Portfolio Decision Analysis for Supporting Project Selection and Resource Allocation

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Portfolio Decision Analysis

• Allocation of resources to projects
  – Projects (= e.g., investments, products, policy actions) consume resources and produce value on multiple criteria
  – Portfolio is a subset of projects
  – Constraints: Limited resources, portfolio balance requirements, etc.

→ Need for decision analytic models and mathematical optimization

• This presentation illustrates some research on PDA at SAL
Bridge Maintenance Programming with Robust Portfolio Modeling (RPM)

• Which of the hundreds of bridges to repair?
  – Client: Road Districts of Finnish Road Administration

• Six criteria indicating urgency for repair for each bridge
  – Overall ‘Repair value’ of each bridge is additive across criteria

• Constraints
  – Repair budget of 9,000,000€
  – Portfolio cannot contain more than 90 bridges
  – Portfolio must reduce the total sum of damages by 15,000 units
Bridge Maintenance with RPM

- Incomplete information on criterion importance
  - E.g. $w_{\text{damages}} \geq w_{\text{visual}}$

- Non-dominated portfolios
  - No other portfolio has greater value for all feasible weights

- Core Index
  - The share of non-dominated portfolios which contain the project (=bridge)

- RPM analyses 2008-2013

\[1\text{Liesiö, Mild, Salo (2007, 2008), EJOR}\]
Scenario based RPM

- Projects’ values evaluated in each future scenario
  - cf. criterion
- Incomplete info. on
  - Scenario probabilities (e.g. $p_1 \geq p_2$)
  - Risk-attitude
    ($\rightarrow$ set of utility functions)

1Liesiö, Salo (2012), *EJOR*
2Liesiö, Ilmola (2011)
Combining PDA with simulation models

- Case: Cost-efficiency analysis of weapon systems\(^1\)
  - Client: Finnish Defense Forces
- Several criteria to measure impact of weapon systems
  - Enemy / friendly casualties, mission success probability, etc.
- Strong interactions among weapon systems
  - Simulator used to estimate impacts of weapon system portfolios

\[ V_1(x), \ldots, V_n(x) \]

\(^1\)Kangaspunta, Liesiö, Salo (2012), *EJOR*
Combining PDA with simulation models

Kangaspunta, Liesiö, Salo (2012), *EJOR*
Optimal project evaluation and selection strategies¹

• Selection of projects is typically based on uncertain value estimates rather than the ‘true’ project values
  → Post-decision disappointment (optimizer’s curse)
  → Erroneous project selections if accuracy of the estimates is not constant for all projects

• Additional evaluation of projects may provide more accurate estimates, but not for free
  – For which projects are more accurate estimates most valuable? (Expect Value of Information, EVI)
  – How should the budget be allocated between evaluating and funding projects?

¹Vilkkumaa, Liesiö, Salo (2013), EJOR
Optimal project evaluation and selection strategies

- Select 20 out of 100 projects
- Re-evaluation strategies
  1. All 100 projects
  2. 30 projects with the highest EVI
  3. ‘Short list’ (30 highest expected values)
  4. 30 randomly selected projects

\(^1\)Vilkumaa, Liesiö, Salo (2013), *EJOR*
Other ongoing PDA research at SAL

- Theoretical foundations of multi-attribute portfolio value functions\(^1\)
  - MAUT/MAVT for portfolios
- Optimal project evaluation and selection policies
  - Funding for entire duration or based on periodical evaluation
- PDA in environmental decision problems
- Optimal reliability improvement portfolios
  - Interval valued failure probabilities for components
  - Which portfolio of components should be enhanced to improve overall system reliability?

\(^1\) Liesiö (2013), *Decision analysis*
References


For these and more PDA publications visit sal.aalto.fi/en/publications/