

**“Towards Modeling and Reasoning Support for Early-phase  
Requirements Engineering”,  
RE’07 MIP Award for papers from RE’97**

***What happened since? What’s next?***

Eric Yu

University of Toronto • iSchool



RE@21 Spotlight session: RE's Most Influential Papers  
IEEE Int. Conf. on Requirements Engineering (RE’13)  
July 15-19, 2013, Rio de Janeiro, Brazil

## Outline

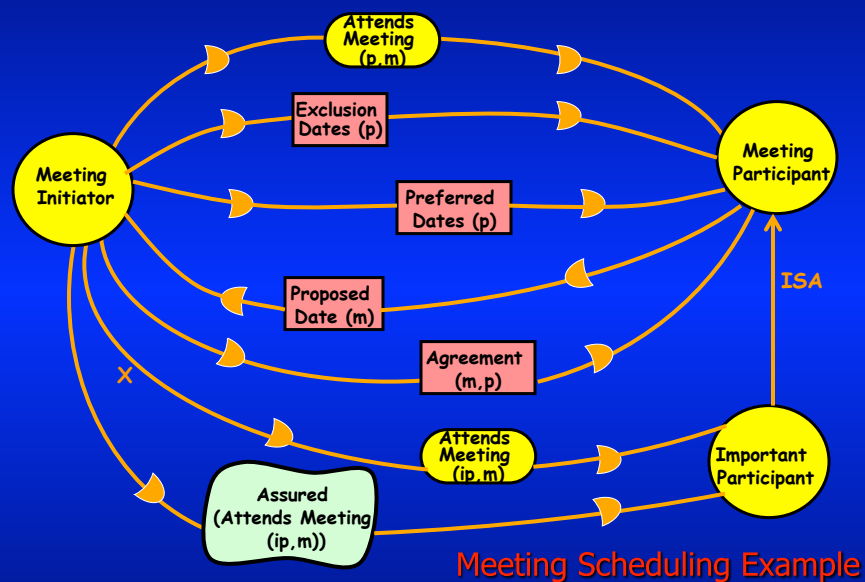
0. What was the paper about?
1. What activities since?
2. What practical applications?
3. What recent activities? New threads?

Towards Modeling and Reasoning Support for Early-Phase Requirements Engineering , RE'97

## Motivations

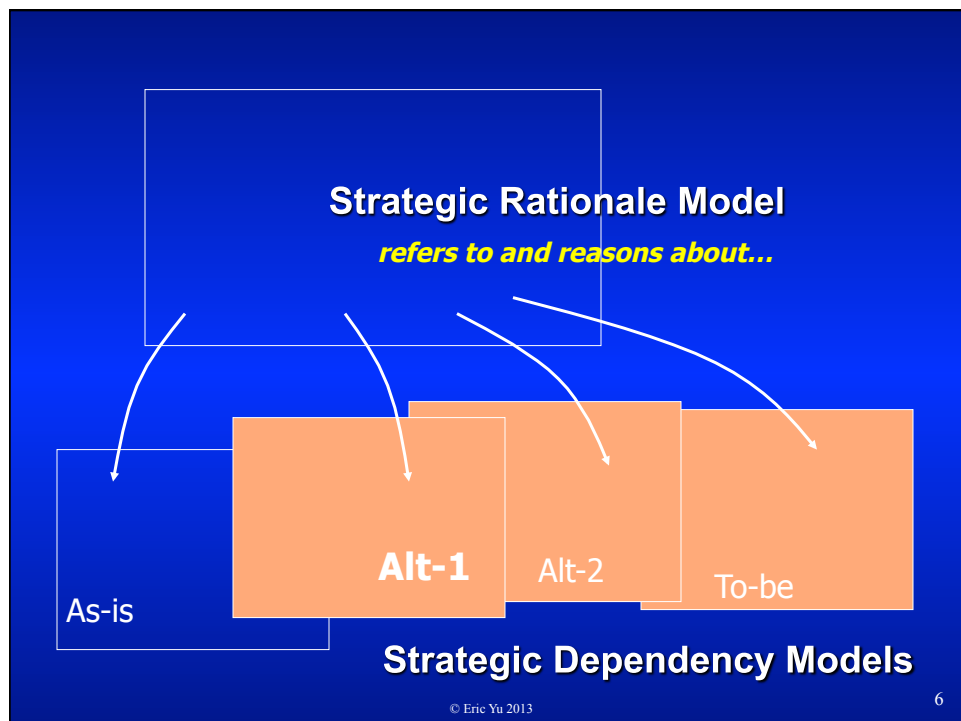
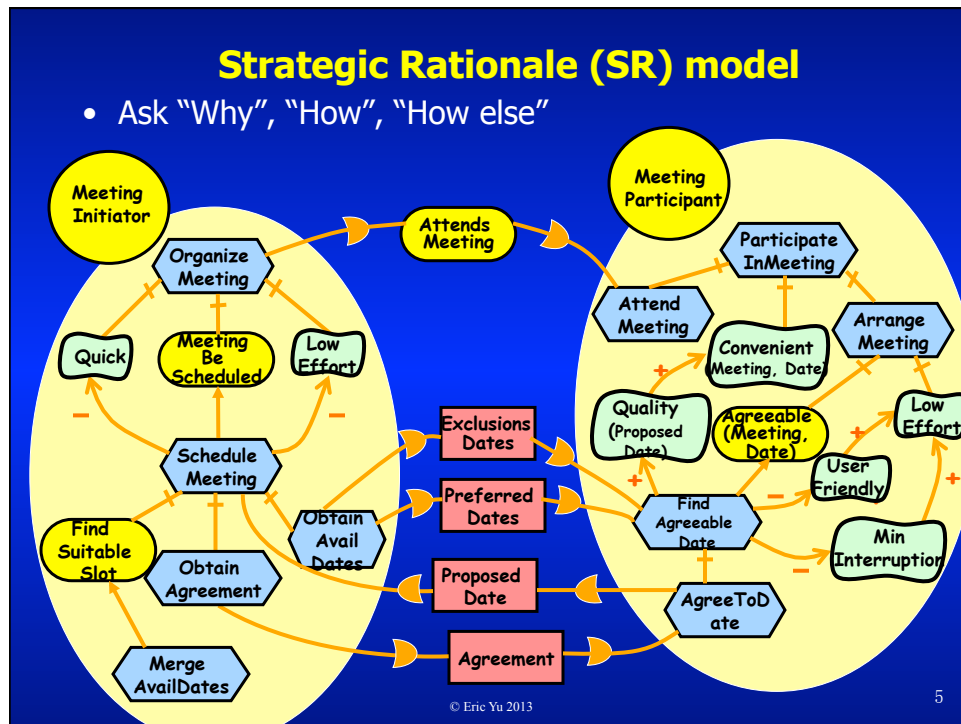
- Much of RE work focuses on "late RE".
- "Early RE" also important because want to:
  - Uncover hidden assumptions, eg stakeholder interests, abilities, ... (the "why's")
  - Explore alternatives, analyze consequences for stakeholders, avoid failures
  - Relate to business and organizational objectives
  - Support change, through traceability to rationales
  - Develop and share domain understanding
  - Have organizational context to facilitate cooperation across systems

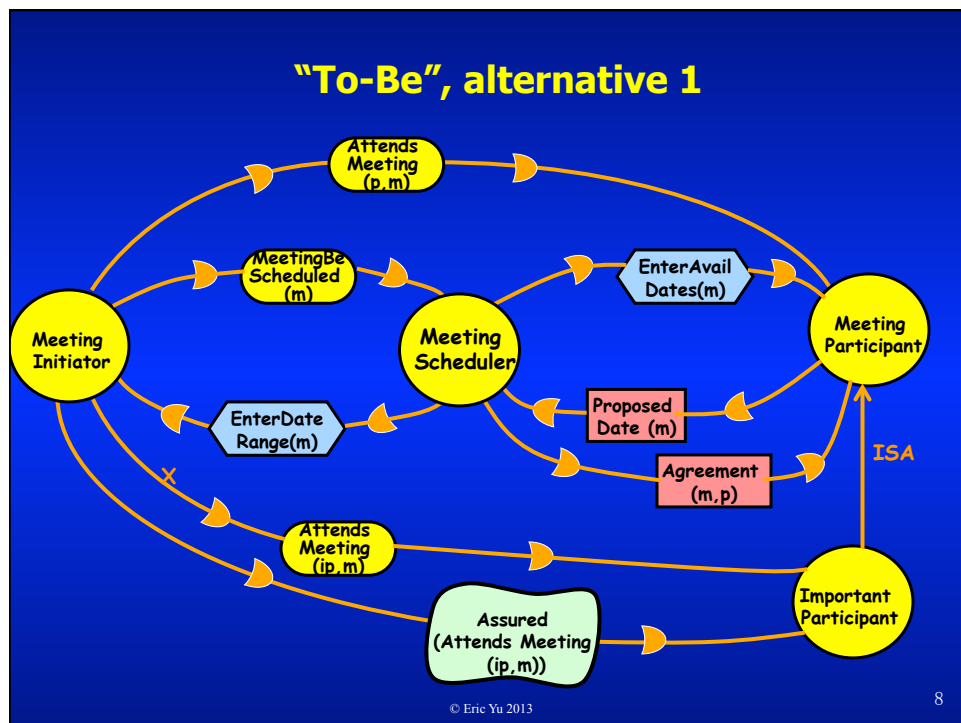
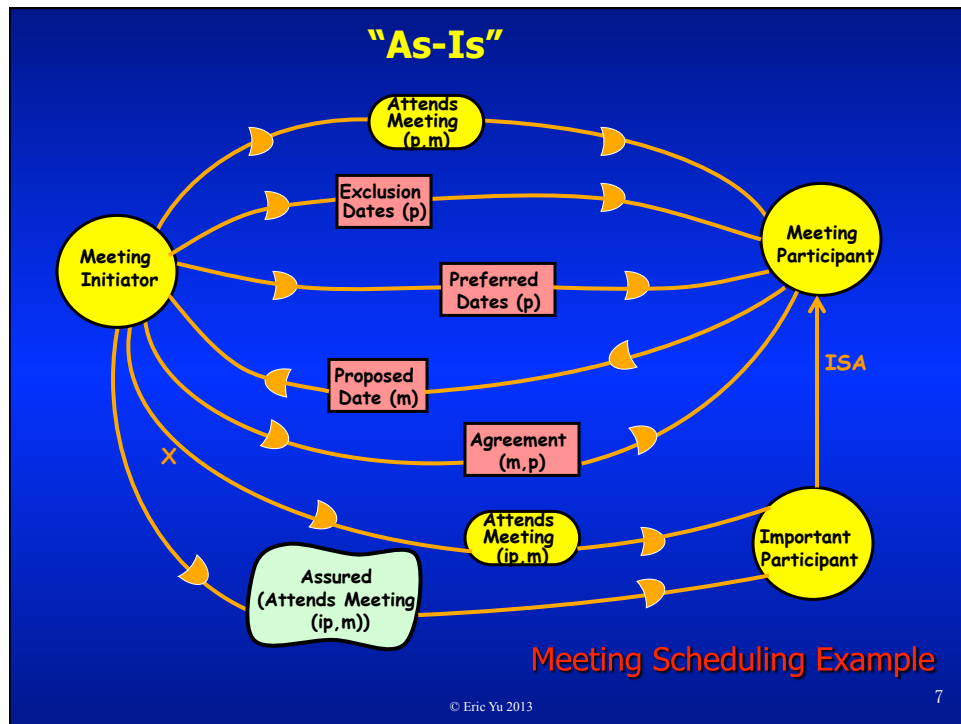
## Strategic Dependency (SD) model

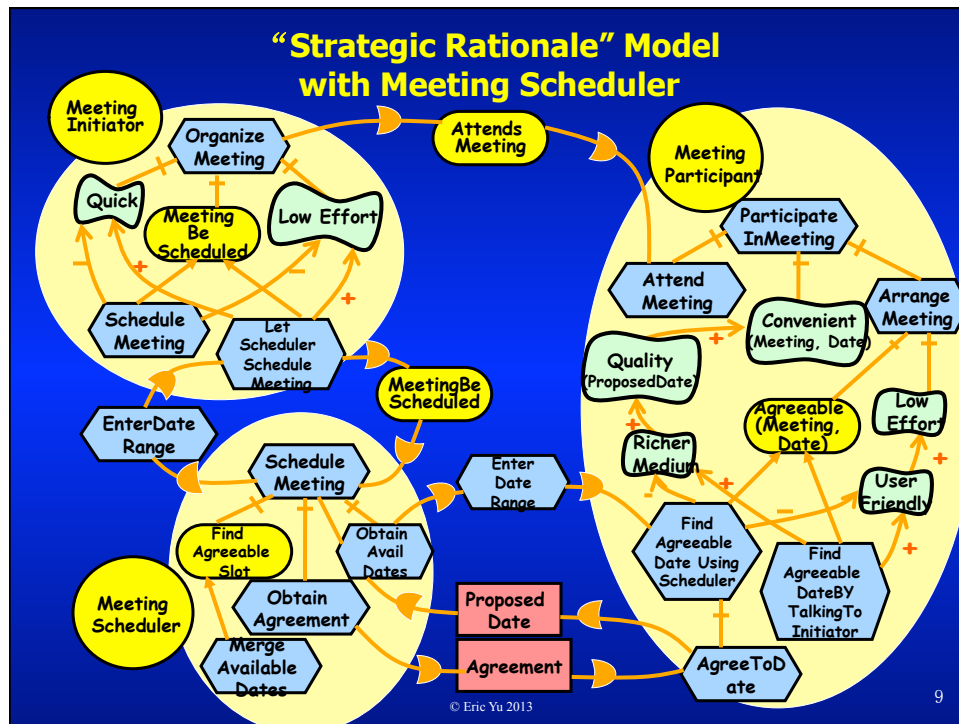


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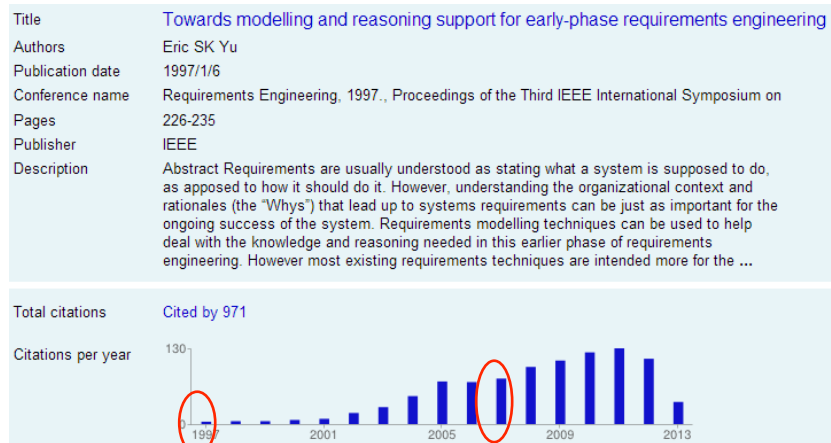
Towards Modeling and Reasoning Support for Early-Phase Requirements Engineering , RE'97

*i\** was offered as an example to motivate and illustrate this question:

### What kinds of modeling and reasoning support do we need for Early RE?

- Knowledge representation and reasoning
- Not over-formalize – eg “softgoals”
- Incorporate intentionality (the *i* in *i\** ☺)
- Multi-lateral intentional relationships
- Distributed intentionality (the *\** in *i\** ☺)
- Means-ends reasoning (goal-based)
- Organizational actors (agents, roles, positions)

## From Google Scholar...



## 1. Activities?

# First Inter-Galactic Workshop on Tropos

IRST-ITC

Trento

November 15-16, 2001

## Tropos

<http://www.cs.toronto.edu/km/tropos>

<http://www.science.unitn.it/tropos>

- Tropos is a project launched almost two years ago at the University of Toronto.
- The objective of the project is to define an agent-oriented software development methodology which is founded on concepts used to model early requirements.
- The concepts that have been adopted are based on Eric Yu's i\* modeling framework.
- The project currently involves at various levels of commitment more than twenty researchers from different universities and research institutes.

## The workshop

- The purpose of the workshop is to bring together researchers working on Tropos and  $i^*$ , so that they can present their current work and discuss short- and long-term research objectives.
- The workshop is also intended as an opportunity to establish and/or further collaborations among participating researchers.

## The program

### Thursday 15

- |      |  |
|------|--|
| 2    | Welcome  |
| 2.10 | Toronto/Trento/Aachen research overview<br><i>John Mylopoulos , Paolo Traverso, Matthias Jarke</i>   |
| 3    | <i>Modelling Complex Design Trade-off Spaces with <math>i^*</math></i><br>Neil Maiden - Centre for HCI Design, City University London  |
| 4    | Coffee break   |
| 4.30 | <i>Enhancing Requirements Engineering by Quality Modelling:<br/>a structured Framework</i><br>Paolo Donzelli - Presidenza del consiglio dei Ministri   |
| 5.30 | <i>A Methodology for Eliciting Requirements and Processes<br/>Re-engineering Using <math>i^*</math></i><br>Luiz Marcio Cysneiros - University of Toronto<br>Daniel Gross - University of Toronto |
| 21   | <i>Social Dinner ☺</i>   |



## The program

### Friday 16

- 9      *Model Checking Early Requirements Specifications in Tropos*  
Marco Pistore - IRST-ITC
- 10     *Modeling Organisation Networks with Tropos: A Trust-Centered Approach*  
Matthias Jarke, Gerhard Lakemeye - RWTH Aachen
- 11     Coffee break
- 11.30   *Social Structures in Tropos*  
Manuel Kolp - University of Louvain  
Paolo Giorgini - University of Trento
- 12.30   Lunch
- 2      *A Knowledge Level Software Engineering Methodology for Agent Oriented Programming. The Tropos framework.*  
Fausto Giunchiglia - University of Trento

## The program

### 3 Short presentations

- The Tropos Advantage*  
Eric Yu University of Toronto
- Using i\* for modelling early requirements of a computer system for hospital emergency departments*  
Michaël Petit - University of Namur
- Modeling Information Technology needs for the Agriculture domain*  
Anna Perini, Angelo Susi - IRST-ITC
- 4      Coffee break
- 4.30   *Algorithms for Goal Analysis*  
Roberto Sebastiani - University of Trento
- Transformational approach for the design process*  
Paolo Bresciani - IRST-ITC
- Closing

## Social Dinner

CHIESA

Ristorante

Parco San Marco

Phone: 0461-238766

Meeting:

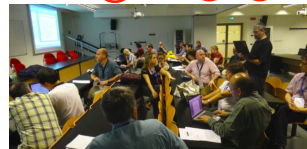
8.30 Piazza Duomo

## iStar workshop series



- iStar workshops

- 2001 Trento
- 2005 London
- 2008 Recife
- 2010 Hammamet
- 2011 Trento @RE
- 2013 Valencia



iStar'11 @RE Trento



iStar'13 @CAiSE Valencia

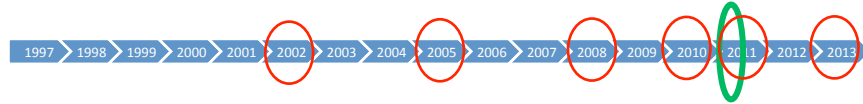
- CEUR Proceedings

- J. Castro, X. Franch, J. Horkoff, E. Yu, J. Mylopoulos, A. Perini (editors)



Tool demos

## Industry showcase



- **“Exploring the Goals of your Systems and Businesses:  
Practical experiences with i\* modelling**
  - 2011 London
  - Co-sponsored by BCS RESG and City U London
  - 19 presentations with posters
  - Organizers: N. Maiden, E. Yu, X. Franch, J. Mylopoulos



## The “i\* book”

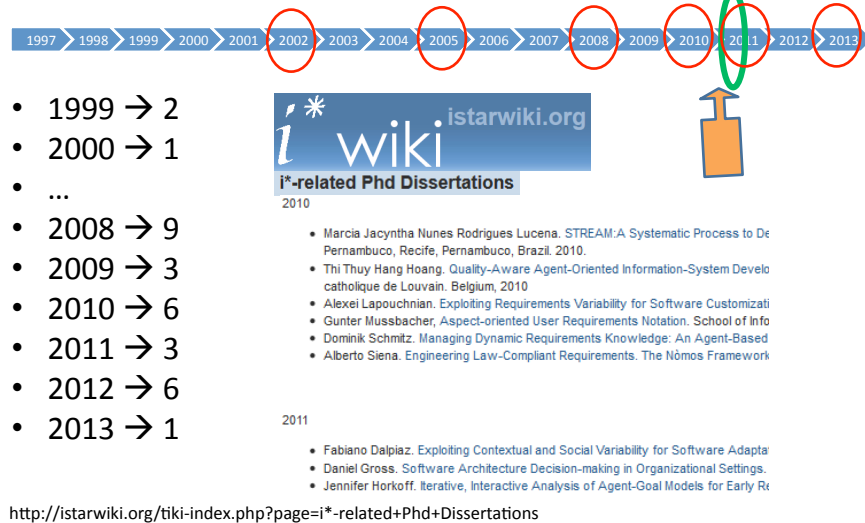


### ***Social Modeling for Requirements Engineering***

- MIT Press 2011. 742 pp.
- E. Yu, P. Giorgini, N. Maiden, J. Mylopoulos
- Reprint of 1995 PhD dissertation
- + 18 chapters on applications from many author



## PhD dissertations



## International Standard

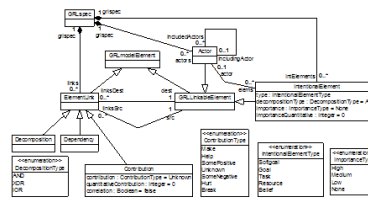
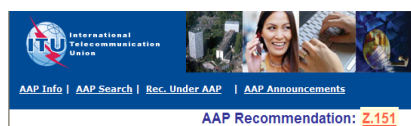
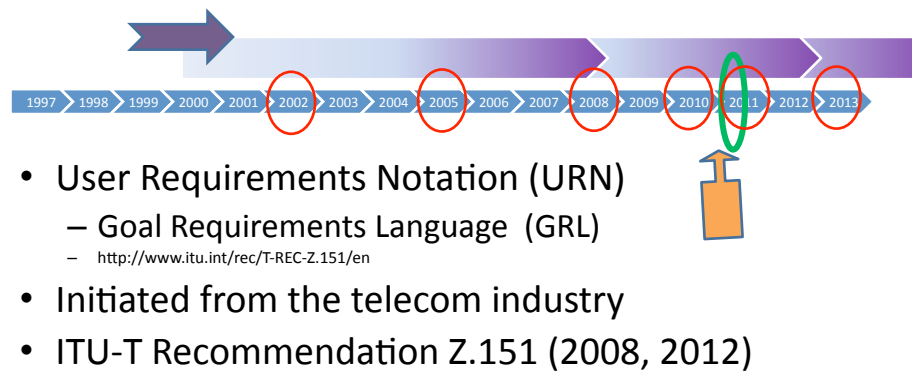




Figure 3/Z.151 GRL specification concepts



# Tools

- Canada (U Toronto)
  - OME, OpenOME
- Canada (U Ottawa)
  - jUCMnav for URN
- England & Spain
  - REDEPEND- REACT
- Italy
  - TAOM4E , GR Tool, T Tool , ST Toc
- Spain
  - GR-Tool , J-PRiM
- Germany
  - Snet Tool
- Brazil
  - Istar Tool, xGOOD, GOOSE
- Belgium
  - DesCARTES




## Available i\* Tools

See a table summary of the features exhibit by this tools in the section [Comparing the i\\* Tools](#).  
See the published metamodels in the section [i\\* Metamodels](#).

- OpenOME
  - As a standalone application and as a plug-in for other popular tools, such as Ec modeling and analysis tool.
- OME
  - A graph editor to support goal-oriented and/or agent-oriented modeling.
- REDEPEND-REACT-BCN
  - REDEPEND-REACT is a tool that supports i\* modelling and the analysis of the res on the representation of the information system using the i\* framework and prov for the modelled information system.
- TAOM4E
  - TAOM4E supports a model-driven, agent oriented software development and, in Architecture (MDA) recommendations.
- GR-Tool
  - Forward and backward reasoning is supported in Tropos by a Goal Reasoning goal models and run the algorithms and tools for forward and backward reason embedded in the GR-Tool.
- T-Tool

22 listed on i\* wiki  
[http://istarwiki.org/tiki-index.php?page=i\\*+Tools&structure=i\\*+Wiki+Home](http://istarwiki.org/tiki-index.php?page=i*+Tools&structure=i*+Wiki+Home)

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# i\* variants & extensions

- Tropos – Mylopoulos, Giorgini, Perini, Castro, Kolp, ...
- GRL – Amyot, Yu, Liu, Mussbacher, Weiss, ...
- TCD – Gans, Lakemeyer, Kethers, Jarke, Schmitz, ...
- REF – Donzelli, Bresciani
- HUCRE – Gregoriadis, Shin, Sutcliffe,
- ERA - Sutcliffe
- RESCUE – Maiden, Jones, ...
- Nomos - Siena, Ingolfo, Perini, Susi, Mylopoulos...
- ...
- Secure Tropos UK – Mouratidis, Giorgini, ...
- Secure Tropos Italy – Giorgini, Massacci, Zannone, ...
- Secure i\* - Elahi, Yu, Liu
- Si\* - Zannone, Massacci, ...
- ...

- BASSiE – vdRaadt, Gordijn, Yu
- SBMO – Samavi, Yu ,...
- PRiM, RiSD – Grau, Franch,...
- CASL – Lesperance, Wang, Lapouchnian,
- ...
- Q-MOPP - Briand, Seaman, Basili,...
- KTA – Strohmaier, Horkoff, Yu ,...
- ...

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In Business Process Management, Vol. 4714 (2007), pp. 246-261, [doi:10.1007/978-3-540-75183-0\\_18](#)  
by [Alexei Lapouchnian](#), [Yiun Yu](#), [John Mylopoulos](#)  
edited by [Gustavo Alonso](#), [Peter Dadam](#), [Michael Rosemann](#)  
posted to [goal-oriented](#) [non-functional](#) [personalization](#) [process-modeling](#) [requirements-engineering](#) [variability](#) [annotation](#) [bpe](#) [configuration](#) by [alexexi](#) to the group [i-star](#) keyed [Lapouchnian2007RequirementsDri](#)  
2013-07-15 16:42:38 ✓/ along with 2 people  
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☐ **Towards supporting business services discovery through the integration of organizational model ontologies.**  
In Memorias de la XVI Conferencia Iberoamericana de Ingeniería de Software CibSE 2013 (8 April 2013), pp. 21:  
by [Blanca Vazquez](#), [Alicia Martinez](#), [Anna Perini](#), [Hugo Estrada](#), [Mirko Morandini](#)  
edited by [Diego Vallespir](#), [Márcio de Oliveira Barros](#)  
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Vazquez2013Towards on 2013-07-09 19:55:43 ★★★★★/  
■ Abstract ■ Copy

☐ **Extension and integration of i\* models with ontologies**  
In Proceedings of the 6th International i\* Workshop 2013, Vol. 978, No. 2. (17 June 2013), pp. 7-12

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**Tag cloud**

**Group: i-star 114 tags**

All tags in this group's library

\_adaptive-systems<sup>20</sup> \_\_agent-oriented<sup>6</sup> \_\_agent-oriented-system-development<sup>24</sup> \_\_air-traffic<sup>1</sup>  
\_aourn<sup>13</sup> \_\_aspect-oriented<sup>19</sup> \_\_bim<sup>6</sup> \_\_business-intelligence<sup>13</sup> \_\_business-modeling<sup>23</sup>  
\_comparision<sup>21</sup> \_\_compliance<sup>18</sup> \_\_data-warehousing<sup>8</sup> \_\_e-services<sup>5</sup> \_\_e3value<sup>3</sup> \_\_elicitation<sup>11</sup>  
\_\_empirical-case-study<sup>24</sup> \_\_enterprise-architecture<sup>3</sup> \_\_environmental<sup>2</sup> \_\_evolution<sup>11</sup> \_\_experiment<sup>1</sup> \_\_formal-specification<sup>1</sup>  
\_\_goal-model-reasoning<sup>66</sup> \_\_goal-oriented<sup>10</sup> \_\_grl<sup>15</sup> \_\_healthcare<sup>26</sup> \_\_i-star<sup>9</sup>  
\_\_indicators<sup>17</sup> \_\_industry-led<sup>4</sup> \_\_industry-partnered<sup>23</sup> \_\_intellectual-property-management<sup>2</sup> \_\_istar<sup>245</sup>  
\_istar-discussed<sup>8</sup> \_\_istar-mentioned<sup>29</sup> \_\_istarfordws<sup>3</sup> \_\_jucmnav<sup>19</sup> \_\_kaos<sup>2</sup> \_\_knowledge-management<sup>13</sup>  
\_\_language<sup>30</sup> \_\_metamodel<sup>28</sup> \_\_method-engineering<sup>11</sup> \_\_metrics<sup>4</sup> \_\_model-checking<sup>4</sup> \_\_modeling<sup>35</sup>  
\_multi-agent<sup>4</sup> \_\_nfr<sup>11</sup> \_\_non-functional<sup>13</sup> \_\_ontology<sup>16</sup> \_\_organization-architecture<sup>6</sup> \_\_patterns<sup>12</sup>  
\_personalization<sup>5</sup> \_\_privacy<sup>2</sup> \_\_process-modeling<sup>27</sup> \_\_process-reengineering<sup>7</sup> \_\_project-management<sup>1</sup> \_\_quantitative<sup>5</sup>  
\_\_requirements<sup>28</sup> \_\_requirements-engineering<sup>129</sup> \_\_reuse<sup>1</sup> \_\_safety<sup>1</sup> \_\_scenario-oriented<sup>8</sup>  
\_\_sd-model<sup>17</sup> \_\_security<sup>15</sup> \_\_service-oriented<sup>5</sup> \_\_simulation<sup>2</sup> \_\_socio-tech-system-design<sup>10</sup>  
\_software-process-improvement<sup>5</sup> \_\_software-process-modeling<sup>11</sup> \_\_software-product-lines<sup>1</sup> \_\_sr-model<sup>28</sup>  
\_\_system-architecture<sup>17</sup> \_\_system-development-methodology<sup>28</sup> \_\_thesis-masters<sup>2</sup> \_\_thesis-phd<sup>6</sup> \_\_tool<sup>1</sup>  
\_\_trade-off<sup>10</sup> \_\_tropos<sup>26</sup> \_\_trust<sup>15</sup> \_\_umi<sup>15</sup> \_\_uncertainty<sup>1</sup> \_\_urn<sup>45</sup> \_\_usage-methodology<sup>22</sup> \_\_use-cases<sup>3</sup>  
validation<sup>3</sup> variability<sup>10</sup> \_\_visualization<sup>1</sup> web-engineering<sup>5</sup> web-modeling-methods<sup>5</sup> \_\_cots<sup>1</sup> acme<sup>1</sup> conceptual<sup>1</sup> context-aware

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## 2. Practical Applications?

### Application domain settings

- Air traffic control
- Food safety
- Hospital wards
- Public health
- Social service organizations
- ...





## Beyond "Early RE"

- Business process modeling
  - Business modeling
- Security, Privacy, Trust,
  - Compliance
- Software methodologies (eg. Tropos)
  - Software processes (e.g., agile)
  - Software ecosystems
- Requirements to architecture
  - Software product lines
- ...

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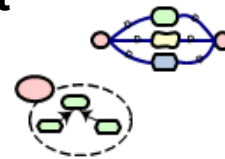
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## Practical Applications of i\* in Industry: The State of the Art



Mini-tutorial @ RE'13 Rio de Janeiro  
July 19, 2013

**This Friday 11-12:30**



**Eric Yu**  
U. Toronto  
Canada



**Daniel Amyot**  
U. Ottawa  
Canada



**Gunter Mussbacher**  
McGill Univ.  
Canada



**Xavier Franch**  
U.P. Catalunya  
Spain



**Jaelson Castro**  
U.F. Pernambuco  
Brazil



## Some early applications (1995~2005)

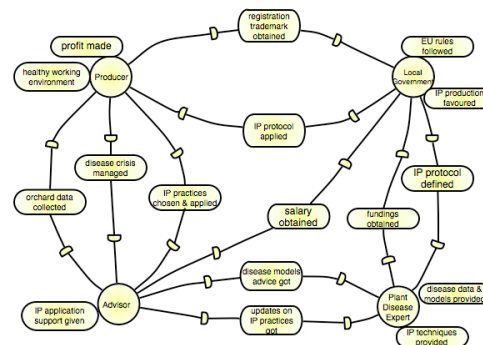
## Software maintenance organization

- Organizational issues in software maintenance

## Agriculture



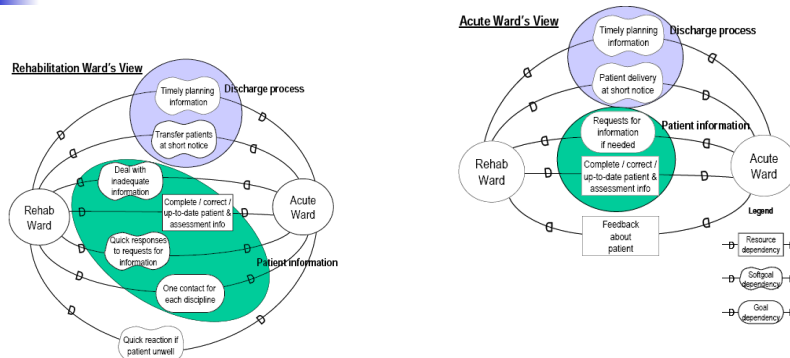
### Decision support in the design of a pheromone trapping system



35 A. Perini and A. Susi, Designing a Decision Support System for Integrated Production in Agriculture, An Agent-Oriented approach, Environmental Modelling and Software Journal, 19(9), September 2004.c

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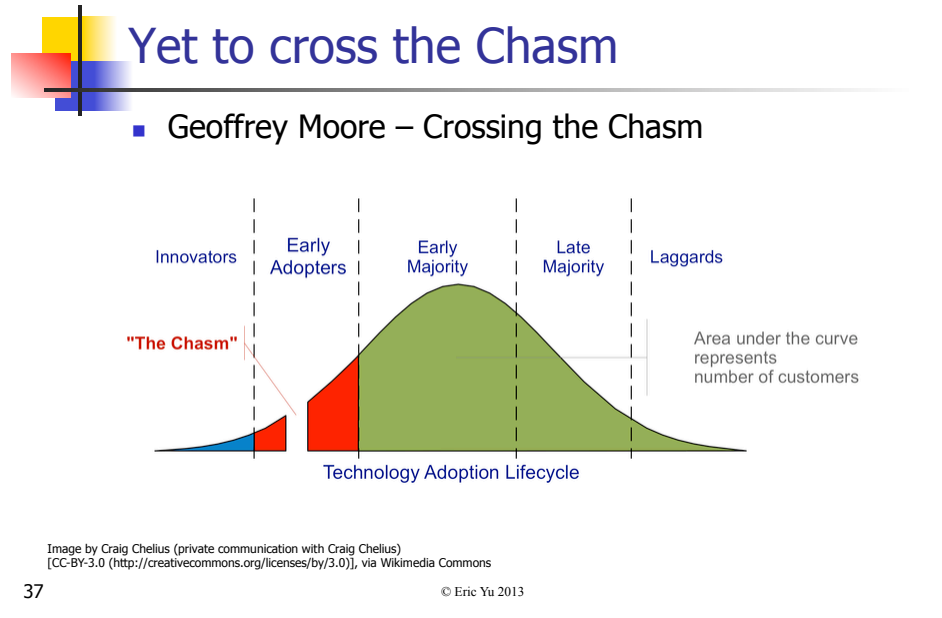
## Trust between hospital wards



Modelling Trust Relationships In A Healthcare Network: Experiences With The TCD Framework  
Kethers, Stefanie, Gans, Günter, Schmitz, Dominik, Sier, David, ECIS 2005

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## Too much diversity?

- Standardization
  - URN standard
- Diverse usage contexts and application domains
- Industry adoption vs research

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## 3. Recent Activities? New threads?



## Recent activities (esp. phd work)

- Variability – [Liaskos'08]...
  - Adaptive systems – [Lapouchnian'10][Silva'12]...
  - Context-aware – [Dalpiaz'11]
  - Software ecosystems - [Deng'10], RISCOSS...
  - Agile – [Chiniforooshin'12]
  - Aspect-oriented – [Mussbacher'10]
  - Managing req't knowledge – [Schmitz'10]
  - Compliance – [Siena'10][Shamsaei'12]
  - Goal model Evaluation – [Horkoff'11]
  - Risk – [Asnar'09]
  - Security trade-offs [Elahi'12]
  - Intentional architecture [Gross'11]
  - Service value co-creation [Lessard]
  - ... many more on i\* wiki and CiteULike
- [http://istarwiki.org/tiki-index.php?page=i\\*-related+Phd+Dissertations](http://istarwiki.org/tiki-index.php?page=i*-related+Phd+Dissertations)

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## New threads

- 1. BI-enabled Adaptive Enterprise Architecture
  - extend i\* modeling for complex dynamic adaptive enterprise
  - BIN network, BIM model
- 2. Know-how maps
  - Means-ends knowledge as the central conceptual structure of technological knowledge
  - Model the know-how landscape of any technological domain
    - to ease dissemination of new know-how
    - to highlight knowledge gaps

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## References

- **i\* homepage** <http://www.cs.toronto.edu/km/istar/>
- **i\* wiki** <http://istarwiki.org>
- **CiteULike** <http://www.citeulike.org/group/14571>
- **iStar'13** <http://www.cin.ufpe.br/~istar13/>
- **iStar workshops** <http://dblp.dagstuhl.de/db/conf/istar>
- **iStar showcase'11** <http://tinyurl.com/istarshowcase11>
- **Social Modeling for Requirements Engineering, MIT Press**

**Thank you!**