Vision Intelligence IV: Visual Event Computations

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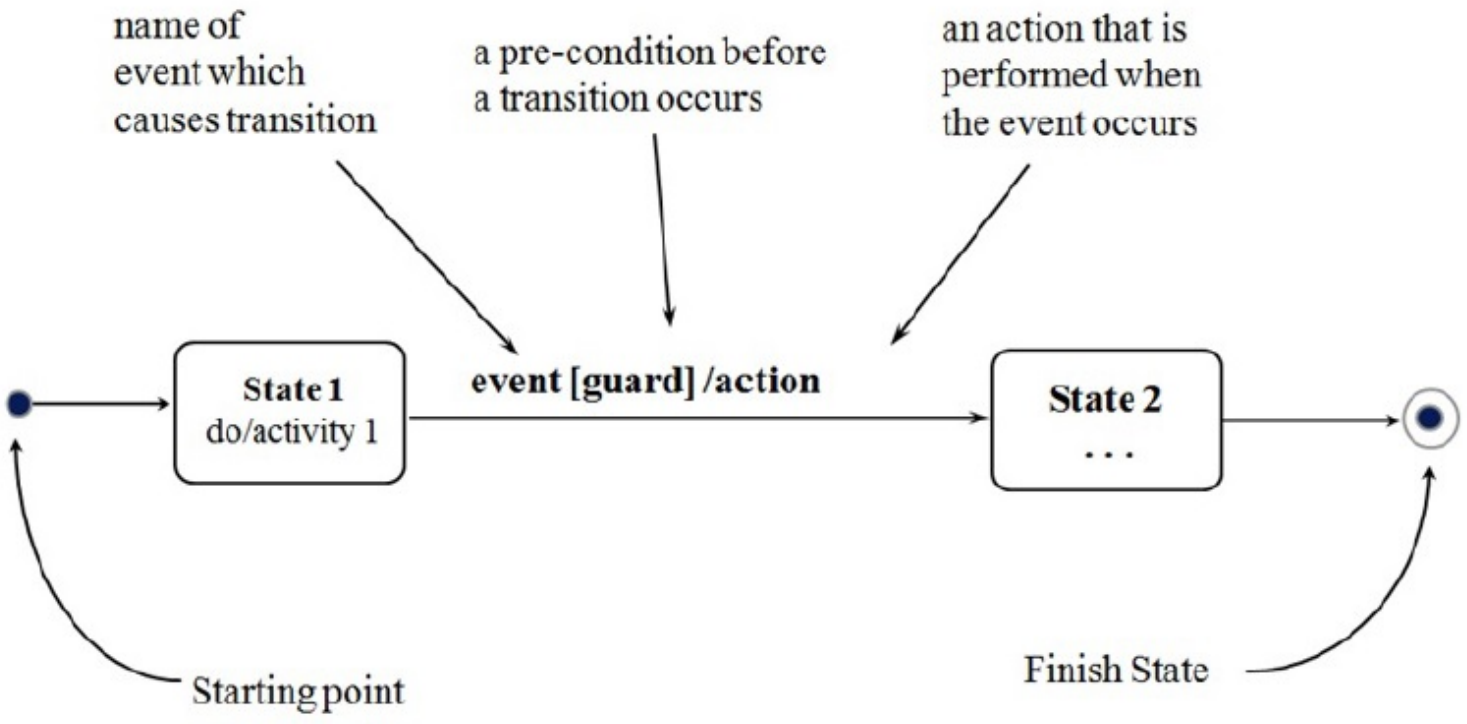
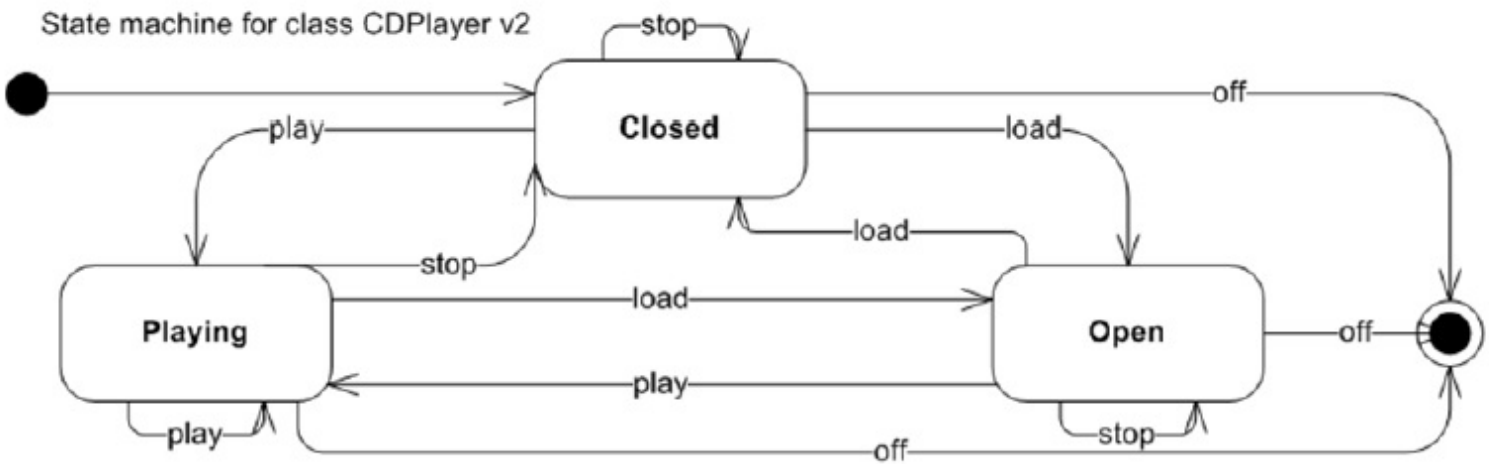
State Diagram

- *State Diagram*: Chart of the life-span of an object
- *State*: Abstraction of the attribute values and links of an object
- *Event*: Something that happens at a point in time
- *Activity*: Operation that takes time to perform during the time when the object is closely associated with a state
- *Action*: Operation performed before / after a state change

State Diagram



e.g., State Diagram of CD Players



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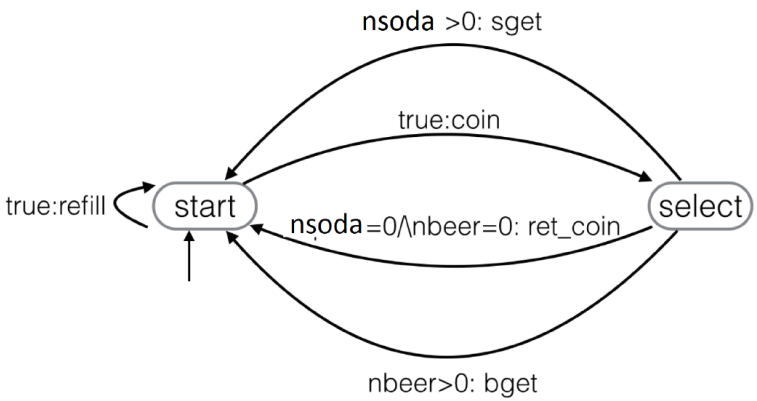
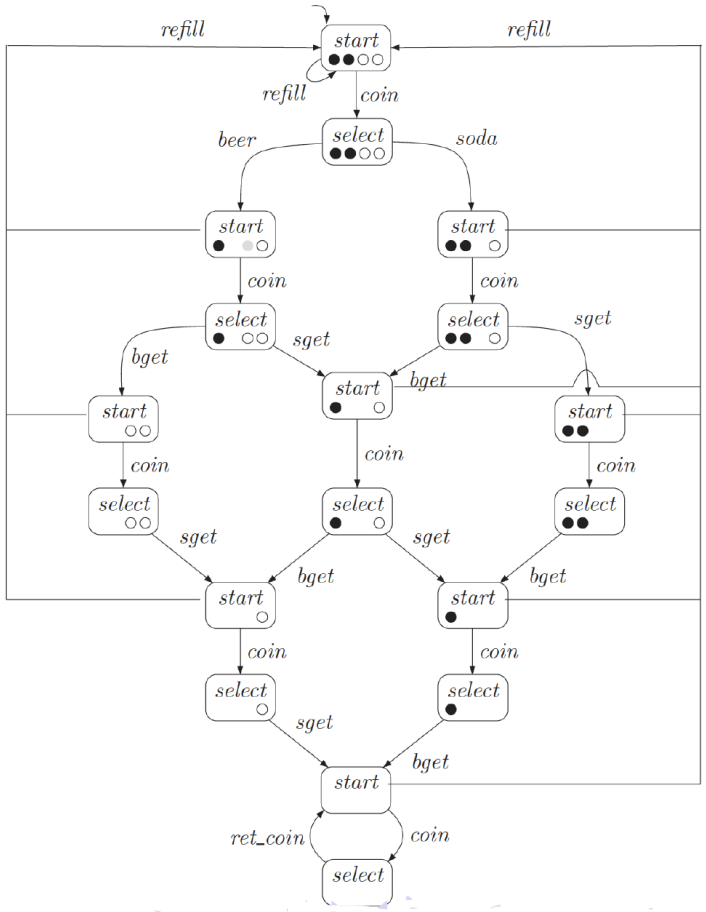
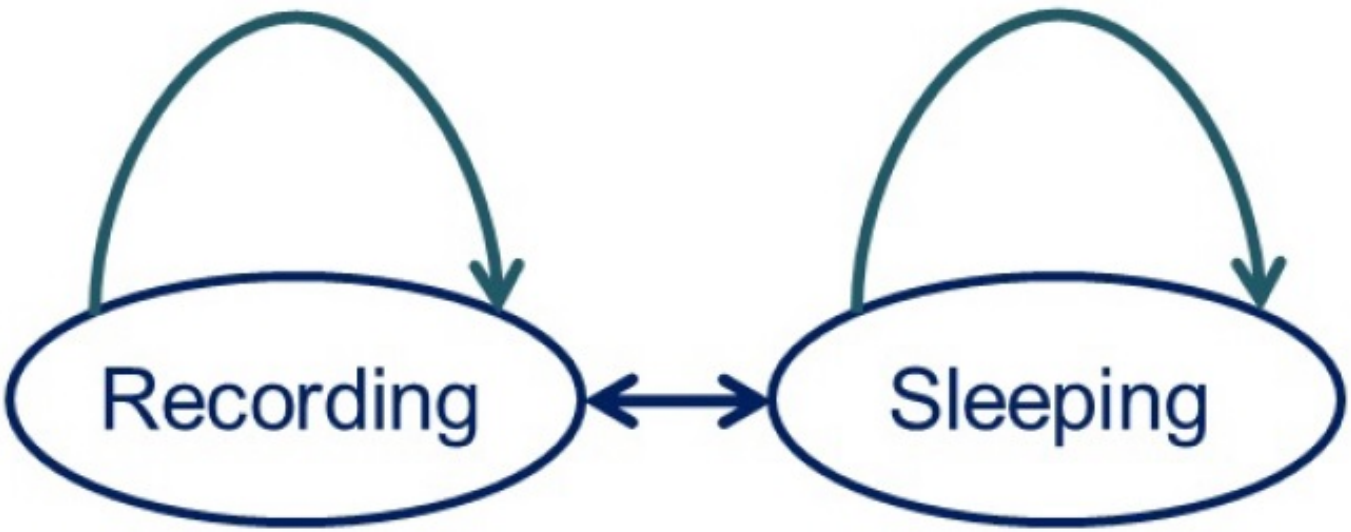
e.g., State Diagram of Beverage Vending Machines





Book: C. Baier, J. Katoen. (2008) Principles of Model Checking. The MIT Press.

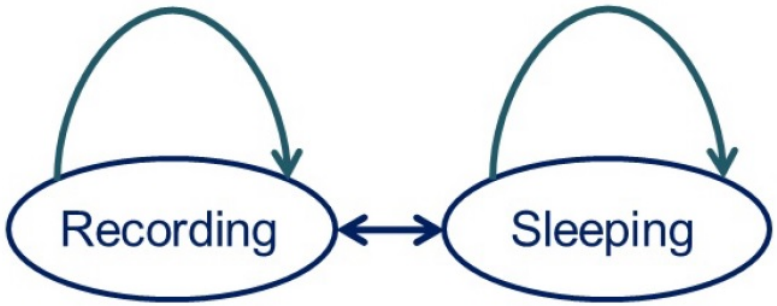
e.g., State Diagram of Surveillance Cameras



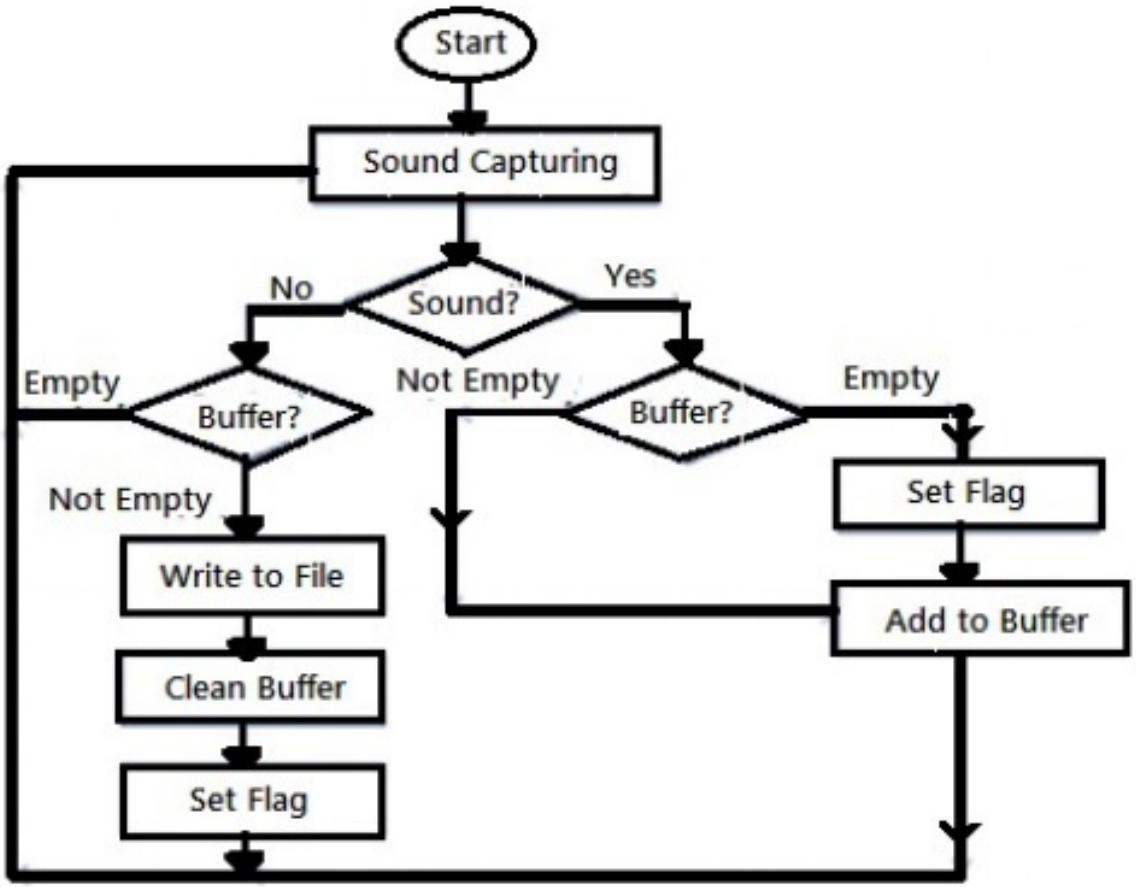
Web: https://www.mathworks.com/videos/using-stateflow-in-your-projects-117944.html

Finite State Machine (FSM)

- FSM is a model of behavior composed of a finite number of independent states, transitions between those states and actions.
- FSM is similar to a "flow graph" where we can inspect the way in which the logic runs when the specific conditions are met.
- A FSM is an abstract model of a machine with a primitive internal memory.



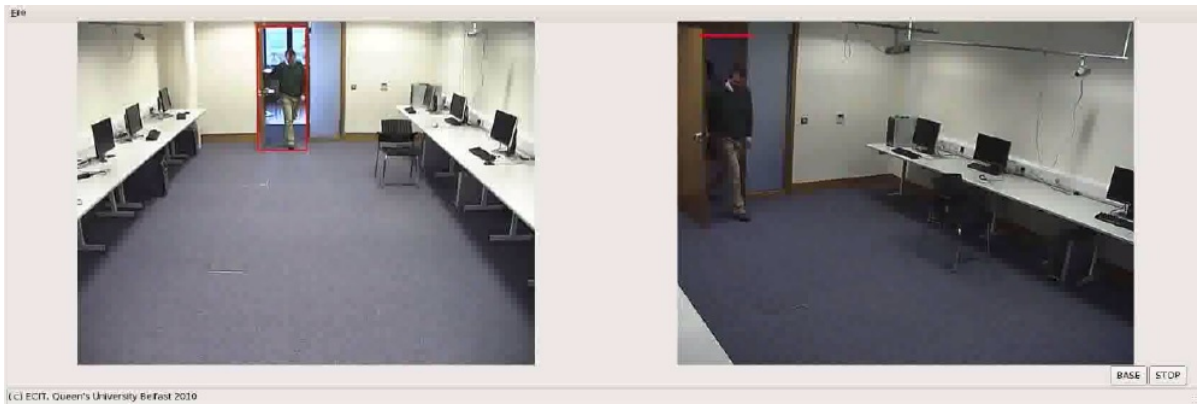
Finite State Machine (FSM): Example



Vision Intelligence: Visual Event Computations

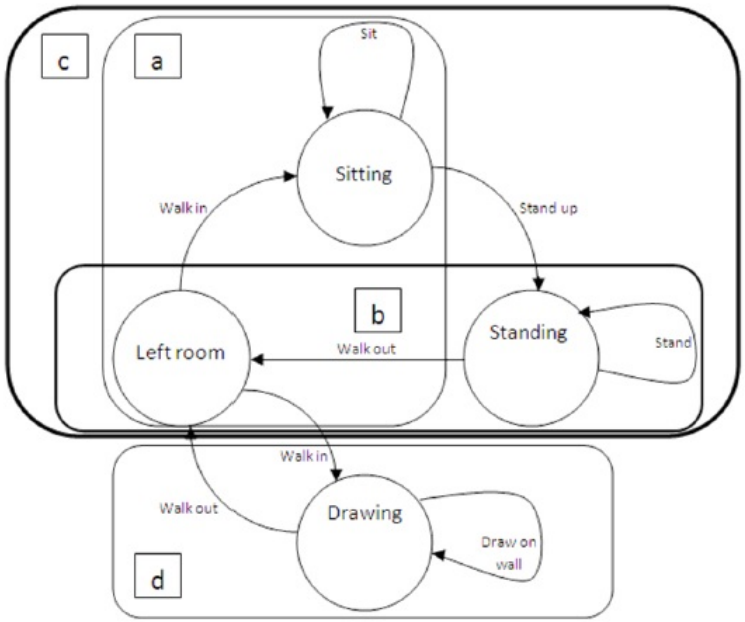
Visual Events (Demo)

- Walk-in and sit-down event(a)
- Stand-up and walk-out event(b)
- Walk-in, sit-down, stand-up and walk-out event(c)



FSM: Visual Events

- Walk-in and sit-down event(a)
- Stand-up and walk-out event(b)
- Walk-in, sit-down, stand-up and walk-out event(c)
- Draw-on-walls event(d)



Vision Intelligence: Visual Event Computations

Definition (NIST)

Event: Something that happens at a given place and time

Importance of Event

- A semantic unit of sensor data
- Bridge the gap between physical world and semantic cyberspace.

Event Components

- Who participated in event?
- When did the event happen?
- Where did the event happen?
- What is the event?
- Why did the event happen?

Event Clustering

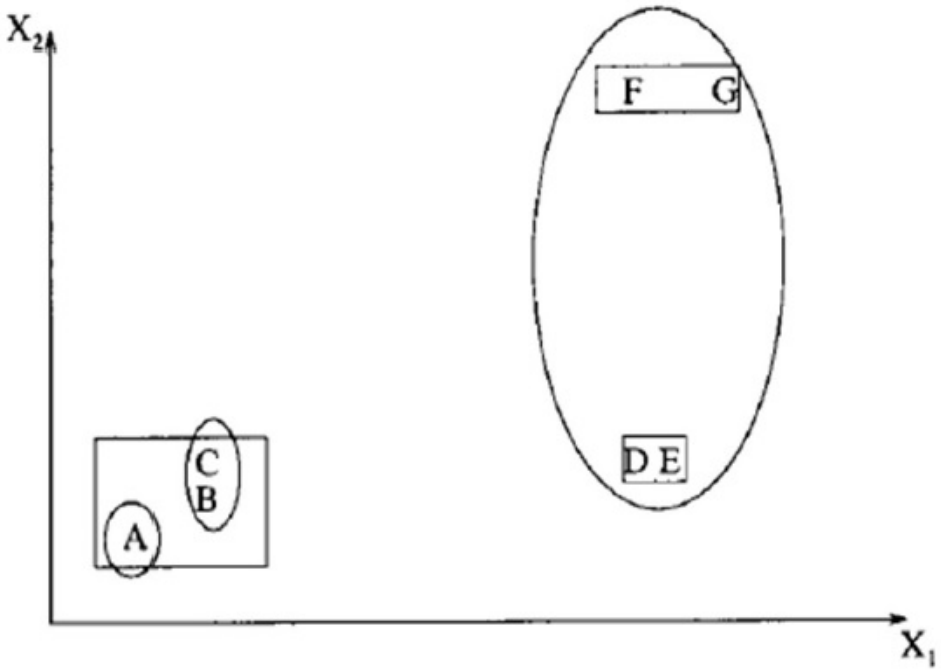
Given a set of data points, find clusters so that:

- Data points in one cluster are more similar to one another.
- Data points in separated clusters are less similar to one another.

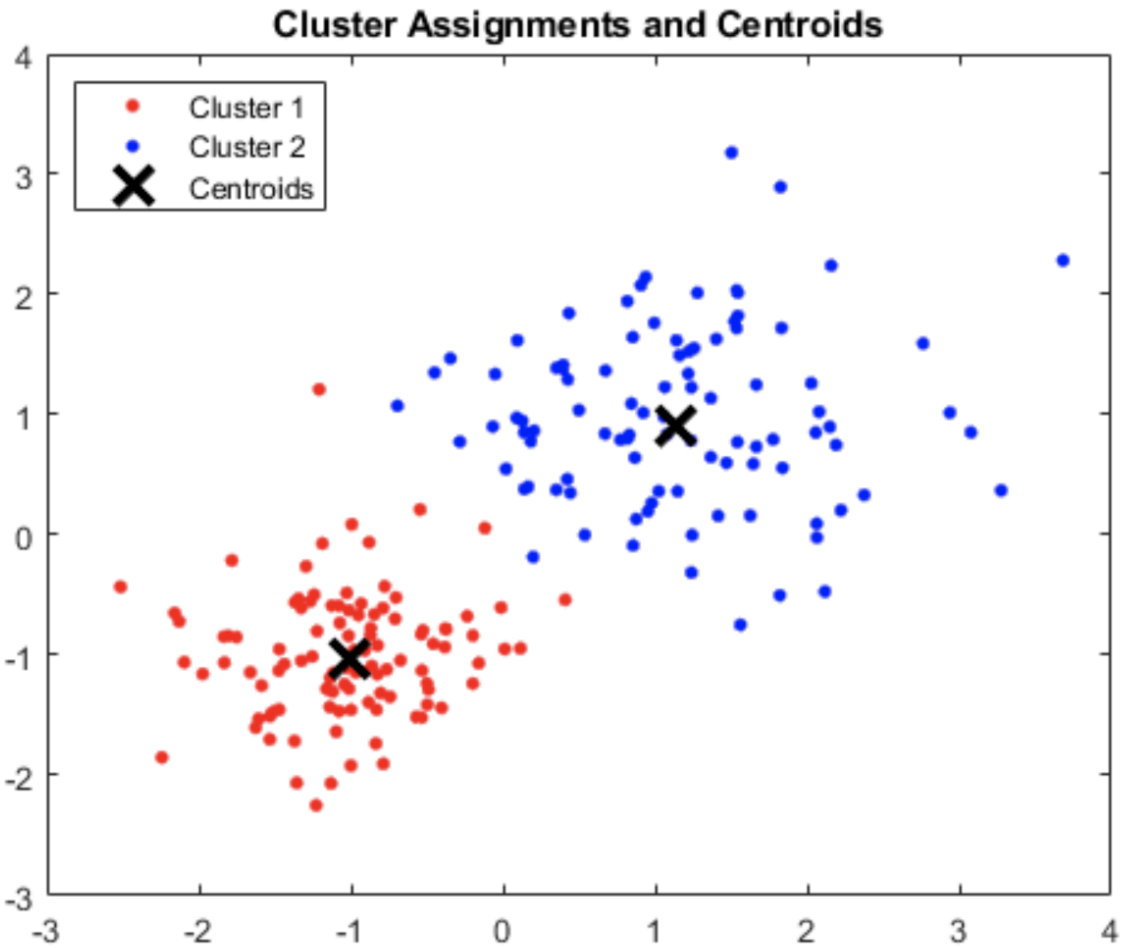
Event Clustering Methods

- *Partitional clustering*: A division of data objects are grouped into non-overlapping subsets so that each data object is in exactly one subset.
- *Hierarchical clustering*: A set of nested clusters are organized as a hierarchical tree.

k-means Clustering



k-means Clustering: MATLAB Example



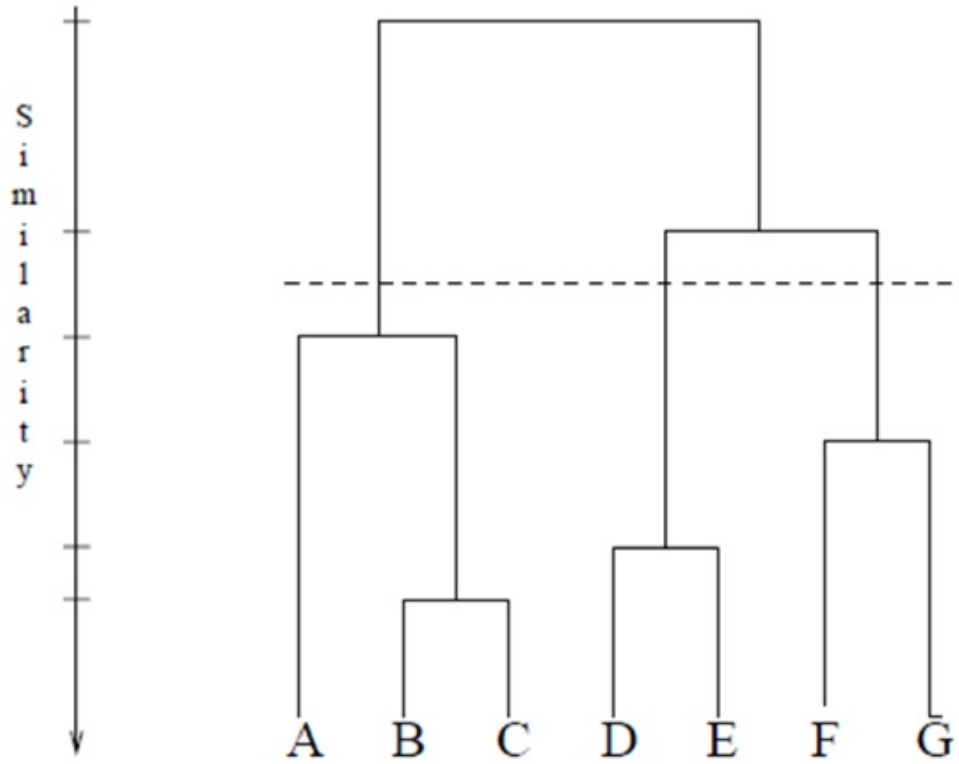
Web: https://www.mathworks.com/help/stats/kmeans.html

k-means Clustering

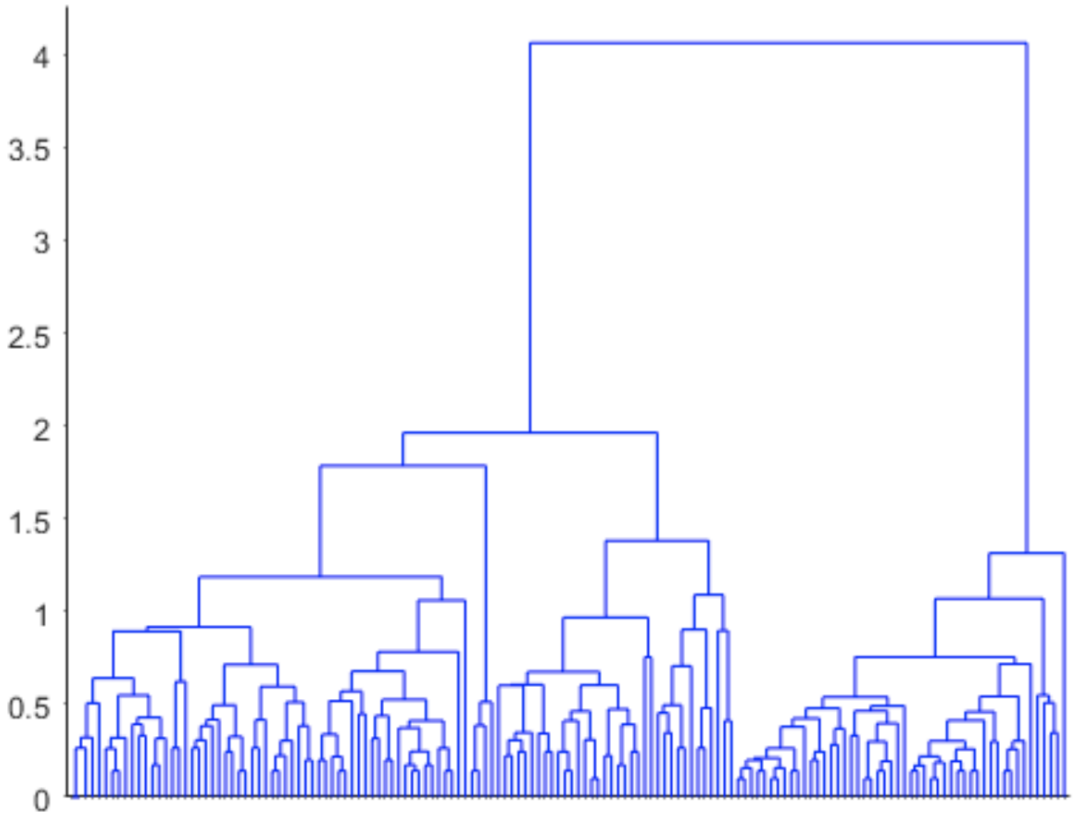
Algorithm Basic K-means Algorithm.

1: Select K points as the initial centroids.
2: **repeat**
3: Form K clusters by assigning all points to the closest centroid.
4: Recompute the centroid of each cluster.
5: **until** The centroids don't change

Hierarchical Clustering



Hierarchical Clustering: MATLAB Example



Web: https://www.mathworks.com/help/stats/examples/cluster-analysis.html

Text Processing

- Tokenization / parsing
- Dropping stop words
- Normalization
- Stemming
- Lemmatization

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Indexing Score

- *Indexing score*: $S(q,d) = \sum(tf\_idf)$
- *Composite weight*: $tf\_idf = tf \times idf$
- *Inverse document frequency*: $idf = \log(\frac{N}{df})$, $N > 0$, $df > 0$
- *Term frequency*: tf

Example: tf_idf

An example of four terms in three documents of a fictional collection consists of $N = 1,000$ documents.

Terms	tf(doc1)	tf(doc2)	tf(doc3)	$\cdots$	df	idf
"method"	4,250	3,400	5,100	$\cdots$	850	0.07
"the"	50,000	43,000	55,000	$\cdots$	1,000	0.00
"water"	7,600	4,000	2,000	$\cdots$	400	0.40
"bioreactor"	600	0	25	$\cdots$	25	1.6

Example: tf_idf

An example of four terms in three documents of a fictional collection consists of $N = 1,000$ documents. The tf_idf values are shown as the following table.

Terms	tf_idf(doc1)	tf_idf(doc2)	tf_idf(doc3)	$\cdots$
"method"	299.97	239.98	359.96	$\cdots$
"the"	0.00	0.00	0.00	$\cdots$
"water"	3,024.34	1,591.76	795.88	$\cdots$
"bioreactor"	961.24	0.00	40.05	$\cdots$
Scores	4285.57	1831.74	1195.89	$\cdots$
Ranking	1	2	3	$\cdots$

Evaluations of Empirical Algorithms

- Training set
- Test set
- Ground truth
- Precision: $p = \frac{TP}{TP+FP}$
- Recall: $r = \frac{TP}{TP+FN}$
- F-measure: $F = \frac{2 \cdot p \cdot r}{p+r}$
- G-measure: $G = \sqrt{p \cdot r}$

Note: F-measure is the harmonic mean (average) of recall and precision, G-measure is the geometric mean (average).

Questions?

Questions?

In state diagram, the concepts:

1. Activity and action are same.
2. Activity and action are different.
3. The relationship between activity and action is uncertain.
4. None of the given options

The right answer is:___

Questions?

Vision Intelligence IV: Visual Event Computations

Learning Objectives

- Explain how AI theories could be used in visual analytics.
- Demonstrate knowledge of how to apply algorithms and techniques for vision modeling.