CSE 475 – Final Project

Semi-Supervised and Self-Supervised Object Detection

Integrated Report Based on Lab Assignment 1 & Lab Assignment 2

Department of Computer Science and Engineering
East West University, Dhaka

Fall 2025

1. Final Project Overview

The CSE 475 Final Project is a **report-based** project that consolidates your work from:

- **Lab Assignment 1:** Baseline **supervised** object detection model.
- **Lab Assignment 2: Semi-supervised** and **self-supervised** object detection experiments.

You are **not required** to design a completely new experiment from scratch. Instead, you must:

- Combine and refine the experiments already done in Lab 1 and Lab 2.
- Present them in a **single, coherent final report**.
- Clearly describe the **baseline model**, the **semi-supervised model**, and the **self-supervised models** you implemented.

Final Deliverables:

- **(1) Final Project Report (PDF)** – Prepared using the following structure and guidelines.
- **(2) Final Viva** – Viva will be on the **entire pipeline**: baseline + semi-supervised + self-supervised experiments.

Viva + Report Submission Dates:

- **Section 1: 15 December 2025**
- **Section 3: 17 December 2025**

All Kaggle notebooks from Lab 1 and Lab 2 must be in working condition and may be checked during viva, but the **primary final deliverable is the written report**.

2. Role of Lab Assignment 1 and Lab Assignment 2

2.1 Lab Assignment 1 – Baseline Supervised Model

- Object detection using your assigned dataset.
- Trained with **fully labeled data** (or labeled subset).
- This model serves as your **baseline**.

In the final report you must:

- Describe the baseline architecture (e.g., YOLO/DETR/EfficientDet).
- Report main metrics (mAP@0.5, mAP@0.5:0.95).
- Show a few qualitative detection examples.

2.2 Lab Assignment 2 – Semi-Supervised and Self-Supervised Models

- **Semi-supervised:** Exactly one SSL method (e.g., STAC, Soft Teacher, Unbiased Teacher, pseudo-labeling) implemented on your dataset.
- **Self-supervised:** Two Self-SL methods (e.g., DINO, BYOL, SimCLR, MoCo, MAE) used for representation learning + fine-tuning for detection.

In the final report you must:

- Integrate the experimental details and results from Lab 2.
- Compare SSL and Self-SL approaches against the baseline from Lab 1.
- Provide a unified analysis across all models.

3. Final Project Report – Structure and Guidelines

The final project report should be a **well-structured technical document**. You may use an Elsevier or similar LaTeX template for the final version, but the content must follow the logical structure below.

3.1 Title and Abstract

- Title should reflect your domain/dataset (e.g., agriculture, medical imaging, manufacturing).
- Abstract should briefly mention:
  1. The dataset and problem (object detection domain).
  2. The baseline, semi-supervised, and self-supervised approaches used.
  3. Key results (e.g., mAP@0.5, mAP@0.5:0.95, precision, recall).
  4. Main takeaways or contributions.

3.2 Introduction

- Introduce the application domain (e.g., agriculture, medical).
- Motivate object detection and the need for label-efficient methods.
- Briefly state that the project builds on Lab Assignment 1 (baseline) and Lab Assignment 2 (SSL + Self-SL).

3.3 Literature Review

Requirement: At least 25 relevant papers.

- Use sources such as Google Scholar, IEEE Xplore, Springer, Elsevier, arXiv.
- Suggested organization:
  1. Domain-specific object detection works.
  2. Semi-supervised learning for detection (pseudo-labeling, consistency, STAC-style).
  3. Self-supervised representation learning (BYOL, DINO, SimCLR, MoCo, MAE).
  4. Gap analysis – what is missing, and how your experiments contribute.
- AI tools (ChatGPT, Perplexity, Elicit) may be used **only** to assist searching/summarizing; your actual written content must be your own.

3.4 Methodology

Dataset

- Describe your assigned dataset: number of images, number of classes, annotation format.

- Train/validation/test splits.
- How you simulate unlabeled data (for SSL and Self-SL).
- Include representative images and class distribution plots.

Models

Describe three main components:

1. **Baseline Model (from Lab 1)** – E.g., YOLOvX/DETR/Faster R-CNN. – Architecture summary and reasoning.

2. **Semi-Supervised Model (from Lab 2)** – Specify SSL method: STAC / Soft Teacher / Unbiased Teacher / pseudo-labeling. – Theoretical explanation:

   - Consistency regularization
   - Teacher–student or pseudo-labeling mechanism
   - Loss formulation (supervised + unsupervised)

3. **Self-Supervised Models (from Lab 2)** – E.g., BYOL, DINO, SimCLR, MoCo, MAE. – Explain the pretext task or contrastive/masked nature. – Describe how pretraining is followed by fine-tuning on your detector.

Training Setup

- List key hyperparameters for each experiment:
  - Learning rate, batch size, number of epochs.
  - Augmentations used.
  - Pseudo-label confidence thresholds (for SSL).
  - Key Self-SL parameters (momentum, temperature, etc. if applicable).

3.5 Experimental Setup

- Indicate that experiments were run using Kaggle GPU (or equivalent).
- Clearly group experiments as:
  - Baseline (Lab 1)
  - Semi-supervised (Lab 2)
  - Self-supervised (Lab 2)
- Include training curves (loss, mAP evolution) where available.

3.6 Results

Performance Metrics

- Report metrics such as mAP@0.5, mAP@0.5:0.95, precision, recall, F1-score.
- Include:
  - One table summarizing the baseline vs SSL vs Self-SL models.
  - Selected detection visualizations (images with predicted bounding boxes).

Ablation Study

- If possible, include small ablations:
  - Varying amount of unlabeled data.
  - Different thresholds for pseudo-labeling.

  - Different augmentations.
- Briefly explain the effect of each change.

3.7 Discussion

- Compare:
  - Baseline vs Semi-supervised vs Self-supervised.
  - Stability and robustness of each method.
  - Benefits of using unlabeled data on your specific dataset.
- Comment on computational cost and practical implications.

3.8 Conclusion and Future Work

- Identify which combination (backbone + SSL/Self-SL) worked best.
- Summarize key lessons learned from Lab 1 + Lab 2 combined.
- Suggest possible future extensions.

3.9 References

- Minimum 25 references.
- Use IEEE or APA style consistently.

4. Final Viva – Scope

The viva will test your understanding of the **entire experimental pipeline**:

- Baseline supervised model from Lab 1.
- Semi-supervised learning method from Lab 2.
- Self-supervised methods from Lab 2.
- How you integrated everything into one coherent story in the report.

Be prepared to:

- Explain all major design choices.
- Justify your evaluation metrics.
- Walk through key figures and tables in your report.

5. Summary

- The **final project** is primarily a **writing and integration task** over your Lab 1 and Lab 2 work.
- The **only final deliverables**:
  - Final project report (PDF).
  - Viva on the overall experimentation.
- Ensure all experiments are clearly documented, analyzed, and presented in a clear, structured report.

End of Final Project Guidelines