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



Yixuan (Janice) Zhang



Kartik Chanana





<< >>	From 08/	23/2017	То	09/05/ 2017	1	st Align Ev	ent 🔻	2nd Align	Event -			Visualization Day By Meal About
2017-08-23 0:00	1 2:00	l 4:00	6:00 B	l l 10:00 10:00	12:00	1 14:00	16:00	1 18:00	1 20:00	22:00	24	T 20.0 T 20.0
				I I 3:00 10:00								75% 9.1 75% 7.9
0:00	2:00	4:00	6:00 8	l l 3:00 10:00	12:00	14:00	16:00	18:00	20:00	22:00	24	median 5.8 median 7.5
2017-08-26	l 2:00	I 4:00		::00 10:00	12:00	14:00	I 16:00	18:00	20:00	22:00	24	25% 1, 3,9 25% 6,3
				I I 3:00 10:00								
0.00	2.00	4.00	0.00 0	:00 10:00	12.00	14.00	10.00	18.00	20.00	22.00	24	Basal Bolus
				B:00 10:00								Basal and Bolus (u)
0:00	2:00	4:00	6:00 8	10:00 10:00	12:00	14:00	16:00	18:00	20:00	22:00	24	
0:00	2:00	4:00	6:00 8	10:00	12:00	14:00	16:00	18:00	20:00	22:00	24	75% 1.4 75% 1.6 75% 0.9
				I I 9:00 10:00								median 1.1 median 1.3 median 1.6 median 0.8
				10:00 10:00								25% H 0.9 25% H 1.1 25% - 1.0 25% H 0.6
				i:00 10:00								Lo.0 Lo.0 Lo.0 Lo.0 Lo.0 Lo.0 Lo.0 Lo.0
0:00	2:00	4:00	6:00 8	10:00	12:00	14:00	16:00	18:00	20:00	22:00	24	Insulin (u)
400 g mg/dL	2:00	4:00	6:00 8	8:00 10:00	12:00	14:00	16:00	18:00	20:00	22:00	24	
^{350 –} 300 – 201							A		_			75% 31.8 75% 50.5 75% 66.8 75% 8.3 75% 35.8
250 - 200 - 150 -			Breakfast	\sim				New				median 29.0 median 43.0 median 49.5 median 6.0 median 28.5
100 -				Sugar to treat					Sugar to treat	\sim	\uparrow	
0	2 4	6	8	10	12	14	16	18		22	24	Breakfast Lunch Dinner SugarTreat Bedtime

- **IDMVis** a temporal event sequence visualization tool to support diabetes treatment decision
- Hierarchical Task Abstraction

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Hierarchical Task Analysis

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- Hierarchical Task Abstraction

Hierarchical Task Analysis > Task Abstraction

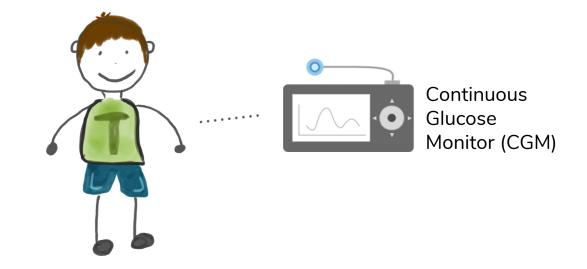
- **IDMVis** a temporal event sequence visualization tool to support diabetes treatment decision
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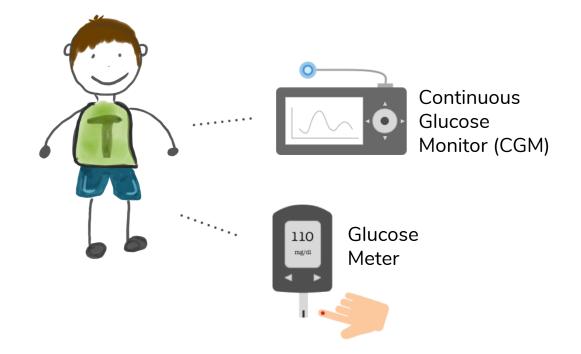
Hierarchical Task Analysis

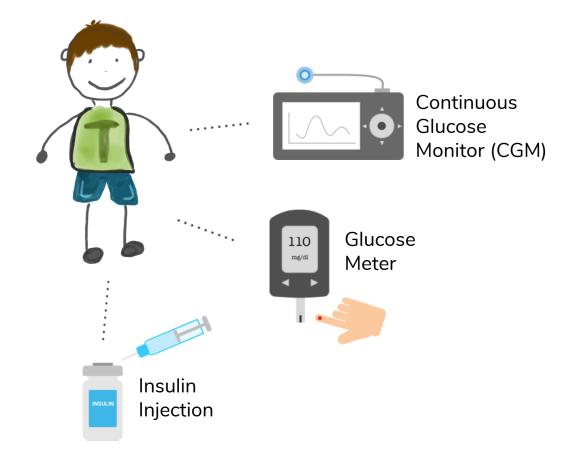
Task Abstraction

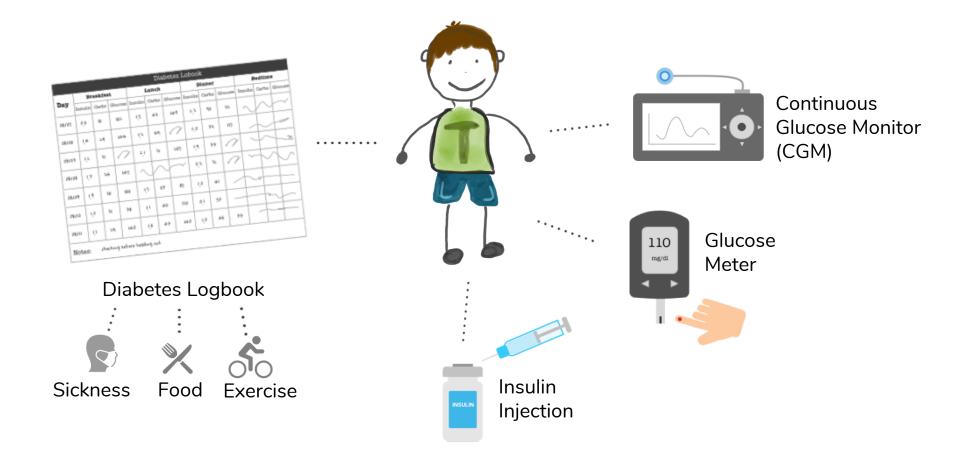
Design



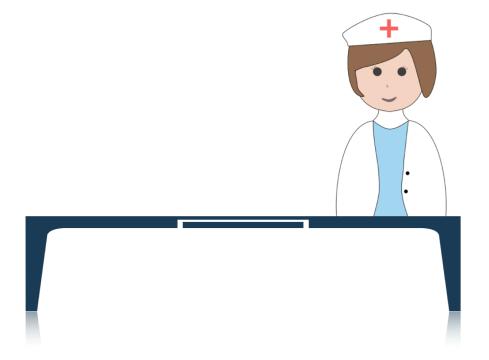




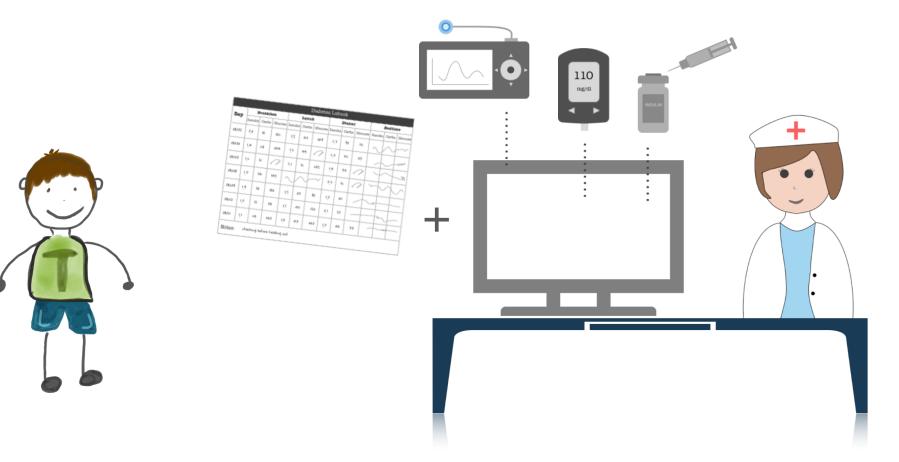














How to help diabetes clinicians make treatment decisions?

What are the **tasks**?

Hierarchical Task Analysis



Task analysis:

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Task Abstraction



Ultimate Goal Task analysis: **Hierarchical** Task 1 Task 2 Task 1.2 Task 1.1





Develop a treatment plan and educate patients

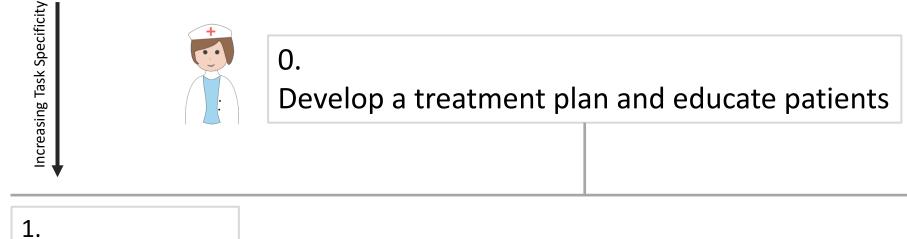




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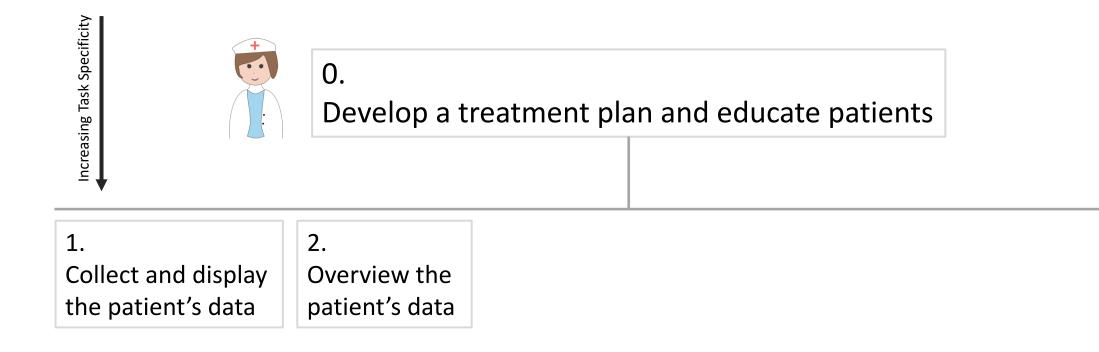
Develop a treatment plan and educate patients





Collect and display the patient's data

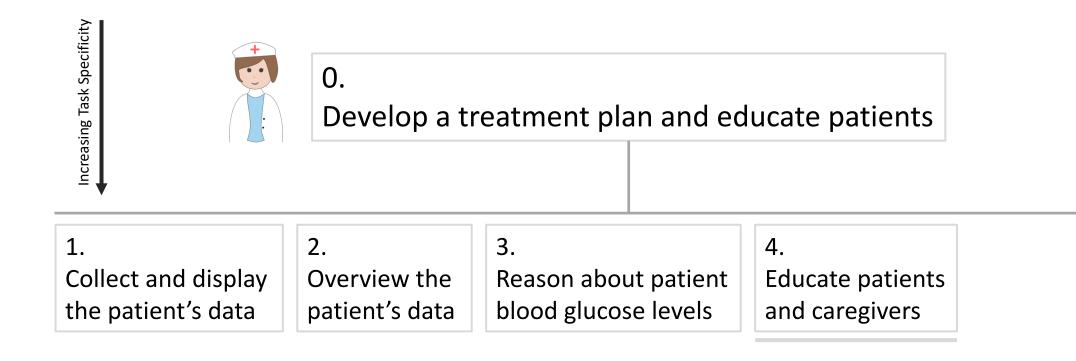




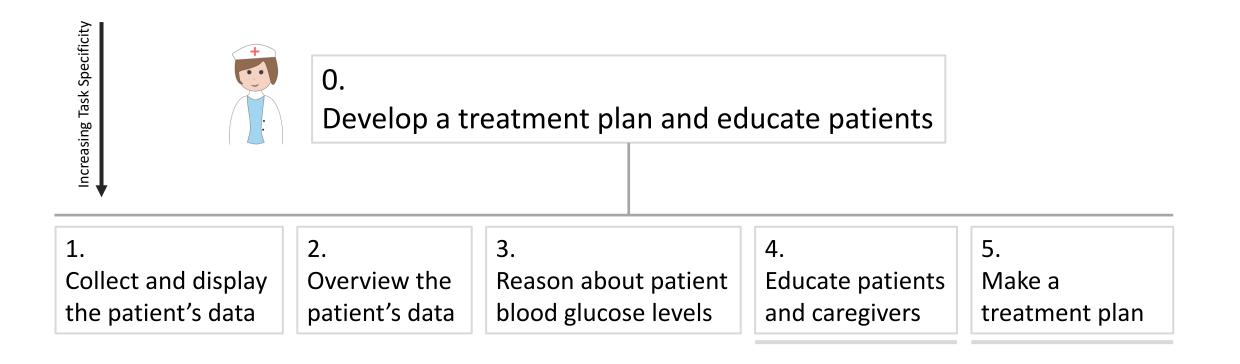


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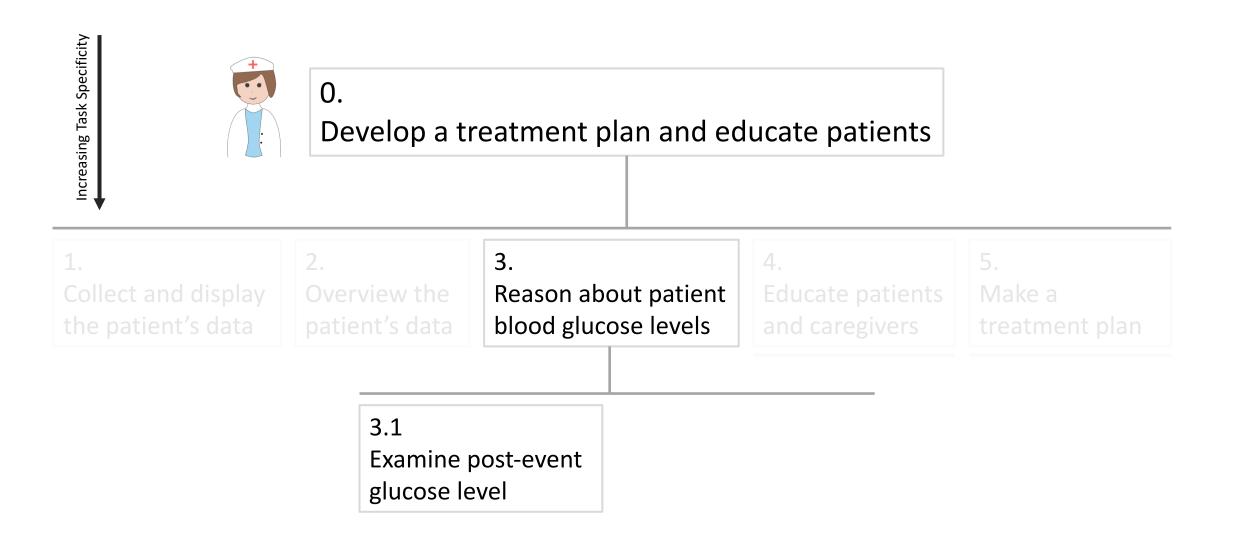




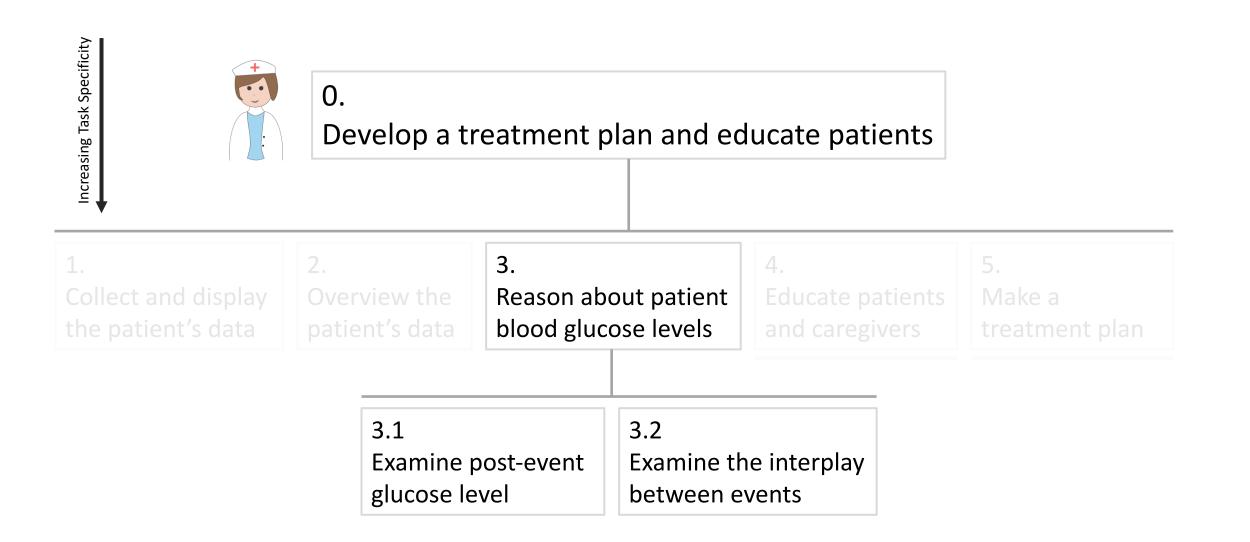




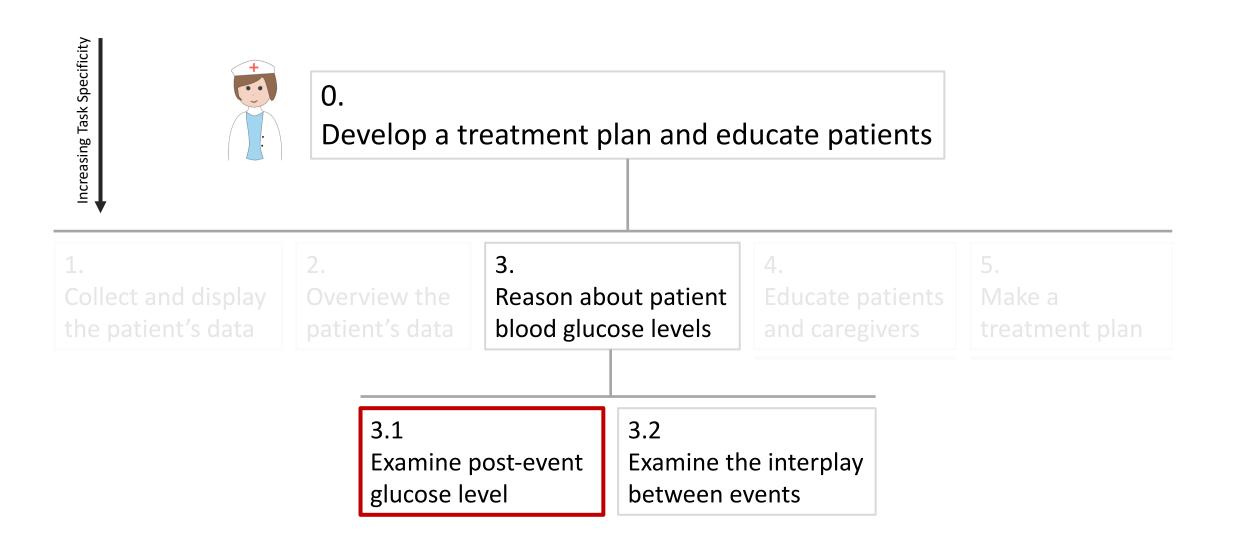














3.1

Examine post-event glucose level

3.1

Examine post-event glucose level



Examine related data to understand observation

Design



• DR1. Composite Visualization of Integrated Data



- DR1. Composite Visualization of Integrated Data
- DR2. Visualization of Folded Temporal Data



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

- 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

Detail

View

Task Abstraction

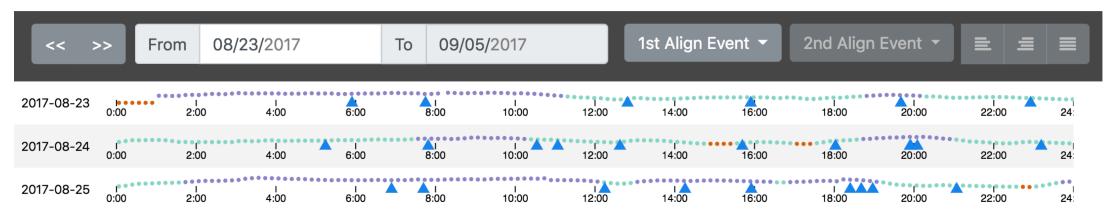


<< >	> Fro	m 05/2	27/2017		To 06/0	9/2017		1st Align Eve	ent 🔻	2nd Align		E i		Visualization Day By Meal About
2017-05-27	0:00	1 2:00	۱ 4:00	I 6:00	I 8:00	▲ I 10:00	l 12:00	і 14:00	I 🔺 16:00	18:00	I 20:00	1 22:00	24	No.Datgo.o No.Datgo.o
2017-05-28	I 0:00	l 2:00	l 4:00	 6:00	8:00	10:00	12:00	14:00	I 16:00	18:00	1 20:00	22:00	24	
2017-05-29	I 0:00	1 2:00	I 4:00	l 6:00	8:00	10:00	12:00	I 14:00	I 16:00	18:00	20:00	22:00	24	
2017-05-30	0:00	2:00	ا 4:00	I 6:00	8:00	I 10:00	I 12:00	I 14:00	Г 16:00	Г 18:00	20:00	22:00	24	
2017-05-31	0:00	۲ 2:00	4:00	l 6:00	8:00	I 10:00	12:00	14:00	I 16:00	18:00	20:00	22:00	24	
								l 14:00						
2017-06-02	r 0:00	I 2:00	I 4:00	l 6:00	1 8:00	I 10:00	12:00	I 14:00	I 16:00	I 18:00	1 20:00	l 22:00	24	Basal and Bolus (u)
2017-06-03	0:00	I 2:00	4:00	l 6:00	8:00	I 10:00	12:00	l 14:00	16:00	I 18:00	20:00	22:00	24	
2017-06-04	i 0:00	2:00	I 4:00	l 6:00	8:00	I 10:00	I 12:00	I 14:00	16:00	1 18:00	20:00	22:00	24	- 4.0 - 4.0 - 4.0 No
2017-06-05	0:00	l 2:00	• 1 4:00	l 6:00	8:00	l 10:00	I 12:00	I 14:00	I 16:00	I 18:00	I 20:00	22:00	24	75% 2.5 75% 2.6 75% 2.0 median 2.0 median 2.0 median 1.8
2017-06-06	I 0:00	l 2:00	1 4:00	I 6:00	1 8:00	I 10:00	12:00	l 14:00	16:00	I 18:00	20:00	22:00	24	25% 1.4 25% 1.4 25% 1.0
2017-06-07	0:00	1 2:00	I 4:00	I 6:00	8:00	I 10:00	l 12:00	l 14:00	16:00	18:00	20:00	22:00	24	
2017-06-08	0:00	l 2:00	۲ 4:00	6:00	8:00	I 10:00	12:00	14:00	16:00	18:00	I 20:00	22:00	24	Breakfast Lunch Dinner SugarTreat Be Insulin (u)
2017-06-09	0.00	2:00	I 4:00	6.00	8:00	I 10:00	12:00	14:00	16:00	18:00	20:00	22:00	24	
400 - mg/dL 350 - 200 - 200 - 150 - 100 - 50 -	017-	05-	31	\sim	~	Lur	tch	Afternoor	n snack	Di	uner Suğu	r to reat		100.0 100.0 100.0 100.0 100.0 100.0 No 75% 39.3 75% 44.5 75% 74.5 75% 7.5 median 36.5 median 58.5 median 6.0 25% 28.8 25% 30.0 25% 48.5 25% 4.0
~	1				1	10	12	14	16	19	A 20	20		→ 0.0 → 0.0 → 0.0 Breakfast Lunch Dinner SugarTreat Be

Summary Statistics Panel



14-Day Overview



Use small multiples to partition data folded by days

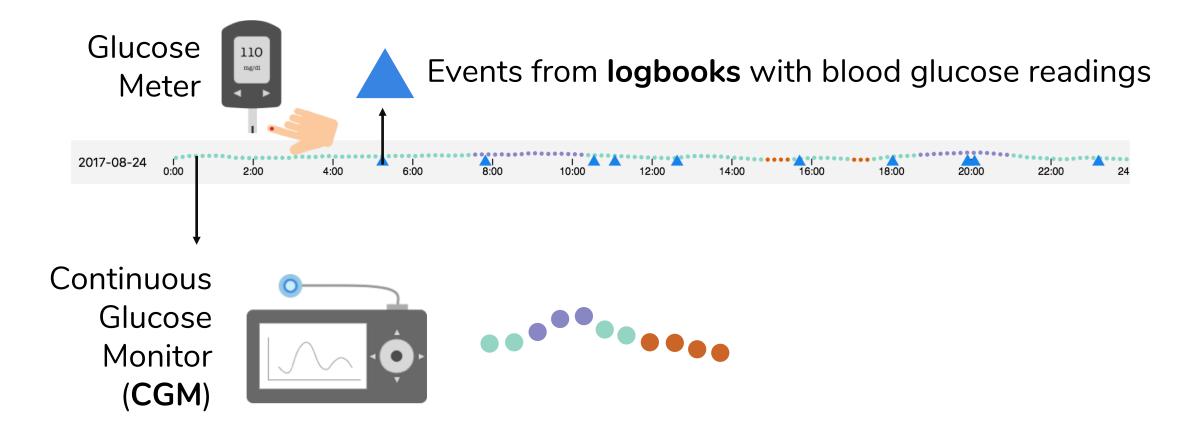


14-Day Overview

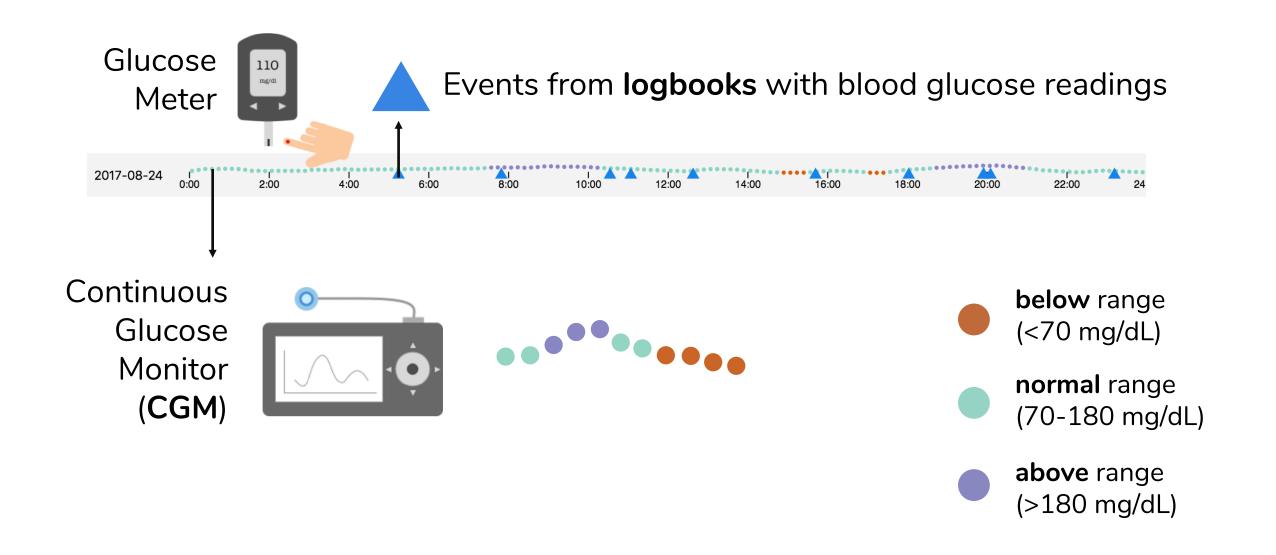
<< >	>> From	08/23/2017	То	09/05/2017		1st Align Ev	ent 🔻	2nd Align	Event -	E E	
2017-08-23	0:00 2:	l l 00 4:00	6:00	I I 8:00 10:00	1 12:00	14:00	16:00	1 18:00	I 20:00	I 22:00	24
2017-08-24	0:00 2:	00 4:00	с. 6:00	8:00 10:00	12:00	14:00	16:00	18:00	20:00	22:00	24:
2017-08-25	0:00 2:	l l 00 4:00	1 6:00	I I 8:00 10:00	I 12:00	I 14:00	16:00	I 18:00	20:00	22:00	24:





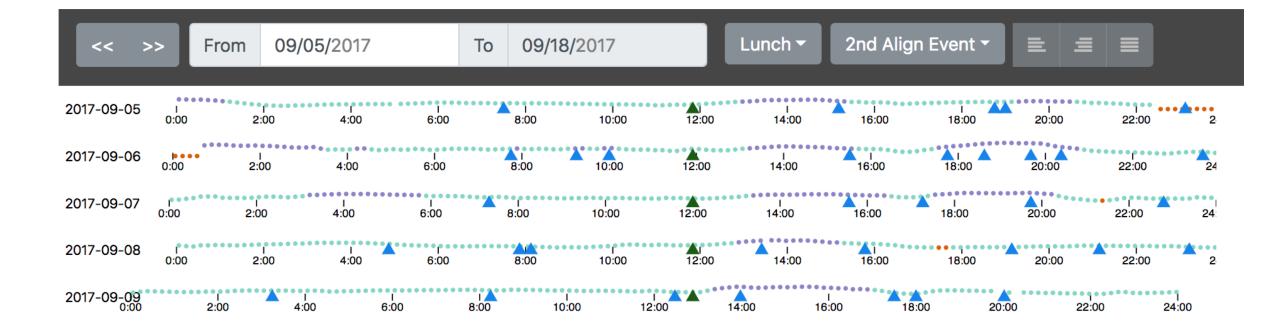






Task Abstraction





Events from logbooks with blood glucose readings

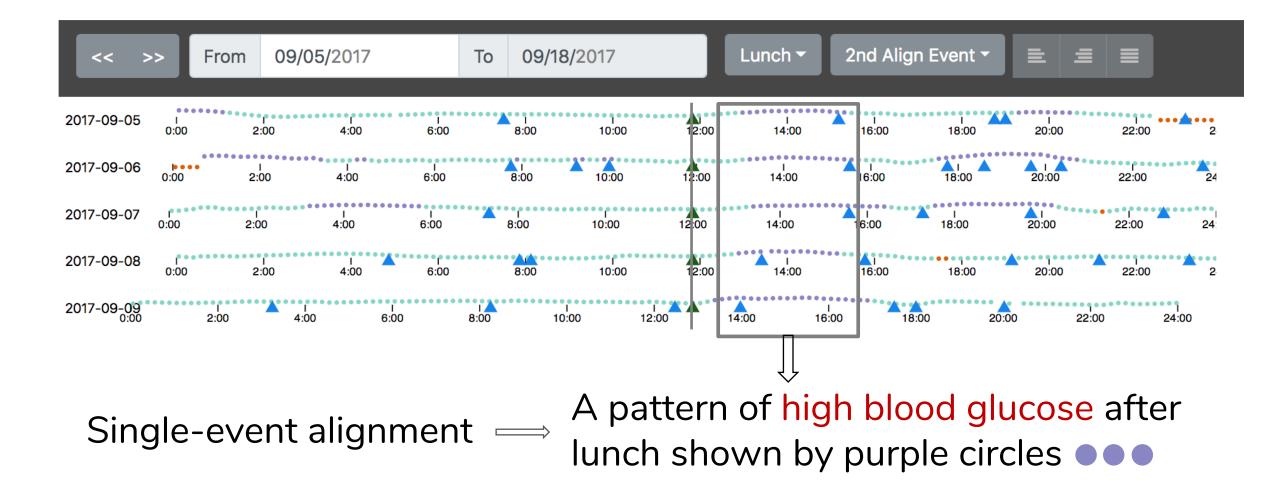
CGM normal range (70-180 mg/dL)

CGM above range (>180 mg/dL)

CGM below range (<70 mg/dL)</p>

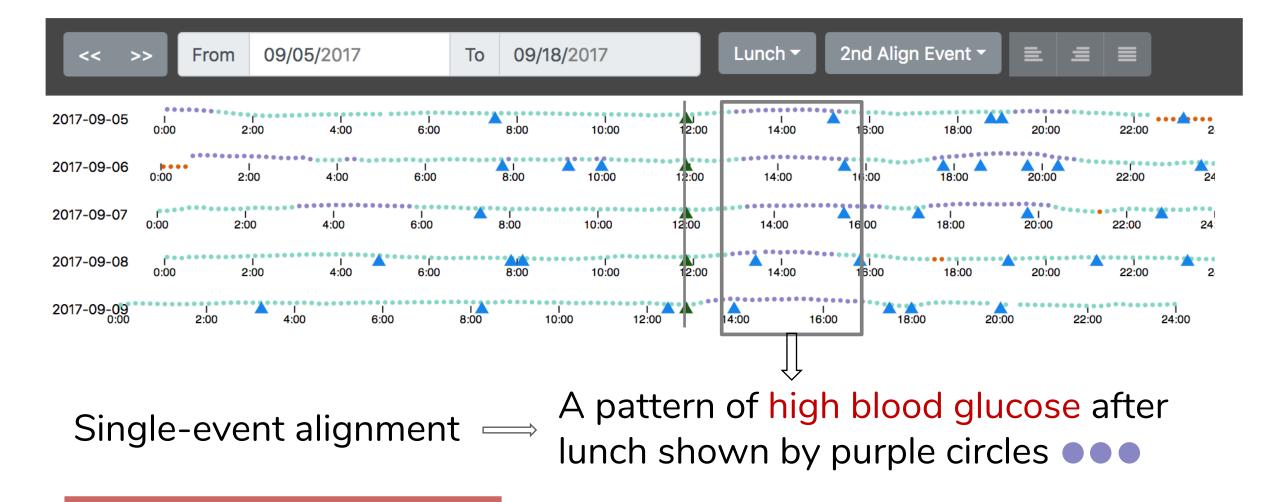
Task Abstraction

Design

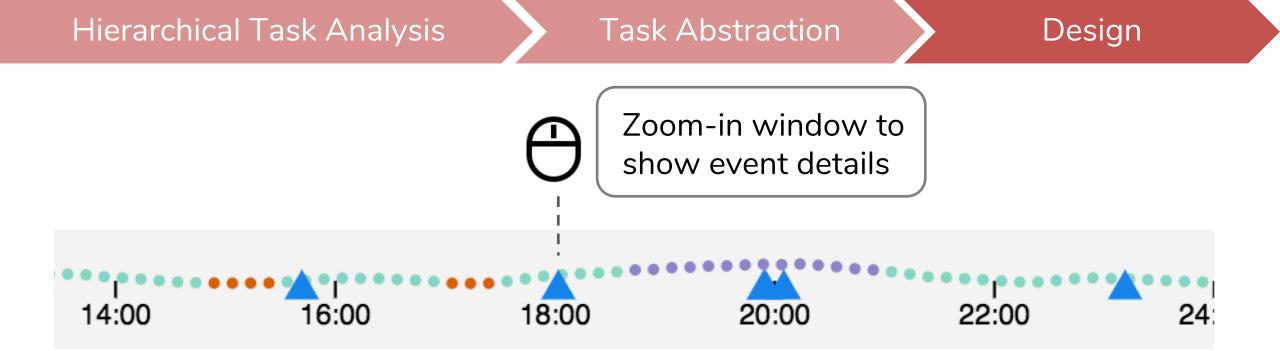


Task Abstraction





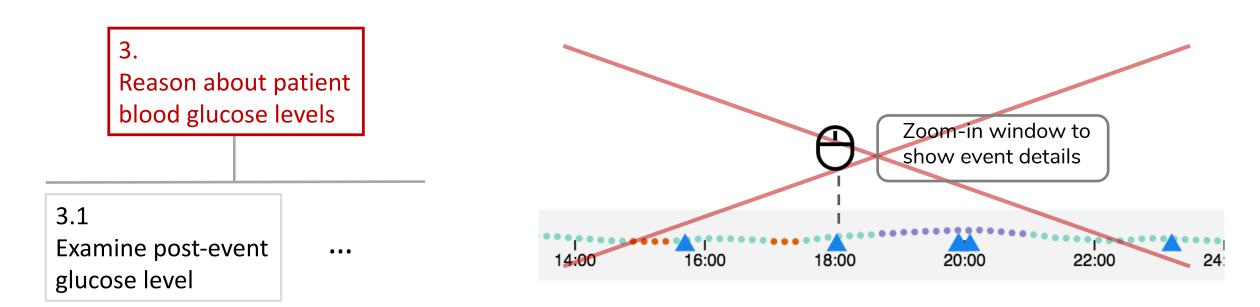
3.1 Examine post-event glucose level



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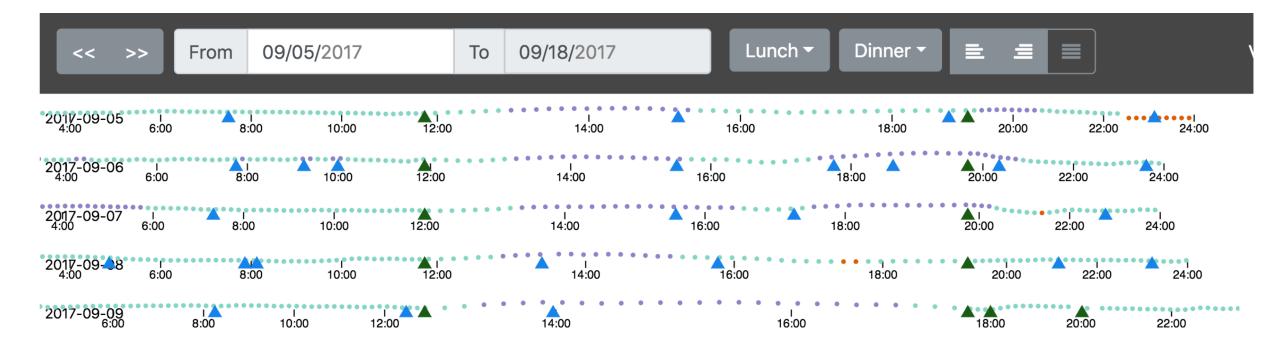
Task Abstraction

Design



Dual-event alignment





Events from logbooks with blood glucose readings

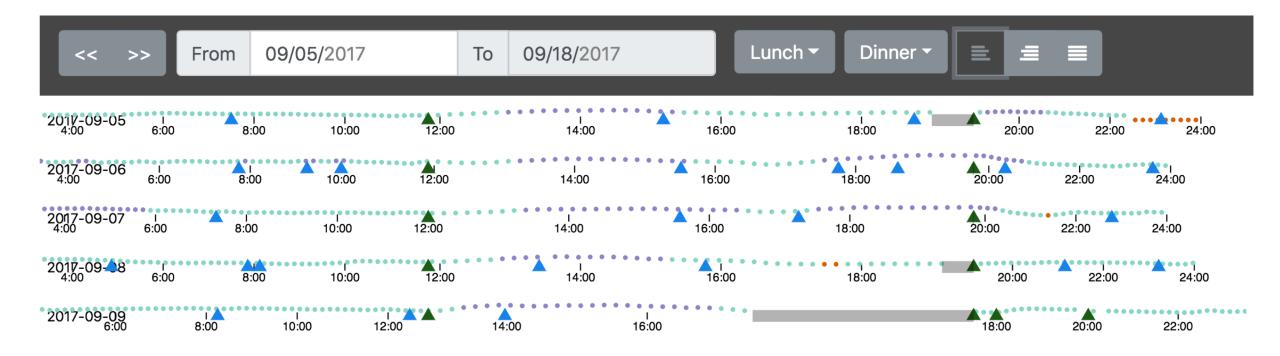
CGM normal range (70-180 mg/dL)

CGM above range (>180 mg/dL)

CGM below range (<70 mg/dL)

Dual-event alignment

Left-justified time scaling



Events from logbooks with blood glucose readings

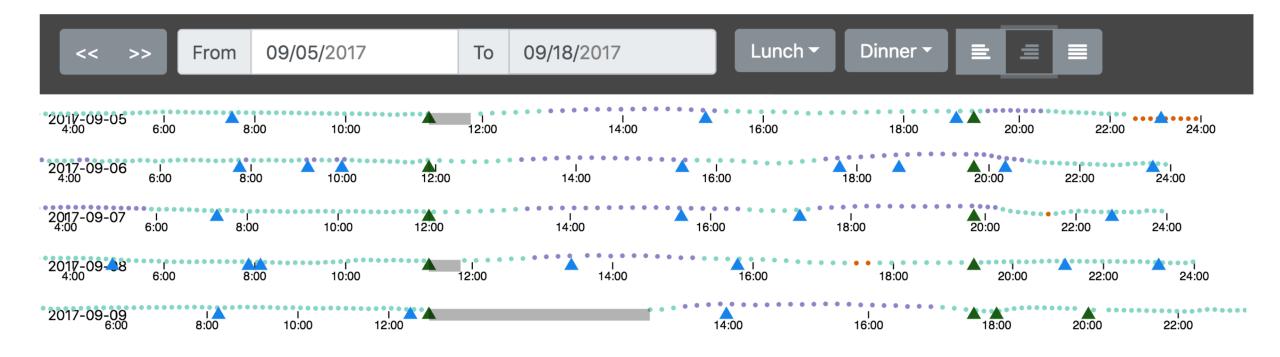
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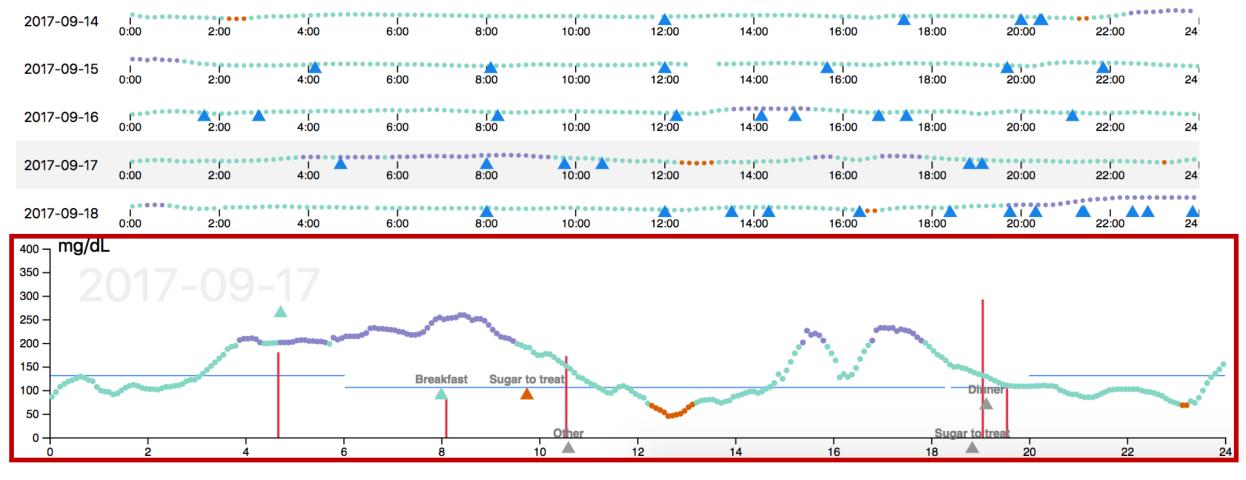
Events from logbooks with blood glucose readings

CGM normal range (70-180 mg/dL)

CGM above range (>180 mg/dL)

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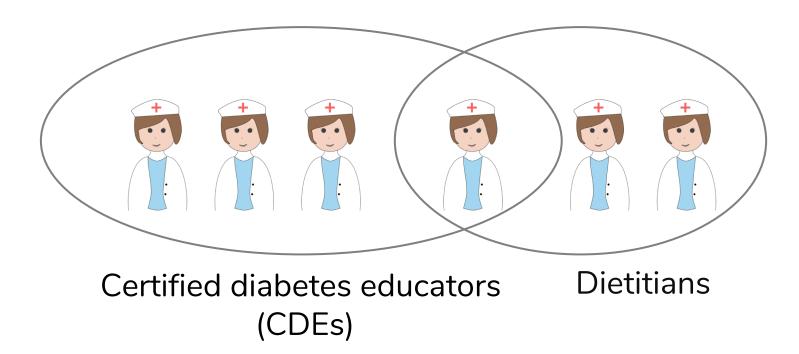




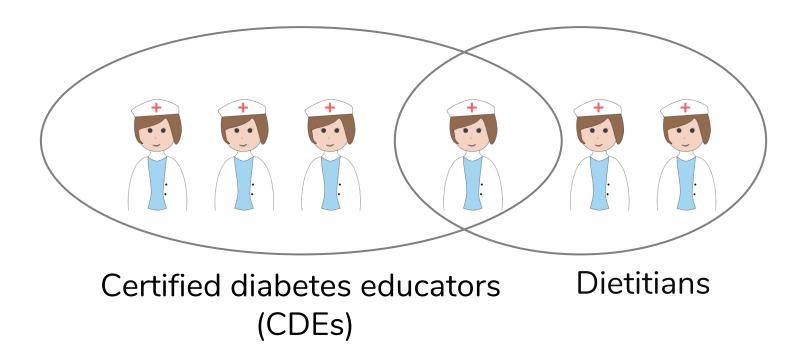
Detail View

Qualitative Study

Participants



Participants



Average years of work experience: 17.2 years

Methodology

<< >>	From	08/23	/2017		То	09	/05/2017				
	Breakfast				nch			Dinner			
Date	Insu	in Carb	n Carbs Glucose			Carb	s Glucose	Insulin Carbs Glucose			
2017-08-23	0.6	16.0	162.0	1.5	2	43.0	149.0	2.3	90.0	111.0	
2017-08-24	1.4	29.0	144.0	1.3	2	49.0	-	2.0	73.0	115.0	
2017-08-25	1.2	31.0	-	2.1	3	31.0	265.0	1.9	77.0	-	
2017-08-26	1.7	34.0	145.0	-	-	-	-	0.3	11.0	-	
2017-08-27	1.9	36.0	166.0	1.5	6	67.0	85.0	1.0	41.0	-	
2017-08-28	1.0	31.0	78.0	1.1	2	40.0	130.0	0.1	5.0	-	
2017-08-29	1.1	29.0	140.0	1.6	2	47.0	140.0	1.0	46.0	77.0	
2017-08-30	1.2	21.0	145.0	1.3	5	54.0	85.0	2.3	72.0	161.0	
2017-08-31	0.6	19.0	88.0	1.7	2	46.0	162.0	-	69.0	184.0	
2017-09-01	-	-	-	1.3	3	36.0	147.0	1.6	63.0	115.0	
2017-09-02	1.8	38.0	138.0	1.3	5	52.0	85.0	1.9	75.0	-	
2017-09-03	-	-	-	1.7	6	60.0	80.0	1.9	65.0	153.0	
2017-09-04	1.1	19.0	151.0	2.4	2	28.0	325.0	-	56.0	-	
2017-09-05	0.6	10.0	135.0	2.1	5	54.0	169.0	1.4	50.0	-	



Day-by-meal table

Exploration using IDMVis

Semi-structured

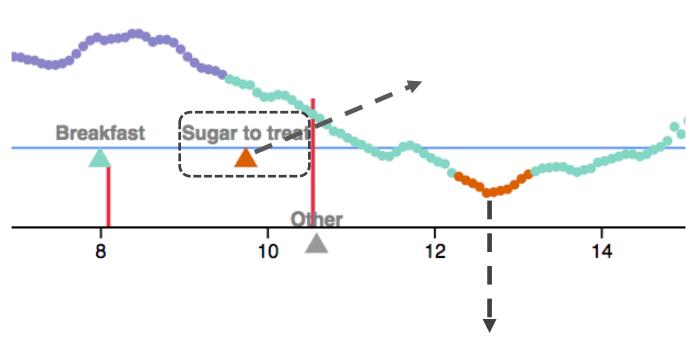
interviews

С

Results

Results

Superimposed detail view helps identify issues of data quality (e.g., missing or conflicting data)



⁶⁶ 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. **99**

Missing something?

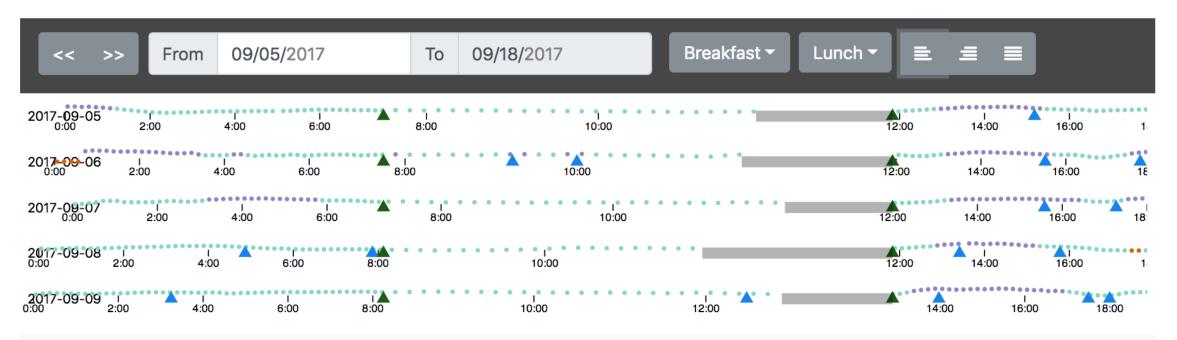
Sentinel event alignment allows exploration of event sequence relationships

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• 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



66

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

Conclusion

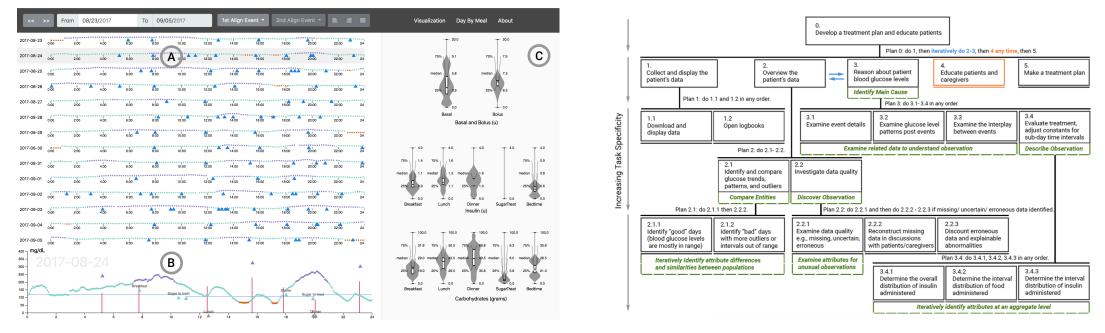
- IDMVis a temporal event sequence visualization
 - Novel techniques for temporal folding
 - Aligning by dual sentinel events & scaling the intermediate timeline

Conclusion

- IDMVis a temporal event sequence visualization
 - Novel techniques for temporal folding
 - Aligning by dual sentinel events & scaling the intermediate timeline
- Hierarchical task abstraction



For more information, please visit **bit.ly/IDMVis**





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