



LES FACULTÉS  
DE L'UNIVERSITÉ  
CATHOLIQUE DE LILLE

Non Linear Models examples

# SPATIAL STATISTICS

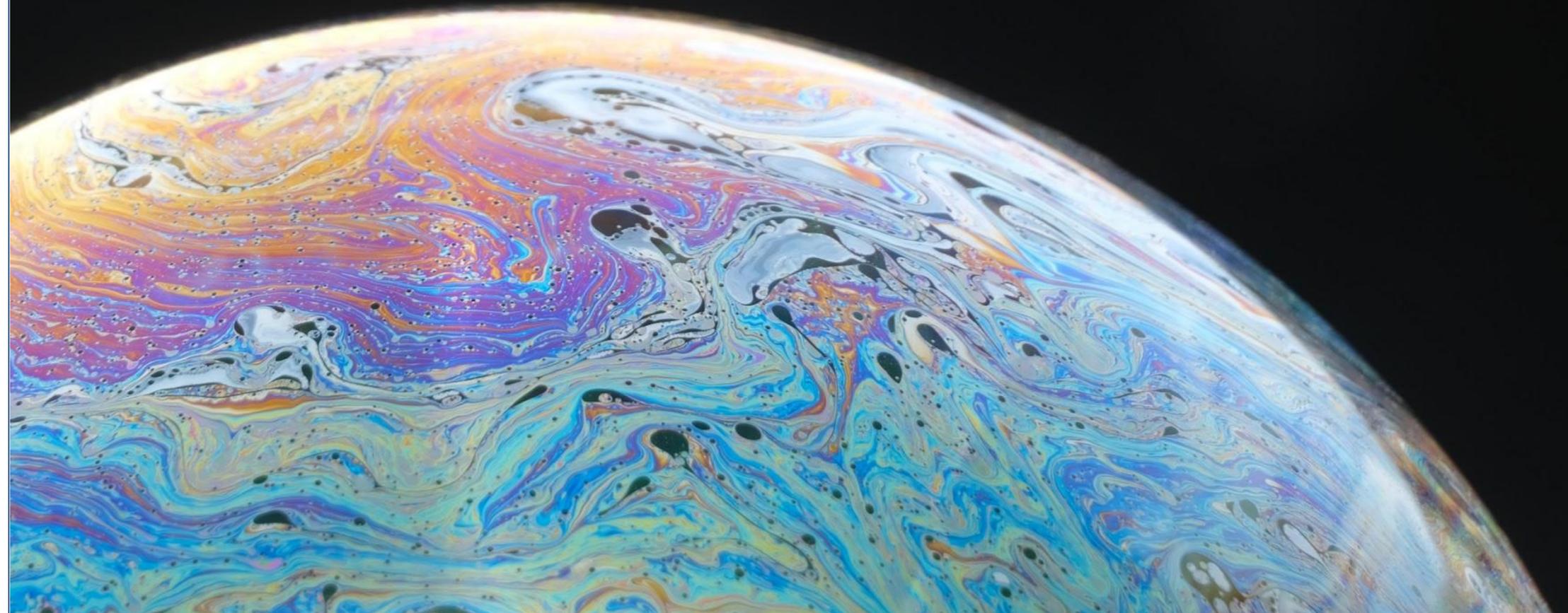
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## Part 1: Introduction to Nonlinear Models Examples

### 1.1 Nonlinear Regression Examples

- Polynomial Regression
- Exponential Growth Models
- Logistic Regression

### 1.2 Nonlinear Time Series Models

- Autoregressive Integrated Moving Average (ARIMA) Models
- GARCH Models for Volatility
- Nonlinear Dynamical Systems in Time Series

### 1.3 Nonlinear Models in Machine Learning

- Neural Networks and Activation Functions
- Decision Trees and Random Forests
- Support Vector Machines (SVM) with Nonlinear Kernels

## Part 2: Spatial Statistics Fundamentals

### 2.1 Spatial Data Analysis

- Characteristics of Spatial Data
- Spatial Data Types (Point, Line, Polygon)
- Challenges in Spatial Analysis

### 2.2 Spatial Autocorrelation

- Moran's I Statistic
- Geary's C Statistic
- Interpretation and Spatial Dependence

### 2.3 Spatial Interpolation

- Kriging and Variogram Analysis
- Inverse Distance Weighting
- Applications in Geostatistics

## Part 3: Spatial Data Visualization and Exploration

### 3.1 Spatial Data Visualization

- Choropleth Maps
- Heatmaps and Density Plots
- Spatial Scatter Plots

### 3.2 Exploratory Spatial Data Analysis (ESDA)

- Local Indicators of Spatial Association (LISA)
- Spatial Autocorrelation Maps
- Detecting Spatial Clusters and Outliers

### 3.3 Spatial Regression Models

- Spatial Lag Models
- Spatial Error Models
- Model Interpretation and Inference

## Part 4: Applications of Spatial Statistics

### 4.1 Environmental Spatial Analysis

- Spatial Distribution of Pollution
- Habitat Modeling
- Geospatial Epidemiology

### 4.2 Urban and Regional Planning

- Spatial Analysis in Urban Development
- Transportation and Traffic Flow
- Land Use Planning

### 4.3 Remote Sensing and GIS

- Satellite Image Analysis
- Geographic Information Systems (GIS)
- Spatial Decision Support Systems (SDSS)

## KEYWORDS (NEW)

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- Nonlinear Models
- Nonlinear Modeling Techniques
- Nonlinear Regression
- Polynomial Regression
- Exponential Growth Models
- Logistic Regression
- Nonlinear Time Series Models
- ARIMA Models
- GARCH Models
- Nonlinear Dynamical Systems
- Chaotic Behavior
- Complex Dynamics
- Nonlinear Models in Machine Learning
- Neural Networks
- Activation Functions
- Decision Trees
- Random Forests
- Support Vector Machines (SVM)
- Nonlinear Kernels
- Data Analysis
- Time Series Forecasting
- Ensemble Methods

In the context of the course on "Nonlinear Models," "Spatial Statistics Fundamentals," and "Applications of Spatial Statistics," which covers topics related to nonlinear regression, spatial data analysis, spatial autocorrelation, spatial data visualization, and spatial regression models, let's explore a use case related to geospatial epidemiology using spatial statistics.

#### Description:

In this use case, we will apply spatial statistics techniques to analyze the geographical distribution of a contagious disease, such as COVID-19, and assess its spatial patterns and correlations with various environmental factors.

#### Key Components:

**Nonlinear Regression Examples:** Understanding various nonlinear regression models, including polynomial regression, exponential growth models, and logistic regression. These models can be useful for modeling disease spread over time.

**Spatial Data Analysis:** Recognizing the characteristics of spatial data, including point, line, and polygon data types. Addressing challenges in spatial data analysis, such as spatial autocorrelation.

**Spatial Autocorrelation:** Learning about spatial autocorrelation measures like Moran's I and Geary's C. Understanding spatial dependence and its implications for disease spread.

**Spatial Interpolation:** Exploring techniques like kriging and inverse distance weighting for estimating disease prevalence at unobserved locations. These methods are valuable for creating spatial disease risk maps.

**Spatial Data Visualization:** Creating choropleth maps, heatmaps, and spatial scatter plots to visualize the spatial distribution of disease cases and environmental factors.

**Exploratory Spatial Data Analysis (ESDA):** Employing local indicators of spatial association (LISA) to identify spatial clusters of disease cases or high-risk areas. Detecting spatial outliers and understanding their significance.

**Spatial Regression Models:** Utilizing spatial lag models and spatial error models to assess the impact of environmental factors on disease spread. Interpreting and making inferences from spatial regression results.

#### Geospatial Epidemiology Scenario:

Imagine a scenario in which you are a public health researcher analyzing the spatial distribution of a contagious disease outbreak, such as a flu or COVID-19 epidemic. You have access to geospatial data on disease cases, environmental factors (e.g., temperature, humidity), and population density. Here's how you can apply spatial statistics techniques:

#### Python Code Example (Spatial Analysis for Geospatial Epidemiology):

```
1 import pysal
2 import geopandas as gpd
3 import pandas as pd
4 import numpy as np
5 import matplotlib.pyplot as plt
6
7 # Load spatial data (shapefile) containing disease cases and environmental factors
8 gdf = gpd.read_file('path_to_shapefile.shp')
9
10 # Calculate Moran's I to assess spatial autocorrelation of disease cases
11 w = pysal.lib.weights.KNN.from_dataframe(gdf, k=5) # Spatial weights matrix
12 y = gdf['DiseaseCases'] # Disease cases variable
13 mi = pysal.explore.esda.Moran(y, w)
14 print("Moran's I:", mi.I)
15 print("Moran's I p-value:", mi.p_sim)
16
17 # Create a choropleth map of disease prevalence
18 gdf.plot(column='DiseaseCases', cmap='coolwarm', legend=True)
19
20 # Perform spatial regression to assess the impact of environmental factors
21 model = pysal.model.spreg.OLS(y[:, np.newaxis], X, w=w, spat_diag=True)
22 print(model.summary)
23
24 plt.show()
25
```

In this code, we load spatial data, calculate Moran's I to assess spatial autocorrelation, create choropleth maps, and perform spatial regression to analyze the relationship between disease cases and environmental factors.

This use case illustrates how spatial statistics can aid in understanding the geographical patterns of disease outbreaks, identifying high-risk areas, and assessing the impact of environmental variables on disease transmission.

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Dive into the dynamic realm of "Nonlinear Models Examples" in this comprehensive course that explores various nonlinear modeling techniques and their real-world applications.

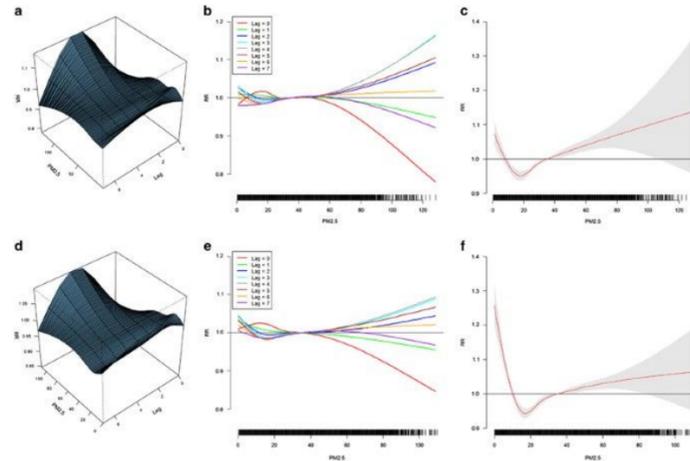
Throughout the course, you'll gain a deep understanding of the intricacies of nonlinear modeling. It covers a wide range of examples and scenarios, providing you with the knowledge and tools to tackle complex relationships in data analysis.

The course begins by delving into "Nonlinear Regression Examples," where you'll learn how to model relationships that don't adhere to linear patterns. This includes exploring polynomial regression, which allows you to capture the curvilinear nature of data, exponential growth models for scenarios involving rapid growth or decay, and logistic regression for modeling binary outcomes or probability estimates. These examples illustrate the versatility of nonlinear regression in various domains.

Moving forward, you'll explore "Nonlinear Time Series Models," which are essential for understanding and forecasting time-dependent data. This section introduces you to techniques such as autoregressive integrated moving average (ARIMA) models, which are commonly used in financial and economic forecasting, as well as GARCH models for capturing volatility patterns in time series data. Additionally, you'll delve into the realm of nonlinear dynamical systems applied to time series, offering insights into chaotic behavior and complex dynamics in various fields.

Furthermore, the course covers "Nonlinear Models in Machine Learning," providing a bridge between traditional statistical techniques and modern machine learning approaches. You'll dive into the world of neural networks, exploring different activation functions and their role in modeling complex data. Decision trees and random forests, powerful ensemble methods, are also discussed for nonlinear classification and regression tasks. Additionally, you'll learn about support vector machines (SVM) with nonlinear kernels, enabling you to tackle nonlinearity in classification problems effectively.

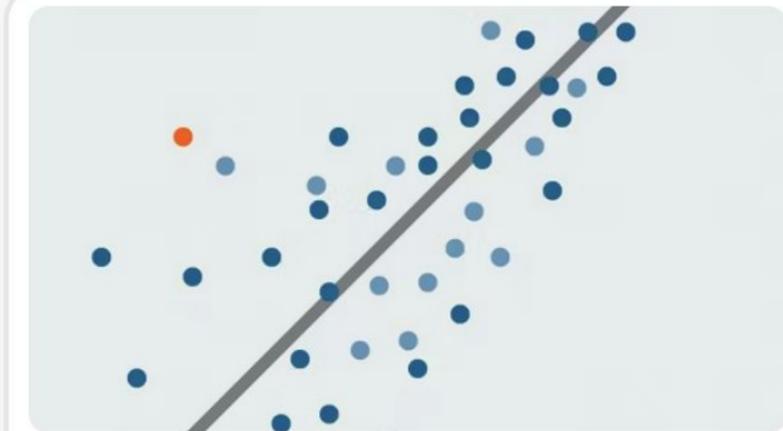
By the end of this course, you'll be equipped with a diverse set of nonlinear modeling tools and a deep understanding of their applications in data analysis, time series forecasting, and machine learning. You'll gain the confidence to handle nonlinear relationships in your data and make informed decisions based on your modeling insights.



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Course Name: Simple Linear Regression

#NonlinearModelsExamples  
#NonlinearRegression  
#SpatialStatisticsFundamentals



 Duke University

**Linear Regression and Modeling**

**Compétences que vous acquerez:** Probability & Statistics, Regression, Business Analysis, Data Analysis, General Statistics, Statistical Analysis,...

★ **4.8** (1.7k avis)

Débutant · Course · 1 à 4 semaines