

Supplementary Table S1. The top ten pathways enriched by any of the five BN reconstruction methods in HNSC dataset.

Pathway Name	Rank in BNrich	Rank in PROPS	Rank in Clipper	Rank in BPA	Rank in Ensemble
Adherens junction	60	65	69	4	65
AGE-RAGE signaling pathway in diabetic complications	15	7	8	31	5
Alcoholism	14	9	9	25	6
Axon guidance	56	39	65	7	42
Basal cell carcinoma	140	11	43	35	9
Central carbon metabolism in cancer	6	34	12	19	11
Chemical carcinogenesis - DNA adducts	5	3	3	2	7
Chemokine signaling pathway	4	NA	NA	NA	NA
Circadian entrainment	25	27	10	27	80
ECM-receptor interaction	2	1	1	3	2
Endocrine resistance	16	8	4	5	4
Focal adhesion	10	NA	NA	NA	NA
JAK-STAT signaling pathway	1	NA	NA	NA	NA
MAPK signaling pathway	8	41	50	NA	31
NF-kappa B signaling pathway	42	12	57	8	37
p53 signaling pathway	7	51	35	21	25
Pancreatic cancer	34	5	5	9	24
PI3K-Akt signaling pathway	3	2	2	1	1
Prostate cancer	18	10	13	22	10
Ras signaling pathway	9	17	53	34	19
Regulation of actin cytoskeleton	12	16	11	6	8
Small cell lung cancer	145	4	7	15	3
Type II diabetes mellitus	98	99	40	10	101
Wnt signaling pathway	11	6	6	13	12

*NA: Pathways failed to be reconstructed into Bayesian network.

Supplementary Table S2. The top ten pathways enriched by any of the five BN reconstruction methods in KIRC dataset.

Pathway Name	Rank in BNrich	Rank in PROPS	Rank in Clipper	Rank in BPA	Rank in Ensemble
Adherens junction	19	3	23	19	12
Adipocytokine signaling pathway	10	93	19	54	26
Cell adhesion molecules	33	10	28	16	40
Chemokine signaling pathway	85	6	7	11	6
Circadian entrainment	49	15	25	4	10
ECM-receptor interaction	2	8	6	13	2
EGFR tyrosine kinase inhibitor resistance	7	45	9	5	17
Insulin resistance	29	5	16	30	16
JAK-STAT signaling pathway	18	NA	8	3	5
Longevity regulating pathway	6	9	22	9	30
Long-term depression	8	28	13	21	24
MAPK signaling pathway	3	27	49	39	51
Morphine addiction	14	1	12	2	13
NF-kappa B signaling pathway	56	7	68	90	124
Pathways in cancer	16	14	2	6	9
PI3K-Akt signaling pathway	1	26	3	14	3
Prostate cancer	9	17	11	10	8
Rap1 signaling pathway	5	13	5	8	7
Ras signaling pathway	4	11	4	12	4
Regulation of actin cytoskeleton	21	4	31	24	15
Retrograde endocannabinoid signaling	113	2	1	1	1
Small cell lung cancer	11	12	10	7	11

*NA: Pathways failed to be reconstructed into Bayesian network.

Supplementary Table S3. The top ten pathways enriched by any of the five BN reconstruction methods in LUAD dataset.

Pathway Name	Rank in BNrich	Rank in PROPS	Rank in Clipper	Rank in BPA	Rank in Ensemble
AGE-RAGE signaling pathway in diabetic complications	71	10	56	70	64
AMPK signaling pathway	12	48	30	46	10
Apoptosis	31	94	31	7	30
Bladder cancer	58	6	2	4	9
Chagas disease	25	7	33	2	16
Chemokine signaling pathway	29	13	5	25	7
Cytokine-cytokine receptor interaction	8	26	18	18	8
Endocrine resistance	14	41	4	6	3
Fc epsilon RI signaling pathway	3	1	45	19	17
Focal adhesion	9	NA	23	NA	4
GABAergic synapse	42	31	50	1	71
Glioma	18	24	35	16	5
Herpes simplex virus 1 infection	2	100	149	112	76
HIF-1 signaling pathway	1	15	20	10	26
Human T-cell leukemia virus 1 infection	115	9	22	52	31
Huntington disease	54	56	9	20	32
JAK-STAT signaling pathway	5	NA	21	21	29
Leukocyte transendothelial migration	39	66	8	50	1
Longevity regulating pathway	32	25	6	24	24
Long-term depression	4	39	7	3	33
Melanoma	37	20	1	37	21
Morphine addiction	68	8	46	22	12
Natural killer cell mediated cytotoxicity	33	3	26	26	70
PI3K-Akt signaling pathway	28	17	10	34	23
Platinum drug resistance	10	29	16	15	25
Prion disease	6	19	11	35	6
Rap1 signaling pathway	7	32	13	23	27

Ras signaling pathway	30	5	60	5	55
Retrograde endocannabinoid signaling	97	38	15	8	11
Type II diabetes mellitus	56	43	3	9	14
Vascular smooth muscle contraction	15	2	17	14	2
Wnt signaling pathway	24	4	24	27	15

*NA: Pathways failed to be reconstructed into Bayesian network.

Supplementary Table S4. The top ten pathways enriched by any of the five BN reconstruction methods in THCA dataset.

Pathway Name	Rank in BNrich	Rank in PROPS	Rank in Clipper	Rank in BPA	Rank in Ensemble
AGE-RAGE signaling pathway in diabetic complications	11	2	7	17	8
Axon guidance	7	3	16	56	18
cAMP signaling pathway	5	17	13	9	7
Cell cycle	49	6	32	57	42
Chagas disease	126	9	152	116	103
Chemical carcinogenesis - DNA adducts	27	1	24	27	27
Chemokine signaling pathway	19	39	18	6	6
Complement and coagulation cascades	23	16	6	14	10
Focal adhesion	34	NA	2	3	3
Insulin resistance	151	7	150	42	133
JAK-STAT signaling pathway	4	NA	4	4	5
MAPK signaling pathway	9	52	12	5	17
Pathways in cancer	24	10	8	12	4
Phospholipase D signaling pathway	45	15	9	8	11
PI3K-Akt signaling pathway	10	5	3	2	2
PPAR signaling pathway	3	4	1	1	1
Proteoglycans in cancer	8	23	15	10	14
Rap1 signaling pathway	2	11	20	13	13
Ras signaling pathway	1	12	5	7	9
Regulation of actin cytoskeleton	6	25	10	16	12
Wnt signaling pathway	31	8	23	26	36

*NA: Pathways failed to be reconstructed into Bayesian network.