# Computer Vision Assignment 3

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## 1 Math: Please prove that $L(\mathbf{h})$ is a strictly convex function.

$$L(\boldsymbol{h}) = \frac{1}{2}(\boldsymbol{f}(\boldsymbol{x}+\boldsymbol{h}))^T\boldsymbol{f}(\boldsymbol{x}+\boldsymbol{h})+\frac{1}{2}\mu\boldsymbol{h}^T\boldsymbol{h} = \frac{1}{2}(\boldsymbol{f}(\boldsymbol{x}))^T\boldsymbol{f}(\boldsymbol{x})+\boldsymbol{h}^T(\boldsymbol{J}(\boldsymbol{x}))^T\boldsymbol{f}(\boldsymbol{x})+\frac{1}{2}\boldsymbol{h}^T(\boldsymbol{J}(\boldsymbol{x}))^T\boldsymbol{J}(\boldsymbol{x})\boldsymbol{h}+\frac{1}{2}\mu\boldsymbol{h}^T\boldsymbol{h} \quad (1)$$

$\boldsymbol{J}(\boldsymbol{x})$ is the Jacobian matrix and $\mu > 0$.

$L(\mathbf{h})$ is differentiable to the first order.

$$dL = (\boldsymbol{J}(\boldsymbol{x}))^T\boldsymbol{f}(\boldsymbol{x}) + (\boldsymbol{J}(\boldsymbol{x}))^T\boldsymbol{J}(\boldsymbol{x})\boldsymbol{h} + \mu\boldsymbol{h} \quad (2)$$

$L(\mathbf{h})$ is differentiable to the second order.

$$d^2L = d(dL) = (\boldsymbol{J}(\boldsymbol{x}))^T\boldsymbol{J}(\boldsymbol{x}) + \mu\boldsymbol{I} \quad (3)$$

$\boldsymbol{I}$ is the identity matrix and $\boldsymbol{I} \in R^n$. For brevity, We will use $J$ instead of $\boldsymbol{J}(\boldsymbol{x})$ in the following proof procedure.

Let $A = J^TJ$, then we can get.

$\forall x \neq 0, y = Jx$

$0 \leq y^Ty = (Jx)^TJx = x^TJ^TJx = x^TAx$

So, $A$ is positive semi-definite.

For all $\boldsymbol{A}'s$ eigen-values $\{\lambda_i \geq 0, i = 1, 2, ..., n\}$

$Av_i = \lambda_i v_i$

$(A + \mu I)v_i = (\lambda_i + \mu)v_i$

All $(A + \mu I)'s$ eigen-values $\{\lambda_i + \mu\} > 0$

So $A + \mu I = J^TJ + \mu I$ is positive definite.

Thus, $L$ is strictly convex.

## 2 Programming

I used YOLOv5's model **yolov5x** as the pre-trained model.Then, I collected 105 pictures of two kinds of instant noodles, xianxia and xianggu. After that, I train the model on the collected datatset. Here are the parameters used in the training process in table 1.

Here are some detected results in table 2. 100 epochs completed in 0.355 hours.

You can get all the code and result files from the **YOLO** file.

| Item | Value |
|---|---|
| GPU | RTX 2080 Ti |
| Platform | AutoDL |
| Model | YOLOv5 |
| Pre-Model | yolov5x |

Table 1: Training Configuration

| Item | Value |
|---|---|
| batch size | 8 |
| epochs | 100 |
| imgsz | 640 |
| lr | 0.01 |
| weight decay | 0.0005 |

Table 2: Parameters

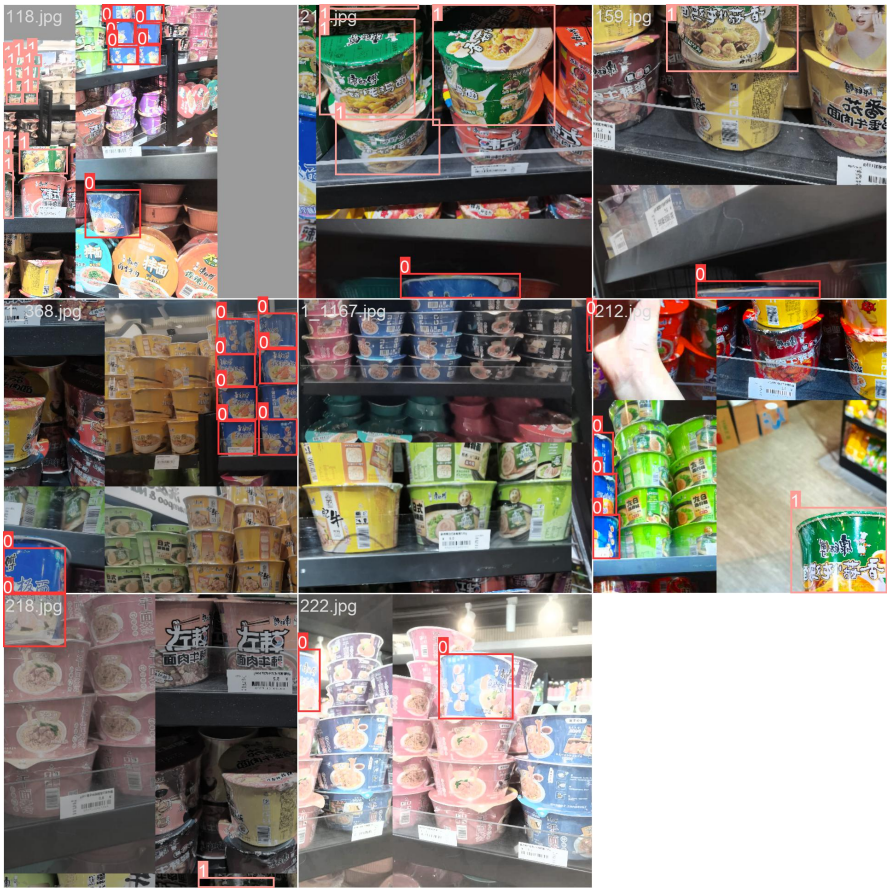


Figure 1: Detected Result

# 3 Experiment

You can get the report from 2054021_ 吕嘉琪 _Report.pdf.