## Working title:

Jigsaw puzzle assistant: Leveraging Image Processing and Object Detection through Machine Learning and Deep Learning

## Overall aim:

Develop a user-friendly, machine learning-powered jigsaw puzzle assistant that utilizes deep learning or machine learning models for feature detection and object recognition to aid users in solving puzzles effectively.

## Objectives:

**1) Develop a machine learning model:**
This object encompasses activities of selecting the appropriate model, preparing training data, training and evaluating the model, and integrating it into the final application.
It focuses on the technical implementation and highlights the creation of the core functionality.

**2) Enhance user experience through an intuitive and accessible user interface (UI):**
This object focuses on creating an easy-to-use and effective interface that allows users to interact with the puzzle assistant seamlessly.
It emphasizes the user-centric aspect of the project and its accessibility considerations.

3) **Evaluate the effectiveness and potential impact of the jigsaw puzzle assistant:**
This object encompasses evaluating the accuracy and performance of the model, as well as assessing the user experience and potential impact of the application on its target audience.
It highlights the assessment and validation of the project.

## Methodology:

**1. Literature Review:**
Review existing research on:
Jigsaw puzzle solving: Explore existing assistive technologies and challenges faced by users.
Object detection in images: Understand different deep learning (DL) and machine learning (ML) models for object detection and their suitability for jigsaw puzzles.
User interface design principles: Learn best practices for designing user-friendly and accessible interfaces.

**2. System Design:**
Define the overall architecture of the application:
Input/Output: How users will interact with the application (e.g., camera, image upload).
Jigsaw puzzle processing: Steps involved in preparing the puzzle image for the ML/DL model (e.g., feature detection, cropping, segmentation).
ML/DL model selection: Choosing the most suitable model based on factors like accuracy, speed, and computational resources.
User interface (UI) design: Designing an intuitive and accessible interface for users to interact with the assistant.

**3. Data Acquisition and Preprocessing:**
Collect a dataset of jigsaw puzzle images:
Themes: Landscapes, portraits, abstract patterns.
Piece sizes and shapes: Consider different puzzle complexities.
Lighting conditions: Ensure diverse lighting scenarios to improve model robustness.
Preprocess the data:
Resize images to a consistent size.
Annotate puzzle pieces with their locations (bounding boxes) and potential rotations.
Consider usage of data augmentation techniques to improve model generalizability (e.g., random cropping, rotation, color jittering).

**4. Model Training and Evaluation:**
Choose a suitable DL or ML model for object detection (e.g., YOLO, SSD, Faster R-CNN).
Train the model on the prepared dataset, using appropriate training parameters and optimization techniques.
Evaluate the model performance on a held-out test set using metrics:
Mean Average Precision (mAP): Measures overall object detection accuracy.
Localization errors: Evaluates the accuracy of bounding box predictions.
Fine-tune the model hyperparameters or explore alternative models if the performance is unsatisfactory.

**5. User Interface Development and Integration:**
Design and develop a user-friendly UI for the jigsaw puzzle assistant, considering:
Ease of use and intuitiveness for diverse users.
Integration with the ML/DL model for seamless interaction.
Functionality for taking pictures of puzzles and displaying results.

**7. Conclusion and Future Work:**
Summarize the project's findings, including:
The chosen ML/DL model and its performance.
The overall effectiveness of the jigsaw puzzle assistant.
Discuss limitations of the project and potential improvements for future work.

## Structure:

1. Introduction:
State the overall aim and objectives of the thesis project.
Introduce jigsaw puzzles and the challenges faced by some users in solving them.
Highlight the potential of using machine learning (ML) and deep learning (DL) to create an assistive technology.

2. Literature Review:
Discuss existing research on jigsaw puzzle solving and existing assistive technologies.
Review relevant literature on object detection with ML/DL models, focusing on their suitability for jigsaw puzzles.
Explore user interface design principles for creating an accessible and user-friendly application.

3. Methodology:
Describe the methods used in the research:
System design: Explain the architecture of the puzzle assistant, including input/output, processing steps, and UI design.
Data acquisition and preprocessing: Explain the process of collecting, preparing, and annotating of the dataset.
Model training and evaluation: Describe the chosen ML/DL model, training process, and evaluation metrics.

User interface development and integration: Explain the UI design principles and the integration process with the ML/DL model.
Testing and refinement: Describe how we will conduct testing.

4. Results and Discussion:
Present the results of the project:
Model training and evaluation results: Discuss the performance of the chosen ML/DL model on the test set.
Discuss the implications of the findings, comparing the results with existing research and highlighting the contributions of the project.

5. Conclusion and Future Work:
Summarize the key findings of the research.
Discuss project limitations and potential areas for future research and improvement.

## Preliminary reading list:


1. Object Detection with Deep Learning: A Review; by Zhong-Qiu Zhao, Member, IEEE, Peng Zheng, Shou-tao Xu, and Xindong Wu, Fellow, IEEE
2. A machine learning based intelligent vision system for autonomous object detection and recognition; by Dominik Maximilián Ramík, Christophe Sabourin, Ramon Moreno & Kurosh Madani
3. Object Detection Using Machine Learning for Visually Impaired People; by Venkata Naresh Mandhala, Debnath Bhattacharyya, Vamsi B., Thirupathi Rao N.
4. User Interface Design Principles for Interaction Design; by Adream Blair-Early and Mike Zender
5. A review on User Interface Design Principles to increase software usability for users with less computer literacy; by Ali Darejeh and Dalbir Singh