

ISSN 2095-9486 (网络) | ISSN 1674-7267 (印刷)

SCIENTIA SINICA Informationis

# 中国科学：信息科学

第53卷 第2期 2023年2月

■ www.scichina.com ■ infocn.scichina.com



中国科学院  
国家自然科学基金委员会 主办

《中国科学》杂志社 出版



23010945

**中国科学:信息科学**  
**SCIENTIA SINICA Informationis**  
(ZHONGGUO KEXUE XINXI KEXUE)

第 53 卷 第 2 期 2023 年 2 月

目 次

**评述**

- 图计算在 ATPG 中的应用探究 ..... 211

毛伏兵, 彭达, 张宇, 廖小飞, 姜新宇, 杨贊, 金海, 赵进, 刘海坤, 王柳峰

**论文**

- 基于学习连续时间事件序列的动态网络链路预测 ..... 234

韩忠明, 王宇航, 陈福宇, 杨伟杰, 毛雅俊

- 基于单细胞数据的癌症协同驱动模块识别方法 ..... 250

陈希, 王峻, 余国先, 崔立真, 郭茂祖

- 国密 SM2 加密算法的 RCCA 安全设计 ..... 266

陈荣茂, 王毅, 黄欣沂

- 三维时频变换视角的智能微观三维形貌重建方法 ..... 282

闫涛, 钱宇华, 李飞江, 闫泓任, 王婕婷, 梁吉业, 郑珂银, 吴鹏, 陈路, 胡治国, 乔志伟,  
张江峰, 翟小鹏

- 基于雾扰动的图像分类对抗性攻击方法 ..... 309

高瑞均, 郭青, 余洪凯, 冯伟

- 网络攻击下产品与供应链协同演进系统数据驱动变更控制设计 ..... 325

李庆奎, 高雪峰, 彭晨, 张蕴隆, 易军凯

- 6G 无线内生安全理念与构想 ..... 344

金梁, 楼洋明, 孙小丽, 钟州, 许晓明, 易鸣, 黄开枝, 季新生, 邬江兴

- 下行 NOMA-HetNet 中联合干扰对齐与功率分配的干扰管理方案 ..... 365

景小荣, 陈怡西, 高维, 陈前斌

- 基于星间协作的低轨卫星物联网鲁棒预编码设计 ..... 387

褚建杭, 陈晓明

- 基于低管秩张量分解的互质阵列自适应波束成形算法 ..... 402

程耘, 刘天鹏, 师俊朋, 苏晓龙, 刘振

# Volume 53 Number 2 February 2023

## Contents

### REVIEW

- Research on the application of graph processing in ATPG ..... 211  
Fubing MAO, Da PENG, Yu ZHANG, Xiaofei LIAO, Xinyu JIANG, Yun YANG, Hai JIN,  
Jin ZHAO, Haikun LIU & Liuzheng WANG

### RESEARCH PAPER

- Dynamic network link prediction based on learning continuous time events ..... 234  
Zhongming HAN, Yuhang WANG, Fuyu CHEN, Weijie YANG & Yajun MAO
- Cooperative driver module identification based on single cell data ..... 250  
Xi CHEN, Jun WANG, Guoxian YU, Lizhen CUI & Maozu GUO
- RCCA-secure public-key encryption based on SM2 ..... 266  
Rongmao CHEN, Yi WANG & Xinyi HUANG
- Intelligent microscopic 3D shape reconstruction method based on 3D time-frequency transformation ..... 282  
Tao YAN, Yuhua QIAN, Feijiang LI, Hongren YAN, Jieting WANG, Jiye LIANG, Keyin ZHENG,  
Peng WU, Lu CHEN, Zhiguo HU, Zhiwei QIAO, Jiangfeng ZHANG & Xiaopeng ZHAI
- Adversarial attack method against image classification based on haze perturbation ..... 309  
Ruijun GAO, Qing GUO, Hongkai YU & Wei FENG
- Data-driven change control design for product and supply chain synchronous evolution systems under  
cyber-attacks ..... 325  
Qingkui LI, Xuefeng GAO, Chen PENG, Yunlong ZHANG & Junkai YI
- Concept and vision of 6G wireless endogenous safety and security ..... 344  
Liang JIN, Yangming LOU, Xiaoli SUN, Zhou ZHONG, Xiaoming XU, Ming YI, Kaizhi HUANG,  
Xinsheng JI & Jiangxing WU
- Joint interference alignment and power allocation interference management scheme for downlink  
NOMA-HetNet ..... 365  
Xiaorong JING, Yixi CHEN, Wei GAO & Qianbin CHEN
- Robust precoding design for inter-satellite cooperation-based low-earth orbit satellite Internet of  
Things ..... 387  
Jianhang CHU & Xiaoming CHEN
- Coprime array-adaptive beamforming based on low-tubal-rank tensor decomposition ..... 402  
Yun CHENG, Tianpeng LIU, Junpeng SHI, Xiaolong SU & Zhen LIU



CN : 11-5846/TP

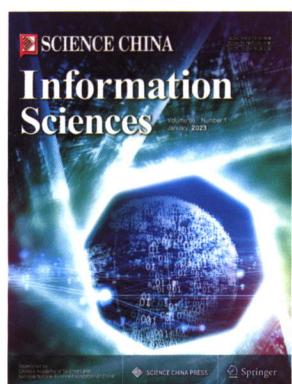
- 主管单位:中国科学院
- 主办单位:中国科学院,国家自然科学基金委员会
- 收录语种:中文
- 主编:梅宏

## 中国科学: 信息科学 (月刊) SCIENTIA SINICA Informationis

**简介:** 力求刊载信息科学领域最高学术水平的中文文章, 及时报道计算机科学与技术、控制科学与控制工程、通信与信息系统、微电子与固体电子学等领域基础与应用研究方面的原创性成果. 推动信息科学技术发展, 搭建理论与技术应用的桥梁, 促进与各学科、各行业的交叉融合. 月刊, 每月20日出版. 中、英文版是相对独立的两个刊物.

**栏目:** 评述、论文、观点与争鸣、快报、学术介绍等

**检索:** 被《中文核心期刊要目总览》、《中国科学引文数据库》、《中国期刊全文数据库》、《中国科技论文与引文数据库》、《中国数字化期刊群》、SCOPUS等收录.



CN : 11-5847/TP

- Supervised by: CAS
- Sponsored by: CAS, NSFC
- Language: English
- Editor-in-Chief: MEI Hong

## SCIENCE CHINA Information Sciences (Monthly)

**SCIENCE CHINA Information Sciences** (Sci China Inf Sci), cosponsored by the Chinese Academy of Sciences and the National Natural Science Foundation of China, and published by Science China Press, is committed to publishing high-quality, original results of both basic and applied research in all areas of information sciences, including computer science and technology; control science and engineering; information and communication engineering; microelectronics and solid state electronics, etc. Sci China Inf Sci is published monthly in both print and electronic forms.

Papers published in Sci China Inf Sci include: Review, Research Paper, Perspective, MOOP, Letter, etc.

It is indexed by Science Citation Index Expanded (SCIE), Engineering Index (EI), Journal Citation Reports/Science Edition (JCR), Academic OneFile, Astrophysics Data System (ADS), CSA, Cabells, Current Contents/Engineering, Computing and Technology, DBLP, Digital Mathematics Registry, Earthquake Engineering Abstracts, Engineered Materials Abstracts, Gale, Google, INSPEC, Mathematical Reviews, OCLC, ProQuest, SCOPUS, Summon by Serial Solutions, VINITI.



万方数据

《中国科学: 信息科学》编辑部  
地址: 北京东黄城根北街16号 (100717)  
电话: 010-64015683 传真: 010-64016350  
E-mail: informatics@scichina.org



《中国科学》杂志社  
SCIENCE CHINA PRESS

ISSN 1674-7267



9 771674 726237