

# Lecture 6

→ (Week 6 - Feb 12, 2024)

## Use Case Diagrams:

- Use case diagrams provide a simplified form of goal modeling in UML.
- Functional goals are represented by bubbles, which name specific functions or features that the system should accomplish.
- Use cases capture the behavioral requirements of the system.

## Actors Representation:

- Actors are represented as stick man on the diagram.
- Actors are associated with the use cases in which they participate. These actors represent roles played by users, external systems, or other entities interacting with the system.

## Visual Representation:

- Use cases are depicted as elliptical bubbles on the diagram to represent desired behavioral goals.
- The relationships between actors and use cases illustrate the interactions and dependencies between various roles and the system's functionalities.

## Purpose:

- Use case diagrams serve as a visual depiction of the goals and interactions within a system.
- They provide a means to understand the functional requirements of the system and the roles involved in achieving those requirements.

## Documentation and Communication:

- Use case diagrams facilitate communication between stakeholders by providing a clear visualization of the system's goals and functionalities.
- They serve as documentation for requirements elicitation, analysis, and validation processes.

## Limitations:

- While use case diagrams are useful for capturing functional goals, they may not adequately represent non-functional requirements or complex relationships between goals.
- They may need to be supplemented with additional modeling techniques for a comprehensive understanding of system goals and constraints.

## Importance of Goals in Requirements Engineering:

- Goals play a crucial role in driving requirements elaboration and understanding the rationale behind system functionalities.
- GRL helps express and clarify ambiguous requirements, supporting argumentation, negotiation, conflict resolution, and decision-making.

## Why GRL?:

- GRL facilitates capturing decision rationale, criteria, and alternatives.
- It provides traceability from strategic objectives to technical requirements and allows for the reuse of stable higher-level goals during system evolution.
- Unlike UML, GRL focuses on the "why" aspect of requirements, emphasizing objectives, alternatives, and decision-making.

## GRL in a Nutshell:

- GRL is a graphical notation that connects requirements to business objectives and allows reasoning about non-functional requirements.
- It has its roots in i\* and the NFR (Non-Functional Requirements) framework, emphasizing objectives, alternatives, and decision rationales.

## UCMs in a Nutshell:

- UCMs, or Use Case Maps, are a graphical scenario notation focusing on the "what" aspects of requirements.
- They depict causal relationships between responsibilities and allocate scenario elements to components, representing functional requirements as scenarios.

#### **Relationship between GRL and UCM:**

- GRL focuses on answering "why" questions and represents both functional and non-functional requirements.
- UCMs focus on answering "what" questions, representing functional requirements as scenarios.
- Goals in GRL are operationalized into tasks, which are elaborated into UCM scenarios, addressing "how" questions.

#### **User Stories and Goal Models:**

- User stories can be aligned with goal models to provide a structured format for expressing requirements.
- They typically follow the pattern: "As a [Actor], I want to [Task] in order to [Contribution] achieve [Goal]."
- User stories help identify tasks, contributions, and their alignment with overarching goals, facilitating requirements understanding and communication.

#### **URN (User Requirements Notation):**

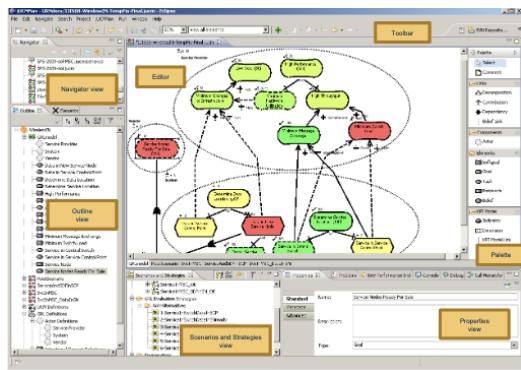
- URN facilitates the specification and discovery of requirements for proposed and evolving systems.
- It allows engineers to review requirements for correctness and completeness.
- URN combines goals and scenarios, bridging the gap between informal and formal concepts, and between requirements models and design models.
- Even when used informally, URN offers significant benefits with little modeling investment.

#### **GRL (Goal-oriented Requirements Language):**

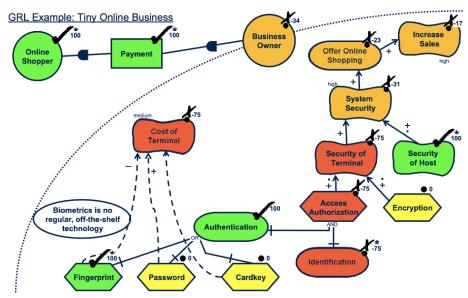
- GRL is suitable for capturing incomplete, tentative, and non-functional requirements.
- It helps in capturing goals, objectives, alternatives, and rationales behind decisions.
- GRL provides a framework for expressing goals, objectives, and their relationships, facilitating decision-making and requirement analysis.

#### **UCM (Use Case Maps):**

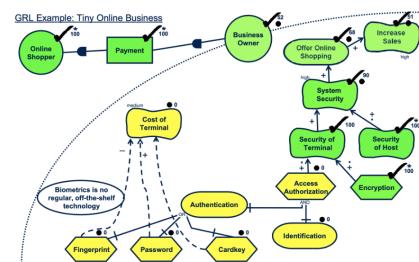
- UCM is used for operational requirements and architectures.
- It enables analysis and transformations, allowing architects to explore architectural alternatives and model dynamic systems.
- UCM provides a graphical scenario notation to depict causal relationships between responsibilities and allocate scenario elements to components.
- It helps in understanding system behavior and interaction between components.



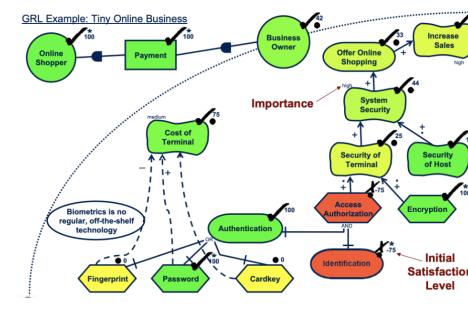
Example 2: Evaluations with GRL (strategy 2):  
Quantitative



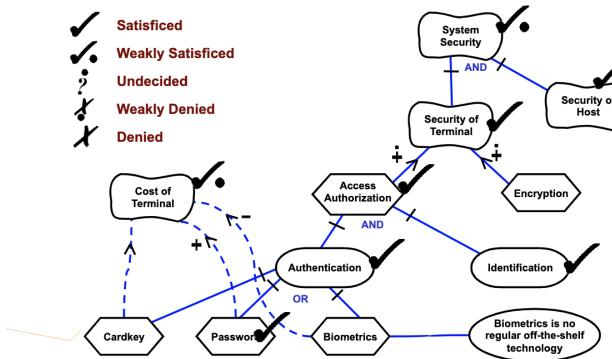
Example 2: Evaluations with GRL (strategy 3):  
Quantitative



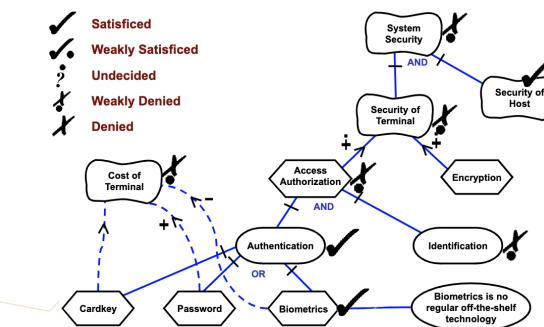
Example 2: Evaluations with GRL (strategy 1):  
Quantitative



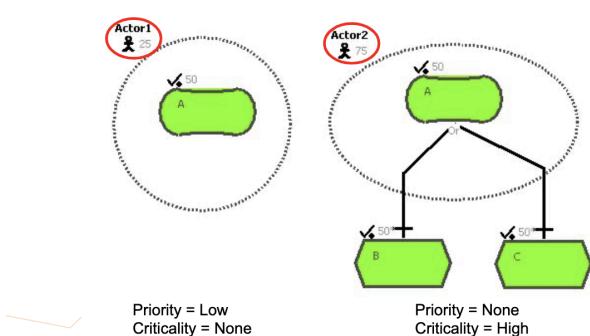
Example 1: Evaluations with GRL (strategy 2):  
Qualitative



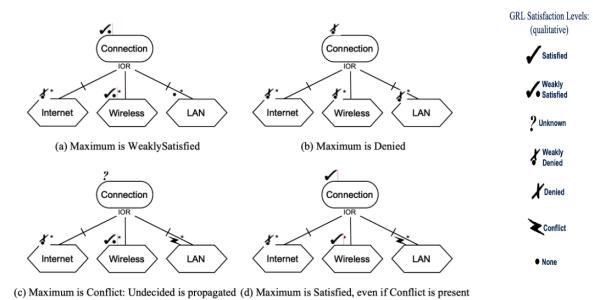
Example 1: Evaluations with GRL (strategy 1):  
Qualitative



### Numerical Evaluation: Actor Evaluation

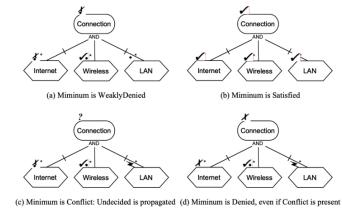


### OR Decomposition: Satisfaction Levels (Qualitative Approach)



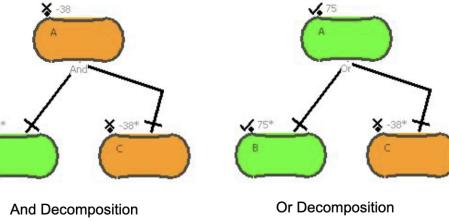
## Numerical Evaluation: Decompositions

### AND Decomposition: Satisfaction Levels (Qualitative Approach)



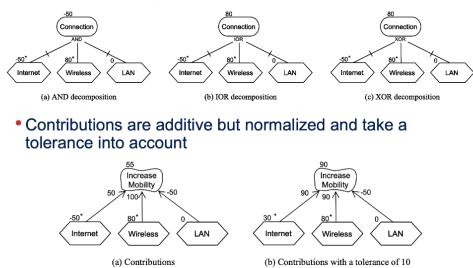
GRL Satisfaction Levels: (qualitative)  
 ✓ Satisfied  
 ✕ Weakly Satisfied  
 ? Unknown  
 ✗ Weakly Denied  
 ✗ Denied  
 ↗ Conflict  
 • None

Minimum for AND, maximum for OR

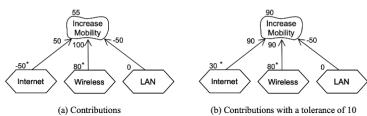


### Satisfaction Levels (Quantitative Approach) Decompositions and Contributions

• Minimum for AND, maximum for OR



• Contributions are additive but normalized and take a tolerance into account



### Numerical Evaluation: Contributions

• For each contribution, convert the contribution level to the corresponding factor

Make = 100

Help = 25

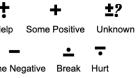
Some Positive = 75

Unknown = 0

Some Negative = -75

Hurt = -25

Break = -100



### Satisfaction Levels (Quantitative Approach)

Evaluation between -100 and 100.

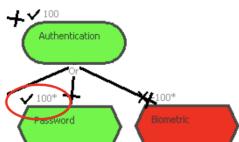
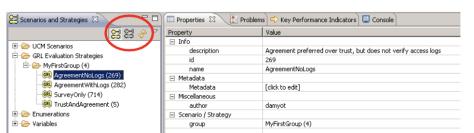
$E = -100 \rightarrow$  Denied  
 $-100 < E < 0 \rightarrow$  Weakly Denied  
 $E = 0 \rightarrow$  Undecided  
 $0 < E < 100 \rightarrow$  Weakly Satisfied  
 $100 \rightarrow$  Satisfied

### GRL Evaluation – Qualitative or Quantitative Approach

- Qualitative Approach
  - Contribution types: From Make to Break
  - Importance: High, Medium, Low, or None
  - Qualitative satisfaction levels
- Quantitative Approach
  - Contribution types: [-100, 100]
  - Importance: [0, 100]
  - Quantitative satisfaction levels: [-100, 100]
- Hybrid Approach is also possible
  - Qualitative contribution types
  - Quantitative importance
  - Quantitative satisfaction levels

GRL Satisfaction Levels: (qualitative)  
 ✓ Satisfied  
 ✕ Weakly Satisfied  
 ? Unknown  
 ✗ Weakly Denied  
 ✗ Denied  
 ↗ Conflict  
 • None

### Strategies in jUCMNav



A star (\*) indicates an initial value part of a given strategy. All the others are evaluated through a propagation algorithm.



(a) GRL Elements



(b) GRL Satisfaction Levels



(c) Link Composition

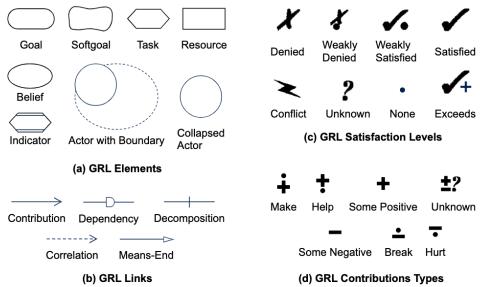
→ Contribution  
 -→ Correlation  
 → Means-end  
 → Dependency  
 → Decomposition

(d) GRL Links

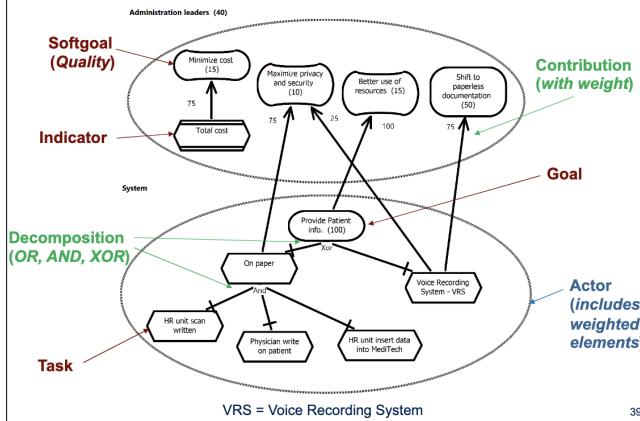
⊕ ⊖ ± ±?  
 Break Hurt Some- Unknown  
 + + + =  
 Make Help Some+ Equal

(e) GRL Contributions Types

## GRL Notation

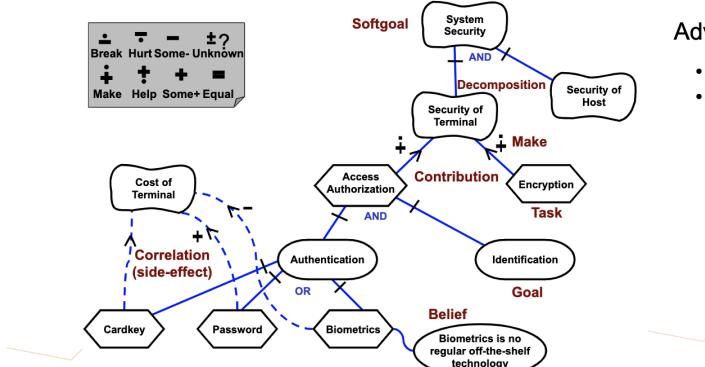


## Example: Voice Recording System



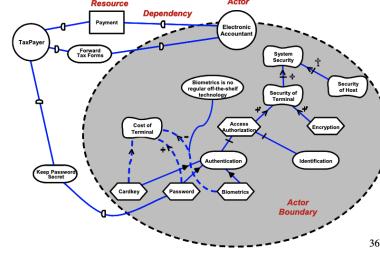
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## Basic GRL Notation



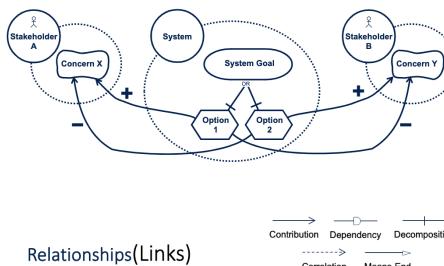
## Advanced GRL Notation

- GRL graphs can be allocated to *actors*
- *Dependencies* can be defined between actors, together with intermediate *resources*.



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## Relationship Notations



Relationships(Links)

- **Contribution Link**
  - A contribution describes desired impact or side effects (positive or negative)
  - Qualitative (symbols) or quantitative (numbers) contribution types are used for these links
- **Decomposition Link**
  - Defines what an intentional element needs to be satisfied
    - AND
    - OR
    - XOR
- **Dependency Link (source → target)**
  - The source of the dependency cannot be more satisfied than its target

GRL Contributions Types:  
(qualitative)

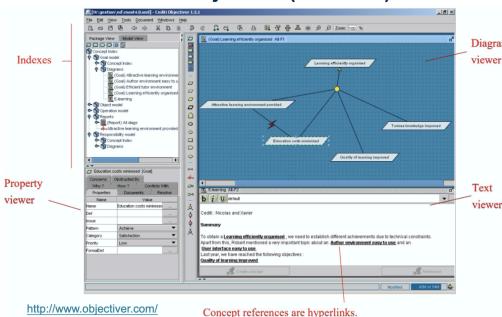


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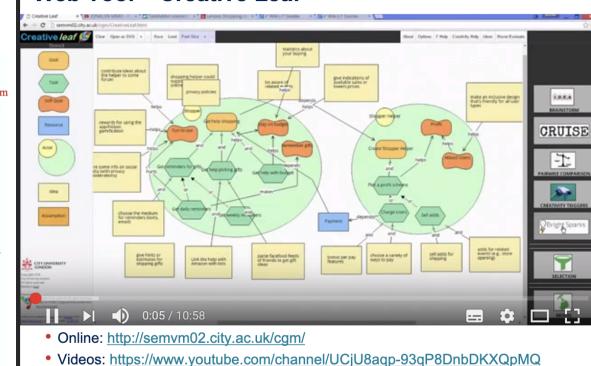
## Intentional elements



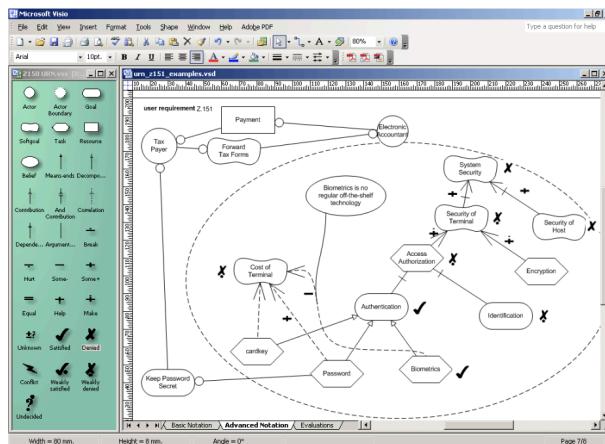
### Commercial Tool: Objectiver (for KAOs)



### Web Tool – Creative Leaf



### Tool Support – SanDriLa (Plug-in for Visio)



### Web Tool – piStar

