Meta-data.

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Topic(s)	Image analysis and Machine learning

Question.

In the field of image processing and analysis, consider two kinds of problems: (A) the problem of *image quality enhancement* that seeks to improve the quality of a *degraded* image. An example of a degraded image can be a photo acquired at night using a low-resolution camera. (B) the problem of *object detection* that seeks to label each pixel in the image to indicate whether the pixel belongs to an object of interest or not. For example, the task is to detect your face (object of interest) from a photograph of a group of people at a party.

1. For task A, consider a supervised learning-based approach that seeks to learn a statistical regression-based framework to map the input degraded image to a quality-improved image. Design such a framework. Specifically, state (i) the proposed statistical model, (ii) the proposed model-fitting or learning scheme, and (iii) the algorithm for the application of the learned model on a test image. Assume the supervision is in the form of N pairs of images $\{(x_i, y_i) : i = 1 \dots N\}$ where x_i denotes a low quality image and y_i denotes the corresponding high quality image.

2. For task B, consider a supervised learning-based approach that seeks to learn a statistical regression-based framework to map the input image to an image of probability values (one probability value for each pixel) indicating the probability of that pixel belonging to the object of interest. Design such a framework. Specifically, state (i) the proposed statistical model, (ii) the proposed model-fitting or learning scheme, and (iii) the algorithm for the application of the learned model on a test image. Assume the supervision is in the form of N pairs $\{(x_i, y_i) : i = 1 \dots N\}$ where x_i denotes an image and y_i denotes a binary image of the same size where a '1' at a position denotes that the corresponding pixel is part of the object of interest.

3. For task A (image quality enhancement), now consider the possibility of multiple solutions to be likely for the same input image, i.e., there could have been multiple high-quality images that could have produced the same low-quality image. To address this scenario, modifty your regression-based framework to output a family of solutions. Specifically, state (i) the proposed statistical model, (ii) the proposed model-fitting or learning scheme, and (iii) the algorithm for the application of the learned model on a test image.

4. For task B (object detection), now consider the possibility of multiple solutions to be likely for the same input image, i.e., there could have been multiple high-quality images that could have produced the same low-quality image. To address this scenario, modifty your regression-based framework to output a family of solutions. Specifically, state (i) the proposed statistical model, (ii) the proposed model-fitting or learning scheme, and (iii) the algorithm for the application of the learned model on a test image.

Grading Scheme.

For the regression frameworks in questions 1 and 2, their design can be based on a nonlinear regressor like a neural network or a decision tree.

For the regression frameworks in questions 3 and 4, their design can be based on a regression framework like a Bayesian neural network or a decision forest.

(1) Weightage: 20%
(2) Weightage: 20%
(3) Weightage: 30%
(4) Weightage: 30%