Detecting opioids hidden inside mail flats using portable Raman spectrometer and chemometrics

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**ALERT** — AWARENESS AND LOCALIZATION OF EXPLOSIVES-RELATED THREATS

ABSTRACT

Deaths by opioid overdose persists as one of the great problems in our country. The U.S. Customs and Border Protection (CBP) agency currently needs better technology for detecting opioids on IMFs. Our work is focused on detecting an opioid simulant inside four different types of mail flats using portable Raman spectroscopy. The developed SIMCA model was able to classify 94% of the test samples correctly.
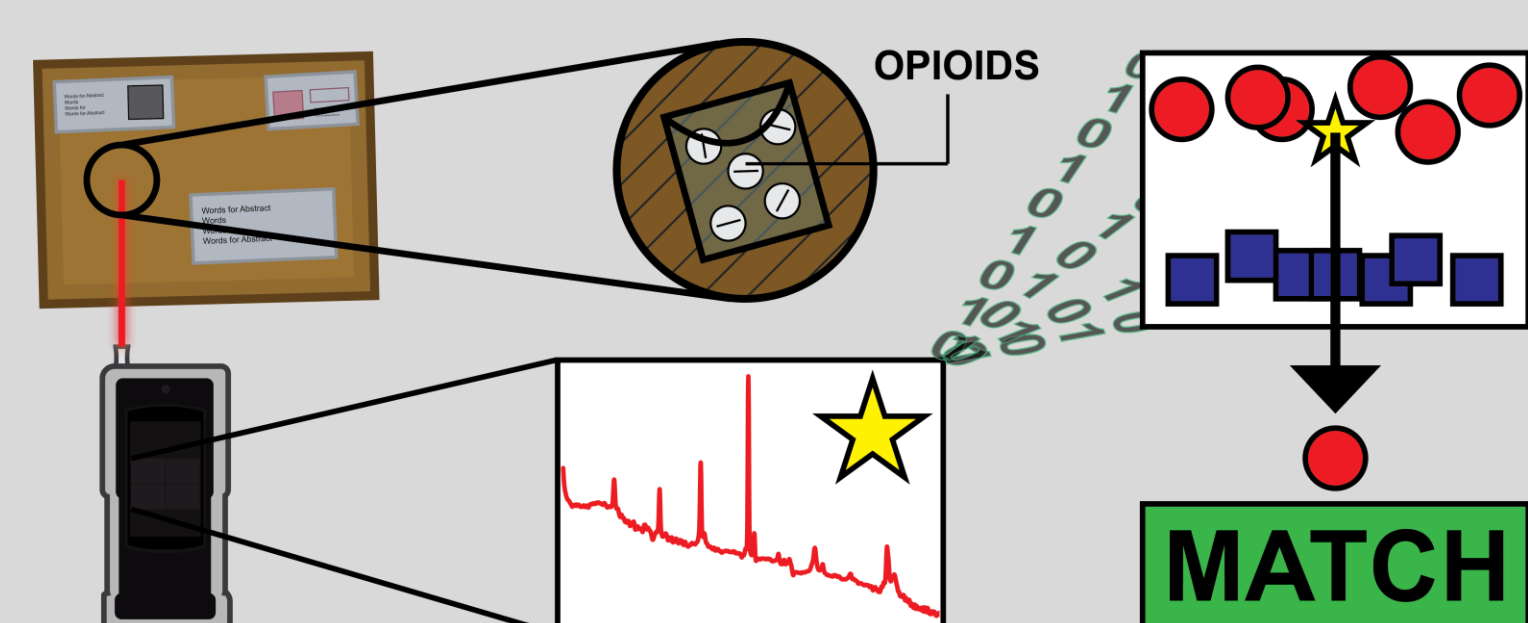
INTRODUCTION

The U.S. Department of Health and Human Services (HHS) declared the opioid use disorder (OUD) in 2017 as a nationwide public health emergency.

Lack of tolerance and addiction attributed the deaths by opioid overdoses. However, the mass number is in great part due the lack of quality from illicit production.

The Department of Homeland Security (DHS) deemed the U.S. CBP agency as deficient at detecting opioids on international mail facilities (IMFs) in 2018.

Our work focuses on proving that opioids hidden in mail can be detected by using portable Raman spectrometers and streamlined by analyzing with chemometrics.

METHODOLOGY

Benzoic acid (BA) simulated the opioid signal for this study. The compound is hidden inside four different mail flat materials.
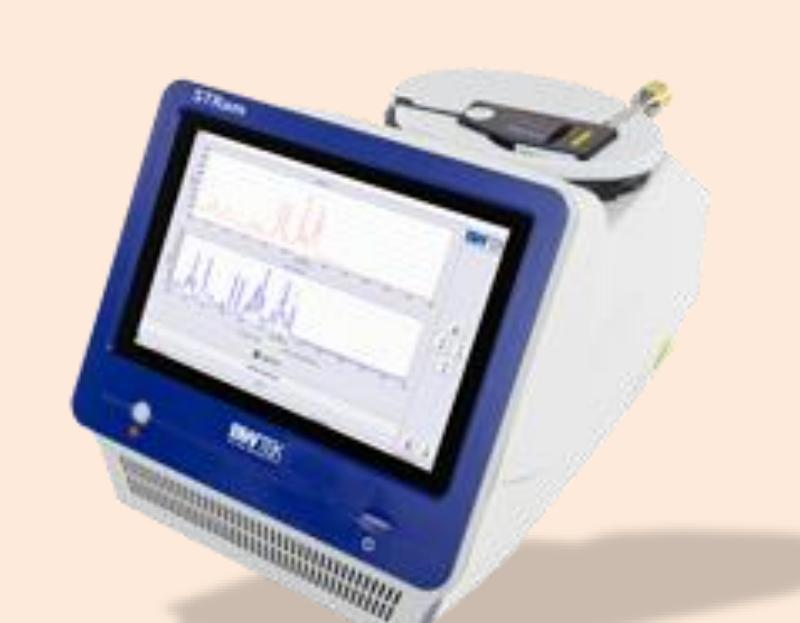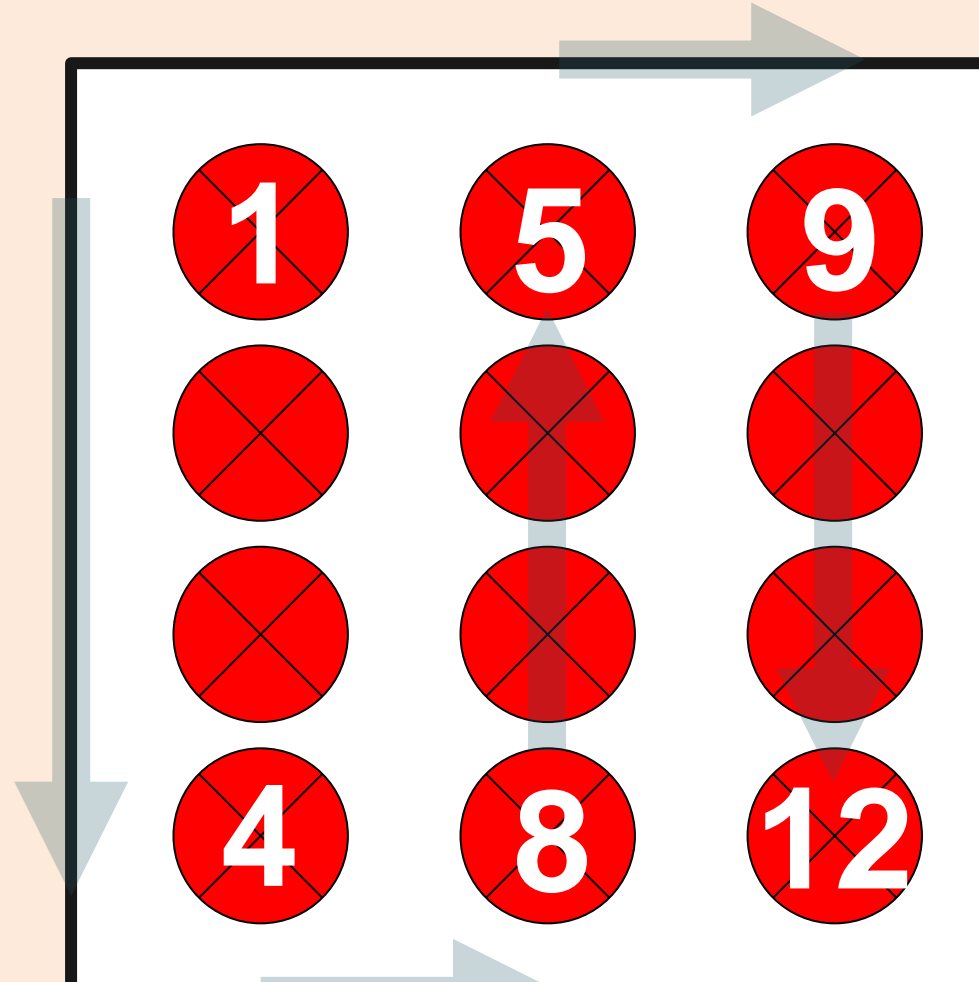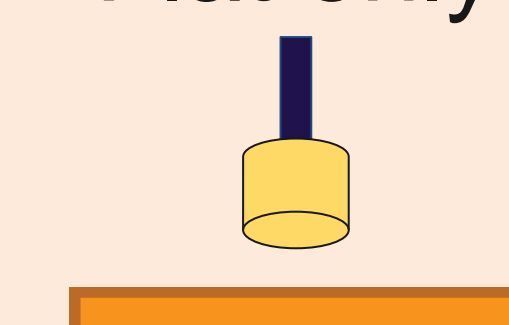
Flat-1   Manila   Bubble wrap   Mili pac

TRAINING SAMPLES
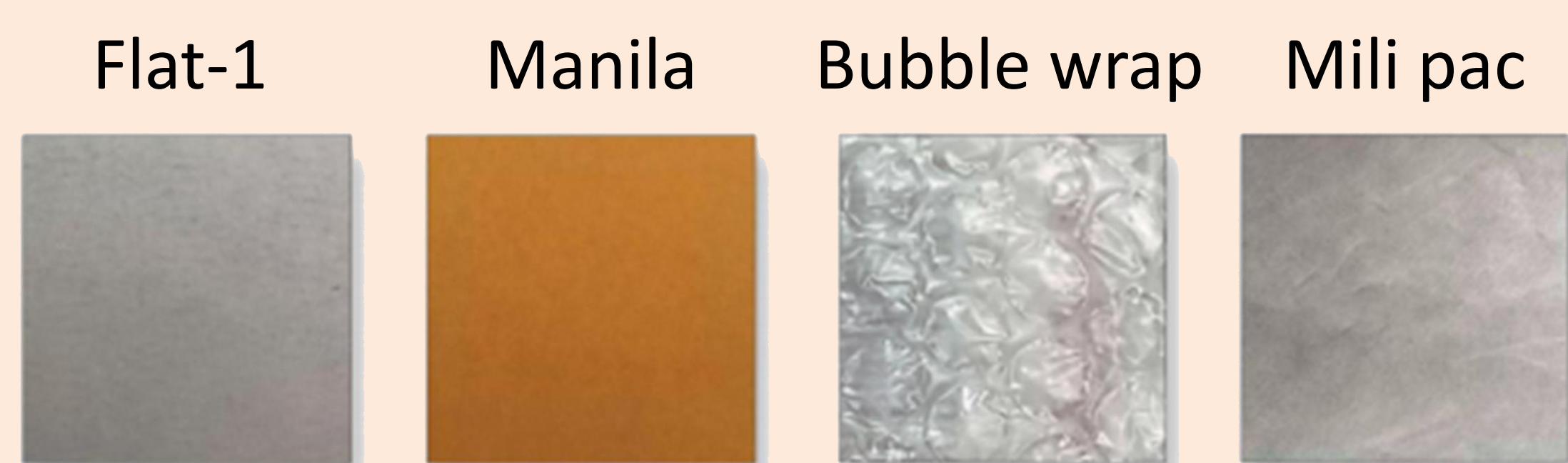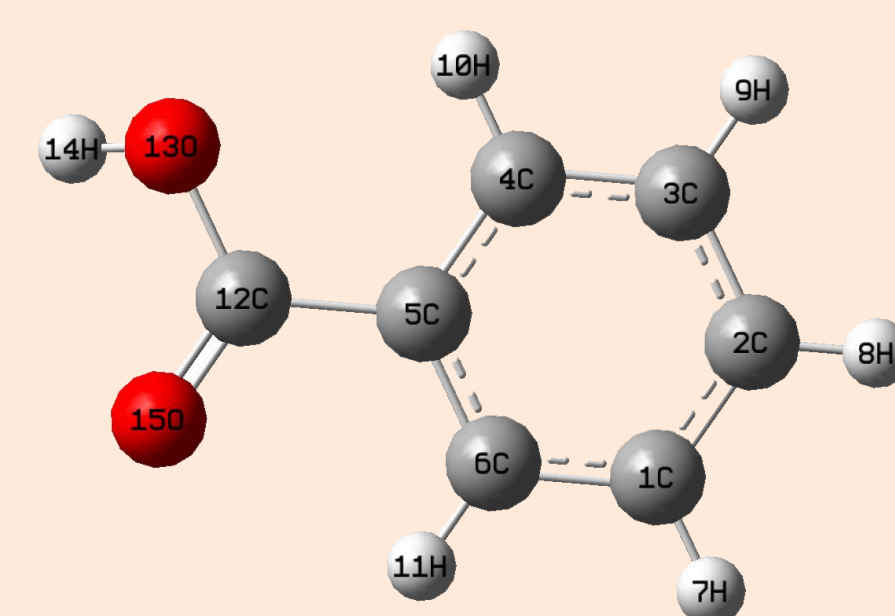
Flat / BA — 1 layer   2 layers
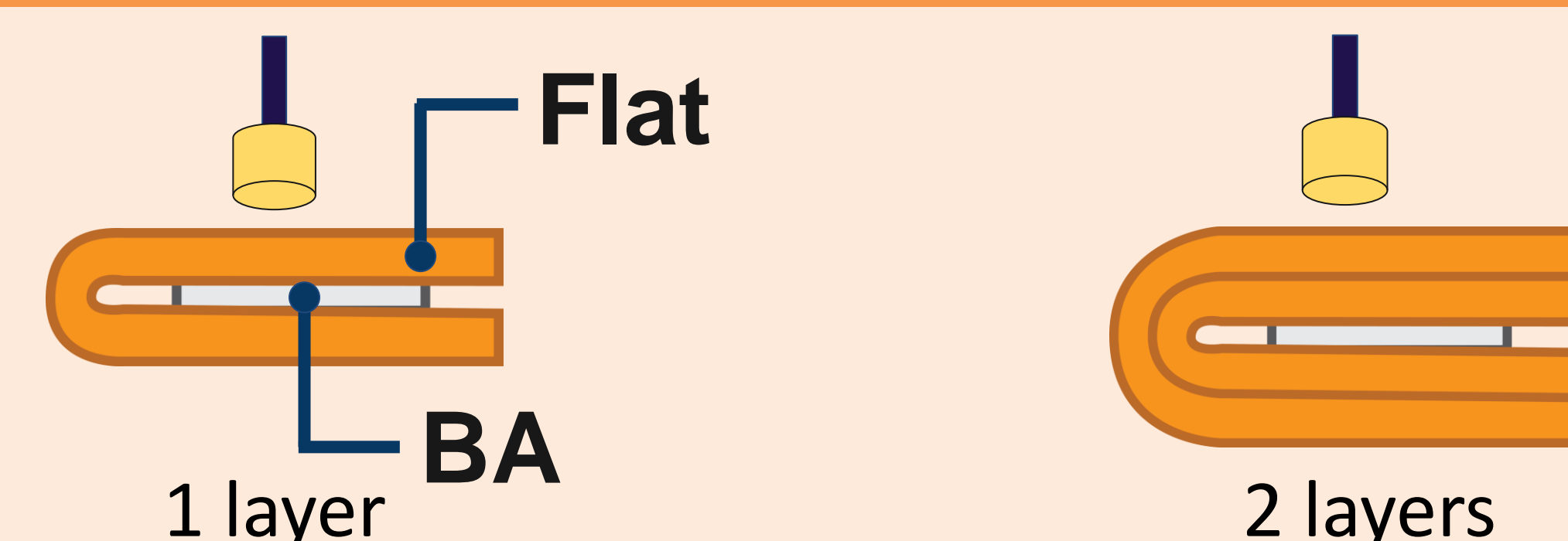
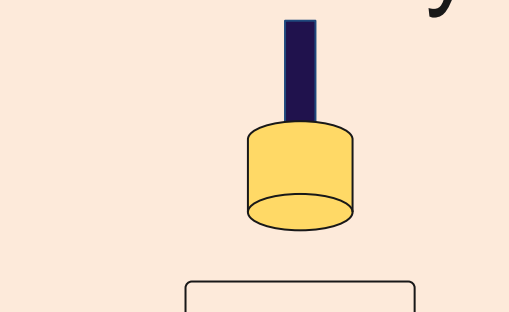**TacticID-1064™**   **STRam™**

Acquired Raman spectra at different positions for each sample.

1 5 9 / 4 8 12

Flat only / BA only

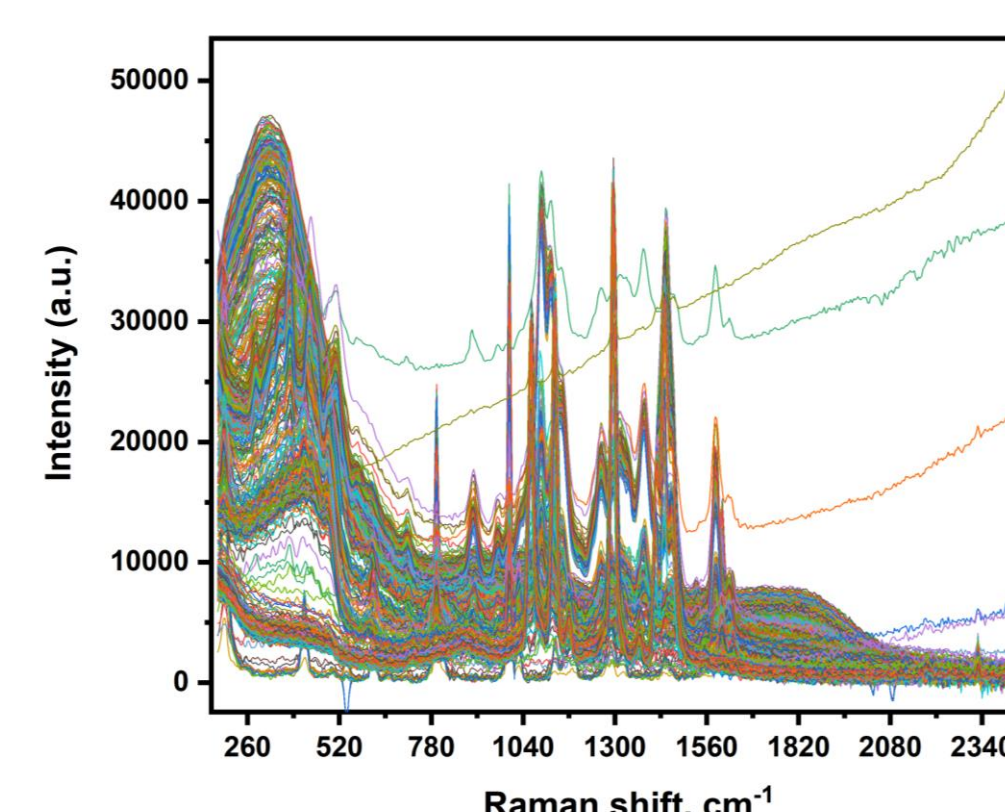**Preprocessed** the data with 12 different methods.

SNV	SNV+SG1	SG1+SNV
MSC	SNV+SG2	SG2+SNV
SG1	MSC+SG1	SG1+MSC
SG2	MSC+SG2	SG2+MSC

Develop a PCA model for all classes in the data (*BA, F01, F02, M01, M02, BW01, BW02, MP01, MP02*).
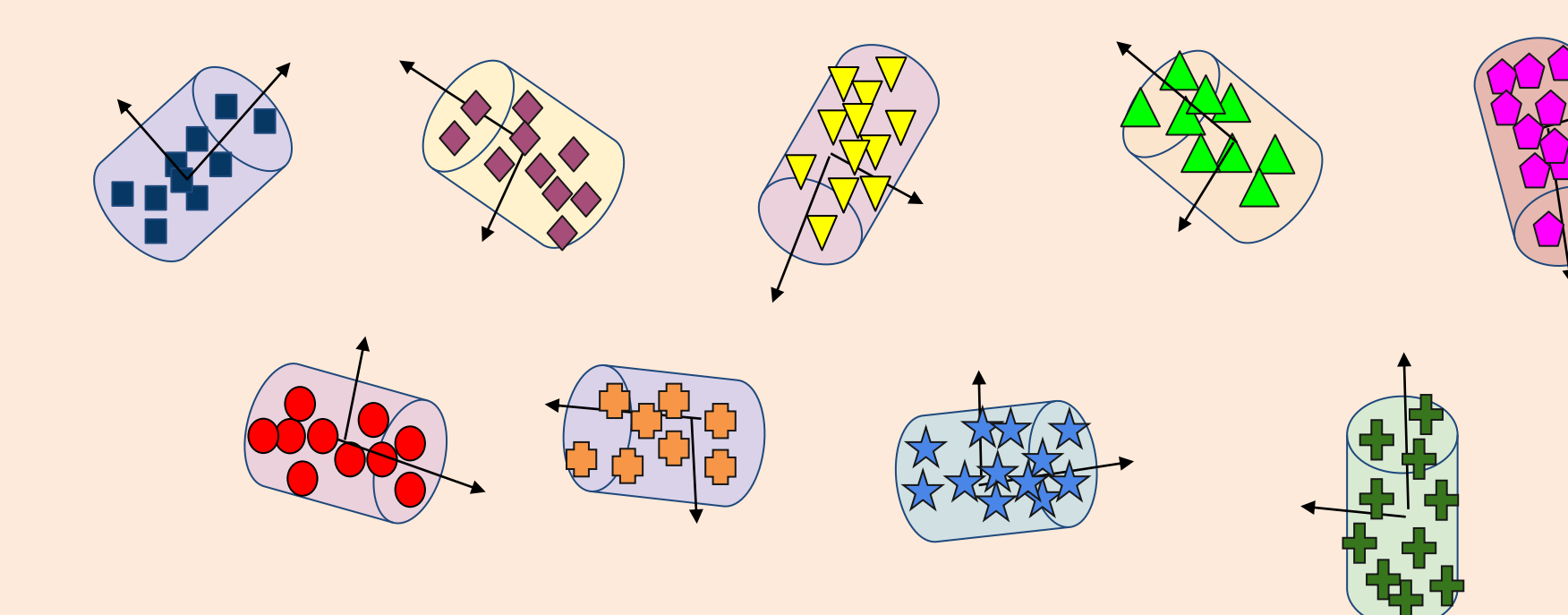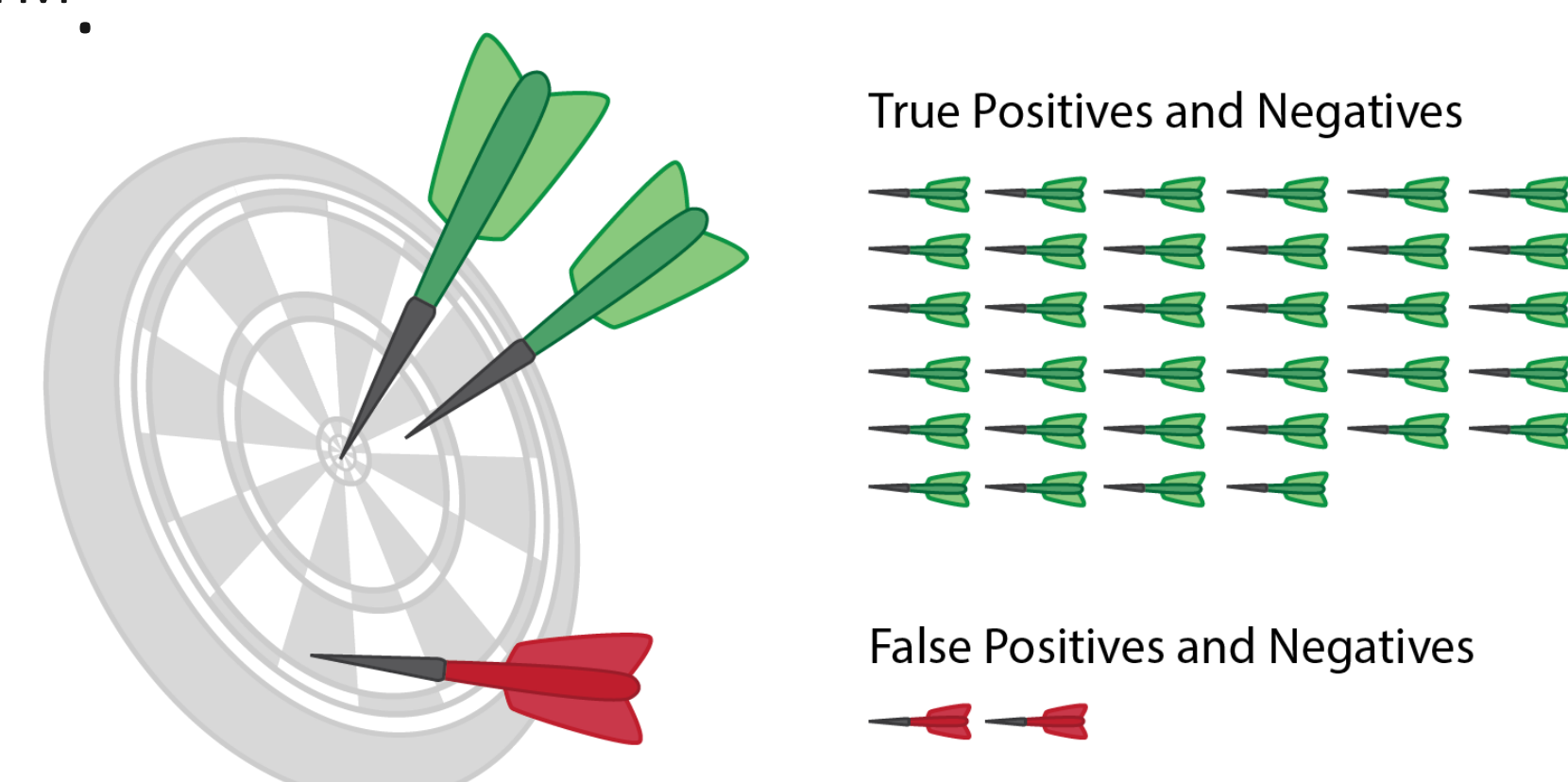
RESULTS

Developed Soft Independent Modelling by Class Analogy (SIMCA) model to detect if samples contain BA.

SIMCA model classified 94% of samples as having or not having benzoic acid (BA) correctly for STRam™ and deficient results with TacticID-1064™.

True Positives and Negatives

False Positives and Negatives

FUTURE WORKS

Writing scientific article and analyzing data with more models.

1	Detecting Opioid Simulant hidden inside Mail Flats non-invasively using
2	Portable and Handheld Raman spectrometers coupled with Chemometric
3	Routines

Develop models with different classifiers (e.g., PLS-DA, SVM, LDA, ANN) to compare and determine the optimal model.

Automatize classification to increase technology readiness level and reduce cognitive load.

Implement more real-life variation to the models to increase robustness.

ACKNOWLEDGEMENT

REFERENCES

Relevant publication references can be accessed by scanning the following QR code.