Supplementary Materials

1. Running Time Analysis

In this section, we analyze the running time of six methods on the PAAD_CHOL_ESCA dataset. Experiments are performed on a PC with Intel (R) Core (TM) i5-10600KF CPU and 16G RAM. All methods are executed ten times and the average running time is recorded in Table I. The t-STRPCA method has the shortest running time because it imposes a sparsity constraint ($L_{2,1}$ -norm). Methods that impose manifold constraints (GTRPCA, HTRPCA and ETHLR) are more computationally expensive than traditional TRPCA and t-STRPCA methods. For example, the running time of the ETHLR method is slightly longer than that of ETRPCA due to the extra time required to build the hypergraph. But the ETHLR method achieves better performance than the ETRPCA method. Overall, the ETHLR method has acceptable and comparable runtimes.

TABLE I

RUNNING TIME COMPARISON OF SIX METHODS

Methods	TRPCA	t-STRPCA	GTRPCA	HTRPCA	ETRPCA	ETHLR
Time(s)	248.0483	138.2310	283.9110	300.5477	250.2122	285.9158

2. Discussion of Complementary Information

In this section, we design experiments to illustrate that the ETHLR method can capture the complementary information among multiple views. Take the PAAD_CHOL_ESCA dataset as an example, it contains three multi-view features, namely gene expression (GE), copy number variation (CNV) and methylation (ME). Table II shows the clustering results of the ETHLR method on single-view (GE, CNV and ME) and multi-view data. It is worth noting that the WTSNM constraint adopted in ETHLR will degenerate to the weighted Schatten p-norm minimization (WSNM) on single-view data. From Table II, we can observe that the clustering results of all views are significantly higher than those of single-view. This confirms that ETHLR is effective in considering complementary information among multiple views. Furthermore, it is important to explore complementary and higher-order information embedded in multi-view data.

TABLE II

CLUSTERING RESULTS ON SINGLE-VIEW AND MULTI-VIEW DATASETS

Metrics	GE	CNV	ME	All Views
AC(%)	90.94	69.37	84.70	**97.03**
NMI(%)	73.28	46.65	59.84	**86.00**
Recall(%)	84.01	63.26	62.58	**92.14**
Precision(%)	92.31	58.88	62.40	**97.83**
F-measure(%)	87.96	60.99	62.09	**94.90**