Journée de restitution Thèses Futur & Ruptures 2015

# Authentication using graphical codes: Information-theoretic approaches

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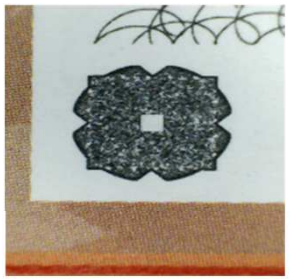
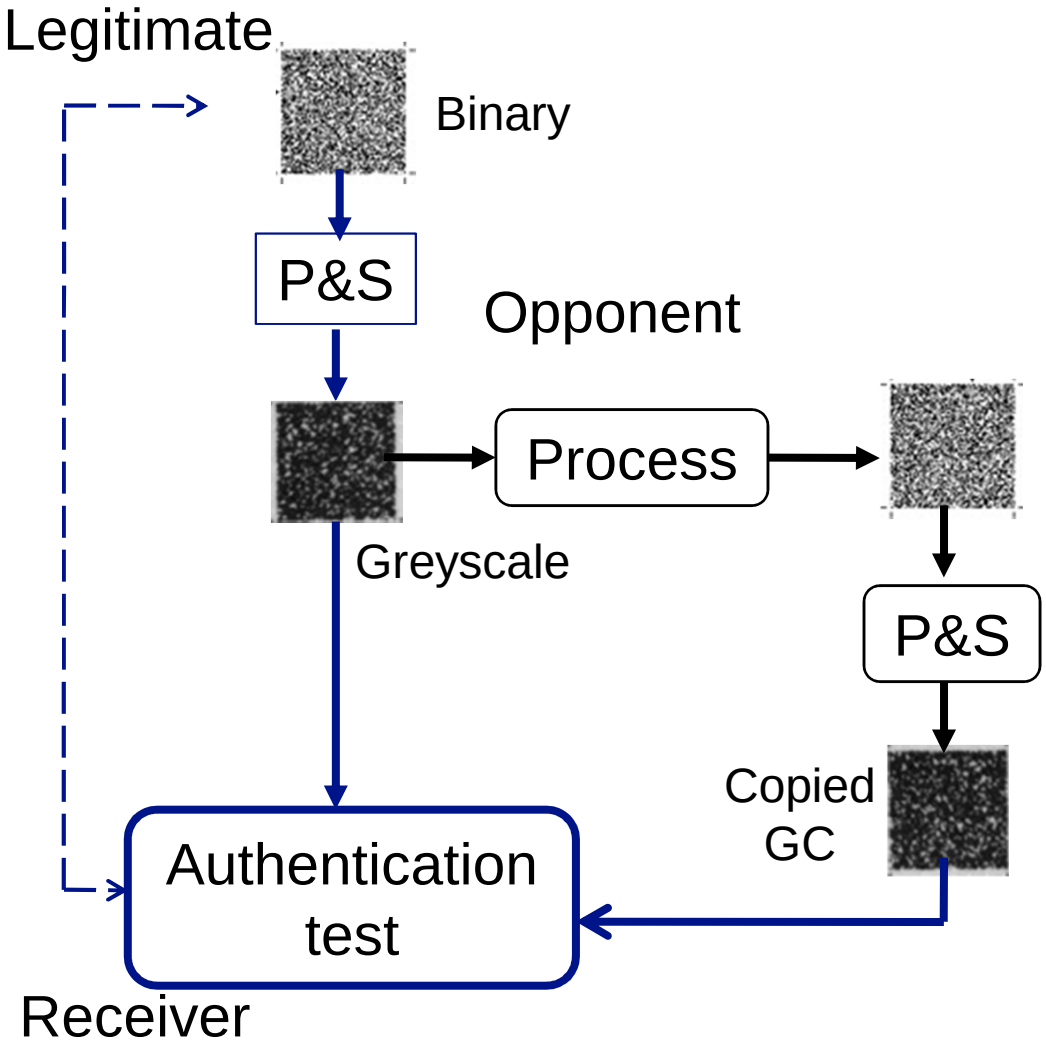
# ESTAMPILLE project (ANR)

- Fight against counterfeit goods
- 6 partners: **ATT**, **LATA**, LAGIS, GIPSA, LGP2, CERDI
- Print 2D graphical codes (GC) at the native resolution of printer
  - Not expensive
  - Easy to implement


patented by ATT

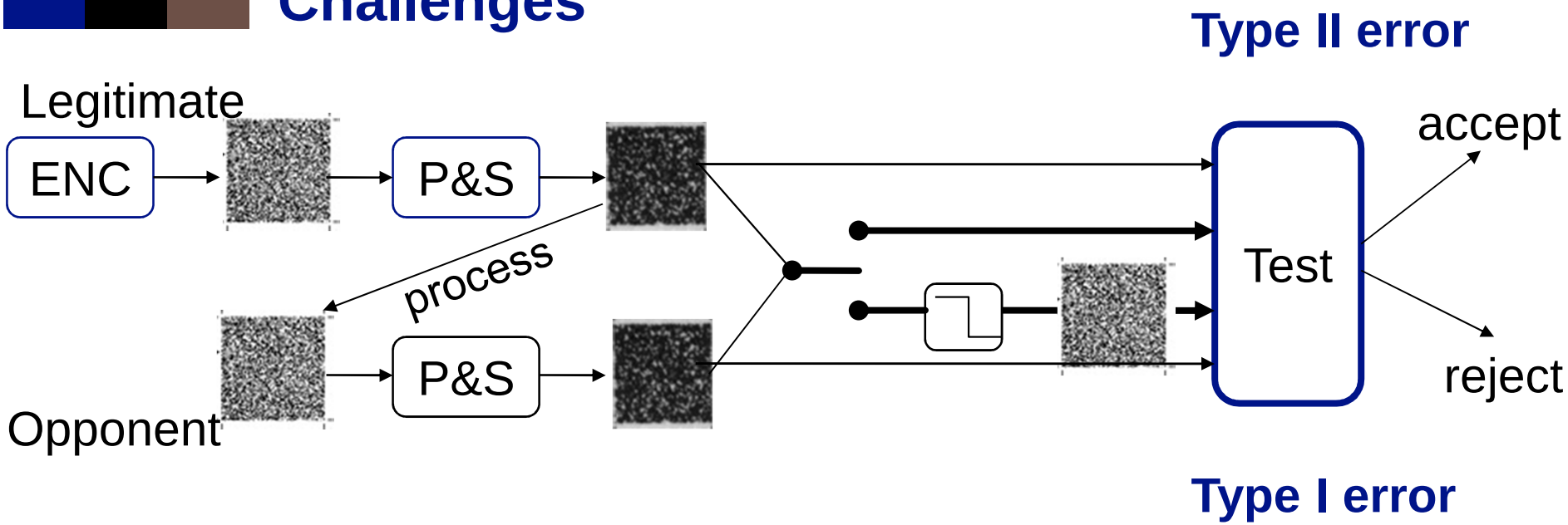


# Principle of the studied system




- Printing and scanning stochastic and irreversible processes
- Copied GC grey scale noisier than original printed GC
- Original codes shared with receiver

# Challenges




**C1: Estimate accurately 2 types of error**

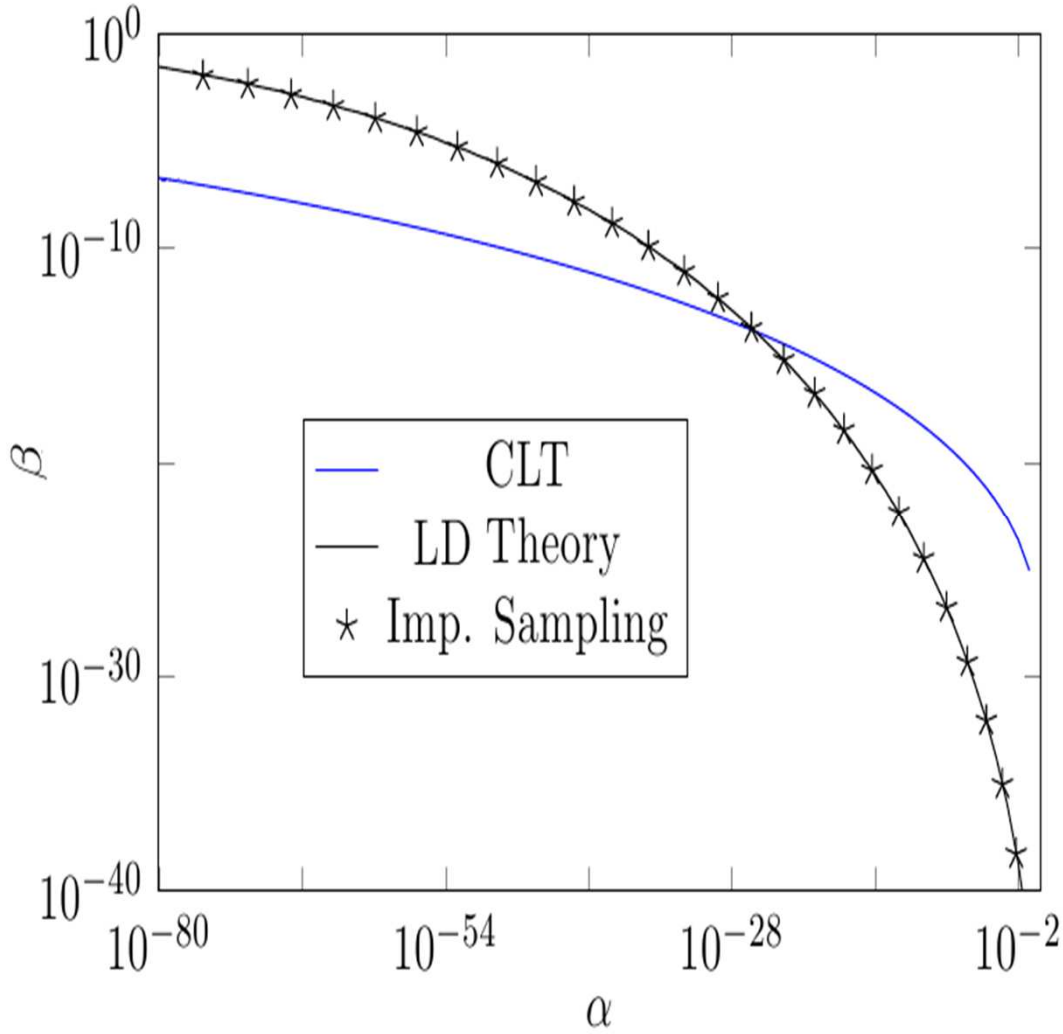
**C2: Binary vs. Grey level observation**

**C3: Tune P&S to optimize authentication**

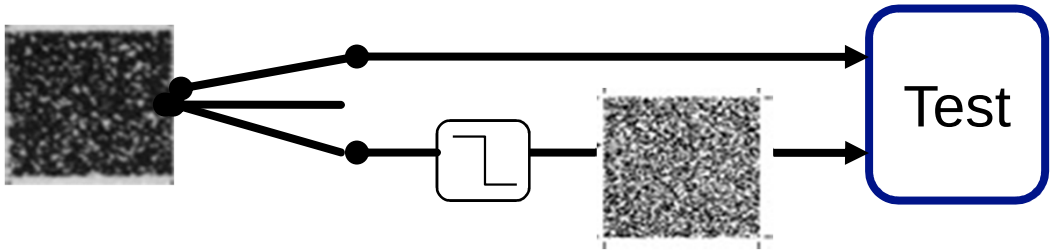
**C4: Can error correcting codes help?**

# C1: Estimating two types of error

- Neyman-Pearson test
  - H0: code is authentic
  - H1: code is fake
- Gaussian approximation is poor
- Large deviation theory to compute accurately α and β
- Importance sampling practically check accuracy

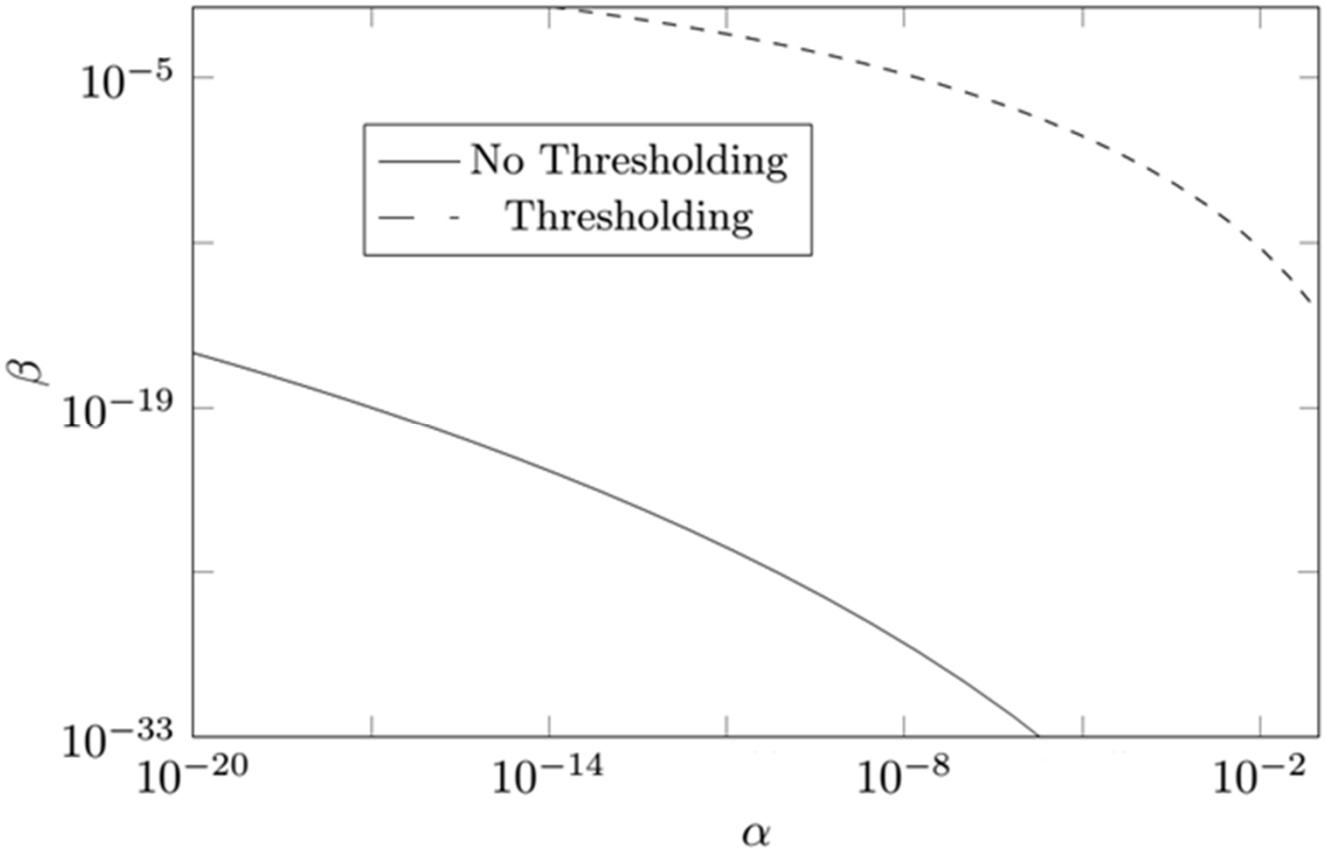


# C2: Binary vs. Grey level observation?




- Binarization
  - Counting error
  - No need to know opponent channel
- Grey level
  - Need to know opponent channel
  - Better performance

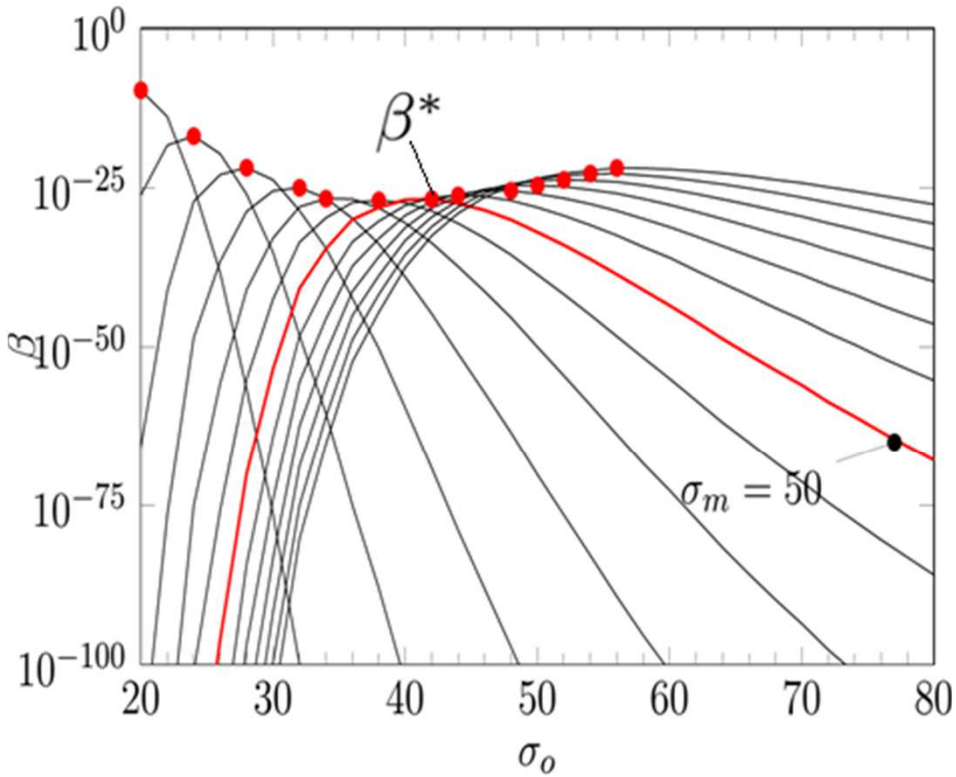
# C2: Binary vs. Grey level observation?



# C3: Optimal channel for authentication

Given α, find a channel to minimize β

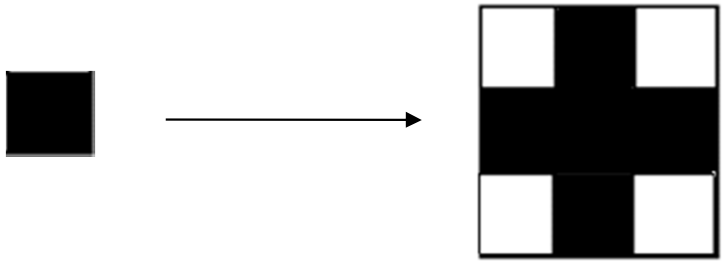
- ❖ Good legitimate printer → good for opponent
- ❖ Noisy printer → authentic & fake equally noisy



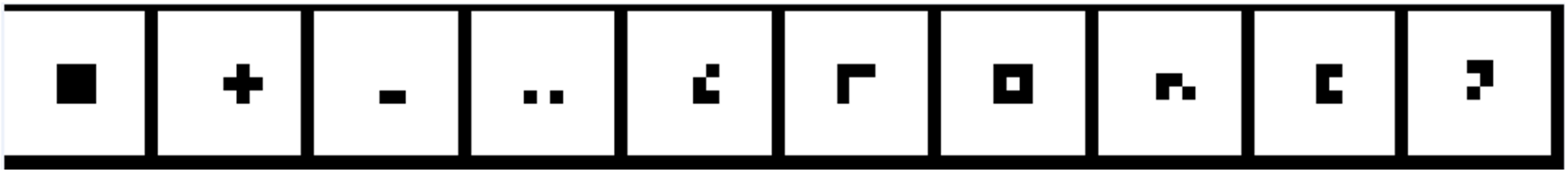

$$\beta^* = \min_{\mathcal{C}_m} \max_{\mathcal{C}_o} \beta(\alpha)$$

# Optimization in practice

- Use a pattern 9 dots (3x3 matrix) instead of a single dot

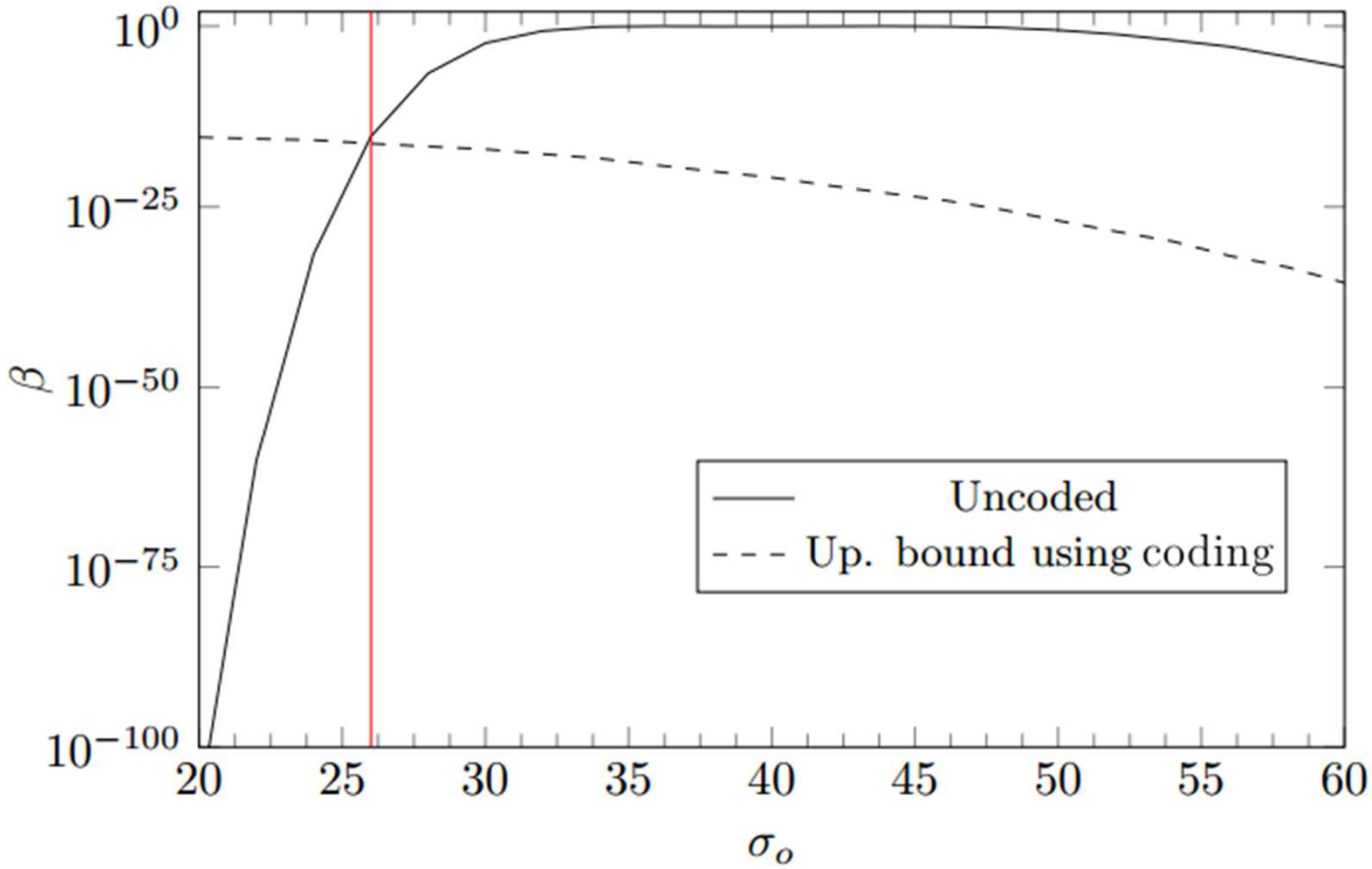


There are 512 patents to tune to optimise



Graphical codes

# C4: Can error correcting codes help?



# Conclusions

❖ Give mathematical models to analyze authentication problem using GC.

❖Applicable for  security problems of physical objects basing on fingerprinting.

# Publications

The thesis “Information-theoretic and statistical approaches to the problem of authentication using graphical codes” was defended on Dec 18th under the committee

- Reporters:
  - M. Jean-Claude Belfiore, Prof. at **Telecom ParisTech**
  - M.Sviatoslav Voloshynovsjiy, Prof. at **University Genève**

- Members:
  - M.Igor Nikiforov, Prof. at **University Technology Troyes**
  - Mme.Tanya Ignatenko, Dr. at **University Tech. of Eindhoven**
  - M.Yves Delignon, Prof. at **Telecom-Lille**
  - M.Zbigniew Sagan, Engineer at **Advanced Track and Trace**

# Publications

- A.T Phan Ho, B.A Mai Hoang, W.Sawaya, and P.Bas. Authentication using graphical codes:optimization of the print and scan channels.In Signal Processing Conference (EUSIPCO), Proceedings of the 22nd European. IEEE, 2014.

- A.T Phan Ho, B.A Mai Hoang, W.Sawaya, and P.Bas. Document authentication using graphical codes: Reliable performance analysis andchannel optimization. EURASIP Journal on Information Security, 2014.

- A.T Phan Ho, B.A Mai Hoang, W.Sawaya, and P.Bas. Document authentication using graphical codes: impacts of the channel model. In Proceedings of thefirst ACM workshopon Information hiding and multimedia security, pages 8794. ACM, 2013.

- A.T Phan Ho, Authentication using graphical codes: statistical analysis, Oral talk at workshop of GdR ISIS, November 2013

- A.T Phan Ho, W.Sawaya, and P.Bas. Authentication Performance Using Channel coding for a System based on Printed Codes, under submission to TIFS, IEEE, 2015.