Super square-root scaling in batch steganography

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Secure payload (iid model)

n pixels / DCTs	.	.	.	...	.
Fisher information	I	I	I	...	I
payloads	α	α	α	...	α

(Ker, 2006) For **fixed statistical detectability**

$$P(n) \propto n^{0.5}$$

Secure payload (content-adaptive)

pixels / DCTs	.	.	.	...	.
Fisher info.	I_1	I_2	I_3	...	I_n
payloads	α_1	α_2	α_3	...	α_n

(Ker, 2018) Secure payload size

$$P(n) \propto n^{0.5}$$

if no diminishing FI: $I_i \geq \delta > 0$

Secure payload (batch steganography)

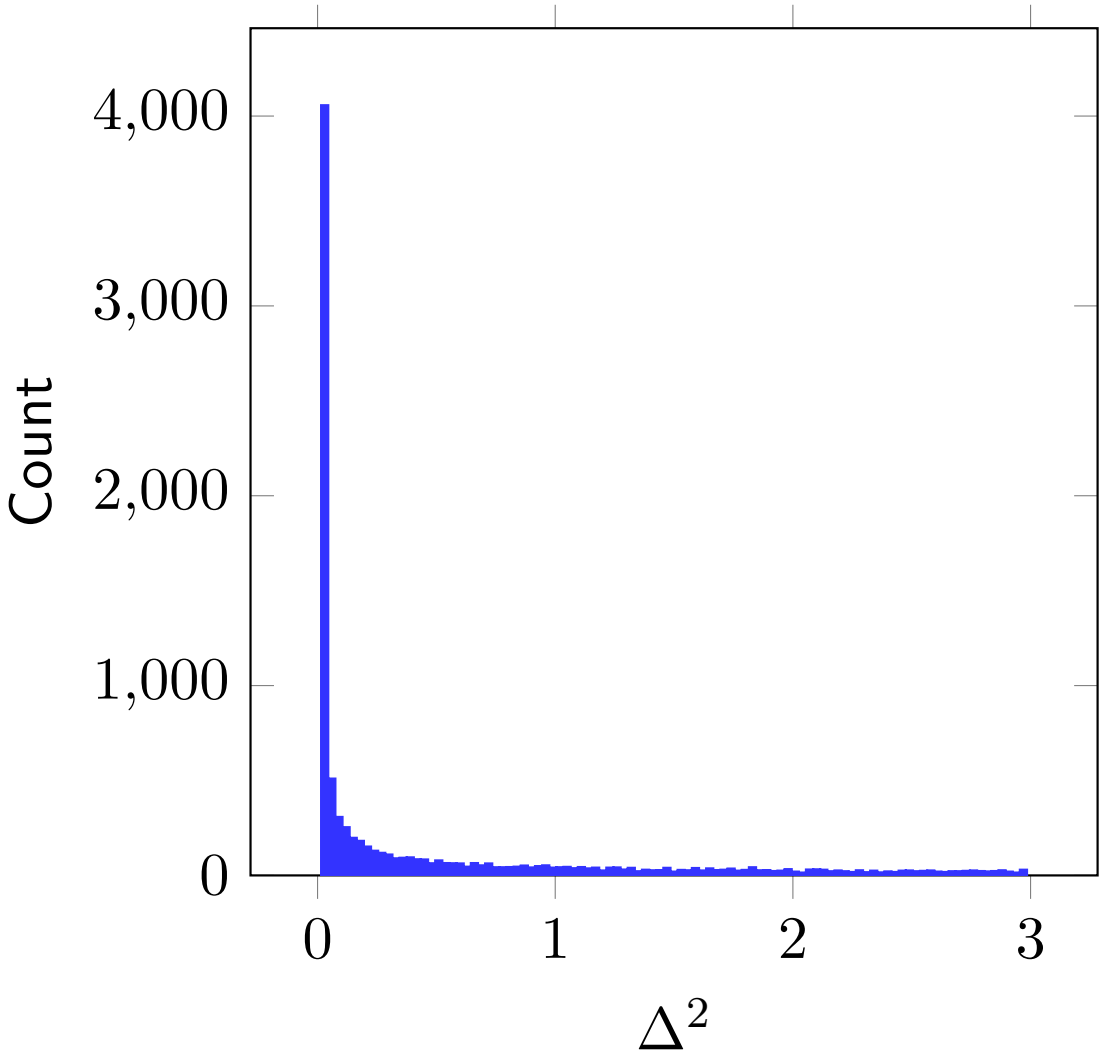
images	X_1	X_2	X_3	$\dots$	X_n
detector response shift	Δ_1	Δ_2	Δ_3	$\dots$	Δ_n
payloads	α_1	α_2	α_3	$\dots$	α_n

$d =$ single image detector, $Y_i =$ fully embed X_i ($\log_2 3$ bpp)
$\Delta_i = \mathbb{E}[d(Y_i)] - d(X_i)$

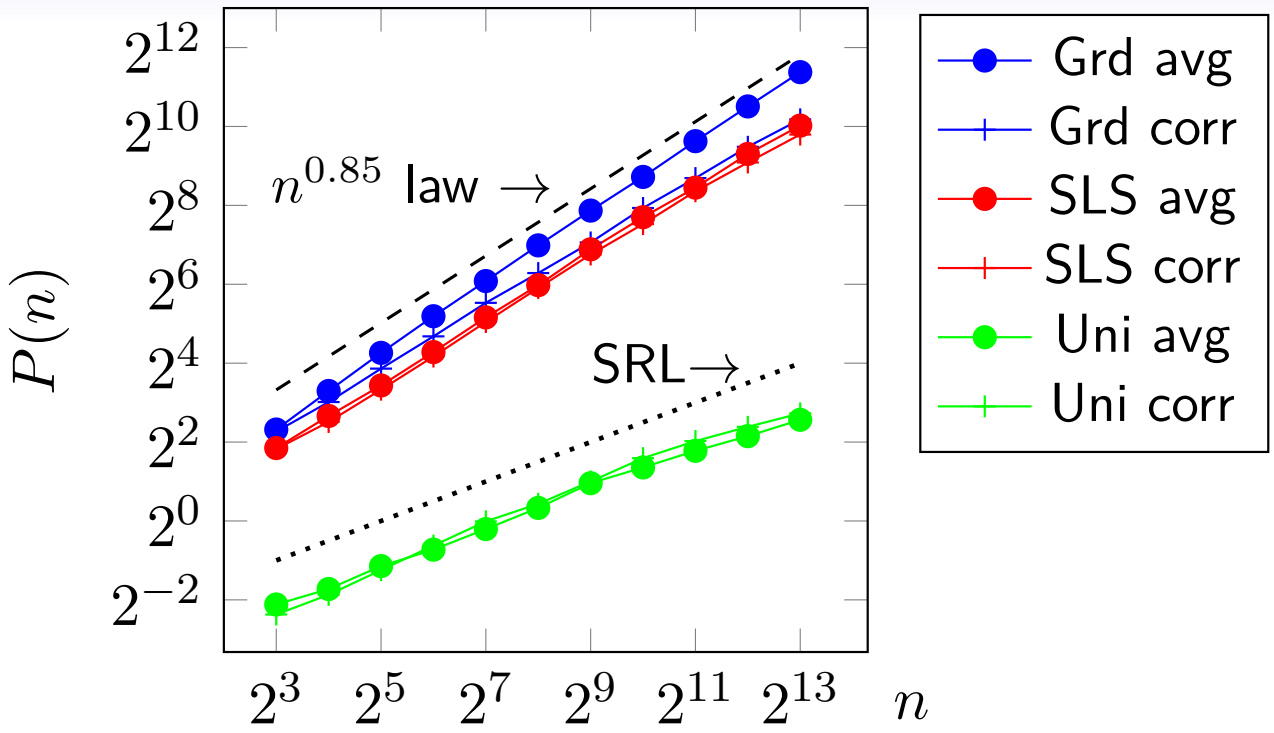
$$P(n) \propto n^{0.85}$$

if payloads assigned based on Δ_i

Squared detector response shift at image capacity (ALASKA II)

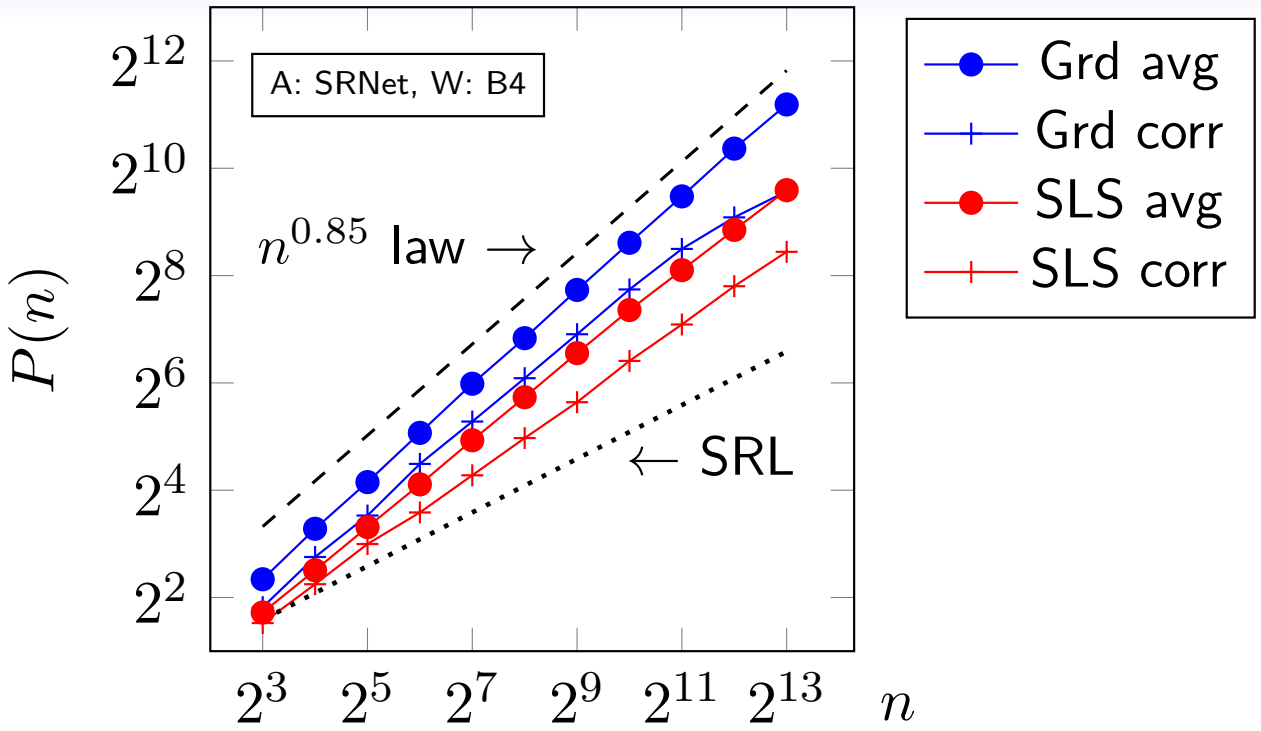


Secure payload $P(n)$ vs. bag size n



- Bag = everything Alice ever sends
- Payload adjusted for constant empirical detectability $P_{\mathrm{E}} = 0.2$
- Alice spreads payload with **Warden's detector** (HILL)

Secure payload $P(n)$ vs. bag size n



- Bag = everything Alice ever sends
- Alice spreads payload with **her own detector**
- There still exist strategies with $P(n) \propto n^{0.85}$

More details

E. Dworetzky, E. Kaziakhmedov, J. Fridrich, "Secure Payload Scaling for Source Adaptive Payload Allocation," Proc. IS&T, Electronic Imaging, Media Watermarking, Security, and Forensics 2024, San Francisco, CA, January 21–25, 2024

http://www.ws.binghamton.edu/fridrich/Research/Scaling.pdf