

Similarity-based Reasoning with Quality Goals

Feng-Lin Li^{1,2,3} , Lin Liu², and John Mylopoulos¹

1: University of Trento, Trento, Italy

2: Tsinghua University, Beijing, China

3: Alibaba Corp., Hangzhou, China

iStar 2016

2016 - 09 - 12

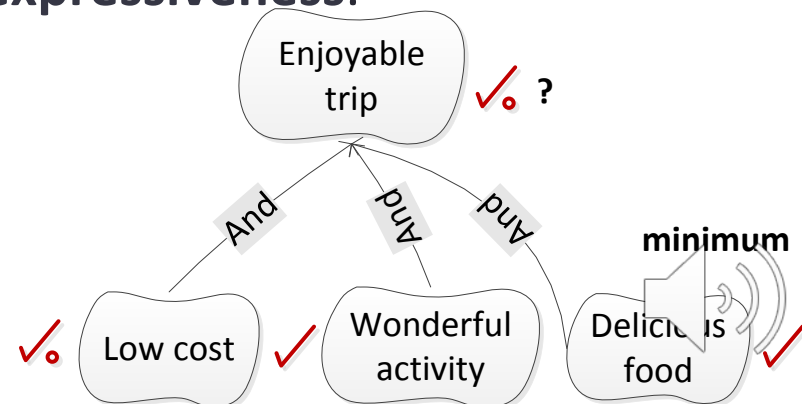


Motivation

- The satisfaction of non-functional requirements
 - Important: user satisfaction
 - Difficult: good enough, not make or break

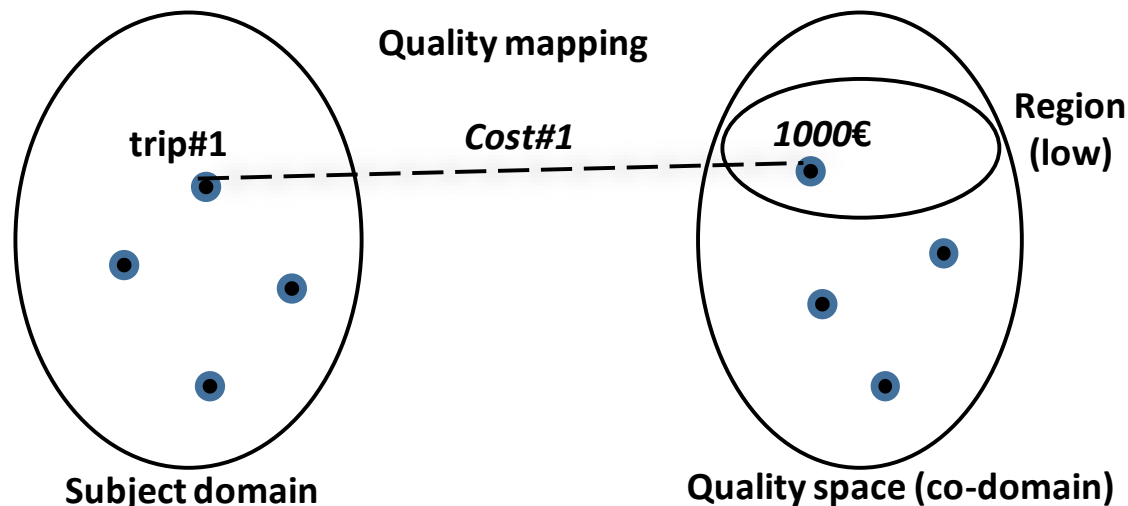
NFRs as Softgoals?

- A useful abstraction for early requirements [Li et al. 2014]
 - Both functional and non-functional, **not just non-functional**
 - E.g., increase profit
 - Non-functional requirements are **not always vague**
 - E.g., the product search function shall take less than 1 second.
- Reasoning with Softgoals
 - Qualitative and quantitative [Horkoff et al. 2013]
 - The satisfaction of leaf-level softgoals is **subjectively assigned**
 - The propagation rules are of **limited expressiveness**.
 - Linear vs. non-linear



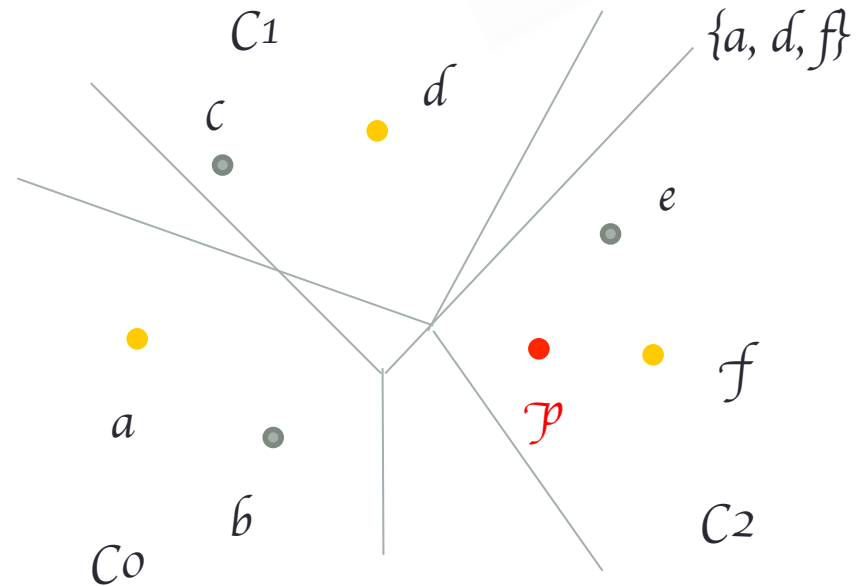
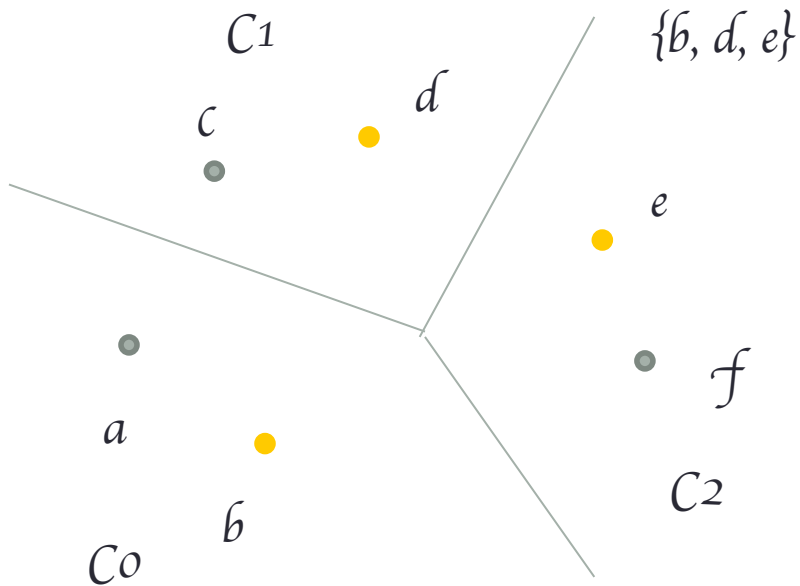
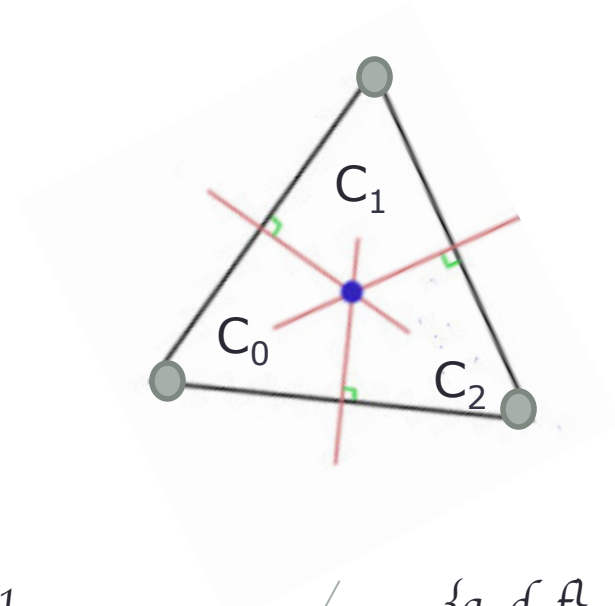
Baseline: NFRs as Qualities

- A quality maps its subject to a value in a space [Li et al. 2014]
 - An NFR is a requirement that requires a quality to take value in a desired region for its subject.
 - A QG specifies a vague region while a QC has a clear one.
 - E.g., “the cost or trips shall be low”
 - QG_1 := Cost (Trip) :: Low
 - QC_2 := Cost (Trip) :: ≤ 1000 (€)



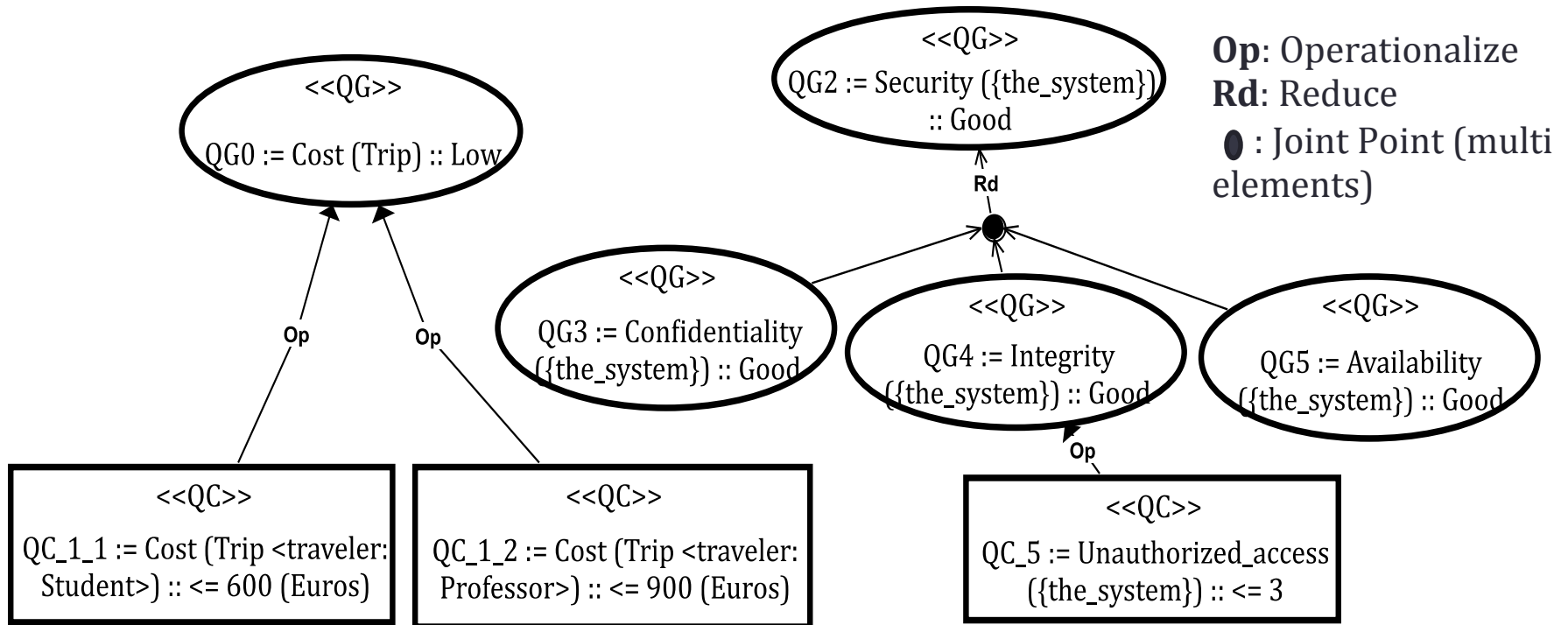
Baseline: Graded Membership

- Graded Membership [Decock et al. 2014]
 - Conceptual space
 - Regions
 - e.g., low
 - Prototype values
 - e.g., a, b



Quality Goals

- $QG := Q(\text{SubjT}) :: \text{QRG}$

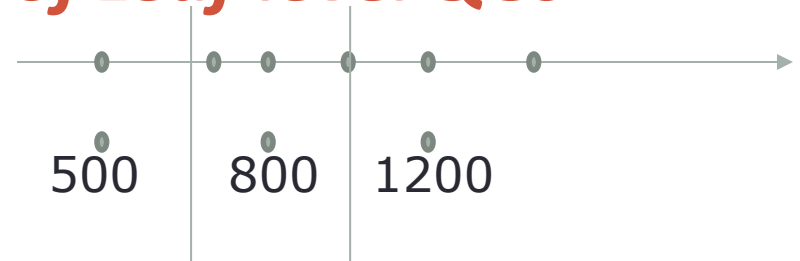


A Two-Staged Approach

- Measure the Satisfaction of Leaf-level QGs
 - Graded membership
- Propagating the Satisfaction of QGs Upstream
 - Similarity measurement

Measuring the Satisfaction of Leaf-level QGs

- A single dimensional example
 - Low: 500 €, 700 €
 - Medium: 800 €, 1000 €
 - High: 1200 €, 1500 €



$$P_{\text{low}}(740) = 0.75$$

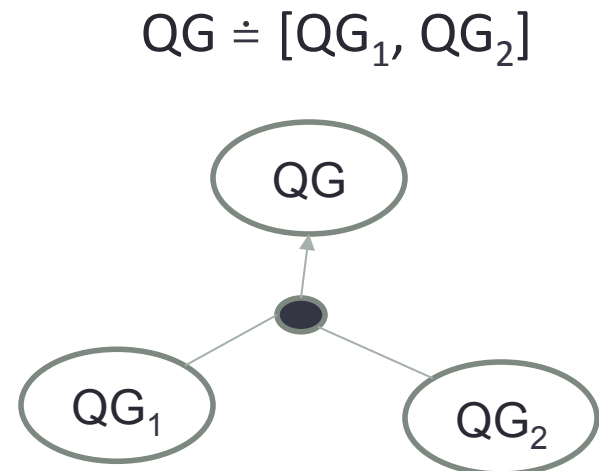
$$P_{\text{medium}}(740) = 0.25$$

- 1: {500, 800, 1200}
- 2: {500, 800, 1500}
- 3: {700, 800, 1200}
- 4: {700, 800, 1500}
- 5: {500, 1000, 1200}
- 6: {500, 1000, 1500}
- 7: {700, 1000, 1200}
- 8: {700, 1000, 1500}

- 1: 0 ... 650 ... 1000 ...
- 2: 0 ... 650 ... 1150 ...
- 3: 0 ... 750 ... 1000 ...
- 4: 0 ... 750 ... 1150 ...
- 5: 0 ... 750 ... 1100 ...
- 6: 0 ... 750 ... 1250 ...
- 7: 0 ... 850 ... 1100 ...
- 8: 0 ... 850 ... 1250 ...

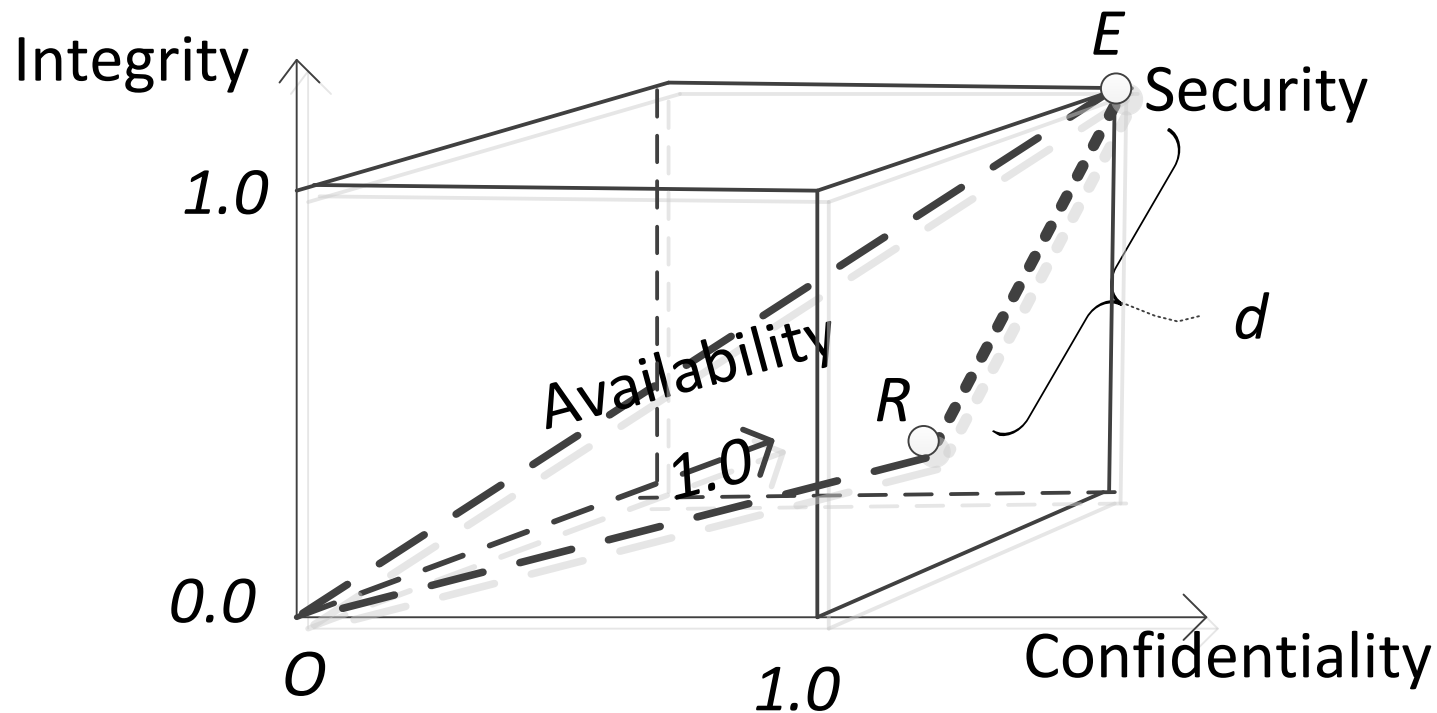
Propagating the Satisfaction of QGs Upstream

- Complex QG are refined to sub-QGs.
 - Leaf-level QGs need to be single dimensional
 - Leaf-level QGs are measured using graded membership
- On refining a QG to QG_1 and QG_2
 - Expectation:
 - $SatE_{QG} = [SatE_{QG1}, SatE_{QG2}] = [1.0, 1.0]$
 - Reality:
 - $SatR_{QG} = [SatR_{QG1}, SatR_{QG2}] = [sat_1, sat_2]$
 - **Satisfaction**
 - $Sat_{QG} = \text{similarity}(SatE_{QG}, SatR_{QG})$



Propagating the Satisfaction of QGs Upstream

- $Sat_{QG} = 1 - d/d_{max} = 1 - ER/OE$, $d = ER$, $d_{max} = OE$



$$Sat_{QG} = 1 - \frac{d}{d_{max}} = 1 - \sqrt{\frac{\sum_{i=1}^n (SatE_{QG_i} - SatR_{QG_i})^2}{n}}$$

Conclusions and future work

- In this work, we have proposed a two-staged procedure for the analysis of quality goal satisfaction
 - Measure the satisfaction of leaf-level QGs based on graded membership
 - Propagate the satisfaction of based on similarity measurement.
- It addresses some deficiencies in existing reasoning procedures
 - The satisfaction of leaf-level goals is subjectively assigned
 - The propagation rules are of limited expressiveness.
- Future Work
 - Evaluate its effectiveness using realistic case studies
 - Dealing with conflicts (trade-offs)
 - Dealing with the importance of QGs

References

- [Li et al. 2014] F.-L. Li, J. Horkoff, J. Mylopoulos, R. S. Guizzardi, G. Guizzardi, A. Borgida, and L. Liu, “Non-functional requirements as qualities, with a spice of ontology,” RE’14.
- [Horkoff et al. 2013] Horkoff, J., Yu, E.: Comparison and evaluation of goal-oriented satisfaction analysis techniques. REJ 18(3), 199–222 (2013)
- [Decock et al. 2014] Decock, L., Douven, I.: What is graded membership? Noûs 48(4), 653–682 (2014)

Acknowledgement



Welcome Questions, Comments and Suggestions !

A prototype tool

Download: <https://goo.gl/oeJ9Fi>

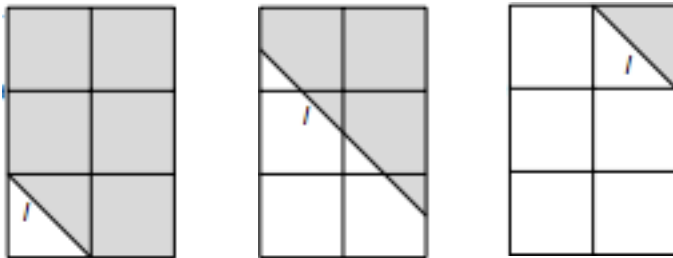
The screenshot displays the Desiree software interface. The main canvas shows a goal model diagram with the following elements:

- Canvas:** A central diagram showing goal decomposition. At the top is Goal G_0: "The system shall collect real time traffic info". It is decomposed into three goals: G_1: "The system shall collect traffic info", G_2: "Collected Traffic info shall be in real time", and G_3: "Traffic info shall include vehicle location and speed". G_1 is further decomposed into Function Goal FG_4: "Traffic_info :< Collected" and Domain Assumption DA_6: "Fixed_sensor :< Installed". FG_4 is supported by Function Func_5: "Collect <actor: {the_system}><object: Traffic_info><means: Fixed_sensor>". G_2 is supported by Quality Goal QG_7: "Timeliness (Func_5.object) :: Real_time", which is supported by Quality Constraint QC_8: "Latency (Func_5.object) :: <= 1 (min)". G_3 is supported by Content Goal CTG_9: "Traffic_info :< <has_location: String><has_speed: String>", which is supported by State Constraint SC_10: "Traffic_info_record :< <location: String><speed: String>".
- Global Outline:** A panel on the left showing a tree view of nodes under "OntoRMLDiagram - new_file.mpe", including various Goal, Function, and Constraint types.
- Navigator:** A panel on the left showing a tree view of models under "Thesis", including "CAISE.2016.Demo.mpe" and its sub-models.
- Node Editing:** A panel at the bottom center for editing the selected node "Goal_3". It shows the name "Goal_3" and the description "Goal G_3:= Traffic info shall include vehicle location and speed;".
- Local Outline:** A panel at the bottom right showing a tree view of nodes under "Outline", including Goal # Goal_3, Goal # Goal_2, ContentGoal # CTG_9, StateConstraint # SC_10, FunctionalGoal # FG_4, JointPoint #, Function # Func_5, DomainAssumption # DA_6, and QualityGoal # QG_7.
- Palette:** A panel on the right showing a list of nodes and relations available for use in the diagram.

Prototype Regions

- Prototype regions
 - $R_i: [a, b], a \leq x \leq b$
 - $R_j: [c, d], c \leq y \leq d$
 - $p \in R_i$ if
 - $p - x < y - p$
 - $x + y - 2p > 0$

Prototype regions:
Low: [500 €, 700 €];
Medium: [800 €, 1000 €];
High: [1200 €, 1500 €],



Prototype Region

