Honz Research Institute of Pharmacometrics and Industrial Engineering
HRIPIE
MA102 Mathematics II
Fall 2020

Time M, W, F 9:00-11:30 (Beijing) **Length** 12 Oct - 10 Feb 2021 (53 lec.)

Location Bernhard Riemann Room **Grade** P/F (Get P by not giving up)

Mathematics at HRIPIE

The MA101/MA102 sequence aims to provide demanding mathematical education to pharmacometricians and industrial engineers (that one cannot find it anywhere else). Reserved as a brave and exploratory learning experience without participant's concern for immediate application, HRIPIE Mathematics emphasizes thinking of mathematical essence behind domain knowledge, representing applied problem in mathematical language, and collaborating with mathematicians in an effective way (but yourself not need to be one of them). It encourages pharmacometricians and industrial engineers to produce timeless and influential works by solving hard-core mathematical question less observed.

The content in this lecture series will be intensive, self-contained, and tailored to specific student's background as much as we can. It requires mathematical rigor and conceptual clear, up to being able to appreciate more advanced material and to communicate with mathematicians. Being able to construct a proof is often not required, but will be the case if it serves the purpose aforementioned.

Introduction

In Fall 2020, MA102 will focus on CCG and CIG:

- applied category theory (ACT)
- discrete differential geometry (DDG)
- computational conformal geometry (CCG)
- computational information geometry (CIG)

CCG mainly concerns about discrete treatment to low-dimensional geometric objects that can be processed by computer program. The high-quality meshing of geometric object, which CCG can help to generate, is of great interest in many applied domains.

CIG considers probability distribution as a point on manifold and applies geometric

techniques to treat statistical inference. By revealing connections between statistics and information geometry, CIG sometimes leads to powerful and astonishing insight.

we start by asking following questions:

(ACT-related)

1. Is the category theory useful in terms of practical output?
2. How does Remy relate category theory and GWAS, genetics and causal inference?
3. How to relate category theory and Traditional Chinese Medicine?

(CCG-related)

1. How is ODE/PDE modeling and simulation used in today's pharmaceutical industry (e.g. pharmaceutics, formulation, release control, chemical engineering)?
2. How is finite element method used in solving ODE/PDE?
3. What role does mesh generating play in finite element method?

(CIG-related)

1. How to evaluate the parameter fitted to data in a linear/non-linear model? What standard is accepted in clinical pharmacology? Is it good enough?
2. Why is non-linear fitting so hard? What is the information geometry interpretation behind?
3. What is transition divergence in MCMC sampling? How can information geometry avoid transition divergence?

Reference Material

- MIT *Category Theory* (Winter 2020)
- CMU *Discrete Differential Geometry* (Spring 2020)
- Computational Conformal Geometry lecture by David Gu (Summer 2020)
- MIT 6.437 *Information and Inference* lecture notes (Spring 2019)
- Amari SI. Information geometry and its applications. Springer; 2016 Feb 2.
- Hofrichter J, Jost J, Tran TD. Information geometry and population genetics. Berlin: Springer; 2017.

Course Page

`https://github.com/NanFangHong/HRIPIE-MA102`

- syllabus will be updated at least a day before lecture date
- lecture notes will be uploaded on a weekly basis.
- the progress planned above is subjected to change.

Last update of this sheet: September 24, 2020