Lecture 9: Agreeing Requirements

Last Week:
Validating Requirements
Validation basics
Reviews and Inspections
Prototyping

This Week:
Agreeing Requirements
Negotiation and Conflict Resolution
Requirements Prioritization

Next Week:
Evolving Requirements
Change management
Inconsistency management
Feature Interaction
Product Families

Outline

- Prioritization
  - Cost-value approach
  - Analytic Hierarchy Process (AHP)

- Ideas from Economics
  - Game Theory
  - Bounded Rationality

- Ideas from Social Psychology
  - Types of social conflict
  - Analysis of task types

- Resolving Requirements Conflicts
  - Definitions
  - Argumentation approaches
  - Using existing domain models to evaluate positions

Requirements Prioritization

- Usually there are too many requirements
  1. Decide which to include in the first release
  2. Balancing quality, cost and time-to-market
  3. Assess each requirement’s importance to the project as a whole
  4. Assess the relative cost of each requirement
  5. Compute the cost-value trade-off:

Analytic Hierarchy Process (AHP)

- Create n x n matrix (for n requirements)
- Compare each pair of requirements
  1. For element \((x,y)\) in the matrix enter:
     - 1 - if \(x\) and \(y\) are of equal value
     - 3 - if \(x\) is slightly more preferred than \(y\)
     - 5 - if \(x\) is strongly more preferred than \(y\)
     - 7 - if \(x\) is very strongly more preferred than \(y\)
     - 9 - if \(x\) is extremely more preferred than \(y\)
  2. ...and for \((y,x)\) enter the reciprocal.
- Estimate the eigenvalues:
  1. E.g. “averaging over normalized columns”
  2. Calculate the sum of each column
  3. Divide each element in the matrix by the sum of it’s column
  4. Calculate the sum of each row
  5. Divide each row sum by the number of rows
- This gives a value for each reqt:
  1. based on estimated percentage of total value of the project
**AHP example**

**Also:** should compute the consistency index (because the pairwise comparisons may not be consistent)

<table>
<thead>
<tr>
<th>Req1</th>
<th>Req2</th>
<th>Req3</th>
<th>Req4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Req1</td>
<td>1</td>
<td>1/3</td>
<td>2</td>
</tr>
<tr>
<td>Req2</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Req3</td>
<td>1/2</td>
<td>1/5</td>
<td>1</td>
</tr>
<tr>
<td>Req4</td>
<td>1/4</td>
<td>1/3</td>
<td>3</td>
</tr>
</tbody>
</table>

Normalise columns

Sum the rows

<table>
<thead>
<tr>
<th>Req1</th>
<th>Req2</th>
<th>Req3</th>
<th>Req4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Req1</td>
<td>0.21</td>
<td>0.18</td>
<td>0.18</td>
</tr>
<tr>
<td>Req2</td>
<td>0.63</td>
<td>0.54</td>
<td>0.45</td>
</tr>
<tr>
<td>Req3</td>
<td>0.11</td>
<td>0.11</td>
<td>0.09</td>
</tr>
<tr>
<td>Req4</td>
<td>0.05</td>
<td>0.18</td>
<td>0.27</td>
</tr>
</tbody>
</table>

**Sum**

- 1.05
- 1.98
- 0.34
- 0.62

**Sum/4**

- 0.26
- 0.50
- 0.09
- 0.16

**Game Theory**

→ Game Theory for conflict resolution

% Given:
- 2 or more players
- Known utilities for each outcome for each player
% Can Calculate:
- What strategy results in the better outcome
- How strategies by different players interact
% E.g. Prisoner's dilemma:

<table>
<thead>
<tr>
<th>Prisoner B</th>
<th>Not Confess</th>
<th>Confess</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prisoner A</td>
<td>1 year each</td>
<td>10 years for A and 3 months for B</td>
</tr>
</tbody>
</table>

- But:
  - In RE, we often don't know what the utilities are
  - Often can resolve conflicts by getting participants to change their utilities
  - Often we don't know even what moves are possible!

**Bounded Rationality**

→ Satisficing participants

% Outcome in complex situations depends on unpredictable events
% People look for 'satisfaction' rather than 'maximal utility'

→ Market Mechanisms

% Conditions:
- Prices drop in the face of excess supply
- Rate of supply drops when prices drop or when inventories mount
% Under these conditions, markets 'clear':
- Equilibrium is reached even under bounded rationality
- i.e. even when participants cannot predict their best option
% But they don't reach Pareto Optimality
- Unless the participants act fully rationally
- i.e. they all can optimize rather than satisfy.
- But requires participants to have an unlimited ability to predict the future

→ Application to RE?

% Need a pricing mechanism that satisfies the appropriate conditions
% Offers stability but not optimality
### Conflict in Social Psychology

**→ Causes of Conflict**
- Deutsch (1973):
  - control over resources
  - preferences and nuances (tastes or activities of one party impinge upon another)
  - values (a claim that a value or set of values should dominate)
  - beliefs (dispute over facts, information, reality, etc.)
  - the nature of the relationship between the parties.
- Robbins (1989):
  - communication (insufficient exchange of information, noise, selective perception)
  - structural (goal compatibility, jurisdictional clarity, leadership style)
  - personal factors, (individual value systems, personality characteristics).

**→ Interesting Results**
- deviant behaviour & conflict are normal in small group decision making
- more aggression and less co-operation when communication is restricted
  - a decrease in communication tends to intensify a conflict (the contact hypothesis)
  - heterogeneous teams experience more conflict;
- homogeneous groups are more likely to make high risk decisions (groupthink)
- effect of personality is overshadowed by situational and perceptual factors

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### Classifying approaches to resolution

<table>
<thead>
<tr>
<th>Quadrant I</th>
<th>Quadrant II</th>
<th>Quadrant III</th>
<th>Quadrant IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generating Ideas</td>
<td>Resolving Conflicts of Viewpoint</td>
<td>Generating Plans</td>
<td>Resolving Conflicts of Interest</td>
</tr>
<tr>
<td>Executing Performance Tasks</td>
<td>Type 2: Mixed-Motive Problems</td>
<td>Executing Performance Tasks</td>
<td>Type 4: Distributive/Competitive Problems</td>
</tr>
<tr>
<td>Solving Problems w/Correct Answers</td>
<td>Type 3: Integrative Problems</td>
<td>Solving Problems w/No right answer</td>
<td>Type 5: Distributional/Confrontative Problems</td>
</tr>
<tr>
<td>Type 6: Psychological Problems</td>
<td>Type 7: Extramotive Problems</td>
<td>Type 8: Performance Problems</td>
<td></td>
</tr>
</tbody>
</table>

### Basic approaches to conflict resolution

**→ Negotiation**
- collaborative exploration:
  - participants attempt to find a settlement that satisfies all parties as much as possible
  - also known as: integrative negotiation
  - distinct from:
    - distributive/competitive negotiation

**→ Competition**
- is maximizing your own gain:
  - no regard for the degree of satisfaction of other parties
  - but not necessarily hostile

**→ Third Party Resolution**
- participants appeal to outside source:
  - the rule-book, a figure of authority, or the toss of a coin
  - can occur with the breakdown of either negotiation or competition as resolution methods
- types of third party resolution:
  - judicial: cases presented by each participant are taken into account
  - extra-judicial: a decision is determined by factors other than the cases presented (e.g. relative status of participants)
  - arbitrary: e.g. toss of a coin

**→ Bidding and Bargaining**
- Bidding:
  - participants state their desired terms
- Bargaining:
  - participants search for a satisfactory integration of bids

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### Conflict Resolution - basics

**→ Defining Conflict**
- In Social psychology, focus is on interdependence and perception:
  - “the interaction of interdependent people who perceive opposition of goals, aims, and values, and who see the other party as potentially interfering with the realization of these goals” [Putnam & Poole, 1987]
- In RE, focus typically is on logical inconsistency:
  - E.g. conflict is a divergence between goals - there is a feasible boundary condition that makes the goals inconsistent (van Lamsweerde et al., 1998)

**→ Resolution Method**
- The approach used to settle a conflict:
  - Methods include negotiation, arbitration, coercion, and education
  - Not all conflicts need a resolution method: not all conflicts need to be resolved.

Three broad types of resolution method can be distinguished:
- Co-operative (or collaborative) methods, which include negotiation and education;
- Competitive methods, which include combat, coercion and competition;
- Third Party methods, which include arbitration and appeals to authority.
Using Argumentation Structuring...

→ gIBIS
   - Developed by Conklin [1989]
   - Represents argumentation process as a hypertextual graph
   - Basic Process:
     - Identify issues
     - Identify positions that one can adopt with respect to the positions
     - Link arguments that support or refute positions

→ Synoptic
   - Developed by Easterbrook [1991]
   - Tool support for collaborative task-focused negotiation
   - Basic Process:
     - Get each participant to externalise their conceptual model(s)
     - Find correspondences between the models
     - Classify mismatches
     - Generate options for resolving each mismatch

Using Pre-existing Domain Models...

→ Oz
   - Developed by Robinson [1992]
   - Uses pre-existing domain model to compare conflicting perspectives
   - Basic process:
     - Identify perspectives (collections of beliefs)
     - Record perspectives by annotating a domain model of goals and objectives
     - Domain model links product attributes to goals
     - Choose combinations of product attributes to maximise participants’ satisfaction

→ WinWin
   - Developed by Boehm & colleagues [mid 1990s]
   - Explicitly identifies win-conditions for each participant
   - Incorporates domain knowledge-base of quality requirements and product attribute links
   - Basic Process:
     - Enter win conditions for each participant
     - Identify attribute strategies for win conditions
     - Determine negative effects for each strategy on each win condition
     - Resolve disagreements manually