



# **Trust Evaluation in Service-Oriented Environments**

by

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of the requirements for the degree of  
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in the  
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Faculty of Science  
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# Statement of Candidate

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I certify that the work in this thesis entitled “**Trust Evaluation in Service-Oriented Environments**” has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree to any other university or institution other than Macquarie University.

I also certify that the thesis is an original piece of research and it has been written by me. Any help and assistance that I have received in my research work and the preparation of the thesis itself have been appropriately acknowledged.

In addition, I certify that all information sources and literature used are indicated in the thesis.

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Lei Li

11 November 2011

*To my parents,  
Guoen Li and Xiulan Zhang,  
who dedicated all their life to me*

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# Abstract

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In service-oriented applications, effective and efficient trust evaluation is crucial. It provides valuable information to service clients, enabling them to select trustworthy service providers, consume high quality services and prevent monetary loss.

One aspect of the work presented in this thesis is trust vector based approaches to trust rating aggregations in service-oriented environments. In the single trust vector approach, a trust vector of three values is computed, which can predict the trust trend and represent a set of ratings distributed within a time interval (e.g. a week or a month etc.). With trust vectors, two service providers with similar final trust values can be compared. In the multiple trust vector approach, a two dimensional aggregation is performed, which consists of both vertical and horizontal aggregations of trust ratings. The vertical aggregation calculates the aggregated rating representing the trust level for the services delivered in a small time period. The horizontal aggregation applies our proposed multiple time interval (MTI) greedy and optimal algorithms to determine the minimal number of time intervals, within each of which a trust vector can be calculated to represent all the ratings in that time interval. The proposed algorithms can return a small set of MTI to represent a large set of trust ratings and preserve the trust features well.

The other aspect of the work presented in this thesis is trust-oriented composite service selection and discovery. In service-oriented environments, a service may invoke other services offered by different providers forming composite services. The complex invocations in composite services greatly increase the complexity of trust-oriented service selection and discovery. To evaluate the subjective global trust of a composite service based on subjective probability theory, a set of subjective trust evaluation approaches have been proposed, which can map the non-binary discrete subjec-

tive ratings to trust values, evaluate the global trust value deductively and maintain the subjective property of trust ratings and trust results. In addition, two algorithms have been proposed for trust-oriented service selection and discovery.

The properties of the above proposed algorithms have been studied both analytically and empirically. These studies illustrate that the proposed algorithms are effective and efficient.

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# Publications

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This thesis is based on research I have performed with the help of my supervisor and other colleagues during my PhD program at the Department of Computing, Macquarie University between 2008 and 2011. Some parts of my research have been published in the following papers:

- [1] Lei Li and Yan Wang, The Study of Trust Vector Based Trust Rating Aggregation in Service-Oriented Environments, *World Wide Web Journal (WWWJ)* (ERA rank A journal<sup>1</sup>) (Impact Factor 1.0), accepted on 03/10/2011.
- [2] Lei Li and Yan Wang, A Subjective Probability Based Deductive Approach to Global Trust Evaluation in Composite Services, *IEEE International Conference on Web Services (ICWS 2011)* (ERA rank A conference), pages 604-611, 4-9 July, 2011, Washington DC, USA.
- [3] Hadi Mashinchi, Lei Li, Mehmet Orgun and Yan Wang, The Prediction of Trust Rating Based on the Quality of Services Using Fuzzy Linear Regression, *IEEE International Conference on Fuzzy Systems (FUZZ-IEEE 2011)* (ERA rank A conference), pages 1953-1959, 27-30 June, 2011, Taipei, Taiwan.
- [4] Yan Wang and Lei Li, Trust Rating Aggregations in Service-Oriented Applications, *IEEE Transactions on Services Computing (TSC)* (regarded as the best journal in the field of services computing), accepted on 27/05/2010.
- [5] Lei Li, Yan Wang and Ee-Peng Lim, Trust-Oriented Composite Service Selection with QoS Constraints, *Journal of Universal Computer Science (J.UCS)*, 16(13), pages 1720-1744, 2010.

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<sup>1</sup>refer to [http://www.arc.gov.au/era/era\\_2010/archive/era\\_journal\\_list.htm](http://www.arc.gov.au/era/era_2010/archive/era_journal_list.htm)

- [6] Lei Li and Yan Wang, Context Based Trust Normalization in Service-Oriented Environments, International Conference on Autonomic and Trusted Computing (ATC 2010), Springer, LNCS Vol. 6407, pages 122-138, 26-29 October, 2010, Xi'an, China.
- [7] Lei Li and Yan Wang, Subjective Trust Inference in Composite Services, Twenty-Fourth AAAI Conference on Artificial Intelligence (AAAI 2010) (ERA rank A conference), pages 1377-1384, 11-15 July, 2010, Atlanta, Georgia, USA.
- [8] Lei Li, Yan Wang and Ee-Peng Lim, Trust-Oriented Composite Service Selection and Discovery, International Conference on Service Oriented Computing and European ServiceWave Conference series (ICSOC/ServiceWave 2009) (ERA rank A conference), Springer, LNCS Vol. 5900, pages 50-67, 24-27 November, 2009, Stockholm, Sweden.
- [9] Lei Li and Yan Wang, Trust Evaluation in Composite Services Selection and Discovery, IEEE International Conference on Services Computing (SCC 2009) (ERA rank A conference), pages 482-485, 21-25 September, 2009, Bangalore, India.
- [10] Lei Li, Yan Wang and Vijay Varadharajan, Fuzzy Regression Based Trust Prediction in Service-Oriented Applications, International Conference on Autonomic and Trusted Computing (ATC-09), Springer, LNCS Vol. 5586, pages 221-235, 7-9 July, 2009, Brisbane, Australia.
- [11] Lei Li and Yan Wang, A Trust Vector Approach to Service-Oriented Applications, IEEE International Conference on Web Services (ICWS 2008) (ERA rank A conference), pages 270-277, 23-26 September, 2008, Beijing, China.
- [12] Yan Wang, Lei Li and Ee-Peng Lim, Price Trust Evaluation in E-Service Oriented Applications, IEEE Conference on E-Commerce Technology and IEEE Conference on Enterprise Computing, E-Commerce and E-Services (CEC/EEE 2008), pages 165-172, 21-24 July, 2008, Crystal City, Washington DC, USA.

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