (0.77)	10.68	0.48	1.89 (0.08)	2.77 (0.12)	0.91 (0.03)	15.2 (0.81)
s = 5	mcp	0.75 (0.02)	3.26 (0.28)	2.57	0.69	1.71 (0.09)	1.67 (0.11)	0.76 (0.04)	6.88 (0.26)
p = 100	scad	0.65 (0.02)	5.65 (0.37)	5.17	0.48	1.67 (0.09)	1.62 (0.1)	0.73 (0.04)	9.69 (0.37)
	vsd	0.82 (0.02)	1.71 (0.15)	0.19	1.52	2.22 (0.15)	1.9 (0.13)	0.98 (0.06)	3.67 (0.13)
	bic	0.72 (0.02)	4.01 (0.32)	3.41	0.6	1.69 (0.1)	1.67 (0.11)	0.74 (0.04)	7.81 (0.31)
	ebic	0.75 (0.02)	3.18 (0.28)	2.52	0.66	**1.7** (0.1)	**1.62** (0.11)	**0.74** (0.04)	6.86 (0.27)
	cv	0.47 (0.02)	14.49 (1.1)	14.18	**0.31**	1.8 (0.09)	2.66 (0.15)	0.85 (0.03)	18.87 (1.12)
	csuv.m.0	**0.81** (0.02)	**1.81** (0.15)	**0.82**	0.99	1.95 (0.13)	1.73 (0.11)	0.85 (0.05)	4.83 (0.13)
	csuv.s.0	0.69 (0.01)	4.03 (0.23)	3.34	0.69	1.84 (0.09)	2.05 (0.1)	0.85 (0.04)	7.65 (0.23)
	csuv.m.5	0.82 (0.02)	1.7 (0.14)	0.67	1.03	1.95 (0.13)	1.71 (0.11)	0.85 (0.05)	4.64 (0.12)
	csuv.s.5	0.67 (0.01)	4.43 (0.21)	3.73	0.7	1.84 (0.09)	2.12 (0.1)	0.86 (0.04)	8.03 (0.21)
	csuv.m.0.all	0.81 (0.02)	1.93 (0.18)	0.98	0.95	1.87 (0.11)	1.71 (0.11)	0.83 (0.05)	5.03 (0.15)
	csuv.s.0.all	0.66 (0.01)	4.67 (0.24)	4	0.67	1.84 (0.09)	2.14 (0.1)	0.86 (0.04)	8.33 (0.26)
	csuv.m.0.mcp	0.78 (0.02)	1.73 (0.13)	0.15	1.58	2.32 (0.14)	2.03 (0.11)	1.04 (0.05)	3.57 (0.1)
	csuv.s.0.mcp	0.78 (0.02)	2.19 (0.17)	1.08	1.11	2.03 (0.11)	1.91 (0.11)	0.92 (0.05)	4.97 (0.1)
setting 2	lasso	0.3 (0.01)	26.02 (1.59)	25.54	0.48	2.19 (0.08)	3.84 (0.15)	1.09 (0.03)	30.06 (1.64)
	elastic net	0.24 (0.01)	32.73 (1.45)	32.32	0.41	2.41 (0.09)	4.46 (0.14)	1.19 (0.03)	36.91 (1.49)
num.factor = 2	relaxed lasso	0.43 (0.01)	14.49 (1.11)	13.72	0.77	2.17 (0.09)	3.44 (0.13)	1.07 (0.03)	17.95 (1.18)
s = 5	mcp	0.68 (0.02)	4.14 (0.28)	3.19	0.95	2.02 (0.12)	1.94 (0.13)	0.89 (0.05)	7.24 (0.26)
p = 300	scad	0.53 (0.01)	8.71 (0.45)	8.12	0.59	1.83 (0.1)	1.87 (0.11)	0.8 (0.04)	12.53 (0.45)
	vsd	0.68 (0.02)	2.52 (0.15)	0.19	2.33	3.16 (0.22)	2.61 (0.14)	1.32 (0.06)	2.86 (0.13)
	bic	0.57 (0.02)	10.8 (1.67)	10.12	0.68	1.91 (0.11)	2.35 (0.2)	0.86 (0.05)	14.44 (1.7)
	ebic	0.66 (0.02)	5.83 (1.15)	4.94	0.89	**2.03** (0.13)	**2.08** (0.16)	**0.88** (0.05)	9.05 (1.17)
	cv	0.4 (0.02)	20.34 (1.67)	19.83	**0.51**	2.12 (0.09)	3.26 (0.17)	1.01 (0.04)	24.32 (1.7)
	csuv.m.0	**0.75** (0.02)	**2.09** (0.13)	**0.52**	1.57	2.28 (0.12)	2.11 (0.1)	1.07 (0.05)	3.95 (0.14)
	csuv.s.0	0.62 (0.01)	5.37 (0.27)	4.44	0.93	2.05 (0.09)	2.49 (0.1)	0.99 (0.04)	8.51 (0.32)
	csuv.m.5	0.74 (0.02)	2.13 (0.14)	0.44	1.69	2.42 (0.13)	2.18 (0.11)	1.11 (0.05)	3.75 (0.13)
	csuv.s.5	0.58 (0.01)	6.04 (0.25)	5.06	0.98	2.11 (0.09)	2.63 (0.09)	1.02 (0.04)	9.08 (0.31)
	csuv.m.0.all	0.75 (0.02)	2.15 (0.13)	0.64	1.51	2.22 (0.11)	2.1 (0.1)	1.05 (0.05)	4.13 (0.15)
	csuv.s.0.all	0.59 (0.01)	6.2 (0.32)	5.31	0.89	2.07 (0.09)	2.58 (0.1)	1 (0.04)	9.42 (0.37)
	csuv.m.0.mcp	0.66 (0.02)	2.47 (0.12)	0.04	2.43	2.92 (0.15)	2.61 (0.1)	1.33 (0.04)	2.61 (0.12)
	csuv.s.0.mcp	0.71 (0.02)	2.63 (0.15)	1.03	1.6	2.57 (0.15)	2.41 (0.12)	1.17 (0.05)	4.43 (0.13)
setting 3	lasso	0.45 (0.01)	25.15 (0.93)	24.76	0.39	2.6 (0.11)	5.16 (0.15)	1.23 (0.03)	34.37 (0.95)
	elastic net	0.41 (0.01)	29.57 (0.97)	29.24	0.33	2.73 (0.11)	5.84 (0.15)	1.3 (0.02)	38.91 (0.99)
num.factor = 2	relaxed lasso	0.56 (0.01)	16.19 (0.9)	15.26	0.93	2.74 (0.12)	4.82 (0.14)	1.25 (0.03)	24.33 (1)
s = 10	mcp	0.79 (0.01)	4.32 (0.24)	2.68	1.64	2.62 (0.16)	3.08 (0.16)	1.14 (0.05)	11.04 (0.22)
p = 100	scad	0.74 (0.01)	6.33 (0.27)	5.11	1.22	2.49 (0.14)	3.02 (0.13)	1.11 (0.05)	13.89 (0.29)
	vsd	0.71 (0.02)	4.26 (0.24)	0.19	4.07	4.24 (0.29)	4.36 (0.19)	1.67 (0.06)	6.12 (0.24)
	bic	0.79 (0.01)	4.77 (0.26)	3.47	1.3	2.47 (0.14)	2.96 (0.15)	1.09 (0.05)	12.17 (0.25)
	ebic	**0.8** (0.01)	4.32 (0.23)	2.85	1.47	**2.56** (0.14)	**2.98** (0.15)	**1.11** (0.05)	11.38 (0.25)
	cv	0.47 (0.01)	24 (1.03)	23.48	**0.52**	2.67 (0.11)	5.1 (0.15)	1.24 (0.03)	32.96 (1.09)
	csuv.m.0	0.79 (0.01)	**3.71** (0.16)	**1.05**	2.66	3.29 (0.17)	3.66 (0.14)	1.4 (0.04)	8.39 (0.2)
	csuv.s.0	0.71 (0.01)	7.01 (0.29)	5.28	1.73	2.82 (0.14)	3.85 (0.12)	1.27 (0.04)	13.55 (0.34)
	csuv.m.5	0.79 (0.01)	3.73 (0.17)	0.94	2.79	3.39 (0.18)	3.71 (0.14)	1.42 (0.05)	8.15 (0.19)
	csuv.s.5	0.7 (0.01)	7.14 (0.27)	5.45	1.69	2.87 (0.14)	3.86 (0.12)	1.26 (0.04)	13.76 (0.32)
	csuv.m.0.all	0.8 (0.01)	3.74 (0.17)	1.25	2.49	3.19 (0.18)	3.58 (0.13)	1.37 (0.04)	8.76 (0.21)
	csuv.s.0.all	0.69 (0.01)	7.88 (0.33)	6.3	1.58	2.84 (0.14)	3.96 (0.13)	1.26 (0.04)	14.72 (0.37)
	csuv.m.0.mcp	0.67 (0.01)	4.84 (0.15)	0.11	4.73	5.18 (0.32)	5.18 (0.16)	1.95 (0.05)	5.38 (0.16)
	csuv.s.0.mcp	0.75 (0.01)	4.26 (0.19)	0.93	3.33	4.23 (0.29)	4.28 (0.17)	1.61 (0.05)	7.6 (0.17)

Table 8: Model 4: performance of CSUV and methods it compares with. Variable selection performance in terms of F-measure (f), total error (FP+FN), false positives (FP) and false negatives (FN), prediction error in terms of mse (pred.err) and estimation error in terms of l1 and l2 distance (l1.diff and l2.diff) and are shown. The numbers are based on 100 simulations. The last 8 rows are the performance of CSUV with different parameters (e.g. csuv.m.0.mcp corresponds to CSUV with MCP as constituent method and r = 0). A bold number represents the best result among delete-n/2 cross validation, eBIC and CSUV using Lasso, MCP and SCAD while a underlined number represents the worst among them. Standard errors are shown inside the parentheses.

parameters	methods	f	FP+FN	FP	FN	pred.err	l1.diff	l2.diff	size
setting 4	lasso	0.32 (0.01)	40.26 (1.61)	39.05	1.21	3.71 (0.18)	7.52 (0.2)	1.64 (0.03)	47.84 (1.67)
	elastic net	0.28 (0.01)	47.74 (1.62)	46.54	1.2	4.11 (0.19)	8.45 (0.19)	1.74 (0.03)	55.34 (1.68)
num.factor = 2	relaxed lasso	0.43 (0.01)	23.75 (1.41)	21.6	2.15	3.87 (0.22)	6.88 (0.21)	1.67 (0.04)	29.45 (1.59)
s = 10	mcp	0.67 (0.01)	7.02 (0.35)	4.06	2.96	4 (0.26)	4.64 (0.2)	1.63 (0.06)	11.1 (0.36)
p = 300	scad	0.58 (0.01)	11.98 (0.47)	9.91	2.07	3.48 (0.22)	4.36 (0.18)	1.49 (0.06)	17.84 (0.49)
	vsd	0.5 (0.02)	7.11 (0.24)	0.26	6.85	6.99 (0.38)	6.89 (0.23)	2.41 (0.07)	3.41 (0.23)
	bic	0.54 (0.02)	22.46 (2.35)	20.64	1.82	3.43 (0.2)	5.61 (0.3)	1.52 (0.05)	28.82 (2.45)
	ebic	**0.66** (0.02)	9.52 (1.27)	7	2.52	**3.63** (0.22)	**4.53** (0.21)	**1.53** (0.05)	14.48 (1.35)
	cv	0.36 (0.01)	36.39 (1.7)	35.02	**1.37**	3.64 (0.17)	7.12 (0.21)	1.63 (0.03)	43.65 (1.81)
	csuv.m.0	0.61 (0.02)	**5.79** (0.17)	**0.63**	5.16	5.54 (0.31)	5.6 (0.16)	2.03 (0.05)	5.47 (0.21)
	csuv.s.0	0.56 (0.01)	10.06 (0.34)	6.51	3.55	4.4 (0.22)	5.77 (0.17)	1.79 (0.05)	12.96 (0.47)
	csuv.m.5	0.6 (0.02)	5.89 (0.17)	0.55	5.34	5.65 (0.31)	5.74 (0.16)	2.07 (0.05)	5.21 (0.2)
	csuv.s.5	0.55 (0.01)	10.51 (0.33)	6.95	3.56	4.49 (0.23)	5.91 (0.16)	1.81 (0.05)	13.39 (0.46)
	csuv.m.0.all	0.62 (0.01)	5.86 (0.18)	0.85	5.01	5.38 (0.3)	5.6 (0.16)	2.02 (0.05)	5.84 (0.22)
	csuv.s.0.all	0.55 (0.01)	11.23 (0.39)	7.89	3.34	4.32 (0.21)	5.88 (0.16)	1.77 (0.05)	14.55 (0.51)
	csuv.m.0.mcp	0.46 (0.02)	6.98 (0.16)	0.05	6.93	7.18 (0.43)	6.98 (0.17)	2.46 (0.05)	3.12 (0.16)
	csuv.s.0.mcp	0.58 (0.02)	6.33 (0.2)	0.9	5.43	5.84 (0.34)	6.06 (0.18)	2.16 (0.05)	5.47 (0.18)
setting 5	lasso	0.39 (0.01)	15.08 (0.68)	14.51	0.57	2.5 (0.09)	4 (0.16)	1.22 (0.03)	18.94 (0.71)
	elastic net	0.33 (0.01)	20.63 (0.96)	20.2	0.43	2.76 (0.1)	4.84 (0.21)	1.32 (0.03)	24.77 (0.97)
num.factor = 10	relaxed lasso	0.42 (0.01)	12.22 (0.73)	11.21	1.01	2.83 (0.13)	4.3 (0.21)	1.32 (0.04)	15.2 (0.8)
s = 5	mcp	0.55 (0.02)	5.41 (0.29)	3.58	1.83	3.36 (0.21)	3.69 (0.2)	1.43 (0.07)	6.75 (0.21)
p = 100	scad	0.51 (0.02)	6.87 (0.33)	5.25	1.62	3.59 (0.25)	3.64 (0.2)	1.42 (0.07)	8.63 (0.27)
	vsd	0.57 (0.03)	3.84 (0.22)	1.02	2.82	3.96 (0.24)	3.65 (0.18)	1.59 (0.07)	3.2 (0.13)
	bic	0.57 (0.02)	5.46 (0.29)	3.83	1.63	3.36 (0.21)	3.66 (0.2)	1.4 (0.07)	7.2 (0.23)
	ebic	0.57 (0.02)	5.24 (0.29)	3.52	1.72	3.27 (0.21)	3.56 (0.2)	1.38 (0.07)	6.8 (0.21)
	cv	0.39 (0.01)	14.96 (0.7)	14.3	**0.66**	**2.53** (0.1)	4 (0.16)	**1.22** (0.04)	18.64 (0.74)
	csuv.m.0	**0.63** (0.02)	**3.61** (0.2)	**1.72**	1.89	2.86 (0.14)	**3.08** (0.14)	1.31 (0.05)	4.83 (0.14)
	csuv.s.0	0.53 (0.01)	6.52 (0.22)	5.24	1.28	2.61 (0.11)	3.42 (0.13)	1.25 (0.04)	8.96 (0.23)
	csuv.m.5	0.62 (0.02)	3.48 (0.19)	1.48	2	2.99 (0.15)	3.12 (0.15)	1.35 (0.05)	4.48 (0.13)
	csuv.s.5	0.52 (0.01)	6.67 (0.21)	5.34	1.33	2.63 (0.11)	3.43 (0.13)	1.26 (0.04)	9.01 (0.21)
	csuv.m.0.all	0.62 (0.02)	3.77 (0.21)	1.93	1.84	2.82 (0.13)	3.11 (0.14)	1.31 (0.05)	5.09 (0.15)
	csuv.s.0.all	0.52 (0.01)	7.29 (0.25)	6.11	1.18	2.61 (0.12)	3.5 (0.13)	1.25 (0.04)	9.93 (0.27)
	csuv.m.0.mcp	0.55 (0.02)	3.45 (0.16)	0.48	2.97	3.78 (0.21)	3.43 (0.14)	1.59 (0.05)	2.51 (0.09)
	csuv.s.0.mcp	0.56 (0.02)	4.49 (0.21)	2.46	2.03	3.14 (0.15)	3.49 (0.16)	1.42 (0.05)	5.43 (0.09)
setting 6	lasso	0.28 (0.01)	22.46 (1.13)	21.37	1.09	3.19 (0.15)	5.23 (0.2)	1.46 (0.03)	25.28 (1.15)
	elastic net	0.23 (0.01)	30.03 (1.38)	29.08	0.95	3.48 (0.15)	5.98 (0.21)	1.55 (0.03)	33.13 (1.39)
num.factor = 10	relaxed lasso	0.32 (0.01)	15.45 (0.87)	13.71	1.74	3.55 (0.19)	5.2 (0.21)	1.56 (0.04)	16.97 (0.92)
s = 5	mcp	0.42 (0.02)	7.03 (0.29)	4.27	2.76	4.64 (0.27)	4.86 (0.21)	1.79 (0.06)	6.51 (0.22)
p = 300	scad	0.37 (0.02)	9.32 (0.3)	7.05	2.27	4.29 (0.29)	4.58 (0.22)	1.71 (0.07)	9.78 (0.25)
	vsd	0.48 (0.02)	4.78 (0.18)	1.06	3.72	5.31 (0.3)	4.62 (0.16)	1.98 (0.06)	2.34 (0.12)
	bic	0.41 (0.02)	10.11 (1.19)	7.7	2.41	4.57 (0.31)	5.2 (0.28)	1.77 (0.07)	10.29 (1.24)
	ebic	0.42 (0.02)	7.11 (0.31)	4.46	2.65	4.69 (0.32)	4.83 (0.23)	1.77 (0.07)	6.81 (0.24)
	cv	0.29 (0.01)	21.97 (1.16)	20.83	**1.14**	**3.24** (0.16)	5.19 (0.21)	**1.47** (0.03)	24.69 (1.19)
	csuv.m.0	**0.5** (0.02)	**4.27** (0.16)	**1.35**	2.92	3.96 (0.2)	**3.85** (0.12)	1.66 (0.04)	3.43 (0.12)
	csuv.s.0	0.39 (0.01)	9.17 (0.28)	7.05	2.12	3.61 (0.18)	4.51 (0.14)	1.56 (0.04)	9.93 (0.29)
	csuv.m.5	0.49 (0.02)	4.23 (0.15)	1.25	2.98	4.03 (0.2)	3.86 (0.12)	1.68 (0.04)	3.27 (0.13)
	csuv.s.5	0.39 (0.01)	9.12 (0.28)	6.97	2.15	3.68 (0.18)	4.57 (0.14)	1.58 (0.04)	9.82 (0.28)
	csuv.m.0.all	0.5 (0.02)	4.42 (0.18)	1.67	2.75	3.82 (0.2)	3.81 (0.13)	1.61 (0.04)	3.92 (0.14)
	csuv.s.0.all	0.37 (0.01)	10.27 (0.32)	8.26	2.01	3.52 (0.16)	4.63 (0.14)	1.55 (0.04)	11.25 (0.34)
	csuv.m.0.mcp	0.43 (0.01)	4.38 (0.12)	0.37	4.01	4.91 (0.26)	4.23 (0.12)	1.93 (0.04)	1.36 (0.08)
	csuv.s.0.mcp	0.41 (0.02)	5.95 (0.17)	2.92	3.03	4.48 (0.24)	4.63 (0.13)	1.8 (0.04)	4.89 (0.1)

Table 9: Model 4: performance of CSUV and methods it compares with (continue). Variable selection performance in terms of F-measure (f), total error (FP+FN), false positives (FP) and false negatives (FN), prediction error in terms of mse (pred.err) and estimation error in terms of l1 and l2 distance (l1.diff and l2.diff) and are shown. The numbers are based on 100 simulations. The last 8 rows are the performance of CSUV with different parameters (e.g. csuv.m.0.mcp corresponds to CSUV with MCP as constituent method and r = 0). A bold number represents the best result among delete-n/2 cross validation, eBIC and CSUV using Lasso, MCP and SCAD while a underlined number represents the worst among them. Standard errors are shown inside the parentheses.

parameters	methods	f	FP+FN	FP	FN	pred.err	l1.diff	l2.diff	size
setting 7	lasso	0.44 (0.01)	21.75 (0.68)	19.99	1.76	4.57 (0.2)	7.63 (0.19)	1.84 (0.04)	28.23 (0.77)
	elastic net	0.4 (0.01)	27.39 (0.79)	26.07	1.32	4.83 (0.23)	8.52 (0.24)	1.89 (0.04)	34.75 (0.86)
num.factor = 10	relaxed lasso	0.46 (0.01)	19.07 (0.88)	16.61	2.46	5.34 (0.26)	8.24 (0.27)	2 (0.04)	24.15 (1.05)
s = 10	mcp	0.51 (0.02)	9.26 (0.28)	4.25	5.01	7.58 (0.44)	8.19 (0.24)	2.47 (0.06)	9.24 (0.27)
p = 100	scad	0.51 (0.02)	9.76 (0.32)	5.05	4.71	7.41 (0.43)	7.93 (0.25)	2.43 (0.06)	10.34 (0.22)
	vsd	0.42 (0.02)	8.28 (0.23)	1.28	7	8.89 (0.52)	8.34 (0.23)	2.7 (0.06)	4.28 (0.18)
	bic	0.55 (0.02)	8.96 (0.39)	4.57	4.39	6.89 (0.41)	7.68 (0.25)	2.32 (0.06)	10.18 (0.38)
	ebic	0.55 (0.02)	8.62 (0.3)	3.98	4.64	7 (0.41)	7.7 (0.25)	2.36 (0.06)	9.34 (0.25)
	cv	0.44 (0.01)	21.75 (0.68)	19.99	**1.76**	**4.57** (0.2)	7.63 (0.19)	**1.84** (0.04)	28.23 (0.77)
	csuv.m.0	**0.58** (0.01)	**7.1** (0.2)	**2.14**	4.96	6.13 (0.36)	**6.78** (0.17)	2.19 (0.04)	7.18 (0.2)
	csuv.s.0	0.53 (0.01)	10.88 (0.25)	7.16	3.72	5.34 (0.24)	7.08 (0.18)	2.05 (0.04)	13.44 (0.32)
	csuv.m.5	0.57 (0.01)	7.11 (0.2)	1.98	5.13	6.45 (0.38)	6.84 (0.17)	2.22 (0.04)	6.85 (0.21)
	csuv.s.5	0.53 (0.01)	10.87 (0.25)	7.15	3.72	5.25 (0.22)	7.05 (0.18)	2.04 (0.04)	13.43 (0.32)
	csuv.m.0.all	0.58 (0.01)	7.41 (0.21)	2.66	4.75	5.94 (0.32)	6.78 (0.18)	2.16 (0.05)	7.91 (0.22)
	csuv.s.0.all	0.52 (0.01)	11.72 (0.24)	8.26	3.46	5.27 (0.22)	7.18 (0.17)	2.03 (0.04)	14.8 (0.33)
	csuv.m.0.mcp	0.39 (0.01)	8.05 (0.16)	0.53	7.52	8.89 (0.47)	8.21 (0.17)	2.73 (0.05)	3.01 (0.12)
	csuv.s.0.mcp	0.53 (0.01)	7.86 (0.23)	2.4	5.46	7.07 (0.38)	7.58 (0.2)	2.38 (0.05)	6.94 (0.13)
setting 8	lasso	0.31 (0.01)	32.71 (1.19)	29.58	3.13	6.43 (0.26)	10.07 (0.22)	2.25 (0.03)	36.45 (1.33)
	elastic net	0.28 (0.01)	38.5 (1.24)	35.73	2.77	6.7 (0.26)	10.7 (0.19)	2.29 (0.03)	42.96 (1.35)
num.factor = 10	relaxed lasso	0.32 (0.01)	25.3 (1.17)	21.11	4.19	7.22 (0.31)	10.41 (0.25)	2.39 (0.04)	26.92 (1.43)
s = 10	mcp	0.35 (0.01)	12.31 (0.29)	5.46	6.85	9.21 (0.39)	10.25 (0.24)	2.91 (0.05)	8.61 (0.23)
p = 300	scad	0.34 (0.01)	13.98 (0.35)	7.49	6.49	9.88 (0.46)	9.88 (0.25)	2.89 (0.06)	11 (0.31)
	vsd	0.25 (0.01)	10.75 (0.15)	1.72	9.03	12.25 (0.59)	10.71 (0.17)	3.36 (0.05)	2.69 (0.13)
	bic	0.36 (0.02)	16.89 (1.3)	11.03	5.86	9.08 (0.44)	10.25 (0.28)	2.76 (0.06)	15.17 (1.52)
	ebic	0.37 (0.01)	12.05 (0.31)	5.52	6.53	9.34 (0.44)	9.78 (0.23)	2.82 (0.05)	8.99 (0.26)
	cv	0.31 (0.01)	32.71 (1.19)	29.58	**3.13**	**6.43** (0.26)	10.07 (0.22)	**2.25** (0.03)	36.45 (1.33)
	csuv.m.0	**0.41** (0.01)	**9** (0.2)	**2.15**	6.85	8.16 (0.35)	**8.41** (0.18)	2.65 (0.05)	5.3 (0.2)
	csuv.s.0	0.37 (0.01)	15.23 (0.26)	9.75	5.48	7.55 (0.3)	9.2 (0.16)	2.47 (0.04)	14.27 (0.35)
	csuv.m.5	0.42 (0.01)	8.87 (0.2)	1.88	6.99	8.32 (0.36)	8.38 (0.19)	2.68 (0.05)	4.89 (0.19)
	csuv.s.5	0.37 (0.01)	15.25 (0.26)	9.77	5.48	7.41 (0.28)	9.2 (0.16)	2.47 (0.04)	14.29 (0.34)
	csuv.m.0.all	0.42 (0.01)	9.23 (0.22)	2.56	6.67	8.15 (0.34)	8.46 (0.18)	2.62 (0.04)	5.89 (0.2)
	csuv.s.0.all	0.36 (0.01)	16.64 (0.29)	11.47	5.17	7.39 (0.29)	9.41 (0.16)	2.45 (0.04)	16.3 (0.38)
	csuv.m.0.mcp	0.24 (0.01)	9.66 (0.13)	0.65	9.01	11.13 (0.5)	9.61 (0.16)	3.17 (0.05)	1.64 (0.09)
	csuv.s.0.mcp	0.34 (0.01)	10.65 (0.22)	3.27	7.38	9.61 (0.45)	9.75 (0.19)	2.92 (0.05)	5.89 (0.1)

Table 10: Model 4: performance of CSUV and methods it compares with (continue). Variable selection performance in terms of F-measure (f), total error (FP+FN), false positives (FP) and false negatives (FN), prediction error in terms of mse (pred.err) and estimation error in terms of l1 and l2 distance (l1.diff and l2.diff) and are shown. The numbers are based on 100 simulations. The last 8 rows are the performance of CSUV with different parameters (e.g. csuv.m.0.mcp corresponds to CSUV with MCP as constituent method and r = 0). A bold number represents the best result among delete-n/2 cross validation, eBIC and CSUV using Lasso, MCP and SCAD while a underlined number represents the worst among them. Standard errors are shown inside the parentheses.

parameters	methods	f	FP+FN	FP	FN	pred.err	l1.diff	l2.diff	size
setting 1	lasso	0.58 (0.02)	9.6 (0.72)	9.6	0	1.18 (0.02)	1.19 (0.05)	0.42 (0.01)	14.6 (0.72)
	elastic net	0.49 (0.02)	12.7 (0.76)	12.7	0	1.23 (0.02)	1.42 (0.06)	0.46 (0.01)	17.7 (0.76)
rho = 0.5	relaxed lasso	0.95 (0.01)	0.84 (0.32)	0.84	0	1.08 (0.02)	0.67 (0.04)	0.32 (0.01)	5.84 (0.32)
s = 5	mcp	1 (0)	0 (0)	0	0	1.06 (0.02)	0.6 (0.03)	0.33 (0.01)	5 (0)
p = 100	scad	1 (0)	0.01 (0.01)	0.01	0	1.21 (0.03)	1.02 (0.05)	0.57 (0.03)	5.01 (0.01)
	vsd	1 (0)	0.03 (0.02)	0.03	0	1.04 (0.02)	0.54 (0.02)	0.29 (0.01)	5.03 (0.02)
	bic	0.92 (0.02)	1.41 (0.33)	1.41	0	1.1 (0.02)	0.73 (0.04)	0.36 (0.02)	6.41 (0.33)
	ebic	1 (0)	0.01 (0.01)	0.01	0	1.07 (0.02)	0.62 (0.03)	0.33 (0.02)	5.01 (0.01)
	cv	1 (0)	**0** (0)	**0**	0	1.06 (0.02)	0.6 (0.03)	0.33 (0.01)	5 (0)
	csuv.m.0	1 (0)	**0** (0)	**0**	0	**1.04** (0.02)	**0.52** (0.02)	**0.28** (0.01)	5 (0)
	csuv.s.0	1 (0)	**0** (0)	**0**	0	**1.04** (0.02)	**0.52** (0.02)	**0.28** (0.01)	5 (0)
	csuv.m.5	1 (0)	0 (0)	0	0	1.04 (0.02)	0.52 (0.02)	0.28 (0.01)	5 (0)
	csuv.s.5	1 (0)	0 (0)	0	0	1.04 (0.02)	0.52 (0.02)	0.28 (0.01)	5 (0)
	csuv.m.0.all	1 (0)	0.01 (0.01)	0.01	0	1.04 (0.02)	0.53 (0.02)	0.28 (0.01)	5.01 (0.01)
	csuv.s.0.all	0.99 (0)	0.06 (0.02)	0.06	0	1.05 (0.02)	0.55 (0.02)	0.29 (0.01)	5.06 (0.02)
	csuv.m.0.mcp	1 (0)	0 (0)	0	0	1.04 (0.02)	0.52 (0.02)	0.28 (0.01)	5 (0)
	csuv.s.0.mcp	1 (0)	0 (0)	0	0	1.04 (0.02)	0.52 (0.02)	0.28 (0.01)	5 (0)
setting 2	lasso	0.49 (0.02)	14.89 (1.18)	14.89	0	1.23 (0.02)	1.46 (0.07)	0.45 (0.01)	19.89 (1.18)
	elastic net	0.39 (0.01)	18.8 (1.03)	18.8	0	1.32 (0.02)	1.74 (0.06)	0.52 (0.01)	23.8 (1.03)
rho = 0.5	relaxed lasso	0.95 (0.01)	0.99 (0.4)	0.99	0	1.08 (0.02)	0.65 (0.05)	0.31 (0.01)	5.99 (0.4)
s = 5	mcp	1 (0)	0.03 (0.02)	0.03	0	1.06 (0.02)	0.57 (0.03)	0.3 (0.01)	5.03 (0.02)
p = 300	scad	0.99 (0)	0.07 (0.03)	0.07	0	1.18 (0.02)	0.94 (0.05)	0.52 (0.03)	5.07 (0.03)
	vsd	1 (0)	0.01 (0.01)	0.01	0	1.05 (0.02)	0.49 (0.02)	0.26 (0.01)	5.01 (0.01)
	bic	0.6 (0.03)	10.86 (1.11)	10.86	0	1.21 (0.02)	1.28 (0.07)	0.43 (0.02)	15.86 (1.11)
	ebic	0.99 (0)	0.08 (0.03)	0.08	0	1.07 (0.02)	0.61 (0.04)	0.32 (0.02)	5.08 (0.03)
	cv	**1** (0)	0.03 (0.02)	0.03	0	1.06 (0.02)	0.57 (0.03)	0.3 (0.01)	5.03 (0.02)
	csuv.m.0	**1** (0)	**0.01** (0.01)	**0.01**	0	**1.05** (0.02)	**0.49** (0.02)	**0.26** (0.01)	5.01 (0.01)
	csuv.s.0	**1** (0)	0.03 (0.02)	0.03	0	**1.05** (0.02)	0.5 (0.02)	**0.26** (0.01)	5.03 (0.02)
	csuv.m.5	1 (0)	0.01 (0.01)	0.01	0	1.05 (0.02)	0.49 (0.02)	0.26 (0.01)	5.01 (0.01)
	csuv.s.5	1 (0)	0.01 (0.01)	0.01	0	1.05 (0.02)	0.49 (0.02)	0.26 (0.01)	5.01 (0.01)
	csuv.m.0.all	1 (0)	0.03 (0.02)	0.03	0	1.05 (0.02)	0.5 (0.02)	0.26 (0.01)	5.03 (0.02)
	csuv.s.0.all	0.99 (0)	0.14 (0.03)	0.14	0	1.07 (0.02)	0.55 (0.03)	0.28 (0.01)	5.14 (0.03)
	csuv.m.0.mcp	1 (0)	0 (0)	0	0	1.04 (0.02)	0.49 (0.02)	0.26 (0.01)	5 (0)
	csuv.s.0.mcp	1 (0)	0 (0)	0	0	1.04 (0.02)	0.49 (0.02)	0.26 (0.01)	5 (0)
setting 3	lasso	0.65 (0.01)	12.17 (0.65)	12.17	0	1.29 (0.02)	1.97 (0.06)	0.56 (0.01)	22.17 (0.65)
	elastic net	0.6 (0.01)	14.68 (0.71)	14.68	0	1.34 (0.02)	2.2 (0.06)	0.59 (0.01)	24.68 (0.71)
rho = 0.5	relaxed lasso	0.97 (0.01)	0.89 (0.32)	0.85	0.04	1.15 (0.02)	1.27 (0.05)	0.46 (0.01)	10.81 (0.32)
s = 10	mcp	0.93 (0.01)	1.23 (0.09)	0.02	1.21	1.91 (0.05)	3.43 (0.1)	1.34 (0.04)	8.81 (0.09)
p = 100	scad	0.95 (0.01)	0.87 (0.09)	0.12	0.75	2.41 (0.06)	4.35 (0.09)	1.65 (0.03)	9.37 (0.09)
	vsd	0.99 (0)	0.25 (0.05)	0	0.25	1.16 (0.02)	1.29 (0.06)	0.52 (0.02)	9.75 (0.05)
	bic	0.83 (0.02)	5.52 (0.73)	5.44	0.08	1.66 (0.05)	2.72 (0.11)	0.95 (0.05)	15.36 (0.74)
	ebic	0.94 (0.01)	1.24 (0.19)	0.71	0.53	1.95 (0.06)	3.37 (0.12)	1.29 (0.05)	10.18 (0.22)
	cv	0.67 (0.01)	11.01 (0.68)	10.83	0.18	1.37 (0.04)	2.15 (0.09)	0.65 (0.03)	20.65 (0.73)
	csuv.m.0	**0.99** (0)	**0.14** (0.03)	**0.02**	0.12	**1.13** (0.02)	1.17 (0.04)	0.46 (0.02)	9.9 (0.04)
	csuv.s.0	**0.99** (0)	0.21 (0.05)	0.15	**0.06**	**1.13** (0.02)	**1.15** (0.04)	**0.44** (0.02)	10.09 (0.04)
	csuv.m.5	0.99 (0)	0.18 (0.04)	0.01	0.17	1.15 (0.02)	1.2 (0.05)	0.48 (0.02)	9.84 (0.04)
	csuv.s.5	0.99 (0)	0.3 (0.06)	0.23	0.07	1.14 (0.02)	1.18 (0.04)	0.45 (0.02)	10.16 (0.05)
	csuv.m.0.all	0.99 (0)	0.13 (0.03)	0.04	0.09	1.13 (0.02)	1.15 (0.04)	0.45 (0.02)	9.95 (0.04)
	csuv.s.0.all	0.98 (0)	0.46 (0.07)	0.42	0.04	1.14 (0.02)	1.21 (0.04)	0.46 (0.01)	10.38 (0.07)
	csuv.m.0.mcp	0.91 (0.01)	1.62 (0.09)	0	1.62	1.74 (0.05)	2.88 (0.13)	1.17 (0.05)	8.38 (0.09)
	csuv.s.0.mcp	0.89 (0)	1.92 (0.05)	0	1.92	1.91 (0.05)	3.23 (0.09)	1.32 (0.03)	8.08 (0.05)

Table 11: Model 5: performance of CSUV and methods it compares with. Variable selection performance in terms of F-measure (f), total error (FP+FN), false positives (FP) and false negatives (FN), prediction error in terms of mse (pred.err) and estimation error in terms of l1 and l2 distance (l1.diff and l2.diff) and are shown. The numbers are based on 100 simulations. The last 8 rows are the performance of CSUV with different parameters (e.g. csuv.m.0.mcp corresponds to CSUV with MCP as constituent method and r = 0). A bold number represents the best result among delete-n/2 cross validation, eBIC and CSUV using Lasso, MCP and SCAD while a underlined number represents the worst among them. Standard errors are shown inside the parentheses.

parameters	methods	f	FP+FN	FP	FN	pred.err	l1.diff	l2.diff	size
setting 4	lasso	0.55 (0.01)	19.23 (1.1)	19.23	0	1.4 (0.02)	2.38 (0.07)	0.62 (0.01)	29.23 (1.1)
	elastic net	0.48 (0.01)	24.02 (1.09)	24.02	0	1.5 (0.03)	2.76 (0.07)	0.67 (0.01)	34.02 (1.09)
rho = 0.5	relaxed lasso	0.96 (0.01)	1.3 (0.44)	1.23	0.07	1.19 (0.02)	1.39 (0.06)	0.5 (0.02)	11.16 (0.44)
s = 10	mcp	0.92 (0)	1.47 (0.09)	0.13	1.34	1.89 (0.04)	3.39 (0.09)	1.33 (0.03)	8.79 (0.08)
p = 300	scad	0.93 (0.01)	1.31 (0.11)	0.51	0.8	2.41 (0.06)	4.29 (0.09)	1.62 (0.03)	9.71 (0.12)
	vsd	0.96 (0)	0.76 (0.07)	0.02	0.74	1.35 (0.03)	1.77 (0.08)	0.74 (0.03)	9.28 (0.07)
	bic	0.61 (0.02)	16.37 (1.2)	16.32	0.05	1.49 (0.04)	2.54 (0.09)	0.72 (0.03)	26.27 (1.22)
	ebic	0.93 (0.01)	1.44 (0.17)	0.76	0.68	2.07 (0.06)	3.54 (0.11)	1.36 (0.04)	10.08 (0.21)
	cv	0.56 (0.02)	18.5 (1.16)	18.38	**0.12**	1.44 (0.03)	2.49 (0.08)	0.67 (0.02)	28.26 (1.2)
	csuv.m.0	**0.99** (0)	**0.27** (0.05)	**0.02**	0.25	1.19 (0.02)	1.3 (0.06)	0.52 (0.02)	9.77 (0.05)
	csuv.s.0	0.98 (0)	0.4 (0.06)	0.26	0.14	**1.17** (0.02)	**1.26** (0.05)	**0.49** (0.02)	10.12 (0.06)
	csuv.m.5	0.98 (0)	0.33 (0.05)	0.02	0.31	1.21 (0.02)	1.34 (0.06)	0.54 (0.02)	9.71 (0.05)
	csuv.s.5	0.97 (0)	0.72 (0.07)	0.64	0.08	1.17 (0.02)	1.3 (0.04)	0.49 (0.02)	10.56 (0.07)
	csuv.m.0.all	0.99 (0)	0.24 (0.05)	0.04	0.2	1.17 (0.02)	1.26 (0.05)	0.5 (0.02)	9.84 (0.05)
	csuv.s.0.all	0.96 (0)	0.8 (0.08)	0.72	0.08	1.19 (0.02)	1.32 (0.05)	0.5 (0.02)	10.64 (0.07)
	csuv.m.0.mcp	0.88 (0.01)	2.1 (0.08)	0	2.1	2.07 (0.08)	3.49 (0.13)	1.4 (0.05)	7.9 (0.08)
	csuv.s.0.mcp	0.89 (0)	2.01 (0.05)	0	2.01	1.99 (0.05)	3.36 (0.1)	1.37 (0.03)	7.99 (0.05)
setting 5	lasso	0.3 (0.01)	25.34 (0.85)	25.34	0	1.46 (0.03)	3.36 (0.09)	0.92 (0.02)	30.34 (0.85)
	elastic net	0.23 (0)	34.05 (0.8)	34.05	0	1.69 (0.04)	4.51 (0.1)	1.1 (0.02)	39.05 (0.8)
rho = -0.5	relaxed lasso	0.62 (0.01)	7.04 (0.48)	7.04	0	1.27 (0.03)	1.76 (0.09)	0.57 (0.02)	12.04 (0.48)
s = 5	mcp	0.98 (0.01)	0.26 (0.06)	0.26	0	1.05 (0.02)	0.55 (0.02)	0.28 (0.01)	5.26 (0.06)
p = 100	scad	0.96 (0.01)	0.55 (0.11)	0.55	0	1.05 (0.02)	0.55 (0.02)	0.28 (0.01)	5.55 (0.11)
	vsd	1 (0)	0.01 (0.01)	0.01	0	1.05 (0.02)	0.53 (0.02)	0.28 (0.01)	5.01 (0.01)
	bic	0.95 (0.01)	0.6 (0.11)	0.6	0	1.05 (0.02)	0.56 (0.02)	0.28 (0.01)	5.6 (0.11)
	ebic	0.96 (0.01)	0.43 (0.09)	0.43	0	**1.05** (0.02)	0.55 (0.02)	**0.28** (0.01)	5.43 (0.09)
	cv	0.97 (0.01)	0.41 (0.09)	0.41	0	**1.05** (0.02)	0.55 (0.02)	**0.28** (0.01)	5.41 (0.09)
	csuv.m.0	**1** (0)	**0.03** (0.02)	**0.03**	0	**1.05** (0.02)	**0.54** (0.02)	**0.28** (0.01)	5.03 (0.02)
	csuv.s.0	0.98 (0)	0.24 (0.05)	0.24	0	1.07 (0.02)	0.61 (0.03)	0.31 (0.01)	5.24 (0.05)
	csuv.m.5	1 (0)	0.03 (0.02)	0.03	0	1.05 (0.02)	0.54 (0.02)	0.28 (0.01)	5.03 (0.02)
	csuv.s.5	0.94 (0.01)	0.68 (0.07)	0.68	0	1.1 (0.02)	0.74 (0.03)	0.36 (0.01)	5.68 (0.07)
	csuv.m.0.all	1 (0)	0.03 (0.02)	0.03	0	1.05 (0.02)	0.54 (0.02)	0.28 (0.01)	5.03 (0.02)
	csuv.s.0.all	0.98 (0)	0.27 (0.05)	0.27	0	1.07 (0.02)	0.62 (0.03)	0.32 (0.01)	5.27 (0.05)
	csuv.m.0.mcp	1 (0)	0.02 (0.01)	0.02	0	1.05 (0.02)	0.53 (0.02)	0.28 (0.01)	5.02 (0.01)
	csuv.s.0.mcp	1 (0)	0.03 (0.02)	0.03	0	1.05 (0.02)	0.54 (0.02)	0.28 (0.01)	5.03 (0.02)
setting 6	lasso	0.21 (0)	40.76 (1.16)	40.76	0	1.86 (0.05)	5.06 (0.14)	1.28 (0.03)	45.76 (1.16)
	elastic net	0.15 (0)	56.91 (1.19)	56.9	0.01	2.72 (0.08)	7.8 (0.19)	1.79 (0.04)	61.89 (1.19)
rho = -0.5	relaxed lasso	0.41 (0.01)	17.7 (1.17)	17.64	0.06	1.74 (0.06)	3.86 (0.2)	0.98 (0.04)	22.58 (1.18)
s = 5	mcp	0.96 (0.01)	0.48 (0.1)	0.48	0	1.05 (0.02)	0.56 (0.03)	0.28 (0.01)	5.48 (0.1)
p = 300	scad	0.92 (0.01)	1.09 (0.16)	1.09	0	1.05 (0.02)	0.56 (0.02)	0.28 (0.01)	6.09 (0.16)
	vsd	1 (0)	0.04 (0.02)	0.04	0	1.05 (0.02)	0.53 (0.02)	0.28 (0.01)	5.04 (0.02)
	bic	0.82 (0.03)	7.95 (1.89)	7.95	0	1.19 (0.05)	1.31 (0.21)	0.41 (0.04)	12.95 (1.89)
	ebic	0.93 (0.01)	0.81 (0.11)	0.81	**0**	**1.05** (0.02)	**0.56** (0.03)	**0.28** (0.01)	5.81 (0.11)
	cv	0.92 (0.01)	1.04 (0.16)	1.04	**0**	**1.05** (0.02)	**0.56** (0.02)	**0.28** (0.01)	6.04 (0.16)
	csuv.m.0	**1** (0)	**0.05** (0.02)	**0.04**	0.01	1.07 (0.02)	**0.56** (0.04)	0.3 (0.02)	5.03 (0.02)
	csuv.s.0	0.96 (0.01)	0.51 (0.08)	0.51	**0**	1.1 (0.02)	0.7 (0.04)	0.35 (0.01)	5.51 (0.08)
	csuv.m.5	0.99 (0)	0.06 (0.02)	0.05	0.01	1.07 (0.02)	0.57 (0.04)	0.3 (0.02)	5.04 (0.02)
	csuv.s.5	0.86 (0.01)	1.73 (0.11)	1.73	0	1.18 (0.02)	1.03 (0.04)	0.46 (0.01)	6.73 (0.11)
	csuv.m.0.all	1 (0)	0.05 (0.02)	0.04	0.01	1.07 (0.02)	0.56 (0.04)	0.3 (0.02)	5.03 (0.02)
	csuv.s.0.all	0.95 (0.01)	0.54 (0.08)	0.54	0	1.1 (0.02)	0.71 (0.04)	0.35 (0.02)	5.54 (0.08)
	csuv.m.0.mcp	0.99 (0)	0.05 (0.03)	0.02	0.03	1.08 (0.03)	0.59 (0.05)	0.31 (0.03)	4.99 (0.03)
	csuv.s.0.mcp	0.99 (0)	0.12 (0.04)	0.12	0	1.06 (0.02)	0.56 (0.03)	0.29 (0.01)	5.12 (0.04)

Table 12: Model 5: performance of CSUV and methods it compares with (continue). Variable selection performance in terms of F-measure (f), total error (FP+FN), false positives (FP) and false negatives (FN), prediction error in terms of mse (pred.err) and estimation error in terms of l1 and l2 distance (l1.diff and l2.diff) and are shown. The numbers are based on 100 simulations. The last 8 rows are the performance of CSUV with different parameters (e.g. csuv.m.0.mcp corresponds to CSUV with MCP as constituent method and r = 0). A bold number represents the best result among delete-n/2 cross validation, eBIC and CSUV using Lasso, MCP and SCAD while a underlined number represents the worst among them. Standard errors are shown inside the parentheses.

parameters	methods	f	FP+FN	FP	FN	pred.err	l1.diff	l2.diff	size
setting 7	lasso	0.37 (0)	34.06 (0.68)	33.96	0.1	1.86 (0.04)	5.83 (0.12)	1.24 (0.03)	43.86 (0.7)
	elastic net	0.35 (0)	38.37 (0.66)	38.29	0.08	2.09 (0.05)	6.83 (0.13)	1.4 (0.03)	48.21 (0.68)
rho = -0.5	relaxed lasso	0.48 (0.01)	22.32 (1.04)	21.73	0.59	1.87 (0.04)	5.2 (0.14)	1.18 (0.03)	31.14 (1.15)
s = 10	mcp	0.85 (0.01)	3.04 (0.21)	1.53	1.51	1.56 (0.04)	2.69 (0.12)	1.06 (0.04)	10.02 (0.15)
p = 100	scad	0.76 (0.01)	5.14 (0.26)	3.25	1.89	1.87 (0.05)	3.81 (0.11)	1.45 (0.03)	11.36 (0.23)
	vsd	0.81 (0.01)	3.01 (0.19)	0.16	2.85	1.81 (0.06)	3.24 (0.14)	1.3 (0.05)	7.31 (0.18)
	bic	0.84 (0.01)	3.58 (0.46)	2.21	1.37	1.58 (0.04)	2.78 (0.13)	1.08 (0.04)	10.84 (0.46)
	ebic	**0.85** (0.01)	**3.09** (0.21)	1.59	**1.5**	**1.58** (0.04)	**2.74** (0.12)	**1.07** (0.05)	10.09 (0.16)
	cv	0.77 (0.01)	5.01 (0.27)	3.09	1.92	1.83 (0.05)	3.68 (0.12)	1.41 (0.04)	11.17 (0.24)
	csuv.m.0	0.76 (0.01)	3.92 (0.13)	**0.22**	3.7	2.08 (0.05)	3.95 (0.11)	1.57 (0.04)	6.52 (0.13)
	csuv.s.0	0.8 (0.01)	3.83 (0.18)	1.56	2.27	1.85 (0.06)	3.44 (0.13)	1.3 (0.04)	9.29 (0.19)
	csuv.m.5	0.75 (0.01)	3.99 (0.13)	0.17	3.82	2.11 (0.05)	4.03 (0.11)	1.6 (0.03)	6.35 (0.13)
	csuv.s.5	0.79 (0.01)	4.15 (0.18)	1.89	2.26	1.92 (0.06)	3.59 (0.13)	1.33 (0.04)	9.63 (0.17)
	csuv.m.0.all	0.76 (0.01)	3.87 (0.13)	0.25	3.62	2.06 (0.05)	3.91 (0.11)	1.55 (0.03)	6.63 (0.13)
	csuv.s.0.all	0.8 (0.01)	3.86 (0.17)	1.71	2.15	1.84 (0.06)	3.4 (0.12)	1.28 (0.04)	9.56 (0.18)
	csuv.m.0.mcp	0.72 (0.01)	4.25 (0.12)	0.03	4.22	2.17 (0.05)	4.22 (0.11)	1.67 (0.03)	5.81 (0.12)
	csuv.s.0.mcp	0.79 (0.01)	3.55 (0.16)	0.54	3.01	1.97 (0.06)	3.67 (0.12)	1.44 (0.04)	7.53 (0.14)
setting 8	lasso	0.26 (0)	50.38 (1.39)	48.77	1.61	3.4 (0.11)	10.41 (0.21)	2.23 (0.05)	57.16 (1.54)
	elastic net	0.22 (0)	59.24 (1.43)	57.32	1.92	4.64 (0.17)	13.28 (0.23)	2.75 (0.06)	65.4 (1.63)
rho = -0.5	relaxed lasso	0.35 (0.01)	26.61 (1.59)	22.95	3.66	3.76 (0.14)	9.65 (0.24)	2.33 (0.06)	29.29 (1.96)
s = 10	mcp	0.76 (0.01)	5.25 (0.28)	3.29	1.96	1.68 (0.05)	3.11 (0.13)	1.18 (0.05)	11.33 (0.25)
p = 300	scad	0.63 (0.01)	9.48 (0.37)	7.35	2.13	1.97 (0.05)	4.2 (0.12)	1.5 (0.04)	15.22 (0.33)
	vsd	0.67 (0.01)	4.87 (0.16)	0.02	4.85	2.49 (0.07)	4.98 (0.16)	1.89 (0.05)	5.17 (0.16)
	bic	0.61 (0.02)	20.31 (2.56)	18.77	1.54	2.04 (0.09)	5.1 (0.37)	1.4 (0.06)	27.23 (2.63)
	ebic	**0.75** (0.01)	**5.32** (0.28)	3.37	**1.95**	**1.69** (0.05)	**3.12** (0.13)	**1.18** (0.05)	11.42 (0.26)
	cv	0.67 (0.01)	8.23 (0.42)	6.13	2.1	1.87 (0.05)	3.85 (0.13)	1.4 (0.04)	14.03 (0.37)
	csuv.m.0	0.59 (0.01)	5.77 (0.11)	**0.09**	5.68	2.96 (0.08)	5.94 (0.14)	2.2 (0.04)	4.41 (0.12)
	csuv.s.0	0.64 (0.01)	6.02 (0.17)	1.64	4.38	2.61 (0.09)	5.37 (0.16)	1.89 (0.05)	7.26 (0.23)
	csuv.m.5	0.59 (0.01)	5.77 (0.11)	0.08	5.69	2.99 (0.09)	5.95 (0.15)	2.2 (0.04)	4.39 (0.12)
	csuv.s.5	0.64 (0.01)	6.69 (0.2)	2.65	4.04	2.56 (0.07)	5.41 (0.15)	1.84 (0.04)	8.61 (0.22)
	csuv.m.0.all	0.59 (0.01)	5.77 (0.11)	0.09	5.68	2.96 (0.08)	5.94 (0.14)	2.2 (0.04)	4.41 (0.12)
	csuv.s.0.all	0.64 (0.01)	6.01 (0.17)	1.66	4.35	2.61 (0.08)	5.37 (0.16)	1.89 (0.05)	7.31 (0.23)
	csuv.m.0.mcp	0.56 (0.01)	6.05 (0.1)	0	6.05	3.18 (0.1)	6.32 (0.14)	2.32 (0.04)	3.95 (0.1)
	csuv.s.0.mcp	0.63 (0.01)	5.63 (0.14)	0.58	5.05	2.81 (0.09)	5.61 (0.15)	2.05 (0.05)	5.53 (0.17)

Table 13: Model 5: performance of CSUV and methods it compares with (continue). Variable selection performance in terms of F-measure (f), total error (FP+FN), false positives (FP) and false negatives (FN), prediction error in terms of mse (pred.err) and estimation error in terms of l1 and l2 distance (l1.diff and l2.diff) and are shown. The numbers are based on 100 simulations. The last 8 rows are the performance of CSUV with different parameters (e.g. csuv.m.0.mcp corresponds to CSUV with MCP as constituent method and r = 0). A bold number represents the best result among delete-n/2 cross validation, eBIC and CSUV using Lasso, MCP and SCAD while a underlined number represents the worst among them. Standard errors are shown inside the parentheses.

methods	pred.err	size
lasso	26.08 (0.39)	12.39 (0.09)
elastic net	26.12 (0.4)	12.38 (0.1)
relaxed lasso	26.53 (0.42)	11.21 (0.14)
mcp	26.16 (0.39)	11.29 (0.15)
scad	26.1 (0.39)	11.54 (0.12)
vsd	28.54 (0.42)	6.03 (0.16)
bic	26.2 (0.4)	11.05 (0.15)
ebic	26.19 (0.4)	11.07 (0.15)
cv	**26.08** (0.39)	12.36 (0.09)
csuv.m.0	26.64 (0.41)	10.02 (0.17)
csuv.s.0	26.73 (0.41)	9.9 (0.16)
csuv.m.5	26.58 (0.41)	10.07 (0.16)
csuv.s.5	26.63 (0.41)	10.07 (0.15)
csuv.m.0.all	26.72 (0.41)	9.95 (0.17)
csuv.s.0.all	26.76 (0.41)	9.81 (0.16)
csuv.m.0.mcp	26.33 (0.4)	10.52 (0.16)
csuv.s.0.mcp	26.39 (0.4)	10.46 (0.15)

Table 14: Boston data: performance of CSUV and methods it compares with. The numbers are based on 100 simulations. The last 8 rows are the performance of CSUV with different parameters (e.g. csuv.m.0.mcp corresponds to CSUV with MCP as constituent method and r = 0). A bold number represents the best result among delete-n/2 cross validation, eBIC and CSUV using Lasso, MCP and SCAD while a underlined number represents the worst among them. Standard errors are shown inside the parentheses.

methods	f	FP+FN	FP	FN	size
lasso	0.46 (0.01)	19.96 (1.45)	16.88	3.08	23.8 (1.48)
elastic net	0.45 (0.01)	22.59 (1.51)	20.44	2.15	28.29 (1.53)
relaxed lasso	0.56 (0.02)	10.15 (0.81)	5.85	4.3	11.55 (0.97)
mcp	0.45 (0.01)	8.97 (0.22)	2.62	6.35	6.27 (0.25)
scad	0.48 (0.02)	13.01 (0.67)	8.35	4.66	13.69 (0.56)
vsd	NaN (NA)	10 (0)	0	10	0 (0)
bic	0.43 (0.01)	15.78 (1.47)	10.5	5.28	15.22 (1.65)
ebic	0.44 (0.01)	11.33 (1.18)	5.09	6.24	8.85 (1.31)
cv	0.45 (0.02)	19.3 (1.45)	15.82	**3.48**	22.34 (1.54)
csuv.m.0	0.45 (0.01)	7.04 (0.12)	**0.03**	7.01	3.02 (0.12)
csuv.s.0	**0.65** (0.01)	**5.49** (0.19)	0.99	4.5	6.49 (0.32)
csuv.m.5	0.43 (0.01)	7.26 (0.12)	0.02	7.24	2.78 (0.12)
csuv.s.5	0.69 (0.01)	5.07 (0.19)	1.08	3.99	7.09 (0.3)
csuv.m.0.all	0.49 (0.01)	6.72 (0.13)	0.02	6.7	3.32 (0.13)
csuv.s.0.all	0.69 (0.01)	5.16 (0.22)	1.3	3.86	7.44 (0.35)
csuv.m.0.mcp	0.28 (0.01)	8.61 (0.09)	0	8.61	1.39 (0.09)
csuv.s.0.mcp	0.44 (0.01)	7.19 (0.09)	0.05	7.14	2.91 (0.09)

Table 15: Riboflavin data with permutation: performance of CSUV and methods it compares with. The numbers are based on 100 simulations. The last 8 rows are the performance of CSUV with different parameters (e.g. csuv.m.0.mcp corresponds to CSUV with MCP as constituent method and r = 0). A bold number represents the best result among delete-n/2 cross validation, eBIC and CSUV using Lasso, MCP and SCAD while a underlined number represents the worst among them. Standard errors are shown inside the parentheses.