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Taking a Systematic Look at Movement: Developing a Taxonomy of Movement Patterns

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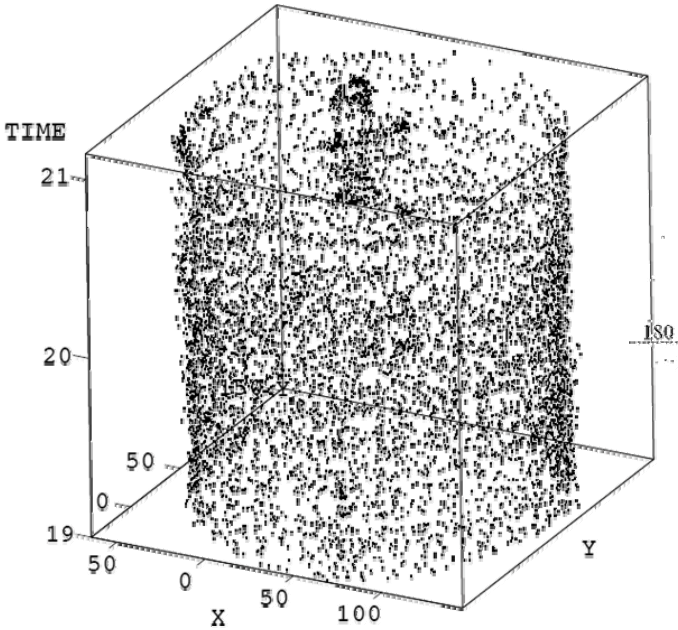
Motivation

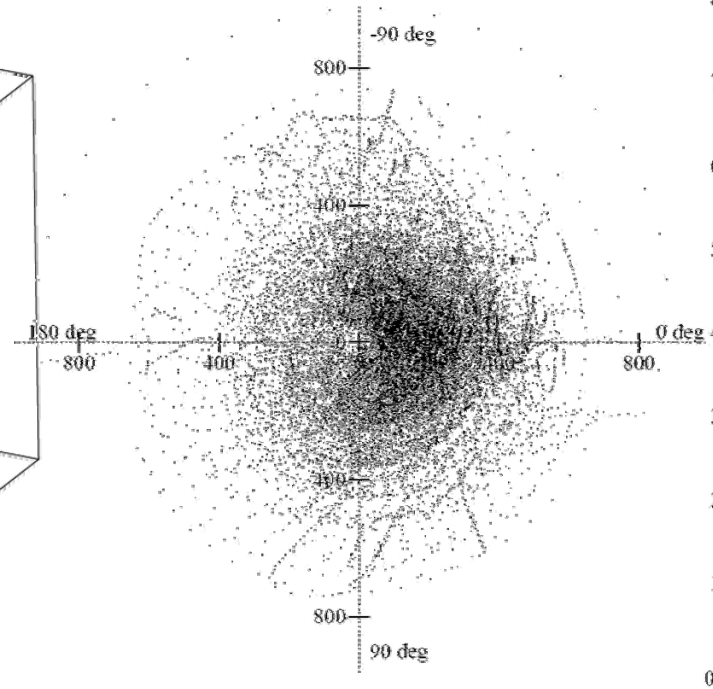
Design and develop of efficient data mining algorithms

- Generic and suitable for different kinds of MPO data.

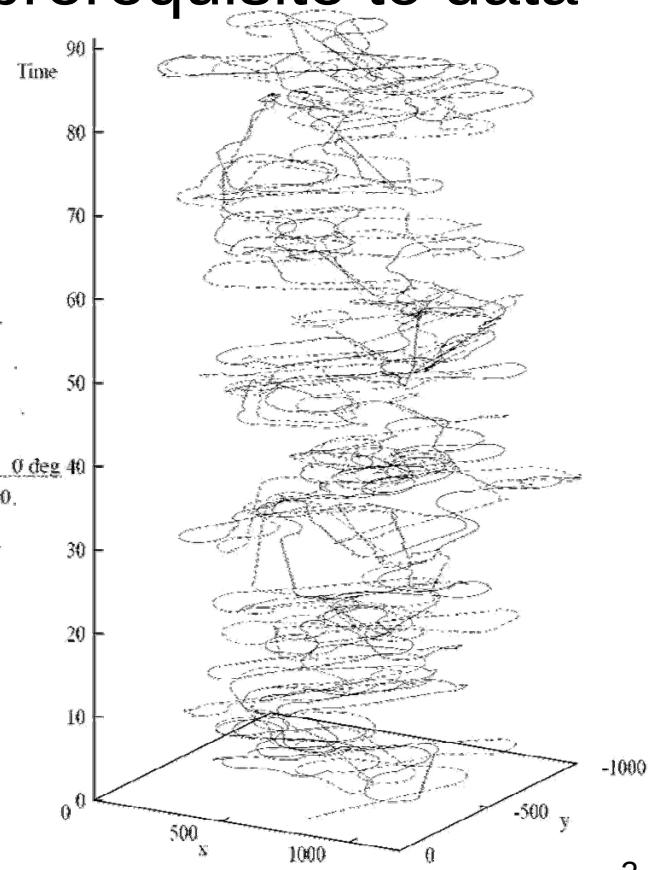
Definition of movement patterns is prerequisite to data mining and visual analytics



Imfeld (2000)



Blythe et al., (1999)



Objectives

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Taking a Systematic Look at Movement

- **Conceptual foundations** for **movement behavior** of different moving objects
- A **comprehensive taxonomy**
- Accurate definitions of **movement patterns**

Outcome**:**

Interoperability to gain the same understanding of the same terms.

Conceptual Foundations

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Movement variables

Movement variables	Basic variables	Derived variables
Spatial (x,y)	Position *(x,y)*	Spatial distribution
	Distance *f(x,y)*	Change of direction (path curvature)
	Direction *f(x,y)*	
Temporal (t)	Instance *(t)*	Duration *f(interval)*
	Interval *f(t)*	Temporal distribution
		Change of duration
Spatio-temporal (x, y,t)	Speed *f(x,y,t)*	Acceleration *f(speed)*
	Velocity f(x,y,t)	

Number of moving objects involved

- **Individual**
- **Group** with functional relationship
- **Cohort** with statistical relationship

Conceptual Foundations (2)

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Path type (depending on the granularity)

- **Continuous** path (e.g. trajectory of elk migration)
- **Discontinuous** path (e.g. stop-and-go movement of butterflies)

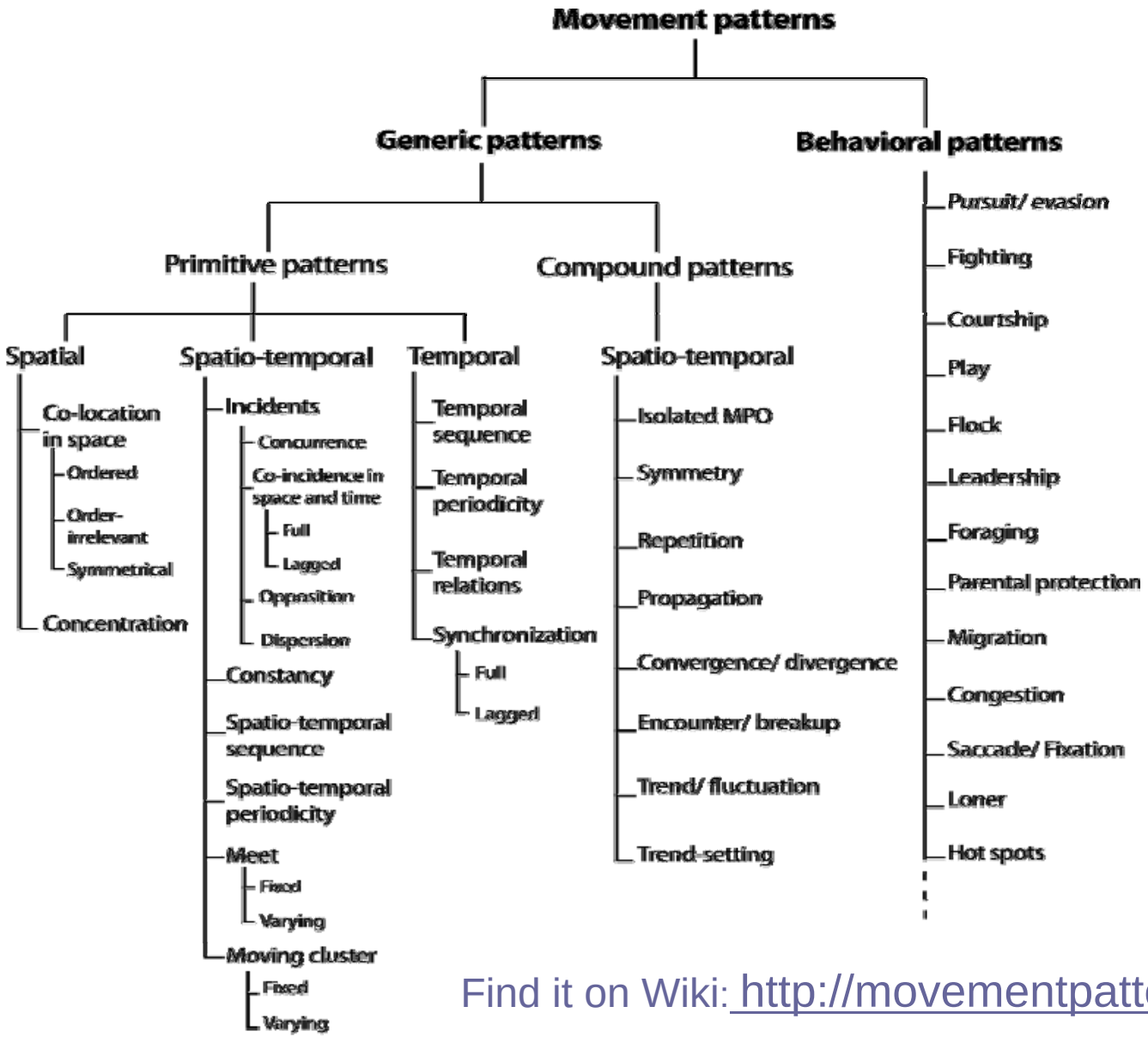
Influencing factors

- Intrinsic properties of the MO (speed, acceleration etc.)
- Spatial constraints (network, barriers etc.)
- Environment (vegetation, image etc.)
- Influence of other agents (competition, attraction etc.)

Scale/ granularity

- **Spatial** scale (very local to global scale)
- **Temporal** scale (very short-term to long-term behavior)

Taxonomy of movement patterns



Find it on Wiki: http://movementpatterns.pbwiki.com

Taxonomy of movement patterns

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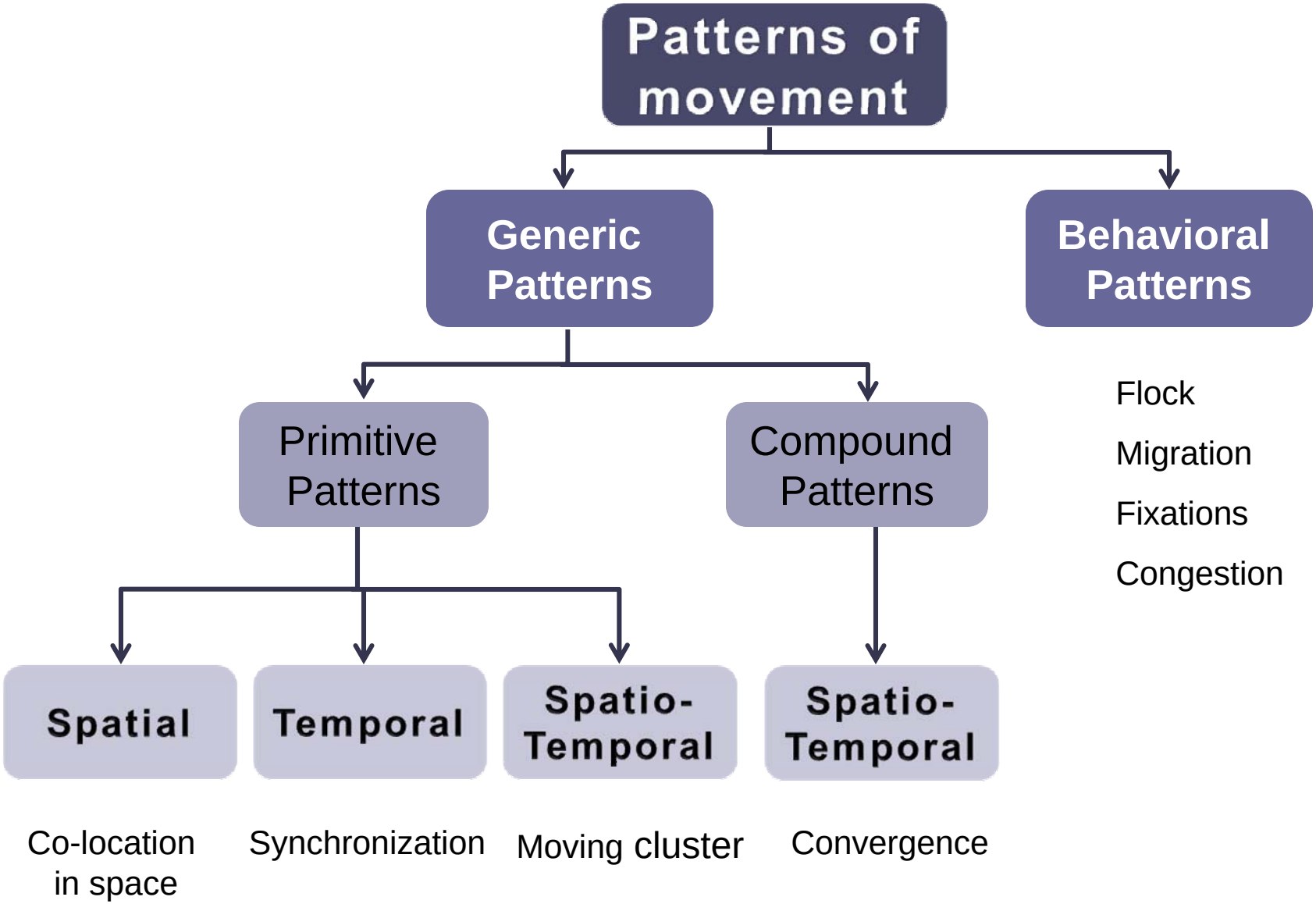


Flock

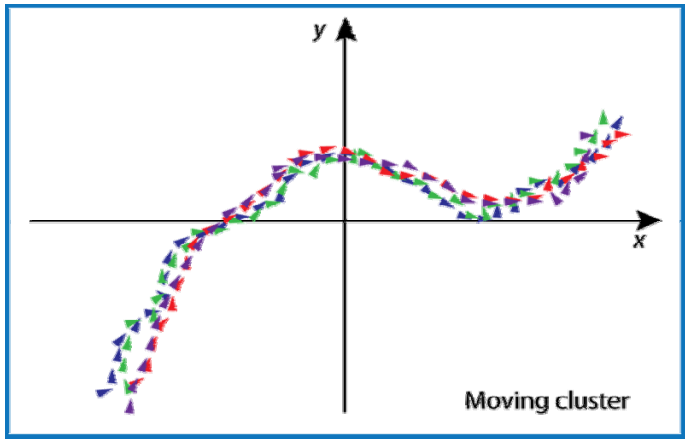
Migration

Fixations

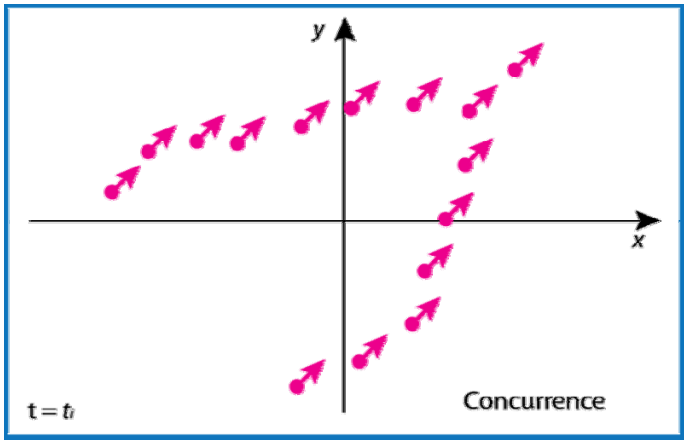
Congestion

Examples

Generic Pattern

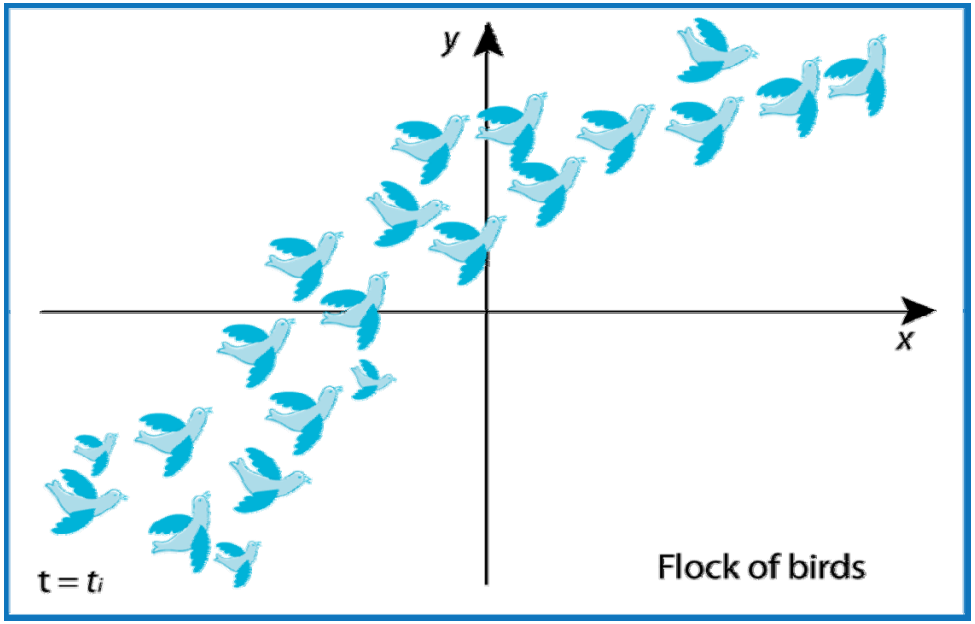


Moving Cluster



Concurrence

Behavioral Pattern



Flock of birds

More examples on Wiki: http://movementpatterns.pbwiki.com

Utilizing the taxonomy- Eye vs. human movement

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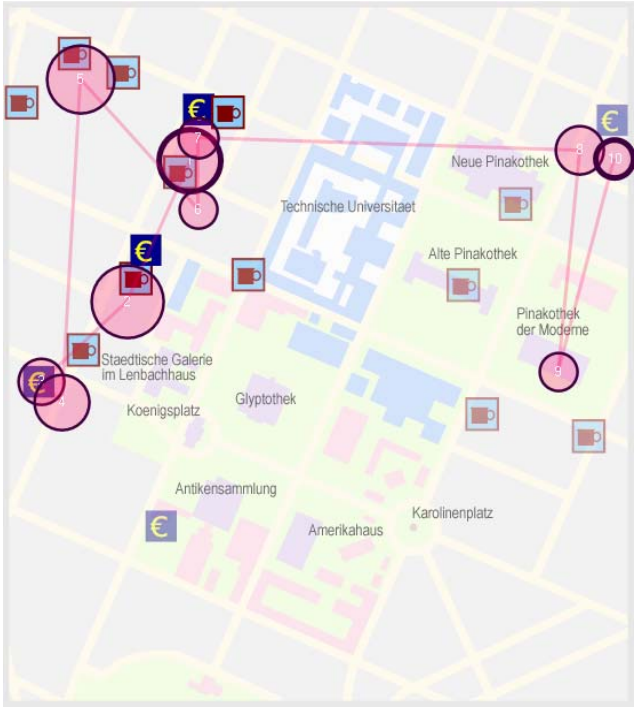
*"To what extent can we use **eye-movement** data as a **proxy** of other kinds of moving point data?"*

Differences in movement behavior (examples):

- Different speed values, speed variation
- Rapid direction changes

Movement pattern

- Similarities and differences
- Overlaid eye movement data from all subject
- A group of people taking part a guided tour
- Eye and human movement can be made comparable by stretching and compressing the spatial and temporal scales.



Reichenbacher (2007)

Conclusion:

There are some commonalities between eye and human whole-body movements on the level of **generic movement patterns.**

A call for collaboration

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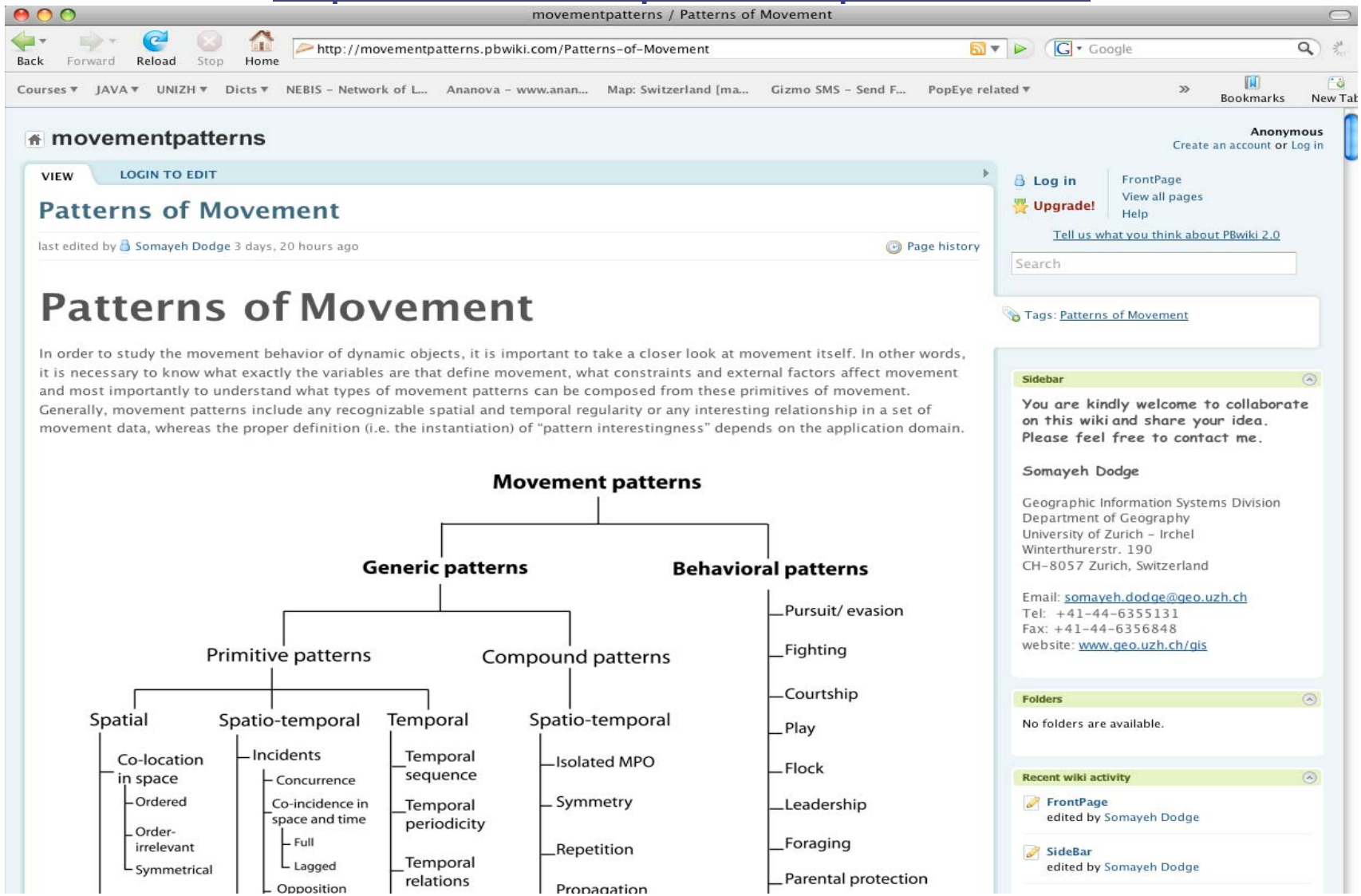
http://movementpatterns.pbwiki.com



Thanks for your attention!

Questions

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- Why do you think it is necessary to have a comprehensive taxonomy and common definition of movement patterns?
- How do you expect the taxonomy to help algorithm developers in data mining and visual analytics?
- How do you think can the proposed taxonomy be extended to encompass future movement pattern data mining research?
- Who is wiling to collaborate on the further development and consolidation of the proposed definition trough the wiki?