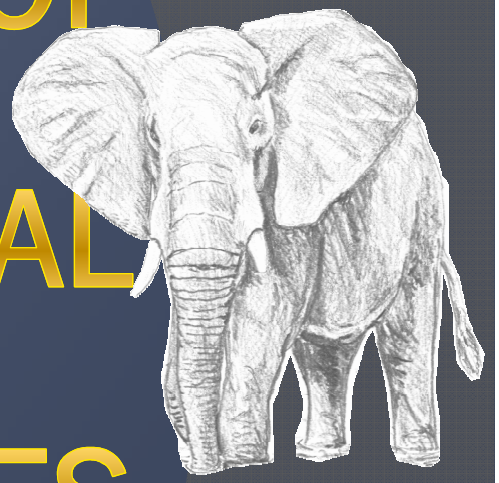
VISUAL EXPLORATION OF LARGE ANIMAL TRAJECTORIES



Buard E., Brasebin M.

PhD supervised by Lena Sanders and Anne Ruas

ICC2011 PARIS

Scientific Context

- PhD:

Analyze interactions between animal movements and topographic space/resources (water, vegetation)

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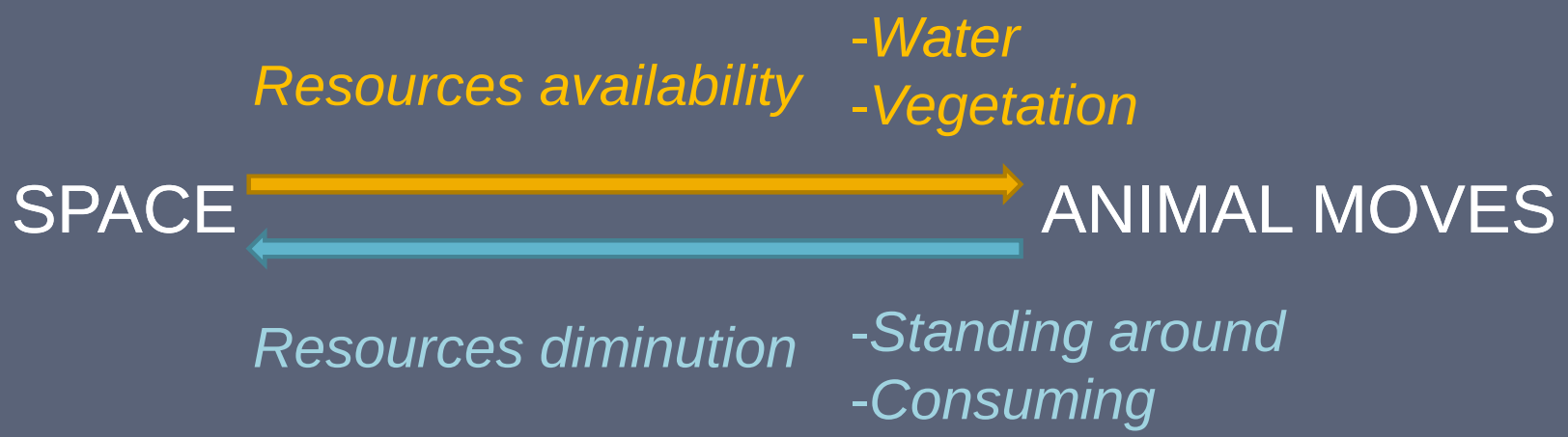
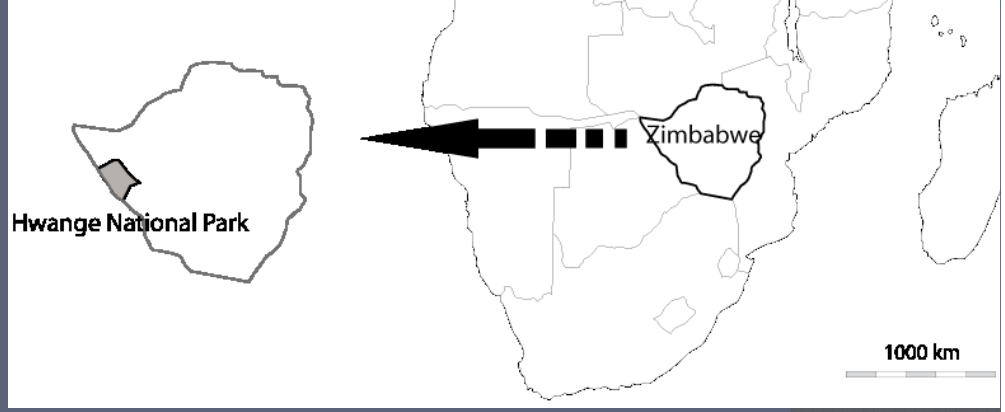


- Implies issues in GIS, geography and ecology

Main questions in this presentation

- How to identify and extract attractive areas, where individuals converge, from GPS data?
  - …and what is the impact of animals on topographic space there?
- How often do animals come in these areas? When?
- Conception of analytical methods and GIS exploration tools

Study Context



- Hwange National Park in Zimbabwe
- Large herbivores studied: elephants, zebras, buffaloes
- Trajectories are built from sets of positions collected by GPS collars.
- 1 GPS collar per group of herbivores

- *With the expertise of LBBE- CNRS UMR 5558 (ecologist research laboratory)*

Proposed method

- From GPS points of herbivore groups
  - To trajectories
  - Identifying attractive areas

- Visual interpretation of attractive areas
  - Detecting time-patterns
  - Detecting animal collocation (temporal or spatial)

Proposed method

2D

M1 From GPS points of herbivore groups

- M1.1 To trajectories
- M1.2 Identifying attractive areas

3D

M2 Visual interpretation of attractive areas

- M2.1 Detecting time-patterns
- M2.2 Detecting animal collocation (temporal or spatial)

Proposed method

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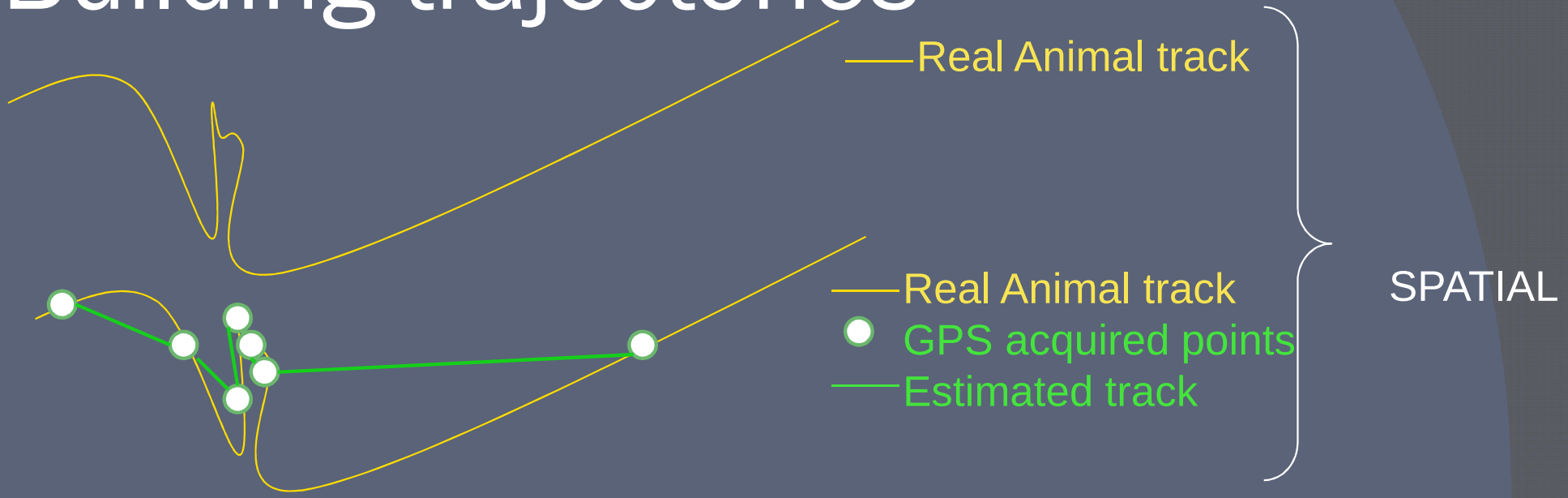
Building trajectories



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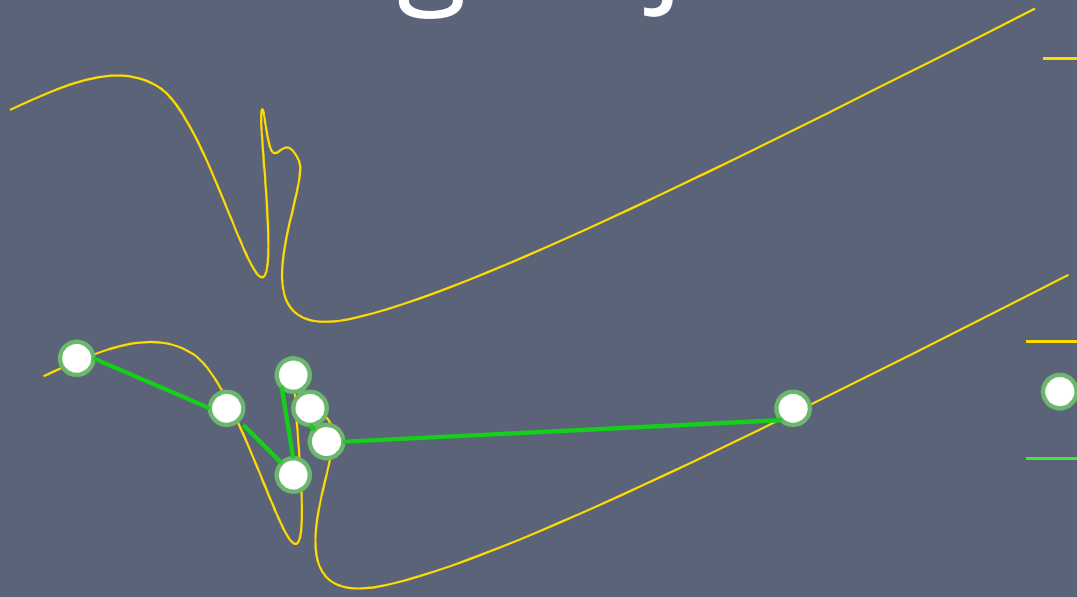
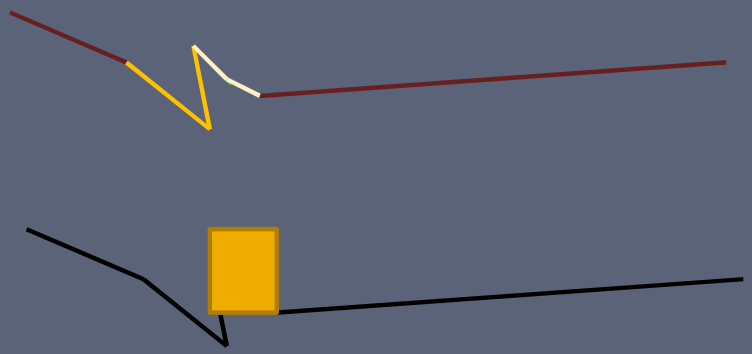


Real Animal track

Real Animal track
GPS acquired points
Estimated track

SPATIAL

Integration of time: speed

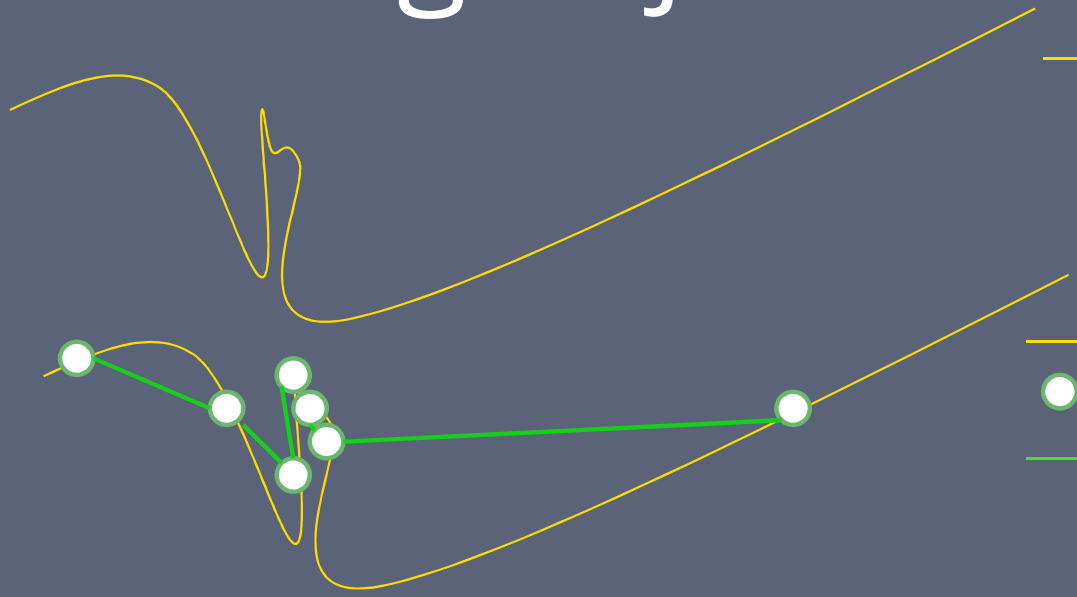


Estimated track
FAST
MEDIUM
SLOW

2 types of entities:
-Stations: no move
-Segment : moves

SPATIAL
+ TEMPORAL

Building trajectories



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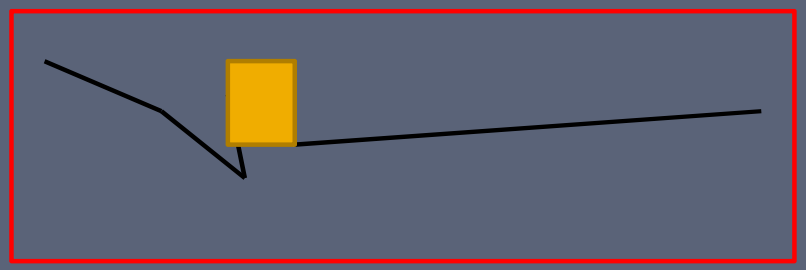


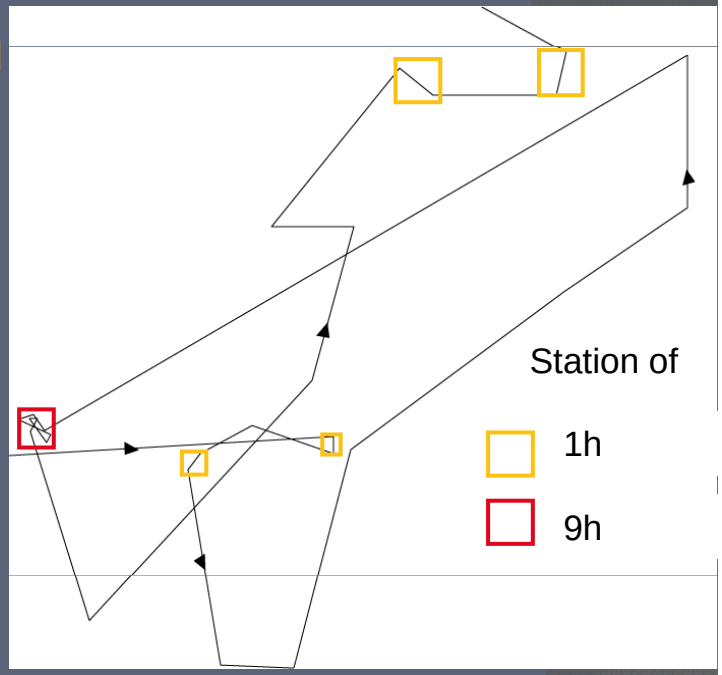
2 types of entities:
-Stations: no move
-Segment : moves

SPATIAL
+ TEMPORAL

TRAJECTORY: the set of stations and segments

Building trajectories

- Time Geography:
  - A place of stop is called a station
- Stations for animals have:
  - Duration
    number of close successive points
  - Spatial extend
    distance max of successive points
- It is the spatial dimension.

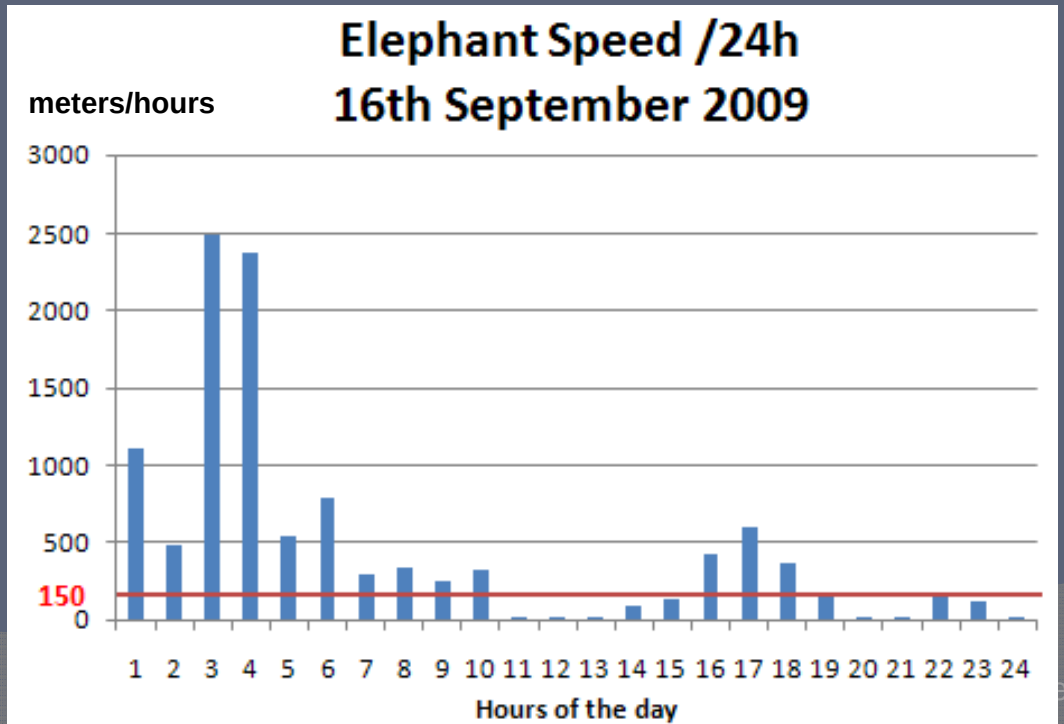


Trajectory	Move	No move
Spatial dimension	Segment	Station
Temporal dimension	Move	Stop

Building trajectories

Trajectory	Move	No move
Spatial dimension	Segment	Station
Temporal dimension	Move	Stop

- Need a speed threshold
  - Here: 1% of the max speed



2 stops in the day:
-The 1rst of 5 hours
-The 2nd of 5 hours

Building trajectories

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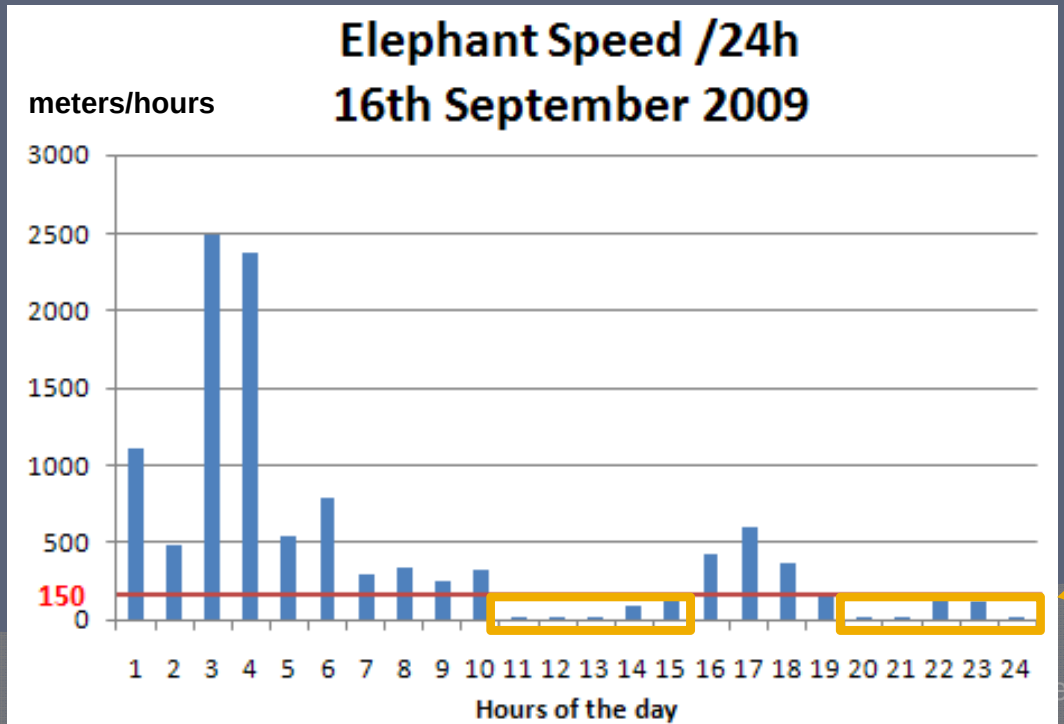

2 stops in the day:
-The 1rst of 5 hours
-The 2nd of 5 hours

Small movements are done during the stop

Identifying attractive areas

- 2 types:
  - Areas of close stations, called **Station Areas**. Activity = static.
  - Areas of close moves, called **Corridors**. Activity = dynamic.
- And we extract them from the trajectories

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  - Areas of close stations, called **Station Areas**
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  - Areas of close
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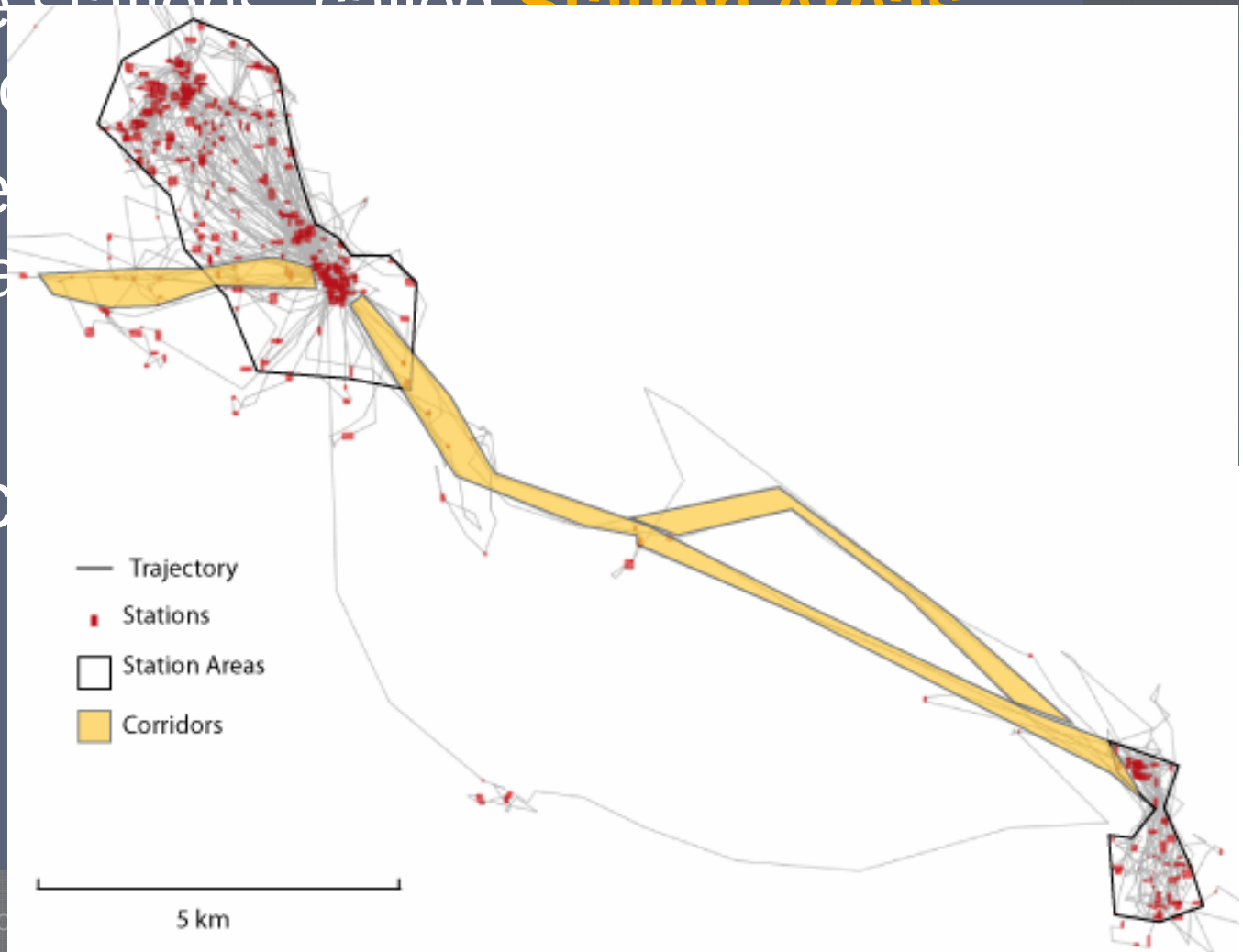


Why 2D representation is not sufficient ?

- In 2D,
  - Time is not displayed, only space
- Trajectories and attractive areas are only calculated by duration and moment.
- How to analyze:
  - Frequency of trajectory?
  - Order of trajectories?

Objectives for a better visualization to study animals trajectories

- What are animals doing when they stop?
  - Duration
  - Geographical context
- What is the rhythm and the typical sequences ?
  - Rhythm of moves between stations
  - Sequences of stations

Proposed method

2D

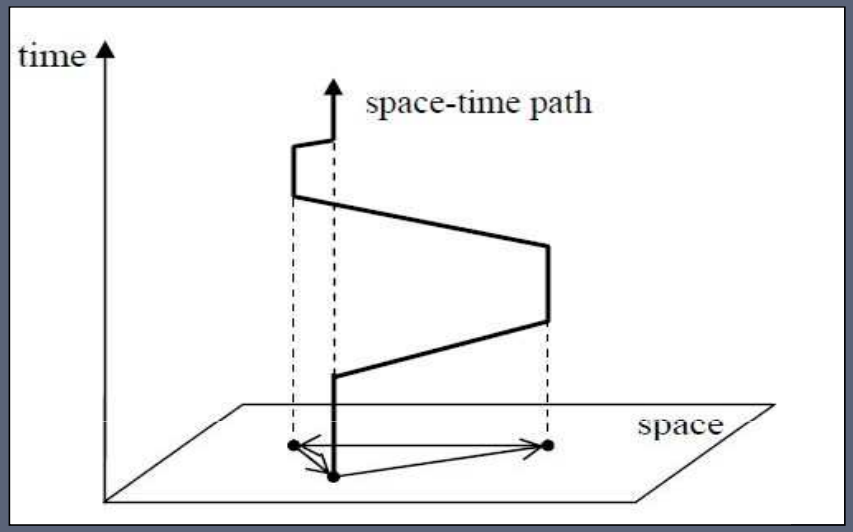
- From trajectories of herbivores groups
  - Re-Building trajectories: movement and stations, activities
  - Identifying attractive areas

3D

- Visual interpretation of attractive areas
  - Detecting time-patterns
  - Detecting animal collocation (temporal or spatial)

3D trajectories

- Time Geography: space-time path of a trajectory (Hägerstrand 1970)



Space : (X,Y)
Time: Z

- Others: Kraak (2003;2006), Li (2010), Peuquet (2002)…

3D trajectories

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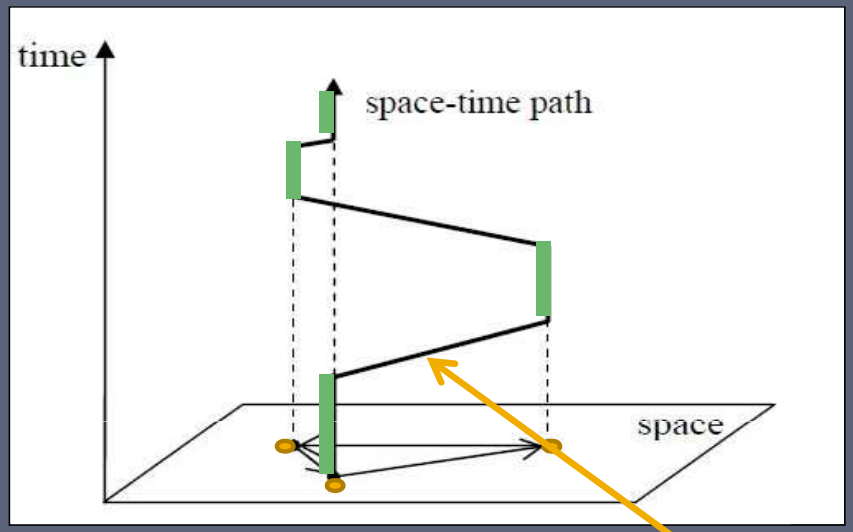


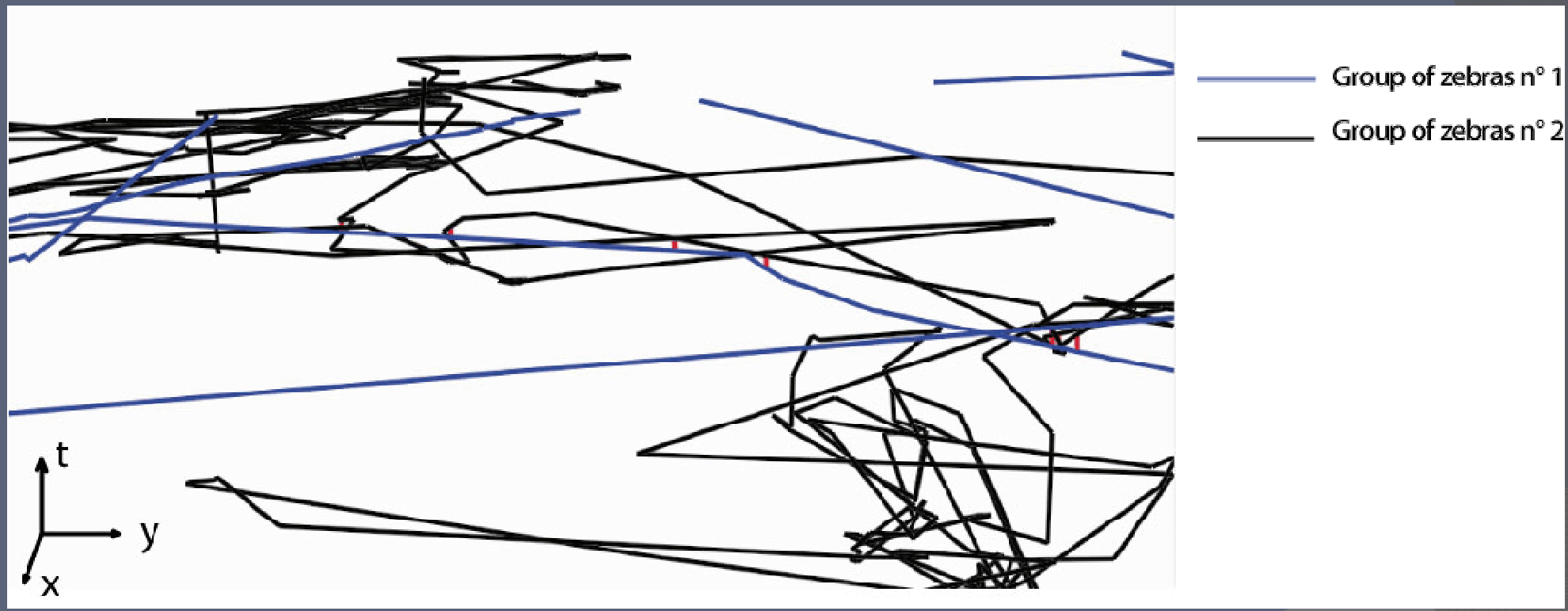
Stops

Stations

Speed of moves
(slope of segment)

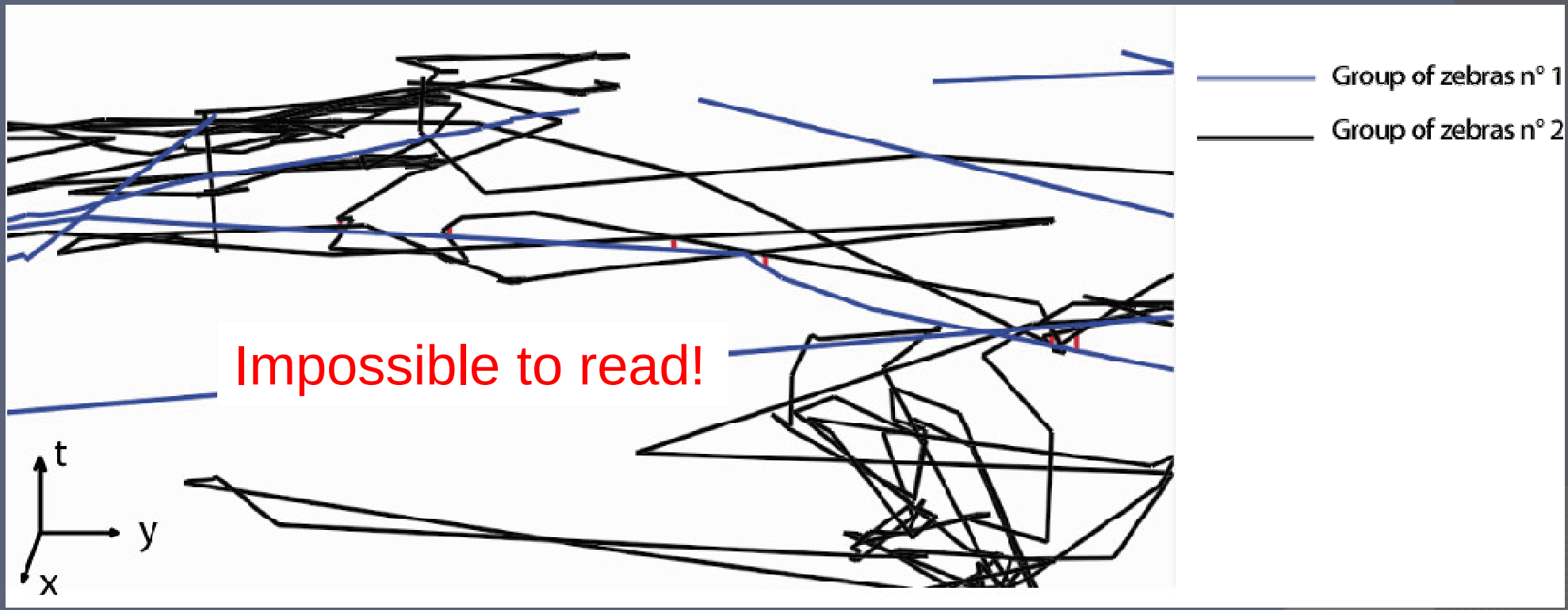
3D time representation

- Apply roughly a ST path on animal trajectories….



3D time representation

- Apply roughly a ST path on animal trajectories….



Small moves disrupt regularity of larger moves
=> impression of random moves

3D time representation

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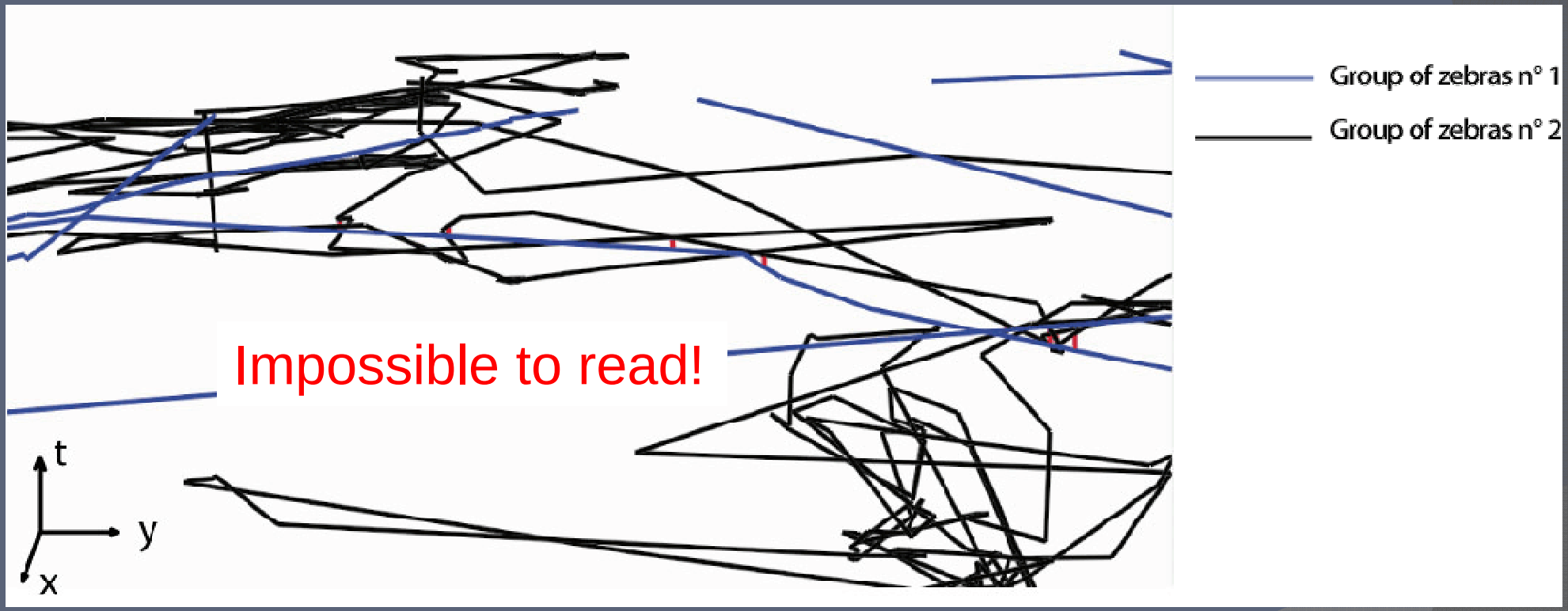

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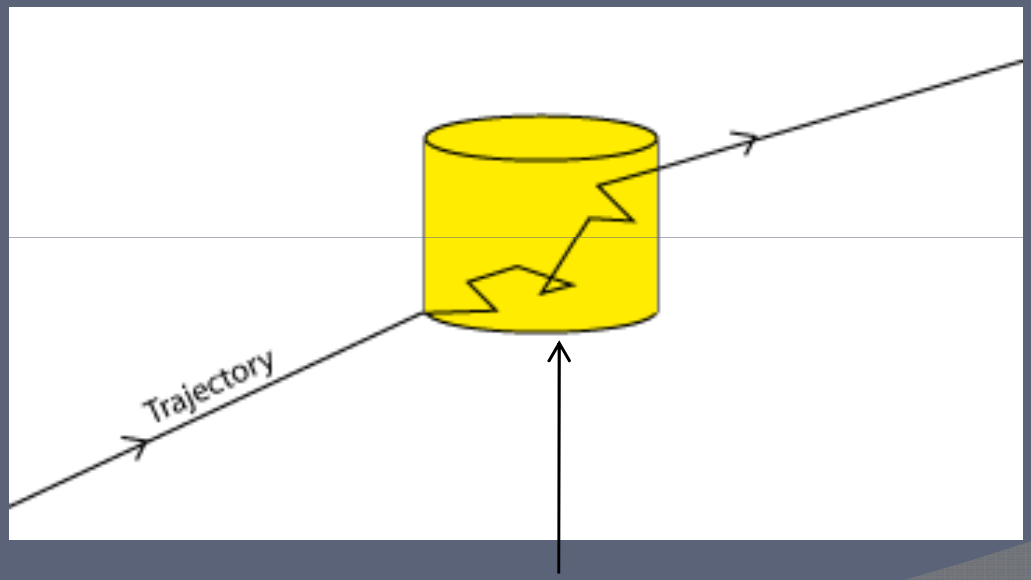
Visualization of trajectories needs
-To be organized (small/large moves)
-To represent concepts of stop/moves
-To integrate different time period

Organizing small and large moves

- Small moves are included in stops/stations
- Stop/station = new object in the 3D view
  - Cylinders



Color border indicates the group in function of its trajectory color
Here: black

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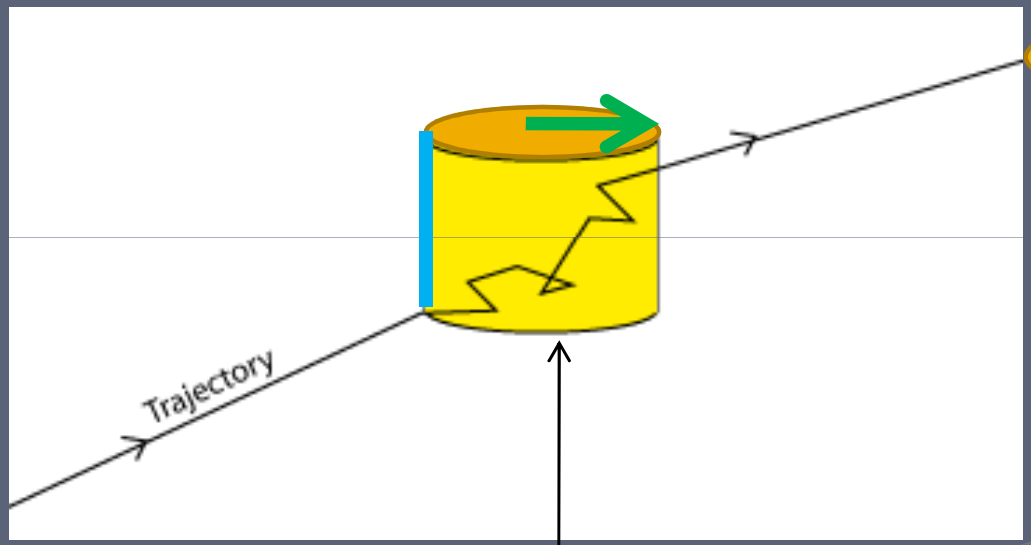

Station

Stop Duration In the station

Station radius = Spatial extend

Color border indicates the group in function of its trajectory color
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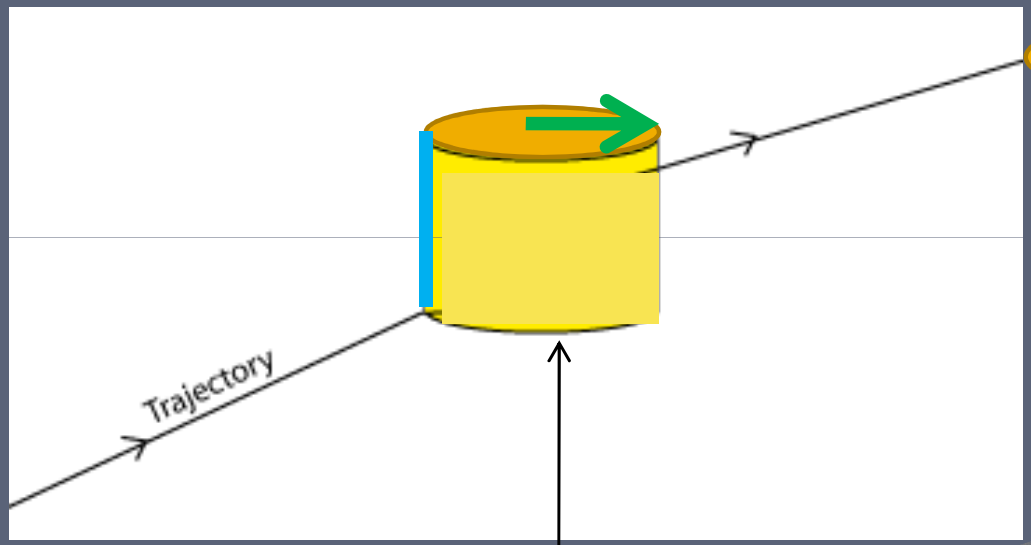
Organizing small and large moves

- Small moves are included in stops/stations
- Stop/station = new object in the 3D view
  - Cylinders
- Small moves are then removed from the view



Station

Stop Duration In the station

Station radius = Spatial extend

Color border indicates the group in function of its trajectory color
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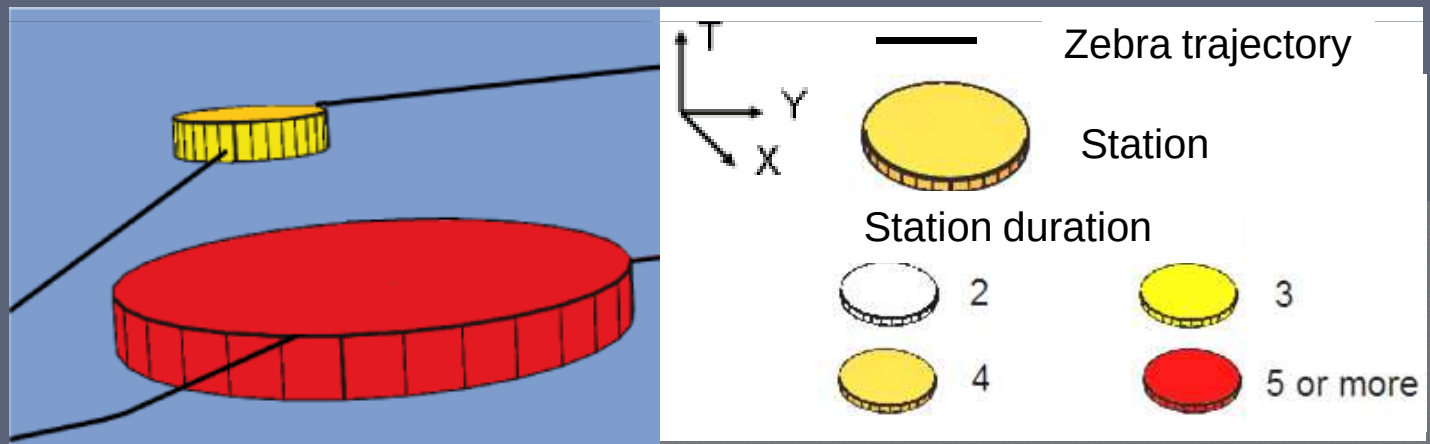
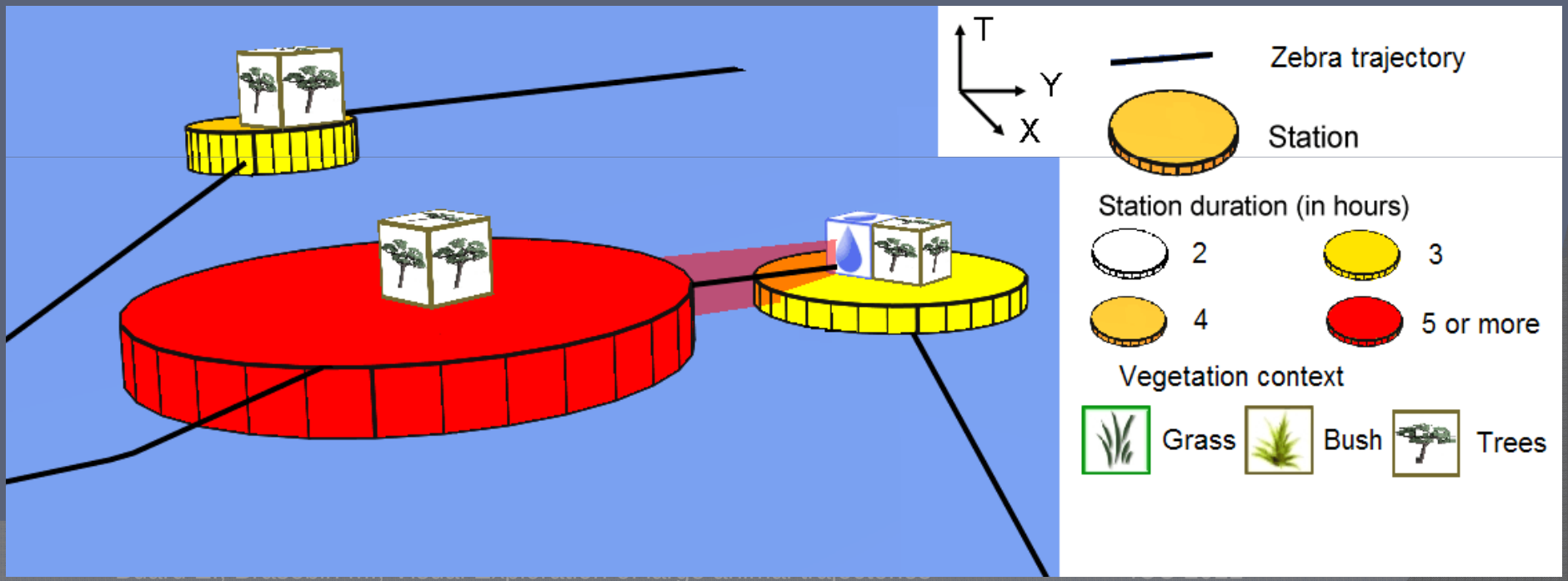
Station 3D visualization

- Problem: proportions difficult to evaluate by eyes
  - Duration (height)
  - Spatial extend (radius)
- Proposal: reinforce one of the proportions with color values. Here: height.



Station 3D visualization

- Give information about environment: at the stations
  - Cubes above the stations showing:
    - water drop = waterhole
    - Vegetation classified in 3 density levels: tree/bush/ grass



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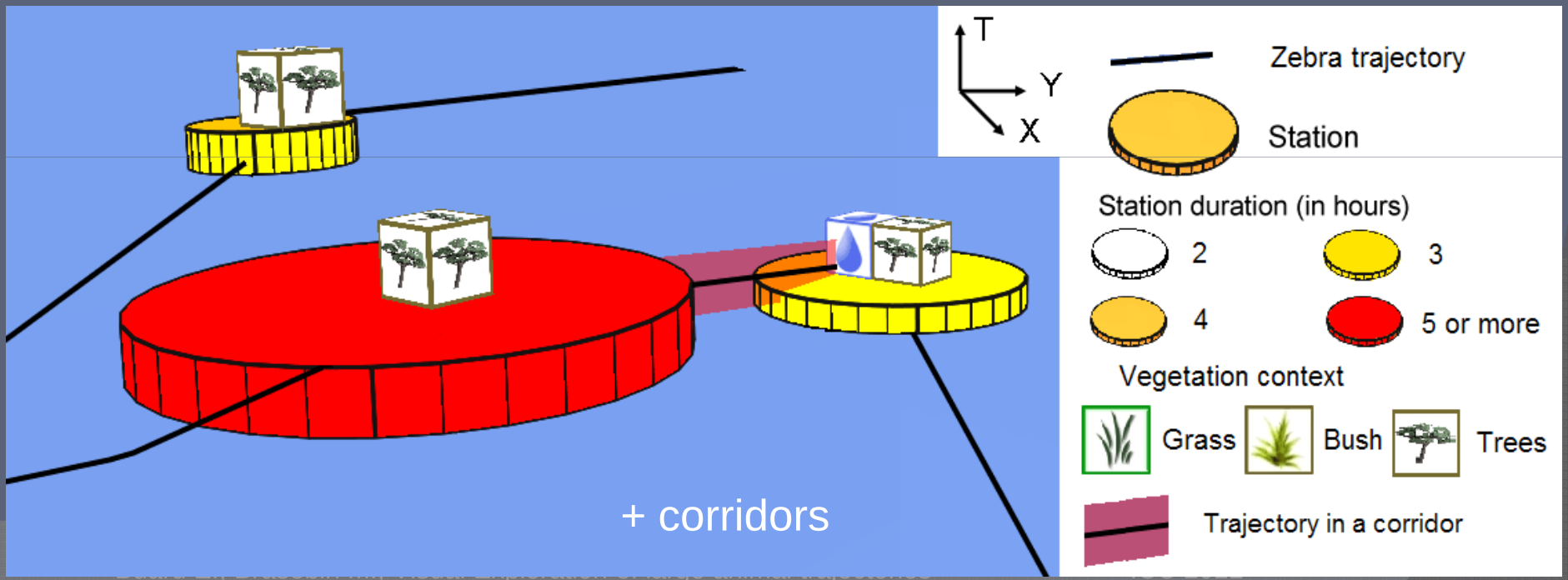
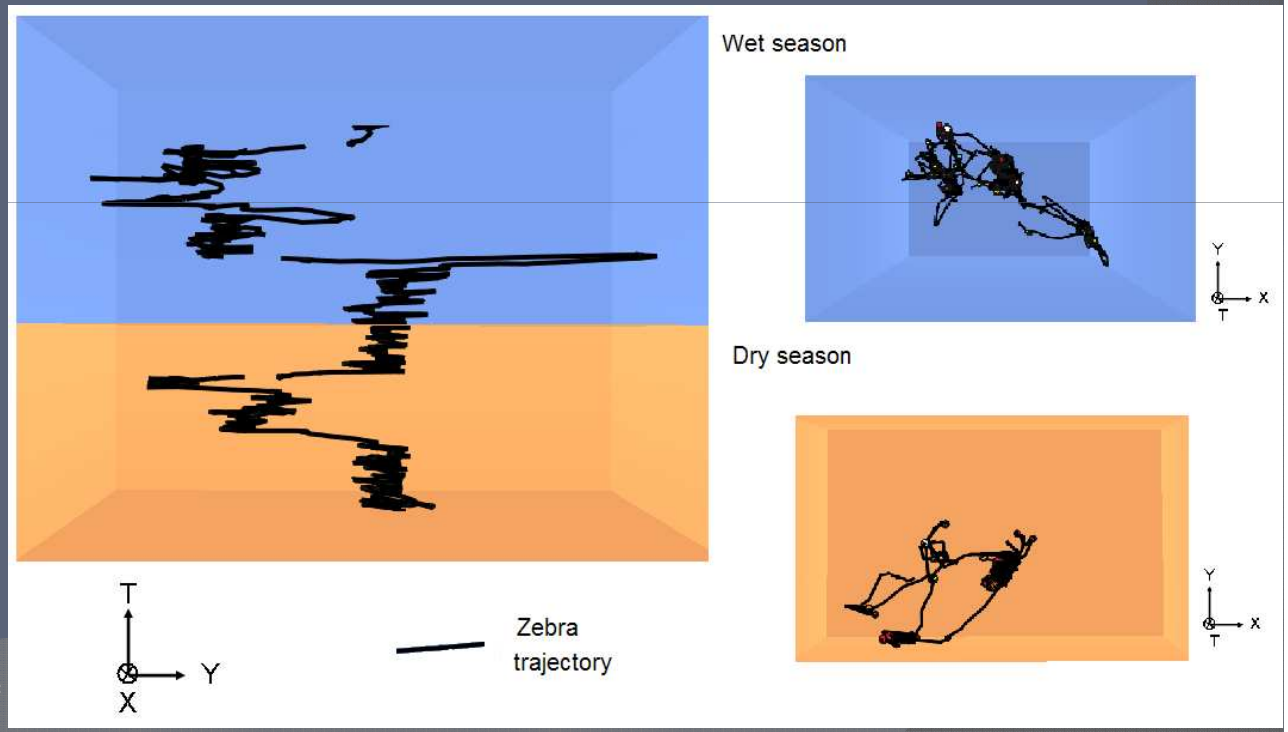


Adding a time Period

- Time period = background color
  - Relevant time intervals chosen by experts:
    - Day
    - Season
    - …



Adding a time Period

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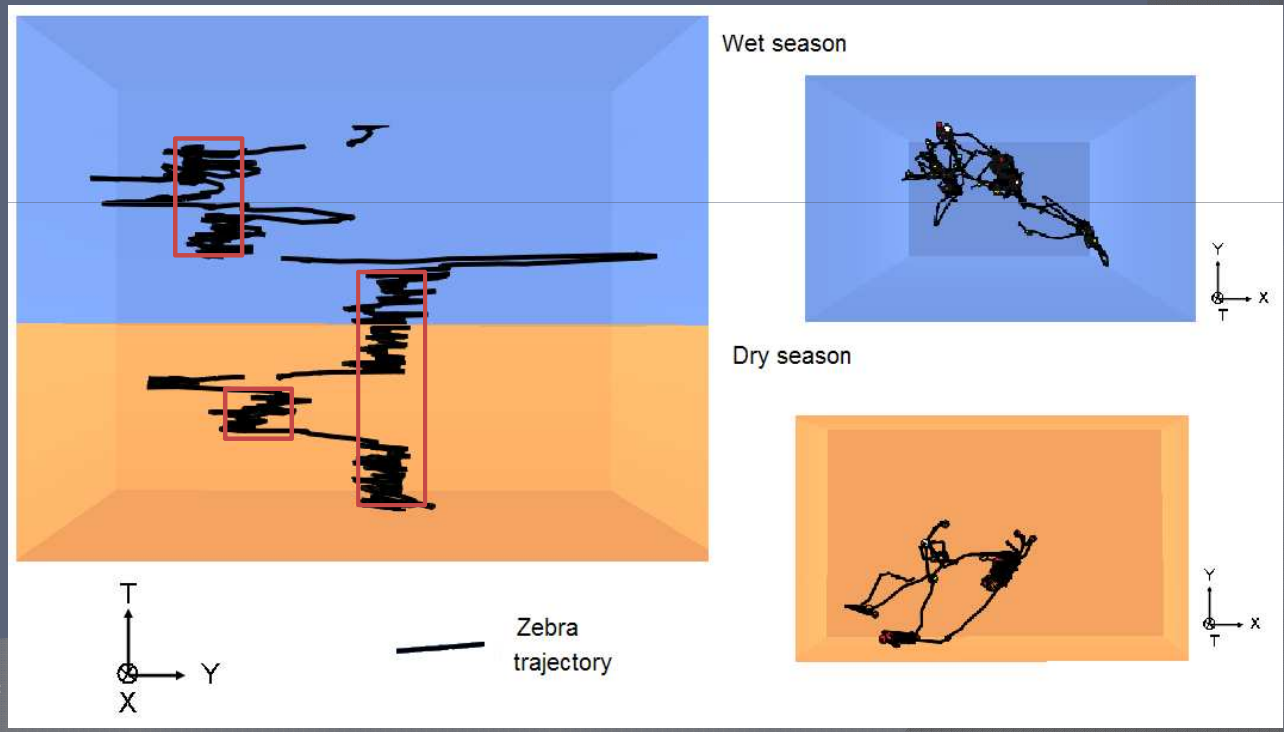
    - …

daily stations

macro stations



Advantages of 2D and 3D views

	+
2D view of trajectories	Thematic analysis: Attractive areas for large datasets: stations and corridors. Activities
3D view of trajectories	

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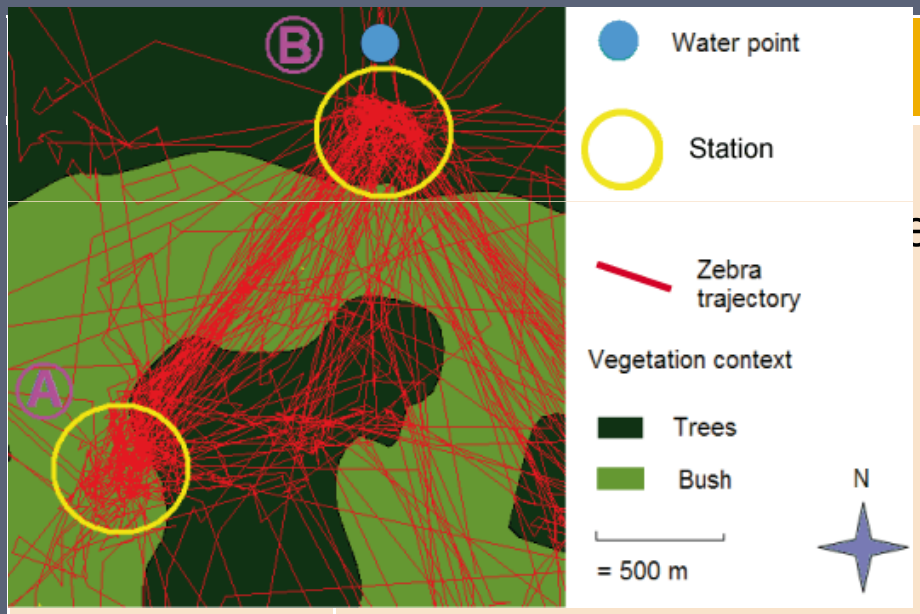
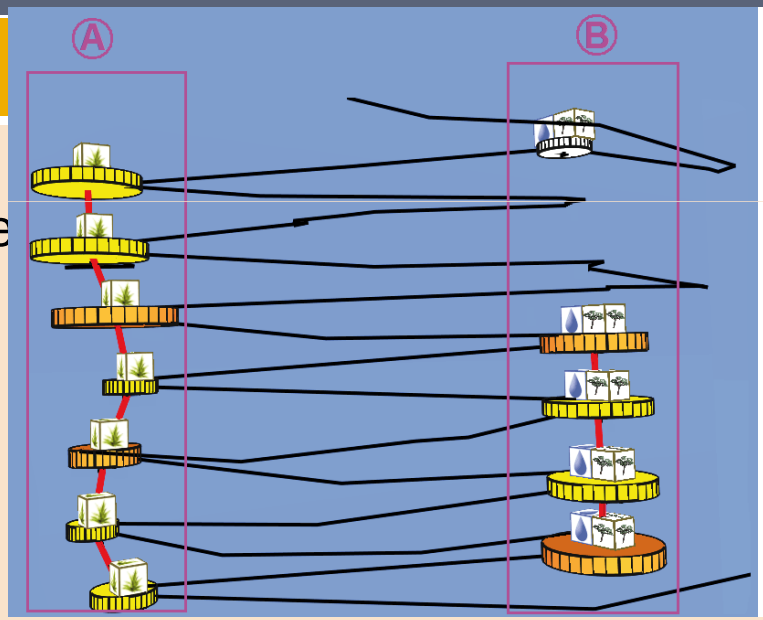
Advantages of 2D and 3D views

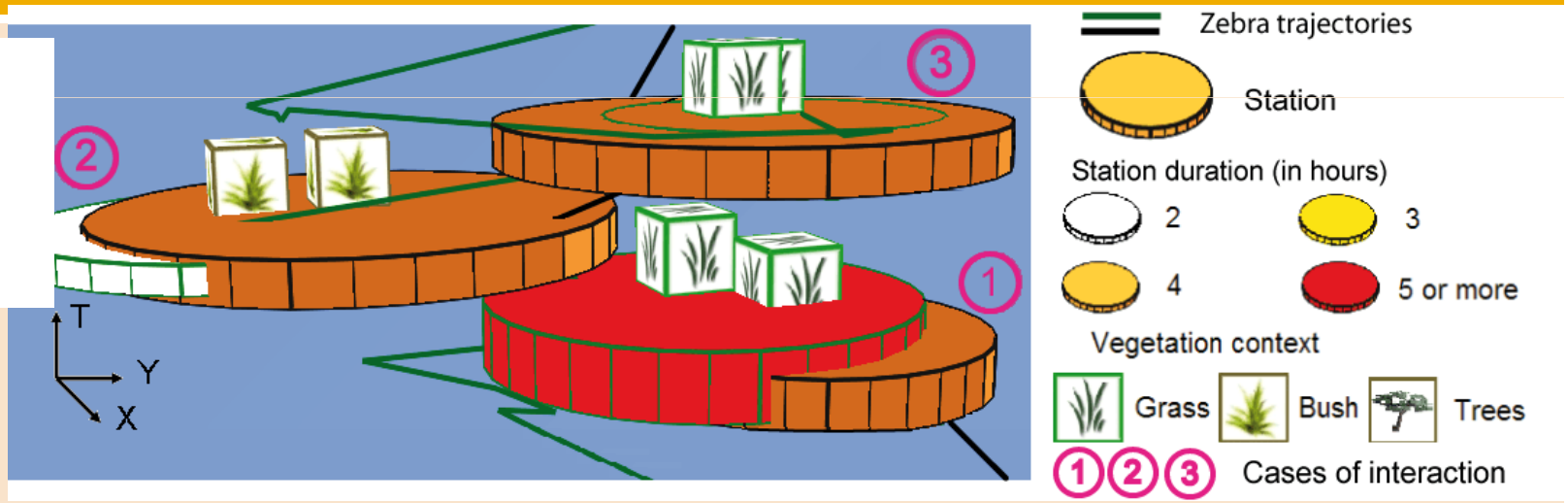




3D view of trajectories

<u>Temporal analysis:</u>
Frequency, Order, time interval, duration of stations

Advantages of 2D and 3D views

	+
The green group follows The black group	
3D view of trajectories	<u>Temporal analysis:</u> Frequency, Order, time interval, duration of stations <u>Interaction between several trajectories:</u> Simultaneous presence of animals

Advantages of 2D and 3D views

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2D view of trajectories	<u>Thematic analysis:</u> Attractive areas for large datasets: stations and corridors. Activities <u>Quantitative analysis:</u> Number of trajectories/area
3D view of trajectories	<u>Temporal analysis:</u> Frequency, Order, time interval, duration of stations <u>Interaction between several trajectories:</u> Simultaneous presence of animals + Space analysis: Fast link to topographic data

Conclusions

- Tools to explore trajectories: stations, corridors..
  - Include visualisation of topographic data
  - designed for the specialists to explore their own data

- Better understanding complex data :
  - Area of pressures (SPACE)
  - Hypothesis on animals activities (topographic data)
  - Duration and frequency (TIME)

  - To better study the pressure of animals on space

Further works

- Improve
  - Integration of various time scale (stations for e.g.)
  - 2D/3D interoperability
  - Add environment info on movements (not only on stations)
  - Studying cases of interactions between trajectories

Geovizualisation

- Study
  - Vegetation changes from satellite imagery

Spatial analysis

Thanks for your attention

For more information:
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