南京航空航天大学

论文集

（二〇〇七年） 第16册

自动化学院

（第5分册）

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自动化学院

033～035 系

序号	作者姓名	职称	单位	论文题目	刊物名称	年卷期
1	张 砦 王友仁	中级 正高	033 033	DNA-based adaptive immune genetic algorithm in intelligence exam-paper generation	DYNAMICS OF CONTINUOUS DISCRETIE AND IMPULSIVE SYSTEMS	2007,14
2	王友仁 张志强 崔 江	正高 硕士 讲师	033 033 033	The Architecture and Circuital Implementation Scheme of a New Cell Neural Network for Analog Signal Processing	Journal of Universal Computer Science	2007，13(9)
3	高桂军 王友仁 姚 睿	硕士 正高 讲师	033 033 033	系统异构冗余容错设计研究	传感器与微系统	2007，26(10)
4	韩晓静 王友仁 崔 江	硕士 正高 讲师	033 033 033	一种模拟电路测试节点优化选择的新方法	仪器仪表学报	2007，28(8)
5	张耀镭 王友仁	硕士 正高	033 033 033	复杂数字电路多级在线进化技术研究	小型微型计算机系统	2007，28(11)
6	张耀镭 王友仁	硕士 正高	033 033 033	快速实现数字仿生电路设计的自适应遗传算法	计算机测量与控制	2007，15(10)
7	计清建 王友仁 谢 敏 崔 江	硕士 正高 硕士 讲师	033 033 033	Research on Fault-Tolerance of Analog Circuits Based on Evolvable Hardware	Proceedings of ICES' 2007	2007，1
8	高桂军 王友仁 姚 睿 崔 江	硕士 正高 讲师 讲师	033 033 033 033	Research on Multi-objective On-line Evolution Technology of Digital Circuit Based on FPGA Model	Proceedings of ICES' 2007	2007，1
9	张 媛 王友仁 杨姗姗	硕士 正高 硕士	033 033 033	Design of a Cell in Embryonic Systems with Improved Efficiency and Fault-tolerance	Proceedings of ICES' 2007	2007，1
10	谢 敏 王友仁 王 莉 张 媛	硕士 正高 硕士 硕士	033 033 033 033	Design on Operator-based Reconfigurable Hardware Architecture and Cell Circuit	Proceedings of ICES' 2007	2007，1
11	王 莉 王友仁 陈则王 姚 瑞	硕士 正高 副高 讲师	033 033 033 033	Reconfigurable Hardware Implement- ation of the Improved Triple DES Based on Genetic Algorithm	Dynamics of Continuous, Discrete & Impulsive Systems	2007，14 (S3)
12	邓晓茜 王友仁 崔 江	硕士 正高 讲师	033 033 033	Intelligent Fault Diagnosis of Digital Circuit Based on SVMs	Dynamics of Continuous, Discrete & Impulsive Systems	2007，14 (S3)
13	刘 权 王友仁 崔 江 姚 瑞	硕士 正高 讲师 讲师	033 033 033 033	Hierarchical Fault Diagnosis of Power Electronic Devices Based on Fuzzy Clustering and Artificial Neural Network	Dynamics of Continuous, Discrete & Impulsive Systems	2007，14 (S3)
14	蔡 鑫 赵 敏 李 然 邓军军	硕士 正高 硕士 硕士	033 033 033	基于热释电红外传感器的火灾探测系统设计	红外技术	2007，29（12）
15	徐 军 赵 敏	硕士 正高	033 033	一种基于ARM的航空发动机振动测量仪的设计	仪器仪表用户	2007，14（1）

16	雷红路 赵　敏	硕士 正高	033 033	基于ARM&uC/OS的振动测量系统设计	仪器仪表用户	2007，14（1）
17	刘文波	正高	033	2*2-scroll attractors generated in a three-dimensional smooth autonomous system	International journal of bifurction and chaos	2007,17(11)
18	孔德明 王友仁	中级 正高	033 033	一种改进LMSTDE算法的硬件设计与实现	计算机测量与控制	2007，15（6）
19	姚恩涛 张　君 倪国芬 季　娟	正高 硕士 硕士 硕士	033 033 033 033	基于图像特征分类和RBF网络的两轴车辆动态称重技术	南京航空航天大学学报	2007，39（1）
20	姚恩涛 张　君 季　娟	正高 硕士 硕士	033 033 033	基于EMD-RBF网络的车辆动态称重信号处理方法	传感器与微系统	2007，26（1）
21	张　君 姚恩涛 倪国芬 季　娟	硕士 正高 硕士 硕士	033 033 033 033	图像分类结合经验模分解和径向基函数网络在车辆动态称重中的应用	机械科学与技术	2007，26（6）
22	徐　君 姚恩涛	硕士 正高	033 033	InSb磁敏电阻脉冲涡流传感器的设计	仪器仪表学报	2007，28（5）
23	孔　燕 姚恩涛 陈　虢	硕士 正高 中级	033 033 033	CSY系列传感器实验系统的动态实验开发	实验室研究与探索	2007，26（1）
24	吴琼琴 石　玉	硕士 中级	033 033	Analog circuit evolution based on FPTA-2	International conference on evolvable systems:from biology to hardware(ICES'07)	2007.1
25	颜　彦	中级	033	传感器网络分布式能量平衡路由	东南大学学报（自然科学版）	2007，37（6）
26	崔　江 王友仁 刘　权	中级 正高 硕士	033 033 033	基于高阶谱与支出向量机的电力电子电路故障诊断技术	中国电机工程学报	2007，17（10）
27	姚　敏 赵　敏	中级 正高	033 033	小卫星多级故障诊断系统设计	中国空间科学技术	2007，27（2）
28	姚　敏 赵　敏	中级 正高	033 033	基于模糊神经网络的小卫星任务自主调度设计	宇航学报	2007，28（2）
29	姚　敏 赵　敏	中级 正高	033 033	基于Matlab和VC++的神经网络仿真实验设计	电气电子学报	2007，29（3）
30	倪立学 徐贵力	硕士 副高	032 032	一种地面合作目标的研究与设计	光电工程	2007，34（7）
31	稽盛育 徐贵力	硕士 副高	032 032	基于红外视觉的无人机自主着舰合作目标的研究	红外技术	2007，29（10）
32	谷　鋆 徐贵力	硕士 副高	033 033	FPGA动态可重构理论及其研究进展	计算机测量与控制	2007，15（11）
33	丁万山 刘　艳	副高 硕士	033 033	水中物体的光学三维形貌测量的研究	光学学报	2007，27（1）
34	丁万山 刘　艳	副高 硕士	033 033	光学傅立叶变换轮廓术的新型改进方法	南京航空航天大学学报	2007，39（2）
35	丁万山 宋红兵	副高 硕士	033 033	基于激光诊断技术的脉冲爆震发动机多参数自动测试系统	传感技术学报	2007，20（9）

36	钱　刚 丁万山	硕士 正高	033 033	基于ARM及CPLD的纸币图像采集系统的设计	计算机测量与控制	2007，15（5）
37	焦杏艳 丁万山	硕士 副高	033 033	基于自适应遗传算法的纸币识别预处理	计算技术与自动化	2007，26（3）
38	贾银亮 张焕春 经亚枝	中级 正高 副高	033 033 033	6步直线生成算法	山东大学学报（工学版）	2007，37（1）
39	陈涛涛 田裕鹏	硕士 副高	033 033	一种非刚体目标的实时检测与跟踪算法	电子科技大学学报	2007，36（1）
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41	赵莹莹 田裕鹏	硕士 副高	033 033	脉冲光热辐射成像测量中缺陷大小的定量分析研究	无损检测	2007，29（11）
42	白茂生 田裕鹏	硕士 副高	033 033	基于UMHexagonS的快速帧间模式选择算法	计算机应用	2007，27（09）
43	江光灵 田裕鹏	硕士 副高	033 033	用于水微电导测量的锁相放大器的设计	计算机测量与控制	2007，15（6）
44	余德兰 田裕鹏	硕士 副高	033 033	基于VRML和ActiveX控件的传感器网络虚拟实验研究	现代电子技术	2007，（2）
45	王海涛 万　敏	副高 硕士	033 033	电子散斑干涉技术的发展及其无损检测方面的应用	南昌航空大学学报	2007，21
46	万　敏 王海涛	硕士 副高	033 033	电子散斑干涉技术在蒙皮蜂窝结构材料的无损检测应用研究	南昌航空大学学报	2007，21
47	方国军 王海涛 罗秋凤	硕士 副高 副高	033 033 035	某小型无人机的串行通信程序的设计	计算机测量与控制	2007，14（12）
48	黄文杰 王海涛 姬建刚	硕士 副高 硕士	033 033 033	一种改进的车牌区域定位算法	交通与计算机	2007，25（3）
49	乔文军 万晓冬	硕士 副高	033 033	嵌入式软件覆盖测试工具的研究	计算机测量与控制	2007，15（9）
50	陈跃武 万晓冬	硕士 副高	033 033	LDAP在仿真资源数据网格中的应用研究	计算机仿真	2007，24（10）
51	万晓冬 杨　燕	副高 硕士	033 033	数据挖掘中聚类算法研究及仿真应用	2007全国仿真技术学术会议论文集	
52	姚　睿 于盛林 王友仁	中级 正高 正高	033 033 033	采用主流FPGA的数字电路在线生长进化方法	南京航空航天大学学报（自然科学版）	2007，26（5）
53	姚　睿 于盛林 王友仁	中级 正高 正高	033 033 033	基于进化硬件的自修复TMR系统设计及其可靠性分析	传感器与微系统	2007，26（8）
54	姚　睿 于盛林 王友仁	中级 正高 正高	033 033 033	Research on the Online Evaluation Approach for the Digital Evolvable Hardware	Proceedings of ICES，2007	2007
55	姚　睿 于盛林 王友仁	中级 正高 正高	033 033 033	A Monkey-King Marrying Immune Genetic Algorithm and Its Applications	Dynamics of Continuous, Discrete & Impulsive Systems	2007,14 (S3)
56	董海艳 王惠南 李　虹	博士 正高 博士	034 034 034	基于血管内超声图像序列的相角配准与边缘检测	中国图像图形学报	2007，12（6）
57	董海艳 王惠南 李　虹	博士 正高 博士	034 034 034	基于血管内超声图像序列的自动边缘检测	南京航空航天大学学报	2007，39（4）

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60	刘新文 王惠南 钱志余 杨天明	博士 正高 正高 正高	034 034 034 外	基于小波变换和非线性能量算子的神经元放电检测	生物医学工程学杂志	2007，24（5）
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62	戴丽娟 王惠南 钱志余	博士 正高 正高	034 034 034	生物组织中光场分布的有限元分析	南京航空航天大学学报	2007，39（2）
63	汤　敏 王惠南	博士 正高	034 034	彩色视网膜血管图像的自动分割算法	仪器仪表学报	2007，28（7）
64	汤　敏 王惠南	博士 正高	034 034	激光扫描共聚集显微镜图像的计算机处理	激光技术	2007，31（5）
65	汤　敏 王惠南	博士 正高	034 034	CTA/MRA图像后处理软件的设计开发	东南大学学报（自然科学版）（增刊）	2007，37
66	郑　罡 王惠南	博士 正高	034 034	基于广义背景填充的塔式多相水平集的脑肿瘤分割算法（英文）	Transactions of Nanjing University of Aeronautics &Astronautics	2007，24（1）
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68	刘海颖 王惠南 程月华	博士 正高 中级	034 034 高新	纯磁控微小卫星姿态控制研究	空间科学学报	2007，27（5）
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73	张焕萍 宋晓峰 王惠南	博士 副高 正高	034 034 034	基于离散粒子群和支持向量机的特征因子选择算法	计算机与应用化学	2007，24（9）
74	张焕萍 王惠南 宋晓峰	博士 正高 副高	034 034 034	最小支撑树算法在基因表达数据聚类分析中的应用	南京航空航天大学学报	2007，39（2）

75	邵小丽 王惠南 黄　伟	硕士 正高 硕士	034 034 034	基于空间ICA和时间相关方法的人脑视觉皮层V5区的功能连通性研究（英文）	生物物理学报	2007，23（5）
76	吴海亮 王惠南 陈志明 刘海颖	硕士 正高 博士 博士	034 034 034 034	基于粒子滤波的微小卫星姿态确定算法	中国惯性技术学报	2007，15（4）
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81	张小白 王惠南 宋晓峰	博士 正高 副高	034 034	一种无参数的微阵列缺失值填补方法（英文版）	计算机与应用化学	2007，24（12）
82	陆丽娜 陈春晓	硕士 副高	034 034	Medical image visualization using true 3D display technology	2007 IEEE/ECME International Conference on Complex Medical Engineering会议	2007，1
83	陈春晓 童　超 王世杰	副高 硕士 副高	034 034 外	MRI刚性平移运动模糊图像建模与恢复	中国生物工程学学报	2007，26（3）
84	陈春晓	副高	034	磁共振成像中抑制尾影技术的研究进展	生物医学工程学杂志	2007，24（2）
85	黄峰茜 陈春晓 吴文佳	硕士 副高 硕士	034 034 034	粒子群优化算法在脑部肿瘤图像分割总的应用	河南科技大学学报	2007，28（6）
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90	陶　玲 钱志余 陈春晓	中级 正高 副高	034 034 034	基于主动轮廓模型的序列图像分割	应用科学学报	2007，25（6）
91	陶　玲 王惠南	中级 正高	034 034	生物医学仪器课程改革的实践	电气电子教学学报	2007，29（1）

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93	王佩佩 宋晓峰 杨　平	硕士 副高 副高	034 034 034	改进型内部递归神经网络在QSAR中的应用	计算机与应用化学	2007，24（2）
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95	王佩佩 宋晓峰 杨　平	硕士 副高 副高	034 034 034	利用基于小波特征提取的网络模型以解析色谱重叠峰	计算机与应用化学	2007，24（5）
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DNA-based Adaptive Immune Genetic Algorithm in Intelligence Exam-paper Generation

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Abstract

Intelligence exam-paper generation (IEPG) requires computers to generate the exam-papers in accordance with the objectives presented by users. In IEPG, high accuracy, high speed and intelligence are the core targets, and its achievement is depended chiefly on the evolutionary algorithms. Compared with the coding approaches and genetic operators of genetic algorithm (GA) in IEPG, this paper proposed a DNA-based adaptive immune genetic algorithm (DNA-AIGA) with DNA coding, immune operator and adaptive tactics. Chromosome of DNA coding is shorter than in binary coding and easier to be executed with genetic operators than the chromosome coded in integer, while immune operator and adaptive tactics were imported to improve the convergence efficiency of local searching. At the last of the paper, an illumination example of IEPG with five intelligence algorithms was exhibited. All the results indicated that the intelligence exam-paper generation on DNA-AIGA is in precise, rapid, efficient and with high success rate.

Keywords: Adaptive Immune Genetic Algorithm (AIGA), Intelligence Exam-paper Generation (IEPG), DNA Chromosome, Intelligence Computing

1 Introduction

Intelligence exam-paper generation (IEPG) has become an important section of examination system automation now. It requires computers to achieve exam-papers accurately and rapidly [1]. With the assistant of computers and intelligence algorithms, IEPG has two obvious advantages over traditional paper generation methods. Firstly, IEPG is much quicker than manpower. Secondly, the teachers are no longer the only one who can generate exam-papers, most work in exam-paper generation has been systematize and modularize by education experts, everyone who use IEPG system can generate exam-paper easily by inputting simple objective parameters.

IEPG is a typical multi-objective optimization problem. It is the integration of exam-paper generation strategy and optimization algorithms. Presently, genetic algorithm (GA) is the most commonly evolution algorithm used in this filed, it imitates the natural selection and mutant mechanism of the nature, searches optimal solutions by simple genetic operators. When GA is used in IEPG, the coding approaches of chromosome are in two kinds, binary [2] and integer [3], [4]. Chromosome in binary is composed of the numbers 0 and 1, its length is the sum of all the items in the database, one number represents one item, 1 means the item is selected, while 0 means not be selected. Chromosomes in binary coding are easy for operation of operators, but will lengthen with the increase of the count of items. Chromosome in integer is composed of the sequence numbers of items in database, its length is determined by the items of the exam-paper, much shorter and more stable, but the operation of crossover and mutation are much more difficult. In addition, another ubiquitous problem of GA is the inefficient convergence at later part of evolutionary process (local searching) for its random searching.

To solve the above problems, this paper proposes an advanced GA with DNA coding, immune operator and adaptive tactics. DNA (Deoxyribonucleic Acid) of organism is a double-strand nucleotides with the subunits called bases bind together using Watson-Crick pairing, A (adenosine) with T (thymidine) and C (cytosine) with G (guanidine). The architecture of a DNA chain is similar to the chromosome architecture of GA [5], [6], it will be easy for genetic operation used in GA. Inspiring from this, the chromosomes can be encoded with A, T, C and G, and the condons, 4^n combinations of n bases, can represent all the items. For solving the inefficient in evolutionary process of GA which is caused by the individual degradation and simplify population of chromosomes, we import immune operator and adaptive tactics. Immune operator imitates the defense mechanism of immune system in organism, has the ability to inhibit individuals from degradation [7-

10], and the changes of crossover probability and mutation probability dynamically with adaptive tactics can strengthen the population variety of chromosome [7], both of them will accelerate the convergence of IEPG.

In this paper, section 2 describes the objectives of IEPG, and section 3 introduces the DNA-AIGA in detail. In section 4, we test some intelligence algorithms in IEPG as an example. Finally, we present the conclusions.

2 Objectives Analysis

According to the quality index and teaching requirements of exam-paper, we extract nine objectives for IEPG, they are: sum score, chapter score, score of item type, difficulty(five grades are included: hard, difficult, medium, easy and light), test time, knowledge, ability levels (understand, comprehend, grasp and flexibility. who has mastered the contents of one level can answer the item correctly), distinguish grades (include low, medium and high, item of low grade means it can be grasped by most students, while of high grade is hard to grasp) and paper form. The process of exam-paper generation is finding out items with attribute values meet all objectives. Matrix (1) shows the mathematics model.

$$A = \begin{vmatrix} a_{1,1} & a_{1,2} & \cdots\cdots & a_{1,9} \\ a_{2,1} & a_{2,2} & \cdots\cdots & a_{2,9} \\ \cdots & \cdots & \cdots\cdots & \cdots \\ a_{N,1} & a_{N,2} & \cdots\cdots & a_{N,9} \end{vmatrix} \quad (1)$$

Where N is the items amount of an exam-paper, attribute values of an item are in row, and one attribute value of all items is in column. Following are the detail descriptions [6]:

①Sum score: $\sum_{i=1}^{N} a_{i,1} = P$, $a_{i,1}$ is the score of item i;

②Chapter score: $\sum_{i=1}^{N} b_{i,s} = P_s$, P_s is the sum score of items in chapter s. if $a_{i,2} = s$, then $b_{i,s} = a_{i,1}$, otherwise, $b_{i,s} = 0$;

③Score of item type: $\sum_{i=1}^{N} g_{i,m} = P_m$, P_m is the score of item type m. If $a_{i,3} = m$, then $g_{i,m} = a_{i,1}$, otherwise, $g_{i,m} = 0$;

④Difficulty: $D = \frac{1}{P} \cdot \sum_{i=1}^{N} a_{i,1} \cdot a_{i,4}$, $a_{i,4}$ is difficulty coefficient of item i;

⑤Test time: $\sum_{i=1}^{N} a_{i,5} = T$, $a_{i,5}$ is the time for answering item i, its value is determined by education experts;

⑥Knowledge: $\sum_{i=1}^{N} u_{i,n} = P_n$, P_n is the sum score of items of knowledge n in the paper. For one item, if $a_{i,6} = n$, then $u_{i,n} = a_{i,1}$, otherwise, $u_{i,n} = 0$;

⑦Ability levels: $\sum_{i=1}^{N} t_{i,g} = P_g$, all contents are divided into four levels: understand, familiar, understand skillful and flexible grasp, P_g is the sum score of items with level $g(g = 1,2,3,4)$. For one item, if $a_{i,7} = g$, then $t_{i,g} = a_{i,1}$, otherwise, $t_{i,g} = 0$;

⑧Distinguish grades: $F = \frac{1}{P} \cdot \sum_{i=1}^{N} a_{i,8} \cdot a_{i,1} = a \cdot \delta + b$, $a_{i,8}$ is the distinguish grade of item i, a and b are constant, δ is a standard deviation;

⑨Paper form: the two forms of objective and subjective are included.

3 DNA-based Adaptive Immune Genetic Algorithm

3.1 Chromosome with DNA Coding

DNA controls the growth and propagation of organism by the hereditary information, it is a double-strand nucleotides chain with A, T, C and G, different combination of bases can express unusually abundant genetic information. In mathematics, single DNA chain is described as a 4 letters coding, like the chromosomes of GA.

In this paper, chromosome of DNA-AIGA is a string of A, T, G and C, its length is determined by the items amount of an exam-paper. Suppose there are m types of items, the chromosome string will like $(J_{1,1}J_{1,2}\ldots J_{1,h_1}),\ldots,(J_{m,1}J_{m,2}\ldots J_{m,h_m})$, where $h_i(i = 1,2\ldots m)$ is the amount of selected items of type i, J_{m,h_i} represents the selected item in type m, J_{m,h_i} is formed by n bases like 'AGCTCGTA'. A sequence of n bases can gain 4^n types compositions, each sequence can represent an item in one type. For example: a sequence with 8 bases can represent $4^8 = 65536$ items.

3.2 Fitness Function

Fitness function is the criterion to check whether the items which chromosome represents have met users' requirements. Equation (2) shows the error function.

$$E = \sum_{k=1}^{9} \alpha_k \cdot exp(e_k) \qquad (2)$$

Where $e_k \in 0 \sim 1$, is the relative error to approaching objective k. $0 \le \alpha_k \le 1$, is the weight coefficient, and $\sum_{k=1}^{9} a_k = 1$. In exam-paper generating, the tolerance range of each relative error between 1% and 5% was set. Once errors within this range, we consider e_k as 0. From equation (2) we know $E \ge 1$, and $E = 1$ when $e_k = 0$. Equation (3) is the fitness function of DNA-AIGA.

$$Fit = E^{-1} \qquad (3)$$

Where $Fit \in 0 \sim 1$, the maximum value is 1.

3.3 Standard Genetic Operators

The initial chromosome population is generated at random.

3.3.1 Selection with Optimal Keeping

Selection of offspring population from parent population operates on gamble rim plate. Select the optimal individual from parent population to substitute the individual with least fitness value in offspring population, this is called optimal keeping.

3.3.2 Crossover

Choose chromosomes from population with probability p_c for crossover. The operation of crossover shows in Fig. 1. Character codes are generated at random.

Fig.1 Crossover of DNA chromosomes

3.3.3 Mutation

Choose bases from a chromosome with probability p_m for mutation. The generally mutation is carried out in two methods: One is transition, the bases can only change to the same type, purine replaces purine, pyrimidine replaces pyrimidine; another is transversion, bases can change to the bases in different type, purine can be replaced by purine, and also be replaced by pyrimidine. We use the second kind.

3.3.4 Inversion

Inversion is an important operator for redefining the blocks of gene in DNA computing, it converts some bases between two positions of a chromosome. Choose chromosomes from the population with probability p_i, pitch two seats at random from the selected chromosomes, converts all bases between them.

3.4 Immunity

Immune operator includes vaccination and immunity selection. It is developed to prevent the population from degradation after the operation of standard genetic operators. Vaccine is a kind of basic characteristic information extracted out from the objectives, and is composed of several bases in the optimal chromosome [7]. Vaccination is a process of extracting m chromosomes (m is not greater than population size) from the population, compares their particular bases with the vaccine, if different, covers them by the vaccine. Immunity selection inspects the fitness value of individuals which has been injected vaccine, if not larger than their parents', replaced by their parents; otherwise, keeping them to the offspring generation.

In the immune mechanism of organism, antibodies can inhibit each other for their difference of their density. In the procedure of updating the population after immunity selection, this paper proposes a population update tactics on antibody (chromosome) density, adjusts the selection probability of antibodies according to their density factor. Those antibodies with large fitness are assured to be with large selection probability.

Using the density factor, we can restrict the antibodies with high density. Antibodies in high density always have the high probability to induce premature and local convergence. Follow this population updating tactics, those antibodies with large fitness and low density are promoted, those antibodies with small fitness and high density are inhibited. This tactics can maintain the variety of population.

The density factor of antibody is calculated as equation (4):

$$G = \frac{antibodies(0.85 \cdot Fit_{max} \sim Fit_{max})}{sum \quad antibodies} \qquad (4)$$

The numerator means the sum antibodies between $0.85Fit_{max}$ and Fit_{max}.

Equation (5) shows the adjusting of selection probability with the density factor of antibody k.

$$h_k = (1 - \alpha_h \cdot G_k) \cdot \frac{Fit_k}{\sum_i Fit_i} \quad (5)$$

Where $\alpha_h \in 0 \sim 1$, is an experimental value, Fit_k is the fitness of antibody k.

3.5 Adaptive Crossover Probability and Adaptive Mutation Probability

Crossover probability p_c and mutation probability p_m will change in dynamic under adaptive tactics. Make p_c and p_m larger when fitness values are tend to unanimity or local optimization, the variety of population will be enhanced. When fitness is in disperse, minish p_c and p_m. In order to assure those individuals with larger fitness than the average one are replicated to next generation, minish their p_c and p_m, and increase p_c and p_m of those individuals with smaller fitness. p_c and p_m are calculated as equation (6) and (7) [7]:

$$p_c = \begin{cases} p_{c1} - \dfrac{(p_{c1} - 0.4)(f_{max} - f_{cur})}{f_{max} - f_{ave}}, & f_{cur} \geq f_{ave} \\ p_{c1}, & f_{cur} < f_{ave} \end{cases} \quad (6)$$

$$p_m = \begin{cases} p_{m1} - \dfrac{(p_{m1} - 0.001)(f_{max} - f_{cur})}{f_{max} - f_{ave}}, & f_{cur} \geq f_{ave} \\ p_{m1}, & f_{cur} < f_{ave} \end{cases} \quad (7)$$

Where $p_{c1} = 0.6, p_{m1} = 0.04$, 0.4 is crossover probability of the optimal individual, 0.001 is the mutation probability of the optimal individual.

3.5 Ending Condition

There are two ways to end the evolution of DNA-AIGA: Firstly, the fitness value is 1. Secondly, the evolutionary generation is more than 100. If the evolution meets the ending condition and the fitness value is smaller than 0.95, it is considered as failure.

The evolutionary steps of DNA-AIGA are: ①Generate the initial chromosome population; ②Operate on standard genetic operators; ③Calculate the fitness of chromosomes and extract vaccine for the optimal individual; ④vaccination, immunity selection and generate the offspring population; ⑤If the fitness and evolutionary generation meet the ending condition, finish the evolution, Otherwise return to step②.

4 Experimental Results

For checking the DNA-AIGA in IEPG, we carry an experiment on the item database of class "Electronic Circuits".

4.1 Objective Parameters

The objective parameters in our experiments are as follow: The sum score of paper is 100, chapter scores are: 8th and 10th chapter is 0, 1st and 6th chapter is 8, 2nd and 4th chapter is 20, 3rd and 7th chapter is 12, 5th chapter is 15, and 9th chapter is 5. The scores of item type are: 30 points for multiple-choice, 20 points for judgment and 50 points for calculation. The difficulty is 3 (hard for 1 (coefficient is $0.75 \sim 1.0$), difficult for 2 (coefficient is $0.5 \sim 0.75$), medium for 3(coefficient is $0.3 \sim 0.5$), easy for 4(coefficient is $0.2 \sim 0.3$) and light for 5(coefficient is $0 \sim 0.2$)). Test time is 120 minutes. Ability levels: understand for 30 points, comprehend for 40 to 45 points, grasp for 20 points and flexibility for 5to10 points. Distinguish grades: low for 55 points, medium for 30 to 35 points, and high for 10 to 15 points.

4.2 Attribute Code

IEPG extracts items based on their attribute values. The attribute code of each item is an integer string of 16 numbers (shown in Fig.2). The forward nine blocks are corresponding to nine objectives. Sequence number is developed for distinguishing the items with same attribute values. For example, the code 0103101001424002 means: an item in the third knowledge point of chapter one, is a multiple-choice item, one point, objective mode, answer should in one minutes, distinguish grade is 4, the ability level is familiar, the difficulty is easy, and it is the second item with same other attribute values.

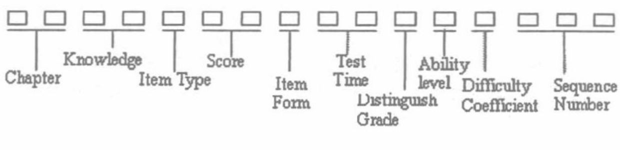

Fig.2 Architecture of attribute code of an item

4.3 Analysis of Results

The controlling parameters in our experiments are as follow: population size is 20, $\alpha_h = 0.3$. Items amount in the database is 6000, the item proportion of judgment, multiple-choice and calculation is 3:4:3. The running environment is as follow: CPU is Pentium IV 3.0GHz, Memory is 512MB, OS is Winxp, program language is VB6.0 and items are stored in SQL Server2000.

Table 1 shows the information of an exam-paper generated with DNA-AIGA. All unconformity values to objective parameters have been labeled with shadow, all of them are in error tolerance.

Table 1. Objective parameters of a paper generated with DNA-AIGA

Chapter Number	one	two	three	four	five	six	seven	eight	nine	ten
Score (point)	7	20	12	20	15	8	13	0	5	0
		Ability Level (point)						Difficulty		
nderstand	29	comprehend	42	grasp	20	flexibility	9	3.02		
	distinguish degree (point)									
low	55	medium	33	high	12					

Table 2 shows the results of five algorithms used in IEPG, all algorithms with the same controlling parameters of p_c, p_m, population size and items amount. In SGA-1, chromosome is encoded in binary. Chromosomes in SGA-2, P-hereboy algorithm and AIGA are encoded in integer. P-hereboy algorithm is a SGA with simulated annealing operator [11], its searching probability is: $p_s = \rho \cdot \frac{Fit_{max} - Fit_{cur}}{Fit_{max}}$, Where ρ is an experience value, is the maximum value of p_s, we set 0.01. Fit_{max} is the convergence fitness and Fit_{cur} is the fitness value of current chromosome. AIGA is a SGA in which immune operator and adaptive tactics are imported. The ending conditions of evolutionary generations are: 1000 generations for SGA-1, 500 generations for SGA-2 and P-hereboy algorithm, and 100 generations for AIGA and DNA-AIGA.

Table 2. Results of five algorithms in IEPG

orithms	Average Generation of 300 times Evolution	Convergence Time (Sec./500 Generations)	Convergence Time (Sec./1 Generation)	Percentage of Generation within Average Generation	Success Rate in IEPG
GA-1	218	71	30.956	52%	88%
GA-2	115	36	8.28	56%	92%
ereboy	103	35	7.21	60%	95%
IGA	30	42	2.52	68%	99%
A-AIGA	16	40	1.28	70%	100%

In table 2, both the average convergence generation and convergence time are decreased from SGA-1 to DNA-AIGA, the success rates of algorithms are increased one by one. IEPG with DNA-AIGA achieves the best result. The percentage of generation within average generation shows the proportion of the evolutions which with smaller convergence generation than average generation in 300 times, it indicates the rationalities of intelligence algorithms in IEPG. Success rate of 100% means all evolutions in DNA-AIGA can find out eligible items in generating exam-paper.

Figure 3 displays the convergence curves of five algorithms in IEPG, which shows the changing of fitness with the convergence generation. In this figure, the efficiency of convergence is improved obviously in AIGA and DNA-AIGA, especially the latter stages, which is the contribution of immune operator and adaptive tactics.

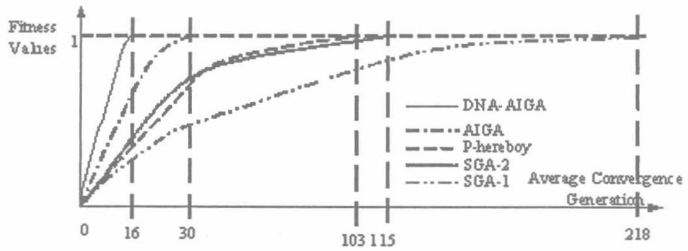

Fig. 3. Convergence curves of five algorithms in IEPG

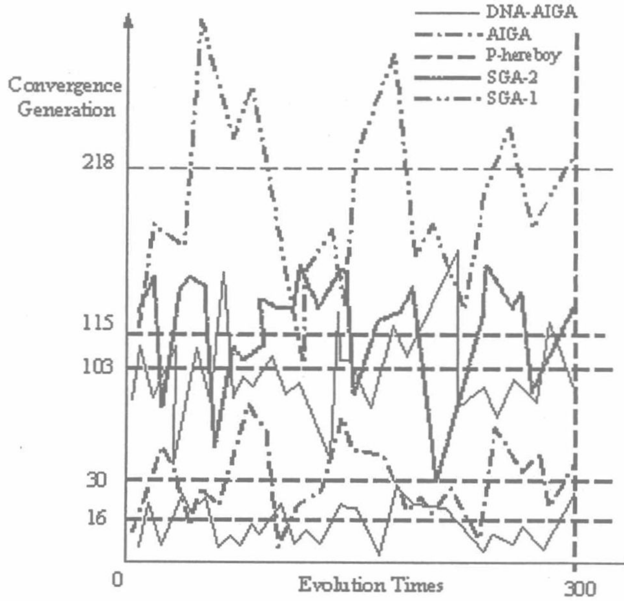

Figure4. The distributing of convergence generation in 300 times evolution of five algorithms

Fig.4 shows the distribution of convergence generation in 300 times evolution of five algorithms. The amplitude of SGA is much bigger than other algorithms', while DNA-AIGA possess of the least one.

5 Conclusions

This paper proposed an advanced GA in intelligence exam-paper generation. In the new GA, the DNA-based coding can shorten the length of chromosomes and speed the convergence of the evolution, immune operator and adaptive tactics are imported to improve the convergence efficiency. In the experiment analysis at the last of the paper, we validate that using DNA-AIGA to IEPG is effective in generating exam-paper.

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The Architecture and Circuital Implementation Scheme of a New Cell Neural Network for Analog Signal Processing

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Abstract: It is a difficult problem that using cellular neural network to make up of analog signal processing circuit. This paper presented the architecture of new cellular neural network SCCNN for analog signal processing circuits, designed the neural cell circuit, and developed the evolutionary design method of the SCCNN based on self-adapting genetic algorithm. In the architecture of new cellular neural network SCCNN, each neural cell connects with four neighborhood neural cells, the neural cell circuit and signal transfer line between neural cells are controlled by programmable switches. The validity of the SCCNN architecture and the evolutionary design method are verified through digital simulation. The experimental results indicate that the SCCNN hardware is a universal cellular neural network for analog signal processing circuit, which can be used to make up of the analog signal amplifier, analog signal filter, digit logic circuit, DAC circuit and so on.

Key Words: Cellular neural network, Evolutionary design, Analog signal processing circuit, DAC circuit

Category: B.7.3, B.2.3, C.5.4

1 Introduction

The artificial neural networks can be realized in two ways: hardware realization and software realization .Software realization of the artificial neural networks have the advantages that it is flexible and does not need the specific hardware, but its speed is low, and it is hard to be used in many real time fields. So hardware realization of the artificial neural networks is the unique effective approach to make the artificial neural networks useful for high speed computing [Wang and Cao 2006]-[Shuai and Feng et al. 2004].

The Hopfield Neural Network (HNN) and Cellular Neural Network (CNN) are widely used in image processing, pattern recognition, combination optimization, associate memory and intelligent control. But the HNN has many problems, for example, parasitic state, local minimum and undetermined parameter of the HNN. Although there have already been many improved methods about the HNN in order to overcome these problems, a universal method has not been developed. The CNN is a regular space structure consisted by a mass of same cells, every neural cell of the CNN has a continuous cell state and can only