TimeNotes: A Study on Effective Chart Visualization and Interaction Techniques for Time-Series Data

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Outline

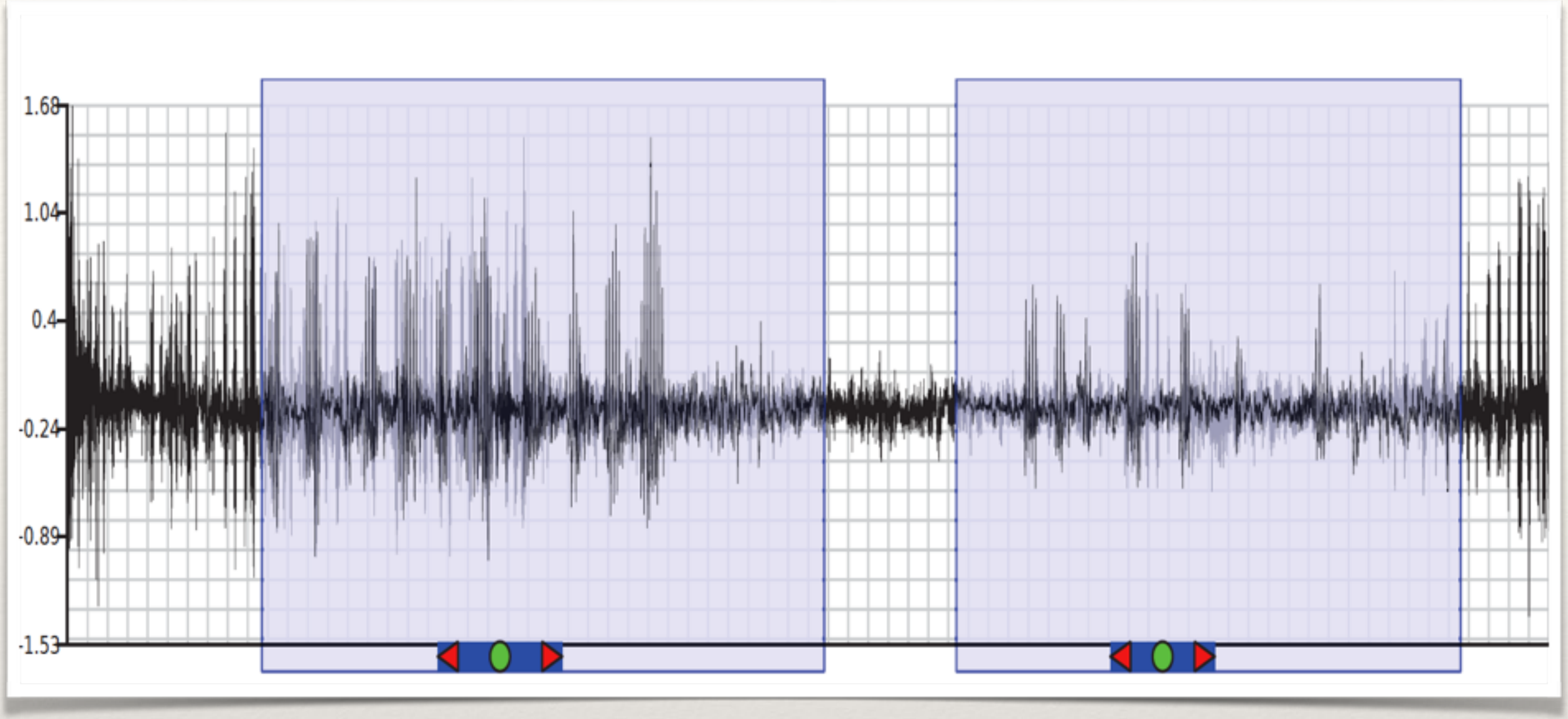
- Time-series Data
  - Chronolens, Stack Zoom
- Domain Situation
- Data
- Visual encoding (TimeNotes)
  - Layout, node manipulation, overlay, annotation
- User Study
- Advantages & Disadvantage

Time-series data

- One challenge is that screen resolution is small in comparison to data storage capacity.
- Over-plotting problem

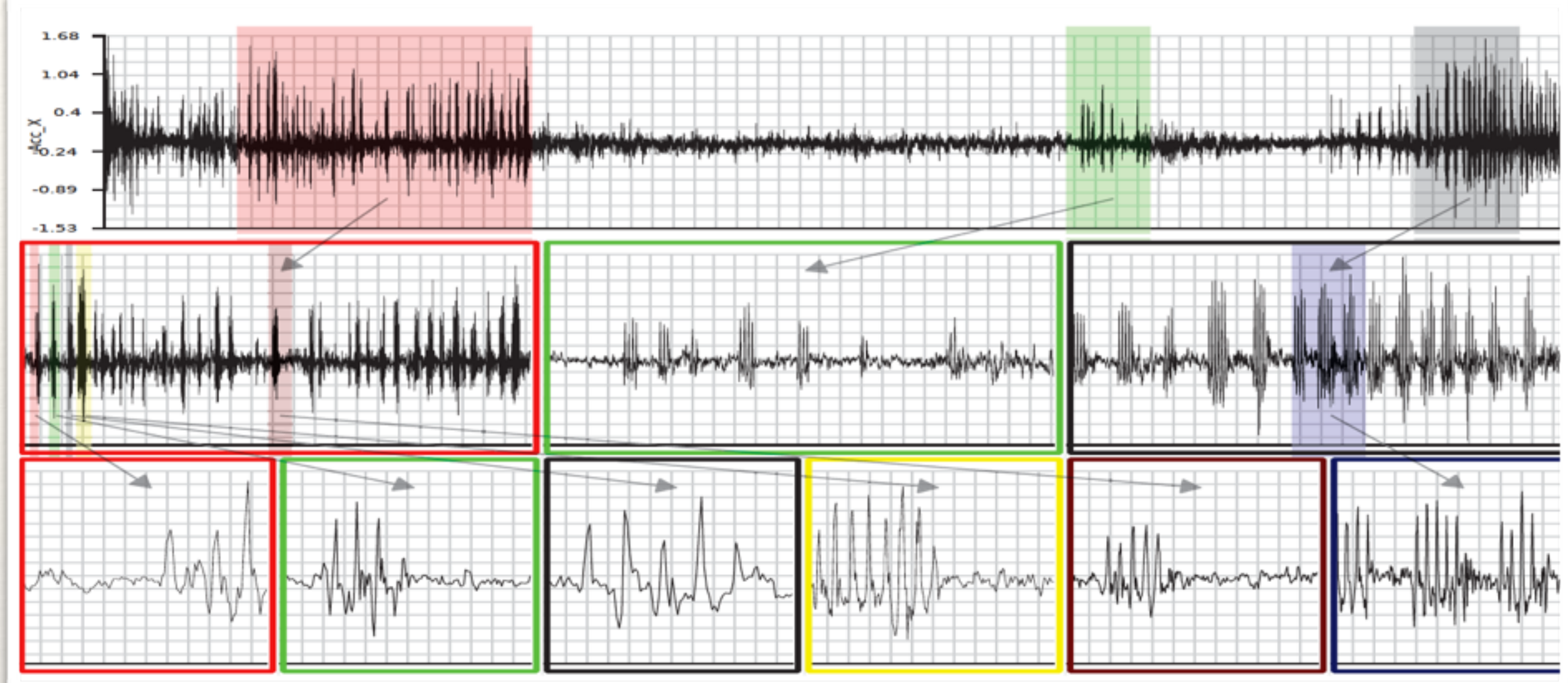
Navigating and communicating through a large data space is an important task. [1]

[1] J.T. Stasko. The value of visualization… and why interaction matters ,capstone speech, euro vis 2014, 2014.



ChronoLens

Chronolenses support more elaborate data analysis tasks, without the need to derive new time series visualizations.



Stack Zoom

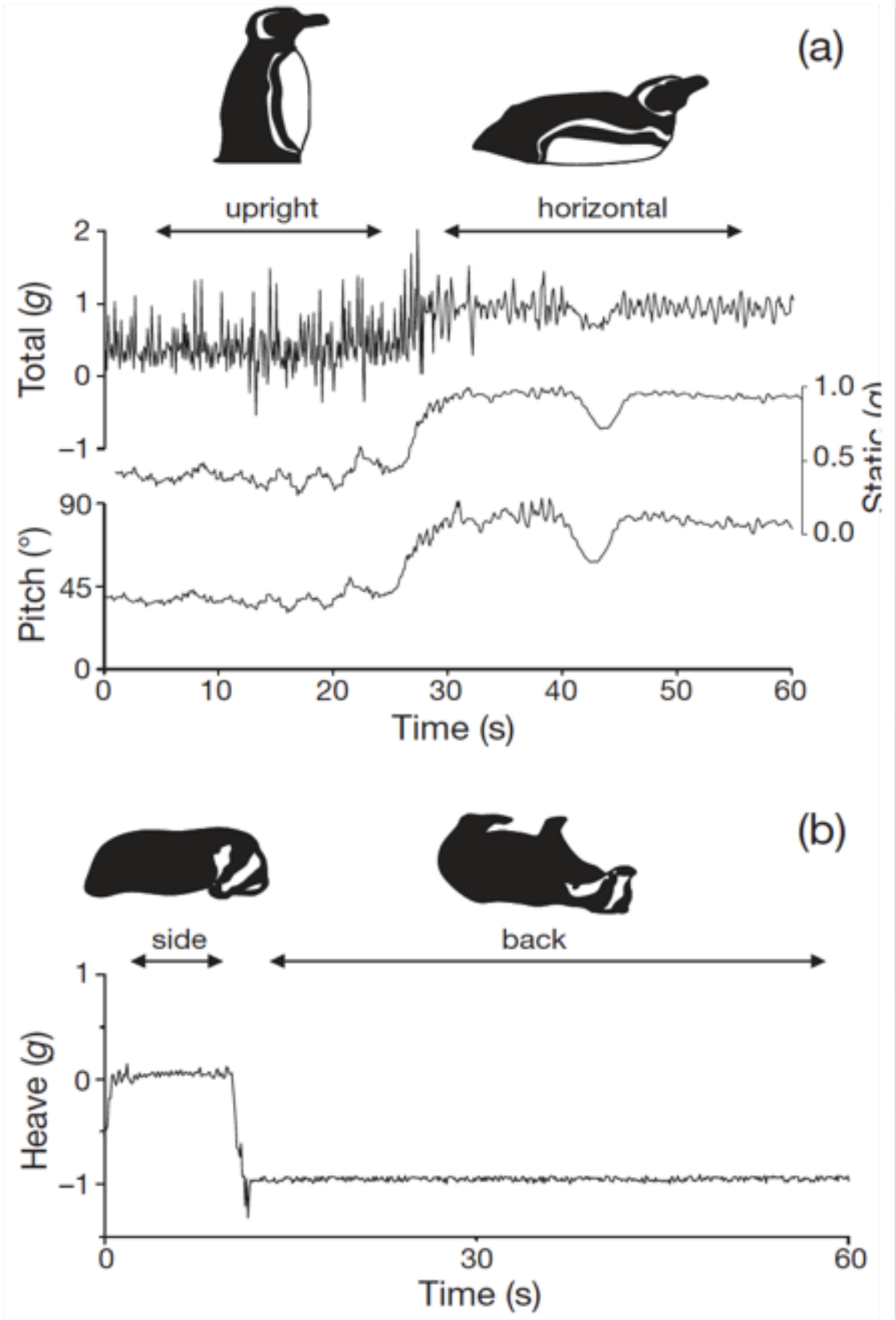
Multi-focus zooming maintains context and temporal distance whilst zooming.

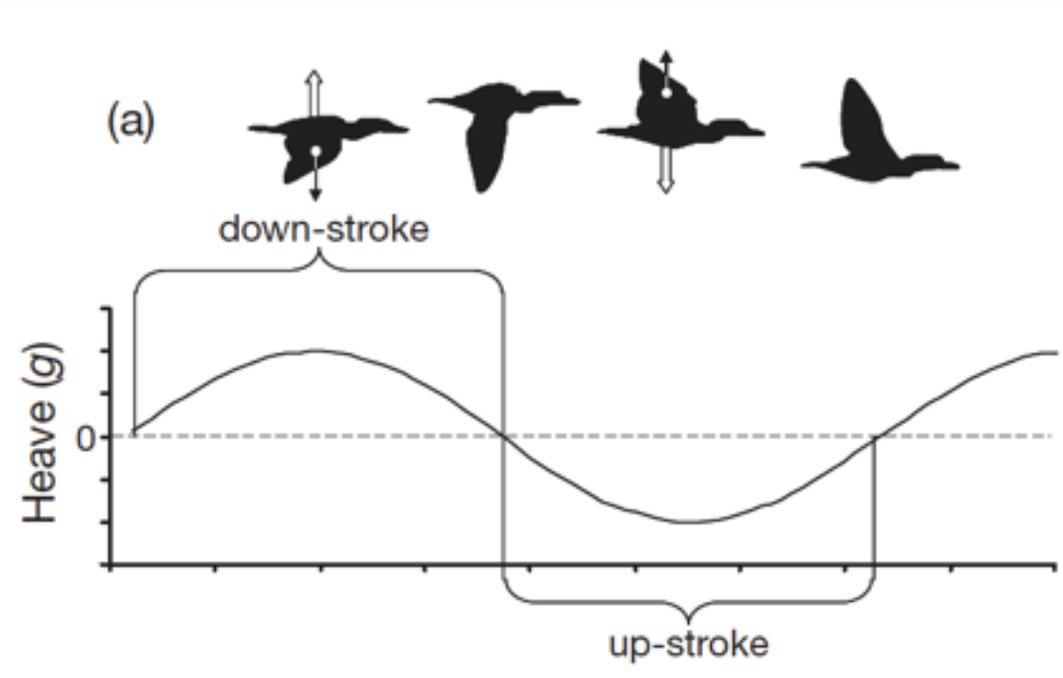
Domain Situation

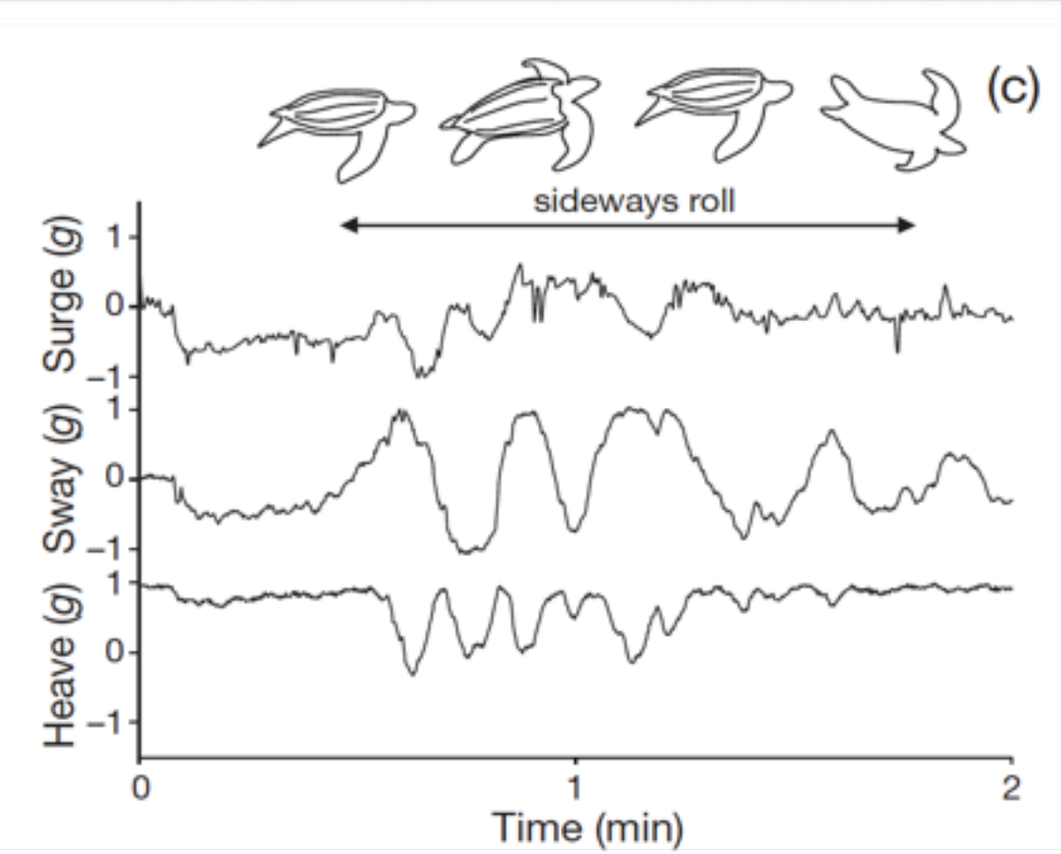
Movement ecologists need to explore time-series graphs of several attributes (acceleration, magnetic field intensity, pressure …) to gain an understanding of the mapping from signal to behavior. [1]

How to efficiently extract the signal of interest and annotate them when considering data recorded at a high-frequency over long periods of time?

[1] E.L.C.Shepardand L.G.Halsey. Identification of animal movement patterns using tri-axial accelerometry .*EndangeredSpeciesResearch*,10:47–60,2008.

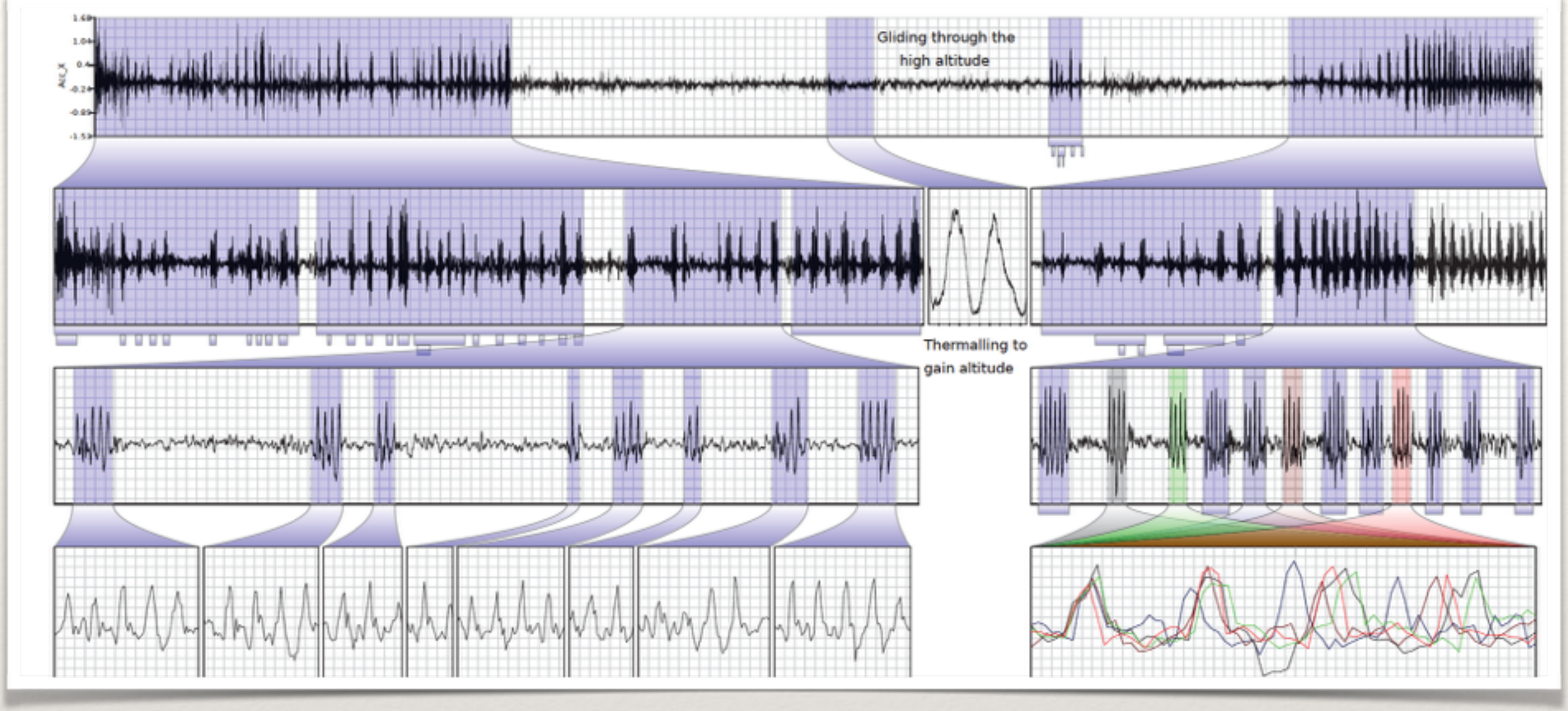

(a)
upright
horizontal
Total (g)
2
1
0
−1
1.0
0.5
0.0
Static (g)
Pitch (°)
90
45
0
0
10
20
30
40
50
60
Time (s)
(b)
side
back
Heave (g)
1
0
−1
0
30
60
Time (s)


(a)
down-stroke
Heave (g)
0
up-stroke


(c)
sideways roll
Surge (g)
Sway (g)
Heave (g)
1
0
−1
0
1
2
Time (min)

Data

15 minute (approximately) sub-section of remote animal monitoring data obtained from a deployment of a behavioral data collection tag on a Condor consisting of 34,746 data items.

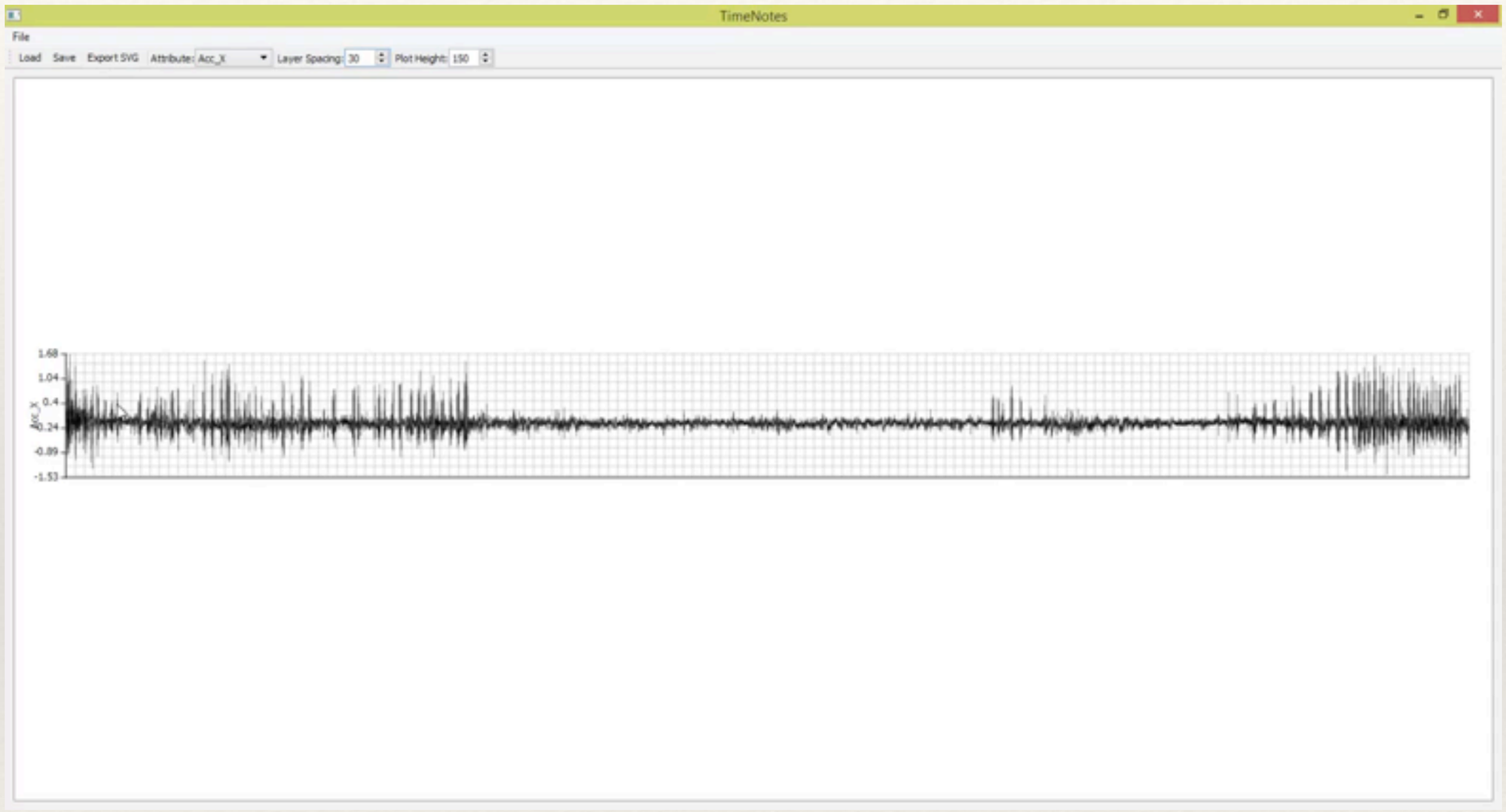


James Walker

Hierarchical zooming provides an efficient method of navigating through time-series by allowing the user to divide the information space and build a view of only the relevant data at the required granularity which also acts as an implicit graphical history of user actions.

TimeNotes

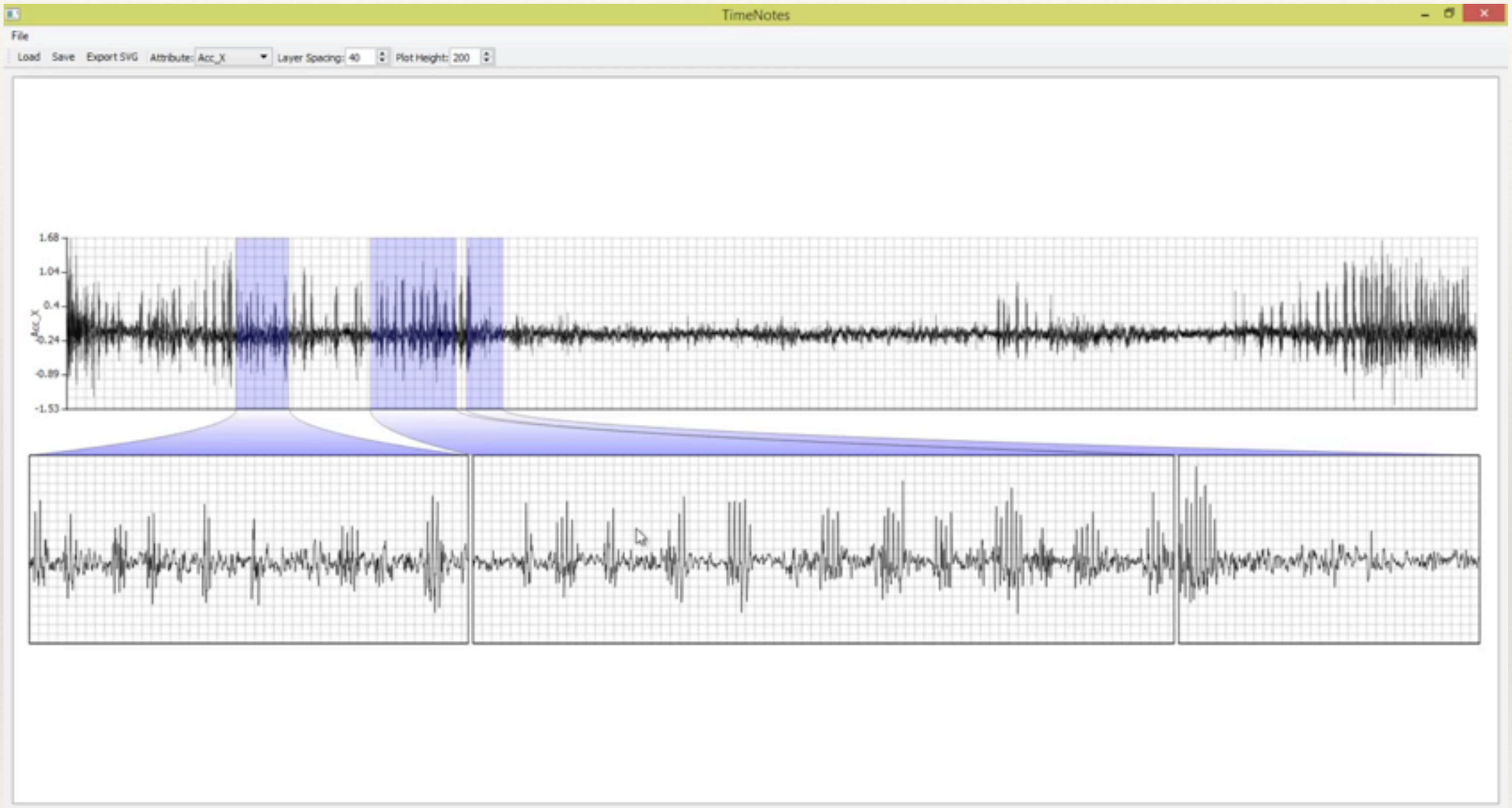
Encode - layout



TimeNotes utilizes a space filling node-link diagram to represent the hierarchical zoom structure.

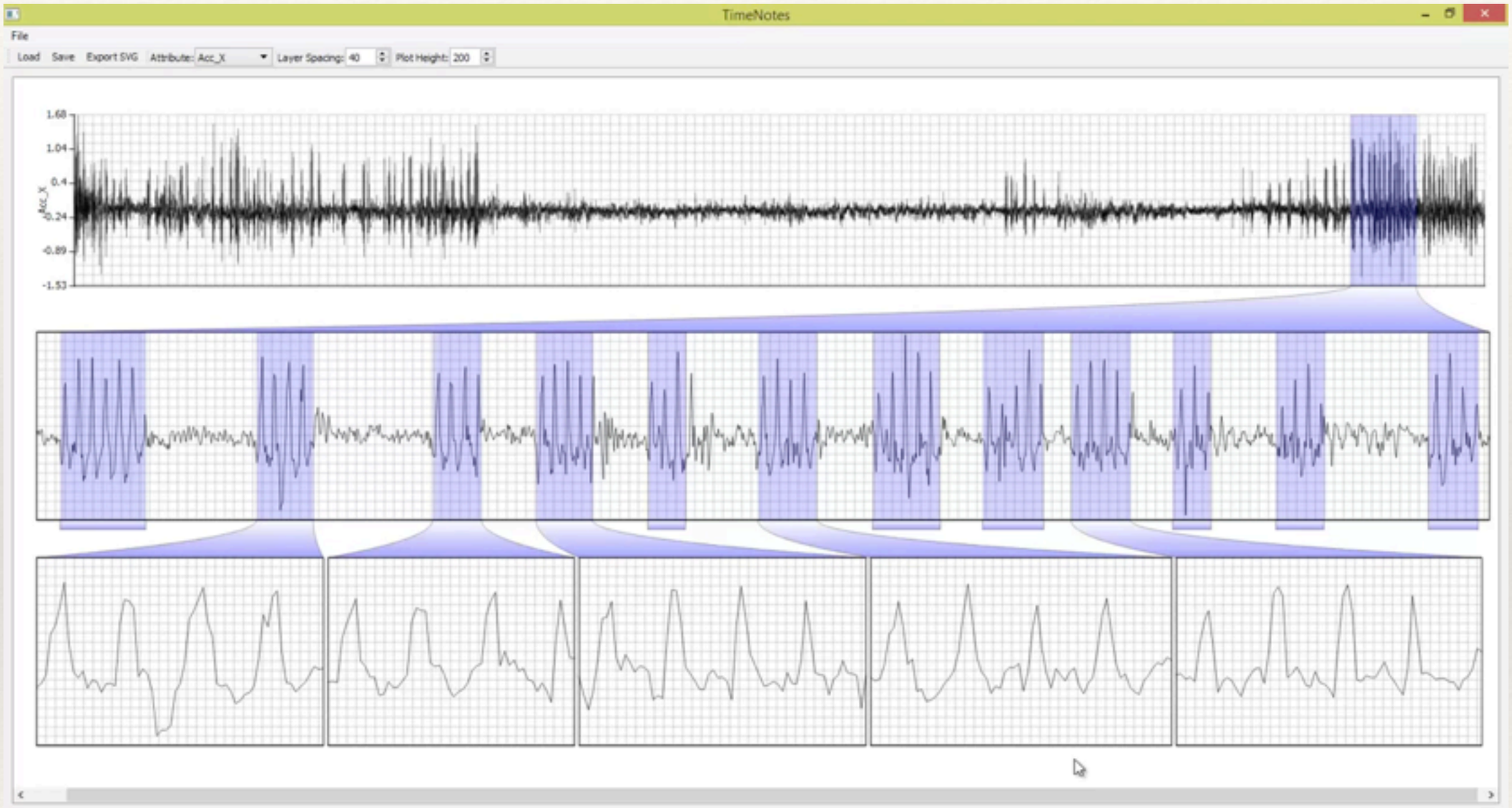
- Child node placed below its parent
- Allocation of display space proportional to the amount of data represented within that level
- Parent-child connection

Manipulate - node interaction and rendering



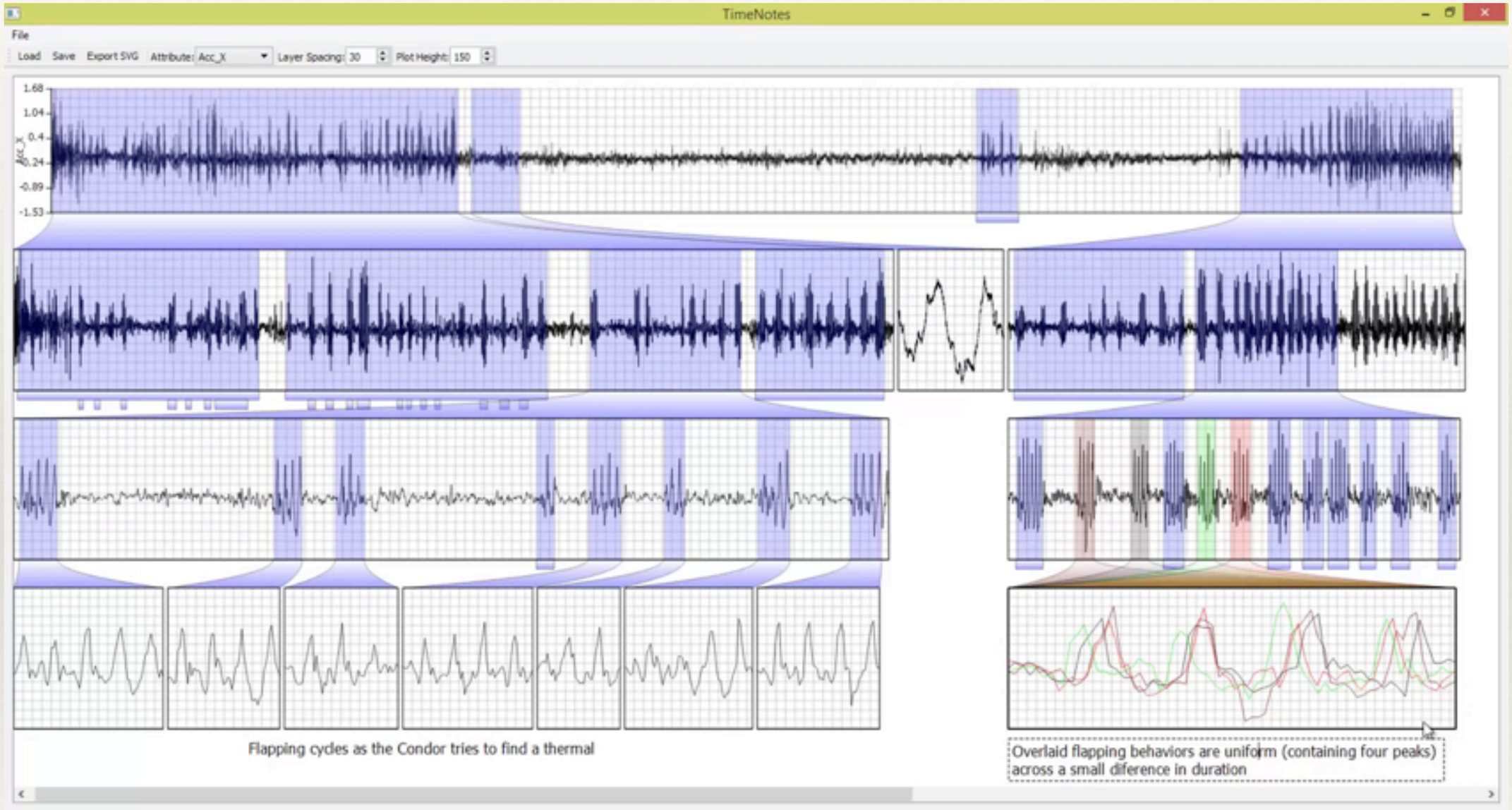
- Nodes can be resized and repositioned
- Panning updates for related children nodes
- Bookmark to represent the underlying data.

Facet: overlay



- Snapping nodes together overlays the nodes together for better comparison of signals.
- Connections are mapped into the overlay plot with unique colour.

Annotation

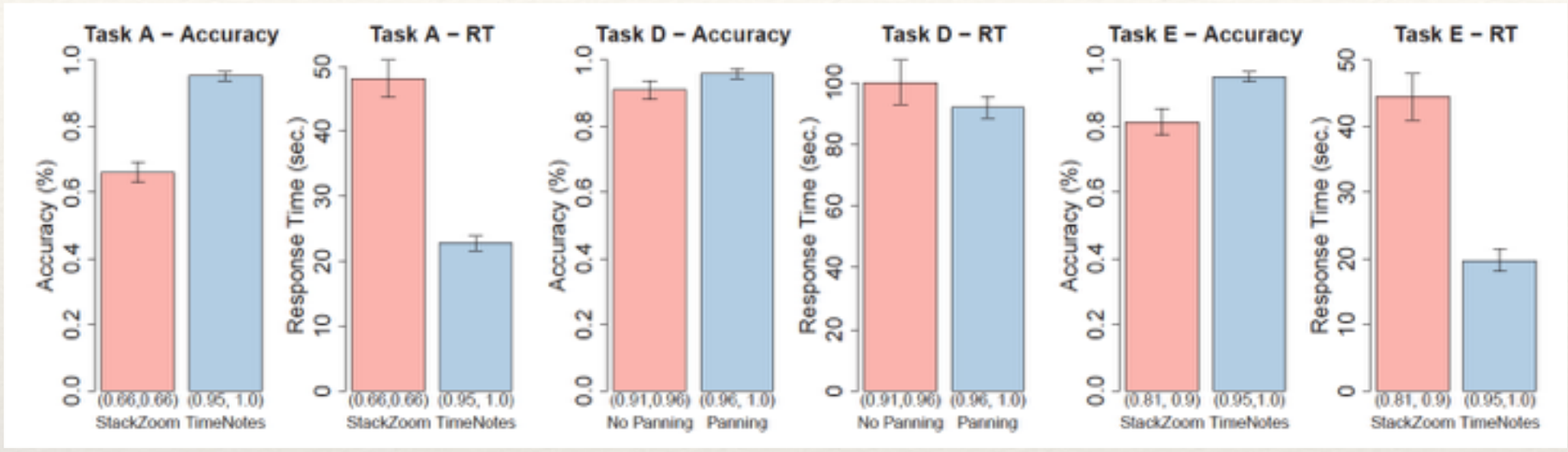


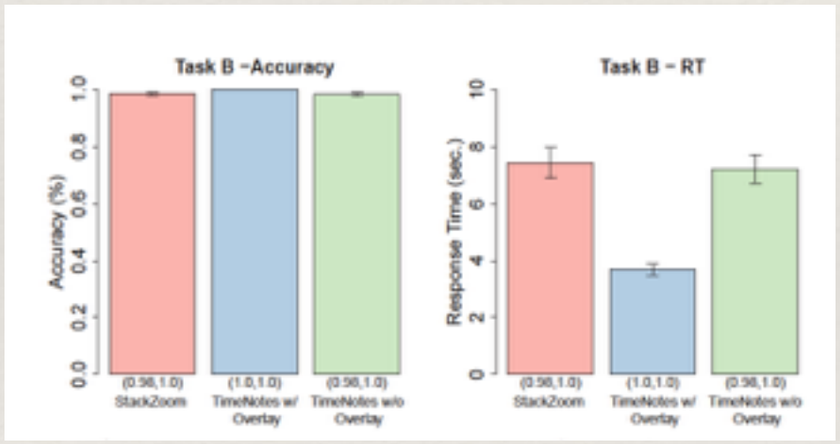
- Annotations be placed anywhere on the display space.
- Annotations move with the node and are hidden when a node is minimized.

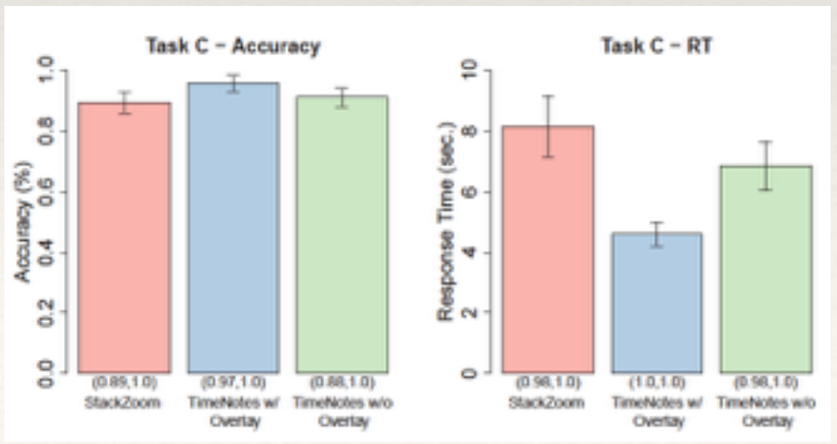
Visual encoding

System	TimeNotes
What: Data	Multidimensional table: multiple qualitative value attribute (signal data), one ordered key attribute (time)
What: Derived	Ordered position of sub-nodes
Why: Tasks	Overview of entire dataset, find patterns/behaviours, compare signals, keep history of actions,construct a presentation view
How: Encode	Space filling node-linked layout, line charts
How: Manipulate	Select patterns across the data-series, navigate with pan, hierarchial zooming, reorder, realign, animated transaction
How: Facet	Superimpose, distinguished with colour
Scale	Ordered key attribute: Ten thousands. qualitative value attribute: one or many

User study







A.Hierarchy Navigation（Leaf Counting）

B.Comparison（Amplitude）

C.Comparison（Frequency）

D.Hierarchy Navigation (Zoom/Pan and Labeling)

E.Hierarchy Navigation (Label Analysis)

Advantage & Disadvantage

- Provide detailed and flexible view for a specific variable dataset
- Hierarchical zooming helps solve the conflict of big data size and limited screen, compare and explore behaviour at different scales
- Bookmark, annotation and export operations help future reference

- Multivariate time-series data is hard to analyze
- Missing time axis
- Simple plot type
- Interval node cannot be hidden with its child node shown

Thanks!