Motion Patterns

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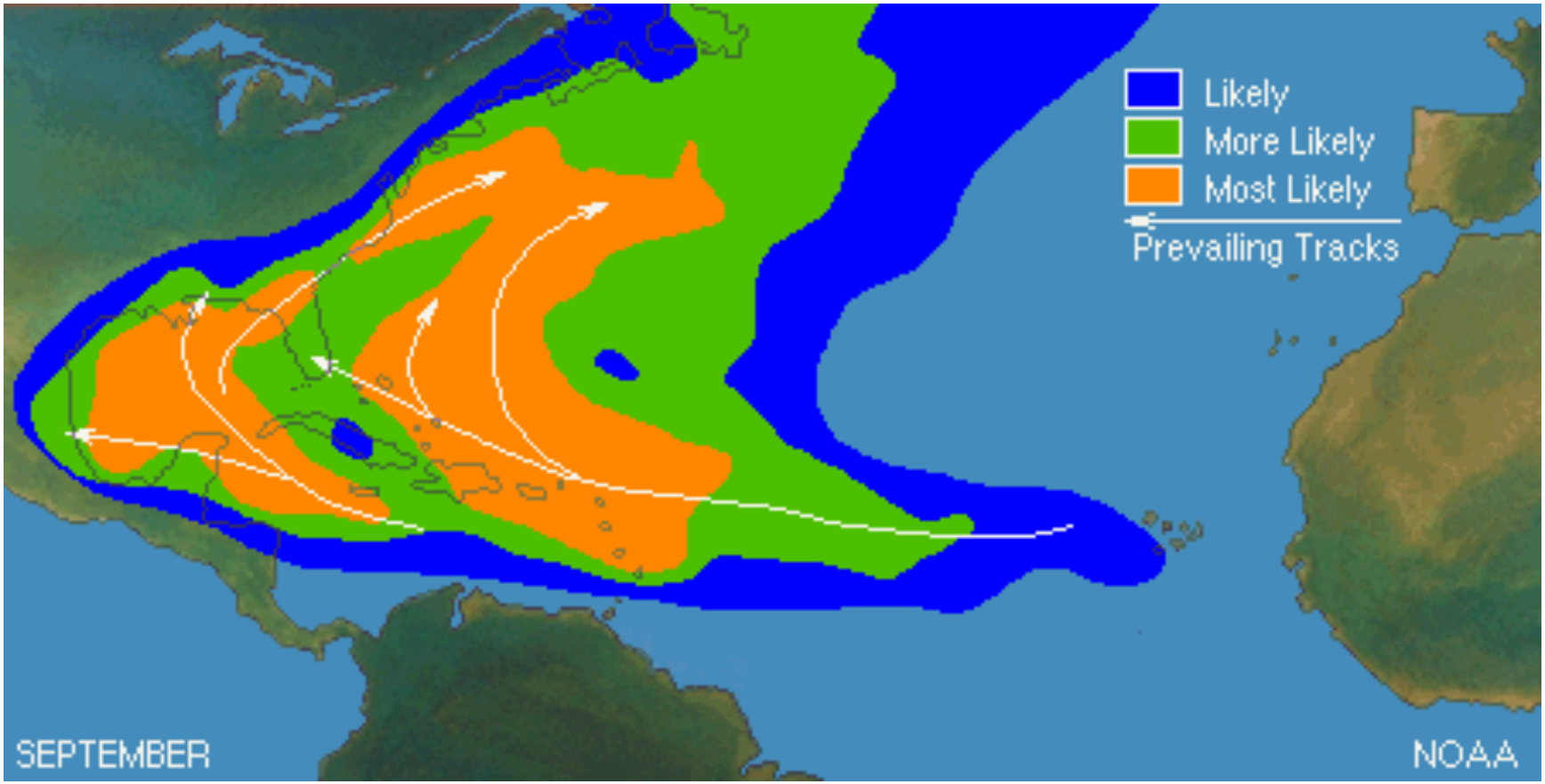
Trajectory Clustering

- Trajectory clustering is a well-established field of research in Data Mining area.
- Clustering: grouping objects into class of similar identities
- Trajectory: a N-dimensional path that a moving object takes through a N-dimensional space as a function of time.

Why cluster trajectories?

- Five desired outcomes:
  - Activity classification or actor identification based on characteristic behavior
  - Abnormality detection
  - Behavior prediction
  - Characterization of interaction
  - Detecting regions of interest

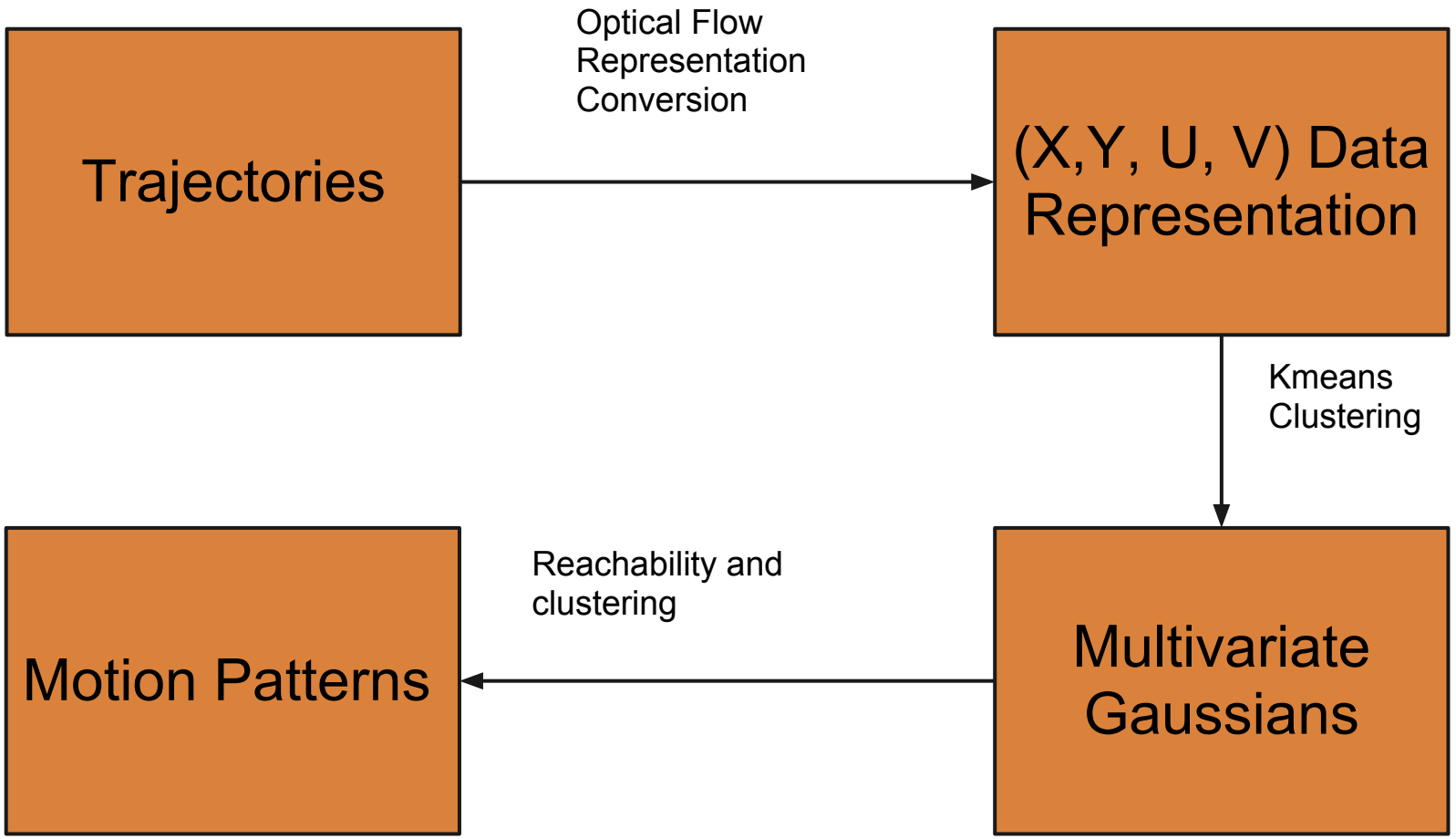
Example - Hurricane Tracks



Existing Methods

- Clustering trajectories as a whole
  - Define similarity measure
  - Use any of the well-established clustering methods
- Partition-based approaches
  - Finding regions of interest, etc.
- All of the above techniques:
  - move from trajectories to clusters

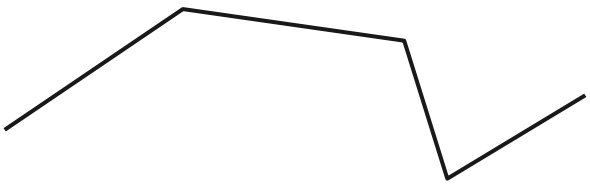
Motion Patterns Algorithm

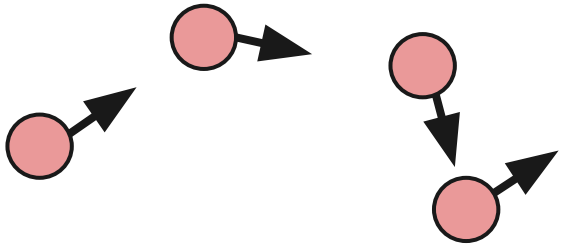


Pseudo-Optical Flow

Suppose the spatial coordinates of a trajectory are (x_i,y_i) where i is the index within the trajectory

The pseudo-optical flow is $(x_i,y_i,x_{i+1}-x_i,y_{i+1}-y_i)$

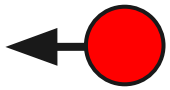




Forming Components

Cluster pseudo-optical flow using k-means in the four dimension space.

For each cluster, make component as average of pseudo-optical flows.



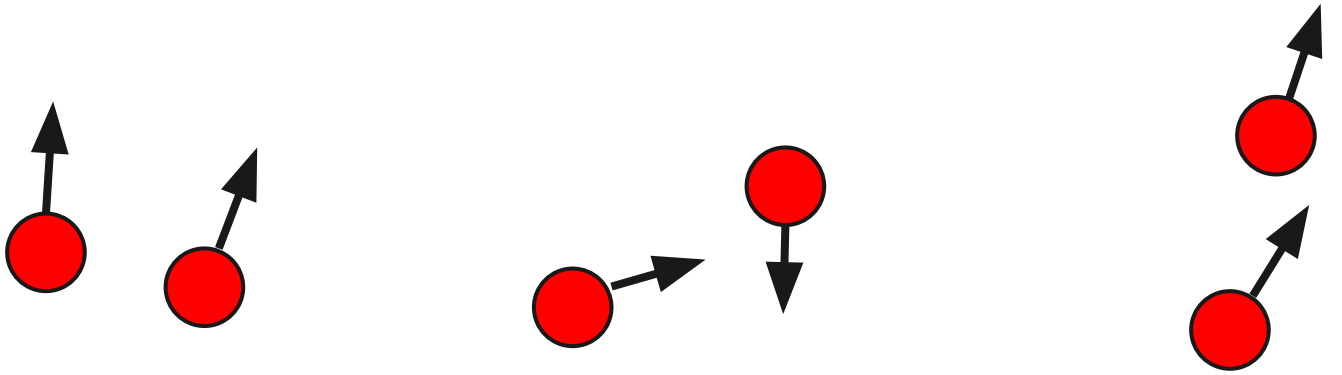
Reachability

Reachability is a relation between components

-Components must be close

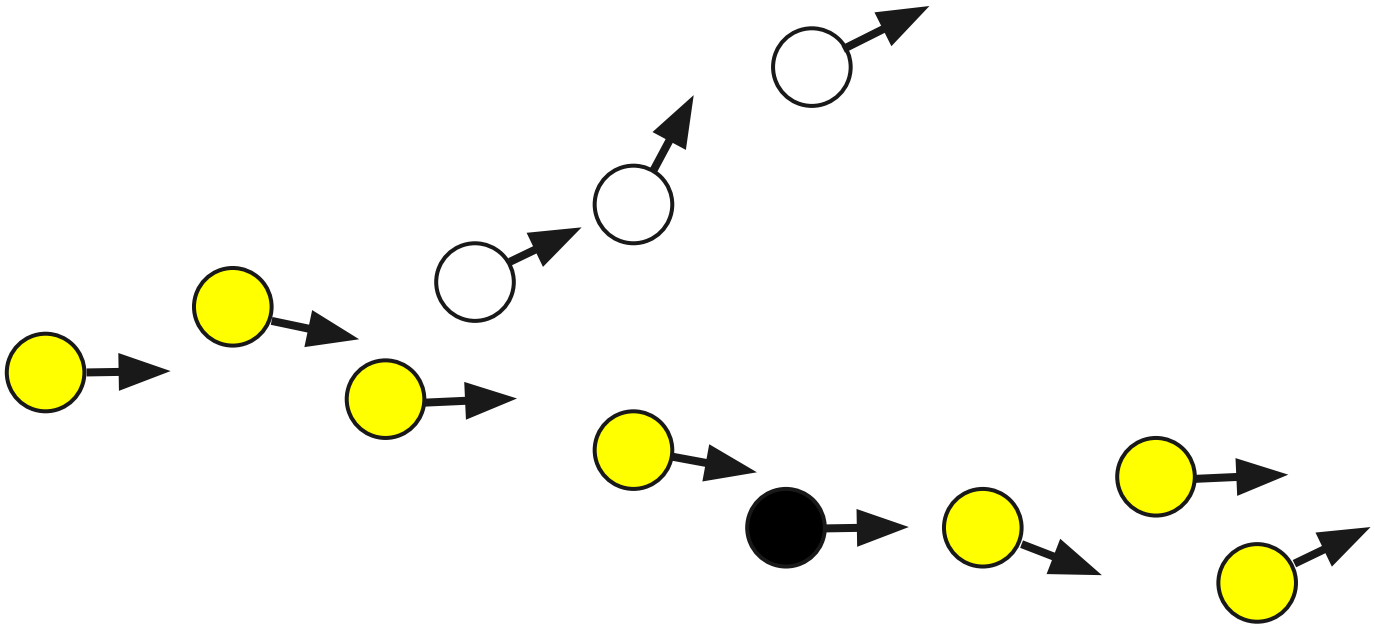
-2nd Component must be in front of first component

-Flow directions must be similar



Signatures

Signature of component C are all components that are "path" reachable from C or from which C is "path" reachable.



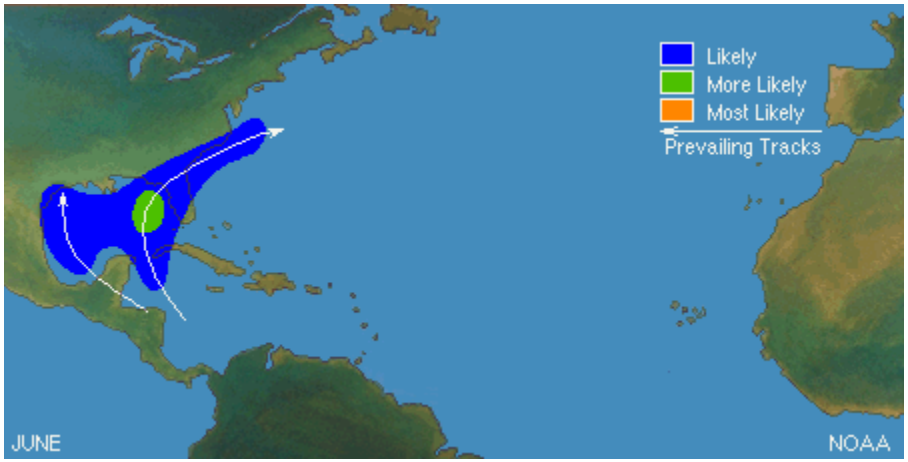
Forming Motion Patterns

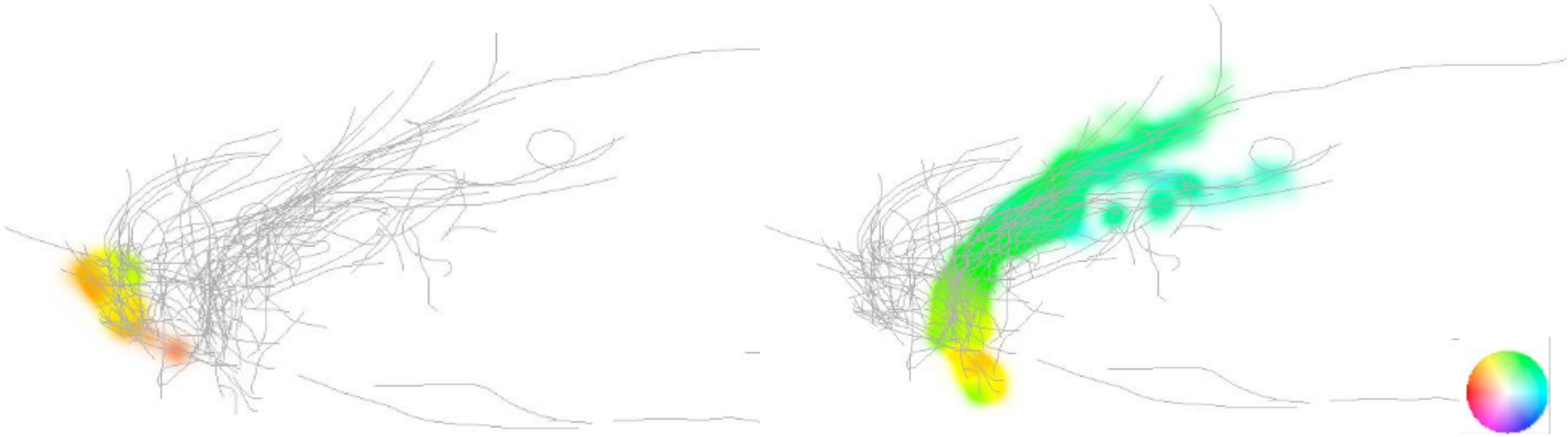
Define distance between components as Jaccard distance of signatures

$$dist(a, b) = \frac{|sig(a) \cap sig(b)|}{|sig(a) \cup sig(b)|}$$

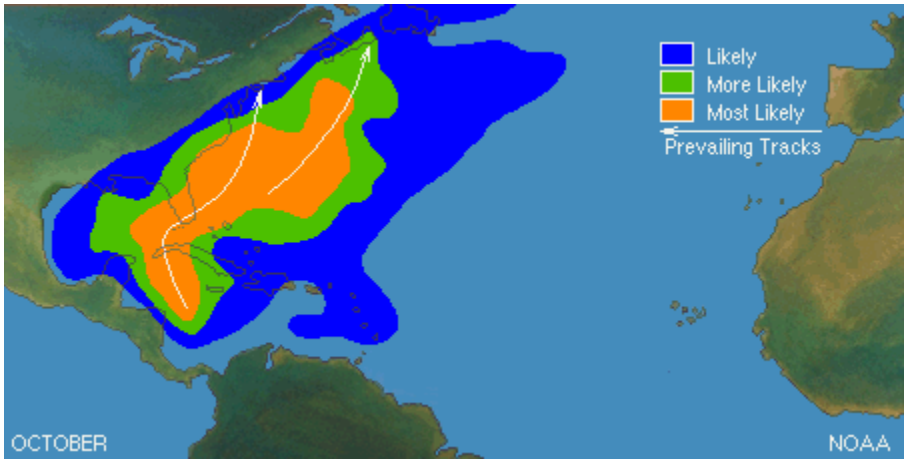
Cluster components into motion patterns via agglomerative clustering using this distance

Atlantic Hurricane Tracks





Atlantic Hurricane Tracks

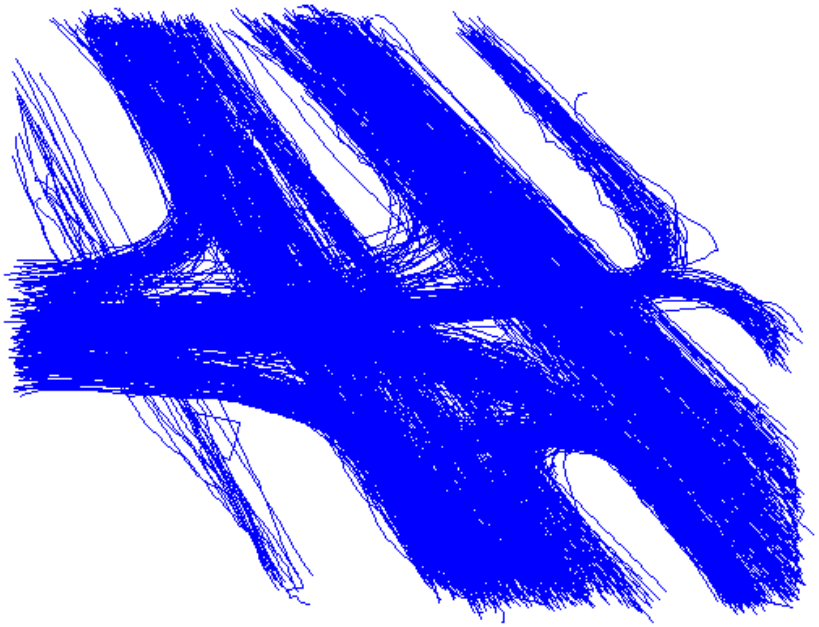






Intersection data

-Trajectories from visual tracking of vehicles at intersection



Intersection

