A Mental Workload Estimation for Visualization Evaluation Using EEG Data and NASA-TLX

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Motivation

- **Mental workload** is a cognitive effort that you feel while solving tasks.
- **NASA-TLX** is a questionnaire that is often used for mental workload measurements.
- **EEG** which can replace questionnaire, is a biological signal specialized for individuals who can estimate mental workload.
- Figure 1 is our work procedure. We present visualization in our experiments to collect EEG data and NASA-TLX scores, preprocess them with band power data and workload levels, and use them as model inputs.
- We propose a **mental workload personalized estimation model** with EEG data to **evaluate visualizations**.
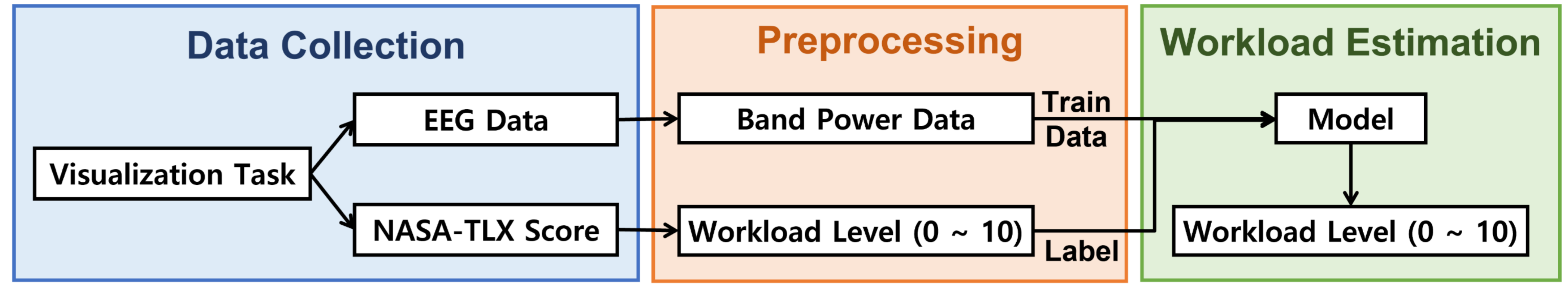

Figure 1. Our work procedure

Experiment Design

- Data collection procedure is demonstrated in Figure 2. The participant is presented with a visualization and a visualization task at the same time. The participant uses the visualization to answer the visualization task and records the answer.
- The participant takes a NASA-TLX survey and takes a break. After the rest, the next set of visualization and visualization task is given newly.
- Since our study creates a **specialized model for each individual**, and one participant is sufficient for the validation. Nevertheless, we recruited 7 participants.
- Figure 3 shows an example set of visualization and corresponding mental workload level.

Mental Workload Estimation Model

- The proposed model classifies the mental workload level as 0~10 with EEG band power data.
- We estimate the mental workload level utilizing various models, including **SVM, DNN, CNN** and **LSTM**, which are the most used models in previous studies.

Conclusion

- In this paper, we proposed a mental workload estimation model for visualization evaluation using EEG data.
- The performances were compared with F1 scores, and the DNN model produced the best performance.
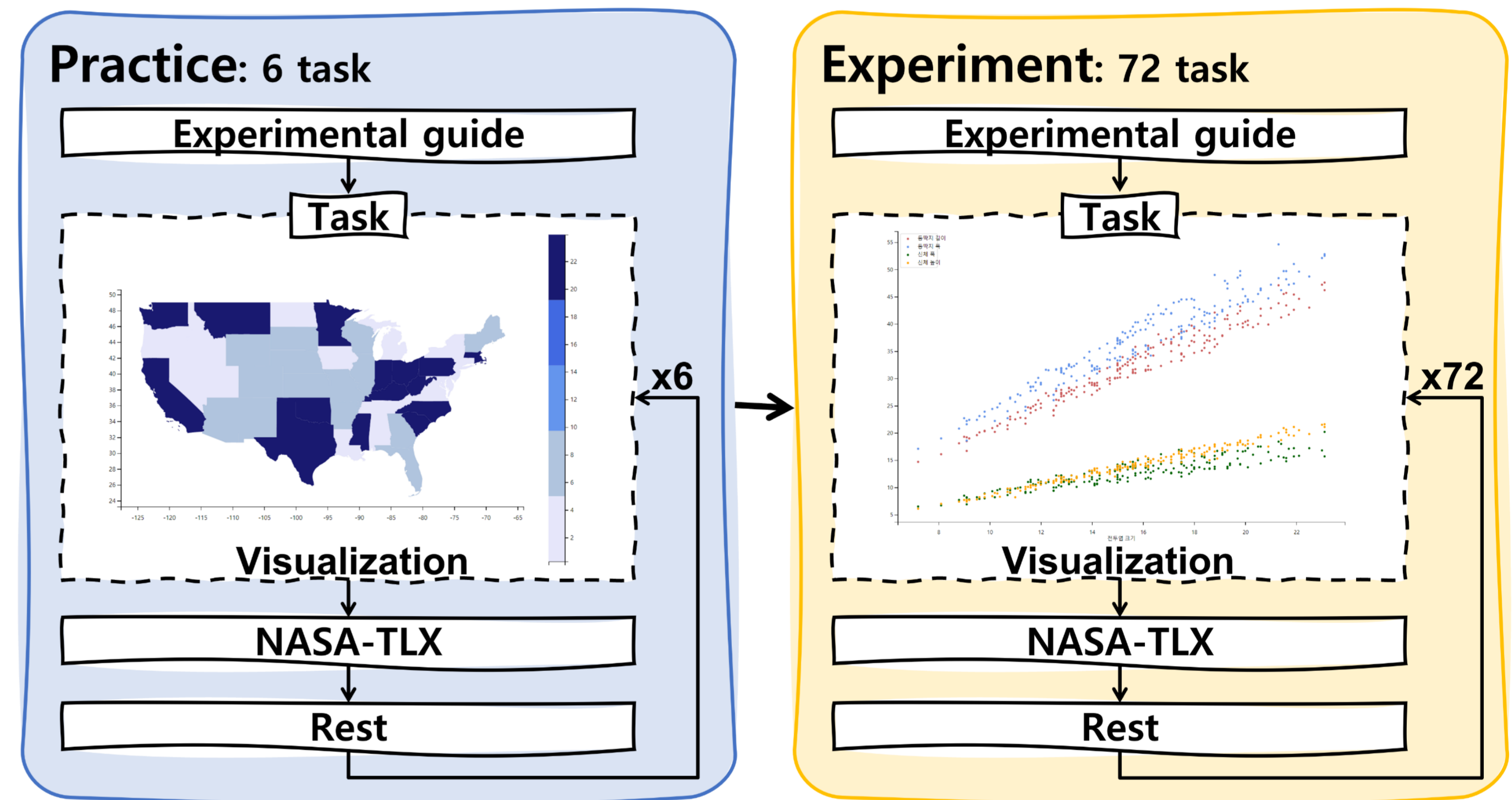

Figure 2. Data collecting experiment procedure

			Visualization Example			
Bar	**Mental Workload Level**	Mead	4.52	4.83	4.86	3.15
		Std	1.91	2.22	2.29	1.65
Line	**Mental Workload Level**	Mean	3.62	4.41	4.93	3.45
		Std	1.89	2.18	2.06	2.15
Scatter	**Mental Workload Level**	Mean	4.69	4.23	4.08	3.06
		Std	2.340	2.02	2.05	2.13
Map	**Mental Workload Level**	Mean	3.67	4.59	5.30	2.68
		Std	1.87	1.64	2.98	1.78

Figure 3. Example of visualization from the visualization and the consequent mental workload level