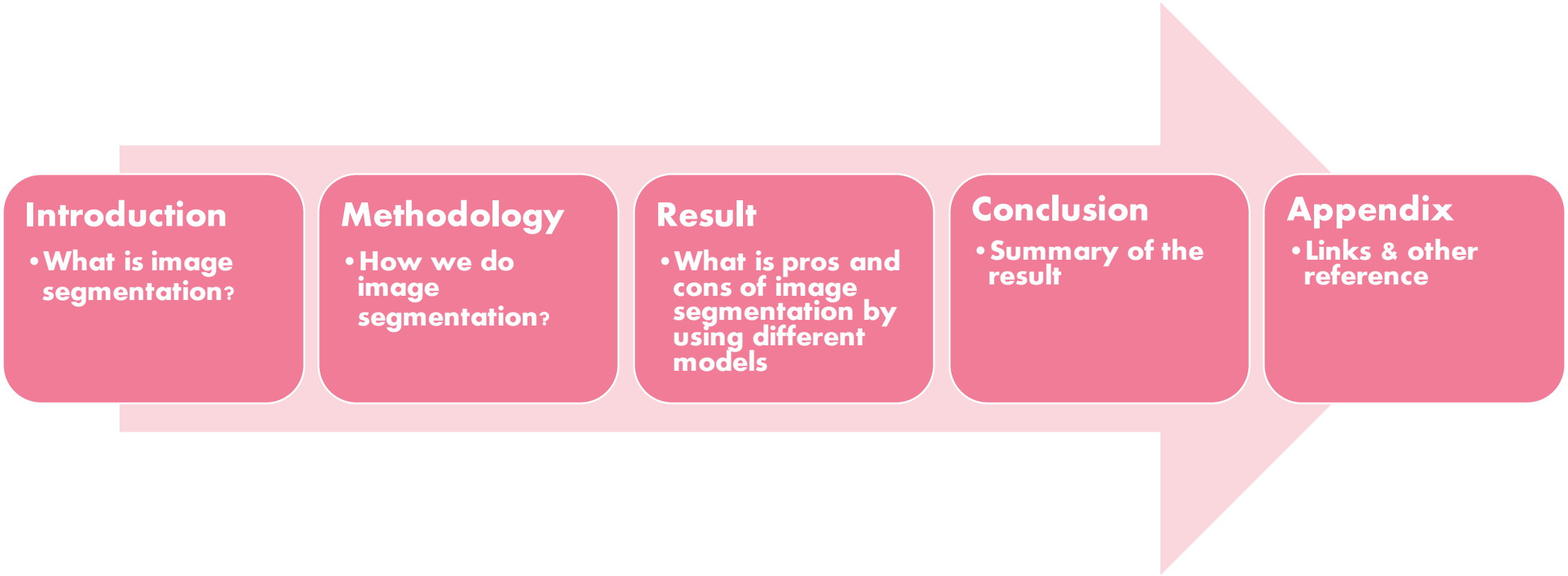
Image Segmentation with Different ML Model

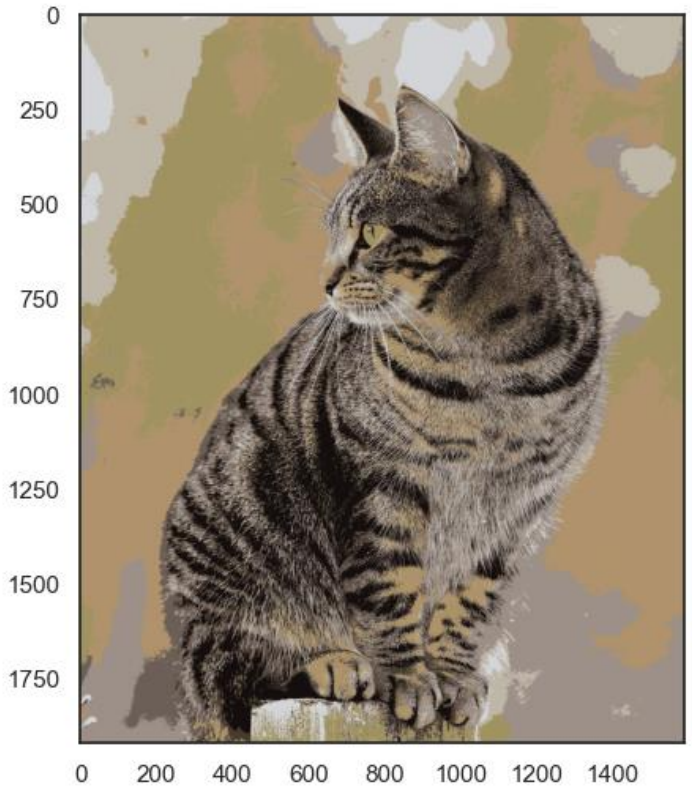
Aung Hein | 10 Jun 2024

Executive Summary



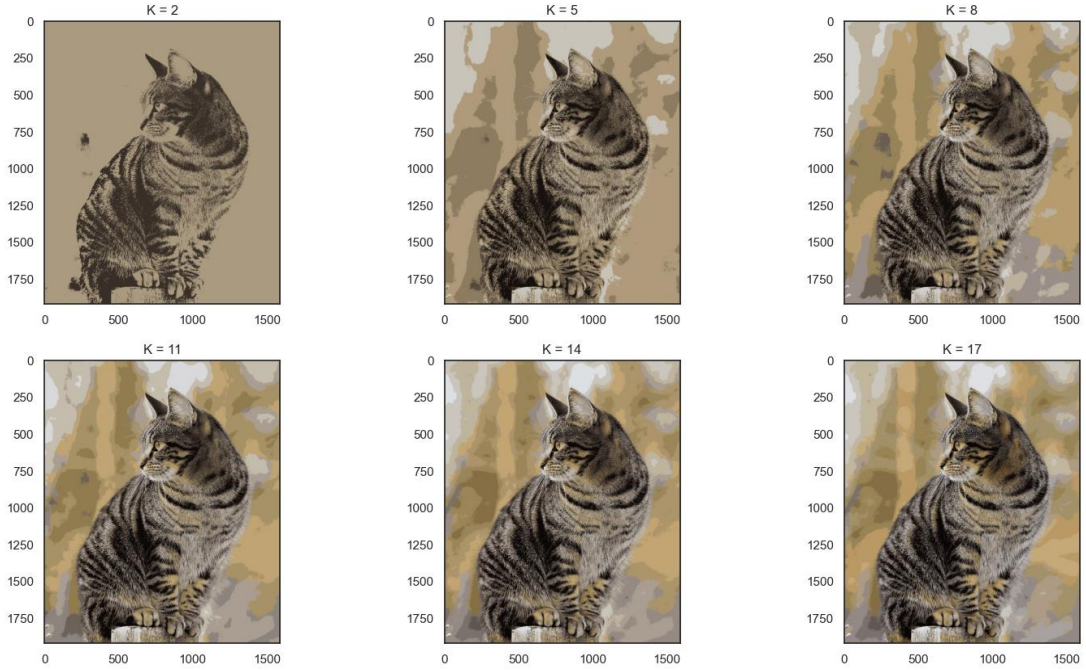
Introduction

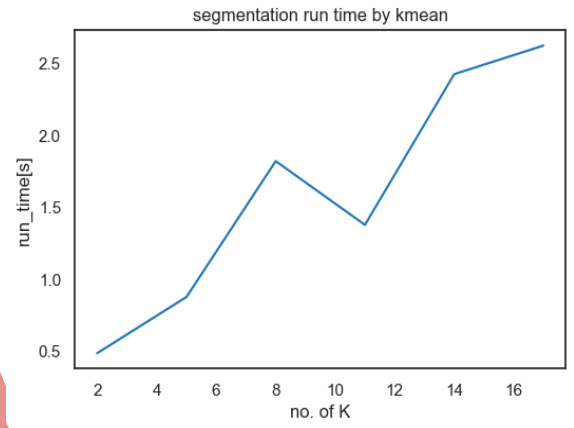
- Image segmentation is a computer vision technique that partitions a digital image into discrete groups of pixels—image segments—to inform object detection and related tasks.
- By parsing an image's complex visual data into specifically shaped segments, image segmentation enables faster, more advanced image processing.



Methodology

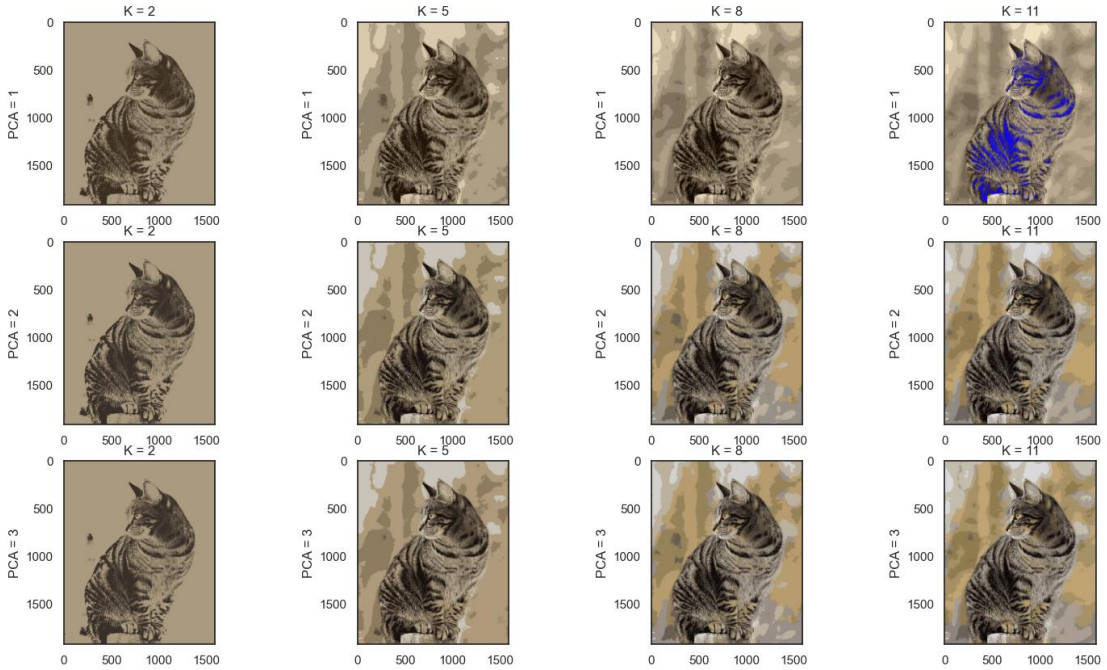
- In this project we used the following library and ML model for image segmentation experience
  - Clustering Models
    - Kmeans (sklearn)
    - GaussianMixture (sklearn)
    - MeanShift
  - Decomposition
    - Principal component analysis (PCA)

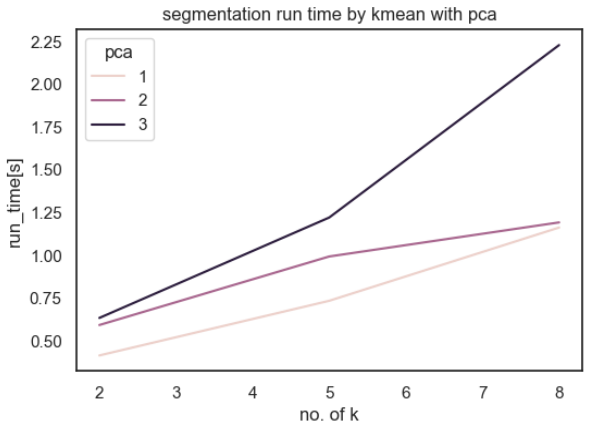




Result

- Kmeans without PCA
  - K=2 mean there is only two groups and our imaged was segmented to two colors only.
  - By increasing K (no. Of colors) we can see our segmented image looks remarkably similar to the original.
  - Increasing K take more time to run than less K

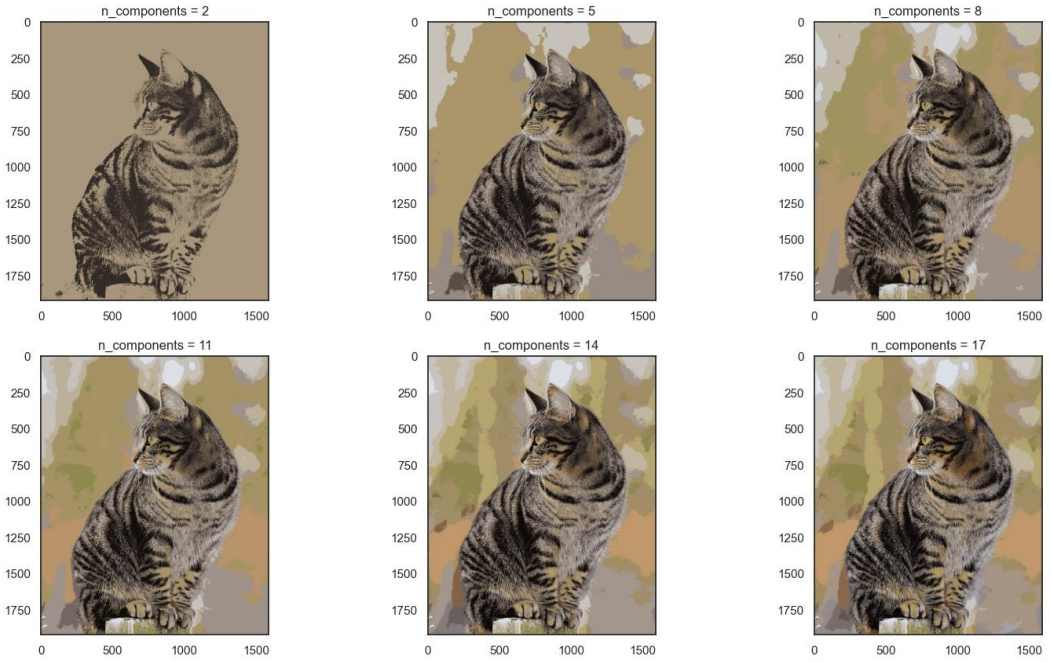


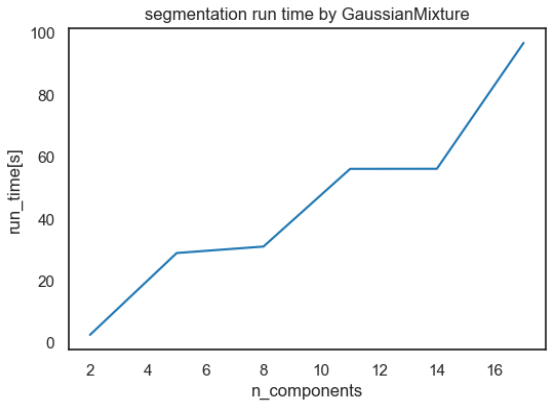


Result

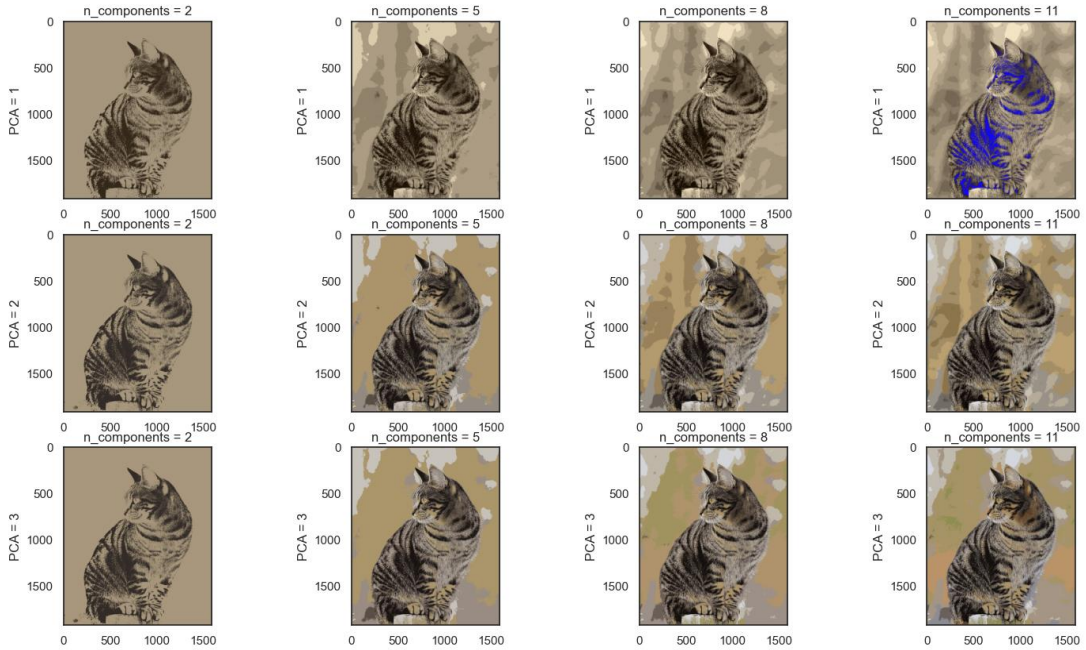
- Kmeans with PCA
  - PCA with less components reduce variance and so we can see it reduced color saturation
  - PCA with less components take less time to run than without pca
  - There was unexpected color when pca = 1 and k =11.

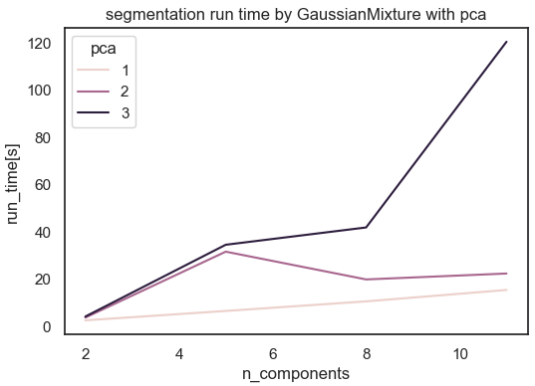
Result





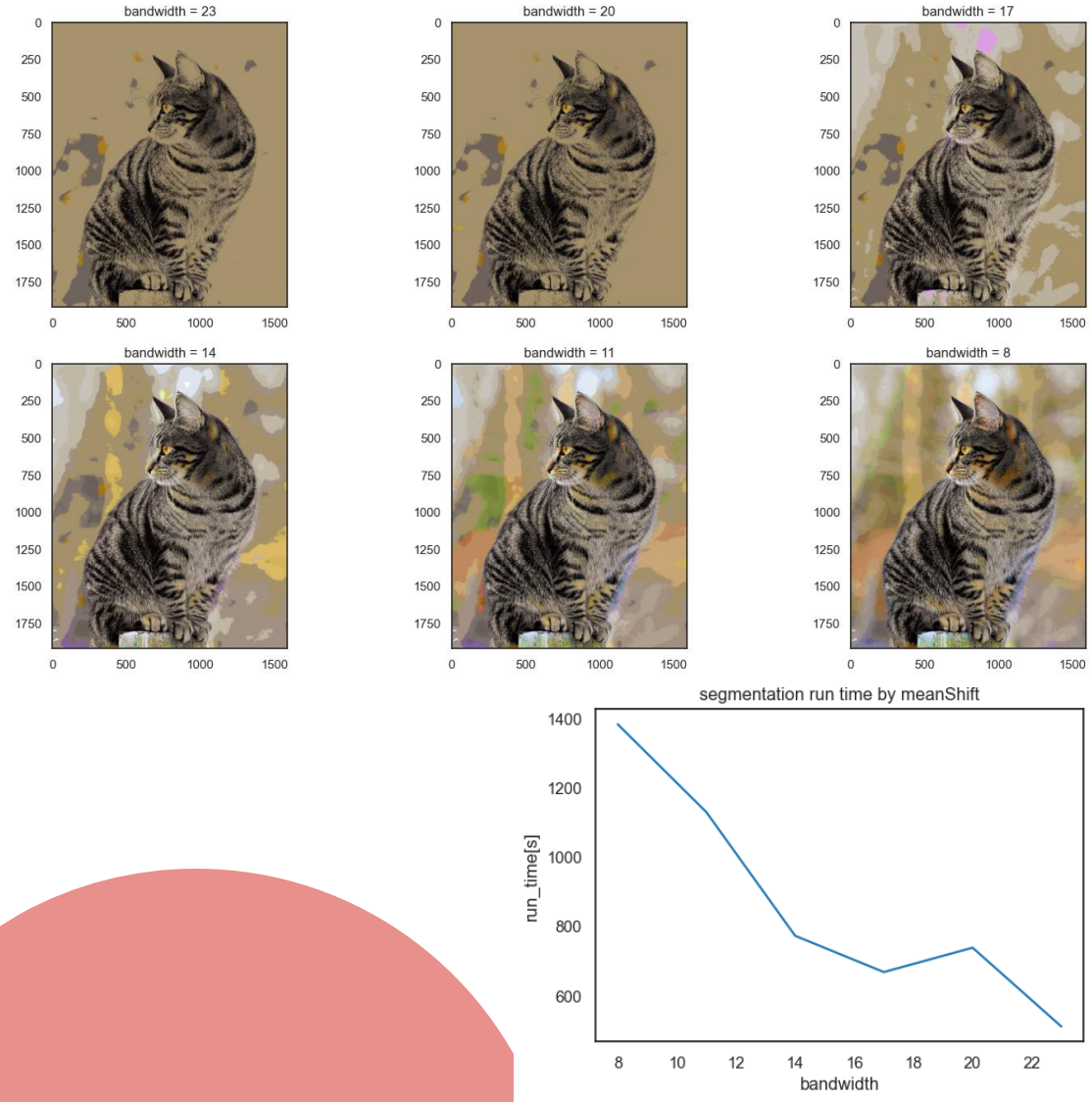
- GaussianMixture without PCA
  - N_components (K) = 2 mean there is only two groups and our imaged was segmented to two colors only.
  - By increasing components we can see our segmented image looks remarkably similar to the original.
  - Increasing components take more time to run than less components





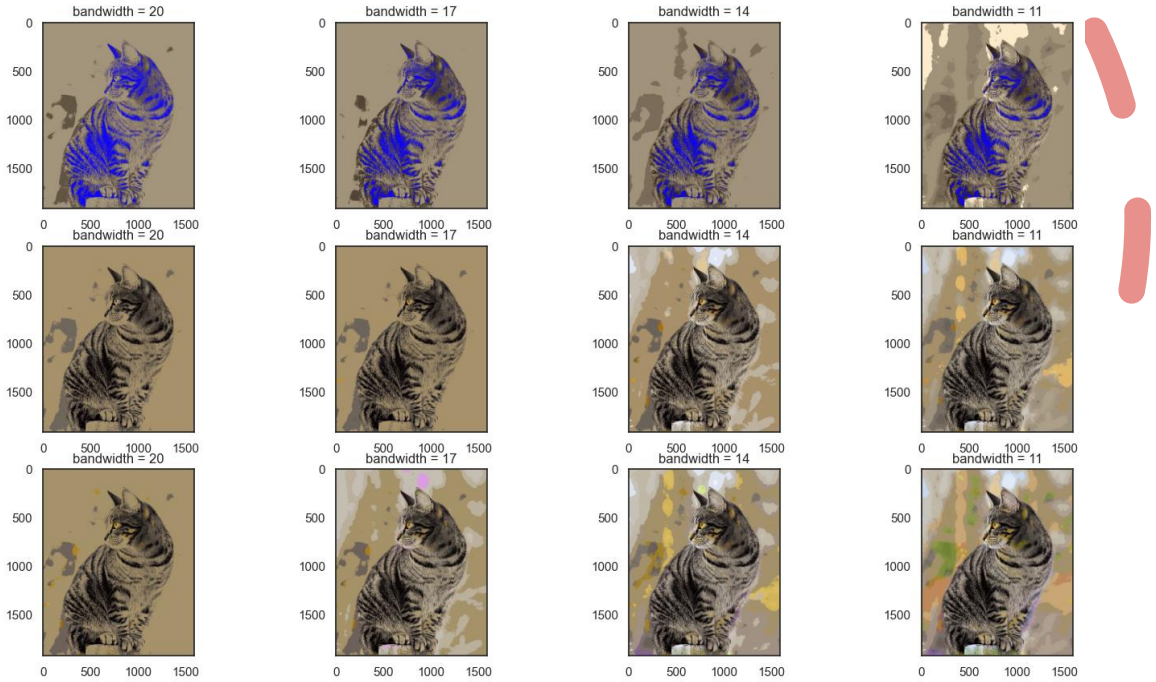
Result

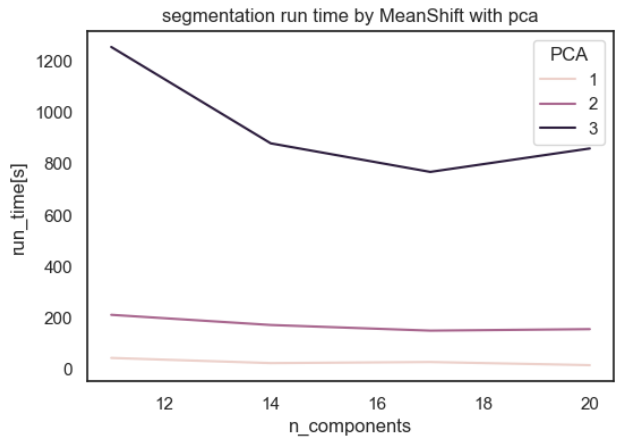
- GaussianMixture PCA
  - PCA with less components reduce variance and so we can see it reduced color saturation
  - PCA with less components take less time to run than without pca
  - There was unexpected color when pca = 1 and k =11.



Result

- MeanShift without PCA
  - Bigger bandwidth make less cluster and so less color
  - By decreasing bandwidth we can see our segmented image increased more cluster (colors) and so more likely to original.
  - MeanShift take a lot of time to segment and so take a lot of computational power
  - Less bandwidth groups make more clusters and so take more computational power.



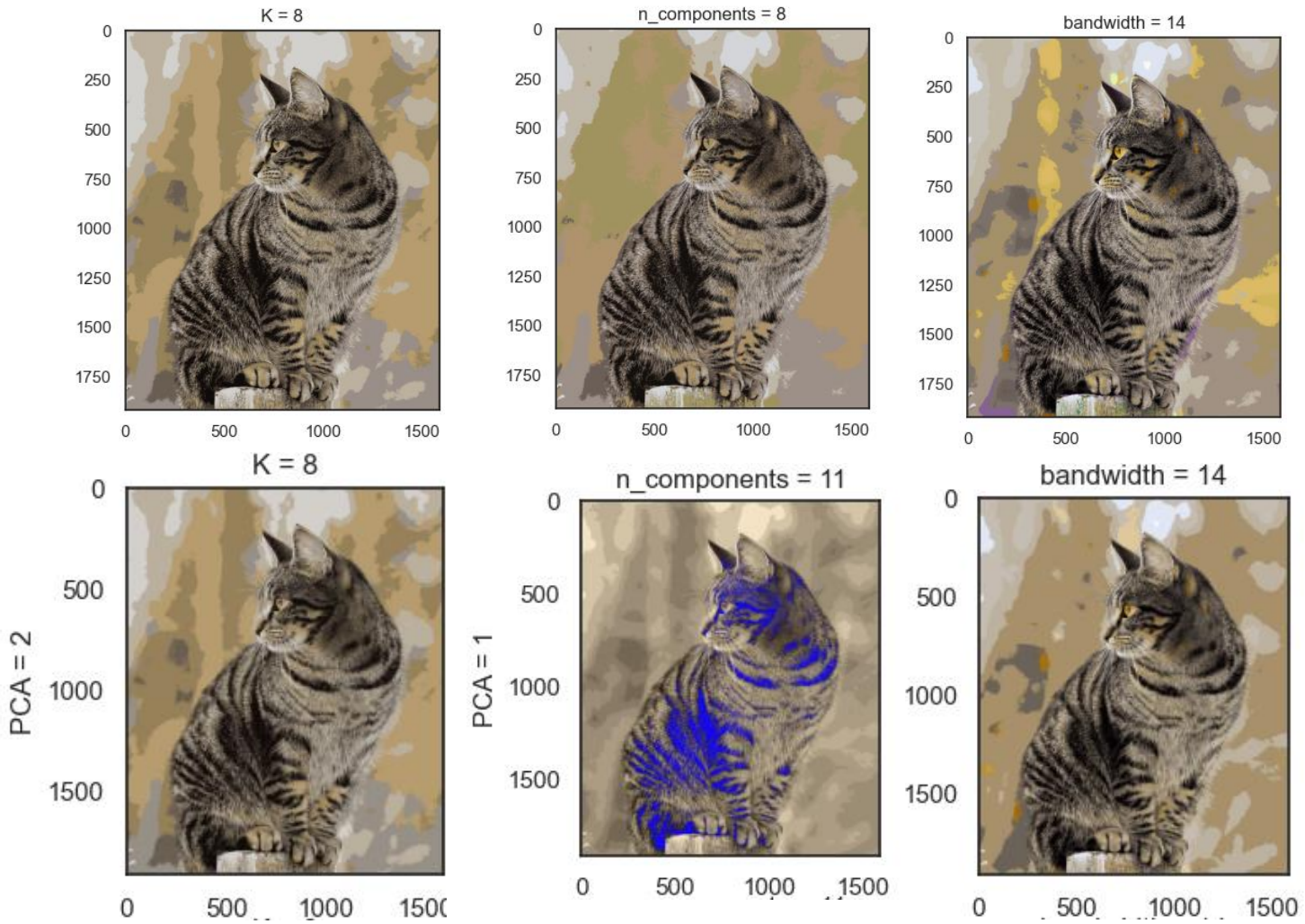


Result

- MeanShift with PCA
  - PCA with only 1 components seen loss some data and strange blue color appear after segmentation
  - PCA with components < original features improve much on run time
  - PCA with components = 2 imporved run time also does not impacted much on quality

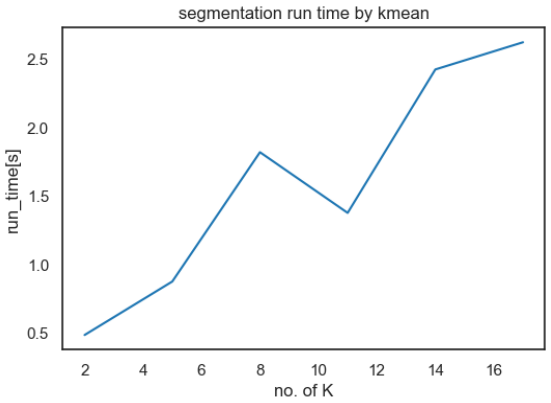
Conclusion

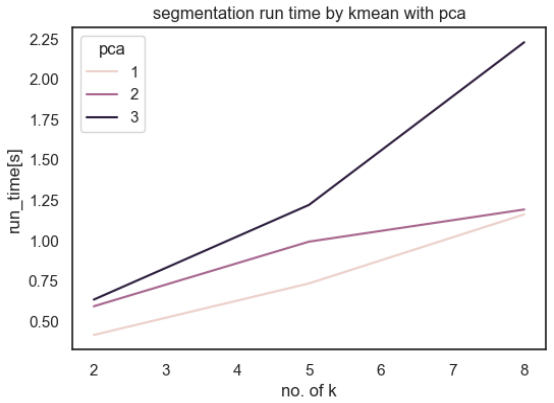
- Segmentation Result
  - Meanshift are sensitive to noise and make more cluster according
  - GaussianMixture seen generalized more than kmeans
  - Decomposition with pca=2 seen does not impact much on quality as we compare on kmean but it more generalized on meanshift result
  - Decomposition with pca =1 seen does not have much variance because it introduce strange blue color when cluster is 11 and more

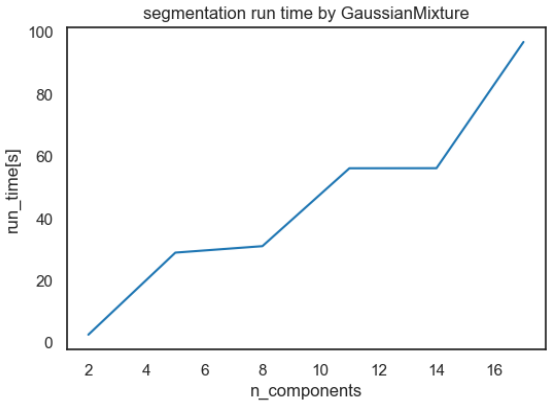


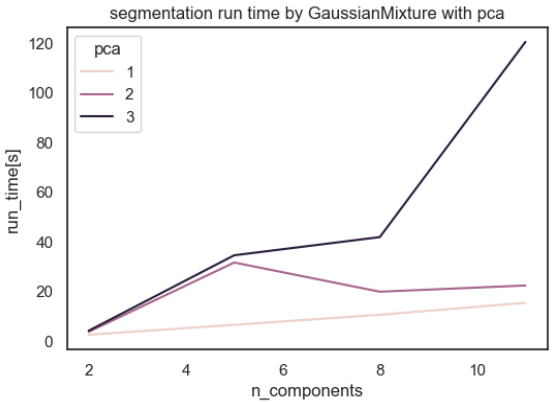
Conclusion

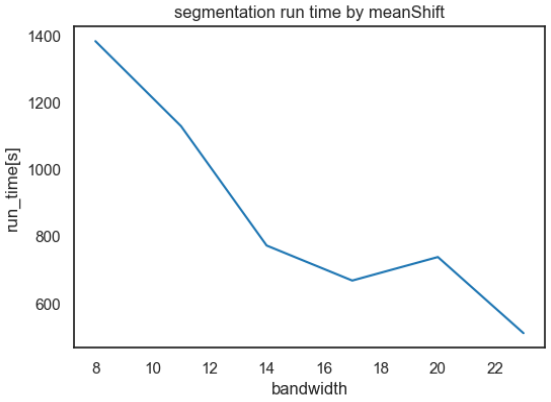
- Segmentation Result
  - Kmean is the fastest and even better with pca
  - GaussianMixture a little bit slower than kmeans but it still acceptable and better performance by pca
  - Meanshift are very slow but got some improvement with pca

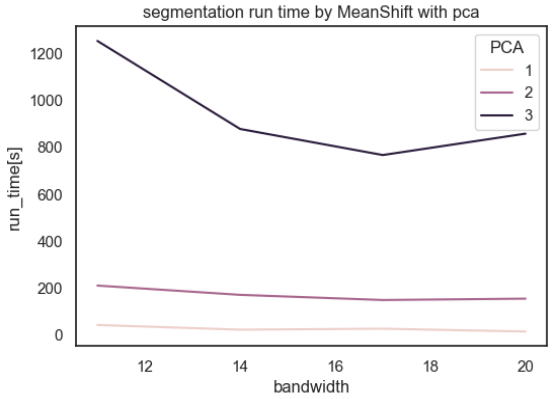












Appendix

- Image in this project was downloaded from the following link
  - https://cf-courses-data.s3.us.cloud-object-storage.appdomain.cloud/IBM-ML0187EN-SkillsNetwork/labs/module%201/images/gauss-cat.jpeg
- Other cluster models such as Agglomerative and DBSCAN seen required more computation power and don't have chance to try it
- Decomposition like kernel PCA and SVD also not tested due to computational limitation

Thank You