Utilizing Linear Classifiers for the Early Detection of Neoplastic Conditions in Canines and Felines

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Abstract:

Neoplasms are a significant health issue in both dogs and cats, with variations in prevalence and severity. Skin tumors are the most common in dogs, accounting for about one-third of all tumors, with female dogs experiencing cancer at three times the rate of males. Over 50% of neoplasms occur in dogs aged 6—14 years, with 20—30% being malignant [1]. In contrast, cats have a higher malignancy rate, with 78.7% of tumors being malignant, and among 685 feline cases, 56% were epithelial tumors [2]. Cancer leads to 15—30% of deaths in dogs and 26% in cats [3]. The disease type at diagnosis is critical for determining prognosis and treatment in companion animal neoplasms. It influences the tumor's growth, spread, stage, and the timing of diagnosis or treatment [4]. Early diagnosis is essential to reduce fatalities and high medical costs, enabling timely intervention and increasing the likelihood of successful, less invasive treatment.

Fine-Needle Aspiration Cytology (FNAC) is considered the gold standard for diagnosing skin tumors in veterinary medicine. This method uses a thin needle to extract cells from a mass, which are then examined microscopically for neoplastic cells [5]. Research by G. Pavel et al. (2016) Formatting... showed that in dogs, FNAC provided a definitive malignant diagnosis in 52.2% of cases, while 47.8% remained inconclusive. In cats, it accurately diagnosed only 40% of cases, requiring further tests in the remaining 60% [6]. Another study highlights the limitations of FNAC, with its sensitivity and specificity for detecting malignancy at 68.6% and 77.2%, respectively [7].

Machine learning can assist pathologists by automatically identifying features in microscopic images and classifying them by tumor type or as healthy versus cancerous tissue. While it has proven effective in diagnosing various cancers from histopathological images in human medicine [8-10], its application in veterinary medicine is still developing. Dank et al. (2023) demonstrated good accuracy, sensitivity, and specificity using a support vector machine classifier on tumor thermal images with leave-one-out cross-validation [11]. However, this study relied on optical imaging tools that are uncommon in veterinary clinics.

Recognizing the importance of early detection, our research focuses on using advanced techniques to diagnose neoplasms at their initial stages by modeling our method accordingly. We apply machine learning linear classifiers to analyze brightfield microscopy images of hematoxylin and eosin (H&E) stained histopathology slides. These classifiers - including linear discriminant analysis (LDA), support vector machine (SVM), Naive Bayes (NB), decision tree (DT), and nearest neighbors (NN)-are aimed