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Cash Tech: The use of new IT tools on fitness control quality

The Banknote and Currency Conference

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Good morning ladies and gentlemen.

It is my pleasure to share with you how machine learning techniques drive substantial benefits both for keeping an adequate quality of banknotes in circulation and for avoiding unnecessary shredding.

One of our missions as Central Bankers is to keep an adequate quality of the banknotes in circulation at the minimum cost. That implies that we have to check on regular basis the fitness sorting carried out by our sorters in order to ensure that the notes sorted out as fit by our sorting machines are really fit and also that we are not prematurely shedding fit notes.

But, how can we check if our sorting machines are doing a good job in the fitness sorting?

- We take some samples of the banknotes sorted as fit and as unfit by the sorting machines.
- Then, a human expert will inspect them visually to determine:
 1. How many unfit notes are in the fit sample, and
 2. How many fit notes are in the unfit sample.

An alternative approach is to carry out this inspection automatically, with our Fitness Control Tool. This tool has been trained with a collection of images of real banknotes labelled as fit or unfit (“Training Sets”) and developed with supervised machine learning (ML) techniques to measure the following fitness features:

1. Soil
2. Stain
3. Graffiti
4. De-inked note
5. Crumples

The Fitness Control Tool works in the following way:

- We first take images of the banknotes using a desktop sheet-fed scanner.
- The tool measures some features on the banknote images.
- The numeric values obtained are pre-processed and fed into supervised ML algorithms for classification
- With the classification into Fit or Unfit carried out by the ML algorithms, we can determine how many Unfit notes are in the sample of notes sorted out as Fit by the sorting machine (the False Fit Rate), and how many Fit notes are in the sample of notes sorted out as Unfit by the sorting machine (the False Unfit Rate).
- If the False Fit Rate or the False Unfit Rate values are too high, that could indicate the need of reviewing the fitness sorting thresholds used in the machines in order to optimize the efficiency of the fitness sorting operations

Conclusions

This Fitness Control Tool presented here is more accurate than the sorting machines in use today: the values of false fit rate and false unfit rates are lower than in the case of sorting machines. The results are much more repeatable and reproducible than with the best human expert at a negligible cost