Yusuf Fawzy Elnady

Vector Quantization

(Using LBG Algorithm with Splitting)

Summary:

We start by **dividing** the image **into blocks (vectors)**, then we generate **Best "K" Vectors** that can be used to **re-Construct** the original Image, these vectors are called **Codebook**. For each Block in the Image, Select the **Nearest** vector (using Euclidean Distance), then **label** each Block in the image with **INDEX** of Nearest Vector (in the Codebook).

In order to **re-Construct** the Image, it is required to have:

- **All Labels** (one label for each BLOCK in the Image).
- **The Codebook itself** which consists of K Vectors, each vector is a small Image with size equal to BLOCK size.

The project is built using Java, **Intellij**.

Example:

- The original **GRAY** image is **600*600 pixels** (each pixel is saved in one byte)
- The image is divided into **Blocks each of size 4*4 pixels**
- **The Codebook** (which will be used to Reconstruct the image) consists of 32 Vectors **(32 blocks each of size 4*4)**

Solution:

- **Number Blocks in the image** = (600*600)/ (4*4) =22500 Blocks
- **Number of labels** = Number of Blocks = 22500 Labels
- As **Number of Vectors in the codebook = 32**, Indexes will range from 0 to 31 (from 00000 to 11111 Binary) In other words, **each index** can be **saved in 5 Bits** (each label is 5 bits)

Compression Ratio:

- **Labels Size** = Number of Labels * bits/Label = 22500 * 5 bits = 112500 bits (14063 Bytes)
- **Codebook Storage Size** = Number of Vectors * Vector Size (in pixels) * number of bits to save a **pixel** = 32 * (4*4) * 8 bits = 4096 bits (512 bytes)
- **Total Compressed Image Size** = Label Size + Code book storage size = 112500+ 4096 = 116596 bits (14575 bytes)
- **Original Image Size** = 600 * 600 (pixels) * 8 bits/pixel = 2880000 bits (360000 Bytes)
- **Compression Ratio** = Original / Compressed = 360000/14575 = **24.7:1**

Source: http://www.learngroup.org/uploads/2015-11-16/Vector_Quantizers_Leangroup_org.pdf

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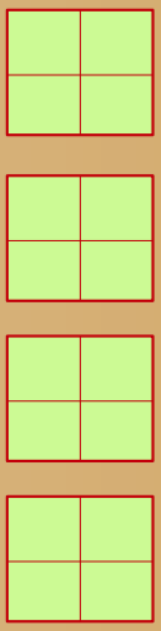
Compress the following Image Using Vector Quantization
(initialize LBG Algorithm using Splitting)
(Each pixel is saved in 8 bits)

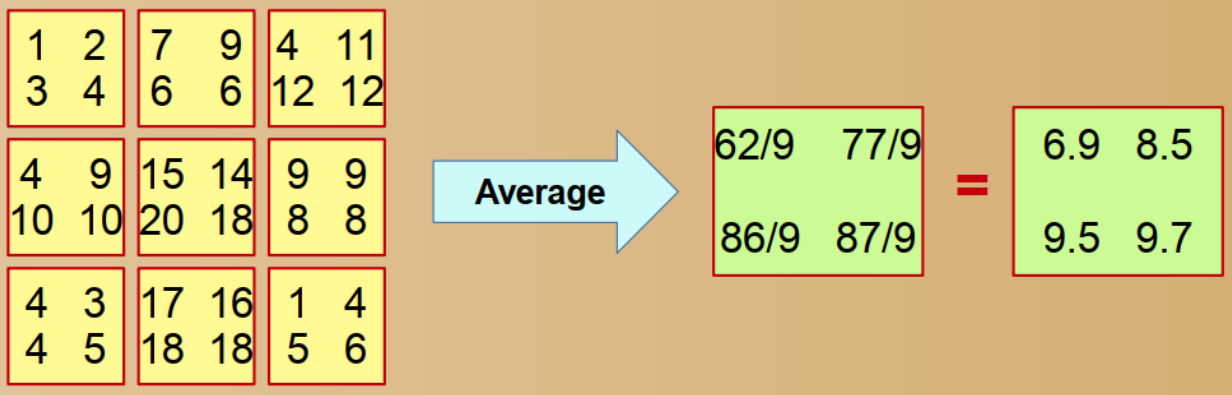
Vector size = 2*2
Number of Vectors in Codebook = 4

1	2	7	9	4	11
3	4	6	6	12	12
4	9	15	14	9	9
10	10	20	18	8	8
4	3	17	16	1	4
4	5	18	18	5	6



Reconstruct the Compressed Image,
Calculate Mean Square error between Original and Reconstructed Image
Calculate Compression Ratio
Re-Calculate Compression Ratio if the image is 600*600 pixels

Prof. Khaled Mostafa
khaledms@fci-cu.edu.eg



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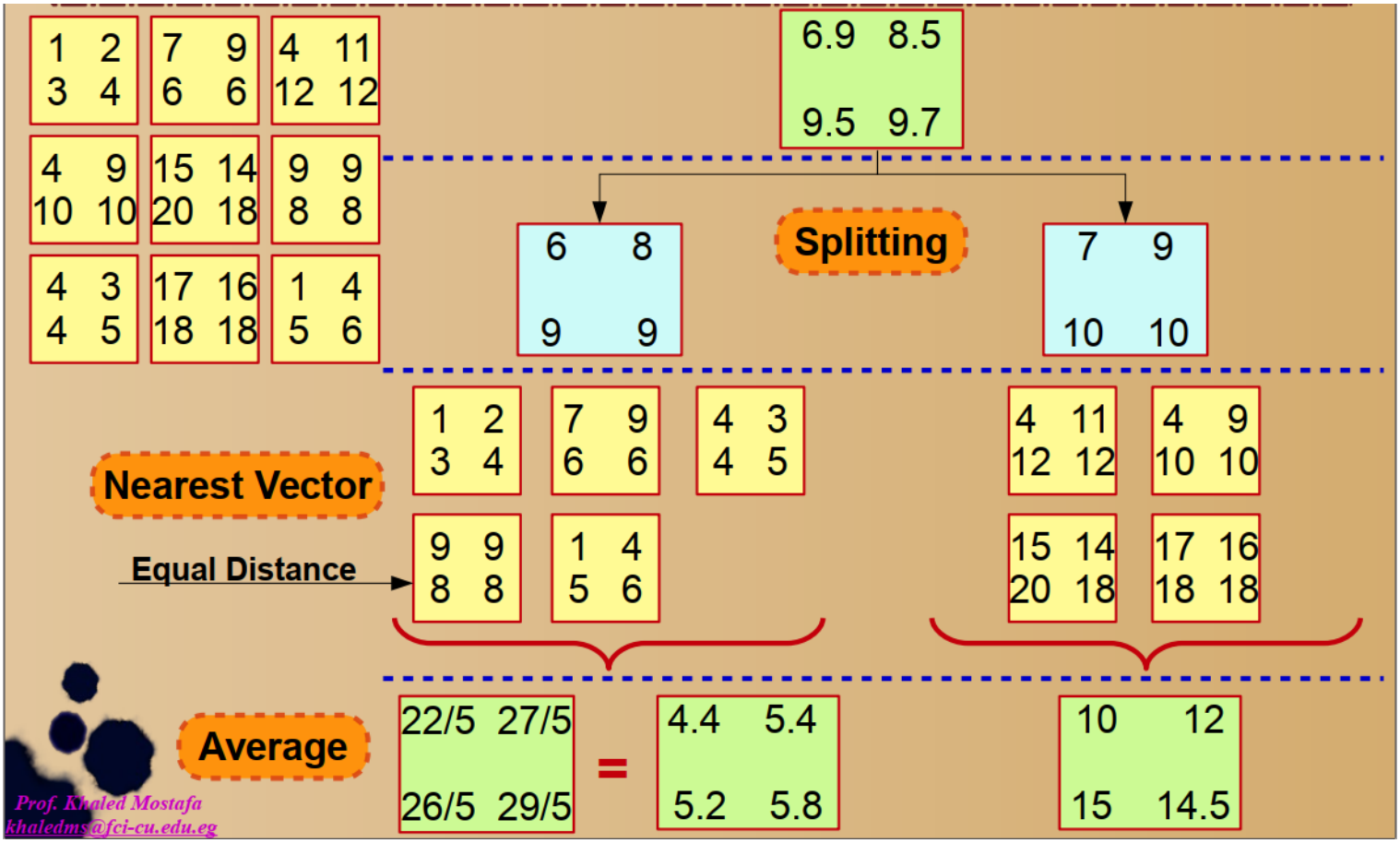

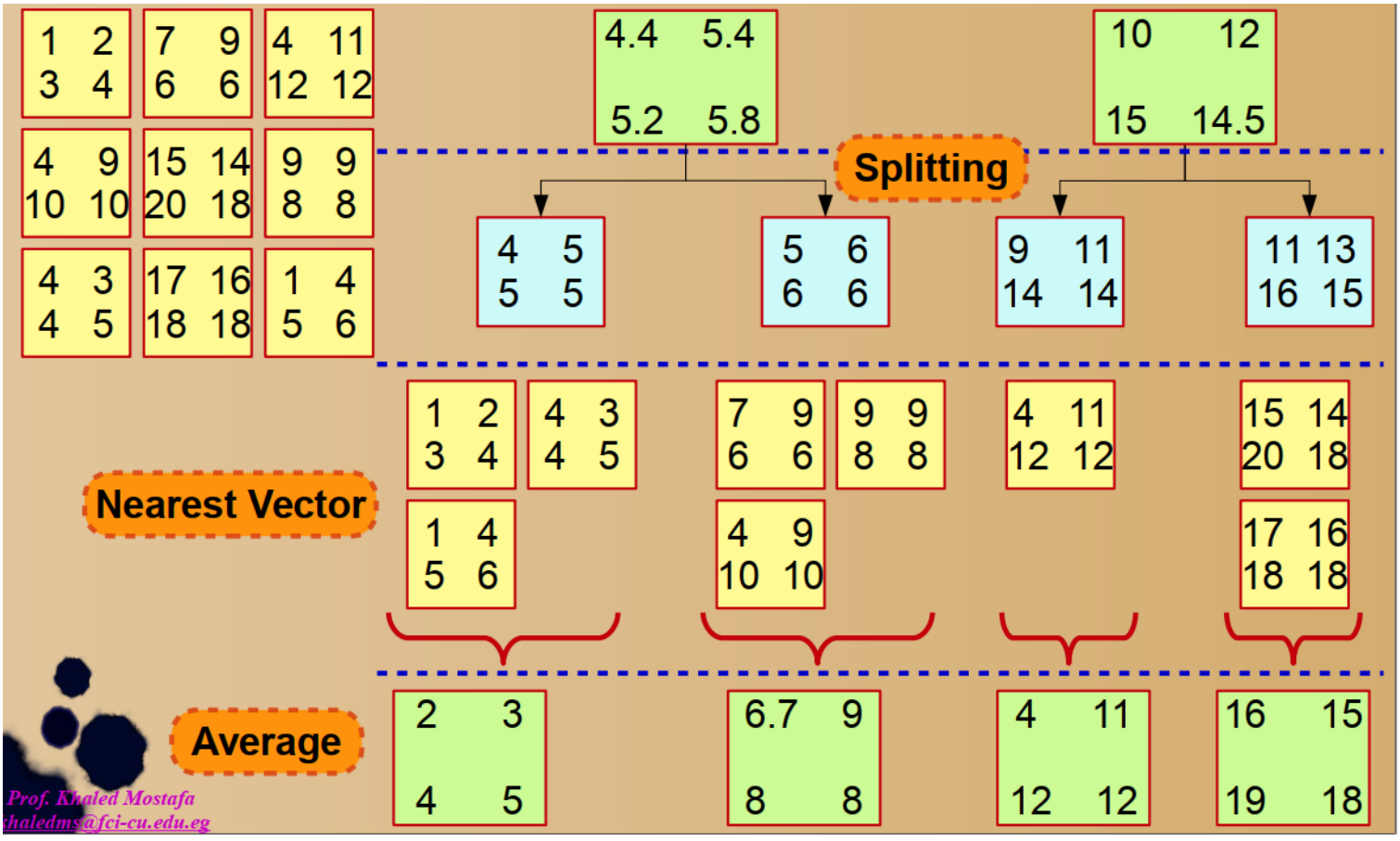

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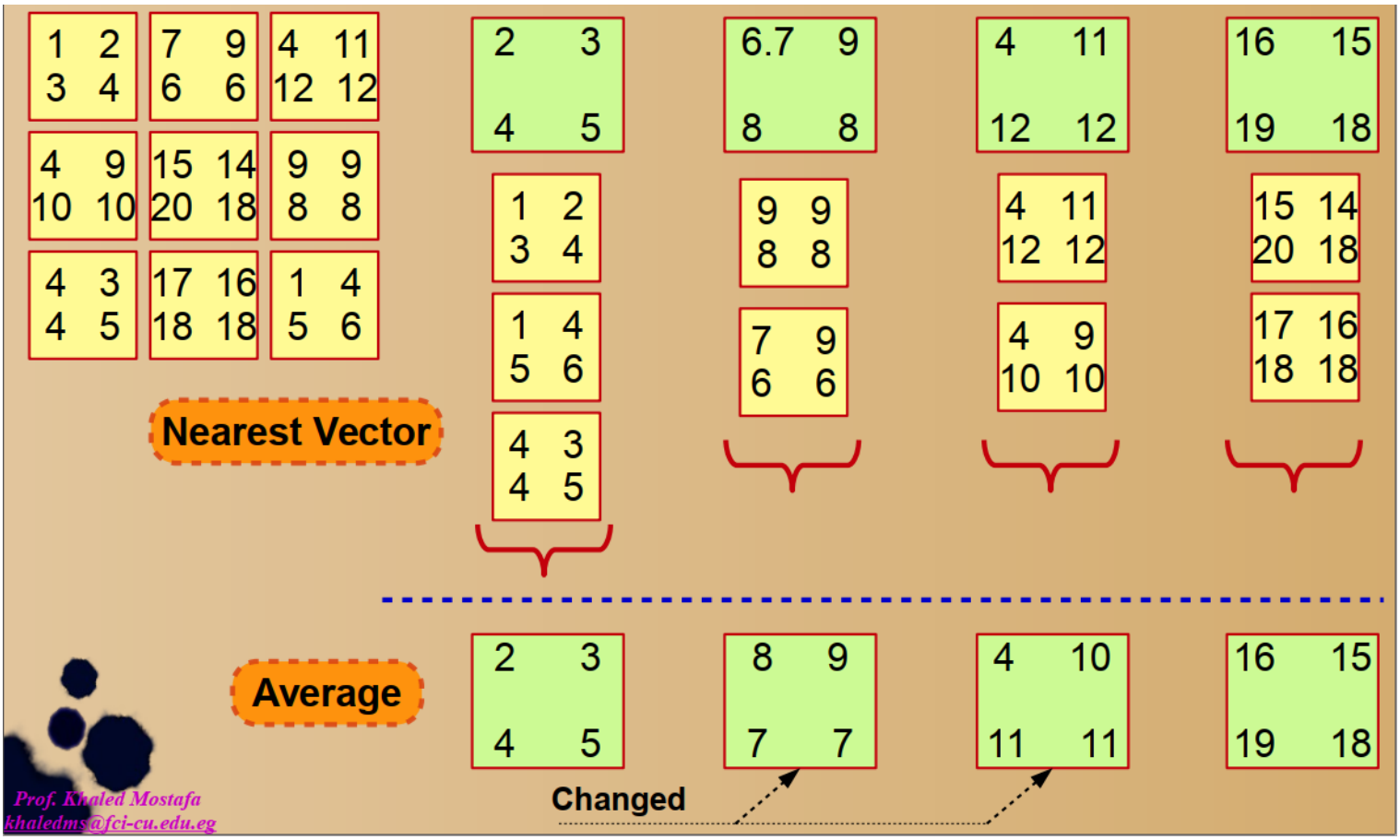

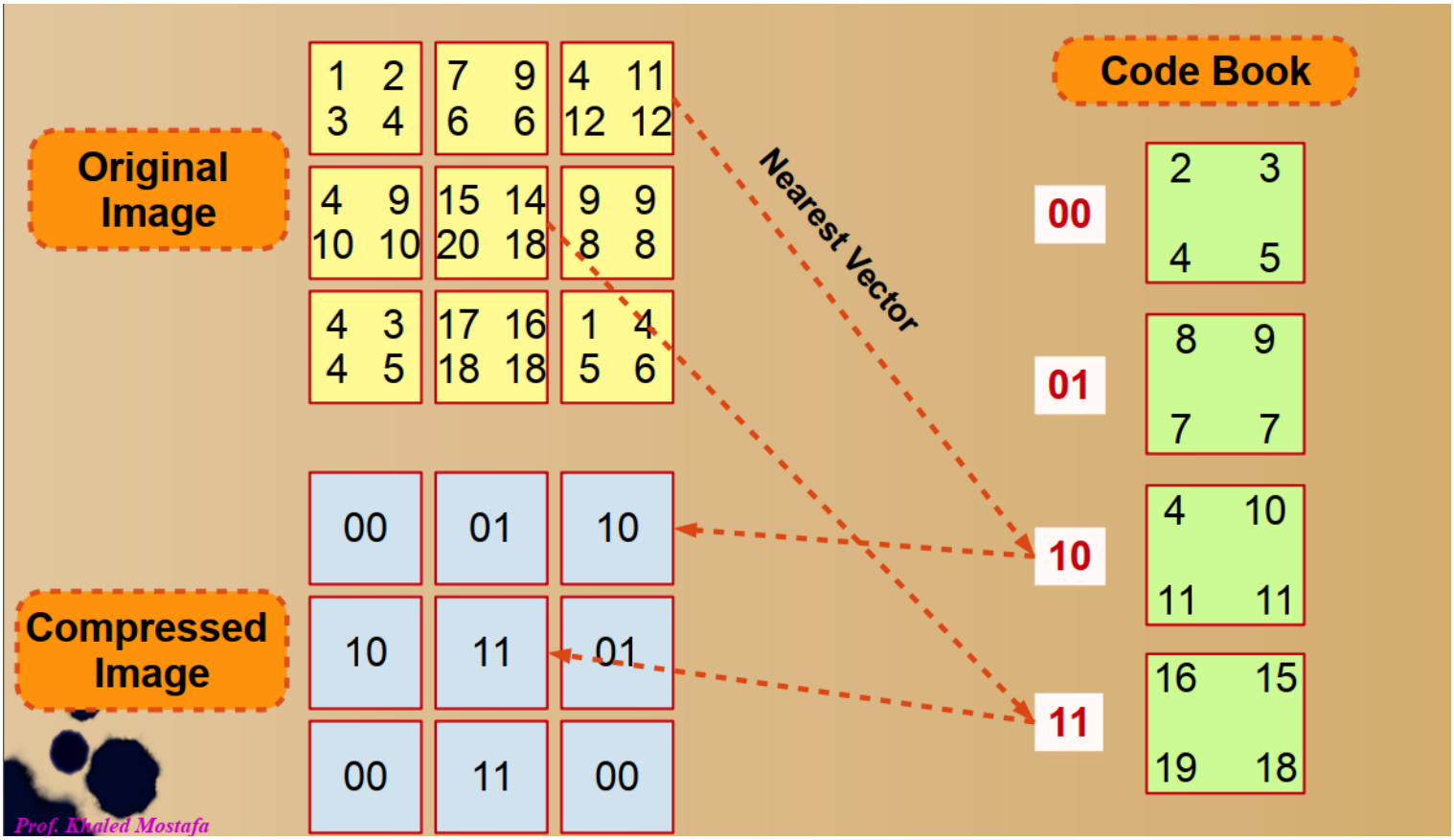

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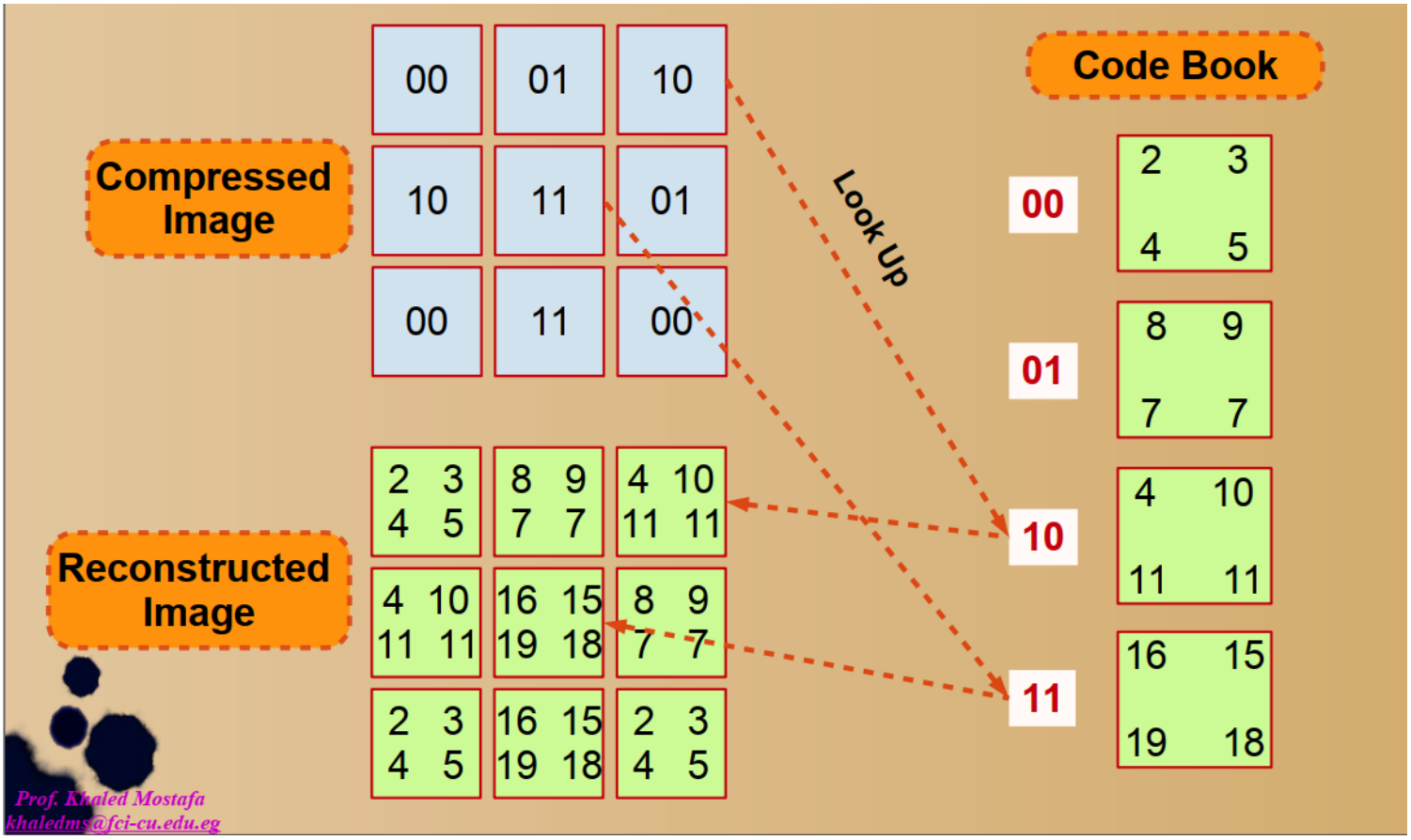

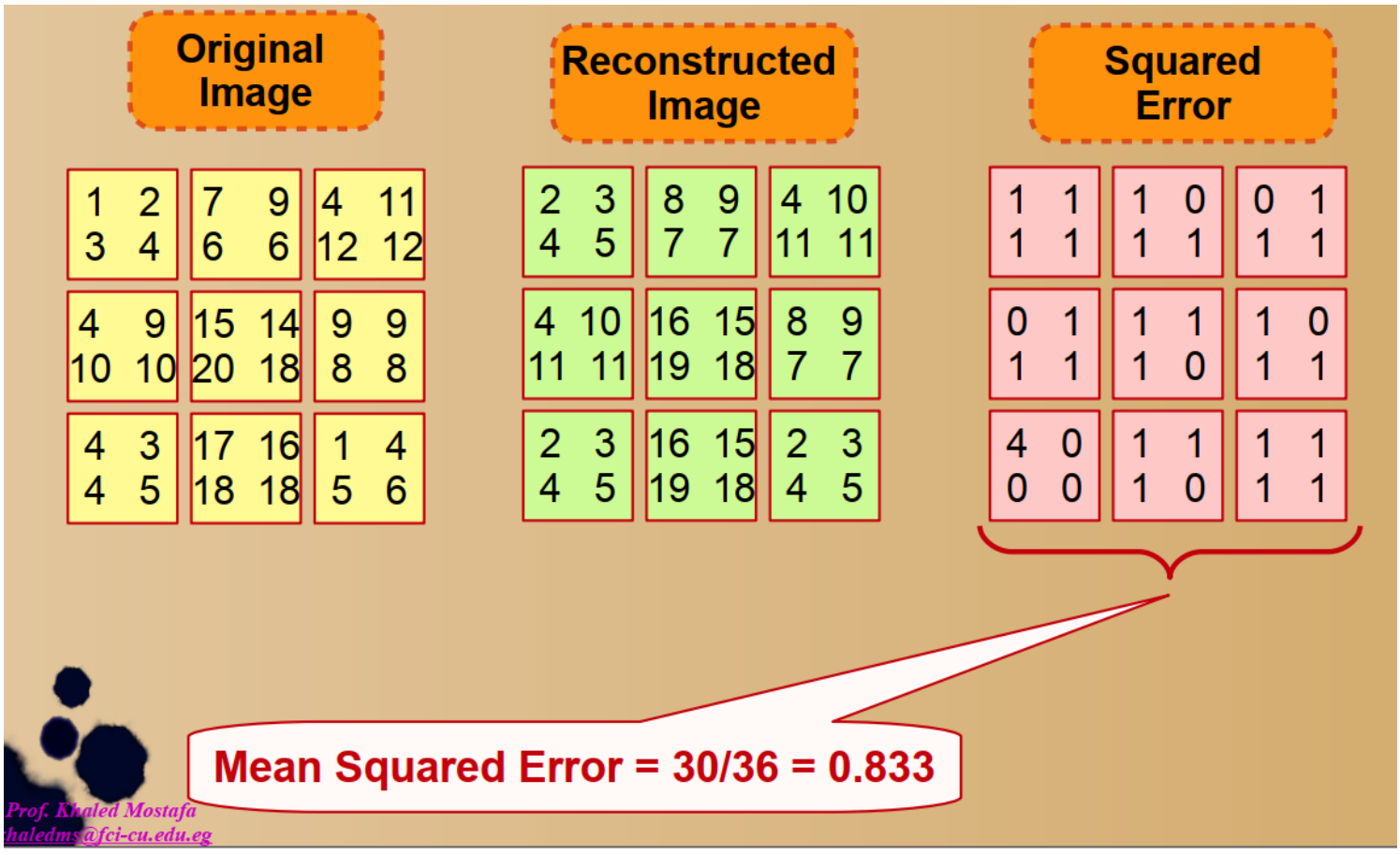

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