CSC 2515 Projects

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Select ONE and only ONE project from this list. Make sure that you do not miss the two deadlines: project proposal submission and final project submission. Make sure to read the instructions about what to submit for each deadline.

1 General Guidelines

The idea of the final project is to give you some experience trying to do a piece of original research in machine learning and writing up your results in a paper style format. What we expect to see is an idea/task that you describe clearly, relate to existing work, implement and test on a dataset. To do this you will need to write code, run it on some data, make some figures, read a few background papers, collect some references, and write a few pages describing your task, the algorithm(s) you used and the results you obtained. As a rough rule of thumb, spend about one week's worth of work (spread out over a longer time to allow the computers to do some work in the interim!), and about a day writing it up after that. Projects can be done individually, or in pairs (or larger groups with permission). We encourage you to work in pairs, but of course, the expectations will be higher for pair projects.

2 Specific Requirements

Your project must implement one or more machine learning algorithms and apply them to some data. Your project may be a comparison of several existing algorithms, or it may propose a new algorithm in which case you still must compare it to at least one other approach. You can either pick a project of your own design, or you can choose from the set of pre-defined projects described below. Regardless of which way you select a project, you cannot use the excuse that you got a "bad project" to explain doing a poor job on it. So select wisely!

You are free to use any third-party ideas or code that you wish as long as it is publicly available. You must properly provide references to any work that is not your own in the write-up. The project is not intended to be a stressful exercise; instead it is a chance for you to experiment, to think, to play and to hopefully have fun! Start with simple methods that work more or less out of the box and go from there.

2.1 Project proposal

You must turn in a brief project proposal. Your project proposal should either say which of the pre-defined projects you plan to pursue, or describe the idea behind your self-defined project. You

should also briefly describe software you will need to write, and papers (2-3) you plan to read. Please also say if you will have a partner, and if so, who it will be.

Include your email address on your proposal. We need this to contact you and arrange meetings to discuss your proposal.

2.2 Project submission

Your submission must include at least two figures which graphically illustrate quantitative aspects of your results, such as training/testing error curves, learned parameters, algorithm outputs, input data sorted by results in some way, etc. Your submission must include at least 3 references to previous published papers or book sections. Your submission should follow the generally accepted style of paper writing: include an introduction section to motivate your problem and algorithm, a section describing your approach and how it compares to previous work, a section outlining the experiments you ran and the results you obtained, and a short conclusions section to sum up what you discovered. Your submission must be prepared in the NIPS paper format `http://nips.cc/Conferences/2015/PaperInformation/StyleFiles`, and must be no longer than 6 pages (10 for pair projects) including the figures and tables and references. Do not hand in any code of any kind.

2.3 Marking scheme

The following criteria will be taken into account when marking:

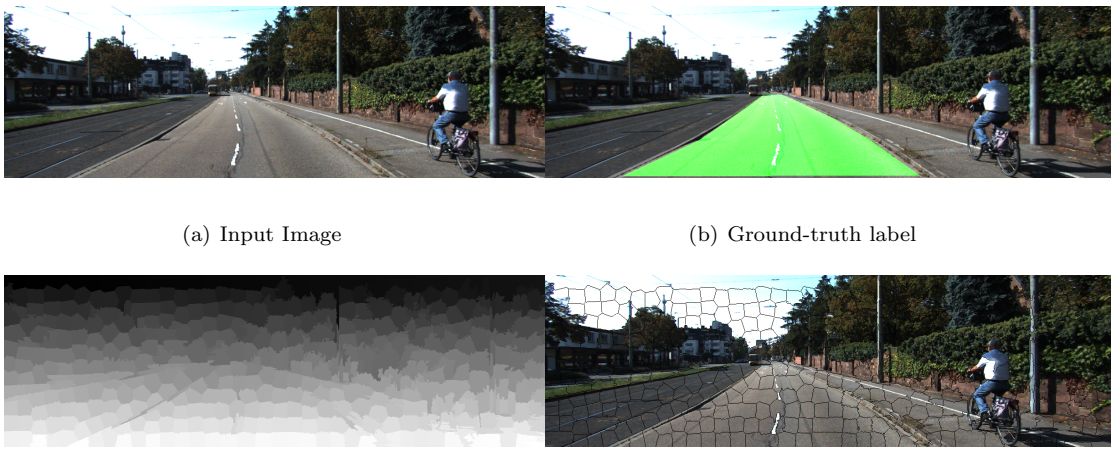
- Clarity/Relevance of problem statement and description of approach.
- Discussion of relationship to previous work and references.
- Design and execution of experiments.
- Figures/Tables/Writing: easily readable, properly labeled, informative.

3 Possible Projects

3.1 Autonomous Driving: Road-Estimation

The goal of this project is to create a classifier that given an image is able to create a pixel wise segmentation of the image in terms of what is road and what is non-road (i.e., binary classification). For this purpose download the base kit of KITTI [3] with: left color images, calibration and training labels data from `http://www.cvlibs.net/datasets/kitti/eval_road.php`. Split the training data into training, validation and testing. The splits should be 60%/10% and 30% of the data. Do not submit to the test set benchmark. Best performing methods will be invited to do so. For more information about the road dataset see [2].

Note that the task is to label each pixel, and thus there is a "classification" problem to be solve per pixel. To ease the computation, for each image first compute super-pixels using for example SLIC `http://ivrg.epfl.ch/research/superpixels#SLICO`. Note that you can use other super pixel code/algorithms if you want to. Classification can then be performed by treating each super pixel as an example.



(a) Input Image (b) Ground-truth label

(c) SLIC superpixel (d) SLIC super-pixel Boundary

Figure 1: An example from KITTI road segmentation benchmark.

The purpose of this project is to investigate machine learning techniques to solve this task. Try things that we have seen in class, or other techniques if you feel like it. Write in your report what you have done, what you observe, what you have tried, why you did what you did, etc.

Write in your report what would you do to scale what you have done to work with pixels, as in that case you have millions of examples.

BONUS: The use of "fancy" techniques such as Markov Random Fields should only be attempted if you want an extra bonus on the project (up to 30% extra). These type of techniques are only covered in class as a sample of exciting things in machine learning and thus I do not expect students to try such things for the purpose of the project.

3.2 Street View House Numbers

This project focuses on classifying digits from street view images. Towards this goal, download the Format 2 images from the Street View House numbers dataset [1] with `train_32x32.mat`, `test_32x32.mat` data, which you can find at `http://ufldl.stanford.edu/housenumbers/`. In this task, all the images have a fixed 32×32 resolution with character-level ground truth labels. For each example, the labeled character is centered at the image. There are ten classes in total 1 for each digit. Divide the training into train and validation (e.g., 80% and 20%).

Note that the data is collected from street-view images, thus there exist vast intra-class variations. To generate competitive performance, you may want to consider exploiting good feature representations that are robust to those variations, whether they should be hand-crafted features or learned features. In order to boost performance, you may also want to consider augmenting the training data with `extra_32x32.mat`.

The purpose of this project is to investigate machine learning techniques to solve this task. Try things that we have seen in class, or other techniques if you feel like it. Write in your report what you have done, what you observe, what you have tried, why you did what you did, etc.

Figure 2: Examples from street view house numbers benchmark.

BONUS: Bonus will be given to attempts to solve both text detection and recognition task, i.e. Format 1 in SVHN dataset (with up to 30% extra). In this task, images are not well cropped with also multiple labeled digits appear in one image. Your task is to first detect the digits with a bounding box then conduct classification on each cropped digit.

3.3 Own Project

You can work on a different project if you want to. Towards this goal, you should submit a one page proposal describing in detail the goal of the project, the data as well as which techniques you plan to use. You are also encouraged to apply machine learning techniques on the open problems in your own research areas. You may also choose a public problem from a website such as Kaggle. In this case you will need to develop and analyze the performance of at least two different ML approaches to the target problem.

BONUS: Bonus will be given according to the importance and difficulty of your problem, the techniques you use and the performance you have achieved compared with the state-of-the-art (with up to 30% extra).

4 Deadlines and Submission Instructions

Make sure that you don't miss any of the following deadlines:

- The **project proposal** should be submitted electronically via MarkUs. Name your submission `Proposal-*your-student-id*.pdf`. The submission deadline is noon on **October 29th**.

- The **project report** should also be submitted via MarkUs by noon on **December 16th**. Name your submission `Project-*your-student-id*.pdf`. A penalty of 25% will be applied per day that the submission is late.

References

[1] Netzer, Yuval, et al. "Reading digits in natural images with unsupervised feature learning." *NIPS workshop on deep learning and unsupervised feature learning*, 2011.

[2] Fritsch, Jannik, Tobias Kuhnl, and Andreas Geiger. "A New Performance Measure and Evaluation Benchmark for Road Detection Algorithms." *ISTC* 2013.

[3] Geiger, Andreas, Philip Lenz, and Raquel Urtasun. "Are we ready for autonomous driving? the kitti vision benchmark suite." *CVPR* 2012.