応用数学特論 II (集中講義)

Lecture Guidance

盧 暁南 (山梨大学)
Xiao-Nan LU (University of Yamanashi)

Aug. 25, 2021
Kobe University

About myself

- 盧 暁南 (ロ ギョウナン) Xiao-Nan Lu
- Born in China.
- Doctor of Information Science (Nagoya University, March 2017).
- Assistant Professor at Department of Computer Science and Engineering, University of Yamanashi.
- Research interests:
  - Math: combinatorial designs (CO), graphs on algebraic structures (CO), finite fields (NT),
  - Stat: designs of experiments, statistical analysis for categorical data
  - IT: algebraic codes, secret sharing, combinatorial searching
  - CS: algorithms for generating combinatorial structures, constraint encoding into SAT

The aim of this course

- Brief introduction of combinatorial design theory (組合せデザイン理論) and algebraic / combinatorial coding theory (代数的・組合せ的符号理論).
- Dealing with statistical problems and information theoretical problems from a perspective of discrete mathematics.
- Showing the fun of combinatorics through puzzles.

Course Webpage

https://xnlu-math.github.io/kobe2021/

Course schedule and Prerequisites

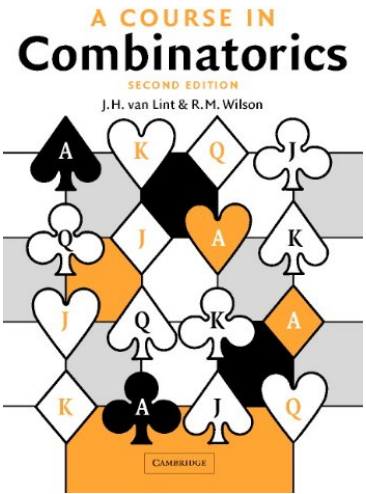
- Three lectures / day $\times$ 5 days (including exercise time)

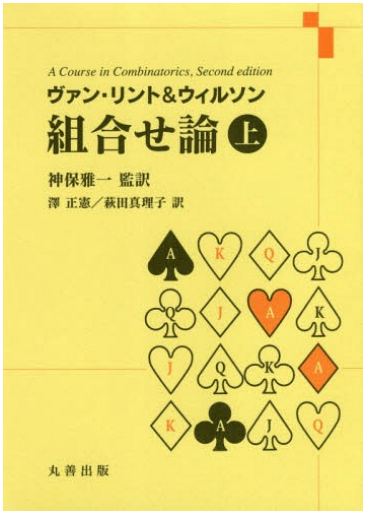
25th Aug.	Lectures 1–3	Latin squares & orthogonal arrays
26th Aug.	Lectures 4–6	Hadamard matrices & BIB designs
27th Aug.	Lectures 7–9	Finite geometries & finite fields
30th Aug.	Lectures 10–12	Error-correcting codes
31st Aug.	Lectures 13–15	Cyclic codes, cyclic designs, and their applications

- No particular prerequisites. Basic knowledge on linear algebra (e.g. linear space, determinant, rank) and statistics (e.g. mean value, variance, linear regression) will help.
- Commonly used techniques in (combinatorial) proofs:
  - mathematical induction (数学的帰納法), contradiction (背理法), counting (数え上げ), proof by cases (場合分け), divide-and-conquer (分割統治法)

Textbook

- No specified textbook.
- I will post lecture notes, slides, and handwritten notes during the classes on my website.
- Reference books:
  1. J. H. van Lint, R. M. Wilson, A Course in Combinatorics, 2nd ed., Cambridge University Press, 2001. ISBN: 978-0521006019
  2. J. H. van Lint, R. M. Wilson (著), 澤正憲, 萩田真理子, 神保雅一 (翻訳), ヴァン・リント＆ウィルソン組合せ論 (上), 丸善出版, 2018. ISBN: 978-4621302453
  3. J. H. van Lint, R. M. Wilson (著), 澤正憲, 萩田真理子, 神保雅一 (翻訳), ヴァン・リント＆ウィルソン組合せ論 (下), 丸善出版, 2019. ISBN: 978-4621304129
  4. 藤原良, 神保雅一 (著), 符号と暗号の数理, 共立出版, 1993. ISBN: 978-4320026612
- For the latter half, any textbook on coding theory (maybe named "information theory and codes") is OK.


A COURSE IN
Combinatorics
SECOND EDITION
J.H. van Lint & R.M. Wilson
CAMBRIDGE


A Course in Combinatorics, Second edition
ヴァン・リント&ウィルソン
組合せ論 上
神保雅一 監訳
澤 正憲／萩田真理子 訳
丸善出版

Language

- I will speak Japanese in this course.
- Lecture notes containing basic definitions and theorems will be given in Japanese.
- Slides and handwritten notes during the classes, which cover the contents in the lecture notes, will be given in English.
- Programming demos will be given in Python 3 (or later ver.) using Jupyter Notebook.
- Proofs will be given in Mathematics (mathematical language).

Language

- I will speak Japanese in this course.
- Lecture notes containing basic definitions and theorems will be given in Japanese.
- Slides and handwritten notes during the classes, which cover the contents in the lecture notes, will be given in English.
- Programming demos will be given in Python 3 (or later ver.) using Jupyter Notebook.
- Proofs will be given in Mathematics (mathematical language).

- However, I'm neither native in English nor native in Japanese. Maybe fluent?
- Maybe also fluent in Python and Mathematics?

Grading

- No exam for this course.
- Grade will be 100% based on homework assignments (100% レポート課題).
- Language of assignments: Japanese or English
- Submission: PDF format using Dropbox

Questionnaire: How much do you know about ...

Three options:

(i) I know much (or I have taken courses on this subject and I still remember well);
(ii) I know a little;
(iii) I know nothing (or I have completely forgotten everything).

Five subjects:

1. linear algebra: (i) linear spaces, eigenvalues, eigenvectors, matrix diagonalization;
   (ii) matrix addition, multiplications;
2. number theory: (i) primitive root, index, Fermat's little theorem;
   (ii) prime numbers, integer problems in high school math;
3. algebra (groups, rings, fields): (i) finite groups, residue rings, Galois field;
   (ii) only the terms;
4. graph theory (i) notion of graphs, graph coloring, matching;
   (ii) only the terms;
5. statistics (i) analysis of variance (ANOVA);
   (ii) basic statistics like means, variances, but not good at statistical models;