Recent Studies on *i**: A Survey

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Abstract. *i** is studied extensively in the requirements engineering and information systems engineering literature since the 90s. The language itself is gradually evolving and extended to *i*Star 2.0, and peoples interest of study is also evolving in the meantime. In this paper, we surveyed recent papers in a few major research databases, identifying key research issues people are aiming at while study *i** language. We classified the work according to the content and nature of the studies, such as, modelling language, techniques, modelling applications, and teaching. This helps us understand the recent research interest centered around *i** modelling language, and discuss about possible further directions for *i** related research and practice.

Keywords: *i**, *i*Star, Empirical Study, Taxonomy

1 Intorduction

*i** has been widely studied as a social modelling language, centred around the concepts of goals, actors and social dependencies. It plays a significant role in modelling organizations, social roles, actors intentions and their interdependencies. People in requirements engineering and information systems engineering community are publishing research work related to different perspectives of *i**. In order to understand the state of the research better, we retrieved recent papers from a few major research databases. The objective of this survey study is to identify the key research issues people are aiming at while study *i** language. We classified the work according to the content and the nature of the study, to reach a clear understanding on the recent research interest centered around the *i** modelling language, based on which we can identify possible further directions with more potential for *i** research and applications.

- **RQ1:** What is the basic classification of research studies in the area of *i*Star/*i**; specifically in Requirements Engineering (RE) field?
- **RQ2:** What are the challenges with respect to *i*Star/*i** discussed by the researchers in the studies?

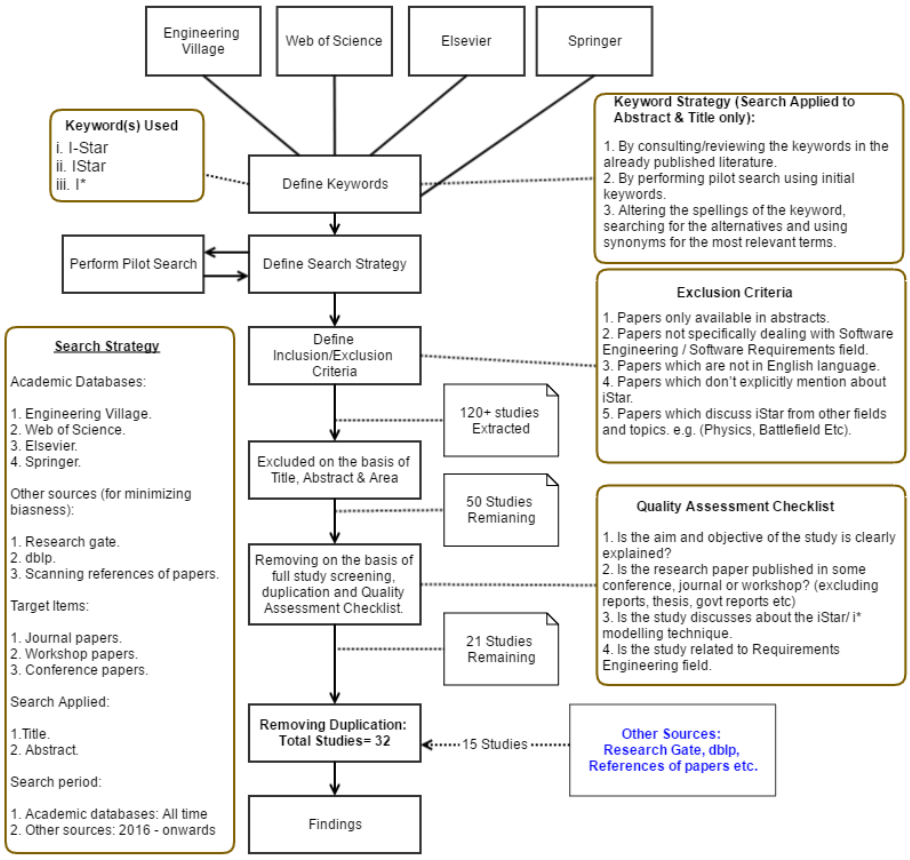

Fig. 1. Detail of SLR : Research Protocol

2 Research Methodology: Systematic Literature Review

We have used Systematic Literature Review (SLR) as a research methodology for this study. We have used Barbara Kitchenham guidelines [13] for performing SLR. The detail of the study can be seen in Figure 1.

We have searched Web of Science, Elsevier and Springer for the extraction of the I-Star related papers. Furthermore, we have searched Engineering Village for possible retrieval of the studies across different databases. Finally, we have searched blogs, papers, references and ResearchGate for further addition of papers. This is done so that we may minimize the biasness in the selection of the studies and also to get maximum of the studies to start. Figure 1 shows the detail of SLR protocol.

Table 1. Summary of Findings : Challenges Discussed

Reference	Challenges Discussed
[1]	Modularity not supported, Scalability Issues. Some solutions proposed for scalability and further tested by one case study.
[2]	Scalability & Usability challenges. Proposed extension for scalability challenge.
[3]	Discussed Usability challenge.
[4]	Solution discussed to mitigate scalability & Complexity challenges.
[5]	Proposed an approach. Scalability still need to be verified.
[6]	Scalability Challenges and solution by using modularity.
[7]	Discussed iStarML using XML challenges with respect to scalability.
[8]	Challenges and tradeoffs regarding i* tools. Discussed Usability, model scalability, installation & maintenance challenges.
[9]	Tool Usability, i^* Tool challenge discussed. Discussed Browser compatibility challenges.
[10]	Consistency challenges.
[11]	Student Adaptability challenge.
[12]	Discussed Model Consistency & completeness. Game based Learning.

Table 2. Summary of Findings : Classification

Reference	Classification
[1]	Application in DW, and extended the language by modules ->scalability problem of i^*
[14]	Application in cloud computing, positive
[2]	Application in web applications ->Scalability
[15]	Application: Tropos Framework for Modeling at high Level.
[16]	Application: (i^* and combination of Scrum)
[17]	Application : Ambient Intelligence App
[18]	Application: Social Threat Modeling - Security
[3]	Application; KBS
[19]	Application: CRS
[20]	Application in OSN
[21]	Application in OSN
[22]	Language (Modeling), i^* ->UML class diagram
[4]	Language ->textual model ->Scalability
[23]	Language ->iStar 2.0
[24]	Language ->comparison : i^* with DEMO
[25]	Language ->comparison : i^* with KAOS
[26]	Language Tool: iStar and Creativity
[5]	Language: Transformation i^* ->STREAM-A
[27]	Language: Ambiguity
[6]	Language: (i^* ML 2.0)
[28]	Language: Guide i^* 2.o
[7]	Language: i^* JSON
[29]	Language: Model repository
[8]	Tool: Survey
[9]	Tool : Growing Leaf Evolution tool
[30]	Technical: Changes impact analysis based on iStar
[31]	Technical: Easier Repository of i^* based Models
[10]	Technical: Identify Consistency Issues in URN Models
[32]	Technical : Reasoning of Qualities
[33]	Technical: Patterns in IS design
[11]	Teaching: Cohorts
[12]	Teaching: Extension of iStar

3 Findings

Based on the survey analysis from Table 1, we can see major open problems yet to be solved with regard to i^* modelling language are: the scalability problem, the clarity problem, and combined use problem. For clarity problem iStar 2.0

has made considerable progress in clarity in modelling syntax and semantics, where earlier vague and confusing definitions and usage suggestions are polished and clarified. Scalability problem remains open, but with actor boundary, we can already separate the analysis of inter-actor relationship analysis and the inner-actor rational analysis. *i**, as an early requirement modelling language, is often used together with other modelling languages to map high-level intentions to operational system behaviours or constraints, including, *i**with UML class diagrams, with URN models, with scrum process, with KAOS, with DEMO, with petri-net. *i**, due to its social nature, is fairly feasible in capturing relations in online social networks, in services modelling, in security, and in knowledge modelling.

Table 2 explains that the studies included in the SLR on the topic of *i** can be divided into fours main categories. First one is studies focusing on Applications of *i** e.g., Application in a web application, Application in Online Social Networking and so on. The second type of studies has a focused on language/tools related to *i**. e.g. creative leaf, language comparison, and language advancement. The third type of papers focuses on technical aspects of *i** e.g. patterns in Information system design and the last categorization focused on the teaching/education aspect of the *i**. The detail of papers and classification can be seen in the Table 2.

We have observed during our empirical study that by searching *i** or " *i** " don't retrieve the results related to *i*Star, as in database "*" means any combination of previous word or string. So from our study we also suggest researchers must use *i*Star or *i** wordings in keywords, abstract and title of the study; so that studies may be retrieved with ease.

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References

1. Maté, A., Trujillo, J., Franch, X.: Adding semantic modules to improve goal-oriented analysis of data warehouses using i-star. Journal of systems and software **88** (2014) 102–111
2. Aguilar, J.A., Zaldívar, A., Tripp, C., Misra, S., Sánchez, S., Martínez, M., García, O.V.: A solution proposal for complex web application modeling with the i-star framework. In: International Conference on Computational Science and Its Applications, Springer (2014) 135–145
3. Basden, A., Brown, A.J.: Istara tool for creative design of knowledge bases. Expert Systems **13**(4) (1996) 259–276
4. Penha, F., Lucena, M., Lucena, L., Angra, C., Alencar34, F.: A proposed textual model for i-star. (2016)
5. Pimentel, J., Lucena, M., Castro, J., Silva, C., Santos, E., Alencar, F.: Deriving software architectural models from requirements models for adaptive systems: the stream-a approach. Requirements Engineering **17**(4) (2012) 259–281

6. Cares, C., López, L.: Towards istarml 2.0: Closing gaps from evolved requirements. In López, L., Yu, Y., eds.: Proceedings of the Ninth International i* Workshop co-located with 24th International Conference on Requirements Engineering (RE 2016), Beijing, China, September 12-13, 2016. Volume 1674 of CEUR Workshop Proceedings., CEUR-WS.org (2016) 91–96
7. Franco-Bedoya, O., Ameller, D., Costal, D., López, L.: istarjson: A lightweight data-format for i^* models. In López, L., Yu, Y., eds.: Proceedings of the Ninth International i* Workshop co-located with 24th International Conference on Requirements Engineering (RE 2016), Beijing, China, September 12-13, 2016. Volume 1674 of CEUR Workshop Proceedings., CEUR-WS.org (2016) 37–42
8. Li, T., Grubb, A.M., Horkoff, J.: Understanding challenges and tradeoffs in istar tool development. (2016)
9. Grubb, A.M., Song, G., Chechik, M.: Growingleaf: Supporting requirements evolution over time. In López, L., Yu, Y., eds.: Proceedings of the Ninth International i* Workshop co-located with 24th International Conference on Requirements Engineering (RE 2016), Beijing, China, September 12-13, 2016. Volume 1674 of CEUR Workshop Proceedings., CEUR-WS.org (2016) 31–36
10. Akhigbe, O., Amyot, D., Anda, A.A., Lessard, L., Xiao, D.: Consistency analysis for user requirements notation models. In López, L., Yu, Y., eds.: Proceedings of the Ninth International i* Workshop co-located with 24th International Conference on Requirements Engineering (RE 2016), Beijing, China, September 12-13, 2016. Volume 1674 of CEUR Workshop Proceedings., CEUR-WS.org (2016) 43–48
11. Svee, E.O., Zdravkovic, J.: istar instruction in mixed student cohort environments. In: iStarT@ CAiSE. (2015) 19–24
12. Oliveira, A.d.P.A., Werneck, V.M.B., do Prado Leite, J.C.S., Cysneiros, L.M.: The monopoly game to teach eri* c-intentional requirements engineering. In: iStarT@ CAiSE. (2015) 49–54
13. Brereton, P., Kitchenham, B.A., Budgen, D., Turner, M., Khalil, M.: Lessons from applying the systematic literature review process within the software engineering domain. Journal of Systems and Software **80**(4) (2007) 571 – 583 Software Performance5th International Workshop on Software and Performance.
14. Oktadimi, N.R., Surendro, K., et al.: Requirements engineering for cloud computing in university using i*(istar) hierarchy method. In: Information Science and Applications. Springer (2015) 885–890
15. Estrada, H., Najera, K., Vázquez, B., Martínez, A., Téllez, J.C., Hierro, J.J.: Applying tropos modeling for smart mobility applications based on the FIWARE platform. In López, L., Yu, Y., eds.: Proceedings of the Ninth International i* Workshop co-located with 24th International Conference on Requirements Engineering (RE 2016), Beijing, China, September 12-13, 2016. Volume 1674 of CEUR Workshop Proceedings., CEUR-WS.org (2016) 85–90
16. de Araujo, L.B., Siqueira, F.L.: Using i^* with scrum: An initial proposal. In López, L., Yu, Y., eds.: Proceedings of the Ninth International i* Workshop co-located with 24th International Conference on Requirements Engineering (RE 2016), Beijing, China, September 12-13, 2016. Volume 1674 of CEUR Workshop Proceedings., CEUR-WS.org (2016) 19–24
17. Guzman, A., Martínez, A., Agudelo, F.V., Estrada-Esquivel, H., Ortega, J.P., Ortiz, J.: A methodology for modeling ambient intelligence applications using i^* framework. In López, L., Yu, Y., eds.: Proceedings of the Ninth International i* Workshop co-located with 24th International Conference on Requirements Engineering (RE 2016), Beijing, China, September 12-13, 2016. Volume 1674 of CEUR Workshop Proceedings., CEUR-WS.org (2016) 61–66

18. Liu, L., Yu, E., Jabeen, G.: Social threats modelling with *i**. In López, L., Yu, Y., eds.: Proceedings of the Ninth International i* Workshop co-located with 24th International Conference on Requirements Engineering (RE 2016), Beijing, China, September 12-13, 2016. Volume 1674 of CEUR Workshop Proceedings., CEUR-WS.org (2016) 97–102
19. Bouraga, S., Jureta, I., Faulkner, S.: Modelling requirements for content recommendation systems. arXiv preprint arXiv:1606.05746 (2016)
20. Bouraga, S., Jureta, I., Faulkner, S.: Representation of rules for relevant recommendations to online social networks users. In: Artificial Intelligence for Requirements Engineering (AIRE), 2015 IEEE Second International Workshop on, IEEE (2015) 1–8
21. Bouraga, S., Jureta, I., Faulkner, S.: Requirements engineering patterns for the modeling of online social networks features. In: Requirements Patterns (RePa), 2014 IEEE 4th International Workshop on, IEEE (2014) 33–38
22. Melo, J., Sousa, A., Agra, C., Júnior, J., Castro, J., Alencar, F.: Formalization of mapping rules from istar to class diagram in uml. In: Software Engineering (SBES), 2015 29th Brazilian Symposium on, IEEE (2015) 71–79
23. López, L., Aydemir, F.B., Dalpiaz, F., Horkoff, J.: An empirical evaluation roadmap for istar 2.0. (2016)
24. Fatyani, T., Iijima, J., Park, J.: Comparing demo with i_star: In identifying software functional requirement. BMSD 2015 (2015)
25. Werneck, V.M.B., Oliveira, A.d.P.A., do Prado Leite, J.C.S.: Comparing gore frameworks: i-star and kaos. In: WER. (2009)
26. Horkoff, J., Maiden, N.: Creative leaf: A creative istar modeling tool. Proc. of iStar **16** (2016)
27. López, L., Franch, X., Marco, J.: Making explicit some implicit i* language decisions. In: International Conference on Conceptual Modeling, Springer (2011) 62–77
28. Dalpiaz, F., Franch, X., Horkoff, J.: istar 2.0 language guide. CoRR **abs/1605.07767** (2016)
29. Abad, K., Carvallo, J.P., Espinoza, M., Saquicela, V.: Towards the creation of a semantic repository of istar-based context models. In: Trends and Applications in Software Engineering. Springer (2016) 125–137
30. Aguilar, J.A., Tripp, C., Zaldivar, A., Garcia, O., Zurita, C.E.: Evaluating a requirements change request in a goal-oriented requirements engineering model. IEEE Latin America Transactions **14**(5) (2016) 2411–2417
31. Abad, K., Pérez, W., Carvallo, J.P.: Managing i*-based reusable context models elements through a semantic repository. In López, L., Yu, Y., eds.: Proceedings of the Ninth International i* Workshop co-located with 24th International Conference on Requirements Engineering (RE 2016), Beijing, China, September 12-13, 2016. Volume 1674 of CEUR Workshop Proceedings., CEUR-WS.org (2016) 67–72
32. Li, F., Liu, L., Mylopoulos, J.: Similarity-based reasoning with quality goals. In López, L., Yu, Y., eds.: Proceedings of the Ninth International i* Workshop co-located with 24th International Conference on Requirements Engineering (RE 2016), Beijing, China, September 12-13, 2016. Volume 1674 of CEUR Workshop Proceedings., CEUR-WS.org (2016) 13–18
33. Abad, K., Carvalho, J.P., Peña, C.: istar in practice: On the identification of reusable sd context models elements. In: iStar. (2015) 43–48