

Haoming Wang

Probabilistic Methods in Combinatorics

A Comprehensive Guide to Multivariate
Statistics

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Preprint Version

*Probabilitas non servitur ad creandum, sed
ad intellegendum. – Probability is not served
for creation, it is for understanding.*

Foreword

Abstract: This book introduces several statistical distributions, like normal distributions, gamma distributions, beta distributions, etc on fibres of Grassmannians, with the exact distribution of the characteristic function and characteristic roots given by the symmetric function. We study the ampleness of such statistical distributions on fibres and classify complete double flags via these results.

Keywords: Integer partition · Young tableaux · Grassmannian · Distribution on fibres

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Haoming Wang

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Part I

Combinatorics

Chapter 1

Calculus of Tableaux

1.1 Integer Partition

1.2 Young Tableaux

1.3 Increasing Sequence

1.4 Robinson-Schensted-Knuth Correspondence

1.5 Symmetric Function

[Ful97], [Mac98], [Sta10, Vol. II, Chap. 7]

Chapter 2

Representation

2.1 The Symmetric Group S_n

2.2 The General Linear Group GL_n

2.3 Schur-Weyl Duality

[GW09]

Chapter 3

Geometry

3.1 Zariski Topology

3.2 Projective Variety

3.3 Fibre Bundle

3.4 CW Complex

[DC92], [Eis06], [Har13], [AM18]

Part II

Probability

Chapter 4

Random Matrix

4.1 Three Gauss Esembles

4.2 Tracy-Widom Law

4.3 Semi-circle Law

4.4 Universality

TBA

Chapter 5

Stochastic Process

5.1 Schur Process

5.2 Determinant Point Process

5.3 Plancherel Measure

[Oko00, Oko03], [BO98]

Part III

Statistics

Chapter 6

Multivariate Distribution on Fibres

6.1 Four Matrix Normal Distributions

6.2 Density Formula

6.3 Characteristic Function

6.4 Characteristic Root

[Wan25], [Shi22]

Chapter 7

Classification of Complete Double Flags

7.1 Ampleness of Probability Distributions

7.2 Injective Property

7.3 Dual Classification

[LB15, LB18]

Appendix A

Set Theory

Appendix B

Topology

Appendix C

Differential Manifold

Appendix D

Miscellaneous

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