1. Supervised and unsupervised deep learning

- Deep representations can be obtained with
  - Unsupervised learning: informative preservation
    - E.g., Stacked autoencoders (SAE), DBN, DBM
    - Generating data from feature representations (related to invertibility)
  - Supervised learning: task-specific, not necessarily invertible

- Unsupervised deep learning (DL) as pretraining for supervised DL

2. Augmenting classification networks

   a. Inverting 16-layer VGGNet
   - SAE
   - SWWAE (layer-wise architecture)
   - SWWAE (all layers)

   b. Inverting AlexNet

   - SAE
   - SWWAE

3. Invertibility of large-scale classification networks

   a. Micro-architectures for SAE & SWWAE
   - Ordinary SAE
   - SWWAE (SWWAE only)

   b. Inverting AlexNet

   - SAE
   - SWWAE

   c. Inverting 16-layer VGGNet

   - SAE
   - SWWAE

   d. Observations & Hypotheses

   - Max-pooling is the main source of information loss (SWWAE sufficiently recovers it)
   - Convolutional filters and non-linearity cause minor information loss

4. Improving large-scale classification networks with decoding pathways

   a. Experiments
   - 16-layer VGGNet on ILSVRC2012
   - Single crop: 224px patch at center
   - Convolution: dense sampling

   b. Conclusions

   - A simple and effective way to incorporate unsupervised objectives into large-scale classification network learning.
   - We improved the image classification performance of the 16-layer VGGNet, a strong baseline model, by a noticeable margin.
   - Comparison among the variants of our models
     - Pooling switch connections in SWWAE slightly benefit classification performance.
     - The decoding pathways mainly help the supervised objective reach a better optimum.
     - The layer-wise reconstruction loss can regularize the solution to the joint objective.

Main references: