**Interpretation Guide for Neurologists and Physicians**

This guide is intended to help you interpret the outputs generated by the eye-tracking analysis software designed to assist in the early detection of Alzheimer’s disease. The software analyzes data collected from four separate sessions with each patient and provides various visualizations and predictions. This guide explains what these outputs mean and how to interpret them to make informed decisions about a patient’s cognitive health.

**1. Overview of Outputs**

After the data collection process is completed, the software will provide the following outputs:

1. **Classification Result**: Whether the patient is classified as Healthy, Early Alzheimer’s, or Alzheimer’s.
2. **Prediction Probabilities**: The likelihood (in percentage) that the patient belongs to each of the above categories.
3. **Visualizations**: A series of graphs that represent the patient’s eye-tracking metrics over the four sessions.

**2. Classification Result**

The software classifies each patient into one of the following categories:

* **Healthy**: The eye-tracking data indicates normal cognitive function.
* **Early Alzheimer’s**: The data suggests early signs of cognitive decline.
* **Alzheimer’s**: The data shows significant evidence of cognitive impairment consistent with Alzheimer’s disease.

**How to Interpret**:

* If the patient is classified as **Healthy**, it means their eye-tracking behavior falls within normal ranges, and there are no significant signs of cognitive decline.
* A classification of **Early Alzheimer’s** suggests that the patient is showing early signs of cognitive decline, and further monitoring or intervention may be required.
* A classification of **Alzheimer’s** indicates that the patient is likely experiencing significant cognitive impairment and may require immediate attention and management.

**3. Prediction Probabilities**

The software provides probabilities for each category, reflecting the confidence of the classification. For example:

* **Healthy**: 15%
* **Early Alzheimer’s**: 70%
* **Alzheimer’s**: 15%

**How to Interpret**:

* Higher probabilities indicate greater confidence in that classification. For instance, if the probability for Early Alzheimer’s is 70%, it suggests a strong likelihood that the patient is in the early stages of the disease.
* If probabilities are close to each other, it may indicate uncertainty, and additional clinical evaluation may be needed.

**4. Visualizations**

The software generates several plots to help you visually interpret the patient’s eye-tracking data. Below are the types of plots you will see and how to interpret them:

**4.1 Line Plots**

* **What They Show**: These plots depict how each eye-tracking metric (Fixation Duration, Saccade Amplitude, Pupil Dilation, Blink Rate) changes across the four sessions.
* **Interpretation**: Consistent or stable patterns typically indicate normal behavior. If you observe a decline in metrics like Fixation Duration over the sessions, this could suggest increasing difficulty in maintaining attention—a potential sign of cognitive decline.

**4.2 Scatter Plot (Pupil Dilation vs. Fixation Duration)**

* **What It Shows**: This scatter plot displays the relationship between pupil dilation (indicating cognitive load) and fixation duration (indicating attention span).
* **Interpretation**: A balanced relationship is typical in healthy individuals. If pupil dilation increases while fixation duration decreases, it may indicate that the patient is experiencing difficulty maintaining attention under cognitive load, which could be a sign of early cognitive decline.

**4.3 Time-Series Analysis**

* **What It Shows**: This plot tracks the progression of each metric over the four sessions.
* **Interpretation**: Look for trends such as a steady increase in Blink Rate or a decrease in Saccade Amplitude, which could indicate worsening cognitive function. Consistent metrics over time generally suggest stable cognitive health.

**4.4 Box Plots**

* **What They Show**: Box plots summarize the distribution of each metric, showing medians, quartiles, and outliers.
* **Interpretation**: A wider spread in the data or the presence of outliers could indicate abnormal eye-tracking behavior. For instance, a higher than normal Blink Rate could suggest cognitive fatigue or stress.

**4.5 Radar Chart**

* **What It Shows**: Radar charts provide a holistic view of all eye-tracking metrics together, allowing you to see how each metric compares to the others.
* **Interpretation**: This chart helps identify imbalances in the metrics. Significant deviations in one or more metrics (e.g., unusually high Pupil Dilation) could be a sign of cognitive impairment.

**4.6 Correlation Heatmap**

* **What It Shows**: The heatmap shows correlations between the different eye-tracking metrics.
* **Interpretation**: Strong correlations are expected in healthy individuals. If certain metrics that are normally correlated (e.g., Gaze Coordinates and Fixation Duration) show weak or unexpected correlations, this could indicate a breakdown in cognitive processing.

**4.7 Distribution Plots**

* **What They Show**: These plots display the distribution of each metric across the sessions.
* **Interpretation**: Distribution plots help you see how each metric is spread out. A wide distribution might indicate variability in the patient’s cognitive performance, which could be a sign of cognitive instability.

**5. Example of Interpreting the Results**

Imagine you are reviewing the results for a patient who has completed the four sessions:

* **Classification Result**: Early Alzheimer’s
* **Prediction Probabilities**:
  + Healthy: 20%
  + Early Alzheimer’s: 65%
  + Alzheimer’s: 15%

**Interpretation**:

* **Line Plots**: The line plots show that the patient’s Fixation Duration is gradually decreasing across the sessions, suggesting that the patient is finding it increasingly difficult to maintain focus.
* **Scatter Plot**: The scatter plot indicates that as Fixation Duration decreases, Pupil Dilation increases, which may reflect higher cognitive load as the patient struggles to maintain attention.
* **Time-Series Analysis**: The time-series plot reveals an increasing Blink Rate, which might indicate cognitive fatigue.
* **Box Plots**: The box plots show a wide range of Saccade Amplitudes, suggesting inconsistency in visual scanning behavior.
* **Radar Chart**: The radar chart reveals a significant deviation in Pupil Dilation compared to the other metrics, reinforcing the possibility of cognitive decline.
* **Correlation Heatmap**: The heatmap shows a weakening correlation between Gaze Coordinates and Fixation Duration, possibly indicating impaired visual processing.
* **Distribution Plots**: The distributions for key metrics like Fixation Duration are unusually wide, suggesting variability in the patient’s cognitive performance.

**Conclusion**: Based on the visualizations and the classification result, the patient is showing early signs of cognitive decline consistent with Early Alzheimer’s. Further clinical evaluation and monitoring are recommended.

**6. Conclusion**

This software provides valuable insights into a patient’s cognitive health through the analysis of eye-tracking data. By understanding and interpreting the visualizations and predictions, you can make informed decisions about the patient’s potential cognitive decline and take appropriate steps for diagnosis and treatment.

This guide is designed to help you quickly and accurately interpret the software’s outputs, allowing you to integrate these insights into your clinical practice. If you have any questions or need further clarification, please consult the software's help documentation or contact the support team.