

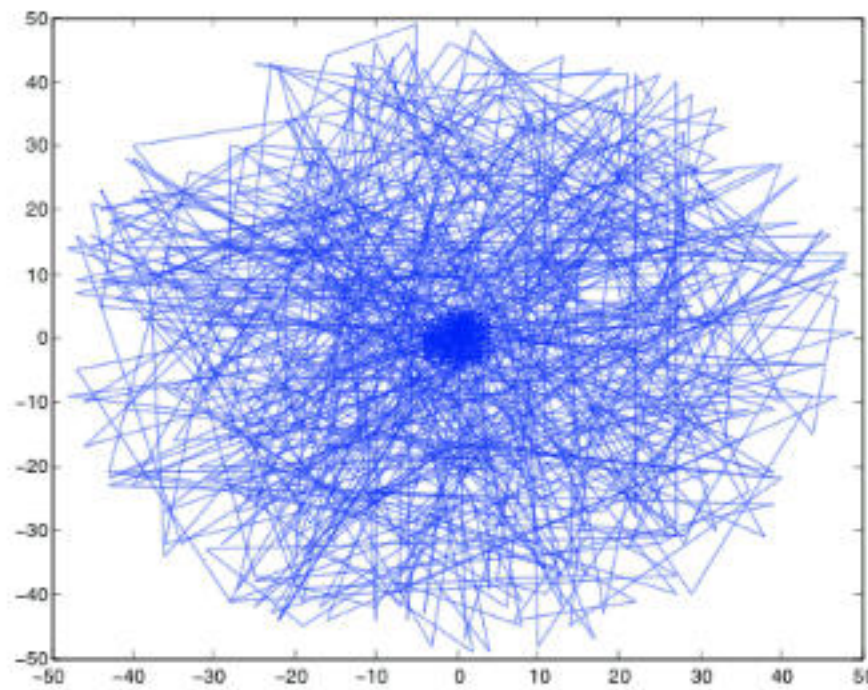
The background of the slide is a complex, abstract composition. It features a dark, reddish-brown base with a network of thin, light-colored lines forming a mesh or web-like structure. Scattered throughout this network are numerous small, green circular dots. In the upper left corner, there is a smaller, lighter-colored rectangular area containing a grid of small, light-colored dots. Overlaid on this background is a large, white, angular shape that resembles a stylized 'V' or a folded piece of paper. The title text is positioned within this white shape.

# Mining Periodic Movement Patterns



# Pattern Discovery in Sparse Movement Data: Finding Good Reference Points

- Pattern discovery in sparse data (e.g., find bird flying patterns) 稀疏数据.
- Periodicity shows up in some reference “spots” (or “cluster centers”) 比如鸟每天回巢.
- Reference spots can be detected using **density-based method** 巢就是点
- Periods are detected for each reference spot using **Fourier Transform** and **auto-correlation**

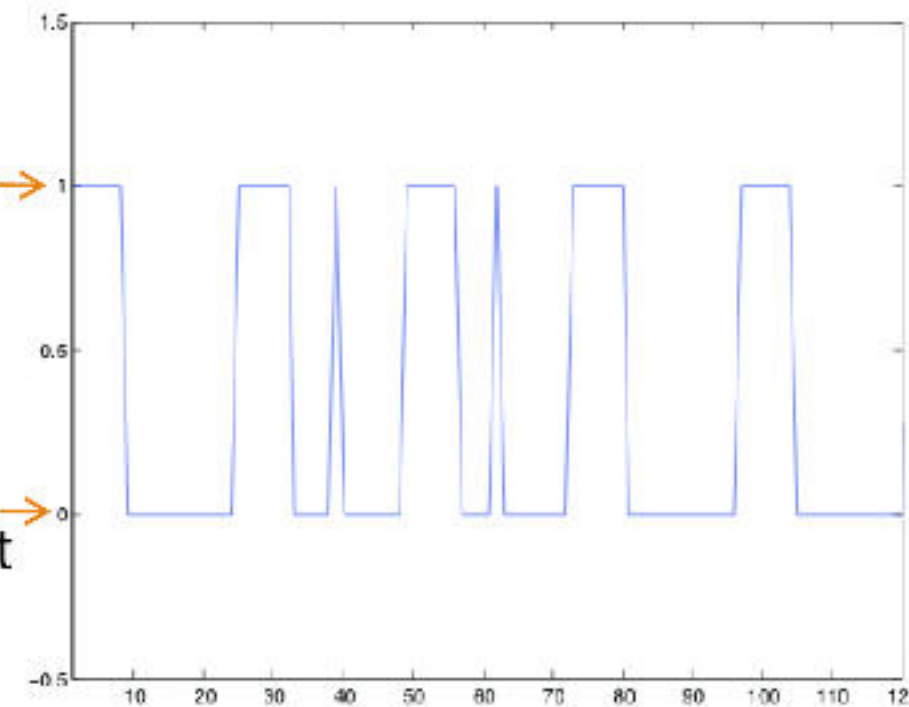


Finding bird flying patterns?  
Bird Nest is a good reference point



in the nest →

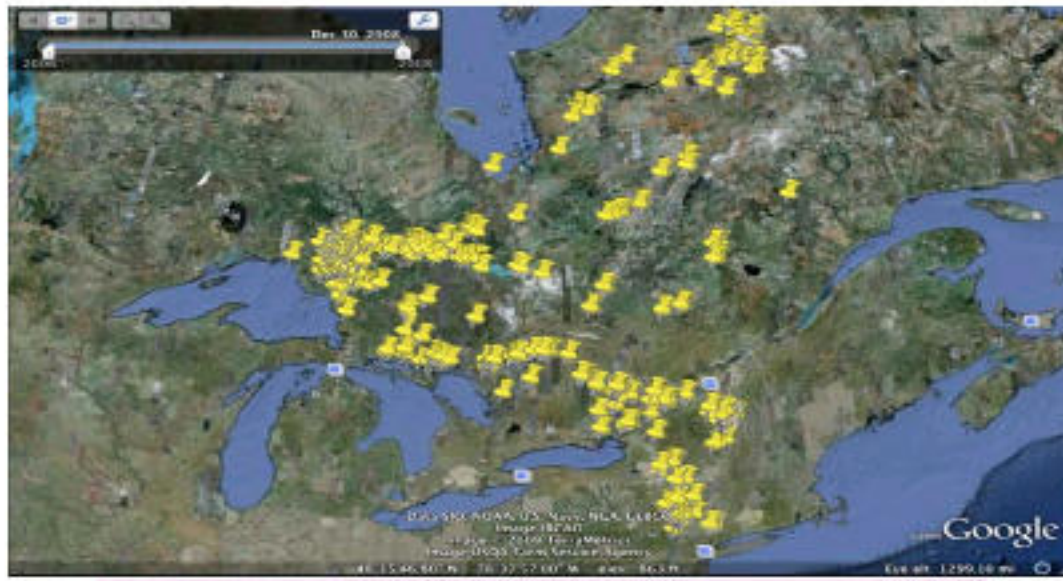
not in  
the nest →



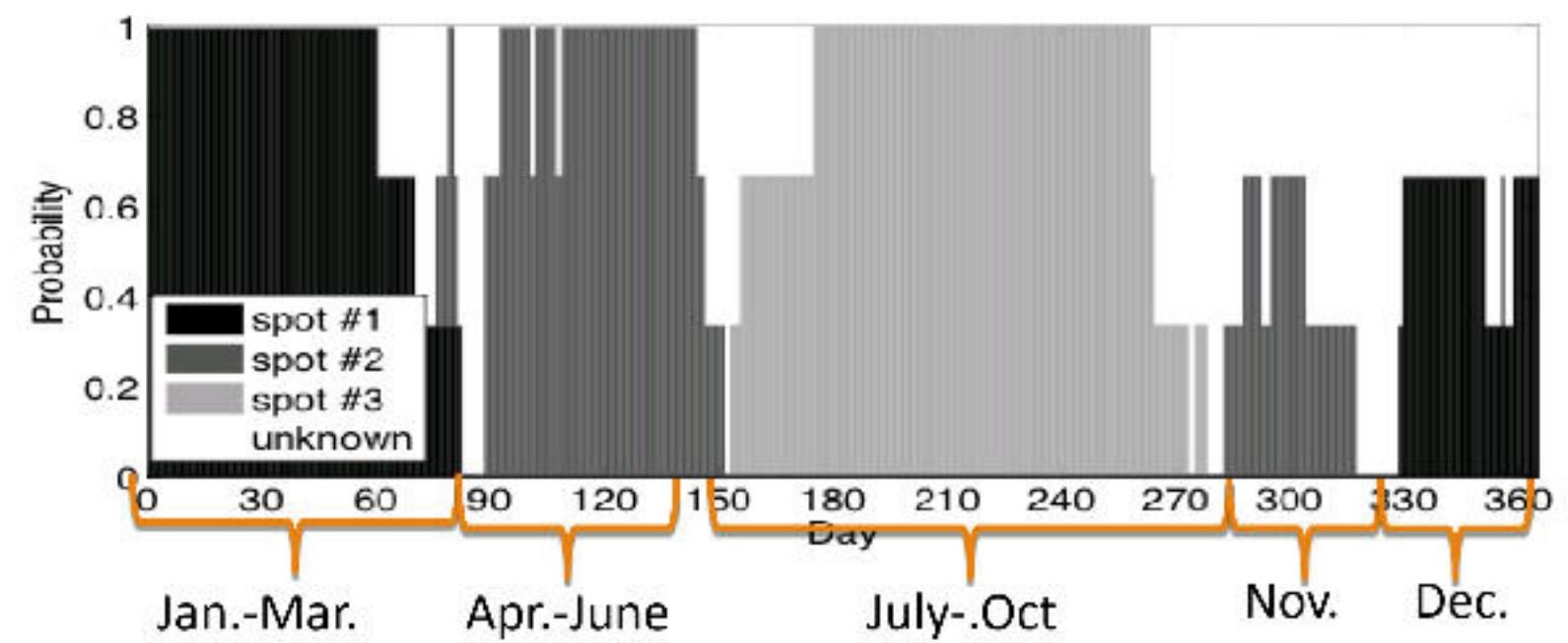
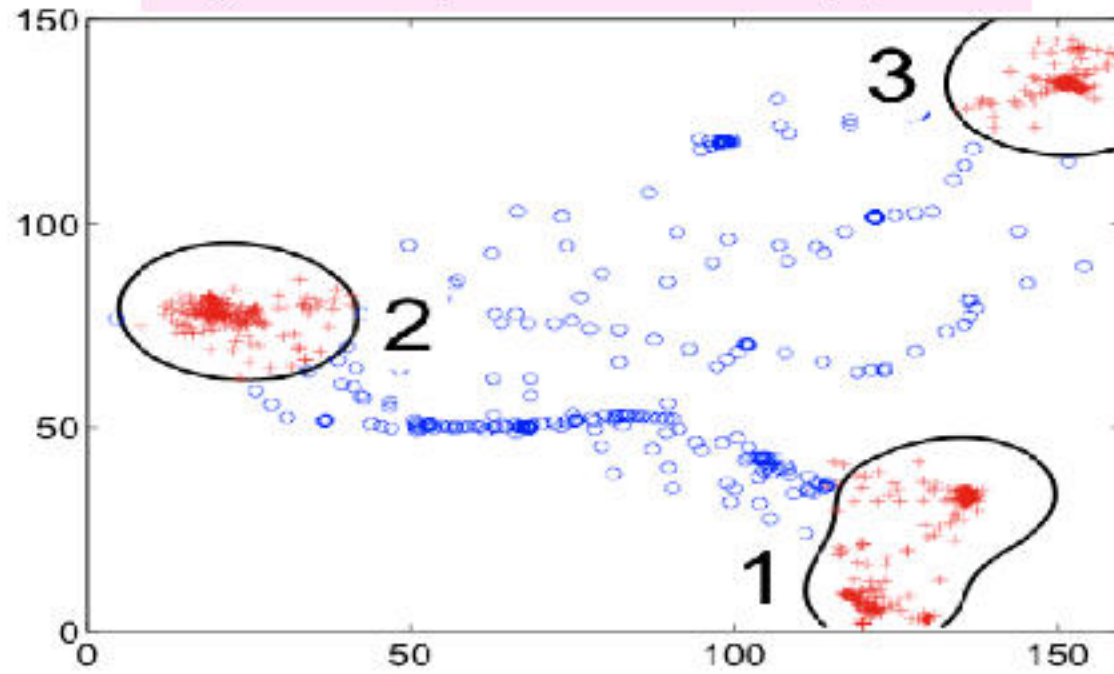
Period is more obvious in this binary sequence!



# Example: Mining Periodic Patterns with Sparse Data



3-yr Bird migration data: very sparse

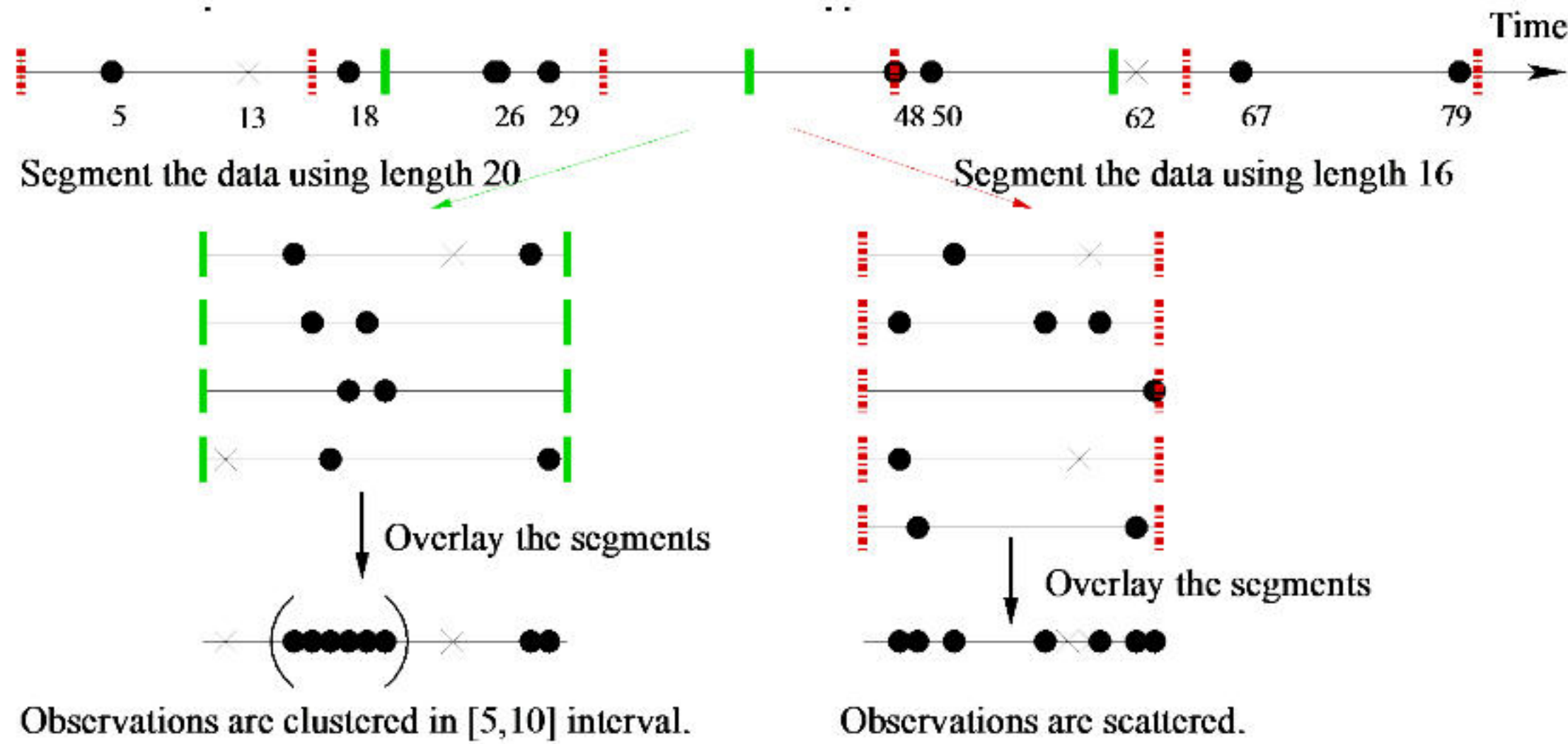


- **Detecting periods:** Cluster data to find reference “points” and then detect multiple interleaved periods by Fourier Transform and auto-correlation
- **Summarizing periodic patterns:** By clustering and pattern discovery

Z. Li, et al.: Mining Periodic Behaviors for Moving Objects. KDD'10

# Periodicity Detection in Sparse Data

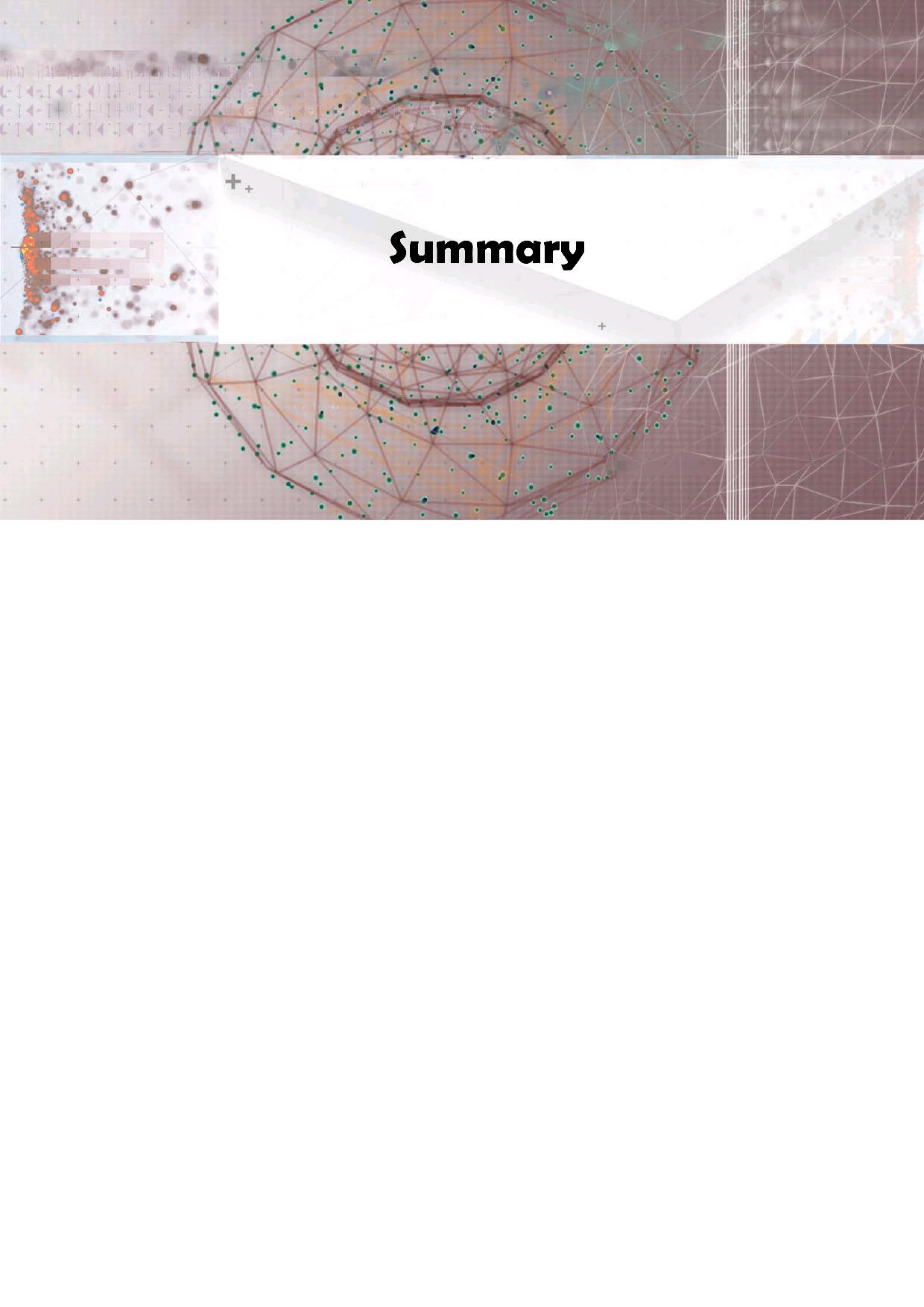
- Time-related data can be scattered and sparse, e.g., phone calls at a location



- Projecting on the true period, it shows a highly skewed (clustered) distribution
- Effective method can be developed based on this observation

Z. Li, et al., ePeriodicity: Mining Event Periodicity from Incomplete Observations. IEEE TKDE, 2015





# Summary

# Summary: Mining Spatiotemporal and Trajectory Patterns

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- ❑ Mining Spatial Associations
- ❑ Mining Spatial Colocation Patterns
- ❑ Mining and Aggregating Patterns over Multiple Trajectories
- ❑ Mining Semantics-Rich Movement Patterns
- ❑ Mining Periodic Movement Patterns



# Recommended Readings

- ❑ F. Giannotti, M. Nanni, F. Pinelli, D. Pedreschi: Trajectory Pattern Mining. KDD'07
- ❑ Y. Huang, S. Shekhar, H. Xiong: Discovering colocation patterns from spatial data sets: A general approach. IEEE Trans. on Knowledge & Data Eng., 16(12), 2004
- ❑ Y. Huang, J. Pei, H. Xiong: Mining Co-Location Patterns with Rare Events from Spatial Data Sets. Geoinformatica 10(3): 239-260, 2006
- ❑ K. Koperski, J. Han: Discovery of Spatial Association Rules in Geographic Information Databases. SSD'95
- ❑ J.-G. Lee, J. Han, and K.-Y. Whang: Trajectory Clustering: A Partition-and-Group Framework, SIGMOD'07
- ❑ Z. Li, B. Ding, J. Han, R. Kays: Swarm: Mining Relaxed Temporal Moving Object Clusters. VLDB'10
- ❑ Z. Li, B. Ding, J. Han, R. Kays, P. Nye: Mining Periodic Behaviors for Moving Objects. KDD'10
- ❑ Z. Li, J. Wang and J. Han, ePeriodicity: Mining Event Periodicity from Incomplete Observations. IEEE TKDE, 27(5): 1219-1232, 2015
- ❑ C. Zhang, J. Han, L. Shou, J. Lu, and T. La Porta: Splitter: Mining Fine Grained Sequential Patterns in Semantic Trajectories. VLDB'14