iStar 2.0: A Guided Tour
Part I: Introduction and Motivation

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Goal modeling

- Most systems today are socio-technical
  - E.g., online commerce, healthcare, government
- Complex relationships among systems and stakeholders
  - Help each other achieve what they want
- Help stakeholders understand their needs
  - Security, privacy, trust, profitability, market positioning, …
- Understanding "why?", not just "what?" or "how?"
  - Different classes (ontologies) of conceptual models [Myl98]
    - Static (e.g., UML class models, ER models)
    - Dynamic (e.g., Activity Diagrams, Statecharts, BPMN)
    - Intentional
    - Social

Goal modeling

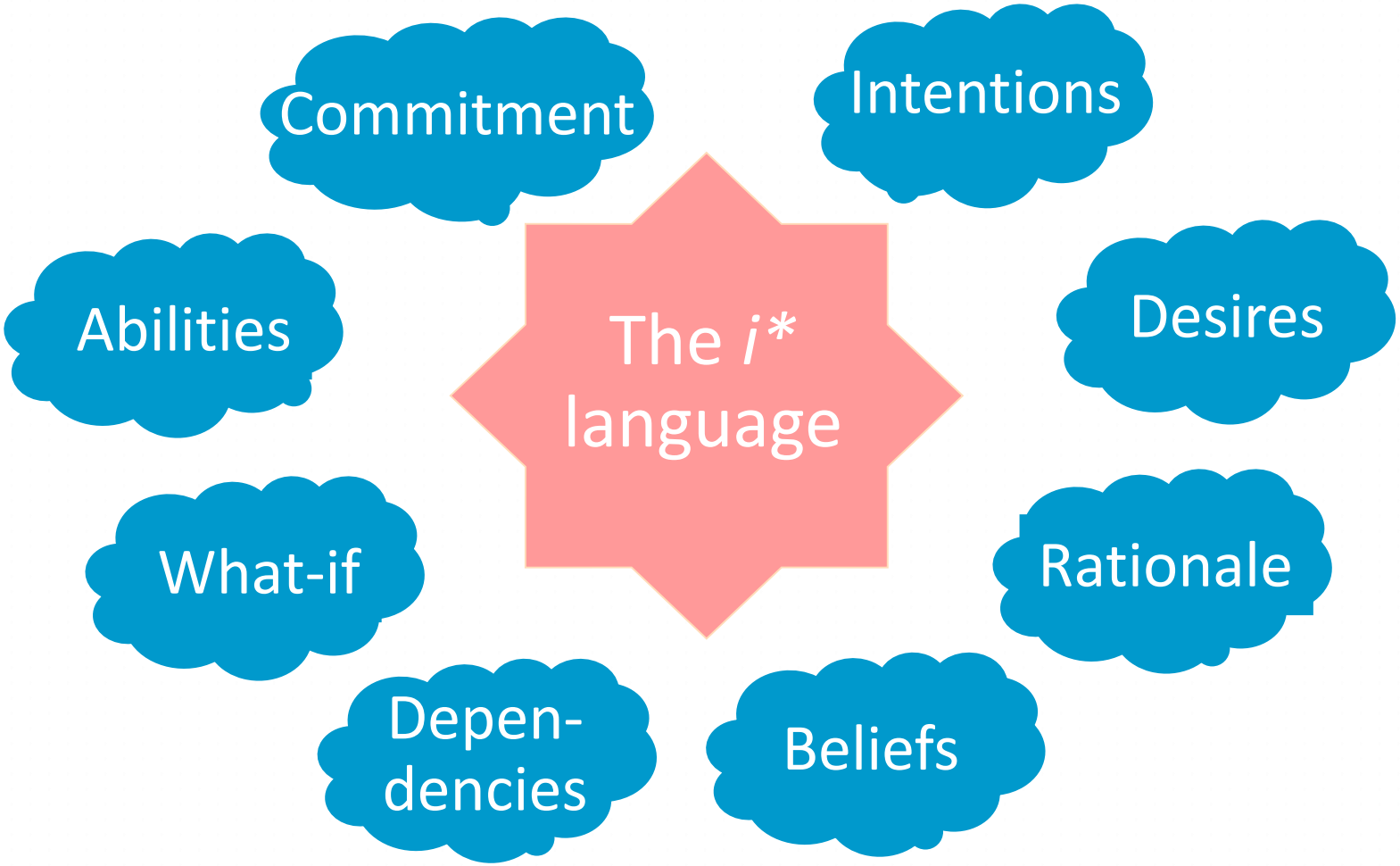
[Hor+2016][Yu+2008]

Approaches to goal modeling

- By discipline
  - Organizational modeling
  - Business intelligence
  - Requirements engineering
  - Systems and software architecting
  - …

- By framework/language
  - KAOS
  - NFR
  - EKD
  - MAP
  - …
  - *i** and variants

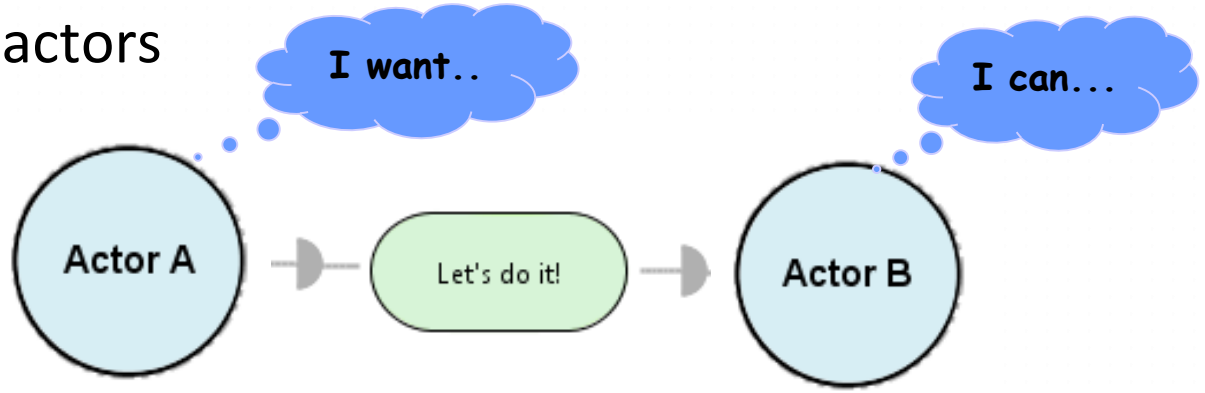
The *i** language: idea



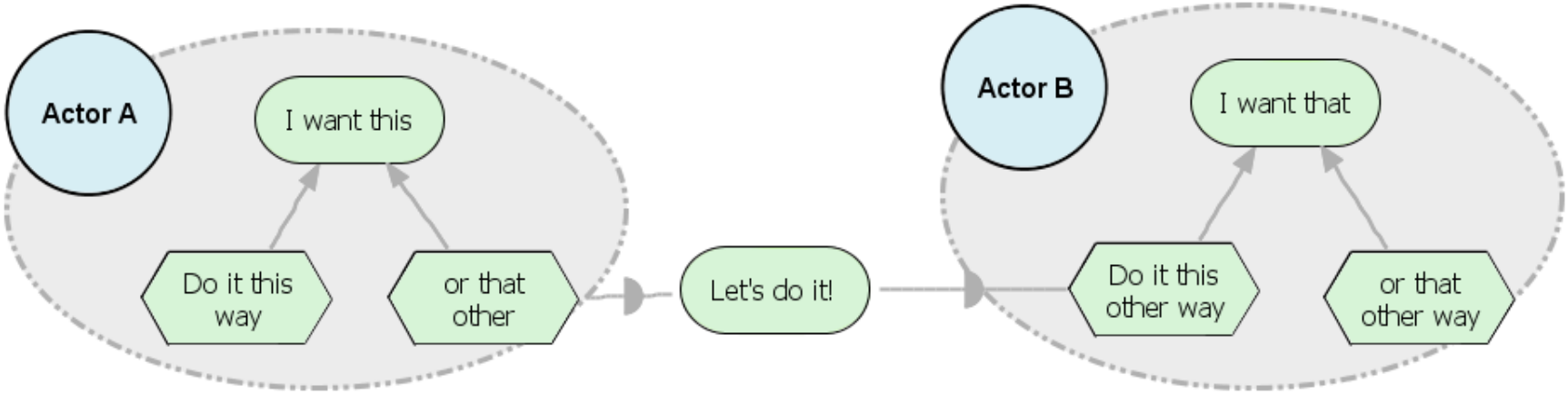
The *i** language: layout

Designed by Eric Yu in the early 90s as his PhD thesis (advised by John Mylopoulos) [Yu95][Yu97]

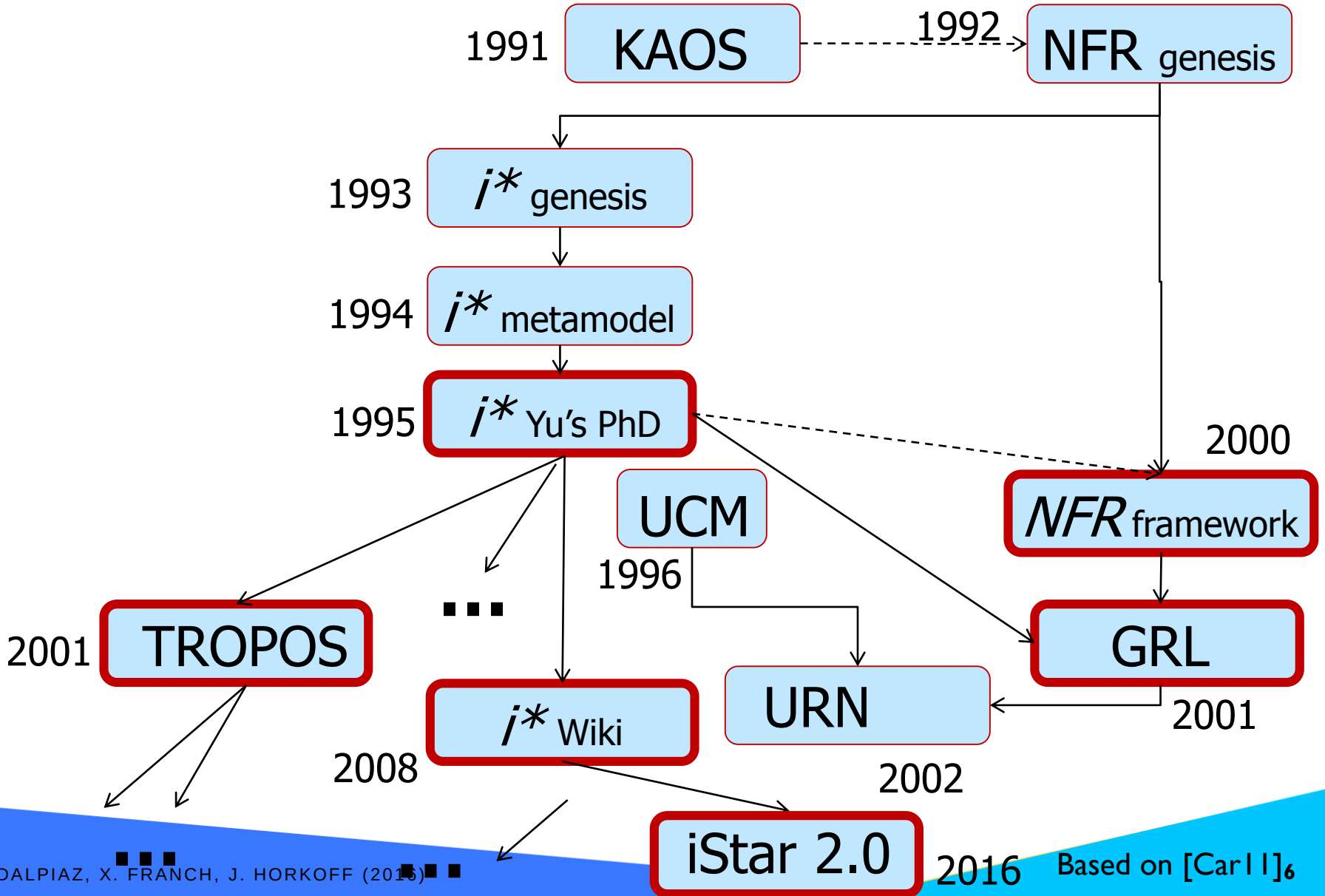
- SD models goal-related dependencies between depender and dependee actors



  - SR models how actors achieve goals, and their dependencies on other actors

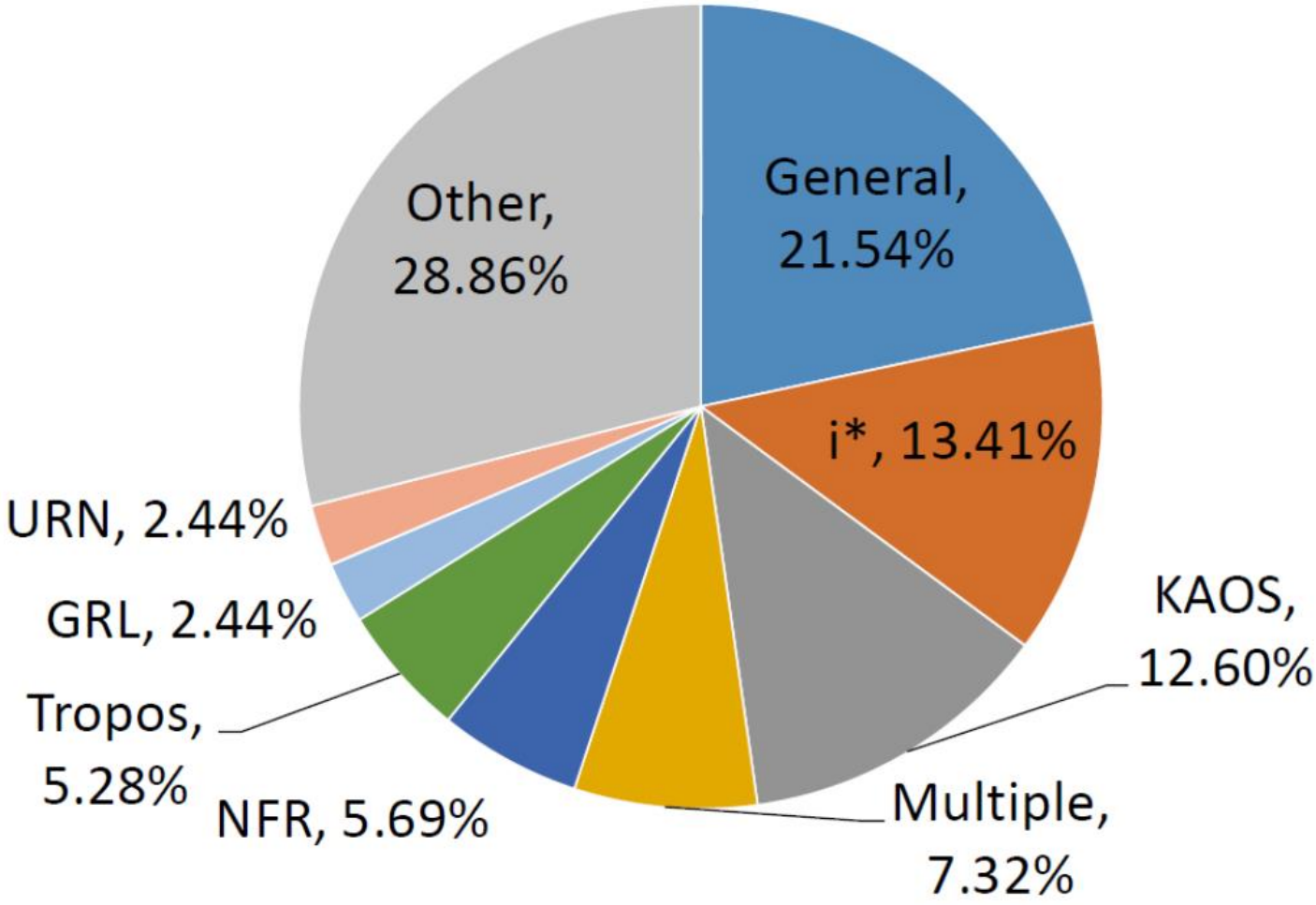


The *i** language: a chronology



Based on [Carl1]

The *i** language: adoption in academy



[Hor+16]

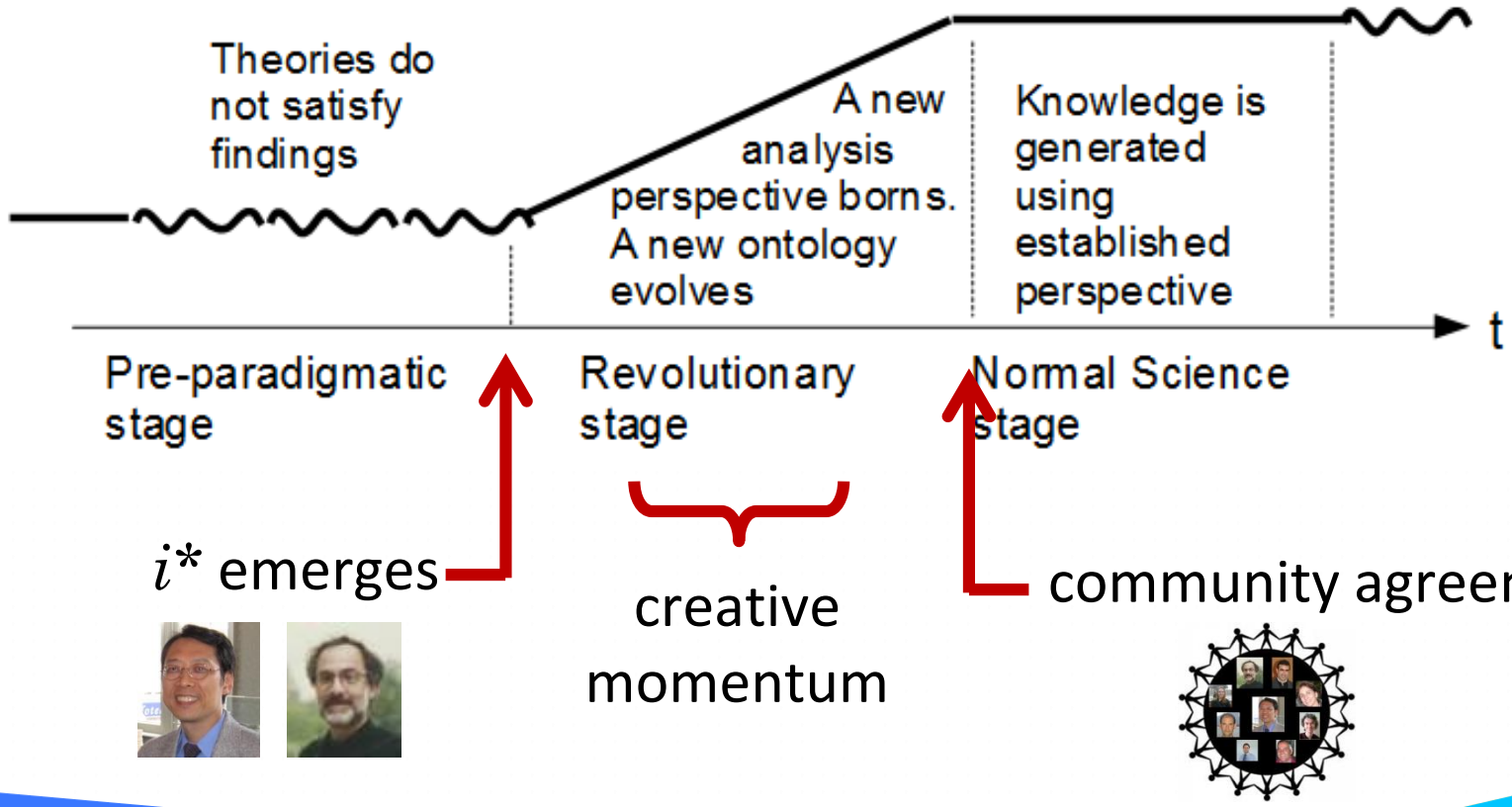
The *i** language: assessment

- Pros
  - Cover a fundamental modeling dimension
  - Not unnecessarily restrictive
  - Good support to decision-making and analysis
  - Supports
    - Thinking out-of-the-box
    - Adoption by researchers in a variety of contexts

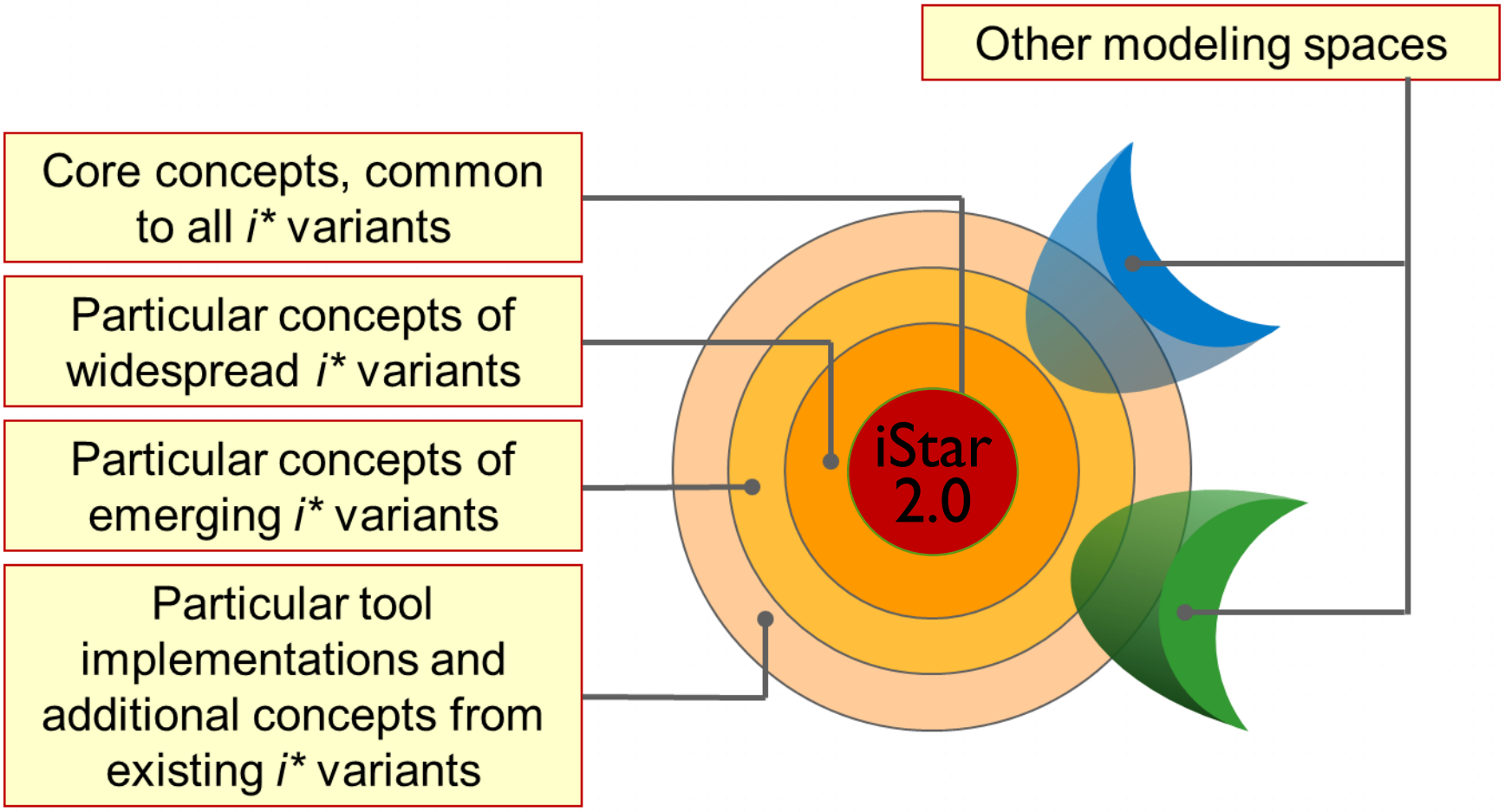
- Cons
  - Too many dialects
  - Constructs' semantics not always clear
  - Hampers
    - Novices' understanding
    - Educators' role
    - Adoption by practitioners

The *i** language: need for a standard

- Kuhn's concept of "scientific revolution" [Kuh62]

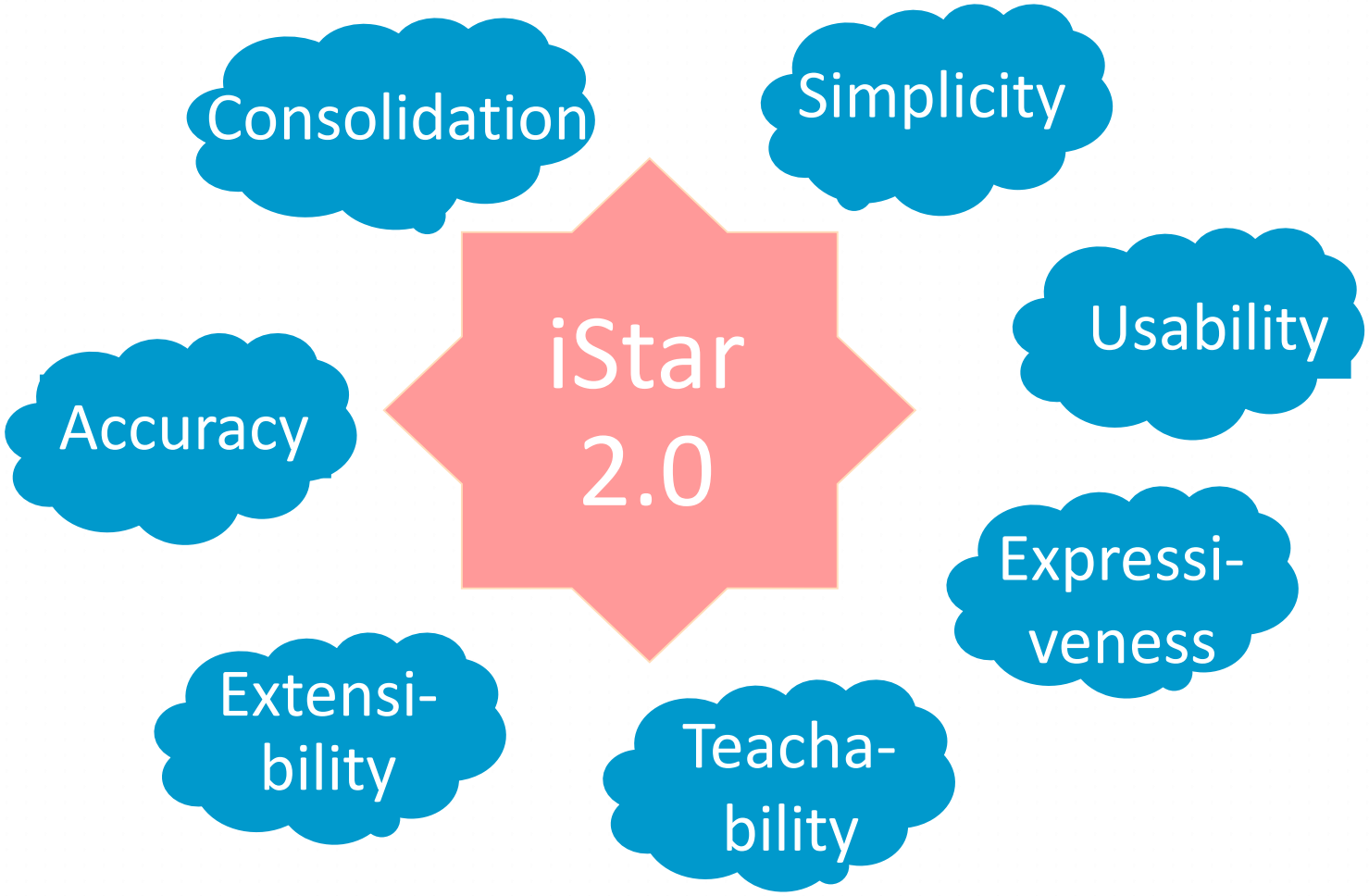


The *i** language: towards a core



Based on [Car11]

iStar 2.0: objectives



The road to iStar 2.0

Oct. 2014 — 1-day meeting @ ER'14, Atlanta

Jan. 2015 — Minutes and open questions

Jun. 2015 — 1-day meeting @ iStar-T'15, Stockholm

CAiSE '15

Aug. 2015 — First draft (v0.1)

Sep. 2015 — Open discussion @ iStar15, Ottawa

Oct. 2015 — 1-day meeting @ ER'15, Stockholm

Jan. 2015 — Draft updated (v0.2)

Mar. 2016 — 3 amigos meeting @ REFSQ-16

Mar. 2016 — iStar 2.0 Language Guide open to discusion

May 2016 — **iStar 2.0 Language Guide Released**

Fabiano Dalpiaz, Xavier Franch, Jennifer Horkoff: **iStar 2.0 Language Guide.** CoRR abs/1605.07767 (2016)

iStar 2.0: what is and what isn't

- In
  - Core constructs
  - Original symbology

- Out
  - Non-essential constructs
  - Domain-related constructs
  - Improved symbology
  - Semantics
  - Methodology

Let's go for it!

iStar 2.0: A Guided Tour
Part I: iStar 2.0 Core: Syntax and Semantics

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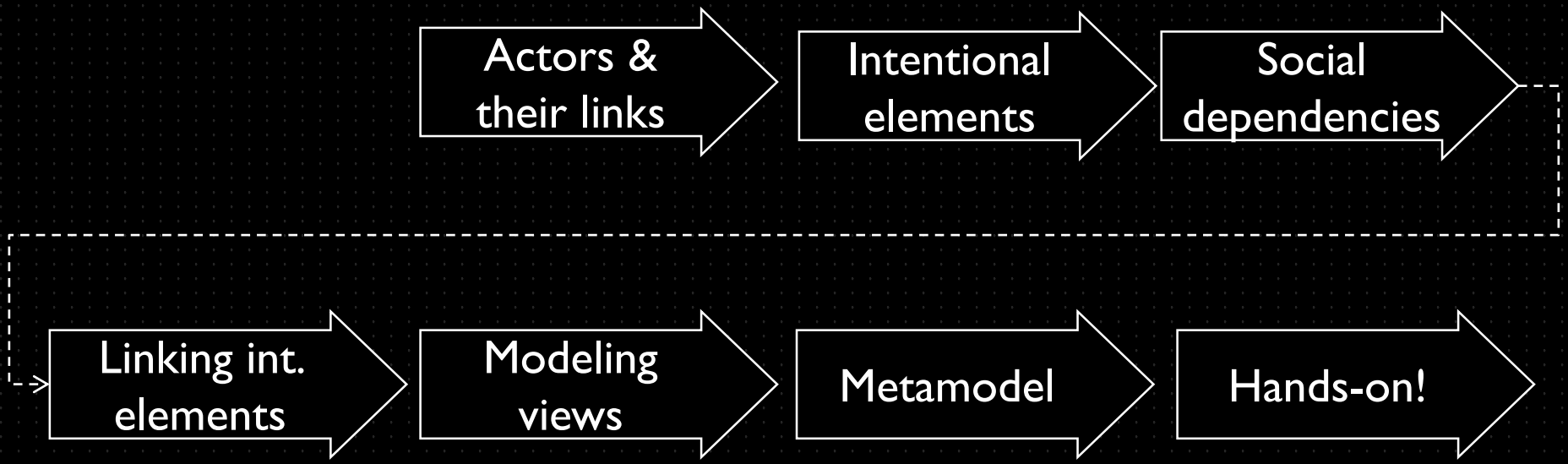
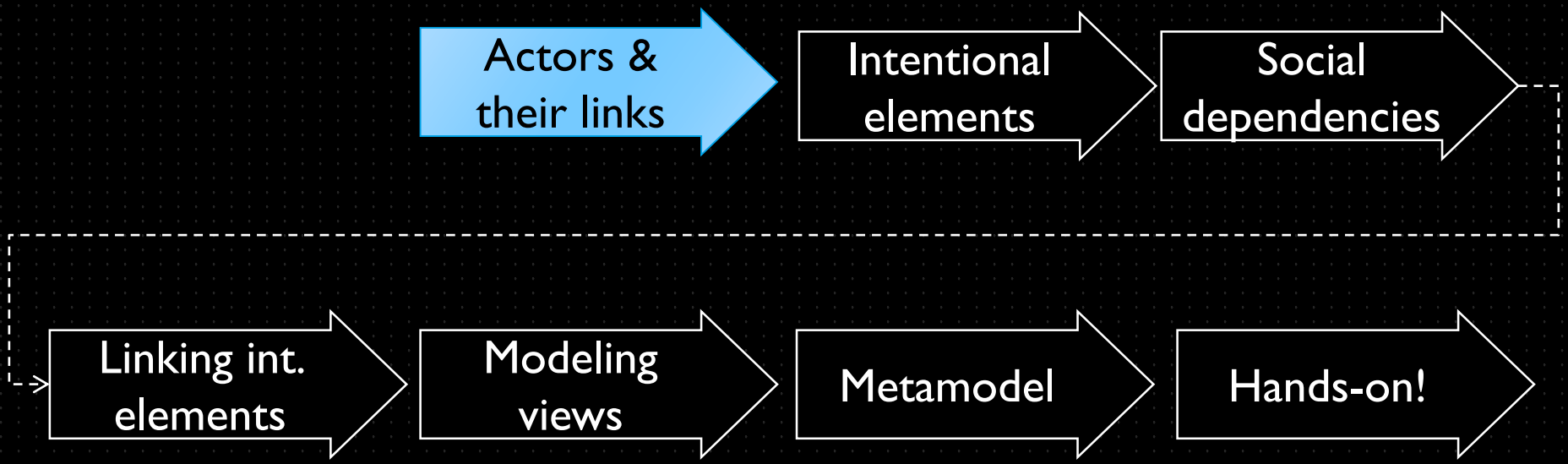
Outline



Running example

- University travel reimbursement
  - **Students** organize trips to conferences
  - They rely on **travel agencies** and the university's **trip management information system**
  - Multiple **alternatives** exist to arrange a trip

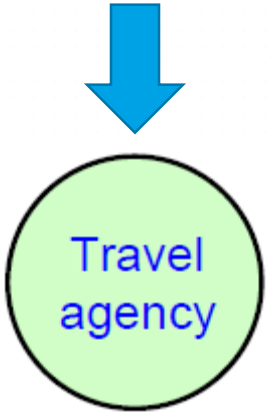
Outline



Actors

- Organizations are social entities
- Their operation relies on the effective interaction among a number of actors

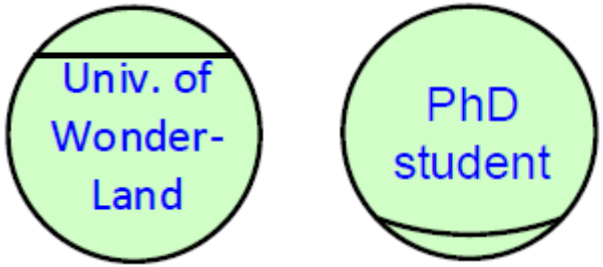
- **Actor:** an active, autonomous entity that aims at achieving its goals by exercising its know-how, in collaboration with other actors



Agents and Roles

- Two types of actors exist in iStar 2.0: agent and role

- **Agent**: an actor with concrete, physical manifestations, such as a human individual, an organization, or a department
- **Role**: an abstract characterization of the behavior of a social actor within some specialized context or domain of endeavor



An agent and a role

Which one should I use?

- Can I identify a concrete individual or (sub)organization?

  → **Agent**

- Do I want to characterize an abstract class?

  → **Role**

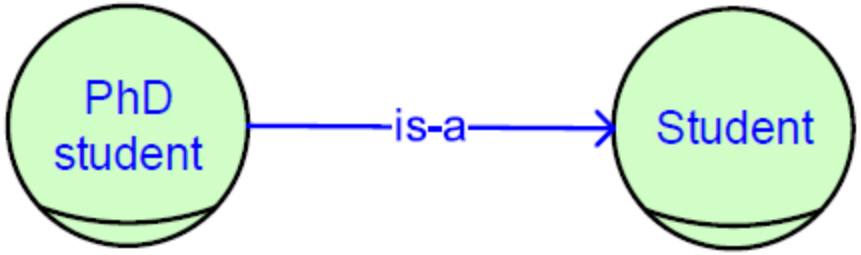
- I don't know at this time, or I do not care

  → **Actor**

Actor association links

- Often one wants to relate multiple actors (incl. agents & roles)
- iStar 2.0 offers binary, directed actor links

- **is-a**: represents the concept of generalization / specialization, and can be applied to (role to role) or (actor to actor)
  - Does not apply to agents. Why?



Actor association links

- **participates-in**: represents any kind of association, other than is-a, between two actors
- Different meanings depending on the linked elements, e.g.
  - (agent to role) may represent the **plays** relationship

  - (linking elements of the same type) may represent the **part-of** relationship

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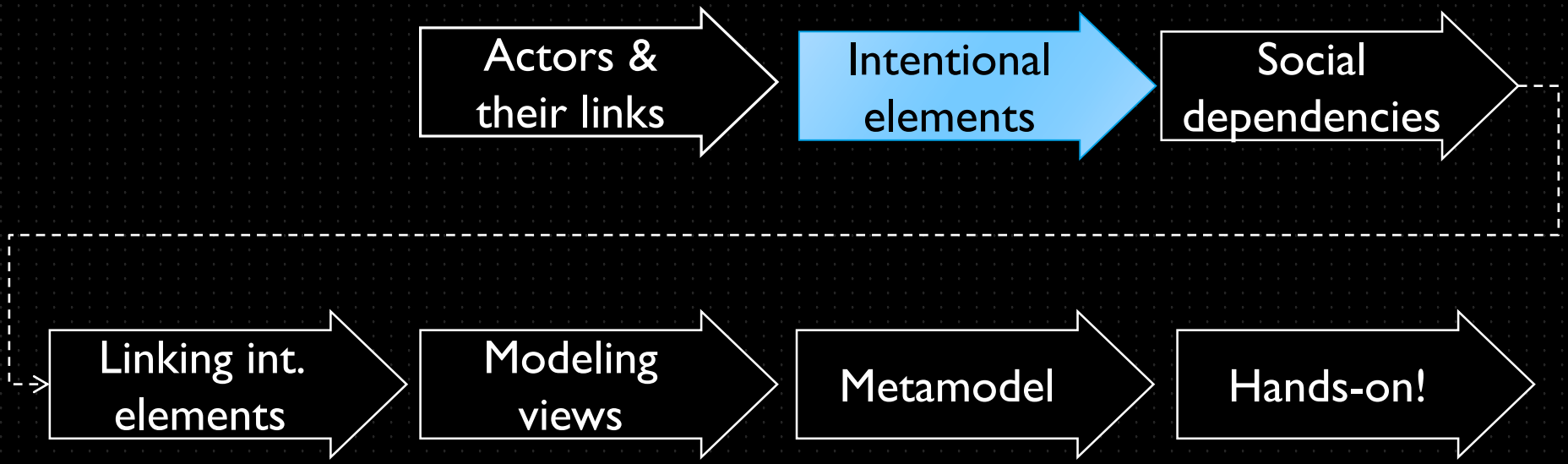
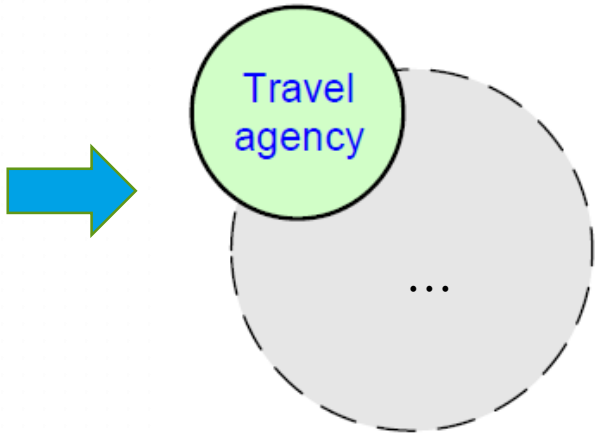
Examples for role-role?

Outline



Intentional elements

- iStar 2.0 focuses on **intentions: things that actors want**
- Intentional elements appear inside a so-called **actor boundary**, representing that actor's perspective in the model
- Four types of intentional elements
  - Goal
  - Quality
  - Task
  - Resource
- An actor with an actor boundary
  - Can be hidden when empty



Goals

- A **goal** is a state of a affairs that the actor wants to achieve and that has clear-cut criteria of achievement
  - "Amsterdam-Gifu travel booked"
  - "Paper published"
  - "Tickets booked"

There is a clear criterion to determine if these are achieved. E.g., did I reach Gifu?

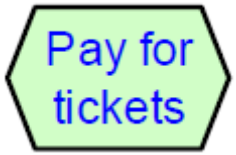
- Goals are represented as ovals

Qualities

- A **quality** is an attribute for which an actor desires some level of achievement
- Being attributes, they always relate to an entity
  - "Performance (of a system)"
  - "Yearly profit (of an organization)"
  - "Quick booking (of a trip)"
- Qualities guide the search for ways of achieving goals
- Represented as curved, cloud-like shapes

Tasks

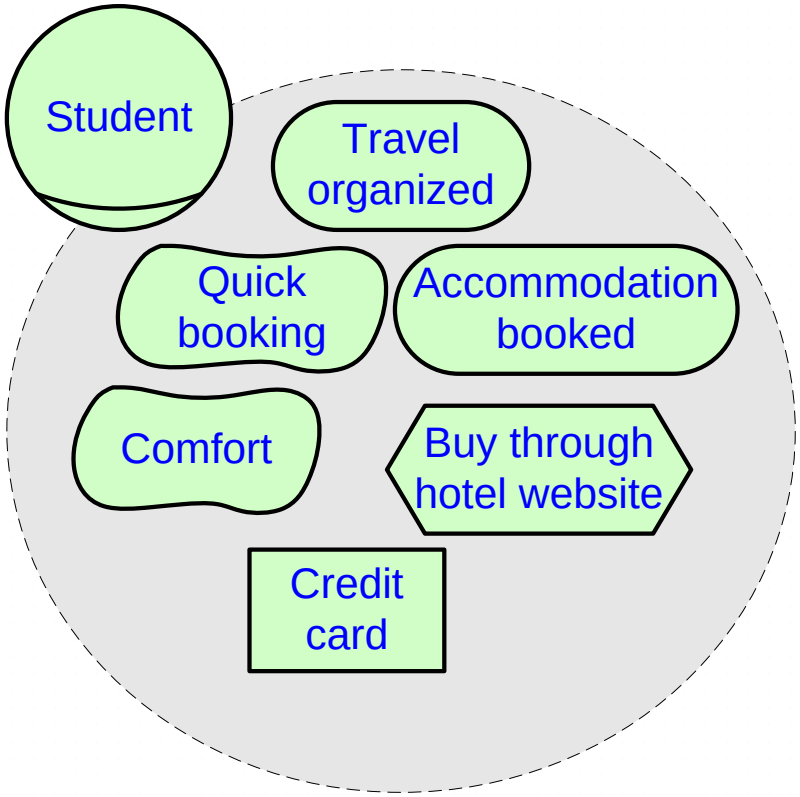
- A **task** represents actions that an actor wants to be executed
  - Usually within the purpose of achieving a goal
- Examples
  - "Pay for tickets"
  - "Take the train"
  - "Scan the receipt"
- Represented as diamonds



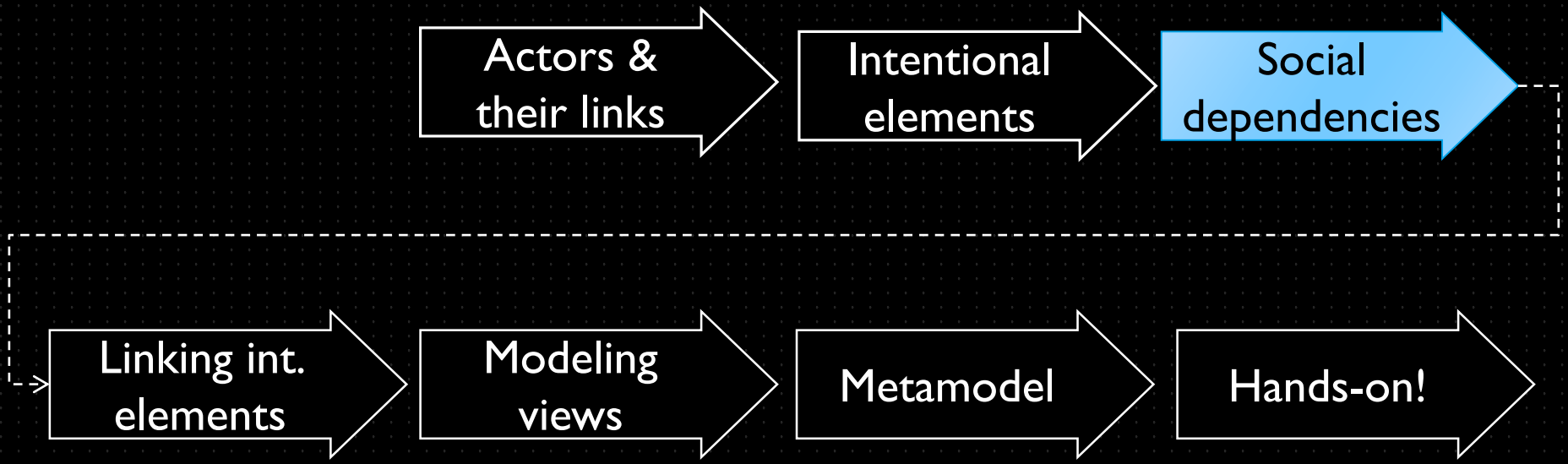
Resources

- A **resource** is a physical or informational entity that an actor requires in order to perform a task
- Examples
  - Credit card
  - Server
  - Personal details
- Represented as rectangles

Intentional elements inside actor boundaries



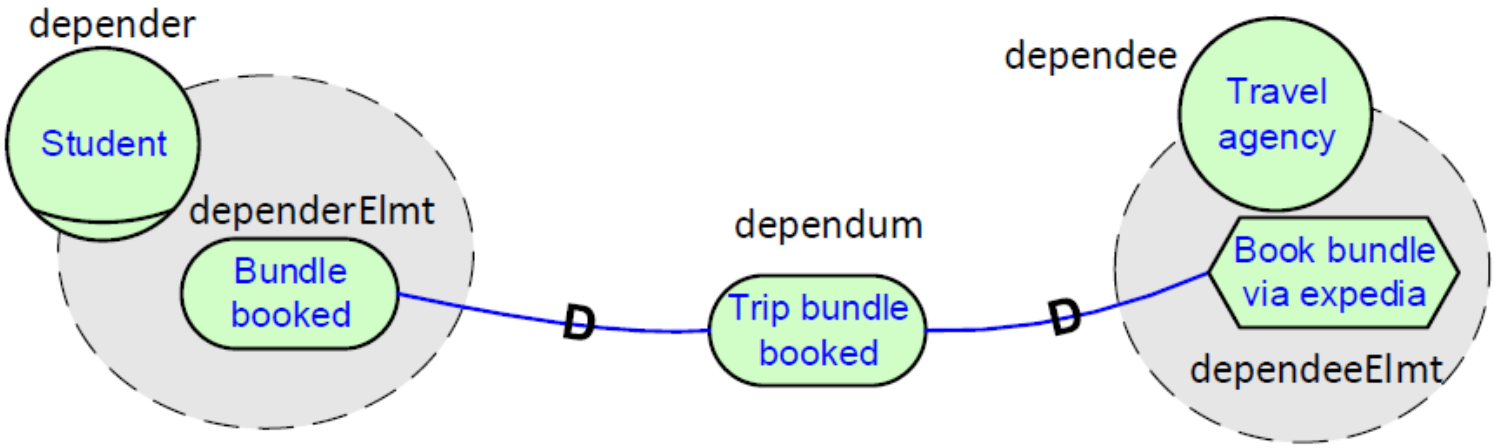
Outline



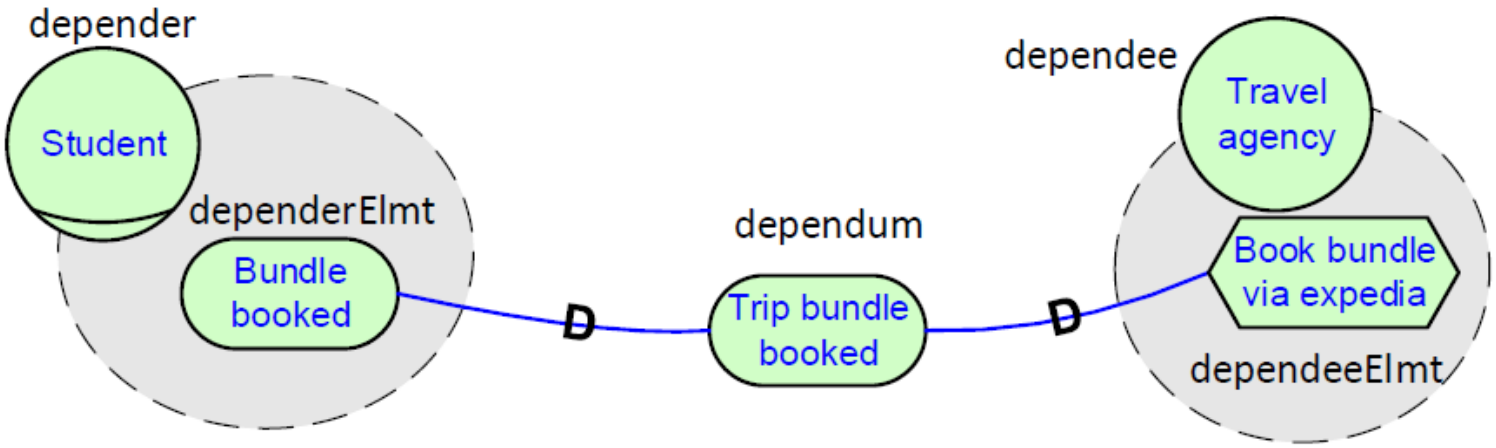
Dependencies

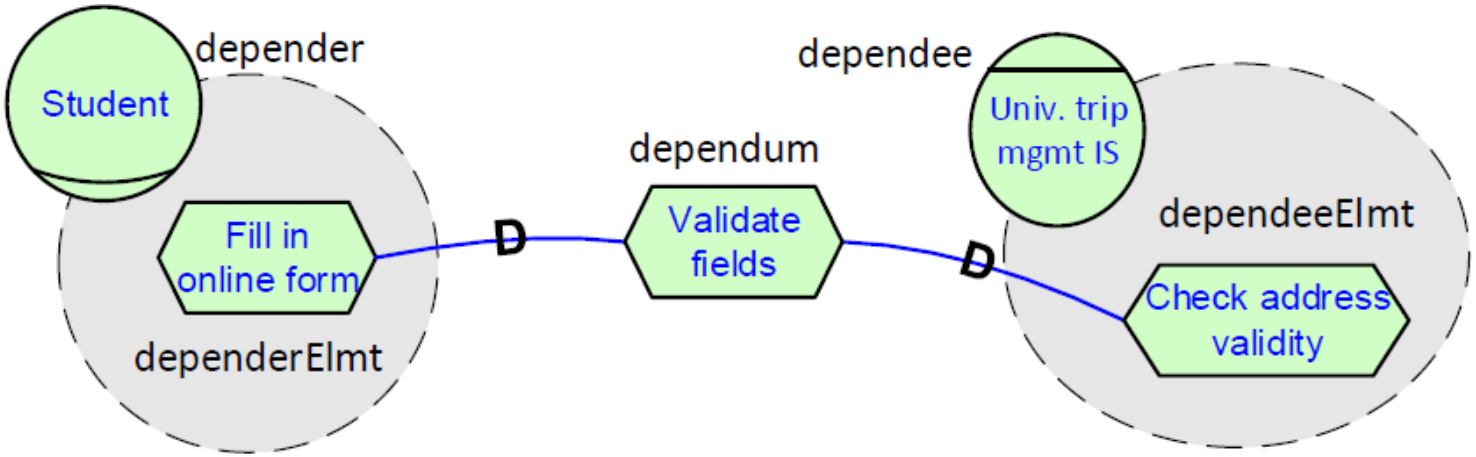
- Social relationships are represented as **dependencies**
- A dependency is a relationship with five arguments:
  - *Depender:* an actor that depends for something (the dependum) to be provided
  - *DependerElmt*: an intentional element within the depender's actor boundary where the dependency starts from, which explains **why** the dependency exists
  - *Dependum*: an intentional element that is the object of the dependency
  - *Dependee*: the actor that should provide the dependum
  - *DependeeElmt*: the intentional element that explains **how** the dependee intends to provide the dependum.

Dependencies, an example



Dependencies, an example





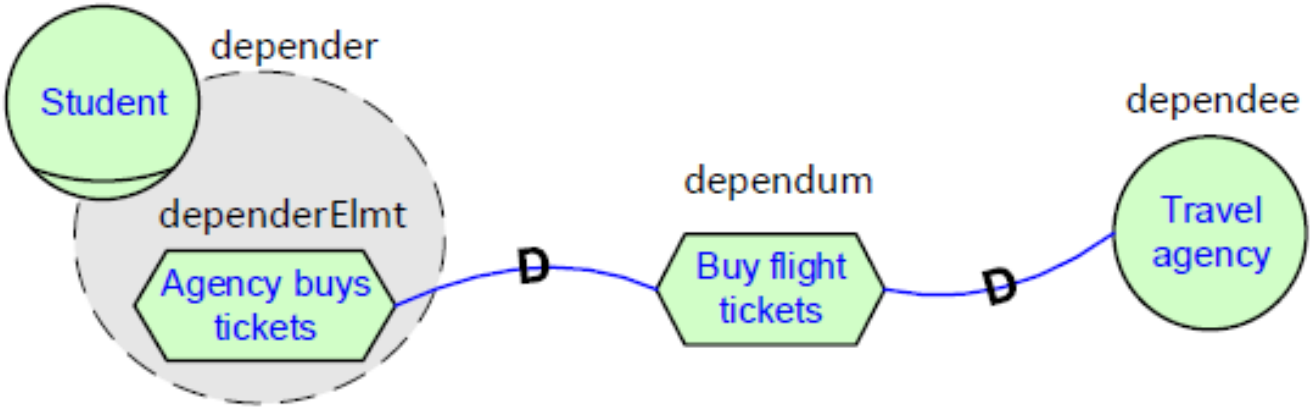
Any differences?

Dependum types

- The type of the dependum specializes the semantics of the dependency relationship
  - **Goal**: the dependee is free to choose how to achieve the goal
  - **Quality**: the dependee is free to choose how to sufficiently satisfy the quality
  - **Task**: the dependee is expected to execute the task in a prescribed way
  - **Resource**: the dependee is expected to make the resource available to the depender
- Different dependum types give the dependee different degrees of freedom

Omitting dependency parts

- **Omitting the dependerElmt** implies not specifying why the dependency exists
- Omitting the **dependeeElmt** implies not specifying how the dependency will be fulfilled



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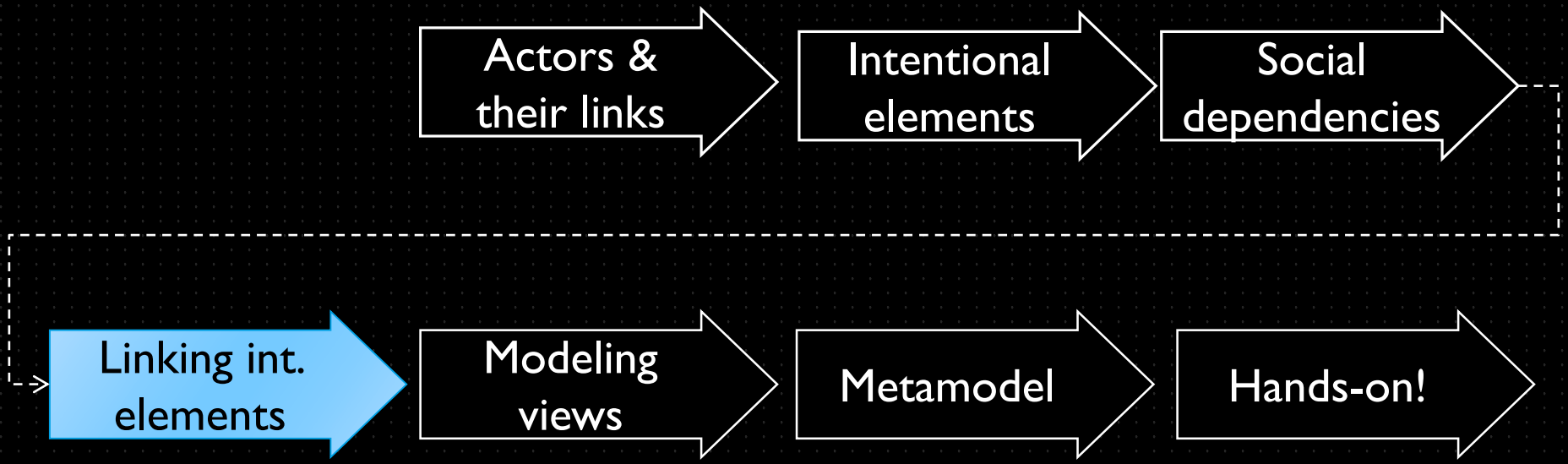
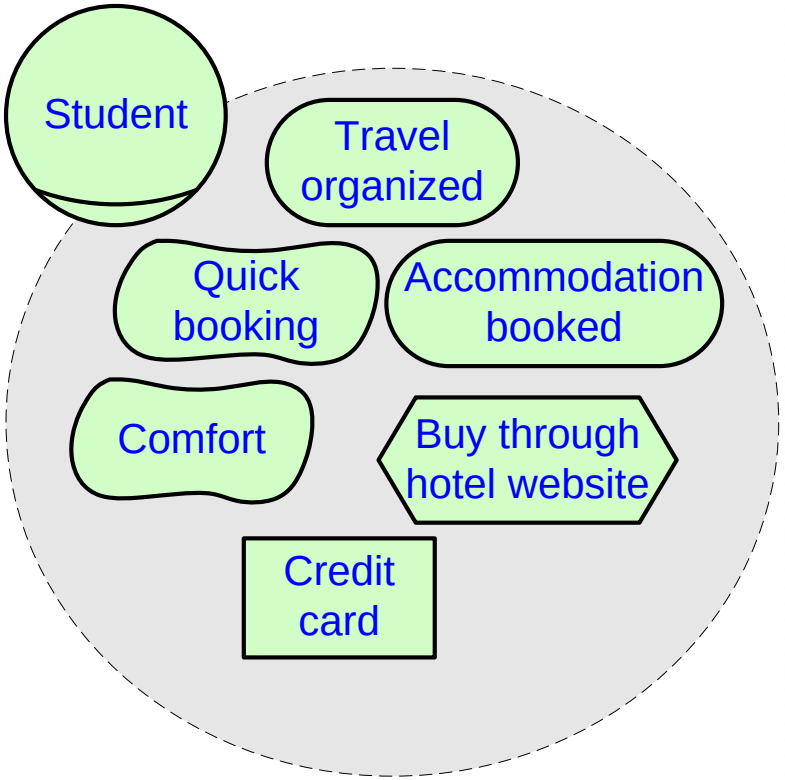


Intentional element links



The elements within an actor boundary are interrelated.

But we have seen no ways to relate them so far.

Any idea?

Intentional element links: overview

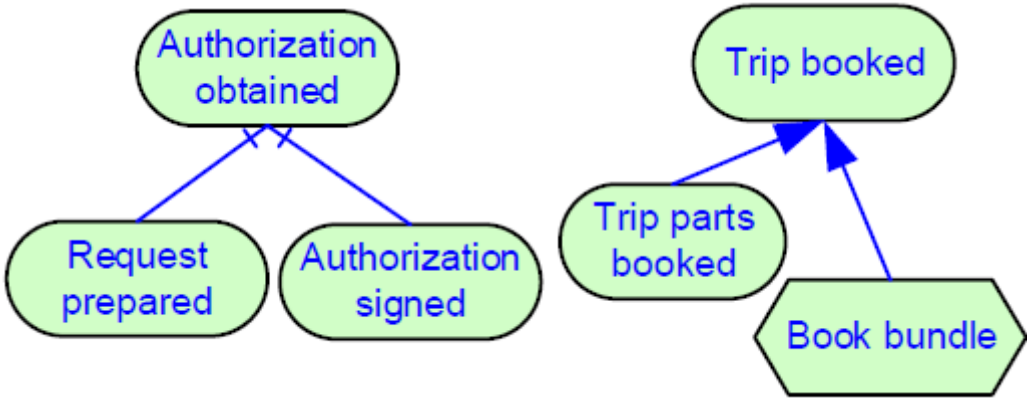
- Four link types:
  - Refinement
  - NeededBy
  - Contribution
  - Qualification

		Arrowhead pointing to			
		Goal	*Quality*	*Task*	*Resource*
Link starts from	*Goal*	Refinement	Contribution	Refinement	n/a
	Quality	Qualification	Contribution	Qualification	Qualification
	Task	Refinement	Contribution	Refinement	n/a
	Resource	n/a	Contribution	NeededBy	n/a

Refinement

- **Refinement** is a generic relationship that links goals and tasks hierarchically
  - n-ary relationship linking one parent to one or more children
  - An intentional element can be the parent in at most one refinement link
- Two types of refinement
  - **AND:** the fulfillment of all *n* children (n≥2) makes the parent fulfilled
  - **Inclusive OR:** the fulfillment of at least one child makes the parent fulfilled

AND refinement

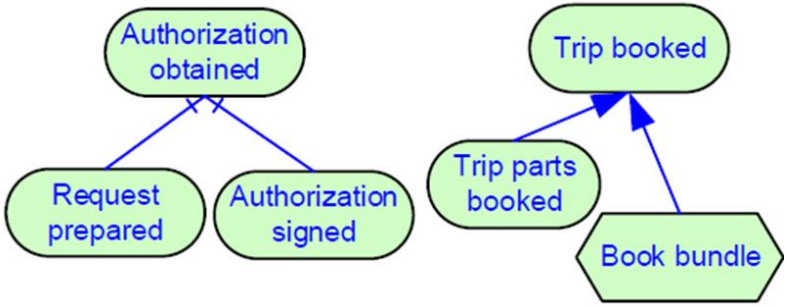


OR refinement

Different meanings of a refinement

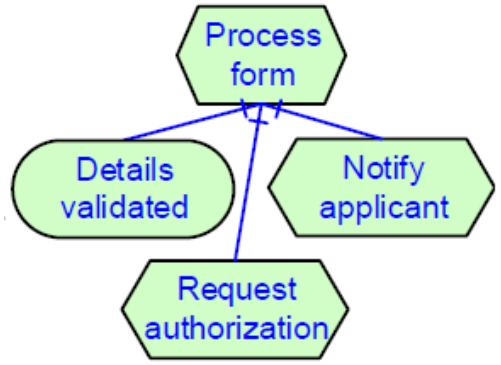
- Refinement takes different meanings depending on the type of connected elements

1. If the parent is a **goal**
   - **AND-refinement**
     - A **child goal** is a sub-state of affairs that is part of the parent goal
     - A **child task** is a sub-task that must be fulfilled
   - **OR-refinement**
     - A **child goal** is a sub-goal that can be achieved for fulfilling the parent goal
     - A **child task** is a particular way for fulfilling the parent goal



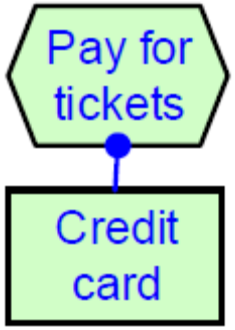
Different meanings of a refinement

2. If the parent is a **task**
   - **AND-refinement**
     - A **child goal** is a goal that is uncovered by analyzing the parent task
     - A **child task** is a sub-task that is identified as part of the parent task
   - **OR-refinement**
     - A **child goal** is a goal that is uncovered by analyzing the parent task which may substitute for the original task
     - A **child task** is a particular way for executing the parent task



NeededBy

- The **NeededBy** relationship links a task with a resource and it indicates that the actor needs the resource in order to execute the task
  - No details on the reason for this need: consumption, reading, …

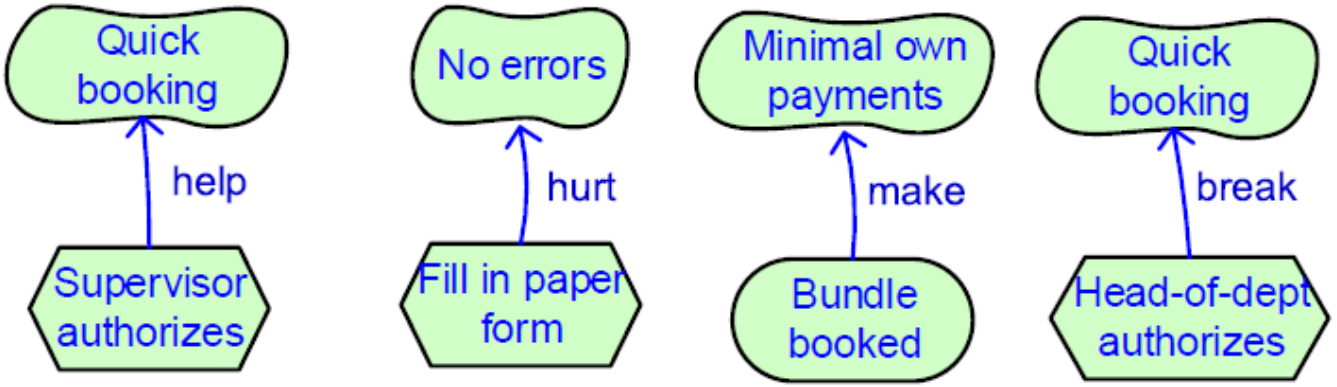


Contribution

- **Contribution links** represent the effects of intentional elements on qualities
  - These are qualitative links
  - Assist analysts in the decision-making process among alternative goals / tasks
- Qualities can be
  - **Fulfilled** (or satisfied), having sufficient positive evidence
  - **Denied**, having strong negative evidence
- No details here on how fulfillment / denial are calculated

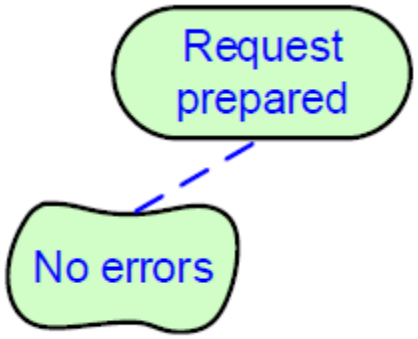
Contribution types

- Four types, expressing that "the source provides…"
  - **Make**: sufficient positive evidence for the satisfaction of the target
  - **Help**: weak positive evidence for the satisfaction of the target
  - **Hurt**: weak evidence against the satisfaction (or for the denial) of the target
  - **Break**: sufficient evidence against the satisfaction (or for the denial) of the target



Qualification

- The **qualification** relationship relates a quality to its subject: a task, goal, or resource
- Examples:
  - the quality "Quick booking" refers to the goal "Trip parts booked", elaborating on how this goal might be achieved
  - the quality "No errors" refers to errors possibly created while fulfilling the goal "Request prepared"



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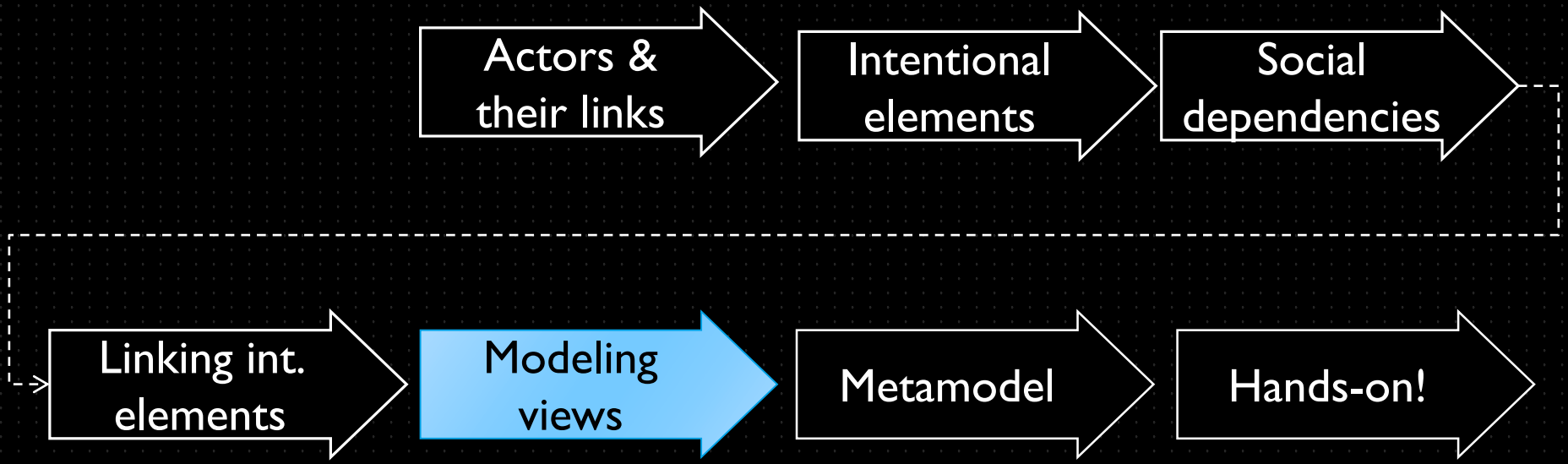
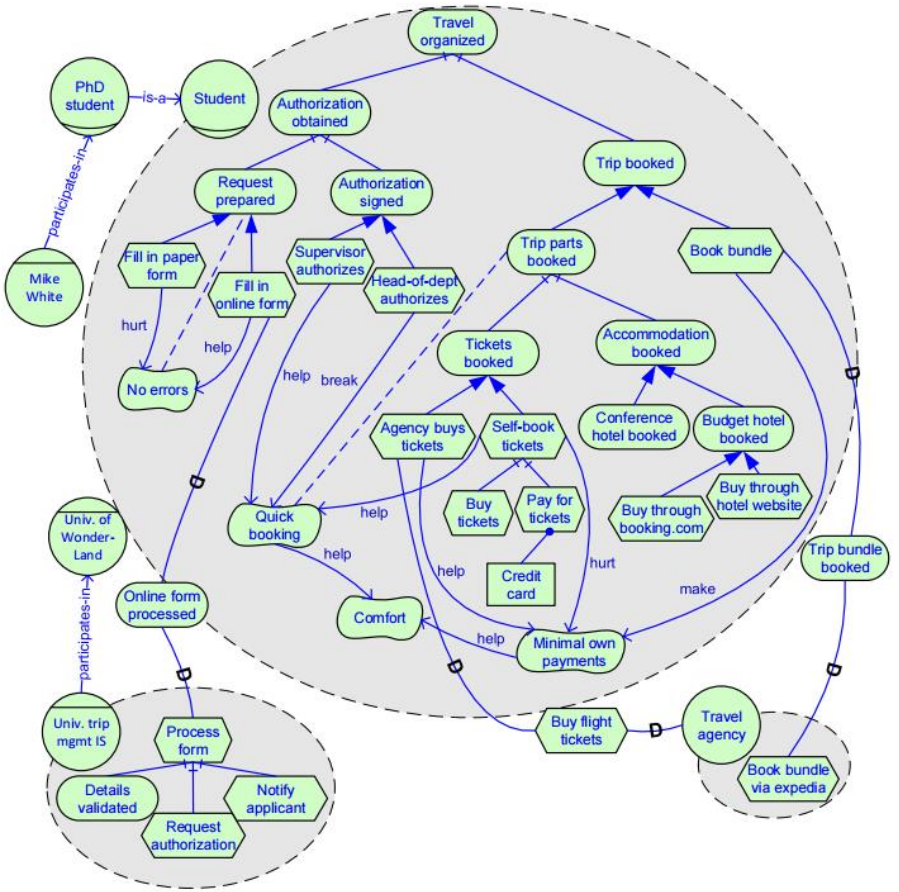


Model views

- When using iStar 2.0, the analyst creates a **model**
- Such model can be visualized via multiple perspectives or **model views**
- Standard views exist, including two from *i**:
  - Strategic rationale (SR)
  - Strategic dependency (SD)
- Hybrid views can be defined

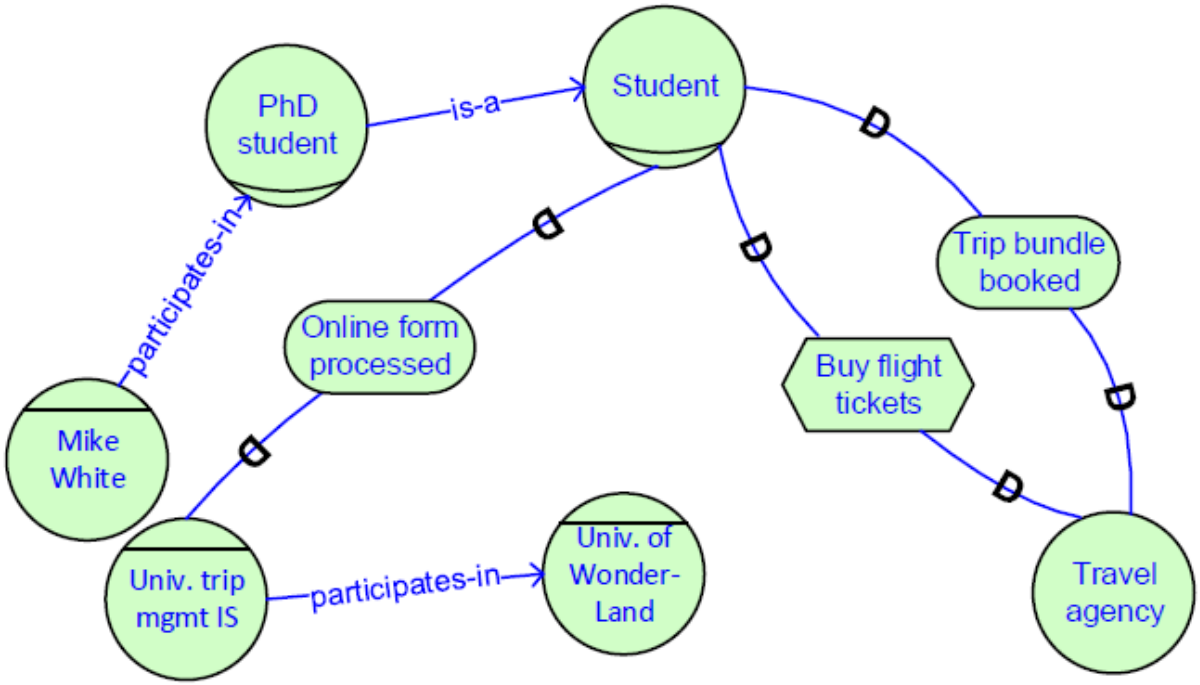
Strategic rationale in iStar 2.0

- Shows **all** details captured in the model!
  - Actors
  - Actor links
  - Intentional elements
  - Dependencies
  - Intentional element links



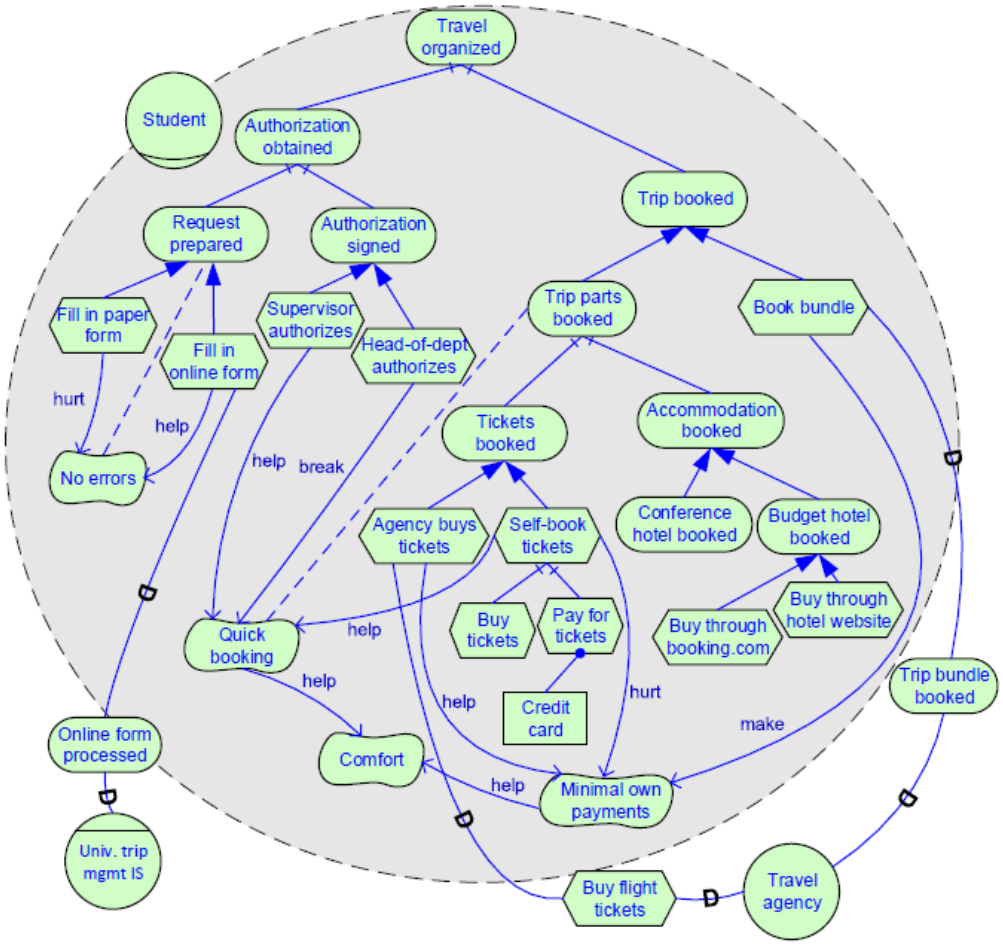
Strategic dependency in iStar 2.0

- Shows **only** the social part of the model
  - Actors
  - Actor links
  - Dependencies
- … but **not** intentional ele-ents and their links

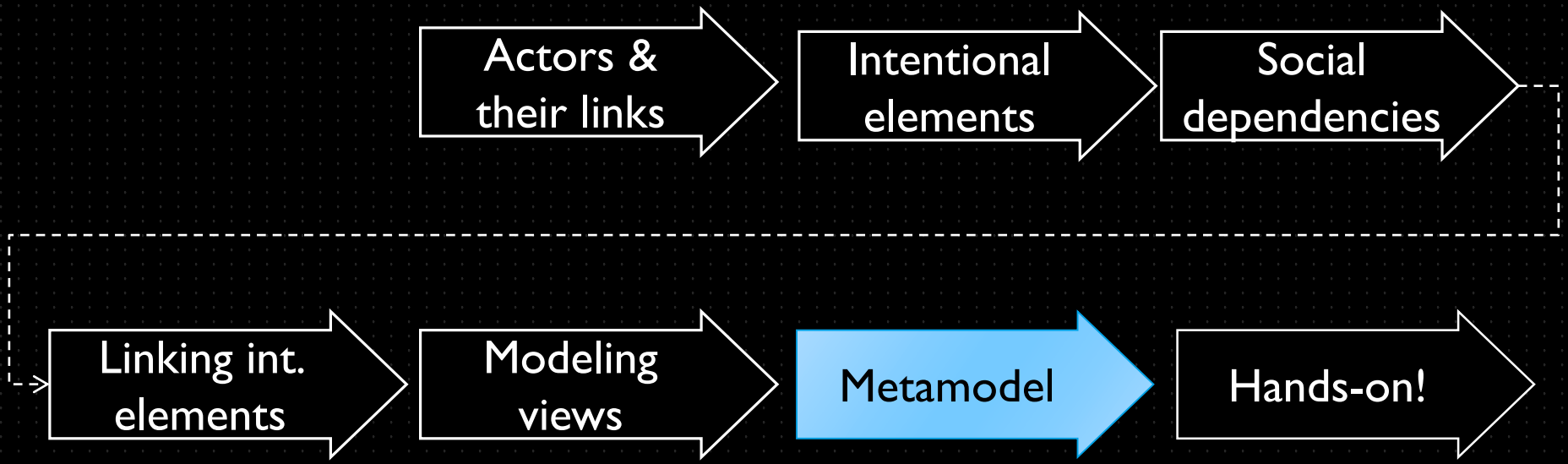


A hybrid view

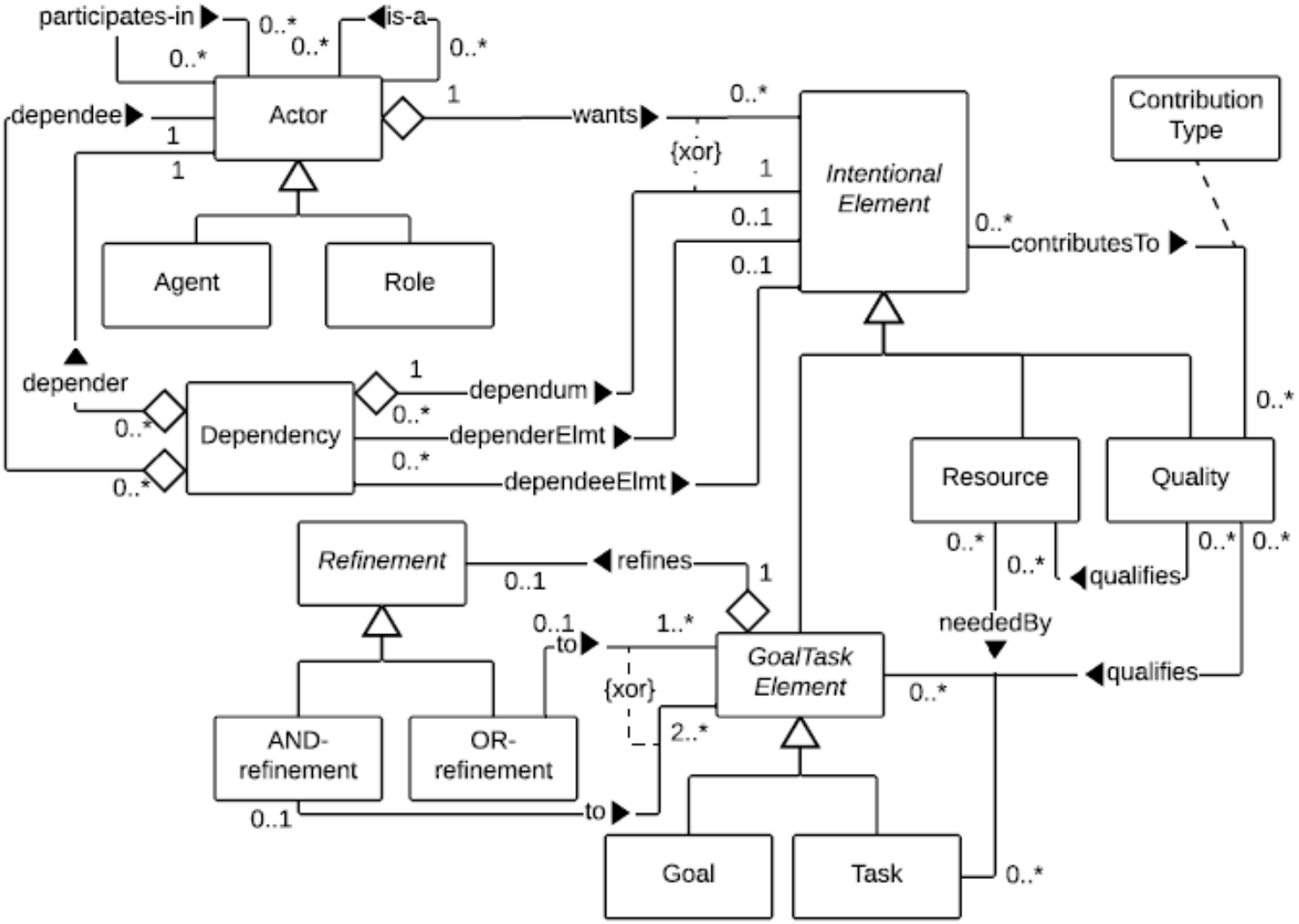
- For example
  - Some actor boundaries are open, but not all
  - Actor links are hidden
- Other hybrid views
  - *Functional* (no qualities)
  - *Actor* view (only actors and their links)



Outline



Syntax of iStar 2.0



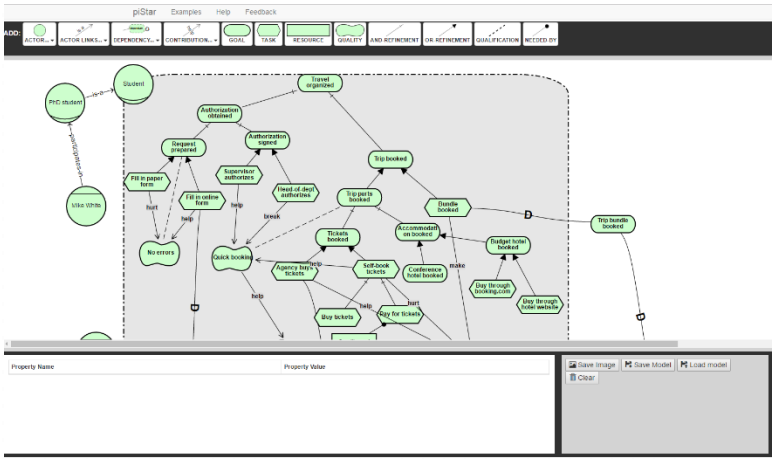
Precise syntax of iStar 2.0

- Some details cannot be captured via a metamodel
- A few of them here (more in the language guide)
  - No *is-a* cycles
  - No *participates-in* cycles
  - Two actors can be linked by at most one actor link
  - The depender and dependee of a dependency should be different actors
  - Refinement should not lead to refinement cycles
  - It is not possible for a quality to contribute to itself

Why is precise syntax that important?

- Minimize ambiguity to facilitate homogeneous learning
- Guide tool developers

- Two weeks after the release of the standard, the first iStar 2.0 compliant tool was released by researchers in Brazil
  - http://www.cin.ufpe.br/~jhcp/pistar/



iStar 2.0: A Guided Tour
Part II: hands-on

Dr. Fabiano Dalpiaz, Utrecht University, the Netherlands,
Prof. Xavier Franch, Universitat Politècnica de Catalunya, Spain,
Prof. Jennifer Horkoff, Chalmers and the University of Gothenburg, Sweden

The Gifu Parking System

Task: model the following scenario using iStar 2.0, and feel free to extend it as you will. You can think of alternative solutions to the listed problem(s), additional actors, etc.

The multi-floor parking lot in the center of Gifu employs a parking lot system that guides drivers that are looking for a parking. The system relies on the data on the number of available spots that is provided floor by floor through sensors. The system guides the drivers via displays, shown on every floor, that retrieve and show data from those sensors.

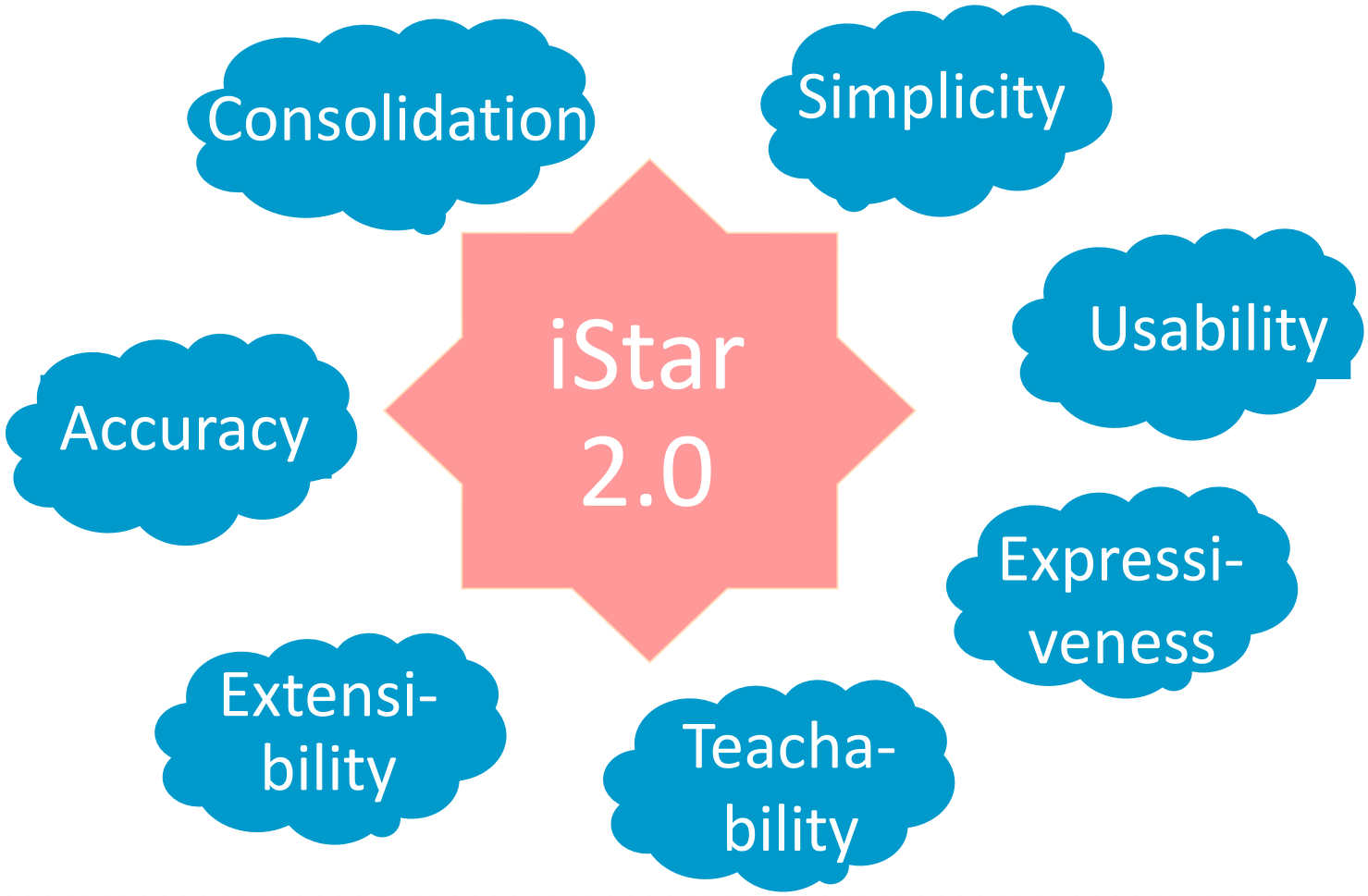
Unfortunately, the system is a bit old and the accuracy of the sensors is sub-optimal. As such, from time to time, lot attendants walk around the floors to check how many spots are actually available and they update the system manually.

The lot management is unhappy with the situation because profit and good reputation are threatened! On the profit side, lot attendants are more expensive than sensors, but the sensors cannot be easily replaced and the only solution would be to re-develop the entire system, which is even more expensive! On the reputation side, the management knows that besides accuracy, car safety and security are necessary to guarantee good reputation!

iStar 2.0: A Guided Tour
Part III: Future Work and Initiatives

Dr. Fabiano Dalpiaz, Utrecht University, the Netherlands,
Prof. Xavier Franch, Universitat Politècnica de Catalunya, Spain
Prof. Jennifer Horkoff, Chalmers and the University of Gothenburg, Sweden

iStar 2.0: objectives (revisited)



iStar 2.0 vs. "classical" *i**

	i 1.0 - wiki [url]*	**iStar 2.0 [url]**	**Comment**
Actors	General actors	General actors	
	Roles, positions, agents	Roles, agents	
Actor links	is-a	is-a	
	is-part-of, plays, occupies, covers	participates-in	iStar 2.0 simplifies iStar 1.0 with a generic relationship that may be applied among two actors of any type
	INS	-	agents can only be instances in iStar 2.0
Intentional elements	Goal, task, resource	Goal, task, resource	
	softgoal	quality	we move away from the hard/soft-goal dichotomy (see footnote in the standard)
Intentional element links	means-end, task decomposition	refinement	a single relationship for simplicity, different semantics depending on the connected elements and the logical connector AND/OR
	contribution	contribution	
		qualification, neededBy	new relationships to link goals/tasks to qualities and resources, respectively

Open issues

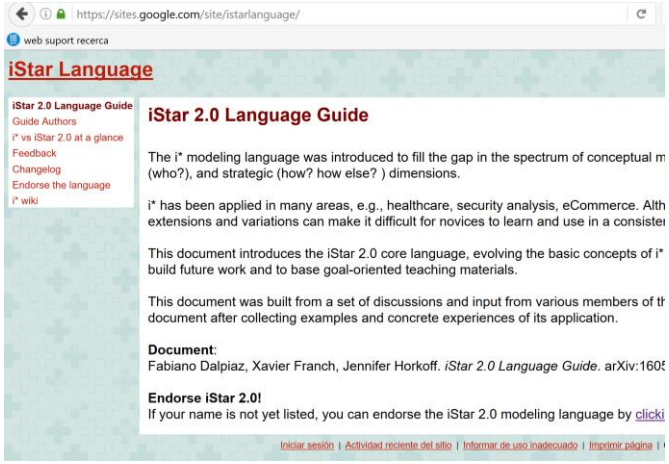
- Semantics
- Evaluation
- Tool support
- Graphical representation
- Terminology
- Construction methods
- Extension mechanisms

Future actions

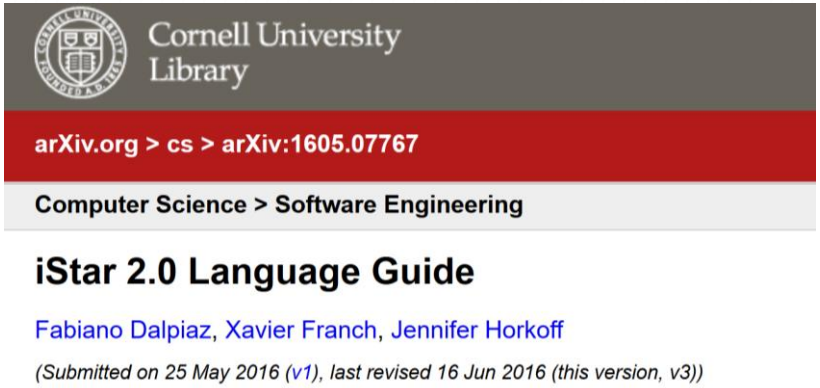
- Call for empirical evaluation
- Way to collect and process evaluation/feedback/examples?
  - Regular meetings? Committees?
- Process for updating standard
- Educational material
  - These slides?
- Industry-oriented material
- Repository of examples
- …

Resources for iStar 2.0

- The iStar 2.0 site: https://sites.google.com/site/istarlanguage/



- The iStar 2.0 language: guide:ttps://arxiv.org/abs/1605.07767



Basic material for this tutorial

- Fabiano Dalpiaz. "Social modeling of organizations with iStar 2.0". Game Production Course Slides, Utrecht University, 2016.
- Jennifer Horkoff. "Goal-Oriented Requirements Engineering: Introduction and Overview". Guest Lecture, Chalmers and the University of Gothenburg, 2016.
- Xavier Franch. "Goal-Oriented Requirements Engineering in the *i** Framework". Tutorial at ICSE 2014.

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- Xavier Franch. "The *i** Framework: The Way Ahead". Keynote at RCIS 2012.
- Jennifer Horkoff, Fatma Başak Aydemir, Evellin Cardoso, Tong Li, Alejandro Mate, Elda Paja, Mattia Salnitri, John Mylopoulos, Paolo Giorgini. "Goal-Oriented Requirements Engineering: A Systematic Literature Map". RE 2016.
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- John Mylopoulos. "Information Modeling in the Time of the Revolution". *Information Systems*, 23(3–4), May–June 1998.
- Eric Yu. *Modelling Strategic Relationships for Process Reengineering*. Diss. Ph. D. Thesis, Dept. of Comp. Science, Univ. of Toronto, 1995.
- Eric Yu. "Towards Modelling and Reasoning Support for Early-phase Requirements Engineering". ISRE 1997.
- Eric Yu, Jaelson Castro, Anna Perini. "Strategic Actors Modeling with i*". Tutorial at RE 2008.
- Eric Yu, Paolo Giorgini, Neil Maiden, John Mylopoulos (eds). *Social Modeling for Requirements Engineering*. MIT Press, 2011.
- ITU-T Z.151 User Requirements Notation. http://www.itu.int/rec/T-REC-Z.151/en

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- Fabiano Dalpiaz, U. Utrecht
- Xavier Franch, U. Politècnica de Catalunya
- Jennifer Horkoff, ~~U. Toronto~~
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