MOVEMINE

Mining Moving Object Databases

Zhenhui Jessie Li, Ming Ji, Lu-An Tang, Yintao Yu, Jiawei Han

University of Illinois at Urbana-Champaign

Jae-Gil Lee
IBM Almaden

Roland Kays
New York State Museum
Director of MoveBank.org

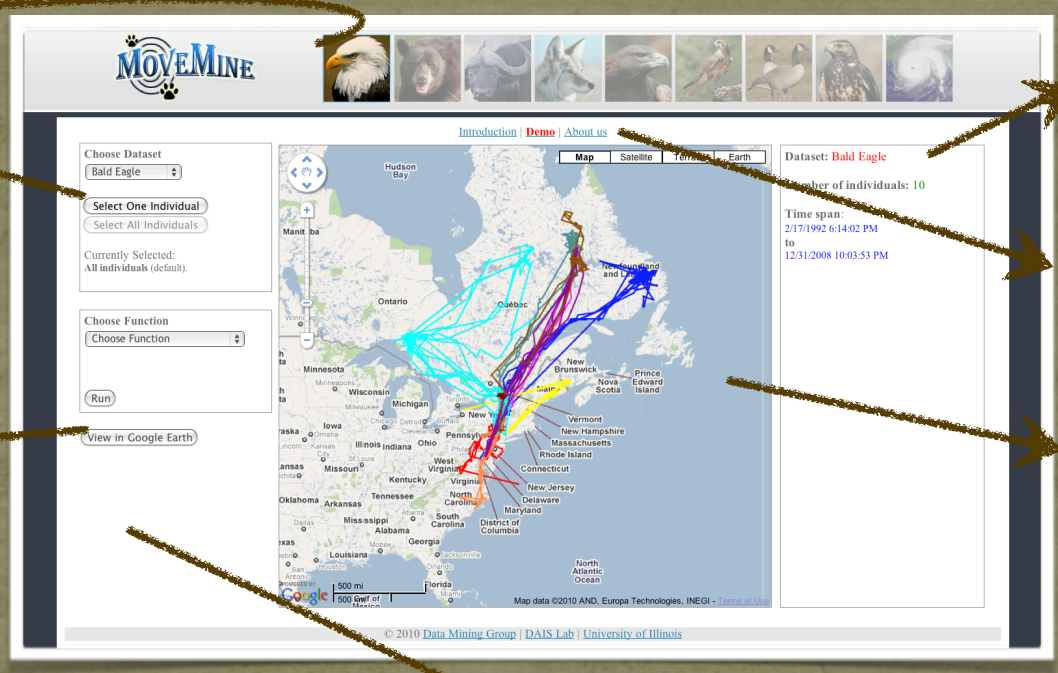
Motivation With the maturity of tracking technologies, increasing amounts of movement data become widely available, such as vehicles, animals, climate, and human movement data. MoveMine, is designed for sophisticated moving object data mining by integrating several useful functions including pattern mining and trajectory mining using the state-of-the-art techniques. Our system is tested on various real movement data sets, such as those provided by MoveBank.org (an international organization of biologists). It will benefit people to carry out versatile analysis on these kinds of data.

Dataset Selection

Data in the format of (id, longitude, latitude, time). Most are real animal movement data from MoveBank.org.

Visualize in Google Earth

Google earth can simulate movements with temporal information; window will pop-out.



Text Message

Dataset properties; results.

External Links

More about the demo and about us.

Visualization

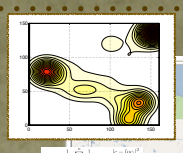
Raw data visualization (each color represents one moving object);
Mining results visualizations.

Interface

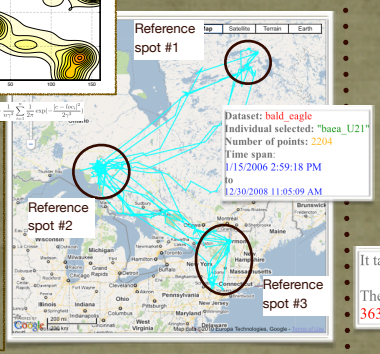
Function Details

Periodic Pattern (KDD'10)

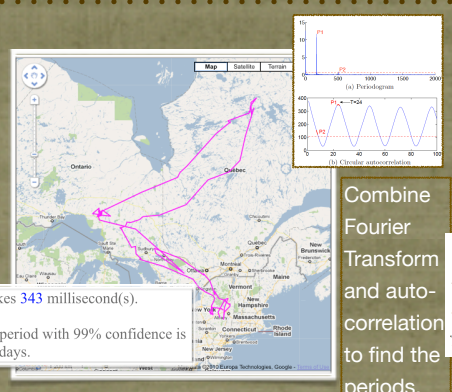
Periodicity is a frequently happening phenomenon for moving objects. Finding periodic patterns is difficult due to the fact that each timestamp is associated with a 2D spatial point as well as the noisy, sparse and uncertain nature of the data.



Kernel method to detect high density area. (popularly used to detect home ranges of animals).



Step 1: Detect the regions that are frequently visited (reference spot).



Step 2: Detect periods for each reference spot.

Combine Fourier Transform and auto-correlation to find the periods.

Periodic behavior

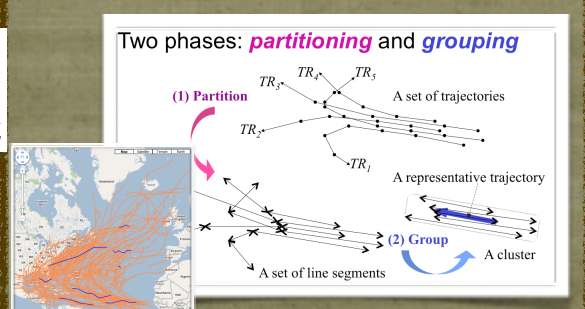
"This bald eagle stays in New York area (i.e., reference spot # 1) from December to March. In March, it flies to Great Lakes area (i.e., reference spot #2) and stays there until the end of May. It flies to Quebec area (i.e., reference spot #3) in the summer and stays there until late September. Then it flies back to Great Lake again staying there from mid October to mid November and goes back to New York in December."

Step 3: Summarize periodic behavior.

Zhenhui Li, Bolin Ding, Jiawei Han, and Roland Kays, "Mining Hidden Periodic Behaviors for Moving Objects", SIGKDD, 2010.

Trajectory Clustering (SIGMOD'07)

Trajectory clustering focuses more on the geometric information of movements. It discovers the clusters of sub-trajectories.

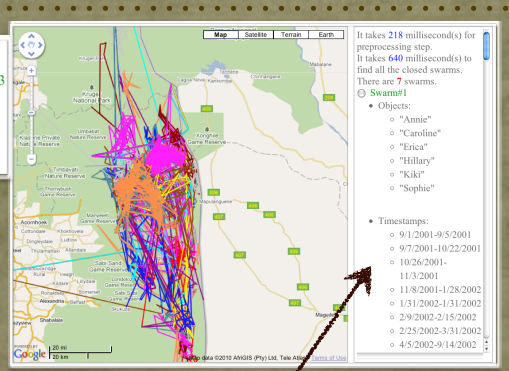


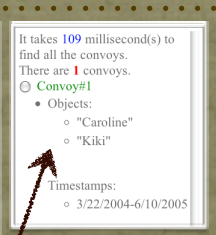
Jae-Gil Lee, Jiawei Han, and Kyu-Young Whang, "Trajectory Clustering: A Partition-and-Group Framework", SIGMOD, 2007.

Swarm Pattern (submitted) v.s. Convoy Pattern

Both swarm and convoy patterns are trying to find the moving objects that move together. Two moving objects are considered "together" at one timestamp if they belong to the same cluster at that timestamp. The goal of convoy is to find objects that move together for at least k consecutive times. Swarm, which is more practical in real application, tries to discover the objects that are close for min_t non-consecutive times. Technique challenge for swarm mining is the exponential search space up to 2^{# of objects}*2^{# of timestamps}.

It could be huge search space: 2^43*2^1000.

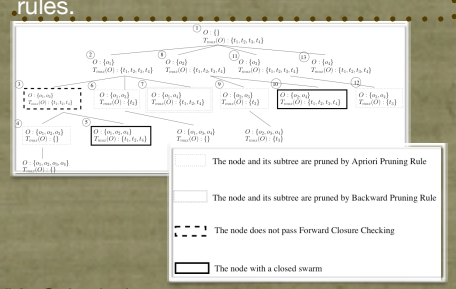




min_t=0.2.Limited convoy are found.

min_t = 0.5. More swarms are discovered. Timestamps are not consecutive.

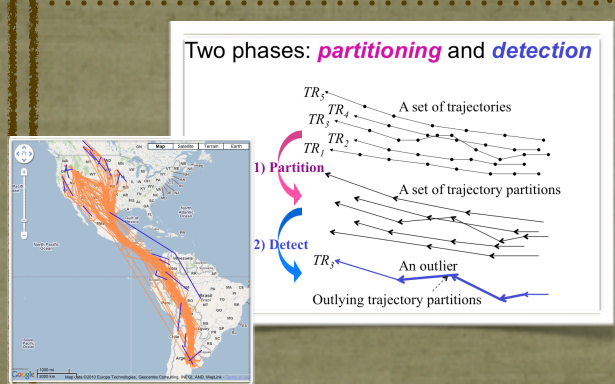
Convoy can be solved in polynomial time. Swarm is an exhaustive search problem which requires strong pruning rules.



Zhenhui Li, Bolin Ding, Jiawei Han, and Roland Kays, "Swarm: Mining Moving Object Clusters",In Submission.
Hoyoung Jeung, Man Lung Yiu, Xiaofang Zhou, Christian S. Jensen, Heng Tao Shen, "Discovery of Convoys in Trajectory Databases", PVLDB, 2008.

Trajectory Outlier (ICDE'08)

This function discovers the sub-trajectories that do not follow the general trend of the movements.



Jae-Gil Lee, Jiawei Han, and Xiaolei Li, "Trajectory Outlier Detection: A Partition-and-Detect Framework", ICDE, 2008.

dm.cs.uiuc.edu/movemine