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GUANGZHOU CHAPTER NEWSLETTER

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主编序语

各位学者：

本期《分会季报》介绍了拟阵熵函数，此源自信息不等式的信息度量进一步建立了拟阵理论、信息理论、组合设计和编码理论之间的关联，为解决信息安全和编码设计等领域的挑战提供了理论工具；同时，还介绍了 DNA 数据存储技术和最新应用。6 月 18-19 日，“粤港澳大湾区编码与存储国际学术研讨会”在广州大学城中心酒店成功举办，从事信息编码和数据存储方面工作的专家学者分享领域最新进展，探讨前沿合作，共同促进知识创新与人才培养。

陈立

From the Editor-in-Chief

Dear Chapter Members,

This issue introduces matroidal entropy functions. This information measure originates from information inequality, and further corresponds several fields including matroid theory, information theory, combinatorial design and coding theory. It can be the theoretical tool for solving some challenges in information security and code design. This issue also introduces DNA storage and its latest applications. The Guangdong-Hong Kong-Macau Greater Bay Area International Workshop on Coding and Data Storage took place during Jun. 18 – 19, at the Guangzhou University Town International Hotel. Scholars and practitioners in the areas of information coding and data storage shared their latest work and explored collaborations in the frontiers. This workshop has promoted knowledge innovation and talents of the area.

Li Chen

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The submission should include the title in both Chinese and English, author contacts, and the column that the article belongs to. Content of the article can be both in Chinese or English, and is limited to 800 words.

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拟阵熵函数
Matroidal Entropy Functions

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For a discrete random vector $X_N \triangleq (X_i : i \in N)$, where N is a finite set with cardinality n, we define its entropy function $\mathbf{h}_{X_N}: 2^N \to \mathbb{R}$ by

$$\mathbf{h}_{X_N}(A) = H(X_A), \forall A \subseteq N,$$

where $X_A = (X_i : i \in A)$ and $H(X_A)$ is its joint entropy. We consider it as a vector in the entropy space $\mathcal{H}_N \triangleq \mathbb{R}^{2^N}$ and denote the set of all entropy functions in $\mathcal{H}_N$ by Γ_N^*. The characterization of entropy functions, i.e., determining whether a vector $\mathbf{h} \in \mathcal{H}_N$ is in Γ_N^*, is of fundamental importance in information theory.

In 1978, Fujishige proved in [1] that any entropy function is (the rank function of) a polymatroid, that is, a set function $\mathbf{h}_{X_N}: 2^N \to \mathbb{R}$ which satisfies nonnegativity, i.e., $\mathbf{h}(A) \geq \mathbf{h}(B)$ for all $A \subseteq B \subseteq N$, and submodularity, i.e., $\mathbf{h}(A \cap B) + \mathbf{h}(A \cup B) \leq \mathbf{h}(A) + \mathbf{h}(B)$ for all $A, B \subseteq N$. We denote the set of all polymatroids in N by Γ_N and call the inequalities implied by those bounding Γ_N listed above Shannon-type information inequalities, as they correspond to the nonnegativity of the Shannon information measures. In 1998, Zhang and Yeung discovered the first non-Shannon-type information inequalities [2], which implies that $\overline{\Gamma_N^*}$, the closure of Γ_N^*, is a proper subset of Γ_N when $N \geq 4$. From then on, a series of non-Shannon-type information inequalities were discovered. In 2007, Matúš proved in [3] that for fixed N, there exist infinitely many independent information inequalities. Thus, to characterize entropy functions, we need to find ways other than information inequalities.

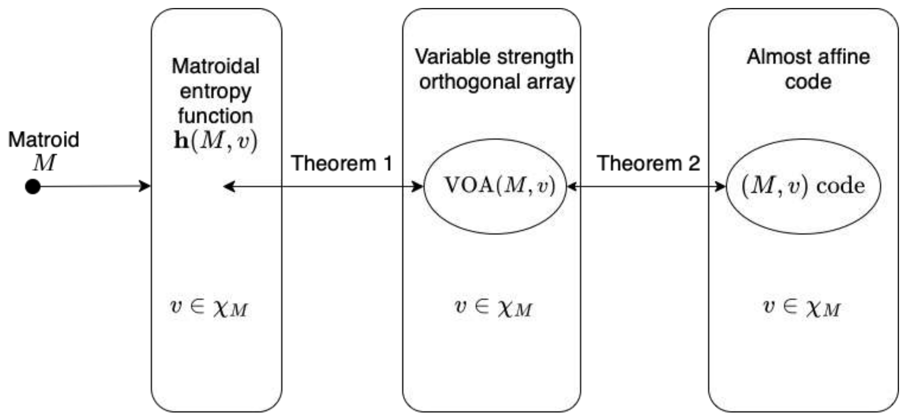

Fig. 1. Correspondences among four fields.

Recently in [4], we characterized the matroidal entropy functions. For a random vector X_N, if its entropy function is in the form

$$\mathbf{h}_{X_N} = \log v \cdot \mathbf{r},$$

where $v \geq 2$ is an integer and $\mathbf{r}$ is the rank function of a matroid M, we call $\mathbf{h}_{X_N}$ a matroidal entropy function. To characterize entropy functions, in [4], we developed correspondences among four fields, i.e., matroids in matroid theory, matroidal entropy functions in information theory, variable strength orthogonal arrays (VOA) in combinatorial design and almost affine codes [5] in coding theory. This is illustrated as in Fig. 1, where Theorems 1 and 2 can be referred in [4].

Thus, we can not only utilize the tools in one field to solve the problems in another field, but also apply the results into some other information theory problems such as secret sharing [6], network coding [7], index coding [8] and locally repairable code [9].

More recently, in [10], utilizing the matroid operations such as deletion, contraction, minor, series and parallel connections and 2-sum, we constructed corresponding VOA and characterized corresponding matroidal entropy functions. Furthermore, using the results as a tool, we characterized matroidal entropy functions induced by regular matroids and some matroids with the same p-characteristic set as uniform matroid $U_{2,4}$.

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DNA 数据存储中的编码方法
Coding Methods for DNA Data Storage

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随着信息技术的大幅发展，全球数据的年产量呈指数级增长，人们对于数据存储的需求也在迅速提高。传统的数据存储介质包括硬盘、闪存、磁带、光盘等，其存在存储密度低、保存时间短、能耗高等问题。为了实现更高的存储密度和更长寿命的存储效果，研究人员探索了在分子中存储信息的相关方法。其中，DNA 数据存储——将信息通过 DNA 中的核苷酸序列信息进行表示与存储——是当前分子信息存储中最为成熟可靠的方式[1]。DNA 是自然选择的信息存储分子，其具有许多适合作为数据存储介质的关键特性：数据存储密度极高，理论上可以储存 455 EB/g [2]；数据存储寿命长，其半衰期约为 520 年，当冷冻和干燥储存时，其寿命可以延长到数千年[3]；在碳排放和能耗、数据安全、便携性等方面，也存在其独特的优势[3]。此外，也有研究表明，DNA 数据存储可以利用作用于 DNA 的生化过程(即 DNA 计算)来执行高度并行计算的潜力[4]。DNA 数据存储通常包括六个环节：编码、写入、保存、检索、读取、解码。其中，在编码步骤中，有许多信息领域的理论与方法可以直接进行应用。然而，DNA 数据存储中存在一些生物学约束限制、读取时的特殊错误类型、特殊的信息检索方式，需要针对这些特点开发相应的编码方法。

目前，多数的 DNA 存储研究与应用中，都是通过直接映射转换的方式，对原始的二进制数据进行编码，转换为核苷酸序列信息(也称碱基或碱基对，包含 A、T、C、G 四种)。Church 等[1] 提出二进制转换方式，即用 A 或 G 表示 0，用 C 或 T 表示 1，其信息密度为 1bit/nt。Goldman 等[5]提出三进制转换方式，结合上一位碱基信息与当前位的数据信息获得编码表进行映射。四进制编码是应用最为广泛的一种转换方式，其信息密度最高可以达到 2bits/nt。然而，由于生物学约束限制(连续性约束、GC 比例约束、均聚物约束等)，通过四进制转换得到的部分 DNA 序列，在进行 DNA 合成与存储的过程中，存在着不稳定的情况。因此，研究人员提出了相关的复合编码转换方法以应对该问题，例如 DNA 喷泉码[6]等，以避免连续碱基过多、碱基比例不均衡等问题。

DNA 数据在测序读取时会出现插入、删除以及替换碱基的错误，常用的纠错码，包括 RS 码、LDPC 码等均被广泛地应用于 DNA 存储中。针对 DNA 的错误特点，部分研究人员设计了特殊的带约束的信道编码方法，以使其在译码时获得更好的性能[7]。此外，DNA 数据在检索时，需要通过引物分子探针获取与之匹配的 DNA 分子链进行读取，因此，其在加密层面具有天然的应用优势。例如，可以利用 DNA 隐写术，将部分有用信息存储于大量无用信息中，通过特定的引物分子探针对信息进行解密读取。

尽管 DNA 数据存储在信息编码和生化方法层面均取得了一定的进展，然而，其落地应用与商业化仍然受限于 DNA 合成的成本与速度。基于此，我们使用 DNA 组装技术作为底层的生化方法，将模块化的 DNA 链作为基本的信息单元，进一步结合上述的生物学约束、信息错误特征以及分子信息检索方式等分子介质的特性，有针对地开发信源信道联合编码，以支持 DNA 数据存储的应用。

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交流活动 • RESEARCH ACTIVITIES •

粤港澳大湾区编码与存储国际学术研讨会
Guangdong-Hong Kong-Macau Greater Bay Area (GBA) International Workshop on Coding and Data Storage

The Guangdong-Hong Kong-Macau Greater Bay Area (GBA) International Workshop on Coding and Data Storage took place on Jun. 18-19, 2022 at the University Town International Hotel, Guangzhou. This workshop was jointly organized by Guangdong University of Technology (GDUT) and the IEEE Information Theory (IT) Society Guangzhou Chapter. Both the National Nature Science Foundation of China (NSFC)-Guangdong Joint Fund and the GDUT "1+2+3" Discipline Improvement Fund sponsored this workshop. Over 100 scholars participated the workshop on the day, from over 30 academic institutions or companies including Tsinghua University, Nanjing Univerisy, Sun Yat-sen University (SYSU), Beihang University, Xinan Jiaotong University, Xidian University, Hangzhou Dianzi University, Huawei Technologies Co., Ltd., Sage Microelectronique Co., Ltd, Shenzhen Longsys Electronics Co. Ltd, DigiCodon Ltd., TenaFe Inc., etc. The workshop was chaired by Dr. Guojun Han, Executive Dean of School of Information Engineering of GDUT, and Dr. Li Chen, Chair of the IT Society Guangzhou Chapter. The organizing committee members include Dr. Yi Fang, Professor of GDUT, Dr. Chang Liu, Associate Professor of GDUT, Dr. Xijun Wang, Associate Professor of SYSU, and Dr. Congduan Li, Associate Professor of SYSU.

With the rapid growth of data and its applications, the next-generation data storage technology needs to be more practical, economic and reliable. This workshop aims to provide an opportunity for academic exchanges on the novel progresses regarding the emerging coding methods that are well suited for the state-of-the-art data storage systems, bridging the collaborations between academia and industry in the GBA.

This two-day workshop invited 10 experts to deliver in-depth talks and selected 4 Ph.D. students to deliver oral presentations. It also contains a poster session with 18 student posters. Welcoming speeches were given by Dr. Chengyong Wang, the Vice President of GDUT, Dr. Guojun Han, and Dr. Li Chen.

On the first day, Dr. Xiaohu Tang, Professor of the Xinan Jiaotong University started the morning session by a talk on minimum-storage regenerating (MSR) codes. Then, Dr. Jianjun Luo, Professor of Hangzhou Dianzi University introduced a two-dimensional turbo product code (2D-TPC) algorithm for the next generation enterprise-level solid state disk (SSD) controllers. Dr. Liuguo Yin, Professor of Tsinghua University presented generalized sparse codes for non-Gaussian channels. The morning session ended with the talk by Dr. Xiaoyang Zhang, who provided an overview of the development and challenges of erasure coding for the current cutting-edge data storage systems. The afternoon session started with the talk delivered by Dr. Zhongfeng Wang, Professor of Nanjing University, who presented novel methods for the design and implementation of three kinds of error-correction codes that could be potentially used in storage systems. Then, Dr. Shutao Xia, Professor of Tsinghua University, discussed about Singleton-optimal constructions of locally repairable codes with small localities. Dr. Qin Huang, Professor of Beihang University, proposed downsampling and transparent coding for blockchain. Dr. Shuo Jiang, co-founder of DigiCodon Inc., discussed new strategies and methods for DNA data storage. On the second day, Dr. Li Chen started the session with a talk of low-complexity chase decoding of Reed-Solomon codes through modules. The last keynote talk was presented by Dr. Yingquan Wu, chief scientist of TenaFe Inc., who provided a comprehensive perspective of low-density parity-check code (LDPC) codec for SSD. Four postgraduate students had also been invited to give a talk of their research during the one-and-a-half-day workshop.

The daily program was hosted by Dr. Guojun Han, Dr. Bazhong Shen, Dr. Xiaohu Tang, and Dr. Li Chen, respectively. Dr. Li Chen concluded the workshop by pointing out that the IEEE IT Society

Guangzhou Chapter holds its mission in promoting exchanges and serving the community. He called on more scholars who are interested in IT to join the Society as the progress of the Chinese IT research requires everyone's effort.

The Workshop Agenda

Speakers	**Titles**
Dr. Xiaohu Tang	Research on MSR Codes for Collaborative Repair
Dr. Jianjun Luo	2D-TPC ECC Algorithm Supporting QLC/HLC Flash Memory
Dr. Liuguo Yin	Generalized Sparse Codes for Non-Gaussian Channels: Code Design, Algorithms, and Applications
Dr. Xiaoyang Zhang	Development and Challenges of Huawei Erasure Code for Storage Systems
Dr. Zhongfeng Wang	Design and Implementation of Error Correction Codes Suited for Storage Systems
Dr. Shutao Xia	Singleton-Optimal Constructions of Locally Repairable Codes with Small Localities
Mr. Teng Lu	Parity Check Matrix Partitioning for Efficient Layered Decoding of QC-LDPC Codes
Dr. Qin Huang	Downsampling and Transparent Coding for Blockchain
Dr. Shuo Jiang	Coding Methods for DNA Data Storage
Ms. Yahui Zhao	Phase-Distribution-Aware Adaptive Decision Scheme to Improve the Reliability of Holographic Data Storage
Dr. Li Chen	Low-Complexity Chase Decoding of Reed-Solomon Codes through Modules
Mr. Xianzhang Wu	Design of Coded Caching Schemes through Proper Orthogonal Arrays
Dr. Cody Wu	LDPC Codec for SSD – From Theory to Practice
Ms. Lin Dai	Design of Protograph LDPC-Coded BICM-ID with Irregular CSK Mapping in VLC Systems

交流活动 • RESEARCH ACTIVITIES •

IEEE 东亚信息论学校(EASIT 2022)筹备会议
Preparatory meeting of the 2022 IEEE East Asian School of Information Theory

由IEEE信息论学会广州分会及清华大学深圳研究生院、中山大学和香港中文大学(深圳)三所高校共同举办的IEEE东亚信息论学校(以下简称EASIT)将于2022年8月2日-5日在深圳市人才研修院举行。5月26日，此次EASIT的组委会成员在深圳市人才研修院召开了筹备工作会议。出席会议的成员有大会主席以及各专委主席。

此次会议重点讨论了四个议题：一、EASIT活动程序册；二、注册方式与参会模式；三、最佳海报奖评选方式；四、学校的会议餐饮和住宿等安排。针对以上问题，各组委会成员都提出了可行方案，并于会后进一步落实执行，为8月份即将到来的EASIT做充分的准备。

会后，组委会实地考察了EASIT的场地和设备等软硬件设施。会议场地在深圳市人才研修院内的智汇中心学术报告厅。深圳市人才研修院是深圳市委开展人才国情研修，为人才提供资智企智对接，创新成果路演展示、学术交流、疗养保健、政策宣传等服务而打造的多功能高层次人才综合服务平台。

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第十一届 IEEE/CIC 中国国际通信大会筹备会议
Preparatory Meeting of the 11th IEEE/CIC International Conference on Communications in China (ICCC 2022)

6 月 23 日，第十一届中国国际通信大会(以下简称 ICCC)筹备会议于佛山市三水区云东海街道办成功举行。ICCC 技术程序委员会共同主席陈立教授带领大会组委会各专委 8 人从广州前往佛山三水参会。当地政府云东海街道党工委书记刘勇海、区经科局副局长晏珊、云东海街道党工委委员黎伟聪、云东海街道经发办项目谭嘉慧主任和三水工业园区管理委员会副主任郭益锡作为当地代表出席会议。会务公司广州科奥团队也一同参与。此外，受疫情影响未能与会的中国通信学会学术工作部吴杰主任与其它专委代表也通过线上视频方式参与其中。

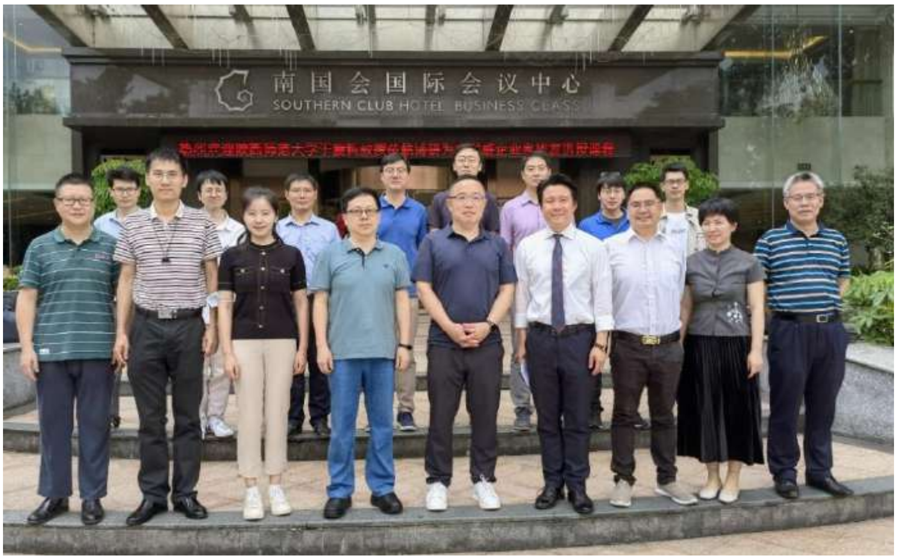

会上，组委会与当地政府对即将在 8 月份开幕的 ICCC 会议筹备工作进展进行了分享，就关键的问题达成了共识。组委会表示，此次 ICCC 会议的投稿数超 600 篇，应邀到场做演讲的嘉宾阵容十分强大，其中包括中国工程院院士龙腾教授(北京理工大学校长)、张宏科教授(北京交通大学)；香农奖得主杨伟豪教授(香港中文大学)、Erdal Arıkan 教授(土耳其 Bilkent 大学)；华为无线 CTO 兼 5G 首席科学家童文博士；英国皇家工程院院士陆贵文教授(香港城市大学)。区经科局晏副局长也表示，当地政府会全力配合组委会此次会议的筹备工作，并希望此次会议可以带动三水区乃至佛山市的通信产业的发展；同时，此次大会将附设产业分论坛，邀请多家当地企业参与。


会议结束后，组委会与当地政府代表一同前往ICCC主会场——绿湖度假酒店进行实地考察，并与酒店和会务公司就场地使用和布展细节等做了进一步的沟通。

此次筹备会议落实了许多关键的会议细节，并解决了产业分论坛会场选址问题。距离大会开幕还有 50 天，组委会、地方政府和会务公司将更紧锣密鼓地对会议的注册、接待等细节工作会做进一步商讨与落实。

信息技术前沿沙龙
Salon on the Frontiers of Information Technology

5 月 28 日，信息技术前沿沙龙在广州大学城南国会国际会议中心顺利举办。本次沙龙由中山大学电子与信息工程学院及广东省光电信息处理芯片与系统重点实验室主办，邀请了中山大学电子与信息工程学院和西安电子科技大学广州研究院的 30 余位学者参与，大家分享了彼此的前沿研究工作。



本次沙龙由中山大学陈立教授主持，会议伊始，陈立教授分别介绍了与会的专家及学者并对大家表示热烈欢迎。随后，由中山大学电子与信息工程学院李朝晖副院长为本次沙龙致辞，李院长指出本次沙龙旨在增进中大和西电两所高校在信息技术领域前沿性工作的交流，促进两所高校的信息与通信工程学科发展。

本次的沙龙共有 12 名专家及学者进行研究工作的汇报与交流，分上、下午场进行。上午，西电广州研究院沈八中教授首先结合自己长期在信息论与编码领域的研究思考为大家分享了信息通信前沿的三个核心问题；随后，中大江明教授分享了其团队在多网络辅助分布式 M-MIMO 三维定位系统的最新研究进展；最后，以西电曹琦博士关于信道零错误容量问题的剖析与讨论为结尾结束了上午场的研讨会。下午, 首先由中大夏明华教授及伍沛然副教授介绍其团队在大规模物联网中的智能无线电力传输技术的相关工作；随后, 西电刘佳宜博士和中大王玺钧副教授分别对动态不确定场景下的网络优化问题和物联网中信息新鲜度问题进行了分享；

此后，西电李晓辉教授和杨清海教授分别介绍了通感一体化的高效传输和目标检测技术以及通算一体网络的自适应任务协同技术；最后是关于天线技术的“专题报告”，中大的陆凯副教授介绍了 3D 打印的圆极化喇叭天线，杨楠副教授介绍了 MIMO 多天线系统的方向图去耦技术，张一明副教授介绍了超大规模天线阵列的解耦与滤波综合技术，胡鹏飞副教授介绍了集成化天线技术。











本次研讨会活动气氛活跃，学术氛围浓厚，为中山大学电子与信息工程学院以及西安电子科技大学广州研究院两所高校的专家学者搭建了一个沟通交流的桥梁，进一步助力两校在信息与通信工程学科的建设与发展。

中山大学信息编码 2022 学术研讨会
2022 Seminar of Information Coding at Sun Yat-sen University

2022年3月19日，由陈立教授带领的中山大学信息编码与智能传输实验室举办了2022年第一场学术研讨会。除实验室的研究生外，此次会议邀请了在《信息论与编码》课程中表现优异的本科生参与。

会议从当天上午9点20分开始。陈立教授作为本次会议主持以及实验室负责人，做了开场讲话。他表示，本次学术研讨会由实验室成员向大家展示实验室的研究工作与成果。这既是对本科生们的嘉奖——让大家开编码研究之眼界，更是对大家的鼓励——让大家立志高远不断求知。

研讨会分为上、下午两场，由实验室的博士生与硕士生主讲，每人发言30分钟。当天研讨会的议程如下表所示。上午首个报告展示了码参数的相关理论，并基于此阐述了什么是好的纠错编码；第二个报告介绍了高效代数译码方案；上午最后两个报告分享了Polar码的相关研究，介绍了Polar码的知识以及PAC码的构造方法。午间休息后，下午的头两个报告分别向我们展示了基于PDA的编码缓存设计和耦合LDPC码的编译码设计；随后两个报告介绍了线性分组码的高效译码方案，包括BMA译码和针对BCH码的低时延OSD译码；研讨会最后一个报告介绍了U-UV码的构造与译码。

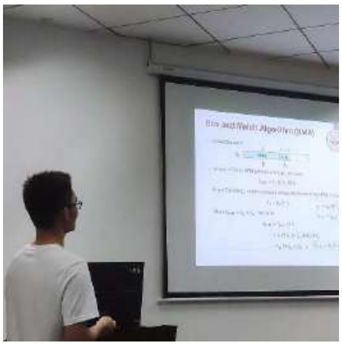
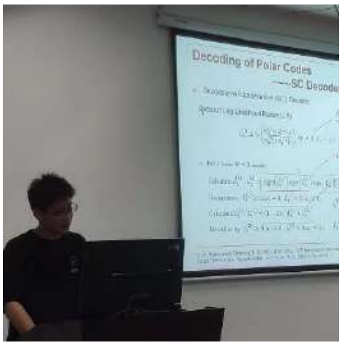
主题

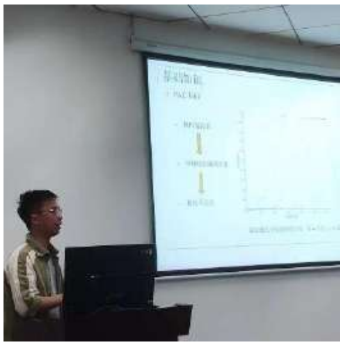
主讲人		主讲人	
赵建国	什么样的码是好码？	吴先章	基于 PDA 的编码缓存方案设计
梁积卫	代数码的高效译码算法	王千帆	耦合 LDPC 码的编译码方案设计
蔡作鑫	Polar 码的构造与译码	陈文浩	线性分组码的 BMA 译码
刘文鑫	PAC 码构造方法	杨立佳	BCH 码的低时延 OSD 译码
		伍湘宇	U-UV 码的构造与译码










全天的会议还包括两场茶歇，为大家提供了更多的自由交流时间。众多本科生纷纷表示，通过此次研讨会获益良多，让自己对编码有了不一样的认识，为自己将来读研选择方向提供了更全面的认识。而实验室的研究生们也借此机会锻炼了自己的演讲能力。

喜讯 • GOOD NEWS •

新书出版
New Book

2022 年 3 月，北京邮电大学牛凯教授撰写的《极化码原理与应用》专著由科学出版社正式出版。极化码(Polar Code)是第一种达到信道容量极限的构造性编码，是信道编码理论的重大突破，已经成为第五代移动通信(5G)的信道编码标准。本书主要介绍极化码的理论与应用。全书分为八章内容，包括信道编码基础、极化码基本原理、编码构造、译码算法、硬件设计、编码调制与极化信号处理。这本专著既对极化码基本理论进行了全面系统的阐述，又归纳总结了作者与极化码领域研究者的重要研究成果，展现极化码研究的最新前沿，是一部兼具基础性与前沿性的著作。本书可以作为通信专业研究生的参考教材和相关领域科研与工程技术人员的参考资料。


牛凯
Kai Niu

机会信息 • OPPORTUNITIES •

副教授/助理教授/博士后招聘，中山大学
AP/Postdoc Positions Opening, Sun Yat-sen University

Li Chen, Sun Yat-sen University
陈立，中山大学
chenli55@mail.sysu.edu.cn

The Information Coding and Intelligent Transmission (ICIT) Laboratory of the School of Electronics and Information Engineering, Sun Yat-sen University is recruiting *Associate Professors and Research Associates (postdoc)* at home and abroad, and sincerely invites young talents to join. The lab is directed by Prof. Li Chen.

1. Recruit Field
Information Theory and Coding, Computation for Information Theory, Intelligent Networks

2. Recruit Positions

- *Associate Professor:* The applicant should have a PhD degree from a well recognized University or research institute, a strong independent research capability and high academic achievements. Applicants should demonstrate their potential in academia, and have at least 3 years working experience at home or abroad. In general, the applicant should not exceed 40 years old.
- *Research Associate:* The applicant should have a PhD degree and a satisfactory volume of publications. They should not exceed 35 years old.

3. How to Apply

- Applicants should first send their CV (including date of birth, education history, working experience, publications, awards, and etc.) to Prof. Li Chen.
- The Lab and the School will review the applications. If suited, the applicants will be contacted. They will be sent the application form, and guided the preparation of other application materials, including references.
- A School interview will be further arranged. If approved, a University interview will be needed for the *Associate Professor* applicants.

新锐风采 • NEW TALENTS •

何宣(Xuan He)，在本科阶段参与了 ACM 世界大学生程序设计竞赛并获得两枚亚洲区域赛金牌以及世界总决赛第 27 名的成绩，并于 2011 年获得电子科技大学通信工程专业学士学位。此后分别于 2013 年和 2018 年获得电子科技大学通信与信息系统专业硕士和博士学位，指导教师为周亮教授。2016 年至 2017 年期间，受到国家留学基金委资助，到加拿大滑铁卢大学联合培养一年，合作导师为龚光(Guang Gong)教授。2018 年至 2020 年在新加坡科技设计大学从事博士后研究，合作导师为蔡葵(Kui Cai)教授。2021 年加入西南交通大学信息科学与技术学院唐小虎教授团队，主要研究方向为纠错编码和 DNA 存储编码。主持在研国家重点研发计划子课题一项，国家自然科学基金青年项目一项。个人主页：https://faculty.swjtu.edu.cn/HeXuan/zh.

近年来一个主要研究方向为 LDPC 码的构造以及低复杂度译码算法/结构，主要工作包括：提出了可避免短环的 LDPC 码随机构造算法[1, 2]，提出了 LDPC 码的最大化互信息量化译码算法[3-7]，推导了一类适用于信息传播算法节点计算的最优结构[8]，推导了适于硬件实现的 LDPC 码分层译码结构[9]。另一个主要研究方向为 DNA 存储编码，主要工作包括：提出了面向 DNA 存储的喷泉码译码算法[10, 11]、构造了容量可达的同时满足 GC 含量和游程限制的约束码[12]、构造了当前码率最高的可纠正插入删除和替换错误的纠错码[13]。

部分重要学术论文：

[1] X. He, L. Zhou, and J. Du, “A new multi-edge metric-constrained PEG algorithm for designing binary LDPC code with improved cycle-structure,” *IEEE Trans. Commun.*, vol. 66, no. 1, pp. 14–25, Jan. 2018.

[2] X. He, L. Zhou, and J. Du, “PEG-like design of binary QC-LDPC codes based on detecting and avoiding generating small cycles,” *IEEE Trans. Commun.*, vol. 66, no. 5, pp. 1845–1858, May 2018.

[3] X. He, K. Cai, W. Song, and Z. Mei, “Dynamic programming for quantization of q-ary input discrete memoryless channels,” *IEEE Int. Symp. Inf. Theory (ISIT)*, pp. 450-454, Jul. 2019.

[4] X. He, K. Cai, and Z. Mei, “On mutual information-maximizing quantized belief propagation decoding of LDPC codes,” *IEEE Global Commun. Conf. (GLOBECOM)*, pp. 1-6, Dec. 2019.

[5] X. He, K. Cai, and Z. Mei, “On finite alphabet iterative decoding of LDPC codes with high-order modulation,” *IEEE Commun. Letters*, vol. 23, no. 11, pp. 1913-1917, Nov. 2019.

[6] X. He, K. Cai, W. Song, and Z. Mei, “Dynamic programming for sequential deterministic quantization of discrete memoryless channels,” *IEEE Trans. Commun.*, vol. 69, no. 6, pp. 3638–3651, Jun. 2021.

[7] P. Kang, K. Cai, X. He, S. Li, and J. Yuan, “Generalized mutual information-maximizing quantized decoding of LDPC codes with layered scheduling,” *IEEE Trans. Veh. Technol.*, Early Access, 2022.

[8] X. He, K. Cai, and L. Zhou, “A class of optimal structures for node computations in message passing algorithms,” *IEEE Trans. Inf. Theory*, vol. 68, no. 1, pp. 93-104, Jan. 2022.

[9] T. Lu, X. He, P. Kang, and X. Tang, “Parity check matrix partitioning for layered decoding of QC-LDPC codes,” *IEEE Globecom Workshops (GC Wkshps)*, pp. 1-6, Dec. 2021.

[10] X. He and K. Cai, “Disjoint-set data structure-aided structured Gaussian elimination for solving sparse linear systems,” *IEEE Commun. Letters*, vol. 24, no. 11, pp. 2445-2449, Nov. 2020.

[11] X. He and K. Cai, "On decoding fountain codes with erroneous received symbols," *IEEE Inf. Theory Workshop (ITW)*, pp. 201-205, Apr. 2021.
[12] Y. Liu, X. He, and X. Tang, "Capacity-achieving constrained codes with GC-content and runlength limits for DNA storage," *IEEE Int. Symp. Inf. Theory (ISIT)*, Jul. 2022.
[13] W. Song, N. Polyanskii, K. Cai, and X. He, "Systematic codes correcting multiple-deletion and multiple-substitution errors," *IEEE Trans. Inf. Theory*, Early Access, 2022.

新锐风采 • NEW TALENTS •

Qianfan Wang (王千帆) received the B.S. degree in applied physics from Henan Polytechnic University and the M.S. degree in electronics and communication engineering from Sun Yat-sen University, in 2014 and 2017, respectively. From 2018 to 2022, he pursued the Ph.D. degree in Communication and Information System from Sun Yat-sen University, under the supervision of Prof. Li Chen, also guided by Prof. Xiao Ma.

He is a newly graduated Ph.D. in the area of channel coding. His thesis is entitled "Encoding/Decoding Design and Performance Analysis of Coupled LDPC Codes", which focuses on constructions and performance analysis of the coupled LDPC codes. Based on three typical coupled techniques, including the spatially coupling, the product construction and the superposition coupling (i.e., BMST), this thesis proposes three classes of coupled LDPC codes, respectively. In addition, by integrating the superposition coupled technique and the hybrid automatic repeat request (HARQ) scheme, this thesis presents a new class of HARQ schemes. He will work as a postdoctor at the School of Computer Science and Engineering, Sun Yat-sen University.

His key publications include:

[1] Q. Wang, S. Cai, W. Lin, S. Zhao, L. Chen, and X. Ma, "Spatially coupled LDPC codes via partial superposition and their application to HARQ," *IEEE Trans. Veh. Technol.*, vol. 70, no. 4, pp. 3493–3504, Apr. 2021.

[2] Q. Wang, S. Cai, L. Chen, and X. Ma, "A throughput-enhanced HARQ scheme for 5G system via partial superposition," *IEEE Commun. Lett.*, vol. 24, no. 10, pp. 2162–2166, Oct. 2020.

[3] Q. Wang, S. Cai, L. Chen and X. Ma, "Semi-LDPC convolutional codes: Construction and low-latency windowed list decoding," *Journal of Commun. and Inf. Networks*, vol. 6, no. 4, pp. 411-419, Dec. 2021.

[4] 王千帆, 毕胜, 陈曾喆, 陈立, 马啸. 分组马尔可夫叠加传输的神经网络译码, *通信学报*, 41(9): pp. 202-209, 2020.

[5] Q. Wang, S. Cai, W. Lin, L. Chen, and X. Ma, "Spatially coupled LDPC codes via partial superposition," in *IEEE Int. Symp. Inf. Theory (ISIT)*, pp. 2614–2618, July 2019.

[6] Q. Wang, L. Chen and X. Ma, "Chained LDPC codes via partial information coupling and partial parity superposition," in *IEEE Globecom Workshops (GC Wkshps)*, pp. 1-6, 2021.

征稿启事 • CALL FOR PAPERS•

IEEE/CIC ICCC Workshop on Information Theory and Coding for Future Wireless

Workshop General Co-Chairs

- Wen Tong, Huawei Technologies Co., Ltd.
- Bazhong Shen, Xidian University
- Pingzhi Fan, Southwest Jiaotong University

Technical Program Committee Co-Chairs

- Baoming Bai, Xidian University
- Kai Niu, Beijing University of Posts and Telecommunications
- Huazi Zhang, Huawei Technologies Co., Ltd.

Keynote Speakers

- Jinhong Yuan, University of New South Wales
- Jincheng Dai, Beijing University of Posts and Telecommunications

Technical Program Committee

- Suihua Cai, Sun Yat-sen University
- Guotai Chen, Fujian Polytechnic Normal University
- Yi Fang, Guangdong University of Technology
- Xuan Guang, Nankai University
- Qin Huang, Beihang University
- Ming Jiang, Southeast University
- Congduan Li, Sun Yat-sen University
- Ling Liu, Shenzhen University
- Linqi Song, City University of Hong Kong
- Dongliang Xiao, China Agricultural University
- Min Ye, Tsinghua-Berkeley Shenzhen Institute
- Min Zhu, Xidian University
- Chao Chen, Xidian University
- Jincheng Dai, Beijing University of Posts and Telecommunications
- Yong Fang, Chang'an University
- Guojun Han, Guangdong University of Technology
- Zhiliang Huang, Zhejiang Normal University
- Bin Li, Huawei Technologies
- Liping Li, Anhui University
- Lu Lu, University of Chinese Academy of Sciences
- Liyuan Song, Fujian Normal University
- Jiongyue Xing, Huawei Technologies
- Qiyue Yu, Harbin Institute of Technology

Scope (including but are not limited to)

Information theory has been the foundation of communication technology, and channel coding is a pivotal mean to combat channel uncertainties. In every generation of wireless communications, the state-of-the-art channel coding schemes are always adopted to achieve high spectral efficiency and reliability. For future wireless communications, information theory and channel coding will continue to play an important role for the two-fold reasons. First, emerging communication scenarios and applications demand novel information theory. For instance, information theoretic perspective on machine learning and related coding schemes deserves in-depth study with the wide adoption of machine learning algorithms. As wireless access becomes ubiquitous for low-cost devices, a new theory for massive random access is required. In addition, some applications will require a peak data rate to the Tbit/s level, while others operate on extremely low power consumption. Second, new breakthroughs in information theory and coding may bring new paradigm in contrast to the Shannon paradigm. For instance, the underlying principle of semantic information theory analyzes how effective a desired meaning is conveyed. Meanwhile, modern coding techniques such as polar codes, LDPC codes will continue to develop to either meet higher performance requirement or reduce implementation complexity. Topics of interest include but are not limited to:

- Latest information theory results
- Novel design of coding schemes
- Machine learning and coding
- Semantic information theory
- Quantum information and coding
- Turbo, LDPC, polar codes, etc.
- Joint algebraic and probabilistic coding
- Joint source channel coding
- Coded modulation and shaping
- Theoretical bounds on performance

Important Dates and Submission

June 1, 2022 (submission) July 10, 2022 (Acceptance) July 24, 2022 (Camera-ready)

Please visit https://iccc2022.ieee-iccc.org/authors/call-for-workshop-papers/ for submission links.

征稿启事 • CALL FOR PAPERS •

IEEE GLOBECOM Workshop on Channel Coding beyond 5G

https://globecom2022.ieee-globecom.org/authors/call-workshop-papers

Call for Workshop Papers

Channel coding is a fundamental component in wireless communication. From 2G to 5G, wireless systems have always adopted state-of-the-art channel coding technologies. For example, convolutional codes for 2G, turbo codes for 3G and 4G, as well as polar and low-density parity-check (LDPC) codes for 5G. In turn, the standardization and applications of state-of-the-art channel coding technologies have accelerated the research and development of channel coding. What will channel coding be as the standards continue to evolve? According to past experiences, channel coding schemes need to deliver performance surpassing previous generations: faster data rates, higher reliability, lower complexity, and lower power consumption. They also need to meet a more diverse range of KPIs that are not present in previous generations. As for 6G, some applications will raise the peak data rate to the Tbit/s level (the current eMBB data plane decoding rate is 10-20 Gbit/s), eliminating the block decoding error floor for URLLC, and improving the short block length decoding performance for mMTC toward the finite-length performance bound. In contrast to past experiences, the channel coding performance now has almost reached the theoretical Shannon limit for an additive white Gaussian noise (AWGN) channel, and Moore’s law almost reached the physical limits. Will future standards follow the same path that led us to where we are now, or take a different path guided by new theoretical foundation or evaluation methodologies? Do we need revolutionary channel coding schemes, or design principles? Many fundamental problems remain open.

This workshop aims at bringing together academic and industrial researchers to discuss channel coding beyond 5G. Topics of interest include but are not limited to:

- Novel design principles and coding schemes toward 6G
- Channel coding requirements and applications for 6G
- Polar coding and decoding
- Probabilistic coding, e.g., turbo, LDPC, etc.
- Joint design of algebraic and polar/probabilistic coding
- High-throughput coding schemes
- Coded modulation and shaping
- Rate matching and HARQ schemes
- Coding and decoding schemes for URLLC/mMTC/etc
- Artificial intelligence/machine learning based coding
- Joint source and channel coding
- Efficient decoding algorithms
- Hardware architecture and implementations
- Testbed and field trials of channel coding schemes
- Performance bounds on coding and decoding

Workshop Co-Chairs

- Dr. Wen Tong, Huawei Technologies Co., Ltd., Canada
- Prof. Erdal Arıkan, Bilkent University, Ankara, Turkey
- Prof. Emanuele Viterbo, Monash University, Australia

Technical Program Committee Co-Chairs

- Prof. Warren J. Gross, McGill University, Canada
- Prof. Stephan ten Brink, University of Stuttgart, Germany
- Dr. Huazi Zhang, Huawei Technologies Co., Ltd., China

Keynote Speakers

- Prof. Jinhong Yuan, University of New South Wales, Australia
- Prof. Michael Lentmaier, Lund University, Sweden
- Prof. Li Chen, Sun Yat-sen University, China

Important Dates

Paper submission deadline: July 15, 2022

Acceptance announcement: September 1, 2022

Final paper submission: October 1, 2022

Submission Guidelines

The workshop accepts only original and previously unpublished papers. All submissions must be formatted in standard IEEE camera-ready format (double-column, 10pt font). The maximum number of printed pages is six including figures without incurring additional page charges (6 pages plus 1 additional page allowed with a charge for the one additional page of USD 100 if accepted)