Table 4: (APPENDIX) The opitmal hyper-parameter settings found by Bayesian HyperOpt for all methods.

	Parameter	CAL	PHO	SIN	NY	Searching space	Description
BPRMF	-embedding_size	60	60	60	60	{60, 90, 120, 150, 180, 210}	the size of embeddings
	-epochs	50	50	50	50	-	the number of epochs
	-lr	0.0093	0.0084	0.0091	0.0089	[0.0001, 0.01]	learning rate
	-lambda	0.0050	0.0081	0.0093	0.0091	[0.0001, 0.01]	L2 regularization coefficient
	-batch_size	256	256	512	512	{256, 512, 1024}	batch size
ST-RNN	-embedding_size	90	90	120	120	{60, 90, 120, 150, 180, 210}	the size of embeddings
	-epochs	50	50	50	50	-	the number of epochs
	-lr	0.0091	0.0086	0.0097	0.0092	[0.0001, 0.01]	learning rate
01 14111	-lambda	0.0015	0.0026	0.0042	0.0013	[0.0001, 0.01]	L2 regularization coefficient
	-batch_size	256	512	512	512	{256, 512, 1024}	batch size
	-layers	1	1	1	1	{1, 2, 3}	the number of RNN layers
	-embedding_size	60	120	120	120	{60, 90, 120, 150, 180, 210}	the size of embeddings
	-epochs	50	50	50	50	-	the number of epochs
ATST-LSTM	-lr	0.0009	0.0010	0.0034	0.0012	[0.0001, 0.01]	learning rate
	-lambda	0.0004	0.0004	0.0003	0.0002	[0.0001, 0.01]	L2 regularization coefficient
	-batch_size	512	512	512	1024	{256, 512, 1024}	batch size
	-layers	1	1	1	1	{1, 2, 3}	the number of LSTM layers
	-embedding_size	90	90	120	120	{60, 90, 120, 150, 180, 210}	the size of embeddings
	-epochs -lr	50 0.0089	50 0.0091	50 0.0085	50 0.0085	- [0.0001_0.01]	the number of epochs
MCARNN	-Ir -lambda	0.0089	0.0091	0.0085	0.0085	[0.0001, 0.01] [0.0001, 0.01]	learning rate L2 regularization coefficient
	-batch size	512	512	512	512	{256, 512, 1024}	batch size
	-layers	2	2	2	2	{230, 312, 1024} {1, 2, 3}	the number of RNN layers
	-embedding_size	120	120	120	120	{60, 90, 120, 150, 180, 210}	the size of embeddings
	-embedding_size -epochs	50	50	50	50	{60, 90, 120, 150, 180, 210}	the number of epochs
	-epochs	0.0001	0.0001	0.0001	0.0002	[0.0001, 0.01]	learning rate
iMTL	-lambda	0.0001	0.0001	0.0001	0.0002	[0.0001, 0.01]	L2 regularization coefficient
	-batch_size	256	512	512	512	{256, 512, 1024}	batch size
	-layers	2	2	2	2	{1, 2, 3}	the number of LSTM layers
	-embedding_size	60	90	90	120	{60, 90, 120, 150, 180, 210}	the size of embeddings
	-epochs	50	50	50	50	-	the number of epochs
SASRec	-lr	0.0005	0.0008	0.0013	0.0016	[0.0001, 0.01]	learning rate
	-lambda	0.0001	0.0002	0.0002	0.0002	[0.0001, 0.01]	L2 regularization coefficient
	-batch_size	256	512	512	512	{256, 512, 1024}	batch size
	-heads	1	1	1	1	{1, 2, 3}	the heads of self-attention
	-blocks	1	1	1	1	{1, 2, 3}	the blocks of self-attention
	-dropout	0.25	0.25	0.25	0.75	{0.25, 0.5, 0.75}	the dropout rate of self-attention
	-embedding_size	90	90	90	120	{60, 90, 120, 150, 180, 210}	the size of embeddings
	-epochs	50	50	50	50	-	the number of epochs
	l -lr	0.0010	0.0014	0.0012	0.0011	[0.0001, 0.01]	learning rate
LightGCN		0.0018					
~1511CU.	-lambda	0.0001	0.0004	0.0002	0.0002	[0.0001, 0.01]	L2 regularization coefficient
2151113014	-lambda -batch_size	0.0001 512	0.0004 512	0.0002 512	512	{256, 512, 1024}	L2 regularization coefficient batch size
2511001	-lambda -batch_size -dropout	0.0001 512 0.25	0.0004 512 0.25	0.0002 512 0.5	512 0.5	{256, 512, 1024} {0.25, 0.5, 0.75}	L2 regularization coefficient batch size the dropout rate of GCN
	-lambda -batch_size -dropout -layers	0.0001 512 0.25 2	0.0004 512 0.25 2	0.0002 512 0.5 2	512 0.5 2	{256, 512, 1024} {0.25, 0.5, 0.75} {1, 2, 3}	L2 regularization coefficient batch size the dropout rate of GCN the number of GCN layers
Digital CIV	-lambda -batch_size -dropout -layers -embedding_size	0.0001 512 0.25 2 120	0.0004 512 0.25 2	0.0002 512 0.5 2	512 0.5 2 120	{256, 512, 1024} {0.25, 0.5, 0.75}	L2 regularization coefficient batch size the dropout rate of GCN the number of GCN layers the size of embeddings
agmoort.	-lambda -batch_size -dropout -layers -embedding_size -epochs	0.0001 512 0.25 2 120 50	0.0004 512 0.25 2 120 50	0.0002 512 0.5 2 120 50	512 0.5 2 120 50	{256, 512, 1024} {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210}	L2 regularization coefficient batch size the dropout rate of GCN the number of GCN layers the size of embeddings the number of epochs
	-lambda -batch_size -dropout -layers -embedding_size -epochs -lr	0.0001 512 0.25 2 120 50 0.0051	0.0004 512 0.25 2 120 50 0.0045	0.0002 512 0.5 2 120 50 0.0091	512 0.5 2 120 50 0.0099	{256, 512, 10 ² 4} {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210} - [0.0001, 0.01]	L2 regularization coefficient batch size the dropout rate of GCN the number of GCN layers the size of embeddings the number of epochs learning rate
SGRec	-lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda	0.0001 512 0.25 2 120 50 0.0051 0.0001	0.0004 512 0.25 2 120 50 0.0045 0.0002	0.0002 512 0.5 2 120 50 0.0091 0.0002	512 0.5 2 120 50 0.0099 0.0004	{256, 512, 10 ² 4} {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210} - [0.0001, 0.01] [0.0001, 0.01]	L2 regularization coefficient batch size the dropout rate of GCN the number of GCN layers the size of embeddings the number of epochs learning rate L2 regularization coefficient
	-lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda -batch_size	0.0001 512 0.25 2 120 50 0.0051 0.0001 512	0.0004 512 0.25 2 120 50 0.0045 0.0002 512	0.0002 512 0.5 2 120 50 0.0091 0.0002 512	512 0.5 2 120 50 0.0099 0.0004 1024	{256, 512, 10 ² 4} {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210} - [0.0001, 0.01] [0.0001, 0.01] {256, 512, 1024}	L2 regularization coefficient batch size the dropout rate of GCN the number of GCN layers the size of embeddings the number of epochs learning rate L2 regularization coefficient batch size
	-lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda -batch_size -dropout	0.0001 512 0.25 2 120 50 0.0051 0.0001 512 0.25	0.0004 512 0.25 2 120 50 0.0045 0.0002 512 0.25	0.0002 512 0.5 2 120 50 0.0091 0.0002 512 0.25	512 0.5 2 120 50 0.0099 0.0004 1024 0.25	[256, 512, 1024] {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210} - [0.0001, 0.01] [0.0001, 0.01] [256, 512, 1024] {0.25, 0.5, 0.75}	L2 regularization coefficient batch size the dropout rate of GCN the number of GCN layers the size of embeddings the number of epochs learning rate L2 regularization coefficient batch size the dropout rate of GAT
	-lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda -batch_size -dropout -layers	0.0001 512 0.25 2 120 50 0.0051 0.0001 512 0.25 1	0.0004 512 0.25 2 120 50 0.0045 0.0002 512 0.25 1	0.0002 512 0.5 2 120 50 0.0091 0.0002 512 0.25 1	512 0.5 2 120 50 0.0099 0.0004 1024 0.25 1	{256, 512, 1024} {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210} - [0.0001, 0.01] [0.0001, 0.01] {256, 512, 1024} {0.25, 0.5, 0.75} {1, 2, 3}	L2 regularization coefficient batch size the dropout rate of GCN the number of GCN layers the size of embeddings the number of epochs learning rate L2 regularization coefficient batch size the dropout rate of GAT the number of GAT layers
	-lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda -batch_size -dropout -layers -embedding_size	0.0001 512 0.25 2 120 50 0.0051 0.0001 512 0.25 1	0.0004 512 0.25 2 120 50 0.0045 0.0002 512 0.25 1	0.0002 512 0.5 2 120 50 0.0091 0.0002 512 0.25 1	512 0.5 2 120 50 0.0099 0.0004 1024 0.25 1	[256, 512, 1024] {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210} - [0.0001, 0.01] [0.0001, 0.01] [256, 512, 1024] {0.25, 0.5, 0.75}	L2 regularization coefficient batch size the dropout rate of GCN the number of GCN layers the size of embeddings the number of epochs learning rate L2 regularization coefficient batch size the dropout rate of GAT the number of GAT layers the size of embeddings
	-lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda -batch_size -dropout -layers -embedding_size -embedding_size -epochs	0.0001 512 0.25 2 120 50 0.0051 0.0001 512 0.205 1 180 50	0.0004 512 0.25 2 120 50 0.0045 0.0002 512 0.25 1 120 50	0.0002 512 0.5 2 120 50 0.0091 0.0092 512 0.25 1 120 50	512 0.5 2 120 50 0.0099 0.0004 1024 0.25 1 120 50	[256, 512, 1024] {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210} - [0.0001, 0.01] [0.0001, 0.01] {256, 512, 1024} {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210}	L2 regularization coefficient batch size the dropout rate of GCN the number of GCN layers the size of embeddings the number of epochs learning rate L2 regularization coefficient batch size the dropout rate of GAT the number of GAT layers the size of embeddings the number of epochs
	-lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda -batch_size -dropout -layers -embedding_size -epochs -lr	0.0001 512 0.25 2 120 50 0.0051 0.0001 512 0.25 1 180 50 0.0043	0.0004 512 0.25 2 120 50 0.0045 0.0002 512 0.25 1 120 50 0.004	0.0002 512 0.5 2 120 50 0.0091 0.0002 512 0.25 1 120 50 0.0016	512 0.5 2 120 50 0.0099 0.0004 1024 0.25 1 120 50 0.0015	[256, 512, 1024] {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210} - [0.0001, 0.01] [256, 512, 1024] {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210} - [0.0001, 0.01]	L2 regularization coefficient batch size the dropout rate of GCN the number of GCN layers the size of embeddings the number of epochs learning rate L2 regularization coefficient batch size the dropout rate of GAT the number of GAT layers the size of embeddings the number of epochs learning rate
SGRec	-lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda	0.0001 512 0.25 2 120 50 0.0051 0.0001 512 0.25 1 180 50 0.0043 0.0001	0.0004 512 0.25 2 120 50 0.0045 0.0002 512 0.25 1 120 50 0.0024 0.0024	0.0002 512 0.5 2 120 50 0.0091 0.0002 512 0.25 1 120 50 0.0016 0.0001	512 0.5 2 120 50 0.0099 0.0004 1024 0.25 1 120 50 0.0015 0.0015	[256, 512, 1024] {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210} - [0.0001, 0.01] [0.0001, 0.01] {256, 512, 1024} {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210} - [0.0001, 0.01] [0.0001, 0.01]	L2 regularization coefficient batch size the dropout rate of GCN the number of GCN layers the size of embeddings the number of epochs learning rate L2 regularization coefficient batch size the dropout rate of GAT the number of GAT layers the size of embeddings the number of epochs learning rate L2 regularization coefficient
	-lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda -batch_size -epochs -lr -lambda -batch_size	0.0001 512 0.25 2 120 50 0.0051 0.0001 512 180 50 0.0043 0.0001 512	0.0004 512 0.25 2 120 50 0.0045 0.0002 512 0.25 1 120 50 0.024 0.0024 0.0001 512	0.0002 512 0.5 2 120 50 0.0091 0.0002 512 0.25 1 120 50 0.001 512	512 0.5 2 120 50 0.0099 0.0004 1024 0.25 1 120 50 0.0015 0.0001 1024	{256, 512, 1024} {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210} - [0.0001, 0.01] [0.0001, 0.01] {256, 512, 1024} {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210} - [0.0001, 0.01] [0.0001, 0.01] {256, 512, 1024}	L2 regularization coefficient batch size the dropout rate of GCN the number of GCN layers the size of embeddings the number of epochs learning rate L2 regularization coefficient batch size the dropout rate of GAT the number of GAT layers the size of embeddings the number of epochs learning rate L2 regularization coefficient batch size
SGRec	-lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda -batch_size -dropout	0.0001 512 0.25 2 120 50 0.0051 0.0001 512 0.25 1 180 50 0.0043 0.0001 512 1	0.0004 512 0.25 2 120 50 0.0045 0.0002 512 0.25 1 120 50 0.0024 0.0024	0.0002 512 0.5 2 120 50 0.0091 0.0002 512 0.25 1 120 50 0.0016 0.0001	512 0.5 2 120 50 0.0099 0.0004 1024 0.25 1 120 50 0.0015 0.0001 1024	[256, 512, 1024] {0.25, 0.5, 0.75} {1, 2, 3} [60, 90, 120, 150, 180, 210] - [0.0001, 0.01] [0.0001, 0.01] {256, 512, 1024} {0.25, 0.5, 0.75} {1, 2, 3} [0.0001, 0.01] [0.0001, 0.01] [0.0001, 0.01] {256, 512, 1024} {1, 2, 3}	L2 regularization coefficient batch size the dropout rate of GCN the number of GCN layers the size of embeddings the number of epochs learning rate L2 regularization coefficient batch size the dropout rate of GAT the number of GAT layers the size of embeddings the number of epochs learning rate L2 regularization coefficient batch size the number of GCN layers
SGRec	-lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda -batch_size -topout -layers -epochs -lr -lambda -batch_size -layers -layers -layers	0.0001 512 0.25 2 120 50 0.0051 0.0001 512 0.25 1 180 50 0.0043 0.0001 512 1	0.0004 512 0.25 2 120 50 0.0045 0.0002 512 0.25 1 120 50 0.0024 0.0001 512	0.0002 512 0.5 2 120 50 0.0091 0.0002 512 0.25 1 120 50 0.0016 0.0001 512	512 0.5 2 120 50 0.0099 0.0004 1024 0.25 1 120 50 0.0015 0.0001 1024 1	[256, 512, 1024] {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210} - [0.0001, 0.01] [256, 512, 1024] {0.25, 0.5, 0.75} {1, 2, 3} {60, 90, 120, 150, 180, 210} - [0.0001, 0.01] [0.0001, 0.01] [256, 512, 1024] {1, 2, 3} {1, 2, 3}	L2 regularization coefficient batch size the dropout rate of GCN the number of GCN layers the size of embeddings the number of epochs learning rate L2 regularization coefficient batch size the dropout rate of GAT the number of GAT layers the size of embeddings the number of epochs learning rate L2 regularization coefficient batch size the number of GCN layers the number of GCN layers the heads of self-attention
SGRec	-lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda -batch_size -dropout -layers -embedding_size -epochs -lr -lambda -batch_size -dropout	0.0001 512 0.25 2 120 50 0.0051 0.0001 512 0.25 1 180 50 0.0043 0.0001 512 1	0.0004 512 0.25 2 120 50 0.0045 0.0002 512 0.25 1 120 50 0.0024 0.0024	0.0002 512 0.5 2 120 50 0.0091 0.0002 512 0.25 1 120 50 0.0016 0.0001	512 0.5 2 120 50 0.0099 0.0004 1024 0.25 1 120 50 0.0015 0.0001 1024	[256, 512, 1024] {0.25, 0.5, 0.75} {1, 2, 3} [60, 90, 120, 150, 180, 210] - [0.0001, 0.01] [0.0001, 0.01] {256, 512, 1024} {0.25, 0.5, 0.75} {1, 2, 3} [0.0001, 0.01] [0.0001, 0.01] [0.0001, 0.01] {256, 512, 1024} {1, 2, 3}	L2 regularization coefficient batch size the dropout rate of GCN the number of GCN layers the size of embeddings the number of epochs learning rate L2 regularization coefficient batch size the dropout rate of GAT the number of GAT layers the size of embeddings the number of epochs learning rate L2 regularization coefficient batch size the number of GCN layers