UNIVERSITÀ DEGLI STUDI
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Taking Goal Models Downstream: A Systematic Roadmap

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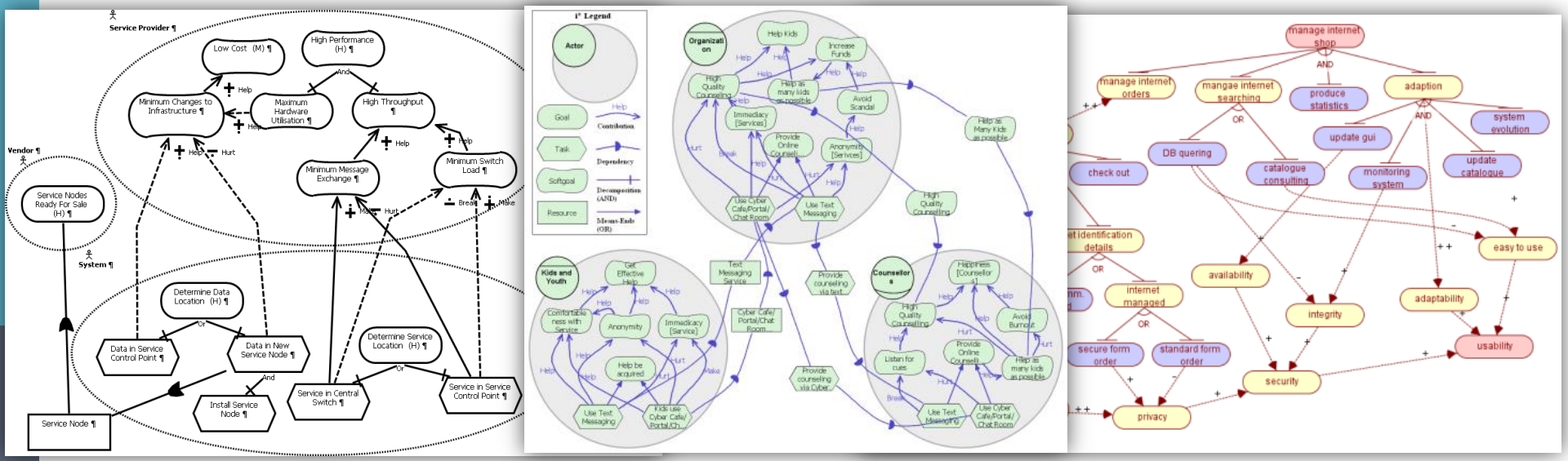
Motivations: Systematic Literature Map

- Most research focuses on new ideas and technical advances
- Some research is reflective
  - Looking at past progress, what has been done? What is true? What is missing?

- A systematic literature review can answer these questions
  - Evidence-based Software Engineering, Kitchenam et al.
  - "Evidence-based Requirements Engineering"
    - In our case: finding and summarizing publications in order to understand state-of-the art with respect challenges in goal model downstream integration

Background: Goal Models

- Successful software must adequately address the needs of system stakeholders
- Goal-Oriented Modeling Languages (Goal Models) (GM)
  - Capture goals, refinements, trade-offs, alternatives, and responsibilities



- Over the last two decades, received focus as part of several fields
  - Requirements Engineering (RE), Software Engineering (SE), Information Systems, Conceptual Modeling, Enterprise Modeling

Goal Model Challenges

- Goal models are helpful in understanding potential problems and solutions, but…
  - it is not always clear what to do with models after they are built

- How to use goal-oriented models to move towards detailed requirements, specification, architecture, or design?
- How can goal models be used not only as part of other RE efforts (e.g. specifications, validation, planning), but as part of the entire SE or system life cycle?
- How can goal models be used to improve system effectiveness at run-time, or as the environment and needs of stakeholders evolve?

Our Objectives

- We want to understand progress towards addressing these challenges by performing a systematic literature review
- Focus on connection between GM and other artifacts
  - Cover approaches which map, integrate or transform goal-oriented languages to or from other languages or artifacts related to software system development
- Our intention is to map the research landscape
- Systematic literature map vs. review
  - We perform a systematic literature roadmap

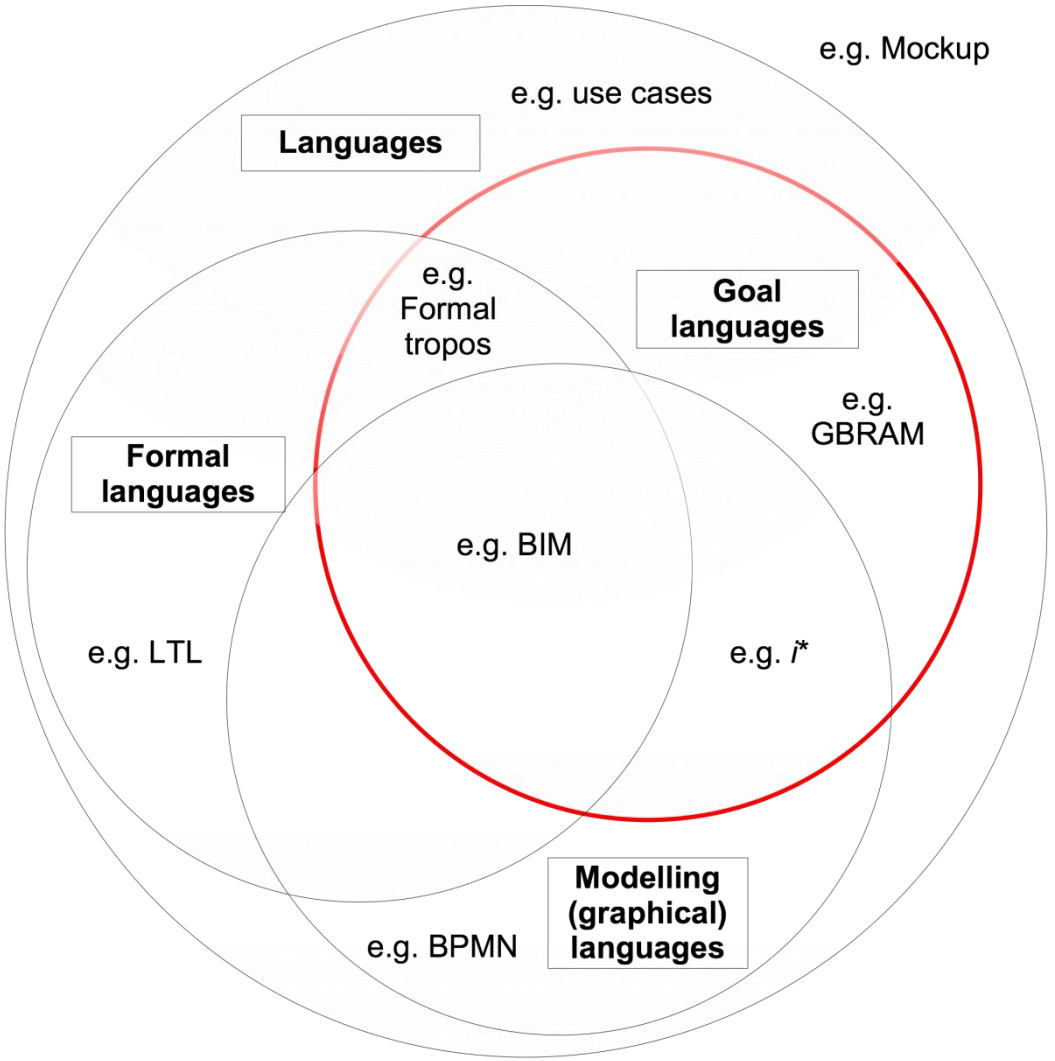
Survey Benefits

- For researchers
  - better enable building upon existing work, avoiding 'reinventing the wheel'
  - helping to understand trends, and guide effort towards new areas

- For practitioners
  - demonstrate the ways in which goal-oriented approaches can be integrated into existing RE/SE approaches
  - providing ideas on how goal-orientation could be adopted in practice, with pointers to further detail

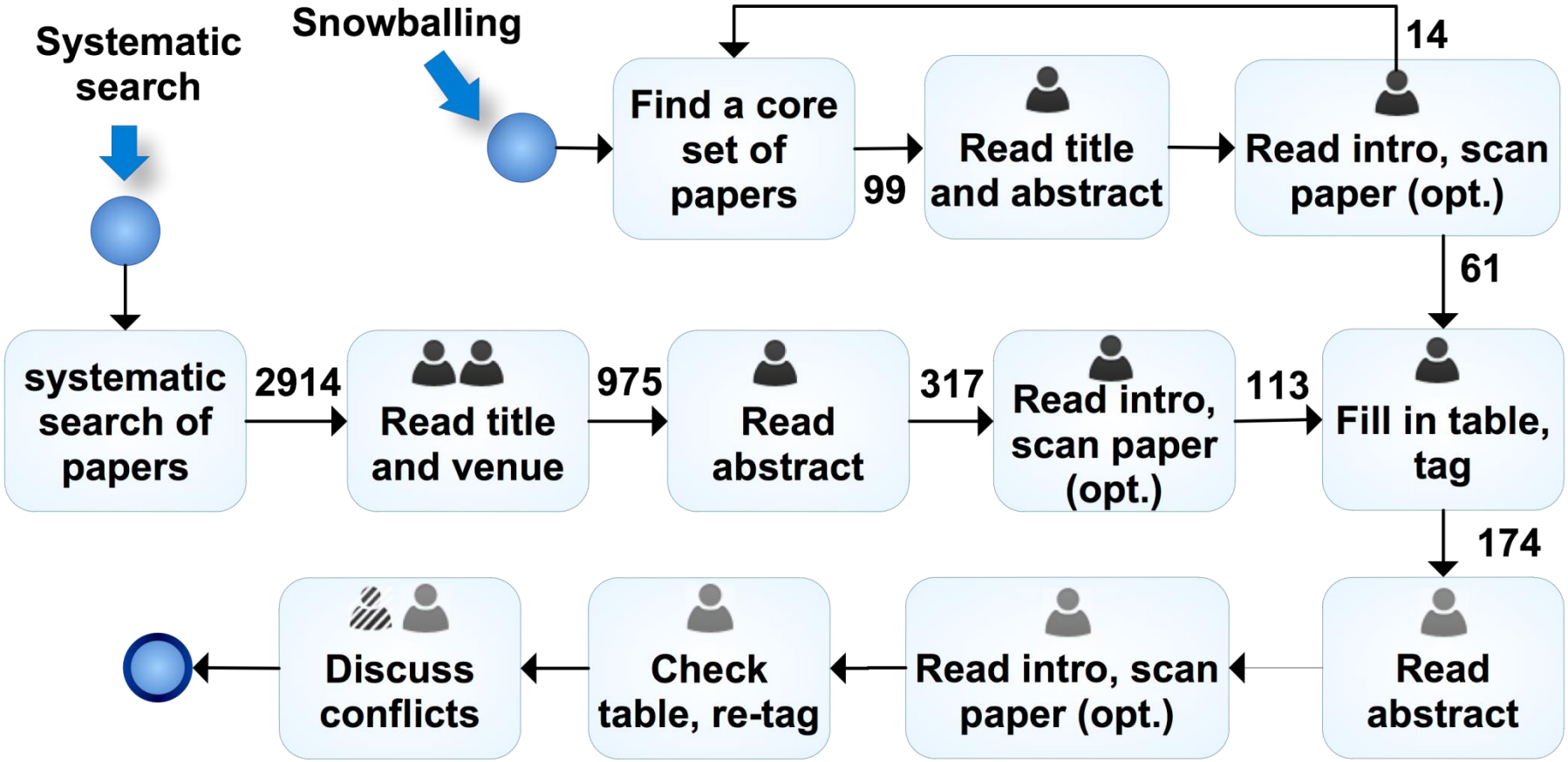
Survey Scope

- Focus on goal-oriented languages, either textual or graphical, formally or informally defined
- Focus on techniques which introduce a transformation, mapping or integration from a goal-oriented language to another SE-related language/artifact
- Focus on exogenous vertical or horizontal mappings or transformations
- Omit model "extensions"
- Conferences, journals, books



Survey Methodology: Process

- We find papers for our survey both through snowballing and systematic search

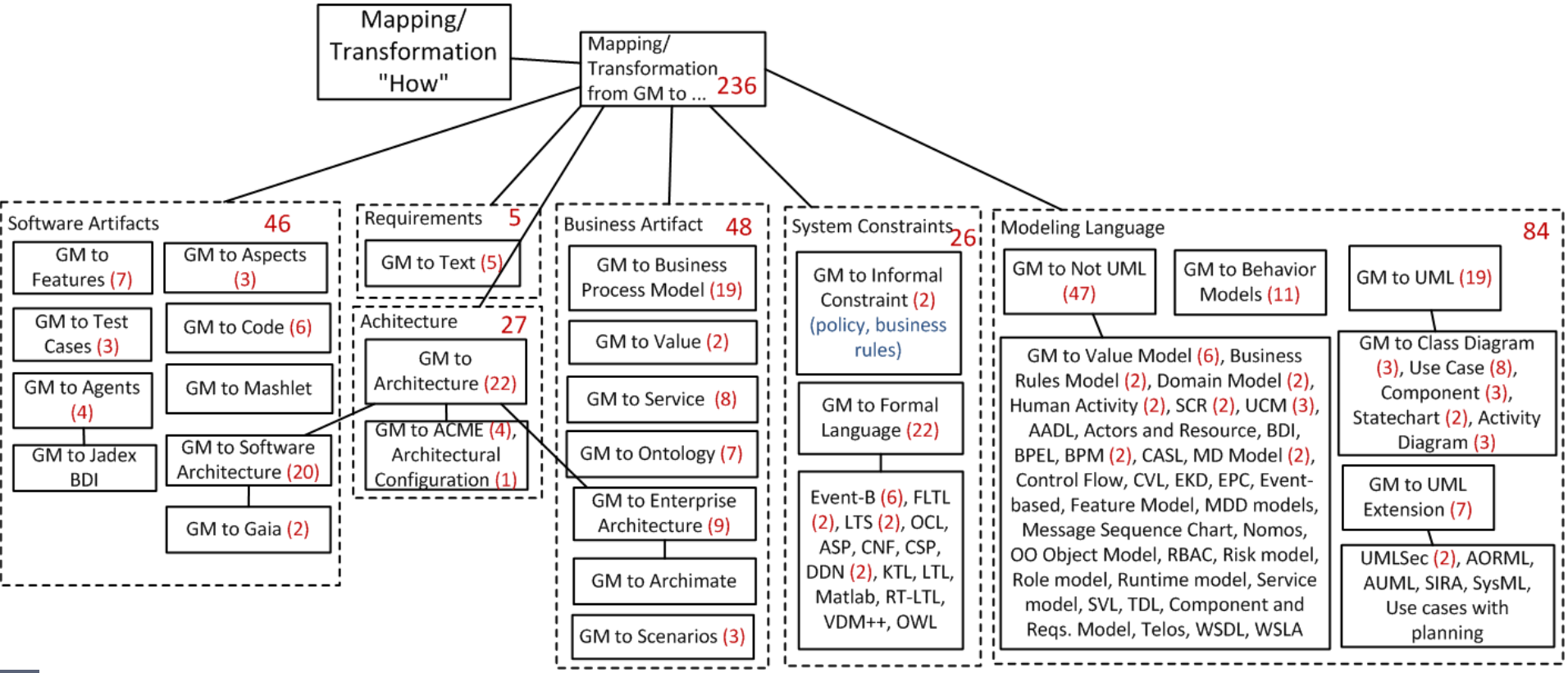


Survey Methodology: Research Questions

- RQ1 What types of transformations are used ([mapping/transformation….)?
- RQ2 What goal modeling frameworks are used most frequently?
- RQ3 What sources or targets are goal models mapping/transformed /integration to/from/with? Are there trends in these choices?
- RQ4 What are the motivations for the approaches? Are there trends in these motivations?
- RQ5 What type of research papers focus on these approaches (validation/evaluation/solution/philosophical/opinion/experience)?
- RQ6 In what journals or conferences do approaches typically appear?
- RQ7 What techniques are most widely cited? Are citations equally distributed?
- RQ8 Who are the main contributors? What does the network of authors look like?
- RQ9 Is interest in goal model transformation increasing or decreasing?

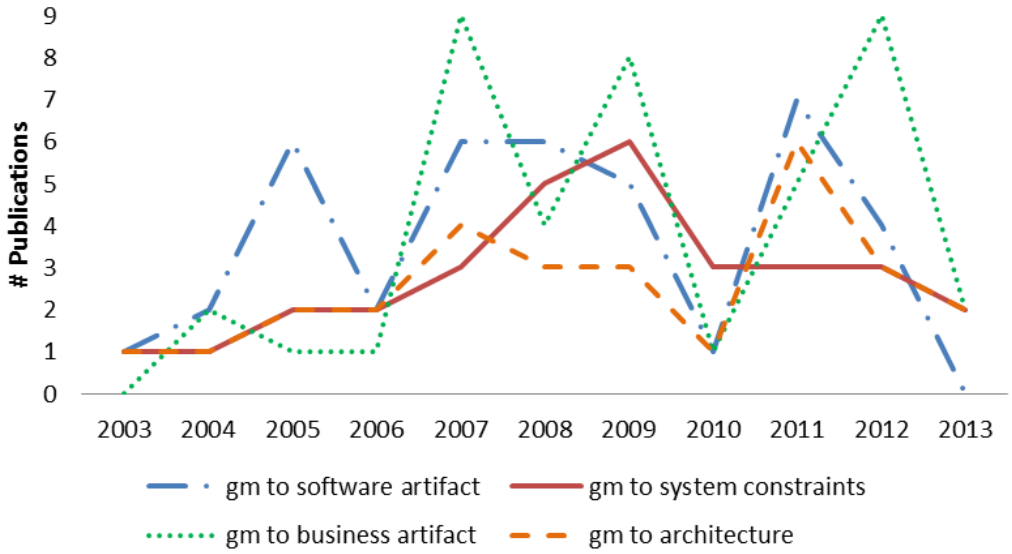
Results

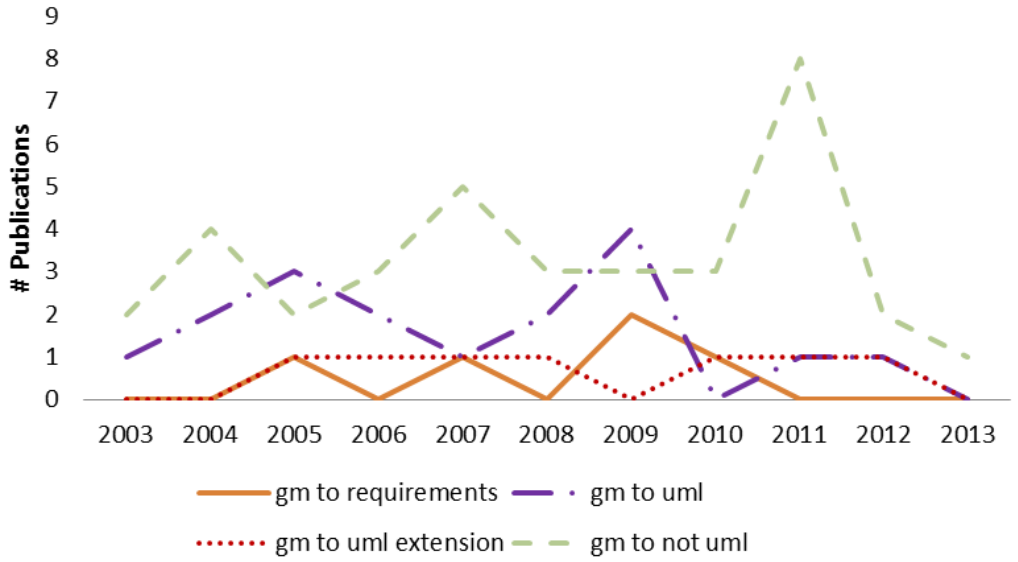
RQ3 What sources or targets? Trends?



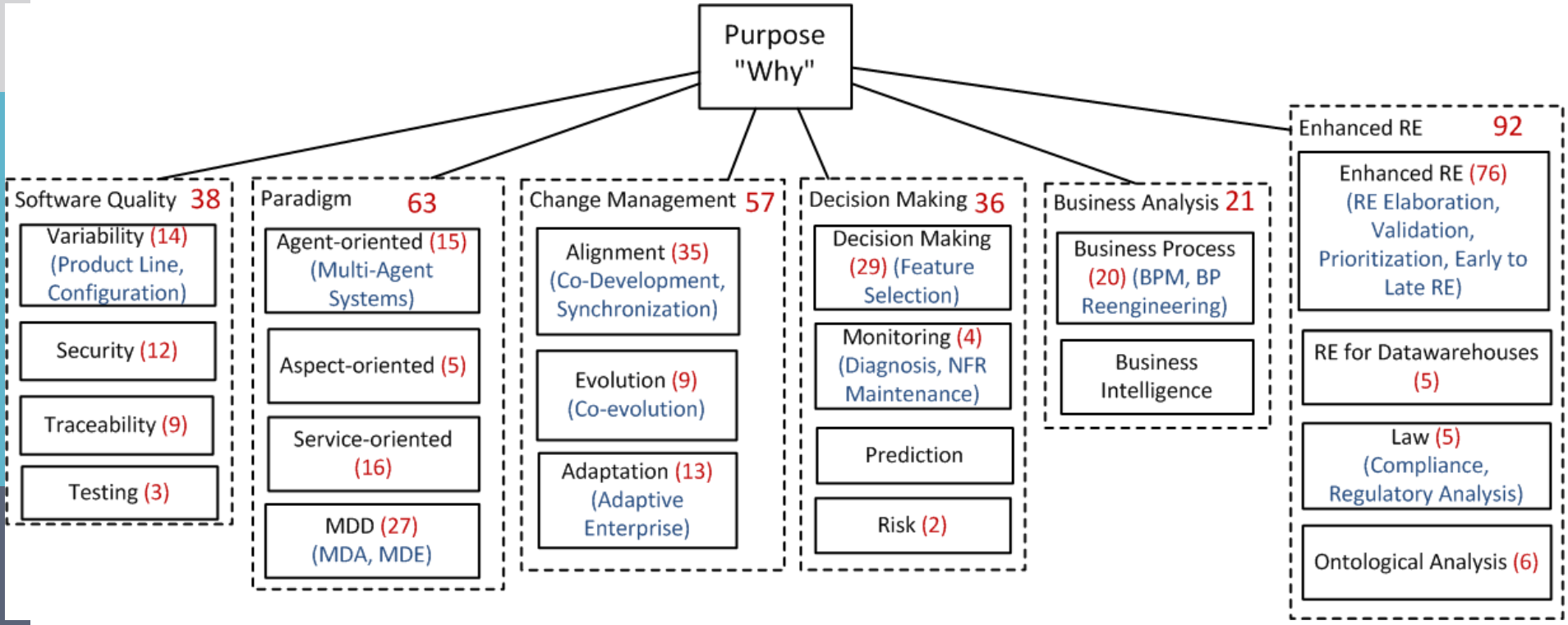
Taxonomy of "how" Tags used to Classify Publications Transforming from Goal Models (synonyms in parentheses, default count of (1))

RQ3 What sources or targets? Trends?



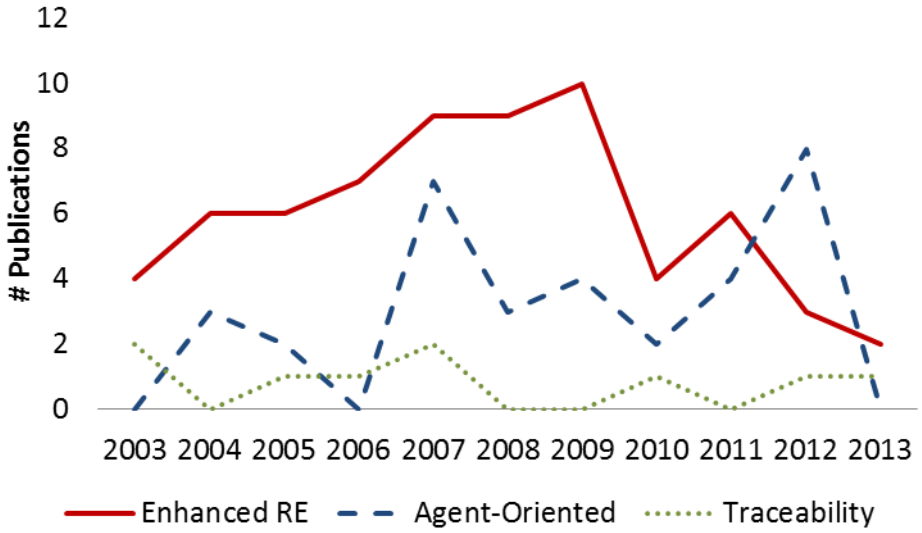


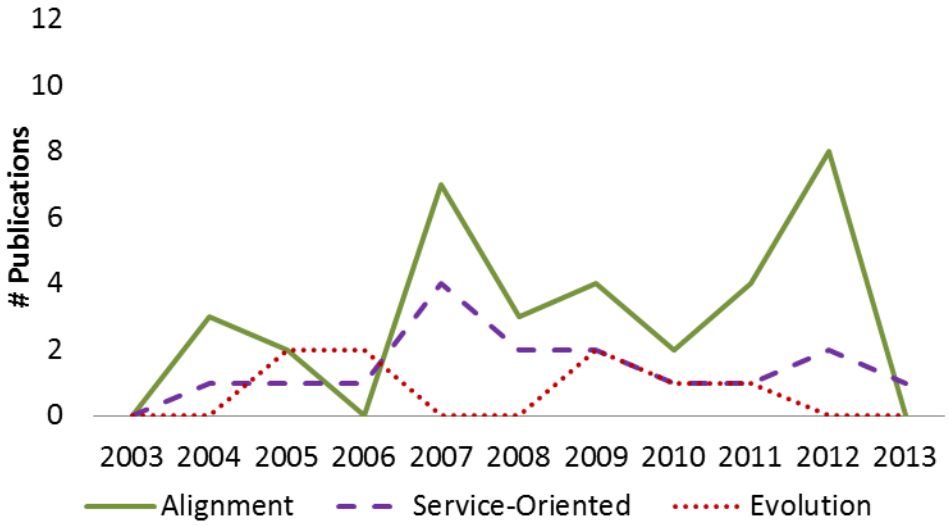
RQ4 What are the motivations for the approaches? Trends?

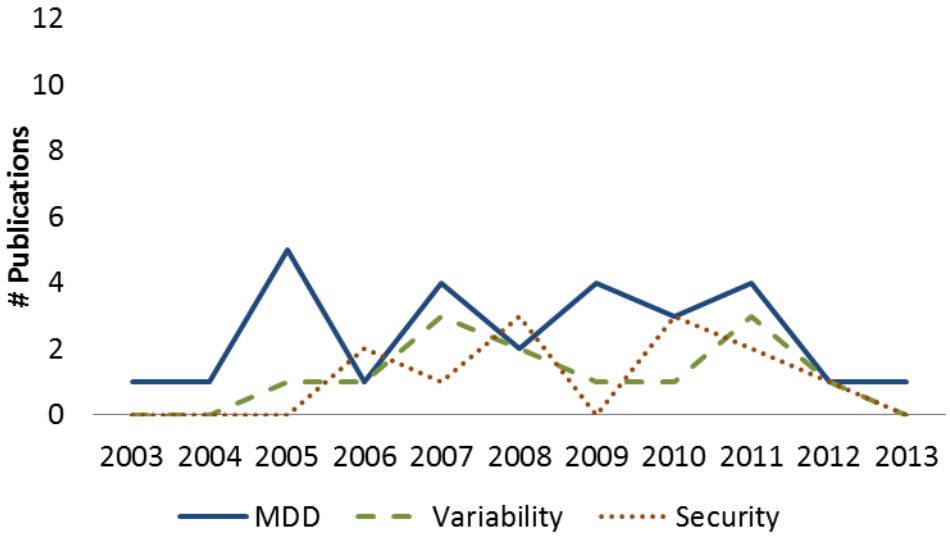


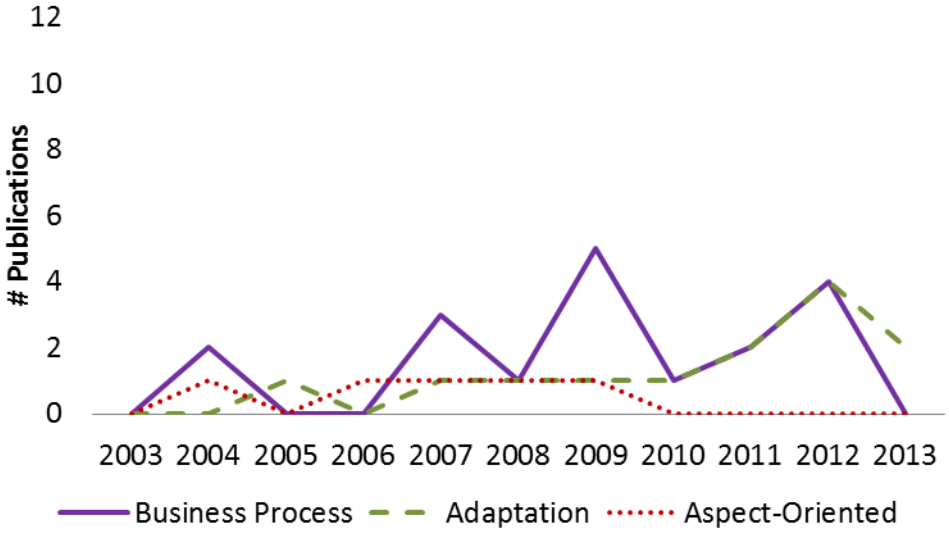
Taxonomy of "why" Tags used to Classify Publications (synonyms in parentheses, default count of (1))

RQ4 What are the motivations for the approaches? Trends?

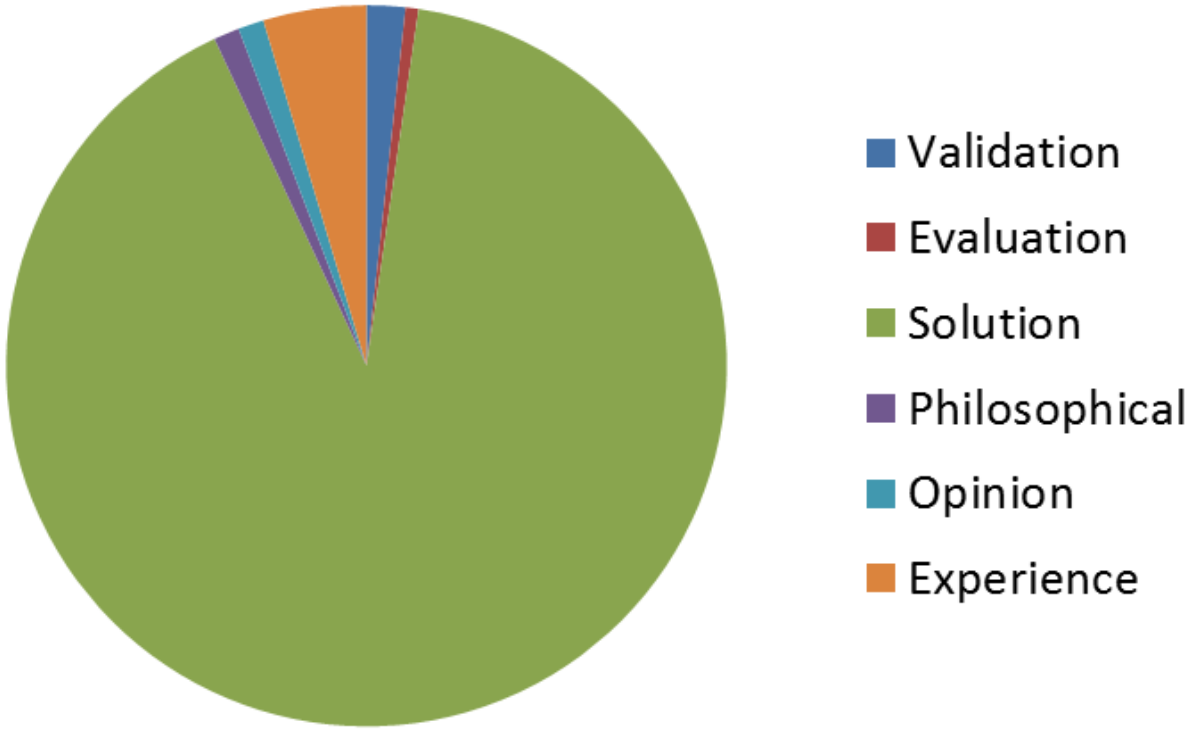






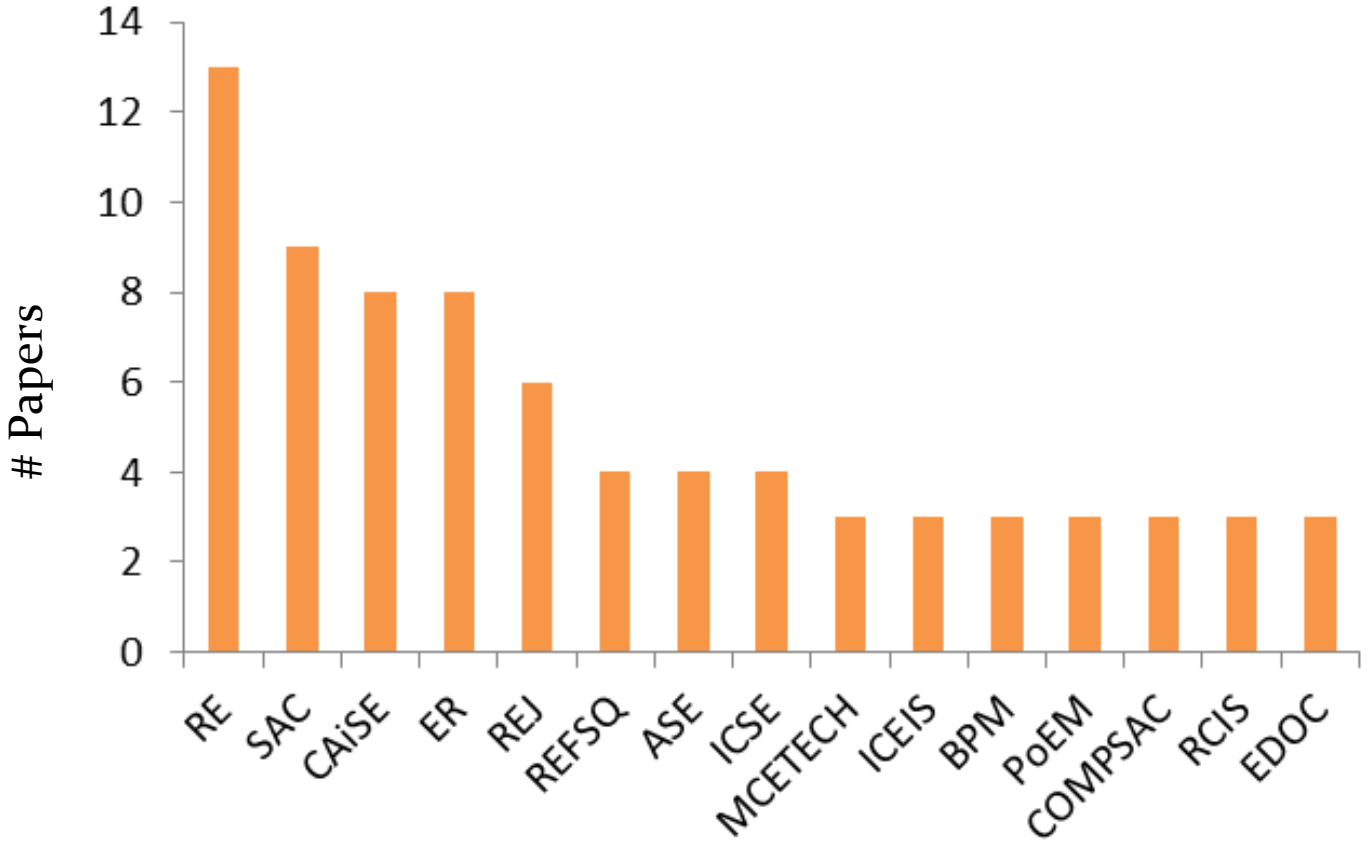


RQ5 What types of research papers?

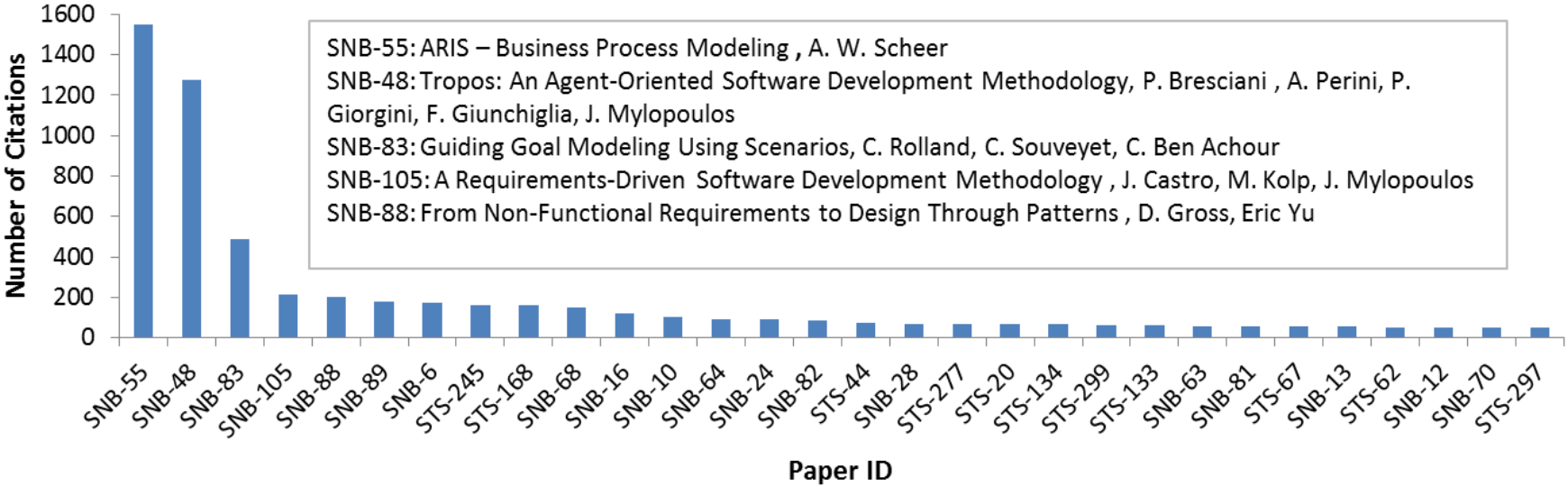


R. Wieringa, N. Maiden, N. Mead, and C. Rolland, "Requirements engineering paper classification and evaluation criteria: a proposal and a discussion," Requirements Engineering, vol. 11, no. 1, pp. 102–107, 2006.

RQ6 In what journals or conferences?



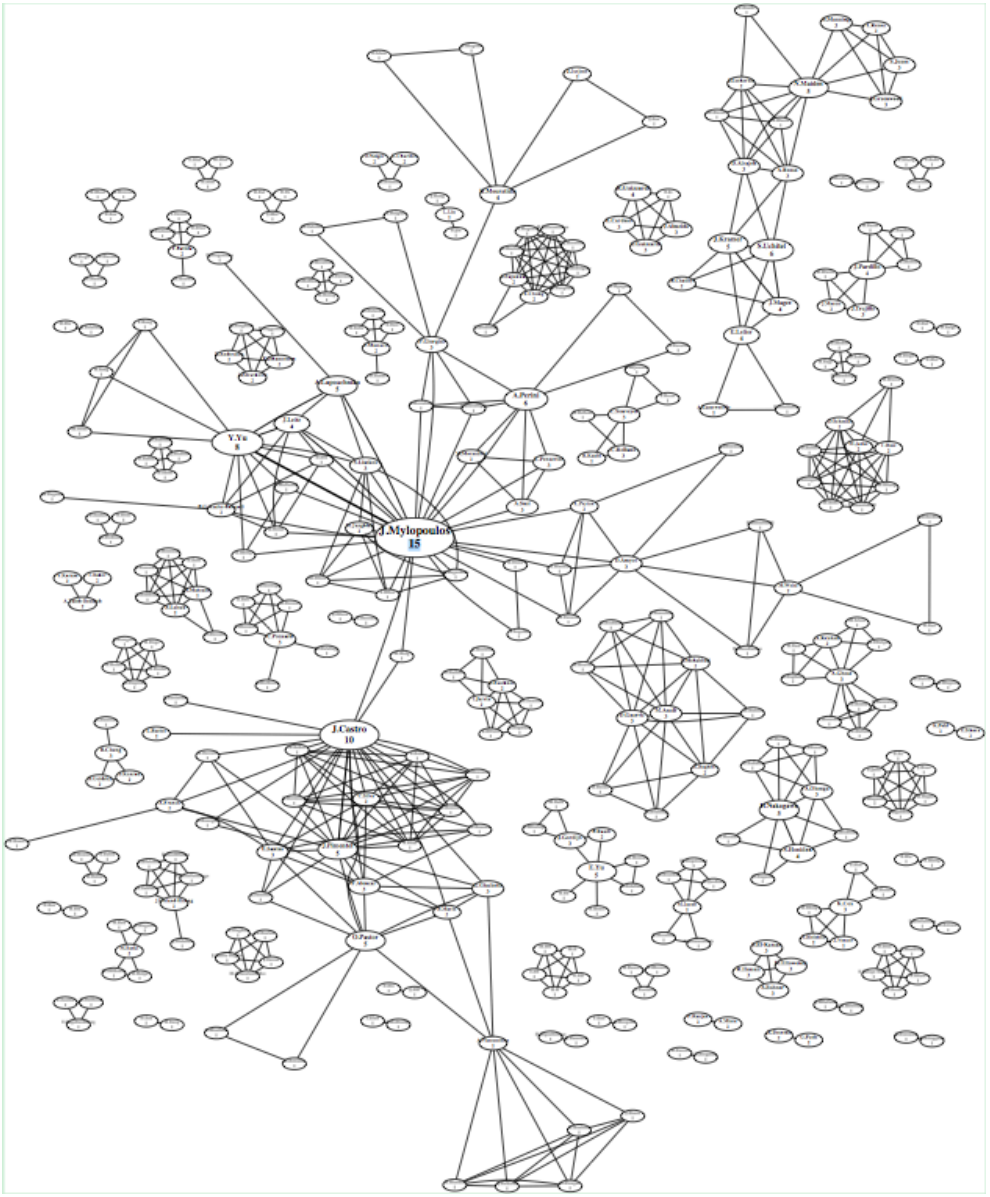
RQ7 What techniques are most widely cited?



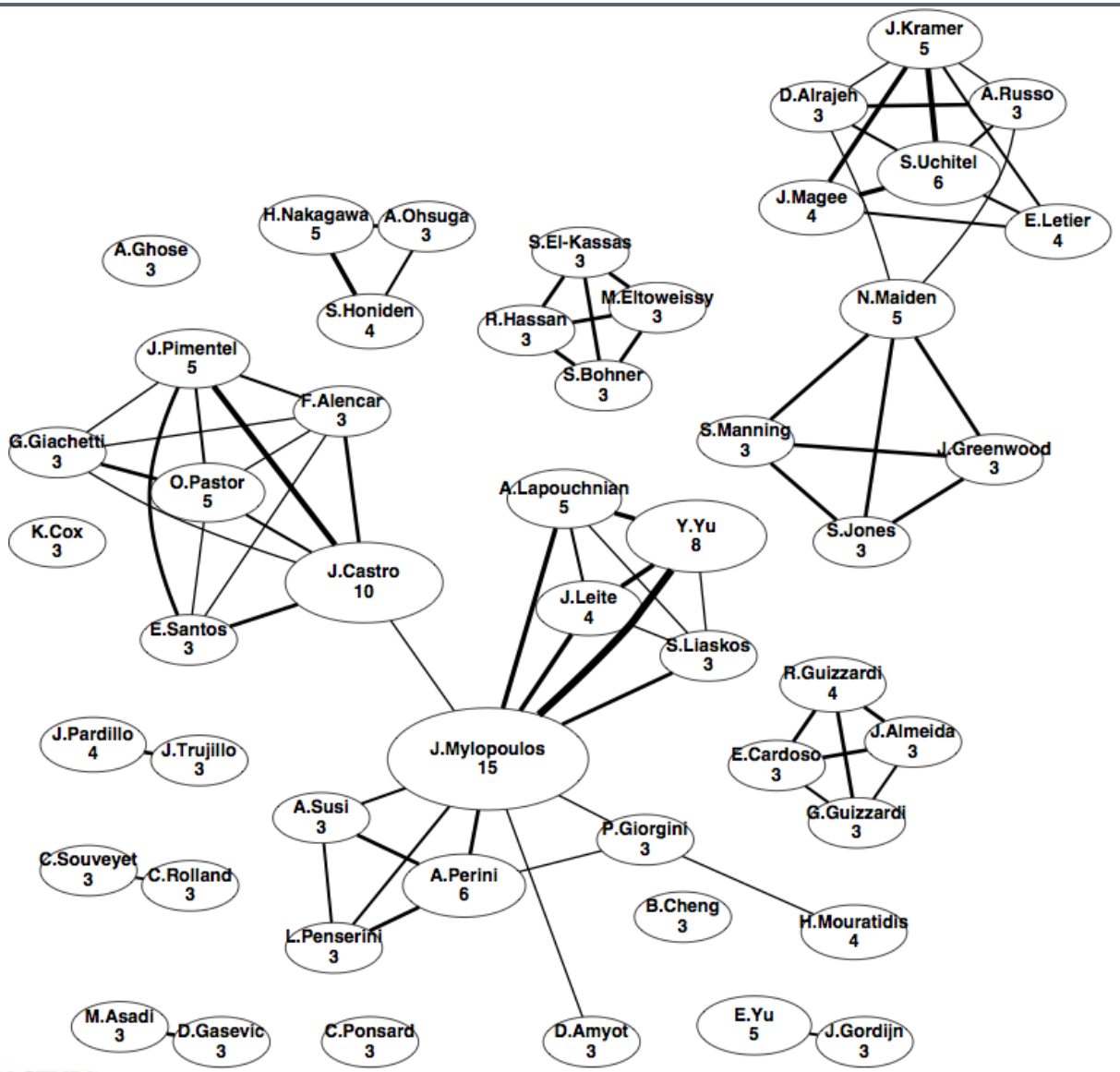
Citation Counts for the Top 50 Publications

- Average number of citations is 43, but most papers have few citations
- The top 10 cited papers have 63.5% of the total citations

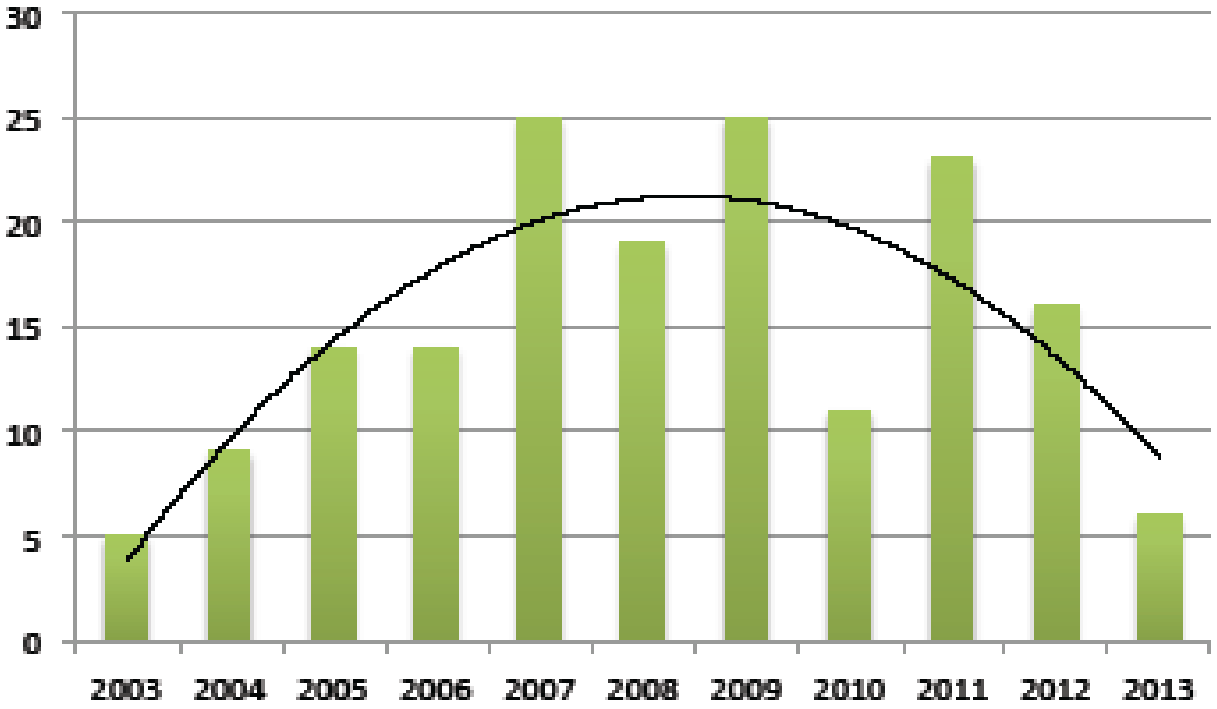
RQ8 Who are the main contributors?



RQ8 Who are the main contributors? (>3 papers)



RQ9 Is interest increasing or decreasing?



Papers per Year

Summary

- Systematic Roadmap of 174 publications describing transformations to/from goal models to other software models or artifacts
- Findings:
  - A wide variety of sources, targets, motivations, paradigms
  - Only a small percentage of approaches widely cited
  - Publication widely distributed
  - Focus on new solutions
  - Authorship is relatively fragmented
  - Interest seems to have peaked
  - However, above indicators show that the area is relatively immature

Future Work

- Depth: perform systematic survey, reviewing covered work in more depth
  - What constructs are typically transformed?
  - How well are the social aspects handled?
- Breadth: expand the roadmap
- More data analysis: e.g., citation graph

- Many examples of successful industrial goal model applications, but, most applications have a high degree of academic participation
  - Practitioners do not often adopt goal-oriented technique on their own initiative
- One hypothesis:
  - Lack of widespread adoption could be due to difficulty in integrating goal-oriented techniques with existing RE and SE approaches
  - Many techniques available

- Further studies to investigate barriers to goal model adoption

Thank you!

Questions?

Survey Preliminaries (1)

- We define key concepts, using these definitions to define our survey scope
  - "A Language consists of a syntactic notation (syntax), which is a possibly infinite set of legal elements, together with the meaning of those elements, which is expressed by relating the syntax to a semantic domain. … Depending on the language type, syntactic elements can be words, sentences, statements, boxes, diagrams, terms, models, clauses, modules, and so on." [3]
  - Languages can be graphical or textual, and the semantics (meaning) can be formal or informal
  - A Goal-Oriented Language is a language which includes the concept of goal as a first class object. Goal-oriented Languages are often graphical (i.e. are modeling languages), having a visual syntax (e.g. Tropos, i*, KAOS, NFR, GRL, etc.) but may also be textual (e.g., GBRAM)

[3] D. Harel and B. Rumpe. Meaningful modeling: What's the semantics of "semantics"? Computer, 37(10):64–72, Oct. 2004.

Survey Preliminaries: Key Concepts

- A Goal-Oriented Language includes goals as a first class object.
  - Goal-oriented Languages are often graphical (i.e. are modeling languages), having a visual syntax (e.g. Tropos, i*, KAOS, NFR, GRL, etc.) but may also be textual (e.g., GBRAM)

- A Model Transformation: takes one or more source models as input and produces one or more target models as output by following a set of transformation rules
- A Model Mapping: a set of rules that describes how one or more constructs in the source modeling language can be connected to one or more constructs in the target modeling language
- Model Language Integration: the creation of a new modeling language which is made up of constructs and relations from the source and target modeling languages

Survey Preliminaries (2)

- A Model Transformation is a process that takes one or more source models as input and produces one or more target models as output by following a set of transformation rules
- A Model Mapping is a set of rules that describes how one or more constructs in the source modeling language can be connected to one or more constructs in the target modeling language
- Can't have a model transformation without a mapping

[4] A. G. Kleppe, J. Warmer, and W. Bast. MDA Explained: The Model Driven Architecture: Practice and Promise. Addison-Wesley Longman Publishing Co., Inc., Boston, MA, USA, 2003.

[5] T. Mens and P. Van Gorp. A taxonomy of model transformation. Electron. Notes Theor. Comput. Sci., 152:125–142, Mar. 2006.

Survey Preliminaries (2)

- An Exogenous Model Transformation
  - between models expressed in different languages
- An Endogenous Model Transformation
  - between models expressed in the same language
- A Vertical Model Transformation
  - the source and target models reside at different abstraction levels
- A Horizontal Model Transformation
  - source and target models reside at the same abstraction level
- Examples:
  - Exogenous vertical: transform GM to class diagrams
  - Exogenous horizontal: transform GM to use case model (another high-level requirements model)
  - Endogenous vertical: refine a GM to include more information, e.g., using patterns
  - Endogenous horizontal: GM visualization techniques, refactoring, syntax analysis

[5] T. Mens and P. Van Gorp. A taxonomy of model transformation. Electron. Notes Theor. Comput. Sci., 152:125–142, Mar. 2006.

Survey Methodology: Snowballing

- Start with a set of 99 core papers known to be included by our scope criteria
- Search references of each core paper, looking for further candidate papers
- Examine papers, deciding whether to include or exclude the papers based on our criteria
- Included papers became candidates for snowballing
- Stop at snowballing depth of 2 (else this process may be infinite)

Survey Methodology: Systematic Search

- Searched through several research databases (IEEE, Springer, ACM) using a specific search string:
  - ("requirements engineering" OR "software engineering") AND ("goal model" OR "goal models“ OR "goal modeling" OR "goal modelling" OR "goal language" OR "goal notation" OR "goal oriented model" OR "goal-oriented requirements“ OR "goal-based model" OR "goal-based requirements“ OR "goal-driven model" OR "goal-driven requirements") AND transformation OR mapping OR derivation OR alignment OR integration OR link)
- 2914 papers
- Each title and venue were read by at least two people
- Abstract for conflicts read by single reader
- Redistribute then read relevant papers

RQ1 What types of transformations are used?
RQ2 What goal modeling frameworks?

	Mapping	Transformation	Integration
Vertical	49	64	12
Horizontal	32	23	12

Technique Count Classified as Mapping, Transformation, or Integration vs. Horizontal or Vertical

	Endogenous	Exogenous
Vertical	9	110
Horizontal	16	47

Technique Count Classified as Exogenous or Endogenous Vs. Horizontal or Vertical

Unidentified GM	i*	KAOS	Tropos	NFR	GRL	AOV	Map
57	46	23	17	8	5	4	4

The Top 8 Goal Model Source Languages