Data-Driven Decision-Making In Enterprise Applications

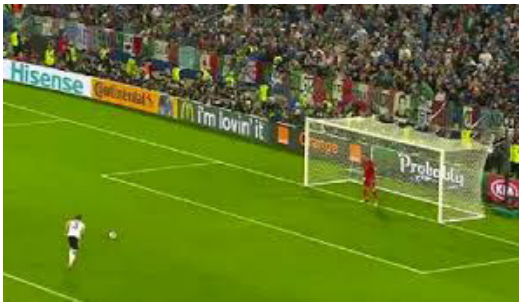
Introduction

Rainer Schlosser

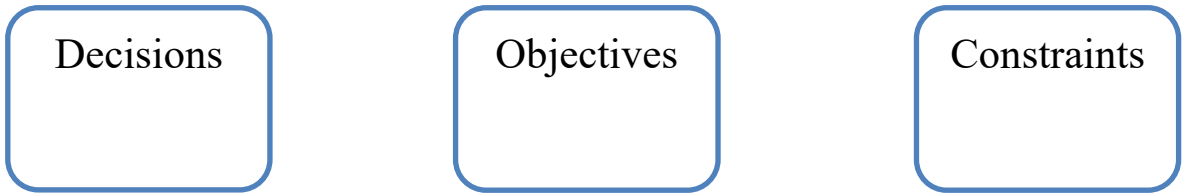
Hasso Plattner Institute (EPIC)

April 27, 2020

The World is Full of Decision Problems



What Constitutes a Decision Problem?



How to Approach Decision Problems?

Decisions x	When can I do what?	Identify.
Objective $F(x)$	What do I want to optimize?	Define.
Constraints $C(x)$	What has to be satisfied?	Determine.

How to Approach Decision Problems?

Decisions x	When can I do what?	Identify.
Impact of x	What happens if a certain decision is made?	Estimate.
Objective $F(x)$	What do I want to optimize?	Define.
Constraints $C(x)$	What has to be satisfied?	Determine.
Optimization	Max $F(x)$ over x such that $C(x)$ is satisfied.	Solve!

Agenda

- Introduction ✓
- **Personal Background**
- Goals of the Course & Grading
- Outlook: Solution Techniques and Problem Examples

Personal Background

- Ph.D. Operations Research (2014), Humboldt-University of Berlin
- Hasso Plattner Institute, EPIC, since 2015
- Field of Research
  - Data-driven decision support
  - Focus on stochastic dynamic models
- Current Areas of Applications
  - Operations management (e.g., dynamic pricing, ordering, advertising)
  - Database configuration (e.g., data placement problems, index selection)

Agenda

- Introduction ✓
- Personal background ✓
- **Goals of the Course & Grading**
- Outlook: Solution Techniques and Problem Examples

Technical Information

- Credits? 4 SWS (V/Ü), 6 ECTS (graded)
- When? Monday 13.30 - 15.00 VL (lecture)
  Thursday 11.00 – 12.30 UE (exercise/questions)
  Start: April 27, 2020, End: July 16, 2020
- Where? currently via Zoom (maybe later Room D-E. 9/10)
- Who? Rainer Schlosser, rainer.schlosser@hpi.de
- Slides? EPIC, Teaching, Summer 2020

Structure of the Course

- April/May: Lectures on „Optimization Techniques“:
  - (i) Linear Programming
  - (ii) Integer Linear Programming
  - (iii) Linear + Logistic Regression
  - (iv) Dynamic Programming
  - (v) Robust + Nonlinear Optimization
- June/July: Choose Projects, Apply/Extend Suitable Techniques, Work in Teams, Input/Support will be given
- July/Aug: Documentation of Projects Results

Overview

Week	Dates	Topic	
1	**April 27**/30	**Introduction** + Linear Programming	
2	May 4/7	Integer Linear Programming	
3	May 11/14	Linear + Logistic Regression	
4	May 18	Exercise Implementations	(Thu May 21 “Himmelfahrt”)
5	May 25/28	Dynamic Programming	(Mon June 1 “Pfingstmontag”)
6	June 4	Dynamic Pricing Competition	
7	June 8/11	Project Assignments	
8	June 15/18	Robust + Nonlinear Optimization	
9	June 22/25	Work on Projects: Input/Support	
10	June 29/2	Work on Projects: Input/Support	
11	July 6/9	Work on Projects: Input/Support	
12	July 13/16	Work on Projects: Input/Support	
13	July/Aug	Finish Documentation (Deadline: Aug 31)	

Goals of the Course & Grading

- Goal: Develop models to compute optimized decisions for different problems & applications
- Learn: Optimization techniques
- Do: Apply & extend different optimization approaches
- Grading: 30% Project results
  70% Documentation (“Projektarbeit”)

Prerequisites

- Programming

  Parameters, Data Preparation
  Loops, Recursions, Simulations

- Basic Mathematical Background

  Sets, Vectors
  Probabilities, Random Variables, Expected Values

- More does not harm

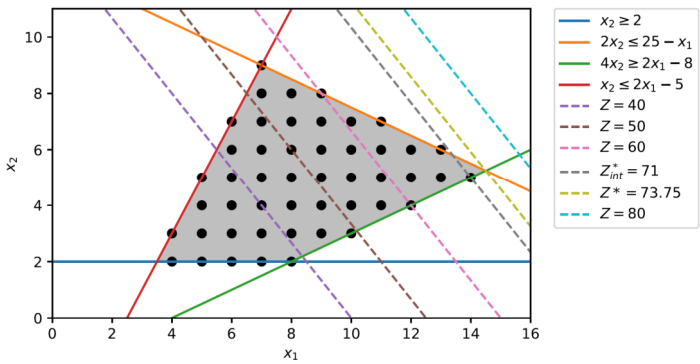
  Regression Analysis
  Experience with Solvers
  Game Theory

Agenda

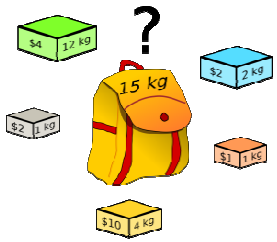
- Introduction ✓
- Personal Background ✓
- Goals of the Course & Grading ✓
- **Outlook: Solution Techniques and Problem Examples**

Week 2-3 – Linear (Integer) Programming

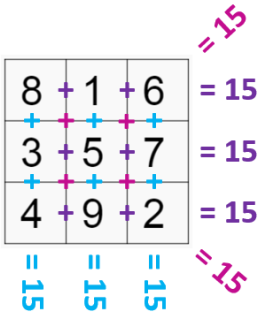
- $\max_{x_1, x_2 \geq 0} \vec{c}\,'\vec{x}$ s.t. $A \cdot \vec{x} \leq \vec{b}$



- Knapsack Problem



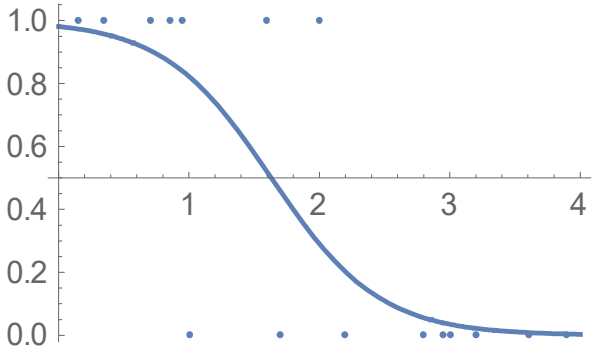
- Matrix Inversion



- Assignment Problems
- Data placement problems

Week 4 – Linear / Logistic Regression

- Least squares
- Maximum Likelihood



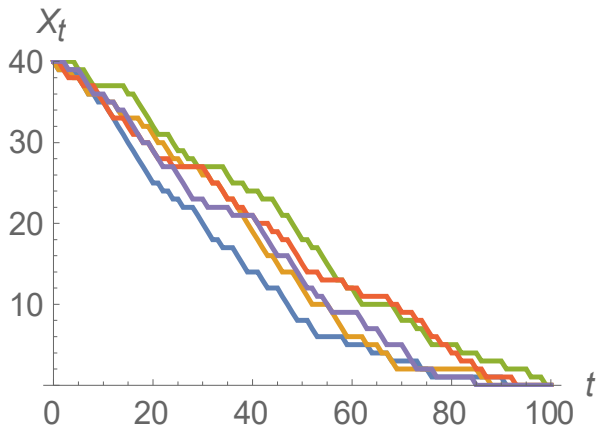
- Estimation of Conditional Probabilities
- Demand Learning on Online Marketplaces

Week 5-6 – Dynamic Programming

- How to control processes over time

- Plan decisions over time
- Consider state transitions

- Inventory Management
- Dynamic Pricing Competition



Week 7 – Choose Your Project

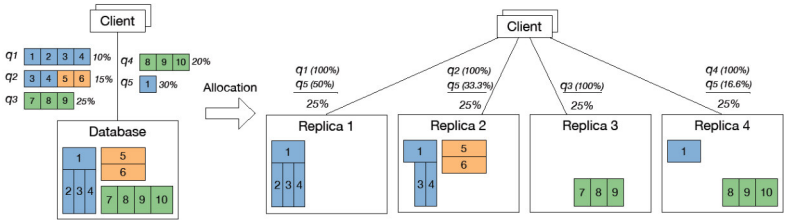
- Form teams of 2-3 students
- Potential projects:

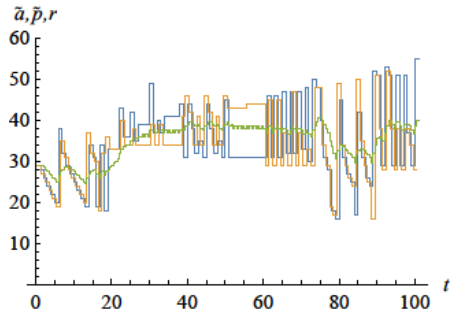
  Data placement problems

  Index Selection

  Dynamic Pricing

  Competition + Game Theory, . . .





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