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Task-Driven Visualisation Framework for Diabetes Management

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BACKGROUND: Flow of Diabetes Monitoring

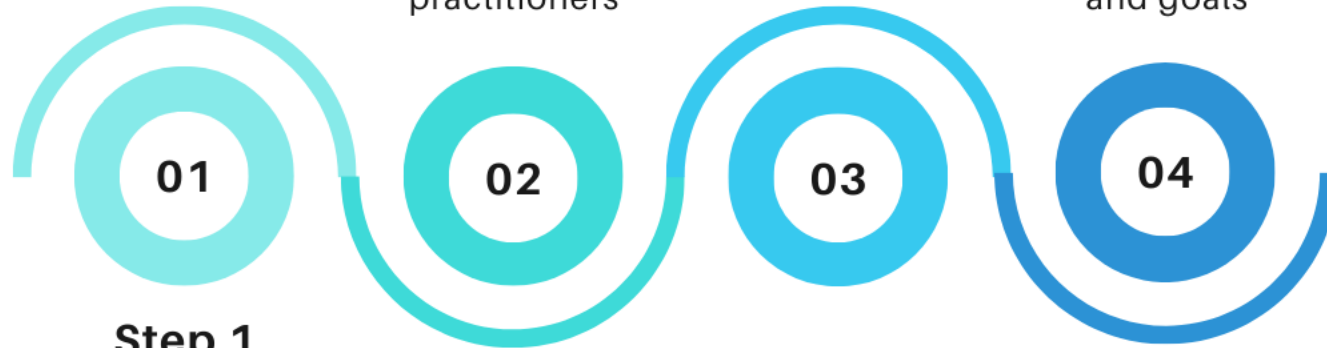


Step 2

Patient go for regular checkups with their practitioners

Step 4

Glancing through all visualization takes time and hard to do analysis to tailor a treatment plan to each patient's needs and goals



- Body check-ups
- Patient-generated data analysis
- Educational sessions
- Treatment plan

Patient-generated data:

- Blood glucose
- Carbohydrates intake
- Medications
- Exercise activities

Step 1

Patient uses different kinds of tools for monitoring different data



Step 3

Practitioners had to go through several visualizations from different tools



Figure 1. Flow of diabetes monitoring

MOTIVATION

Health data comes with different formats and from different sources therefore integrating them for visualization is difficult.

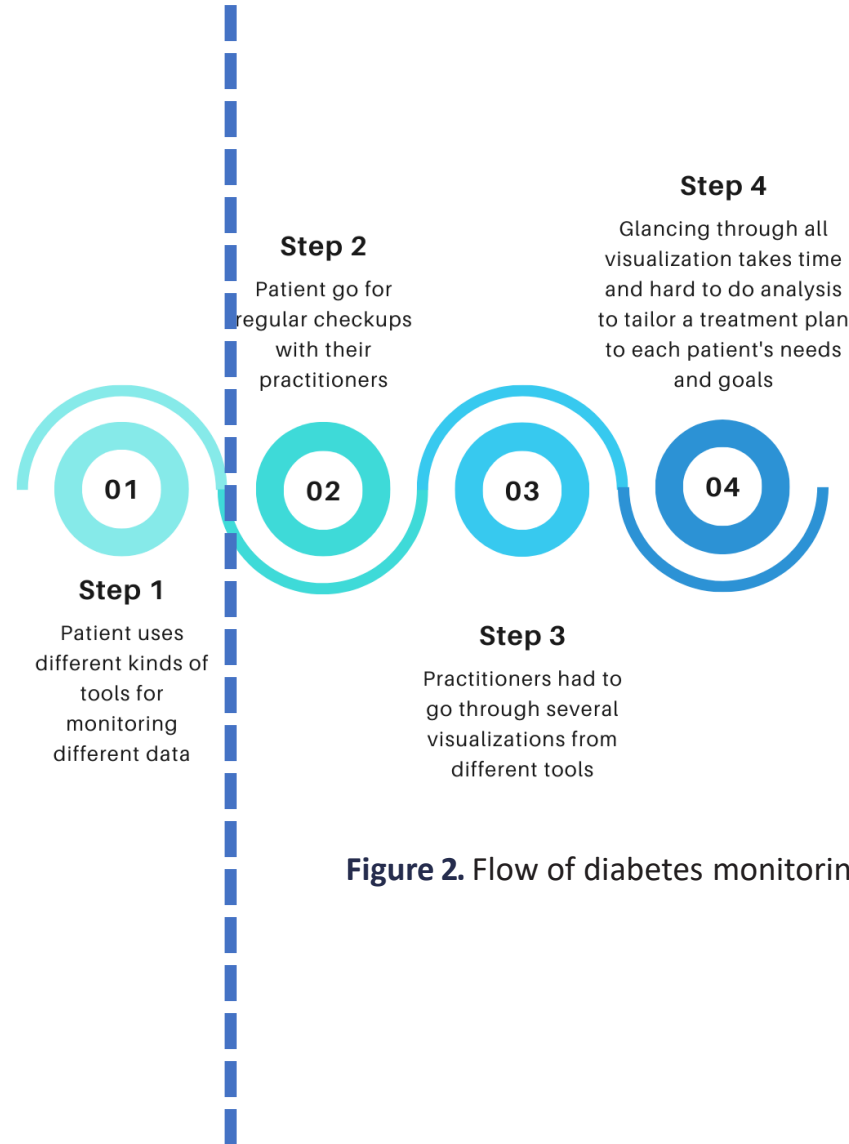


Figure 2. Flow of diabetes monitoring

Different tasks creates different kinds of visualizations making it hard for practitioners to make temporal analysis of events or analytical reasoning.

CURRENT SOLUTION

IDMVis (Zhang, Chanana, Dunne 2018)

- Interactive temporal event sequence visualization tool
- Integrates multiple pre-defined diabetes data
- Hierarchical task abstraction
- Determine HCP (health care providers) decision-making process
- Design requirements for IDMVis

Tidepool¹ & Glooko²

- Integrates various diabetes data from limited amount of devices

Visualization strategies

- Views/Arrangement
 - Juxtaposed/Superimposed
- Analytical strategies
 - Aims to increase analytic focus during analysis
- Applied in numerous applications including diabetes domain

HOWEVER...

¹ <https://www.tidepool.org/>

² <https://glooko.com/>

CURRENT PROBLEMS

IDMVis (Zhang, Chanana, Dunne 2018)

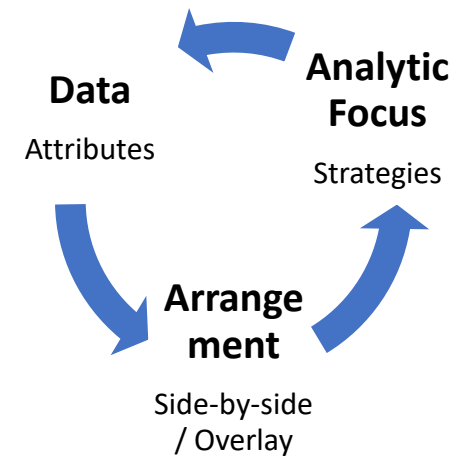
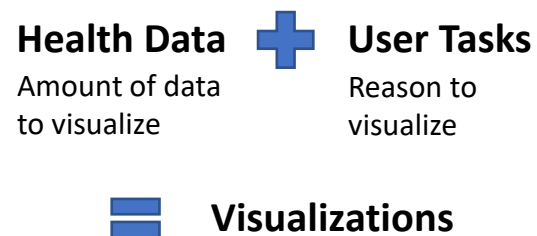
- Solely focuses on Type 1 diabetes
- Limits visualization approaches

Current tools

- Specifically designed to fit certain types of patient health data and user tasks
- Predefined visualization and user tasks

Lack of study

- Data, view and analytical strategy



SOLUTION/CONTRIBUTION

Conceptual Framework – *TaskVisDM*

- Task-driven visualization of patient-generated health data for diabetes management
- Task base
 - **12** analytic tasks with corresponding data attributes and visualization idioms
- Strategy base
 - **8** groups of analytic tasks summarised with visual and analytic strategies
 - Arrange/process design choices

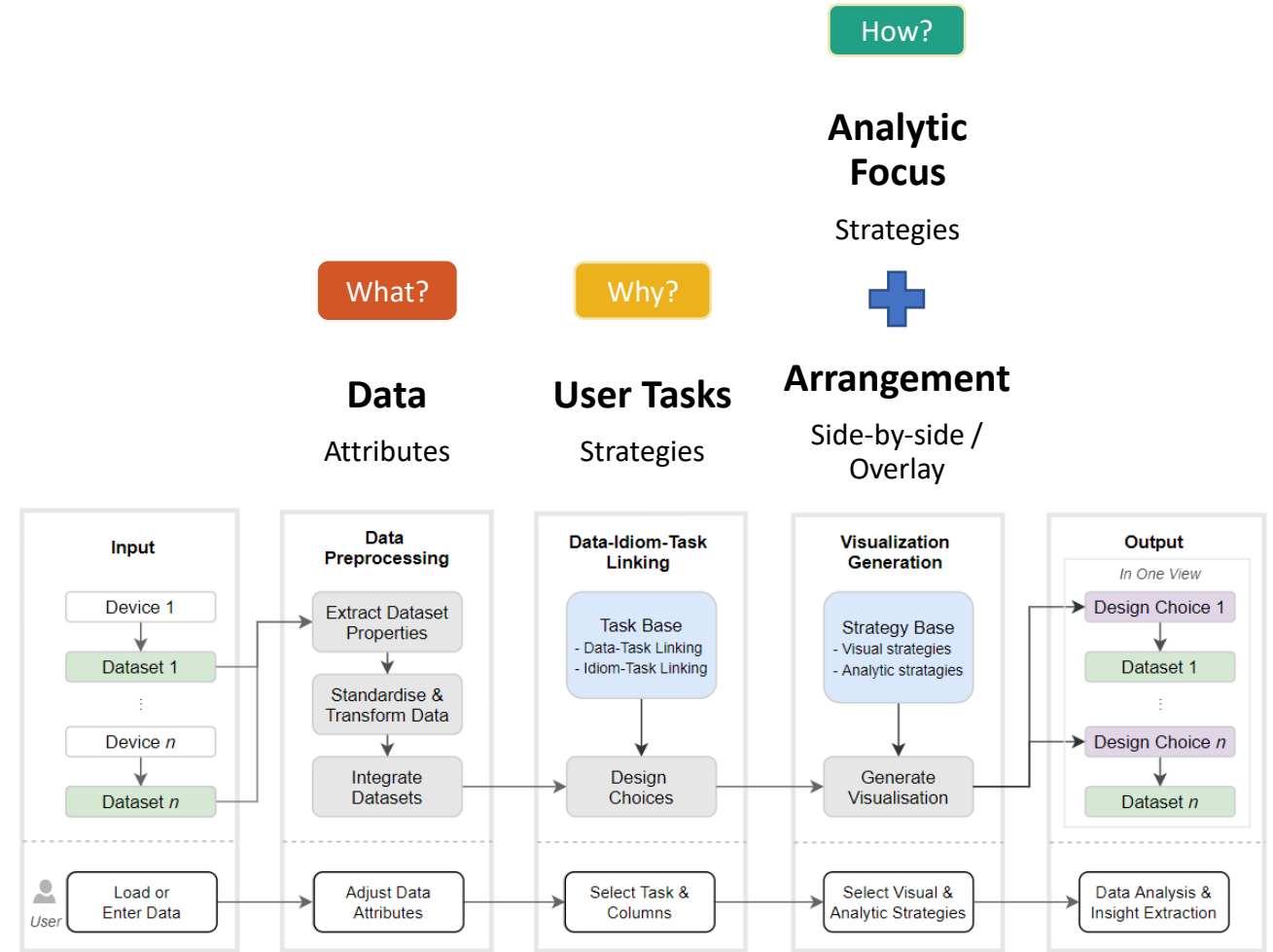


Figure 3. A conceptual task-driven visualisation framework for diabetes management, *TaskVisDM*

TASKVISDM - Input

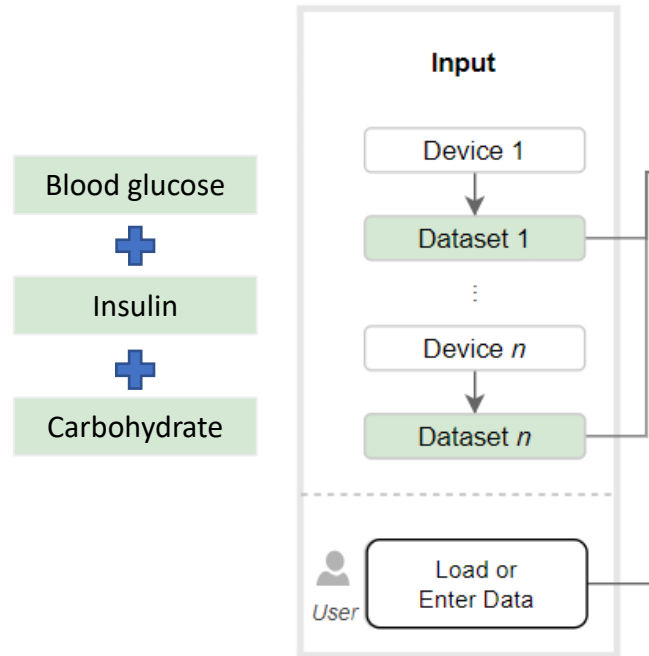


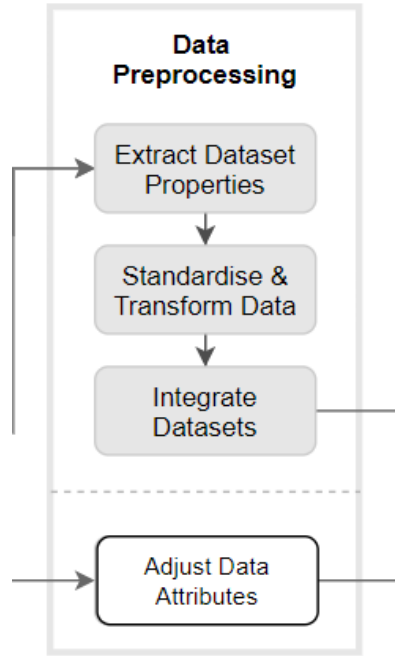
Figure 4. Input module of TaskVisDM

Conceptual Framework – *TaskVisDM*

Input

- Datasets from multiple sources of devices
- CSV or Excel file

TASKVISDM - Data Pre-processing Module



Conceptual Framework – *TaskVisDM*

Data Pre-processing Module

- Process and integrate multisource datasets
- Extract meta information
- Pre-process data into structured and standardized format
- Map time-series datasets to same temporal interval

Figure 5. Data pre-processing module of TaskVisDM



1
2 columns
Datetime, BGM
1 temporal, 1 quantitative

Datetime	BGM
01/04/2022 08:00	5.8
01/04/2022 08:30	1.3
01/04/2022 09:00	
01/04/2022 09:30	1.7
01/04/2022 10:00	5.2
01/04/2022 10:30	3.8
01/04/2022 11:00	5.6

2 columns
Datetime, Insulin
1 temporal, 1 quantitative

Datetime	Insulin (unit)
01/04/2022 08:00	2.00
01/04/2022 08:30	
01/04/2022 09:00	
01/04/2022 09:30	
01/04/2022 10:00	
01/04/2022 10:30	
01/04/2022 11:00	3.00

*Allow user interference

2
Datetime
BGM in mmol/L

Datetime	BGM
01/04/2022 08:00	5.8
01/04/2022 08:30	1.3
01/04/2022 09:00	
01/04/2022 09:30	1.7
01/04/2022 10:00	5.2
01/04/2022 10:30	3.8
01/04/2022 11:00	5.6

Datetime
Insulin in units

Datetime	Insulin (unit)
01/04/2022 08:00	2.00
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01/04/2022 09:30	
01/04/2022 10:00	
01/04/2022 10:30	
01/04/2022 11:00	3.00

*Allow user interference

3
Integrates to one multi-dimensional time-series dataset

Datetime	BGM	Insulin (unit)
01/04/2022 08:00	5.8	5.8
01/04/2022 08:30	1.3	
01/04/2022 09:00		
01/04/2022 09:30	1.7	
01/04/2022 10:00	5.2	
01/04/2022 10:30	3.8	
01/04/2022 11:00	5.6	5.6

Figure 6. Example of the 3 main parts in pre-processing module

TASKVISDM - Data-Idiom-Task Linking Module

Conceptual Framework – *TaskVisDM*

Data-Idiom-Task Linking Module

- Determine the best design choices for the pre-processed datasets based on the tasks and data attributes (or columns) selected by users
- Utilizes 12 data analysis tasks to design choice properties

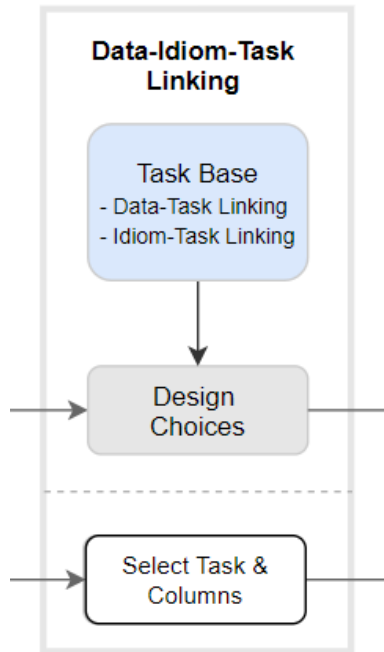


Figure 7. Data-Idiom-Task module of TaskVisDM

Data Analysis Task	Data Attribute	Idiom	Reference
<i>Correlation</i> between physical exercise and blood glucose levels	Physical exercise (NUM), Blood glucose (NUM)	Scatterplot	Ehrmann, 2014, p. 332

Figure 8. An example of data analysis task

TASKVISDM - Visualisation Generation Module

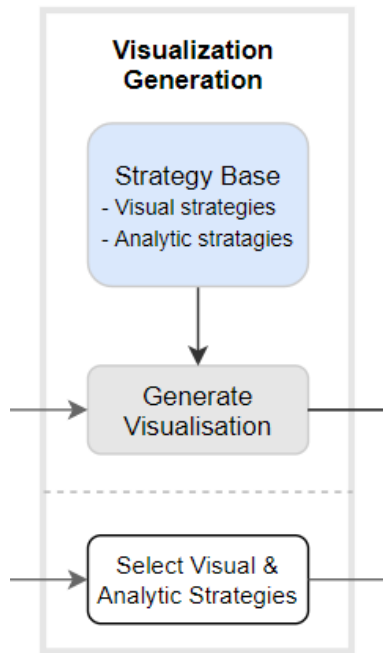


Figure 9. Visualization generation module of TaskVisDM

Conceptual Framework – *TaskVisDM*

Visualisation Generation Module

- Arrangement of visualizations
 - Juxtaposed
 - Superimposed
- Utilizes analytical strategies
 - Aligning
 - Temporal folding



Figure 10. Blip interface (Wong et al. 2017)

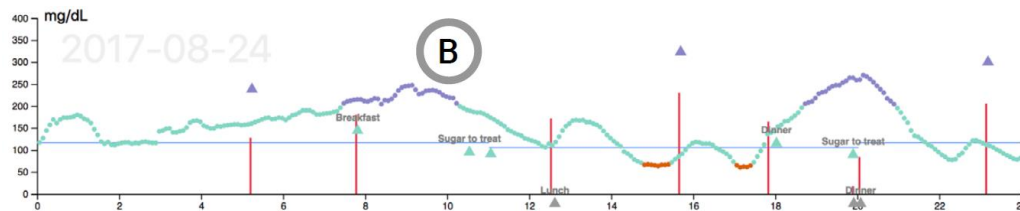


Figure 11. IDMVis superimposing CGM, SMBG, and insulin data (Zhang, Chanana, Dunne 2018)

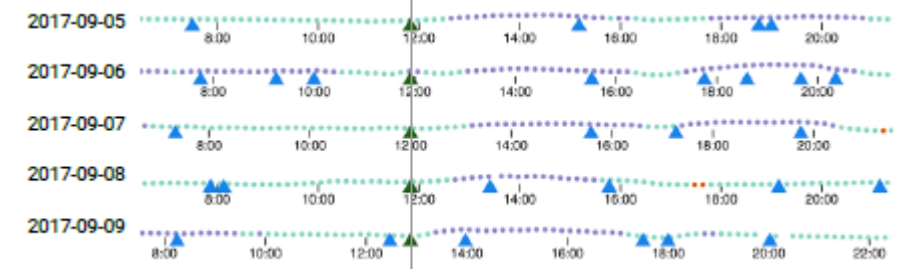


Figure 12. IDMVis single event aligning by meal types (Zhang, Chanana, Dunne 2018)

TASKVISDM - Output

Conceptual Framework – *TaskVisDM*

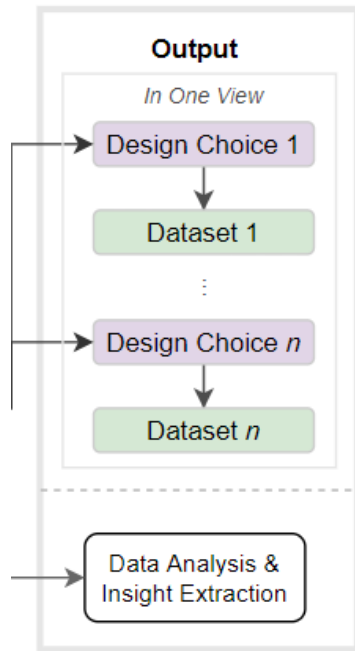


Figure 13. Output module of TaskVisDM

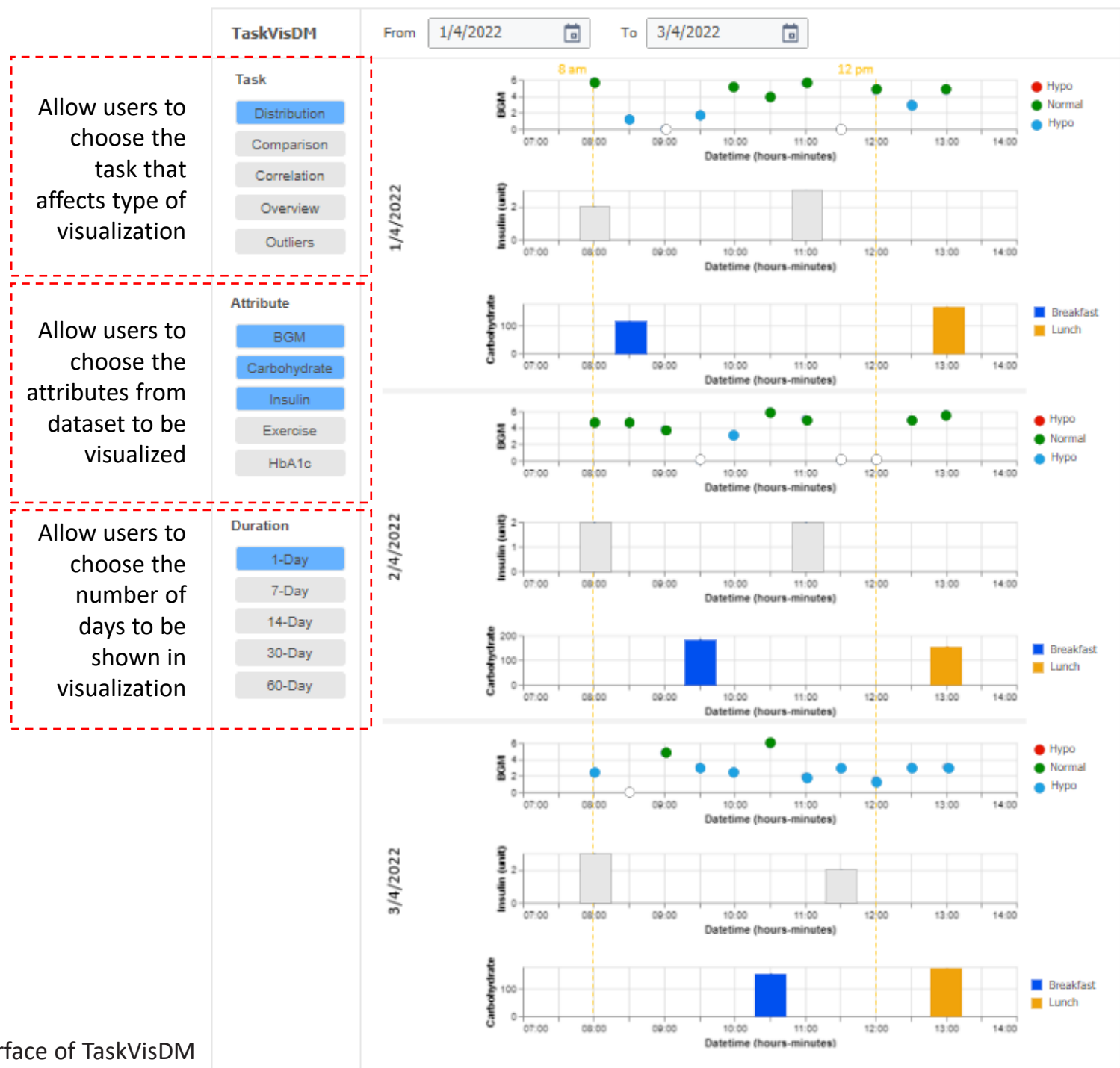


Figure 14. General output interface of TaskVisDM

REFERENCES

- Wong, JC, Neinstein, AB, Look, H, Arbiter, B, Chokr, N, Ross, C & Adi, S 2017, 'Pilot Study of a Novel Application for Data Visualization in Type 1 Diabetes', *Journal of Diabetes Science and Technology*, vol. 11, no. 4, pp. 800-807.
- Zhang, Y, Chanana, K & Dunne, C 2018, 'IDMVis: Temporal event sequence visualization for type 1 diabetes treatment decision support', *IEEE transactions on visualization and computer graphics*, vol. 25, no. 1, pp. 512-522.

**That is all.
Thank you very much.**