FACULTY MENTOR
Pengtao Xie

PROJECT TITLE
Leveraging Side Information for Text-to-Image Generation

PROJECT DESCRIPTION
Description: Text-to-image generation (TIG), which aims to generate images from input texts, is a widely studied problem in textual-visual learning and finds broad applications. For TIG in special domains such as healthcare, satellite imagery, manufacturing, etc. where side information (e.g., MeSH tags, view consistency, scene tags) is rich, it is important to make generated images compatible with these side information; otherwise, the generated images may be insensible and have low fidelity. Towards this goal, we study side-information grounded text-to-image generation, where side information is leveraged to train a generator so that it can generate side information-compatible images.

In our proposed general framework, for each type of side information, a compatibility function, which is the conditional probability of side information given a generated image, is defined to measure how consistent the image is with the side information. During the training of the generator, these compatibility functions are used as regularizers to encourage generated images to have high compatibility with various types of side information. To enable compatibility functions and text-to-image generation models to be trained end-to-end instead of separately, we propose a three-level optimization framework. We will apply our proposed methods for the side information guided generation of chest X-rays from radiology reports and generation of satellite images from textual descriptions by taking domain-specific side information into account.

This project can accommodate both remote and in-person students

INTERNS NEEDED
3 Students

PREREQUISITES
1. Basics of machine learning
2. Familiar with PyTorch or TensorFlow

FACULTY MENTOR
Pengtao Xie

PROJECT TITLE
Prevent Performance Collapse of Differentiable Neural Architecture Search by Encouraging Transferability

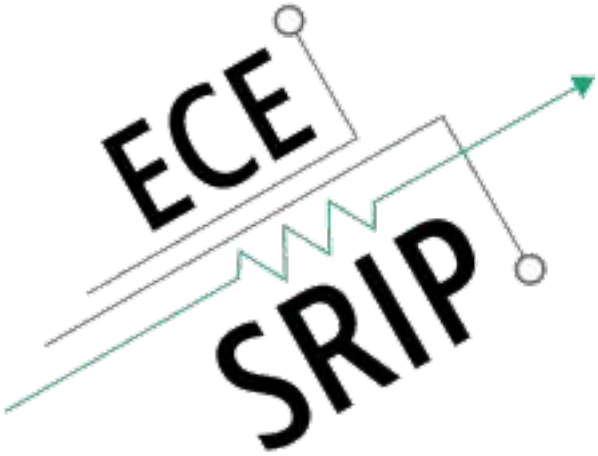
PROJECT DESCRIPTION
Description: Neural architecture search (NAS), which aims to automatically search for high-performance architectures of neural network, has attracted much research attention recently. In particular, differentiable NAS has been broadly adopted due to its computational efficiency. One well-known problem of differentiable NAS is performance collapse: the searched architectures are overfitted to validation data and generalize poorly on unseen data. To address this problem, we propose a transferability-encouraging tri-level optimization framework, which prevents performance collapse of a neural architecture by encouraging good transferability to an auxiliary model.

Our framework involves three stages performed end-to-end: 1) train network weights of a main model; 2) transfer knowledge from the main model to an auxiliary model; 3) optimize the architecture of the main model by maximizing transferability to auxiliary. We propose a new knowledge transfer approach based on predicting quadruple relative similarities.

This project can accommodate both remote and in-person students

INTERNS NEEDED
3 Students

PREREQUISITES
1. Basics of machine learning
2. Familiar with PyTorch or TensorFlow



FACULTY MENTOR
Pengtao Xie

PROJECT TITLE
Performance-Aware Mutual Knowledge Distillation

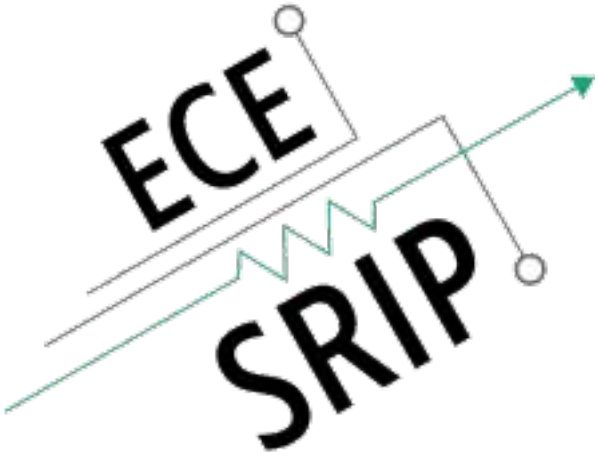
PROJECT DESCRIPTION
Description: Mutual knowledge distillation (MKD), where a group of models mutually generate knowledge to train each other, has achieved promising results in many applications. In existing MKD methods, knowledge distillation is performed between models without scrutiny: a worse-performing model is allowed to generate knowledge to train a better-performing model, which may lead to collective failures. To address this problem, we propose a performance-aware MKD approach, where knowledge generated by model A is allowed to train model B only if the performance of A is better than B.

We propose a three-level optimization framework to formulate PAMKD, where three learning stages are performed end-to-end: 1) each model trains an initial model independently; 2) the initial models are evaluated on a validation set and better-performing models generate knowledge to train worse-performing models; 3) meta-parameters are updated by minimizing a validation loss. We will evaluate our methods in two applications -- differentiable neural architecture search and data reweighting.

This project can accommodate both remote and in-person students

INTERNS NEEDED
3 Students

PREREQUISITES
1. Basics of machine learning;
2. Familiar with PyTorch or TensorFlow



FACULTY MENTOR
Pengtao Xie

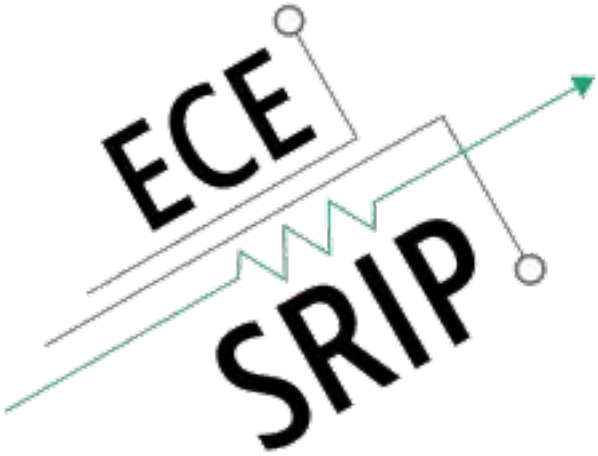
PROJECT TITLE
Automatic Annotation of Objects Based on Image Captions

PROJECT DESCRIPTION
Description: Object detection is a fundamental problem in computer vision. To train accurate object detection models, a lot of annotations of objects are needed. However, in many applications, such annotations are difficult to obtain. We aim to automatically infer object annotations from image captions which are widely available. To address this problem, we propose a tri-level optimization framework for automatic annotation of objects based on image captions. Our framework consists of three learning stages performed end-to-end. At the first stage, we use a neural network to map image captions into object annotations. At the second stage, we train an object detection model on auto-inferred object annotations. At the third stage, we evaluate the object detection model on a human-labeled dataset and update meta parameters by minimizing the validation loss.

This project can accommodate both remote and in-person students

INTERNS NEEDED
3 Students

PREREQUISITES
1. Basics of machine learning;
2. Familiar with PyTorch or TensorFlow



FACULTY MENTOR
Pengtao Xie

PROJECT TITLE
Curriculum Self-Supervised Learning

PROJECT DESCRIPTION
Description: Self-supervised learning, which learns data representations by solving prediction tasks constructed from input data, has shown promising results. Existing SSL methods solve a single prediction task. How to choose a proper difficulty level for the task is technically nontrivial. In this paper, we propose a curriculum self-supervised learning approach. Our approach learns a sequence of K SSL tasks that have increasing levels of difficulties. Our framework is based on multi-level optimization, which involves K+2 learning stages. Each of the first K stages solves an SSL task. At the K+1 stage, a classification head is trained on a classification dataset. At the K+2 stage, the classifier is evaluated on a validation set. Meta parameters are updated by minimizing the validation loss.

This project can accommodate both remote and in-person students

INTERNS NEEDED
3 Students

PREREQUISITES
1. Basics of machine learning;
2. Familiar with PyTorch or TensorFlow

FACULTY MENTOR
Pengtao Xie

PROJECT TITLE
Reweight Source Data via Tri-Level Optimization

PROJECT DESCRIPTION
Description: In many applications, to mitigate data deficiency in a target task, source data is collected to help with target model training. However, it is often the case that many source data examples are noisy or have large discrepancies with the target domain. Such source data needs to be removed or down-weighted. Existing data reweighting methods either do not explicitly leverage target validation loss to learn source example weights or are not optimal for source-to-target knowledge transfer. To address these problems, we propose a tri-level optimization framework which learns to reweight source training examples by explicitly minimizing target validation loss and performs target-oriented transfer learning. Our framework consists of three learning stages performed end-to-end. At the first stage, a source model is trained on weighted source data. At the second stage, a target model is trained utilizing knowledge transferred from the source model. At the third stage, importance weights of source data are learned by minimizing validation loss of the target model. We propose a new ranking-based knowledge transfer approach where the target model is trained by predicting a ranking generated by the source model. We will apply our method for CT-based screening of COVID-19 and classification of general-domain images.

This project can accommodate both remote and in-person students

INTERNS NEEDED
3 Students

PREREQUISITES
1. Basics of machine learning;
2. Familiar with PyTorch or TensorFlow