Class Test Questions

Q1. What is the main difference between nearest-neighbor interpolation and radial basis function (RBF) interpolation when fitting scattered data?

Q2. Given 15 random sample points from a smooth 2D function, which interpolation technique would you choose to get a smooth continuous surface and why?

Q3. You fit a function using interpolation and get the following MSEs: Method A: training=0.001, validation=0.200; Method B: training=0.020, validation=0.025. Which method shows signs of overfitting and why?

Q4. Why might the L1 norm be preferred over the L2 norm when fitting data that contains outliers?

Q5. What is the general form of an energy minimization problem in variational methods, and what do the data term and regularization term represent?

Q6. What property does total variation regularization preserve better than simple L2 smoothing, especially in image denoising?

Q7. What is the key advantage of a bilateral solver compared to a standard smoothing filter?

Q8. In an image labeling MRF, what do the unary and pairwise potentials represent?

Q9. How does a Conditional Random Field (CRF) differ from a standard MRF in terms of probability modeling?

Q10. In interactive segmentation using an MRF, how can user-provided scribbles be incorporated into the energy minimization formulation?

Answer Sheet with Explanations

Q1 Answer: Nearest-neighbor assigns the value of the closest sample point; RBF uses weighted sums of radial basis functions for smooth interpolation.
Explanation: RBF interpolation considers all sample points for smoothness, while nearest neighbor is discontinuous.

Q2 Answer: RBF interpolation or Kriging, because they handle irregularly spaced data and produce smooth continuous surfaces.
Explanation: Global smooth methods like RBF work well without grid constraints.

Q3 Answer: Method A shows overfitting: very low training error but high validation error.
Explanation: Overfitting = learns noise in training data, poor generalization.

Q4 Answer: L1 norm is less sensitive to outliers than L2 norm.
Explanation: L2 squares errors, amplifying large deviations; L1 treats all proportionally.

Q5 Answer: $E(f) = E_{data}(f) + \lambda E_{reg}(f)$, where data term fits observed data and regularization imposes smoothness or priors.
Explanation: Variational methods balance data fidelity with smoothness or prior knowledge.

Q6 Answer: Preserves sharp edges while removing noise.
Explanation: TV penalizes total gradient magnitude, allowing edges but removing small noise gradients.

Q7 Answer: Smooths while preserving strong edges by considering both spatial proximity and intensity similarity.
Explanation: Bilateral filters adapt smoothing strength to avoid blurring across edges.

Q8 Answer: Unary: cost of assigning a label to a pixel based on data. Pairwise: penalty for label differences between neighbors.
Explanation: Unary = pixel data; Pairwise = spatial coherence.

Q9 Answer: CRF models $P(x|y)$ directly given observations, MRF models joint $P(x, y)$.
Explanation: CRFs avoid modeling data distribution explicitly.

Q10 Answer: Add scribbles as hard constraints or high-weight unary terms forcing pixels to take user-specified labels.
Explanation: Guidance is integrated so optimization respects user input.