SF2863 Systems Engineering, 7.5 HP

Lecturer: Per Enqvist

Optimization and Systems Theory
Department of Mathematics
KTH Royal Institute of Technology

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Teachers

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Literature

- Main Literature: “Introduction to operations research”, Tenth edition, by Hillier and Lieberman.

Available at the KTH Bookshop

The following material will be available on *Bilda* for registered students:

- Exercises in SF2863 Systems Engineering, 2014.

Further material will be posted on the homepage.

Course homepage

On the course homepage

http://www.math.kth.se/optsyst/grundutbildning/kurser/SF2863/

you can find

1. a preliminary schedule
2. reading instructions, recommended exercises etc.
3. home assignments, rules and information about deadlines
4. these slides

Home assignments

There will be two voluntary home assignments.

- HA 1: Markov chain/process example - the ferry (2 bonus points)
- HA 2: Spare parts optimization (4 bonus points)

Exam

The maximal result on the exam (not counting bonus points) is 50 points.

Preliminary grade limits:

Grade	A	B	C	D	E	FX
Points	43-50	38-42	33-37	28-32	25-27	23-24

- At the exam a brief formula sheet will be handed out. No other tools, such as calculators, are allowed.
- The first written exam is January 11, 2016, at 14.00-19.00.
- It is necessary to sign up for the exam, and it can be done on "My pages", Nov. 2 - Dec. 13.

Course Information

Course in Systems Engineering with Introduction to Markov Chain/Process theory.

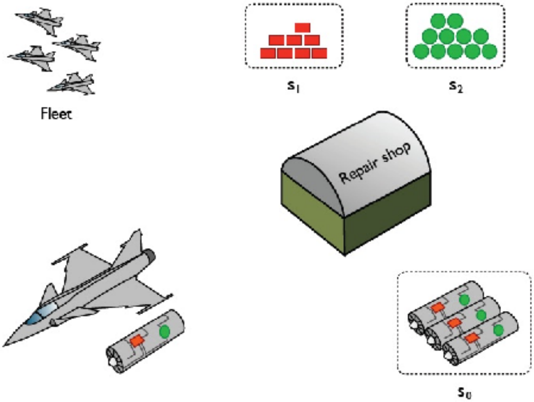
> "We use statistics, probability theory and differential/difference equations to build mathematical models for processes, combine them to complex systems, analyze them and optimize to find the best control/management policy."

Course elements

1. Markov chains/processes
2. Queueing theory
3. Spare parts optimization
4. Marginal Allocation
5. Deterministic/Stochastic Inventory theory
6. Dynamic Programming
7. Markov Decision Processes

Spare Parts Optimization

How many spareparts of each type should be held, in which location, and where should they be repaired?

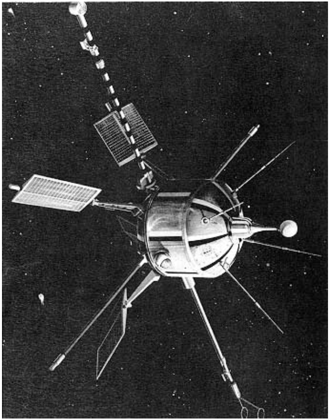


Newsvendor Problem

How many newspapers should the vendors buy each day ?

Marginal Allocation Problem

Where should you use redundance to get the best reliability ?
(relative to the weight)

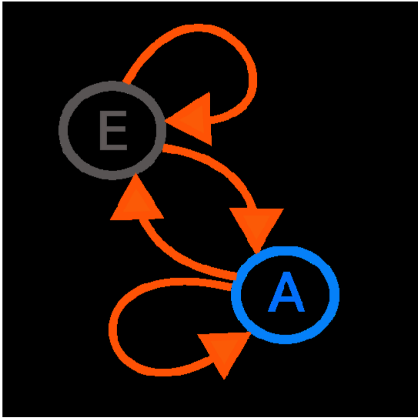


Queueing theory

Figure : Queueing strategy

Markov Chain

Example with two states, ’E’ and ’A’.



Examples

Markov Chains with state X_t where $t = 0, 1, 2, \cdots$.

- X_t = wind condition $\{1 = \text{Calm}, 2 = \text{breeze}, 3 = \text{storm}, \}$ at a particular place on day t.
- X_t = number of items in stock of a particular item on day t.
- X_t = accumulated sum of points after t rolls of a die.
- X_t = number of rabbits living on Gärdet at time t.
- X_t = number of complaint phone calls to the help desk at day t.
- X_t = condition of patient $\{1 = \text{stable}, 2 = \text{manic}, 3 = \text{depressive}\}$ on day t.

Some useful results from probability theory

The **conditional probability** of A given B is defined by

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

Law of total probability

If B_n form a partition of the sample space, i.e., the B_n are disjoint and the union is the whole sample space, then

$$Pr(A) = \sum_n Pr(A|B_n)Pr(B_n)$$

In particular, if X and Y are discrete valued stochastic variables, then

$$Pr(X = x) = \sum_y Pr(X = x|Y = y)Pr(Y = y)$$