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:

![Cost-Value Trade-Off Chart]

- **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., bubblesort - start in random order, and swap each pair if out of order
      - Requires \(n(n-1)/2\) comparisons
    - Construct a Binary Sort Tree
      - Requires \(O(n \log n)\) comparisons
    - Construct a Minimal Spanning Tree
      - For each pair \((R_i, R_{i+1})\) get the distance between them
      - Requires \(n-1\) comparisons
Some complications

- Hard to quantify differences
  - 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 x 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 reqt:**
  - ...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>
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<td>1/3</td>
<td>2</td>
<td>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</td>
<td>1/3</td>
</tr>
<tr>
<td>Req4</td>
<td>1/4</td>
<td>1/3</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Normalise columns

<table>
<thead>
<tr>
<th></th>
<th>Req1</th>
<th>Req2</th>
<th>Req3</th>
<th>Req4</th>
</tr>
</thead>
<tbody>
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<td>0.18</td>
<td>0.48</td>
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<tr>
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<tr>
<td>Req3</td>
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<td>0.09</td>
<td>0.09</td>
</tr>
<tr>
<td>Req4</td>
<td>0.05</td>
<td>0.18</td>
<td>0.27</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Result

- Req1 - 26% of the cost
- Req2 - 50% of the cost
- Req3 - 9% of the cost
- Req4 - 16% of the cost

Source: Adapted from Karlsson & Ryan 1997
Plot ROI graph

- Repeat AHP process twice:
  - Once to estimate relative value
  - Once to estimate relative cost

- Use results to calculate ROI ratio:

![ROI Graph]

Other selection criteria

- ROI ratio is not the only way to group requirements

![Other Selection Criteria Graph]
Visualizing “Value by stakeholder”

- 10 Stakeholders:
  - M1
  - M2
  - M3
  - M4
  - M5
  - M6
  - M7
  - M8
  - M9
  - M10

Variation coefficient (right hand scale)
"Level of disagreement for each feature"

Percentage of total value

Source: Adapted from Regnell et al, 2000

Visualizing stakeholder satisfaction

- Graph showing correlation between stakeholder’s priorities and the group’s priorities
- Can also be thought of as “influence of each stakeholder on the group”

Source: Adapted from Regnell et al, 2000
Can also weight each stakeholder

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

- Example:

Result:
(The priorities have changed)

Resolving Stakeholder Conflict

- Causes of Conflict
  - Deutsch (1973):
    - control over resources
    - preferences and nuisances (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
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
- 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.

Basic approaches to conflict resolution

Negotiation

-is collaborative exploration:
- participants attempt to find a settlement that satisfies all parties as much as possible.
- also known as:
- integrative behaviour
- constructive 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.
- Extreme form:
- when all gains by one party are at the expense of others
- i.e. a zero-sum game.

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