Introduction to clustering

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Course objectives

- By the end of this module, you will be able to answer the following questions:
  - What is clustering?
  - What is the significance of learning clustering algorithms?

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What is clustering?

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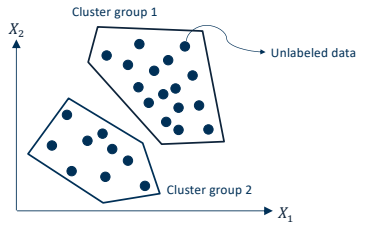
Clustering definition

- What is clustering?
  - It is the process of identifying similar data points and assigning them to clusters



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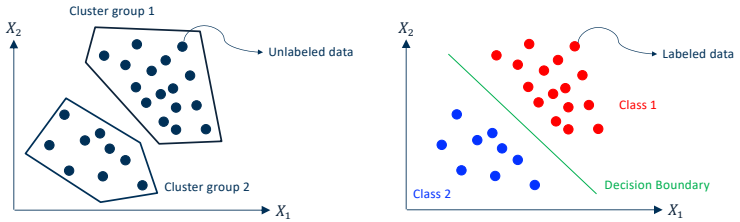
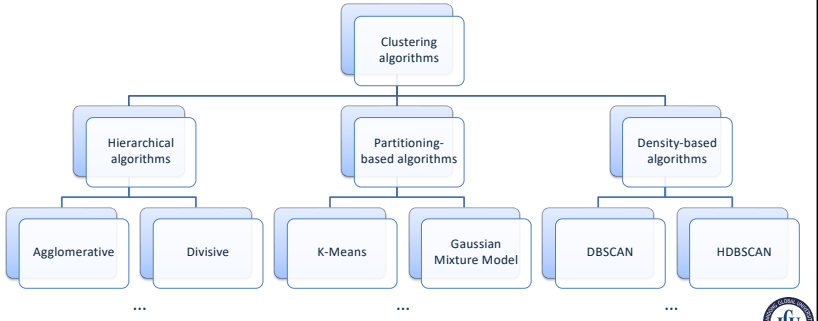
Clustering definition

- What is the difference between clustering and classification?
  - Clustering is to group similar data points (unlabeled) together
  - Classification is to categorize input data into pre-defined classes based on the patterns



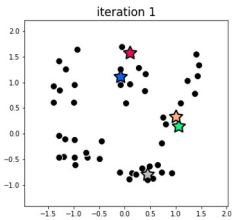
Clustering algorithms

- What are the algorithms for performing a clustering task?

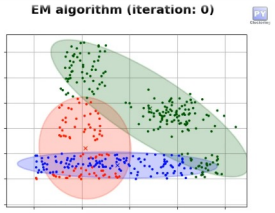


Types of partitioning-based clustering algorithms

- What are the types of partitioning-based clustering algorithms?
  - K-Means algorithm
  - Gaussian mixture model (GMM)
  - ...



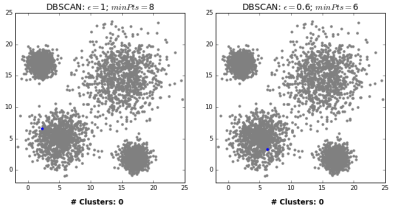
https://jermwatt.github.io/machine_learning_refined/notes/8_Linear_unsupervised_learning/8_5_Kmeans.html



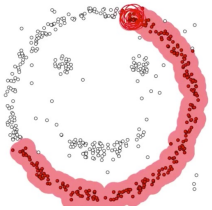
https://www.youtube.com/watch?v=REypj2sy_5U

Types of density-based clustering algorithms

- What are the types of density-based clustering algorithms?
  - Density-based spatial clustering of applications with noise (DBSCAN)
  - Hierarchical Density-based spatial clustering of applications with noise (HDBSCAN)
  - ...



https://iq.opengenus.org/dbscan-clustering-algorithm/



https://www.youtube.com/watch?v=h53WMIImUuc

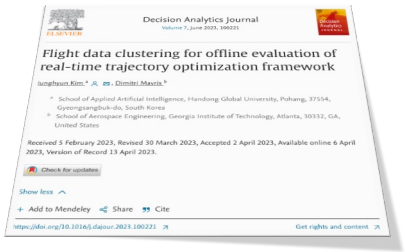
What is the significance of learning clustering algorithms?

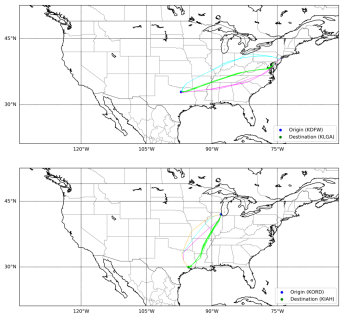
Clustering applications

- Clustering algorithms are used in a wide variety of applications including:
  - Flight data analysis
  - Vertiport placement
  - Anomaly detection
  - Image segmentation
  - Customer segmentation
  - Social network analysis
  - Recommendation system
  - …

Clustering applications

- Case 1: Flight data clustering

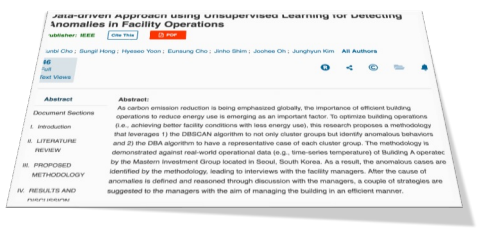


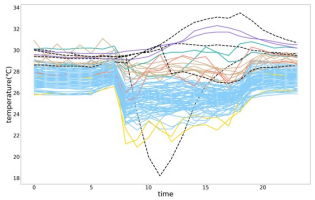


Related Publication: **Junghyun Kim** and Dimitri Mavris, "*Flight Data Clustering for Offline Evaluation of Real-Time Trajectory Optimization Framework*", Decision analytics, Published in April 2023

Clustering applications

- Case 2: Detecting anomalies in facility operations

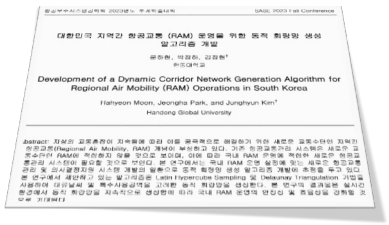




Related Publication: Eunbi Cho, Sungil Hong, Hyeseo Yoon, Eunsung Cho, Jinho Shim, Joohee Oh, and **Junghyun Kim***, "*Data-Driven Approach using Unsupervised Learning for Detecting Anomalies in Facility Operations*", Institute of Electrical and Electronics Engineers (IEEE) International Conference on Big Data, Published in December 2022

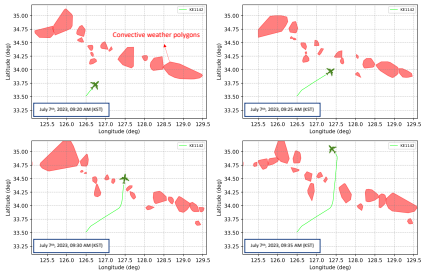
Clustering applications

- Case 3: Convective weather modeling


Development of a Dynamic Corridor Network Generation Algorithm for Regional Air Mobility (RAM) Operations in South Korea

Hahyeon Moon, Jeongha Park, and Junghyun Kim

Handong Global University



Related Publication: Hahyeon Moon, Jeongha Park, and **Junghyun Kim***, *"Development of a Dynamic Corridor Network Generation Algorithm for Regional Air Mobility (RAM) Operations in South Korea"*, SASE 2023 Fall Conference, Published in October 2023

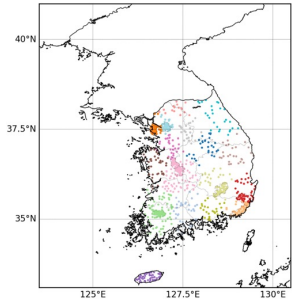
Clustering applications

- Case 4: Vertiport placement


Data-Driven Approach Toward Airspace Design for Regional Air Mobility Operations in Korea

Junghyun Kim, Handong Global University, Pohang 37554, Republic of Korea

Seulki Kim, Georgia Institute of Technology, Atlanta, Georgia 30332



Related Publication: **Junghyun Kim** and Seulki Kim, *"Data-Driven Approach Towards Airspace Infrastructure Establishment for RAM Operations in South Korea"*, AIAA Journal of Aerospace Information Systems, Published in June 2023

Course summary

- Throughout this module, you have learned:
  - What is clustering?
  - What is the significance of learning clustering algorithms?

THANK YOU

For more information, please reach out to Prof. Junghyun Kim at junghyun.kim@handong.edu