Abstract ID:CAOP21

The Role of Deep Learning-based Automation in Identifying the Onset of Cognitive Impairments through Revolutionized Evaluation of Cognitive Function Tests for Subjects in Remote Geographic Locations

(Computational Tools for Early Cognitive Impairment Detection)

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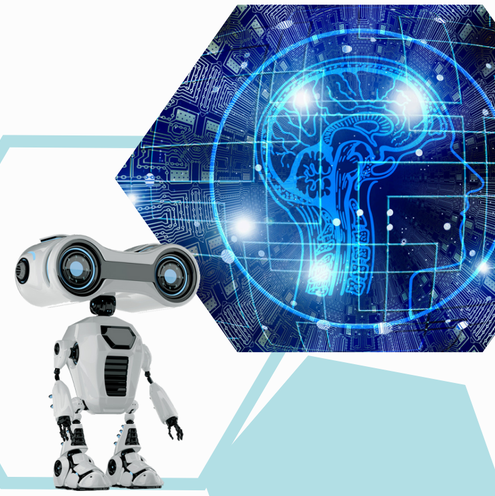

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Challenges in Cognitive Function Assessment AND OBJECTIVE

Geographic Barriers

Limited access to specialized healthcare professionals and facilities in remote areas creates significant obstacles to timely and accurate cognitive function assessment.

Subjective Evaluations

Traditional cognitive tests rely on subjective self-reporting, which can be unreliable and prone to bias, especially in individuals experiencing cognitive decline.

Objective

- Detect errors and hesitations in speech.
- Analyze user descriptions based on picture or environment and compare them to standard descriptions.
- Generate cognitive score based on some visualization based games to know user insights .
- VibeCheckAI to analyse emotion based on user input text.

Significance

Early detection of cognitive disorders plays a vital role in improving patient outcomes by enabling timely intervention and tailored care plans. Leveraging automation in assessments not only enhances efficiency but also minimizes human error, ensuring consistent, accurate, and objective evaluations.

Leveraging Deep Learning for Remote Monitoring

Accessibility

Remote access to cognitive assessments via smartphone apps or online platforms expands reach and enables earlier intervention.

Automation

Deep learning can automate the analysis of cognitive function tests, eliminating the need for manual scoring and interpretation.

Approach Taken for Evaluation

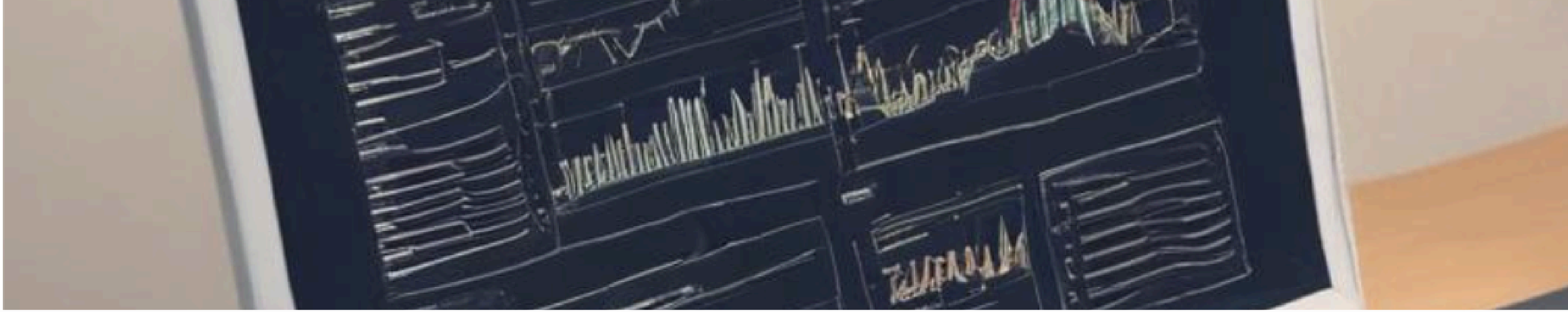
01 Verbal Fluency Test

02 Picture Description

03 Environment Description

04 VibeCheck AI

05 Mental Rotation Orientation Mapping



Verbal Fluency ->Speech Analysis:

Objective

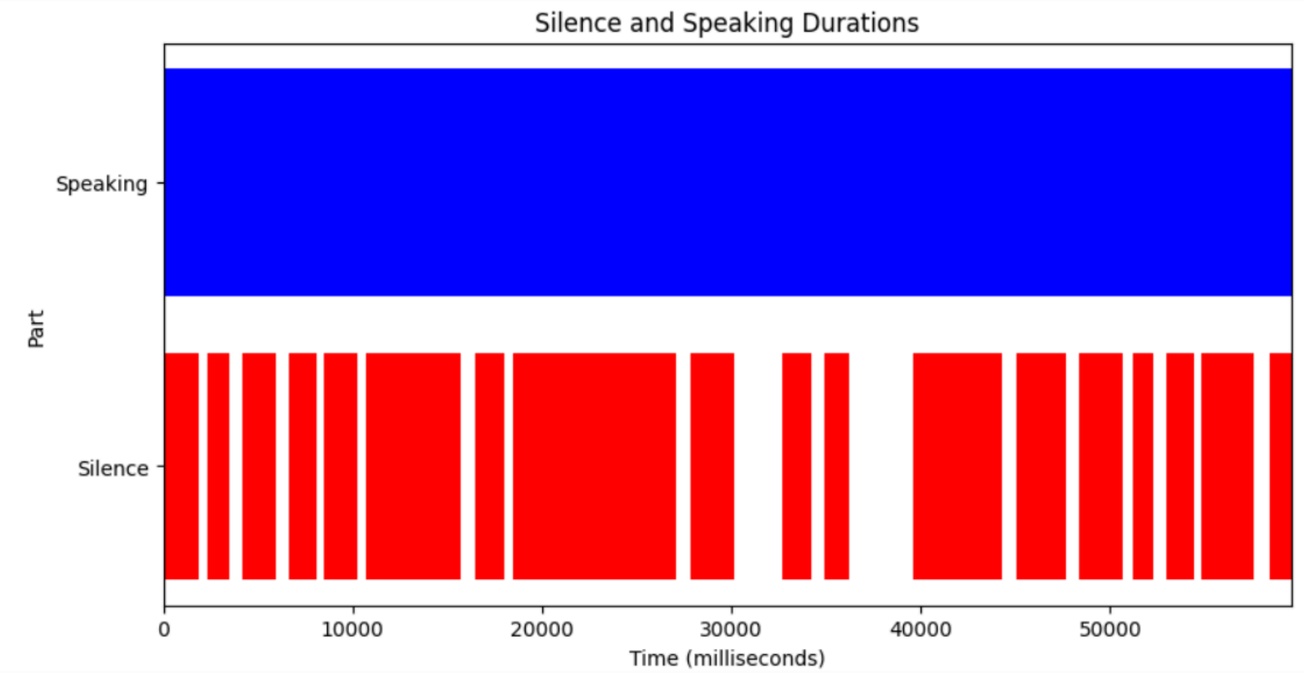
The goal of this analysis is to analyze audio recordings for silent and spoken segments and detect correctly spoken words to assist in evaluating cognitive abilities.

By identifying pauses (silences) and speech durations, this tool provides insights into communication patterns and cognitive behavior, which can help in diagnosing and assessing cognitive impairments.

Why Silence Detection Matters for Cognitive Analysis

The Bar Graph Will Illustrate this query.....

Practical Implications: Results and Analysis



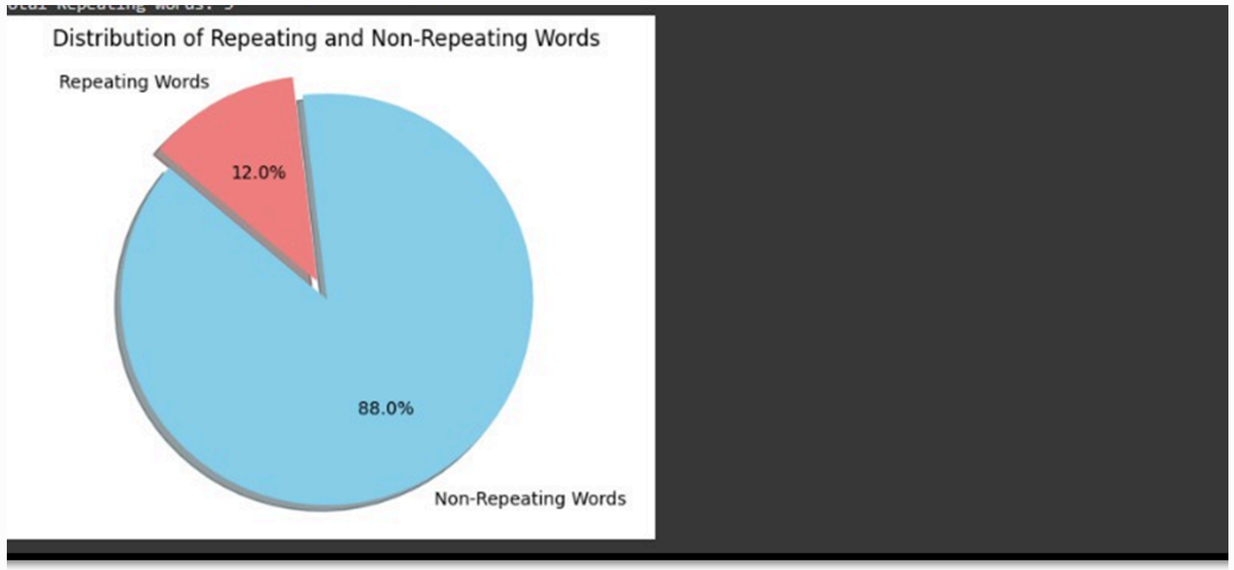

```
Silent Parts:
Start: 0.0s, End: 1.893s, Duration: 1.893s
Start: 2.352s, End: 3.508s, Duration: 1.156s
Start: 4.141s, End: 5.912s, Duration: 1.771s
Start: 6.628s, End: 8.064s, Duration: 1.436s
Start: 8.517s, End: 10.231s, Duration: 1.714s
Start: 10.708s, End: 15.7s, Duration: 4.992s
Start: 16.453s, End: 18.017s, Duration: 1.564s
Start: 18.504s, End: 27.106s, Duration: 8.602s
Start: 27.844s, End: 30.143s, Duration: 2.299s
Start: 32.713s, End: 34.226s, Duration: 1.513s
Start: 34.887s, End: 36.229s, Duration: 1.342s
Start: 39.612s, End: 44.311s, Duration: 4.699s
Start: 45.035s, End: 47.694s, Duration: 2.659s
Start: 48.344s, End: 50.663s, Duration: 2.319s
Start: 51.242s, End: 52.295s, Duration: 1.053s
Start: 52.983s, End: 54.46s, Duration: 1.477s
Start: 54.842s, End: 57.573s, Duration: 2.731s
Start: 58.444s, End: 59.553s, Duration: 1.109s
TOTAL SILENCE IN THE AUDIO:  44.329 s
PERCENTAGE OF SILENCE IN THE AUDIO:  73.03 %
```

Silences Reflect Thought Processing:

- Delays in responding can indicate difficulty in processing information or formulating responses.
- Speech-to-Silence Balance:
- An imbalanced ratio may highlight specific cognitive or emotional states, such as anxiety, depression, or brain injury.
- Visualization for Better Understanding:
- A clear graphical representation enables clinicians to identify irregular patterns at a glance and track changes over time.

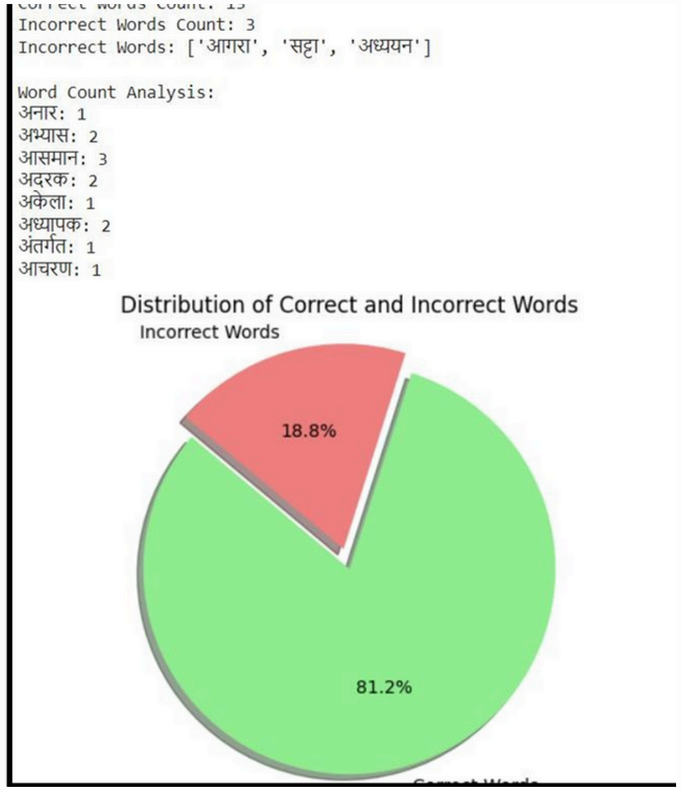
Practical Implications: Results and Analysis

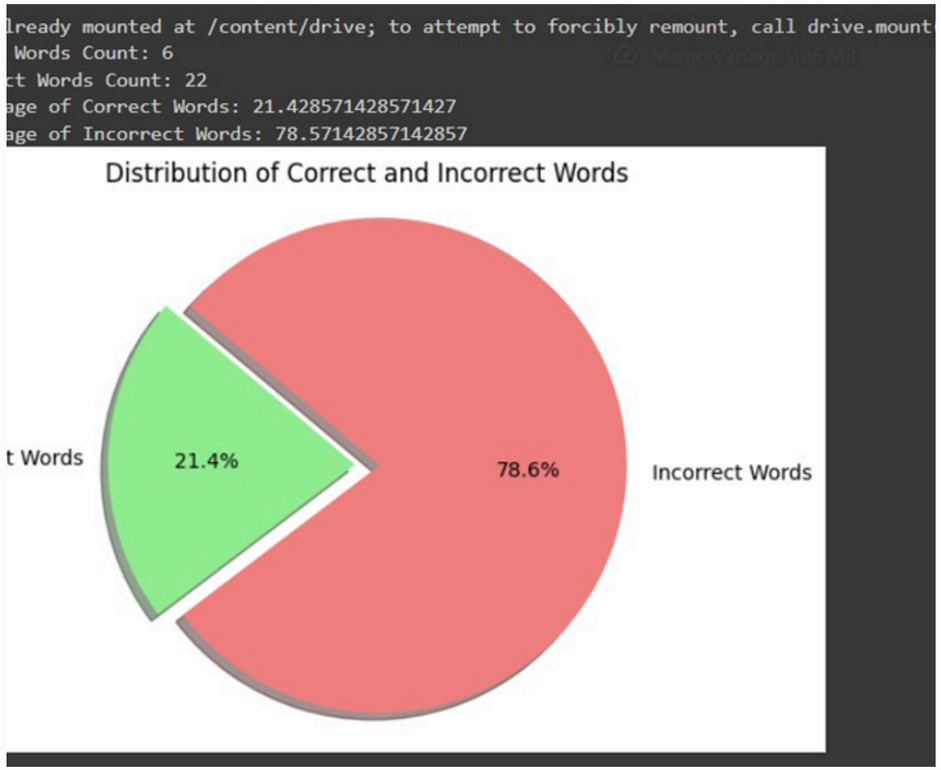
```
Unique Words and Their Counts:
apple - 1
banana - 1
lychee - 1
watermelon - 1
melon - 1
english - 1
hindi - 1
gk - 1
signs - 1
general - 1
science - 2
computer - 1
information - 1
technology - 1
artificial - 1
intelligence - 1
green - 2
yellow - 1
blue - 2
orange - 1
red - 1
purple - 1
violet - 1
light - 1
sky - 1

Repeating Words: ['science', 'blue', 'green']
Total Repeating Words: 3
```



- Translation from speech to text using Speech Recognition module of Goolgle speech API.
- This translation analyses the speech fluency difference and accent and translates into words for Hindi and English Language.

Practical Implications: Results and Analysis



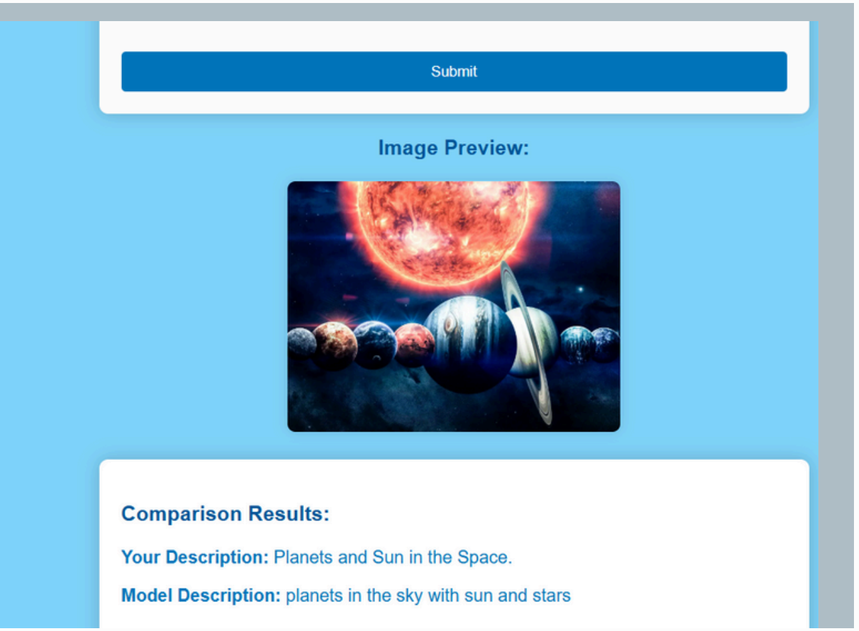


- These figures show the repetition of words. It also shows correctly and incorrectly spelled words as per the fluency and in comparison to actual word.

- This helps us to gain Valuable insights into a user's underlying cognitive or neurological conditions.

Image Description and Similarity Evaluation using BLIP and Cosine Similarity

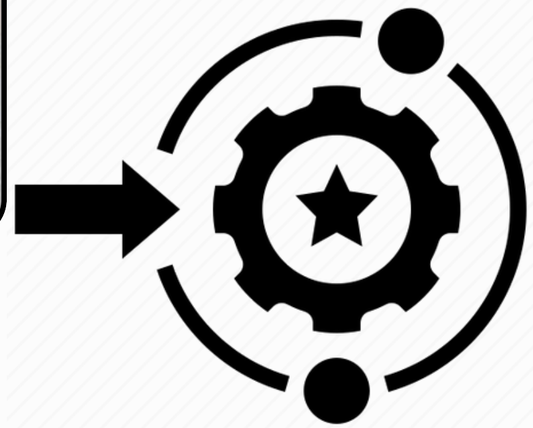
Subtitle:
A Cognitive Evaluation Methodology Using Image Recognition and Natural Language Processing



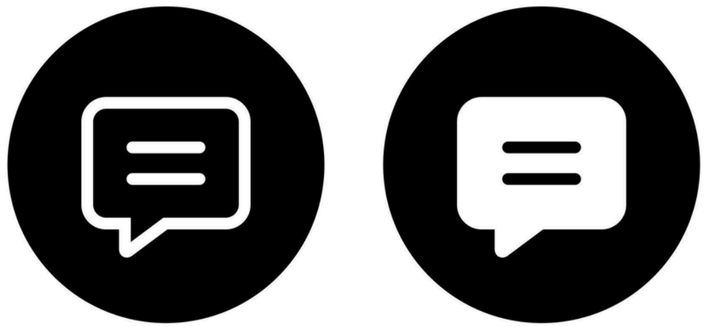
Problem Statement:

- Understanding how well a user perceives an image and how closely it aligns with an AI-generated description.
- Using similarity metrics to evaluate the user's cognitive response to an image.

Input image



Blip Model Processor



Text Generation and comparison with user

Image Description and Similarity Evaluation using BLIP and Cosine Similarity

Subtitle:The BLIP model (Bootstrapping Language-Image Pretraining) is a pre-trained image captioning model designed to generate textual descriptions of images. It is a combination of computer vision and natural language processing techniques, specifically built to generate captions or descriptions from the contents of an image.

Example Description by Application:

"This is an image of a traditional Indian saree in a vibrant pink color."

User Description:

"It is a beautiful pink saree."

Cosine Similarity (processed):

- Application Description: "image traditional indian saree vibrant pink color"
- User Input: "beautiful pink saree"

Cosine Similarity Percentage: 85.43%

Environmental Description :

Subtitle: A Python-Based Approach Using NLP for Answer Validation
Visual: Image of language processing or cognition.

Objective:

- Validate user responses to predefined questions by comparing semantic similarity with correct answers.

Purpose in Cognitive Assessment:

- Analyze linguistic and semantic reasoning in cognitively impaired individuals.
- Provide insights into the user's ability to process and generate meaningful language.

Environmental Description :

Evaluation Metrics :

$$\text{Cosine Similarity} = \frac{\vec{A} \cdot \vec{B}}{\|\vec{A}\| \|\vec{B}\|}$$

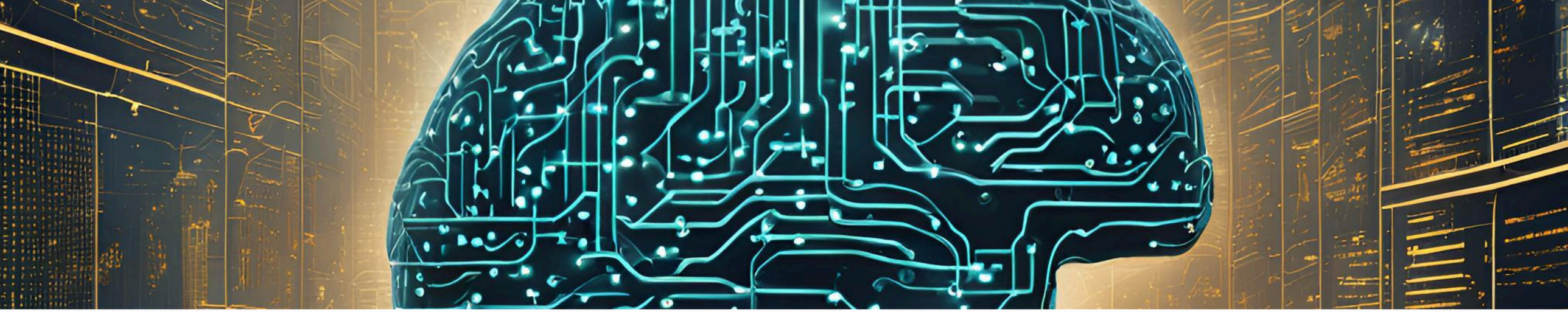
Example Output

Questions:

1. What color are you wearing?
   - User Answer: "Red"
   - Cosine Similarity: 0.72 → 1 Point
2. Can you tell me what is the weather today?
   - User Answer: "Cloudy"
   - Cosine Similarity: 0.40 → 0 Points

Final Scores:

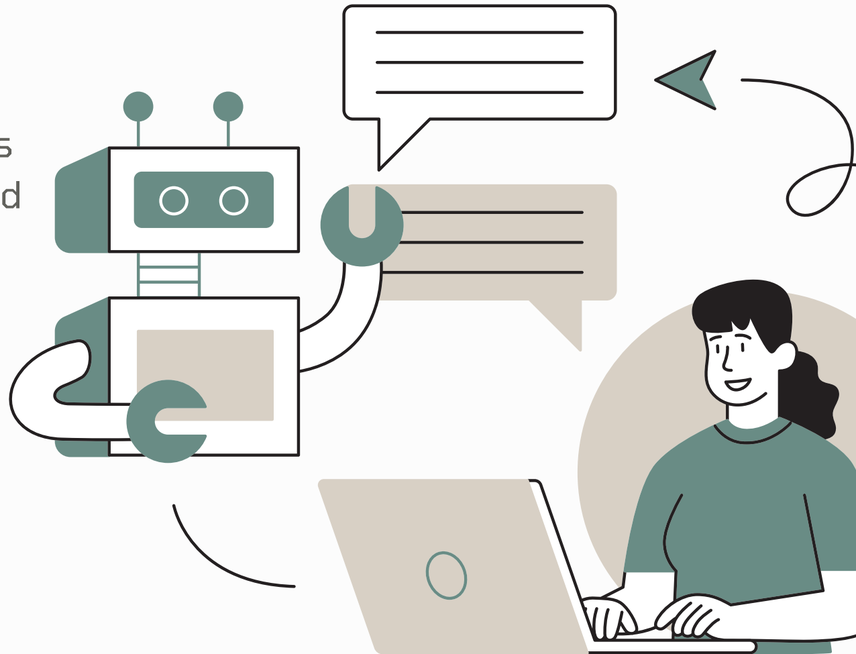
- Total Score: 3/4 (75%)
- Accuracy Rate: 50%
- Partial Understanding Rate: 25%
- Semantic Deviation: 25%

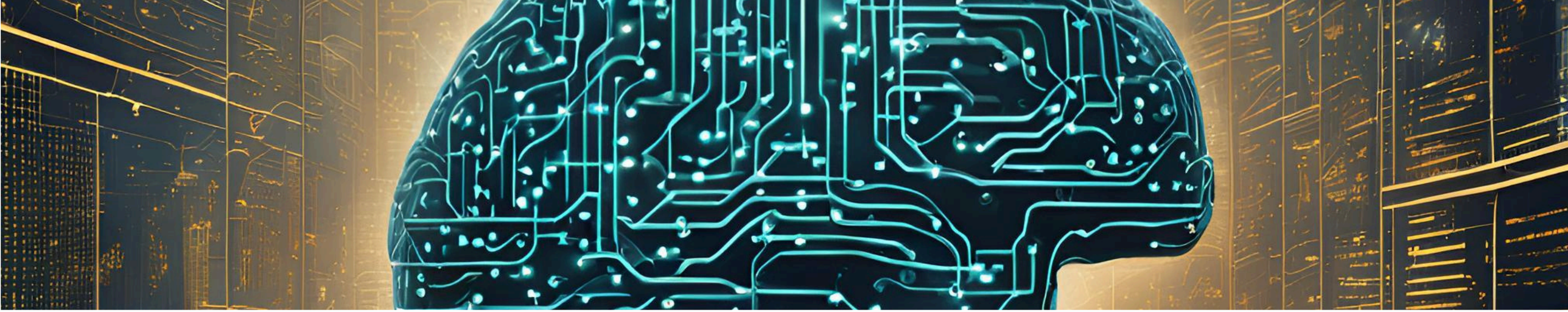


VibeCheck AI: LSTM and BERT-Based Text Analysis for Cognitive Analysis

Objective

The primary objective of this VibeCheck AI is to classify emotional states (depression, anxiety, and stress) based on user text inputs and provide actionable suggestions.
By leveraging advanced natural language processing (NLP) techniques, such as BERT embeddings and an LSTM model, the system identifies the emotional category of a given text, which can be used for cognitive assessment and support interventions.





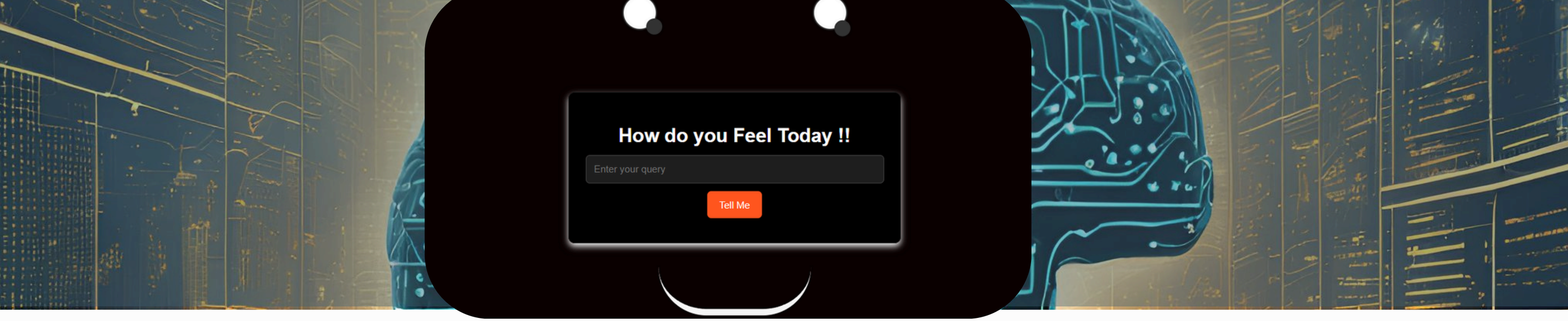
VibeCheck AI: LSTM and BERT-Based Text Analysis for Cognitive Analysis

Use Case

1. Cognitive Analysis and Emotional Assessment:
    - Scenario: A therapist collects text-based responses from individuals (e.g., diary entries, therapy notes, or surveys).
    - Goal: Classify emotional states to assess mental well-being and cognitive health.
    - Output: Assigns labels (depression, anxiety, or stress) to the text and provides personalized suggestions for mental health support.
2. Applications:
    - Healthcare: Enables therapists to monitor emotional trends and intervene early.
    - Self-Help Tools: Integrates into applications for users to self-assess their emotional state and receive coping strategies.
    - Corporate Wellness Programs: Assesses employee stress or anxiety levels based on anonymous feedback to improve workplace well-being.

How this Model works and gives analysis for chat

Let's See...



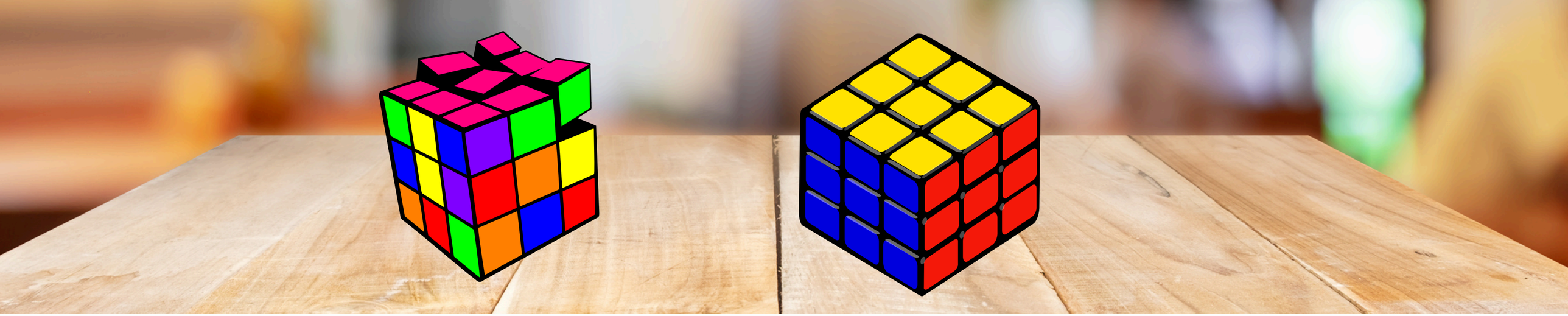
LSTM and BERT-Based Text Analysis for Cognitive Analysis

- **Synthetic Example: How the Model Works**

- **Input Text:**
- A user enters the following text into the system:
- **"I feel so overwhelmed with everything at work. There’s too much to handle, and I can’t seem to find a way to relax. It’s affecting my sleep, and I feel on edge all the time."**
- Preprocessing and Feature Extraction:
- The text is cleaned (e.g., removing punctuation, normalizing case).
- BERT Embeddings: The system extracts rich contextual word embeddings, where words like “overwhelmed,” “relax,” and “on edge” are understood in context.
- LSTM Processing: The embeddings are passed through the LSTM, which captures sequential dependencies (e.g., how "overwhelmed" relates to "work" and "relax").
- Emotion Classification:
- **The model classifies the emotional state of the text as: Stress.**

- **Actionable Suggestions:**
- Based on the classification, the system provides the following personalized suggestions:
- Stress Management Tips: “Consider practicing relaxation techniques such as deep breathing or meditation for 10–15 minutes a day.”
- Workload Management: “Try breaking down your tasks into smaller, manageable chunks and prioritize them to reduce overwhelm.”
- Sleep Improvement: “Avoid caffeine close to bedtime and establish a calming bedtime routine to improve sleep quality.”

Visualization of Results:
Input Text:
"I feel so overwhelmed with everything at work.
There’s too much to handle, and I can’t seem to find a way to relax.
It’s affecting my sleep, and I feel on edge all the time."
Predicted Label: Stress
Confidence Scores:
Stress: 82%
Anxiety: 12%
Depression: 6%



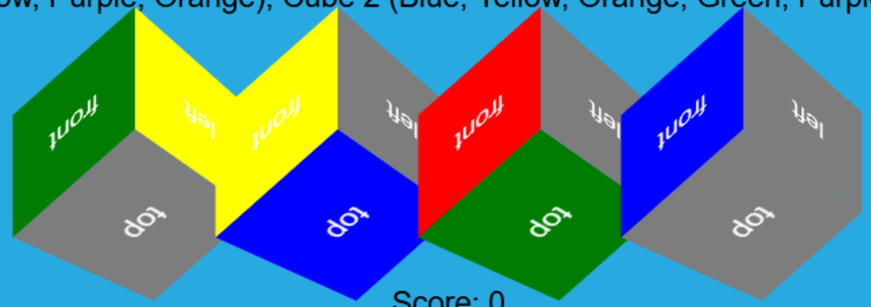
Mental Rotation Orientation Mapping

Objective

- To match the faces of 3D cubes with a predefined set of target colors.
- Players interact with each face of the rotating cubes, aiming to achieve accurate matches to maximize their score.
- Individuals seeking cognitive exercises.
- People recovering from cognitive impairments or neurological conditions (e.g., dyslexia, ADHD, or early dementia).
- Improves Focus and Attention: Requires sustained attention to details on multiple cube faces.
- Enhances Short-Term Memory: Players must recall the target colors and remember past choices.

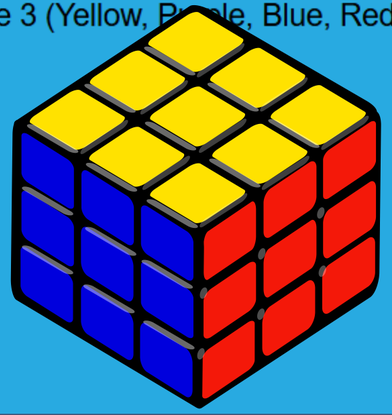
3D Color-Matching Cubes Game

Match each face with the target colors: Cube 1 (Red, Blue, Yellow, Purple, Orange), Cube 2 (Blue, Yellow, Orange, Green, Purple), Cube 3 (Yellow, Purple, Blue, Red, Green), Cube 4 (Purple, Red, Green, Orange, Blue).



Score: 0

Submit

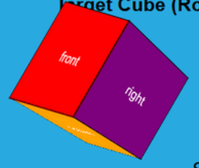


Mental Rotation Orientation Mapping

Mental Rotation Orientation Mapping Game

Rotate and color-match the **Player Cube** to match the **Target Cube** exactly!

Target Cube (Rotating)



Player Cube

Score: -15

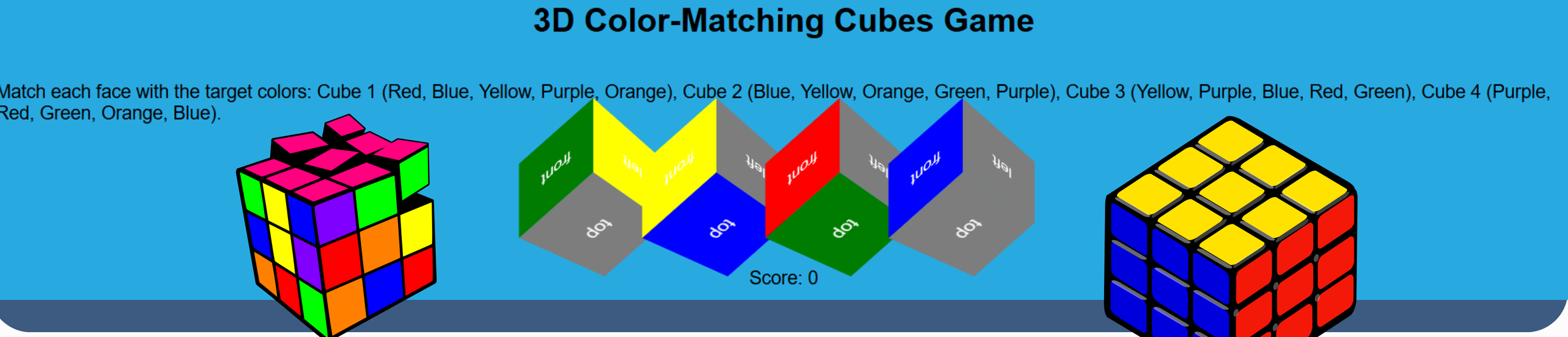
Time Left: 0s

Rotate Player Cube

Rotate X | Rotate Y | Rotate Z

Submit

Session	Score	Response Time (Seconds)	Feedback
1	70	45	Good start! Aim for quicker decisions.
2	60	50	Slight decline. Focus on accuracy.
3	80	40	Great improvement! Keep it up!
4	55	60	Performance dropped; take a short break.
5	90	38	Outstanding progress! You're doing great.



Mental Rotation Orientation Mapping

- **Behavioral Progress Analysis**
- Tracking Performance:
- **Input: Scores: [70, 60, 80, 55, 90]**

- **Trend Analysis:**
- "The user's performance shows some fluctuations. After a slight decline in Session 2, there was a significant improvement in Session 3, followed by a drop in Session 4. Session 5 indicates the best performance so far."
- Progressive Insights:
- Generated Feedback:
- "Your performance has improved significantly over the sessions. Session 4 might indicate signs of fatigue or loss of focus. It's recommended to take breaks between sessions for better performance."

- **Personalized Feedback:**
- Based on Response Time and Score:
- If response time increases while the score decreases:
- "It seems like you're taking longer to decide, leading to a lower score. Consider practicing for shorter durations to maintain focus."
- If the score improves with stable response time:
- "Great progress! Your quick decisions are leading to better results."

THANK **YOU**