

第十三届中国数学会计算机数学大会

辽宁·大连

2023年6月15日~18日

(<http://www.mmrc.iss.ac.cn/cscm/cm2023>)

会议手册

· 承办单位 ·

大连理工大学数学科学学院

大连海事大学理学院

中国科学院数学机械化重点实验室

大连理工大学数学科学学院简介

大连理工大学原应用数学系创建于1950年；1958年全国性院系调整时被取消，成立应用数学专业，隶属数理力学系；1979年应用数学系得以恢复重建，设应用数学本科专业。1982年开始招收硕士研究生。1986年计算数学专业获得博士学位授予权；1988年被批准设立数学博士后流动站；1998年运筹学与控制论专业获得博士学位授予权；2002年计算数学博士点被评为国家重点学科；2003年获数学一级学科博士学位授予权，涵盖基础数学、计算数学、概率论与数理统计、应用数学和运筹学与控制论5个二级学科博士点，并经教育部批准自主增设金融数学与保险精算博士点；2008年被批准为辽宁省重点一级学科，同年被批准为“国家理科基础科学研究和教学人才培养基地”。

2009年，数学科学学院成立。2012年与中国科学院数学与系统科学研究院联合设立华罗庚班；2019年，数学与应用数学专业获批教育部首批“双万计划”国家一流本科专业建设点，“计算数学与数据智能重点实验室”获批辽宁省重点实验室；2020年，数学与应用数学专业入选教育部“强基计划”，信息与计算科学专业获批教育部“双万计划”国家一流本科专业建设点，辽宁省科技厅批准大连理工大学成立“辽宁应用数学中心”；2021年，“华罗庚数学拔尖学生培养基地”获批教育部“基础学科拔尖学生培养计划2.0基地”。经过几代人不懈努力，特别是近年来通过“211工程”、“985工程”和“双一流”建设的实施，学科的学术水平和综合能力得到明显提高。ESI国际学科排名前1%，QS世界排名350位左右。学院近5年承担国家自然科学基金项目和省部级科研项目100余项，在数学若干重要前沿领域取得具有国际水平的成果。

数学科学学院现有5个研究所和1个教研室：数学研究所、计算科学研究所、统计与金融研究所、应用数学研究所、运筹学与控制论研究所和盘锦校区数学教研室；3个中心：辽宁应用数学中心、数学教学中心和数学研究中心；2个实验室：辽宁省计算数学与数据智能重点实验室、计算几何与图形图像实验室。主办核心学术期刊《数学研究及应用》(英文版)。

数学科学学院现有教授45人、副教授55人、讲师5人、正编审1人，其中国务院学科评议组成员1人、教育部数学基础课教学指导委员会委员1人、国家教学名师2人、辽宁省数学类专业教指委主任委员1人、辽宁省教学名师4人、宝钢优秀教师奖获得者7人；国家杰出青年科学基金获得者1人、国家级青年人才4人、教育部跨世纪人才1人、教育部新世纪人才4人。

大连海事大学理学院简介

大连海事大学理学院的前身是1960年成立的数理力学系，后依次更名为六系、基础部、数理系。2005年，学校撤销数理系，组建数学系和物理系。2017年6月，数学系与物理系合并成立理学院。

理学院下设应用数学系、统计学系、应用物理系、高等数学教研中心、大学物理教研中心、物理实验教研中心六个教学机构。学院现有专任教师119人，实验教师11人，管理人员（含指导员）11人。教师队伍中，教授34人，副教授47人，博士生导师9人，硕士生导师86人，具有博士学位109人，其中长江学者特聘教授、杰青1名，辽宁省教学名师6人。在校全日制本科生472人，硕士研究生244人。

学院承担了全校本科生与研究生的数学、物理学公共课程教学任务，充分发挥基础学科在学校人才培养中的重要作用。“数学建模”“大学物理”获评国家级一流课程，“聚焦离子束系统虚拟仿真实验”获评国家级虚拟仿真实验项目，“大学物理实验”获评国家级课程思政示范课程、名师和团队，“数学分析”、“发光材料原理与应用”等16门课程获评辽宁省一流示范课程。物理实验教学中心获评辽宁省实验教学示范中心，物理虚拟仿真实验教学中心获评辽宁省虚拟仿真实验教学示范中心，《大学物理实验》获评辽宁省首届教材建设奖优秀教材。

学院的数学和物理学本科专业教育可以上溯到上世纪60年代，2001年设立信息与计算科学本科专业（2012年停止招生），2005年设立应用物理学本科专业，2007年设立数学与应用数学本科专业，2012年设立统计学本科专业。应用物理学专业、数学与应用数学专业、统计学专业先后于2019年、2020年、2022年获评辽宁省普通高等学校一流本科教育示范专业。

学院于20世纪80年代开始研究生教育，1997年批准设立应用数学硕士学位授权点（二级学科），并入选辽宁省重点培育学科，2006年批准设立运筹学与控制论、等离子体物理、凝聚态物理硕士学位授权点（二级学科），2011年批准设立数学和物理学硕士学位授权点（一级学科）。高气压强电场电离放电实验室获评辽宁省重点实验室，强电离放电单分子工程实验室获评辽宁省高校重点实验室。

学院在组合数学及其应用、微分方程及其应用、数据科学中的数学方法、优化方法及其应用、等离子体气体放电物理与应用工程、固体发光与光电技术、场论与量子信息学、原子分子与物质相互作用等研究方向上取得了丰硕成果。学院自2017年成立以来，共承担国家自然科学基金项目30余项，省部级项目40余项，发表高水平学术论文429篇，科研经费累计超过3千万元，主办或承担多次重要的学术会议，提高了学院和学科的学术声誉。

在学校深化改革的大背景下、在学校整体加快发展的形势推动下，学院将进一步整

合资源、优化结构、扩大影响，全面提升学院教学科研水平，积极履行人才培养、科学研究、服务社会、文化传承创新和国际交流合作的职责，努力为学校“双一流”建设和研究型世界一流海事大学建设贡献力量！

会议住宿与交通

会议地点： 辽宁大连市海创 (大连) 科技交流中心 (大连市甘井子区高新园区黄浦路 507 号)

宾馆电话： 0411-62620777



交通信息： 参会代表无论是从火车站还是机场均可乘坐地铁到达海创 (大连) 科技交流中心

- 周水子机场—会议宾馆 (总路程约 14 公里, 乘出租车约 35 元)
地铁: 2 号线 (在西安路站) 换乘 1 号线到海事大学站 D 口出, 约 50 分钟, 票价 5 元
- 大连火车站—会议宾馆 (总路程约 13 公里, 乘出租车约 30 元)
地铁: 5 号线 (在青泥洼桥站) 换乘 2 号线 (在西安路站) 换乘 1 号线到海事大学站 D 口出, 约 40 分钟, 票价 4 元
- 大连北站—会议宾馆 (总路程约 23 公里, 乘出租车约 50 元)
地铁: 1 号线到海事大学站 D 口出, 约 50 分钟, 票价 5 元

会议联系人： 董 波 大连理工大学 13591137353
周代珍 中科院数学与系统科学研究院 13693282978

CM2023

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第十三届中国数学会计算机数学大会

主办单位
中国数学会计算机数学专业委员会

承办单位
大连理工大学数学科学学院
大连海事大学理学院
中国科学院数学机械化重点实验室

协办单位
中国数学会

会议资助
国家自然科学基金委
大连理工大学
大连海事大学
中国数学会
Maplesoft中国

2023年6月15-18日, 中国 大连



大会主席 于波 大连理工大学

程序委员会共同主席

冯如勇 中科院数学与系统科学研究院
孙怡东 大连海事大学
雷 娜 大连理工大学

■ “计算几何”专题

朱春钢 大连理工大学
申立勇 中国科学院大学
伍铁如 吉林大学
李 新 中国科学技术大学
徐 岗 杭州电子科技大学
贾晓红 中科院数学与系统科学研究院

■ “密码学”专题

林昌露 福建师范大学
王保仓 西安电子科技大学
孙 兵 国防科技大学
龚 征 华南师范大学
崔 霆 信息工程大学
潘彦斌 中科院数学与系统科学研究院

■ “人工智能”专题

刘日升 大连理工大学
王怡洋 大连海事大学
李 波 南昌航空大学
苏 卓 中山大学
蓝如师 桂林电子科技大学

■ “组合数学”专题

林志聪 山东大学
宁 博 南开大学
严慧芳 浙江师范大学
杨立波 南开大学
陈绍示 中科院数学与系统科学研究院
陈 曦 大连理工大学
周 悦 国防科技大学
侯庆虎 天津大学

■ “符号计算”专题

唐晓弦 北京航空航天大学
孙 瑞 中科院信息工程研究所
李 伟 中科院数学与系统科学研究院
杨 静 广西民族大学
张 熠 西交利物浦大学
陈长波 中科院重庆绿色智能技术研究院
徐 鸣 华东师范大学
程进三 中科院数学与系统科学研究院

■ “符号数值混合计算”专题

董 波 大连理工大学
叶 科 中科院数学与系统科学研究院
李子佳 中科院数学与系统科学研究院
吴文渊 中科院重庆绿色智能技术研究院
张雷洪 苏州大学
胡胜龙 杭州电子科技大学

■ “数学软件”专题

杨争峰 华东师范大学
李 楠 深圳大学
夏壁灿 北京大学
陈长波 中科院重庆绿色智能技术研究院
程进三 中科院数学与系统科学研究院

■ “数学教育”专题

申立勇 中国科学院大学
牟晨琪 北京航空航天大学
陈玉福 中国科学院大学
张树功 吉林大学
赵丽娜 北京化工大学

大会邀请报告

祁力群 香港理工大学
闫振亚 中科院数学与系统科学研究院
李子明 中科院数学与系统科学研究院
高卫国 复旦大学

青年邀请报告

王 杰 中科院数学与系统科学研究院
刘美成 中科院信息工程研究所
李子佳 中科院数学与系统科学研究院
罗自炎 北京交通大学
侯臣平 国防科技大学
董 波 大连理工大学
熊 欢 哈尔滨工业大学
潘茂东 南京航空航天大学

组织委员会

董 波 大连理工大学	陈晓彤 大连海事大学
孙怡东 大连海事大学	周代珍 中科院数学与系统科学研究院
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宋晓良 大连理工大学	黄 辉 大连理工大学
张旭平 大连理工大学	

大会联系人

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第十三届中国数学会计算机数学大会

2023 年 6 月 15 日 ~ 18 日

辽宁大连

注：海创厅位于海创宾馆第 3 层，中关村厅位于第 5 层。海创厅由 A、B 两厅组成，只用海创 B 厅时只能从 B 门进入。

2023 年 6 月 16 日

开幕式与合影

6 月 16 日 8:30-9:30 海创厅

大会报告 (1)

6 月 16 日 9:30-10:30 海创厅

主持人：于波

9:30 - 10:30 Dual Quaternion and Dual Quaternion Matrices ([abstract](#))

P.13

祁力群 (香港理工大学)

茶歇

6 月 16 日 10:30-10:40

大会报告 (2)

6 月 16 日 10:40-11:40 海创厅

主持人：董波

10:40 - 11:40 从稀疏矩阵计算到矩阵稀疏计算([abstract](#))

P.13

高卫国 (复旦大学)

茶歇

6 月 16 日 11:40-11:50

S1 分组报告 (1): 数值与混合计算

6 月 16 日 11:50-12:20 海创 B 厅

主持人：吴文渊

11:50 - 12:05 Inversion And Multiplication of Quaternion Matrices ([abstract](#))

P.18

陈琦元 (中国科学院数学与系统科学研究院系统科学研究所数学机械化实验室)

12:05 - 12:20 一种改进的奇异两点边值问题三次 B 样条数值解法([abstract](#))

P.18

张晓磊 (浙江工商大学)

S2 分组报告 (2): 组合数学

6 月 16 日 11:50-12:20 中关村厅

主持人: 孙怡东

11:50 - 12:05 T-type Digraphs via Kronecker Canonical Form ([abstract](#)) P.19

胡昊飞 (哈尔滨工业大学)

12:05 - 12:20 Decorated Motzkin Paths, Riordan arrays, and the Colored Ascents ([abstract](#)) P.19

辛华 (哈尔滨工业大学)

午餐

6 月 16 日 12:20-14:00

Y1 青年邀请报告 (1)

6 月 16 日 14:00-14:30 海创 B 厅

主持人: 唐晓弦

14:00 - 14:30 多项式优化与低秩 SDP 求解([abstract](#)) P.15

王杰 (中国科学院数学与系统科学研究院)

Y2 青年邀请报告 (2)

6 月 16 日 14:00-14:30 中关村厅

主持人: 林志聪

14:00 - 14:30 On the Expressivity of Convolutional Neural Networks ([abstract](#)) P.15

熊欢 (哈尔滨工业大学)

JSSC 计算机数学论坛 (1)

6 月 16 日 14:35-15:35 海创 B 厅

主持人: 冯如勇

14:35 - 14:50 Permutation symmetric tensors with applications in automated proof of positive definite homogeneous polynomials ([abstract](#)) P.19

曾振柄 (上海大学理学院)

14:50 - 15:05 二元多项式矩阵等价的新结果([abstract](#)) P.20

李冬梅 (湖南科技大学)

15:05 - 15:20 Some Recent Advances in Algebraic Vision ([abstract](#)) P.20

秦小林 (中国科学院成都计算机应用研究所)

15:20 - 15:35 A Characterization of Perfect Strategies for Mirror Games ([abstract](#)) P.20

Yu Tianshi (中科院数学与系统科学研究院)

主持人: 严慧芳

- 14:35 - 14:50 Total positivity of amazing matrices ([abstract](#)) P.21
毛建玺 (大连理工大学)
- 14:50 - 15:05 New equidistributions on plane trees and decompositions of 132-avoiding permutations ([abstract](#)) P.21
Bai Ziwei (合肥工业大学)
- 15:05 - 15:20 The number of leaves in a tree with given diameter and maximum degree ([abstract](#)) P.21
Feng Xing (Jimei University)
- 15:20 - 15:35 Polynomial χ -binding Functions for Graphs with Forbidden Configurations ([abstract](#)) P.22
Xu Yian (Southeast University)

茶歇

6 月 16 日 15:35-15:50

主持人: 张志芳

- 15:50 - 16:05 Mahler discrete residues and summability for rational functions ([abstract](#)) P.22
Zhang Yi (Xi'an Jiaotong-Liverpool University)
- 16:05 - 16:20 Enforcing continuous symmetries in physics-informed neural network for solving forward and inverse problems of partial differential equations ([abstract](#)) P.22
张慧 (中央民族大学)
- 16:20 - 16:35 Two Improved Algorithms to Compute the Minimal Bases of Univariate Matrices ([abstract](#)) P.23
姚姗姗 (北京邮电大学)
- 16:35 - 16:50 On the Parameter Selection of LWE-based Encryption Scheme ([abstract](#)) P.24
徐娟 (中国科学院重庆绿色智能技术研究院)

S4 分组报告 (4): 组合数学

6月16日 15:50-16:50 中关村厅

主持人: 宁博

- 15:50 - 16:05 On the differences between proper coloring and DP coloring ([abstract](#)) P.24
Zhang Meiqiao (National Institute of Education, Nanyang Technological University)
- 16:05 - 16:20 A sharp upper bound on the cycle isolation number of graphs ([abstract](#)) P.24
崔庆 (南京航空航天大学)
- 16:20 - 16:35 On directed strongly regular Cayley graphs over non-abelian groups with an abelian subgroup of index 2 ([abstract](#)) P.25
黄雪毅 (华东理工大学)
- 16:35 - 16:50 Resistance distances and the Moon type formula of a vertex-weighted complete split graph ([abstract](#)) P.25
Ge Jun (Sichuan Normal University)

JSSC 期刊宣讲

6月16日 16:55-17:35 海创 B 厅

主持人: 冯如勇

- 16:55-17:35 提升期刊服务水平, 扩大期刊影响力
吴国云 (JSSC 期刊编辑部)

晚餐

6月16日 17:40-19:30

计算机数学专委会会议

6月16日 20:00-22:00 中关村厅

主持人: 陈绍示

2023 年 6 月 17 日

大会报告 (3)

6月17日 9:00-10:00 海创厅

主持人: 陈绍示

- 9:00 - 10:00 Additive Decompositions in Symbolic Integration ([abstract](#)) P.13
李子明 (中科院数学与系统科学研究院)

茶歇

6月17日 10:00-10:10

Y3 青年邀请报告 (3)

6月17日 10:10-10:40 海创 B 厅

主持人: 程进三

10:10 - 10:40 多项式方程组全部解问题: 数值算法及应用 ([abstract](#))

P.16

董波 (大连理工大学)

Y4 青年邀请报告 (4)

6月17日 10:10-10:40 中关村厅

主持人: 朱春钢

10:10 - 10:40 Domain Parameterization and Efficient Matrix Assembly for Isogeometric Analysis ([abstract](#))

P.16

潘茂东 (南京航空航天大学)

S5 分组报告 (5): 数值与混合计算

6月17日 10:40-11:10 海创 B 厅

主持人: 李子佳

10:40 - 10:55 Simple Characteristic Decomposition of Polynomial Sets ([abstract](#))

P.26

王林朋 (北京航空航天大学)

10:55 - 11:10 Hybrid method for solving polynomial systems ([abstract](#))

P.26

尹哲东 (大连理工大学)

S6 分组报告 (6): 计算几何与数控

6月17日 10:40-11:10 中关村厅

主持人: 李新

10:40 - 10:55 Toric parameterization based isogeometric collocation method for planar multi-sided physical domains ([abstract](#))

P.26

周沛 (大连理工大学)

10:55 - 11:10 Topology Guaranteed B-Spline Surface/Surface Intersection ([abstract](#))

P.27

杨婕吟 (中国科学院数学与系统科学研究院)

茶歇

6月17日 11:10-11:25

S7 分组报告 (7): 数值与混合计算

6 月 17 日 11:25-12:10 海创 B 厅

主持人: 徐鸣

- 11:25 - 11:40 连续区间上积分值的二次三角样条插值([abstract](#)) P.27
吴金明 (浙江工商大学)
- 11:40 - 11:55 An efficient Levenberg-Marquardt method for Nonlinear Least-Squares Problems ([abstract](#)) P.27
Chen Liang (Changzhou Institute of Technology)
- 11:55 - 12:10 可信距离约束下的 B 样条曲线拟合([abstract](#)) P.28
贺诗涛 (中国科学院大学数学科学学院)

S8 分组报告 (8): 符号计算

6 月 17 日 11:25-12:10 中关村厅

主持人: 李伟

- 11:25 - 11:40 Reducing Hyperexponential Functions ([abstract](#)) P.28
高艺漫 (中国科学院数学与系统科学研究院)
- 11:40 - 11:55 Reduction systems and degree bounds for integration ([abstract](#)) P.29
Du Hao (Beijing University of Posts and Telecommunications)
- 11:55 - 12:10 Symbolic Computation in Abel's Addition Formulae ([abstract](#)) P.29
王艺森 (中国科学院数学与系统科学研究院)

午餐

6 月 17 日 12:10-14:00

Y5 青年邀请报告 (5)

6 月 17 日 14:00-14:30 海创 B 厅

主持人: 陈长波

- 14:00 - 14:30 Factorization of Motion Polynomials ([abstract](#)) P.16
李子佳 (中国科学院数学与系统科学研究院)

Y6 青年邀请报告 (6)

6 月 17 日 14:00-14:30 中关村厅

主持人: 王杰

- 14:00 - 14:30 Second-Order Methods for Large-Scale Sparse Optimization ([abstract](#)) P.17
罗自炎 (北京交通大学)

S09 分组报告 (9): 数学软件

6 月 17 日 14:35-15:35 海创 B 厅

主持人: 李楠

- 14:35 - 14:50 Mathematical modeling for the local flow of a generalized Newtonian fluid in 3D porous media ([abstract](#)) P.30
Li Shuguang (Dalian Maritime University)
- 14:50 - 15:05 The Allocation Scheme of Software Development Budget with Minimal Conflict Attributes ([abstract](#)) P.30
马艳芳 (常州工学院)
- 15:05 - 15:20 Maple 数字孪生应用介绍([abstract](#)) P.31
徐俊林 (Maplesoft)
- 15:20 - 15:35 Isabelle2Cpp 的类型推理系统([abstract](#)) P.31
付辰曦 (北京林业大学信息学院)

S10 分组报告 (10): 计算机数学及其应用

6 月 17 日 14:35-15:35 中关村厅

主持人: 叶科

- 14:35 - 14:50 张量的低 α -秩逼近及其应用([abstract](#)) P.31
赵新竹 (辽宁大学)
- 14:50 - 15:05 实数域上单变元平方模的成员判定算法([abstract](#)) P.32
尚伟峰 (北京航空航天大学)
- 15:05 - 15:20 带零点的非负系数 Bernstein 展开([abstract](#)) P.32
徐嘉 (西南民族大学数学学院)
- 15:20 - 15:35 A Sample-Driven Solving Procedure for the Repeated Reachability of Quantum Continuous-Time Markov Chains ([abstract](#)) P.33
蒋慧 (华东师范大学)

茶歇

6 月 17 日 15:35-15:50

S11 分组报告 (11): 符号计算

6 月 17 日 15:50-17:20 海创 B 厅

主持人: 牟晨琪

- 15:50 - 16:05 Signature-based standard basis algorithm under the framework of GVW algorithm
(abstract) P.33
郑晓鹏 (中国科学院数学与系统科学研究院)
- 16:05 - 16:20 神经理想的 Gröbner 基与典范形式集(abstract) P.34
郑丽翠 (湖南科技大学)
- 16:20 - 16:35 Restricted Gröbner Basis Theory for Normalization of Indexed Differential Riemann
Metric Tensor Polynomials (abstract) P.34
刘姜 (上海理工大学)
- 16:35 - 16:50 Bézout Subresultants for Univariate Polynomials in General Basis (abstract) P.34
杨卫 (广西民族大学)
- 16:50 - 17:05 Stability Problems in Symbolic Summation (abstract) P.35
李秀云 (中国科学院数学与系统科学研究院)
- 17:05 - 17:20 Embedding of unimodular row vectors (abstract) P.35
吴弢 (湖南科技大学)

S12 分组报告 (12): 计算几何与数控

6 月 17 日 15:50-17:20 中关村厅

主持人: 申立勇

- 15:50 - 16:05 Adaptive and feature-preserving spline surface fitting with arbitrary topological con-
trol mesh (abstract) P.35
寇宜博 (中国科学院大学数学科学学院)
- 16:05 - 16:20 An adaptive collocation method on implicit domains using weighted extended THB-
splines (abstract) P.36
杨晶晶 (大连理工大学)
- 16:20 - 16:35 Computing Moving Planes of Rational Parametric Surfaces Using Dixon Resultants
(abstract) P.36
李凯 (中国科学院数学与系统科学研究院)
- 16:35 - 16:50 Tool path planning method with effective preservation of sharp features (abstract)
P.37
马鸿宇 (中国科学院大学)
- 16:50 - 17:05 基于向量场的全局刀路规划方法(abstract) P.37
张朝前 (数学与系统科学研究院)
- 17:05 - 17:20 基于时间样条的五轴数控的 G01 代码插补(abstract) P.38
吴芹 (中国科学院数学与系统科学研究院)

晚餐

6月17日 18:00-20:00

2023年6月18日

大会报告 (4)

6月18日 9:00-10:00 海创厅

主持人: 李志斌

9:00 - 10:00 深度学习与智能数学物理([abstract](#))

P.15

闫振亚 (中科院数学与系统科学研究院)

茶歇

6月18日 10:00-10:10

Y7 青年邀请报告 (7)

6月18日 10:10-10:40 海创 B 厅

主持人: 刘日升

10:10 - 10:40 面向开放场景的自适应机器学习初探([abstract](#))

P.17

侯臣平 (国防科技大学)

Y8 青年邀请报告 (8)

6月18日 10:10-10:40 中关村厅

主持人: 林昌露

10:10 - 10:40 对称密码分析中的若干代数方法及应用([abstract](#))

P.18

刘美成 (中国科学院信息工程研究所)

S13 分组报告 (13): 人工智能

6月18日 10:40-11:10 海创 B 厅

主持人: 刘日升

10:40 - 10:55 Developable approximation by deep learning ([abstract](#))

P.38

曾铮 (中国科学院数学与系统科学研究院)

10:55 - 11:10 A lightweight model for feature points recognition of tool path based on deep learning ([abstract](#))

P.39

陈硕鹏 (中国科学院大学数学科学学院)

S14 分组报告 (14): 密码学

6 月 18 日 10:40-11:10 中关村厅

主持人: 孙瑶

10:40 - 10:55 基于同态加密的隐私保护主成分分析方法([abstract](#)) P.39

张金斗 (中国科学院重庆绿色智能技术研究院)

10:55 - 11:10 Functional Bootstrapping for Larger Size Plaintext with Less Memory ([abstract](#)) P.39

刘登发 (中国科学院数学与系统科学研究院)

茶歇

6 月 18 日 11:10-11:25

S15 分组报告 (15): 人工智能

6 月 18 日 11:25-12:10 海创 B 厅

主持人: 王怡洋

11:25 - 11:40 基于多项式抽象的神经网络控制系统的障碍函数构造([abstract](#)) P.40

黄程 (浙江理工大学)

11:40 - 11:55 Upper Bounds on the Node Numbers of Hidden Layers in MLPs ([abstract](#)) P.40

NI Feng (上海理工大学)

11:55 - 12:10 A Residual UNet Denoising Network Based on Multi-scale Feature Extraction and Attention-guided Filter ([abstract](#)) P.41

Li Zhe (长春理工大学)

S16 分组报告 (16): 符号计算

6 月 18 日 11:25-12:10 中关村厅

主持人: 杨静

11:25 - 11:40 基于强化学习的柱形代数分解变元择序([abstract](#)) P.41

钱铨镕 (江苏大学数学科学学院)

11:40 - 11:55 Maple 数学四件套及其在 STEM 教学中的应用([abstract](#)) P.42

徐俊林 (Maplesoft)

11:55 - 12:10 一种稀疏三角分解变元序的选取策略([abstract](#)) P.42

齐朝星 (北京航空航天大学)

午餐

6 月 18 日 12:10-14:00

S17 分组报告 (17): 计算机数学及其应用

6月18日 14:00-15:30 海创 B 厅

主持人: 张熠

- 14:00 - 14:15 一元半正定多项式的降次有理平方和表示算法([abstract](#)) P.42
黄勇 (广州大学)
- 14:15 - 14:30 A modified quantum-behavior heuristic algorithm for scheduling optimization problems in container terminals ([abstract](#)) P.42
李真 (北京邮电大学)
- 14:30 - 14:45 Birational quadratic maps with generalized complex rational representations ([abstract](#)) P.43
Han Yuhao (Hohai University)
- 14:45 - 15:00 Four limit cycles in three-dimensional Lotka-Volterra competitive systems for classes 28, 30 and 31 in Zeeman's classification ([abstract](#)) P.43
Hu Mingzhi (School of Mathematical Sciences, Sichuan Normal University)
- 15:00 - 15:15 A class of reduced framework for large scale sparse optimization ([abstract](#)) P.46
王国强 (上海数字大脑研究院)
- 15:15 - 15:30 基于图的多尺度空间特征提取与协同融合的高光谱影像分类([abstract](#)) P.44
王蕊 (辽宁师范大学)

S18 分组报告 (18): 符号计算

6月18日 14:00-15:30 中关村厅

主持人: 郭峰

- 14:00 - 14:15 Parametric "Non-nested" Discriminants for Multiplicities of Univariate Polynomials ([abstract](#)) P.44
Yang Jing (Guangxi Minzu University)
- 14:15 - 14:30 A Field-Theoretic Approach to Unlabeled Sensing ([abstract](#)) P.45
梁昊 (中国科学院数学与系统科学研究院)
- 14:30 - 14:45 Subresultant of Bernstein polynomials and Its Applications ([abstract](#)) P.45
谭美 (广西民族大学)
- 14:45 - 15:00 Computing sparse Fourier sum of squares on finite abelian groups in quasi-linear time ([abstract](#)) P.45
杨剑霆 (中国科学院数学与系统科学研究院)
- 15:00 - 15:15 Stability Problems for D-finite Functions ([abstract](#)) P.44
Guo Zewang (中科院数学与系统科学研究院)
- 15:15 - 15:30 Distance between non-equidimensional positive semidefinite matrices via the fibre bundle structure ([abstract](#)) P.46
刘鹏 (中国科学院数学与系统科学研究院)

闭幕式

6月18日 15:35-16:00 海创B厅

晚餐

6月18日 17:30-19:30

[P1]

Dual Quaternion and Dual Quaternion Matrices

* 祁力群 (香港理工大学)

Dual quaternions, in particular, unit dual quaternions, have found wide applications in robotics, 3D motion modelling and control, and computer graphics. Some very important engineering problems, such as the formation control of UAV (unmanned aerial vehicles) and small satellites are now based upon dual quaternions. In the past two years, my collaborators and I have explored dual quaternions and dual quaternion matrices as well as their applications in formation control, hand-eye calibration and simultaneous location and mapping (SLAM). In this talk, I will report our results in dual quaternions and dual quaternion matrices in the past two years.

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[P2]

从稀疏矩阵计算到矩阵稀疏计算

* 高卫国 (复旦大学)

数值模拟是科学研究的重要手段，数值算法是科学与工程计算的基石，数值线性代数数值软件包提供核心算法。本报告结合报告人在计算物质科学和数据科学应用研究中遇到的数值线性代数问题，介绍矩阵乘法、正交分解、混合精度计算等稠密矩阵算法，特征值计算、鞍点计算、低秩矩阵分解等稀疏矩阵计算，以及变换域下的广义低秩矩阵重构、无线通信中的矩阵簇求解等稀疏矩阵计算算法。

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[P3]

Additive Decompositions in Symbolic Integration

* 李子明 (中科院数学与系统科学研究院)

Symbolic integration aims to develop algorithms for evaluating integrals in finite terms. One of its classical topics is determining whether an integrand has an elementary integral, and computing such an integral if one exists. Fundamental results on this topic are collected and reviewed in [13]. Algorithms for integrating transcendental functions are presented in [3].

Additive decompositions compute “remainders” and determine the so-called “in-field integrability”. More precisely, for a given function f in a differential field F , an additive decomposition computes $g, r \in F$ such that

$$f = g' + r$$

with the following two properties:

- (i) (minimality) r is minimal in some technical sense,
- (ii) (in-field integrability) f has an integral in F if and only if $r = 0$.

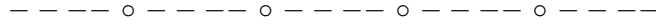
The Hermite-Ostrogradsky reduction [10, 12] developed in the 19th century is an additive decomposition for rational functions. However, additive decompositions for more sophisticated functions had not yet been developed until the Hermite reduction for hyperexponential functions [2] was introduced in 2013.

We are going to review classical Risch's algorithm for integrating transcendental functions [14, 15, 16], and present recent progress in additive decompositions [7, 6, 4, 9, 11, 8, 5] in this talk. Additionally, new results will be discussed on how to combine classical algorithms with additive decompositions so as to enhance and accelerate the integrators implemented in computer algebra systems such as MAPLE and MATHEMATICA.

This talk is dedicated to a special memorial of Professor Marko Petkovšek. His paper [1] coauthored with Sergei Abramov played a key role in bringing additive decompositions back to symbolic integration.

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[P4]

深度学习与智能数学物理

* 闫振亚 (中科院数学与系统科学研究院)

首先介绍人工智能、机器学习和深度学习的研究背景及主要进展。然后讨论深度学习方法如何研究数学物理。最后，通过一些例子，分析深度神经网络方法在非线性的数学物理方程（如孤子方程）正反问题中的应用等。



青年邀请报告摘要

[Y1]

多项式优化与低秩 SDP 求解

* 王杰 (中国科学院数学与系统科学研究院)

多项式优化是一类重要的非线性非凸优化问题，既与测度论、多项式非负性等数学理论密切相关，同时也在最优电力流、计算机视觉、组合优化、神经网络、量子信息等许多领域有广泛的应用。本报告将介绍多项式优化问题的全局求解框架 Moment-SOS 半定松弛分层，以及如何利用系统的结构降低 SDP 松弛问题的复杂度。为利用最优解的低秩性质，我们将介绍基于黎曼流形优化的增广拉格朗日框架高效求解 SDP 松弛问题。



[Y2]

On the Expressivity of Convolutional Neural Networks

* 熊欢 (哈尔滨工业大学)

One fundamental problem in deep learning is understanding the excellent performance of deep Neural Networks (NNs) in practice. An explanation for the superiority of NNs is that they can realize a large family of complicated functions, i.e., they have powerful expressivity. The expressivity of a Neural Network with Piecewise Linear activations (PLNN) can be quantified by the maximal number of linear

regions it can separate its input space into. In this talk, we provide several mathematical results needed for studying the linear regions of Piecewise Linear Convolutional Neural Networks (PLCNNs), and use them to derive the maximal and average numbers of linear regions for one-layer PLCNNs. Furthermore, we obtain upper and lower bounds for the number of linear regions of multi-layer PLCNNs. Rectified Linear Unit (ReLU) is a piecewise linear activation function that has been widely adopted in various architectures. Our results suggest that deeper ReLU CNNs have more powerful expressivity than their shallow counterparts, while ReLU CNNs have more expressivity than fully-connected ReLU NNs per parameter, in terms of the number of linear regions.

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[Y3]

多项式方程组全部解问题：数值算法及应用

* 董波 (大连理工大学)

多项式方程组求解问题是代数几何中的基本问题，众多科学及应用问题也可转化为此问题。从多项式方程组的角度重新看待这些科学和应用问题将会为相关研究开辟新的思路。在此次报告中，我们将从多项式方程组的角度看待代数几何中的混合三角多项式方程组问题、数值逼近中的插值问题、数值代数中的特征值问题及张量低秩逼近问题，结合问题本身的结构及多项式方程组的相关理论和数值算法，融合相关领域的知识给出上述问题的更加深刻的理论结果及高效算法。

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[Y4]

Domain Parameterization and Efficient Matrix Assembly for Isogeometric Analysis

* 潘茂东 (南京航空航天大学)

Isogeometric analysis is a recent technology for numerical simulation, unifying computer aided design (CAD) and computer aided engineering (CAE). It possesses significant advantages over the traditional finite element method. These include the avoidance of mesh generation, exact representation of geometries, higher regularity of the isogeometric discretizations of PDEs, improved accuracy of the obtained numerical solutions, etc. However, it has been noted that these advantages come at the price of constructing spline parameterizations for physical domains and the increased computational cost in the matrix assembly process. This talk will introduce our work on the topics of domain parameterization and matrix assembly in isogeometric analysis.

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[Y5]

Factorization of Motion Polynomials

* 李子佳 (中国科学院数学与系统科学研究院)

Motion polynomials (polynomials over the dual quaternions with the non-zero real norm) describe rational motions. We will present a necessary and sufficient condition for reduced bounded monic motion polynomials to admit factorizations into linear factors, and we give algorithms to compute them. We can use those linear factors to construct mechanisms because the factorization corresponds to the decomposition of the rational motion into simple rotations or translations. In addition, bounded motion polynomials always admit a factorization into linear factors after multiplying with a suitable real or quaternion polynomial.

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[Y6]

Second-Order Methods for Large-Scale Sparse Optimization

* 罗自炎 (北京交通大学)

With the intrinsic sparsity arising from data modeling and the dimensionality reduction demands in large-scale computations, sparse optimization has attracted significant attentions from both academic and industrial communities, with extensive efforts distributed in a variety of specific applications including compressed sensing, signal and image processing, machine learning and neural networks, etc. As the sparsity characterizations are nonconvex and nonsmooth in general, and the underlying optimization for practical problems are of huge sizes, traditional optimization approaches have been facing big challenges in both theory and algorithms for handling large-scale sparse optimization. In this talk, we will focus on the how to appropriately exploit the inherent sparse and dimension reducible structures from the optimization models based on in-depth nonsmooth and variational analysis, and propose two types of Newton-type methods with fast theoretical convergence and superior numerical performances in terms of computation time and solution accuracy for solving large-scale sparse optimization models.

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[Y7]

面向开放场景的自适应机器学习初探

* 侯臣平 (国防科技大学)

人工智能在各个领域有着广泛而深入的应用。自适应学习是一种主动应对开放环境带来变化的机器学习新范式。本报告从人工智能视角，把自适应学习看作是模拟人类思考和解决开放环境下复杂问题的结构化求解模式，主要介绍课题组在自适应学习认知机理揭示、表征机制发现、建模方法构造等方面一些初步尝试。最后，对该研究方向进行了简单的总结和展望。

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[Y8]

对称密码分析中的若干代数方法及应用

* 刘美成 (中国科学院信息工程研究所)

报告主要介绍报告人在对称密码中的代数次数估计和线性化技术、密码攻击代数原理等研究工作,包括“数值映射”方法 (CRYPTO 2017)、“相关立方攻击”(EUROCRYPT 2018)、“线性结构”技术 (ASIACRYPT 2016) 和“差分代数过渡型”方法 (CRYPTO 2021), 以及它们在欧洲序列密码 eSTREAM 工程获胜算法 Trivium 和 Grain v1、美国第三代密码哈希算法标准 SHA-3、美国 AES 竞赛决赛算法 SERPENT、美国轻量级认证加密算法 LWC 标准 Ascon 等密码算法的安全性分析中的应用。

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[P000026]

Inversion and Multiplication of Quaternion Matrices

叶科 (中国科学院数学与系统科学研究院) * 陈琦元 (中国科学院数学与系统科学研究院)

Frobenius inversion algorithm is an important early result for matrix inversion for decomposing the inverse of a complex matrix into a form requiring only the evaluation of inverses of real matrices. We consider the problem if this method can be generalized to quaternion matrix. Gauss method is a classical method for complex matrix multiplication, we consider if we can generalize this method to quaternion case and prove the non-existence of generalized Gauss method.

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[P000006]

一种改进的奇异两点边值问题三次 B 样条数值解法

* 张晓磊 (浙江工商大学) 杨晶晶 (浙江工商大学) 龚佃选 (华北理工大学)

奇异两点边值问题常广泛出现于应用数学和物理学中, 这是一个经典问题. 本文提出了利用三次 B 样条函数来计算一类奇异两点边值问题的数值解的方法. 该方法主要基于三次 B 样条函数在节点处的二阶导数值线性组合去逼近给定函数的二阶导数值, 使其具有超收敛性. 本文的三次 B 样条函数在节点处逼近给定函数的一阶导数值和二阶导数值都具有超收敛性, 从而该数值格式的逼近阶达到四阶. 与其他已有方法相比, 数值实验表明该方法是有效可行的.

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[P000078]

T-type Digraphs via Kronecker Canonical Form

陈胜 (哈尔滨工业大学) * 胡昊飞 (哈尔滨工业大学)

In this paper, we aim to study Kronecker canonical form theory for T-type digraphs, which can be used to construct trees by tensor product with some directed paths. Firstly, we show that some bicyclic digraphs and multicyclic digraphs are T-type digraphs. Secondly, we provide a characterization for T-type digraphs by their Kronecker canonical form. Moreover, we present an algorithm for computing the Kronecker canonical form, which can be used to determine whether or not a digraph is a T-type digraph. Lastly, for a class of T-type digraphs, we show that their incidence matrix pair can be transformed into Kronecker canonical form using unimodular matrices. We also present an algorithm related to finding such unimodular matrices.

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[P000049]

Decorated Motzkin Paths, Riordan arrays, and the Colored Ascents

陈胜 (哈尔滨工业大学) * 辛华 (哈尔滨工业大学) 吴龙军 (哈尔滨工业大学)

We present a combinatorial explanation of (α, β, γ) -Motzkin and Riordan paths by using Riordan arrays. In addition, we prove some well-known combinatorial identities by algebraic methods. Furthermore, we apply the symbolic method or the object grammars and Lagrange inversion formula to Motzkin paths with colored ascents to get some interesting combinatorial identities, in which the ascents colored by Dyck path, Motzkin path, Schröder path, small Schröder path, Catalan rook path and Delannoy path, respectively.

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[P000062]

Permutation symmetric tensors with applications in automated proof of positive definite homogeneous polynomials

魏晔荣 (上海大学理学院) * 曾振柄 (上海大学理学院) 杨争峰 (华东师范大学软件工程学院) 秦小林 (中国科学院成都计算机应用研究所)

In this paper, we present a method to lift a homogeneous polynomial of n variables and degree d to a permutation symmetric tensor in $\otimes^d R^n$, which can be regarded as a variable grouped multilinear function with $n \times d$ variables, and map the vertices of a polyhedron in R^n to a finite point set in $R^{n \times d}$, so to prove

the positive definiteness of given homogeneous polynomials on the given polyhedron by calculating values of the constructed tensors on the set of finite points together with the barycenter partition technique.

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[P000065]

二元多项式矩阵等价的新结果

* 李冬梅 (湖南科技大学) 陈小权 (湖南科技大学) 关剑成 (湖南科技大学)

本文主要讨论研究两类二元多项式矩阵与其 Smith 型等价的问题, 并给出了这几类矩阵与其 Smith 型等价的充要条件, 也给出了一个例子说明如何把给定的二元多项式矩阵等价地约化到其 Smith 型.

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[P000068]

Some Recent Advances in Algebraic Vision

* 秦小林 (中国科学院成都计算机应用研究所) 王乾垒 (中国科学院成都计算机应用研究所) 张少林 (中国科学院成都计算机应用研究所)

Algebraic vision is an interdisciplinary field that combines algebraic geometry and computer vision. Its origin lies in the need to extract three-dimensional information from two-dimensional visual information, such as images and videos. Algebraic vision bridges the gap between algebraic geometry and computer intelligence by using efficient geometric and algebraic computational methods to extract geometric and topological information from images and videos. Algebraic vision is mainly applied in areas such as virtual reality, 3D reconstruction, and autonomous driving. By transforming visual geometric problems into algebraic systems, it achieves stable and efficient solutions. This report will provide a brief introduction to the theory, algorithms, and latest developments in algebraic vision, and explore its prospects in various application fields.

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[P000002]

A Characterization of Perfect Strategies for Mirror Games

Yan Sizhuo (Key Lab of Mathematics Mechanization, AMSS, University of Chinese Academy of Sciences) Yang Jianting (Key Lab of Mathematics Mechanization, AMSS, University of Chinese Academy of Sciences) * Yu Tianshi (Key Lab of Mathematics Mechanization, AMSS, University of Chinese Academy of Sciences) Zhi Lihong (Key Lab of Mathematics Mechanization, AMSS, University of Chinese Academy of Sciences)

We associate mirror games with the universal game algebra and use the *-representation to describe quantum commuting operator strategies. We provide an algebraic characterization of whether or not a mirror game has perfect commuting operator strategies. This new characterization uses a smaller algebra introduced by Paulsen and others for synchronous games and the noncommutative Nullstellensätze developed by Cimpric, Helton and collaborators. An algorithm based on noncommutative Gröbner basis computation and semidefinite programming is given for certifying that a given mirror game has no perfect commuting operator strategies.

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[P000007]

Total positivity of amazing matrices

* 毛建玺 (大连理工大学) 王毅 (大连理工大学)

We show that the transition probability matrix of the carries process is totally positive, which gives an affirmative answer to the conjecture proposed by Diaconis and Fulman.

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[P000010]

New equidistributions on plane trees and decompositions of 132-avoiding permutations

* Bai Ziwei (合肥工业大学)

Our main results in this paper are new equidistributions on plane trees and 132-avoiding permutations, two closely related objects. As for the former, we discover a characteristic for vertices of plane trees that is equally distributed as the height for vertices. The latter is concerned with four distinct ways of decomposing a 132-avoiding permutation into subsequences. We show combinatorially that the subsequence length distributions of the four decompositions are mutually equivalent, and there is a way to group the four into two groups such that each group is symmetric and the joint length distribution of one group is the same as that of the other. Some consequences are discussed. For instance, we provide a new refinement of the equidistribution of internal vertices and leaves, and present new sets of 132-avoiding permutations that are counted by the Motzkin numbers and their refinements.

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[P000013]

The number of leaves in a tree with given diameter and maximum degree

* Feng Xing (Jimei University) Huang Zejun (Shenzhen University)

We determine the minimum number and the maximum number of leaves in a tree with given order, diameter and maximum degree.

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[P000014]

Polynomial χ -binding Functions for Graphs with Forbidden Configurations

* Xu Yian (Southeast University)

A graph G is said to be H -free if it contains no induced subgraph isomorphic to H . A family of graphs \mathcal{G} is said to be χ -bounded if there exists some function f such that $\chi(G) \leq f(\omega(G))$ for every $G \in \mathcal{G}$, and f is said to be the binding function of G . In this talk, we will talk about the binding functions of graphs with some specific forbidden configurations, and we present some recent results on coloring P_5 -free graphs.

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[P000020]

Mahler discrete residues and summability for rational functions

Arreche Carlos (The University of Texas at Dallas) * Zhang Yi (Xi'an Jiaotong-Liverpool University)

We construct Mahler discrete residues for rational functions and show that they comprise a complete obstruction to the Mahler summability problem of deciding whether a given rational function $f(x)$ is of the form $g(x^p) - g(x)$ for some rational function $g(x)$ and an integer $p > 1$. This extends to the Mahler case the analogous notions, properties, and applications of discrete residues (in the shift case) and q -discrete residues (in the q -difference case) developed by Chen and Singer. Along the way we define several additional notions that promise to be useful for addressing related questions involving Mahler difference fields of rational functions, including in particular telescoping problems and problems in the (differential) Galois theory of Mahler difference equations.

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[P000061]

Enforcing continuous symmetries in physics-informed neural network for solving forward and inverse problems of partial differential equations

张智勇 (中央民族大学) * 张慧 (中央民族大学) 张立升 (北方工业大学) 郭磊磊 (北方工业大学)

As a typical application of deep learning, physics-informed neural network (PINN) has been successfully used to find numerical solutions of partial differential equations (PDEs) and has developed into one of the most effective methods to solve the forward and inverse problems of PDEs, but the limited accuracy of algorithm and the shortage of sufficient inherent physical laws of PDEs are two main weaknesses of PINN. Thus we first introduce a new method, symmetry-enhanced physics informed neural network (SPINN) where the invariant surface conditions induced by the Lie symmetries or non-classical symmetries of PDEs are embedded into the loss function in PINN, to improve the accuracy of PINN for solving the forward and inverse problems of PDEs. Then motivated by the success of the above technique and the idea of the gradient-enhanced PINN (gPINN), we enforce the generalized conditional symmetry of PDEs to the loss function of PINN, i.e. the generalized conditional symmetry enhanced PINN (gsPINN), to improve the accuracy and reliability of solutions of PDEs. The SPINN and gsPINN methods incorporate the inherent physical laws of PDEs to PINN and exert high-efficiencies in solving the forward and inverse problems of PDEs.

Then, we test the effectiveness of SPINN and gsPINN for the forward problem via two groups of ten independent numerical experiments using different numbers of collocation points and neurons per layer for the linear and nonlinear equations, and for the inverse problem by considering different layers and neurons as well as different numbers of training points with different levels of noise for the Burgers equation in potential form and a coupled system with two-component nonlinear diffusion equations. The numerical results show that SPINN and gsPINN perform better than PINN with fewer training points and simpler architecture of neural network, and the L_2 relative error of SPINN and gsPINN can reach 10^{-5} which is seldom in the literatures. Furthermore, we discuss the computational overhead of SPINN and gsPINN in terms of the relative computational cost to PINN and show that the training time of SPINN and gsPINN have no obvious increases, even less than PINN for certain cases.

Moreover, by considering the Sawada-Kotera equation the SPINN method exhibits superiorities than the PINN method and the two-stage PINN method. The analysis of three methods, PINN, gPINN and gsPINN, on a non integrable PDE shows that gsPINN has significant superiorities in terms of accuracy, robustness and training time. The results further demonstrate that the inherent physical properties of PDEs can further improve the performances of PINN and thus is worthy of deep exploring.

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[P000077]

Two Improved Algorithms to Compute the Minimal Bases of Univariate Matrices

陈凌帆 (中国科学技术大学) * 姚姗姗 (北京邮电大学)

The minimal basis of a univariate polynomial matrix $M(s) \in K[s]^{m \times n}$ is a basis of the syzygies of the polynomial matrix $M(s)$ with lowest possible degree, where $K[s]$ is the univariate polynomial ring over the field of K . It provides an efficient tool to compute the moving planes and moving quadratics of a rational parametric surface, which are employed to implicitize the parametric surface as a powerful implicitization method. In this paper, we develop two improved algorithms for computing the minimal bases of polynomial matrices. The algorithms are based on efficient methods to reduce the degrees of a set of univariate polynomial vectors. It is shown that the computational complexities of the two algorithms are $\mathcal{O}(m^2n^3d^2 + d^2n^5 - (2mn^4d^2 - \frac{1}{6}m^3nd))$, and $\mathcal{O}(m^2nd^2 + (n-m)n^3d^2 + \frac{m^2n^2d^2}{n-m})$ respectively, where m, n are the sizes of the polynomial matrix $M(s)$ and d is the degree of each entry of the matrix. The new algorithms are faster than the state-of-the-art methods by experimental examples. Some properties about the degree of the minimal basis are also provided.

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[P000070]

On the Parameter Selection of LWE-based Encryption Scheme

* 徐娟 (中国科学院重庆绿色智能技术研究院)

The selection of parameters for LWE-based schemes becomes an important problem as lattice-based cryptography attracts increasing attention. We consider the state-of-the-art scheme Brakerski-Gentry-Vaikuntanathan (BGV) and provide the optimal choice of its parameters in the context of minimizing the communication overhead. We also give a closed formula to estimate the security level of the scheme in terms of the parameters.

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[P000018]

On the differences between proper coloring and DP coloring

* Zhang Meiqiao (National Institute of Education, Nanyang Technological University) Dong Fengming (National Institute of Education, Nanyang Technological University)

DP coloring was introduced by Dvořák and Postle in 2015 to solve a problem in the field of list coloring. Broadly speaking, DP coloring is a generalization of both proper coloring and list coloring, which takes all possible compatible or exclusive relationships between the colors used on every pair of adjacent vertices into consideration. One of the main research topics in this area is to identify the commonalities and differences among proper coloring, list coloring and DP coloring. In this paper, we focus on the gap between the chromatic number $\chi(G)$ and the DP-chromatic number $\chi_{DP}(G)$ of any graph G .

Motivated by known results on the gap between chromatic numbers and list-chromatic numbers, Bernshteyn, Kostochka and Zhu defined $Z_{DP}(n)$ as the minimum natural number s such that $\chi(G \vee K_s) = \chi_{DP}(G \vee K_s)$ holds for every graph G of order n , where $G \vee K_s$ is the join of G and the complete graph with s vertices. They showed that $Z_{DP}(n) \leq 1.5n^2$, which indicates that the join of any graph and a large enough complete graph has its chromatic number and DP-chromatic number equal. In this paper, we improve this best current upper bound into $n^2 - (n+3)/2$, narrowing the gap between proper coloring and DP coloring to our knowledge.

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[P000025]

A sharp upper bound on the cycle isolation number of graphs

* 崔庆 (南京航空航天大学) 张婧姝 (南京航空航天大学)

For any graph G , a subset $S \subseteq V(G)$ is said to be a cycle isolating set of G if $G - N[S]$ contains no cycle, where $N[S]$ is the closed neighborhood of S . The cycle isolation number of G , denoted by $\iota_c(G)$, is the minimum cardinality of a cycle isolating set of G . Borg (2020) showed that if G is a connected n -vertex graph that is not isomorphic to C_3 , then $\iota_c(G) \leq \frac{n}{4}$. We present a sharp upper bound on the cycle isolation number of a connected graph in terms of its number of edges. We prove that if G is a connected m -edge graph that is not isomorphic to C_3 , then $\iota_c(G) \leq \frac{m+1}{5}$. Moreover, we characterize all connected graphs attaining this bound.

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[P000045]

On directed strongly regular Cayley graphs over non-abelian groups with an abelian subgroup of index 2

* 黄雪毅 (华东理工大学) 鲁卢 (中南大学) Park Jongyook (韩国庆北大学)

In 1988, Duval introduced the concept of directed strongly regular graphs, which can be viewed as a directed graph version of strongly regular graphs. Such directed graphs have similar structural and algebraic properties to strongly regular graphs. In the past three decades, it was found that Cayley graphs, especially those over dihedral groups, play a key role in the construction of directed strongly regular graphs. In this paper, we focus on the characterization of directed strongly regular Cayley graphs over more general groups. Let G be a non-abelian group with an abelian subgroup of index 2. We give some necessary conditions for a Cayley graph over G to be directed strongly regular, and characterize the directed strongly regular Cayley graphs over G satisfying specified conditions. This extends some previous results of He and Zhang (2019).

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[P000046]

Resistance distances and the Moon type formula of a vertex-weighted complete split graph

* Ge Jun (Sichuan Normal University) Liao Yucui (Sichuan Normal University) Zhang Bohan (Sichuan Normal University)

The complete split graph $S_{m,n}$ is a bipartite graph with two parts, a clique part with m vertices which induces K_m as a subgraph, and an independent part with n vertices which induces an empty subgraph $\overline{K_n}$ as a subgraph. There are exactly one edge between each vertex in the clique part and each vertex in the independent part. In this paper, we first determine resistance distances in the vertex-weighted complete split graph $S_{m,n}^\omega$. We also obtain the moon type formula for the vertex-weighted complete split graph $S_{m,n}$, that is, the weighted spanning tree enumerator of $S_{m,n}^\omega$ containing any fixed spanning forest.

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[P000060]

Simple Characteristic Decomposition of Polynomial Sets

* 王林朋 (北京航空航天大学) 牟晨琪 (北京航空航天大学)

Characteristic pairs consist of lexicographical Groebner bases and the minimal triangular sets, called W-characteristic sets, contained in them, and they are good representations of multivariate polynomial ideals in terms of Groebner bases and triangular sets simultaneously. In this paper, we study how to decompose a polynomial set of arbitrary dimension into characteristic pairs with simple W-characteristic sets, and two algorithms are proposed over fields of zero characteristics and over finite fields respectively. Both of the algorithms rely on the concept of strong regular characteristic divisors, and the one for zero-characteristic fields also uses Lazard Lemma to test whether an ideal is radical. Experimental results are presented to illustrate the effectiveness of the proposed algorithms.

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[P000076]

Hybrid method for solving polynomial systems

* 尹哲东 (大连理工大学) 董波 (大连理工大学) 于妍 (大连外国语大学)

Polynomial systems arising from the practice are often highly sparse, that is, the number of isolated solutions of a polynomial system is generally far less than their Bézout number. Therefore, the full exploration of the sparsity is an important topic in the field of homotopy method for solving polynomial systems. In this paper, we exploit the product structure of each polynomial to characterize the sparsity and further present a hybrid method, in which the homotopy is the combination of the random product homotopy and the coefficient-parameter homotopy and the method is the combination of the symbolic methods and the numerical methods, to solve polynomial systems. Numerical results show that the hybrid method is more efficient than the existing homotopy methods.

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[P000055]

Toric parameterization based isogeometric collocation method for planar multi-sided physical domains

* 周沛 (大连理工大学) 朱春钢 (大连理工大学)

Isogeometric collocation method (IGC) shows high computational efficiency compared with isogeometric Galerkin method (IGG) when solving partial differential equations (PDEs). However, few studies about IGC have focused on multi-sided physical domains. In this paper, we propose a new IGC method based on toric parameterization (IGCT) for the multi-sided planar physical domains. Due to the high order continuity of toric basis functions, the IGCT method shows more accurate numerical approximation. Moreover, we generalize the adaptive w-refinement method into IGCT (IGCT-w), in which the weights of basis functions in physical domains are optimized independently for geometry representation.

The numerical accuracy of IGCT-w is significantly improved by an order of magnitude in comparison with IGCT method. To save the computational cost of IGCT-w, we devise a selection of weights scheme according to relative residuals. Finally, several numerical examples demonstrate the effectiveness and robustness of our proposed method.

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[P000039]

Topology Guaranteed B-Spline Surface/Surface Intersection

* 杨婕吟 (中国科学院数学与系统科学研究院) 贾晓红 (中国科学院数学与系统科学研究院)

The surface-surface intersection serves as one of the most fundamental problems in CAD systems. We present a topology guaranteed algorithm of computing the intersection of two B-spline surfaces, which is built upon a fast surface implicitization approach using the Dixon matrix, an inversion formula for a 3D point given by the Dixon matrix, a novel clipping method of the intersection curve within the required parametric domain, and a topology determination strategy that eases the tracing of the intersection locus.

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[P000004]

连续区间上积分值的二次三角样条插值

* 吴金明 (浙江工商大学) 杨晶晶 (浙江工商大学) 刘向云 (浙江工商大学) 朱春钢 (大连理工大学)

在某些实际问题中, 插值结点处的函数值是未知的, 而仅仅知道一些连续等距子区间上的积分值. 如何利用连续区间上积分值信息来解决函数重构是一个重要的问题. 本文利用 C^1 连续的二次三角样条函数来解决此问题. 首先, 提出了 C^1 连续的二次三角样条插值格式. 该三角样条函数对 $\{1, \sin x, \cos x\}$ 具有再生性. 然后, 给出了该二次三角样条函数逼近节点处的函数值和一阶导数值的收敛阶. 最后, 数值实验表明该方法是可行和有效的.

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[P000017]

An efficient Levenberg-Marquardt method for Nonlinear Least-Squares Problems

* Chen Liang (Changzhou Institute of Technology) Wu Zhenxiang (Anhui Institute of Information Technology)

One of the famous methods for system of nonlinear equations as well as nonlinear least-squares problems is the Levenberg-Marquardt method. Various modifications of this method have been given by improved LM parameters. In this paper, we give a new efficient Levenberg-Marquardt method by using a geometric mean to update the LM parameter. According to the rank of the Jacobian matrix, some relevant assumptions are given. Under a new local error bound condition, we consider the local convergence properties of our efficient Levenberg-Marquardt method without requiring zero residues. Numerical experiments show that the new efficient Levenberg-Marquardt method is effective.

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[P000058]

可信距离约束下的 B 样条曲线拟合

* 贺诗涛 (中国科学院大学数学科学学院)

B 样条曲线拟合是计算机辅助几何设计中的经典问题, 在不同的领域中被广泛应用。这一问题在近年的研究中被重新提起, 以解决具有新要求的拟合问题, 比如计算机数控加工中的 G01 光顺要求路径满足全局误差约束。这一问题具体是说: 给定 G01 数据点, 构造一条 B 样条曲线对数据点进行拟合, 拟合曲线和数据点按顺序所连折线段的 Hausdorff 距离不能大于给定常数。

本研究提出了一个算法以解决具有误差约束的 3 次 B 样条拟合问题, 包括逼近问题和插值问题。Piegl 和 Tiller 曾提出带有插值点处导矢方向约束的插值问题, 本研究对这一问题也进行了关注。以上 3 种拟合问题都可以在本研究所提出的算法框架下解决。

算法包含两个阶段: 在第一阶段, 通过将全部数据点都取为 B 样条曲线的控制点, 并在每条相邻数据点所连线段内取两个互异控制点, 可以根据一个含有 n 个点的数据集算出 $3n - 2$ 个控制点。使用 Riesenfeld 方法可以根据控制点生成节点矢量, 由此得到一条 3 次 B 样条初始拟合曲线。可以证明, 按上述方法所生成的拟合曲线满足 Hausdorff 距离约束。

在第二阶段, 需要对初始拟合曲线的控制点进行优化, 得到满足约束的优化拟合曲线。首先, 本研究对非均匀 B 样条曲线证明了基于节点的强凸包性。相比于经典的 B 样条强凸包性, 这一性质使用了节点信息, 不再用控制点本身、而是以控制点的线性组合作为顶点生成凸包。这使得可以将定义在节点区间上的一段 B 样条曲线段的端点作为顶点, 且这样构造的凸包对曲线段的逼近效果优于以控制点自身作为顶点生成的凸包, 更适合被用来对 B 样条曲线进行位置控制。

在上述性质的基础上, 本研究在 R^2 和 R^3 中分别定义了基本结构, 由此得以将全局误差控制转化为局部误差控制, 并能够逐段地对定义在每个节点区间上的 B 样条曲线段进行误差控制。基于几何上的分析, 本研究给出并证明了对任意误差限进行 Hausdorff 距离控制的充分条件, 并证明了它可被写为一系列线性和凸二次约束, 这一条件在 R^2 和 R^3 中都成立。此外, 本研究还证明了插值约束和导矢方向约束都可被写为线性约束。因为误差可以被先验地严格约束, 所以在算法中目标函数可以直接被取为光滑函数, 而无需像传统方法一样将目标函数取为距离项和光顺项的线性组合, 避免了调节光顺项参数的问题, 且无需使用脚点参数更新等方法多次求解优化模型。在算法的第二阶段只需要求解一个凸二次约束二次规划 (QCQP) 问题, 就可以将之前提到的 3 种拟合问题都解决, 而实验结果展示了拟合算法的有效性。

时间样条算法是计算机数控加工中的前沿算法, 本研究将提出的拟合算法与 3 轴时间样条算法相结合以做出改进。在 3 轴加工中, zigzag 路径被大量使用。全局 B 样条拟合方法难以在保持较小误差限的情况下对 zigzag 路径进行光顺, 原有的时间样条方法也不例外。而本研究提出的改进时间样条算法能够解决这一问题, 得到满足运动学约束和误差约束、实现 Bang-Bang 控制的时间样条曲线。

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[P000069]

Reducing Hyperexponential Functions

陈绍示 (中国科学院数学与系统科学研究院) 杜昊 (北京邮电大学) * 高艺漫 (中国科学院数学与系统科学研究院) 李子明 (中国科学院数学与系统科学研究院)

We extend the shell and kernel reductions for hyperexponential functions over a field of rational functions to a monomial extension. Both of the reductions are combined into one algorithm. As an application, we present an additive decomposition in rationally hyperexponential towers. The decomposition yields an alternative algorithm for computing elementary integrals over such a tower. Preliminary experiments show that the alternative can be used to compute elementary integrals that are not found by the integrators in the latest versions of Maple and Mathematica.

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[P000044]

Reduction systems and degree bounds for integration

* Du Hao (Beijing University of Posts and Telecommunications) Raab Clemens (Johannes Kepler University Linz)

In symbolic integration, the Risch-Norman algorithm tries to find the closed forms of elementary integrals over differential fields based on heuristic degree bounds. Norman presented an approach that avoids degree bounds and only relies on the completion of reduction systems. We give a formalization of complete reduction systems and develop a refined algorithm with a proof of correctness, which terminates in more instances. In some situations, when the algorithm cannot terminate, we can also find infinite reduction systems that are complete. We present such infinite systems for the fields generated by Airy functions, complete elliptic integrals, and solutions of certain second-order linear differential equations, respectively. Moreover, complete reduction systems can be used to find rigorous degree bounds. We give a general formula for the weighted degree bounds and also find tight bounds for above examples.

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[P000029]

Symbolic Computation in Abel's Addition Formulae

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Integration problems of algebraic functions, including problems on elliptic integrals, had been the research focus of many mathematicians in the 19th century, such as Euler, Legendre, Abel, Jacobi etc. Abelian integrals are the generalization of elliptic integrals, which can be written as

$$\int R(x, y)dx,$$

where $R(x, y)$ is a rational function of x and y with the polynomial relation $P(x, y) = 0$. Abel's addition theorem has played an important role in exploring the theory of elliptic integrals which says that

$$\int_a^u R(x, y)dx + \int_a^v R(x, y)dx = \int_a^w R(x, y)dx,$$

where a, u, v, w are on the Riemann surface corresponding to $R(x, y)$ such that a is a fixed point and w is an algebraic function of u and v . A simple and classical example is

$$\int_0^u \frac{1}{\sqrt{1-x^2}}dx + \int_0^v \frac{1}{\sqrt{1-x^2}}dx = \int_0^{u\sqrt{1-v^2}+v\sqrt{1-u^2}} \frac{1}{\sqrt{1-x^2}}dx,$$

which leads to the trigonometric formula: $\sin(u+v) = \sin(u)\cos(v) + \cos(u)\sin(v)$. Usually the procedure of deriving Abel's addition formulae by hand is complicated and highly skillful. In this paper, we show that some algorithms in symbolic computation can be used to find the explicit forms of w in a more efficient way.

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[P000041]

Mathematical modeling for the local flow of a generalized Newtonian fluid in 3D porous media

* Li Shuguang (Dalian Maritime University) Dimitrienko Yu.I. (Bauman Moscow State Technical University)

This research is devoted to the mathematical modeling for the filtration of a generalized Newtonian fluid in porous media by applying the homogenization method. The so-called local problem on a periodic cell are given for describing the local transfer of a Carreau-Yasuda fluid. The permeability tensor of a Carreau-Yasuda fluid is obtained, which is proved to be symmetric and positive definite. The particularity of local problems is discussed. A new numerical method for solving local problems is developed, which is based on the physical properties of microstructures to transform local problems into problems defined on one-eighth periodic cells, and solved by the finite element method. The solution of the local problems allows us to determine the precise local distributions of velocities, pressures and non-Newtonian viscosities in a separate pore, and also to evaluate the permeability coefficient and effective viscosity of the generalized Newtonian fluid in porous media. The local flows of a Carreau-Yasuda fluid in the three-dimensional ceramic porous structure are simulated, and the proposed model and numerical method are verified. Finally, this model is applied to the sensitivity of non-Newtonian viscosities to the permeability and the effective viscosity.

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[P000066]

The Allocation Scheme of Software Development Budget with Minimal Conflict Attributes

* 马艳芳 (常州工学院) 周伟 (中国矿业大学) 高晓彤 (淮北师范大学)

During software development, a major challenge is to estimate software development costs. Project managers' core objective is to deliver a high trustworthiness product within the budget. However, trustworthy software is related to several different attributes. Conflicts between different attributes may occur when a budget allocation scheme is adopted to improve trustworthy attributes. Therefore, it is necessary to select an optimal allocation scheme to reduce conflict cost. In this paper, we first propose a conflict cost and costs estimation model. The difficulty coefficient constrain for improving attributes are established. The importance weights of attributes are analyzed. Then, based on conflict cost, importance weights, and difficulty coefficient constrain, an algorithm to obtain an budget allocation scheme is presented, which can minimize conflict cost. Finally, an example is showed to demonstrate the feasibility of the proposed algorithm. The research can help the manager of software to use the budget funds more reasonably and gain maximum benefit.

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[P000090]

Maple 数字孪生应用介绍

* 徐俊林 (Maplesoft)

介绍 Maple 数字孪生应用。

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[P000079]

Isabelle2Cpp 的类型推理系统

蒋东辰 (北京林业大学信息学院) * 付辰曦 (北京林业大学信息学院)

Isabelle2Cpp 是一个从 Isabelle/HOL 规范到 C++ 程序的代码生成框架, 它使得人们能够将 Isabelle/HOL 规范形式化验证的方便性和 C++ 程序的高效性相结合, 实现从验证过的 Isabelle/HOL 函数式规范到高效 C++ 代码的自动正确转换. 针对代码生成框架在类型提取方面的欠缺, 本文为 Isabelle2Cpp 框架添加了类型推理系统, 用于完成对 Isabelle2Cpp 中间表示所有表达式的类型推理及类型实例化工作. 基于该系统的类型推理, Isabelle2Cpp 框架能够获得更为完善的类型信息, 实现了对缺失类型信息 Isabelle/HOL 规范的 C++ 代码自动生成.

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[P000043]

张量的低 α -秩逼近及其应用

* 赵新竹 (辽宁大学) 于波 (大连理工大学)

随着大数据产业的不断发展, 矩阵已无法满足人们存储数据的需求. 大数据的特点不仅体现在数据规模上, 也体现在数据的多标签性和强结构性上, 利用张量理论存储、分析数据则可以很好地还原这些特性. 事实上, 张量在信号处理、数据挖掘、神经科学、计算机视觉、量子力学等领域中已经开始扮演着重要角色. 张量补全、张量回归、张量分类、张量主成分分析等解决数据分析问题的重要模型也得到了广泛关注. 而此类模型的求解通常需借助张量低秩逼近算法, 因此对张量低秩逼近相关概念及算法进行讨论和研究是非常必要的.

现有的张量低秩逼近问题一般来源于经典的张量 CP 分解和 Tucker 分解, 还有部分低秩逼近问题来源于 t-SVD、张量列式分解等分解形式. 但是, 这些张量分解方法并不是时刻都能满足数据分析需求. 例如, 多模态数据分析问题和多体量子态可分性分析问题所涉及的张量就具有更特殊的结构, 现有的分解方式则会破坏这种结构. 由此可见, 综合分析张量在不同角度下所表现出来的特征的异同, 才能更准确地分析张量数据. 本报告的主旨就是对该问题进行探讨和研究.

首先, 本报告将介绍一种张量维度的分组方式. 张量维度的不同分组对应着张量的不同研究角度, 通过变化分组可以实现张量分析角度的变化. 其次, 本报告将基于张量维度的不同分组及张量与多重线性映射的关系介绍一种新的张量分解定义—张量 α -CP 分解, 并提出相应的低 α -秩逼近问题及求解算法. 该定义以经典的 CP 分解为特例, 将其向量分解因子推广为低阶张量, 为张量分解增添了更多可能性. 最后, 本报告还将分享将 α -秩和低 α -秩逼近应用于张量补全、张量压缩问题时所产生的效果, 并探讨实际应用中最佳分组的选择方法. 数值实验表明, 本报告中所提出的张量 α -CP 分解和张量 α -秩的概念对研究带特定结构的张量具有着重要意义.

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[P000031]

实数域上单变元平方模的成员判定算法

* 尚伟峰 (北京航空航天大学) 牟晨琪 (北京航空航天大学)

平方模之于实代数几何, 如同多项式理想之于代数几何, 它可用于证明正点定理、研究希尔伯特第十七问题. 本报告介绍了验证实数域上一元有限生成平方模的成员判定和一类有限生成平方模的包含关系的算法. 对于无界平方模, 我们给出了构造任意多项式的平方和系数的精确次数上界, 并利用该上界设计了这类平方模的成员判定算法. 对于有界平方模, 根据其有限生成元的非负点集, 我们定义了该平方模的唯一签名. 然后我们利用平方模的签名给出了两个有限生成平方模包含的关系准则和相应验证算法, 而成员判定作为平方模包含关系的特例而自然得以解决. 我们还证明了任意有界平方模至多可以由两个生成元等价生成, 并设计了构造这些生成元的算法.

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[P000024]

带零点的非负系数 Bernstein 展开

* 徐嘉 (西南民族大学数学学院) 姚勇 (中科院成都计算机应用研究所)

一个熟知的结论是说, 如果多项式 $f \in \mathbb{R}[x]$ 在单位方体 $I_n = [0, 1]^n$ 上的值是严格正的, 则 f 可以用带正系数的 Bernstein 基表示. 但是, 当 f 在单位方体 I_n 上存在零点时, 上述结论不再成立. 本文中我们研究了 f 带有角零点 (单位方体的顶点) 的情况. 我们找到了在仅有角零点的假设下 f 存在非负系数

的 Bernstein 展开需要满足的充分必要条件. 我们的方法是引入了 d -对偶形式, 将问题转化为 d -对偶形式的系数问题.

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[P000067]

A Sample-Driven Solving Procedure for the Repeated Reachability of Quantum Continuous-Time Markov Chains

* 蒋慧 (华东师范大学) 傅剑铃 (华东师范大学) 徐鸣 (华东师范大学)

Reachability analysis plays a central role in system design and verification. Recently, the reachability problem, embedded into a model-checking algorithm, has been considered and solved on a novel kind of real-time system — quantum continuous-time Markov chains (QCTMCs). In this paper, we further study the repeated reachability problems in QCTMCs, denoted $\square^I \diamond^J \Phi$, which concerns whether the system at any absolute time in I would meet the property Φ after some coming relative time in J . First of all, we establish the decidability by a reduction to the real root isolation of a class of real-valued functions. To speed up the procedure, we employ a sampling-based approach. The original problem is shown to be equivalent to the existence of a finite collection of solution samples. We then present a sample-driven procedure, which can effectively refine the sample space after each times of sampling, no matter whether the sample itself is successful or conflicting. The improvement on efficiency is validated by extensive randomly-generated examples. Hence the proposed method would be promising to attack the repeated reachability problems together with checking ω -regular properties in a wide scope of real-time systems.

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[P000015]

Signature-based standard basis algorithm under the framework of GVW algorithm

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Cover theorem is the theoretical foundation of GVW algorithm and also the core of the signature-based algorithm to eliminate a large number of useless J-pairs without any reduction. In this paper, we extend the cover theorem to the case of any semigroup order. Since a semigroup order is not necessary to be global or local, there may not be a minimal or maximal signature in an infinite set, which results in the difficulty of proving the cover theorem by the classical method. Based on the pioneering idea of Mora normal form algorithm, we propose a more essential and general proof for the cover theorem with avoiding the choice of a minimal or maximal signature. Therefore, the signature-based standard basis algorithm for any semigroup order under the framework of GVW algorithm is presented, and an example is given to illustrate the algorithm.

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[P000035]

神经理想的 Gröbner 基与典范形式集

* 郑丽翠 (湖南科技大学) 刘金旺 (湖南科技大学)

本文主要研究了神经理想的典范形式集与 Gröbner 基之间的关系, 并根据 Gröbner 中的元素给出了三种新的 RF-类型。

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[P000085]

Restricted Gröbner Basis Theory for Normalization of Indexed Differential Riemann Metric Tensor Polynomials

* 刘姜 (上海理工大学) Ni Feng (上海理工大学)

Riemann metric tensor plays a significant role in deducing basic formulas and equations arising in differential geometry and (pseudo-)Riemannian manifolds. It is a fundamental problem to develop general computational theories for polynomials involving Riemann metric tensor and its differential forms. This paper solves the problem by extending Gröbner basis theory and the previous work on the computational theory for indexed differentials. An L-expansion of an elementary indexed Riemann metric tensor monomial is defined. Then a decomposed form of the Gröbner basis of defining syzygies of the polynomial ring is presented, based on a partition of elementary indexed monomials. Meanwhile, the upper bound of the dummy index numbers of sim-monomials of the elements in each disjoint elementary indexed monomial subset is found. Finally, a DST-fundamental restricted ring is constructed, and the canonical form of a polynomial is confirmed to be the normal form with respect to the Gröbner basis in the DST-fundamental restricted ring.

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[P000052]

Bézout Subresultants for Univariate Polynomials in General Basis

杨静 (广西民族大学) * 杨卫 (广西民族大学)

Subresultant is a powerful tool for developing various algorithms in computer algebra. Subresultants for polynomials in standard basis (i.e., power basis) have been well studied so far. With the popularity of basis-preserving algorithms, resultants and subresultants in non-standard basis are drawing more and more attention. In this paper, we develop a formula for Bézout subresultants of univariate polynomials in general basis, which covers a broad range of non-standard bases. More explicitly, the input polynomials are provided in a given general basis and the resulting subresultants are Bézout-type expressions in the same basis. It is shown that the subresultants share the essential properties as the subresultants in standard basis.

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[P000028]

Stability Problems in Symbolic Summation

陈绍示 (中国科学院数学与系统科学研究院) * 李秀云 (中国科学院数学与系统科学研究院)

Continuing the dynamical studies in symbolic integration, we focus on stability problems in symbolic summation, which connect the theory of dynamical systems to difference algebra. We explore the structure of stable sequences in difference fields and characterize some special families of stable sequences including rational sequences, hypergeometric terms and P-recursive sequences. We conclude that P-recursive sequences are eventually stable. This is a joint work with Shaoshi Chen.

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[P000064]

Embedding of unimodular row vectors

* 吴弢 (湖南科技大学) 刘金旺 (湖南科技大学)

Algorithmic algebra and symbolic computation have important scientific significance and application value in mathematical theory and engineering calculations. Some problems in many mathematical and engineering fields, such as algebraic geometry, computer algebra, algebraic topology, circuit analysis, multi-dimensional control, signal processing, multi-dimensional systems, can be transformed into problems of multivariate polynomial matrix. In 1955, J.P. Serre put forward the famous Serre conjecture: any finitely generated projective module in a polynomial ring over a field must be a free module, which is equivalent to that any ZLP matrix can be embedded into an invertible matrix. The embedding problem of a ZLP matrix A is equivalent to finding a right identity matrix of A , i.e., finding the invertible matrix U such that $AU = (E_r, 0)$. Logar and Fabianska gave the Quillen-Suslin algorithm involved calculating polynomial zeros, but there is no general algorithm for calculating polynomial zeros. The embedding of ZLP polynomial matrix can be transformed into the embedding problem of unimodular rows by recursive method. This paper mainly investigates the existence of the minimal syzygy module of ZLP polynomial matrix, and demonstrates that the minimal syzygy module has structural properties similar to the fundamental solution system of homogeneous linear equations in linear algebra. We proved that the minimal syzygy module of ZLP matrix is free, and the embedding problem of unimodular vector is studied by avoiding finding the zeros of polynomials. The generator set of the syzygy module of unimodular vector is given in formulaic form, and the invertible matrix of unimodular vector embedded in it is further given in several cases.

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[P000056]

Adaptive and feature-preserving spline surface fitting with arbitrary topological control mesh

* 寇宜博 (中国科学院大学数学科学学院)

Fitting spline surfaces to 3D objects is a fundamental problem in the fields of computer-aided design and engineering. In this paper, we propose a surface fitting method using G-NURBS which is capable of handling control meshes with arbitrary topology. This method can adaptively adjusting the number and positions of control points based on the geometrical features of the surface, while accurately capturing sharp features such as sharp edges and corners. The proposed method has been tested and evaluated on various surface fitting tasks, demonstrating its effectiveness. Our method can achieve higher fitting accuracy and well respect the geometrical features of the input data with fewer control points.

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[P000034]

An adaptive collocation method on implicit domains using weighted extended THB-splines

* 杨晶晶 (大连理工大学) 朱春钢 (大连理工大学)

Implicit representations possess many merits when dealing with geometries with certain properties, such as small holes, reentrant corners and other complex details. Truncated hierarchical B-splines (THB-splines) has recently emerged as a novel tool in many fields including design and analysis due to its local refinement ability. In this paper, we propose an adaptive collocation method with weighted extended THB-splines on implicit domains. After the level by level classification, the centers of the supports of basis functions on each level are chosen to be collocation points. Weighted collocation is used in the transition regions, in order to enrich information concerning the hierarchical basis. The proposed approach not only improves the accuracy, but also reduces the oscillation in the WEB-collocation method, while retaining the fundamental property of collocation. To show the efficiency and superiority of the proposed method, numerical examples in two and three dimensions are performed to solve Poisson's equations.

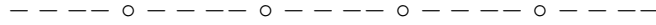
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[P000040]

Computing Moving Planes of Rational Parametric Surfaces Using Dixon Resultants

* 李凯 (中国科学院数学与系统科学研究院) 贾晓红 (中国科学院数学与系统科学研究院) 陈发来 (中国科学技术大学)

Moving planes have been widely recognized as a potent algebraic tool in various fundamental problems of geometric modeling, including implicitization, intersection computation, singularity calculation, and point inversion problems of parametric surfaces. Typically, a matrix representation that inherits the key properties of a parametric surface is constructed from a series of moving planes. In this paper, we present an efficient approach to computing such a series of moving planes that that follow the given rational parametric surface. Our method is based on the calculation of Dixon resultant matrices, which allows for the computation of moving planes with much simpler coefficients and improved efficiency when compared to the direct way of solving a linear system of equations for the same purpose. We also demonstrate the performance of our algorithm through experimental examples when applied to implicitization, surface intersection, singularity computation as well as inversion formula computation.



[P000051]

Tool path planning method with effective preservation of sharp features

* 马鸿宇 (中国科学院大学)

High-end subtractive fabrication machining technology with high efficiency and high surface quality occupies a growing proportion in complex workpiece manufacturing. The whole frame includes computer aided design (CAD), computer aided manufacturing (CAM) and computer numerical control (CNC) processes. Among them, tool path generation is a fundamental element, as it bridges the geometry designed in CAD and the machining process controlled in CAM. Therefore, the quality of the tool path intrinsically influences the machining accuracy and efficiency of the machined surface. The construction of a tool path in free form surface machining can be based on plenty of quality objectives, such as less machining error and shorter path length, which would directly impact the performance and costs in the entire product lifecycle from design to recycling. However, the current tool path planning processes omit the global geometric construction, and these methods would lose some essential geometric information (such as sharp features) during machining. Therefore, we implement a global tool path planning method with effective preservation of sharp features, which consists of optimal surface segmentation for CNC and tool path planning using Connected Fermat Spirals (CFS). We take G-nurbs spline surface as input, and give a fast and robust optimal surface segmentation method by establishing a weighted graph and searching the minimum spanning tree of the graph for extraordinary points. The method is easy to implement and can control the number of segmented patches while preserving the sharp features of the workpiece. Then, we build the connected weighted graph between each surface patch, obtain its corresponding minimum spanning tree, and construct the global CFS tool path that parallel to sharp features. The entire path contains only one start point and one end point, which means that we do not need to frequently lift and switch the cutter, thus improving the machining efficiency.



[P000063]

基于向量场的全局刀路规划方法

* 张朝前 (数学与系统科学研究院)

基于向量场的路径规划方法指通过待加工曲面的几何信息计算出局部的最优加工方向，在曲面上形成向量场，再通过向量场指导整体的路径规划。然而，由于向量场没有连续性的保证，往往需要在生成路径前进行预先的曲面分区域，这可能在区域的连接处造成路径的不光滑。此外，对于向量场发散度较高的情况，其相邻流线不具备“平行”的特征，本身并不适用于直接作为刀具路径。为解决这两个问题，我们提出了一种基于向量场的全局刀路规划方法，省去了曲面预先划分区域的过程，并且加入对相邻路径的“平行”分布的考量，在全局生成光滑的刀路路径，同时达到长度最优。

基于向量场的刀具路径规划一般采用标量函数方法，即用一个定义在曲面参数域的标量函数的等值线表示潜在路径。为了满足加工需求，提出以下三个优化目标：等值线方向沿向量场方向（即梯度方向垂直于向量场方向），相邻等值线间残高分布均匀，全局等值线曲率和最小。对于该多目标优化问题，无法

直接求解。我们采用的优化方法是：首先转化前两个目标，将其组合为一个二次规划问题，求解该问题得到一个初值标量函数，再将原来的三个目标以合适的系数线性组合起来，采用最优梯度下降方法进行迭代优化，最终得到优化后的标量函数，然后根据残高约束计算标量函数的等值线用来生成刀具路径。

具体来说，我们使用一个双三次样条曲面来表示标量函数，将控制点作为优化变量，将曲面离散，并取均匀样本点作为局部的优化位置，首先对转化前两个目标得到的优化问题进行凸优化求解初值，再对完整的优化问题进行最优梯度下降方法求解最终结果。以此得到光滑的标量函数，再用其等值线进行路径生成。

实验结果表明，该方法生成全局光滑的路径，无需进行曲面分块，且对高散度的向量场能够自动给出贴合向量场与邻接路径“平行”之间的最优考量结果，与已有的向量场方法及等残高方法对比，达到了全局长度最优和路径光滑的效果。此外，用于线性组合优化目标的系数也具有调节路径拓扑的功能，如控制标量函数山峰与山谷个数，限制路径曲率等。

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[P000033]

基于时间样条的五轴数控的 G01 代码插补

* 吴芹 (中国科学院数学与系统科学研究院)

五轴数控机床是高精度、高速加工中的关键，在航天、航海、汽车等领域有重要应用。数控加工的路径通常由 G01 代码表示，即离散的数据点，连续性差，直接插补会导致加工质量差、加工效率低。而五轴数控中，平动轴和旋转轴耦合，导致需要在工件坐标系和机床坐标系同时考虑问题，且五轴数控要求精度较高。本算法提出时间样条拟合，即以时间为参数的样条曲线拟合 G01 代码，曲线既包含位置信息，其 1-3 阶导数又包含速度、加速度和加加速度的运动信息。本算法把路径拟合和速度规划结合为一步完成，得到一条严格满足高精度误差控制和运动约束，且尽可能利用机床的运动能力的的时间样条曲线，实现高精高速的数控加工。仿真和加工实验结果表明，时间样条拟合算法可得到光滑的拟合路径，满足误差、运动约束，达到“bang-bang”控制，即每个时刻，至少一个轴的速度、加速度、加加速度或切速度达到边界。

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[P000038]

Developable approximation by deep learning

* 曾铮 (中国科学院数学与系统科学研究院)

Developable surfaces find extensive applications in various fields such as Computer-Aided Design (CAD), computer graphics, architecture geometry, and manufacturing. In this report, we propose two novel geometry-informed neural networks, namely GINN-SP and GINN-DA, for efficient surface partition and developable approximation of an input triangular mesh. GINN-SP utilizes a graph neural network to divide a complex surface into several semi-developable surface patches, which have simple topology, few critical points, and are amenable to deep learning-based aggregation of geometric information. On the other hand, GINN-DA parameterizes the two-dimensional surface, reduces Gaussian curvature, and incorporates geometric information for better approximation. We demonstrate the superior performance of GINN-SP and GINN-DA over existing methods through extensive benchmarking examples.

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[P000057]

A lightweight model for feature points recognition of tool path based on deep learning

* 陈硕鹏 (中国科学院大学数学科学学院) 马鸿宇 (中国科学院大学数学科学学院) 申立勇 (中国科学院大学数学科学学院) 袁春明 (中国科学院数学与系统科学研究院)

Recognizing feature points in the tool path is a crucial process in Computer Numerical Control (CNC) machining. Traditional methods rely on geometric descriptors and given thresholds to identify feature points, which cannot be automated due to the need for threshold selection. Recently, a new approach was introduced that uses deep learning to recognize feature points by converting Cutter Location (CL) points into images and using Convolutional Neural Networks. However, this method requires time-consuming preprocessing and large size storage of the model. To address this issue, we propose a novel lightweight deep learning-based method that efficiently recognizes feature points with significantly shorter preprocessing time. Our method encodes CL points as matrices and stores them as text files. We have developed a neural network with an Encoder-Decoder architecture, named EDFP-Net, which takes the encoding matrices as input, extracts deeper features using the Encoder, and recognizes feature points using the Decoder. Our experiments on industrial parts demonstrate the superior efficiency of our method.

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[P000073]

基于同态加密的隐私保护主成分分析方法

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本研究利用了 CKKS 同态加密方案, 通过幂法迭代的奇异值分解 (SVD) 技术实现了两方加密数据的主成分分析 (PCA) 方法。相比于目前的算法, 在保证较小的通信开销下, 达到了更高的精度, 提高了计算效率。

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[P000042]

Functional Bootstrapping for Larger Size Plaintext with Less Memory

* 刘登发 (中国科学院数学与系统科学研究院) 李洪波 (中国科学院数学与系统科学研究院)

The bootstrapping technique introduced by Gentry plays a significant role in fully homomorphic encryption schemes where a leveled FHE scheme is converted to a true FHE scheme. It ensures homomorphic evaluation of functions of arbitrary depth without decrypting. Development of bootstrapping technique can improve the efficiency of the whole scheme. Over the past several years, a large amount of work is dedicated to this subject.

In previous schemes such as TFHE, the decryption circuit is implemented by the multiplication of some monomials and a test polynomial. Such procedure causes the information shifting between the coefficients of test polynomial. And finally extract the message we need from the constant term of test polynomial. In this methods, the degree limits the message space severely and it just allows us to handle only messages of small size. If we want to handle high precision messages, we have to improve the degree of polynomials used in TFHE shceme and the memory occupied by bootstrapping keys will become too large.

Our method can deal with such problem well by making some modification to TFHE scheme. We utilize a new group presentation of integer cyclic group instead of the one generated by monomials. Such group acts on r test polynomials result in shifting of the coefficients of r test polynomials. We have a larger space contain information and it allows us to handle larger size plaintexts. Besides, the memory which bootstrapping keys occupy remains invariant when we evaluate larger size plaintexts.

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[P000086]

基于多项式抽象的神经网络控制系统的障碍函数构造

* 黄程 (浙江理工大学) 林望 (浙江理工大学)

针对神经网络控制系统的安全性验证, 提出了基于多项式抽象的障碍函数构造方法. 首先, 采用全局扇区约束方法, 局部扇区约束方法和区域叠加约束方法等对神经网络模型进行抽象, 从而得到了相应的半代数约束; 然后, 运用计算实代数几何中的正点定理, 将障碍函数条件转变为相应的 SOS 约束条件, 再采用半正定规划方法进行求解. 最后, 通过实例对上述不同的神经网络抽象方法就神经网络控制系统的障碍函数构造能力的影响进行了分析与比较.

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[P000087]

Upper Bounds on the Node Numbers of Hidden Layers in MLPs

* NI Feng (上海理工大学)

It is one of the fundamental and challenging problems to determine the node numbers of hidden layers in neural networks. Various efforts have been made to study the relations between the approximation ability and the number of hidden nodes of some specific neural networks, such as single-hidden-layer and two-hidden-layer feedforward neural networks with specific or conditional activation functions. However, for arbitrary feedforward neural networks, there are few theoretical results on such issues. This paper gives an upper bound on the node number of each hidden layer for the most general feedforward neural networks called multilayer perceptrons (MLP), from an algebraic point of view. First, we put forward

the method of expansion linear spaces to investigate the algebraic structure and properties of the outputs of MLPs. Then it is proved that given k distinct training samples, for any MLP with k nodes in each hidden layer, if a certain optimization problem has solutions, the approximation error keeps invariant with adding nodes to hidden layers. Furthermore, it is shown that for any MLP whose activation function for the output layer is bounded on \mathbb{R} , at most k hidden nodes in each hidden layer are needed to learn k training samples.

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[P000019]

A Residual UNet Denoising Network Based on Multi-scale Feature Extraction and Attention-guided Filter

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In order to obtain high quality images, it is very important to remove noise effectively and retain image details reasonably. In this paper, we propose a residual UNet denoising network that adds the attention guided mechanism and multi-scale feature extraction blocks. We design a multi-scale feature extraction block as the input block to expand the receiving domain and extract more useful features. We also apply the attention guided mechanism to filter the edge holding operation. Besides, we use the global residual network strategy to model the residual noise instead of directly modeling clean images. Experimental results show our proposed network performs favorably against state-of-the-art models. Our proposed model can not only suppress the noise more effectively, but also improve the image sharpness and detail performance, so as to obtain better recovery effect.

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[P000011]

基于强化学习的柱形代数分解变元择序

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柱形代数分解是半代数系统求解和实量词消去的基本工具。实际求解过程中,不同变元序的选择对柱形代数分解的效率影响重大。目前已有的启发式或机器学习择序的方法基本都建立在多项式系统的支撑集是影响变元序的决定因素这一隐含假设上。本文首先通过设计同支撑集变系数的实验对这一假设进行了检验,实验表明支撑集确实是影响最佳变元序的重要因素但并非唯一因素.,针对同支撑集变系数的柱形代数分解最佳择序问题,本文设计了基于强化学习的择序方案,四变元的实验表明该方案可以突破已有方法只依赖支撑集选择最佳变元序准确率的天花板。另外,针对多达几百万可选序系统的实验表明,该方案远优于传统的启发式方法。同已有的针对较少变元的监督学习择序方案相比,该强化学习方案克服了变元增多导致序数量组合爆炸时获得高质量标记数据的困难。

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[P000089]

Maple 数学四件套及其在 STEM 教学中的应用

* 徐俊林 (Maplesoft)

介绍 Maple 数学四件套及其在 STEM 教学中的应用。

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[P000088]

一种稀疏三角分解变元序的选取策略

* 齐朝星 (北京航空航天大学) 牟晨琪 (北京航空航天大学)

基于弦图的稀疏三角分解算法相较于传统三角分解算法在处理变元稀疏的多项式系统时效率更高, 在本文中我们研究了一种选择稀疏三角分解更好变元序的策略. 我们提出了多项式组的点权关联图和图的顶点序的点权指标的概念, 并基于计算图的完美消除序的 MCS-M 算法提出了计算点权指标较低的完美消除序的 MCS-M-VW 算法. 然后我们针对大规模生物系统中出现的多项式系统进行了程序实验. 实验结果表明, 使用 MCS-M-VW 算法计算得到的点权指标较低的完美消除序作为变元序时, 稀疏三角分解算法的性能更佳.

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[P000036]

一元半正定多项式的降次有理平方和表示算法

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本文给出一个构造性算法, 将一元半正定多项式表示为一些次数递降的多项式的平方和, 当输入的多项式的系数是有理数时, 本算法所得的降次多项式的系数也是有理数. 我们还把这种方法推广到多元多项式情况, 即如果该多项式有 SOS 表示, 我们也能得到该半正定多元多项式的一个特殊的平方和分解.

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[P000080]

A modified quantum-behavior heuristic algorithm for scheduling optimization problems in container terminals

李真 (北京邮电大学) 李树荣 (北京邮电大学)

In this paper, we concern with the utilization and improvement of quantum-behavior heuristic algorithm for scheduling optimization problems. In order to solve a large-scale integral optimization problem with multiple extrema, a modified quantum-behavior genetic algorithm with strong global searching ability is developed with the following measures, including (i) a dynamic quantum rotation gate mechanism to improve the tendency of convergence, (ii) a criteria of annealing operation to improve global search ability, and (iii) a storage space and reconstruction operation for updating population. Meanwhile, a mathematical model of scheduling problem in container terminals is proposed named berth allocation, quay crane assignment and scheduling problem. At last, several experimental studies of scheduling optimization problems are taken in the experiment section, which verifies the effectiveness and the superiority of the modified algorithm.

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[P000053]

Birational quadratic maps with generalized complex rational representations

Wang Xuhui (Hohai University) * Han Yuhao (Hohai University) Ni Qian (Nanjing Tech University) Li Rui (Hohai University) Goldman Ron (Rice University)

Complex rational maps have been used to construct birational quadratic maps based on two special syzygies of degree one. Similar to complex rational curves, rational curves over generalized complex numbers have also been constructed by substituting the imaginary unit with a new independent quantity. We first establish the relation between degree one generalized complex rational Bézier curves and quadratic rational Bézier curves. Then we provide conditions to determine when a quadratic rational planar map has a generalized complex rational representation. Thus a rational quadratic planar map can be made to be birational by suitably choosing the middle Bézier control points and their corresponding weights. In contrast to the edges of complex rational maps of degree one, which are circular arcs, the edges of the planar maps can be generalized to be hyperbolic and parabolic arcs by invoking the hyperbolic and parabolic numbers.

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[P000054]

Four limit cycles in three-dimensional Lotka-Volterra competitive systems for classes 28, 30 and 31 in Zeeman's classification

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The three-dimensional Lotka-Volterra competitive systems with four limit cycles are constructed for classes 28, 30 and 31 in Zeeman's classification, together with the results from Gyllenberg, Yan and Wang (2009) for class 27, from Wang, Huang and Wu (2011) for classes 28 and 29 and Yu, Han and Xiao (2016) for class 26 which indicate that for each class among classes 26–31, there exist systems with at least four

limit cycles. This gives a partial answer to a conjecture proposed in Hofbauer and So (1994) as well as in Yu, Han and Xiao (2016).

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[P000030]

Stability Problems for D-finite Functions

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Guo Zewang (中科院数学与系统科学研究院) Lu Wei (中科院数学与系统科学研究院)

The integration problem for D-finite functions was to compute the order and the defining operator of their integrals. It was studied by Abramov and van Hoeij and the interesting case is that the integral has the same order as the integrand. The main goal of this paper is to investigate Abramov-van Hoeij's algorithm iteratively.

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[P000071]

基于图的多尺度空间特征提取与协同融合的高光谱影像分类

* 王蕊 (辽宁师范大学) 谢福鼎 (辽宁师范大学) 王耕 (辽宁师范大学)

目前,大量的工作已经证明了结合谱-空信息的高光谱图像分类可以获得令人较为满意的结果。但空间信息获取过程中边界信息模糊,如何在信息丰富的高光谱图像中获取更加全面的知识,从而更好的利用高光谱图像特性是我们要解决的问题。本文提出了一种基于图的多尺度空间特征提取与协同融合的高光谱图像分类方法。该方法利用高光谱波段信息冗余的特性,从多视图角度提取不同尺度的空间特征,并使用一种新的融合方式将不同分视图的空间信息融合。本文提出的方法利用多尺度空间信息矫正了边界信息,提取到不同尺度的谱-空特征,一定程度上降低了对充分训练样本数量的依赖。我们的方法在 Indian Pines 和 Salinas 两个数据集上进行了实验,通过实验和比较结果表明,该方法在总体精度和稳定性等方面均优于其他流行的方法。

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[P000032]

Parametric “Non-nested” Discriminants for Multiplicities of Univariate Polynomials

Hong Hoon (North Carolina State University) * Yang Jing (Guangxi Minzu University)

We consider the problem of complex root classification, i.e., finding the conditions on the coefficients of a univariate polynomial for all possible multiplicity structures on its complex roots. It is well known

that such conditions can be written as conjunctions of several polynomial equations and one inequation in the coefficients. Those polynomials in the coefficients are called discriminants for multiplicities. It is also known that discriminants can be obtained by using repeated parametric gcd' s. The resulting discriminants are usually nested determinants, that is, determinants of matrices whose entries are determinants, and so on. In this paper, we give a new type of discriminants which are not based on repeated gcd' s. The new discriminants are simpler in the sense that they are non-nested determinants and have smaller maximum degrees.

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[P000012]

A Field-Theoretic Approach to Unlabeled Sensing

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We study the recent problem of unlabeled sensing from the information sciences in a field-theoretic framework. Our main result asserts that, for sufficiently generic data, the unique solution can be obtained by solving $n + 1$ polynomial equations in n unknowns.

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[P000075]

Subresultant of Bernstein polynomials and Its Applications

* 谭美 (广西民族大学) 杨静 (广西民族大学)

In this paper, we propose a new approach to formulating the subresultant polynomials for two Bernstein polynomials and develop two explicit formulas for them, i.e., one in the determinant form and the other in the determinantal polynomial form. It should be pointed out that both formulas can be expanded into polynomials in the Bernstein form, and the resulting subresultant polynomials are exactly the same as those for the polynomials obtained by expanding the given Bernstein polynomials into their standard power-basis forms. In addition, two applications are provided to show the effectiveness of the newly developed subresultant formulas, i.e., computing the greatest common divisor of parametric Bernstein polynomials and solving the real root classification problem for Bernstein polynomials in the unit interval.

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[P000009]

Computing sparse Fourier sum of squares on finite abelian groups in quasi-linear time

* 杨剑霆 (中国科学院数学与系统科学研究院) 叶科 (中国科学院数学与系统科学研究院) 支丽红 (中国科学院数学与系统科学研究院)

The problem of verifying the nonnegativity of a real valued function on a finite set is a long-standing challenging problem, which has received extensive attention from both mathematicians and computer scientists. Given a finite set X together with a function $F : X \rightarrow \mathbb{R}$, if we equip X a group structure G via a bijection $\varphi : G \rightarrow X$, then effectively verifying the nonnegativity of F on X is equivalent to computing a sparse Fourier sum of squares (FSOS) certificate of $f = F \circ \varphi$ on G . In this talk, we show that by performing the fast (inverse) Fourier transform, we are able to compute a sparse FSOS certificate of f on G with complexity $O(|G| \log |G| + |G|t^4 + \text{poly}(t))$, which is quasi-linear in the order of G and polynomial in the FSOS sparsity t of f . We demonstrate the efficiency of the proposed algorithm by numerical experiments on various abelian groups of order up to 10^6 .

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[P000023]

A class of reduced framework for large scale sparse optimization

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Sparse optimization is a series of basic problems in the field of optimization and has important applications in science and engineering. The efficient algorithms for solving sparse optimization has always been an important topic and research direction in the field of numerical optimization. This paper introduces a class of reduction methods for solving large-scale sparse optimization. By using the sparsity of gradient, the framework filters out most of the variables that do not need to be updated. Specially, the original large-scale problem is decomposed into a series of small-scale subproblems, which greatly reduces the calculation of the matrix vector multiplication in the iterative process of the subproblems. Meanwhile, through the reduced framework, we can obtain the subproblems with a better number of conditions, which greatly improves the stability and efficiency of the algorithm. Based on this framework, our algorithm can efficiently solve sparse signal compression sensing problems with tens of millions of variables and samples.

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[P000027]

Distance between non-equidimensional positive semidefinite matrices via the fibre bundle structure

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Positive semidefinite matrices are important structure matrices in many applications. For example,

the covariance matrix of a random variable is positive semidefinite [2, 5]; a density matrix of a quantum system is positive semidefinite [3, 10]; a quadratic Mahalanobis distance metric can be represented by a positive semidefinite matrix as well [11]. Since $n \times n$ positive semidefinite matrices of fixed rank consist a submanifold of $\mathbb{R}^{n \times n}$, it is natural to measure the difference between two such matrices by the geodesic distance on this submanifold [4, 9]. In practice, however, it is inevitable to measure the difference between two non-equidimensional positive semidefinite matrices[1]. Unfortunately, as far as we are aware, there is no existing method to deal with the situation. In this paper, we propose one such method, based on the fibre bundle structure of fixed rank positive semidefinite matrices.

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