



**Ministry of Science and Higher Education of the Republic of Kazakhstan
L.N. Gumilyov Eurasian National University**

**Faculty of Information Technology
Department of Information Systems**

Face Detection using Viola Jones Algorithm

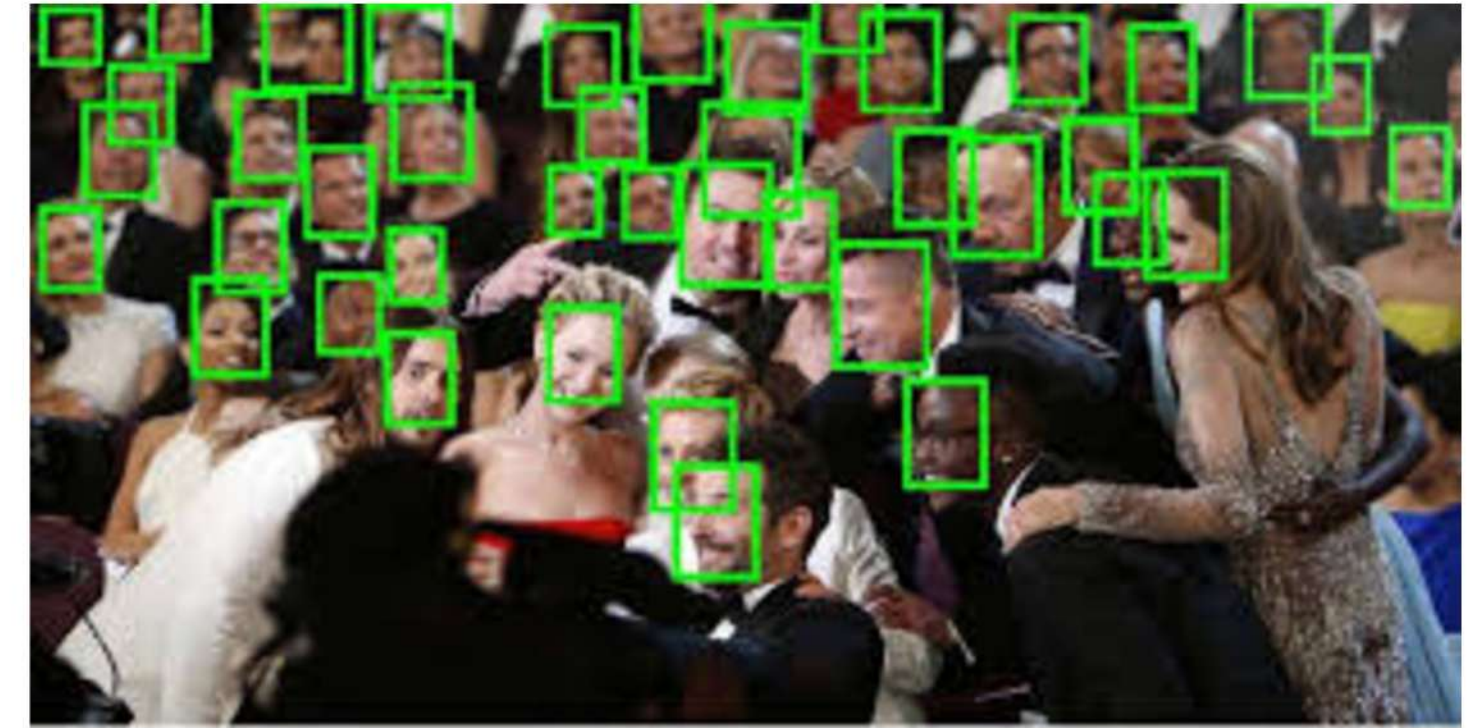
Done by: Iskakov Yerassyl

CHECKED BY: PROF. T.K. ZHUKABAYEVA

INTRODUCTION

The Face Detection task is easily done in the perspective of human visual task but when it comes in the view of computer it is little bit difficult. An image is given in which the faces are detected leaving the illumination, pose variation and lighting factors.

The module normalizes and illuminates the image, extracting facial features to differentiate faces from non-faces despite photometric and geometric variations.



Face detection in crowd



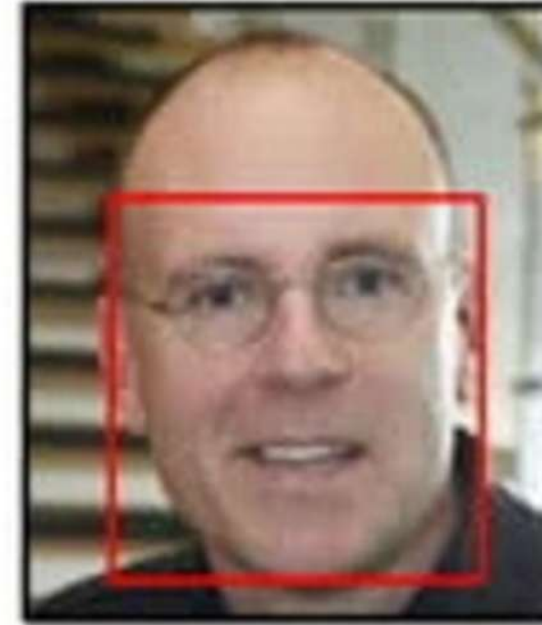
Also could ve applied to Anime character face detection
based on: <https://github.com/qhg2013/anime-face-detector?tab=readme-ov-file>



Animal face detection

INTRODUCTION

The Viola-Jones face detection method is the first framework based on object detection that provides good detection rates in real-time is given by Paul Viola & Michael Jones in the year of 2001. This algorithm has been implemented in a software 'Matlab' using the method vision.



Paul Viola

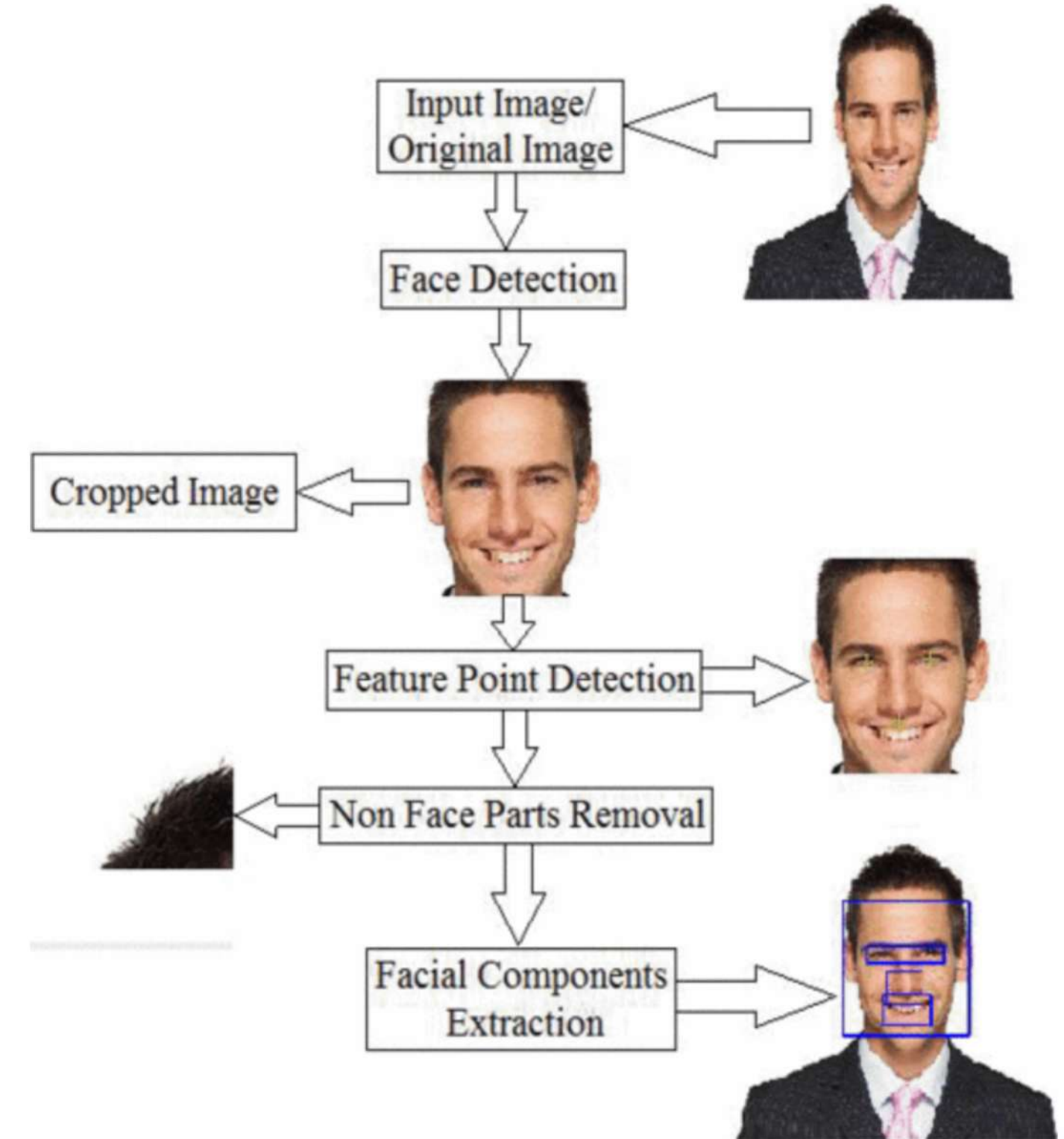


Michael J. Jones

VIOLA-JONES FACE DETECTION

The Viola - Jones contains of 3 techniques for the facial parts detection:

- The Haar like features for the feature extraction is of a rectangular type which is determined by an integral image.
- **Ada boost** is a machine-learning method for detecting the face. The term 'boosted' determines the classifiers that are complex in itself at each stage, which are built of basic classifiers using any one of the four boosting techniques.
- **Cascade classifier used** to combine many of the features efficiently. The term 'cascade' in a classifier determines the several filters on a resultant classifier.



WHAT ARE HAAR-LIKE FEATURES?

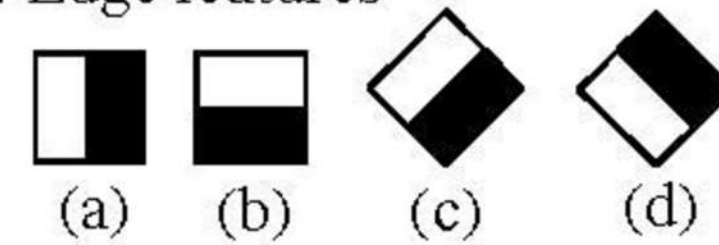
The Haar wavelet was introduced by Alfréd Haar in 1909 in his dissertation.

In simple word Haar-like features are used to detect patterns of light and dark areas in an image.

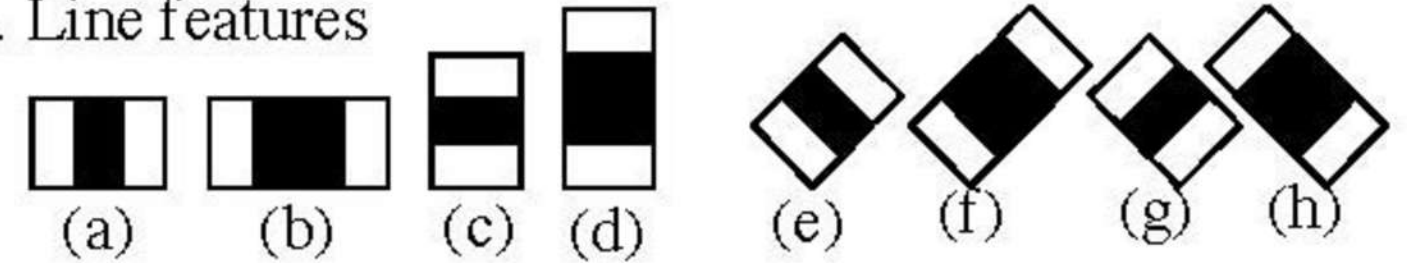
How it works?

- Each feature consists of two or more adjacent rectangular regions.
- The sum of pixel intensities in one region is subtracted from the sum in another region.
- The difference is used as a feature to classify regions of the image.

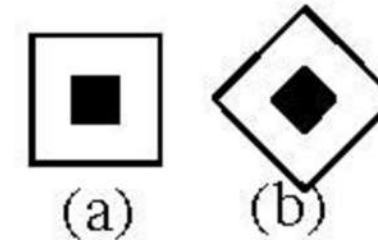
1. Edge features



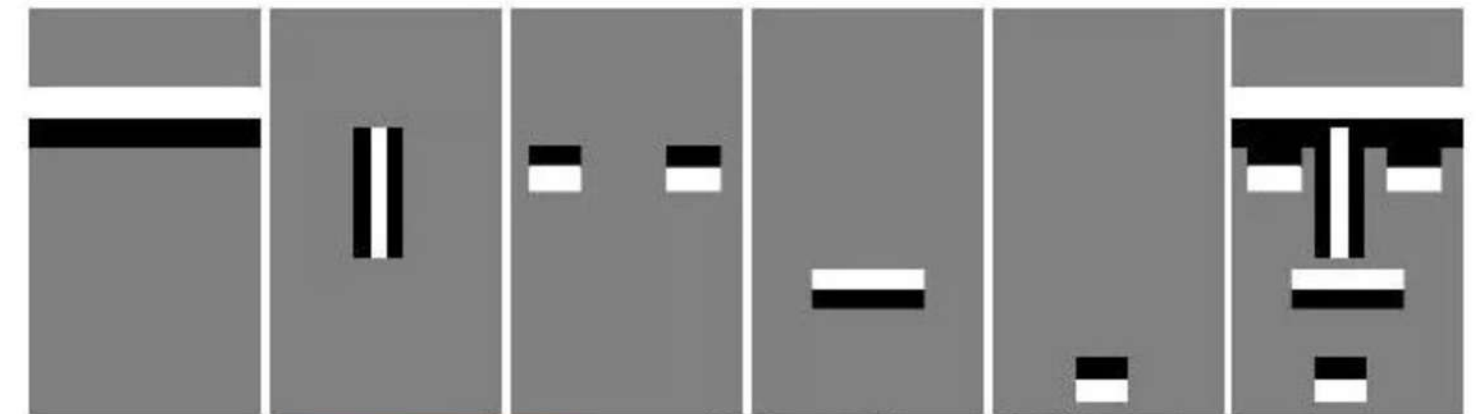
2. Line features



3. Center-surround features



4. Special diagonal line feature used in [3,4,5]



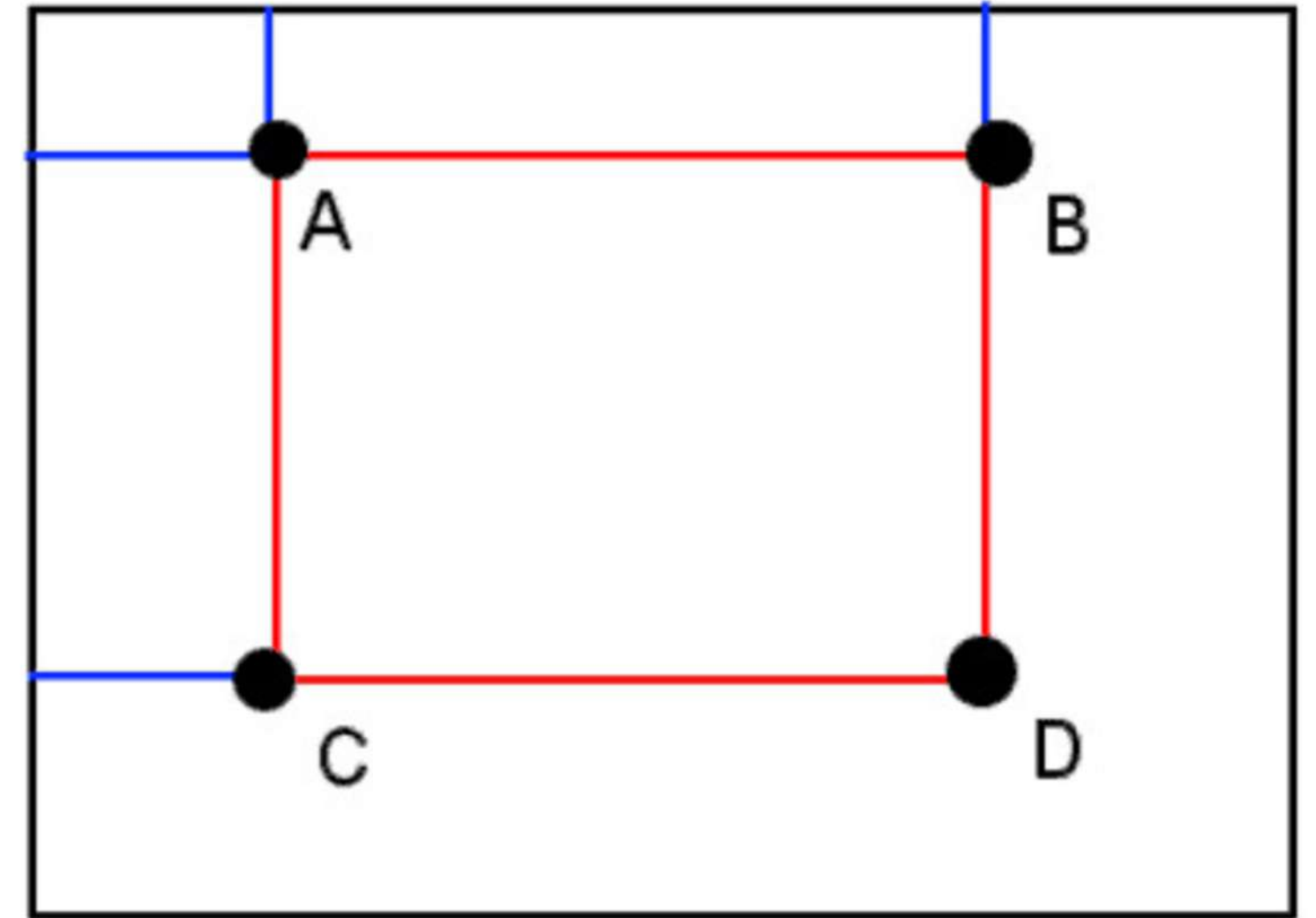
INTEGRAL IMAGE

Instead of computing pixel sums repeatedly, the integral image allows for fast calculation of Haar-like features.

- The integral value at any point (x, y) is the sum of all pixels above and to the left of (x, y) .
- Using this approach, any rectangular region's sum can be computed in constant time ($O(1)$).

the sum of pixel values within the rectangle ABCD shown above can be computed as:

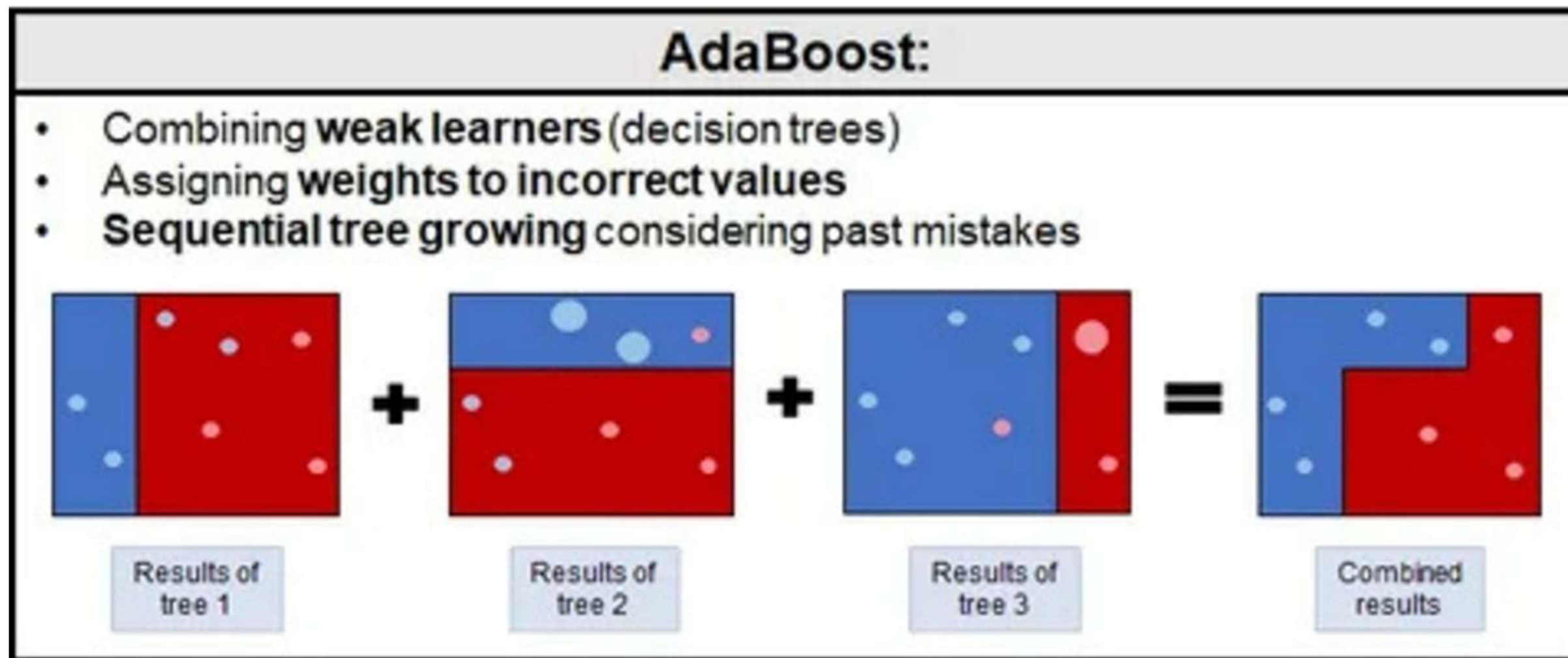
$$\sum_{\substack{x_0 < x \leq x_1 \\ y_0 < y \leq y_1}} I(x, y) = ii(D) + ii(A) - ii(B) - ii(C).$$



ADABOOST LEARNING

Since a face contains thousands of Haar-like features, only the most useful ones are selected.

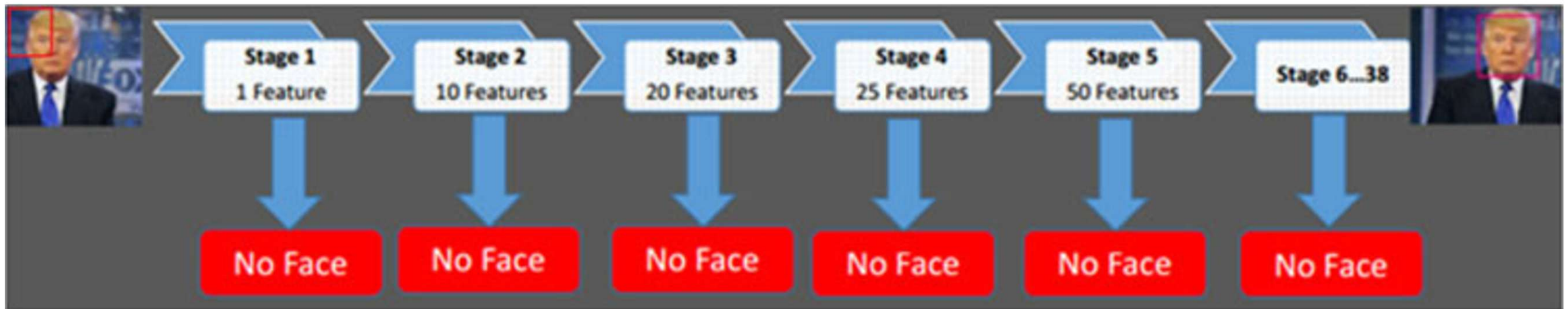
- AdaBoost (Adaptive Boosting) selects the best features and creates a strong classifier from multiple weak classifiers.
- It assigns higher weights to important features and lowers weights to irrelevant ones.
- This reduces computation time while maintaining high accuracy.



CASCADE CLASSIFIER FOR FAST DETECTION

A face has many distinctive features, such as eyes and nose, but not all image regions contain a face.

- The cascade classifier speeds up detection by processing images in stages.
- If a region fails early-stage tests, it is immediately discarded.
- Only likely face candidates pass through all stages.



Cascade classifier method


```

# Load face cascade
def load_cascade(cascade_name):
    cascade_path = cv2.data.harcascades + cascade_name
    if not os.path.exists(cascade_path):
        print(f"Warning: {cascade_name} not found at {cascade_path}")
        return None
    return cv2.CascadeClassifier(cascade_path)

face_cascade = load_cascade('haarcascade_frontalface_default.xml')
if face_cascade is None:
    print("Error: Could not load face cascade. Exiting.")
    exit()

cap = cv2.VideoCapture(0)
if not cap.isOpened():
    print("Error: Could not open camera")
    exit()

cv2.namedWindow("Face Detection", cv2.WINDOW_NORMAL)

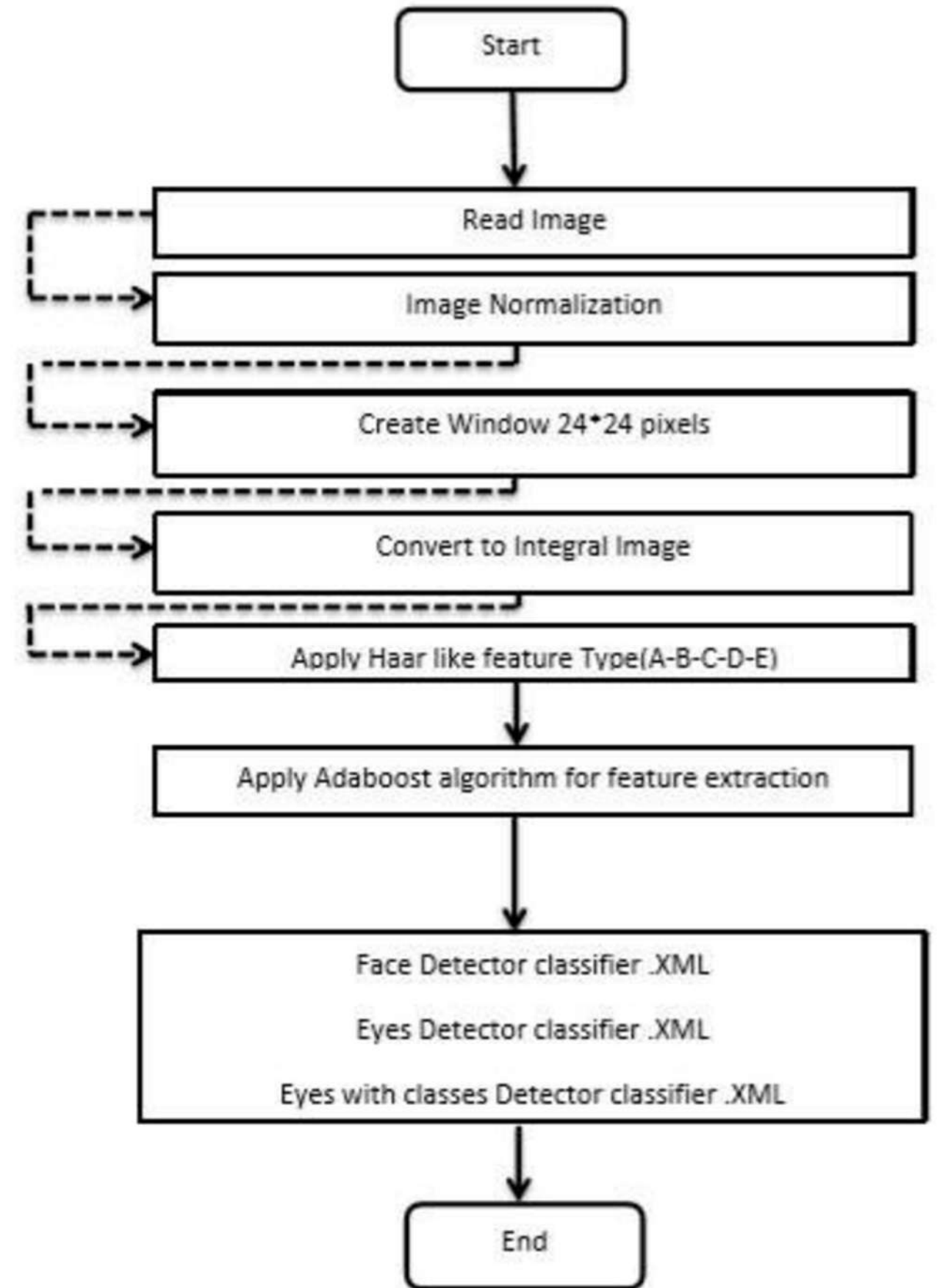
while True:
    ret, frame = cap.read()
    if not ret:
        print("Error: Can't receive frame")
        break

    gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
    faces = face_cascade.detectMultiScale(
        gray, scaleFactor=1.1, minNeighbors=5, minSize=(30, 30)
    )

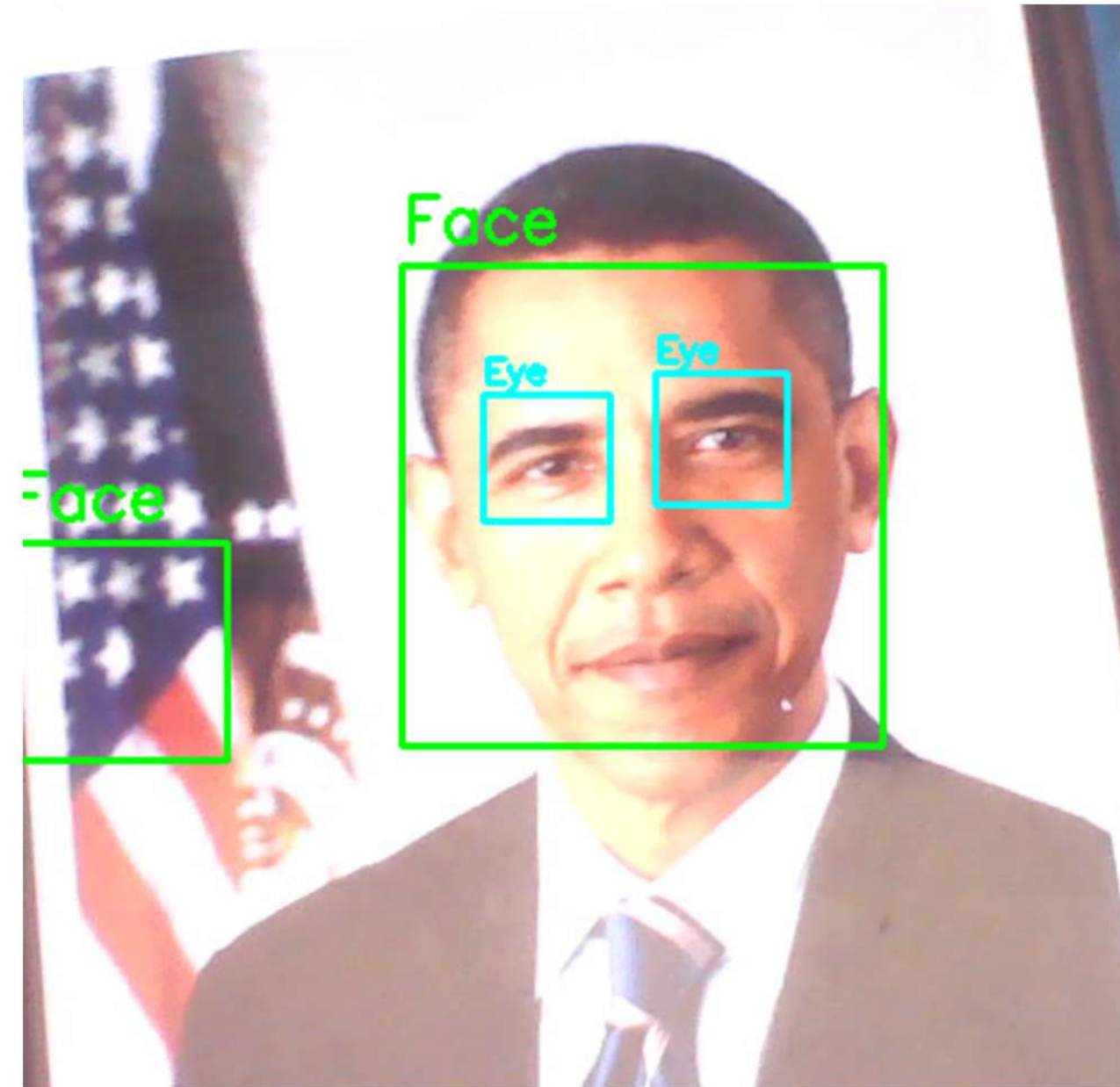
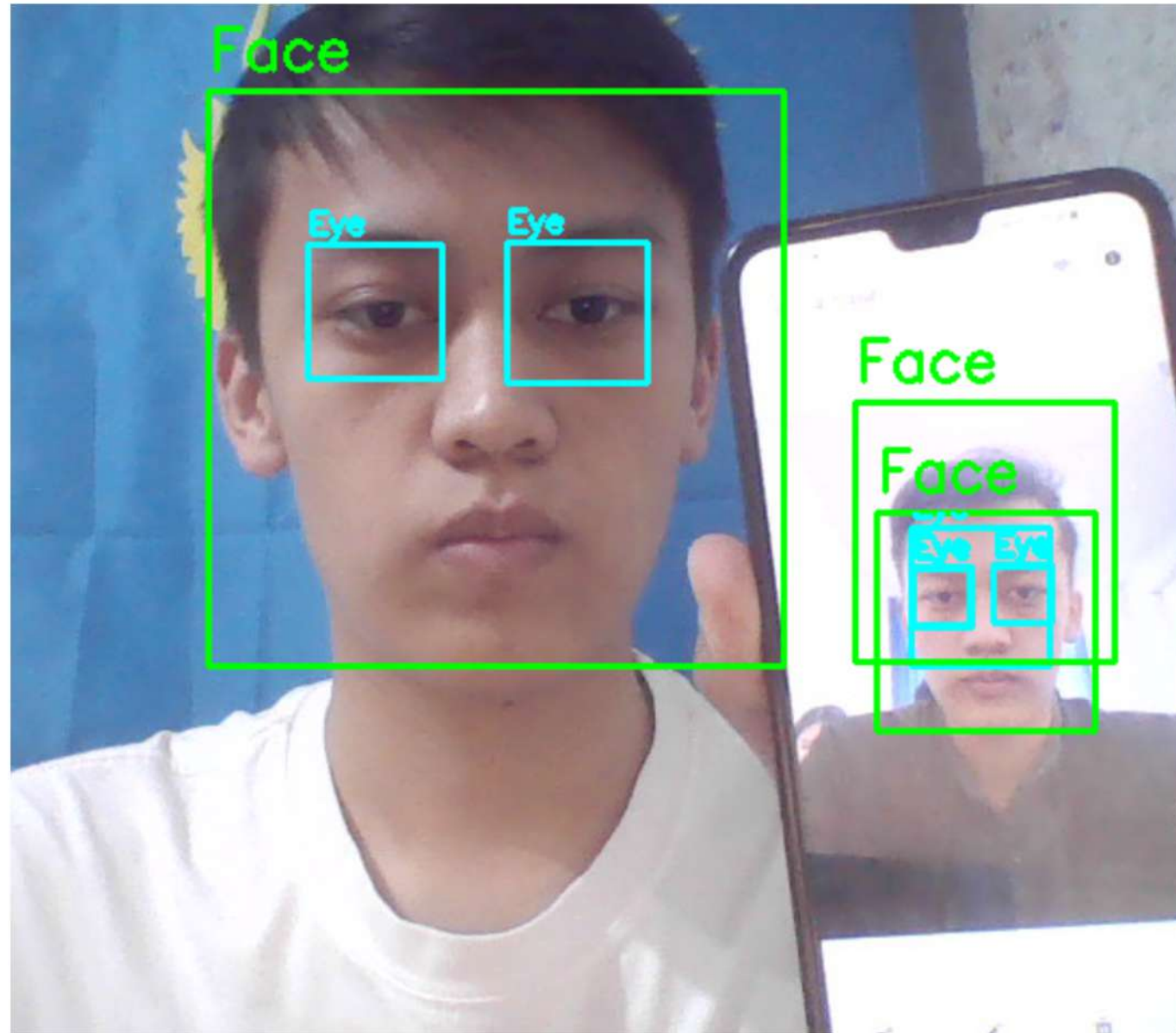
    for (x, y, w, h) in faces:
        cv2.rectangle(frame, (x, y), (x + w, y + h), (0, 255, 0), 2)
        cv2.putText(frame, 'Face', (x, y - 10), cv2.FONT_HERSHEY_SIMPLEX,
0.9, (0, 255, 0), 2)

```

ALGORITHM



EXPERIMENTAL RESULTS



LIMITATIONS

- Sensitive to pose variations (faces must be front-facing).
- Prone to false positives (detects non-faces as faces).
- Does not recognize individual faces (only detects presence of faces).

Obaida, T., Hassan, N., & Jamil, A. (2022). Comparative of Viola-Jones and YOLO v3 for Face Detection in Real time. IRAQI JOURNAL OF COMPUTERS, COMMUNICATIONS, CONTROL AND SYSTEMS ENGINEERING, 22(2), 63-72. doi: <https://doi.org/10.33103/uot.ijccce.22.2.6>

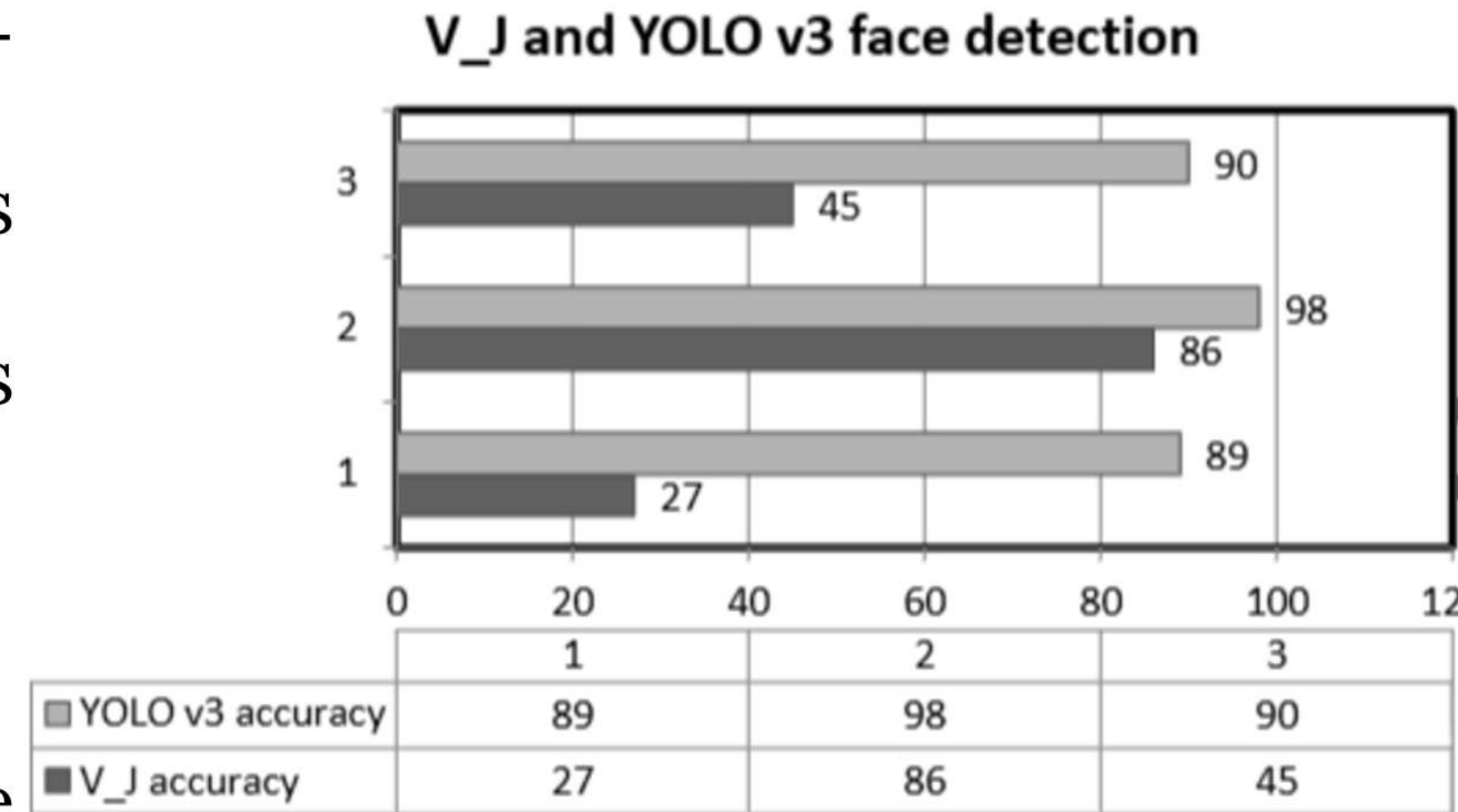


FIG. 11. GRAPH OF TEST RESULTS.

Conclusion

The Viola-Jones algorithm is a real-time face detection method using Haar-like features to identify patterns of light and dark areas.

The algorithm is fast and effective but works best for frontal faces and may produce false positives. It is widely used in security systems, cameras, and AI applications. Despite newer deep learning models, Viola-Jones remains a foundation for face detection technology.

References

1. K. Vikram and S. Padmavathi, "Facial parts detection using Viola Jones algorithm," 2017 4th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, 2017, pp. 1-4, doi: 10.1109/ICACCS.2017.8014636.
2. <https://habr.com/ru/articles/133826/>
3. <https://www.baeldung.com/cs/viola-jones-algorithm>
4. https://www.researchgate.net/publication/364311838_Comparative_of_Viola-Jones_and_YOLO_v3_for_Face_Detection_in_Real_time/figures

Страница ресурсов

Откройте для себя волшебство и веселье с презентациями Canva. Нажмите на следующие клавиши во время режима презентации!

В

ДЛЯ РАЗМЫТИЯ

С

ДЛЯ КОНФЕТТИ

Д

ДЛЯ БАРАБАННОЙ ДРОБИ

О

ДЛЯ ПУЗЫРЕЙ

Q

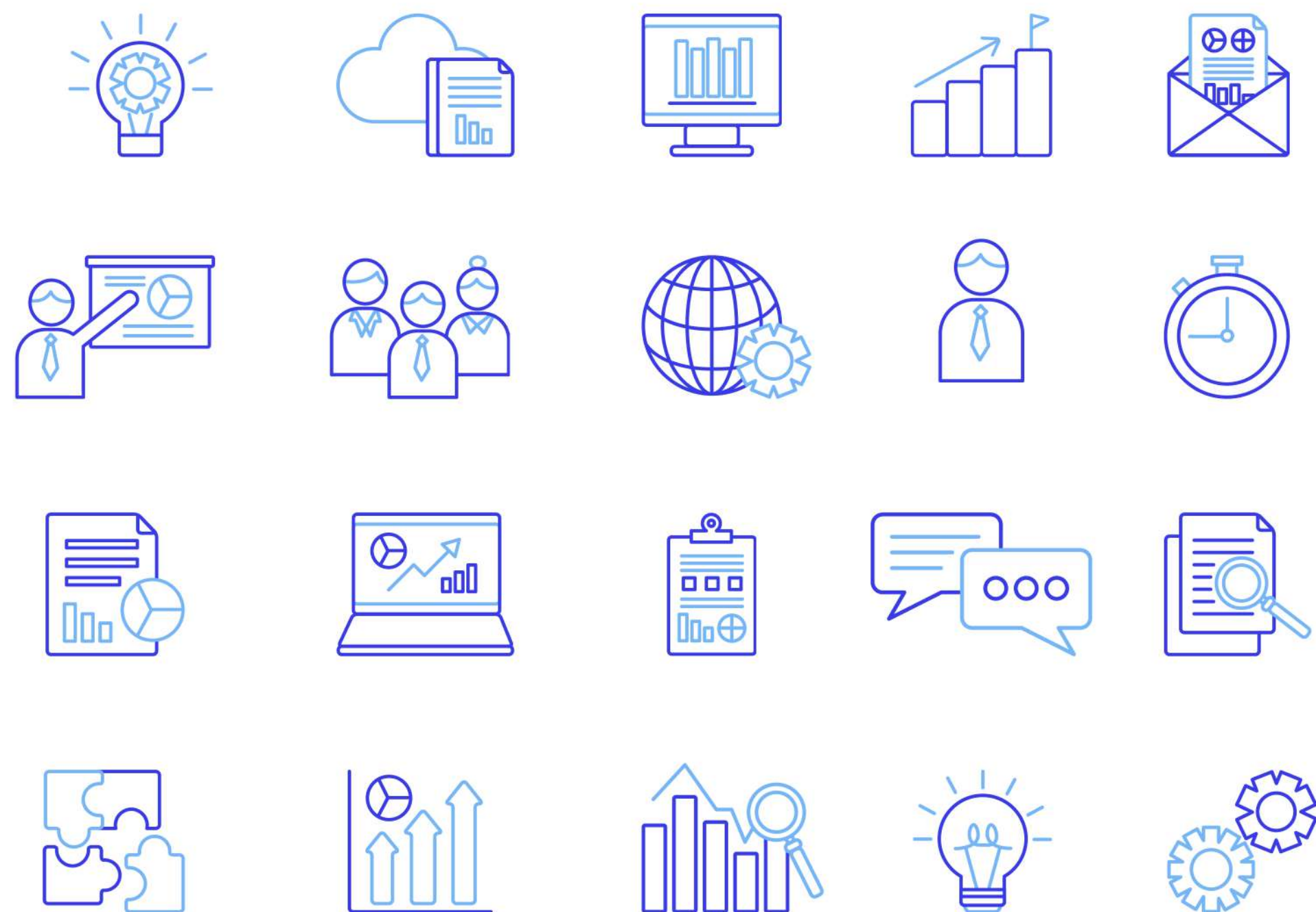
ДЛЯ ТИШИНЫ

X

ДЛЯ ЗАКРЫТИЯ

ЛЮБОЕ ЧИСЛО 0-9 ДЛЯ ТАЙМЕРА

Страница ресурсов



Используйте эти значки и иллюстрации в своей презентации Canva. Удачных дизайнов!