



## Stochastic Programming

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### Exercise sheet 1

**Exercise 1.1** Compute the expected value solution of the farmer's decision given the optimal first-stage decisions under certainty:

Given the optimal first-stage solution (under certainty)  $\begin{matrix} x_1 & x_2 & x_3 \\ 120 & 80 & 300 \end{matrix}$ .

Compute the optimal second-stage values for sales and purchases for states  $s = 1$ ,  $s = 2$  and  $s = 3$  (+20% yield, average yield, -20% yield with identical probabilities of  $1/3$ ), i.e. a similar table to the one of page 5 of the lecture notes.

*Note: For the computation of the optimal solutions use any LP/MIP solver of your choice, e.g. the freely available GLPK (see <http://www-m9.ma.tum.de/WS2011/StochPro> for a download link).*

**Exercise 1.2** Assume the farmer to have four different fields of sizes 185 acres, 145 acres, 105 acres and 65 acres, which is in total still 500 acres of available land. The yield of each planted crop is unknown. Formulate this problem as a two-stage stochastic program with a first-stage program with binary variables under the condition that on each field only one type of crop is allowed to be planted.

**Exercise 1.3** Assume the farmer to have certain contracts on the amount to purchase and sale of each crop. Assume these contracts to specify the farmer to sell and purchase only by multiples of 100 tons. The yield of each planted crop is unknown. Formulate this problem as a two-stage stochastic program with a second-stage program with integer variables.

**Exercise 1.4** Solve the linear programs of Exercises 1.2 and 1.3 with given states  $s = 1$ ,  $s = 2$  and  $s = 3$  (+20% yield, average yield, -20% yield with identical probabilities of  $1/3$ ).