Border control:
From Technical to Operational evaluation

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Agenda

➢ *Context*

    ✓ Evaluation of border control systems.

    ✓ Video acquisition samples.

➢ *Two basic methods*

    ✓ Internal workflows.

    ✓ FAR evaluation for the "score driven" method.

    ✓ Performances comparison.

➢ *Operational considerations*

➢ *Conclusion*

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Context

- **For automated border control, the goal of a good biometric solution is to ensure the security of the border and improve passenger experience.**

- **Trends for Improving passenger experience :**
  - **Lower passenger behaviour constraints.**
  - **Intensive use of full video streams.**

- **Ensure security :**
  - **Evaluation of operational FAR (false accept rate)**
  - **Avoid possible bias between off-line and live evaluation.**

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Context

Samples of video acquisitions in different environments.

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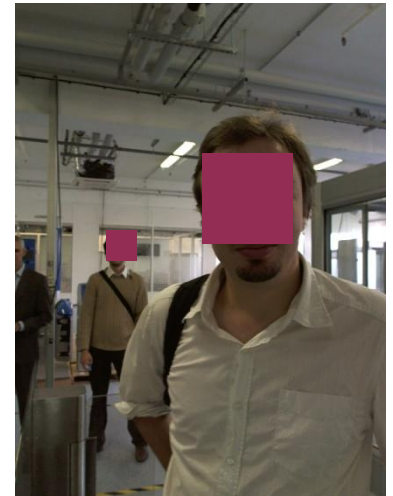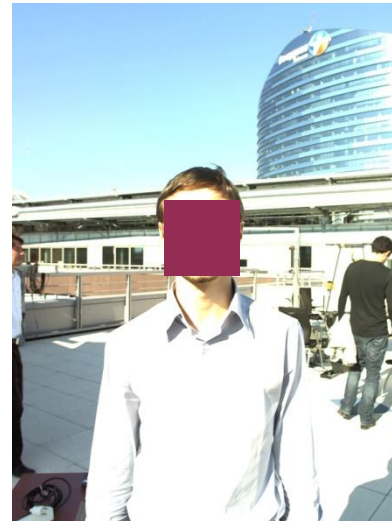
two basic methods

▍ **In order to describe the different issues linked to video stream management, we will focus on two basic methods.**

▍ **The "score driven" method: Images are continuously processed and matched against the reference image until a matching score is above a certain threshold.**
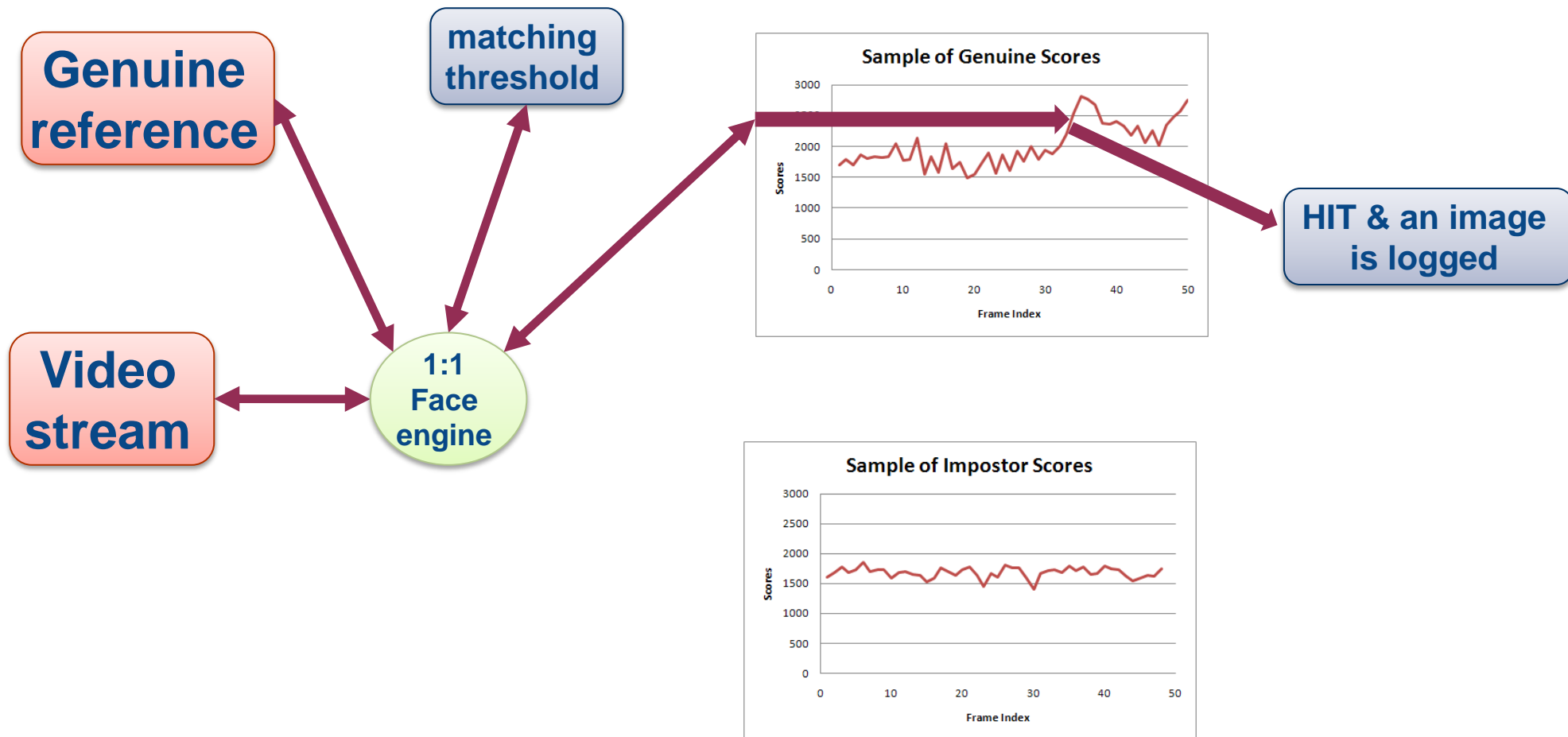
At a given frame rate, for each image, a face is found, encoded and matched against the reference. If the score is above a matching threshold, the door opens, the image is logged, the acquisition process is stopped. If no score reaches the threshold, at a given timeout, the passenger is rejected.

▍ **The "quality driven" method: Images are processed until a quality intrinsic to the considered image is above a threshold.**

At a given frame rate, on each image, a face is found and a quality is computed. If the quality is above a threshold, the image is encoded, and matched against the passport image. The image is logged, the acquisition process is stopped. If the matching score is above a threshold, the door opens, if not, the passenger is rejected.
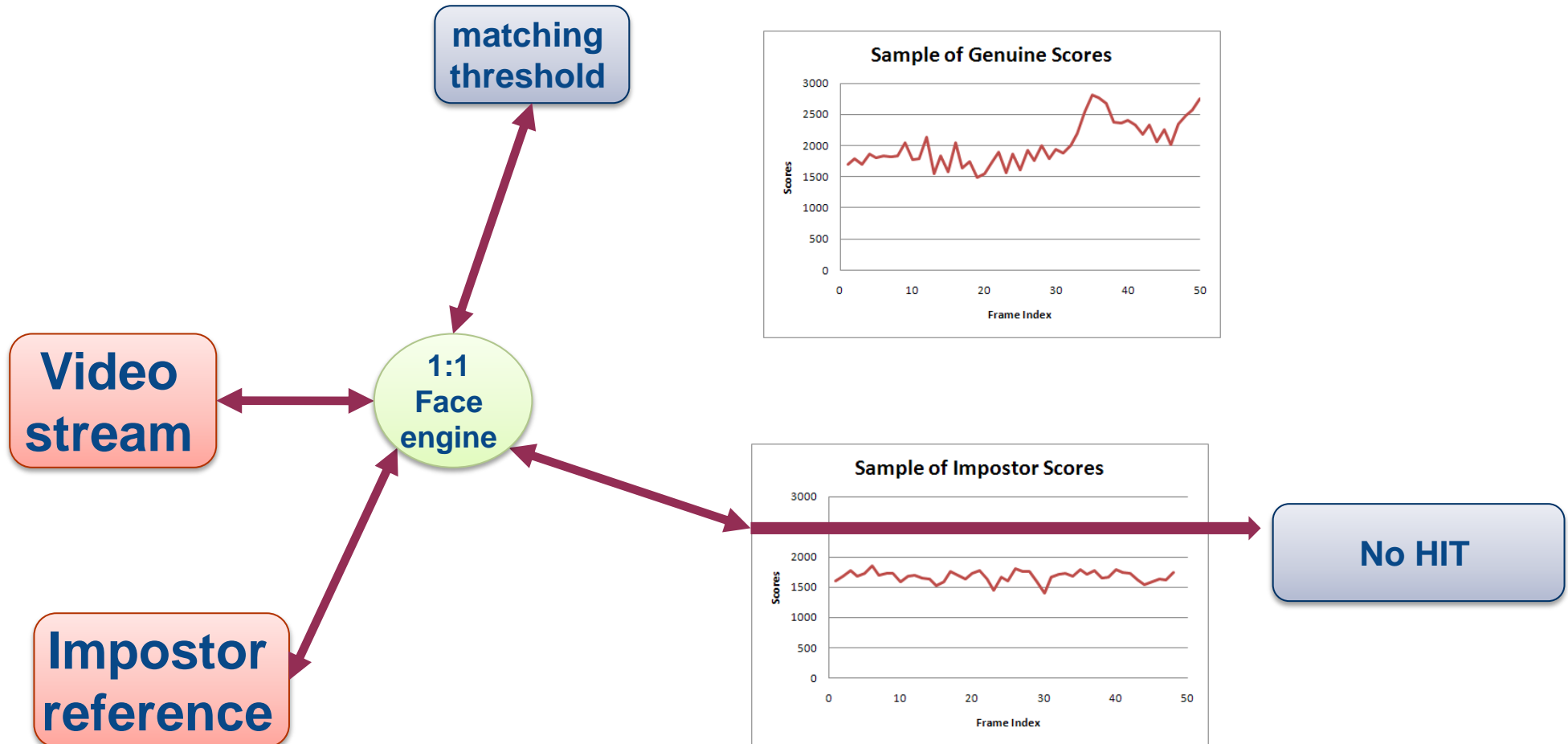
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Internal workflow

The **"score driven" method:** Images are continuously processed until a matching score is above a threshold.

Genuine reference

matching threshold

Video stream

1:1 Face engine

HIT & an image is logged

Sample of Genuine Scores

Scores — Frame Index

Sample of Impostor Scores

Scores — Frame Index

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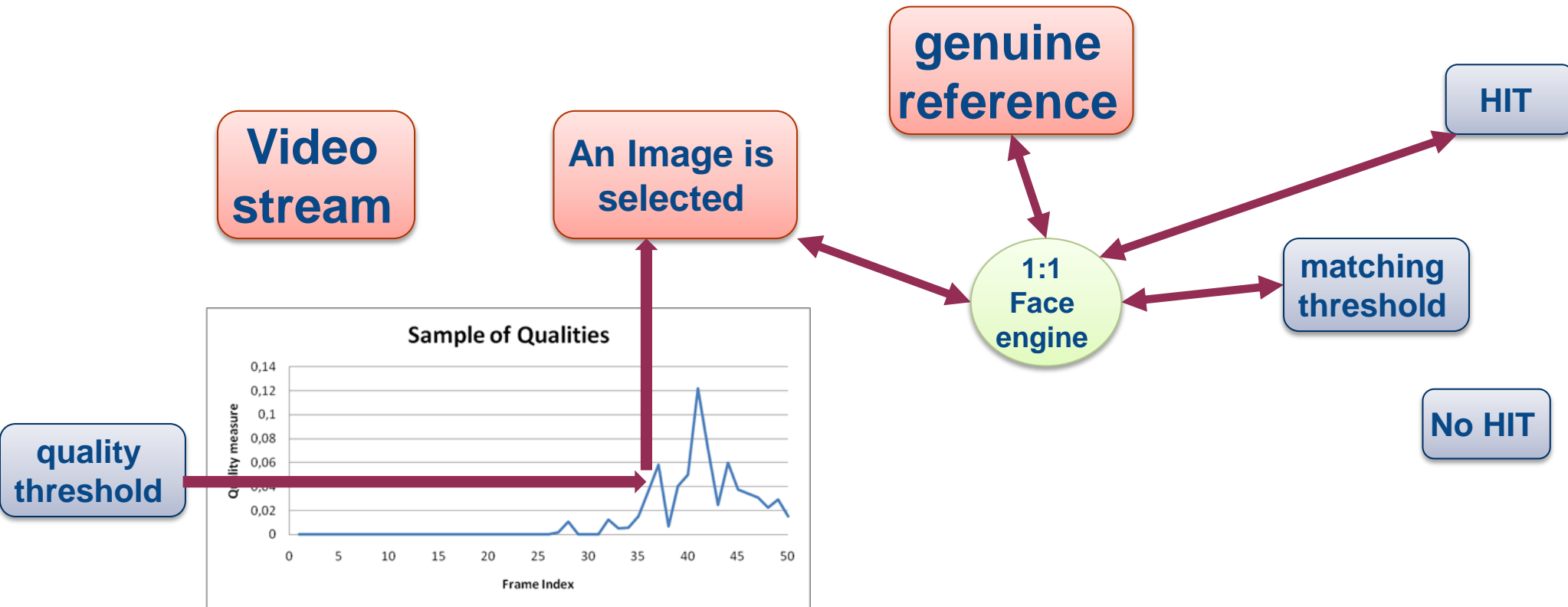# Internal workflow

- **The "score driven" method:** Images are continuously processed until a matching score is above a threshold.

- **The "quality driven" method**: Images are processed until a quality intrinsic to the considered image is above a threshold.

Video stream

An Image is selected

genuine reference

HIT

1:1 Face engine

matching threshold

No HIT

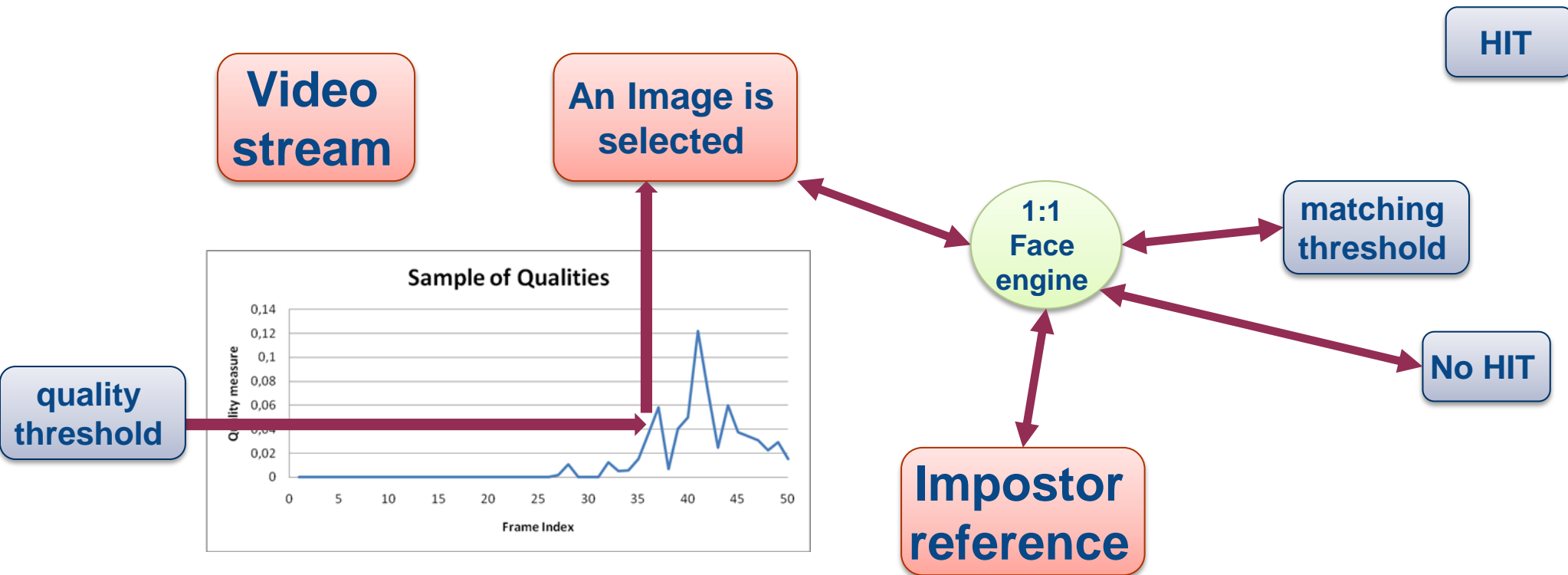**quality threshold**

Sample of Qualities

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Internal workflow

The "quality driven" method: Images are processed until a quality intrinsic to the considered image is above a threshold.

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operational FAR vs off-line FAR

- **With the "quality driven" method, operational FAR and off-line FAR from the logged image are the same.**
  - ➢ **The selection process of the logged image is not linked to the reference image**

- **With the "score driven" method, operational FAR and off-line FAR from the logged image are different.**
  - ➢ **The score of an impostor test is the maximum of all scores from images in the video stream. This maximum is not reached with the same image as the one selected with the genuine test.**

- **Acquisition campaign for Off-line tests.**
  - ➢ **We record video streams : 10 seconds, 5 fps, 180 subjects.**
  - ➢ **And use 4800 ICAO images as reference.**

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# FAR evaluation for the "score driven" method

➢ **When an impostor tries to forge the system, the probability of reaching the threshold increases with the number of tries.**

➢ **The score of an impostor, after a given number of frames is the maximum score obtained with all the previous frames.**
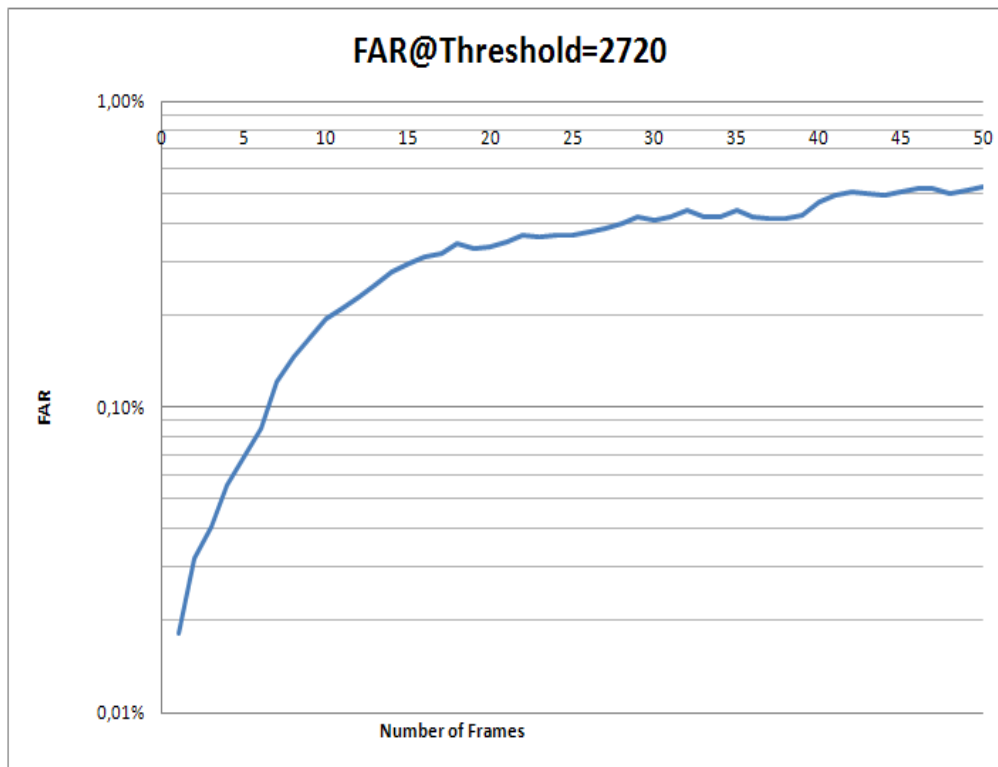
FAR@Threshold=2720

➢ **For a threshold and an algorithm we have computed the associated FAR.**

➢ **The operational FAR is the one obtained at the timeout.**

Operational FAR

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FAR evaluation for the "score driven" method

FAR@Threshold=2720
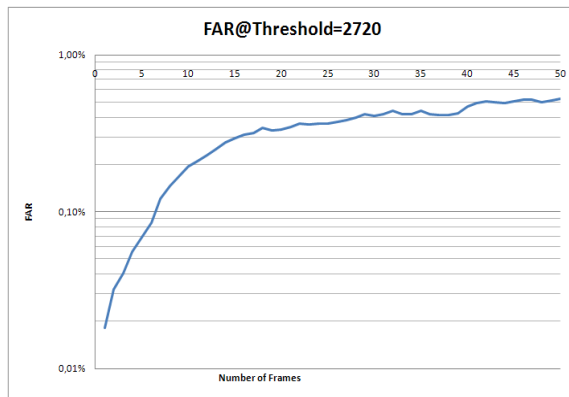
Operational FAR

➢ **If the FAR is computed with only one image or few images, for the same threshold, the obtained estimation is lower than the real one.**

➢ **This is true, even if this image is selected by a matching process against a genuine image.**

➢ **Here, for this threshold of 2720, the operation FAR is 0.5% and the FAR computed from the logged image is 0.03%.**

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FAR evaluation for the "score driven" method

- **To see if this estimation error is linked to the intrinsic properties of the face recognition algorithms, we have tested multiples algorithms.**

Algorithm	FAR on the logged image	Threshold	Operational FAR	Error factor
1	0.5%	2530	7.2%	14.4
2	0.5%	2510	7.4%	14.8
3	0.5%	2560	6.9%	13.8
4	0.5%	2540	7.1%	14.2
Eigenfaces*	0.5%	2510	9.1%	18.2

*Eigenfaces : FaceFinder from OpenCV, PCA learn on Yale database

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Performances comparison

■ **Performance comparison at the same operational security level.**

		FAR	threshold	FRR	Genuine mean crossing time
score driven method	logged image	0,03%	2720	7,6%	
	operational	0,50%			5,2s
quality driven method	logged image	0,50%	2550	4,4%	
	operational				7s

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Trade-off for the "quality driven" method

"Quality driven" method.

Quality threshold	Average Time (s)	FRR @FAR=0,5%
0.03	7	4.4%
0.012	5	6.1%
0.007	4	7.8%
0.005	3	10.1%
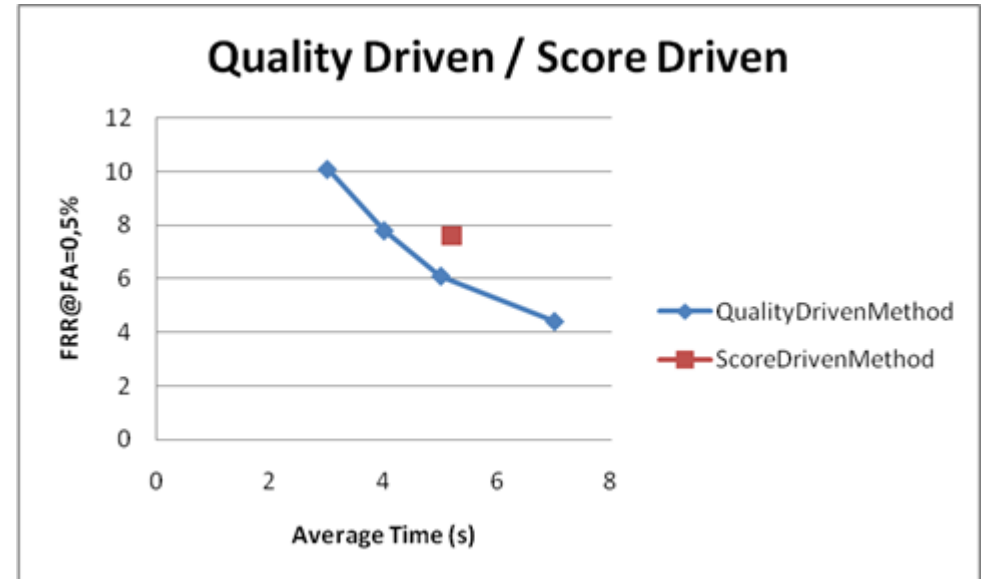
The "quality driven" method can have (and have in this test) better performances than the "score driven" method, because :

➢ **Multiple impostor tests lead to an increase of the matching threshold in order to have the same security level.**

➢ **This leads to an increase of the FRR.**

➢ **It is possible to build a quality that leads to a smaller FRR degradation.**

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Operational considerations

How to check the FAR of a system, in the "score driven" method ?

- **The use of a logged image from a "score driven" method, to compute off-line the FAR leads to a huge error in true FAR estimation.**

- **Recording the full video stream (as we have done here) implies a crossing time fixed by the time-out duration.**

- **Organizing a real impostor campaign can be the solution.**
  - ➢ **Huge costs as thousands of FA tests are needed.**

- **Having an estimation of the error factor as in this study, and verifying that the FAR computed from logged image is coherent.**
  - ➢ **This protocol is not a formal enough validation of the security of a border.**

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Operational considerations

How to check the FAR of a system, in the "quality driven" method ?

- **Simply by using logged images.**
  - ➢ **Full score matrices computed from logs allow to compute operational performances.**
  - ➢ **Impact of matching threshold modification can be anticipated.**
  - ➢ **Independent audits of the system are enabled.**
  - ➢ **Multifactor analysis can be performed.**
  - ➢ **Overtime performances evolutions can be survey.**

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Conclusion

Off course, these two basic methods can be enhanced, however :

- **When the acquisition process takes the reference as an input, FAR can't be computed offline.**

- **It is possible to achieve good & certifiable performances by using a good quality metric.**

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Thanks !

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