Mathematical Statistics

Estadística Matemática Extremadura
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Overview

Lines of Research

1. Markov Kernels
   Agustín García Nogales
2. Nonparametric Statistics
   José Enrique Chacón Durán: Tarn Duong (Sorbonne, France), Carlos Tenreiro (Coimbra, Portugal)
3. Flexible Modelling of Linear and Directional Data
   Arthur Pewsey: M.C. Jones (Open, UK), Toshihiro Abe (Nanzen, Japan), Shogo Kato (ISM, Japan)
4. Applications of Statistics in Medical Research
   Jesús Montanero Fernández

Markov kernels

Agustín García Nogales

Markov kernels, also referred to as stochastic kernels or transition probabilities, are fundamental to Probability Theory and Mathematical Statistics because, in one sense, any Markov kernel is a conditional distribution.

Examples of Markov kernels include:

1. Transition matrices of Markov chains,
2. Posterior distributions in Bayesian analysis,
3. Decision rules in decision theory.

A Markov kernel can also be considered to be a generalization of the concepts of random variable and sub-σ algebra.

References

In recent years, we have extended the concepts of completeness, ancilliarity, independence and regular conditional probability to Markov kernels.

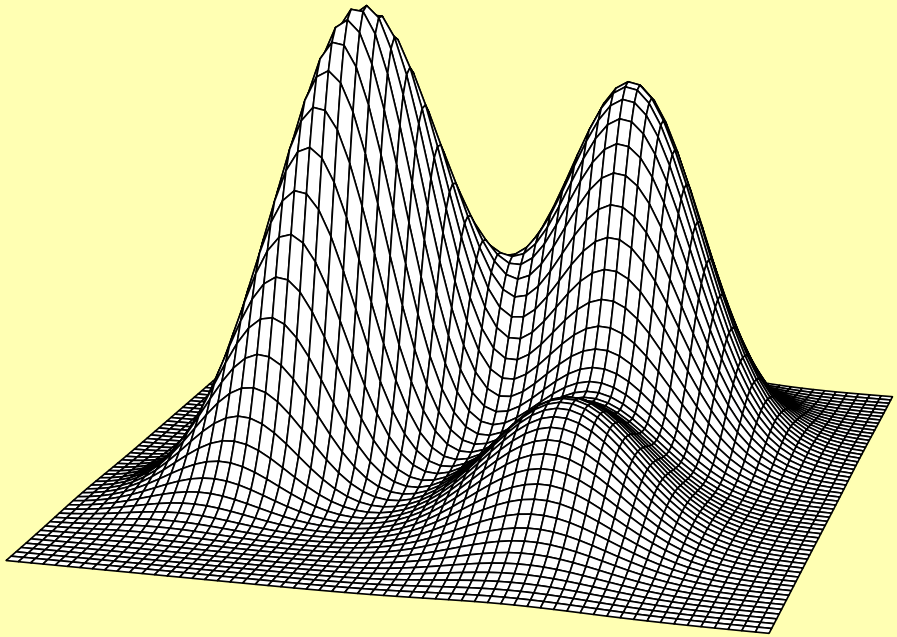
Nogales, A.G. (2013) On independence of Markov kernels and a generalization of two theorems of Basu. Journal of Statistical Planning & Inference, **143**, 603–610.

Nogales, A.G. (2013) The existence of regular conditional probabilities for Markov kernels. Statistics & Probability Letters, **83**, 891–897.

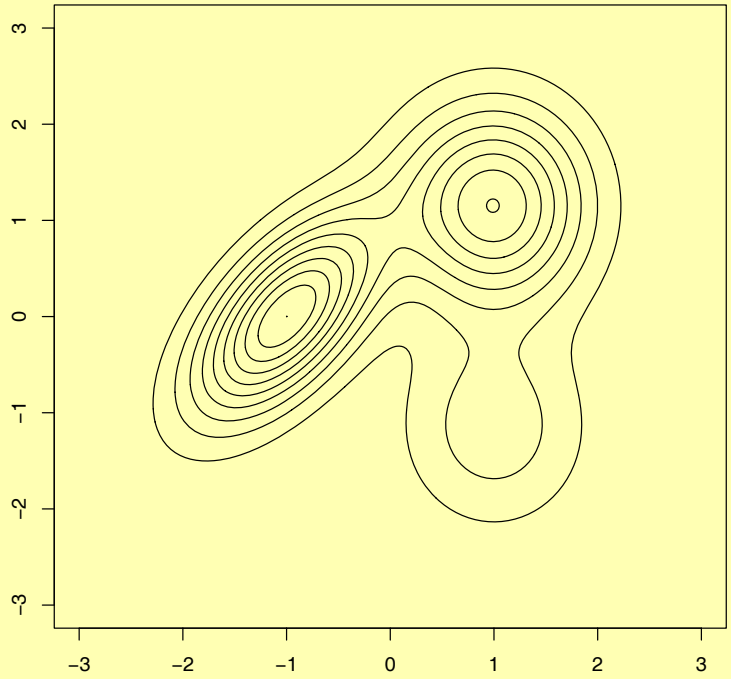
Nonparametric Statistics

José Enrique Chacón Durán

The primary focus of this line of research is nonparametric density estimation for data distributed on $\mathbb{R}$ or $\mathbb{R}^p$.



Perspective plot

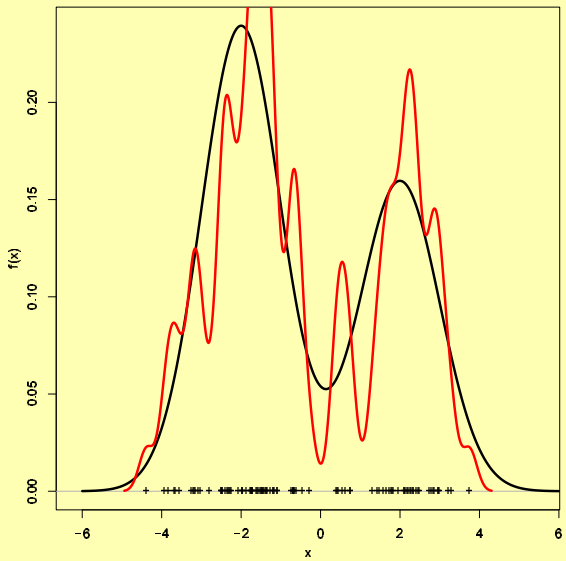


Contour plot

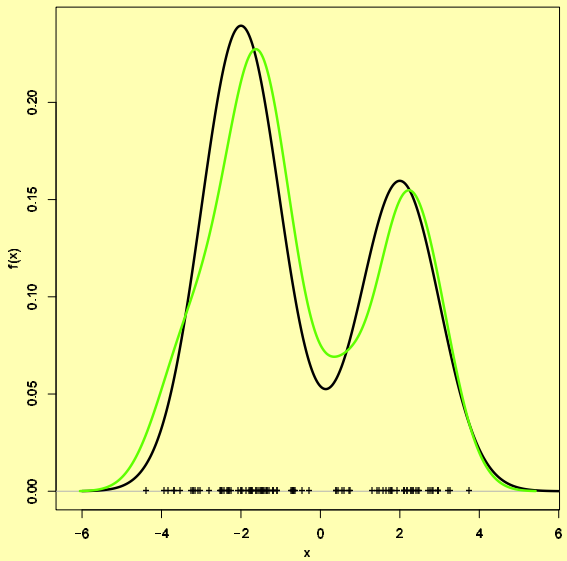
Nonparametric Statistics

The main approach to nonparametric density estimation considered is that based on kernel smoothing and the related problem of bandwidth selection.

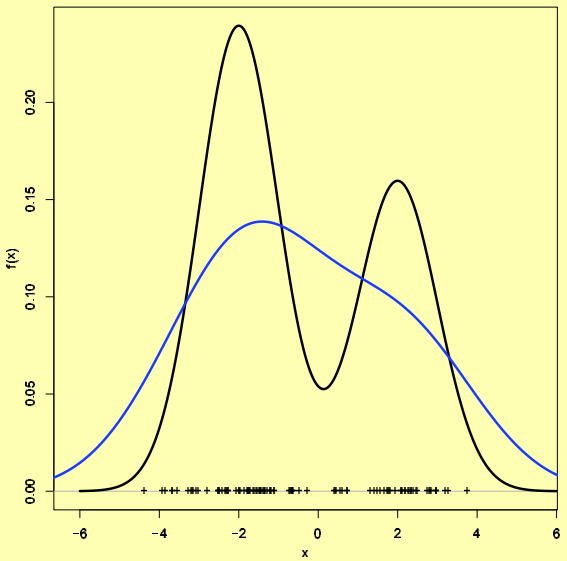
Under-smoothing



Optimal

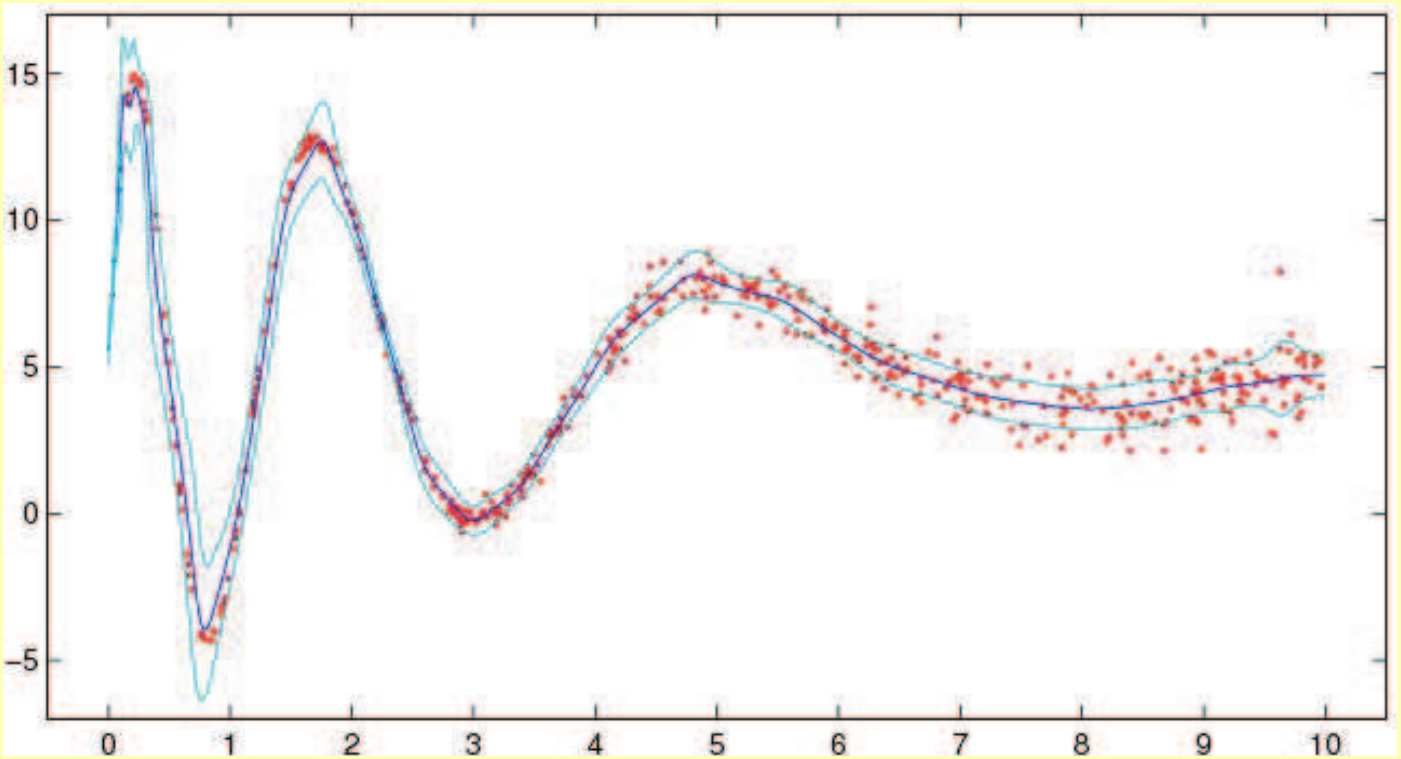


Over-smoothing



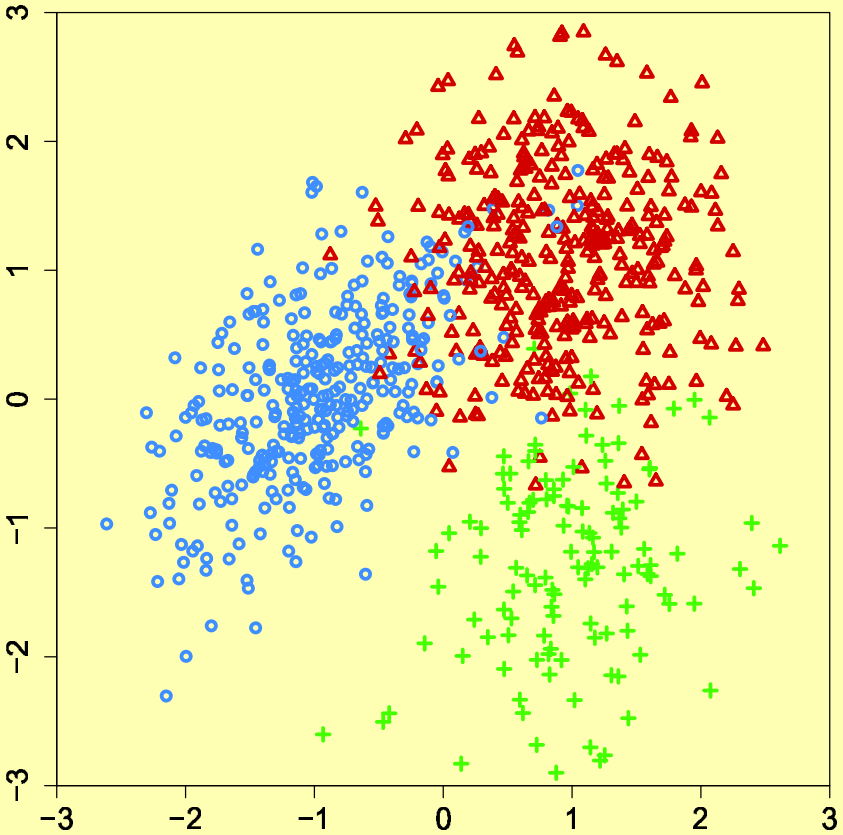
Nonparametric Statistics

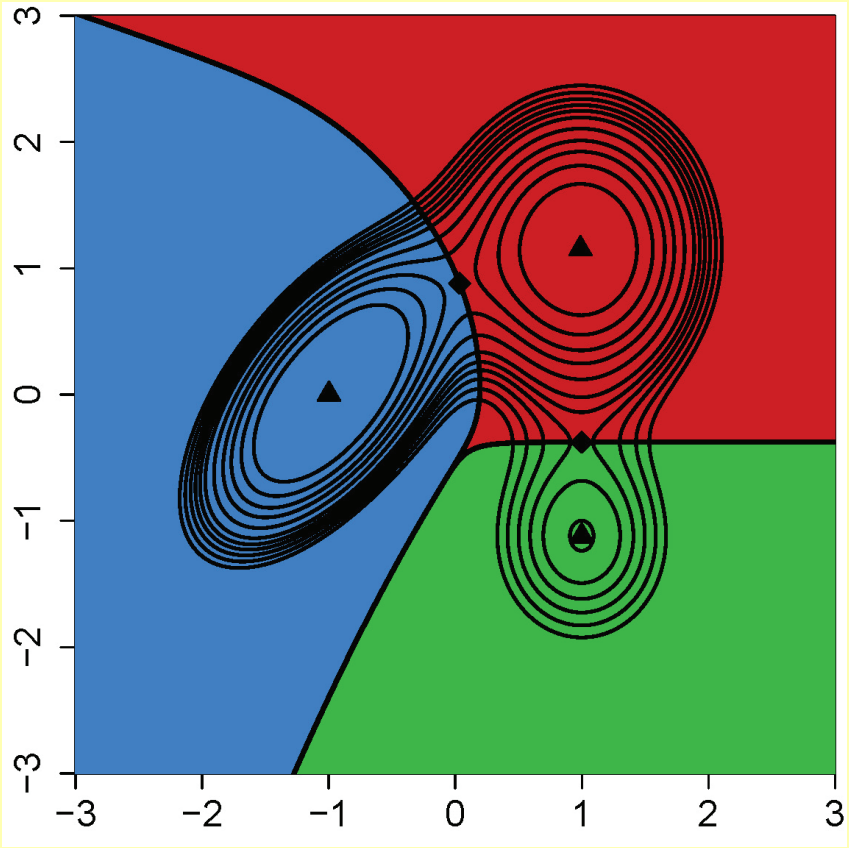
A related problem is nonparametric regression.



Nonparametric Statistics

A further related problem is cluster analysis.





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Flexible modelling

Arthur Pewsey

The focus for this line of research is the flexible parametric modelling of linear data, distributed on (subsets of) $\mathbb{R}$ or $\mathbb{R}^p$, and directional data, distributed on the unit circle, torus, cylinder, sphere, or multivariate extensions of such supports.

By flexible we mean that the models should be able to describe features such as varying degrees of asymmetry, kurtosis, shape and multimodality often manifested by real data. For data on $\mathbb{R}$, this usually means that the number of parameters involved is 4 or more.

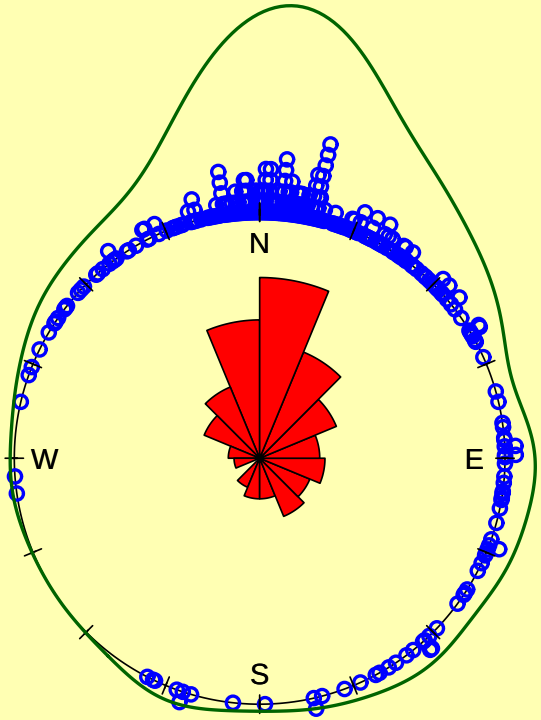
Directional data

Directional data arise, for example, when we measure:

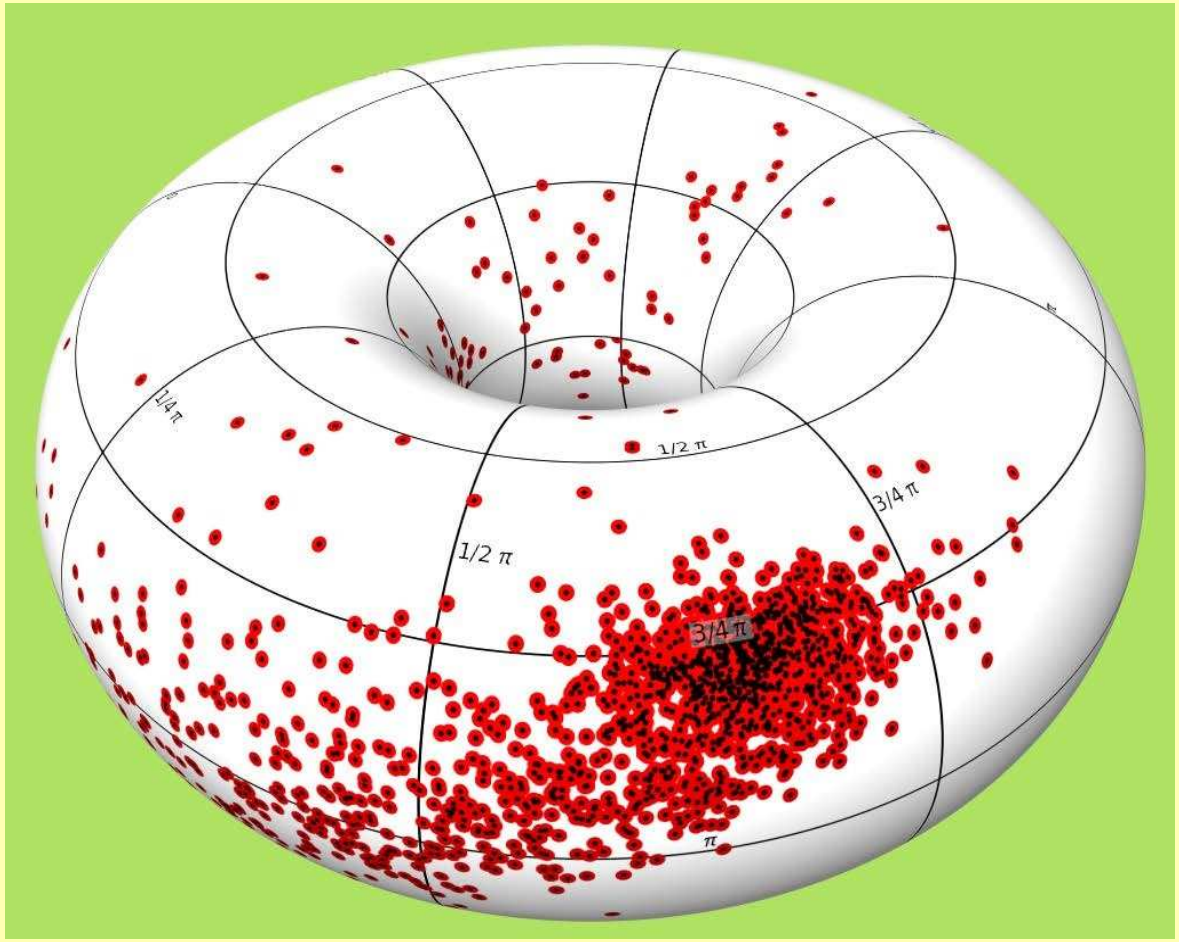
1. Wind direction (an angle or direction of a unit vector in 2D: circular),
2. Ozone concentration and wind direction (a real variable and an angle: cylindrical),
3. Pairs of dihedral angles between the amino acids making up a protein (two angles: toroidal),
4. Locations of impacting meteorites (direction of a unit vector in 3D: spherical).

Directional data on compact manifolds

Circular



Toroidal



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