Der Einsatz der Optionstheorie zur Optimierung des Projektportfolios

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Task - Challenge

- Optimisation between

  risks of failure of R&D projects and

  best exploitation of project results
- Multi-dimensional project valuation
- Real options
- Portfolio selection considering:

  limited resources

  limited risk

  project interrelations

Evaluation of R&D Projects

- High uncertainty about project's value
- Gain of knowledge during the project
- Flexibility to react to new information
- Multi-dimensional aspects
- Interrelations between projects

Real Options – Definition

- A right to buy or sell specific securities or commodities at a stated price (exercise or strike price) within a specified time.
- A call option on an asset gives the right, but no obligation, to acquire the underlying asset by paying a prespecified price—the exercise price—on or before a given maturity.
- A call option on an R&D project gives the right, but no obligation, to implement the results by investing in production and marketing when the research phase is completed.

Real Options – Options Thinking

- Flexibility creates value
- “It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change” [Darwin, 1835]
- Every successful R&D project represents an option on future market introduction

Real Options

Characteristics

Characteristics of real investment projects regarded as option rights:

- **Uncertainty**
- **Flexibility**
- **Irreversibility**

[Hommel, Baecker, 2004]

Kinds of Real Options

- Learning options (option to wait, option to stage investment, option to switch)
- Insurance options (option to abandon, option to shut down, option to switch)
- Growth options (option to expand, option to innovate)
- Improvement options (option to shelve, option to accelerate, option for corrective action)

[Hommel, Baecker, 2004]

Real Options – Shortcomings

- Lack of underlying market for R&D projects
- Various kinds of uncertainty (technical, operational)
- Competition reduces the value of waiting
- Additional complexity by interaction between options

Mapping of Option Pricing Theory to Project Analysis

Underlying S – Present value of project benefits

Volatility σ – Uncertainty

Exercise price K – Present value of investment cost

Expiration date of option t – Project duration

Dividend payments y – Payments lost through waiting

Payoff call option – $(S-K)^+ \equiv \max\{S-K, 0\}$

[Luehrman, 1998]

variable	A now	B maybe now	C never	D probably never	E maybe later	F probably later
underlying	100	100	100	100	100	100
investment	90	90	110	110	110	110
duration	0	2	0	0.5	1	2
volatility	0.3	0.3	0.3	0.2	0.3	0.4
interest rate	0.06	0.06	0.06	0.06	0.06	0.06
NPV	10	10	-10	-10	-10	-10
call value	10	27.23	0	3.06	10.42	23.24

0/1 Knapsack Algorithm

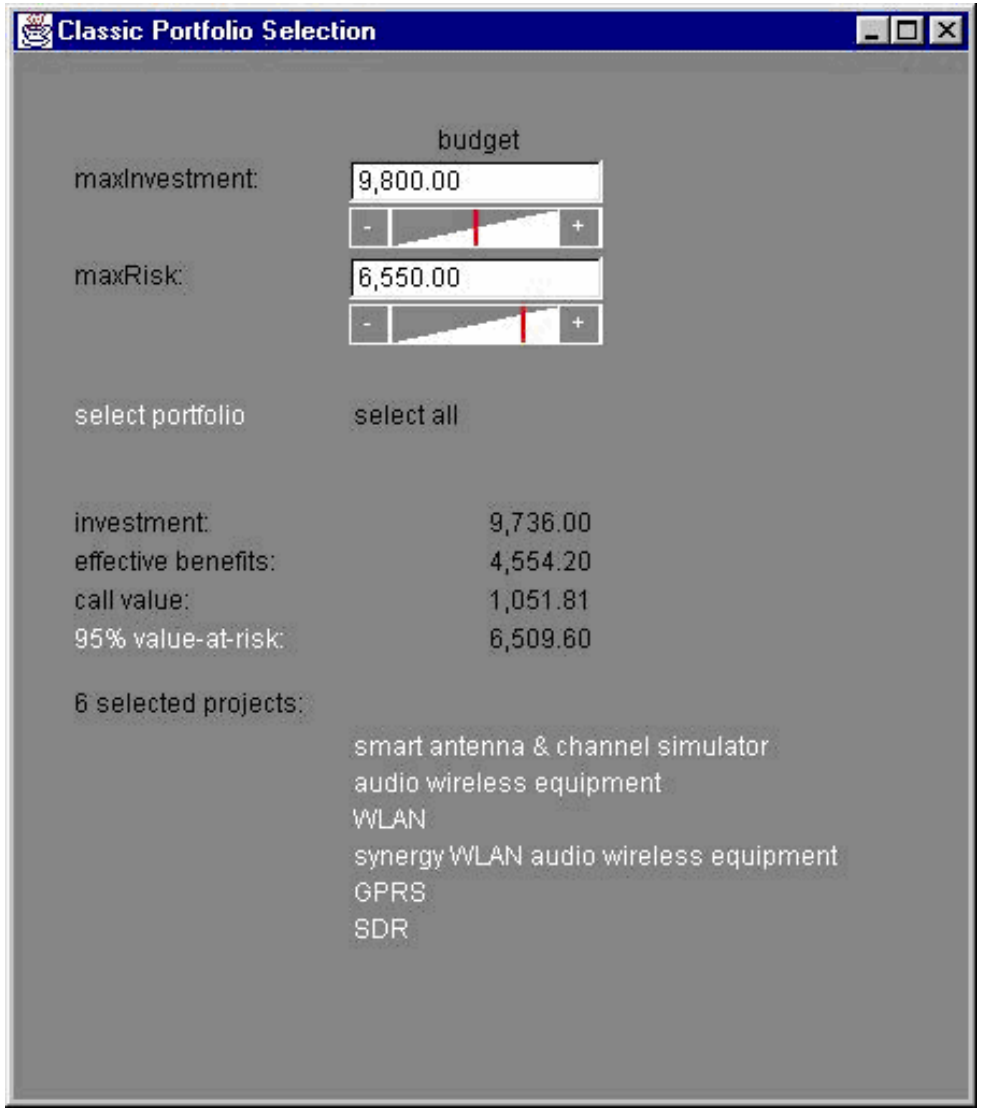
- Given a Knapsack of capacity *c* and *n* objects with sizes $s_1,...,s_n$ and “profits" $p_1,...,p_n$, find the largest total profit of any subset of the objects that fits into the Knapsack (and find a subset that achieves the maximum profit)

- Selects projects with the highest utility values for a portfolio not exceeding a given maximum cost value

0/1 Knapsack with Dependencies

- Project is only considered if the indices of all of its preconditional projects are already members of the current subset.

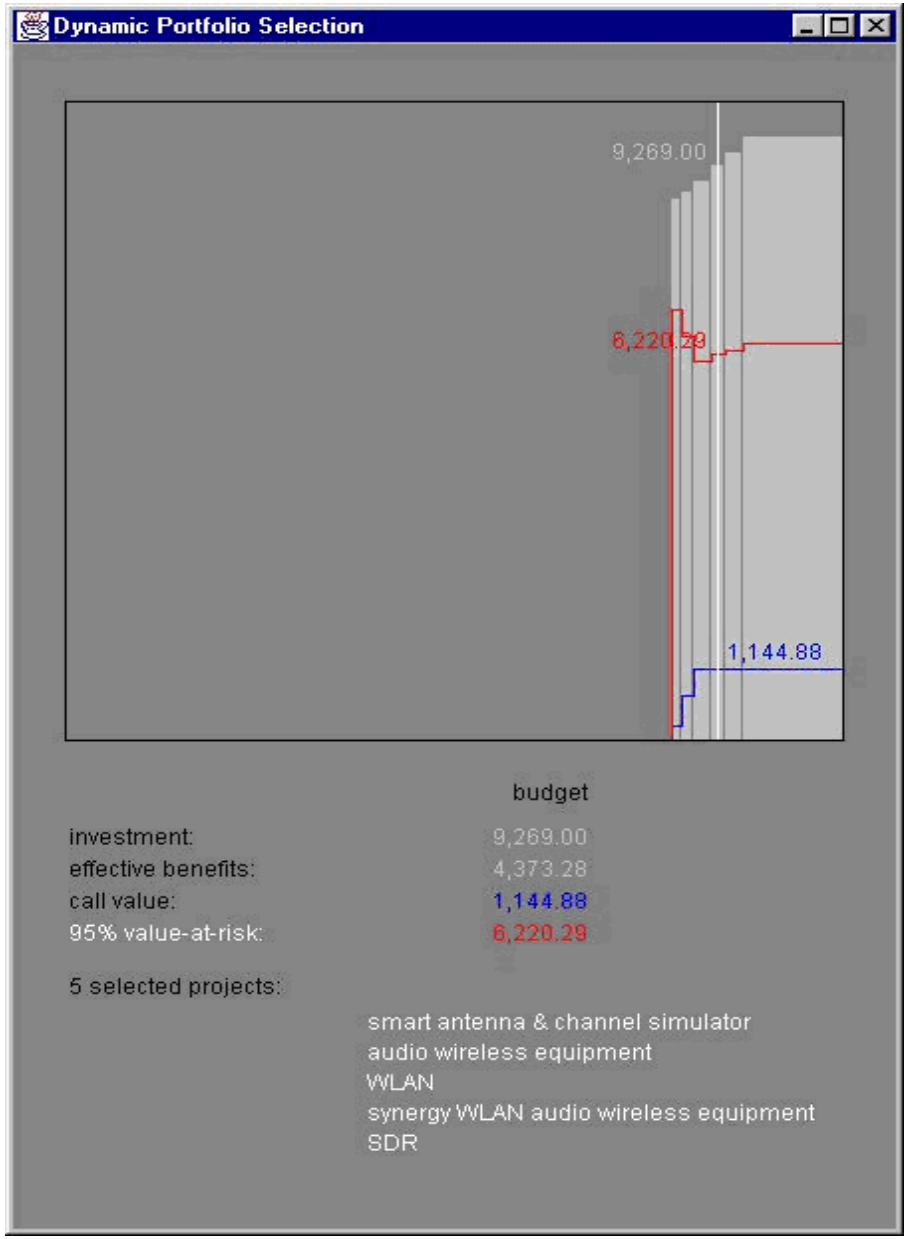
- In order to allow the indices of all preconditional projects to be members of the subset the projects have to be traversed in topological order.


Classic Portfolio Selection
budget
maxInvestment:
9,800.00
-
+
maxRisk:
6,550.00
-
+
select portfolio
select all
investment:
9,736.00
effective benefits:
4,554.20
call value:
1,051.81
95% value-at-risk:
6,509.60
6 selected projects:
smart antenna & channel simulator
audio wireless equipment
WLAN
synergy WLAN audio wireless equipment
GPRS
SDR

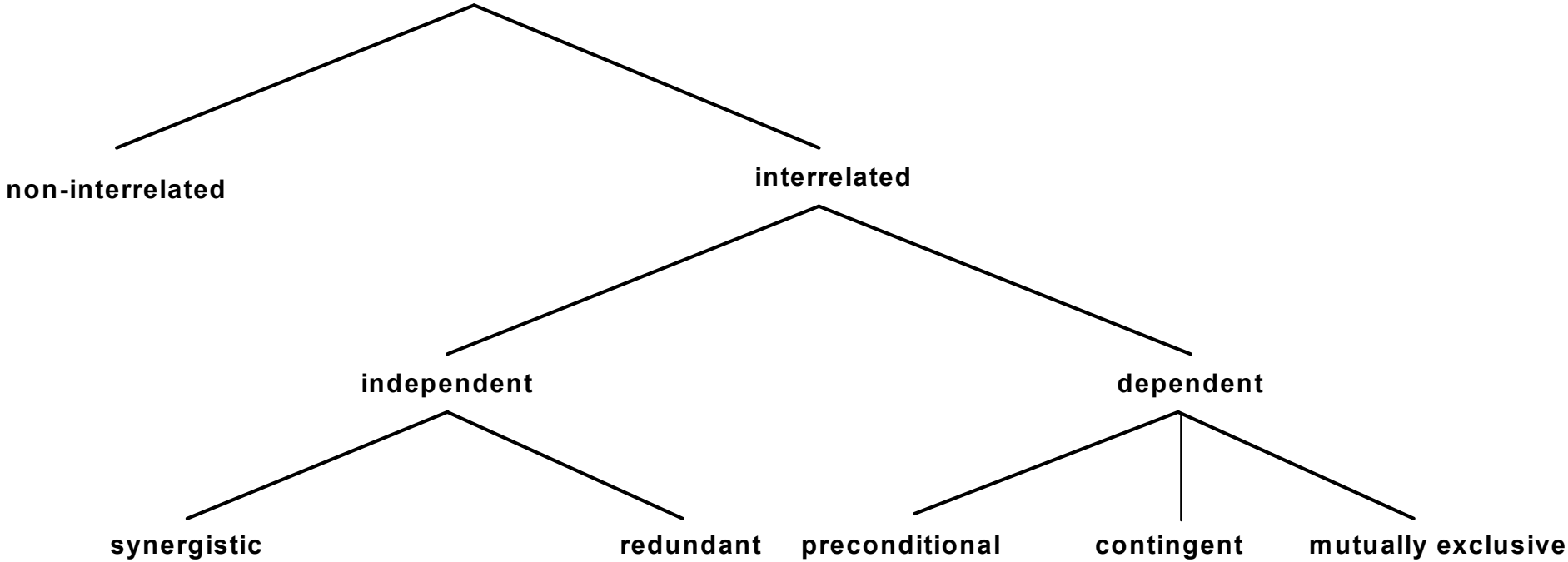
0/1 Knapsack with Risk Limit

- Set risk limit in selected dimensions additional to investment limit.

- Check risk of the selection with respect to each dimension, against the risk limit. If for any dimension the risk limit is exceeded the selection is not considered as a candidate for optimisation.


Dynamic Portfolio Selection
9,269.00
6,220.29
1,144.88
budget
investment: 9,269.00
effective benefits: 4,373.28
call value: 1,144.88
95% value-at-risk: 6,220.29
5 selected projects:
smart antenna & channel simulator
audio wireless equipment
WLAN
synergy WLAN audio wireless equipment
SDR

Hierarchy of Project Interrelations



back

Copula

- $C(p_1,...,p_n)$ maps multivariate distribution functions to the interval [0,1]

$$C:[0,1]^n \rightarrow [0,1]$$

- Copulae represent the interrelations between the values p_i of the distribution functions
- e.g. product copula:

$$C(p_1,...,p_n)=\prod_{i=1}^{n} p_i$$

[McNeil, Frey and Embrechts, 2004]

References

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