**Title:**

How Reed-Solomon Codes Detect and Correct Errors: A Hands-On Demonstration

**Abstract:**

Error correction is essential for ensuring reliable digital communication and data storage. Reed-Solomon (RS) codes are a widely used error correction technique found in QR codes, CDs/DVDs, Blu-ray discs, and deep-space transmissions, where data corruption from noise or physical damage can render information unreadable. This study explores the mathematical foundation of RS codes, specifically their ability to detect and correct burst errors using polynomial division over Galois Fields of order 2⁸ (GF(2⁸)). By encoding data as polynomials and performing arithmetic within GF(2⁸), RS codes enable fast and efficient error detection and correction at the hardware level. Through a Java-based application, we demonstrate the encoding, error injection, and decoding process, revealing how syndrome calculation and polynomial division identify and correct errors. Our results demonstrate the efficiency of RS codes in recovering lost data, such as restoring content from a scratched disc or reconstructing missing segments in a damaged QR code. Understanding these principles provides insight into the critical role RS codes play in ensuring reliable communication and data storage in an increasingly digital world.