COMPUTER SCIENCE TRIPOS Part II – 2017 – Paper 8

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 (512×512) 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]