Final Project Proposal

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1 Dataset Abstraction

1.1 Data Description

The *BOHB Sampled Configuration & Results* dataset, which I made, consists of the sampled configuration's data and its evaluation results while performing the hyperparameter optimization method, BOHB. BOHB optimizes randomly created hyperparameter configurations of the deep learning model using Bayesian Optimization and Hyperband method. The dataset's type is a table with 575 items, each comprising thirteen attributes. One attribute, **sample_id**, is a unique key attribute, and others are just values.

1.2 Data Abstraction Results

- Nominal Attributes

Name	Semantics	Values
sample_id	Key of Sample data	{bracket}-{round}-{trial}
sample_type	Where the configuration was sampled	random, samples, BO
config_optimizer	The type of optimizer in the sampled configuration	adam, sgd, rms
config_scheduler_p	Whether the learning rate scheduler is enabled or not	True, False
config_activation	The type of activation function in the sampled configuration	relu, lrelu, tanh

- Ordinal Attributes

Name	Semantics	Values	Direction
config_batch_size	The value of batch size in the sampled configuration	8, 16, 32	Sequential
config_hidden_size	The value of hidden size in the sampled configuration	16, 32, 64	Sequential

- Quantitative Attributes

Name	Type	Semantics	Range	Direction
budget	Ratio	Budget (e.g., epoch) used to evaluate the configuration	[1, 300]	Sequential
config_momentum	Ratio	The value of momentum in the sampled configuration	[0, 1]	Sequential
config_learning_rate	Ratio	The learning rate value in the sampled configuration	[1e-4, 1e-1]	Sequential
config_weight_decay	Ratio	The value of weight decay in the sampled configuration	[0, 1e-3]	Sequential
sample_loss	Ratio	Loss value for the sampled configuration	[0, inf)	Sequential
sample_acc	Ratio	Accuracy value for the sampled configuration	[0, 100]	Sequential

2 Task Abstraction

Through this visualization system, users should be able to visually analyze the experimental results of BOHB, gaining insights into the optimization of hyperparameters. Users can use these insights to set experiment settings in future BOHB experiments to achieve desired performance. The following are abstractions of tasks users can perform in this visualization system.

Task 1: Summarize the operational principles of BOHB

Given the complexity of the BOHB algorithm, it is essential to provide a visualization system that enables users to understand the operational principles of BOHB through active interaction.

Task 2: Present where the configuration with the best performance is.

BOHB creates the best configuration within a given budget through Bayesian Optimization and Hyperband. Hence, by presenting a visualization system, users can not only present the operational principles of BOHB but also explain the origin of the optimal configuration produced via BOHB.

Task 3: Compare the distribution of data for each bracket.

BOHB generates new configurations randomly in each bracket. If the distribution of the configurations generated in each bracket is similar, there is no need for multiple brackets. Therefore, to determine if each round is meaningful, it is necessary to visualize the data distribution per round. Through this, users will gain insights into appropriate budgets, ranges of hyperparameters, and their values.

Task 4: Discover the Correlation between Attribute Pairs

Hyperparameters are not always independent of each other; they often interact and influence each other. Therefore, discovering correlations between attributes through dedicated tasks can help users identify which attributes significantly impact the model's performance.

3 Persona

Figure 1: Ph.D. student Yuna Jeon

3.1 Primary Persona: Ph.D. student Yuna Jeon

Yuna Jeon is a 31-year-old woman living in Seoul, South Korea. She is currently a fifth-year doctoral student in the field of Artificial Intelligence. Her primary goal is to graduate soon and secure a position in an international company. All that stands between Yuna and her graduation is the acceptance of one more research paper.

Her graduation depends on a paper submitted to an AI conference. The deep learning model used in her paper had its hyperparameters optimized using BOHB, one of the hyperparameter optimization techniques. The reviewers of her paper have expressed interest in a detailed account of this optimization process. While Yuna deeply understands BOHB, she believes data visualization is necessary to explain the process to the reviewers. However, as her specialization is not in data visualization, she finds herself in a challenging situation, uncertain about how to proceed.

Figure 2: Machine Learning engineer Sangwoo Mun

3.2 Secondary Persona: ML Engineer Sangwoo Mun

Sangwoo Mun is a 27-year-old male residing in Pangyo, South Korea. He recently joined KAOKAO, a company specializing in machine learning solutions related to stock market prediction, as a junior Machine Learning Engineer. His immediate goal is to gain recognition for his technical prowess and to ascend to a senior engineer position as quickly as possible.

In a new project he is tasked with, he is responsible for optimizing the hyperparameters of a deep learning model. Among various methods, he decided to employ BOHB, an optimization technique. However, due to his limited understanding of BOHB, he needs help to analyze the results and determine how to improve them. Consequently, he is actively searching for resources and tools that could help him address this problem.

3.3 Difference between two personas.

Yuna Jeon, a doctoral student, and Sangwoo Moon, a novice machine learning engineer, exhibit unique needs in their respective situations. Yuna, well-versed in using BOHB for hyperparameter optimization, is challenged by visualizing and effectively expressing its results under a tight research paper deadline. Her primary goal is to complete her research for timely graduation swiftly. In contrast, Sangwoo, new to BOHB, aspires to enhance his technical competency to accelerate his career. He seeks resources or tools to help him comprehend and utilize this optimization technique.

4 Visualization Idioms

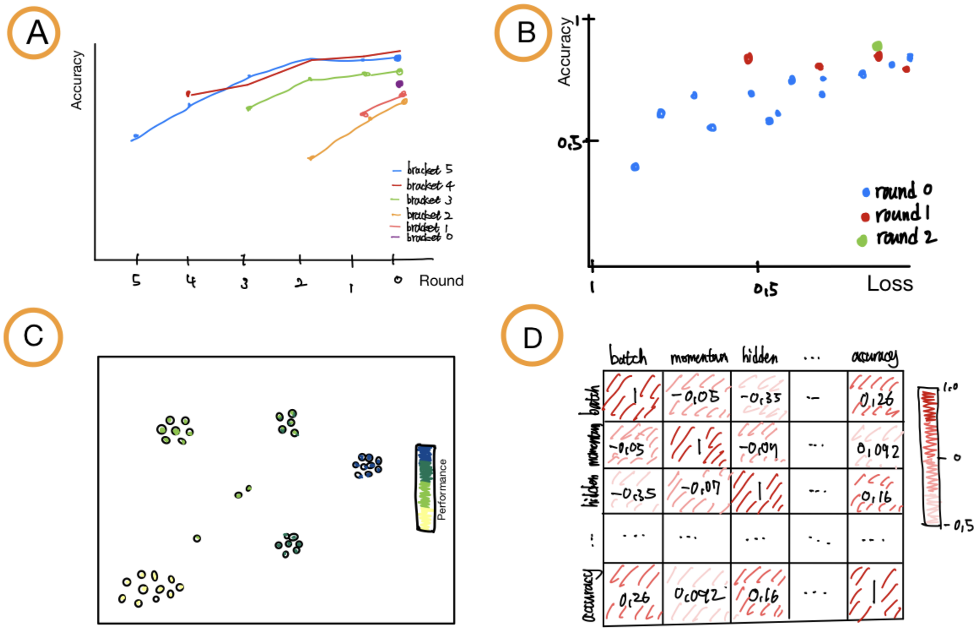

Figure 3: Sketch of the Visualization Idioms.

4.1 Line Chart

In Figure 3-A, the line chart summarizes the average accuracy across each bracket round. The x-axis represents the round, the y-axis represents accuracy, and different colors denote distinct brackets. Upon hovering the mouse over a line corresponding to a bracket, users can obtain summarized information about that bracket's sampling method and specific performance using the tooltip. Because this visualization represents the average accuracy for each bracket, it ensures adequate scalability and supports Task 1, allowing users to comprehend the overall operational principle of BOHB through interaction.

4.2 Scatterplots

When a user clicks on a specific bracket line in Figure 3-A, the data related to that bracket is filtered, and Figures 3-B and 3-C are subsequently rendered. As only a subset of the total data is visualized, the scalability of both scatterplots is appropriately maintained.

Figure 3-B visualizes the loss and accuracy for the selected bracket via a scatterplot. The x-axis represents the loss value, the y-axis signifies accuracy, and different colors denote various rounds. As the tooltip enables users to verify the configuration information for each data point, Task 2 is fulfilled.

Figure 3-C portrays the data distribution for the corresponding bracket through a scatterplot. Dimension reduction techniques map the attributes of the data to two-dimensional values(x and y), and colors represent the performance of each data point. This idiom lets users observe each bracket's data distribution, satisfying Task 3.

4.3 Heatmap

The heatmap in Figure 3-D represents the correlation values among various attributes. By fulfilling Task 4, this idiom allows users to discern the extent of correlation among the attributes.