Stochastic Programming and Scenario Generation within a Simulation Framework :

An Information Systems Perspective

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OptiRisk SYSTEMS

Outline

- Scope and Objectives
- SP & SG Background
- Information Systems Components
- Data Viewing : OLAP
- SP and OLAP Integration
- Generation of Scenarios
- Integrating SP, SG and Simulation
- Conclusions

CARISMA

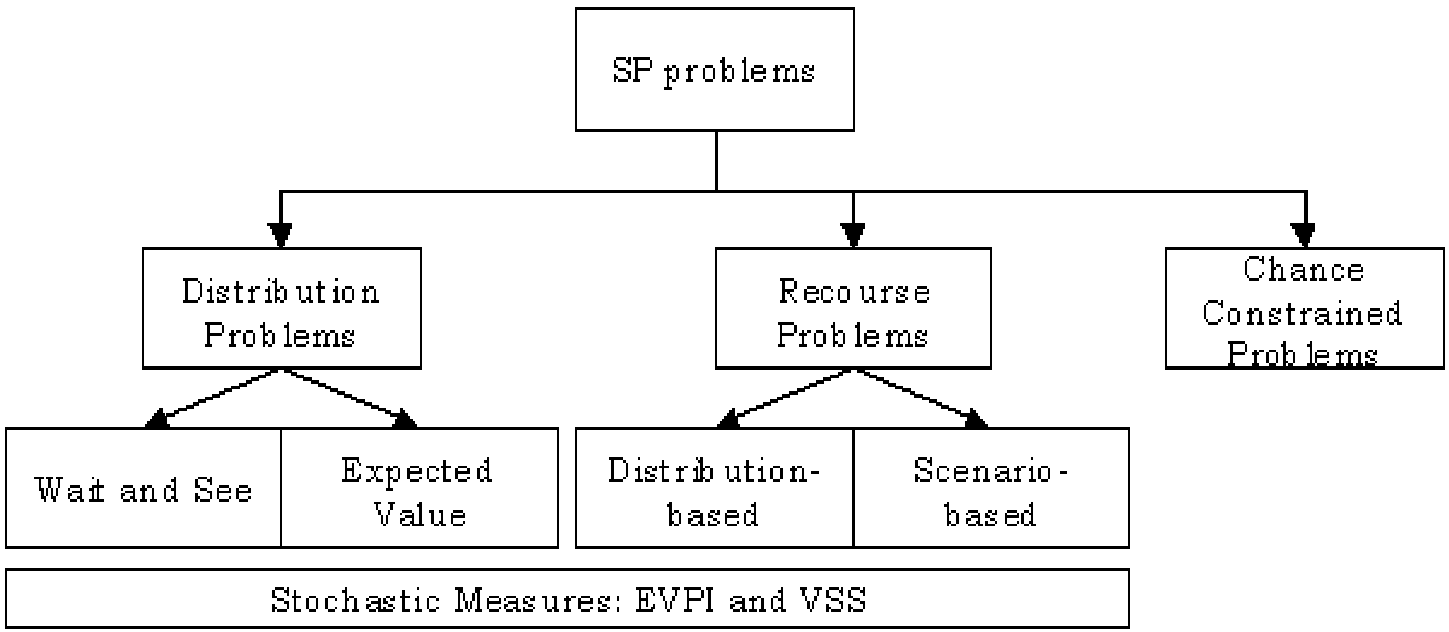
Scope and Objectives

- SP and DSS Applications
- Role of Decision and Descriptive Models
- Models and Datamart Integration
- Optimisation and and Simulation Models

Stochastic Program

- Average value
- Chance constraint
- Recourse model

SP Problems Structure



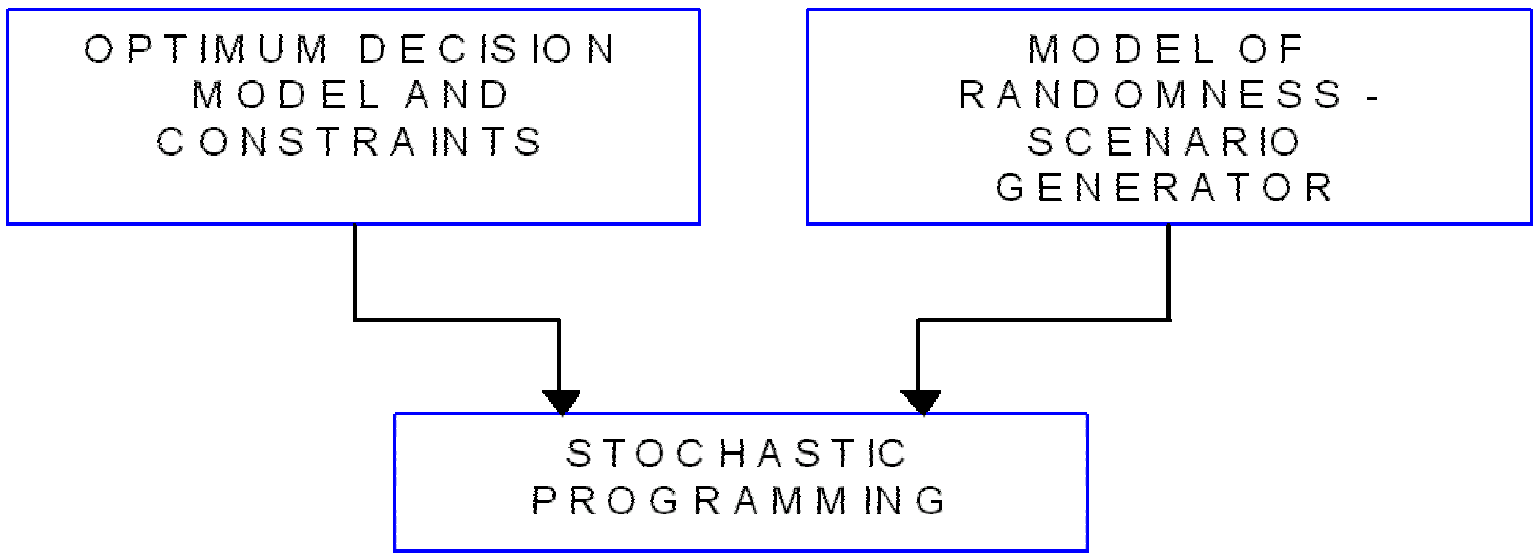
SP Models

- Sensitivity Analysis
- Scenario Analysis
- Questions
  - What is an optimal policy for the underlying deterministic version of the problem
  - How much information about the probability distribution is required to arrive at an optimum solution under uncertainty

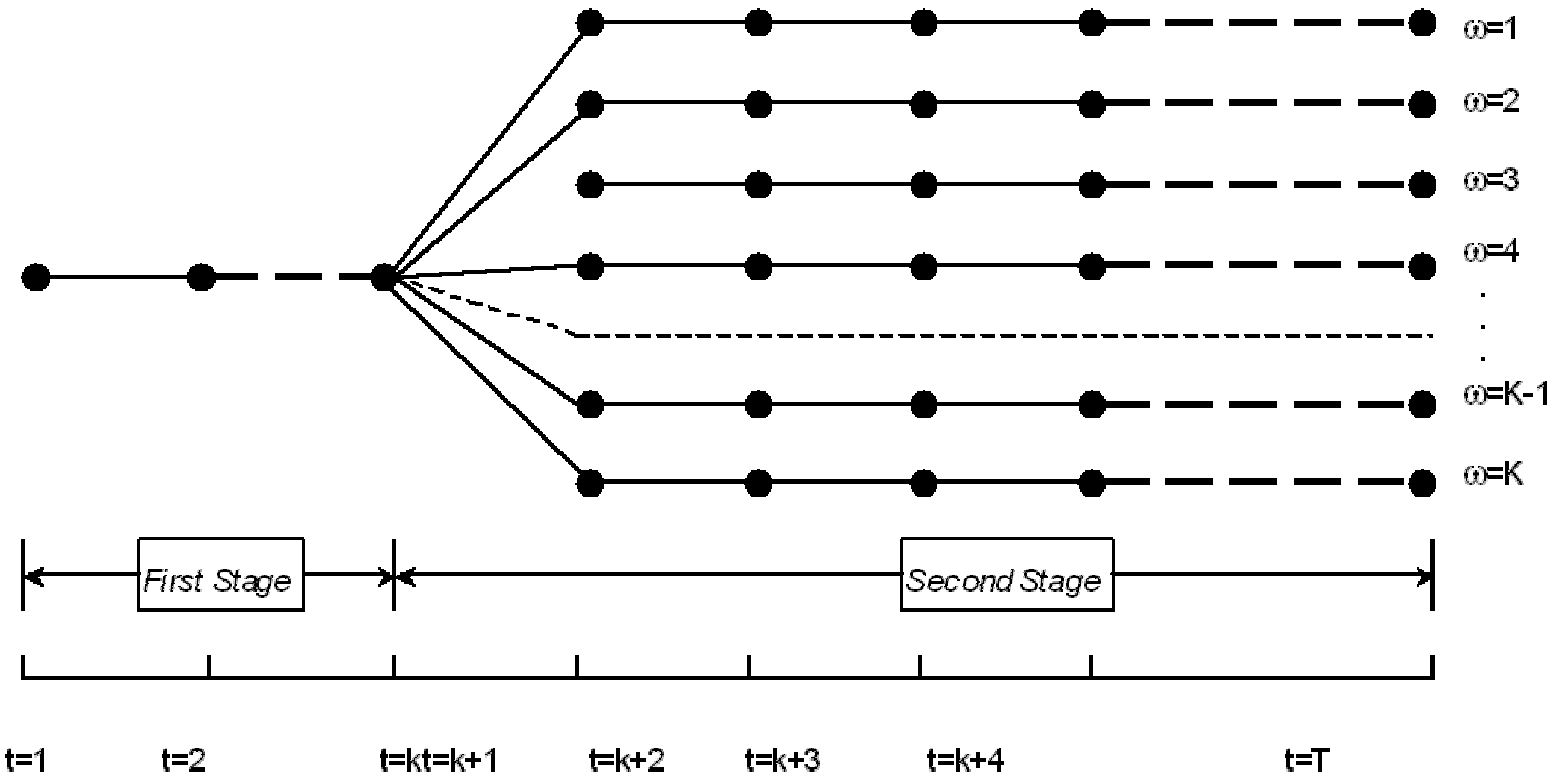
Family of SP Problems

Problem Type	Classification	ID
Expected Value	Distribution	EV
Wait and See	Distribution	WS
Here and Now	Recourse	HN

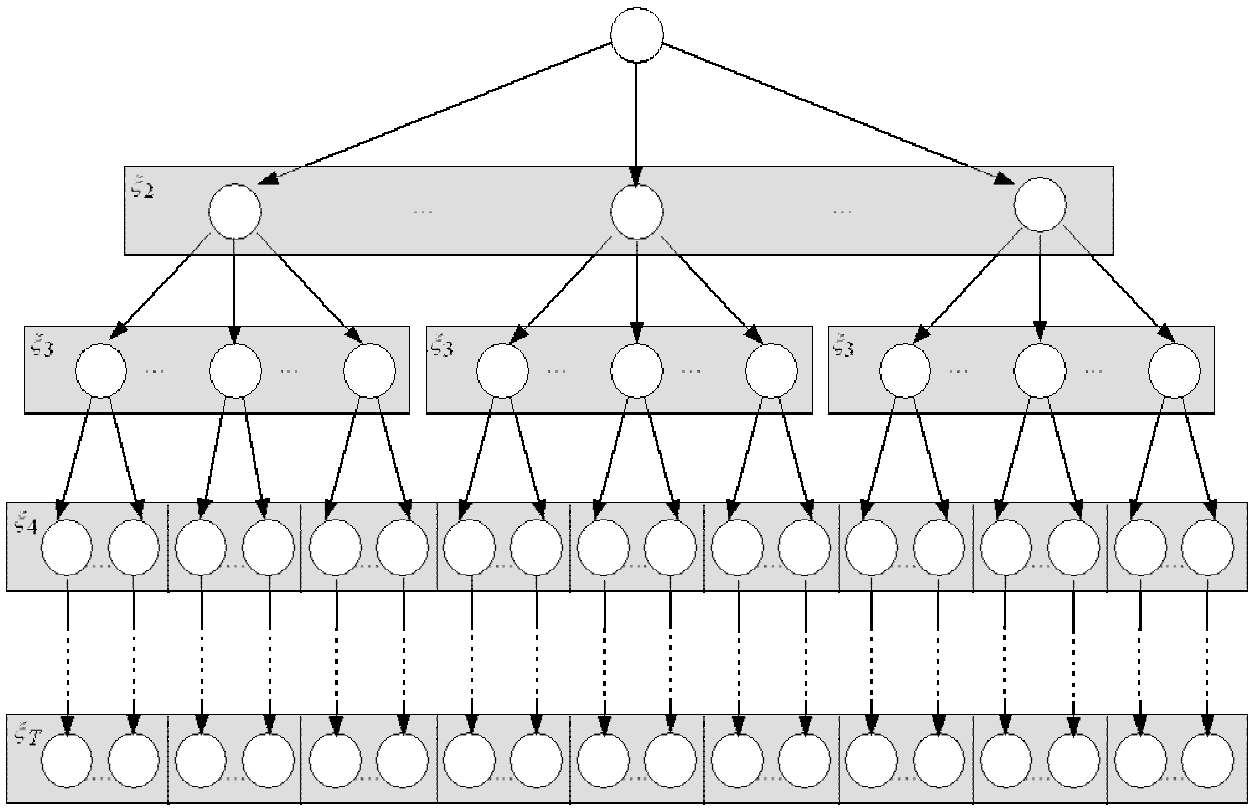
SP Paradigm


OPTIMUM DECISION MODEL AND CONSTRAINTS
MODEL OF RANDOMNESS - SCENARIO GENERATOR
STOCHASTIC PROGRAMMING

Two stage Tree



Multistage Tree



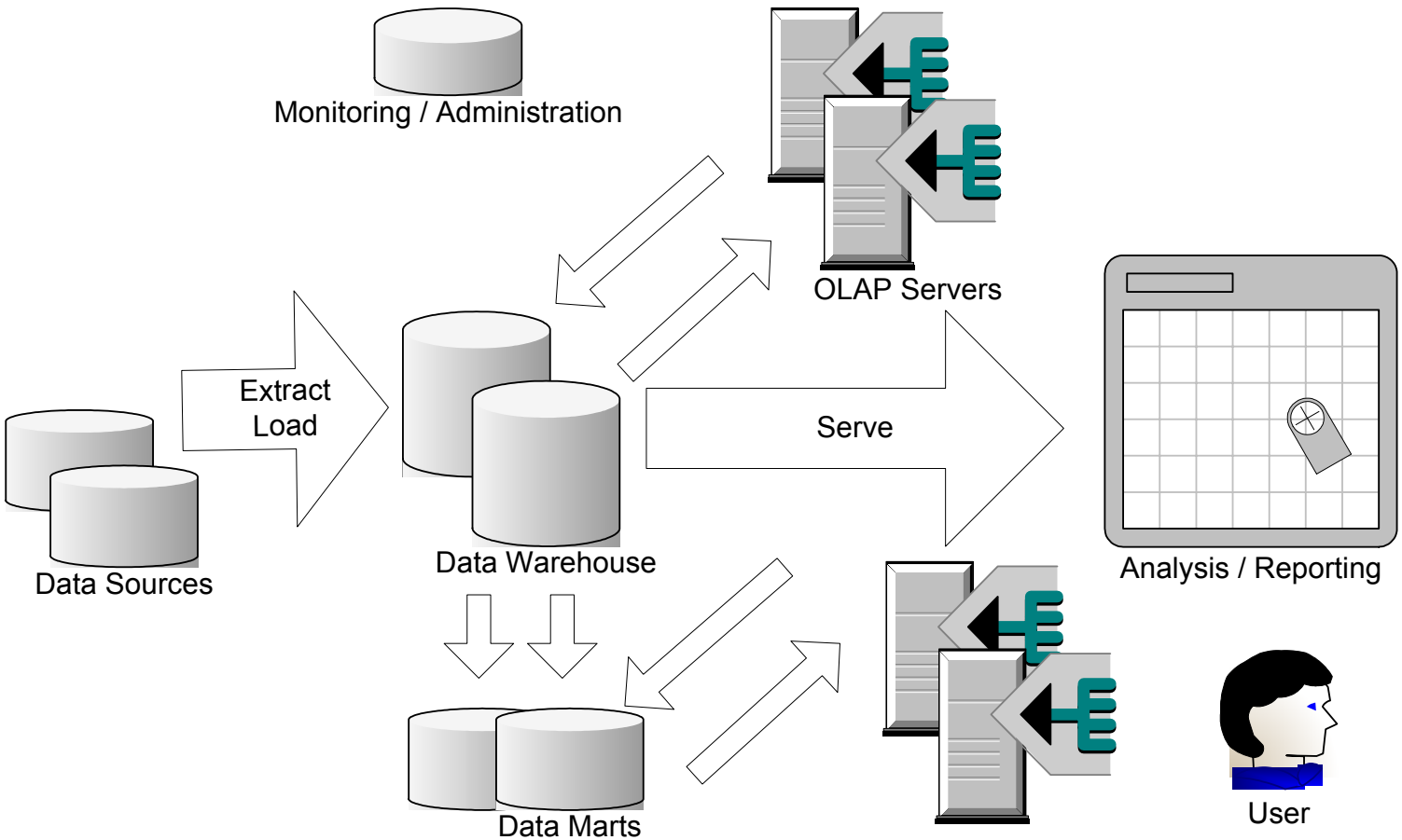
SG Methods

- Moment Matching (Kaut & Wallace)
- Diffusion Processes
  - Wiener Processes (Brownian Motion)
  - Generalised Wiener Processes (Brownian motion with drift)
- Time Series
  - Autoregressive Models : AR(p)
  - Moving Average Models : MA(q)
  - Autoregresssive Moving Average Models : ARMA(p,q)
  - Generalised Autoregressive Conditional Heteroscedasticity : GARCH (p,q)

Data Modelling

- Transactional Data
- Analytic Data
- Decision Data

OLAP (1)


Monitoring / Administration
OLAP Servers
Extract
Load
Serve
Data Sources
Data Warehouse
Analysis / Reporting
Data Marts
User

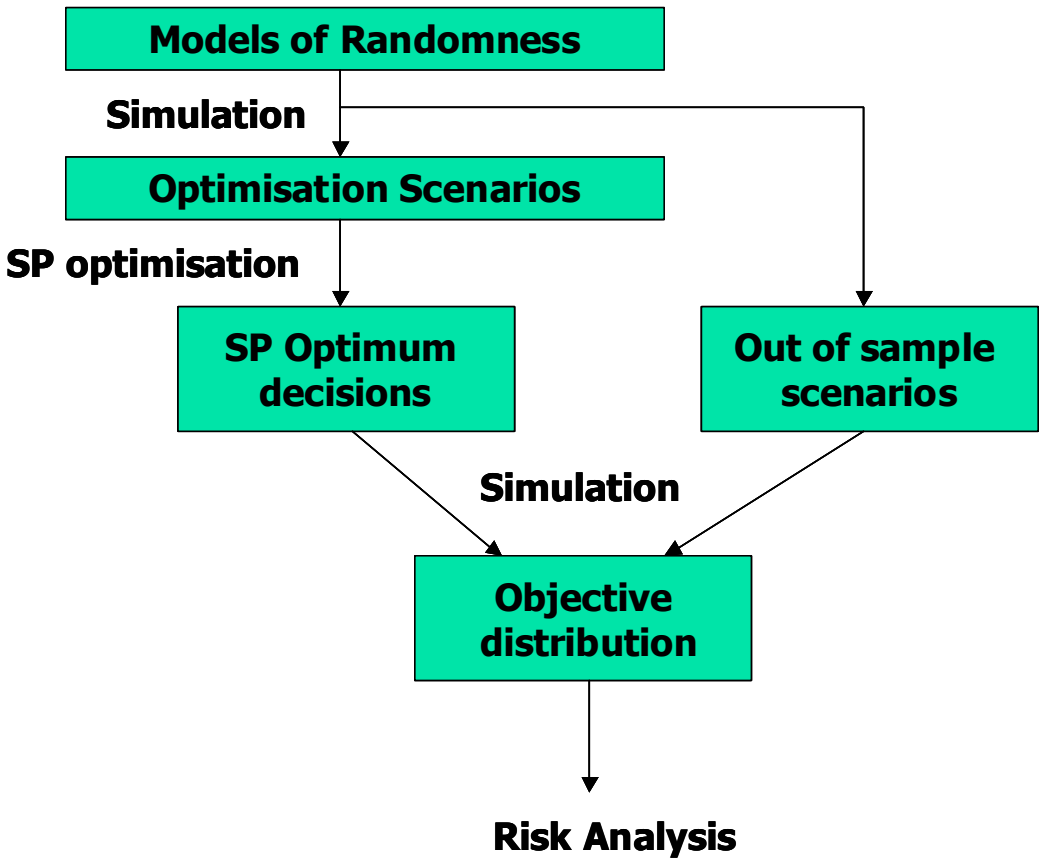
OLAP (2)

- **Model investigation**: Summarise, Detail, or Filter data before model instantiation
  - Requires careful data preparation and database design (e.g. alternative summary functions may be required for model consistency)
  - May require dynamic changes in the model
  - Industry standard connectivity with OLAP tools
- **Data Analysis**: Summarise, Detail, or Filter data following model instantiation
  - Most typical use of OLAP (e.g. Pivot tables)
  - Requires basic preparation at the data level

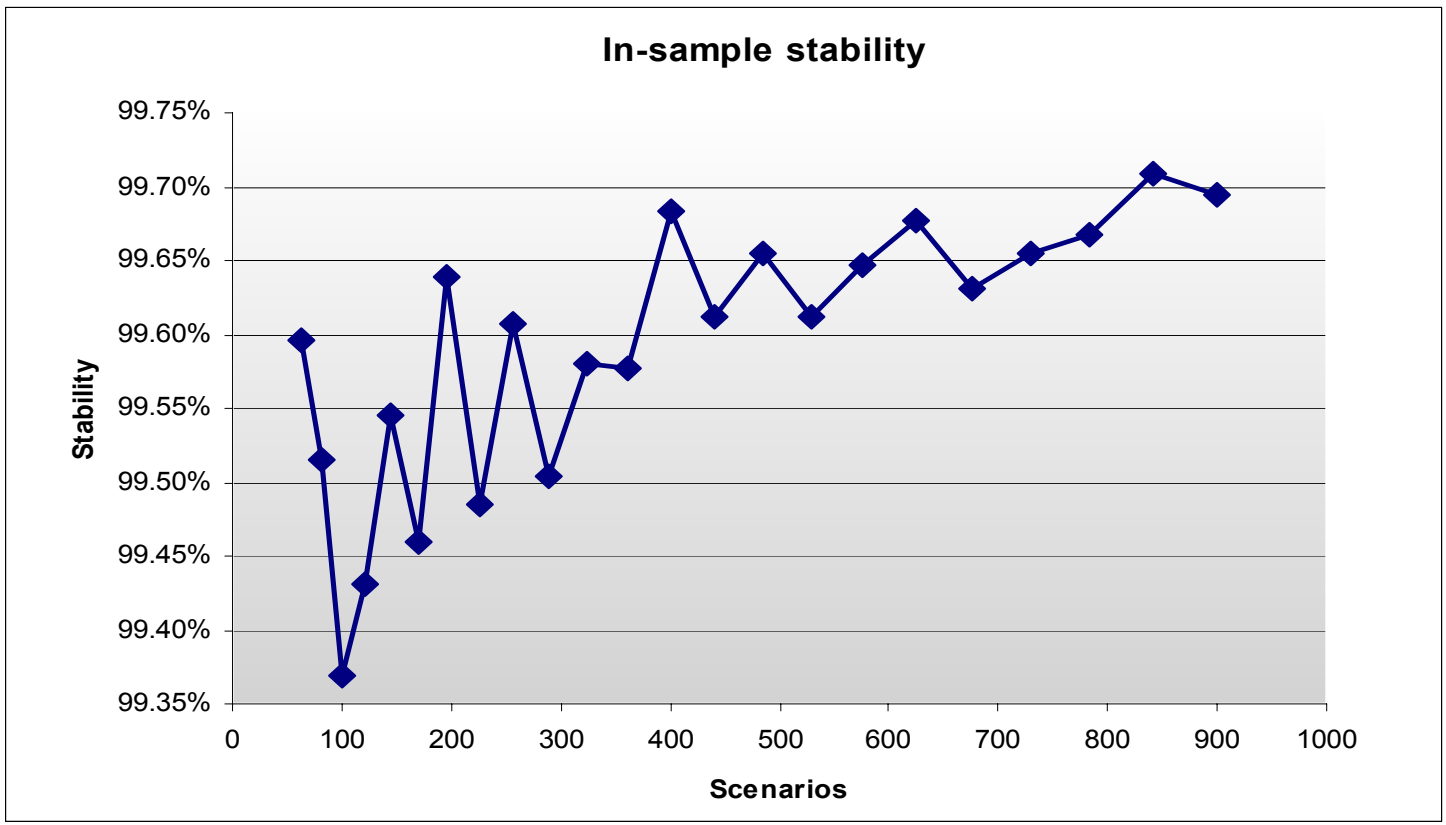
Simulation and SP

- Scenario generation (for the approximation of distributions and stochastic processes by discretisation)
- Scenario generation method evaluation
- Solution algorithm (see stochastic decomposition methods)
- Evaluation of solutions (in order to prove the robustness of a model or the robustness of a set of decisions)
- Analysis of the risk associated with a given set of decisions.

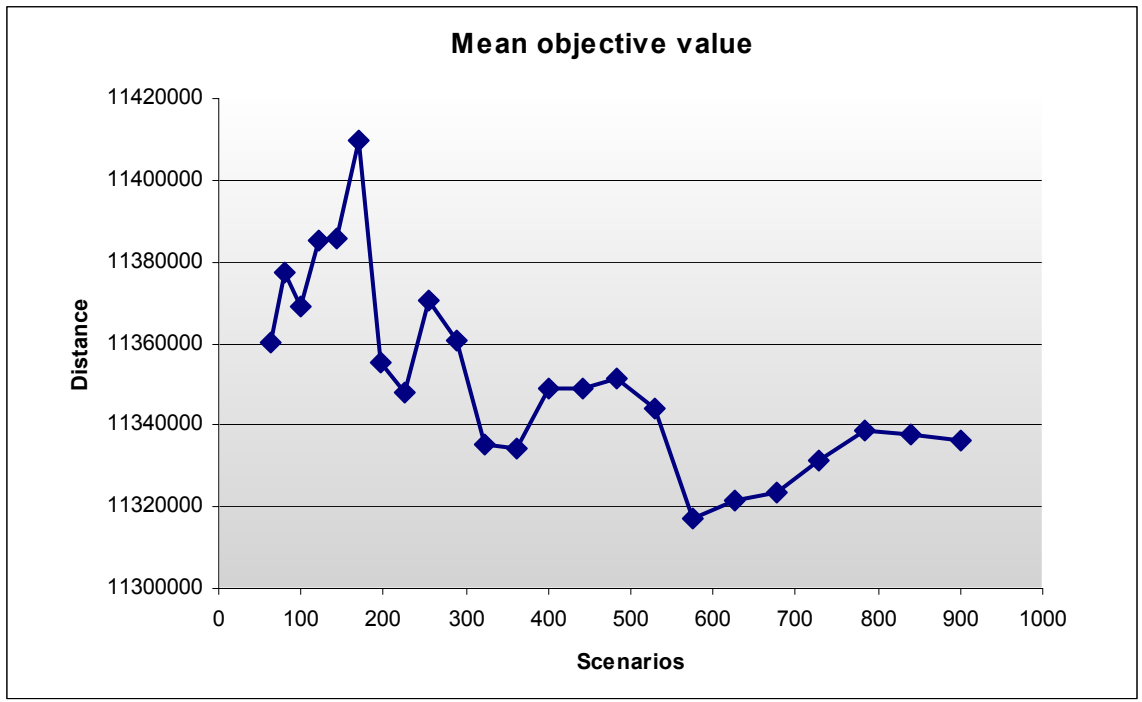
SP Models and Simulation



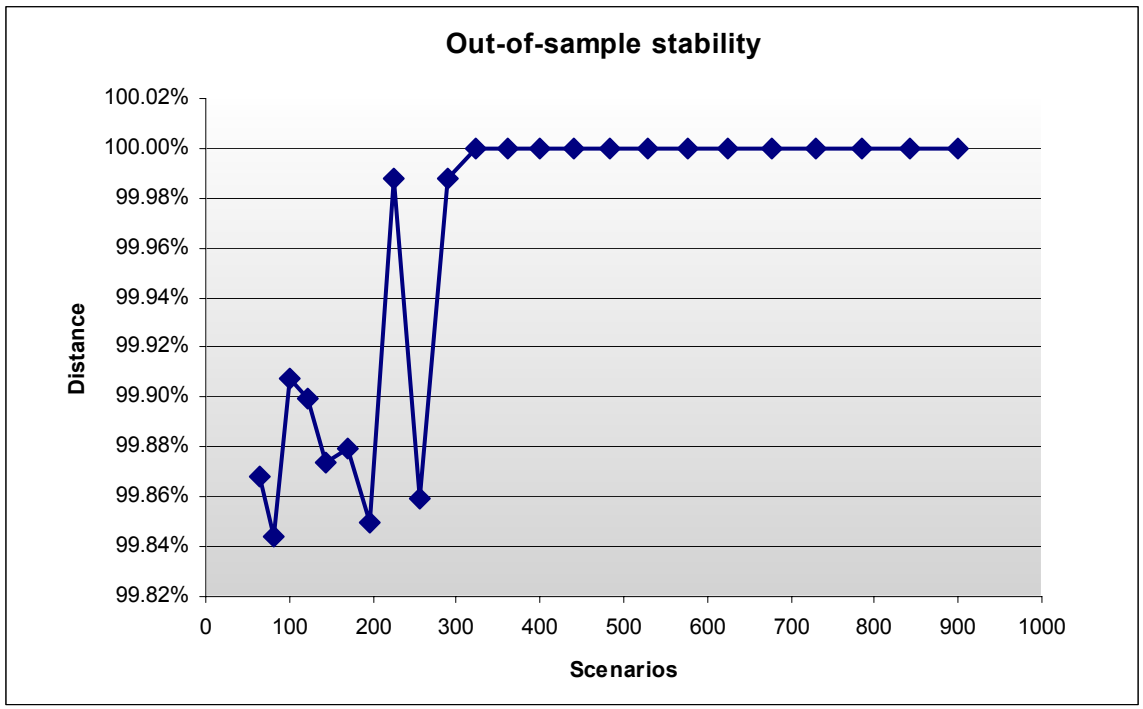
In-sample Stability



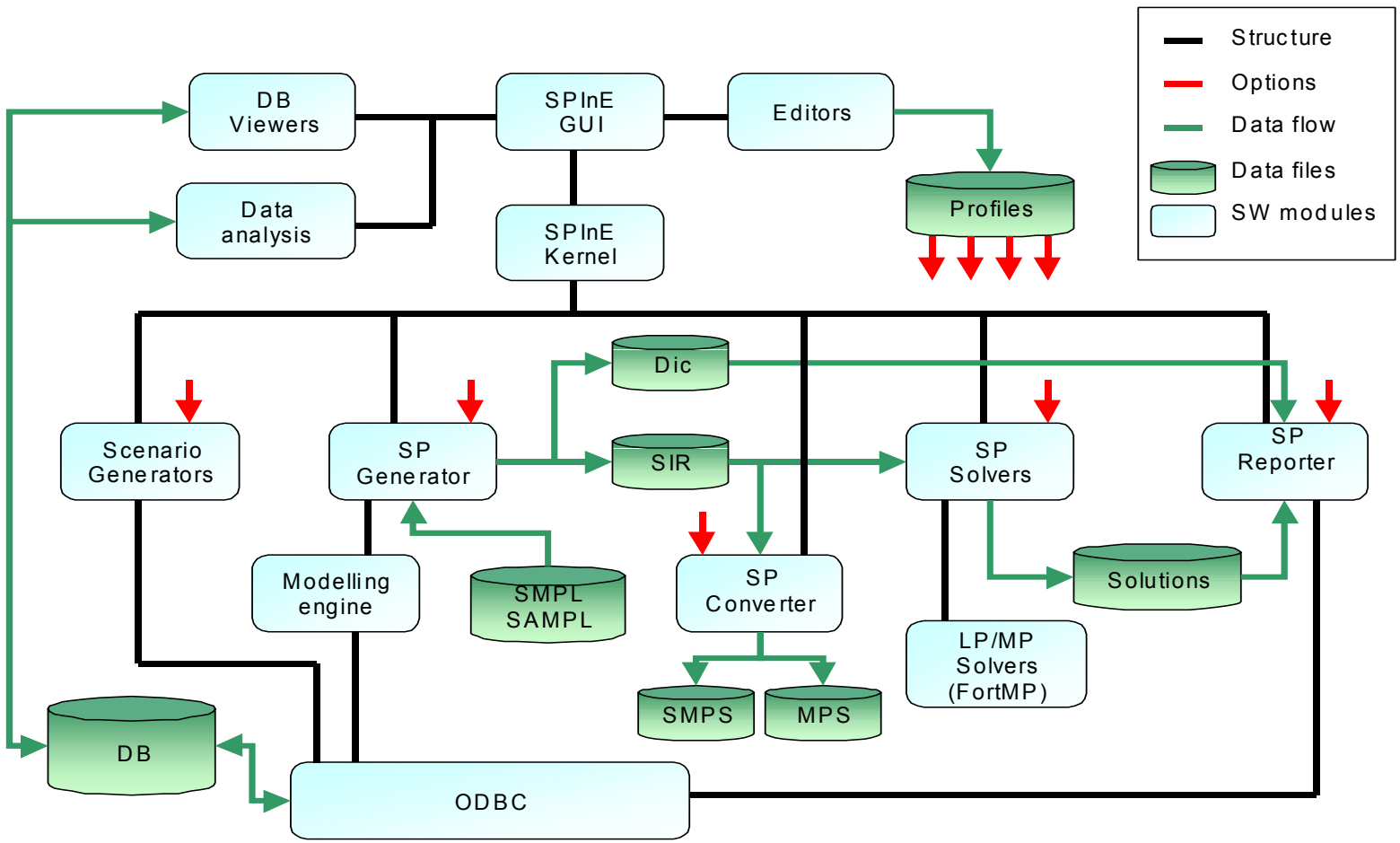
Mean Objective Value



Out of Sample Stability



SPInE Structure Analysis

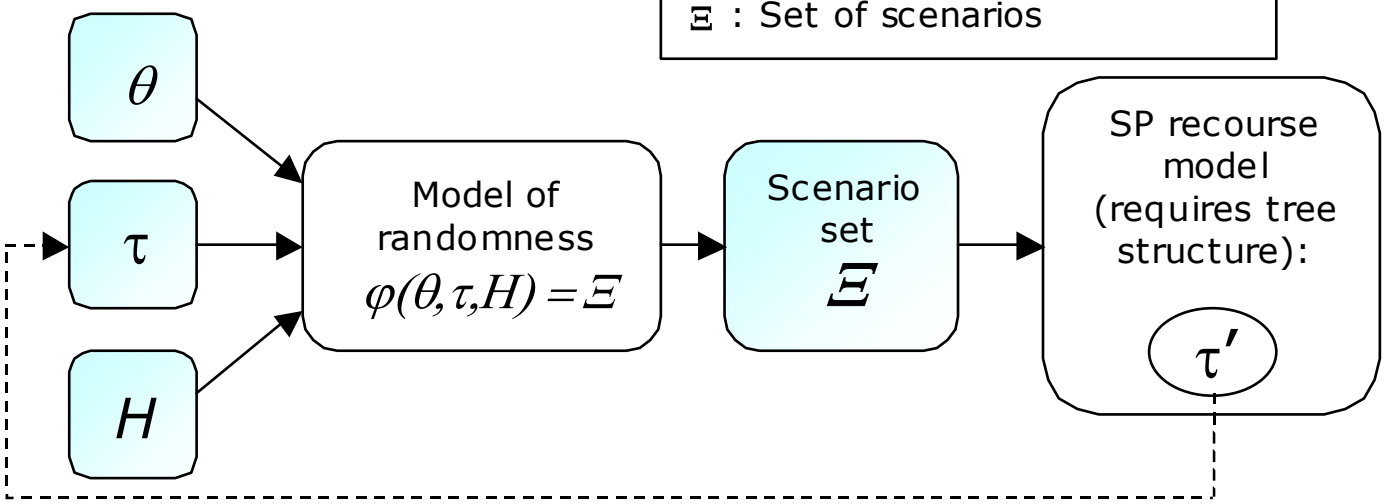


SG Integration Problem

Consistency condition:

$$\tau = \tau'$$

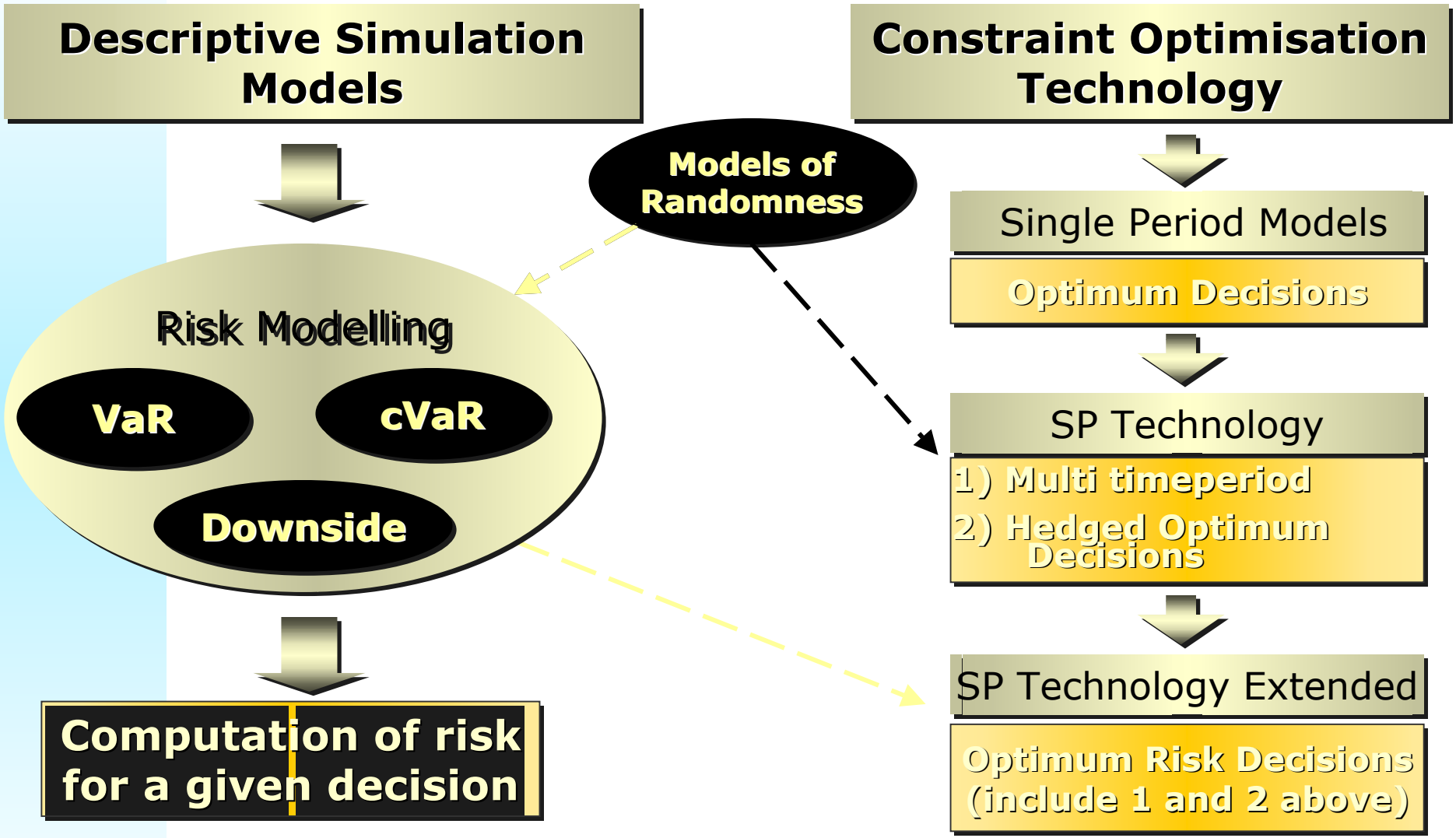
τ : Scenario tree structure
τ' : SP model tree structure
φ : Model of randomness
θ : Other parameters of φ
$\boldsymbol{H}$: Historical data
Ξ : Set of scenarios



Integrated Environment for SP

- Multistage SG based on Moment Matching method
- SPInE : Stochastic Programming Integrated Environment
- Integration of SG, OLAP in SPInE

Risk Decisions



Conclusions

- Regulatory Regime : Basle accord(BIS 1998,2001)
- Emergence of Risk Modelling
- Optimum Risk Decisions : The Combined Paradigm of Optimisation and Simulation
- How to bring together :
  - Quantitative modelling and financial engineering skills
  - Algorithm and software engineering skills
  - Information engineering skills

Thank You

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http://carisma.brunel.ac.uk/