De-Correlating CNN Features for Generative Classification

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**Problem Definition:**
- Given a handful of images as positive examples for the class of interest, how do I build a classifier without any labeled negative training data?

**Motivating Applications:**

1. Content based Searching and Tagging:
   - Suppose you go Rafting with friends and take pictures:
     - How do you search for similar Rafting pictures in your photo collection using only the images taken on that day as source of class specific training data?

2. Improving Recall for a Pure Cluster:
   - Given the output of a clustering algorithm (a mix of pure and impure clusters), how can I use the images of a "pure" cluster to bootstrap a model that can help improve its recall?

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**Pipeline of the proposed LDA based approach:**

OFFLINE STEP:
- Collect a large collection of unlabeled images
- Extract CNN features and compute mean and covariance for the entire set
- Train LDA classifier for foreground class as $W_i = \Sigma_k (\mu_k - \mu_i)$

ONLINE STEP:
- User provides positive images for a class (foreground images)
- Outputs of different mixtures need to be calibrated using class specific negatives
- Whereas our model implicitly models mixtures and needs no calibration

**Closest Related Work (Malik et. at. ECCV 2012):**

- Different viewpoints of an object have different appearances in HOG space, and are modeled using different templates.
- Each template is built using viewpoint specific foreground images and a common background model.

**Experiments:**

- Quantitative Scene Classification results on SUN-Scene database
  - SVM based models
  - LDA based models
  - Comparable performance
  - In spite of the fact that the LDA model was not provided any class specific negative data

- Qualitative results of using our LDA based classifiers:
  - Railway
  - Rafting

- Application to Query Expansion (QE):
  - Nearest neighbor
  - Average QE
  - Discriminative QE
  - LDA based QE
  - Ranked List of retrieved results on the Paris 6K dataset using off the shelf CNN features