IDMVis: Temporal Event Sequence Visualization for Type 1 Diabetes Treatment Decision Support

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Contributions
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• **IDMVis** – a temporal event sequence visualization tool to support diabetes treatment decision

• **Hierarchical Task Abstraction**
Contributions

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• **Hierarchical Task Abstraction**
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• **Hierarchical Task Abstraction**

Contributions
Imagine a 10-year-old kid, who has been diagnosed with type 1 diabetes...
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During a clinical visit ...
During a clinical visit ...
During a clinical visit ...
During a clinical visit ...
How to help diabetes clinicians make treatment decisions?

What are the tasks?
Hierarchical Task Analysis
Task analysis:

Task 1  Task 2  Task 3  Task 4
Task analysis:

Hierarchical

Ultimate Goal

Task 1

Task 1.1

Task 1.2

Task 2
Hierarchical Task Analysis  Task Abstraction  Design

Develop a treatment plan and educate patients
0. Develop a treatment plan and educate patients
0. Develop a treatment plan and educate patients

1. Collect and display the patient’s data
Hierarchical Task Analysis  

Increasing Task Specificity

0. Develop a treatment plan and educate patients

1. Collect and display the patient’s data

2. Overview the patient’s data
0. Develop a treatment plan and educate patients

1. Collect and display the patient’s data

2. Overview the patient’s data

3. Reason about patient blood glucose levels
0. Develop a treatment plan and educate patients

1. Collect and display the patient’s data
2. Overview the patient’s data
3. Reason about patient blood glucose levels
4. Educate patients and caregivers
0. Develop a treatment plan and educate patients

1. Collect and display the patient’s data
2. Overview the patient’s data
3. Reason about patient blood glucose levels
4. Educate patients and caregivers
5. Make a treatment plan
0. Develop a treatment plan and educate patients

1. Collect and display the patient’s data

2. Overview the patient’s data

3. Reason about patient blood glucose levels
   3.1 Examine post-event glucose level

4. Educate patients and caregivers

5. Make a treatment plan
0. Develop a treatment plan and educate patients

1. Collect and display the patient’s data
2. Overview the patient’s data
3. Reason about patient blood glucose levels
   3.1 Examine post-event glucose level
   3.2 Examine the interplay between events
4. Educate patients and caregivers
5. Make a treatment plan
0. Develop a treatment plan and educate patients

1. Collect and display the patient’s data
2. Overview the patient’s data
3. Reason about patient blood glucose levels
   - 3.1 Examine post-event glucose level
   - 3.2 Examine the interplay between events
4. Educate patients and caregivers
5. Make a treatment plan
3.1 Examine post-event glucose level
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Examine related data to understand observation
Design Requirements
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• DR1. Composite Visualization of Integrated Data
Design Requirements

• DR1. Composite Visualization of Integrated Data
• DR2. Visualization of Folded Temporal Data
Design Requirements

- DR1. Composite Visualization of Integrated Data
- DR2. Visualization of Folded Temporal Data
- DR3. **Align and Scale** Temporal Data
Design Requirements

• DR1. Composite Visualization of Integrated Data
• DR2. Visualization of Folded Temporal Data
• DR3. **Align and Scale** Temporal Data
• DR4. **Summary** Statistics
Design of IDMVis
14-Day Overview

Use small multiples to partition data folded by days
14-Day Overview
Hierarchical Task Analysis  
Task Abstraction  
Design

Events from **logbooks** with blood glucose readings

Glucose Meter
Hierarchical Task Analysis

Task Abstraction

Design

Events from **logbooks** with blood glucose readings

Glucose Meter

Continuous Glucose Monitor (CGM)

Glucose Meter

Continuous Glucose Monitor (CGM)
Hierarchical Task Analysis

Task Abstraction

Design

Events from logbooks with blood glucose readings

Glucose Meter

Continuous Glucose Monitor (CGM)

below range (<70 mg/dL)

normal range (70-180 mg/dL)

above range (>180 mg/dL)
Events from logbooks with blood glucose readings

- CGM normal range (70-180 mg/dL)
- CGM above range (>180 mg/dL)
- CGM below range (<70 mg/dL)
A pattern of high blood glucose after lunch shown by purple circles.
Single-event alignment → A pattern of high blood glucose after lunch shown by purple circles

3.1 Examine post-event glucose level
3.1 Examine post-event glucose level
3. Reason about patient blood glucose levels

3.1 Examine post-event glucose level

Zoom-in window to show event details
Dual-event alignment

Events from logbooks with blood glucose readings

- CGM normal range (70-180 mg/dL)
- CGM above range (>180 mg/dL)
- CGM below range (<70 mg/dL)
Events from logbooks with blood glucose readings

- CGM normal range (70-180 mg/dL)
- CGM above range (>180 mg/dL)
- CGM below range (<70 mg/dL)
Dual-event alignment

Events from logbooks with blood glucose readings:
- CGM normal range (70-180 mg/dL)
- CGM above range (>180 mg/dL)
- CGM below range (<70 mg/dL)
Qualitative Study
Participants

Certified diabetes educators (CDEs)

Dietitians
Participants

Certified diabetes educators (CDEs)

Average years of work experience: 17.2 years

Dietitians
Methodology

Day-by-meal table

Exploration using IDMVis

Semi-structured interviews
Results
Superimposed detail view helps identify issues of data quality (e.g., missing or conflicting data)

So sugar-to-treat [blood glucose] should have gone up from here, not down. It went down. Kept going down. Sugar to treat should be here, before this curve comes back up. That’s my concern. It’s missing something here.
Sentinel event alignment allows exploration of event sequence relationships
Sentinel event alignment allows exploration of event sequence relationships

• Use **single-event** alignment to look for event consistency
Sentinel event alignment allows exploration of event sequence relationships

- Use **single-event** alignment to look for event consistency
- Use **dual-event** alignment to examine variability of patterns
"I like being able to see how you could separate and see between the length, the time between meals... You can’t tell them to eat three times a day at the same time. So it’s just sort of helpful to see the variability... It would help you plan for it in the fact that you might reduce his basal based on the fact that he’s an erratic eater."
Conclusion
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• IDMVis – a temporal event sequence visualization
  • Novel techniques for temporal folding
  • Aligning by dual sentinel events & scaling the intermediate timeline
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  • Novel techniques for temporal folding
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• Hierarchical task abstraction
For more information, please visit bit.ly/IDMVis

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