Introduction to Deep Learning (I2DL)

Tutorial 3: Data

Reminder

- Use Piazza for general and private questions
  - Do not email us personally!
- Office hours started last week
  - Find schedule on Piazza
- Solutions to the exercises
  - Will be published together with the following exercises

Today's Outline

- Exercise outline
  - Pillars of Deep Learning
  - Reinvent the wheel

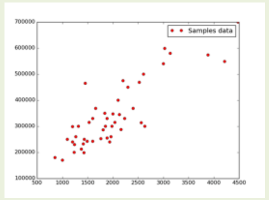
- Contents of
  - Example Datasets & -loader
  - Exercise 3 (Submission #2)

General Exercise Overview

The Pillars of Deep Learning

Data

$\{x_{1:n}, y_{1:n}\}$



Model

Network

Loss/Objective

Solver

Optimizer

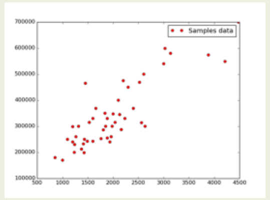
Training Loop

Validation

The Pillars of Deep Learning

Data

$$\{x_{1:n}, y_{1:n}\}$$



Model

$$\hat{y}_i = \boxed{\theta_0} + \sum_{j=1}^{d} x_{ij}\theta_j$$

bias

$$J(\boldsymbol{\theta}) = \frac{1}{n}\sum_{i=1}^{n}(\hat{y}_i - y_i)^2$$

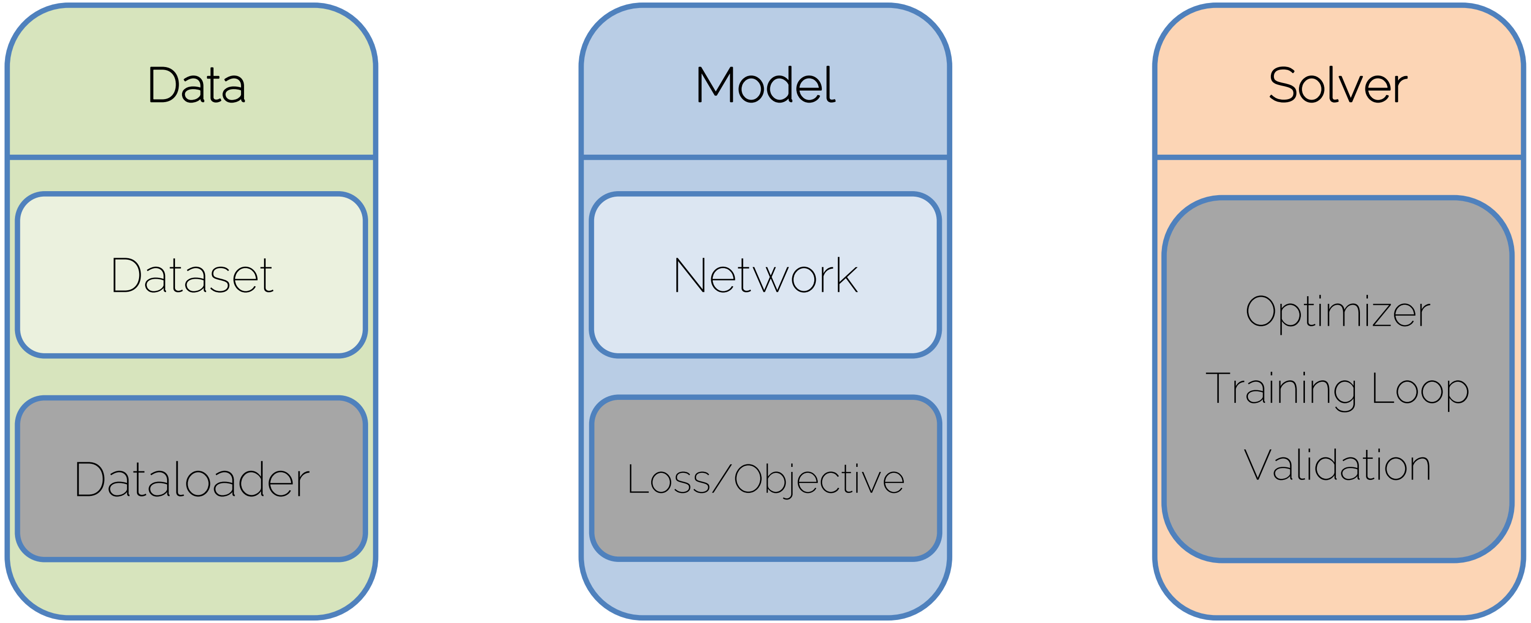
Solver

Optimizer

Training Loop

Validation

The Pillars of Deep Learning



Can be implemented once and used in multiple projects

Your task for exercise 3-5

Exercise 03: Dataset and Dataloader
Exercise 04: Solver and Linear Regression
Exercise 05: Neural Networks
Exercise 06: Hyperparameter Tuning

Numpy
(Reinvent the wheel)

- Implementation of
  - A simple dataset and data loading
  - Regression/classification pipeline using Neural Networks

Exercise 3

Exercise 3: Dataset

- Reads data and provides a simple way to access it
- Performs on-the-fly data preprocessing / augmentations
  - Preprocessing: e.g. scale image to fixed size
  - Augmentations: e.g. random image flips, crops, etc.

Example: Image Classification Dataset

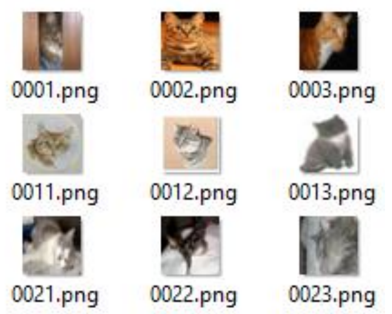
- Given: Path to a folder with 10 sub-folders
  - <dataset_root>

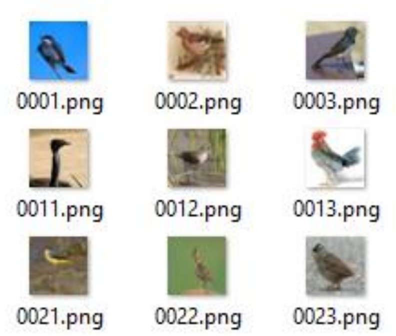
    |- cat

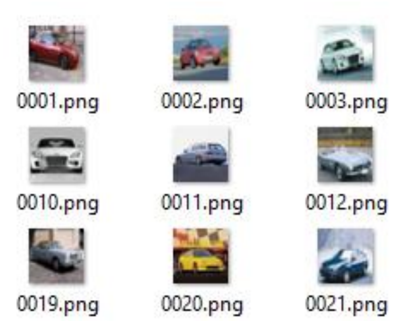
    |- bird

    |- car

    |- …
- Each folder contains X images of a specific category



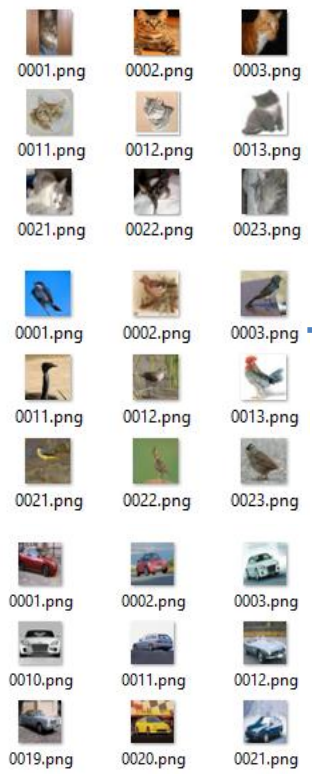




Example: Image Classification Dataset

- Dataset class reads structure of that folder
  - ImageDataset(<dataset_root>)
    → samples = [(“cat/0001.png”, 1), …, (“plane/4986.png”, 10)]
  - Usually, it does not open the images yet!
  - Define class ID<->label mapping
- Accessing/calling the dataset class with an index gives a single element:
  - Reads image from disk
  - Performs on-the-fly preprocessing
  - Preforms augmentations

Example: Image Classification Dataset



Dataset creation

Samples

$$\left[\begin{array}{l}
\text{cat/0001.png} \rightarrow \text{cat} \\
\text{cat/0002.png} \rightarrow \text{cat} \\
\text{cat/0003.png} \rightarrow \text{cat} \\
\dots \\
\text{plane/4986.png} \rightarrow \text{plane}
\end{array}\right]$$

Image Path → Label

Accessing an element

Single sample

dataset[1] →

{ image:

label: 1 }

Image → Class ID

Class ID<->Label mapping:
- cat → 1
- bird → 2
- ...
- plane → 10

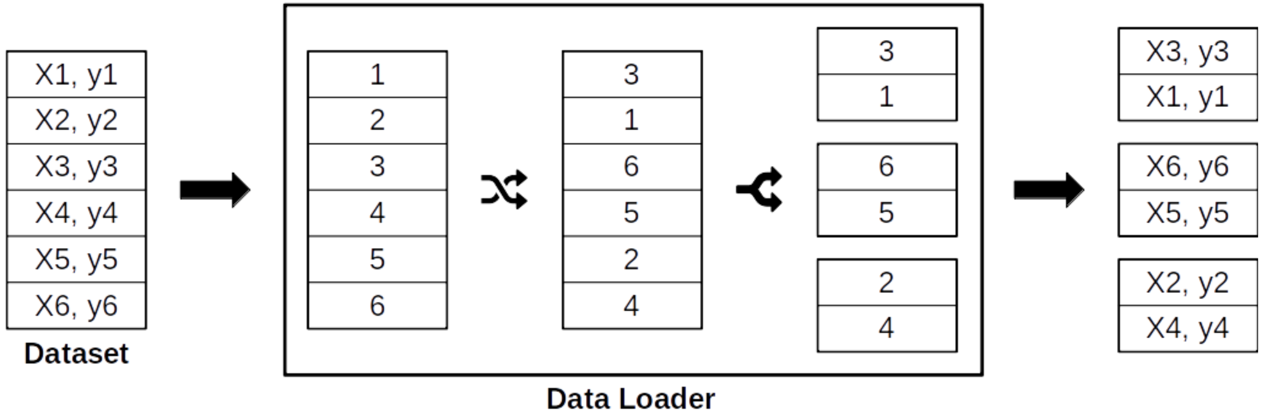
Exercise 3: Dataset

- What we excluded
  - Low level "scripting" details using operating system calls

- Reading every file from disk one-by-one vs loading the entire dataset into memory
  - Usually, datasets are too big to load entirely into memory, but it provides exceptional performance boosts when applicable

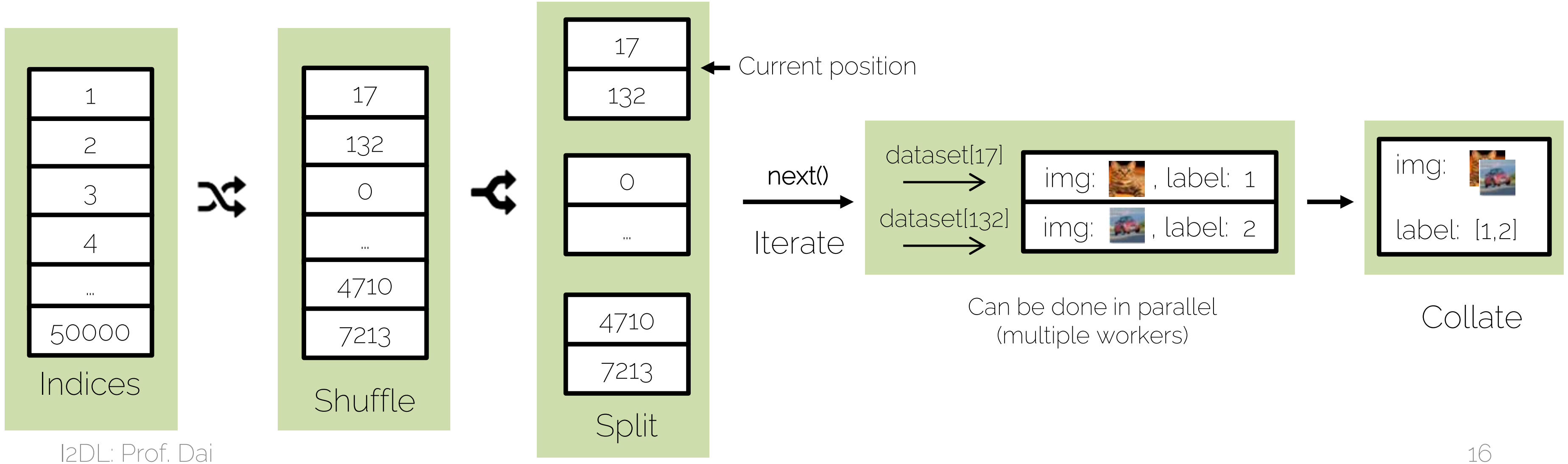
Exercise 3: Dataloader

- Defines how to load the dataset for model training
  - E.g., number of images per batch, number of workers
- Shuffles the dataset
- Splits the dataset into small subsets: (mini) batches



Exercise 3: Dataloader – Iterator & Batching

- Dataloader is an "iterator", not a list
  - Cannot be directly accessed with an index: ~~*dataloader[9]*~~
  - Instead iterate using "next" to get next element: next(dataloader)
  - __iter__() function uses "yield" instead of "return"
- Returns a (mini-) batch of samples in a batched format



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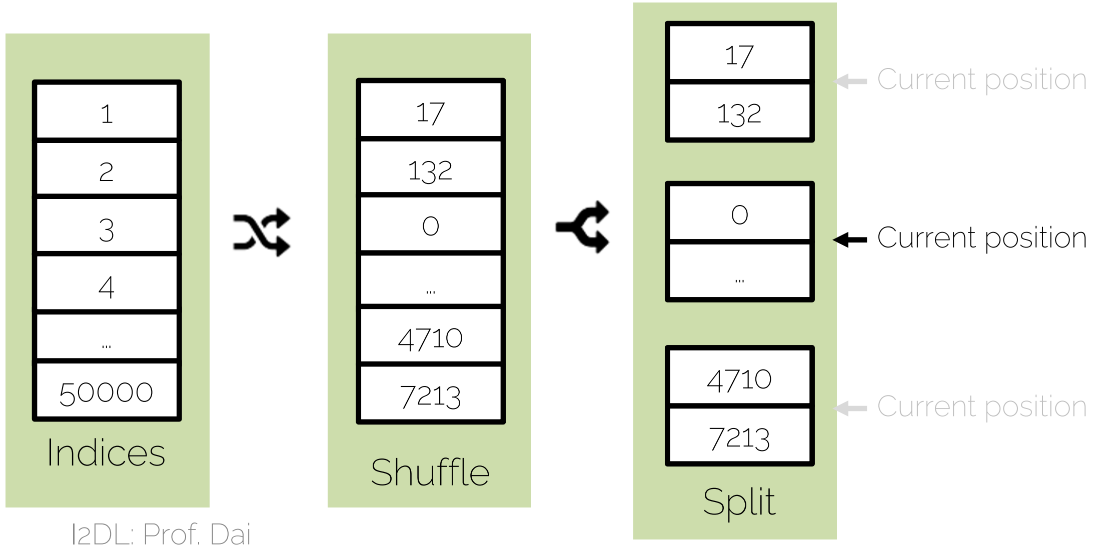

Overview Exercise 3

- Two notebooks
  - Dataset: CIFAR10
  - Dataloader

<u>Fixed Deadline!</u>

<u>November 9, 2022 15:59</u>

- Submission
  1. Implement solution in both notebooks
  2. Single submission zip is created in Dataloader notebook

See you next week

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