Lecture 20: Requirements Prioritization

Why Prioritization is needed
- Basic Trade-offs

Cost-Value Approach
- Sorting Requirements by cost/value
- Estimating Relative Costs/Values using AHP
- What if stakeholders disagree?
  - Visualizing differences in priority
  - Resolving Disagreements

Basics of Prioritization
- Need to select what to implement
  - Customers (usually) ask for way too much
  - Balance time-to-market with amount of functionality
  - Decide which features go into the next release
- For each requirement/feature, ask:
  - How important is this to the customer?
  - How much will it cost to implement?
  - How risky will it be to attempt to build it?
- Perform Triage:
  - Some requirements *must* be included
  - Some requirements should definitely be excluded
  - That leaves a pool of "nice-to-haves", which we must select from.

A Cost-Value Approach
- Calculate return on investment
  - Assess each requirement’s importance to the project as a whole
  - Assess the relative cost of each requirement
  - Compute the cost-value trade-off:

Estimating Cost & Value
- Two approaches:
  - Absolute scale (e.g. dollar values)
    - Requires much domain experience
  - Relative values (e.g. less/more; a little, somewhat, very)
    - Much easier to elicit
    - Prioritization becomes a sorting problem
- Comparison Process - options
  - Basic sorting - for every pair of requirements (i,j), ask if i>j?
    - E.g. bubble sort - start in random order, and swap each pair if out of order
    - Requires n(n-1)/2 comparisons
  - Construct a Minimal Spanning Tree
    - Requires O(n log n) comparisons
  - Construct a Binary Sort Tree
    - for each pair (Ri, Ri+1) get the distance between them
    - Requires n-1 comparisons

Source: Adapted from Karlsson & Ryan 1997
Some complications

- Hard to quantify differences
  - It's easier to say \( x \) is more important than \( y \)...
  - than to estimate by how much.
- Not all requirements comparable
  - E.g. different level of abstraction
  - E.g. core functionality vs. customer enhancements
- Requirements may not be independent
  - No point selecting between \( X \) and \( Y \) if they are mutually dependent
- Stakeholders may not be consistent
  - E.g. If \( X > Y \) and \( Y > Z \), then presumably \( X > Z \)?
- Stakeholders might not agree
  - Different cost/value assessments for different types of stakeholder

Hierarchical Prioritization

- Group Requirements into a hierarchy
  - E.g. A goal tree
  - E.g. A NFR tree
- Only make comparisons between branches of a single node:

Analytic Hierarchy Process (AHP)

- Create \( n \times n \) matrix (for \( n \) requirements)
  - 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 \( y \)
    - (use the intermediate values, 2, 4, 6, 8 if compromise needed)
  - and for \((y,x)\) enter the reciprocal.
- Estimate the eigenvalues:
  - E.g. “averaging over normalized columns”
    - Calculate the sum of each column
    - Divide each element in the matrix by the sum of it’s column
    - Calculate the sum of each row
    - Divide each row sum by the number of rows
- This gives a value for each req’t:
  - Giving the estimated percentage of total value of the project

AHP example - estimating costs

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

Result

<table>
<thead>
<tr>
<th></th>
<th>Sum</th>
<th>sum/4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Req1</td>
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<td>0.26</td>
</tr>
<tr>
<td>Req2</td>
<td>1.98</td>
<td>0.50</td>
</tr>
<tr>
<td>Req3</td>
<td>0.34</td>
<td>0.08</td>
</tr>
<tr>
<td>Req4</td>
<td>0.62</td>
<td>0.16</td>
</tr>
</tbody>
</table>
Repeat AHP process twice:
- Once to estimate relative value
- Once to estimate relative cost
Use results to calculate ROI ratio:

ROI ratio is not the only way to group requirements

Visualizing “Value by stakeholder”

Visualizing stakeholder satisfaction
Can also weight each stakeholder

- Weight each stakeholder
  - E.g. to reflect credibility?
  - E.g. to reflect size of constituency represented?

- Example:

![Graph showing stakeholder weights]

Result:

(The priorities have changed)

Example:

Source: Adapted from Regnell et al., 2000

Resolving Stakeholder Conflict

- Causes of Conflict
  - Deutsch (1973):
    - control over resources
    - preferences and nuisances (tastes or activities of one party impinge upon another)
    - values (e.g., 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):
    - communicational (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 cooperation 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

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]
  - Note:
    - conflict may occur between individuals, groups, organizations, or different roles played by one person

- Resolution Method:
  - The approach used to settle a conflict
  - Methods include negotiation, competition, arbitration, coercion, and education

- 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.

Basic approaches to conflict resolution

- Negotiation
  - Is collaborative exploration,
  - Participants attempt to find a settlement that satisfies all parties as much as possible.

- Competition
  - 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.

- Extreme Forms
  - When all gain by one party are at the expense of others
  - 2 x a zero-sum game.