Towards a Decision Making Framework for Model Transformation Languages

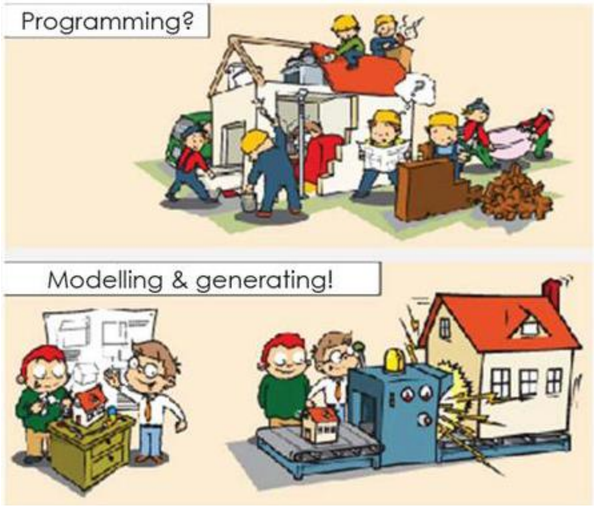
Soroosh Nalchigar
soroosh@cs.toronto.edu

Outline

- Introduction
- Research problem
- Proposed solution
- Application (3 scenarios)
- Where to go from here?

Introduction

- Model Driven Engineering (MDE) is growing.
- Model transformation is primary activity in MDE.
- A wide variety of tools and languages:
  - QVT
  - ATL
  - AGG
  - …



Research problem

- A challenging task of software engineer is to choose a particular language given a set of non-functional requirements.
- Challenges:
  - Multiple
  - Intangible and difficult to measure, if not impossible
  - Some are conflicting

Research goal

- The main goal of this research is to propose a decision making framework for selecting most suitable model transformation language given non-functional requirements

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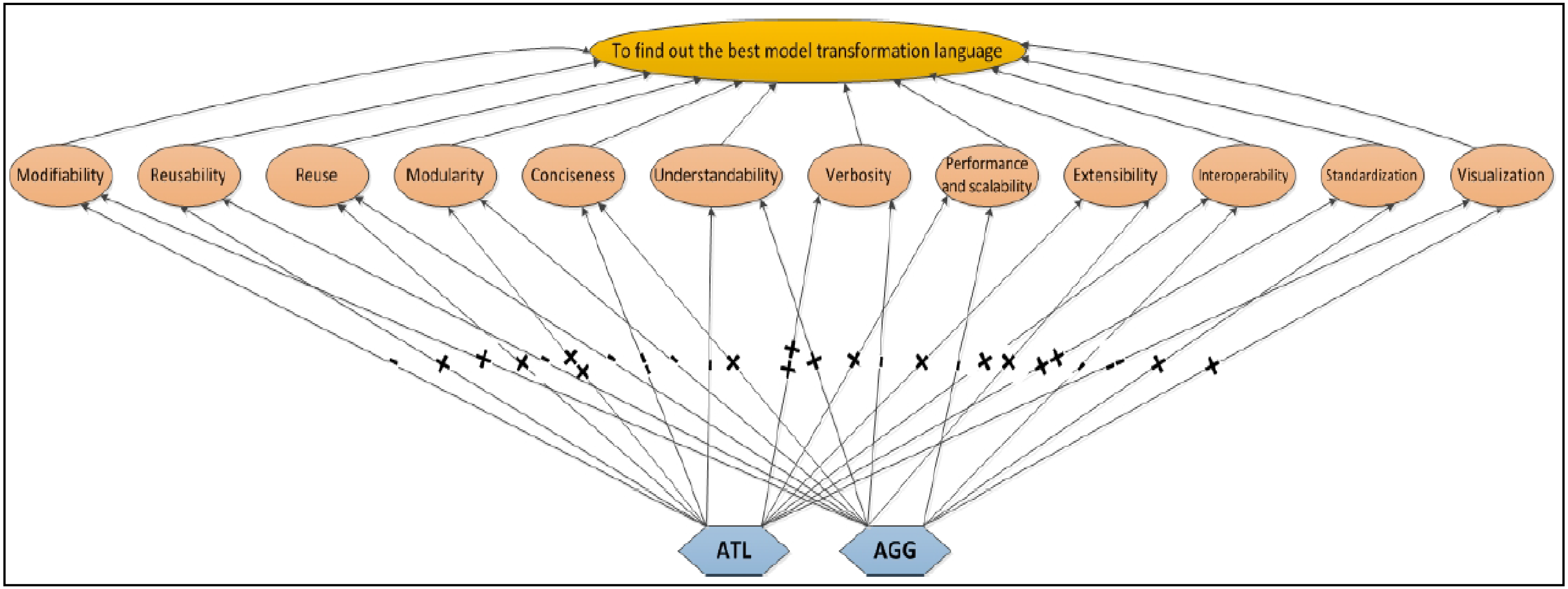
Non-Functional Requirements in Model Transformations

Non-functional Requirement	Definition	Author(s)
Understandability (UN)	The amount of effort required to understand a model transformation.	[3–5, 37, 40, 47]
Modifiability (MF)	The extent to which a model transformation can be adapted to provide different or additional functionality.	[4, 5, 37, 40, 43, 47]
Reusability (RY)	The extent to which (a part of) a model transformation can be reused by other model transformations (as-is reuse).	[4, 37, 40, 43, 47]
Reuse (RE)	The extent to which a model transformation reuses parts of other model transformations. It is considered as a quality attribute since it is good practice to reuse tested units.	[5, 37, 40, 47]
Modularity (MD)	The extent to which a model transformation is systematically structured (every model in a model transformation has its own purpose).	[4, 47]
Conciseness (CS)	The extent to which a model transformation does not include superfluous information.	[35, 47, 47]
Verbosity (VB)	The transformation to introduce extra syntactic sugar for frequently used syntactic constructs.	[35]
Performance and Scalability (PS)	Ability of language or tool to cope with large and complex transformations or transformation of large and complex software models without sacrificing performance.	[5, 35, 43]
Extensibility (EX)	The ease with which the tool can be extended with new functionality.	[35, 37]
Interoperability (IN)	The ease with which the tool can be integrated with other tools used within the (model-driven) software engineering process.	[35, 37, 43]
Standardization (ST)	The transformation tool should be compliant to all relevant standards (e.g. XML, UML, MOF).	[35, 37]
Visualization (VS)	Whether the transformation technology provides visual specifications of transformation.	[5, 40]

Comparison of Two Languages

- We compared ATL and AGG with regarding to all non-functional requirements.
- This was done by reviewing previous works.
- Example:
  - ATL is capable of managing complex models because of its imperative language constructs and use of helper functions (Stephan & Stevenson, 2009).
  - Graph transformations are sometimes accused of generating inefficient programs or having inefficient algorithms (Mens et al. 2006).

Comparison of Two Languages



We used qualitative contribution links since NFRs are intangible and difficult to measure.

However, is this model enough for decision making?

It lacks a systematic way of choosing an specific alternative.

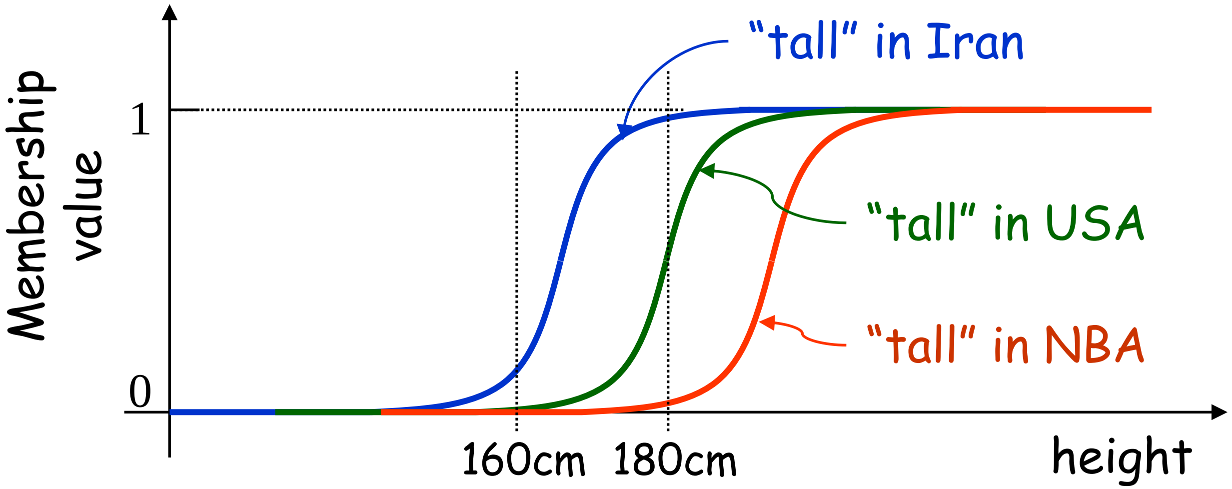
Fuzzy-AHP approach

- The decision mechanism used in this paper is called Fuzzy-AHP.

- Fuzzy-AHP = Fuzzy set theory + AHP

Fuzzy set theory

- Proposed by Zadeh in 1965.
- To deal with vagueness of human thought
- Degree of membership is between 0 and 1.
- It resembles human reasoning in its use of approximate information and uncertainty to generate decisions.

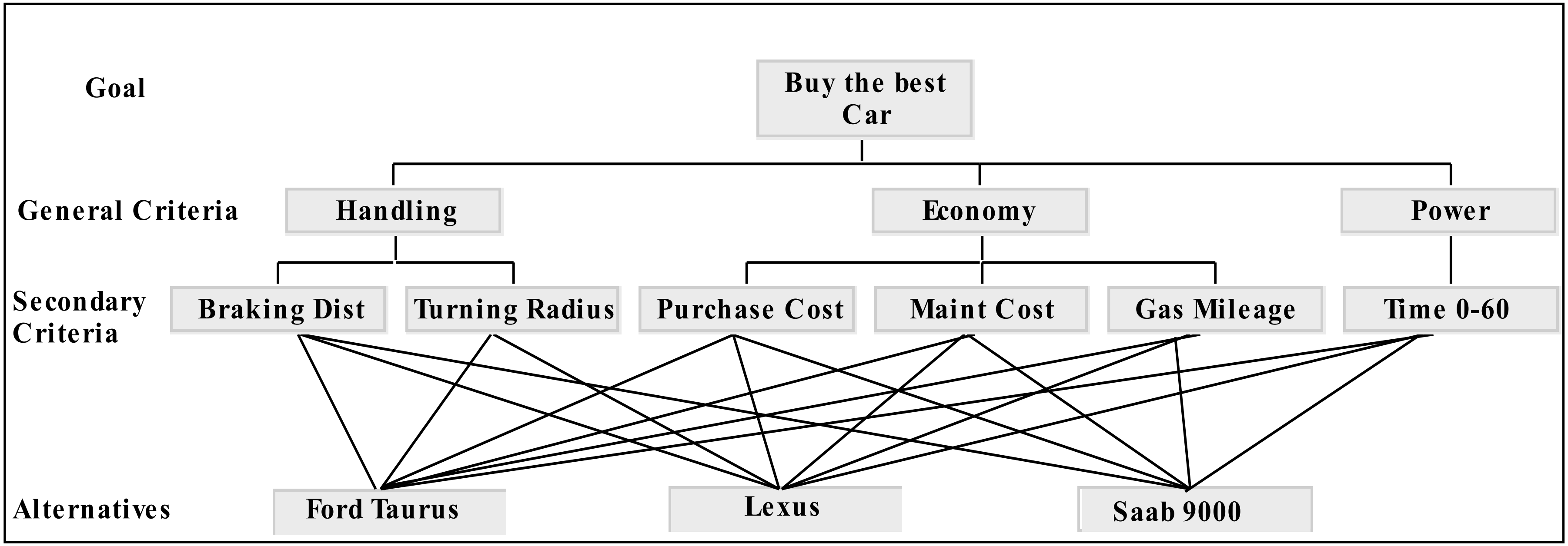


AHP

- Analytic Hierarchy Process (AHP)
- Proposed by Saaty in 1980.
- One of the Multi-Criteria Decision-Making (MCDM) methods.
- Four steps:
  - problem hierarchy,
  - judgment matrices by pairwise comparisons,
  - calculation of local priorities
  - calculation of global priorities

AHP

- Example:



	F	L	S
F	1	3	5
L	1/3	1	3
S	1/5	1/3	1

Fuzzy-AHP

- **Step 1**. Development of problem hierarchy
- **Step 2**. Fuzzy comparison matrix
- **Step 3**. Calculation of fuzzy synthetic extents
- **Step 4**. Fuzzy synthetic extents are compared
- **Step 5**. Find minimum degree of possibilities
- **Step 6**. Normalization of weight vector

$$M = \begin{bmatrix} M_{g_1}^1 & M_{g_1}^2 & \cdots & M_{g_1}^m \\ M_{g_2}^1 & M_{g_2}^2 & \cdots & M_{g_2}^m \\ \vdots & \vdots & \ddots & \vdots \\ M_{g_n}^1 & M_{g_2}^2 & \cdots & M_{g_n}^m \end{bmatrix}$$

Intensity of importance	Membership function
Extremely more importance (EMI)	(7,9,9)
Very strong importance (VSI)	(5,7,9)
Strong importance (SI)	(3,5,7)
Moderate importance (MI)	(1,3,5)
Equal importance (EI)	(1,1,3)

$$S_i = \sum_{j=1}^{m} M_{gi}^j \odot \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^j \right]^{-1}$$

$$w_i = \frac{w_i'}{\sum_{i=1}^{n} w_i'}$$

$$V(S_i \geq S_j) = hgt(S_j \cap S_i) = \begin{cases} 1 & \text{if } m_i \geq m_j \\ 0 & \text{if } l_j \geq u_i \\ \frac{l_j - u_i}{(m_i - u_i) - (m_j - lj)} & \text{otherwise} \end{cases}$$

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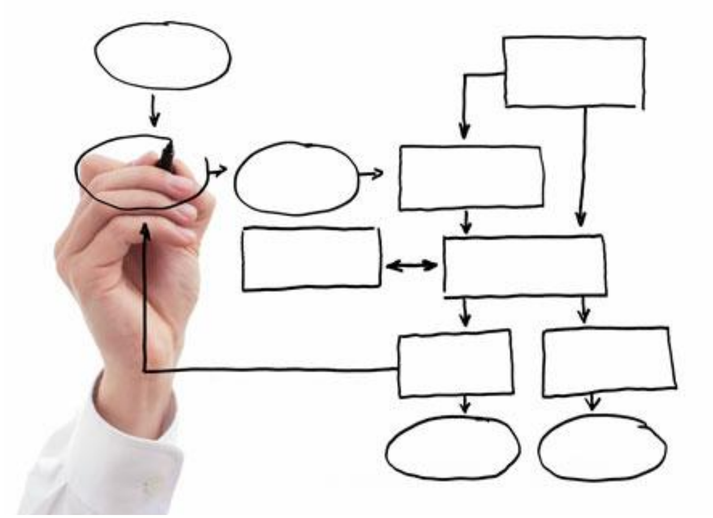
Case 1

- From [17]
- M2M transformation
- Business process models
- BPMN to BPEL
- Since we are dealing with business analyst, we assume that understandability, conciseness, modularity, and visualization are more important than other NFRs.



Case 1

- Inputs to fuzzy-AHP method form expert:

	UN	MF	RY
UN	(1,1,1)	(3,5,7)	(5,7,9)
MF	(0.14,0.20,0.33)	(1,1,1)	(3,5,7)
RY	(0.11,0.14,0.20)	(0.14,0.20,0.33)	(1,1,1)

- From literature:

		ATL	AGG
SD	ATL	(1,1,1)	(1,3,5)
	AGG	(0.20,0.33,1)	(1,1,1)

Intensity of importance	Membership function
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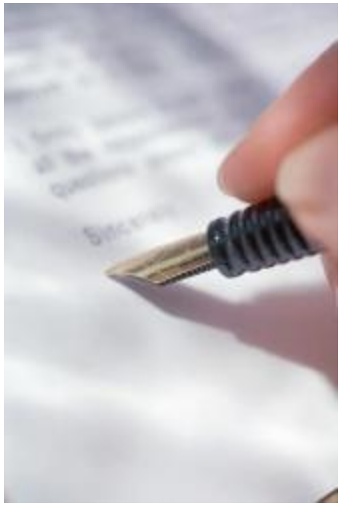
Case 2

- From [1,14,45,32]
- ER model from class diagram
- Has been implemented in ATL, AGG, QVT, etc…
- In this case we assume that all the non-functional requirements are of same level of importance.



Case 3

- From [6]
- Large industrial context
- Code generations from huge models
- Important NFRs for this case:
    - Scalability,
    - Interoperability,
    - Standardization and
    - Reusability

MOTOROLA

Results

	Languages	Score
Case 1	ATL	0.45
	AGG	**0.55**
Case 2	ATL	**0.59**
	AGG	0.41
Case 3	ATL	**0.67**
	AGG	0.33

Conclusion

- Main contribution of my work.
- Advantages:
  - Introduction of fuzzy concepts to NFRs
  - Ease of use
- Future works:
  - Extend the number of languages
  - Real experts, more than one, for fuzzy pairwise comparisons
  - Sensitivity analysis
  - And to publish it somewhere …