MemSearch: In-Memory Search with the Memristor

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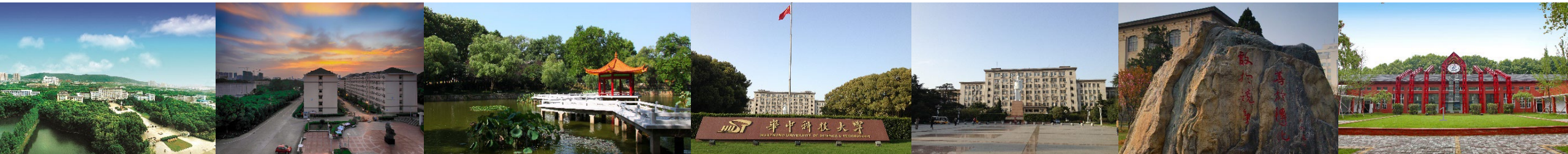

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Find the top-k most similar items in the database

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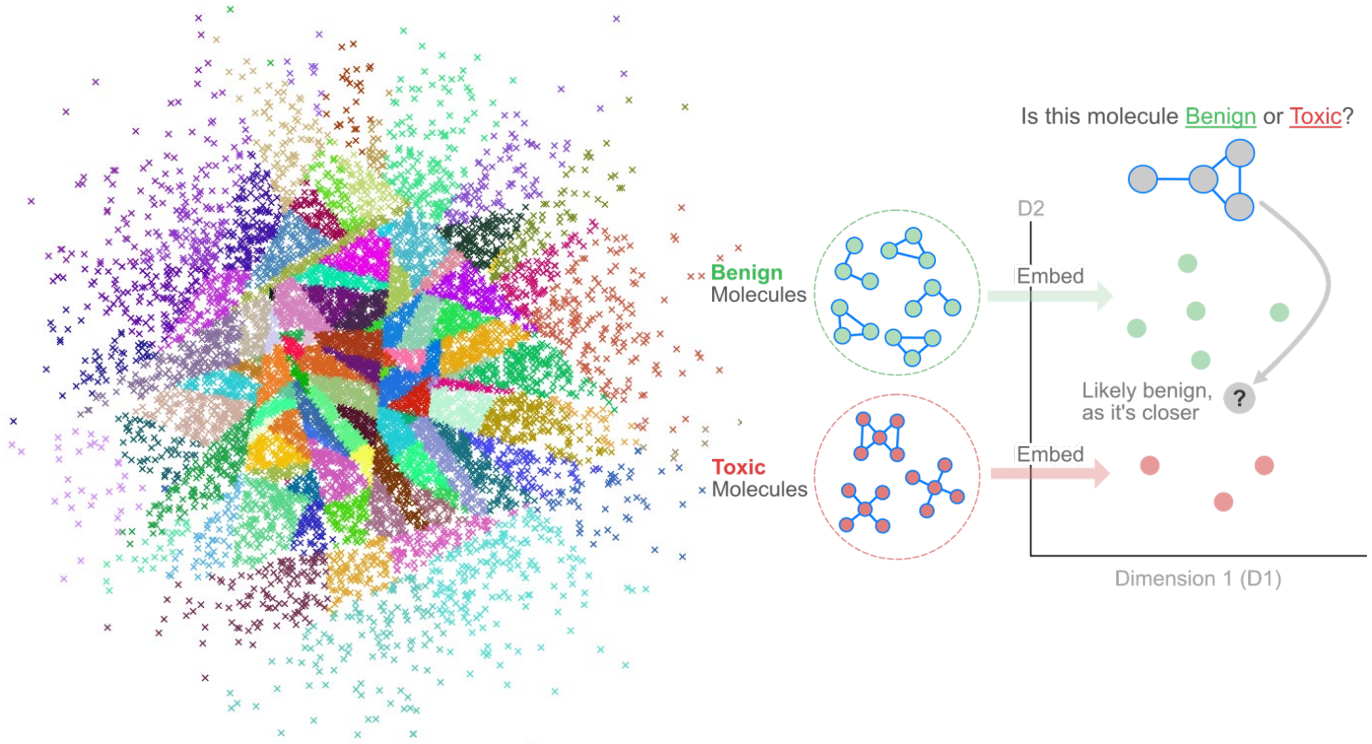
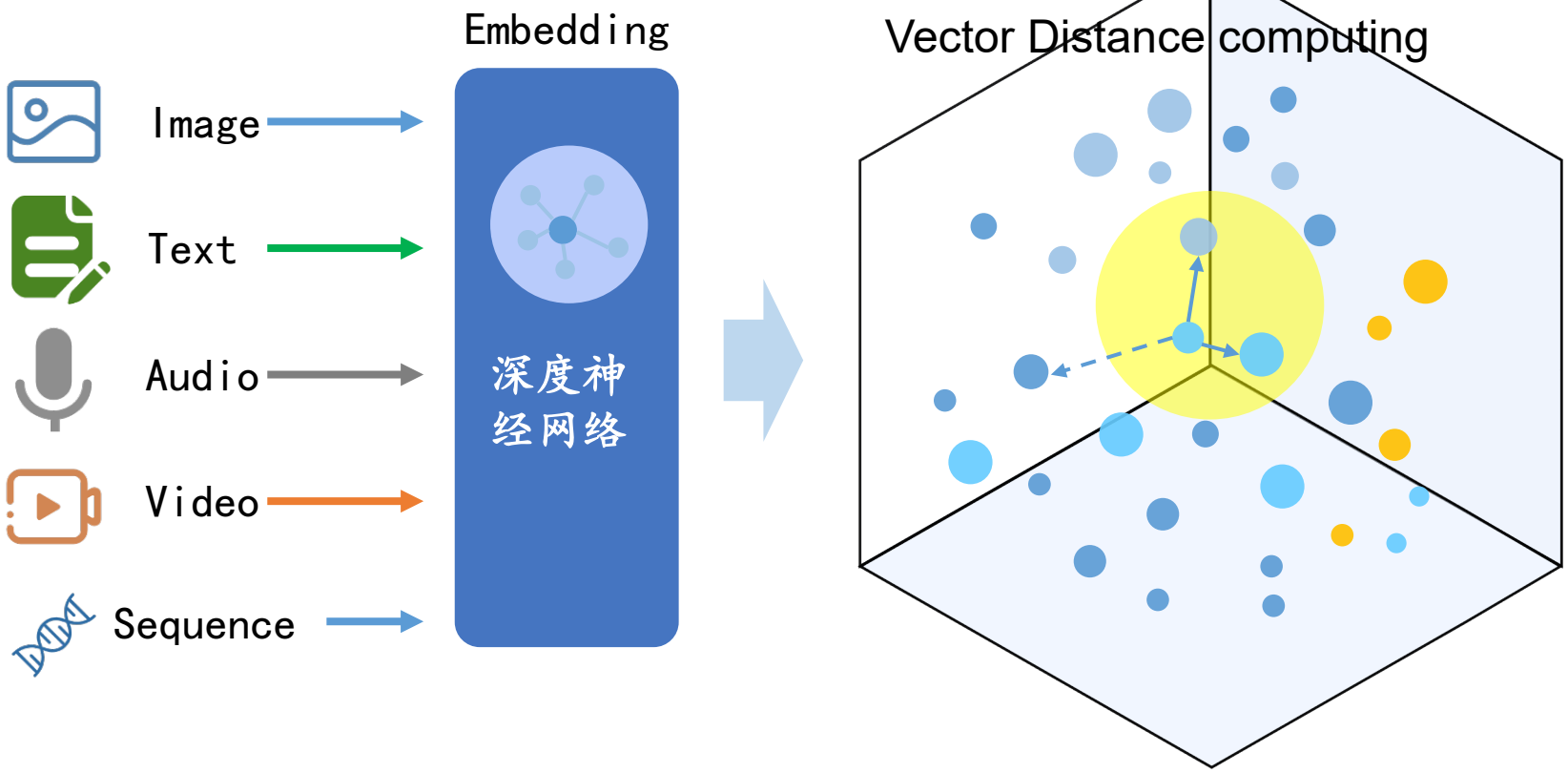
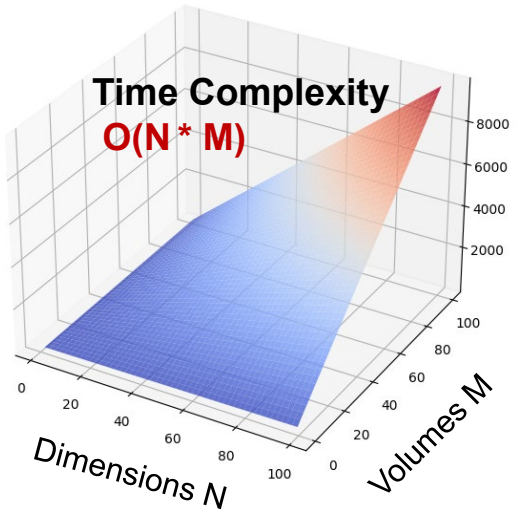


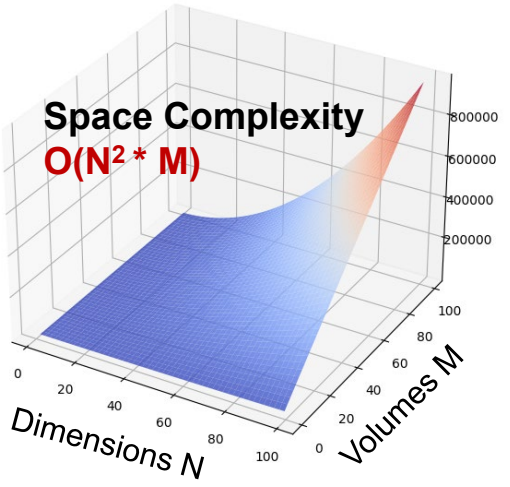
Similarity search is a key part for the AI technology chain

1. Background: Similarity search is fundamental computing problem

Find the similar items by computing the distance

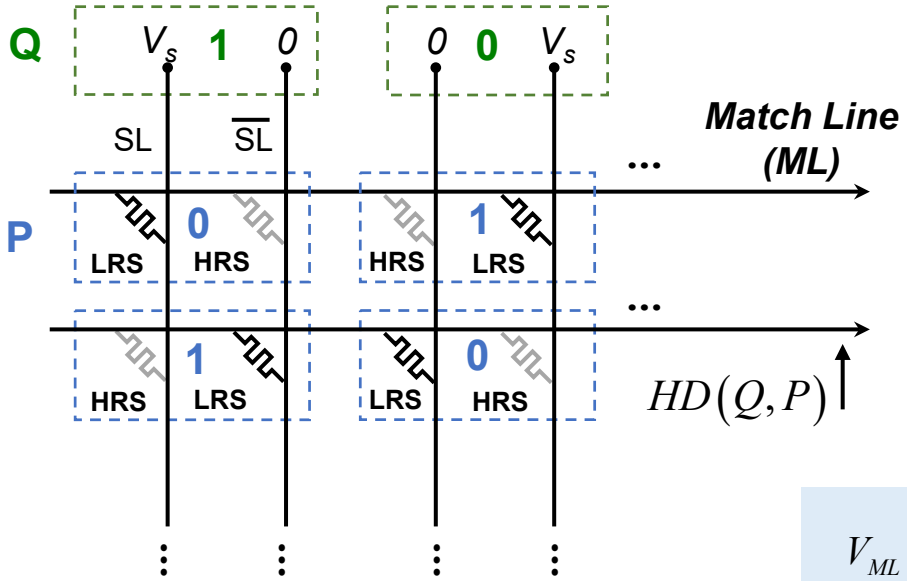


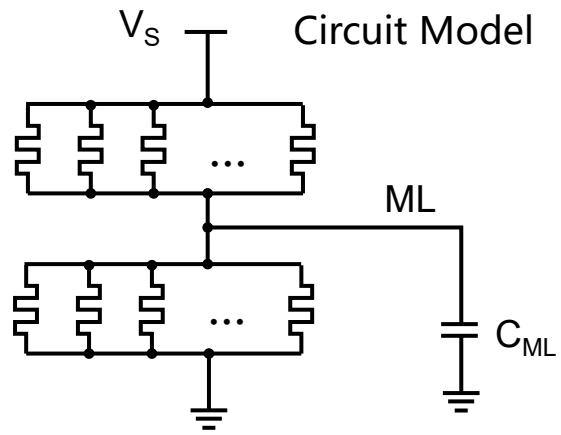


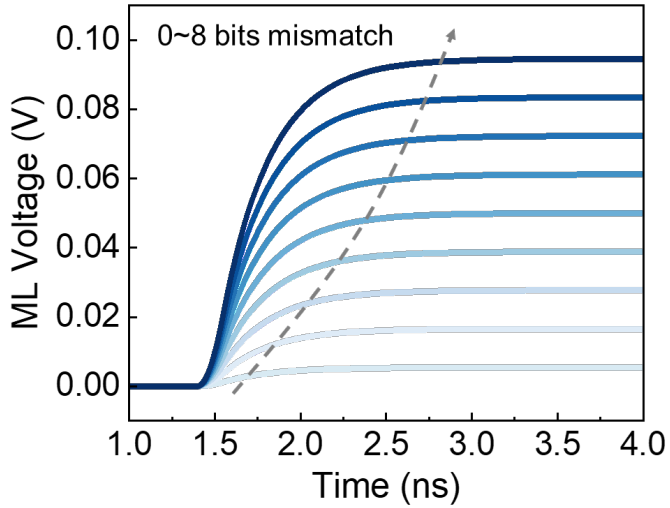


Vector distance computing requires huge resources!

2.Memristive TCAM

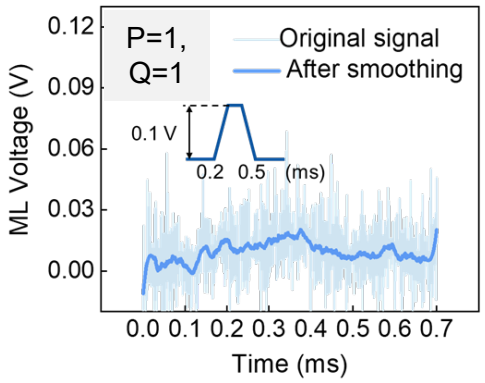


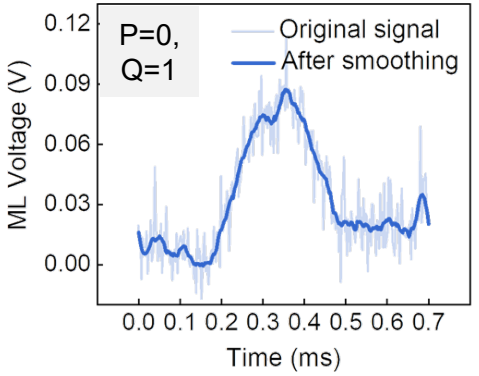


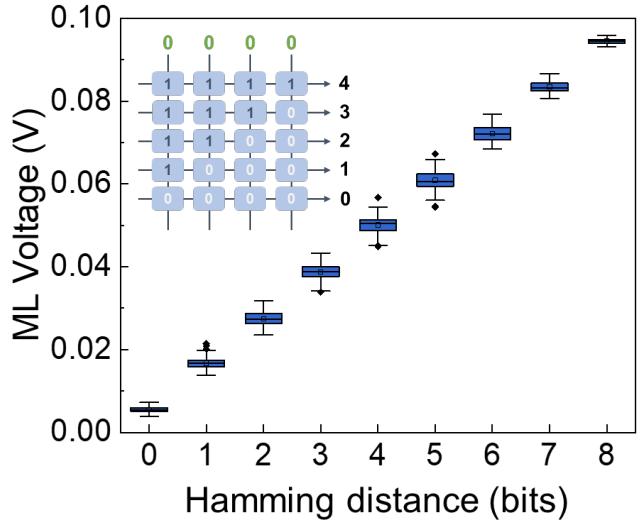


$$V_{ML} = V_s \frac{N \cdot LRS + HD(HRS - LRS)}{N(HRS + LRS)} = a \cdot HD + b$$

State	P	Q
0	(LRS, HRS)	(0, V_S)
1	(HRS, LRS)	(V_S, 0)
X	(HRS, HRS)	(0, 0)

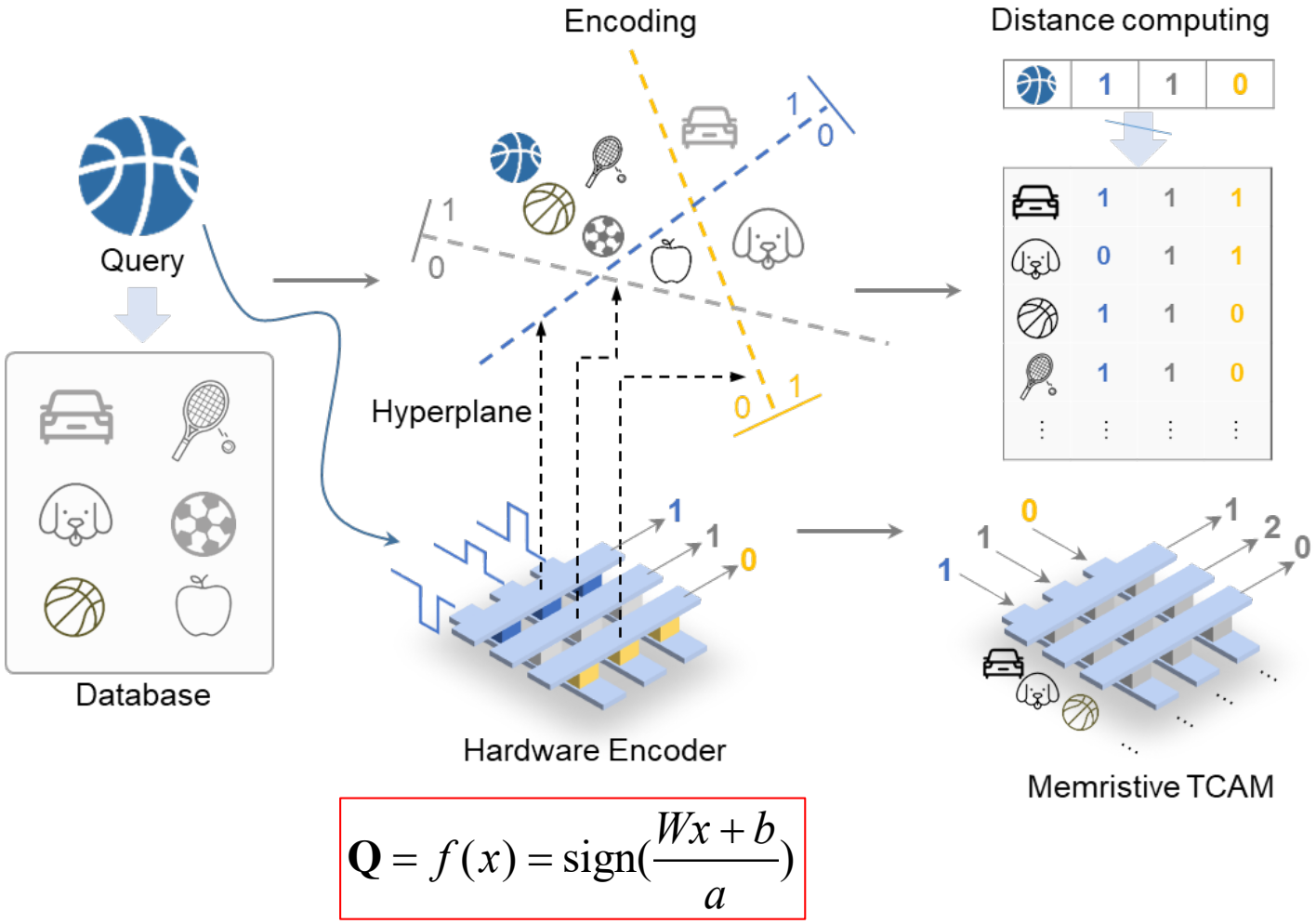




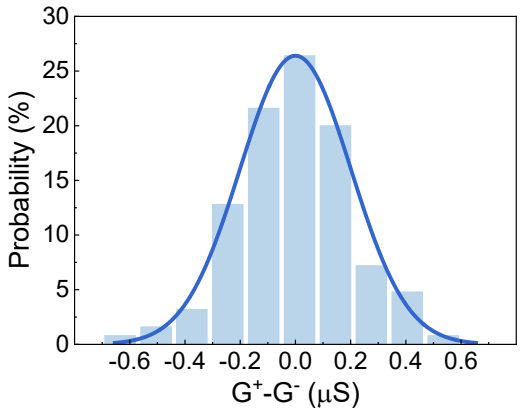


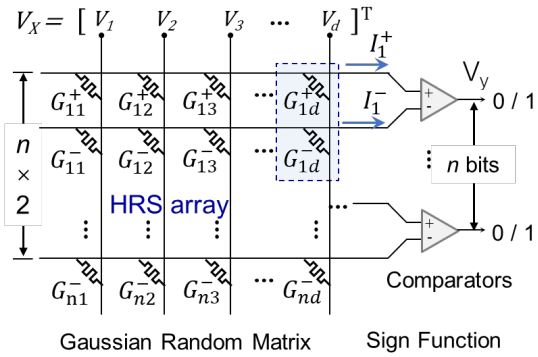
The Match line voltage maps the Hamming distance between the stored data and query data linearly.

3. Hardware Locality sensitive hashing encoder



$$\mathbf{Q} = f(x) = \mathrm{sign}\left(\frac{Wx + b}{a}\right)$$



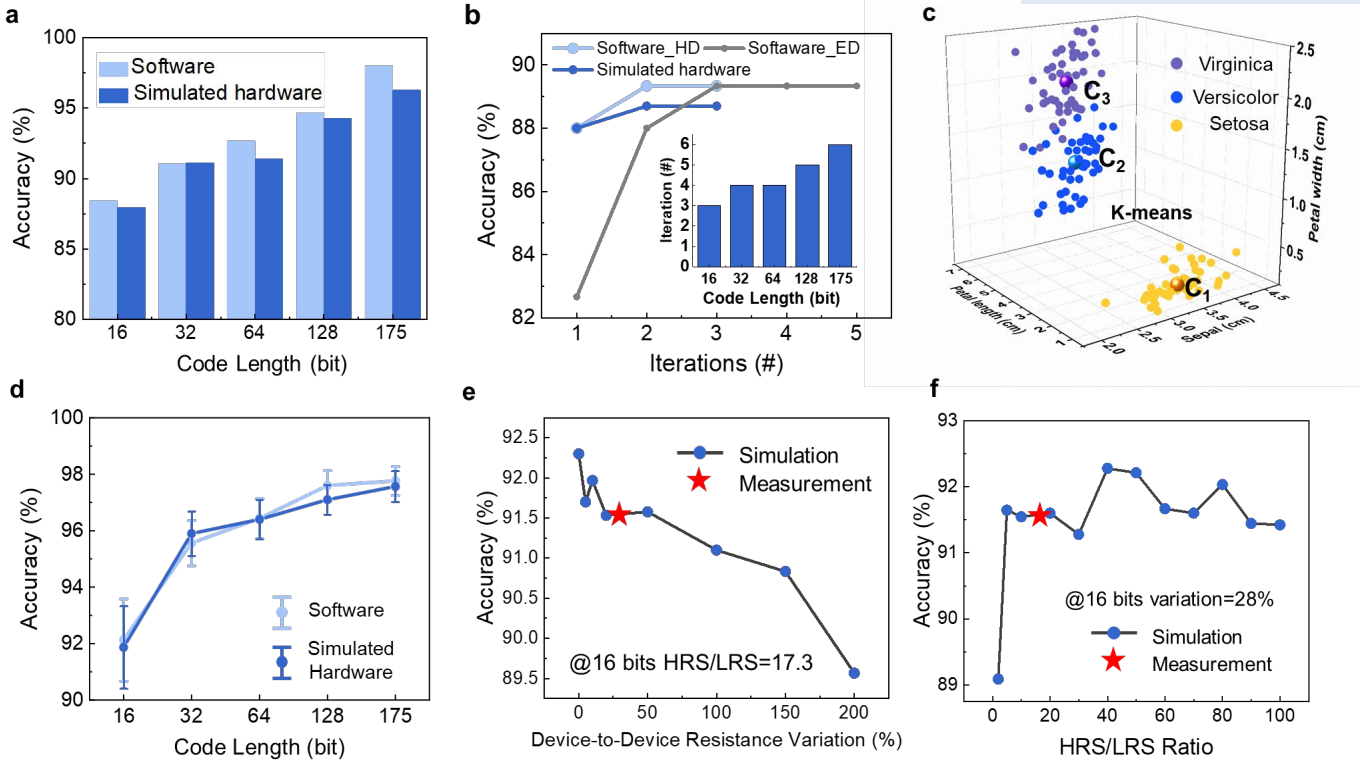


By utilizing the intrinsic randomness of the memristors, the crossbar array serves as a natural hardware locality sensitive hashing encoder.

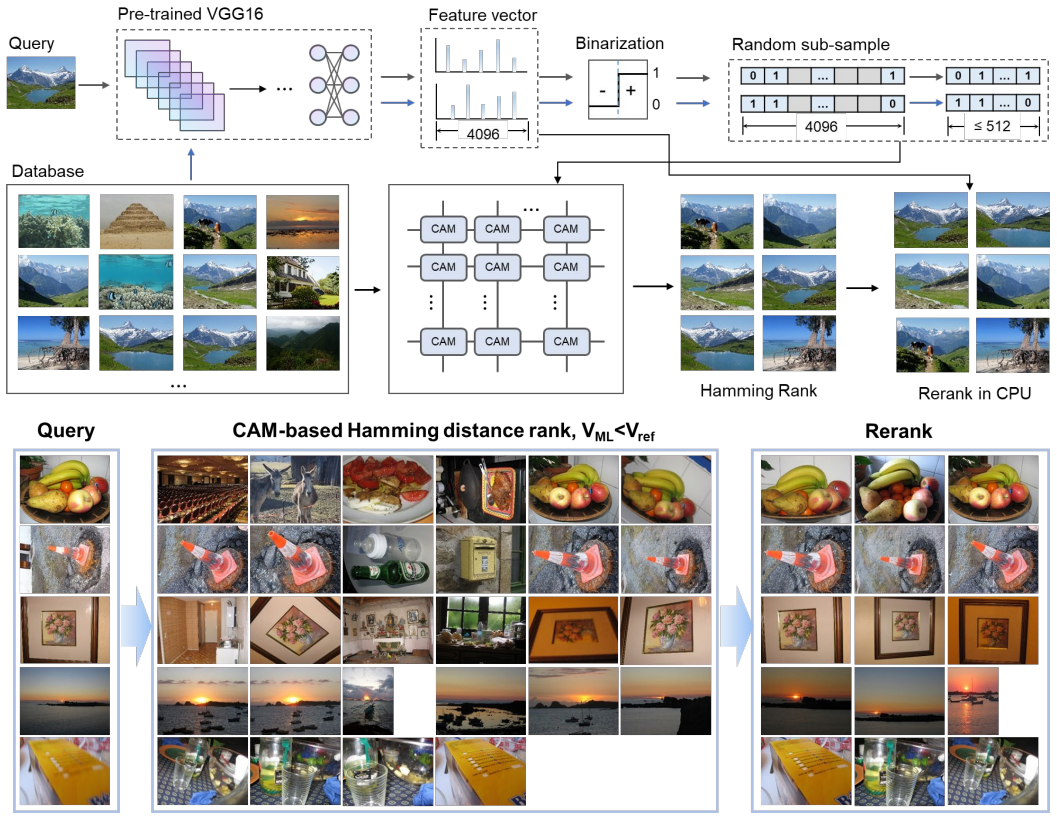
L. Yang et al., InfoMat, p. e12416, 2023

4. Applications

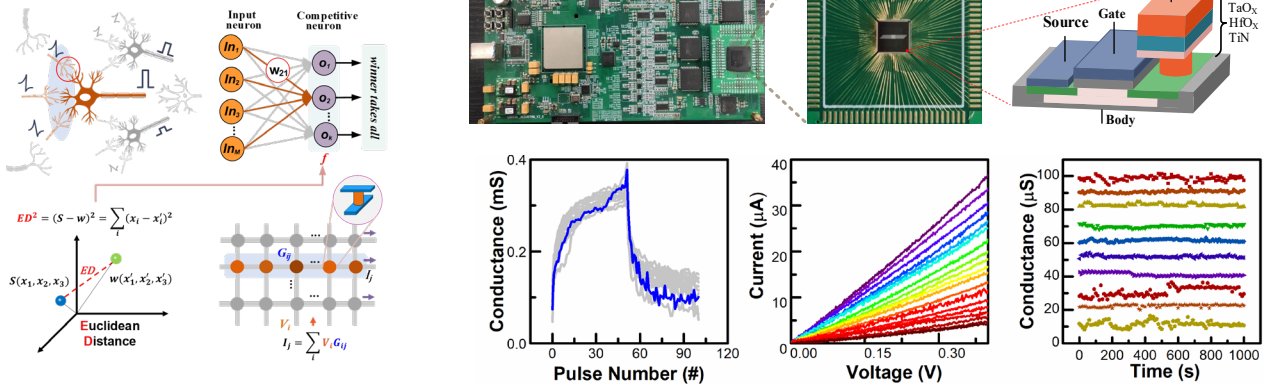
Data Mining



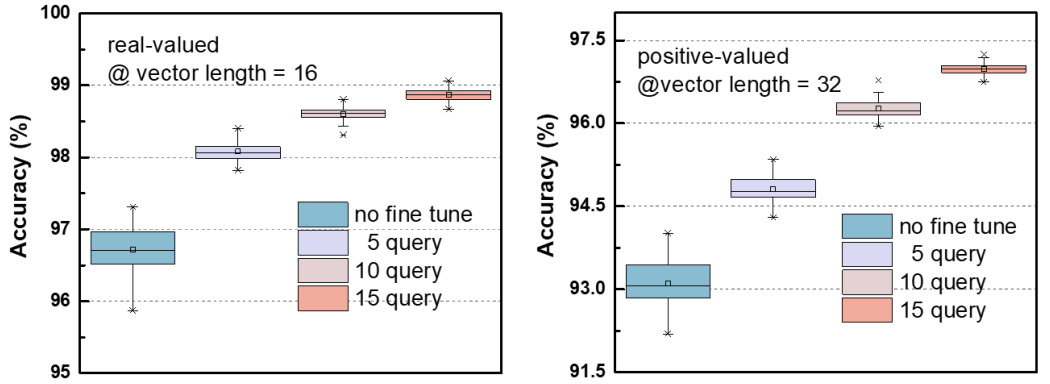
Information Retrieval



competitive learning



Few shot learning



Thanks for Your Attention!

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[1] L. Yang et al., InfoMat, p. e12416, 2023
[2] Y. Yu et al., Advanced Intelligent Systems, vol. 5, no. 3, 2023.
[3] H. Zhou, et al,Advanced Intelligent Systems, vol. 5, no. 2, p. 2200173, 2023.