Experience In "Lights Out" Latent Processing

- **Introduction**
  - **What do we mean by "Lights Out"?**
  - **What are the different technical issues?**
- **What can the technology offer?**
  - **What can be automated?**
  - **What is the impact on accuracy?**
    - What is the degradation of accuracy?
    - Is it possible to use quality metrics to predict when automated processing will be accurate?
- **How can this (non perfect) technology be used to solve more cases?**

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Introduction

- **"Lights Out" exists today for Ten Print Person Identification**
  - Fast and fully automated search
  - Very selective threshold to eliminate no-hits

- **In latent processing, human expertise is needed**
  - Operationally the expert is often the bottleneck of the system
  - In most systems, all the latents are not processed
  - The result of a search can arrive several days after the evidence collection

⇒ **There is a need for more automation** *("Latent Lights Out")*
  - Some customers request it *(for example RCMP)*
  - Fast and fully automated search
  - Very selective threshold to eliminate no-hits
  - Fingerprint experts still need to confirm the hits

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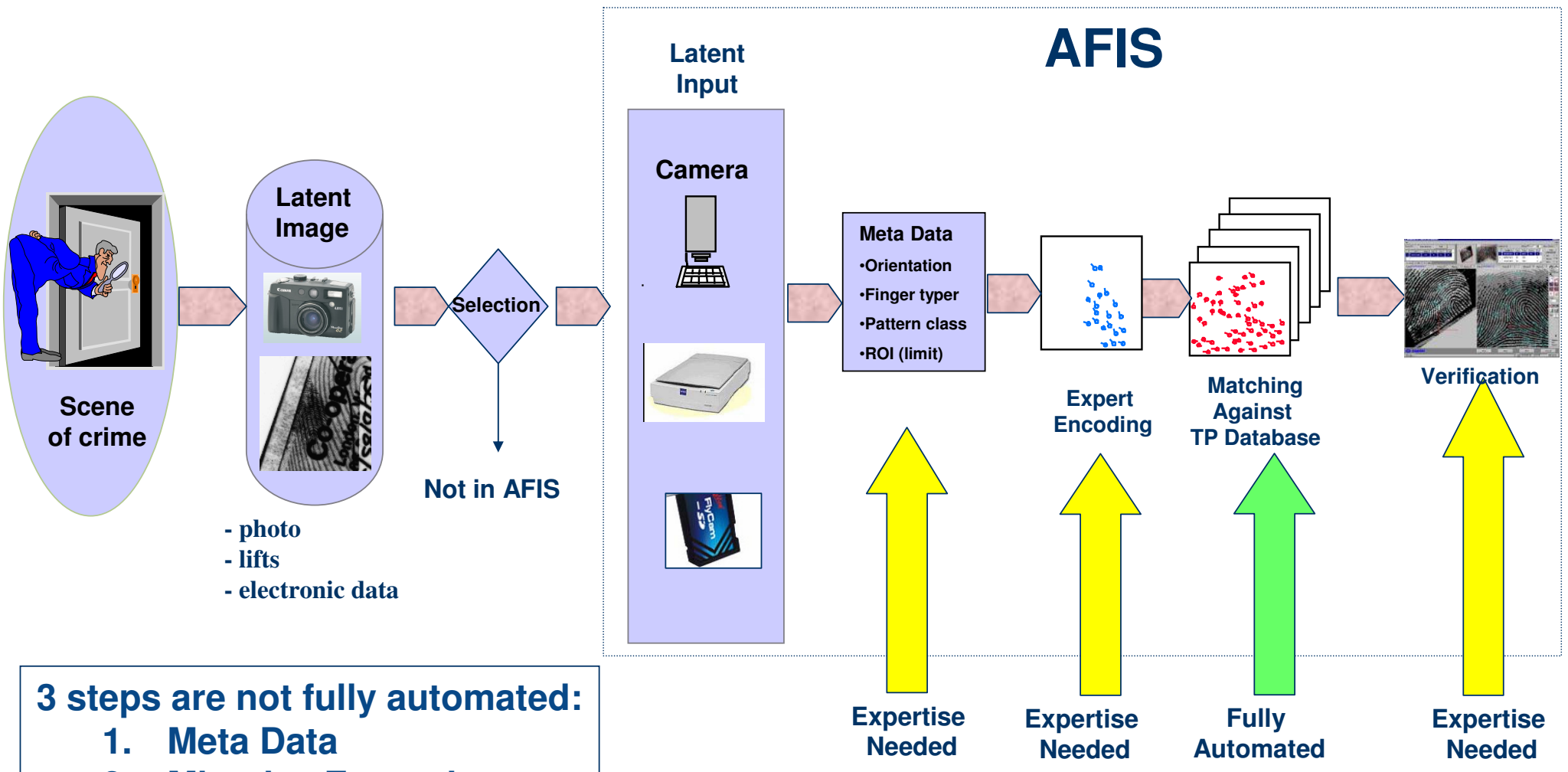
Latent Processing Workflow



3 steps are not fully automated:

1. **Meta Data**
2. **Minutiae Extraction**
3. **Verification**

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Step 1: Meta Data

Orientation of the latent	**Non oriented matching can be used.** **Some automation is possible (not presented here)**
Finger number	**Optional for matching**
Pattern classification	**Optional for matching** **Some automation is possible (not presented here)**
Latent area	**Automatic feature extraction can be done on the full image**

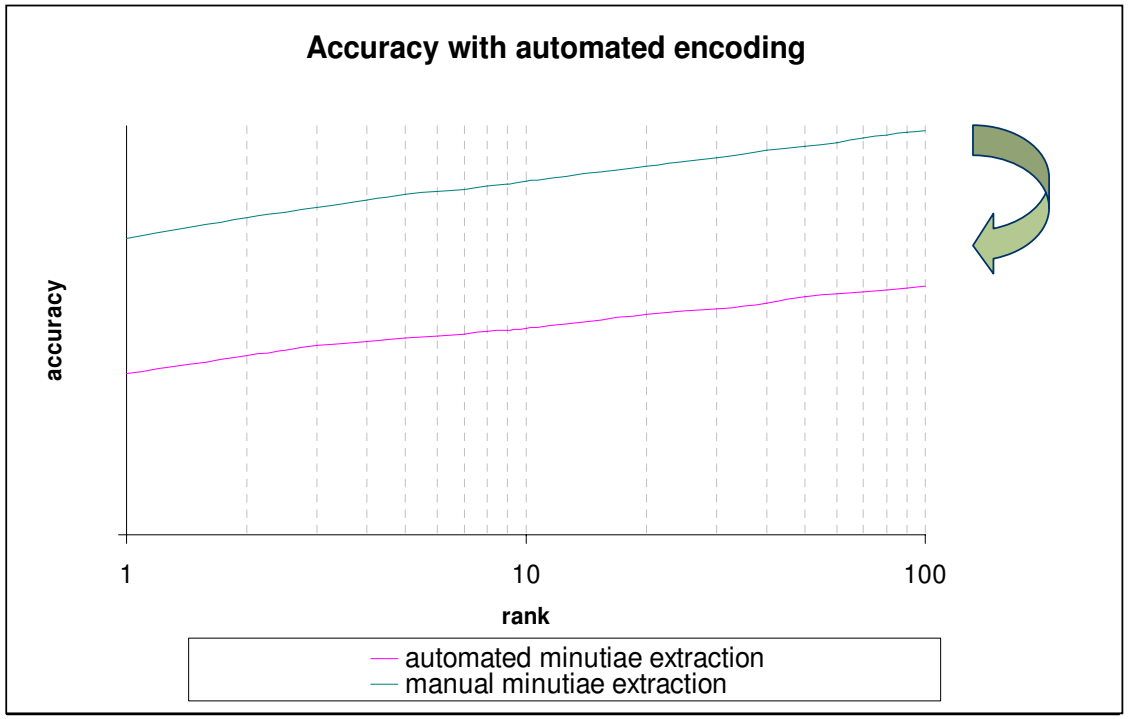
=> For each of these operations

- Search can be done without the information (“Brute Force”)
- Some automation is possible

=> Several trade offs (speed / accuracy / automation) are possible

Step 2 : Minutiae Extraction
Impact of Automated Encoding on Accuracy

- Latent minutiae encoding is a very time consuming expert task
- Fully automated minutiae extraction can be performed on latents



Accuracy typically decreases
by 10% to 20%
with automated encoding
(depending on latent quality)

Test results on 1350 latents
Background database 1 million fingers

=> Accuracy decreases but –depending on database quality-
<u>many hits are still found</u>

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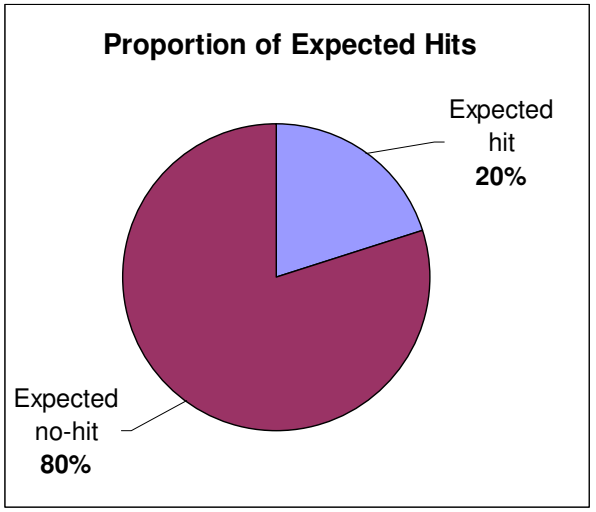
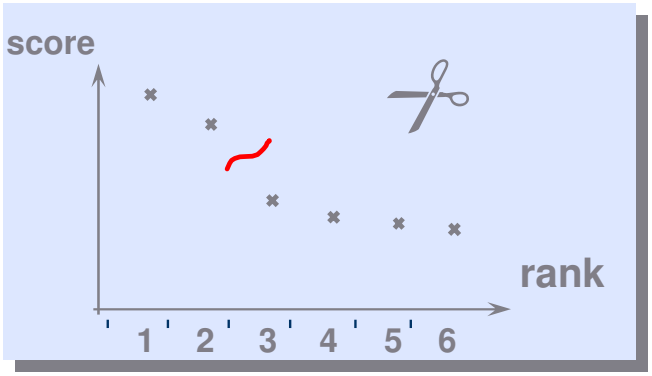
Step 3 : Thresholding Impact on Accuracy



- Most candidates are “expected no-hits”, and they still have to be verified
- Most of the expert time is spent to confirm no-hits, not to confirm hits
- Selective thresholding techniques can be used to eliminate most of the no-hits



Objective of threshold algorithm

- “Expected hits” latents should be over the threshold to *maximize the accuracy*
- “Expected no-hits” latents should be below the threshold to *minimize the number of verifications*

- Human verification is still needed to confirm the hits

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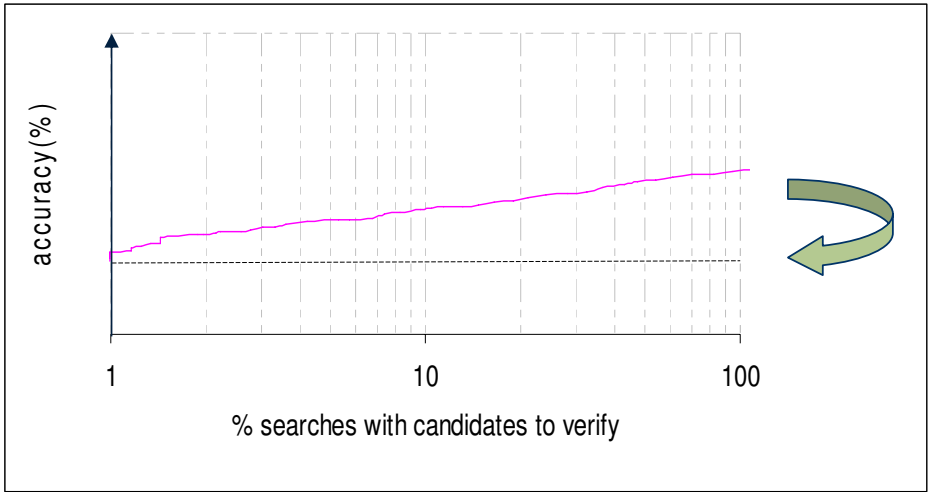
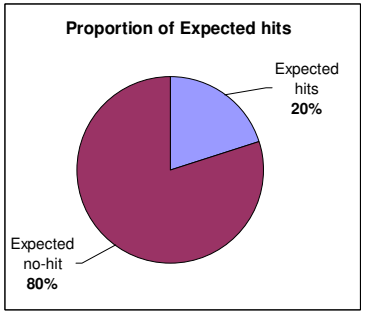
Step 3 : Thresholding Impact on Accuracy



Accuracy typically decreases
by 5 % to 15%
when threshold is set for 1% verification
(depending on latent quality)

Test results on 1350 latents
Background database 1 million fingers



For 100 Latent searches

For 19 verifications

No Threshold	Threshold	No Threshold
= 100 verifications	= 19 verifications	for 19 verifications
20 hits	18 hits	4 hits
80 no-hits	1 no hit	15 no-hits

When number of verifications is an issue, automated threshold can be used

=> Experts will mainly have to verify hits.
=> Accuracy decreases but many hits are still found

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Impact of Automation on Performances Synthesis

⇒ Clearly the expert is more accurate than the machine

But fully automated process can produce additional hits with minimum of effort

⇒ Is there way to use this automation in the operational process ?

⇒ Can be used to improve number of cases solved ...

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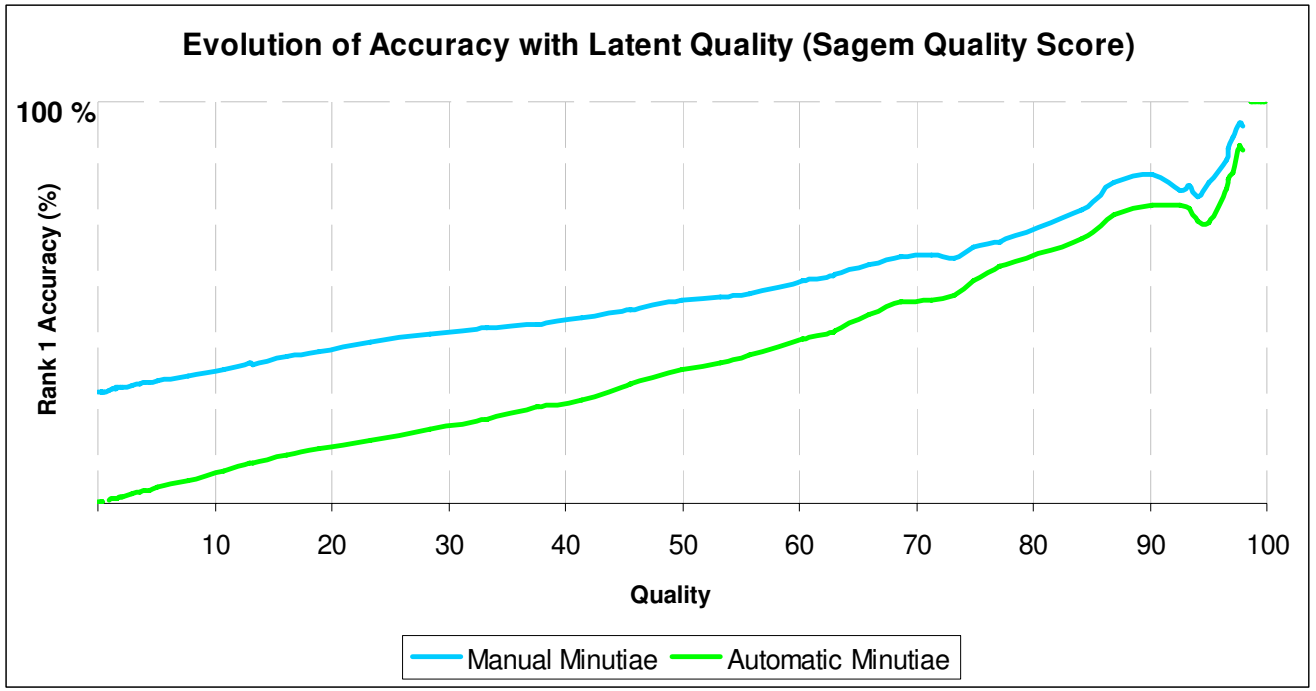
A Few Comments: Impact of Latent Quality



- Accuracy increases when bad quality Latents are rejected
- Sagem Quality Score (originally designed for Ten Print) correlates well (but not perfectly) to

Latent matching accuracy decreases when bad latents are rejected

- Prediction is not good enough yet to guarantee no accuracy loss
- Difference between manual and automatic Minutiae

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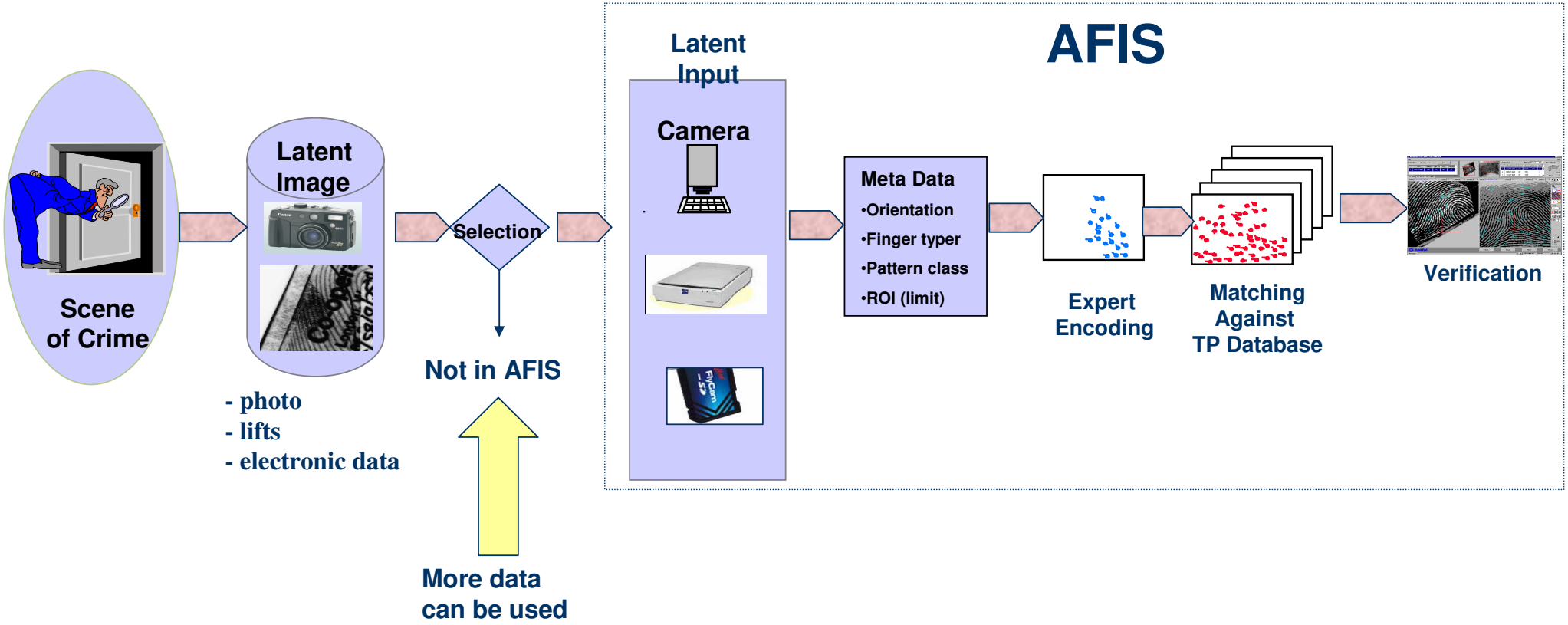
Automation of Criminal Investigation Processing

Suggestion 1 : Process more latents with same expert effort

All latents are not always processed today, although some of them are good enough for AFIS



⇒Fully automated search could be launched on these latents

- Very little extra effort for the experts
- More hits found

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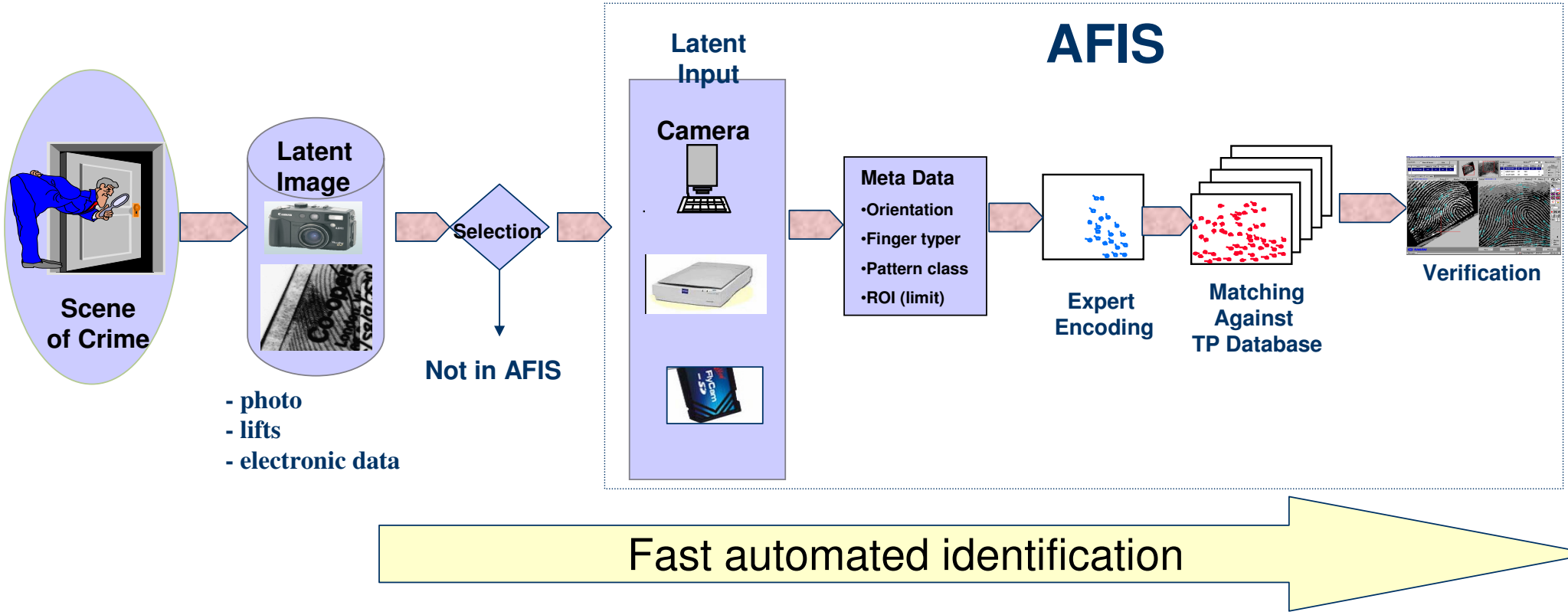
Automation of Criminal Investigation Processing

Suggestion 2 : Immediate feedback to investigator



⇒ When fast feedback is needed, automatic search can be launched first

- Manual process may be launched too (=> no loss of accuracy)
- Allows improved efficiency in investigation

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Automation of Criminal Investigation Processing

Suggestion 3 : Automatically process good quality latents

- Clear fingerprint marks with lots of visible minutiae
- Large area latents
- Needs further study to improve Latent Quality Measurement

=> The expert could concentrate on more difficult latents

Suggestion 4 : Processing latents from paper archive

- “Bulk” scan by non expert operators
- Automatic minutiae encoding
- Selective threshold
- Very few verifications to perform, mostly hits.

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Experience in Latent "Lights Out" Processing

- Fully automated process is possible
  - Automated feature extraction
  - Very selective threshold
  - Accuracy is lower but many hits are still found

- Automated process is not as accurate as the expert and cannot replace human expertise

- In some scenarios, automation can be used to solve more cases

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