Blue-Light Blocking Glasses Using ML

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***Abstract*—The objective of short-wavelength (”blue”) light-filtering lenses is to boost physiological wellness and sleep. While UV filters are frequently used, there is little information about their relative effectiveness in reducing exposure to blue light while preserving visibility. Five light sources were used to test fifty standard lenses: the sun, a fluorescent ceiling luminaire, an incandescent lamp, and a blue LED array. In order to calculate the percentage transmission, absolute irradiance was measured at baseline and for each lens across the visible spectrum (380-780 nm). Additionally, transmission specificity was evaluated to identify whether light transmission was primarily non-proficient (380-454 nm and 561-780 nm) or circadian-proficient (455-560 nm). By tint, lenses were grouped, and metrics were contrasted between the groups. The least amount of circadian-proficient light was transmitted by red-tinted lenses. In this paper, we want to focus on studying the various properties of blue blockers across different lighting conditions and study patterns that can possibly help future users of blue blockers effectively through different findings.**

***Index Terms*—component, formatting, style, styling, insert**

I. Introduction

The characteristics of light absorption and transmission displayed by materials are referred to as spectrophotometric qualities. These characteristics are essential to the efficiency of blue blockers in blocking or filtering blue light. Blue light, which is released by electronics, LED lights, and sunshine, is harmful to the eyes and can be blocked by using glasses or contact lenses called blue blockers. Blue light is selectively filtered or blocked by blue blockers that are marketed for use in industry. Other wavelengths of light are allowed to flow through while the blue light is blocked. The precise qualities of the lenses and the lighting circumstances in which they are used can affect how effective blue blockers are. Blue light is emitted in variable volumes and spectra under various lighting circumstances, including artificial lighting, natural sunlight, and screens on electronic devices. Therefore, to determine how well blue blockers perform overall, it is necessary to study their spectrophotometric characteristics under various lighting scenarios. The transmittance spectrum, which shows how much light is transmitted at various wavelengths, is a significant characteristic of blue blockers. While having higher transmittance in other regions of the visible light spectrum, blue blockers often have reduced transmittance in the blue light range (about 400–500 nanometers). The inclusion of particular lens coatings or additives can frequently affect a blue blocker's capacity to selectively filter blue light. As an illustration, some blue-blocking materials may have a yellow or amber color to improve the absorption of blue light. By decreasing transmission in the blue region and changing the impression of color, these tinted lenses can affect the spectrophotometric properties.

Identify applicable funding agency here. If none, delete this.

II. Literature Review

Due to its possible effects on human health and wellbeing, blue light has drawn a lot of study. Blue light emitted by electronic gadgets, LED lights, and sunlight can be avoided by using blue-blocking eyewear and lenses, which are commercially available. The ability of blue blockers to block or filter blue light is greatly influenced by their spectrophotometric characteristics. This review of the literature seeks to present an overview of recent studies on the spectrophotometric characteristics of commercially available blue blockers under various illumination situations. Indicating the amount of light transmitted at various wavelengths, the transmittance spectrum is a significant spectrophotometric characteristic of blue blockers. According to studies, blue light blockers have lower transmittance in the 400–500 nm range of blue light while maintaining higher transmittance in other regions of the visible light spectrum. Blue blockers' transmittance spectra can be affected by a variety of manufacturing processes and materials employed in their construction, which will have an impact on how well they filter blue light. To improve their capacity to filter blue light, blue blockers frequently use lens coatings also known as tinting. The spectrophotometric characteristics of the lenses are altered by these coatings or tints, which causes a stronger attenuation of blue light. For instance, lenses with a yellow or amber tint have been proven to successfully block blue light and offer a more accurate perception of color. Studies have looked at how various coatings and tinting methods affect the spectrophotometric qualities of blue blockers, emphasizing the significance of these elements in blue light filtration. Depending on the lighting conditions they are used in, blue blockers may or may not be effective. The quantity and spectrum of blue light emitted by various illumination sources varies. Studies have looked at the spectrophotometric characteristics of blue blockers under a range of lighting circumstances, including artificial lighting, natural light, and screens. According to these studies, blue blockers may display various degrees of blue light filtration and color perception changes depending on the individual lighting situation. Researchers have used a variety of measurement strategies and evaluation procedures to evaluate the spectrophotometric characteristics of blue blockers. Quantifying the transmittance spectra, color distortions, and general spectrum properties of blue blockers has been done using spectrophotometers and colorimeters. Through these measurements, a thorough understanding of the spectrophotometric characteristics and functionality of blue blockers under various lighting circumstances is made possible. User experience and visual comfort are crucial factors to take into account when assessing blue blockers in addition to spectrophotometric characteristics. Individuals who use blue blockers in various lighting environments have been the focus of certain research examining their subjective experiences. Beyond their spectrophotometric qualities, blue blockers have further practical advantages that have been shown by assessments of visual comfort, color perception, and visual performance.

III. Research Methodology

To develop a machine learning model for "blue light emission glasses" using the k-nearest neighbors algorithm, we can follow the following methodology:

A. Data Collection

Gathering a dataset that contains information about different types of glasses and their corresponding blue light emission levels.

B. Data Preparation

Preprocessing the collected data by cleaning it, handling missing values, and ensuring it is in a suitable format for training the k-nearest neighbors algorithm. This may involve converting categorical variables to numerical representations or normalizing numerical features.

C. Feature Selection/Extraction

Identifying the relevant features from the dataset that can help predict blue light emission levels. Consider factors such as glass material, manufacturing process, coating, and other relevant characteristics.

D. Splitting the Dataset

Dividing the preprocessed dataset into a training set and a test set. The training set will be used to build the k-nearest neighbors model, while the test set will be used to evaluate its performance. A common split is to use around 70-80% of the data for training and the remaining portion for testing.

E. Choosing the Value of k

Determining the appropriate value of k for the k-nearest neighbors algorithm. We can experiment with different values of k and use techniques such as cross-validation or grid search to find the optimal value that results in the best performance.

F. Training the Model

Applying the k-nearest neighbors algorithm to the training set. During training, the algorithm will identify the k nearest neighbors for each instance in the training set based on the chosen distance metric.

G. Model Evaluation

We have to use the test set to evaluate the performance of the trained k-nearest neighbors model. After that we calculate relevant evaluation metrics such as accuracy, precision, recall, or mean squared error to assess how well the model predicts blue light emission levels.

H. Parameter Tuning

Iterating over steps 4 to 7, adjusting the value of k or exploring different distance metrics to find the optimal configuration for our model.

I. Parameter Tuning

Model Deployment Once we are satisfied with the performance of our model, we can deploy it to make predictions on new instances of glasses. We can either integrate it into an application or use it as a standalone tool.

IV. Data Analysis

A. Commercially available lenses and circadian rhythm

Commercially available lenses that block short-wavelength ("blue") light are promoted to enhance circadian rhythm health and sleep. Despite their extensive use, there is little information about their relative effectiveness in reducing blue light sensitivity while preserving visibility. A blue LED array, a computer tablet display, an incandescent lamp, a fluorescent overhead luminaire, and sunshine were used to test fifty commercial lenses. Maximal irradiance across the visual spectrum (380–780 nm) was measured at baseline and for each lens, allowing percent transmission to be calculated.

B. Data Requirements

50 blue blocker glasses were chosen based on their prior use in studies examining the non-visual effects of light, current marketing assertions regarding blocking circadian-proficient or ”blue” light, and the degree to which the lenses were tinted or otherwise filtered (and thus would be expected to reduce light exposure). If the lenses required a prescription, were unavailable on the American market, or featured magnification or distortion, they were omitted.

C. Data Cleaning

The collected raw data of Blue Blocker glass was presented in a table form. This sufficed all the necessary and irrelevant information in this particular study. The usage of OpenRefine helped tabling and segregating rows and columns for scanning through the data and hence cleansing. Missing and null data values were omitted and column and rows were merged in order to fit the study criteria and software analysis.

D. Data Processing

In order to identify whether light transmission was mostly circadian-proficient (455–560 nm) or non-proficient (380–454 nm and 561–780 nm), transmission specificity was also measured. Measurements were examined between groups of lenses after grouping them according to tint. The propagation of circadian-proficient illumination was lowest through red-tinted glasses and highest through reflecting blue lenses. Similar amounts of circadian-proficient light were transmitted by orange-tinted lenses and red-tinted lenses, but more non-circadian-proficient light was also transmitted, leading to increased transmission specificity. In normal daylight, orange-tinted glasses provided the maximum transmission specificity while restricting exposure to physiologically active light. Presently, a significant chance exists for glasses with these lenses to help regulate circadian sleep-wake rhythms.

V. PROTOTYPE IMPLEMENTATION

A. Import Necessary Libraries

The code begins by importing the required libraries such as `numpy`, `pandas`, `sklearn` (scikit-learn), and `matplotlib`. These libraries are essential for data manipulation, machine learning modeling, and visualization.

B. Load the Dataset

We have a dataset containing relevant features and the target variable (spectrometric values) stored in a CSV file. The `pd.read_csv()` function from the `pandas` library is used to load the data into a DataFrame named `data`.

C. Data Preprocessing

The dataset is split into input features (`X`) and the target variable (`y`). The `train_test_split()` function from `sklearn` is used to split the data into training and testing sets, which is a common practice in machine learning to evaluate model performance.

D. Model Initialization and Training

Three regression models are initialized: Support Vector Machine (SVM), K-Nearest Neighbors (K-NN), and Linear Regression. These models are initialized using their respective classes from the `sklearn` library. Each model is then trained using the training data (input features and target variable) using the `.fit()` method.

E. Prediction and Evaluation

After training, the models are used to make predictions on the testing set (`X_test`). The predicted values are stored in `svm_pred`, `knn_pred`, and `linear_pred` for each respective model. Several evaluation metrics are calculated for each model, including Mean Squared Error (MSE), Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and R-squared (R2). These metrics are used to assess the performance of each model.

F. Visualization

A scatter plot is created to visually compare the actual spectrometric values (`y_test`) against the predicted values (`knn_pred`) from the K-NN model. This plot helps to visualize how well the model’s predictions align with the actual values.

G. Metric Interpretation

The code provides an interpretation of the evaluation metrics for each model. It explains how to interpret higher and lower values of MSE, RMSE, and MAE, and how R2 indicates the variance explained by the models.

H. Conclusion

Based on the evaluation results and interpretation, the K-NN model performs the best among the three models for predicting the spectrometric characteristics of blue-light-blocking eyewear. It recommends using the K-NN model due to its accuracy and strong R2 score.

VI. RESULT ANALYSIS

This analysis is aimed at comparing the performance of three regression models for predicting the spectrometric characteristics of blue-light-blocking eyewear: Support Vector Machine (SVM), K-Nearest Neighbors (K-NN), and Linear Regression. The goal is to comprehend how well these models predict the spectral properties of the glasses based on input parameters. We implement the following evaluation indicators to rate the performance of the models:

Mean Squared Error (MSE): Mean squared error (MSE) measures the average squared difference between the predicted and actual spectrometric values. A lower MSE suggests more accurate prediction. Mathematically, it is calculated from the formula:

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2 \tag{1}$$

Root Mean Squared Error (RMSE): Root Mean Squared Error (RMSE) measures error in the same unit as spectrometric data and is the square root of Mean Squared Error (MSE). Mathematically calculated as:

$$RMSE = \sqrt{MSE} \tag{2}$$

Mean Absolute Error (MAE): Mean Absolute Error (MAE) represents the average absolute difference between the expected and actual values. Mathematically calculated as:

$$MAE = \frac{1}{n}\sum_{i=1}^{n}|y_i - \hat{y}_i| \tag{3}$$

R-squared (R2): R-squared (R2) denotes the percentage of the variance in the spectrometric data that the models are able to account for. The better the fit, the greater the R2. Mathematically calculated as:

$$R2 = 1 - \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2} \tag{4}$$

A. Model Evaluation Results

Support Vector Machine (SVM):

$$MSE = 211.039; \qquad RMSE = 14.527$$
$$MAE = 10.365; \qquad R2 = 0.483$$

K-Nearest Neighbors (K-NN):

$$MSE = 35.059; \qquad RMSE = 5.921$$
$$MAE = 3.844; \qquad R2 = 0.914$$

Linear Regression:

$$MSE = 82.907; \qquad RMSE = 9.105$$
$$MAE = 1.399; \qquad R2 = 0.797$$

B. Metric Interpretation

- Higher MSE, RMSE, and MAE values in the SVM model point to more prediction errors and a weaker fit.
- Lower MSE, RMSE, and MAE values for K-NN indicate superior performance with higher predicted accuracy, as well as a better R2.
- By balancing fit and accuracy, linear regression delivers a decent R2 score and reasonable error metrics.

C. Conclusion

The K-NN model stands out as the best performance when evaluation criteria and visualizations are taken into account. The highest R2 score and the lowest error metrics indicate accurate and well-fitted predictions. While the SVM model trails behind due to larger prediction errors and lesser explanatory power, linear regression also demonstrates promise.

In conclusion, it is advised to use the K-NN model to forecast the spectrometric characteristics of blue-light-blocking eyewear. Its remarkable accuracy and strong R2 score show that it is capable of accurately estimating spectral characteristics. This analysis offers suggestions for choosing a reliable regression model to forecast spectrometric characteristics in the context of blue-light-blocking eyewear.

Acknowledgment

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References

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