Assignment 3 (Due: Dec. 31, 2024)

1. (**Math**) Please prove the Proposition 20 mentioned in our lecture.

> **Proposition 20**:   Assignment!
>
> Suppose that $\mathbf{x}^*$ and (α^*, β^*) are primal feasible and dual feasible respectively. If the duality gap associated with them is 0, i.e.,
>
> $$f_0\left(\mathbf{x}^*\right) - g\left(\alpha^*, \beta^*\right) = 0$$
>
> Then, $\mathbf{x}^*$ and (α^*, β^*) should be primal optimal and dual optimal, respectively, and the primal problem has strong duality

2. (**Programming**) On the website, I provide you a Matlab program which demonstrates how to train a soft-margin SVM model from simulated data. Please add comments, as detailed as possible, to the code.

3. (**Programming**) RT-DETR is a modern transformer-based real-time object detector. It has been implemented in Ultralytics (https://docs.ultralytics.com/models/rtdetr/#usage-examples). Please try to use Ultralytics to train an RT-DETR model to detect speed-bumps and persons in a video. The training data can be downloaded from https://github.com/csLinZhang/CVBook/tree/main/chapter-15-YOLO/For-yolov4. Test your model on the provided test video (on the course website). For this question, you only need to hand in your video with detected bounding-boxes to the TA. A sample frame of our result video may like the following image.