

Profiling China's AI Developers:

# NUDT and Chinese Military Education In Artificial Intelligence

## Summary

What kinds of artificial-intelligence-enabled weapons or systems are the Chinese currently developing? The answers are not yet clear. A look at the work underway at the People's Liberation Army (PLA) Artificial Intelligence Research Center in Beijing showed that many of the key AI researchers there had been professors or doctoral students at the PLA's National University of Defense Technology. NUDT is the top Chinese military institution for scientific research and education. This report takes a look at the undergraduate and graduate curriculum at NUDT for potential indicators of AI-related themes in Chinese military education and, by extension, AI development goals for enhancing Chinese military power.

### National University of Defense Technology (NUDT)



Source: kknews.cc

NUDT documents show a robust AI-related curriculum that can be divided into **four categories that appear to contribute directly to military systems and operations**:

- **Intelligence analysis**, supported by courses in big data intelligence analysis and smart intelligence processing;
- **Target identification**, supported by courses in cognitive science, pattern recognition, intelligent sensing and processing, and automatic target recognition;
- **Autonomous weapons operations**, supported by courses in intelligent unmanned systems, robot technology, cluster groups and cooperative control, and intelligent vehicle driving technology; and
- **Command control**, supported by courses in command control systems optimization, optimized decision-making, and intelligent task assignment.

In sum, NUDT appears to have a significant AI development program underway and serves as a central institution in the development of PLA personnel capable of creating and functioning in a future AI-enabled combat operations system.

## Background

China is in the midst of a technological revolution that is driven in part by government policy and investment in high-tech development. One major component of this government-supported technology effort is artificial intelligence (AI), a capability that is being introduced into the service of many commercial, social, and government functions. China's State Council issued an Artificial Intelligence Development Plan in 2017 calling specifically for AI theoretical research in eight areas: advanced machine learning, big data intelligence, perceptual computing, intelligent man-machine symbiosis, collective intelligence, autonomous collaborative control and decision optimization, brain-like intelligent computing, and quantum intelligence computing.

In Chinese government guidance, AI is foreseen as impacting a full range of functions such as education, medical care, social governance, government decision-making, the courts system, transportation systems, and public safety monitoring and control systems. In addition, the AI Development Plan calls for its application to military power through AI-enabled weapons technology, command control and decision-making, and military analysis.

What new high-tech military systems, specifically, is China trying to develop with AI technology? Obviously, they are unlikely to describe these publicly while in still development. Some insight has been gained by examining publicly-posted research documentation from the PLA's new Artificial Intelligence Research Center (AIRC). Journal articles by this center's key AI researchers revealed, for example, that development of AI-enabled swarm robots such as swarm unmanned aerial vehicles is currently a central research focus for this institute.

Prior to assignment at AIRC, several of these researchers were either professors or doctoral students at NUDT, itself the central institution in the Chinese military education system for technology research and development. If the AI researchers at AIRC got their education at NUDT, a look at the full scope of AI-related education at NUDT might further illuminate the AI technologies that the Chinese military sees as keys to enhancing military power.

Insight into the NUDT program is available from open sources. Documents that outline the undergraduate majors taught at NUDT are available from the university's website. These show no academic major in AI, but do list several education programs that pertain to AI development. Documentation on NUDT graduate majors and graduate research topics, available because NUDT advertises for civilian graduate students in addition to educating military personnel, shows a great range of AI-related graduate programs. These programs could be viewed as the threads of AI development that the PLA, through NUDT, is attempting to develop. Details on both undergraduate and graduate programs are discussed below.

## Undergraduate Programs

The National University of Defense Technology (NUDT), located in Changsha, Hunan Province, is the top Chinese military institution for scientific research and education. Subordinate to the Central Military Commission, NUDT has developed a sterling international reputation based on achievements such as its development of the Tianhe series of supercomputers and China's Beidou navigation satellite system. NUDT is currently the home of major research labs in information technology including the State Key Laboratory of High Performance Computing, the National Key Laboratory for Parallel and Distributed Processing, and the National Laboratory of Science and Technology for Automatic Target Recognition.

NUDT's logo



Source: nudt.edu.cn

The NUDT undergraduate curriculum for 2020 was spelled out in the document entitled “NUDT Officer Development Undergraduate Education Majors” (生长军官本科教育专业介绍) that is posted at the university's website (nudt.edu.cn). The full set of majors named in this document is shown in the table below. Again, there is no undergraduate major called “Artificial Intelligence” taught at this school. However, there is a full range of technical majors that are applicable to AI development as indicated by how they flow into the AI-related graduate programs at this institution. Based on the titles of the undergraduate majors, those **highlighted in green** below are assessed to be applicable to graduate AI programs at this school.

NUDT Undergraduate Majors	(in Chinese)
Aircraft Design and Engineering	飞行器设计与工程
Applied Meteorology	应用气象学
Applied Statistics	应用统计学
Atmospheric Science	大气科学
<b>Big Data Engineering</b>	<b>大数据工程</b>
<b>Command Information Systems Engineering</b>	<b>指挥信息系统工程</b>
<b>Command Network Engineering</b>	<b>网电指挥与工程</b>
Communications Engineering	通信工程
<b>Computer Science and Technology</b>	<b>计算机科学与技术</b>
Cyberspace Security	网络空间安全

Earth Information Science and Technology	地球信息科学与技术
<b>Electronic Information Engineering</b>	<b>电子信息工程</b>
<b>Electronic Science and Technology</b>	<b>电子科学与技术</b>
Foreign Affairs	外交学
Foreign Languages and Literature	外国语言文学
Guided Missile Engineering	导弹工程
<b>Information Combat Technology</b>	<b>信息对抗技术</b>
<b>Information Engineering</b>	<b>信息工程</b>
Information Security	信息安全
Integrated Circuits Design and Integrated Systems	集成电路设计与集成系统
Intelligence Analysis and Imagery Interpretation	情报分析、图像判读
International Affairs and International Relations	国际事务与国际关系
<b>Internet Of Things Engineering</b>	<b>物联网工程</b>
Management Science and Engineering	管理科学与工程
Marine Technology	海洋技术
Materials Science and Engineering	材料科学与工程
Mathematics	数学
Measurement Control Technology and Instrumentation	测控技术与仪器
Mechanical Engineering	机械工程
Micro-Electronics Science and Engineering	微电子科学与工程
Military Oceanography	军事海洋学
Navigation Engineering	导航工程
<b>Network Engineering</b>	<b>网络工程</b>
Network Intelligence Analysis	网电情报分析
Nuclear Engineering and Nuclear Technology	核工程与核技术
<b>Operations Research and Task Planning</b>	<b>运筹与任务规划</b>
Opto-Electronics Information Science and Technology	光电信息科学与工程
Physics	物理学
Radar Engineering	雷达工程
<b>Simulation Engineering</b>	<b>仿真工程</b>
<b>Software Engineering</b>	<b>软件工程</b>
Space Science and Engineering	空间科学与技术
<b>Target Engineering</b>	<b>目标工程</b>
<b>Unmanned Equipment Engineering</b>	<b>无人装备工程</b>

Unmanned Systems Engineering	无人系统工程
Weapons Systems and Engineering	武器系统与工程

## Graduate Programs

The graduate curriculum is enumerated in a recruiting document entitled “NUDT 2020 Graduate Student Recruiting Catalog” which was posted at the NUDT website and could be found at many other graduate education reference websites. The catalog is organized by the various colleges (学院) at NUDT, then by graduate major (专业), and under these the courses (literally, “research directions,” 研究方向) available for each major were listed. The tables below show the colleges, majors (with major number), and courses from the catalog that appeared to have an AI association.

NUDT Students and faculty on campus



Source: 163.com

Based on the course names themselves, those **highlighted in blue** appear to be courses that directly apply to AI development. Many include the term “intelligent” (智能) in the title, a term in Chinese that could also be translated as “smart” and usually connotes a technology that is AI-enabled. Those **highlighted in green** are topics that are not themselves AI technologies but can be categorized as either supporting development of AI technologies or are enhanced by AI technologies. Courses with titles that include terms such as distributed computing, high-performance simulation, quantum control, virtual reality, systems optimization, and decision-making appear to fit into this category.

The AI-related majors and courses shown in these tables are, of course, a subset of the full graduate curriculum. For comparison, see the fuller list of technical majors and courses for NUDT graduate students in the Appendix on page 10 of this report.

NUDT College of Computers	
Computer Science and Technology (0812)	计算机科学与技术
Distributed Computing Technology	分布计算技术
Artificial Intelligence	人工智能
Digital Media and Virtual Reality Technology	数字媒体与虚拟现实技术

High-Performance Simulation	高性能仿真
Quantum Computing	量子计算
Software Engineering (0835)	软件工程
Intelligent Software Technology	智能软件技术
Parallel and Distributed Software Technology	并行与分布软件技术

NUDT College of Electronic Science	
Electronic Science and Technology (0809)	电子科学与技术
Intelligent Information Components and Circuits	智能信息器件与电路
Information and Communications Engineering (0810)	信息与通信工程
Intelligent Sensing and Processing	智能感知与处理
Automatic Target Recognition	自动目标识别
Intelligent Electronic Combat and Assessment	智能电子对抗与评估

NUDT College of Intelligent Sciences	
Control Science and Engineering (0811)	控制科学与工程
Artificial Intelligence	人工智能
Cognitive Science and Information Processing	认知科学与信息处理
Control Theory and Applications	控制理论与应用
Intelligent Unmanned Systems	智能无人系统
Intelligent Vehicle Driving Technology	车辆智能驾驶技术
Machine Learning	机器学习
Pattern Recognition	模式识别
Quantum Control	量子控制
Robot Technology	机器人技术
Task Planning Technology	任务规划技术
Mechanical Engineering (0802)	机械工程
Intelligent Equipment Precision Engineering	智能装备精密工程
Intelligent Mechanical Systems	智能机械系统
Photo-Electronic Intelligent Task Loading	光机电智能任务载荷



NUDT College of Systems Engineering	
<b>Control Science and Engineering (0811)</b>	<b>控制科学与工程</b>
Cluster Groups and Cooperative Control	集群组织与协同控制
High-Performance Simulation	高性能仿真
Intelligent Energy Systems Engineering	智慧能源系统工程
Multimedia Information Systems and Virtual Reality Technology	多媒体信息系统与虚拟现实技术
Systems Optimization and Decision-making	系统优化与决策
<b>Management Science and Engineering (0871)</b>	<b>管理科学与工程</b>
Big Data Analysis and Intelligence	大数据分析情报智能
Big Data Analysis and Social Computing	大数据分析与社会计算
Command Control and Decision-making	指挥控制与决策
Computer Intelligence and Optimized Decision-making Technology	计算智能与优化决策技术
Information Management and Intelligent Decision-making Technology	信息管理与智能决策技术
Intelligent Human Resources Planning	智慧人力资源规划
Intelligent Planning Systems Technology	智能规划系统技术
Intelligent Task Planning and Assignment	智能任务规划与调度
Systems Optimization and Meta-Synthesis Technology	系统优化与综合集成技术
<b>Military Command Studies (1105)</b>	<b>军队指挥学</b>
Command Control and Intelligent Decision-making	指控控制与智能决策
Command Control Systems Optimization	指挥控制系统优化
Intelligent Information Processing	智能情报处理

## Comments

What does the NUDT curriculum for undergraduate and graduate education tell us about Chinese military goals for the use of artificial intelligence? It should be remembered that the nature and purpose of this institution—military officer and military systems development—make clear that each topic outlined above is one with importance to Chinese military power. None of these classes are offered merely to stimulate the interest of the student or give him training for life after military service.

The focus on NUDT academic training and research is the development of intelligent personnel capable of creating and operating modern military systems.

The most obvious feature of the catalog contents shown above is that NUDT has a very robust, broad, and technologically-oriented set of AI-related courses. Of the 109 courses offered by the four NUDT colleges profiled here, 41 appeared to be about AI-related technologies. NUDT's College of Intelligent Sciences dominates in terms of the number of AI-related courses offered. As a major, Control Science and Engineering has the deepest AI-related program, with a total of 15 AI courses available. This major is available from either the College of Intelligent Sciences or the College of Systems Engineering, with different AI-related courses covered separately by these two colleges.

It should be noted that the range of intelligent systems topics covers many **military applications other than weapons systems or combat operations**. Some of the graduate offerings cover artificial intelligence and machine learning and are apparently directed at general development of AI technologies, applicable across the spectrum of military missions and systems. Others focus on aspects of virtual reality, simulation, and quantum computing that are likewise applicable to general AI development. Some focus on AI aspects of hardware and software. There are even specific programs for AI implementation in human resources planning and energy systems engineering.

However, many of the remaining graduate topics available can be divided into **four categories that appear to contribute directly to military systems and operations**. These tasks are:

- **Intelligence Analysis:** The courses Big Data Analysis and Intelligence and Smart Intelligence Processing appear targeted on AI support to the intelligence analysis mission.
- **Target Identification:** The AI-enabled acquisition and identification of targets would be supported by the classes Cognitive Science and Information Processing, Pattern Recognition, Intelligent Sensing and Processing, and Automatic Target Recognition.
- **Autonomous weapons operations:** Development of AI weapons themselves would be supported by courses such as Intelligent Unmanned Systems, Robot Technology, Cluster Groups and Cooperative Control, and Intelligent Vehicle Driving Technology.
- **Command Control:** The implementation of AI support to command operations would be fostered by courses including Command Control Systems Optimization, Optimized Decision-making, and Intelligent Planning and Task Assignment.



In summary, the NUDT curriculum suggests that the PLA is investing significant human capital and research resources to develop AI technologies for all four of these military functions. The goal is more than autonomous weapons systems; it is the development of a full combat operational system that is enhanced by AI technology. More to the point, NUDT appears to be a central institution in the development of PLA personnel capable of creating and functioning in a combat operations system that employs AI technology to advance Chinese military power.

## Appendix: NUDT 2020 Graduate Student Recruiting Catalog

The tables below show NUDT colleges, graduate majors, and all research areas for each college as they appeared in the catalog. As above, those **highlighted in blue** appear to be courses that directly apply to AI development. Those **highlighted in green** are courses that either support development of AI technologies or are enhanced by AI technologies. There are several other colleges at NUDT: Arts and Sciences, Advanced Interdisciplinary Sciences, Aerospace Science, International Relations, Information and Communications, Electronic Combat, Atmospheric and Hydrology, and Basic Military Education. Some of these have technical majors, but these did not appear to include courses that were AI-related.

NUDT College of Computers	
<b>Cyberspace Security (0839)</b>	<b>网络空间安全</b>
Basic Theory For Cyberspace Security	网络空间安全基础理论
System Security	系统安全
Network Technology and Network Security	网络技术与网络安全
Cryptography and Its Applications	密码学及其应用
Content Security and Application Security	内容安全与应用安全
<b>Computer Science and Technology (0812)</b>	<b>计算机科学与技术</b>
Computer Science Theory	计算机科学理论
Computer Architecture	计算机体系结构
Microprocessor Architecture	微处理器体系结构
Computer Networks and Communications	计算机网络与通信
System Software	系统软件
<b>Distributed Computing Technology</b>	<b>分布计算技术</b>
<b>Artificial Intelligence</b>	<b>人工智能</b>
Large-Scale Science and Engineering Computing	大规模科学与工程计算
<b>Digital Media and Virtual Reality Technology</b>	<b>数字媒体与虚拟现实技术</b>
<b>High-Performance Simulation</b>	<b>高性能仿真</b>
Information Security Technology	信息安全技术
<b>Quantum Computing</b>	<b>量子计算</b>
Ocean Hydrology and Atmospheric Numeric Modeling	海洋水文气象数值模拟
Marine Information Engineering	海洋信息工程

<b>Electronic Science and Technology (0809)</b>	<b>电子科学与技术</b>
Microprocessor Technology	微处理器技术
On-Chip Systems and Embedded Applications	片上系统与嵌入式应用
Super-Large-Scale Integrated Circuit Cad and Physical Production Technolog	超大规模集成电路 cad 与物理实现技术
Micro- and Nano- Electronic Components and Circuits	微纳电子器件与电路
<b>Software Engineering (0835)</b>	<b>软件工程</b>
Software Engineering Theory and Methodlogy	软件工程理论与方法学
<b>Intelligent Software Technology</b>	<b>智能软件技术</b>
<b>Parallel and Distributed Software Technology</b>	<b>并行与分布软件技术</b>
System Software and Software Engineering	系统软件软件工程
Equipment Software Technology	装备软件技术
High-Reliability Software Technology	高可信软件技术
Embedded Software Engineering	嵌入式软件工程
Software Engineering For Scientific Computing	科学计算领域软件工程
Software Project Management	软件项目管理

<b>NUDT College of Electronic Science</b>	
<b>Cyberspace Security (0839)</b>	<b>网络空间安全</b>
Cyberspace Control and Use	网络空间控制与利用
Cyberspace Security Modeling, Simulation and Assessment	网络空间安全建模仿真与评估
<b>Electronic Science and Technology (0809)</b>	<b>电子科学与技术</b>
<b>Intelligent Information Components and Circuits</b>	<b>智能信息器件与电路</b>
Radio Frequency Microwave Technology	射频微波技术
Integrated Design Of Electrical Systems	电子系统集成设计
<b>Information and Communications Engineering (0810)</b>	<b>信息与通信工程</b>
Navigation and Space-Time Technology	导航与时空技术
<b>Intelligent Sensing and Processing</b>	<b>智能感知与处理</b>
<b>Automatic Target Recognition</b>	<b>自动目标识别</b>
<b>Intelligent Electronic Combat and Assessment</b>	<b>智能电子对抗与评估</b>
Communications and Information Processing	通信与信息处理

NUDT College of Intelligent Sciences	
<b>Control Science and Engineering (0811)</b>	<b>控制科学与工程</b>
<b>Artificial Intelligence</b>	<b>人工智能</b>
Automated Monitoring and Troubleshooting	自动检测与故障诊断
<b>Cognitive Science and Information Processing</b>	<b>认知科学与信息处理</b>
<b>Control Theory and Applications</b>	<b>控制理论与应用</b>
Electromagnetic Suspensions and Emissions Technology	电磁悬浮与发射技术
<b>Intelligent Unmanned Systems</b>	<b>智能无人系统</b>
<b>Intelligent Vehicle Driving Technology</b>	<b>车辆智能驾驶技术</b>
<b>Machine Learning</b>	<b>机器学习</b>
Navigation Technology	导航技术
<b>Pattern Recognition</b>	<b>模式识别</b>
Precision Guidance and Control	精确制导与控制
<b>Quantum Control</b>	<b>量子控制</b>
<b>Robot Technology</b>	<b>机器人技术</b>
Systems Simulation	系统仿真
<b>Task Planning Technology</b>	<b>任务规划技术</b>
<b>Instrument Science and Technology (0804)</b>	<b>仪器科学与技术</b>
Equipment Testing and Military Measurement	装备测试与军事计量
Network Space Monitoring and Control	网电空间测控
Sensing and Detection	传感与探测
Space Apparatus Engineering	空间仪器工程
<b>Mechanical Engineering (0802)</b>	<b>机械工程</b>
Equipment Integration Safeguards	装备综合保障
<b>Intelligent Equipment Precision Engineering</b>	<b>智能装备精密工程</b>
<b>Intelligent Mechanical Systems</b>	<b>智能机械系统</b>
Micro- and Nano- Electro-Mechanical Systems	微纳机电系统
<b>Photo-Electronic Intelligent Task Loading</b>	<b>光机电智能任务载荷</b>
Reliability Testing and Assessment	可靠性试验与评估
Status Monitoring and Troubleshooting	状态监控与故障诊断
Vibration and Noise Control	振动与噪声控制

NUDT College of Systems Engineering	
<b>Control Science and Engineering (0811)</b>	<b>控制科学与工程</b>
Cluster Groups and Cooperative Control	集群组织与协同控制
High-Performance Simulation	高性能仿真
Information Fusion and Situational Awareness	信息融合与态势认知
Information Systems Engineering	信息系统工程
Intelligent Energy Systems Engineering	智慧能源系统工程
Mathematical Modeling and Data Analysis	数学建模与数据分析
Multimedia Information Systems and Virtual Reality Technology	多媒体信息系统与虚拟现实技术
Network Information Systems and Complexity Science	网络信息体系与复杂性科学
Systems Optimization and Decision-making	系统优化与决策
System Simulation	系统仿真
Systems Verification and Simulation Assessment	系统论证与仿真评估
<b>Management Science and Engineering (0871)</b>	<b>管理科学与工程</b>
Big Data Analysis and Intelligence	大数据分析情报智能
Big Data Analysis and Social Computing	大数据分析社会计算
Command Control and Decisionmaking	指挥控制与决策
Complex Systems and Complex Networks	复杂系统与复杂网络
Complex Information Systems Analysis and Design	复杂信息系统分析与设计
Computer Intelligence and Optimized Decision-making Technology	计算智能与优化决策技术
Equipment Reliability and Integrated Safeguards	装备可靠性与综合保障
Information Management and Intelligent Decision-making Technology	信息管理与智能决策技术
Intelligence and Security Informatics	情报与安全信息学
Intelligent Human Resources Planning	智慧人力资源规划
Intelligent Planning Systems Technology	智能规划系统技术
Intelligent Task Planning and Assignment	智能任务规划与调度
Knowledge Management and Knowledge Engineering	知识管理与知识工程
Military Cyber-Physical Systems Technology	军事信息物理系统技术
National Defense Purchasing and Systems Engineering Management	国防采办与体系工程管理
National Security and Risk Management	国家安全与危机管理

Project Management and Engineering Management	项目管理与工程管理
Social Systems and Group Behavior Computational Analysis	社会系统与组织行为计算分析
Systems Engineering and Systems Simulation	体系工程与体系仿真
<b>Systems Optimization and Meta-Synthesis Technology</b>	<b>系统优化与综合集成技术</b>
Systems Structural Development and Application	体系结构开发与应用
Systems Testing and Assessment	系统试验与评估
<b>Military Command Studies (1105)</b>	<b>军队指挥学</b>
Combat Data Analysis	作战数据分析
<b>Command Control and Intelligent Decision-making</b>	<b>指控控制与智能决策</b>
<b>Command Control Systems Optimization</b>	<b>指挥控制系统优化</b>
Command Control Theory and Methodology	指挥控制理论与方法
Command Information Systems	指挥信息系统
Complex Information Systems Analysis and Design	复杂信息系统分析与设计
<b>Intelligent Information Processing</b>	<b>智能情报处理</b>
Military Operations Theory and Applications	军事运筹理论与应用
Systems Structure Development and Application	体系结构开发与应用