Homework 11: ML Applications in CV

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Handout: 2025-11-17

Due: 2025-11-24, 11:59pm, on Canvas

General Instructions:

- You should solve the homework and submit your report **individually**. Identical submissions will receive a grade of zero.
- Getting help from others or checking your answers with other students (not the TAs) is okay and encouraged.
- Ask any questions on **Ed Discussion** (instead of emailing).
- **Before** the homework due date, TAs are strictly prohibited from **pre-grading** your homework. Do not expect the TAs to help you verify if your answers are correct or give you the problem solution.
- **After** the homework due date, if you do not know how to solve a problem, reach out to the TAs. They will walk you through the solution and help you understand it. Note that homework solutions will **not** be posted because some problems will be used in next year's class.
- **Exams** may contain questions related to homework, so make sure you learn how to solve the homework problems correctly.
- The deliverables are outlined for each problem, and you should carefully **follow the instructions**. Failing to follow instructions will result in **points being subtracted**.
- You will submit a **single PDF** file to Canvas as your homework report. The PDF must contain your **answers** and any requested **outputs** (e.g., printouts, snapshots of code, or GUIs). If requested, follow the instructions specified by the problem to provide your **code** (e.g., in a compressed .zip or .tar file) in addition to the PDF file.
- **Grading:** Each homework in this class will contribute **5pts** to your final grade (there will be 12 homework assignments, each 5pts, leading to 60pts for all assignments). A detailed grading **rubric** will be posted on **Canvas** after the homework due date. Any bonus points will be added to your overall course bonus points, which will be added to your final grade.
- **Late submission:** Late or missed submission will not be accepted and will receive a grade a zero. Any excused absence must be documented and disclosed to the instructor (extensions will be granted on a case-by-case basis). Three or more missed homework lead to an INC grade.

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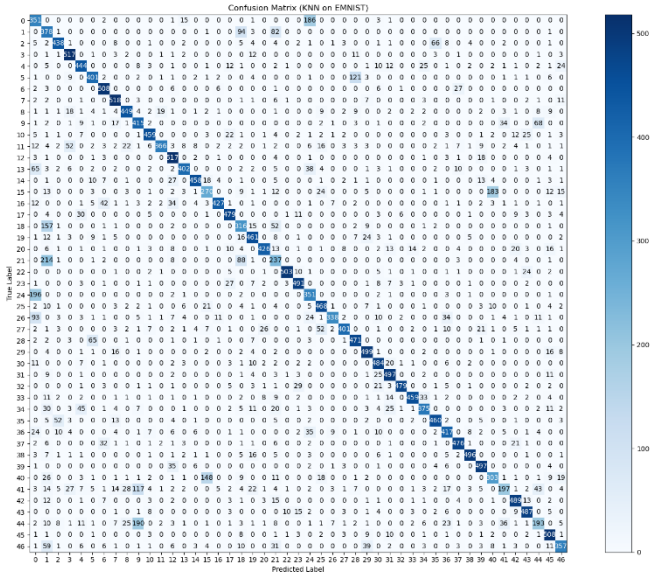
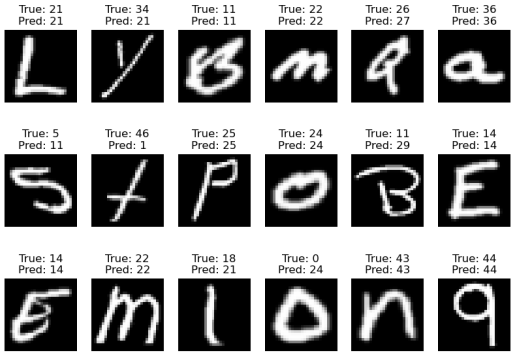
EXERCISE 1 (2pts) – Write an algorithm to classify English letters and numbers in an image using **KNN** in the EMNIST dataset. The template for loading the EMNIST dataset is provided at "hw11_template.ipynb" in the course repo, and you may use "14_knn_mnist.ipynb" in the course repo as a reference for implementing the classifier. Split the data into train and test sets. Use **20%** of the data for **test** (and do not train on it). Compute & report the **accuracy** of the trained classifier evaluated on the test set (e.g., 70%). In addition, display the **confusion matrix**:



Display a 3x6 array of **test** images, selected randomly, with their **ground truth** and **predicted labels**:



Deliverables:

- Printout of your entire code
- Accuracy of the trained KNN classifier
- Confusion matrix
- 3x6 randomly selected test images with their ground truth and predicted labels

IMPORTANT: You must solve the following problems using the **images you take personally** (e.g., using your phone's camera). Do **not** use images you find online or from other sources. If two submissions have **identical images**, they will both receive a grade of **zero**.

EXERCISE 2 (1.5pts) – Use OpenCV's classifier cv2.HOGDescriptor (Dalal-Triggs pedestrian detector algorithm) to detect pedestrians in an image you took **personally**. The image should contain at least **one** pedestrian. You may use "15_pedestrian_detection.ipynb" provided in the course repo as a reference. Tune algorithm parameters to improve detections. Explain what each parameter is, and how it affects the detection, i.e., what will happen if its value is decreased or increased from its default value.

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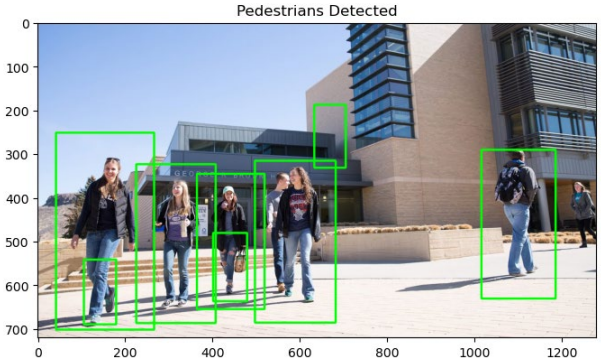
Deliverables:

- Copy of your entire code
- Image with detected pedestrians shown via bounding boxes
- Explanation of the following algorithm parameters: hitThreshold, winStride, padding, scale, & groupThreshold



EXERCISE 3 (1.5pts) – Use OpenCV's classifier cv2.CascadeClassifier (Viola-Jones face detector) to detect faces in an image you took **personally**. The image should contain at least **one** face. You may use "16_face_detection.ipynb" provided in the course repo as a reference. Tune algorithm parameters to improve detections. Explain what each parameter is, and how it affects the detection, i.e., what will happen if its value is decreased or increased from its default value.

Deliverables:

- Copy of your entire code
- Image with detected faces shown via bounding boxes
- Explanation of the following algorithm parameters: scaleFactor, minNeighbors, minSize, & maxSize