

Reliability Optimization: Improving Robustness of Service-based Applications by Leveraging Inter-Service Redundancy

PhD Thesis

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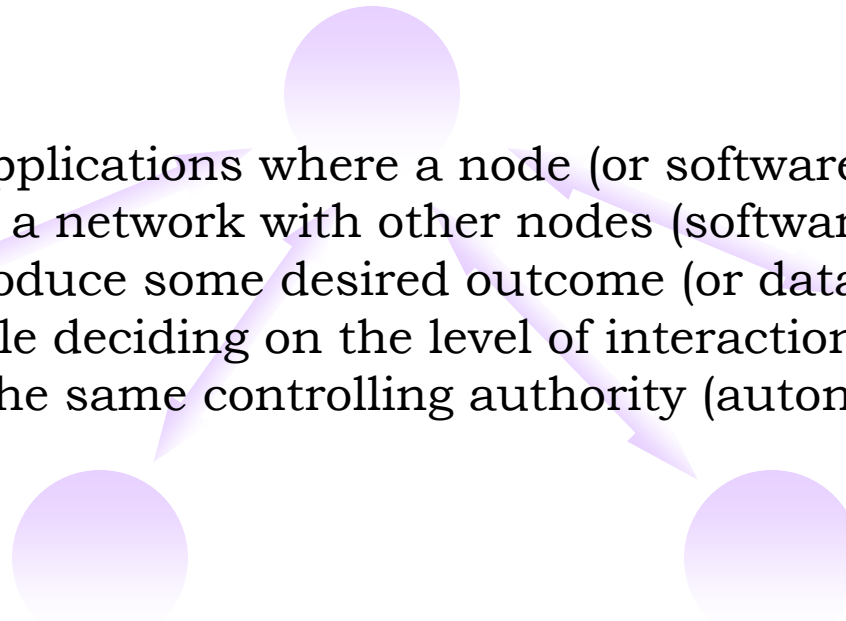
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Context

Distributed applications where a node (or software, agent, ...) interacts over a network with other nodes (software, agents, ...) in order to produce some desired outcome (or data, document, state, ...), while deciding on the level of interaction and not being under the same controlling authority (autonomous behavior)





Application Domains

Peer-to-Peer
Service Oriented Architecture
Web Services
GRID
Virtual Organizations

Contribution 1: Service-based distributed collaborative application



Problem

How to make a robust whole from unreliable parts



Distributed applications where a node (or software, agent, ...) interacts over a network with other nodes (software, agents, ...) in order to produce some desired outcome (or data, document, state, ...), while deciding on the level of interaction and not being under the same controlling authority (autonomous behavior)

Network down, ...

Software bugs, ...

Rationality, malice

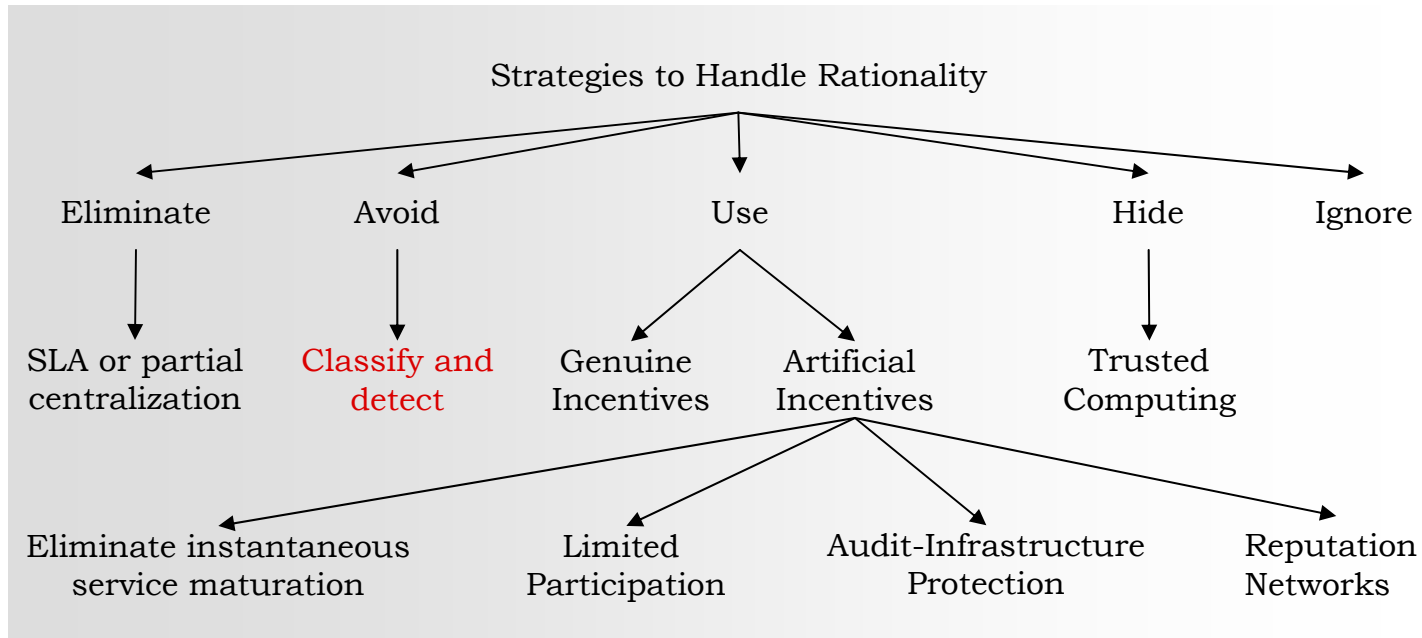


Consequence

Just as with software bugs or intermittent network connectivity, rationality may render the desired result difficult to obtain



Related Work



“Unreliable services” assumes we can detect and differentiate between reliable and unreliable services
Contribution 2: Incentive Reference Framework (INCA)



Solution

Upon detection of an unreliable service, we can search for its replacement → presumes equivalent service exists and can be found (...unstructured P2P)

An alternative approach to searching for an equivalent service is to take a “similar” service and adapt it → presumes inter-service redundancy can be computed and used to create an equivalent service



Solution

We consider three machines, T_I , T_S and T_G :

T_I computes some relations computed by T_T

If $r \in R_T$ and $r \notin T_I$ then r is computed by T_S

T_G controls which machine performs the computation

Such that $T_T \equiv T_G \circ T_I \circ T_S$

Contribution 3: for certain types of transducers, define the concept of redundancy and a heuristic to find redundant relations such that $R_I \subseteq R_T \cap R_C$

Contribution 4: an algorithm to find T_G (global machine), T_I (intermediate machine) and T_S (stub machine)



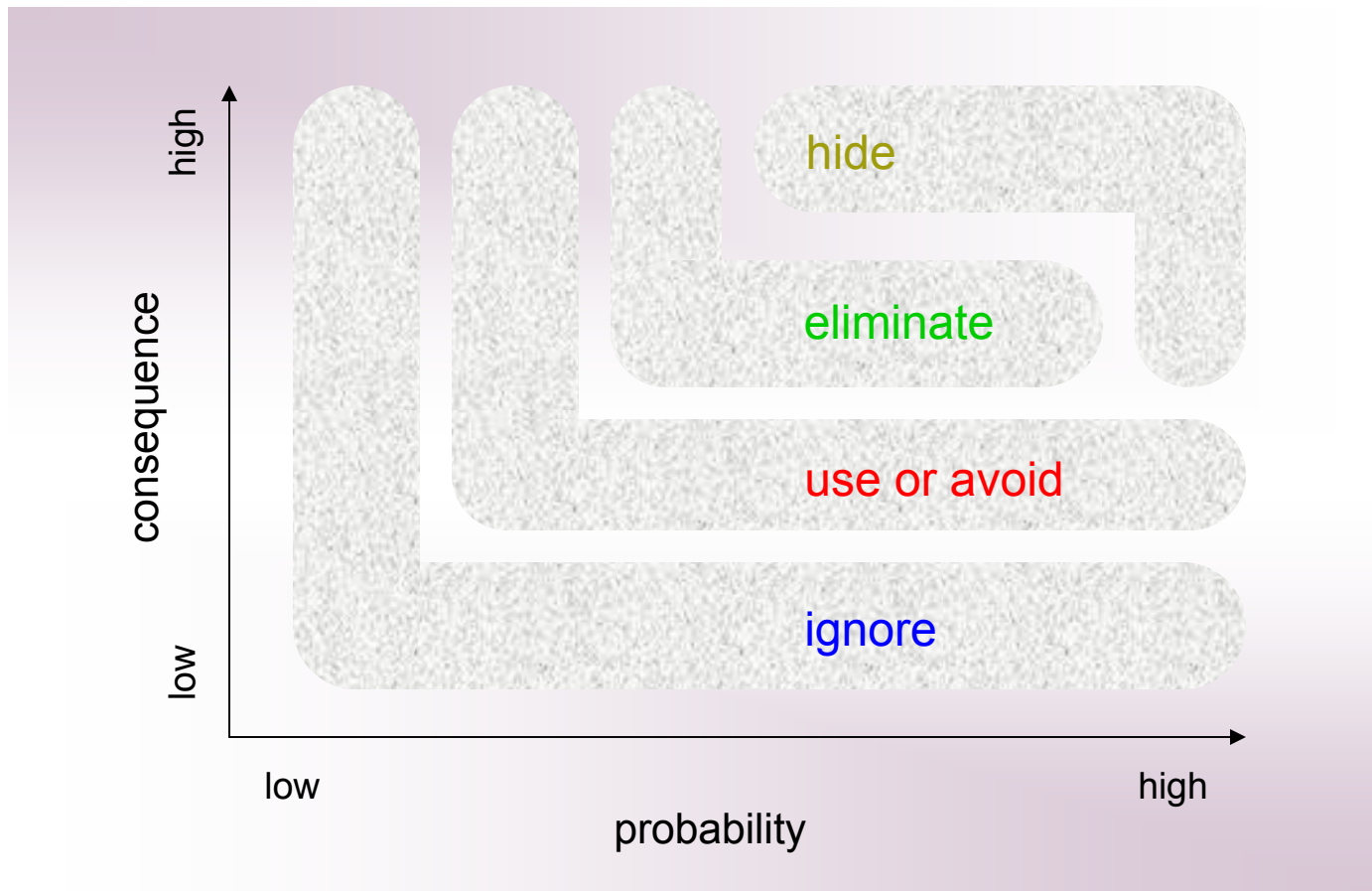
Results

Possibility of expressing one machine (T_T) in terms of another (T_C) and extra implementation (T_G and T_S)

Polynomial time complexity, linear states and transitions complexity



Results





Publications

Journals

- 1 - Andrew Roczniak, Pierre Lévy and Abdulmotaleb El Saddik, "Improving Robustness of Service-based Applications", (Submitted)
- 2 - Andrew Roczniak, Alexandre Miège and Abdulmotaleb El Saddik, "An Architecture for Access Control in Service-based Collaborative Applications", (Submitted)
- 3 - Andrew Roczniak, Abdulmotaleb El Saddik and Pierre Lévy, "INCA: Qualitative Reference Framework for Incentive Mechanisms in P2P Networks" in International Journal of Computer Applications in Technology, Vol. 29, No. 1, pp.71–80, 2007

Book Chapters

- 4 - Andrew Roczniak and Abdulmotaleb El Saddik, "Mobile P2P Data Retrieval And Caching", in Encyclopedia of Wireless and Mobile Communication, Edited by Borko Furht, CRC Press, 2007

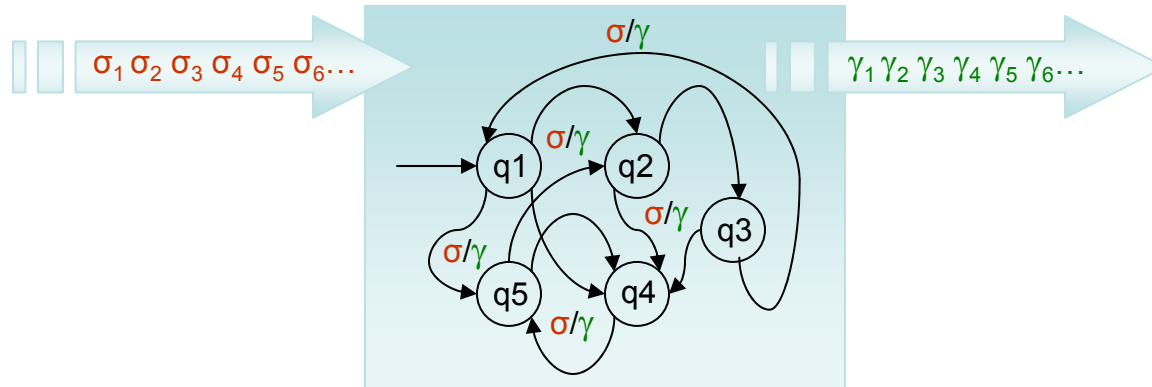
Conferences

- 5 - Andrew Roczniak, Ross Kouhi and Abdulmotaleb El Saddik, "Design of Application-Specific Incentives in P2P Networks", In Proceedings of the 12th IEEE International Symposium on Distributed Simulation and Real Time Applications (DS-RT 2008), October 27 - 29, 2008 Vancouver, British Columbia, Canada
- 6 - Andrew Roczniak, Alexandre Miège and Abdulmotaleb El Saddik, "Security Considerations for SOA-based Multimedia Applications". In Proceedings of the IEEE International Symposium on Multimedia (ISM 2006), December 11-13, 2006, San Diego, California, USA
- 7 - Andrew Roczniak, Jamil Melhem, Pierre Lévy and Abdulmotaleb El Saddik, "Design of Distributed Collaborative Application through Service Aggregation", In Proceedings of the 10th IEEE International Symposium on Distributed Simulation and Real Time Applications (DS-RT 2006), Oct. 2-6, 2006, Torremolinos, Malaga, Spain
- 8 - Andrew Roczniak, Salinah Janmohamed, Christian Roch, Abdulmotaleb El Saddik and Pierre Lévy, "SOA-based Collaborative Multimedia Authoring", In Proceedings of 2nd Montréal Conference on e-Technologies (MCeTECH'06), May 17-19, 2006, Montréal, Canada
- 9 - Andrew Roczniak and Abdulmotaleb El Saddik, "JADE: Jabber-based Authoring in Distributed Environments" In Proceedings of 13th Annual ACM International Conference on Multimedia (ACM-MM 2005), November 06-12, 2005, Singapore
- 10 - Andrew Roczniak and Abdulmotaleb El Saddik, "Impact of Incentive Mechanisms on Quality of Experience" In Proceedings of 13th Annual ACM International Conference on Multimedia (ACM-MM 2005), November 06-12, 2005, Singapore.
- 11 - Andrew Roczniak, Abdulmotaleb El Saddik and Pierre Lévy, "Survey of Collaborative Environments", In Proceedings of 17th Canadian Conference on Electrical and Computer Engineering (CCECE 2004), May 2004, Niagara Falls, Canada



Appendix

Finite State Transducers



notation:

$\sigma_i \in \Sigma$	$\gamma_i \in \Gamma$	Alphabet
$q_i \in Q$		States
$\omega: Q \times \Sigma \rightarrow \Gamma$		Output function
$\delta: Q \times \Sigma \rightarrow Q$		Transition function

interpretation:

A transducer computes a relation on $\Sigma^* \times \Gamma^*$

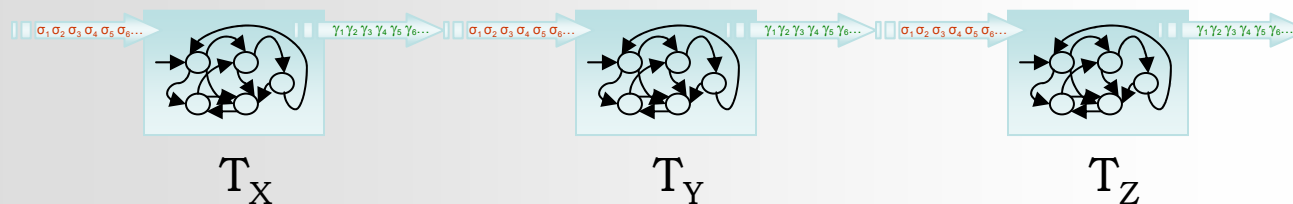
Those relations are called regular, and are expressed as $R_T = \{(s_i, s_o) \mid s_i \in \Sigma^*, s_o \in \Gamma^*\}$



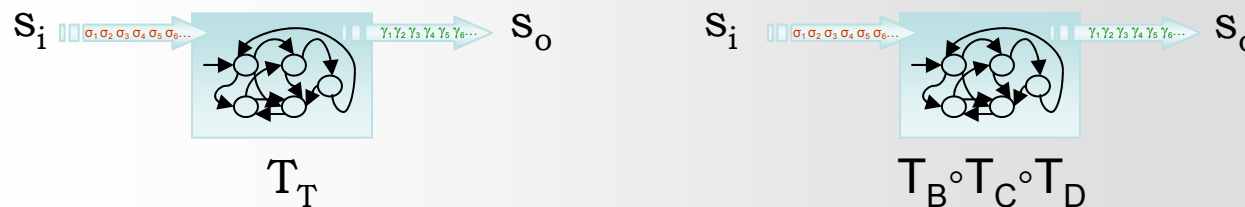
Appendix

Problem Formulation

Given a composition operator on transducers, $T_X \circ T_Y \circ T_Z$:



a target transducer T_T and a candidate transducer T_C ,
then find transducers T_B and T_D such that $R_T \subseteq R_{T_B \circ T_C \circ T_D}$



In other words, if the target transducer outputs a sequence s_o to some input sequence s_i , then the $T_B \circ T_C \circ T_D$ transducer will also output s_o when presented with s_i .