5 Computer Vision (JGD)

(a) Discuss the problem of figure-ground segmentation for the natural image below, and evaluate the prospects that a data-driven ("bottom-up") edge detection algorithm can correctly find the outline of the fox in the lower left. (See extract.) Explain how global, Gestalt information about the entire scene can help bring high-level knowledge and low-level data together, and consider the relevance of the massive feedback projection from the brain’s visual cortex back down to the thalamus where it meets afferent retinal data. [5 marks]

(b) Define two-dimensional convolution and list some of its uses in computer vision. Derive an estimate for the size \((N \times N)\) of a convolution kernel to be used on a \((512 \times 512)\) image, at which it becomes more efficient to perform the convolution using a Fast Fourier Transform algorithm rather than explicitly computing the 2D convolution integral. [5 marks]

(c) Explain what is meant by the phrase “to estimate a homography”. Discuss how this can be achieved, and for what purposes it is useful. [5 marks]

(d) For two-state decision problems, define and draw a receiver operating characteristic (ROC) curve. Explain why the total area under an ROC curve is a metric for the discriminability in a “same versus different” classification problem. Does the area-under-ROC metric depend on a specific choice for decision threshold? [5 marks]