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Statistics in Calculation and Computer Vision

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Abstract

Statistical Inference on Random Fields in the IEEE Proceedings while looking for a topic for my Ph.D. dissertation. Methods for estimating parameters and testing hypotheses in two-dimensional non-causal models were the subject of this article. This paper led me to classic papers as well as a paper on parameter estimation in Gaussian Markov random field models. I was naturally drawn to the possibilities of using a mathematical statistical framework for computer vision problems because I had been exposed to fundamental concepts in parameter estimation, random processes, and decision theory as a student of electrical and computer engineering. My dissertation dealt with stochastic models for understanding and processing images. Since then, I have worked on computer vision problem-solving strategies based on mathematical statistics. Mathematical statistics tools are very helpful in solving computer vision problems because the majority of them involve inferring some properties (radiometric, geometric, etc.) from images and videos. For mathematical statisticians, computer vision problems can be extremely challenging when it comes to inferring 3D geometry from images and videos. The ability to use appropriate distributions to account for degradations in the data is another reason why statistical methods may be useful for computer vision issues; A Bayesian framework can also take into account any previous data. Manifolds, non-parametric inference tools, and other tools, it's possible to have even more fun.

Keywords: 3D Geometry • Fundamental Concepts • Parameter Estimation

Introduction

Factual strategies were not generally welcome in PC vision. In the early stages of the development of statistical inference methods for computer vision, primarily linear models and Gaussian distributions were utilized; Leading computer vision researchers did not like these models' simplicity. was of the opinion that statistical techniques will not be able to cope with the difficulties of computer vision issues unless they are supported by approaches that do not rely on linear models and Gaussian distributions. on abstract mathematical and statistical models and techniques for numerous computer vision issues. He presented his findings in books that mainstream computer vision researchers struggled to comprehend. Therefore work was viewed as elusive. David Cooper was likewise vivaciously chasing after Bayesian strategies for limit and article acknowledgment The seminal paper on simulated annealing, stochastic relaxation, and MAP restoration of images published in PAMI in 1984 caused a seismic shift. This paper demonstrated that computer vision can and will benefit greatly from fundamental statistical techniques. The computer vision community began to accept statistical models and techniques from this point on. A flurry of papers on image segmentation, restoration, classification, optical flow estimation, and other topics followed the Geman paper. In a paper published in the Journal of the Royal Statistical Society on statistical analysis of dirty images, a deterministic alternative referred to as the iterated condition mode was presented. Mean field annealing, graduated non-convexity, and maximum posterior marginal are examples of algorithms that were influenced by the simulated annealing algorithm. Numerous computer vision researchers are steadfastly pursuing the Bayesian formulation as a method. In computer vision, MRFs are here to stay. The optimization of MRF-derived posterior probability density functions is the foundation for a number of popular optimization techniques [1].

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Discussion

The well-cited paper on the comparison of energy minimization methods for MRFs that appeared in PAMI in 2008 [8] is a good illustration of the impact of MRF-driven methods. Time is everything, even in scholarly research, according to common wisdom. In statistics, Principal Component Analysis (PCA) is a well-known method for reducing dimensionality. In the late 1980s and early 1990s, various subspace-based approaches to face and object recognition were developed as a result of PCA's application to face representation and recognition. Over the past two decades, numerous variations of Fisher's Linear Discriminant Analysis (LDA), kernel-PCA, and kernel-LDA, as well as partial least squares, have been developed. Another positive example of the impact of methods rooted in mathematics and statistics on the resolution of computer vision issues is the application of Support Vector Machines (SVM) to issues ranging from optical character recognition (OCR) to face recognition. Even though these methods seem to work, they don't work well with poses, lighting, occlusions, and other variations. Classifiers that are capable of adapting to so-called domain shifts caused by pose, illumination, blur, and other factors are being designed using methods based on domain adaptation in recent years. This seems like a promising strategy [2,3].

Conclusion

The development of particle filters is yet another well-known illustration of how statistical inference affects computer vision. Particle filtering's adaptation to a tracking that computer vision researchers can relate to contributed to its immense success, despite the fact that the radar tracking community was familiar with the concept of particle filtering and the jump diffusion process in the world of stochastic filtering. Even students who have not been exposed to random process, estimation theory, or the Kalman filter are able to use the particle filter with ease because it has evolved into one of the most important tools in the computer vision toolkit! The takeaway from this is that a computer vision algorithm has a long lifespan if it can be used in OpenCV or MATLAB! On the other hand, using particle filters by people who have not even been exposed to the fundamentals of random processes and estimation theory is not a good idea. This can be examined in a different article on the most proficient method to teach a PC vision scientist [4].

The final illustration I'd like to give is the statistical analysis of shapes, boundaries, and landmarks using manifolds, among other things have brought new models and methods based on differential geometry and statistical inference to bear fruit in an important area of computer vision. These efforts follow the seminal works of Kendall, Mardia, Grenander, Cooper, and others. The computer vision community is accepting statistical inference on manifolds for object, event, and gesture recognition. Robust computer vision methods, performance evaluation, Monte Carlo techniques, Lasso, and ensemble learning are other mathematical statistics concepts that have influenced the field of computer vision. Due to space constraints, these subjects cannot be discussed in depth [5].

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Conflict of Interest

None.

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