RheoCognition

A scaffolding approach for slip casting and edifying its graph literacy

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RESEARCH QUESTION

Slip casting is a technique that involves pouring liquid clay into a mold to create intricate ceramics. However, it requires a high level of instruction and experience. Even minor variations in the preparation process can result in defects (Fig. 1). While sensor data can tell how the slip behaves (rheology) and predict certain outcomes, it is difficult to interpret, especially for newcomers to the craft.

How might large language models scaffold the development of sensor-reading skills in non-expert users working with rheological data visualizations?

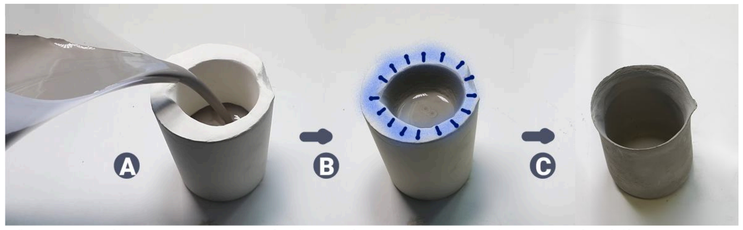

Figure 1. Slip casting a cup before glazing and putting it in the kiln.

APPROACH

We evaluated the LLMs' perception of visual difference between rheological curves of different slip while varying their (1) color, (2) thickness, and (3) grid lines of the graph. We then mapped each part of the graph with the corresponding slip behavior and used the LLMs to translate the visual variance in terms of rheology, then in terms of analogies and plain language. After this translational process, we evaluated makers' recognition of the different slip rheology and how it would affect the casting process by introducing all this information initially, then gradually removing parts of it to gauge their understanding.

RELATED WORK

Two-dimensional graphs are found to be an effective technique to support cognitive ability in drawing relationships between data [1]. This is also supported by a deductive learning technique where students drew relations between their hypothesis and the visualization of sensor data when learning about motion [2]. We aim to introduce an LLM-assisted graphical representation of slip to learn inductively about it. While ML models are used in detecting and searching of abnormalities in graphs [3], we have not found sufficient research exploring the use of models to aid in interpreting graphs, and not be an authoritative figure on what to do with them. This is especially important as LLMs are known to have preferences when it comes to artistic expression [4] that we want to avoid in the slip-casting realm.

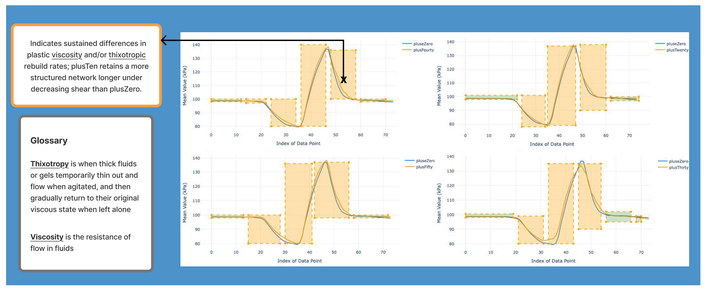

Figure 2. Chat bubbles interpreting each region of interest.

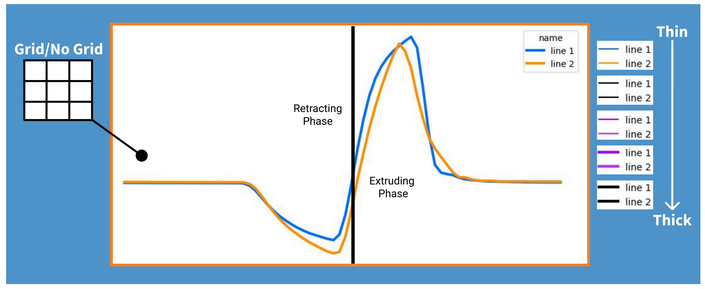

Figure 3. Different graph morphologies when evaluating LLMs' perception.

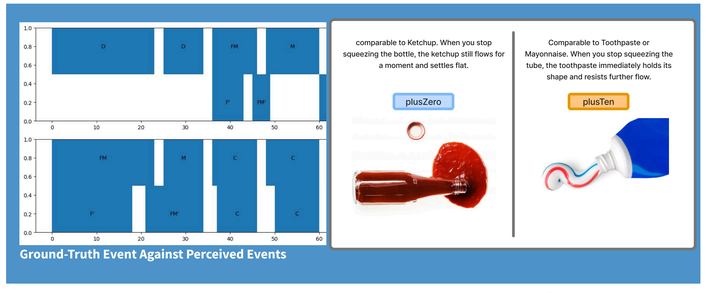

Figure 4. Ward metrics evaluation for perception (left) ; Comparison abilities of the LLMs' (right).

Different morphologies give varying depths of efficacy in LLM's describing the visual difference between curves. The mapping of graph to rheology was done by visualizing the different types of materials that vary vastly by one thing like Ketchup & Mayonnaise or Toothpaste & Hair gel. Users learn by interacting with the graph and seeing the effects of what it means structurally.

EVALUATION

To evaluate our interactive sensing system, we plan to conduct a small user pilot study. This pilot will introduce users to different slip variations alongside our scaffolding system. We will observe how users engage with the interface as the interpretation and comparison scaffolds are gradually removed. The primary goal of this pilot is to assess immediate comprehension and gather preliminary feedback on the system's usability. The insights gained will help us refine the LLM's translational analogies and establish a foundation for future, larger-scale comparative studies measuring retention in graph literacy.

DISCUSSION

When removing information gradually and letting users recall interactions, we solidify their understanding of slip behavior without the LLM being an authoritative figure on what to do. This system can be applied in more than slip; EKG/ECG's involve identifying differences in cardiac cycles, EEG's monitor brain activity in the form of voltage signals. Mel Spectrograms are used in audio similarity measures.

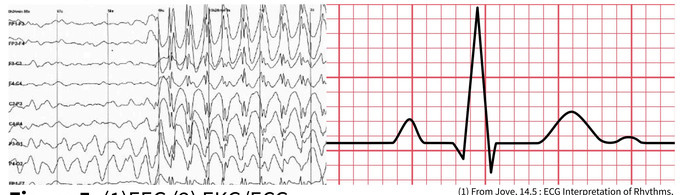

Figure 5. (1)EEG (2) EKG/ECG

(1) From Jove, 14.5 : ECG Interpretation of Rhythms,
(2) From Der Lange uploaded on Wikipedia

PRELIMINARY RESULTS

We introduce a new methodology to enhance the comprehension of slip rheology graphs. Initial LLM morphology perception results show that incorporating a grid improves LLM perception by 22% compared to a gridless baseline. Additionally, monochromatic color schemes outperform single-color designs by 47% and complementary color groups by 21%. We hope this approach will effectively train users to interpret graphs from uncharted domains, utilizing their improved conceptual understanding to make informed slip casting decisions.

REFERENCES

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