

Study Notes of Numerical Optimization

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Chapter 1

Preface

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Chapter 2

Motivation

2.1 Why we need to learn high-dimensional probability?

Here are the key reasons why it is important to learn about high-dimensional probability:

1. Real-world problems are often high-dimensional: In practical applications and scientific research, we often encounter high-dimensional data and high-dimensional models. For example, in fields like machine learning, data mining, and signal processing, the input data and model parameters are often high-dimensional. Therefore, understanding and applying high-dimensional probability is necessary.

2. Properties of high-dimensional spaces differ from low dimensions: In high-dimensional spaces, some intuitive geometric concepts and conclusions no longer hold. For instance, the volume of a high-dimensional sphere is mostly concentrated near the surface, which is very different from the 2D or 3D cases. Only by deeply understanding the characteristics of high-dimensional spaces can we correctly handle high-dimensional problems.

3. High-dimensional statistical inference is more complex: In high-dimensional settings, traditional statistical inference methods often fail or suffer severe performance degradation. Therefore, specialized high-dimensional statistical theories and methods are needed, such as high-dimensional parameter estimation, hypothesis testing, and confidence interval construction.

4. High-dimensional optimization problems are more challenging: Many real-world problems can be formulated as high-dimensional optimization problems, such as parameter optimization in machine learning. In high dimensions, the complexity of optimization problems increases significantly, requiring new algorithms and techniques.

In summary, learning high-dimensional probability helps us better understand and address various high-dimensional problems, which have important applications in many cutting-edge scientific and engineering fields.

