CSL7360:Computer Vision
Assignment 2

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Objective:

Implement the Ratio-Cut based clustering technique from scratch and compare it with the K-means clustering technique.

Input Images:

https://drive.google.com/drive/folders/1_Pev8HZcQZNVv_MGwivts63WvI_tMLMC

Key Formulas Used:

1. **Ratio-Cut**

   Ratio-Cut is a graph-based segmentation technique that aims to minimize the ratio of the cut to the total volume of the segments.

   $$\text{Ratio-Cut}(A, B) = \frac{\text{cut}(A,B)}{\text{vol}(A)} + \frac{\text{cut}(A,B)}{\text{vol}(B)}$$

   Where:

   - "cut(A,B)" represents the total weight of edges between nodes in segment "A" and segment "B".
   - "vol(A)" and "vol(B)" represent the total volume of segments "A" and "B" respectively.

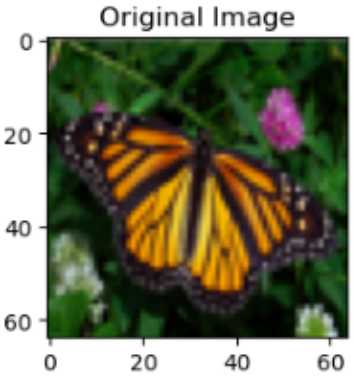
2. **K-Means**

   K-means clustering is a centroid-based clustering technique that aims to partition data into "k" clusters.

   $$J = \sum_{i=1}^{k} \sum_{x \in C_i} ||x - \mu_i||^2$$

   Where:

   - "J" represents the objective function to be minimized.
   - "C_i" represents the "i-th" cluster.
   - "μ_i" represents the centroid of the "i-th" cluster.


Original Image
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K-means Clustering with 3 clusters
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Ratio-Cut Clustering with 3 clusters
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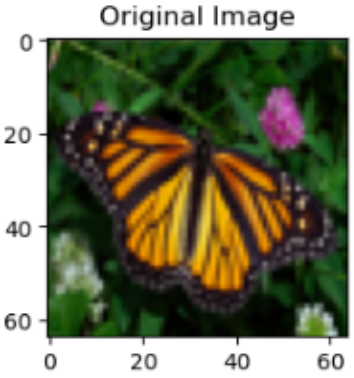
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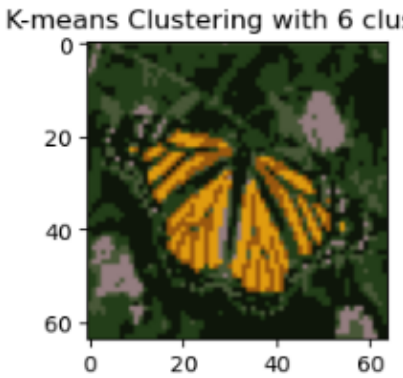
K-means Clustering with 6 clusters
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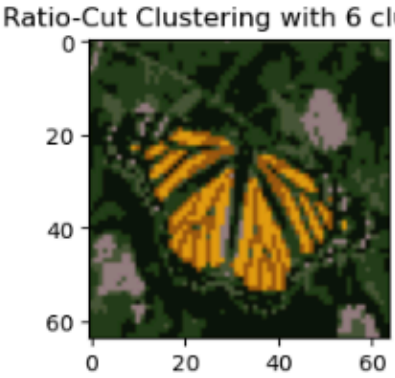
Ratio-Cut Clustering with 6 clusters
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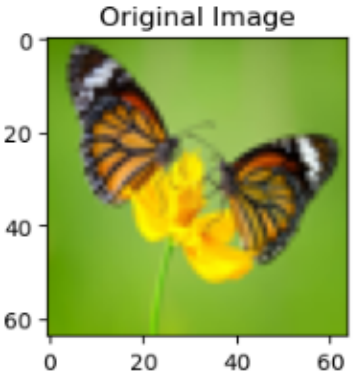
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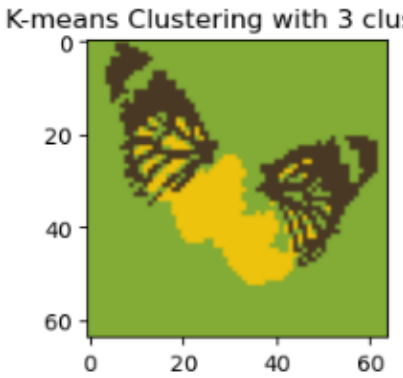
K-means Clustering with 3 clusters
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Ratio-Cut Clustering with 3 clusters
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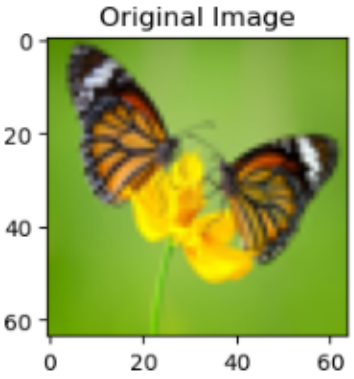
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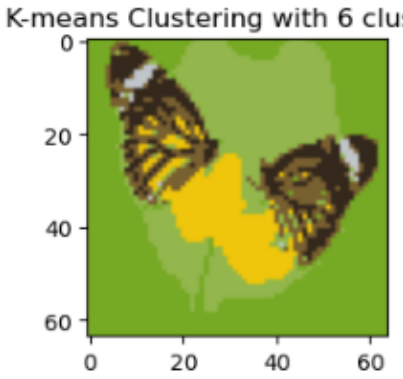
K-means Clustering with 6 clusters
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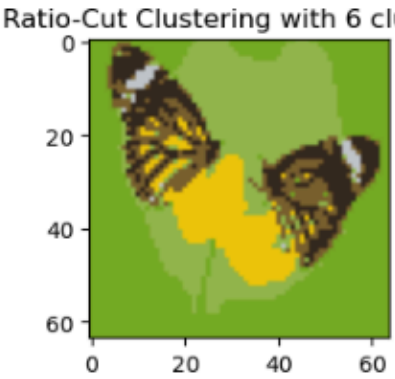
Ratio-Cut Clustering with 6 clusters
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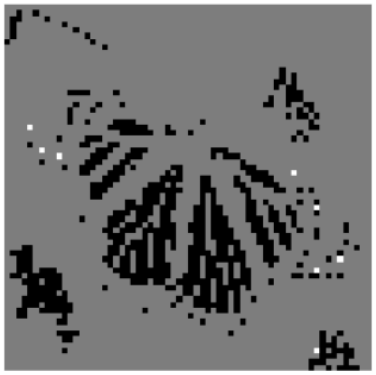
Observations:

Original Image 1

Segmented (Ratio-Cut)
clusters=3



Segmented (K-means)
clusters=3

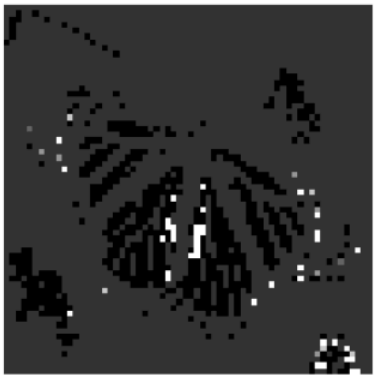
Original Image 2

Segmented (Ratio-Cut)
clusters=3

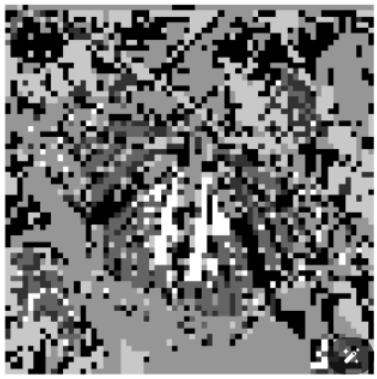
Segmented (K-means)
clusters=3

Original Image 1

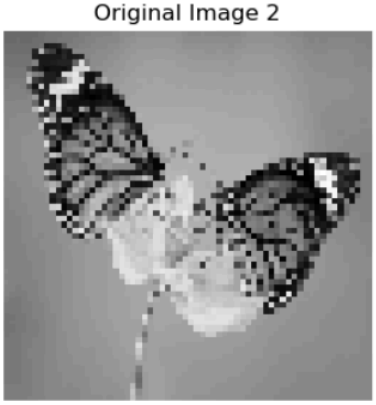
Segmented (Ratio-Cut)
clusters=6



Segmented (K-means)
clusters=6



Original Image 2



Segmented (Ratio-Cut)
clusters=6

Segmented (K-means)
clusters=6

Comparison:

- Segmentation Quality:
    - Ratio-Cut generally produces higher-quality segmentations with well-defined boundaries and balanced segment sizes.
    - K-means clustering may produce less accurate segmentations, especially when clusters are not well-separated or when the data distribution is irregular.
- Computational Complexity:
    - Ratio-Cut is computationally intensive, especially for large datasets, due to the need to construct and analyze a graph.
    - K-means clustering is computationally efficient and scales well to large datasets.
- Applicability:
    - Ratio-Cut is well-suited for tasks requiring precise boundary delineation, such as medical image analysis or object detection.
    - K-means clustering is widely used in various applications, including image compression, feature extraction, and data clustering.
