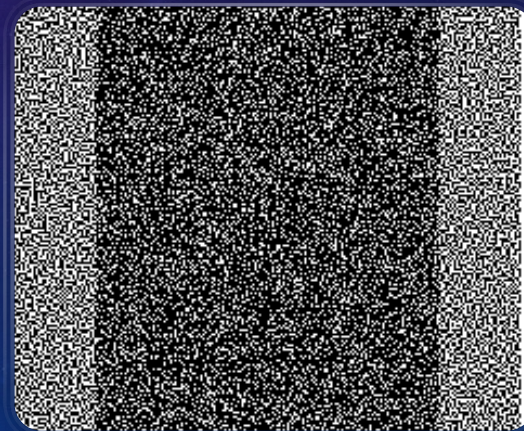
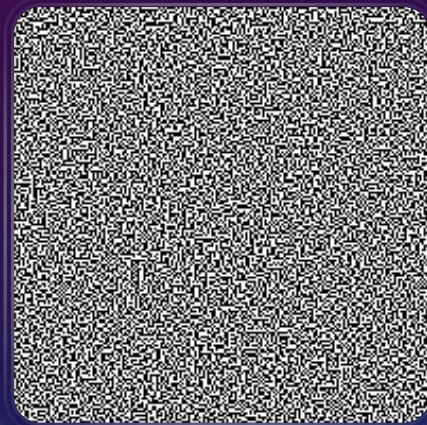
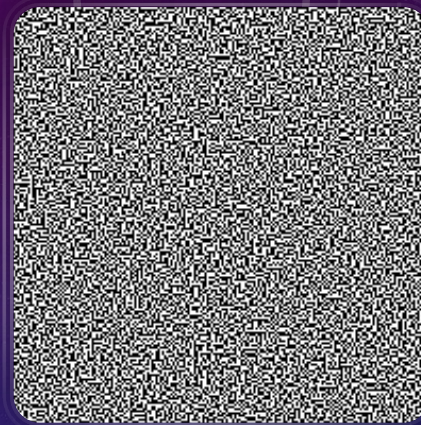
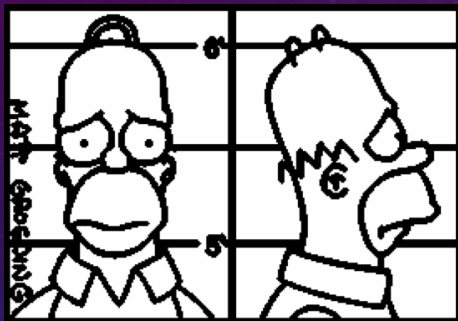


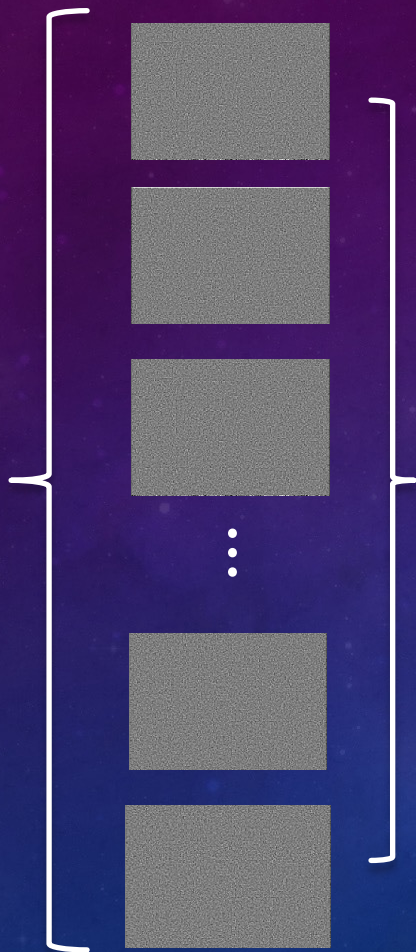
# VISUAL CRYPTOGRAPHY

SPARSH GUPTA, MARK BELANGER, SIDNEY TAYLOR





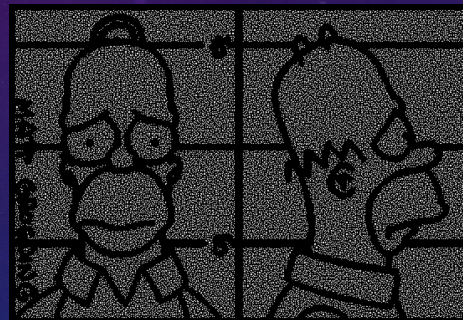
Original image



$n$  encrypted shares



Less than  $k$   
shares  
overlaid



$k$  shares overlaid  
(decrypted image)

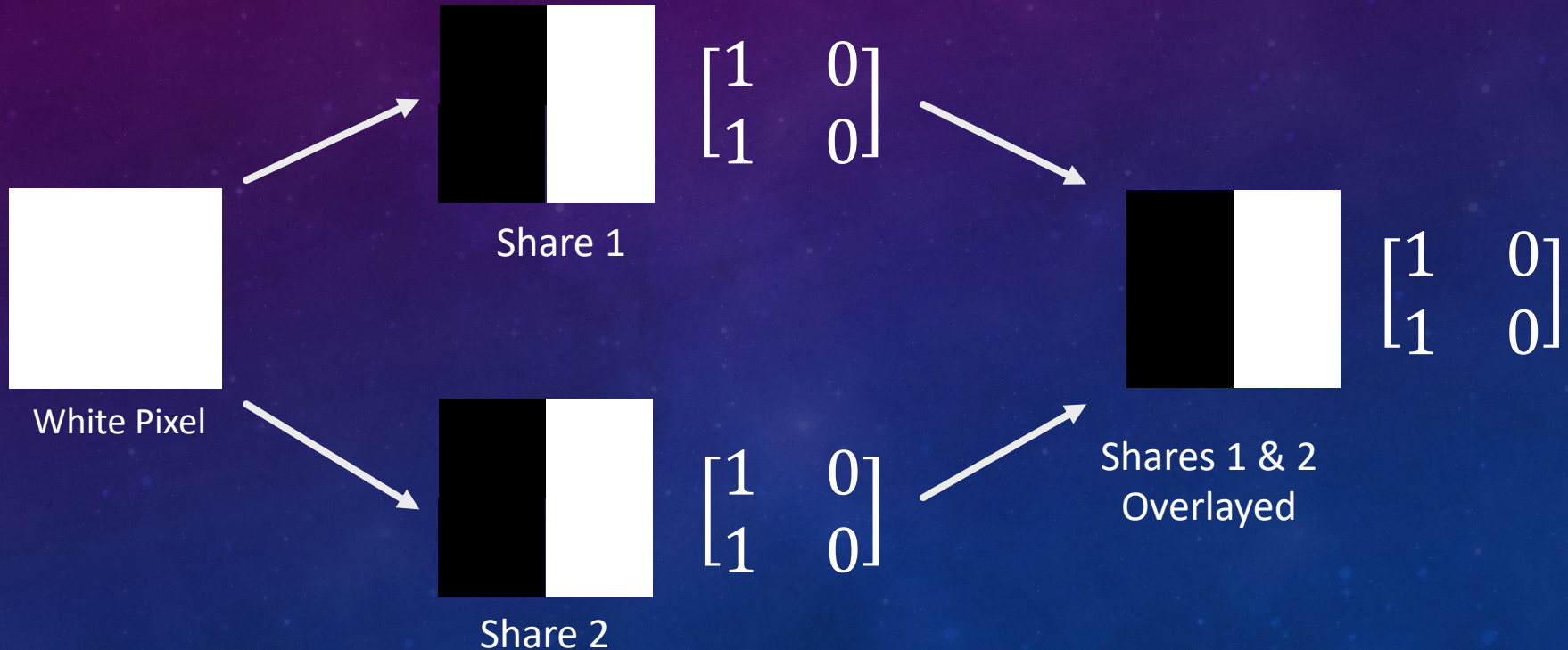


# SHAMIR'S VISUAL CRYPTOGRAPHY SCHEME

The background is a dark blue gradient with faint, glowing particles. On the right side, there are several technical diagrams. At the top right, a circular scale with degree markings from 0 to 210 is visible. Below it, there are concentric circles and dashed lines, some with arrows indicating a clockwise direction. In the bottom right corner, there are more concentric circles and dashed lines, also with arrows. The overall aesthetic is technical and futuristic.

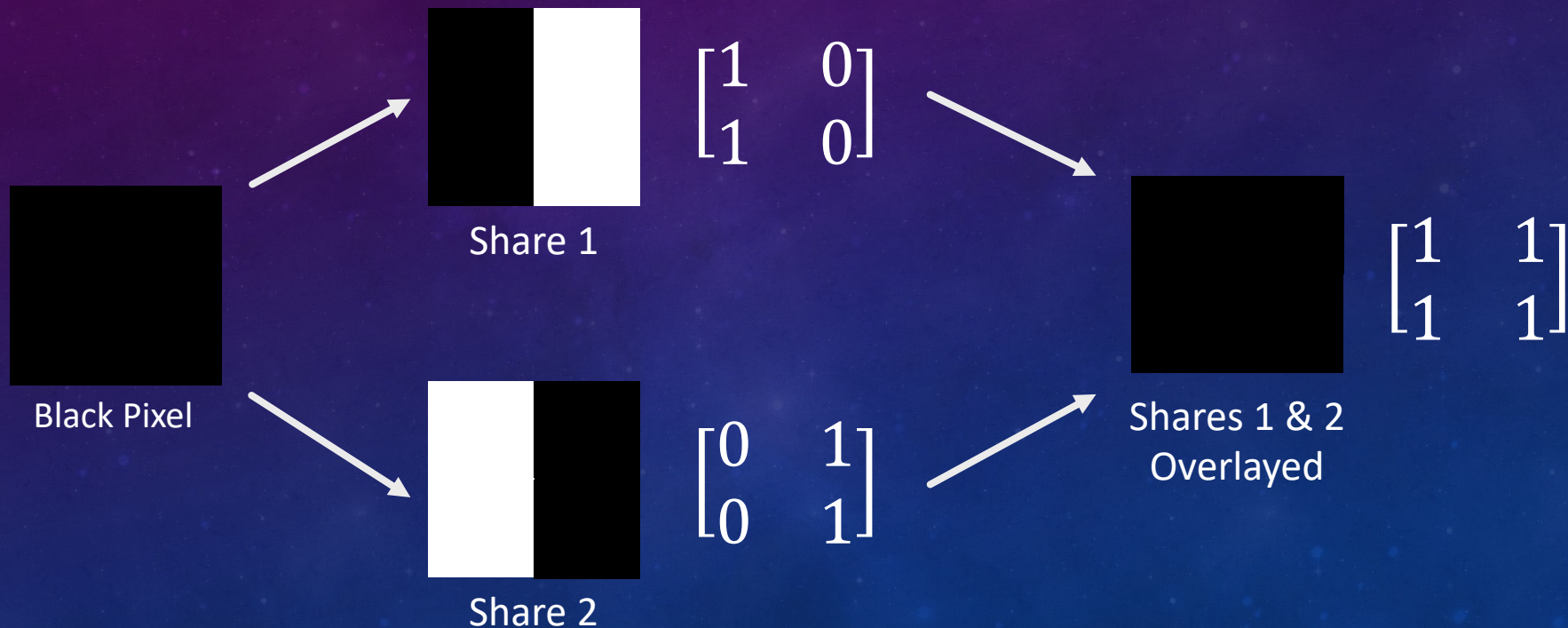
# HOW WHITE PIXELS ARE HANDLED

Shares are made of the same subpixel arrangement



# HOW BLACK PIXELS ARE HANDLED

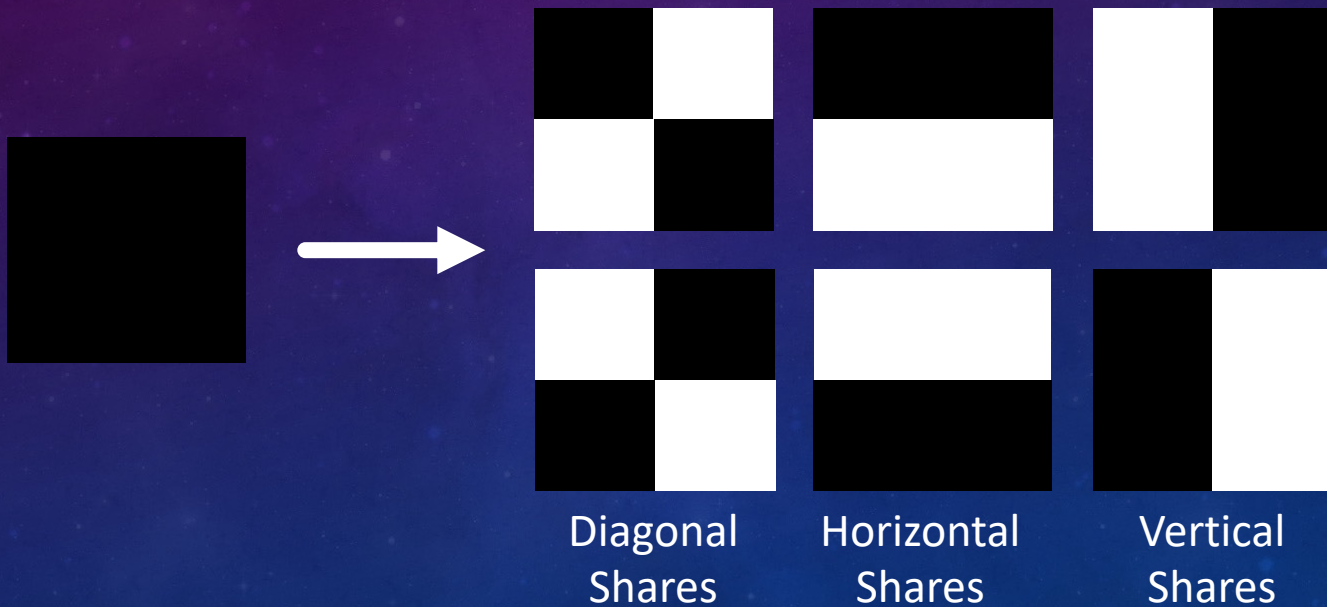
Shares are made of reciprocal subpixel arrangements



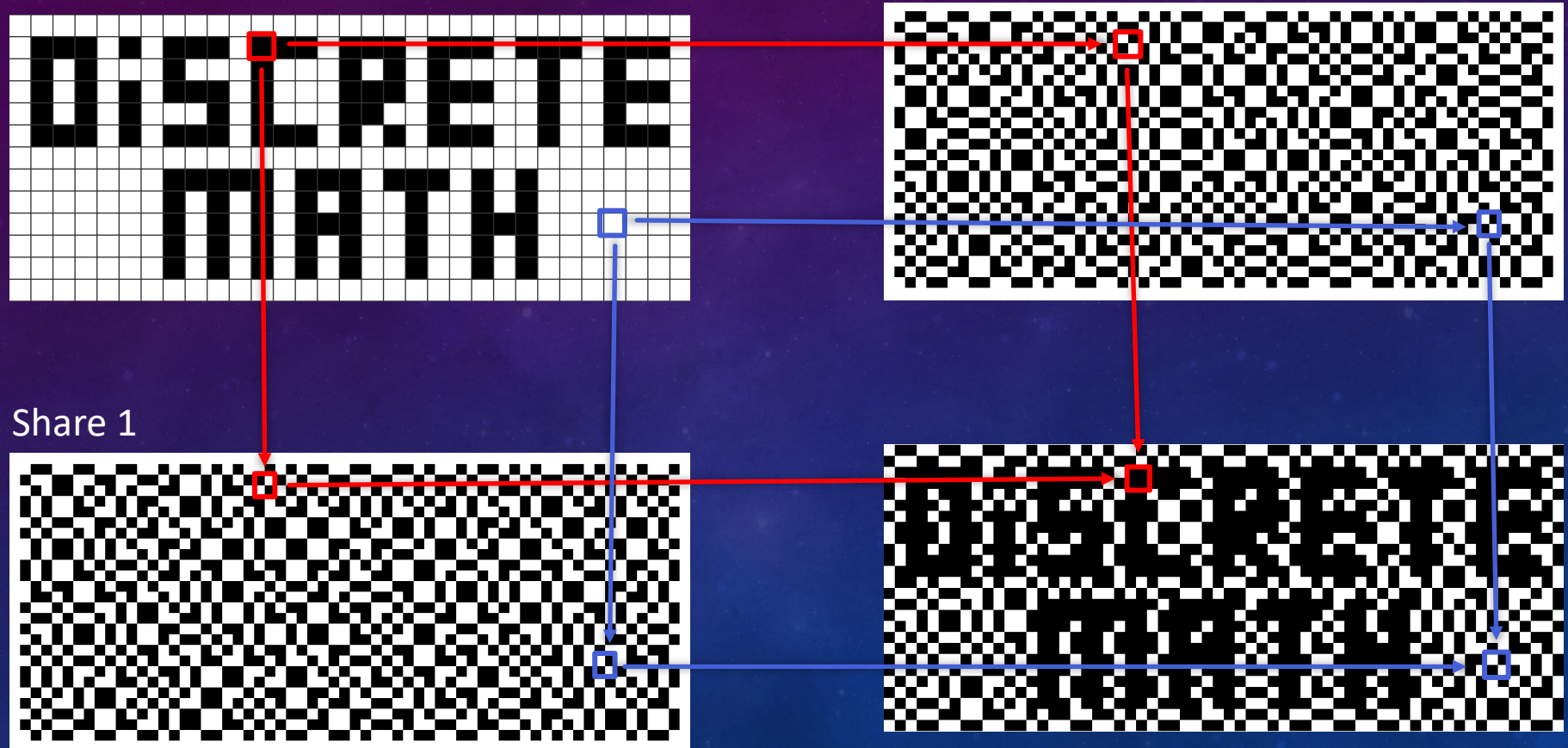


# PIXEL EXPANSION (BLACK PIXEL SHARES)

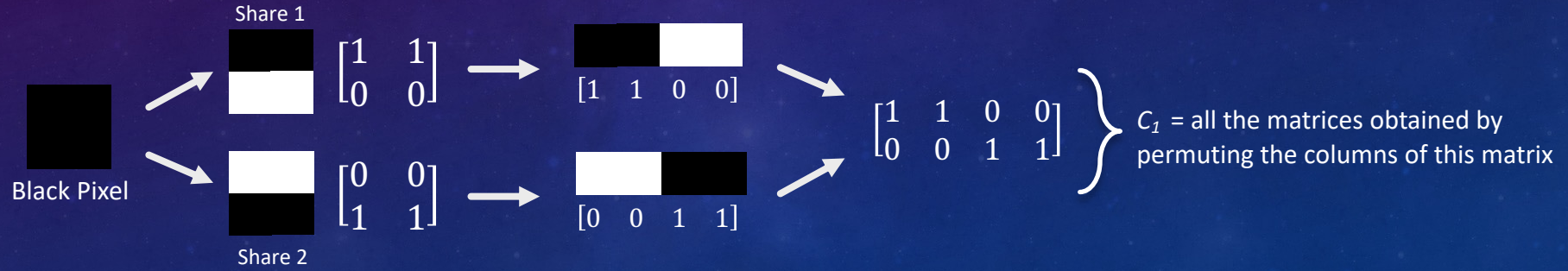
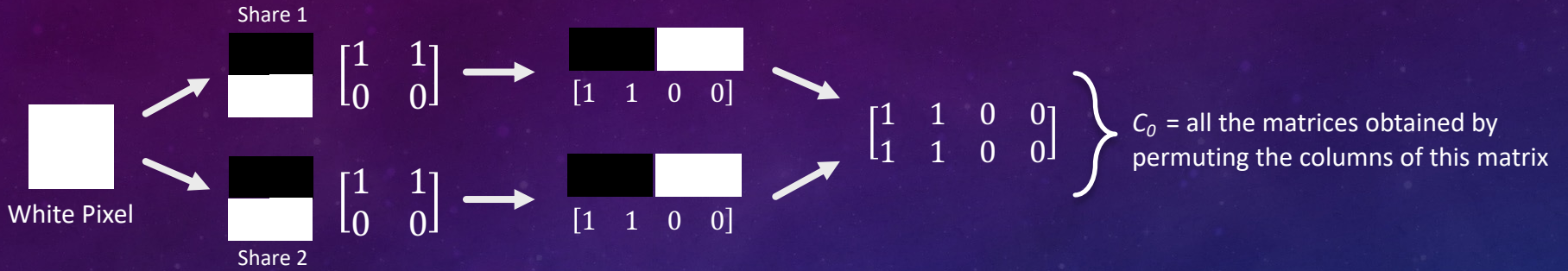
- Each pixel is broken into sub-pixels, and that get encoded



# SHAMIR'S SCHEME EXAMPLE (PIXEL EXPANSION)

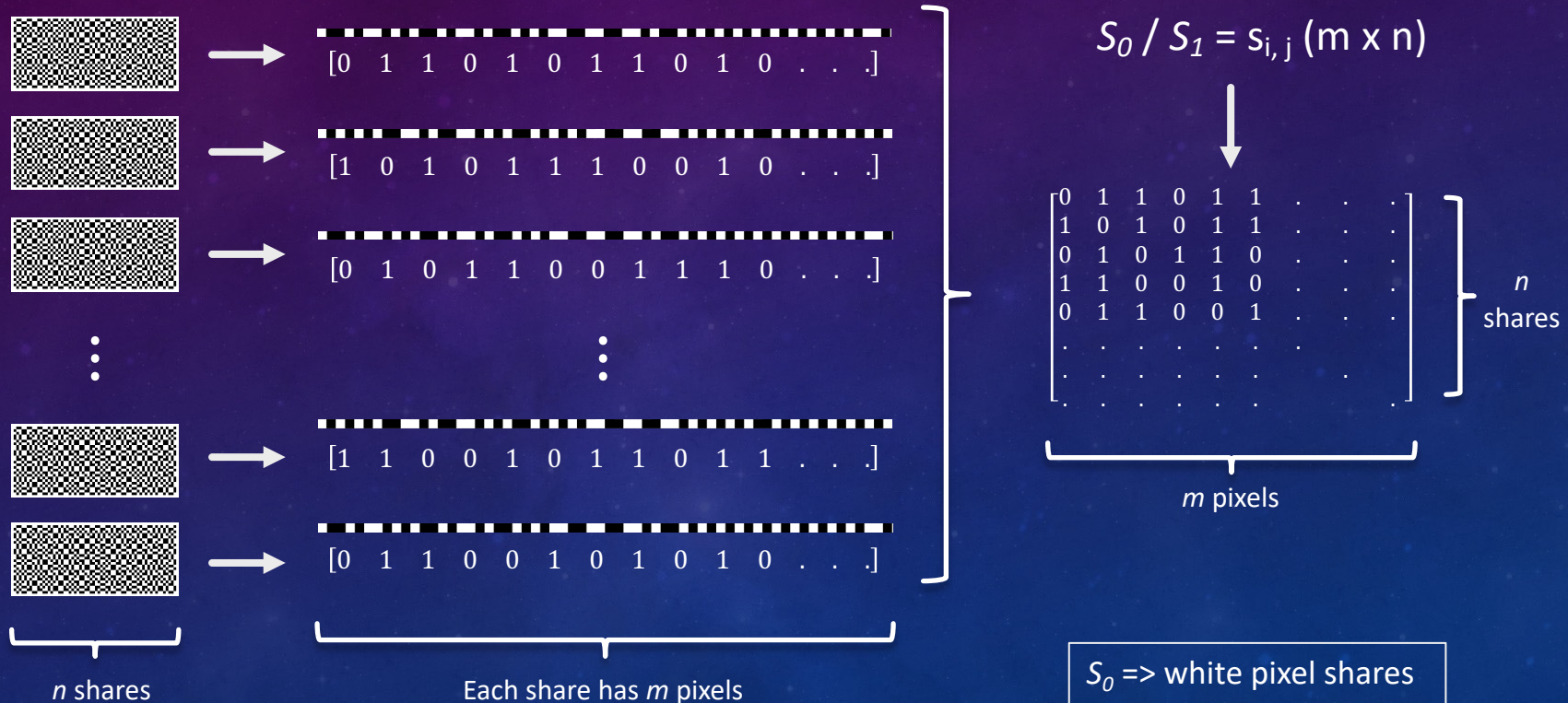


# GENERAL PIXEL ENCODING MATRIX (FOR 2 SHARES)

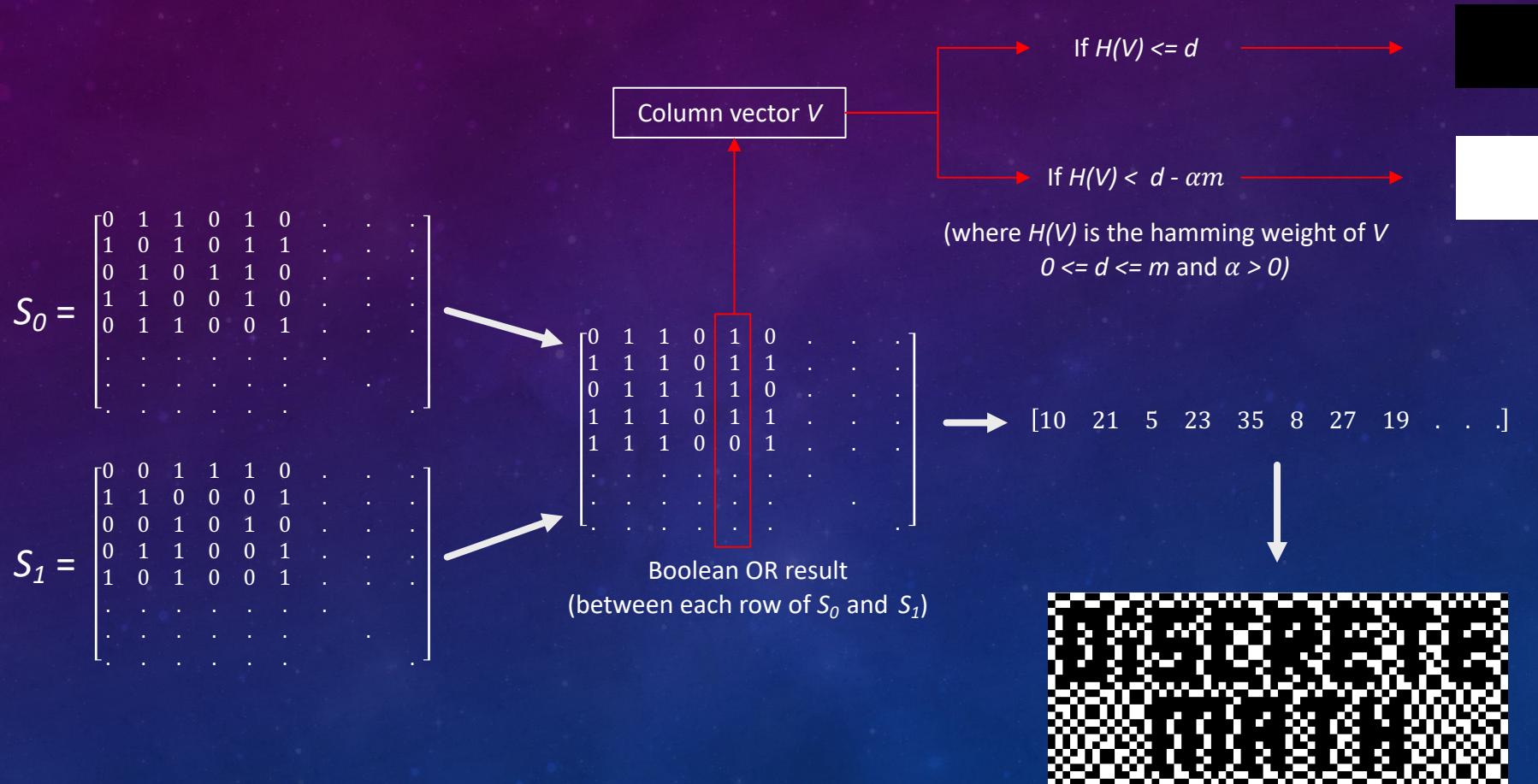




# K OUT OF N SCHEME – DECODING SHARES



# K OUT OF N SCHEME - DECRYPTING IMAGE

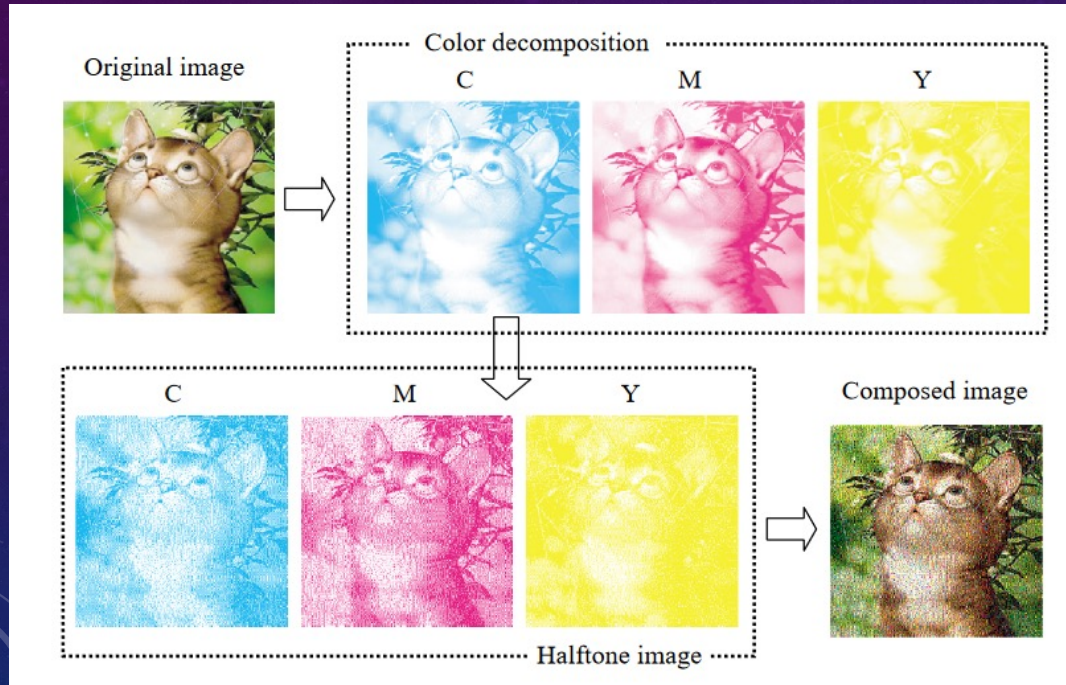


The background is a dark blue gradient with faint, glowing particles. In the top right corner, there is a large, semi-transparent circular graphic. It features a scale from 0 to 200 in increments of 10, with a dashed line and an arrow pointing clockwise. Below this, there are several concentric circles, some solid and some dashed, with arrows indicating a clockwise direction. In the bottom left corner, there is another similar circular graphic with a dashed line and an arrow pointing clockwise. The text "WHAT IF WE EXPAND THIS ALGORITHM FOR COLOR IMAGES?" is centered in the middle of the image in a white, sans-serif font.

WHAT IF WE EXPAND THIS ALGORITHM FOR COLOR IMAGES?



# DECOMPOSING COLOR IMAGES

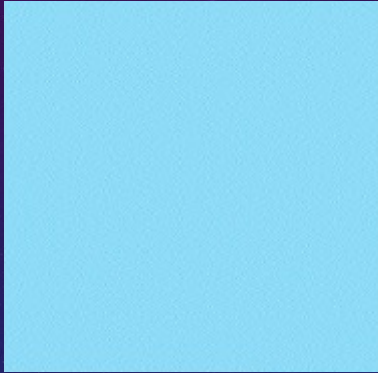


Color images can be represented using combinations of cyan, magenta, and yellow

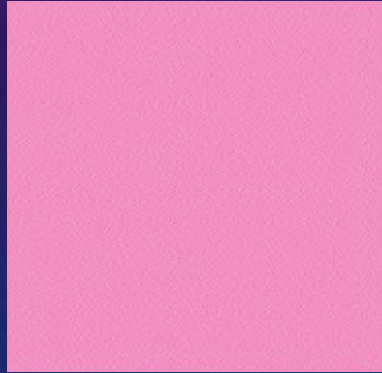
$$\begin{array}{c} \text{Red} \\ (0, 1, 1) \end{array} = \begin{array}{c} \text{Cyan} \\ 0 \end{array} + \begin{array}{c} \text{Magenta} \\ 1 \end{array} + \begin{array}{c} \text{Yellow} \\ 1 \end{array}$$

# HOW IT WORKS

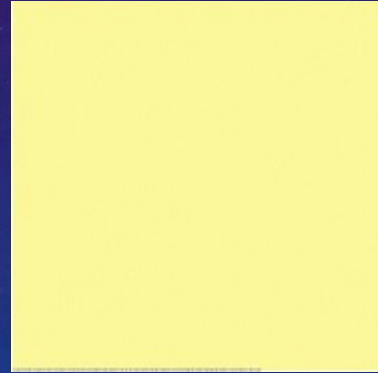
Decompose image into CMY (i.e each pixel looks something like  $(1, 0, 1)$ ) → pixel-by-pixel encryption into the 4 shares with pixel expansion



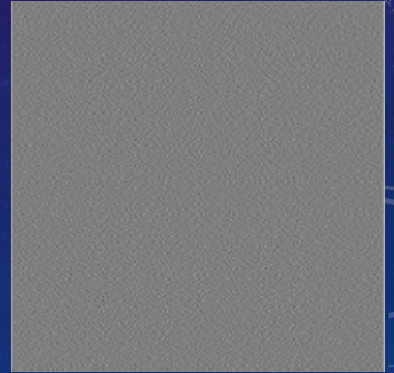
Cyan Share



Magenta Share



Yellow Share

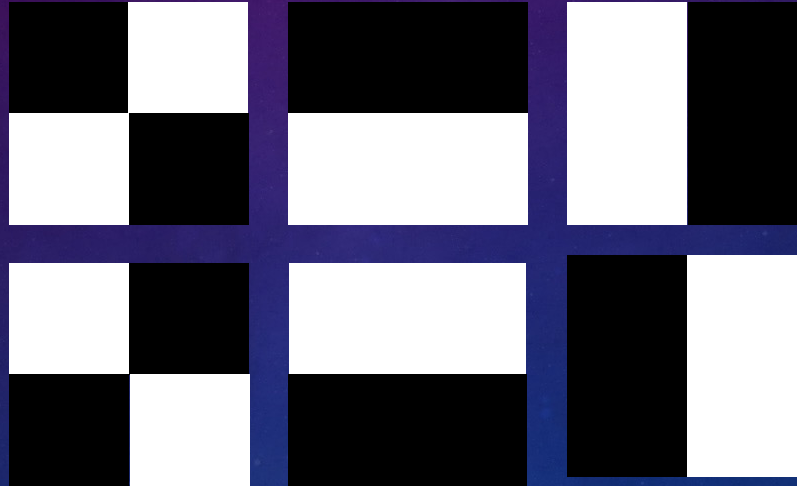


Black Share



# CREATING THE BLACK SHARE

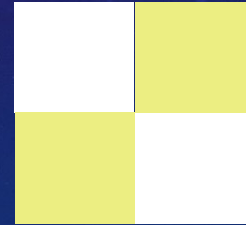
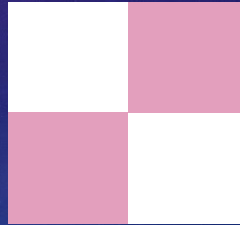
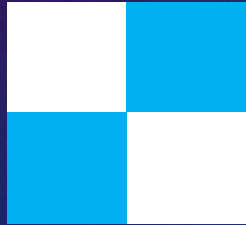
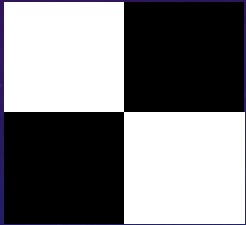
Step 1: Select  
one of these  
for each pixel:






































# ARRANGEMENT OF COLOR SHARES

- Depends on the black share
- CMY fills white space depending on if it needs to be shown

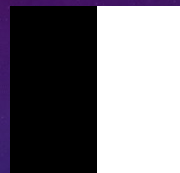


# COLORS THAT CAN BE CREATED

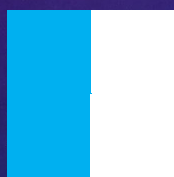
Mask	Revealed color (C,M,Y)	Share1(C)	Share2(M)	Share3(Y)	Stacked image	Revealed color quantity (C,M,Y)
	(0, 0, 0)					(1/2, 1/2, 1/2)
	(1, 0, 0)					(1, 1/2, 1/2)
	(0, 1, 0)					(1/2, 1, 1/2)
	(0, 0, 1)					(1/2, 1/2, 1)
	(1, 1, 0)					(1, 1, 1/2)
	(0, 1, 1)					(1/2, 1, 1)
	(1, 0, 1)					(1, 1/2, 1)
	(1, 1, 1)					(1, 1, 1)

# RED PIXEL EXAMPLE

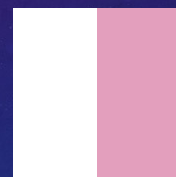
If black share subpixel group is



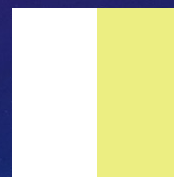
+



+



+



=



Red  
(0, 1, 1)

Cyan  
0

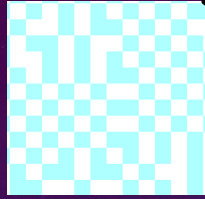
Magenta  
1

Yellow  
1

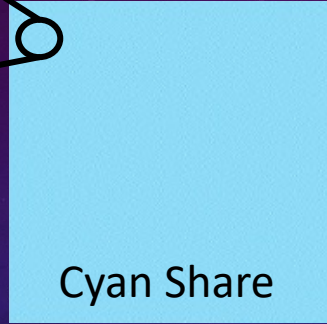
Cyan must be covered by black  
since Cyan weight = 0



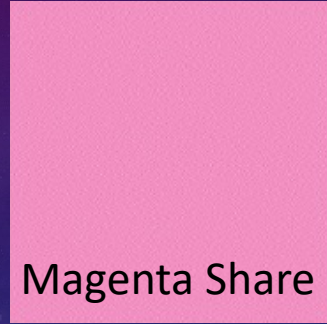
# COLOR IMAGE VISUAL CRYPTOGRAPHY EXAMPLE



Original image



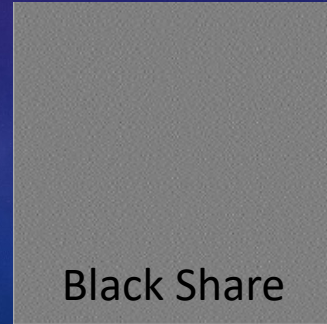
Cyan Share



Magenta Share



Yellow Share



Black Share



Decrypted image

# REFERENCES

- [1] <https://www.cs.jhu.edu/~fabian/courses/CS600.624/NaorShamir-VisualCryptography.pdf>
- [2] <https://www.researchgate.net/publication/353374619> An overview of visual cryptography techniques
- [3] <https://www.ciphermachinesandcryptology.com/en/visualcrypto.htm>
- [4] <https://www.sciencedirect.com/science/article/pii/S0031320302002583#SEC3>
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- [6] <https://fardapaper.ir/mohavaha/uploads/2018/12/Fardapaper-A-Comprehensive-Study-of-Visual-Cryptography.pdf>
- [7] <https://www.101computing.net/visual-cryptography/>