

## Author Information

### Primary Author

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### Author Contributions

Haobo Ma conceptualized the XOR-SHIFT framework, developed the mathematical formalism, designed the simulation protocols, and wrote the manuscript.

### Author Statement

I, as the sole author of this work, have made all substantial contributions to the conception, analysis, and writing of this paper. I have approved the final version for submission and take full responsibility for all aspects of the work including its accuracy and integrity.

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