



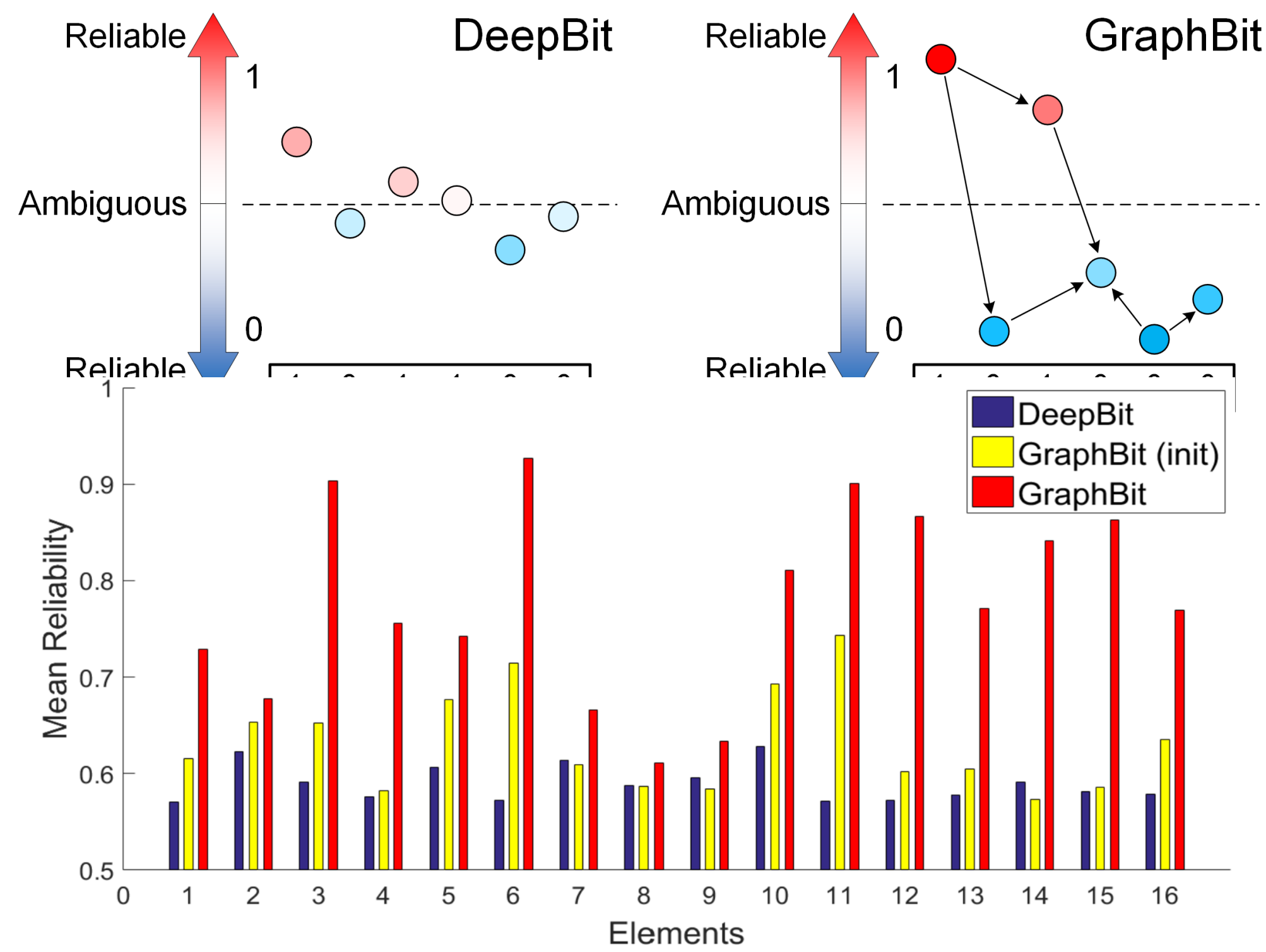
GraphBit: Bitwise Interaction Mining via Deep Reinforcement Learning

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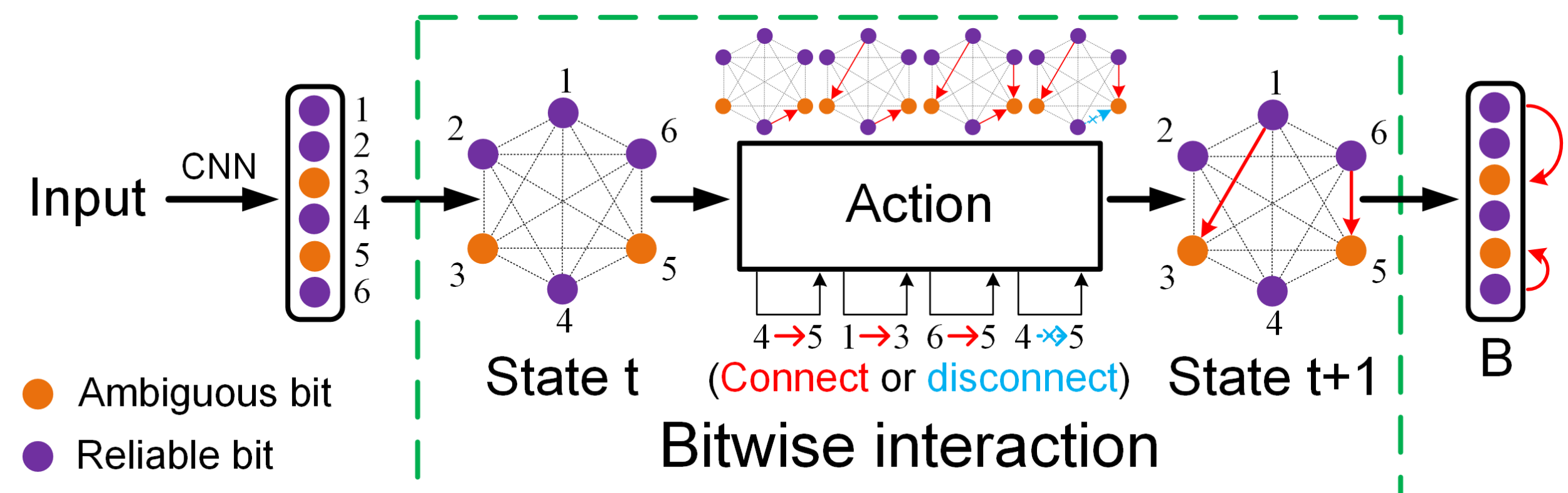
Motivation

- Most deep binary descriptor learning approaches rely on quantization loss [1], whose limitation lies in ambiguous bits.



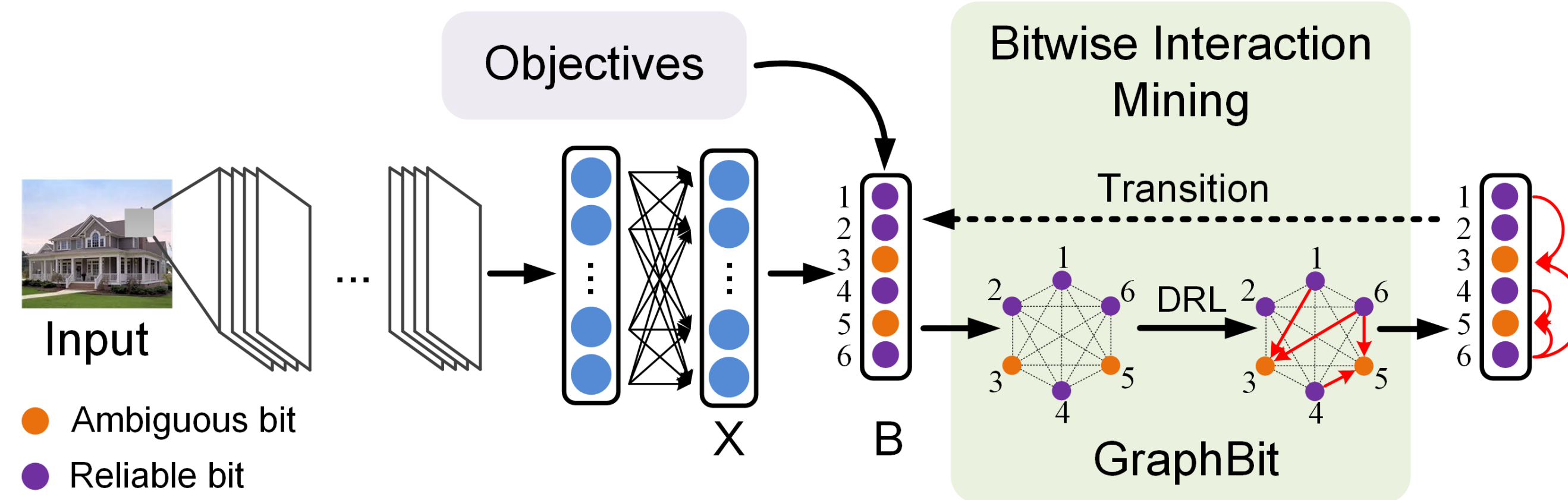
- Our ideas:
 - Probabilistic modeling of bits, instead of explicit quantization.
 - Mining bitwise relationships to teach ambiguous bits.

Flowchart



- Utilizing reinforcement learning to learn bitwise interaction graph.
- Sequentially add or remove directed connections until finalizing the structure of the graph.

GraphBit



- For each input image, we first learn a normalized feature which represents the possibility of being binarized into one.
- We simultaneously train the parameters of the backbone CNN and the structure of the graph for ambiguity elimination in an unsupervised manner.

Objective Function

- Overall

$$J = \sum_{k=1}^K \left\| \sum_{n=1}^N (b_{kn} - 0.5) \right\|^2 - \alpha \sum_{n=1}^N \left(\sum_{b_r \notin \mathbf{b}_s^T} I(b_r; \mathbf{x}_n) + \sum_{\Phi} I(b_s; \mathbf{x}_n, b_t) \right) + \beta \sum_{n=1}^N \sum_{\Phi} \left\| p(b_s | \mathbf{x}_n) - p(b_s | \mathbf{x}_n, b_t) \right\|^2$$

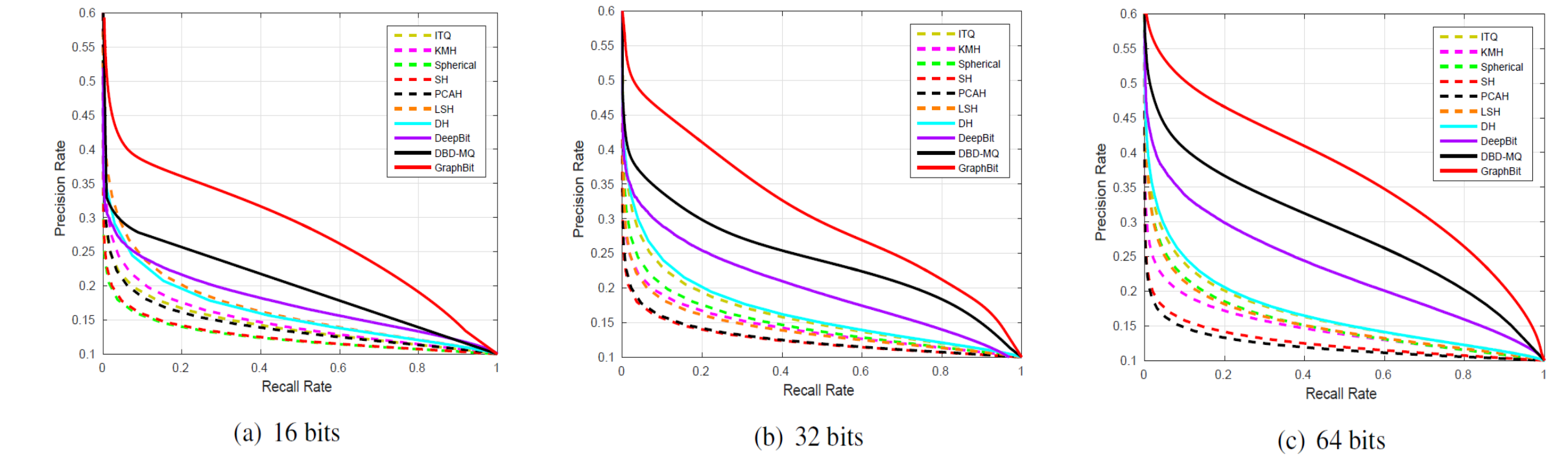
- The first term to make each bit evenly distributed.
- The second term encourages the non-interacted bits b_r to obtain most information from the input samples.
- The third term aims to prevent the interacted bits to become trivial.

References

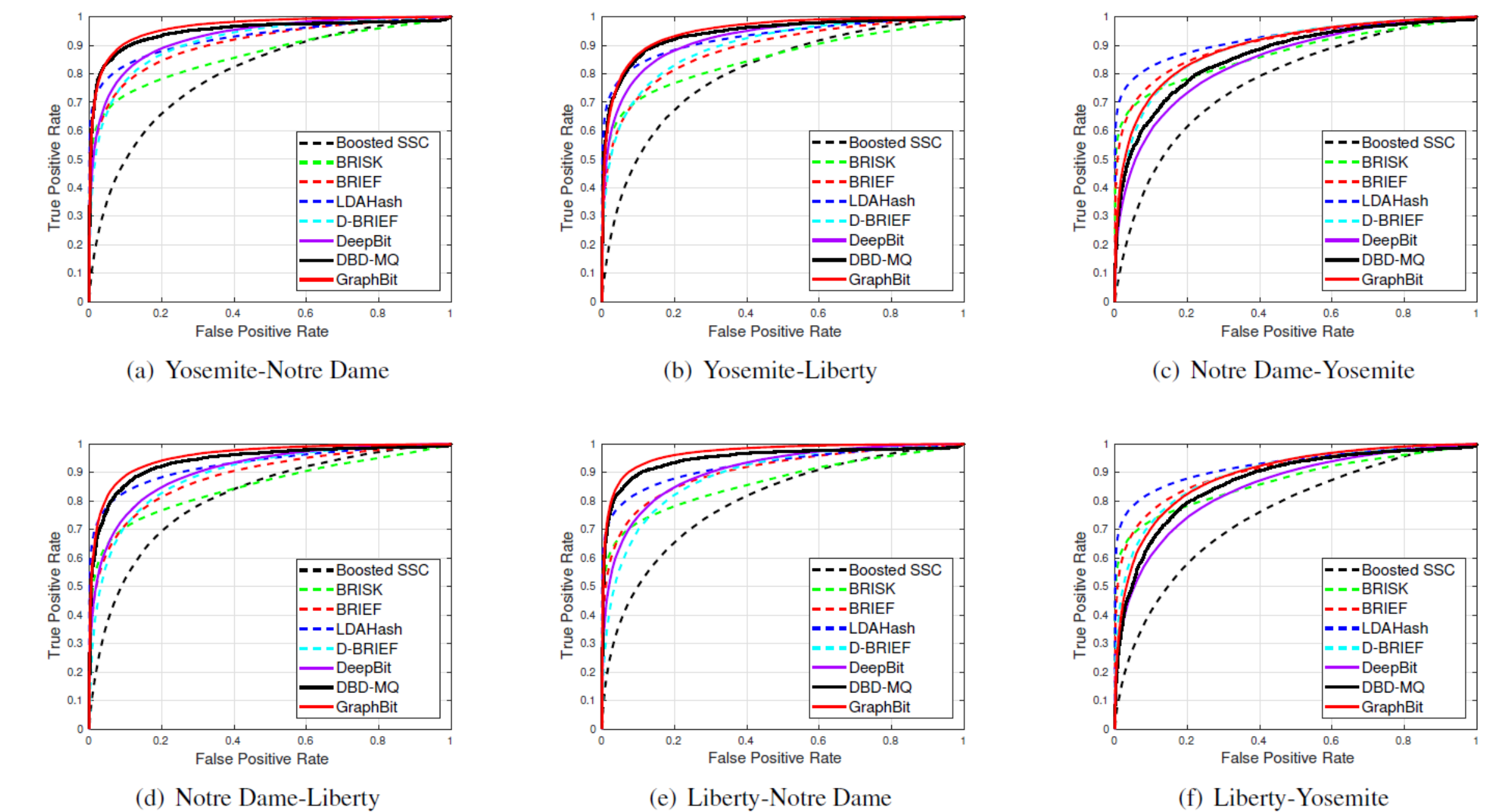
[1] Yueqi Duan, Jiwen Lu, Ziwei Wang, Jianjiang Feng, and Jie Zhou. Learning deep binary descriptor with multi-quantization. CVPR, 2017.

Experiments

- The CIFAR-10 dataset



- The Brown dataset



Train Test	Yosemite Notre Dame	Yosemite Liberty	Notre Dame Yosemite	Notre Dame Liberty	Liberty Notre Dame	Liberty Yosemite	Average ERR
SIFT [30] (128 bytes)	28.09	36.27	29.15	36.27	28.09	29.15	31.17
Boosted SSC [37] (16 bytes)	72.20	71.59	76.00	70.35	72.95	77.99	73.51
BRISK [25] (64 bytes)	74.88	79.36	73.21	79.36	74.88	73.21	75.81
BRIEF [8] (32 bytes)	54.57	59.15	54.96	59.15	54.57	54.96	56.23
DeepBit [27] (32 bytes)	29.60	34.41	63.68	32.06	26.66	57.61	40.67
DBD-MQ [12] (32 bytes)	27.20	33.11	57.24	31.10	25.78	57.15	38.59
LDAHash [42] (16 bytes)	51.58	49.66	52.95	49.66	51.58	52.95	51.40
D-BRIEF [47] (4 bytes)	43.96	53.39	46.22	51.30	43.10	47.29	47.54
BinBoost [45] (8 bytes)	14.54	21.67	18.96	20.49	16.90	22.88	19.24
RFD [14] (50-70 bytes)	11.68	19.40	14.50	19.35	13.23	16.99	15.86
GraphBit (init) (32 bytes)	21.18	28.33	51.62	25.00	18.32	52.58	32.83
GraphBit (32 bytes)	17.78	24.72	49.94	21.18	15.25	49.64	29.75

Code: <https://github.com/duanyq14/GraphBit>