DATSAW: Dynamically Adjusting Tool Selection with Federated Average Weighing

Introduction

DATSAW optimizes tool selection based on image quality using a federated averaging approach. This document details the mathematical steps involved and the relationships between different variables.

Step 1: Calculate Image Quality

For each image, the image quality, represented as Epsilon (ϵ), is calculated:

$$\epsilon = \text{Image Quality Metric}$$

Step 2: Define Tools

We define a bag of k tools, denoted as $T = \{t_1, t_2, \ldots, t_k\}$, arranged in ascending order based on a factor α:

$$\alpha = \text{cost} \times \text{performance}$$

The tools are sorted such that:

$$t_1 < t_2 < \ldots < t_k \quad (\text{where } \alpha(t_i) \text{ is increasing})$$

Step 3: Calculate Window Parameters

Two additional factors, γ and δ, are calculated as:

$$\gamma, \delta = \left\lfloor \frac{1}{\epsilon} \right\rfloor$$

These factors represent the start and end indices of the selection window.

Step 4: Define Beta

Let β represent the subset of tools selected between α and γ, defined as:

$$\beta = \{t_i \mid \alpha < i < \gamma\}$$

where t_i are the tools within the specified range.

Step 5: Relationship Between Beta and Epsilon

The relationship between β and ϵ is significant because ϵ influences the selection window:

- A higher value of ϵ results in a smaller γ and δ, thus reducing the range of selected tools, which may limit the elements in β.
- Conversely, a lower value of ϵ expands the selection window, potentially increasing the size of β.

This relationship emphasizes how image quality affects the diversity of tools available for federated averaging.

Step 6: Assign Priorities for Federated Averaging

The tools in the selected window are assigned priorities:

- First tool (t_γ): Priority = 0.2
- Last tool (t_δ): Priority = 0.2
- Middle tools (t_i for $\gamma < i < \delta$): Priority = 0.4

Step 7: Federated Averaging

The final output z is computed using federated averaging:

$$z = \frac{\sum_{i=\gamma}^{\delta} p_i \cdot t_i}{\sum_{i=\gamma}^{\delta} p_i}$$

where p_i is the priority assigned to tool t_i.

Conclusion

The output z is returned to the user after applying the federated averaging method, balancing contributions from different tools based on their assigned priorities and the influence of image quality through ϵ.