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Python-based algorithm for binary classification of lateral flow test for HIV drug resistance detection

- Ria Sonigra [Abstract ID: 1533781]
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Introduction

- OLA-Simple is a simplified lab kit (LFT) that classifies WT and MUT HIV strains
- 5-10% operators in LMICs mistakenly classify OLA – Simple test image results
- Goal: Develop an automatic quantitative analysis system for the OLA-Simple test

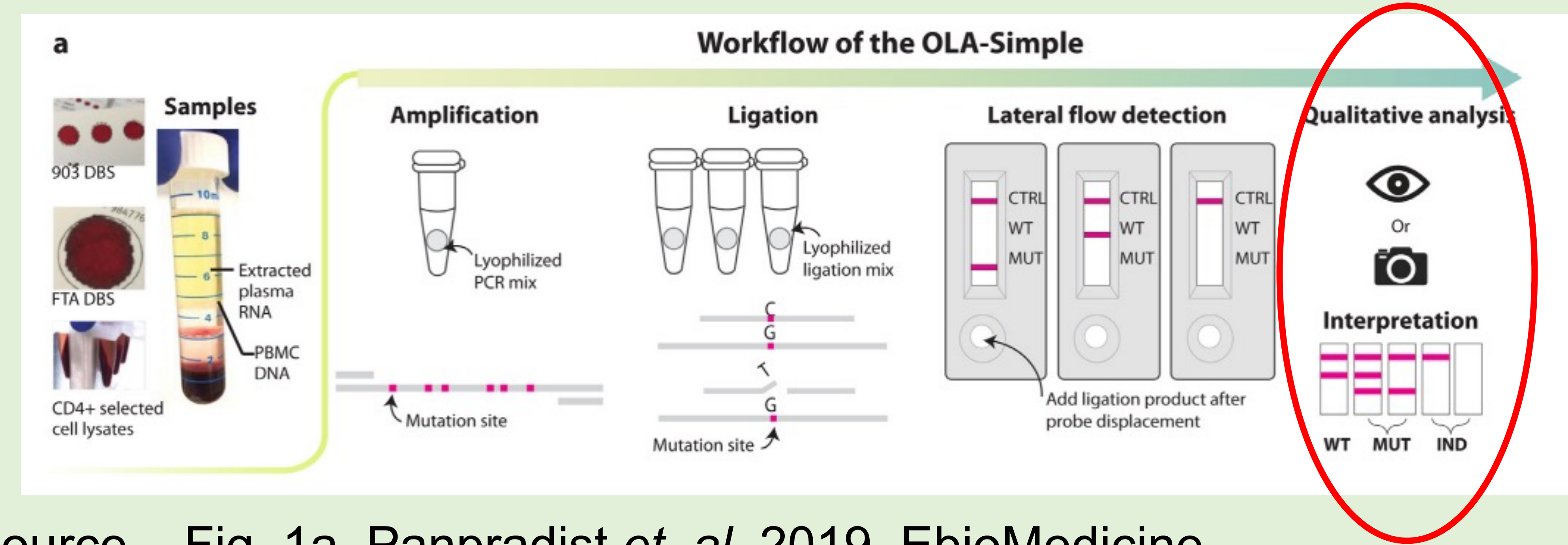


Image Source – Fig. 1a, Panpradist *et. al.* 2019, EbioMedicine

Concept

WT

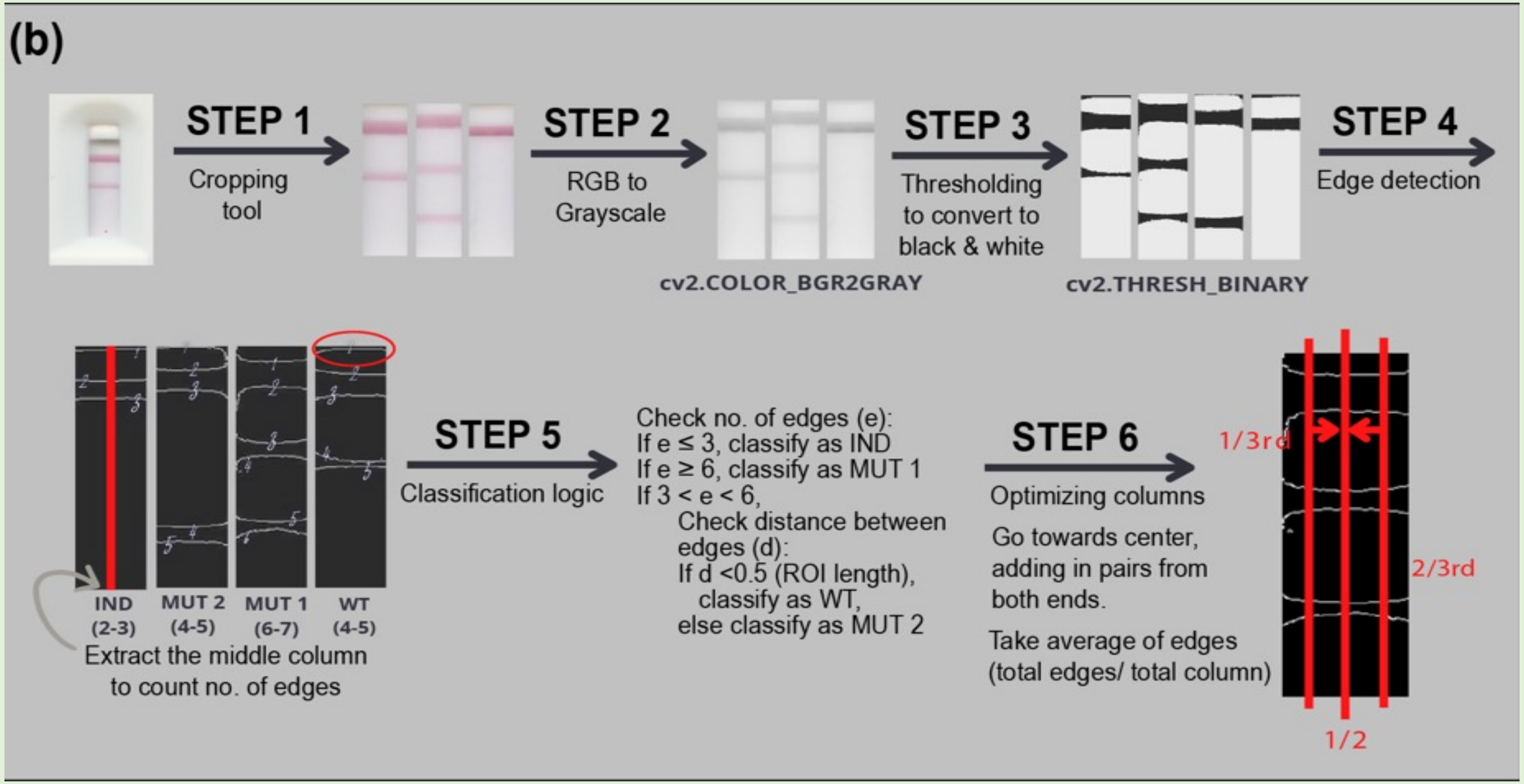
MUT

IND

Dataset : 170WT, 60MUT and 10IND images

WT : Wild Type; MUT : Mutant; IND : Indeterminate

Algorithm Pipeline



OpenCV, a computer vision Python library with built-in functions useful for image pre-processing

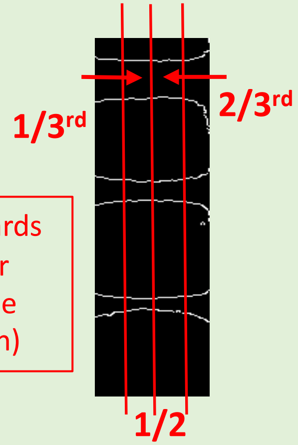
Initial Results

WT			MUT			IND		
WT	MUT	IND	WT	MUT	IND	WT	MUT	IND
111	0	59	5	38	17	0	0	10
True WT : 111/170			True MUT : 38/60			True IND : 10/10		
= 65.3%			= 63.33%			= 100%		

Increasing the contrast using Pillow or OpenCV did not increase model efficiency.

Function Used for Conversion to Gray (Step 3)	Binary Threshold {205, 225}	Adaptive Threshold (mean) {55,8}	Adaptive Threshold (Gaussian mean) {89,4}
COLOR_BGR2GRAY [0.299·B+0.587·G+0.114·R]	WT =65.3% MUT = 63.33% IND = 100%	WT = 144/170 = 84.7% MUT = 51/60 = 85% IND = 100%	WT = 156/170 = 91.76% MUT = 56/60 = 93.33% IND = 100%
COLOR_RGB2GRAY [0.299·R+0.587·G+0.114·B]	WT = 117/170 = 68.82% MUT = 35/60 = 58.33% IND = 100%	WT = 152/170 = 89.41% MUT = 52/60 = 86.66% IND = 100%	WT = 161/170 = 94.71% MUT = 59/60 = 98.33% IND = 100%

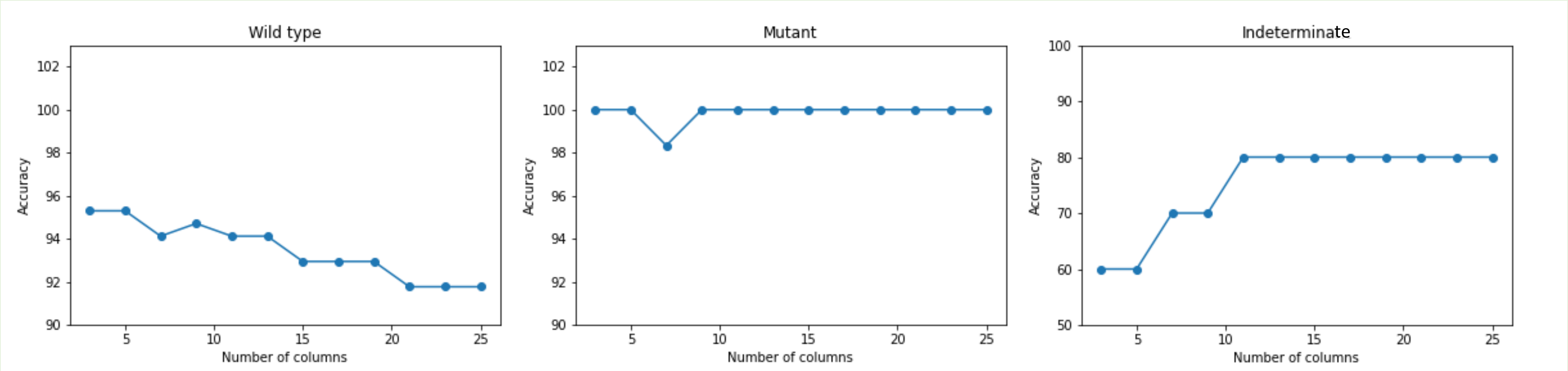
Optimizing the Algorithm



Go towards center (middle column)

Optimization - to decide the number and position of columns to be extracted for counting bands (step 5 and 6)

Conclusion - 3 columns positioned at 1/3rd, 1/2th, and 2/3rd of the ROI width gave the best accuracy



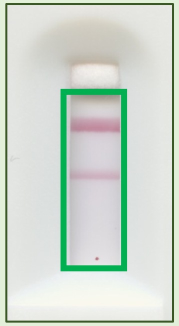
Results

Summary of highest accuracy classified by our pipeline

WT			MUT			IND		
WT	MUT	IND	WT	MUT	IND	WT	MUT	IND
168	2	0	0	60	0	2	1	7
True WT : 168/170			True MUT : 60/60			True IND : 7/10		
= 99%			= 100%			= 70%		

- Misclassified WT images had erroneous ROI selection
- Limited accuracy of IND due to the nature of our dataset [IND only 2% - 5%]
- Misclassified IND images had very light MUT or WT band, showing that algorithm was more accurate in binary classification than the mode calls by the human eye

Wonders of the Grabcut algorithm



ROI coordinates extracted as area selected by user

Goes into our algorithm pipeline

WT			MUT			IND		
WT	MUT	IND	WT	MUT	IND	WT	MUT	IND
169	1	0	0	60	1	0	0	10
True WT : 169/170			True MUT : 59/60			True IND : 10/10		
= 99.41%			= 98.33%			= 100%		

- In-built algorithm in Python; misclassified images had low band intensity
- Requires user interaction wherein users select the coordinates of the ROI

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Jason Rupp
Other Lutz lab members

Check out other 10 BMES posters/talks: download here: