COIN-SMI and Test Sets

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Objectives

- A. COIN-SMI
- B. Test Sets
- C. Research Groups

Source of Information:

www.coin-or.org

www.stoprog.org

A. COIN-SMI

COIN-OR

• COmputation INfrastructure for Operations Research = intiative to develop an open source software for Operations Research Community

• organization into individual **projects**, each with its own project manager, management Web site (use **Trac**), project wiki, mailing list(s), bug tracking system

• COIN-OR's new source code control system is based on **Subversion** (= versions control system, SVN)

• old CVS system will continue to work for the time being, but the CVS repository is now frozen – no new updates will be available

Obtaining source code of a COIN-OR project

- **Unix:** install Subversion

  type

svn co https://projects.coin-or.org/svn/*Pg*/trunk Coin-*Pg*

  where *Pg* is name of the project

- **Windows:** install **TortoiseSVN**

  follow instructions on the web site

COIN-SMI

- Stochastic Modelling Interface for COIN-OR
- recourse programming, chance constrained programming, stochastic control and dynamic programming, robust optimization etc.
- current release: implements a multiperiod scenario stochastic programming object "SmiScnModel" – – supports SMPS file reader method, direct "genScenario" method (= method to generate a deterministic equivalent), several methods to get solution data by scenario

- COIN-SMI is just a C++ interface !!!
- by installating it, you obtain huge library of functions, solvers, prepared example programs and related source data (SMPS)
- launching program (C++):

jitka@ladybird:~/coin-Smi_0.5/Smi/examples$ ./stoch

- the program calls instances (data files, solvers) from the installed library and "organizes their cooperation"
- results output: screen or predefined file

Now you will see:

- code of the Example program in C++
- resulting output you obtain on the screen

Advantages

- wide spectrum of possibilities
- open source
- free software

Disadvantages

- no documentation available
- no mathematical formulation of examples available
- lack of users – dying discussion

B. Test Sets

- data and problem formulation, results
- usually several instances of the problem $\rightarrow$ comparison
- computational results, analyses
- sometimes also links to used software tools

1. SGPF – Portfolio Test Problem

Description:

• financing business activities by borrowing or lending bonds with different maturities

• maximize profit – depends on interest rate, price changes of bonds, earnings of the underlying business

• decisions: borrowing and lending

• stochasticity (via scenarios): in the objective function (dynamic interest rates over time) and in the RHS; left-hand side of the constraints is deterministic

Format:

• three files in SMPS
(SGPF*Y*.COR, SGPF*Y*.TIM, SGPF*Y*.STOCH)

Used methods:

• baryocentric approximation (evaluating scenario trees), demonstrations for distinct dimensions (25 – 15625 scenarios)

• primal and dual simplex (CPLEX), gradient methods, nested decomposition, combination of nested Benders decompozition and simplex (MSLiP+OSL)

Results:

• number of iteration steps, result, time,
relative EVPI (4%–12%)

2. WATSON – Pension Fund Management Test Problems

University of Cambridge

Description:

• maximize expected terminal wealth over 10Y subject to required service on 5 pension funds

• stochasticity: assets (random price movements and cash returns), liabilities (scenario-dependent pension payments and borrowing costs)

• scenario generation: **independent** (independent runs of the simulator, and then bundling according to the predefined tree structure) and **conditional** (the simulator is embedded in the tree structure)

• sets for 16 – 2688 scenarios available

Format:

• core, time, stoch files in SMPS

Used methods:

• direct solution of deterministic equivalent problem by the simplex method (OSL Release, CPLEX), primal-dual interior point method (OB1, CPLEX), nested Bendes decomposition (MSLip, MSLiP-OSL)

Results:

• relative EVPI 12% – 63%

3. Interactive Stochastic Programming Case Study in the NEOS Guide

Description:

- in fact Flower girl; running a small natural gas company
- minimize costs
- decisions: how much gas to purchase, sell, store for the following year
- stochasticity: demand for next years
- interactive part of the case study

AMPL code of the problem:

```
param LastPeriod > 0;    # No. of periods in the model #
param PurchasePrice{0..LastPeriod} >= 0;
param Demand {0..LastPeriod} >= 0;
param Probability {0..LastPeriod} >= 0;
param StorageCost > 0;

# VARIABLES #

var Purchase {0..LastPeriod} >= 0;
var UseFromStorage {0..LastPeriod} >= 0;
var Storage {-1..LastPeriod} >= 0;
```

```
# OBJECTIVE FUNCTION #
minimize TotalCost:
sum{t in 0..LastPeriod} (PurchasePrice[t] * Purchase[t] +
                                    + StorageCost * Storage[t]);

# CONSTRAINTS #
subject to MeetDemand{t in 0..LastPeriod}: Purchase[t] +
                                    + UseFromStorage[t] >= Demand[t];

subject to StorageBalance{t in 0..LastPeriod}: Storage[t] =
                                    = Storage[t-1] + Purchase[t] - Demand[t];

subject to UseLessThanHave{t in 0..LastPeriod}:
                                    UseFromStorage[t] <= Storage[t-1];

subject to InitialStorage: Storage[-1] = 0;
```

4. Test Set for Stochastic Linear Programming by Andy Felt

- 11 problems have a short description, mathematical problem statement, and notational reconciliation to a standard problem format
- in addition 21 specific test cases with data in SMPS format: airlift, assets, cargo, chemistry, electricity, environmental, forest planning etc.
- available SMPS files and description of the problems

5. Test Problems Compiled by Steve Wright

Description:

• data and problems researched in "The Empirical Behavior of Sampling Methods for Stochastic Programming" (by Linderoth, Shapiro, Wright)
$\rightarrow$ quality of solutions obtained from sample-average approxiamtions to 2-stage stochastic linear programs with recourse

• 5 problems: Vehicle assignment, Aircraft allocation, Electricity planning, Telecom network design, Cargo flight scheduling

• from 10^5 to 10^{81} scenarios

Tools:

• Condor, MW, ATR

Results:

• for problems with similar structure, we need samples of very different sizes to obtain "sufficiently good solution"

6. SIPLIB: Stochastic Integer Programming Test Problems Maintained by Shabbir Ahmed

• collection of test problems of stochastic integer programming, data in SMPS format

• information on the underlying problem formulation and known solution also included

Problem Sets:

DCAP Test Set

• collection of 12 two-stage stochastic integer programs – dynamic capacity acquisition and allocation under uncertainty

• complete recourse, integer first-stage variables, pure binary second-stage variables, discrete distributions

SEMI Test Set

• 3 instances of a two-stage multi-period stochastic integer problem arising in the planning of semiconductor tool purchases (expected value of the unmet demand is minimized subject to capacity and budget constrain)

• mixed-integer first-stage variables and continuous second-stage variables.

SIZES Test Set

• 3 instances of a two-stage multi-period stochastic mixed integer program arising in the product substitution applications (problem and data from paper "Selection of an optimal subset of sizes")

• mixed-integer variables in both stages

SSLP Test Set

- 12 instances of a two-stage stochastic mixed-integer programs arising in server location under uncertainty (random demand / potential clients)
- pure binary first-stage variables, mixed-binary second-stage variables, and discrete distributions

C. Research Groups

- who with whom and where
- very high number on full-text articles and presenations

1. Centre for Financial Research

The Judge Institute of Management,
University of Cambridge

- **Objectives:** dynamic portfolio management, firm-wide risk, FX dynamics, merges and acquisitions
- **People:** Michael Dempster
  Elena Medova
  Ch. Jones
  G. Thompson
  cooperates R. Bates, V. Leehmans
- **Link:** http://mahd-pc.jbs.cam.ac.uk

2. Centre for Analysis of Risk and Optimisation Modeling Application (CARISMA)

Brunel University

- **Objectives:** risk optimisation modelling, combined paradigm of risk and return quantification
- **People:** Guatam Mitra
  John Beasley
  Paresh Date
  Cormac Lucas
- **Link:** http://carisma.brunel.ac.uk
- Article "Using @RISK to calculate portfolio performance" (@RISK = MS Excel risk analysis add-in)

3. IBM Research in Stochastic Programming

(NOT up-to-date ?)

- **Objectives:** software for solving multiperiod stochastic programs in S-MPS format, library of extending tools
- **People:** Alan King
  Shabbir Ahmed
- **Link:** http://www.research.ibm.com/stopro/

4. Risk Management and Financial Engineering Lab (RMFE)

University of Florida

- **Objectives:** risk management in finance, energy, controlling nuclear risk; military, medical, agriculture and environmental applications; financial engineering
- **People:** George Casella
  Joseph Glover
  Panos Pardalos
  cooperates T. R. Rockafellar
- **Link:** http://www.ise.ufl.edu/rmfle

5. Stochastic Optimization Research Group

School of Industrial and Systems Engineering
Georgia Institute of Technology

- **Objectives:** theory, algorithms and applications of stochastic programming; robust optimization
- **People:** Shabbir Ahmed
  Alexander Shapiro
  Arkadi Nemirovski
- **Link:** http://www2.isye.gatech.edu/so/
- Link to SIPLIB (Stochastic Integer Programming Test Problem Library)

6. Modeling, Optimization, Research and Education Institute (MORE)

University of Arizona, Tucson

- **Objectives:** integer and combinatorial programming, stochastic and dynamic optimization, game theory and equilibrium models
- **People:** Moshe Dror
  Guzin Bayraskan
  Jita Desai
  Jeff Goldberg
  Suvrajeet Sen
- **Link:** http://tucson.sie.arizona.edu/MORE

7. Advanced Models, Applications and Software Systems for High Performance Computing (AURORA)

University of Viena

$\rightarrow$ working group in HPC in finance

- **Objectives:** large stochastic financial management models, pricing path-dependent financial instruments
- **People:** George Ch. Pflug
  Ronald Hochreiter
  David Wozabal
  Engelbert Dockner
- **Link:** http://www.univie.ac.at/sor/aurora6

8. Stochastic Programming and its Applications in finance

Helsinki Schoool of Economics

- **Objectives:** developing techniques of SP and applying them to financial planning
- **People:** Petri Hilli
  Markku Kallio
  Matti Kiovu
  Teemu Pennanen
- **Link:** http://hkkk.fi/ systems/sp/