

3rd International Symposium on Search Based Software Engineering
September 10 - 12,
Szeged, Hungary

A Fuzzy Approach to Requirements Prioritization

Dayvison Chaves Lima, Fabrício Gomes de Freitas,
Gustavo Augusto Lima de Campos, Jerffeson Teixeira de Souza

Optimization in Software Engineering Group (GOES.UECE)
State University of Ceará (UECE), Brazil

Agenda

- o Introduction
- o Requirements Prioritization
- o The General Approach
- o Fuzzy Framework
- o Evaluation
- o Conclusions

Introduction

- o Software Requirements
- o Planning decisions
 - o Constraints
 - o Project risk
 - o Stakeholders' preference
- o Which Requirements should be implemented?

Requirements Prioritization

- Ordering the Requirements allows to:
 - Delivery of “most important”;
 - Manage project risk;
 - Efficiently budget use.

- How to prioritize?
 - Important decision.
 - Hard task;
 - Several aspects;

SBSE

- Search Based Software Engineering
 - Automated process;
 - Mathematical approach
 - Scalable;
- Optimize objective functions
- Solutions evaluation based on fitness

General Approach

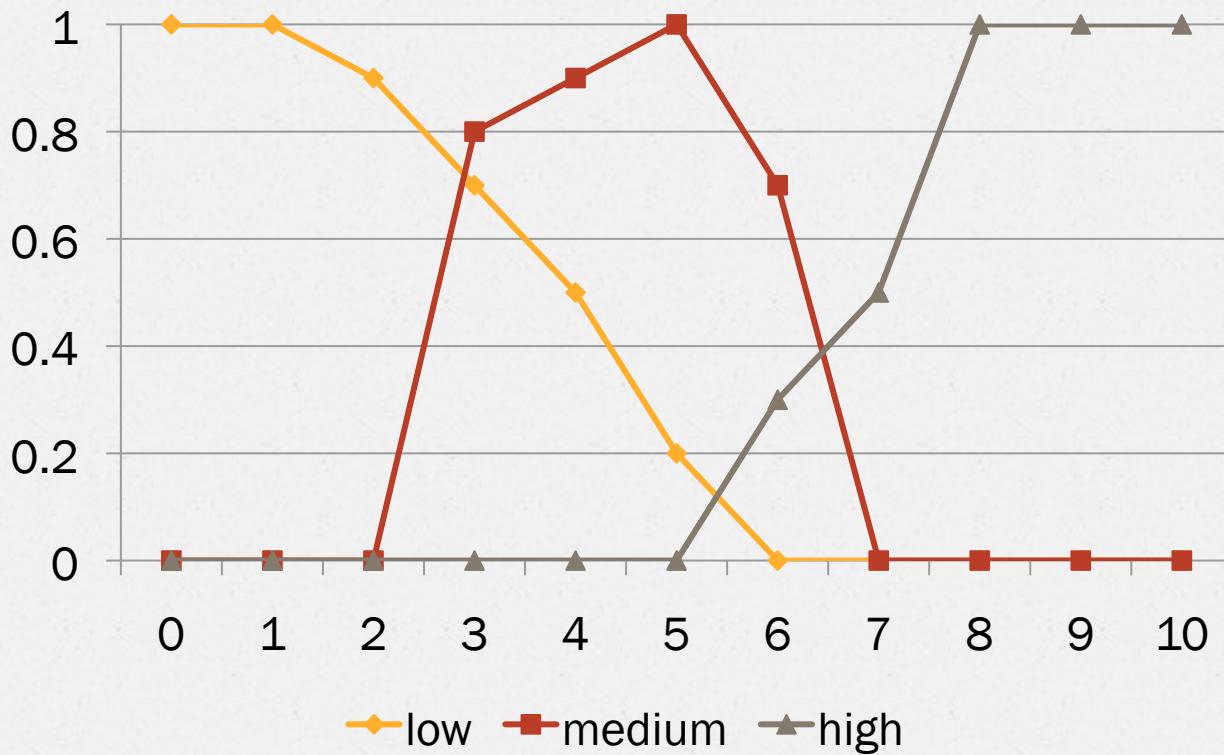
Fuzzy

- Representation of human communication;
- Flexible

Goal

- Project aspects to be considered;
- Requirements alignment to goals

Fuzzy Numbers



Goal-oriented

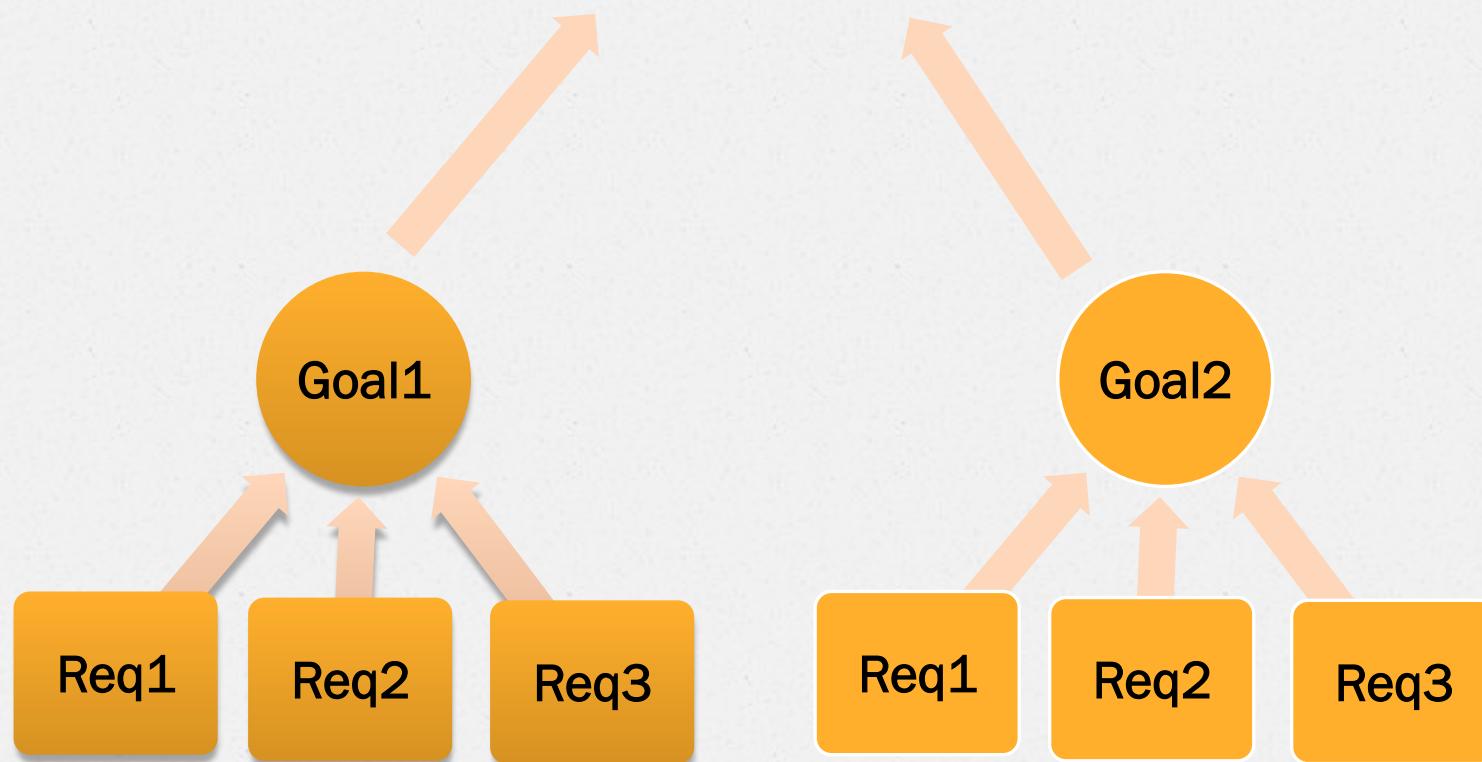
Goals

- Stakeholders' satisfaction
- Delivery on time
- Delivery on budget
- Deliver all planned scope
- Meet quality requirements
- Team satisfaction
- Deliver high-priority reqs first

General Approach

- A Desired Situation (DS) is pursued;
- DS is defined by Goals.
Each Goal has an importance value.
- A Goal is composed by an aspect and its aspiration level;
- Requirements are defined with alignment levels to each goal.

Desired Situation



Example

Goal 1

Deliver on budget

Aspiration level:
“high”

Goal 2

**Meet quality
requirements**

Aspiration level:
“low”

Fuzzy Framework

o We use Logic Fuzzy notation:

\sum means union;

$/$ means participation level

o X represents the linguistic variable aspect

o A is the aspiration level

Desired Situation

$$DS = \sum_{m=1}^M \mu_m / G_m$$

G1

G2

G3

G4

G5

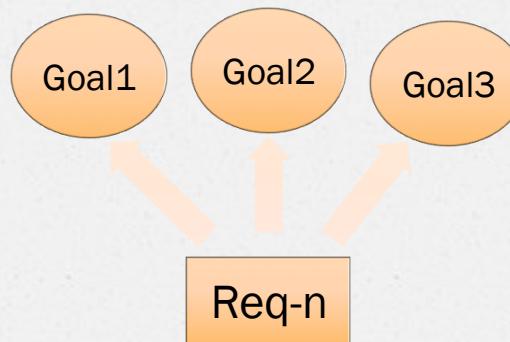
The Goal

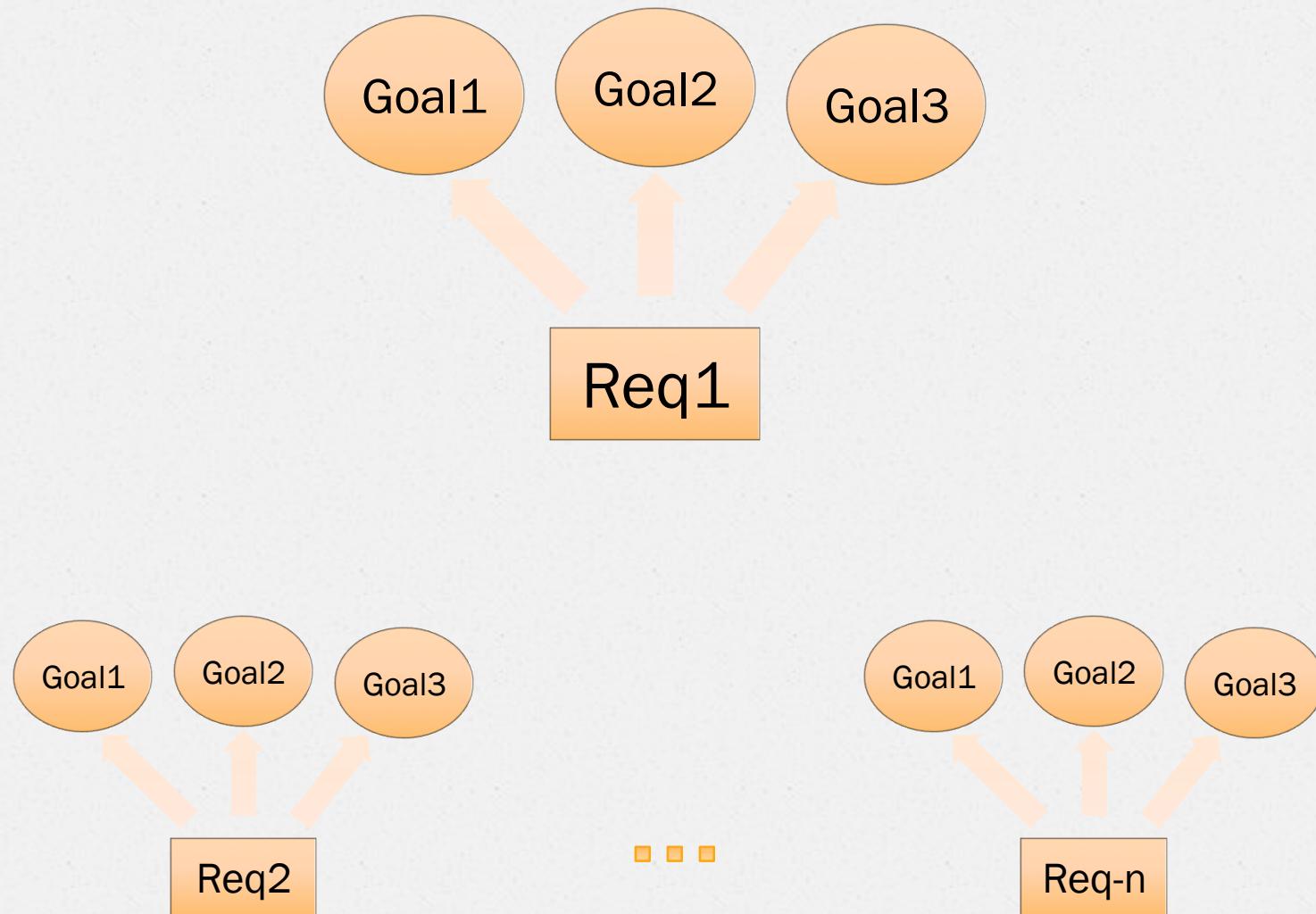
$$G_m = \left(X_m, A_m = \sum_{i=1}^L A_m(u_i)/u_i \right),$$

“Stakeholders’
satisfaction is of
high importance”

Requirement

$$Re_r = \sum_{m=1}^M \mu_m / (X_m, R_{mr})$$





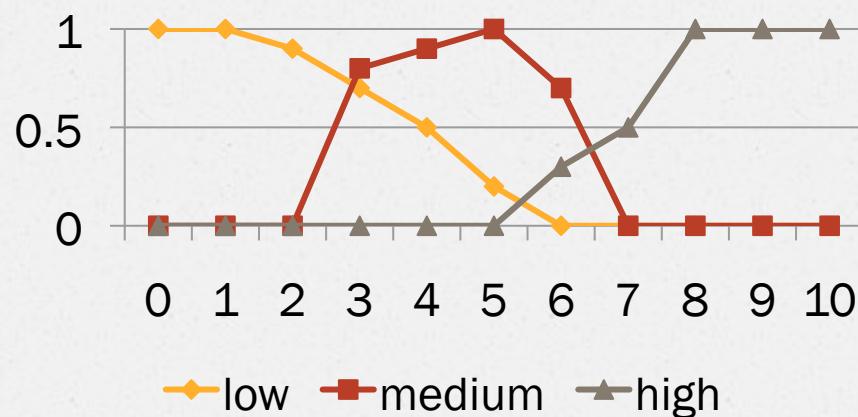
Similarity

$$\alpha(R_{mr}, A_m) = 1 - \left(\sum_{i=1}^L |R_{mr}(u_i) - A_m u_i| / L^{1/2} \right)$$

$$f_{eval(Re_r, DS)} = \sum_{m=1}^M \mu_m \alpha(R_{mr}, A_m) / \sum_{m=1}^M \mu_m$$

Evaluation

Linguistic Term	Fuzzy Set Representation
low (l)	[1.0, 1.0, 0.9, 0.7, 0.5, 0.2, 0.0, 0.0, 0.0, 0.0, 0.0]
medium (m)	[0.0, 0.0, 0.0, 0.8, 0.9, 1.0, 0.7, 0.0, 0.0, 0.0, 0.0]
high (h)	[0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.3, 0.5, 1.0, 1.0]



Attributes (X_m)	X_1 0.6	X_2 1.0	X_3 0.4	X_4 0.2	X_5 0.4	X_6 0.8	X_7 0.6
Importance	m	h	l	h	l	h	m
Desired Situation							
Re_1	m	h	l	h	l	h	m
Re_2	h	m	h	m	h	l	l
Re_3	h	h	m	h	l	m	h
Re_4	h	l	m	h	l	l	h
Re_5	m	l	l	m	h	h	m
Re_6	h	l	m	h	l	m	h
Re_7	l	m	m	h	l	h	h
Re_8	m	m	m	h	l	h	h
Re_9	h	m	m	h	l	h	h

Results

Test 1	Test 2	Test 3
$Re_1,1.00$	$Re_5,0.88$	$Re_1,1.00$
$Re_5,0.68$	$Re_1,0.80$	$Re_8,0.69$
$Re_8,0.64$	$Re_8,0.67$	$Re_5,0.63$
$Re_3,0.57$	$Re_7,0.58$	$Re_3,0.62$
$Re_7,0.55$	$Re_6,0.57$	$Re_7,0.61$
$Re_9,0.53$	$Re_9,0.56$	$Re_9,0.59$
$Re_6,0.37$	$Re_4,0.56$	$Re_6,0.45$
$Re_4,0.36$	$Re_3,0.37$	$Re_4,0.44$
$Re_2,0.26$	$Re_2,0.29$	$Re_2,0.26$

Results

Test 1	Test 2	Test 3
$Re_1,1.00$	$Re_5,0.88$	$Re_1,1.00$
$Re_5,0.68$	$Re_1,0.80$	$Re_8,0.69$
$Re_8,0.64$	$Re_8,0.67$	$Re_5,0.63$
$Re_3,0.57$	$Re_7,0.58$	$Re_3,0.62$
$Re_7,0.55$	$Re_6,0.57$	$Re_7,0.61$
$Re_9,0.53$	$Re_9,0.56$	$Re_9,0.59$
$Re_6,0.37$	$Re_4,0.56$	$Re_6,0.45$
$Re_4,0.36$	$Re_3,0.37$	$Re_4,0.44$
$Re_2,0.26$	$Re_2,0.29$	$Re_2,0.26$

Results

Test 1	Test 2	Test 3
$Re_1,1.00$	$Re_5,0.88$	$Re_1,1.00$
$Re_5,0.68$	$Re_1,0.80$	$Re_8,0.69$
$Re_8,0.64$	$Re_8,0.67$	$Re_5,0.63$
$Re_3,0.57$	$Re_7,0.58$	$Re_3,0.62$
$Re_7,0.55$	$Re_6,0.57$	$Re_7,0.61$
$Re_9,0.53$	$Re_9,0.56$	$Re_9,0.59$
$Re_6,0.37$	$Re_4,0.56$	$Re_6,0.45$
$Re_4,0.36$	$Re_3,0.37$	$Re_4,0.44$
$Re_2,0.26$	$Re_2,0.29$	$Re_2,0.26$

Preliminary Analysis

- The approach generates a prioritized list of requirements, based on alignment to goals
- Controlled changes in aspiration levels and goals' importance has lead to different lists
- The solution considers the flexibility present in the requirements planning

Conclusions

- o Framework tackles uncertainty
- o Goal-oriented approach
- o Preliminary results show the applicability of the approach

Future Works

- o The current stage covers:
 - o Goals with one aspect;
 - o Goals without dependence
 - o One point-of-view in the definition of goals
- o Requirements without dependence

A FUZZY APPROACH TO REQUIREMENTS PRIORITIZATION

Dayvison Lima de Chaves, Fabrício Gomes de Freitas,
Gustavo Lima de Campos, Jerffeson Teixeira de Souza

Optimization in Software Engineering Group (GOES.UECE)
State University of Ceará (UECE) - Brazil



symposium on search based software engineering

3rd SSBSE – Szeged, Hungary; 10-12 September 2011