

行政院國家科學委員會專題研究計畫 期中進度報告

路徑相關型與彩虹型衍生性金商品之效率計價演算法(2/3) 期中進度報告(精簡版)

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計畫主持人：呂育道

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主持人：呂育道 臺灣大學資訊工程系教授

一、中文摘要

衍生性金融商品為一種價值決定於某標的資產(如股票)的金融商品而標的物價格則為一連續時間隨機程序，衍生性金融商品之定價問題等同於在適當機率測度空間(稱為風險中立機率測度空間)下，計算其收益的數學期望值。強烈路徑相關型衍生性金商品的收益，則取決於整個標的物之歷史價格，其計價問題在效率、精確度、及收斂性方面皆十分具挑戰性。亞式選擇權價值取決於基本資產價格之歷史算數平均價格，此種選擇權十分受到資本市場歡迎，而且在學術界亦受到廣泛地研究，但定價之收斂性與效率十分具挑戰性。本計劃利用Lagrange乘數得到最佳效率的 $O(n^2)$ 演算法。演算法寫成程式，並與文獻上其他演算法在效率、精確度、及收斂性方面做徹底的比較。

英文摘要

Financial derivatives are financial instruments whose payoff depends on some underlying asset such as stock. The underlying asset is described by a continuous-time stochastic process. It is known that derivative pricing is equivalent to calculating the expected value of its payoff function under a suitable probability measure called the risk-neutral probability measure. Strongly path-dependent derivatives are derivatives whose payoff depends nontrivially on the history of the underlying asset's price. Their pricing problem poses a challenge in terms of efficiency, accuracy, and convergence. The price of the Asian option depends on the historic arithmetic average price. They are very popular in the capital markets and have been intensively investigated in the literature. But the convergence behavior and the efficiency issue are both challenging. This proposal uses Lagrange multipliers to derive an optimal $O(n^2)$ -time pricing algorithm. The algorithm is

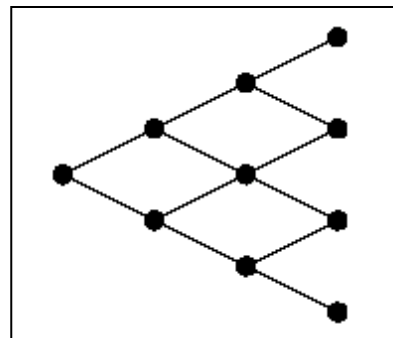
turned into programs and thoroughly compared with other methods proposed in the literature in terms of efficiency, accuracy, and convergence.

二、計劃緣由與目的

Derivatives are financial instruments whose payoff depends on some underlying asset such as stock. Pricing such products is equivalent to calculating the discounted expected value of a function of random variables. These products provide tools for managing financial risks and speculation and are essential for the health of the markets. The notional market size of derivatives is in the trillions US dollars range (72 trillion US dollars as of June of 1998). Research in this area therefore has important practical implications and has been extremely active (see Lyuu (2002)).

Path-dependent derivatives are derivatives whose payoff depends nontrivially on the *history* of the underlying asset's price. The price is usually described as a continuous-time stochastic process. For our purpose, we will take the asset prices to be a time series $S_0, S_1, \dots, S_n$, where the price S_i is a *lognormal* random variable with a known mean and variance. Pricing is usually computationally nontrivial for such derivatives.

In practice, the lognormal variables are approximated by a binomial random walk:



The purpose of our proposal is the pricing of a famous path-dependent derivative: the Asian

option. “Exact” polynomial-time pricing algorithms do not exist for this option; only subexponential-time exact algorithms exist (see Dai and Lyuu (2007)). The purpose of this proposal is quadratic-time algorithm that converges to the true price fast.

Although efficient numerical methods and approximate closed-form formulas are available, most lack convergence guarantees. Asian options can also be priced on the lattice. All efficient lattice algorithms keep only a polynomial number of states and use interpolation to compensate for the less than full representation of the states. Let the time to maturity be partitioned into n periods. This proposal presents the first $O(n^2)$ -time convergent lattice algorithm for pricing European-style Asian options; it is the most efficient lattice algorithm with convergence guarantees. The algorithm relies on the Lagrange multipliers to choose optimally the number of states for each node of the lattice. The algorithm is also memory efficient. Extensive numerical experiments and comparison with existing PDE, analytical, and lattice methods confirm the performance claims and the competitiveness of our algorithm. This result places the problem of European-style Asian option pricing in the same complexity class as that of the vanilla option on the lattice.

The payoff of an Asian option depends on whether the arithmetic average stock price. A tremendous amount of research has been carried out to attack the pricing problem of such options. See Aingworth et al. (2000), Benhamou (2002), Bouaziz et al. (1994), Boyle et al. (1997), Chen and Lyuu (2007), Dai, Huang, and Lyuu (2005), Dai and Lyuu (2002, 2007), Dewynne and Wilmott (1995), Dubois and Lelievre (2005), Forsyth, Vetzal, and Zvan (2002), Fu et al. (1998/9), Fusai (2004), Henderson and Wojakowski (2002), Hsu and Lyuu (2007), Hull and White (1993), Ju (2002), Klassen (2001), Lyuu (2002), Nielsen and Sandmann (2003), Schroder (2000), Rogers and Shi (1995), Tavella and Randall (2000), Thompson (1999), Vecer (2001), Wei (1998), and Zhang (2001, 2003).

Approximate closed-form formulas have been derived under various assumptions. These formulas have been evaluated thoroughly. The general conclusion is that all are as good as their

assumptions, and most lack convergence guarantees. As no simple, exact closed-form solutions exist yet, the development of efficient numerical algorithms becomes an important alternative. First, there are the popular Monte Carlo and the related quasi-Monte Carlo methods. Both the Monte Carlo approach and the analytical approach suffer from the inability to handle early exercise without bias. Although Longstaff and Schwartz have developed a least-squares Monte Carlo approach to tackle the problem, a convergence proof remains elusive.

The third type of approach, the lattice and the closely related PDE methods, are more general as they can handle early exercise. The main challenge with the lattice method in the case of Asian options is its exponential nature: An exponential number of arithmetic operations seem needed for an exact evaluation. This is because every price path, which corresponds to a state (that is, the average to date, also called the running average), leads to a different average price, thus payoff as well. To reduce the complexity, all known practical lattice algorithms keep only a small subset of the states. When an option value for a missing state is called for in the pricing algorithms, it is interpolated from the option values of the neighboring states. This successful paradigm is due to Hull and White. We will call it the interpolation paradigm. The interpolation paradigm obviously introduces interpolation error, and a major concern is whether the magnitude of the interpolation error converges to zero. Pricing Asian options with 2-dimensional PDEs also tackles the issue of exploding state space with the interpolation paradigm.

Partition the time to maturity into n periods. It is well-known that a binomial lattice with n periods contains about $n^2/2$ nodes. Let the average number of states (running averages) kept at each node be k , a critical adjustable parameter for lattice algorithms. As the total number of states is $kn^2/2$, the asymptotic running time of the lattice algorithm is $O(kn^2/2)$. An algorithm must decide upon how to distribute these $O(kn^2/2)$ states among the nodes. The choice will determine whether a small k guarantees convergence to the true value. The ultimate goal

is that a constant k , thus quadratic running time, suffices.

A uniform allocation scheme is perhaps the most straightforward scheme. It simply allocates the same number of states k for each node. Unfortunately, a uniform allocation scheme with k states per node is suboptimal. First, a small k may result in large deviations from the correct option price because of the low resolution, but a k that grows in some way with n makes the algorithm less efficient. Hence we are confronted with the conflicting demands of accuracy and speed. Second, an identical k for all nodes may be sufficient for nodes where few paths lead to, but hardly enough for nodes where exponentially many paths lead to. Intuitively, an algorithm should assign a smaller number of states to a node with a low probability of occurrence than one with a high probability of occurrence. The problem is how to find the numbers methodically. This proposal addresses these issues by an optimization technique, which yields nonuniform allocation schemes. In particular, the number of states allocated for each node is determined by the Lagrange multiplier. It is then proved that a constant k suffices for convergence purposes, resulting in a running time of $O(n^2)$.

This proposal designs the first $O(n^2)$ -time lattice algorithm for pricing European-style fixed-strike Asian options. The algorithm is guaranteed to converge to the true value of the continuous-time model. It is hence the first convergent lattice algorithm competitive with the one-dimensional PDE method in terms of efficiency. Interestingly, our algorithm's convergence rate does not go down with high volatilities or long maturities; in fact, the opposite is true. Extensive numerical experiments and comparison with existing methods back up the claims.

Our algorithm draws on four ideas. First is the methodology of Dai et al., which establishes the advantages of nonuniform allocation schemes based on optimization principles. Second, Forsyth et al. make explicit some of the plausible assumptions adopted in our analysis. These assumptions combined with the nonuniform allocation scheme allow detailed analysis of individual nodes' contribution to the total error. Third, we only need to work with running

averages below a threshold at each node. The reason is that for European-style Asian options, running averages at or over this threshold will necessarily result in the option being in the money at maturity, in which case their contribution to the option value can be given by a simple formula. Accordingly, the algorithm devotes resources only to running averages lower than the said threshold. This idea is from Aingworth et al. Finally, the algorithm adopts the 4-point polynomial interpolation instead of the common 1-point (nearest), 2-point (linear), or 3-point (quadratic) interpolation scheme. The advantages of higher-order interpolation have been documented before by, for instance, Hull and White.

三、實驗方法

The node at time i that results from j down moves and $i - j$ up moves will be denoted by $N(i, j)$. Let $B(i, j, p)$ denote the probability of getting j heads when tossing a coin i times with p being the probability of getting heads. Node $N(i, j)$ can be reached from the root node with probability $B(i, j, p)$. Note that

$B(i, j, p) = \binom{i}{j} p^j (1-p)^{i-j}$. The payoff of an

Asian option is $\frac{\sum_{i=1}^n S_i}{n+1}$ in discrete time, where

S_i denotes the price at time i . To be more precise, the payoff equals $\max\left[\frac{\sum_{i=1}^n S_i}{n+1}, 0\right]$. Here, X is

called the strike price and is specified in the contract.

Let k_{ij} denote the number of states at node $N(i, j)$. Using Lagrange multipliers to minimize the errors, we find that

$$k_{ij} = \frac{kn^2}{2} \cdot \frac{\left(\frac{B(i, j, p)}{i^4}\right)^{0.2}}{\sum_{s=1}^n \sum_{t=0}^s \left(\frac{B(s, t, p)}{s^4}\right)^{0.2}}$$

Figure 1 at the end of the report shows the convergence of our algorithm as n increases. It is linearly convergent.

Figure 2 demonstrates the running time of the algorithm. It is indeed quadratic as the analysis proves. Figure 3 shows the convergence to the true value as n increases and under various numbers of states.

In the table in Figure 4, we compare our algorithm with various algorithms under many conditions. It clearly shows the superior performance of our algorithm in terms of convergence and efficiency, especially when the volatility is high.

四、結論與討論

Our quadratic-time algorithm for Asian options is a breakthrough in the literature. It achieve good convergence with a time bound of only $O(n^2)$. This is apparently optimal. The techniques rely on the Lagrange multipliers and high-order interpolation. Numerically, it compares favorably with many other methods in the literature.

五、計畫成果自評

The results accomplish what the proposal set out to do. We designed an algorithm for Asian options, analyzed it, and programmed it for comparison with other existing algorithms. The running time and error rate are both optimal and as desired. The method used is novel and can be applied to other options. The comparison with other methods are favorable.

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Figure 1:

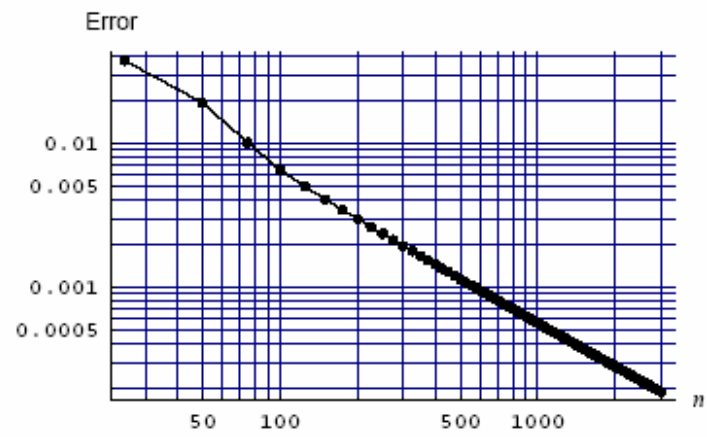


Figure 2:

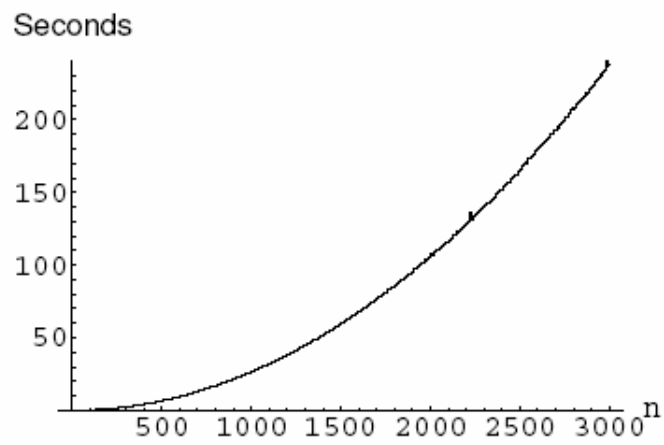


Figure 3:

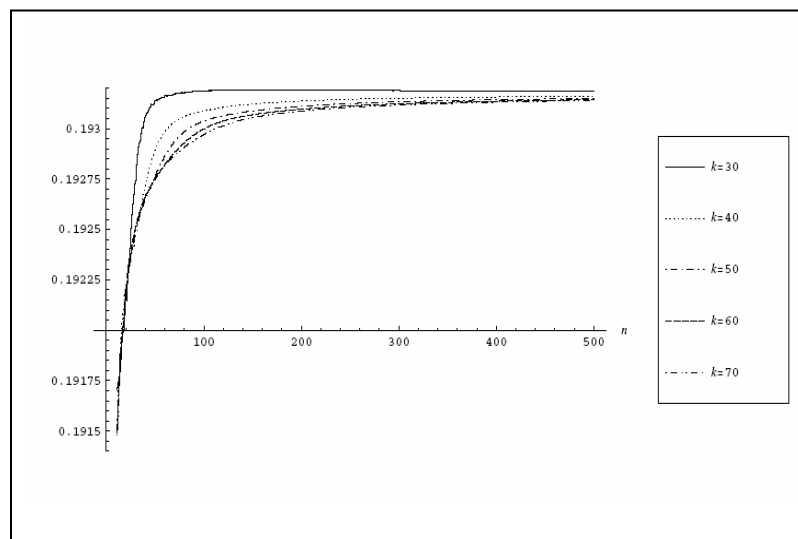


Figure 4:

X	σ	r	Exact	AA2	AA3	Ours	Time (sec)
95	0.05	0.05	7.1777275	7.1777244	7.1777279	7.178812	5.30
100			2.7161745	2.7161755	2.7161744	2.715613	5.37
105			0.3372614	0.3372601	0.3372614	0.338863	5.47
95		0.09	8.8088392	8.8088441	8.8088397	8.808717	5.39
100			4.3082350	4.3082253	4.3082331	4.309247	5.30
105			0.9583841	0.9583838	0.9583841	0.960068	5.34
95		0.15	11.0940944	11.0940964	11.0940943	11.093903	5.44
100			6.7943550	6.7943510	6.7943553	6.795678	5.31
105			2.7444531	2.7444538	2.7444531	2.743798	5.52
RMSE:			0.0000041	0.0000007	0.001062		
90	0.10	0.05	11.9510927	11.9509331	11.9510871	11.951610	5.36
100			3.6413864	3.6414032	3.6413875	3.642325	5.38
110			0.3312030	0.3312563	0.3311968	0.331348	5.42
90		0.09	13.3851974	13.3851165	13.3852048	13.385563	5.41
100			4.9151167	4.9151388	4.9151177	4.914254	5.42
110			0.6302713	0.6302538	0.6302717	0.629843	5.30
90		0.15	15.3987687	15.3988062	15.3987860	15.398885	5.39
100			7.0277081	7.0276544	7.0277022	7.027385	5.39
110			1.4136149	1.4136013	1.4136161	1.414953	5.33
RMSE:			0.0000670	0.0000072	0.000678		
90	0.20	0.05	12.5959916	12.5957894	12.5959304	12.596052	5.37
100			5.7630881	5.7631987	5.7631187	5.763664	5.35
110			1.9898945	1.9894855	1.9899382	1.989962	5.43
90		0.09	13.8314996	13.8307782	13.8313482	13.831604	5.38
100			6.7773481	6.7775756	6.7773833	6.777748	5.35
110			2.5462209	2.5459150	2.5462598	2.546397	5.34
90		0.15	15.6417575	15.6401370	15.6414533	15.641911	5.39
100			8.4088330	8.4091957	8.4088744	8.408966	5.38
110			3.5556100	3.5554997	3.5556415	3.556094	5.29
RMSE:			0.00063735	0.0001190	0.000301		
90	0.30	0.05	13.9538233	13.9555691	13.9540973	13.953937	5.36
100			7.9456288	7.9459286	7.9458549	7.945918	5.44
110			4.0717942	4.0702869	4.0720881	4.071945	5.39
90		0.09	14.9839595	14.9854235	14.9841522	14.984037	5.35
100			8.8287588	8.8294164	8.8289978	8.829033	5.40
110			4.6967089	4.6956764	4.6969698	4.696895	5.34
90		0.15	16.5129113	16.5133090	16.5128376	16.512963	5.38
100			10.2098305	10.2110681	10.2101058	10.210039	5.36
110			5.7301225	5.7296982	5.7303567	5.730357	5.33
RMSE:			0.0011016	0.0002383	0.000193		

Report: The 10th World Multi-Conference on Systemics, Cybernetics and Informatics (WMSCI2006) and the 3rd Symposium on Risk Management and Cyber-Informatics (RMCI2006)

Yuh-Dauh Lyuu

Professor

Dept. Computer Science and Information Engineering

Department of Finance

National Taiwan University

Taipei, Taiwan

Tel: 886-2-2362-5336 ext 429

Fax: 886-2-2362-8167

lyuu@csie.ntu.edu.tw

<http://www.csie.ntu.edu.tw/~lyuu>

July 24, 2006

1 About the Symposium

- Program Committee Chairs: William Lesso and Zale Zinn
- General Chair: Nagib Callaos
- Location: Rosen Centre Hotel, Orlando, Florida, U.S.A.
- Time: July 16–19, 2006
- Organizer: International Institute of Informatics and Systemics (IIS)

2 Lessons Learned

“Risk management has been related, in increasing degree, to Informatics and Cybernetics. Today, almost every organization depends on Information and Communications Technologies. Software and networks supporting organizational everyday activities must be reliable, secure and safe. Flawed or failed software can present severe organizational and business risks that include liability costs, productivity loss, quality decreasing, brand damage, revenue loss, etc. Simultaneously, cyber crimes (cyber frauds, sensible data protection, etc.) and liability in the ?electronic workplace? are requiring, with increasing urgency, an adequate risk management. Consequently, Organizational/business risk management is increasingly including informatics and cybernetics in their planning and activities. And vice versa, Informatics and Cybernetics technologies, concepts and theories are increasingly being used in risk management?s research, consulting, studies, projects, training, and activities. Accordingly, the main purpose of the Symposium on Risk Management and Cyber-Informatics (RMCI 2006) is to bring together researchers, practitioners and consultants from both Risk Management areas and informatics and cybernetics fields and disciplines to presents results of their research, as well as their problems and solutions in Risk Management, the reciprocal applications between both field. And the application of both fields in other areas.”

For RMCI2006, my presentation was at 16:00 on July 19, 2006. I find papers for work done in the following 61 countries:

1. Algeria
2. Armenia
3. Australia
4. Austria
5. Belgium
6. Brazil
7. Bulgaria
8. Canada
9. China
10. Colombia
11. Croatia
12. Czech Republic

13. Denmark
14. Egypt
15. Finland
16. France
17. Germany
18. Greece
19. Guam
20. Hong Kong
21. Hungary
22. India
23. Iran
24. Ireland
25. Israel
26. Italy
27. Japan
28. Jordan
29. Korea
30. Latvia
31. Lithuania
32. Macedonia
33. Malaysia
34. Mexico
35. Morocco
36. Netherlands
37. New Zealand

38. Pakistan
39. Peru
40. Poland
41. Portugal
42. Puerto Rico
43. Romania
44. Russian Federation
45. Saudi Arabia
46. Serbia
47. Slovakia
48. South Africa
49. Spain
50. Sweden
51. Taiwan
52. Tanzania
53. Thailand
54. Tunisia
55. Turkey
56. Ukraine
57. United Arab Emirates
58. United Kingdom
59. United States
60. Vietnam
61. Yugoslavia

There are several papers from Taiwan this year.

A total of ~ 900 papers/abstracts were submitted. Among them, 712 were accepted for presentation. (Our paper “Very Fast Algorithm for Barrier Options” appears on the *Proceedings*’ pp. 306–311.) The papers were “reviewed as carefully as time permitted.”

There were also 3 plenary presentations: “Legacy of Professor Bela H. Banathy: Conversational Meetings for Social Systems Design” by Gary Metcalf (IFSR), “Cybernetics as a Language for Interdisciplinary Communication” by Stuart Umpleby (George Washington), and “The Mouse That Roared: Epiphanies on the Road to the Ubiquity of the Desktop Computer” by Robert James (Air Force Academy).

3 A Glimpse of the Papers

There are many papers in the *Proceedings*. From the talks and the printed papers, the techniques used vary widely. Although all papers are interesting, I will focus the report on topics that I am personally interested in because I am not an expert in every field.

- “Fundamentals and History of Cybernetics: Development of the Theory of Complex Adaptive Systems”
- “Personal Asset Management Tools: Review and EvaluationAn Approach for an Efficient Software Engineering Course Project”
- “New Pulsing Codes for System Performance Enhancement in the Presence of ISI and Gaussian Noise”
- “Various Scenarios for Maximizing the Life Time of Wireless Sensor Networks”
- “Future Cellular Systems: With Lightning Prediction Capability and Adaptive Coding for Reliable Communications”
- “Applying Pattern Detection Network Security Against Denial-Of-Service Attacks”
- “Direct Tests on Individual Behaviour in Small Decision-Making Problems”
- “Finite Automata Crossing the Border into Economics”
- “Adapted Online Lesson for ESL Learners”
- “Technological and Logical Conversions of Digital Cultures”
- “Non-Arbitrary Judgment Algorithm for Periodicity of Time Series”
- “Some New Industrial Polymer Manufacturing Technologies Originated in Japan”

- “Nonparametric Comparison of Two Dynamic Parameter Setting Methods in a Meta-Heuristic Approach”
- “Generation Methods for Multidimensional Knapsack Problems and their Implications”
- “Ratios in Simulated 0-1 Knapsack Problems”
- “Simulation of Random Set Covering Problems with Known Optimal Solutions and Correlated Coefficients”
- “A Novel LP-Based Neighborhood Search for General Integer Programs”
- “Design and Simulation of Intelligent Global Medical Networks”
- “Unsupervised Bayesian Image Segmentation Using Adaptive EM Algorithm Based on Pearson System”
- “Study on the Failure of SVD-Based Watermarking Schemes for Copyright Protection Applications”
- “A Dynamic Model for the Hepatitis B Virus Infection”
- “Preparing Precollege Students for HPC”
- “Systems and other Related Fractals”
- “A Java Based Tool for Supporting High Level Architecture Federation Execution Control over a WAN”
- “Exchange Information or Knowledge?”
- “Scientific Policy of the European Union in the Light of the Lisbon Strategy”
- “PCA-Based Learning Algorithm for Solving Recognition Tasks”
- “Presenting at the Majors: A Comparison of Finance, Anaesthesia and Biomedical Engineering”
- “Closed-Form Approximation Solution for an Inventory Model with Supply Disruptions and Non-ZIO Reorder Policy”
- “Unleashing the Power of Networks - Case Study”
- “Modelling Knowledge-Based Economies”
- “Monte Carlo Simulation for Assessing Software Reliability”
- “Manuscript Status Control Algorithm in Electronic Periodicals”

- "Improved Optimal Strong Password Authentication"
- "Diffusion of IP Telephony in Undergraduate Private Colleges"
- "Integrated Model for Shopping Motivations on the Internet"
- "Secure Key Distribution Protocol in Mobile Communications"
- "A Minimal Linux Environment for High Performance Computing Systems"
- "Global Interconnect Optimization and Impact of Inductance on the Overall Performance"
- "Embedding Gray Images Using Multiple Quantization"
- "A Case-Based System to be Applied in the Brazilian Public Health System"
- "Stochastic and State Space Models of Human Cancers: Some New Approaches"
- "DFA on Cardiac Rhythm: Fluctuation of the Heartbeat Interval Contain Useful Information for the Risk of Mortality in Both, Animal Models and Humans"
- "Ontological Implications of the Levels of Conceptual Interoperability Model"
- "Engineering Education as Support to a Better Knowledge Communication"
- "Some Aspects in the Education of Projects of Engineering for Students with Degree in Sciences"
- "International Master Programs in a Global Perspective. A Case Study of Introducing Problem-Based Learning and Project Work to Foreign Students"
- "Developing Knowledge Communication by Dynamic Presentations in Teacher Education"
- "Institutional Foundations of Building Trust in Electronic Commerce"
- "Inverse Optimization Methods of Linear Programming Model for Optimal Production Plan in Supply Chain"
- "A Watermark-Based Rights Management Scheme of Mobile Digital Distribution Service"
- "Management of Information System Security in Polish Enterprises. Review and Analysis of Selected Empirical Researches"
- "A Watermark Technology Based on Visual Cryptography"
- "The Effects of Software Development Environment on Software Cost Estimation"

- “Protecting Web Server from DDoS Attacks Using Three-Layer Detection Mechanism”
- “Session Key Generation for Micropayment Transactions in Wireless Environments”
- “Semantic Schemas: The Least Upper Bound of Two Interpretations”
- “A Novel Quantum Entanglement Model for Self-Organizing Data Clustering”
- “Cyber Ethics in the 21st Century: Beyond the Creative Product Paradigm”
- “Numerically Stable Fast Recursive Least Squares Algorithms in Adaptive Filtering”
- “Iris Biometrics for Network Security”
- “Product Bug Reports Data Mining Model”
- “A Study of Continuing Education VA Case on Leisure Boredom and Constraints”
- “Event from Exposure to Financial Statements”
- “Comparisons between the UK and US Home Telecare Delivery Modes to the Elderly”
- “Communicating with Multi-Disciplinary Audiences: Factors to Enhance Effective Communication”
- “Organising Documentation in Knowledge Evolution and Communication”
- “Knowledge Communications for the Solution of Algebraic Equations from an Educational Point of View”
- “Theory of Constraints Experience: Batch Size and Multitasking”
- “Cross Decomposition of the Degree-Constrained Minimum Spanning Tree Problem”
- “ARTMAP-IC Neural Networks for Predicting Insurance Policy Ownership”
- “Executive Criteria of Agent-Based Support Executive Information Systems”
- “Short Term Forecast of Occupation Tax at University Hospital of Santa Maria Using Autoregressive Vectors”
- “The Software Architecture of a Secure and Efficient Group Key Agreement Protocol”
- “A Multiple Matrix Spaces Scheme Based on Combinatorial Key Management for Sensor Networks”

- "Certificateless Public Key Encryption from the Weil Pairing"
- "View-Invariant Face Recognition from a Single Example"
- "Optimization in Real Time Simulation"
- "New Efficient Algorithm for Reliability Formula of WeightedVkVoutVofVn System"
- "Evolution with Fittest Individual Local Tuning"
- "Knowledge Communication through Conferences: A Knowledge Acquisition Perspective"
- "How Can Complex Knowledge, Which May be Scientific, be Communicated to Heterogeneous Audiences?"
- "Creating a Flow of Knowledge"
- "Mind Tools for Intellectual Produce"
- "Shoppers Attitudes Toward Different Product Categories at the Web Stores in China"
- "Implementing Shared Generation of RSA Keys"
- "An Adaptive Process Allocation Scheme in Grid Environment"
- "Automatic Analyzer for Security Protocol Verification"
- "Survivability in Wireless Sensor Networks"
- "The Mechanisms of the Differentiation of Species through Coevolution"
- "Problem Solving Based on Collective Intelligence of Generalized Particle Model"
- "The Database Management of Earthquake Precursory Observational Data in China"
- "Using Chaos and Complexity Theory and Design of Experiments to Forecast Stock Prices: Tools of Artificial Intelligence"
- "Improving the Performance of Genetic Simulation for Asynchronous Finite State Machines"
- "A UML for a Multiprocessor System-On-Chip"
- "Distributed Grid Service Broker for Web-Services Based Grid Applications"
- "Grid File Systems: A Forensic Analysis"

- “Decision Making Management in Emerging Capital Markets”
- “N-Queens Optimization by the Distributed Double Guided Genetic Algorithm”
- “A Computerised Business Ethics Expert System - A New Approach to Improving the Ethical Quality of Business Decision-Making”
- “Analytical Bayes Estimator and Distribution for Outlier Infested Time Series Data”
- “The Presentation of Scientific Research to a Non-Scientific Audience”
- “Volunteer vs. Professional Management of Academic Conferences: A Comparison of Five Meetings”
- “A Small-World Caching Strategy for P2P Storage System”
- “A Method to Generate a Fair Curve with Specified Curvature Distribution for Computer Aided Aesthetic Design”
- “The Double Trump Portfolio as the Core of Sustainable Decision Making Strategy in Currency Markets”
- “Mutual Funds Development Strategy in Lithuania”
- “Advanced Security Infrastructures for Grid Education”
- “Managing Foreign Direct Investment Risks”
- “The Integral Risk Management Process”
- “Algorithm and Mathematical Modeling for Atmospheric Correction and Classification Accuracy for Hyperspectral Data”
- “Engineering Optimization Using Distributed Artificial Immune Algorithm”
- “A New Computing Paradigm Towards Least Risk”

4 Recommendations

WMSCI and RMCI provide a gathering place for computer scientists, communication scientists, physicists, policy makers, and applied mathematicians to communicate their ideas. There are researchers, industry leaders, and government employees from all over the world. Every speaker spoke for 20 minutes and had 5 minutes for questions from the audience. I found 20 minutes too short in many cases to fully understand the paper. Some papers are original and represent significant progress in research. Others talk about policies and market research.

5 Materials Brought Back

Proceedings of the 10th World Multi-Conference on Systemics, Cybernetics and Informatics (WMSCI2006), 3 Volumes and 1 CD.