Homework 2 Bonus

2D Convolutions and Max Pooling

April 2020

Start Here

Collaboration policy

- You are expected to comply with the University Policy on Academic Integrity and Plagiarism
- You are allowed to talk with / work with other students on homework assignments
- You can share ideas but not code, you must submit your own code. All submitted code will be compared against all code submitted this semester and in previous semesters using MOSS.

Overview

- MyTorch
- 2D Convolution
- 2D Max Pooling
- 2D Mean Pooling

Directions

- You are required to do this assignment in the Python (version 3) programming language. Do not use any auto-differentiation toolboxes (PyTorch, TensorFlow, Keras, etc) - you are only permitted and recommended to vectorize your computation using the Numpy library.
- If you haven't done so, use pdb to debug your code effectively.

1 MyTorch

The culmination of all of the Homework Part 1's will be your own custom deep learning library, which we are calling MyTorch. It will act similar to other deep learning libraries like PyTorch or Tensorflow. The files in your homework are structured in such a way that you can easily import and reuse modules of code for your subsequent homeworks. For Homework 2 bonus, MyTorch will have the following structure:

- mytorch
  - pool.py
  - conv.py
- autograder
  - hw2_bonus_autograder
    - runner.py
    - test.py
- create_tarball.sh

- **Install** Python3, NumPy and PyTorch in order to run the local autograder on your machine:
  - pip3 install numpy
  - pip3 install torch
- **Autograde** your code by running the following command from the top level directory:
  - python3 autograder/hw2_bonus_autograder/runner.py
- **Hand-in** your code by running the following command from the top level directory, then SUBMIT the created handin.tar file to autolab:
  - sh create tarball.sh
- **DO**
  - We strongly recommend that you review the lectures on CNNs.
- **DO NOT**
  - Import any other external libraries other than numpy, as extra packages that do not exist in autolab will cause submission failures. Also do not add, move, or remove any files or change any file names.

2 2D Convolution

In homework 2 part 1, you implemented 1D convolutions, which involved the scanning over multiple channels each with a 1D sequence. In this bonus, you will consider a higher dimensional algorithm, the 2D convolution.

This task requires you to implement both forward propagation and backward propagation for 2D convolutions. The reader is encouraged to reference the pseudocode presented in lecture and consider these notes on CNNs.

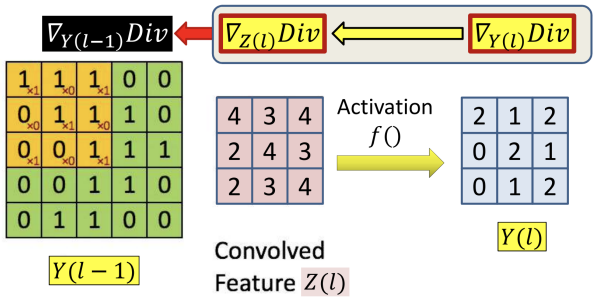

Figure 1: 2D Convolution Example

3 2D Max Pooling

Max pooling selects the largest from a pool of elements and is performed by "scanning" the input. In this bonus, you will implement both forward propagation and backward propagation for 2D max pooling. The reader is similarly encouraged to reference the pseudocode presented in lecture and consider these notes on max pooling.

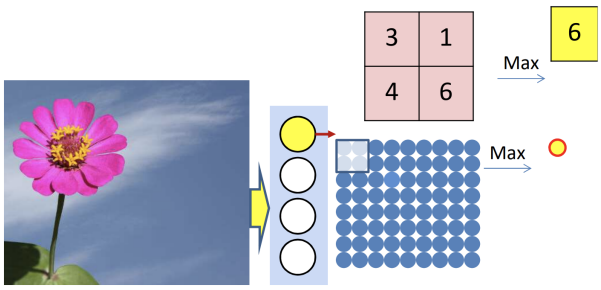

Figure 2: 2D Max Pooling Example

4 2D Mean Pooling

Mean pooling takes the arithmetic mean of elements and is performed by "scanning" the input. In this bonus, you will implement both forward propagation and backward propagation for 2D mean pooling. The reader is similarly encouraged to reference the pseudocode presented in lecture and consider these notes on mean pooling.

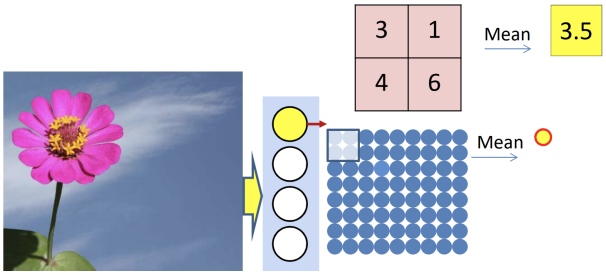

Figure 3: 2D Mean Pooling Example